Annals of Plant and Soil Research 17 (2): 196-199 (2015)

EFFECT OF VERMICOMPOST AND BIOFERTILIZERS ON STRAWBERRY I: GROWTH, FLOWERING AND YIELD

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Received: December, 2014: Revised accepted: April, 2015

ABSTRACT

The present investigation was undertaken at Varanasi during 2012-14 to study the effect of vermicompost and biofertilizers on: growth, flowering and yield of strawberry. The experiment was laid out in randomized block design with twelve treatments and three replications. Application of vermicompost + Azotobacter + PSB + AM produced maximum plant height (20.26 cm), plant spread (25.64 cm), number of leaves (54.30) and leaf area (97.87 cm^2) $plant^{-1}$, whereas all the growth characters were found minimum in control. Earliest flowering (50.39 days) and maximum number of runners (7.12) $plant^{-1}$ were repcorted in vermicompost + AM, while minimum runners (3.27) were recorded in vermicompost alone treated plants. Duration of harvesting (66.80 days) was highest in treatment (vermicompost + PSB + AM), while number of flowers (64.23) and number of fruit set (50.63) $plant^{-1}$ were recorded highest in vermicompost + Azotobacter + PSB + AM treatment. Days to fruit set (6.30 days) were minimum in vermicompost + Azotobacter. All the characters were found minimum in control. Maximum yield (311.26 g) $plant^{-1}$was recorded with vermicompost + Azotobacter + PSB + AM, and minimum in control (136.59 g).

Keywords: Vermicompost, biofertilizers, flowering, growth, strawberry, yield

INTRODUCTION

Strawberry (*Fragaria* × *ananassa* Duch.) belongs to the family Rosaceae. The cultivated strawberry (*F.* × *ananasaa* Duch.) was originated from the hybridization of two American species *viz.*, *Fragaria chilioensis* Duch. and *Fragaria verginiana* Duch. All the cultivated varieties of strawberry are octaploid (2n = 8x = 56) in nature. It is herbaceous crop with prostate growth habit, which behaves as an annual in sub-tropical region and perennial in temperature region. Strawberry is used as fresh fruit being rich in vitamin C and ellagic acid, which has anti cancerous property. Fruits are attractive with distinct pleasant aroma and flavour, consumed as dessert and also have a special demand by the fruit processing units for the preparation of jams, ice cream, syrups etc.Vermicompost contains plant growth regulating materials, such as humic acids and plant growth regulators like auxins, gibberellins and cytokinins; (Grappelli *et al.*, 1987), which are responsible for increased plant growth and yield of strawberry fruit crops. Biofertilizers are one of the best modern tools for agriculture and are used to improve the fertility and quality of the soil. It offers an economically attractive and ecologically sound route for augmenting nutrient supply that enables to plant growth and development of strawberry. Keeping these facts in view, the present investigation was initiated to study the effect of vermicompost and bio-fertilizers on growth and yield of strawberry.

MATERIALS AND METHODS

The experiment was conducted at Horticulture Research Farm, Banaras Hindu University, Varanasi during 2012-13 and 2013-14.Treatments namely T_0: Control, T_1: Vermicompost (10 t ha^{-1}), T_2: *Azotobacter* (7 kg ha^{-1}), T_3: PSB (6 kg ha^{-1}), T_4: Arbuscular Mycorrhiza (5 kg ha^{-1}), T_5: Vermicompost + *Azotobacter*, T_6: Vermicompost + PSB, T_7: Vermicompost + AM, T_8: Vermicompost + *Azotobacter* + PSB, T_9: Vermicompost + *Azotobacter* + AM, T_{10}: Vermicompost + PSB + AM, T_{11}: Vermicompost + *Azotobacter* + PSB + AM were tested in randomized block design with three raplications.The observations were recorded on five randomly selected plants from each treatment. Growth characters (plant height, plant spread, number of leaves $plant^{-1}$, number of runner $plant^{-1}$ and leaf area), floral characters (days to produce first flower, number of flowers $plant^{-1}$, days to fruit set, number of fruit set $plant^{-1}$, duration of harvesting) and yield $plant^{-1}$ were recorded.The data recorded during the course of investigation was subjected to statistical analysis.

