Journal of Applied and Natural Science 9 (1): 55 - 59 (2017)

JANS

Effect of biofertilizers on soil microbial count, nutrient availability and uptake under november sown onion

Dilpreet Talwar[1*], Kulbir Singh[1] and Jagdish Singh[2]

[1]Department of Vegetable Science, Punjab Agricultural University, Ludhiana- 141004 (Punjab), INDIA
[2]Department of Soil Science, Punjab Agricultural University, Ludhiana -141004 (Punjab), INDIA
[*]Corresponding author. E-mail: dsingh381@gmail.com

Received: May 9, 2016; Revised received: August 12, 2016; Accepted: January 6, 2017

Abstract: Biofertilizers improves the soil microbial content, Soil nutrient status and nutrient uptake by plant. In an experiment, fifteen treatments comprised of various combinations of biofertilizers, organic manures and chemical fertilizers were compared to access the impact of different sources of nutrient on performance of onion. The highest soil organic carbon (0.40%) was observed in the treatments T_{12} (Farm Yard Manure (FYM) @ 20 t/ha) and T_{11} (FYM @ 20 t/ha + *Azotobacter* + *Vesicular-Arbuscular Mycorrhizae* (VAM)). Highest bacterial (24.5 X 10^6) and actinomyctes count (29.9 X 10^4) was recorded in T_{11} (FYM @ 20 t/ha + *Azotobacter* + VAM) treatment while highest fungal count (17.5 X 10^3) was observed in T_3 (*Azospirillium* + Recommended dose of NPK) treatment. At the time of harvesting, available nitrogen (N), Available phosphorus (P) and Available potassium (K) were higher in treatment T_3 (*Azospirillium* + Recommended dose of NPK), T_9 (*Azotobacter* + VAM + Recommended dose of NPK) and T_{13} (Poultry Manure @ 5t/ha) treatments respectively than that in other treatments. *Azospirillum* and *Azotobacter* application along with recommended dose of N, P and K improved the fertility status of soil. The N uptake was significantly higher in T_3 treatment (162.6 Kg ha^{-1}) as compared to all other treatments except T_1 and T_9 treatments while P uptake (13.6 Kg ha^{-1}) was significantly higher in T_9 treatment than that in other treatments except T_1, T_3, T_5 and T_7 treatments. The K uptake was significantly higher in T_3 treatment (126.9 Kg ha^{-1}) as compare to all other treatments except T_1 and T_9 treatments. The present study highlights the need of use of biofertilizers along with organic and inorganic manures/fertilizer to enhance the nutrient availability and improve soil health.

Keywords: Chemical fertilizers, Nutrient uptake, Organic carbon, Organic manures, *Vesicular-Arbuscular mycorrhizae*

INTRODUCTION

Onion is used in raw form as well as in dehydrated form to add flavor and taste to Indian foods as a culinary ingredient in wide range of food preparations. It is also used as salad. Onion is also a rich source of minerals like phosphorus, calcium, vitamin C, protein and carbohydrates. Onion is used in pharmaceutical preparations due to its medicinal values. Onion is also known to cure heart diseases as it checks the deposition of cholesterol in blood vessels (Barakade *et al.*, 2011). India is the second largest producer of onion (with area of 117.4 thousand hectare and production of 203.3 lakh tonnes) in the world next only to China and third largest exporter after Netherland and Spain (Anonymous, 2016a). In Punjab, it is cultivated over an area of 8264 hectare with a production of 183 thousand metric tonnes and average productivity of 22.3 tons per hectare (Anonymous, 2016b).

Onion is a shallow rooted and high nutrient demanding vegetable; its productivity depends on soil fertility status and nutrients applied. Under inadequate fertilization considerable yield losses have been reported (Balemi *et al.*, 2007). The increasing cost and decreasing availability of inorganic fertilizers in peak periods is making crop production uneconomical particularly for small and marginal farmers. Therefore it is essential to evolve and adopt a suitable strategy for integrated nutrient supply by using combination of inorganic fertilizers, organic manures and biofertilizers. The use of nitrogen fixing microbes will help in reducing the dependence on urea, while phosphorus solubilizing microbes will increase the availability of P from relatively unavailable pools, thus use of integrated source of nutrients will help in curtailing over dependence on inorganic fertilizers alone for nutrient supply to onion.

