Performance of Organically Grown Strawberry cv. Douglas under the South Chhotanagpur Plateau Region of Jharkhand

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ABSTRACT

In India, cultivation of strawberry has become popular in plains and hilly areas of Himachal Pradesh, Jammu and Kashmir, Uttar Pradesh, Haryana, Punjab, Maharashtra and Uttarakhand. The crop is mainly grown in temperate climates, but now it is being successfully grown under subtropical and tropical climates as well. Strawberry is cultivated in most parts of the world either in open fields or in protective conditions of greenhouses and plastic tunnels.The present experiment was conducted during *rbi-summer* seasons of 2016-17 at the organic experimental farm of the Faculty Centre for Integrated Rural &Tribal Development and Mamagement, Ramakrishna Mission Vivekananda Educational and Research Institute, Ranch Campus by employing Strawberry cv. Douglas grown through seven organically designed treatments *viz.* T_1: *Amritjal* (1%), T_2: *Amritjal* (3%), T_3: *BD-501* (1%), T_4: *BD-501* (3%), T_5: *Shasyagavya* (10%); T_6: *Sanjeevani* (10%), and T_7: Absolute Control (without any organic formulation).The experiment was designed after RCBD with three replications for each treatment. Several growth, yield and quality attributes of the crop were evaluated and the results revealed that T_5 (10% *Shasyagavya*) is the best treatment in expression ofgrowth and yield attributes. As a consequence, the higher yield(25.02 t ha^{-1}) was obtained from T_5 (10% *Shasyagavya*) treatment. The performance of strawberry was not up to the mark in the case of the treatment where no organic input was applied (T_7) and as a consequence, poor yield (3.87 t ha^{-1}) was documented from this treatment. However, different organic treatments performed independently in terms of the expression of quality traits and showed better results than control in this context. Thereby, it may be concluded from the present findings that the variety Douglas of strawberry can be grown successfully in Ranchi areas of the Chhotanagpur plateau without application of any inorganic sources of plant nutrientsincluding protection inputs.

Keywords: Strawberry;*Fragariaananassa*Duch.; organic farming; growth; yield; quality.

INTRODUCTION

Strawberry (*Fragariaananassa*Duch.) is one of the most delicious and refreshing soft fruit of the world under the Potentilloideae (formerly classified in Rosoideae) subfamily of the family Rosaceae (Potter *et al.*, 2007). It is a cross between two American varieties *F. virginiana* and *F. chiloensis* (Nallanchakravarthula, 2013). The fruits are widely acclaimed for pleasant flavour, conspicuous colour and varied blend of taste. Strawberries have a history that goes back over 2200 years when it was first described by the Roman senator Cato around 200 BC. It grew wild in Italy as long ago as long ago as 234 BC and were discovered in Virginia by the 1st Europeans when their ships landed there in 1588 (Das, 2015). Strawberry plants require proper mulch for optimal growth and yield and the mulching material also improves soil quality as it decomposes. At the time of the growing season, a layer of paddy straw 1 to 2 inches thickness retards weed growth and keeps dirt off the fruit. In the winter, strawberry plants are damage because of repeated freezing and thawing of the ground, as well as temperatures 20^{0}F or below. Colour is an important quality trait for berries. The components that give colour to strawberries are anthocyanins, which are polyphenols that belong to the larger group of flavonoids. In addition to being responsible for colouring, these components also exhibit antioxidative properties that can have health benefits. Owing to its anti-carcenogenic and anti-diabetic properties strawberry is gaining popularity among all age group of consumers (Ram and Patel, 2003). The red colour of strawberries comes from anthocyanins, pelargonidin-3-glucoside and cyanidin-3-glucoside. Their phenolics are reported to have anti-cancer, antioxidant, and anti-inflammatory effects as well as having effects against type 2 diabetes and obesity (Hannum, 2004; Giampieri*et al.*, 2012). Strawberries are good sources of natural antioxidants (Wang *et al*., 1996; Heinonen*et al*., 1998) including carotenoids, vitamins, phenols, flavonoids, dietary glutathionine and endogenous metabolites (Larson, 1988) and it also exhibit a high level of antioxidant capacity against free radical species: superoxide radicals, hydrogen peroxide, hydroxyl radicals and singlet oxygen (Wang and Jiao, 2000). A study was conducted onstrawberry and it was found that itsantioxidant activity levels are affected not only by the genotype but also by both growing temperatures (Wang and Zheng, 2001) and cultural practices (Wang *et al*., 2002). Strawberry is affected by different pests, diseases and weeds as well. The protection of strawberries against diseases, pests and weeds is mainly based on the chemical method and thereby sraberry fruis contain a lot of peticides residues (Sójka *et al.*, 2015; Szpyrka, 2018). A study have been carried-out during the two subsequent years,*i.e.*, 2010-11 and 2011-12 to observe the effect of organic, inorganic and bio-fertilizer on vegetative growth, flowering and yield of strawberry cv. Chandler. The study conducted by Beer *et al.* (2017) revealed that the highest number of plant height (23.91 cm) and number of leaves per plant (65.37) were obtained where the plants treated in vermicompost (30 t ha^{-1}) + *Azotobacter* (7 kg ha^{-1}) + NPK (80:100:100 kg ha^{-1}). The highest TSS (9.39^{0}Brix) and total sugars (8.59 %) contents were obtained from those plants which were treated in vermicompost (25 t ha^{-1}) + *Azotobacter* (6 kg ha^{-1}) + NPK (70:80:80 kg ha^{-1}). Considering all of the above mentioned valuable information, the current investigation