RESULTS AND DISCUSSION

Vegetative characters

It is clear from the Table 1 that the plant height, plant spread, leaf area and number of leaves $plant^{-1}$ increased significantly with biofertilizers and vermicompost at different treatment combinations. The maximum plant height (20.26 cm), plant spread (25.64 cm), leaf area (97.87 cm^2) and number of leaves (54.30) $plant^{-1}$ were obtained in vermicompost + *Azotobacter* + PSB + AM treated plants which were significantly and statistically at par to vermicompost + PSB + AM treatment .This increase in height of plant, plant spread, leaf area and number of leaves

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plant^{-1} with the application biofertilizers and vermicompost get the support of Tripathi *et al.* (2010) in strawberry.The increase in vegetative growth and other parameters might be due to the production of more chlorophyll content with inoculation of nitrogen fixers. The other reason for increased vegetative growth may be the production of plant growth regulators by microorganism in rhizosphere, which are absorbed by the roots. Therefore increased vegetative growth may be attributed to the increased biological nitrogen fixation. Better development of root system and the possibly synthesis of plant growth hormones like IAA, GA and Cytokinins and direct influence of bio-fertilizers (Gajbhiye *et al.*, 2003) might have caused increase in plant growth parameters. The increase leaf area might be due to increased nitrogen availability which was affected by higher percentage of nitrogen through nitrogen fixing culture (Bambal *et al.* 1998) and production of growth regulators by the *Azotobacter* in the root zone (Rana and Chandel 2003). Pooled data (Table 1) revealeded that number of runners significantly increased in vermicompost and biofertilizers treated plant. The maximum number of runners (7.12) was produced in the plant treated with vermicompost + *Azotobacter* + PSB followed by vermicompost + *Azotobacter* + PSB + AM (6.97), whereas minimum (3.27) in vermicompost alone fertilized plants. These findings are in agreement with those of Umar *et al.* (2009) who narrated highest runners per plant in strawberry with PM + *Azotobacter* + wood ash + vermicompost + oil cake application. Increase in number of runners per plant might be due to increased growth of plant in the form of height and number of leaves, which accumulated more photosynthates and thereby increased runners of strawberry plants.

Table1: Effect of vermicompost and biofertilizers on growth characters of strawberry

Treatment	Plant height (cm)	Plant spread (cm)	Leaves plant^{-1}	Leaf area (cm^2) plant^{-1}	Runners plant^{-1}
Control	11.54	17.26	35.08	87.64	3.74
10 t VC ha^{-1}	14.83	19.69	37.84	88.01	3.27
Azoto. (7 kg ha^{-1})	15.86	18.76	38.82	88.81	4.72
PSB (6 kg ha^{-1})	14.30	21.19	41.03	89.14	4.14
AM (5 kg ha^{-1})	15.83	21.43	42.30	91.13	4.98
VC + *Azotobacter*	15.69	22.11	52.17	96.70	5.38
VC + PSB	14.30	23.15	47.11	95.62	4.97
VC + AM	16.02	22.95	48.52	94.68	5.61
VC + *Azoto.* + PSB	16.71	23.70	49.16	89.99	7.12
VC + *Azoto.*+ AM	18.04	24.41	50.97	88.48	6.53
VC + PSB + AM	19.83	24.87	51.98	88.20	6.61
VC + *Azoto.* + PSB + AM	20.26	25.64	54.30	97.87	6.97
SEm±	0.60	0.73	1.11	0.48	0.27
CD (P=0.05)	1.76	2.15	3.25	1.41	0.80

VC = Vermicompost, AM = Arbuscular Mycorrhiza

Floral characters

Pooled data (Table 2) clearly indicated that minimum number of days (50.39) to produce first flower was recorded in the plants treated with vermicompost + *Azotobacter* + PSB followed by *Azotobacter* (52.22 days) alone. However, the maximum number of days to produce first flower (58.42 days) was recorded in vermicompost + *Azotobacter* + PSB + AM treatment. This phenomenon may be on account of prolonged growth of plant in the presence of biofertilizers and Vermicompost. These results got the support of the findings of Shukla *et al.* (2009) who recorded earliest flowering with NPK + PSB and NPK + *Azotobacter* treatments. Kumar *et al.* (2007) and Singh *et al.* (2008) also recorded advancement in flowering in tomato and Calendula, respectively. Minimum number of days taken to produce first flower may be due to balanced application of vermicompost and biofertilizers which supplies the all essential elements to plant to get early flowering in strawberry crop.