Biofertilizers are products containing live or latent microorganisms that are capable of mobilizing nutrients from unavailable form to available form through biological processes (Gaur, 2010). Proper use of biofertilizers on farm organic wastes and microbial inoculants help in maintaining the fertility of agricultural soils (Kannaiyan, 2002). *Azotobacter* and *Azospirillium* are free living bacteria which colonize near the root zone and enhance the available nitrogen in the soil by N fixation, whereas *phosphate solubilizing bacteria* (PSB) solublize the unavailable phosphorus in the soil and make it available for the plants (Devi *et al.*, 2003, Gupta and Samnotra, 2004, Yadav *et al.*, 2004, Singh and Singh, 2007, Kachari and Korla, 2009).*Vesicular-Arbuscular Mycorrhizae* (VAM) help in the development of stronger root system, increase root surface area, improve growth (Zandavalli *et al.*, 2004), nutrient uptake and increased tolerance of host roots to soil borne pathogens (Nelson and Achar, 2001, Singh and Singh, 2007). The present investigation was initiated to access the effect of biofertilizers, organic manures and synthetic fertilizers on microbial count, nutrient availability and uptake by onion plant.

MATERIALS AND METHODS

The present investigation was carried out at Vegetable Research Farm of Punjab Agricultural University, Ludhiana during the *rabi* season 2013-14. The soil was loamy sand in texture with pH 7.6. Soil was low in organic carbon and nitrogen, high in phosphorus and medium in potassium. The onion cultivar Punjab Naroya was sown in nursery beds during November and transplanted in January with space of 15 cm X 7.5 cm between rows and plants respectively. The experiment was carried out in a randomized block design with fifteen treatments replicated thrice. The detail of treatments has been given in Table 1.

Organic carbon was determined by Walkley and Black method (1934). Bacterial count was determined by using serial dilution pour plate method (Gerhardt *et al.*, 1981). Actinomycetes count was determined by using serial dilution pour plate method (Nonomura and Ohara, 1969). Fungi count was determined by using serial dilution pour plate method (Kanwar *et al.*, 1997). Available Nitrogen in soil was estimated by alkaline potassium permanganate method by Subbiah and Asija (1965). Available Phosphorus in soil was estimated by method given by Olsen *et al.* (1954). Available Potassium in soil was estimated with ammonium acetate and estimated by Hange's flame photometer (Jackson, 1967).

The N, P and K uptake by bulb was computed by multiplying the percentage N, P and K content in bulb with bulb dry mass as given in the equation.

Nutrient uptake by bulb (Kg ha^{-1}) = nutrient content (%) x bulb dry mass (Kg ha^{-1})

Plant N, P and K uptake was computed by multiplying the N, P and K content with plant dry mass. Finally total N, P and K uptake was calculated by sum of N, P and K uptake by bulbs and N, P and K uptake by plants, respectively.

RESULTS AND DISCUSSION

Microbial count of soil at the time of transplanting and harvesting: At the time of transplanting, organic carbon in the soil was 0.26 per cent, bacterial count was 20.5 X 10^6, Actinomyctes count was 24.3 X 10^4 and fungus count was 15 X 10^3 (Table 2). After harvesting, biofertilizers improved the soil organic carbon status and highest soil organic carbon was found in T_{12} (FYM @ 20 t ha^{-1}) andT_{11} (FYM @ 20 t ha^{-1} along with *Azotobacter* and VAM) that was 0.40 per cent followed by T_{13} (Poultry manure @ t ha^{-1}) that was 0.38 per cent. Highest number of bacteria was found in T_{11} where FYM along with *Azotobacter* and VAM was applied (24.5 X 10^6) followed by T_{13} where poultry manure was applied @ 5 t ha^{-1} (23.8 X 10^6) (Table 2). Highest number of Actinomyctes were found in treatment T_{11} (FYM along with *Azotobacter* and VAM) that was 29.9 X 10^4 and T_{12} (FYM@ 20 t ha^{-1}) that was 29.1 X10^4. The application of *Azospirillum* along with recommended dose of fertilizers (T_3) had highest number of fungi microorganism (17.5 X 10^3) at the time of harvesting followed by T_7 (16.8 X 10^3) where VAM along with recommended dose of fertilizers was applied (Table 2). Thus, biofertilizers had improved the microorganisms in the soil. FYM treatments improved the microbial count at harvesting time due to slow releasing of nutrients. The plots without inoculation of biofertilizers and application of chemical fertilizer did not differ significantly than inoculated ones initially at time of transplanting. At harvesting, application of chemical fertilizer alone showed lower microbial count for bacterial group compared to inoculated ones. The results corroborate with the finding of Mandic *et al.* (2011) and Javoreková *et al.* (2015) who reported that the application of biofertilizers alone with organic manures resulted in enhanced microbial activity.

