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# EVALUATION OF SOILLESS STRAWBERRY (*FRAGARIA ANANASSA* DUCH.) CULTIVATION USING ALTERNATIVE GROWING DEVICES

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**Abstract**

The effect of different growing systems containing soilless media and the traditional system of field cultivation was evaluated for the yield and quality of strawberry. *In vitro* propagated strawberry plants (RABI-3) were grown in the combined compost media of water hyacinth and vermin compost in a ratio of 4:1 in five growing systems *viz.* field (control), gunny mat (horizontal), gunny bag (vertical), earthen pot and PVC pipe. The result indicated that the growing systems showed highly significant differences for fruit characteristics but less difference for leaf characteristics. Among the treatments, horizontal system performed the best in case of leaves plant$^{-1}$ (18.78) at flowering, fruits plant$^{-1}$ (9.89) and fruit length (28.79 mm) while the maximum fruit diameter (27.27 mm) and fruit weight (24.92 g) were recorded in vertical system. The fruit number in vertical system (8.00) and in earthen pot (8.00) were similar, but the fruit quality (i.e. fruit length, fruit diameter, fruit weight etc.) was found improved in vertical system, although the differences were just numerical. Plants grown in PVC pipe system had showed poor results. The horizontal system gave maximum fruit yield (235.44 g) and minimum fruit yield (12.09 g) was obtained from field. The traditional system of field cultivation gave significantly the most inferior results regarding all the parameters under study. The present findings, therefore, support that both horizontal and vertical systems may be practiced for good production of soilless strawberry cultivation.

**Key words:** Strawberry, soilless culture systems, yields.

## Introduction

Strawberry (*Fragaria ananassa* Duch.), belonging to the family Rosaceae, is one of the most delicious fruits of the world. It is an excellent source of antioxidant, vitamin C and manganese together with a very good source of dietary fiber, iodine, copper, potassium, biotin, phosphorus, magnesium, vitamin $B_6$, omega-3 fatty acids and sugar having a delicate flavor (Sharma and Sharma, 2004; Finn and Strik, 2008). The fruits are eaten fresh as it is tasty and nutritious or may be used in making ice-cream, jam and other processed products. The strawberries are native to North America and its cultivation was started in Europe in early 18$^{th}$ century (Ayesha *et al.*, 2011). It is a fruit of temperate regions but it can be grown even in tropical as well as in subtropical regions. The area of strawberry cultivation in the sub-continent is increasing rapidly (Paul *et al.,* 2017). It can be grown in a wide range of soil but sandy to sandy loam soil is most suitable with a pH range of 4.6-6.5 (Milosevic, 1997).

In Bangladesh strawberry has became very popular. It was not grown in large quantities few years back but with gradual increase in demand for table dishes as well as for industrial processing, a

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considerable number of growers have now taken up this activity. Strawberries have been introduced in Bangladesh over a decade ago and are getting popularity because of huge economic benefit. According to Bangladesh Strawberry Association, around 1043.63 ha of land have been brought under strawberry cultivation throughout the country in 2016 (Firoz, 2016). Rajshahi district is ahead of other districts in strawberry farming. The fruits are supplied to different markets across the country and now, a large number of people, mostly unemployed youths, have become attracted to strawberry farming to earn their livings, as its cultivation is easier and more profitable than other crops (Mondal, 2016).

Professor Manzur Hossain of Rajshahi University is the pioneer of strawberry cultivation in Bangladesh (Firoz, 2016). There is a great possibility of strawberry production in Bangladesh. Though strawberry is cultivated mainly in the northern region of the country but the farmers of the southern regions are showing interest for the cultivation of this delicious fruit. There are a number of problems of strawberry cultivation in southern regions of the country. The main season of strawberry cultivation in Bangladesh is October to April (Ahmed and Uddin, 2012). Strawberries are usually planted in the field in October to November. But at that time, harvesting of *Aman* rice is not completed and after harvesting of rice, soil moisture remains high that makes it difficult to prepare soil for strawberry cultivation in most areas of southern Bangladesh. In this situation, soilless cultivation system may be an alternative technique for this region. Hydroponic, aeroponics, air-dynaponics, organic culture etc. are the alternatives to soil for strawberry cultivation but these systems are costlier. At present rooftop gardening is being popular in Bangladesh. Rarely it could be found a single building in any city of Bangladesh without rooftop gardening. Strawberry is an expensive and important fruit. People can make their won organic substances with kitchen waste and other household materials that may allow rooftop soilless organic farming of strawberry.

