Indian J. Hort. 69(2), June 2012: 177-180

Effect of integrated organic nutrient sources on soil nutrient status and microbial population in strawberry field

Nowsheen Nazir, S.R. Singh*, M.K. Sharma, F.A. Banday, V.K. Sharma, Aroosa Khalil and Shazia Hayat**

Division of Pomology, Sher-e-Kashmir University of Agricultural Sciences and Technology, Shalimar Campus, Srinagar 191 121, Jammu and Kashmir

ABSTRACT

Field experiment was carried out to ascertain the effect of integrated organic nutrient resources on plant growth, fruit yield, soil fertility and soil microbial population growth under organic strawberry production system. Five treatments combinations of nutrient resources, *viz.* T_1 - Farm yard manure + *Azotobacter* + phosphorus solublizing bacteria + oil cake , T_2 - Poultry manure + *Azotobacter* + Wood ash + phosphorus solubilizing bacteria + Oil Cake , T_3 - Farm yard manure + *Azospirillum* + phosphorus solubilizing bacteria + oil cake, T_4 - Poultry manure + *Azospirillum* + Wood ash + phosphorus solubilizing bacteria + oil cake and T_5 - recommended dose of NPK (i.e. 340 :150 : 340 kg/ha) were tested on strawberry var. Senga Sengana. Maximum plant growth and fruit yield (132.75 q/ha) obtained with treatment T_2 closely followed by treatment T_4. Maximum available nitrogen (370.29 kg ha^{-1}) and phosphorus (22.11 kg ha^{-1}) was recorded with treatment T_4 with a gain of 36.29 and 4.61 kg /ha, respectively. Where as maximum potassium (331.79 kg ha^{-1}) was observed with treatment T_2 with a gain of 12.29 kg/ha. The population of *Azospirillium* (1.55 x 10^6) was highest with treatment T_4, however, maximum population of *Azotobacter* (1.45 × 10^5) and phosphorus solubilizing bacteria (1.16 × 10^6) were observed with treatment T_2 . On the basis of performance, treatments T_2 and treatment T_4 may be adopted for higher yield and sustainability.

Key words: Organic strawberry, bio-inoculants, nutrient uptake, microbial population.

INTRODUCTION

Modern agricultural practices largely rely on high inputs of mineral fertilizer to achieve high yield and also involve applications of chemical pesticides against pathogens and pests. Use of chemical fertilizers and pesticides not only extensively damage the beneficial microbes in the soil but also cause ill effects on human health as well as environment hazards and reduce the soil fertility (Macid *et al.*, 7). It is now well established that application of chemical fertilizers (especially nitrogen) can result in ground water contamination by nitrate leaching through the soil profile. Concerns about the possible consequences of using increasing amount of chemical fertilizers and 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 ecofriendly and maintain the long term ecological balance of the soil ecosystem. The judicial use of beneficial microbial inoculants (bio-fertilizers) along with organic manure is considered as the alternative source to meet the nutrient requirements of crop.

The strawberry (*Fragaria* × *ananassa* Duch.) fruits are rich in vitamin C. The presence of ellagic acid which prevents cancer and occurrence of heart disease and the abundance of anthocyanins have made it a more valuable fruit. Because of these, strawberry producers often use very large amounts of synthetic mineral nutrients which is not sustainable due to ill effects on soil and environment *viz-a-viz* much involvement of non-renewable energy in production input used, attempt to improve yield and quality of the crop. Keeping in view the above facts the present experiment was conducted to study the effect of different organic nutrient sources on soil fertility status and beneficial microbial population in organic strawberry production.

