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Effect of organic substrates on productivity and quality of strawberry, cv Chandler

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Abstract
An experiment entitled "Effect of organic substrates on growth, yield and quality of strawberry, cv Chandler" was carried out in the polyhouse at the Division of Fruit Science SKUAST-K during the year 2021-22. The investigation involved 07 treatment combinations laid out in randomized complete block design (RCBD), having three (3) replications. All organic substrates significantly increased fruit length, fruit diameter, berry set, No. of berries/plant, Total plant yield, TSS, Acidity, Anthocyanin and fruit weight except T_1 (Control). The maximum fruit length (3.05 cm), fruit diameter (2.42 cm), Berry set (91.92%), number of berries per plant (21.95), yield (198.80 g/plant) and fruit weight (9.06 g/plant) was recorded from the plants grown on substrate T_5 (15 kgs FYM +7.5 kgs VC+ biofertilizers), whereas, minimum fruit length (2.32 cm), fruit diameter (2.15 cm), berry set (84.05%), number of berries per plant (16.66), yield (125.51g/plant), and fruit weight (7.53 g/plant) was recorded in T_1 (Control). Hence from current study it can be concluded that combination of FYM+VC+Biofertilizers proved to be the best for organic production of strawberry in passively ventilated greenhouse conditions.

Keywords: Strawberry, chandler, organic substrates, growth, yield

Introduction
Strawberry is a fruit plant of temperate climate, but it is successfully grown in a broad range of climates including temperate, Mediterranean, and subtropical (Hancock and Erez., 2000) [2]. It is the most important berry fruit and globally produced in twice the amount of all other berry crops combined (Liston *et al*., 2014) [8]. Strawberries are not only high in the nutrient content, vitamin C and folate, but are also rich in phenolic compounds, including anthocyanins, tannins, and phenolic acids and have several health benefits (Giampieri *et al*., 2012) [2]. In India, temperate regions of Jammu & Kashmir, Himachal Pradesh and Uttarakhand have been known for strawberry cultivation, but in the recent decades, there has been a phenomenal increase in area and production of strawberry in North-Eastern regions, and pockets of subtropical plains of India. In India, it is cultivated over 1,000 ha with a total production of 5,000 MT, where Mizoram has emerged the leading producer of strawberry, with the production of 2900 MT from an area of 150 hectares followed by Meghalaya (0.11 ha area and 0.82 Thousand Tonne production), while Jammu and Kashmir ranks 5th with a total production of 2803 MT harvested from 145 ha area (Anonymous, 2019-20) [1]. While analyzing the area and production data of 2016-17, it is a matter of concern that the productivity of strawberry in J&K is about 30 per cent lower as compared with those in Himachal Pradesh. The strawberry (*Fragaria* × *ananassa*) is considered the most economically important berry worldwide (Hummer and Hancock 2009) [4]. The fruits are highly perishable and thus have limitations in long distance transport in conventional systems of fruit growing.
Strawberry being a shallow rooted plant needs effective nutrient management. The soil acts as a reservoir to retain nutrients and water, and also provides physical support for the root system. Organic farming is very healthy and remunerative practice in strawberry production. It not only improves the quality of fruits but also provide sustainability in production for long term. Intelligent anticipatory management strategies and adaptation will be the critical components for successful and sustainable quality fruit production. The literature relevant to organic farming on soil properties, growth, yield and quality with special reference to strawberry cultivation reviewed in this paper. A thorough knowledge of the critical levels of different kinds of organics and their long term influence on soil and productivity is essential to get better growth and yields, and also to maintain optimum nutrient balancing, a prerequisite enhancing nutrient use efficiency.(Illgin *et al*., 2006) [5]. Efficient nutrient management plays an important role for better production of quality attributes of strawberry.

