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Rhizosphere effects of biofertilizers on growth attributes of mango grafts

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Abstract
The field experiment has been conducted for six months to study the *rhizosphere* effects of biofertlizers such as *Azotobacter* and PSB on growth attributes of mango grafts. The *rhizosphere* effects of added biofertilizers such as *Azotobacter* and Phosphate Solubilizing Bacteria (PSB) in a potting mixture significantly shows higher bacterial, fungal, *Azotobacter* and PSB population in the *rhizosphere* of the mango crop. The increased microbial population especially *Azotobacter* and PSB in *rhizosphere* made available the nutrient content such as available nitrogen and available phosphorous significantly improves the growth components such as graft survival, number of leaves, and number of shoot, height and girth of the plant.

Keywords: *Rhizosphere*, mango grafts, biofertilizers, *Azotobacter*, PSB, bacteria, fungi, growth attributes

Introduction
Mango (*Mangifera indica* L.) is the most important and commercially grown fruit crop in India and is considered as national fruit. India ranks first among world's mango producing countries accounting for 50 percent of world mango production. The increasing cost of excessive use of chemical fertilizers and their harmful effects on the soil health is also an important consideration for the use of organic nutrients enriched with biological organism. Several PGPR acts as biofertilizer and promotes growth of the plant. Microorganisms mainly phosphate solubilizer, nitrogen fixer, are the main source of bio-fertilizers. The addition of these microbes increases the population in *rhizosphere* of mango. *Rhizosphere* refers to the immediate area of soil surrounding the surface of the root (Rovira and Davey, 1975) [8]. It plays an important role in providing environment conducive for growth of plants, therefore the knowledge about its living constituents is of paramount importance. Many microbes inhabit this area because plants are thought to selectively enrich their *rhizospheres* for microorganisms that may be well adapted to utilizing the released exudates Soil microbial populations such as bacteria respond to the release of organic materials in the immediate vicinity of the plant root increasing their numbers and changing their characteristics (Harley, 1990) [11]. In case of mango graft it is also necessary to provide organic based graft to the Mango growers by addition of biofertilizers. In view of this, the present study was taken to study the dynamics effect of added biofertilizers in the form of *Azotobacter* and PSB in the *rhizosphere* soil on growth attributes of mango graft.

Materials and Methods
A Field experiment was conducted on Mango grafts for six months started from 2021-22 at the Regional Fruit Research Station, Vengurla, Dist. Sindhudurg. The experiment was laid in Randomized Block Design (RBD) with three replications and nine treatments. The fresh Mango stone were sown in Polybags of size 6 x 9 inch filled with different media treatments in the month of May (third week) and grafting was done in the first week of June. After grafting, 100 successful grafts per treatment per replication were selected and for three replications total 2700 Nos. of grafts were selected for experimentation. The uniform package of practices were followed for all treatments including fertilizer application through potting media with 19:19:19 @ 2 gm, plant protection measure and application of water, regular removal of sprouts below graft union etc. The bioinoculants such as *Azotobacter* and PSB biofertilizer is prepared by using local strain isolated from mango plant. The estimation of microbes and soil analysis has done at initial stage and final stage (After six months of the mango graft) by serial dilution plate count technique and soil standard techniques respectively.

Results and Discussion

The present study was conducted at RFRS, Vengurla for six months to know the *rhizospheric* effect of added biofertilizers on growth of mango grafts. The combine application (T_5 and T_9) of biofertilizers such as *Azotobacter* and Phosphate Solubilizing Bacteria (PSB) in a potting mixture shows significant improvement in the microbial population (Total bacterial, Total fungal population, *Azotobacter* and PSB populations), nutrient content (Available nitrogen and Available Phosphorous) and growth components (Graft survival, Number of leaves, Number of shoot, height and girth of the plants) as compared to potting mixture (Control) after six months of the graft (Table no. 2 & 3). The more addition of *Azotobacter* and PSB in the form of biofertilizers directly increases the total bacterial population and indirectly stimulates the fungal population. The added population in the form of biofertilizer and native population of *Azotobacter* and PSB in the *rhizosphere* shows combine beneficial effect on growth attributes of Mango graft in the (T_5 and T_9) treatments. The *Azotobacter* and PSB promotes the functional activities such as nitrogen fixation and phosphate solubilisation and increases the available nitrogen and available phosphorous content in potting mixture (Table no.3) which has been absorbed by the roots of the plant. The absorption of available nitrogen and available phosphorous further significantly improves the growth attributes of the mango grafts.

Table 1: Initial Microbial and Nutrients status of the potting mixture of mango graft

A. Microbial population (CFU)		
1	Total bacterial population	37 x 10^6
2	Total fungal population	1 x 10^4
3.	Total actinomycetes population	3 x 10^3
B. Nutrients		
1	pH	6.20
2	EC	0.56
3	Total Nitrogen (%)	1.17
4	Total Phosphorous (%)	0.84
5	Total Potassium (%)	1.34

Table 2: Effects of different bio-inoculants on growth parameters of six months mango grafts.

