International Journal of
Innovative Research

International Journal of Innovative Research, **7(3): 33-36, 2022**
ISSN 2520-5919 (online)
www.irsbd.org

SHORT COMMUNICATION

Production Potential of Solanaceous Vegetables in Hydroponic System

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ARTICLE HISTORY

Received: June 12, 2022
Revised : September 10, 2022
Accepted: December 22, 2022
Published: December 31, 2022

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ABSTRACT

Tomato and bell Pepper are the most important solanaceous vegetables grown widely all over the world. Now-a-days different vegetables especially tomato and lettuce are starting to grow hydroponically in Bangladesh. Use of sawdust as a hydroponic growing medium is a new concept and practiced in many countries of the world. However, there is little or no information of growing solanaceous vegetables in sawdust medium in Bangladesh. In the study, the effect of the use of sawdust as a growth medium on growth and yield of tomato and bell pepper was evaluated against the use of soil medium. The result of this study showed that all the growth parameters (percent survival, plant height, number of leaves, leaf length and leaf width, and number of fruits) in sawdust medium were delayed and less in number as compared to those planted on the soil. The highest germination percentage (tomato: 99.69%; bell pepper: 98.42%) were obtained from both the vegetables germinated with soil compared to cocopeat and sawdust. The plant height (tomato: 99.89cm; bell pepper: 18.63), leaf length and leaf width (tomato: 32.58cm; 8.20cm; bell pepper: 25.91cm; 8.58cm respectively), number of fruit plant^{-1} (tomato: 44.33; bell pepper: 6.67), of tomato and bell pepper were highest in soil compare to sawdust. However, sawdust is relatively inexpensive and readily available material for use in hydroponic culture. Therefore, sawdust can be used as an alternative growth medium in planting solanaceous vegetables for commercial production of the vegetables and need further studies on the use of mixture of sawdust and soil media for growing vegetables hydroponically.

Key words: Sawdust, hydroponic, cocopeat, tomato, bell pepper

Introduction

Solanaceous vegetables being a good source of different vitamins (vitamin C, A, E), thiamine, niacin, pyridoxine, folacin, minerals play a vital role in our diet and helps to cope with malnutrition (Dias 2011, Quebedeaux & Bliss, 1990). Among different members solanaceous vegetables tomato (*Lycopersicum esculentum* Mill) and bell pepper (*Capsicum annuum*) are the most important vegetables grown widely all over the world. Tomato is a rich source of lycopene, ascorbic acid, and beta-carotene and contain vitamin A, C and minerals and has multi-purpose application in fresh as well as processed food industries (Serio *et al*. 2006). Whereas, bell peppers contain vitamins C, K, carotenoids, flavonoids and capsaicinoids which aid to improve eye health and reduce risk of several chronic diseases and prevent anemia (Dias 2012). Out of worldwide 53% malnourished and underweight children about 40% live in Bangladesh. As the solanaceous vegetables especially tomato and bell pepper are rich in different vitamins and minerals their regular consumption can protect the human body from several types of chronic diseases.

Tomato is the most important and popular vegetable in Bangladesh. The area under vegetable cultivation in Bangladesh is limited of which tomato is cultivated under 13,069 ha with the production of about 74,000 m tons (Ferdous 2020). Without some summer varieties tomato is mainly cultivated in winter season. Therefore, the price of tomato is reasonable in winter but it goes up during rainy season due to heavy rain and flood and lack of raised and high land. Bell pepper is not widely cultivated due to scarcity of land and other socioeconomic problem in Bangladesh. The shortage of cultivable land together with natural disaster frequently affects the vegetable cultivation and ultimately affect the people life and causes food insecurity in the country. Hence, an alternative sustainable cultivation system for seasonal vegetables needs to be implemented for the year round production vegetables. Hydroponics/soil less culture is a promising tool in the vision of the general

challenge of food security in sustainable and environmental friendly agriculture system. Among different hydroponic cultures using sawdust offers a new way of cultivation and can be used for commercial production of vegetable. Sawdust is suitable for use as a growing medium and is affordable compared to imported growing media. Researchers have reported the favorable effect of organic growing media such as sawdust on plant growth and development (Tzortzakis & Economakis 2013, Maboko & Du Plooy 2013), as it increases the porosity and water retention of the growing medium (Marinou *et al*. 2013, Hardgrave & Harriman 1994). The present research has been designed to examine the suitability of sawdust as growing media in hydroponic system and to evaluate the growth performance of tomato and bell pepper on sawdust media against the use of soil media.

