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Effect of integrated organic nutrient management on fruit yield and quality of strawberry cv Senga Sengana

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ABSTRACT

The present research was conducted in the departmental field of Division of Fruit Science, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Srinagar, J&K to study the effect of various organic nutrient combinations on growth, yield and quality of strawberry cv Senga Sengana. The experiment comprised of five organic nutrient treatments with different combinations of FYM, *Azotobacter*, PSB, mustard oil cake, poultry manure, wood ash, *Azospirillum* including the recommended doses of N, P and K through chemical fertilizer as control. Treatment combination of poultry manure + *Azotobacter* + wood ash + phosphorus solubilizing bacteria + mustard oil cake significantly improved growth, yield and quality of strawberry. Observations recorded on different growth parameters depicted that maximum plant height (23.39 cm), plant spread (24.21 cm) and runners/plant (13.03) were in treatment poultry manure + *Azotobacter* + wood ash + phosphorus solubilizing bacteria + mustard oil cake along with maximum yield (238.95 g/plant) and different physical characters of fruits in respect of length (3.95 cm), diameter (3.11 cm), volume (20.39 cm^3), weight (11.11 g) and chemical characters viz total sugars (7.95%), total soluble solids (9.01^oB), acidity (0.857%) and TSS/acidity ratio (11.12).

Keywords: Strawberry; organic manure; fruit quality; yield

INTRODUCTION

Modern agricultural practices largely rely on high inputs of mineral fertilizers to achieve high yields. It is widely recognized that application of mineral fertilizer (especially nitrogen) can result in ground water contamination by nitrate leaching through the soil profile. Concerns about the possible consequences of using higher amounts of chemical pesticides have led to a strong interest in alternative strategies to ensure competitive yields and protection of crops. The new approach to farming often referred to as sustainable agriculture seeks to introduce agricultural practices that are friendlier to the environment and that maintain the long term ecological balance of the soil ecosystem. The use of microbial inoculants (biofertilizers) is considered as the alternative source to meet the nutrient

requirements of crops. The commercial strawberry (*Fragaria* x *ananassa*) is treasure of vitamin C. The presence of ellagic acid which prevents cancer and relieves heart disease and the abundance of anthocyanin has made it more valuable fruit. Because of this strawberry producers often use very large amounts of synthetic mineral nutrients and agrochemicals in an attempt to improve yield and quality. Keeping this in view present study was conducted to observe the effects of different organic nutrient combinations on growth, yield and quality attributes of Senga Sengana cultivar of strawberry.

MATERIAL and METHODS

The experiment was carried out at experimental farm of Division of Fruit Science, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar, J&K. Initial nutrient composition of the soil was OC 0.69%, available N 334.00 kg/ha, P_2O_5 17.50 kg/ha and K_2O 333.50 kg/ha. The texture of the soil was clay loam (21.8% sand, 41.7% silt and 33.6% clay). The cultivar Senga Sengana was used to evaluate the various treatments. Five treatments viz T_1 (farm yard manure + *Azotobacter* + phosphorus solubilizing bacteria + mustard oil cake), T_2 (poultry manure + *Azotobacter* + wood ash + phosphorus solubilizing bacteria + mustard oil cake), T_3 (farm yard manure + *Azospirillum* + phosphorus solubilizing bacteria + mustard oil cake), T_4 (poultry manure + *Azospirillum* + wood ash + phosphorus solubilizing bacteria + mustard oil cake) and T_5 (recommended dose of NPK ie 340:150:340 kg/ha). The nutrient composition of FYM was 1.0, 0.5 and 1.0 per cent, poultry manure was 1.25, 1.5 and 2.15 per cent and mustard oil cake was 5.5, 1.75 and 1.2 per cent N, P_2O_5 and K_2O respectively. Runners treated with biofertilizers according to respective treatments were planted at a spacing of 60 cm x 30 cm in a well prepared bed of 1.8 m^2 during the month of March 2004. Runners were treated with *Azotobacter* + phosphorus solubilizing bacteria and *Azospirillum* + phosphorus solubilizing bacteria at the time of transplanting in 1 per cent jaggery solution according to the proposed treatments. At the time of calibration of nutritional requirement it was assumed that *Azotobacter* and *Azospirillum* would fix nitrogen at the rate of 25 kg/ha. FYM and poultry manure were applied 15 days before transplanting in their respective plots while well rotten mustard oil cake was applied in April.