Nutrient status of soil: At the time of transplanting N level in soil was140 kg ha^{-1}, P level was 32 kg ha^{-1} and K level was 150 kg ha^{-1}. N level in soil at time of harvesting was maximum in treatment T_3 (*Azospirillum* and recommended dose of N, P and K) that was 156 kg ha^{-1} followed by treatment T_1 (*Azotobacter* along with recommended dose of fertilizers) that was 154 kg ha^{-1}, treatment T_9 (*Azotobacter* along with VAM and recommended dose of N, P and K) and treatment T_{12} (FYM @ 20 t ha^{-1}) that was 150 kg ha^{-1} and minimum level of N in soil was found in treatment T_{15} (control) that was 136 kg ha^{-1}(Table 2). While P level was found maximum in treatment T_9 (*Azotobacter* along with VAM and recommended dose of N, P and K) that was 42 kg ha^{-1} followed by treatment T_7 (VAM along with recommended dose of fertilizers), treatment T_{11} (FYM @ 20 t ha^{-1} along with *Azotobacter* and VAM) and treatment T_{13} (Poultry Manure @ 5t ha^{-1}) that was 40 kg ha^{-1} and minimum level of P in soil was found in treatment T_{15} (control) that was 30 kg ha^{-1}. While K level was found maximum in treatment T_{13} (poultry manure @ 5 t ha^{-1}) that was 160 kg ha^{-1} followed by treatment T_{11} (FYM @ 20 t ha^{-1} along with *Azotobacter* and VAM) and treatment T_{12} (FYM @ 20 t ha^{-1}) that was 158 kg ha^{-1} and minimum level of K in soil was found in treatment T_{15} (control) that was

Table 1. Detail of treatments

Treatments	Treatment detail
T_1	*Azotobacter* + Recommended dose of NPK
T_2	*Azotobacter* + 75% of recommended dose of N + Recommended dose of PK
T_3	*Azospirillium* + Recommended dose of NPK
T_4	*Azospirillium* + 75% of recommended dose of N + Recommended dose of PK
T_5	*Phosphate Solubilizing Bacteria* (PSB) + Recommended dose of NPK
T_6	*Phosphate Solubilizing Bacteria* (PSB) + 75% of recommended dose of P + Recommended dose of NK
T_7	*Vesicular-Arbuscular Mycorrhizae* (VAM) + Recommended dose of NPK
T_8	*Vesicular-Arbuscular Mycorrhizae* (VAM) + 75% of recommended dose of P + recommended dose of NK
T_9	*Azotobacter* + *Vesicular-Arbuscular Mycorrhizae* (VAM) + Recommended dose of NPK
T_{10}	*Azotobacter* + *Vesicular-Arbuscular Mycorrhizae* (VAM) + 75% of recommended dose of N + 75% recommended dose of P + recommended dose of K
T_{11}	FYM @ 20 t/ha + *Azotobacter* + *Vesicular-Arbuscular Mycorrhizae* (VAM)
T_{12}	FYM @ 20 t/ha
T_{13}	Poultry Manure @ 5t/ha
T_{14}	Recommended dose of NPK
T_{15}	Control

Recommended dose of fertilizers (100:50:50, N: P: K kg per hectare).

146 kg ha^{-1}(Table 2).