Materials and Methods

Soil, cocopeat and sawdust were used to germinate the tomato and bell pepper seeds. Seeds of tomato and bell pepper were planted in cube tray and paper sheet containing cocopeat, soil and sawdust at the rate of 3 seeds/cube which serves as a nursery stage. After 3-5 days, the germination percentages were recorded for the seeds (Fig. 1).

Fifty plastic pots were filled with sawdust. The base of the pots was perforated to ensure proper drainage of water and aeration. Before filling up into the pots the sawdust were first moistened with water to improve moisture condition and reduce transplant shock. Staking was done at the time of fruiting. Ten days old tomato and bell pepper seedlings were transplanted (3 seedlings/bucket) into plastic pots filled with sawdust as growing medium and 10 seedlings were planted on the soil to serve as control for each crop (Fig. 2).

Figure 1 Seeds of tomato and bell pepper germinated in soil, sawdust and cocopeat

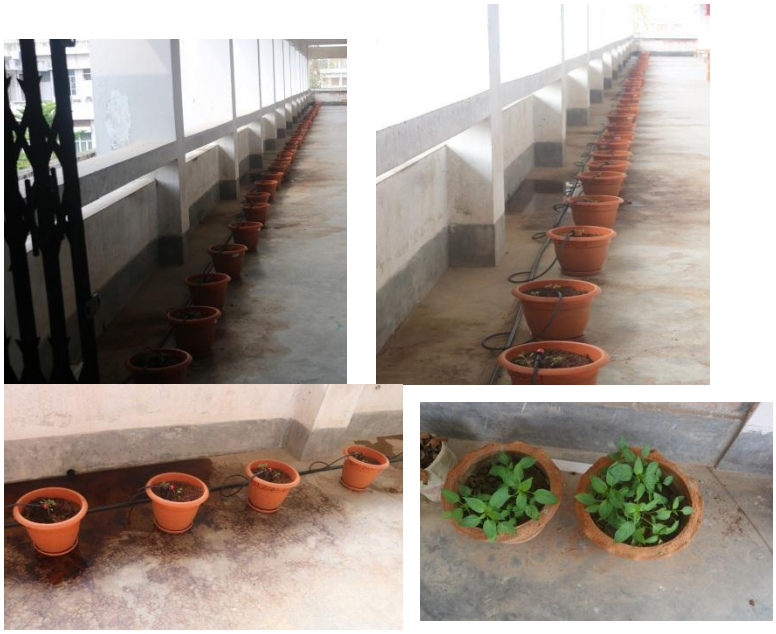

Figure 2 Transplanting the seedlings in plastic pots containing sawdust and soil

Fertigation: The plants were irrigated one times per day and the irrigation volume was gradually increased as plants were becoming larger, to ensure at least 5-10% of the applied water leached out from the pots to reduce salt build-up in the growing medium. The compositions of fertilizers used in media are: Hygroponic® (A: Monoamonic phosphate, Calcium nitrate, Potassium nitrate. B: $MgSO_4$, $CuSO_4$, $ZnSO_4$, $MnSO_4$, Boric acid, Ammonic Molybolate, $MgNO_3$, Iron chelate). Hydroponic solution A was prepared by diluting 2.5 ml of the chemicals in 1 litre of water while solution B was prepared by diluting 1 ml of the chemicals with 1 litre of water.

Plant height, number of leaves and stem diameter: The plant height and stem diameter of plants per pot & soil were recorded from one week to eight weeks after transplanting (WAT). A meter measuring tape was used to measure the plant height. The number of leaves of plants per pot & soil were also counted.