MATERIALS AND METHODS

The experiment was carried out at experimental farm of Division of Pomology, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar for two consecutive years. Soil texture of experimental field was clay loam (21.8% sand, 41.7% silt & 33.6% clay). Initial nutrient status of experimental soil was O.C 0.69%, available N 334.00 kg ha^{-1} ha, P 17.50 kg ha^1 & K_2O 319.50 kg ha^{-1}. Cultivar Senga Sengana was used to evaluate the influence of five treatments comprising

*Corresponding author's E-mail: drsingh_sr@rediffmail.com
**Regional Agriculture Res. Station, Leh, J&K

different combination of nutrient resources *viz.* T_1 - Farm yard manure (FYM) + *Azotobacter* (AZ) + phosphorus solublizing bacteria *(PSB)* + Oil cake (OC) T_2 - poultry manure (PM)+ *Azotobacter* + Wood ash (WA) + phosphorus solubilizing bacteria + oil cake , T_3 - Farm yard manure + *Azospirillum* (Azs)+ phosphorus solubilizing bacteria + oil cake, T_4 - poultry manure + *Azospirillum* + wood ash + phosphorus solubilizing bacteria + oil cake and T_5 - recommended dose of NPK (i.e. 340 :150 : 340 kg/ ha). The nutrient composition of used FYM was 1%N, 0.5% P_20_5 and 1% K_20, poultry manure was 1.25% N, 1.5% P_2O_5 and 2.15% K_20 and mustard cake was 5.5%N, 1.75% P_2O_5 and 1.2% K_2O. The amount of respective nutrient resources was calibrated on basis of recommended NPK doses. Roots of runners were dipped in bio-fertilizer solution having 10% sugar for 30 minute in shady place. The Microbial population in solution were 10^7 cell per ml, 10^6 per cell per ml and 10^5 cell per ml for *Azospirillum, Azotobacter and* PSB, respectively .The treated runners were planted at 60 cm × 30 cm of inter and intra row spacing in a well prepared bed of $1.8m^2$ size in the month of October. At the time of calibration of nutritional requirement it was assumed that *Azotobacter* and *Azospirillium* would fix nitrogen at 25 kg/ha. FYM and poultry manure were mixed 15 days before transplanting in their respective plots while well rotten mustard cake was applied in the month of March before flowering.

For estimating soil pH, available N, P and K and population of *Azospirillium, Azotobacter* and phosphorous solubilizing bacteria, samples were collected from each plot before transplanting and after harvesting the crop. Soil organic carbon and available N, P, K contents were estimated by standard procedures (Jackson, 5). Record on microbial population was estimated by serial dilution method (Aaronson, 1). The data was pooled and statistical methods described by Gomez and Gomez (3) was followed to analyze and interpret the data.

RESULTS AND DISCUSSION

Different treatment combinations of organic nutrients resources influenced the plant growth and yield significantly. Treatment T_2 recorded highest plant height,(23.39 cm) plant spread (24.21 cm) number of runners /plant (13.03), average fruit weight (11.11 g) and total yield (132.75 q/ha) closely followed by treatment T_4 with 23.50 cm plant height, 23.99 cm plant spread, 12.99 number of runners/plant, 10.01 g average fruit weight and 132.42 q/ha fruit yield, respectively. The differential response of various organic manures may be attributed to rate of their nutrient availability. As 90% of N poultry manures and 35% N of FYM becomes available in first year (Mathers and Goss, 8) and higher N availability favours better growth and yield (Table 1).

Available soil N, P and K were significantly influenced by different organic nutrient sources in comparison to inorganic sources. Treatment T_4 markedly increased the soil available nitrogen (370. 29 kg ha^{-1}) followed by T_2 (370.24 kg ha^{-1}) with a gain of 36.29 and 36.24 kg/ha, respectively. However, lowest available soil N was recorded in T_5 (335.30 kg ha^{-1}) with only 1.30 kg/ha nitrogen gain. Higher available soil nitrogen with respect to different organic nutrient sources as compared to inorganic sources with plant growth promoting rhizobacteria might be due to slow releasing nature of organic manure which helps in reducing the nutrient loss and synergetic effect of bio-inoculants enhance their a symbiotic nitrogen fixing capabilities. Similar results were also reported by Mohandas (9), and Tiwary *et al*. (13) in *Azospirillum* inoculated banana crop. The highest available phosphorus was recorded in treatment T_4 (22.11 Kg ha^{-1}) closely followed by treatment T_2 (22.07 kg ha^{-1}) with a gain of 4.61 and 4.57 kg respectively. Higher availability of phosphorus under poultry manure and oil cake combinations might be due to the production of organic acids by phosphorus solubilizing bacteria which act as a chelating agent and form stable complexes with Fe and Al abundantly available in acid soils and thereby releasing phosphorus to the soil solution making it available for more uptake

