International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2017; 5(4): 1251-1254

Received: 01-05-2017
Accepted: 02-06-2017

Sunita Kumari
Department of Horticulture, G.B. Pant University of Agriculture and Technology, Pantnagar, Uttrakhand, India

VM Prasad
Department of Horticulture, Sam Higginbottom University of Agriculture Technology and Sciences, Allahabad, Uttar Pradesh India

Correspondence
Sunita Kumari
Department of Horticulture, G.B. Pant University of Agriculture and Technology, Pantnagar, Uttrakhand, India

Effect of bio and chemical fertilizers on plant growth and yield of petunia (*Petunia hybrida*) var. Picotee

Sunita Kumari and VM Prasad

Abstract
The present investigation conducted at the Department of Horticulture, Sam Higginbottom university of Agriculture, Technology and Sciences, Allahabad, (U.P.) during the winter season 2014-2015. The results revealed that treatments T_{13} (Azotobacter + PSB +PMB + N_{120}:P_{90}:K_{60}) had significant response most of the traits studied. The maximum plant height (25.20 cm), plant spread (43.43 cm), number of branches per plant (17.66), number of leaves per plant (300.30), yield of flower per plant (81.30 gm), yield of flower per plot (731.76 gm), flower yield per hectare (4.32 t/ha) and the economics reveals that maximum benefit - cost ratio (1:2.46) were produced by the treatment T_{13} (Azotobacter + PSB +PMB + $N_{120:}$ $P_{90:}$ K_{60}).

Keywords: *Petunia hybrida*, PSB, KMB, *Azotobacter*, Bio-fertilizer and yield

Introduction

Petunia (*Petunia hybrida* Vilm) belongs to the family Solanaceae and it is originated in South America. Petunia plants are perennials but are generally grown as half-hardy annuls in open gardens. The common garden petunia (*Petunia* × *atkinsiana*) is an ornamental plant whose showy trumpet-shaped flowers make it popular for summer flower beds and window boxes. It is a versatile annual with showy flowers and has the longest season of bloom of all garden annuals. A wide range of colors and forms has been developed over the years, which are classified on the basis of characteristics of flowers.

Presently the indiscriminate use of chemical fertilizers and pesticides has caused tremendous harm to the environment as well as human health (Talukdar *et. al.*, 2003). The safest answer to this is the use of bio-fertilizer, an environmentally friendly bio-fertilizer which is now used in most countries for sustainable horticulture. Bio fertilizers are widely used to accelerate those microbial processes which augment the availability of nutrients that can be easily assimilated by the plants. The most striking relationship that these have with plants is symbiosis, in which the partners derive benefits from each other (Wand and Ling, 1997).They improve soil fertility by fixing the atmospheric nitrogen and solubilizing insoluble phosphates and produce plant growth-promoting substances in the soil (Mazid and Khan, 2015) [6].

Bio-fertilizers are microorganisms that enrich the nutrients quality of soil (Vessey, 2003) [18]. The main sources of bio-fertilizers are bacteria, fungi and cynobacteria (blue green algae) to increase the fertility of soil, has been identified as harmless input help in safeguarding the soil health and also the quality of crop products. Biofertilizers add nutrients through the natural processes of nitrogen fixation, solubilising phosphorus, and stimulating plant growth through the synthesis of growth promoting substances. They are also environment friendly and responsible for continuous availability of nutrients from natural sources (Suhag, 2016) [16].

One of the dominant non-symbiotic nitrogen fixing heterotrophic bacterium in Indian soils is *Azotobacter* spp. The ability to fix elemental nitrogen is a vital physiological characteristic of *Azotobacter* spp. The range fixing is 2-15 mg N fixed in one gm of carbon source utilized, although higher values have been reported. The ability of *Azotobacter* spp. to synthesize and secrete Thiamine, Riboflavin, pyridoxine, and cyanocobalamin and Indole acetic acid like substances has well documented (Davies, 2010) [2]. It can utilize a variety of carbon sources (mono, di and certain polysaccharides), organic acids of the fatty and aromatic series, ethyl alcohol, glycerol, mannitol, vapours of acetone and other waste organic acids (Sahoo and Singh, 2005) [20].