Organic substrates significantly affect the growth, yield and other qualitative parameters of strawberry. Rather than the conventional cultivation in soil, organic substrates are the main part of the planting system of strawberry (Ayesha *et al*., 2011). The most commonly used organic substrates for strawberry cultivation are gravel, sand, peat, vermiculite, perlite, coco-peat etc. (Celikel, 1999). Vegetative growth, yield and other qualitative parameters of strawberry can be improved with the use of organic substrates compared to soil or with addition (Ercisli *et al*., 2005, Ebrahimi *et al*., 2012 and Marinou *et al*., 2013). Vermi-compost provides an advantageous effect on the growth and yield of strawberry (Arancon *et al*., 2004). Strawberry grown in combination of coco-peat, perlite and vermi-compost on earthen pot produces the highest shoot length (Godara and Sharma, 2016). Perlite performs best in growing container i.e. bag on gutter and bag on ground in case of growth and yield of strawberry (Cantliffe *et al*., 2007).

Organic substrates i.e. water hyacinth, cow-dung, vermi-compost, coco-dust, rice husk, straw, saw dust, leaf peat etc. available in the locality may be suitable alternatives to soil for strawberry cultivation. It is easy to prepare organic growing media with minimum cost within a short time. Just after decomposing, these organic substrates could become effective growing medium that facilitates anchorage the root system, better root space, minerals supply, moisture holding capacity, gaseous exchange of $CO_2$ and $O_2$ for respiration, proper growth and development of plants. Considering the above situations, a study was undertaken to evaluate the performance of different growing media and different devices for growth and fruit yield of RABI-3 strawberry.

## Materials and Method

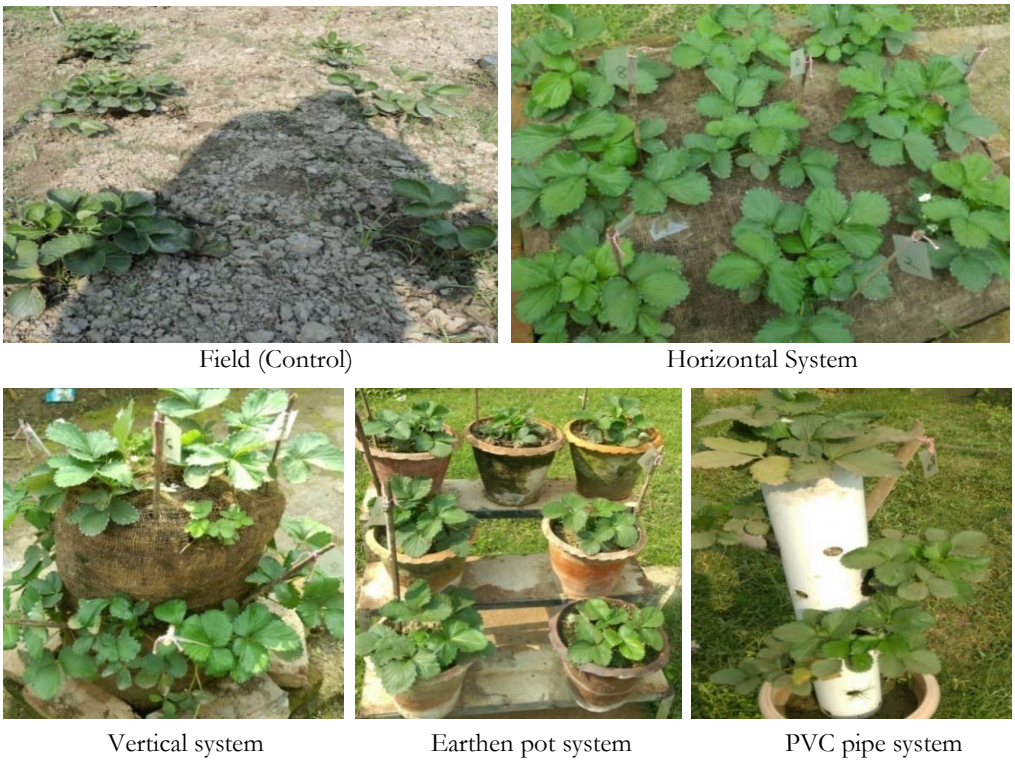
The experiment was carried out at the field of Agrotechnology Discipline, Khulna University (lat. 22°79'88" E, long. 89°53'44" N and elevation: 18 m) of Bangladesh during November 2017 to March 2018. The environmental conditions that prevailed during the cropping season were: temperature