Observations were recorded on plant height (cm), plant spread (cm), runners/plant, initial bloom (DARD) and full bloom (DARD). The reference date was considered 1 April. For physical parameters five randomly selected fruits from each treatment were analysed for fruit weight (g), fruit length (cm), fruit diameter (cm) and fruit volume (cm^3). Yield per plant (g) was also recorded. Fruit length and

diameter were worked out by vernier calliper. Fruit volume was calculated by using the formula (Westwood 1993):

$$\text{Fruit Volume} = 4.189\ ab^2$$

where
a= ½ length of fruit, b= ½ diameter of fruit

Total soluble solids (°B) were recorded using hand refractometer. Total sugars and acidity content were determined as per standard procedure (Anon 1989). Experimental data were statistically analyzed following the analyses of variance (Gomez and Gomez 1984).

RESULTS and DISCUSSION

Perusal of data presented in the tables indicates that all the growth, flowering and physio-chemical characters were significantly affected by different nutrient sources. Maximum plant height (23.39 cm), plant spread (24.21 cm) and runners/plant (13.03) were observed in treatment T_2 and minimum values for these characters were recorded in treatment T_5 (control) (Table 1). All the growth parameters were significantly better when organic manures were applied as compared to inorganics. The differential response to various organic manures could be attributed to the rate of decomposition of the material, their C:N ratio and rate of availability to the plant. The increased vegetative growth might be due to the fact that nitrogen has role in the assimilation of numerous amino acids that are subsequently incorporated in proteins and nucleic acids which in turn increase the photosynthetic efficiency (Tisdale et al 1997). Increase in plant spread might be due to the fact that for an optimum growth there must be a balanced rate of photosynthates production and N-assimilation for this reason N-nutrition must be high (Mengel and Kirby 1987). The secretion of growth promoting substances by *Azotobacter* especially cytokinin might have increased the runners per plant as it helps in branching and development of side buds. Similar results were also reported by Rana and Chandel (2003).

The 1 April was considered as reference date to represent the average number of days taken to a particular phenological stage. It is evident from the data that the flowering commenced earliest in treatment T_2 (10.33 days) which was at par with treatment T_5 (10.44 days) and treatment T_4 (11.22 days) (Table 1). Maximum days (14.22 days) were taken to open first flower under the influence of treatment T_3. On an average treatment T_5 recorded minimum number of days (19.22) to full bloom which was statistically at par with T_2 (20.44 days) and T_4 (20.24 days). Maximum days (23.23) was noted with treatment T_1 followed by T_3 (23.64). This might be due to the fact that composts continued to decompose after application resulting in increased temperature in the rhizosphere which may be responsible for accelerating the early bloom.

Physical parameters of fruits viz length, diameter and volume were significantly increased in organically treated plots as compared to plots receiving inorganic treatment. The maximum fruit length (3.95 cm), fruit diameter (3.11 cm), fruit volume (20.39 cm^3) and fruit weight (11.11 g) were recorded with treatment T_2 (Table 2). However minimum values for these characters were recorded under control. The increase may be due to balanced availability of macro and micronutrients and growth promoting hormones produced by different biofertilizers applied in different treatment combinations. This may be attributed to better filling of fruits due to more balanced uptake of nutrients which may have lead to better metabolic activities in the plant ultimately leading to high protein and carbohydrate synthesis (Singh et al 1970). Besides nitrogen fixing abilities of the microbial inoculants the capacity to release phytohormones especially gibberellins increase the fruit size. The efficient partitioning of photosynthates towards the sink by *Azotobacter* inoculation also increases the fruit size and weight (Brown et al 1993). Treatment T_2 registered maximum yield (238.95 g/plant) which was statistically higher among all the treatments. The increase in yield can be because of better root proliferation, increased nutrient elements in the soil, enhanced uptake of nutrients and water and higher photosynthesis leading to an increase in the assimilation rates. The generation of CO_2 during compost decomposition has also been found responsible for increasing yield (Lieten 1996).

The juice content, total sugars, total soluble solids, acidity and TSS/acidity ratio were also significantly influenced by the organic nutrient application. The maximum juice content (82.39%), total sugars (7.95%), total soluble solids (9.01°B), TSS/acidity ratio (11.12) and minimum acidity (0.857%) were recorded with treatment T_2 and the minimum values were recorded in treatment T_5 (Table 3). A positive relation has been found in fruit size and fruit juice content and increase in fruit size might have been due to steady balance of nutrient availability to the plant and secretion of growth promoting hormones by applying biofertilizers. It has also been suggested that growth regulators increase the mobilization of carbohydrates to the developing fruit and increase berry size (Sidahmed and Kliewer 1980). Increased TSS and total sugars at higher levels of nitrogen might have resulted due to the fact that absorption of nitrogen may have exerted regulatory role as an important constituent of endogenous factors in affecting the quality of fruit in which carbohydrate is important and during ripening of fruits the carbohydrate reserves of the roots and stem are drawn upon heavily by fruits which might have resulted into higher TSS and sugar contents in fruits. Increased TSS and total sugars in fruits were in agreement with the findings of

