Original Research Article

Response of Biofertilizers on Growth and Yield Parameters of Brinjal (*Solanum melongena* L.) cv. Azad B-3

Abstract

The present experiment was carried out during *kharif* 2017-18 at Vegetable Research Farm, Department of Vegetable Science, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur. The experiment was conducted in Randomized Block Design (RBD) with ten treatments and each replicated thrice. The treatments were T_1 (Control), T_2 (PSB + *Azotobacter* +75% P + Full N&K), T_3 (*Azotobacter* + *Azospirillum* +75% N + Full P&K), T_4 (PSB+VAM+75% P +Full N&K), T_5 (*Azospirillum*+ PSB+75% N + Full P&K), T_6 (*Azospirillum* + RDF NPK), T_7 (*Azotobacter* + RDF NPK), T_8 (PSB + RDF NPK), T_9 (VAM + RDF NPK) and T_{10} (RDF NPK). The observations were recorded on growth and yield parameters (Plant height, No. of primary branches per plant, No. of secondary branches per plant, Fruit length, Fruit width, Total no. of fruits per plot and Fruit yield/ha) of brinjal cv. Azad B-3 and subjected to statistical analysis. The economics of cultivation was also studied. From the present investigation it was found that the treatment T_5 (*Azospirillum* +PSB + 75% N + Full P &K) was proved as a best combination of biofertilizers along with inorganic fertilizer for the improvement of brinjal cultivation through organically. It recorded plant height 96.23 cm, No. of primary branches 6.32, No. of secondary branches 11.27,Fruit length 13.89 cm, Fruit width 8.42 cm, Total no. of fruits per plot 724.66 and yield 448.65 q/ha. Where treatment T_5 significantly enhances the growth and yield traits of brinjal, it also recorded maximum benefit per hectare (B:C ratio 1:3.50).

Key Words : Brinjal, Biofertilizer, *Azotobacter*, *Azospirillum*, PSB,VAM

Introduction

Brinjal (*Solanum melongena* L.) is one of the most common and principle vegetable grown in India and other tropical and subtropical regions of the world. It is a staple vegetable in almost all tropical countries in the world and liked by both poor and rich consumers. Brinjal fruits are rich in carbohydrate, protein, fat, calcium, phosphorus, iron, riboflavin, thiamine, niacin, ascorbic acid, etc. It is also found effective against treatment of diabetes, asthma, cholera, bronchitis and diarrhea. Generally, solanaceous vegetables require large quantity of major nutrients like nitrogen, phosphorus and potassium, in addition to secondary nutrients such as calcium and sulphur for better growth, fruit and seed yield. However, the continuous sole and erratic use of chemical fertilizers in imbalance form has led to decline in soil fertility as well as nutrient uptake efficiency of plants, resulting in either yield stagnation or decrease consequently. The rising cost of chemical fertilizers and its potential hazard to environment has further focused attention on recycling of plant nutrients through organic materials. Effort to improve the fertilization system can be done by balancing the application between inorganic and organic fertilizers in the soil. One of the ways is the combined application between inorganic fertilizer and biofertilizer.

Biofertilizers are the bio-inoculants of specific beneficial microorganisms that promote the growth of plants by converting the unavailable form of nutrients into available form. They also induce resistance in plants against pests, improve soil fertility, help plant growth by increasing the number and biological activity of desired microorganisms in the root surface (Sivasakthivelan and Saranraj, 2013). Biofertilizers are eco-friendly and low cost input which not only improve the crop growth and yield but also improve fruit quality and fertilizer use efficiency. They improve the quantitative and qualitative features of many plants (Yosefi *et al.*, 2011).

In brinjal, generally biofertilizers like *Azotobacter*, *Azospirillum*, Phosphate Solubilizing Bacteria (PSB) and Vesicular Arbuscular Mycorrhiza (VAM) are used. *Azatobacter* is a group of aerobic, free living soil microbes which grows well on a nitrogen free medium. They utilize atmospheric nitrogen for their cell protein synthesis which is then mineralized in soil after their death, thereby contributing towards the nitrogen availability of the crop plants. They can fix nitrogen equivalent to 30-40 kg N/ha and also produce hormones like IAA,GA_3,vitamins like biotin and folic acid which ensure good seed germination and increases productivity. *Azospirillum* is an eco-friendly liquid bio fertilizer formulation containing bacteria *Azospirillum* which can positively influence plant growth, crop yield and nitrogen content of the plant under certain environmental and soil conditions. They fix up atmospheric nitrogen(around 40-50 kg/ha), produce biologically active substances like vitamins, nicotinic acid, IAA, Gibberllins, etc and help in retention of flowers and enhance plant growth. It increases root biomass in the inoculated plant thereby helps in greater absorption of native nutrients in soil resulting in higher yield. The Phosphate solubilizing bacteria (PSB) convert insoluble form of phosphate to soluble form by producing organic acids. About 15-25% of insoluble phosphate can be solubilized saving chemical fertilizers significantly. Vesicular Arbuscular Mycorrhiza (VAM) is found associating symbiotically with root of the plants and helps in greater absorption of phosphorous, water and other important macro and essential micro elements and making them available to the plants in an easily usable organic form. Besides they are also reported to impart resistance to plants against drought and soil borne fungal pathogens and nematodes. Biofertilizers, being cheap input, provide high economic assurance ,eco-friendly environment, sustain soil health and plant growth by adding organic contents as well as supplement 25-40% of chemical fertilizers N and P requirement in terms of urea and DAP. Keeping all these facts in view, the present investigation was undertaken with objectives to know the effect of biofertilizers on growth and yield parameters and economics of brinjal cv. Azad B-3.

