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Yield and quality of polyhouse grown strawberries as affected by soilless media and jeevamrit

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Abstract
Strawberry (*Fragaria* x *ananassa* Duch.) is an important small-fruit crop, belonging to the family Rosaceae. It is best grown under protected conditions but in Himachal Pradesh, it is mostly grown in open field conditions using soil as a growing media which invariably leads to many problems related to soil borne pests, diseases, nematodes and other soil limiting factors resulting in poor quality planting material thereby yielding poor quality fruits. Hence the present investigations was carried out at the Horticultural Research & Training Station and Krishi Vigyan Kendra, (HRTS & KVK) Kandaghat, Solan (H.P.), India during the cropping seasons of 2018-19 to study the effect of soilless substrates and jeevamrit on yield and quality of starawberry. The experiment comprised of six treatments viz. cocopeat (50%) + FYM (50%) + jeevamrit; perlite (50%) + FYM (50%) + jeevamrit; cocopeat (50%) + perlite (50%) + jeevamrit; perlite (75%) + cocopeat 25%) + jeevamrit; soil (50%) + FYM (50%) + jeevamrit and soil + FYM as control with four replications. The results revealed that perlite (75%) + cocopeat (25%) + jeevamrit resulted in the maximum berry yield, size, weight, total soluble solids and sugars as compared to control. Based on the results obtained, perlite (75%) + cocopeat (25%) + jeevamrit can be successfully used for the production of good quality strawberry under polyhouse.

Keywords: Strawberry, soilless substrates, perlite, cocopeat, Jeevamrit**,** berry yield, fruit quality

Introduction
Strawberry (*Fragaria* x *ananassa* Duch) is one of the most popular small fruits in the world which is mostly grown under protective structures. In India, such a system of strawberry cultivation is becoming quite popular, particularly in the Western and Southern parts of the country and is being grown over an area of 1000 hectares with an annual production of 5000 MT (Anonymous 2017a) [6] wherein, Haryana is the leading producer (1650 MT) followed by Mizoram (1080 MT), Meghalaya, Maharashtra and Himachal Pradesh (Anonymous, 2019) [8]. In Himachal Pradesh, the agro-climatic conditions are congenial for strawberry production and has a high potential of being a remunerative crop, but its cultivation has spread over an area of only 55 hectares with an annual production of 559 MT (Anonymous, 2017b) [7] mainly due to the fact that it is mostly grown in open field conditions using soil as a growing media which invariably leads to many problems related to soil borne pests, diseases, nematodes and other soil limiting factors resulting in poor quality planting material thereby yielding poor quality fruits. In the recent past, the use of soilless growing media is gaining popularity as they are mostly free from soil borne diseases, pests and nematodes (Tehranifar *et al.* 2007) [25] and prevents problems such as drainage, poor structure, salt accumulation and soil fumigation (Vassilakakis *et al.* 1991) [29], thereby resulting in better vegetative growth parameters, number of fruits and yield of good quality strawberry fruits (Adak and Gubbuk, 2015; Shylla *et al.* 2018) [2, 24]. Further, the use of conventional farm based products like jeevamrit, beejamrut, panchagavya, etc. are also gaining popularity, because, apart from enriching the soil with indigenous microorganisms, they are also known to decrease the incidence of diseases in many crops (Amareswari and Sujathamma, 2014) [4]. Hence, the present investigation was carried out with the objective to study the effect of soilless substrate combinations and jeevamrit on yield and fruit quality of strawberry under protected conditions.

Materials and Methods

The present study was carried out during the cropping seasons of 2018-19 in a naturally ventilated polyhouse, equipped with sprinkler and drip irrigation system and located at the Horticultural Research & Training Station and Krishi Vigyan Kendra (HRTS & KVK) Kandaghat, Solan (H.P.). Uniform runners of strawberry cv. Chandler were selected and planted in October 2018 within the polyhouse at a distance of 20 cm x 20 cm in 1m x1m beds filled with six different growing media combinations viz. T_1: Cocopeat (50%) + FYM (50%) + jeevamrit; T_2: Perlite (50%) + FYM (50%) + jeevamrit; T_3: Cocopeat (50%) + perlite (50%) + jeevamrit; T_4: Perlite (75%) + cocopeat 25%)+ jeevamrit; T_5: Soil (50%) + FYM (50%)+ jeevamrit; T_6: Soil + FYM as control with four replications. The media were filled in beds of twelve inches depth lined with perforated black polythene sheet. The plants were irrigated at 1-2 days' interval through micro sprinkler irrigation during the initial stages and through drip irrigation during fruiting stages while recommended dose of fertilizers were applied through fertigation using soluble fertilizers. Jeevamrit prepared as per procedure suggested by Devakumar *et al.* (2014) [11] was applied at the rate of 5 per cent (5 L per 100 L of water) as foliar spray, at 30 days' interval (Acharya D, 2017) [1]. All plants were given uniform cultural practices during the course of investigations.