Table 1. Effect of different organic nutrient resources on plant growth and yield of strawberry.

Treatment	Plant height (cm)	Plant spread (cm)	Runners/ plant	Av. fruit weight (g)	Fruit yields (q/ha)
T1 (FYM + Az + PSB + OC)	21.91	22.89	12.85	9.81	128.28
T2 (PM + Az + WA + PSB + OC)	23.39	24.21	13.03	11.11	132.75
T3 (FYM + Azs + PSB + OC)	21.88	22.91	12.81	9.53	128.26
T4 (PM + Azs + WA + PSB + OC)	23.35	23.99	12.99	10.01	132.42
T5 (Recommended NPK)	19.41	20.62	9.41	7.99	116.88
LSD (p = 0.05)	0.045	0.061	0.032	0.25	4.27

by the plant. These results are in conformity with findings of Gogoi *et al.* (3), and Tiwary *et al*. (13).

There was an appreciable increase in soil available potassium content with organic treatment as compared to chemical fertilization though it declined slightly in comparison to initial status. Higher available potassium content was observed in T_2 (331.79 kg ha^{-1}) closely followed by T_4 (330.76 kg ha^{-1}) with gain of 12.29 and 11.26 kg /ha, respectively. However least soil available potassium content (315.80 kg ha^{-1}) were observed with chemical fertilization T_5. Relatively less availability of K_2O in inorganic fertilizer treated soil (T_5) might be attributed to increased soil pH resulting in K fixation. However, with organic manure decline in potassium status of soils may be due to the fact that humification of plant residues and soil organisms produce a type of organic matter with high CEC capable of holding soil K. Moreover, humus retains divalent cations (Mg^{2+}, Ca^{2+}) more strongly than the monovalent cations. Weaker retention of potassium relative to Ca and Mg may increase K availability but, at the same time, it renders the K more liable to leaching (Somani and Kanthaliya, 12). These findings get support from the findings of Gogoi *et al.* (2)

Soil population of *Azospirillium, Azotobacter* and phosphorous solubilizing bacteria increased with the application of different treatments (Figs. 1-3). *Azospirilium* inoculated runner induced maximum number of N-fixing microbial colonies (1.55×10^6) in treatment T_4 followed by T_3 (1.52×10^6). Minimum number of N - fixing microbial colony (0.75×10^6) was observed under treatment T_5. *Azotobacter* population was higher (1.45×10^5) in treatment T_2 followed by T_1 (1.42×10^5). Minimum number of microbial colony was recorded under treatment T_5 (0.74×10^5). Enhanced population of *Azospirillium* and *Azotobacter* with organic practices under present investigation is generally linked with changes in soil organic matter content and its characteristics. Moreover, there is also increase in soil microbial biomass with the addition of organic matter. The higher microbial biomass pool size may accumulate after regular addition of manures under organic practices compared to chemical based conventional practice of crop production. Basal respiration rate as well as higher rate of microbial activity per unit biomass indicate change in a process rate due to either the presence of larger population capable of carrying out the process or due to the shift in microbial community structures under organic than conventional systems.

Changes in microbial community structure in soil receiving organic inputs compared to chemical fertilizer are well documented (Gunapala *et al.*, 4). Lundquist *et al.* (6) observed higher microbial biomass carbon as an indicator of carbon availability in soil under organic practices with distinct changes in community structure measured using PLFA profiles.