Materials and Methods

Experimental site

The experiment was carried out at the Vegetable Research Farm, Department of Vegetable Science, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur during the *kharif* season of 2017-18.Geographically, Kanpur district is situated in the Gangetic alluvial belt of Central Uttar Pradesh ,thus enjoys a sob-tropical climate. The temperature of the location ranged between 36-5.3^{0}C during the experiment period. The relative humidity ranged between 48.16-90%.The average rain fall in this area is around 820mm annually. However, occasional precipitation is also not uncommon during winter months.

Experimental details

The brinjal crop with variety Azad Brinjal-3 (Kalyanpur Selection-331) was grown in Randomized Block Design with 10 treatments and each replicated thrice. Treatment details were T_1 (Control with no RDF and biofertilizers), T_2 (PSB + *Azotobacter* + 75% P+ Full N& K), T_3 (*Azotobacter* + *Azospirillum* + 75% N + Full P&K), T_4 (PSB + VAM + 75% P + Full N&K), T_5 (*Azospirillum* +PSB + 75% N + Full P&K), T_6 (*Azospirillum* + RDF NPK), T_7 (*Azotobacter* + RDF NPK), T_8 (PSB + RDF NPK), T_9 (VAM + RDF NPK) and T_{10} (RDF NPK). Each plot comprised of 6 X 3.60 m^2 area with a spacing of 60 cm row to row and 60 cm plant to plant. As per the treatment details, all the biofertilizers were used for root inoculation of brinjal seedlings (root dipping). For the preparation of biofertilizer solution 200g each of *Azospirillum*, *Azotobacter*, PSB and VAM were dissolved in 3 liters of water in plastic containers separately. Immediately after uprooting, the seedlings were dipped in each of the solution separately for 10 minutes and again for 10 minutes in case of more than one biofertilizer combination. Then the roots were allowed to dry in the shade for 5-10 minutes and then they were used for transplanting. The observations were recorded on Plant height (cm), No. of primary branches per plant, No. of secondary branches per plant, Fruit length (cm), Fruit width (cm), Total no. of fruits per plot and Fruit yield (q/ha). The plant height was measured at the time of last harvest. No. of primary and secondary branches per plant were recorded on different intervals. No. of fruits per plot, fruit length and width were recorded at the time of each picking. Economics was calculated with respect to different treatments on the basis of prevalent rates at the time of experiment. The data were collected from five randomly selected plants of each treatment and the analysis of variance and interpretation of data were done as per procedures given by Chandel (1984).

Table-1 : Effect of biofertilizers on growth and yield parameters of brinjal cv. Azad Brinjal-3

Treatment Symbol	Treatment Details	Plant Height (cm)	No. of Primary branches	No. of Secondary branches	Fruit Length (cm)	Fruit Width (cm)	Total no. of Fruits per plot	Yield (q/ha)	Benefit cost ratio
T_1	Control	79.15	3.95	7.15	7.25	6.65	580.00	237.44	1:1.46
T_2	PSB + *Azotobacter* + 75% P + Full N&K	92.30	5.48	9.42	12.24	8.08	698.00	404.35	1:3.06
T_3	*Azotobacter*+ *Azospirillum* + 75% N + Full P&K	86.66	4.50	9.21	9.42	7.50	682.33	332.48	1:2.34
T_4	PSB + VAM + 75% P + Full N&K	93.41	5.88	11.21	12.87	8.41	705.33	413.26	1:3.15

T_5	*Azospirillum* + PSB + 75% N + Full P&K	96.23	6.32	11.27	13.89	8.42	724.66	448.65	1:3.50
T_6	*Azospirillum* + RDF NPK	86.30	4.56	10.43	10.91	8.02	676.00	378.10	1:2.80
T_7	*Azotobacter* + RDF NPK	90.11	5.07	10.12	10.82	7.94	695.33	336.81	1:2.38
T_8	PSB + RDF NPK	90.52	4.35	9.90	10.47	7.75	672.33	360.20	1:2.62
T_9	VAM + RDF NPK	92.19	5.63	10.93	11.94	8.27	636.66	393.00	1:2.95
T_{10}	RDF NPK	83.25	4.24	8.25	9.04	8.00	625.66	291.12	1:1.92
	C.D. at 5%	5.16	1.21	1.82	1.45	0.60	43.20	50.77	
	SEm	1.73	0.40	0.61	0.49	0.20	14.53	17.08	
	SEd	2.45	0.57	0.86	0.69	0.28	20.55	24.15	

Results and Discussion

Growth Parameters

The data recorded at the time of final harvest clearly indicated that the differences in plant height due to different treatments were significant. Maximum plant height was recorded in T_5 (*Azospirillum* +PSB + 75% N + Full P&K) which was 96.23 cm followed by T_4 (93.41 cm) and T_2 (92.30 cm) which were at par to each other while the minimum plant height was recorded in T_1 (Control) which was 79.15cm.