Phosphate Solubilizing Bacteria (PSB) is a group of beneficial bacteria capable of hydrolyzing organic and inorganic phosphorus from insoluble compounds. Some PSB produce phosphatase like phytase that hydrolyses organic forms of phosphate compounds efficiently. The use of phosphate solubilizing bacteria as inoculants simultaneously increases Phosphorus uptake by the plant and crop yield. Strains from the genera *Pseudomonas, Bacillus* and *Rhizobium* are among the most powerful phosphate solubilizers (Satyaprakash, 2017) [9].

Potash Mobilizing Bacteria (PMB) has great role as for plant growth it is usually abundant in soil. Total Potash Mobilizing Bacteria contents in soil range between 3000 to 100,000 kg/ha in the upper 0.2 m of the soil layer. PMB plays a vital role in the formation of amino acids and proteins from ammonium ions, which are absorbed by roots, from the soil. PMB are also responsible for the transfer of carbohydrates, proteins, etc. from the level to the roots. Potash Mobilizing Bacteria are also known to produce amino acids, vitamins and growth promoting substances like Indole acetic acids and Gibberellins (Ponmurugan and Gopi, 2006) [8].

Materials and methods

The experiment was laid out in Randomized Block Design (RBD) with thirteen treatments and replicated thrice. The recommended doses of nitrogen, phosphorus and potassium fertilizer were 120:90:60 per hectare and three bio fertilizers *Azotobacter*, phosphorus solubilising bacteria and potash mobilizing bacteria @ 5 Kg/ha. Seedlings of petunia were raised in the beds of the nursery. The treatment combinations were T_1 (Absolute control), T_2 (*Azotobacter* + $N_{60:}$ $P_{90:}$ K_{60}), T_3 (*Azotobacter* + $N_{120:}P_{90:}K_{60}$), T_4 (PSB + $N_{60:}$ $P_{90:}$ K_{60}), T_5 (PSB + $N_{120:}P_{90:}K_{60}$), T_6 (PMB + $N_{60:}$ $P_{90:}$ K_{60}), T_7 (PMB + $N_{120:}P_{90:}K_{60}$), T_8 (*Azotobactor* + PSB + $N_{60:}$ $P_{90:}$ K_{60}), T_9 (*Azotobactor* + PSB + $N_{120:}P_{90:}K_{60}$), T_{10} (PSB + PMB + $N_{60:}$ $P_{90:}$ K_{60}), T_{11} (PSB + PMB + $N_{120:}P_{90:}K_{60}$), T_{12} (*Azotobactor* + PSB + PMB + $N_{60:}$ $P_{90:}$ K_{60}) and T_{13} (*Azotobactor* + PSB + PMB + $N_{120:}P_{90:}K_{60}$). The observations were recorded plant height (cm), plant spreading (cm), number of branches per plant, number of leaves per plant, number of flowers per plant, flower yield per plant(gm), flower yield per plot(gm), flower yield per hectare, cost of cultivation(Rs), net income (Rs), gross income (Rs) and benefit - cost ratio.

Results and discussion

Plant height (cm)

The maximum plant height (23.73cm) was recorded in treatment T_{13}- *Azotobactor* + PSB + PMB + $N_{120:}$ $P_{90:}$ K_{60} followed by T_{12}- *Azotobactor* + PSB + PMB + $N_{60:}$ $P_{90:}$ K_{60} (21.13cm). Minimum plant height (19.46cm) was recorded in treatment T_{1-} control.

The maximum plant height was *Azotobactor* + PSB + PMB + $N_{120:}P_{90:}K_{60}$ may be attributed due to the presence of non-symbiotic nitrogen fixing bacteria which might have given the boosting effect to the roots of the plant and by stimulating plant growth through synthesis of growth promoting substances. These findings are in conformity with the results of Kathiresan (1999) and Rajadurai *et al*. (2000), Hoda *et al.* (2014) [4] in Petunia and Sarwa *et al.* (2014) [17] in Petunia and Barman *et al.* (2003) in Tuberose cv. single.

Plant spreading (cm)

The maximum plant spread (43.43cm) was recorded in treatment T_{13}- *Azotobactor* + PSB + PMB + $N_{120:}$ $P_{90:}K_{60}$followed by T_{12}- *Azotobactor* + PSB + PMB + $N_{60:}$ $P_{90:}$ K_{60} (40.66 cm). Minimum plant spread (35.83 cm) was recorded in treatment T_1 control. The ability of *Azotobactor* spp. to synthesize and secrete Thiamine, Riboflavin, Pyridoxine, Cyanocobalamin, and Indole acetic acid like substances which in turn increased the nutrient absorption from the soil leading to the luxuriant vegetative growth. Similar finding was found by Sarwa *et al.* (2014) [17] in Petunia and Koley and Pal (2011) [5] in tuberose.