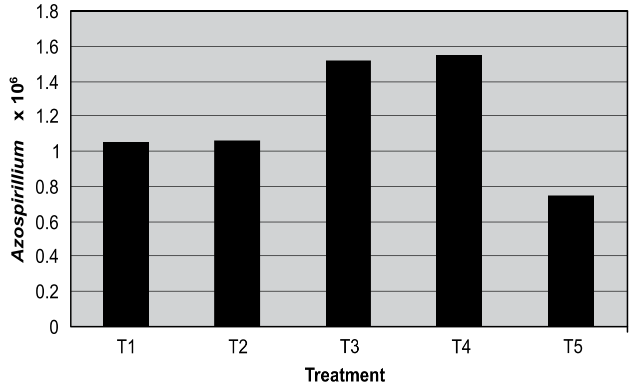

Fig. 1. Effect of organic nutrient resources on soil *Azospirillium* population.

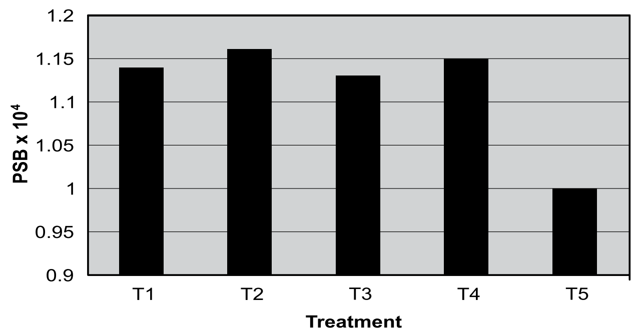

Fig. 2. Effect of organic nutrient resources on soil phosphorous solubilizing bacteria (PSB) population.

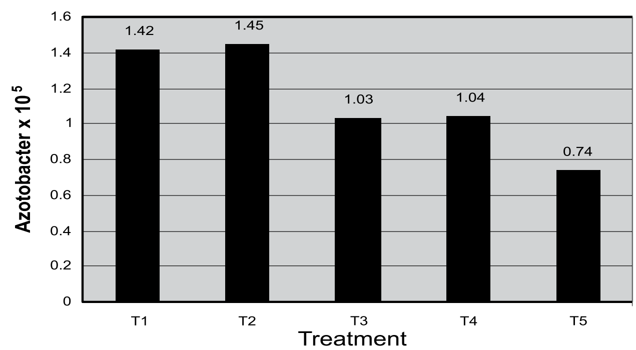

Fig. 3. Effect of different organic nutrient resources on soil *Azotobacter.*

The lower C:N ratio of microbial biomass in organic compared to conventional soil suggests that bacteria are more important than fungi in organic compared to conventional soils. The conventional system receives C inputs mostly from rhizo-deposition and litter fall after harvest. While under organic system, soil is fertilized with large inputs of C as manure.

Highest phosphorous solubilizing bacterial population was observed under the treatment T_2 (1.16×10^4) however the population was lowest in T_5 (1.0×10^4). Highest population observed in T_2 might be due to more

Table 2. Effect of different organic nutrient sources on the nutrient status of soil at harvest in field of strawberry.

Treatment	Available N (kg ha^{-1})	Available P (kg ha^{-1})	Available K (kg ha^{-1})
T1 (FYM + Az + PSB + OC)	360.78 (+26.78)	21.98 (+4.48)	323.88 (+4.38)
T2 (PM + Az + WA + PSB + OC)	370.24 (+36.24)	22.07 (+4.57)	331.79 (+12.29)
T3 (FYM + Azs + PSB + OC)	360.81 (+26.81)	21.96 (+4.46)	322.92 (+3.42)
T4 (PM + Azs + WA + PSB + OC)	370.29 (+36.29)	22.11 (+4.61)	330.76 (+11.26)
T5 (recommended NPK)	335.30 (+01.30)	19.92 (+2.42)	315.80 (-3.70)
Initial soil nutrient status	334.00	17.50	319.50
LSD (p = 0.05)	0.041	0.035	0.097