Number of primary branches were found maximum in T_5 (*Azospirillum* +PSB + 75% N + Full P&K) which was 6.32 followed by T_4 (5.88) and T_9 (5.63) while the minimum was found in T_1 (Control) which was 3.95.

The data mentioned in Table-1 depicted that Number of secondary branches were found maximum in T_5 (*Azospirillum* + PSB + 75% N + Full P&K) which was 11.27 followed by T_4 (11.21) and T_9 (10.93) while the minimum was found in T_1 (Control) which was 7.15.

. Similar results were also reported by Kiran *et al*.(2010), Solanki *et al*.(2010), Doifode and Nandkar (2014), Nanthakumar and Veeraraghavathatham (2003), Wange and Kale(2004), Anburani and Manivanna(2002).

Significant increase in plant height, number of primary branches and number of secondary branches were due to increased uptake of nutrients in the plant leading to enhanced chlorophyll content and carbohydrate synthesis and increased activity of hormones produced by *Azospirillum* and phosphate solubilizing bacteria (PSB). The PSB seedling root treatment increased phosphate availability in soil which in turn helped better proliferation of root growth and uptake of other nutrients to the greater extent so that there is enlargement in cell size and cell division which might have helped in increasing plant height, number of primary and secondary branches.

Yield Parameters

The length of fruits as presented in Table-1 found highest in treatment T_5 (*Azospirillum* +PSB + 75% N + Full P&K) which was 13.89 cm followed by treatment T_4 (12.87 cm) and T_2 (12.24 cm) which were significantly superior over all the treatments. The statistically lowest fruit length was observed in treatment T_1 (Control) which was 7.25 cm.

Maximum fruit width was recorded in T_5 (*Azospirillum* +PSB + 75% N + Full P&K) with 8.42 cm followed by treatment T_4 (8.41 cm) and T_9 (8.27 cm) which were significantly superior over other treatments. The statistically lowest fruit width was observed in treatment T_1 (Control) with 6.65 cm.

Total number of fruits per plot as presented in table-1 was found maximum in treatment T_5 (*Azospirillum* +PSB + 75% N + Full P&K) with 724.66 number of fruits followed by T_4 (705.33) and T_2 (698.00), whereas minimum total number of fruits per plot was reported in T_1(Control) with 580.00.

These results were in close conformity with Suryanto *et al*.(2017), Nanthankumar and Veeraragavathatham (2003) and Kiran *et al*.(2010).

Fruit development is highly affected by auxin formation in the growing seeds and other parts of the fruit to supply food reserves in order to increase fruit development. Moreover, microorganisms that produce auxin are *Azospirillum* and VAM as microbe, which attaches nitrogen and plays as growth regulator.

Yield/ha was recorded maximum in treatment T_5 (*Azospirillum* +PSB + 75% N + Full P&K) which was 448.65 q/ha followed by T_4 (413.26 q/ha) and T_2 (404.35 q/ha) and the lowest fruit yield per hectare was found in treatment T_1 (Control) which is 237.44 q/ha. The above result corroborates with Kiran *et al*.(2010), Nanthakumar and Veeraraghavathatham (2003), Anburani and Manivanna (2002). Increase in fruit yield and its parameters may be due to increase in number of branches which produced more leaves and this worked as an efficient photosynthesis structure and produced high amount of carbohydrate in the plant. More number of branches produced more number of flowers which resulted higher fruits per plant and increased fruit yield and their attributes.

Economics

The economics is the need of the farmers while taking decision regarding the adoption of the techniques and scientific knowledge. Maximum Gross Return, Net Return and Cost Benefit ratio of 1:3.50 was recorded in treatment T_5 with *Azospirillum* +PSB + 75% N + Full P&K and the minimum Gross Return, Net Return and Cost Benefit ratio of 1:1.46 was recorded in treatment T_1 (Control). This result clearly indicates the importance of biofertilizers and also the use of fertilizers upto an optimal range results in higher yield and high dose of fertilizers diminished net return and benefit: cost ratio. Such results are also confirmed by Bhonde *et al.* (1997) and Mishra *et al*.(2017).The beneficial use of nitrogen fixing microorganisms and PSB as a supplementary source of plant nutrition on agricultural crops is well documented (Barakart and Gabr,1998).These non-conventional sources of fertilizers are not only cost effective but also boost up the productivity of field crops simultaneously(Patra *et al.*,1989).

Conclusion

On the basis of present investigation, it is concluded that the treatment T_5 (*Azospirillum* +PSB + 75% N + Full P&K) is proved as a best combination of biofertilizers along with inorganic fertilizer for the improvement of brinjal cultivation through organically. Where treatment T_5 (*Azospirillum* +PSB + 75% N + Full P&K) significantly enhances the growth and yield parameters of brinjal ,it also gave maximum benefit/ha.

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