Results and Discussion

A perusal of data presented in Table 1 reveal that all treatments exerted a positive influence on berry yield, size and weight of strawberry. The maximum berry yield of 210.09 g per plant was observed under perlite (75%) + cocopeat (25%) + jeevamrit treatment, followed by perlite (50%)+ FYM (50%) + jeevamrit. However, minimum berry yield per plant (181.33 g) was recorded under soil + FYM treatment. Similarly, the maximum yield per hectare (42.01 t/ha) was obtained when plants were grown in perlite (75%) + cocopeat (25%) + jeevamrit treatment, which was found to be statistically at par with perlite (50%) + FYM (50%) + jeevamrit and cocopeat (50%) + perlite (50%) + jevamrit. Whereas, minimum yield per hectare (36.26 t/ha) was observed under soil + FYM treatment. Similar results of increased yield in perlite and its mixtures have been reported in Sweet Charlie strawberry (Cantliffe *et al*. 2008) [10]; Camarosa strawberry (Hochmuth, 2008) [17] and Chandler strawberry (Thakur and Shylla, 2018a) [26]. The increase in berry yield may be attributed to better nutrient uptake as a result of better root system that may have developed due to improved soil environment under perlite and its mixtures. These are in line with the findings of Verdonck and Demeyer, 2004 [30]; Ghazvani *et al.* 2007 [14]; Albaho *et al*. 2009 [3]; Jafarnia *et al.* 2010 [19]; Hassan *et al*. 2011 [16] and Shylla *et al*. 2018 [24]. Application of liquid organic manures i.e. jeevamrit may have also helped in improving growth and yield (Gore, 2009) [15]. Jeevamrit which acts as a tonic may have also helped in improving soil health (Vasanth Kumar, 2006) [28].

The data also indicates that the berry size in terms of both berry length and breadth was highest (40 mm and 26.55 mm respectively) in plants grown under perlite (75%) + cocopeat (25%) + jeevamrit treatment which was statistically different from all other treatments, whereas, the lowest berry length and breadth (32.75 mm and 19.95 mm respectively) was obtained under soil + FYM treatment. The good physical conditions, moisture holding capacity and aeration properties of perlite as a medium may have improved the growth and vigour of the plants which possibly increased photosynthesis and translocation of assimilates in the berries (Younis *et al*. 2015; Thakur and Shylla, 2018b) [31, 27]. These results are in accordance with the findings of Fornes *et al.* (2003) [13] and Ayesha *et al.* (2011) [9], who also found that perlite with manure based medium increased the berry size in strawberry and they had attributed to the ability of this medium to provide essential micro nutrients to the plants.

The data pertaining to berry volume and weight (Table 1) also exhibited significant differences among different treatments. It is clear from the data that the maximum berry volume (25 cc) and heaviest berry weight (18.59g) was recorded under perlite (75%) + cocopeat (25%) + jeevamrit treatment, which was statistically at par with perlite (50%) + FYM (50%) + jeevamrit treatment whereas, the minimum berry volume (19.56 cc) and lightest berry weight (11.55 g) was observed under soil + FYM treatment.

These results are in congruence with the findings of Linardakis and Manios (1991) [21] who reported the highest yield and fruit weight when plants were grown in peat + perlite medium. Similar results were also reported by Paraskevopoulou *et al.* (1995) [22] who obtained maximum yield and berry weight in Selva cultivar of strawberry when grown in soilless mixture as compared to normal soil solution. Joshi (2003) [20] also observed an increase in berry volume of strawberry when perlite mixtures were used as growing media and reported that it may be due to better growing conditions that might have improved the growth and vigor of plants, possibly resulting in an increased translocation of assimilates in the berries.