Leaf length and width: The leaf length and width of plants per pot & soil were measured and recorded from one week to eight weeks after transplanting.

Number of fruits and time of fruiting: The number of fruits per plant was counted and the time of fruiting was recorded under the two different media.

Data and Statistical Analysis: The mean and standard error of all the growth parameters were analyzed using Microsoft Excel, 2007. All the data regarding the growth parameters were plotted as a line graph using Microsoft Excel, 2007. One-way ANOVA were utilized to compare the mean of the growth parameters of two different media. Statistical analysis was performed using Minitab software.

Results and Discussion

Effect of different media on germination of tomato and bell pepper

Wood waste/sawdust is easily available in Bangladesh and commonly used in cooking purpose and as mulch for nursery crops. In different countries of the world sawdust is used as mulching material and as a substrate component for nursery stock for greenhouse vegetable production (Ehret & Helmer 2009). In order to reduce production costs and improve product quality on hydroponic we used sawdust as growing media. The seeds of tomato and bell pepper were germinated in cocopeat and found about 97% germination rate (Table 1, Table 2). Lower germination percentage (tomato: 76.12%; bell pepper: 72.12%) was observed in sawdust and when mixed it with cocopeat (tomato: 83.39%; bell pepper: 81.93%) indicating that cocopeat is preferable for germination of tomato and bell pepper than sawdust (Table 1, Table 2). Both the tomato and bell pepper germinated earlier (tomato: 9 days after seeding; bell pepper: 19 days after seeding) in soil compared the sawdust and cocopeat substrate (Table 1 & 2). Germination attributes of tomato and bell pepper is superior in soil compared to sawdust and cocopeat indicating that media composition may have some effect on germination characteristics of seed (Sawan & Eissa 1996).

Table 1 Effect of different media on germination of tomato

Germination media	Mean germination time (Days)	Germination%	Co-efficient of variation (CV)
Soil	9.73^{d}	99.690^{a}	0.41
Cocopeat	18.06^{a}	97.53^{a}	1.85
Mixture of cocopeat and sawdust	12.59^{c}	83.39^{b}	5.47
Sawdust	15.43^{b}	76.12^{b}	8.91
Significance level $\alpha = 0.05$			

N.B. Values followed by the same letter are not significantly different ($P < 0.05$), as per Tukey's pairwise comparisons.

Table 2 Effect of different media on germination of bell pepper

Germination media	Mean germination time (Days)	Germination%	Co-efficient of variation (CV)
Soil	19.67^{b}	98.42^{a}	1.06
Cocopeat	23.52^{a}	97.02^{a}	1.76
Mixture of cocopeat and sawdust	24.11^{a}	81.93^{b}	0.01
Sawdust	26.71^{a}	72.12^{c}	2.24
Significance level $\alpha = 0.05$			

N.B. Values followed by the same letter are not significantly different ($P < 0.05$), as per Tukey's pairwise comparisons.

Effect of sawdust on seedling growth and fruiting of tomato and bell pepper

The highest survival percentage of tomato and bell pepper seedlings was observed in soil (91.39% in tomato, 58.80% in bell pepper) followed by sawdust (60.08% in tomato, 42.53% in bell pepper) (Fig. 3, Fig. 4). Leaf length values also shows similar trend. Highest leaf length was observed in soil (25.58 cm in tomato, 12.91 cm in bell pepper) followed by sawdust (17.43 cm in tomato, 11.75 cm in bell pepper) (Fig. 3, Fig. 4).