maximum 30.67 °C and minimum 20.5 °C with a mean of 25 °C; mean precipitation 12.75 mm month$^{-1}$, mean wind speed 7.42 kmh$^{-1}$, relative humidity 45.83%; mean sun hours per day 8.02 and mean UV index 6.67.

***Source of strawberry plant:*** The variety used in the study was RABI-3 Strawberry. *In vitro* micropropagated plantlets of RABI-3 Strawberry were collected from Plant Breeding and Biotechnology Laboratory of Agrotechnology Discipline.

***Preparation of growing medium:*** Water hyacinth compost and vermi-compost were manually mixed in the ratio of 4:1. These mixed organic substrates were stuffed in the devices for strawberry growing.

***Experimental treatments:*** Different growing devices *viz.* horizontal (gunny mat), vertical (gunny bag), earthen pot (12 inches regular) and vertical column (1.5 m) made from PVC (Polyvinyl Chloride) pipe (3 inch) were used as experimental treatments. Traditional cultivation system (in field) was considered as control.



Field (Control) Horizontal System

Vertical system Earthen pot system PVC pipe system

Fig. 1. Pictorial view of the treatments considered in the experiment

***Planting:*** Micro propagated strawberry plantlets of about 3.5 to 4.0 cm long at 4-5 leaf stage were planted in different growing system in the first week of November 2017. About 8-10cm diameter hole in 18-20 inch apart were made in each system and a plantlet per hole was planted manually. In each system, there were nine plants with three replications i.e. each replication contained three plants. For better root growth, the plantlets were treated with 50 mgL$^{-1}$ NAA before transplanting. The plantlets were planted in row maintaining 30 cm plant to plant and 30 cm row to row distance. A light irrigation was applied just after planting the plantlets.

***Intercultural operations:*** Irrigation: Irrigation (traditional system) was adjusted with the requirement of the plants.

***Runner removal:*** Strawberries tend to reproduce through runners. As runners reduce yield, they were removed continuously as and when appeared.

***Weeding:*** Weeds and dead leaves were removed periodically along with runner removal to avoid competition and maintain clean cultivation, respectively.

***Foliar spray:*** Urea, triple super phosphate (TSP) and muriate of potash (MoP) @ 20 g in each was dissolved in 4L water, and then 1L was taken and mixed with 10L water. That solution was sprayed over the plants for three times *viz.* at vegetative, flowering and fruiting stage.

***Plant protection:*** At early vegetative stage, spraying with Dithane M-45 @ 1 $gL^{-1}$ of water was used to protect the plants from stem end rot disease caused by *Gnomonia comari*.

***Harvesting:*** Ripe berries were harvested at 2 to 3 day intervals. Fruits with 60-70% reddish pink color were harvested in poly bag. Fruit harvesting commenced on January and continued till mid March 2018.

Fig. 2. Fruits of RABI-3 strawberry at harvesting stage

***Data collection:*** To determine the effects of different growing systems on strawberry production, data on leaf number at flowering $plant^{-1}$, leaf area, number of fruits $plant^{-1}$, fruit size and fresh weight of fruit were recorded. Four leaves from each plant were selected randomly and leaf length and diameter were measured in millimeter by using a scale. Leaf number of each plant was counted manually. Fruit number was recorded at the time of harvest. Five berries of each plant were selected randomly for measuring fruit length, diameter and weight. Length and diameter of the fruits were measured in millimeter by using a slide calipers and fruit weight in milligram by using an electronic balance.