Number of branches per plant

The maximum number of branches per plant (17.66) was recorded in treatment T_{13}- *Azotobactor* + PSB + PMB + $N_{120:}$ $P_{90:}K_{60}$ followed by T_{12}- *Azotobactor* + PSB + PMB + $N_{60:}$ $P_{90:}$ K_{60} (16.20cm). Minimum number of branches per plant (12.06) was recorded in treatment T_1 (Control). Besides nitrogen fixing plants reported that *Azotobactor* was found to be synthesizing various growth promoting substances like IBA, NAA, which help in enhancing the root biomass. Similar results were finding conformity by Narasimha and Haripriya (1998) in Crossandra, Chaitra, (2006) [1] in China aster and Pandey *et al.* (2017) [7] in dahlia

Number of leaves per plant

The maximum number of leaves per plant (300.80) was recorded in treatment T_{13}- *Azotobactor* + PSB + PMB + $N_{120:}P_{90:}K_{60}$ followed by T_{12}- *Azotobactor* + PSB + PMB + $N_{60:}$ $P_{90:}$ K_{60} (275.95). Minimum number of leaves per plant (210.93) was recorded in treatment T_1-control. The increased production of leaves helps to elaborate more photosynthesis and faster the maturity. The PSB, *Azotobacter* or *Azospirillium* alone or in combination produces growth promoting substances such as IAA or GA like substances Vit B12, thiamine, riboflavin (B_2) etc. which might have helped to increase number of leaves.

Similar results were finding conformity by Narasimha and Haripriya (1998), Santhi *et al*. (1998) [16], Sarwa *et al.* (2014) [17] and Yadav *et al.* (2005) [20] on Tuberose cv. Double.

Yield of flower per plant (gm)

Data given in (Table 1) revealed that significantly highest yield of flower per plant was recorded in treatment T_{13}- *Azotobactor* + PSB + PMB + $N_{120:}P_{90:}K_{60}$ (81.30g) than all other treatment. This treatment was followed by T_{12-} *Azotobactor* + PSB + PMB + $N_{60:}$ $P_{90:}$ K_{60} (73.90 g) and minimum flower yield (40.11 g) was obtained in treatment T_{1-} Control. T_{13-} *Azotobactor* + PSB + PMB + $N_{120:}P_{90:}K_{60}$ gave the best response due to fixation of phosphorus and potash in soil which is mostly unavailable to crops because of its low solubility. The effect of *Azotobactor* is generally due to the production of organic acids, vitamins, growth promoting substances like IAA, IBA which help in better growth of plants.

The findings are in conformity with the result of Raja and Haripriya (2001) [15] while working on Crossandra, Jayamma (2008) [4] in jasminum and Pandey *et al.* (2017) [7] in dahlia.

Yield of flower per plot (gm)

From the data given in (Table 1.) it is observed that significantly highest yield of flower per plot was recorded in treatment T_{13}-*Azotobactor* + PSB + PMB + N_{120}: P_{90}: K_{60} (731.76g) as compared to other treatment. This treatment was followed by T_{12}- *Azotobactor* + PSB + PMB + $N_{60:}$ $P_{90:}$ K_{60} (665.18g), and minimum flower yield (361.07g) was obtained in treatment T_1 Control.

Yield of flower per hectare (t)

Data given in (Table 1.) revealed that significantly highest yield of flower per hectare was recorded in treatment T_{13}- *Azotobacter* + PSB + PMB + $N_{120:}P_{90:}K_{60}$ (4.32t) than all other treatment. This treatment was followed by T_{12} (3.93t), T_9 (3.78t), T_5 (3.52t), and minimum flower yield (2.14t) was obtained in treatment T_1 Control. Similar result was also reported by Ravichandran (1991) [12], Ravichandran and Pappiah (1995) [13] in Crossandra, Santhi *et al.*, (1998) [16], Raja and Haripriya (2001) [15] in Crossandra.

Economics of different treatments

The economics of different treatments viz. cost of cultivation (Rs. /ha). Yield of flower (t/ha), gross return, net return and Cost: Benefit Ratio has been worked out and presented in table 1.