was carried out to study the effect of different organic liquid formulations over growth, yield and quality of strawberry under organic management condition.

MATERIALS AND METHODS

Materials and methodologies followed for conducting the experiment were summarized below:

Experimental Location

The experiment was conducted in the open field condition during Sept.-2016 to May-2017 at the IRTDM Faculty Centre of Ramakrishna Mission Vivekananda Educational and Research Institute, Morabadi, Ranchi, Jharkhand of the south Chhotanagpur plateau.

Treatment Combinations, Experimental Material and Experimental Design

Seven organically designed treatments including control were included for the investigation by employing Strawberry cv. Douglas. Seven treatments along with their three replications were allocated in twenty one experimental plots of 2.40 m x 2.40 m by adopting Randomized Complete Block Design (RCBD). Plants were transplanted at 30 cm.x 30 cm spacing, thus accommodated 64 plants per experimental plot. Seven organically designed treatments included T_1: *Amritjal* (1%), T_2: *Amritjal* (3%), T_3: *BD-501* (1%), T_4: *BD-501* (3%), T_5: *Shasyagavya* (10%); T_6: *Sanjeevani* (10%), and T_7: Absolute Control (without any organic formulation). Organic liquid manures were applied after 15 days of transplanting and thereafter at 15days interval for six consecutive times @ 500 ml litre^{-1}. Mulching with 5 cm thick paddy strawberry was done after 30 days of planting.As a basal dose, FYM 10 t ha^{-1} was evenly applied in all experimental plots before 7 days of planting.

Organic Plant Protection Measures

Mulching with paddy straw significantly reduced weed infestation and need based hand weeding was also practiced to check weeds under control. As prophylactic measures against pests, alternately tobacco stalk decoction @ 10% and neem leaves extract @ 10% concentrations were appliedand to check pathogenic infection, 10% solution of turmeric powder mixed whey water was used at fortnight interval.

Observations Recorded and Statistical Analysis

The observations for growth, yield and yield attributing characters, namely number of leaves plant^{-1}, leaf area (cm^2), plant spread (cm), number of fruits plant^{-1}, fruit length (cm), fruit breadth (cm), average fruit weight (g), fruit yield plant^{-1} (g) and yield (t ha^{-1}) were taken from eight randomly selected plantsand their fruits for each treatment and their average was considered for data analysis. However, the quality attributing characters like total soluble solids (ºBrix), titrable acidity (%), reducing sugar (%), total sugar(%), ascorbic acid (mg 100g^{-1}) and lycopene (mg 100g^{-1}) were estimated from fully ripe fruits.The data thus obtained were subjected to statistical analysis as per the method of Gomez and Gomez (1996). Critical Difference (C.D) at 5% level was used for finding the significance differences, if any, among the treatment means.

RESULTS AND DISCUSSION

The results of the investigation were presented through different tables section wise (growth, yield and its attributes, and quality traits) and relevant discussion was made as against each of the sections.