release of CO_2 during organic matter decomposition. The CO_2 produced in the rhizosphere by the micros organisms has been reported to be involved in increased phosphorous availability to plants. The reaction may be with CO_2 directly or due to formation of carbonic acid which reacts with $Ca_3(PO_4)_2$ forming $Ca(HPO_4)$ or $Ca(HPO_4)_2$ with formation of $CaCO_3$. Application of organic matter has also been reported to improve the physical, chemical and biological properties of soil which provide better environment for the growth and activity of introduced phosphorous solubilizing bacteria (Somani, 11). Use of phosphorus solubilizing bacteria along with diazotrophs, which serves the dual purpose of fixing atmospheric nitrogen besides solubilizing phosphorous. Similar results of increase in the *Azotobacter* population in the rhizosphere of lavender plants when coinoculation with phosphorous solubilizing bacteria was also observed by Ocampo *et al*. (10).

On the basis of above finding it may be concluded that use of organic nutrient resources enhance soil fertility and microbial population in soil as compared to chemical nutrient resources, which can maintain and sustain the crop productivity and soil fertility.

REFERENCES

1. Aaronson, S. 1970. *Experimental Microbial Ecology*. Academic Press, New York, 236 p.
2. Gogoi, D., Kotoky, U. and Hazarika, S. 2004. Effect of biofertilizers on productivity and soil characteristics in banana. *Indian J. Hort.* **61**: 354-56.
3. Gomez, K.A. and Gomez, A.A. 1983. *Statistical procedures for Agricultural Research* (2nd Edn.), John Wiley and Sons, New York.
4. Gunapala, N., Venette, R.C., Ferris, H. and Scow, K.M. 1998. Effect of soil management history on the rate of organic matter decomposition. *Soil Biol. Biochem.* **30**: 1917-27.
5. Jackson, M.L. 1967. *Soil Chemical Analysis*. Asia Publishing House, Bombay, India.
6. Lundquist, E.J., Scow, K.M., Jackson, L.E., Uesugi, S.L. and Johnson, C.R. 1999. Rapid response of soil microbial communities from conventional low input and organic farming system to a wet/dry cycle. *Soil Biol. Biochem.* **31**: 1661-75.
7. Macid, I., Koc, A., Guler, S. and Deligoz, I. 2007. Yield, quality and nutritional status of organically and conventionally strawberry cultivars. *Asian J. Pl. Sci.* **6**: 1131-36.
8. Mathers, A.C. and Goss, D.W. 1979. Estimating animal waste application to supply nitrogen requirements. *J. American Soc. Soil Sci.* **43**: 364-66.
9. Mohandas, S. 1996. Biofertilizer in banana cultivation. Abstracted in the *Conference on Challenges of Banana Production and Utilization in 21st Century* held at NRC on Banana, Trichy, September 24-25, 1996 pp. 33-38.
10. Ocampo, J.A., Barea, J.M. and Montoya, E. 1975. Interactions between *Azotobacter* and phosphobacteria and their establishment in the rhizosphere as effected by the soil fertility. *Canadian J. Microbiol.* **21**: 1160-65.
11. Somani, L. 2004. *Handbook of Biofertilizers.* Agrotech Publishing Academy, Udaipur.
12. Somani, L.L. and Kanthaliya, P.C. 2004. *Soils and Fertilizers at a Glance* (Ist Edn.), Agrotec Publishing Academy, Udaipur, 694 p.
13. Tiwary, D.K., Hassan, M.A. and Chattopadhyay, P.K. 1999. Effect of biofertilizer on soil nutrient status and microbial population in banana (*Musa* AAA subgroup Cavendish cv. Giant Governor) plantation. *Env. Ecol.* **17**: 338-41.

Received: February, 2011; Revised: September, 2011; Accepted: January, 2012