Table 1: Effect of different soilless substrates and jeevamrit on yield per plant, yield per hectare, berry length, berry breadth, berry volume and berry weight, in strawberry cv. Chandler**.**

Treatments	Yield/plant (g)	Yield/ha (t/ha)	Berry length (mm)	Berry breadth (mm)	Berry volume (cc)	Berry weight (g)
T_1	201.62	40.32	35.10	21.87	21.06	15.22
T_2	207.92	41.58	38.19	24.34	23.72	16.87
T_3	205.39	41.09	36.25	22.03	22.27	15.66
T_4	210.09	42.01	40.00	26.55	25.00	18.59
T_5	187.26	37.45	33.58	20.84	20.12	14.52
T_6	181.33	36.26	32.75	19.95	19.56	11.55
$CD_{0.05}$	2.85	1.591	1.42	2.17	1.94	1.40

All the treatments of growing media had a significant effect on berry chemical characteristics in comparison to control. It is apparent from the data given in Table 2 that the total soluble solids of the berries in the present studies were the highest (11.15°B) under perlite (75%) + cocopeat (25%) + jeevamrit treatment and it was statistically different from all other treatments which may be due to the ability of the media to improve nutrient availability. The lowest total soluble solid contents of (8.66°B) was recorded in the berries of the plants grown in soil + FYM. These findings in the present studies are in congruence with that of Ghazvani *et al*. (2007) [14] who recorded the highest total soluble solids in mixture of perlite

medium than perlite alone. Similarly, Jafarnia *et al.* (2010) [19] as well as Thakur and Shylla (2018b) [27] reported significantly higher percentage of total soluble solids when plants were grown in mixture of perlite.

When the influence of different soilless substrates and jeevamrit on titratable acidity were studied, it was observed that, there was very little difference among the treatments. However, soil + FYM treatment recorded the highest titratable acidity (0.73 per cent) while perlite (75%) + cocopeat (25%) + jeevamrit treatment recorded the lowest titratable acidity (0.68 per cent) though it was statistically at par with perlite (50%) + FYM (50%) + jeevamrit treatment and cocopeat (50%) + perlite (50%) + jeevamrit treatment.

Lesser breakdown of metabolites in fruits grown in soil + FYM may have resulted in a higher content of titratable acidity and according to Sharma (2015) [23] it is due to the fact that, the strawberries grown in soil required a longer period to reach harvesting stage as compared to those grown in soilless growing media. These results are also in line with the findings of Hassan *et al.* (2011) [16] who reported higher acidic fruits when grown in soil and lower acidic fruits when grown in other media like coconut coir. Contrary to this, Fernandez *et al.* (2004) [12] did not find any significant difference as far as values of acidity in fruits are concerned when grown with or without soil.

On examining the data presented in Table 2, it is apparent that the total sugars, reducing sugars and non-reducing sugars were highest under perlite (75%) + cocopeat (25%) + jeevamrit treatment though they were statistically at par with perlite (50%) + FYM (50%) + jeevamrit treatment. The lowest total sugars, reducing sugars and non reducing sugars were recorded under soil + FYM treatment which were statistically different from all other treatments.

Based on the observations recorded during the present investigation, the total soluble solids and sugars increased significantly under different combinations of soilless substrates and jeevamrit. The increased total soluble solids and sugars in fruits could be attributed to the increased leaf area, which in turn might have favored photosynthetic rate, translocation and accumulation of sugars and metabolites in fruits under soilless culture. Similar results were obtained by Inden and Torres (2004) [18] Jafarnia *et al.* (2010) [19], Ayesha *et al*. (2011) [9], Ameri *et al.* (2012) [5] and Shylla *et al.* (2018) [24]. Who reported maximum total soluble solids and better taste, when strawberry was grown in various combinations of substrate as compared to soil.

Table 2: Effect of different soilless substrates and jeevamrit on total soluble solids, titratable acidity, total sugars, reducing sugars and non - reducing sugars in strawberry cv. Chandler.

Treatments	Total soluble solids (°B)	Titratable acidity (%)	Total sugars (%)	Reducing sugars (%)	Non-reducing sugar (%)
T_1	9. 60	0.71	8.02	6.00	1.80
T_2	10.13	0.69	8.30	6.13	1.89
T_3	9.77	0.70	8.09	6.12	1.86
T_4	11.15	0.68	8.85	6.54	1.94
T_5	9.11	0.72	7.78	5.82	1.72
T_6	8.66	0.73	7.34	5.76	1.70
$CD_{0.05}$	0.63	0.02	0.54	0.29	0.06

Fig 1: Fruiting under perlite (50%) + FYM (50%) + Jeevamrit

Fig 2: Fruiting under perlite (75%) + cocopeat (25%) + Jeevamrit

Fig 3: Fruiting under soil (50%) + FYM (50%)

Fig 4: Fruits under perlite (75%) + cocopeat (25%) + Jeevamrit

Fig 5: Layout of Experimental Area

Conclusion

On the basis of the results obtained in the present course of investigation, it can be concluded that perlite (75%) + cocopeat (25%) + jeevamrit@ 5 per cent can be successfully used for better yield of good quality strawberry under polyhouse conditions.

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