This information will definitely be useful in better understanding of organic farming package for strawberry as a holistic and sustainable approach so as to improve the productivity and profitability of quality fruits as well as to improve soil health. Conventional farming of fruits in present scenario is becoming unsustainable in consonance with economics, ecology, energy-equity and socio-cultural dimensions. Indiscriminate use of chemical fertilizers, weedicides and pesticides has resulted in various environmental and health hazards along with socio-economic problems. In general 6-8 sprays are required for different fruits' production. The degenerative effects of intensive farming practices have forced for alternate system of farming. Organic farming is one among the broad spectrum of production methods that is supportive of the environment organic production systems in fruit are based on specific standards precisely formulated for food production and am at achieving agro-ecosystems which are socially and ecologically sustainable. It is based on minimising the use of external inputs to use of on farm resources efficiently compared to industrial farming and the use of synthetic fertilizers and pesticides is avoided (Inden and Torres., 2004) [6]. The consumer's demand is the driving force for organic food production. Nowadays consumers' attitude is changing. The consumer wants a product which is antibiotic/growth promoter free, additive free, good for kids, chemical free, grown without damaging or influencing the environment in a negative way i.e. an organic product. Consumer has understood that eating properly is critical to stay healthy and is willing to pay more for food they know that is good for themselves and for their families. Organic farming is an innovative farming system that balances multiple sustainability goals and will be of increasing importance in global food and ecosystem security.

Strawberry farming in India Strawberry is an important food crop of India and its commercial production is possible in temperate and subtropical areas of the country but varieties are available which can be cultivated in the subtropical climate. In India it is generally cultivated in the hills and in recent years Haryana has emerged as the state with highest area under strawberry cultivation (150 hactares) and highest strawberry production (2010 MT) (Horticultural Statistics at a Glance, 2017). The wide variation in climates within these regions and the wide adaptation of the strawberry plant, permits harvesting and marketing of fruit during the greater part of the year.

Materials and Methods

The Experiment was undertaken under controlled conditions in a Polyhouse in the experimental field of Division of Fruit Science, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar Campus, Srinagar during the year 2021-22.

In the present investigation, different growing media were prepared using Farmyard manure, Vermicompost and Biofertilizers in different proportions. Thorough cleaning of the media constituents was done by removing the stones, pebbles and unwanted materials present in it. In addition, plants were planted in soil beds of 5 x 3.3 feet dimension at a distance of 20cm×30 cm under Polyhouse conditions.

The uniform runners of strawberry cultivar chandler, procured from farm nursery of Wadura, Sopore, SKUAST-K were selected for planting in the first week of November, 2021-22. Weeding-cum-hoeing and plant protection measures were carried out as and when required.

Fruit length, Fruit diameter and Berry set was recorded as per standard procedures. TSS, Acidity, Total sugars, Anthocyanin, No. of berries per plant, was also recorded as per standard procedure. Yield in g/ plant was calculated by dividing the recorded yield by the number of surviving plants. Harvesting was done on alternate days, and the total yield (g/plant) was worked out by adding the yield (g/plant) from 2nd week of April to the fourth week of May.

The number of pickings was observed from the tagged plants in each replication by counting the number of time the fruits were harvested and average was drawn to record the data. The weight of the representative fruits of each treatment from each plant was recorded by weighing the individual fruits on an electronic balance and average weight (g) per berry was worked out.