The maximum number of flowers (64.23) plant^{-1} was recorded in vermicompost + *Azotobacter* +PSB+AM treated plants followed by vermicompost + PSB+AM (62.73), whereas the minimum in the control (45.28). It may possibly be due to the fact that biofertilizers and Vermicompost application accelerated the development of inflorescence, leaf number in autumn, which are positively correlated with the number of flowers and fruits in the following spring. Increased number of flowers might have also resulted because of increase in number of crowns per

plant. Similar observations were also reported by Tripathi *et al.* (2010) in strawberry, who found that higher dose of *Azotobacter* and PSB (7 kg/ha) increased number of flowers per plant.The minimum number of days to fruit set (6.30 days) were recorded in plants treated with vermicompost + *Azotobacter* followed by vermicompost + *Azotobacter* + PSB (6.44 days), whereas, the unfertilized plants (control) took maximum days (8.81 days) for fruit setting. The number of fruits set (50.63) and number of fruit (44.44) plant^{-1} were recorded maximum when the plants were treated with vermicompost + *Azotobacter* + PSB + AM which was statistically at par to vermicompost + PSB + AM treatment (Table-2). The least number of fruit set (31.25) and fruit number plant^{-1}(25.49) was obtained from control. These results are in conformity with the finding of Gajbhiye *et al.* (2003) who noted that increase in *Azotobacter* and PSB concentration resulted in higher fruit set in tomato. *Azotobacter* is expected to hasten plant development hence the increase in fruit set is due to commutative effect of *Azotobacter* and vermicompost that results the more number of fruit per plant.

Table2: Effect of vermicompost and biofertilizers on floral characters and yield plant^{-1} of strawberry

Treatment	Days to first flower	Flowers plant^{-1}	Days to fruit set	Fruit set plant^{-1}	Duration of harvesting (days)	Yield plant^{-1} (g)
Control	54.07	44.97	8.81	31.25	48.00	136.59
10 t VC ha^{-1}	53.62	47.06	8.24	33.14	50.91	159.13
Azoto. (7 kg ha^{-1})	52.22	49.15	7.60	34.73	49.40	164.90
PSB (6 kg ha^{-1})	52.96	50.79	7.65	37.16	49.69	201.52
AM (5 kg ha^{-1})	54.47	53.23	8.36	38.04	55.18	195.89
VC + *Azotobacter*	53.98	53.83	6.30	41.32	60.14	210.9
VC + PSB	53.76	55.97	7.07	41.56	61.01	237.01
VC + AM	56.14	58.48	6.69	45.38	60.66	251.38
VC + *Azoto.* + PSB	50.39	61.79	6.44	47.09	60.37	279.05
VC + *Azoto.*+ AM	56.17	61.18	7.17	47.44	61.87	284.28
VC + PSB + AM	58.42	62.73	6.70	49.14	66.80	297.73
VC + *Azoto.* + PSB + AM	57.67	64.23	7.04	50.63	64.70	311.26
SEm±	0.92	1.86	0.18	1.44	1.43	2.05
CD (P=0.05)	2.71	5.47	0.54	4.22	4.22	6.02

Duration of harvesting was significantly increased with biofertilizers and vermicompost application. The maximum duration of harvesting (66.80 days) was observed vermicompost + PSB + AM followed by (64.70 days) in vermicompost + *Azotobacter* + PSB + AM treatment, whereas minimum in control (48.00 days).Similar results were also recorded by Tripathi *et al.* (2010), Singh and Singh (2009) in strawberry, who got advanced duration of harvesting (earliness) by approximately one month which obviously extended the period of harvesting. The increase in duration of harvesting under present studies may be due to the capability of vermicompost in producing growth hormones and enzymes, which in turn enhanced growth and extended the duration of harvesting.

Yield

Biofertilizers and vermicompost application increased the yield of strawberry fruits and maximum yield (311.26 g) plant^{-1} was recorded with vermicompost + *Azotobacter* + PSB + AM followed by (297.73 g) in Vermicompost + PSB + AM fertilized plants. The minimum yield plant^{-1} was recorded in control (13.59 g). These findings are in line with those of Wange *et al.* (1998) in strawberry, Kadlage *et al.* (2007) in tomato and Tripathi *et al.* (2010) in strawberry, who recorded higher yield with *Azotobacter* application. The increase in yield might be due to increased fruit set per plant, fruit length and fruit width as well as berry weight with nitrogen fixers.

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