***Experimental design and data analysis:*** The experiment was laid out in a Completely Randomized Design (CRD) with five treatments and three replications. The collected data were analyzed statistically for analysis of variance (ANOVA) by using the computer package program- Statistical Tool for Agricultural Research (STAR). Differences among the treatment means were compared by using Duncan's New Multiple Range Test (DMRT) (Gomez and Gomez, 1984).

**Results and Discussion**

The study was conducted to evaluate the performance of different growing systems in foliar growth and fruit yield of strawberry. The results reveal that growing systems had variable effects on leaf and

fruit characters of strawberry. Leaf number at flowering differed significantly, but in case of leaf area (leaf length and leaf diameter) there was no significant differences among the treatment means (Table 1).

Table 1. Effect of different growing systems on leaf attributes of RABI-3 strawberry at flowering

| Treatments | Leaves plant$^{-1}$ | Leaf length (cm) | Leaf diameter (cm) |
|---|---|---|---|
| Field (control) | 08.89 b | 7.35 | 5.63 |
| Horizontal (gunny mat) | 18.78 a | 7.10 | 5.61 |
| Vertical (gunny bag) | 11.33 b | 7.83 | 6.02 |
| Earthen pot | 09.67 b | 7.15 | 5.55 |
| PVC pipe | 08.11 b | 6.69 | 5.19 |
| Level of significance | ** | NS | NS |
| CV (%) | 23.57 | 20.08 | 17.20 |

**= Significant at 1% level of significance (P≤0.01), NS = Not significant, CV = Co -efficient of variance. Data in a column followed by same letter are not significantly different as per DMRT.

The maximum (18.78) number of leaves plant$^{-1}$ was obtained from horizontal system and that was minimum (08.11) from PVC pipe system. Plants growing in earthen pot and PVC pipe system had poor performance both in respect of leaf number and leaf area (Table 1). Hassan *et al.* (2011) also found no significant differences in leaf number and leaf area of strawberry grown in black poly bags and white plastic containers.

The different growing systems had significant effects on fruit size and fruit weight (Table 2). Among the systems, horizontal and vertical systems provided more advantageous results for both yield and fruit plant$^{-1}$. Maximum (9.89) and minimum (1.32) number of fruits were obtained from the horizontal and PVC pipe systems, respectively. There was also a highly significant difference in weight of fruit for the treatments. Vertical system produced maximum (24.92 g) fruit weight and that of minimum (9.31 g) was recorded from the field (control) (Table 2).

Table 2. Effect of different growing systems on fruit yield and yield attributes of RABI-3 strawberry

| Treatments | Fruit plant$^{-1}$ | Fruit length (mm) | Fruit diameter (mm) | Weight fruit$^{-1}$ (g) | Fruit yield plant$^{-1}$ (g) |
|---|---|---|---|---|---|
| Field (control) | 1.32 c | 25.43 b | 09.65 b | 09.31 b | 12.09 c |
| Horizontal (gunny mat) | 9.89 a | 28.79 a | 26.84 a | 22.60 a | 235.44 a |
| Vertical (gunny bag) | 8.00 ab | 28.20 a | 27.27 a | 24.92 a | 198.38 a |
| Earthen pot | 8.00 ab | 26.92 ab | 22.74 a | 21.39 a | 178.55 ab |
| PVC pipe | 3.56 bc | 24.70 b | 14.14 b | 12.67 b | 48.61 bc |
| Level of significance | ** | ** | ** | ** | ** |
| CV (%) | 38.39 | 17.59 | 21.18 | 21.08 | 26.66 |

**= Significant at 1% level of significance (P≤0.01), CV = Co-efficient of variance. Data in a column followed by same letter(s) are not significantly different as per DMRT.

Horizontal, vertical and earthen pot systems showed no significant differences in fruit characteristics (fruit length, fruit diameter and fruit weight). Numerically horizontal system produced more fruits

(9.89) but the highest fruit weight (24.92 g) was obtained from vertical system. In horizontal system, plants gave maximum fruit yield (235.44 g) followed by vertical system, whereas plants grown in field produced minimum fruit yield (12.09 g) followed by PVC system (48.61 g). Cantliffe (2007) observed that bag on gutter and bag on ground performed best in yield, crown size and leaf area of strawberry.