Results and Discussion

It is evident from the present investigation that substantial variation existed among the organic substrates. Increased fruit length, fruit diameter, berry set, No. of berries/plant, Total plant yield, TSS, Acidity, Anthocyanin and fruit weight was found in T5 except T1 (Control). The maximum fruit length (3.05 cm), fruit diameter (2.42 cm), Berry set (91.92%), number of berries per plant (21.95), yield (198.80 g/plant) and fruit weight (9.06 g/plant) was recorded from the plants grown on substrate T5 (15 kgs FYM +7.5 kgs VC+ biofertilizers), whereas, minimum fruit length (2.32 cm), fruit diameter (2.15 cm), berry set (84.05%), number of berries per plant (16.66), yield (125.51 g/plant), and fruit weight (7.53 g/plant) was recorded in T1 (Control). Apparently, this might be due to the availability of nutrients to the plants and improvement in physical and chemical conditions of soil which also paved the way for availing the nutrients to the strawberry plants. The maximum fruit yield per plant (198.80 g) was observed in treatment T5 (15 kgs FYM+7.5 kgs VC+Biofertilizers) followed by treatment T6 (190.73 g) whereas the minimum fruit yield was recorded in T1 (Control) (125.51 g). The variation in the physical and chemical characteristics of fruits & yield characters might be due to the properties of different materials used as growing substrates which exhibit direct and indirect effects on plant growth. Further, berry set and no. of fruits per plant under different organic substrate combinations might be due to the fact that variety chandler itself have high vigour to produce more photosynthates and therefore higher ability to produce flowers and fruits. The present results are in line with earlier findings of Verdonck *et al*. (1982) [11]. The use of sole organic substrate and their different proportion optimize water and oxygen holding capacity and allows better nutrient uptake for sufficient growth and development (Ozekar *et al*., 1999) [9]. One of the physiological reasons of reduced growth in treatment T1 (control) may be due to the less availability of nutrients in the plant. (Soltani, 2004) [10] reported that organic substrates like vermicompost and farmyard manure proved to be effective in root due to better interchange of the elements especially cations inside the substrate and proper moisture distribution that improves root system and finally overall growth and development of the strawberry plants.

Table 1: Effect of Organic substrates on Fruit Length and Fruit Diameter of Strawberry cv Chandler

Treatments	Fruit Length (cm)			Fruit Diameter (cm)		
	2020	2021	Pooled	2020	2021	Pooled
T_1 Sole FYM 22 kgs/bed	2.88	2.90	2.89	2.38	2.40	2.39
T_2 Sole FYM 15 kgs/bed	2.58	2.65	2.61	2.25	2.27	2.26
T_3 Sole VC 7.5 kgs/bed	2.91	2.96	2.93	2.50	2.53	2.51
T_4 Sole VC 5.5 kgs/bed	2.72	2.82	2.77	2.17	2.19	2.18
T_5 15 kgs FYM+7.5 kgs VC +B.F	3.10	3.40	3.25	2.45	2.47	2.46
T_6 15 kgs FYM+5.5 kgs VC +B.F	3.00	3.11	3.05	2.41	2.44	2.42
T_7 Control	2.22	2.42	2.32	2.10	2.20	2.15
CD (p<0.05)	0.18	0.25	0.31	0.15	0.17	0.20

*Biofertilizers BF (Azotobacters +PSB), VC=Vermicompost, FYM=Farmyard manure

Table 2: Effect of Organic substrates on Fruit weight and Fruit firmness of Strawberry cv Chandler

Treatments	Fruit weight (g)			Berry set (%)		
	2020	2021	Pooled	2020	2021	Pooled
T_1 Sole FYM 22 kgs/bed	8.65	8.69	8.67	88.75	90.11	89.43
T_2 Sole FYM 15 kgs/bed	8.17	8.21	8.18	85.90	87.98	86.94
T_3 Sole VC 7.5 kgs/bed	8.75	8.79	8.77	89.90	90.17	90.03
T_4 Sole VC 5.5 kgs/bed	8.60	8.64	8.62	87.88	89.90	88.89
T_5 15 kgs FYM+7.5 kgs VC +B.F	9.04	9.09	9.06	91.43	92.41	91.92
T_6 15 kgs FYM+5.5 kgs VC +B.F	8.81	8.85	8.83	90.43	91.83	91.13
T_7 Control	7.50	7.56	7.53	83.55	84.56	84.05
CD (p<0.05)	0.24	0.58	0.81	1.23	1.33	1.48

*****Biofertilizers BF (Azotobacters +PSB), VC=Vermicompost, FYM=Farmyard manure

Table 3: Effect of Organic substrates on No. of fruits per plant and Total plant yield of Strawberry cv Chandler