Tr. No.	Treatments	Percent% Sprouting (%)	Grafts survival (%)	No. of leaves	No. of shoot	Height of the plant (cm)	Girth of the plant (cm)
T_1	Potting mixture alone	82.80	48.20	18.00	1.07	30.00	3.37
T_2	Potting mixture + *Azotobacter* 50 g	85.50	50.18	20.27	1.00	35.41	3.55
T_3	Potting mixture + PSB 50 g	91.10	51.20	19.77	1.03	33.23	3.52
T_4	Potting mixture + Talc based *Trichoderma* 50 g	90.18	52.35	20.23	1.00	32.51	3.31
T_5	Potting mixture + *Azotobacter* 50 g+PSB 50 g + Talc based *Trichoderma* 50 g	88.00	53.20	23.77	1.37	43.20	4.03
T_6	T_2 + Spraying of *Trichoderma* (Spore formulation) 3 times at 2 months interval @ 1 g/10 L	86.40	48.50	20.20	1.07	36.87	3.63
T_7	T_3 + Spraying of *Trichoderma* (Spore formulation) 3 times at 2 months interval @ 1 g/10 L	89.90	49.10	19.90	1.03	32.15	3.57
T_8	T_4 + Spraying of *Trichoderma*(Spore formulation) 3 times at 2 months interval @ 1 g/10 L	87.30	52.10	19.63	1.03	31.08	3.51
T_9	T_5 + Spraying of *Trichoderma*(Spore formulation) 3 times at 2 months interval @ 1 g/10 L	89.01	50.18	20.80	1.40	42.15	3.51
	SE.+-	1.55	0.97	0.59	0.04	1.29	0.15
	C.D. @ 5%	4.65	2.92	1.75	0.12	3.86	0.44

Table 3: Effects of different bio-inoculants on microbial population and nutrient status of six month Mango grafts

Tr. No.	Treatments	Microbial population (CFU)				Available nutrients	
		Bacteria X10^6	Fungi X10^4	*Azotobacter* X10^3	PSB X10^3	N (Kg/ha)	P (Kg/ha)
T_1	Potting mixture alone	56.00	2.67	3.00	2.00	217.98	11.82
T_2	Potting mixture + *Azotobacter* 50 g	68.67	2.33	7.00	1.00	228.29	11.14
T_3	Potting mixture + PSB 50 g	65.67	2.67	2.33	5.00	218.68	16.64
T_4	Potting mixture + Talc based *Trichoderma* 50 g	52.33	6.00	2.00	1.00	216.98	10.95
T_5	Potting mixture + *Azotobacter* 50 g + PSB 50 g + Talc based *Trichoderma* 50 g	98.33	4.33	5.00	3.00	226.61	15.83
T_6	T_2 + Spraying of *Trichoderma* (Spore formulation) 3 times at 2 months interval @ 1 g/10 L	65.33	5.00	4.00	1.00	227.11	11.60
T_7	T_3 + Spraying of *Trichoderma* (Spore formulation) 3 times at 2 months interval @ 1 g/10 L	63.33	5.33	2.00	3.00	217.73	14.81
T_8	T_4 + Spraying of *Trichoderma* (Spore formulation) 3 times at 2 months interval @ 1 g/10 L	53.00	6.67	1.00	2.00	217.64	11.71
T_9	T_5 + Spraying of *Trichoderma* (Spore formulation) 3 times at 2 months interval @ 1 g/10 L	92.33	5.67	4.00	3.00	227.32	15.56
	SE.+-	5.12	1.55	1.14	0.80	1.82	0.69
	C.D.@5%	15.35	4.55	3.41	2.39	5.47	2.07

This has been supported by Kamil (2008) [5] who shown that the *Azotobacter* is capable of converting nitrogen to ammonia which in turn is taken up by the plants. The *Azotobacter* has been reported to contribute 15 Kg N ha^{-1} per year. It has been also observed that inoculation of soil or seed with *Azotobacter* causes increase in growth attributes of different crops (Sindhu *et al*. 2010) [10]. Whereas the phosphate-solubilizing bacteria active in solubilizing insoluble P improving growth attributes of various crops. (Cattelan *et al*. 1999) [3]. These organisms solubilize the unavailable forms of inorganic P like tricalcium phosphate iron phosphate, aluminium phosphate and rock phosphates into soluble forms by release of a variety of organic acids like succinic, citric, malic, fumaric, glyoxylic and gluconic acids. (Venkateswarlu *et al*. 2008) [10]. The results were also in line up with that of Prabhu *et al*. (2003) [6] Asad *et al* (2017) [2] and Ritik Chawla and Ramesh Kumar Sadawarti (2020) [7]. They revealed that the application of bio fertilizer rate directly help in increasing plant height, Plant leaves which might be due to the nutrient uptake of plants, that is important to improved chlorophyll content, carbohydrate synthesis and increased the activity of hormones. Thus Bio-fertilizer increases overall development of vegetative growth parameters like in higher growth rates stem girth of plant. (Alam and Seth, 2014) [1].

Conclusion

It is thus concluded that the combine application of *Azotobacter* and PSB in the form of biofertilizers in the *rhizosphere* significantly add the microbial population and increases the nutrient content such as available nitrogen and available phosphorous of the potting mixture which further improve the growth attributes of Mango grafts.

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