Maximum cost of cultivation (43899.17 Rs. /ha) was T_{13-} *Azotobacter* + PSB + PMB + $N_{120:}$ $P_{90:}K_{60}$ and minimum was control (36300.00 Rs. /ha).

Maximum gross return was treatment T_{13}- *Azotobacter* + PSB + PMB + $N_{120:}$ $P_{90:}K_{60}$ (Rs.108249/ha) followed by T_{12}- *Azotobacter* + PSB + PMB + $N_{60:}$ $P_{90:}$ K_{60} (Rs.98400/ha) and the minimum gross return (Rs.53414 /ha) was recorded treatment T_1 Control.

Maximum net return was treatment T_{13}- *Azotobacter* + PSB + PMB + $N_{120:}$ $P_{90:}K_{60}$ (Rs.64350 /ha) followed by T_{12}- *Azotobacter* + PSB + PMB + $N_{60:}$ $P_{90:}$ K_{60} (Rs.55362/ha) and the minimum net return (Rs.17114 /ha) was recorded treatment T_1-Control.

Benefit - cost ratio was Maximum in treatment T_{13}- *Azotobacter* + PSB + PMB + $N_{120:}$ $P_{90:}K_{60}$ (1:2.46) followed by T_{12}- *Azotobacter* + PSB + PMB + $N_{60:}$ $P_{90:}$ K_{60} (1:2.28) and the minimum benefit- cost ratio was found in treatment T_1 control (1:47).

Maximum yield flower, gross return, net return and cost: benefit ratio was observed in treatment T_{13}- *Azotobacter* + PSB + PMB + $N_{120:}$ $P_{90:}K_{60}$.

Table 1: Effect of different nitrogen doses, Azotobacter, PSB and PMB on plant growth, yield and economics of petunia (Petunia hybrida) cv. Picotee

Treatments	Plant height (cm) at 120th days	Plant spreading (cm) at 120th days	Number of branches at 120th days	Number of leaves at 120th days	Yield of flower per plant (gm)	Yield of flower per plot (gm)	Yield of flower per hectare (t)	Cost of cultivation (Rs./ ha)	Gross income profit (Rs. /ha.)	Net profit (Rs./ha)	Benefit - cost ratio
T_1	19.46	35.83	12.06	210.03	40.11	361.07	2.14	36300.00	53413.58	17113.58	1:1.47
T_2	23.06	37.76	13.40	255.36	58.26	524.43	3.10	42538.33	77578.25	35039.92	1:2.12
T_3	23.40	39.03	14.40	267.06	61.46	553.17	3.36	43399.17	81830.25	38431.08	1:1.88
T_4	21.13	36.73	12.60	241.03	59.51	535.63	3.16	42538.33	79235.08	36696.75	1:1.86
T_5	21.66	37.26	12.26	250.90	66.29	596.65	3.52	43399.17	88278.58	44879.41	1:2.03
T_6	20.26	36.46	13.06	239.10	58.55	527.02	3.11	42538.33	77961.91	35423.58	1:1.83
T_7	21.46	38.00	13.93	247.16	61.05	549.62	3.24	43399.17	81291.66	37892.49	1:1.87
T_8	22.00	38.56	14.60	274.56	66.69	600.29	3.54	42788.33	88800.75	46012.42	1:2.07
T_9	23.53	39.43	15.26	285.93	71.02	639.26	3.78	43649.17	94565.00	50915.83	1:2.16
T_{10}	19.80	38.03	12.06	247.63	62.06	558.65	3.30	42788.33	82640.41	39852.08	1:1.93
T_{11}	21.13	38.33	12.46	256.63	65.05	585.53	3.46	43649.17	86617.66	42968.49	1:1.98
T_{12}	23.73	40.66	16.20	275.93	73.90	665.18	3.93	43038.33	98400.33	55362.00	1:2.28
T_{13}	25.20	43.43	17.66	300.80	81.30	731.76	4.32	43899.17	108248.41	64349.24	1:2.46
C.D S(P=0.05)	1.86	1.05	1.07	10.16	4.30	38.75	0.22				

Conclusions

It is concluded that, the application of *Azotobacter* + PSB +PMB + $N_{120:}$ $P_{90:}$ K_{60} (T_{13}), was found effective in enhancing the growth, yield of flower (4.32t) and yield attributing parameters. The cost benefit ratio (1:2.46) also found highest cost ratio for petunia (*Petunia hybrida*). The experiment may be repeated to substantiate the results; hence it is one reason finding.

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