Treatments	No. of fruits per plant			Total plant yield (gms)		
	2020	2021	Pooled	2020	2021	Pooled
T1 Sole FYM 22 kgs/bed	18.76	20.11	19.43	162.27	174.75	168.51
T2 Sole FYM 15 kgs/bed	16.37	18.89	17.63	133.74	155.08	144,41
T_3 Sole VC 7.5 kgs/bed	18.98	20.21	19.59	166.00	177.64	171.82
T_4 Sole VC 5.5 kgs/bed	16.06	18.68	17.37	138.11	161.40	149.75
T_5 15 kgs FYM+7.5 kgs VC +B.F	21.86	22.05	21.95	197.61	200.00	198.80
T_6 15 kgs FYM+5.5 kgs VC +B.F	21.20	22.00	21.60	186.77	194.70	190.73
T_7 Control	15.89	17.44	16.66	119.18	131.84	125.51
CD (p<0.05)	1.50	1.52	1.54	7.40	7.43	8.43

*****Biofertilizers BF (Azotobacters +PSB), VC=Vermicompost, FYM=Farmyard manure

Table 4: Effect of Organic substrates on Fruit TSS and Fruit Acidity of Strawberry cv Chandler

Treatments	Fruit TSS (%)			Fruit Acidity (%)		
	2020	2021	Pooled	2020	2021	Pooled
T_1 Sole FYM 22kgs/bed	9.60	9.62	9.61	0.86	0.87	0.86
T_2 Sole FYM 15kgs/bed	9.55	9.57	9.56	0.87	0.88	0.87
T_3 Sole VC 7.5kgs/bed	9.71	9.73	9.72	0.85	0.86	0.85
T_4 Sole VC 5.5kgs/bed	9.42	9.44	9.43	0.89	0.90	0.89
T_5 15kgs FYM+7.5kgsVC +B.F	10.10	10.12	10.11	0.82	0.83	0.82
T_6 15kgs FYM+5.5kgsVC +B.F	9.86	9.88	9.87	0.84	0.85	0.84
T_7 Control	8.70	8.72	8.71	0.91	0.92	0.91
CD(p<0.05)	0.26	0.29	0.34	0.08	0.10	0.11

*****Biofertilizers BF (Azotobacters +PSB), VC=Vermicompost, FYM=Farmyard manure

Table 5: Effect of Organic substrates on Total sugars and Fruit Anthocyanin of Strawberry cv Chandler

Treatments	Total sugars (%)			Fruit Anthocyanin (mg/100g)		
	2020	2021	Pooled	2020	2021	Pooled
T_1 Sole FYM 22 kgs/bed	7.60	7.62	7.61	47.77	47.79	47.78
T_2 Sole FYM 15 kgs/bed	7.30	7.32	7.31	45.20	45.22	45.21
T_3 Sole VC 7.5 kgs/bed	7.20	7.22	7.21	49.96	49.98	49.97
T_4 Sole VC 5.5 kgs/bed	7.06	7.08	7.07	43.13	43.15	43.14
T_5 15 kgs FYM+7.5 kgs VC +B.F	7.67	7.69	7.68	52.67	52.69	52.68
T_6 15 kgs FYM+5.5 kgs VC +B.F	7.40	7.42	7.41	51.97	51.99	51.98
T_7 Control	6.60	6.62	6.61	39.71	39.73	39.72
CD (p<0.05)	0.17	0.20	0.23	1.09	1.19	1.29

*****Biofertilizers BF (Azotobacters +PSB), VC=Vermicompost, FYM=Farmyard manure

Conclusion

The findings of the study enable us to conclude that the applied substrates directly influenced growth, yield and quality of strawberry fruits. The sole and different combinations of organic substrates significantly improved the growth in strawberry compared to the treatment T1 (control) and the organic combination T5 (15 kgs FYM+7.5 kgs VC+Biofertilizers) was found superior among all the treatments. Hence from the current study it can be concluded that FYM+VC+ Biofertilizers are the best for organic strawberry production in passively ventilated greenhouse conditions. Among different organic substrate combinations variety chandler flourished its genetic potential not only in treatment T5 (15 kgs FYM + 7.5 kgs VC+Biofertilizers) but also under sole treatment of vermicompost (7.5 kgs VC) in treatment T4 also.

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