Significant difference was observed between the two media (sawdust and soil) concerning the seedling length of tomato and bell pepper (Fig. 3, Fig. 4). The number of leaves differed significantly among the plants growing in sawdust and soil (Fig. 3, Fig. 4). The height of tomato and bell pepper seedling planted on soil was significantly higher than those planted on sawdust (Fig. 3 & 4). Significant differences in the values of leaf width were also observed in the plants of sawdust and soil. For tomato mean leaf width values were fluctuated between 22.20 cm in soil and 16.49 cm in sawdust (Fig. 3). For bell pepper mean width values varied between 6.63 cm in soil and 6.22 cm in saw dust (Fig. 4). The process of fruiting and fruit setting has shown significant difference in these two media for both tomato and bell pepper (Fig. 3, Fig. 4). The tomato planted on sawdust started fruiting at 9 WAT (week after transplanting) while in soil at 8 WAT. Similar trend was also observed in case of bell pepper fruiting. The plants on sawdust started fruiting at 12 WAT while in soil it was 10 WAT (Fig. 4). Variation was also found in number of fruits per plant between the two media. Fruit number increased about 25% in tomato and bell pepper plants grown in soil in comparison with plants grown in sawdust (Fig. 3 & 4).

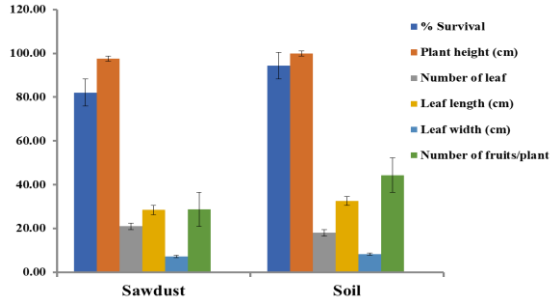

Figure 3 Effects of sawdust and soil media on the percent survival, plant height, number of leaves, leaf length and leaf width and number of fruits of tomato.

The startup costs to implement a hydroponic farm are usually higher than soil based farming. Therefore, it is important to develop technologies that lower the overall operation and startup cost and dependence on human labour. Locally available products like sawdust as hydroponic substrate is desirable and increasing concern since it can potentially reduce the overall production costs in hydroponic system and recycle the nutrients and thereby, would become a latest trend in hydroponic system. Several studies reported the favorable effect of sawdust on plant growth in hydroponic system (Marinou *et al*. 2013, Ehret & Helmer 2009, Sawan & Eissa 1995, Muro *et al*. 2004, Agboola *et al*. 2018). Sawdust is preferable and suitable growing media as compared to imported media. Positive physical properties such as high porosity, moderate drainage, acceptable biogradability rate, high water retention, low apparent specific gravity, high bacterial tolerance and moderate drainage enhanced the use of sawdust as substrate in hydroponic system (Maharani *et al*. 2010). In our study, sawdust was used as a substrate in planting tomato and bell pepper. However, all the growth parameters (germination, seedling growth characteristics and fruiting) were observed delayed and lower than those planted on soil. The reason might be due to the lack of soil microorganism which enriches the nutrient contents of soil.

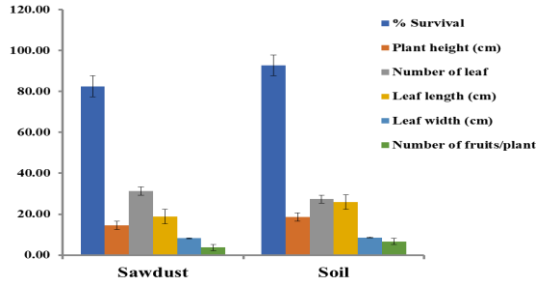

Figure 4 Effects of sawdust and soil media on the percent survival, plant height, number of leaves, leaf length and leaf width and number of fruits of bell pepper

Conclusion

The present study highlighted the use of sawdust as an alternative growth medium for tomato and bell pepper cultivation. Although the performance of plants grown on sawdust is not considerably better than the plants grown in soil. However, sawdust has great scope to use as a substrate for cultivation of vegetable crops throughout the country as well as throughout the year. Therefore, further research study is necessary for using the sawdust as an alternative media for hydroponically grown crops.

Competing interests

The authors declare that they have no competing interests.

Acknowledgments

This research work was supported by the Ministry of Science & Technology (MOST), Bangladesh for Special Allocation Project for the Year 2020-2021.

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