Biofertilizers improved the N status of the soil due to N fixation by *Azotobacter* and *Azospirillum*. These bacterium convert the unavailable form of nitrogen (nitrate) to available form of nitrogen (nitrite), thus improved the nitrogen availability in the soil (Kalyani *et al.*,1992). PSB and VAM improved the phosphorus status in the soil by solublization process. PSB and VAM solublize the unavailable form of phosphorus into available form (Jayathilake *et al.,* 2002). Our results are in conformity with Mengistu and Singh (1999). Biofertilization had moderately enhanced the fertility level of the soil after crop harvest. Application of *Azospirillum* and VAM resulted in increase 13.81 % soil N and 13.41 % soil P as compared to initial fertility status of the soil of onion crop. Similarly, Nelson and Achar (2001), Devi *et al.* (2003), Yadav *et al.,* (2004), Gupta and Samnotra (2004), Singh and Singh (2007) and Kachari and Korla (2009) also reported increase in soil N and P with the application of biofertilizers alone with manures.

Nutrient uptake

Total nitrogen uptake: The data pertaining to the effect of different treatments on the total uptake of N, P and K nutrients has been presented in Table 3. Application of *Azospirillum* along with recommended dose of N, P and K (100 Kg N, 50 Kg P and 50 Kg K per ha^{-1}) resulted in maximum total nitrogen uptake (162.6 Kg ha^{-1}) which was statistically at par with *Azotobacter* along with recommended dose of fertilizers (T_1) and *Azotobacter* along with VAM and recommended dose of fertilizers (T_9) and was significantly higher from rest of treatments. Among organic manure, maximum N uptake was recorded with farm yard manure (T_{12}) that was 115.2Kg ha^{-1} but the difference among other organic manure treatments was non-significant. Total N uptake attained with treatment T_{14} where recommended dose of fertilizers (105.7 kg ha^{-1}) was significantly higher than treatment T_{15} (53.3 kg ha^{-1}) where no fertilizer was applied.

Total phosphorus uptake: The maximum total phosphorus uptake of 13.6 Kg ha^{-1} was attained in treatment T_9 followed by treatment T_6 (PSB along with recommended dose of fertilizers) that was 12.6 Kg ha^{-1} which was significantly higher than rest of treatments except treatment T_1, T_3, T_5 and T_7. The minimum total uptake of 2.9 Kg ha^{-1} phosphorus was observed in control (T_{15}) that was significantly lower from treatment T_9 where maximum P content was found. Total uptake of P attained with application of recommended dose of fertilizers (T_{14}) was statistically at par with treatment T_{15}.

Total potassium uptake: Application of *Azospirillum* along with N, P and K (T_3) resulted in maximum total potassium uptake of 126.9 Kg ha^{-1}(Table 3) which was significantly higher than rest of treatments except T_1 and T_9. Minimum total potassium uptake of 59.8 Kg ha^{-1} was observed in control. Total K uptake attained with T_{14} where recommended dose of fertilizers (86.3 Kg ha^{-1}) was significantly higher from T_{15} where no fertilizer (59.8 kg ha^{-1}) was applied.

The application of full dose of nitrogen along *Azospirillum* and *Azotobacter* showed significantly higher total nitrogen uptake as compared to reduced

Table 2. Effect of different treatments on Microbial count and Nutrient status of soil at the time of transplanting and harvesting

Treatments	O.C. %	Microbial count			Soil nutrient status (kg/ha)		
		Bacterial (10^6)	Actinomyctes (10^4)	Fungi (10^3)	N	P	K
At Transplanting time	0.26	20.5	24.3	15.0	140	32	150
At harvesting time							
T_1	0.30	19.2	25.8	16.3	154	38	155
T_2	0.28	18.3	25.1	15.2	145	35	150
T_3	0.31	20.2	26.3	17.5	156	36	156
T_4	0.28	22.4	26.1	17.0	146	34	148
T_5	0.32	21.7	28.0	16.5	142	38	150
T_6	0.27	19.4	27.4	16.1	140	36	146
T_7	0.31	19.6	26.6	16.8	148	40	152
T_8	0.28	19.1	26.2	16.2	145	35	148
T_9	0.30	20.8	26.8	16.1	150	42	156
T_{10}	0.28	20.4	26.2	16.3	146	38	155
T_{11}	0.40	24.5	29.9	16.2	150	40	158
T_{12}	0.40	23.7	29.1	15.7	150	38	158
T_{13}	0.38	23.8	28.3	16.1	148	40	160
T_{14}	0.32	19.1	23.9	16.7	142	36	152
T_{15}	0.26	20.5	24.3	15.0	136	30	146