Table 1. Effect of integrated organic nutrient management on growth and flowering characters of strawberry

Treatment	Parameter				
	Plant height (cm)	Plant spread (cm)	Runners/plant	Initial bloom (DARD)	Full bloom (DARD)
T_1	21.91	22.89	12.85	12.67	25.23
T_2	23.39	24.21	13.03	10.33	20.44
T_3	21.88	22.91	12.81	14.22	23.64
T_4	23.35	23.99	12.99	11.22	20.24
T_5	19.41	20.62	9.41	10.44	19.22
$CD_{0.05}$	0.04	0.061	0.03	1.32	1.27

DARD: Days after reference date

T_1 (farm yard manure + *Azotobacter* + phosphorus solubilizing bacteria + mustard oil cake), T_2 (poultry manure + *Azotobacter* + wood ash + phosphorus solubilizing bacteria + mustard oil cake), T_3 (farm yard manure + *Azospirillum* + phosphorus solubilizing bacteria + mustard oil cake), T_4 (poultry manure + *Azospirillum* + wood ash + phosphorus solubilizing bacteria + mustard oil cake) and T_5 (recommended dose of NPK ie 340:150:340 kg/ha)

Table 2. Effect of integrated organic nutrient management on yield and fruit characters of strawberry

Treatment	Parameter					
	Fruit length (cm)	Fruit diameter (cm)	Fruit volume (cm^3)	Fruit weight (g)	Yield (g/plant)	Yield (q/ha)
T_1	3.76	2.98	18.91	9.81	230.91	128.28
T_2	3.95	3.11	20.39	11.11	238.95	132.75
T_3	3.79	2.96	18.87	9.53	230.87	128.26
T_4	3.91	3.08	20.34	10.01	238.35	132.42
T_5	3.00	2.80	16.40	7.99	210.40	116.88
$CD_{0.05}$	0.03	0.04	0.04	0.25	0.04	0.15

T_1 (farm yard manure + *Azotobacter* + phosphorus solubilizing bacteria + mustard oil cake), T_2 (poultry manure + *Azotobacter* + wood ash + phosphorus solubilizing bacteria + mustard oil cake), T_3 (farm yard manure + *Azospirillum* + phosphorus solubilizing bacteria + mustard oil cake), T_4 (poultry manure + *Azospirillum* + wood ash + phosphorus solubilizing bacteria + mustard oil cake) and T_5 (recommended dose of NPK ie 340:150:340 kg/ha)

Table 3. Effect of integrated organic nutrient management on chemical characters of strawberry

Treatment	Parameter				
	Fruit juice (%)	Total sugars (%)	TSS (%)	Acidity (%)	TSS/acidity ratio
T_1	80.85	6.75	8.85	0.840	10.85
T_2	82.39	7.95	9.01	0.857	11.12
T_3	80.91	6.79	8.82	0.842	10.82
T_4	82.34	7.91	8.99	0.851	10.89
T_5	76.40	5.40	8.41	0.813	10.41
$CD_{0.05}$	0.04	0.03	0.02	0.003	0.13

T_1 (farm yard manure + *Azotobacter* + phosphorus solubilizing bacteria + mustard oil cake), T_2 (poultry manure + *Azotobacter* + wood ash + phosphorus solubilizing bacteria + mustard oil cake), T_3 (farm yard manure + *Azospirillum* + phosphorus solubilizing bacteria + mustard oil cake), T_4 (poultry manure + *Azospirillum* + wood ash + phosphorus solubilizing bacteria + mustard oil cake) and T_5 (recommended dose of NPK ie 340:150:340 kg/ha)

Antipchuk et al (1982) who reported that inoculation of different *Azotobacter* strains in soil resulted in higher fruit sugars in tomato. The increase in acidity may be due to more balanced uptake of nutrients. The results are in line with findings of Prabakaran and Pichal (2003) who found increase in titratable acidity of the fruit due to the use of 100 per cent nitrogen in the form of poultry manure. Maximum TSS/acidity ratio recorded in treatment N_2 might be due to corresponding increase in total soluble solids and acidity. These results are in confirmation with the findings of Pereira and Mitra (1999) who reported that TSS/ acidity ratio is superior with organic manure. The efficiency of poultry manure among all other organic sources was more as 90 per cent of nitrogen in the poultry manure becomes available during first year (Mathers and Goss 1979). Poultry manure contains all essential plant nutrients that play significant role in improving quality as reported by Prabakaran and Pichal (2003).

Amongst different organic nutrient combinations treatment T_2 (poultry manure + *Azotobacter* + wood ash + phosphorous solubilizing bacteria + oil cake) was more effective to improve the growth, yield and quality (physico-chemical) characters of strawberry. Among various organic sources tried poultry manure ranked first and FYM ranked second in their performance.

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