Effects on Growth Attributes

Number of leaves per plant (at flowering stage) was recorded maximum (10.00) in T_4 treatment [BD-501 (3%)] as against the lowest (7.44) as recorded in the case of T_1 treatment [*Amritjal* (1%)]. From the findings it was also revealed that among different treatment conditions the maximum leaf area of 25.57cm^2 was recorded per plant inT_3 treatment followed by T_5 (25.46 cm^2), T_6 (25.49 cm^2) as against the lowest of 21.21 cm^2 as recorded in T_2 treatment (Table-1). However, the findings of the present investigation are not matched with Khalid *et al.* (2013) where they studied the effect of organic amendments on vegetative growth, fruit and yield quality of strawberry and the highest leaf area (43.07 cm^2) was obtained from vermicompost used treatment. On the otherhand, the maximum plant spread (for both N-S and E-W directions) was documented in the case of *BD-501* (1%) *i.e.* T_3 treatment as the lowest as recorded in the cases of *BD-501* (3%) *i.e.* T_4 treatment (Table-1).

Effects on Yield and its Attributes

The results on yield and its associated traits were shown in Table-2 and data revealed statistically significant at 0.05 probability level in all traits under different treatment conditions. The table illustrated that T_4 as the best with maximum number of fruits per plant (15.67) as against the lowest of 10.00 fruits per plant as observed in control treatment (T_7).The average number of fruits as recorded here well harmonized with the earlier finding of Bakshi *et al.*(2014). Table-2 also illustrated that in the case of T_5 treatment the maximum fruit length (7.83cm) followed by T_7 (7.10cm), T_4 (6.70cm) and subsequently culminated with the minimum fruit length in T_2 (5.30cm) followed by T_1 (5.43cm.).In the case of fruit breadth, T_1 had the maximum value(6.63cm) followed by T_3 (6.43 cm), T_6 (6.40 cm). However, the minimum fruit breadth was recorded in T_7 (4.43 cm.). When yield was taken into account, the highest was recorded in T_5 (25.02 t ha^{-1}) as against the lowest as recorded in control (T_7) treatment (3.87 t ha^{-1}). From this result it can be concluded that T_5 [*Shasyagavya*(10%)] is the best treatment because it produces maximum yield which is the most essential factor for the farmers for producing any crop. The yield documented here in different organically designed treatments closely matched with the earlier findings of Bakshi *et al.* (2014).

Effects on Quality Attributes

Findings on different quality attributes were shown in Table-3. In case of TSS content of fruit juices, the maximum TSS recorded in the T_2(14.70^{0}Brix) followed by the T_4(13.93^{0}Brix),T_2(13.20^{0}Brix) as against the minimum TSS recorded in the T_7(11.53^{0}Brix) treatment. The results on TSS content had shown close conformity with the finding of Rao and Swamy (2017). The values of titrable acidity demonstrated for different treatments conditions with the maximum asrevealed in the T_7(2.92%) followed by T_4 (2.47%) and T_2 (2.26%) and the minimum titrable acidity showed in the T_1 (1.45%). Reducing sugar content as recorded

in different treatments conditions. In this case, the minimum reducing sugar recorded in the T_1(4.40%) followed by T_2(4.97%) as against the maximum in both T_5 and T_6 (5.69%).The total sugar content of fruit juices showed the maximum value in the T_1 (8.97%) followed by the T_3(7.96%) and T_7(6.93%) and both $T_4$and T_5treatments with (6.61 %) but the minimum total sugar was recorded in the T_6(5.10%) treatment followed by the T_2 (5.29%). The present findings on reducing sugar and total sugar as recorded here corroborated well with the earlier findings of Rao and Swamy (2017).The ascorbic acid content as recorded in different treatmentsshowed statistically significant differences at 0.05 probability level with the maximum ascorbic acid recorded in both T_1 and T_3 (306.67 mg $100g^{-1}$) but the lowest level of ascorbic acid as recorded in T_6 (200.00 mg $100g^{-1}$). The higher level of ascorbic acid content as recorded under different treatments contradicted with the earlier findings of Bakshi *et al.* (2014). The lycopene content of fruit juices as recorded in different treatment conditions also documented significant differences at 0.05 probability level. In this context, the highest lycopene content was recorded in T_1 (0.66 mg $100g^{-1}$) treatment but the lowest level of lycopene was recorded in T_4 (0.09 mg $100g^{-1}$) followed by T_5 (0.11 mg $100g^{-1}$).