Table 3. Effect of different treatments on total nutrient uptake of onion

Treatments	Nutrient uptake (Kg ha^{-1})		
	Total N	Total P	Total K
T_1	154.0	11.5	119.9
T_2	119.5	9.4	108.4
T_3	162.6	12.4	126.9
T_4	133.8	10.1	105.8
T_5	87.7	12.6	102.1
T_6	78.7	8.6	95.9
T_7	109.2	12.0	104.9
T_8	76.5	8.8	84.8
T_9	142.1	13.6	125.4
T_{10}	103.2	5.9	91.9
T_{11}	103.1	5.1	82.8
T_{12}	115.2	5.6	86.1
T_{13}	98.8	6.5	84.0
T_{14}	105.7	4.9	86.3
T_{15}	53.3	2.9	59.8
CD (P = 0.05)	24.5	3.26	13.4

nitrogen application. The higher total nitrogen uptake could be due to the improved availability of nitrogen to plants due to N fixation by biofertilizers that helped in improvement vegetative growth and reproductive cycle. This may also be due to increased dry matter production due to the effects of plant growth substances and nitrogen fixation or assimilation by *Azospirillum* (Devi *et al.*, 2003, Gupta and Samnotra, 2004). Increase in P uptake with application of PSB and VAM may be attributed to accelerated root development and enhanced root surface area which might have resulted in effective mining of soil phosphorus and higher availability of P in soil (Kachari and Korla, 2009).

Conclusion

The inorganic/chemical fertilizers are costly, result in soil and environmental pollution and also pose human health hazards, while, biofertilizers are eco-friendly, non-toxic and relatively cheaper natural products. The integrated use of biofertilizers along with organic and inorganic manures/fertilizers will help in improving nutrient use efficiency, protect nutrients against losses (such as leaching and volatilization losses) and reduce soil and environmental degradation. The results revealed that highest soil organic carbon (0.40%) was observed in the treatments T_{12} and T_{11}. Highest bacterial and actinomyctes count was recorded in T_{11} treatment while highest fungal count (17.5 X 10^3) was observed in T_3 treatment. The soil available nitrogen (N), Available phosphorus (P) and Available potassium (K) were higher in treatment T_3, T_9 and T_{13} treatments, respectively than that in other treatments. The N uptake was significantly higher in T_3 treatment (162.6 Kg ha^{-1}) as compare to all other treatments except T_1 and T_9 treatments while P uptake (13.6 Kg ha^{-1}) was significantly higher in T_9 treatment than that in other treatments except T_1, T_3, T_5 and T_7 treatments. The K uptake was significantly higher in T_3 treatment (126.9 Kg ha^{-1}) as compare to all other treatments except T_1 and T_9 treatments. The application of biofertilizers along with recommended dose of fertilizers not only improves nutrient availability but also improves the yield and protects the soil against degradation.

REFERENCES

Anonymous (2016a). Area and production of onion in India. Retrieved July, 26, 2016 from www.indiastat.com.

Anonymous (2016b). *Package of Practices for cultivation of Vegetables.* pp 1-2, 59-62. Punjab Agricultural University, Ludhiana.

Balemi, T., Pal, N. and Kumar, A. (2007). Response of onion (*Allium cepa* L.*)* to combined application of biological and chemical nitrogenous fertilizers. Acta Agriculturae Scandinavica, 89: 107-114

Barakade, A.J., Lokhande,T.N. and Todkari, G.U. (2011). Economics of onion cultivation and its marketing pattern in Satara district of Maharashtra. *International Journal of Agricultural Statistics,* 3: 110-117

Devi, H.J., Maity, T.K. and Paria, N.C. (2003). Effect of different sources of nitrogen on yield and economics of cabbage. *Environment and Eco*logy, 21: 878-888

Gaur, V. (2010). Biofertilizer – Necessity for Sustainability. *Journal of Advance Development,* 1:7-8

Gerhardt, P., Murray, R.G.E., Costilow, R.N., Wood, W.A., Nester, E.W., Kreig, N.R. and Phillips, G.B. (1981). *Manual of methods for general bacteriology*, Washington: American Society for Microbiology.