Among the five treatments, the best results for leaf and fruit characters were obtained from the horizontal system followed by vertical system. Salame and Santos (2012) found no significant effect between horizontal and vertical systems in case of early fruiting, total fruit number and average fruit weight of strawberry.

The increased yield of horizontal and vertical systems was related to the leaf number and leaf area of the plants. The leaf number and leaf area had significant effect on fruit number, fruit size and fruit weight. Leaf number and leaf area had a positive correlation with fruit characteristics (fruit number, fruit length and fruit diameter) of strawberry (Figure 3).

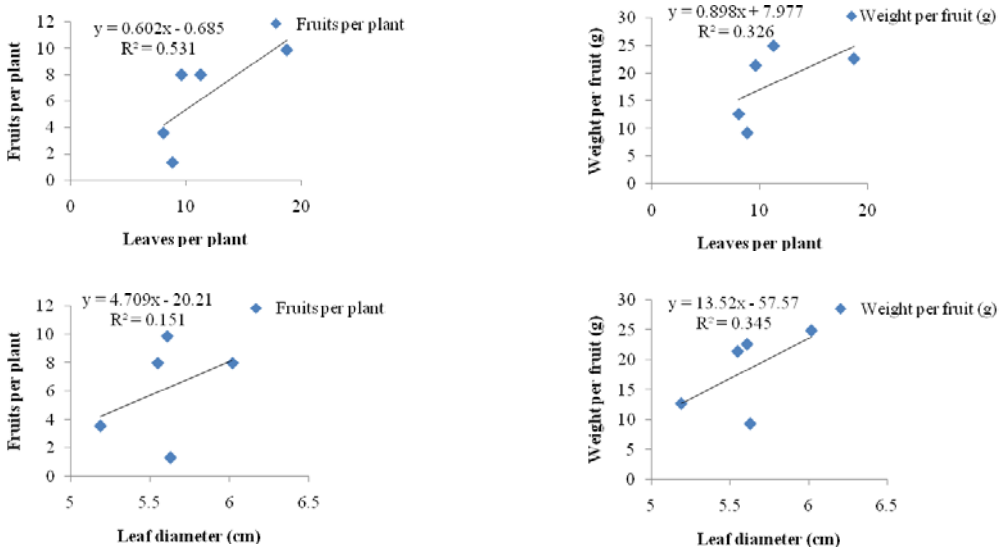



Fig. 3. Functional relationship between leaf characters with fruit characters of RABI-3 strawberry

In horizontal system, though the fruit number was high but fruit weight was less. This may be due to excess vegetative growth (leaf number) which may be responsible to reduce the source sink ratio. Performance of other treatments i.e., field (control), earthen pot and PVC pipe on leaf and yield of strawberry were poor compared to the horizontal and vertical system. Plants growing in earthen pot had an adverse effect on leaf (causes leaf scorching) and fruit quality. PVC pipe showed an extreme adverse effect on leaf number, leaf area, fruit number, fruit quality (fruit size, fruit texture, fruit structure) and average yield. Hesami and Khorami (2012) also observed that high leaf area in strawberry produced more flower and fruit, and finally increase yield.

## Conclusion

Horizontal gunny mat and vertical gunny bag system appeared to be suitable for strawberry production. Horizontal gunny mat and vertical gunny bag produced maximum number of leaf and there were significant differences among the systems. The highest leaf length and leaf diameter were higher in vertical system and that of lower from PVC pipe system. Horizontal system produced

maximum fruits and that of fruit length from horizontal gunny mat but maximum fruit diameter and fruit weight from vertical gunny bag. Horizontal and vertical systems had been proven better for soilless strawberry cultivation.

Instead of being an exotic fruit, popularity of strawberry in Bangladesh is increasing day by day due to its deliciousness, sweet flavor, nutritional value and nice appearance. In this situation, soilless cultivation system can able to open a new era of strawberry cultivation in Bangladesh. It can play an important role to meet the malnutrition problem of our huge population and can create employment opportunities for a number of unemployed people. It may create an opportunity for strawberry cultivation in small scale in homestead gardens, balconies, rooftop gardens and so on.

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