CONCLUSION

From the findings of the present investigation, it may be concluded that the Douglas variety of Strawberry performed well under organic management conditions, especially with the application of organic liquid formulations like *Shasyagavya*(10%) culminated with the highest yield (25.02 t ha^{-1}). Other organic liquid solution containing treatments also performed well in term of yield expression and recorded at least four times more yield than those of control treatment (3.87 t ha^{-1}). However, quality contributing traits performed independently under the influenced of organic growing conditions. Thus, this variety of strawberry may be recommended for commercial scale cultivation organically by employing *Shasyagavya*(10%) as a source of plant nutrients in the south Chottanagpur regions of the eastern Indian plateau.

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Table-1: Effect of Organic Liquid Manures on Growth Attributes of Strawberry cv. Douglas

Treatments	Numberof leaves plant^{-1}(at flowering stage)	Leaf area (cm^2)	Plant spread (cm)	
			N-S	E-W
T_1: *Amritjal* (1%)	7.44	21.92	25.43	26.17
T_2: *Amritjal* (3%)	7.78	21.21	26.90	25.27
T_3: *BD-501* (1%)	8.78	25.57	28.70	27.13
T_4: BD-501 (3%)	10.00	22.44	21.67	22.87
T_5: *Shasyagavya* (10%)	8.67	25.46	26.70	24.67
T_6: *Sanjeevani* (10%)	7.89	25.49	23.93	23.03
T_7: Absolute Control	9.67	21.79	25.53	22.87
SEm (±)	0.99	1.56	2.21	2.88
$CD_{P\leq0.05}$	2.50	3.93	5.57	7.27

Table-2: Effect of Organic Liquid Manures on Yield and its Attributes of Strawberry cv. Douglas

Treatments	Number of fruits Plant^{-1}	FruitLength (cm)	Fruit Breadth (cm)	Average Fruit Weight (g)	Fruit Yield Plant^{-1} (g)	Yield (t ha^{-1})
T_1: *Amritjal* (1%)	13.00	5.43	6.63	14.03	182.39	20.27
T_2: *Amritjal* (3%)	11.67	5.30	5.93	12.01	140.16	15.57
T_3: *BD-501* (1%)	12.00	6.20	6.43	11.61	139.32	15.48
T_4: BD-501 (3%)	15.67	6.70	5.73	11.83	185.38	20.60
T_5: *Shasyagavya* (10%)	15.33	7.83	5.97	14.69	225.20	25.02
T_6: *Sanjeevani* (10%)	14.00	5.90	6.40	10.66	149.24	16.58
T_7: Absolute Control	10.00	7.10	4.43	3.48	34.80	3.87
SEm (±)	1.71	0.59	0.63	2.13	34.51	3.83
$CD_{P\leq0.05}$	4.30	1.49	1.60	5.84	94.90	10.54

Table-3: Effect of Organic Liquid Manures on Quality Contributing Attributes of Strawberry cv. Douglas

Treatments	TSS (°Brix)	Titrable Acidity (%)	Reducing Sugar (%)	Total Sugar(%)	Ascorbic Acid (mg 100g^{-1})	Lycopene (mg 100g^{-1})

T_1: *Amritjal* (1%)	13.03	1.45	4.40	8.97	306.67	0.66
T_2: *Amritjal* (3%)	14.70	2.26	4.97	5.29	240.00	0.45
T_3: *BD-501* (1%)	12.93	1.96	5.07	7.96	306.67	0.27
T_4: BD-501 (3%)	13.93	2.47	5.45	6.61	22667	0.09
T_5: *Shasyagavya* (10%)	13.20	2.15	5.69	6.64	253.33	0.11
T_6: *Sanjeevani* (10%)	11.93	1.62	5.68	5.10	200.00	0.35
T_7: Absolute Control	11.53	2.92	5.11	6.93	253.33	0.45
SEm (±)	1.42	0.41	0.39	1.05	25.78	0.10
$CD_{P\leq0.05}$	NS	NS	NS	NS	NS	0.26