Gupta, A.K. and Samnotra, R.K. (2004). Effects of biofertilizers and nitrogen on growth, quality and yield of cabbage (Brassica oleracea var. capitata) cv. Golden acre. *Environment and Ecology,* 22: 551-553

Jackson, M.L. (1967). *Soil Chemical Analysis*, pp.134-65, 429-51. Prentice Hall of India Pvt. Ltd. New Delhi.

Javoreková, S., Maková, J., Medo, J., Kovácsová, S., Charousová, I., Horák, J. (2015). Effect of bio-fertilizers application on microbial diversity and physiological profiling of microorganisms in arable soil. *Eurasian Journal of Soil Science*, 6: 54-61

Jayathilake, P.K.S., Reddy,I.P., Srihari, D. and Reddy, R. (2002). Effect of nutrient management on growth, yield and yield attributes of *rabi* onion (*Allium cepa* L.). *Vegetable Science*, 29: 184-185

Kachari, M. and Korla, B.N. (2009). Effect of biofertilizers on growth and yield of cauliflower cv. PSBK-1. *Indian Journal of Horticulture*, 66: 496-501

Kalyani, D.P., Sankar, C.R., Pillai, R.N. and Parsad, D.M. (1992). Studies on the effect of nitrogen and *Azospirillum* on dry matter and nutrient uptake of cauliflower. *Vegetable Science,* 19: 147-151

Kannaiyan, S. (2002). Biofertilizers for sustainable crop production, In: Kannayan (ed) *Biotechnology of Biofertilizers.* pp. 9-49. Narosa Publication House, New Delhi.

Kanwar, S.S., Gupta, M.K. and Punj, V. (1997). *Laboratory manual of basic microbiology,* Department of Microbiology, Collage of Basic Sciences, Himachal Pradesh Krishi Vishvavidyala, Palampur.

Mandic, L., Djukic, D., Beatovic, I., Jovovic, Z., Pesakovic, M. and Stevovic, V. (2011). Effect of different fertilizers and biofertilizers on the microbial activity and productivity of soil under potato cultivation. *African Journal of Biotechnology,* 10:6954-6960

Mengistu, F. and Singh, N. (1999). Effect of biofertilizers on growth, yield and nutrient uptake of onion (*Allium cepa* L.). *Vegetable Science* 26: 193-195

Nelson, R. and Achar, P.N. (2001). Stimulation of growth and nutrient up take by VAM fungi in *Brassica oleracea* var. *capitata. Plant Biology,* 4:277-281

Nonomura, H. and Ohara, Y. (1969). Distillation of actinomycetes in soil. A cultural method effective for both preferential isolation and enumeration of *Microbiospora* and *Streptosporangium* strains in soil. *Hakko Kogaku Kaishi,* 49: 895-903

Olsen, S.R., Cole, C.V., Watanabe, F.S. and Dean, L.A. (1954). *Estimation of available phosphorus in soils by extraction with sodium bicarbonate*. United States Department of Agriculture. pp 939. U. S. Govt. Printing Office, Washington D C.

Singh, D. and Singh, A. (2007). Role of biofertilizers in vegetable production. *Intensive Agriculture*. pp. 24-26. Krishi Vigyan Kendra, Kumher (Bhartapur) Rajasthan.

Subbiah, B.V. and Asija, C.L. (1965). A rapid procedure for the estimation of available nitrogen in soils. *Current Science,* 2: 259-268

Walkley, A. and Black, C.A. (1934). An examination of the Degtijareff method for determining soil organic matter and a proposed modification of the chromic acid titration method. *Indian Journal of Soil Science,* 37: 27-38.

Yadav, B.D., Khandelwal, R.B., and Sharma, Y.K. (2004). Use of biofertilizers (Azospirillum) in onion. *Haryana Journal of Horticulture Science,* 33: 281-283

Zandavalli, R.B.D., Dillenburg, L.R. and Desouza, P.V.D. (2004). Growth responses of *Araucaria angustifolia* inoculation with the mycorrhizal fungus *Glomusclarum. Applied Soil Ecology,* 25:245-255