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RESEARCH ARTICLE :

Effect of application of PGPRM on growth parameters of cashew seedlings under polyhouse condition

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SUMMARY : *Azotobacterchroococcum*, *Bacillus megaterium*, *Pseudomonas fluorescens*, *Trichodermaviride* and *Glomusfasciculatum* were found to be efficient PGPR microorganisms. Hence, they were subjected to compatibility test by dual culture method. All the four PGPR microorganisms (*A. chroococcum*, *B. megaterium*, *P. fluorescens*, and *T. viride*) were found to be compatible under *in vitro* condition both on solid and in liquid media. Percentage of germination and plant height at different intervals were found to be maximum in the treatments which received *B. megaterium*with *P. fluorescens* and *B. megaterium* with *G. fasciculatum*, respectively. The stem girth of cashew seedlings before and after were found to be maximum in the treatment receiving *B. megaterium* with *G. fasciculatum*.

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KEY WORDS:
Azotobacterchroococcum, *Bacillusmegaterium*, *Pseudomonasfluorescens*, *Trichodermaviride* and *Glomusfasciculatum*

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BACKGROUND AND OBJECTIVES

Cashew (*Anacardiumoccidentale* L.) a tropical plant of commercial importance, belongs to the family Anacardiaceae. It is one of the export oriented cash crops of our country. Cashew is a cross pollinated crop and as such highly heterozygous plants are produced if seed propagation is resorted. The most common and the simplest method of raising cashew trees is from seeds, with the advancement in propagation techniques, it is now possible to propagate vegetatively in large numbers. Approximate methods of propagation like rooting of cuttings, budding, layering and grafting were standardized in various horticultural crops. Commercial cashew varieties are multiplied by soft wood grafting which is the cheapest and easiest method of vegetative propagation. This method also proved to be the best under 'maidan parts' of Karnataka (Anon., 1994). Apart from all these advantages, the success of soft wood grafting depends on the type of media used to raise the root stocks and the quality of root stocks and scions. In the eastern dry zone of Karnataka, it has been observed that poor quality of root stocks is one of the major causes for low success of soft wood grafts even under conducive environment. It has

been observed that stocks raised using potting mixture (red earth, sand and FYM – 1:1:1) have minimum roots, thus making the stock growth less vigorous and more lanky. It has been suspected that the less environment of beneficial soil microorganisms might be the reasons for such results. Application of biofertilizers is known to improve the soil fertility and crop productivity in several crops through atmospheric nitrogen fixation, solubilization of inorganic and organic phosphorus and other nutrients and synthesis of growth regulators. They also play an important role in improving germination, root proliferation and suppress plant diseases (Verma, 1993; SubbaRao, 1995). The beneficial effect of *Azotobacter* treatment has been reported in establishment of healthy and sturdy seedlings (SundaraRao *et al*., 1963a).

RESOURCES AND METHODS

This experiment was carried out during the year 2007- 08 in collaboration with All India Coordinated Research Project on cashew, nursery section at Agricultural Research Station (ARS), Chintamani, Kolar (Dist.), Karnataka.

The soaked seeds were sown in poly bags containing 2 kg of potting mixture with punch holes for drainage. The seeds were sown such that the stalk end facing upwards in polythene bags at about 2 – 3 cm below the soil surface. Germination of seeds started 15 days after sowing and continued till 30thday. Regular watering and weeding was attended.

Five grams of lignite based inoculum of plant growth promoting rhizomicroorganism was applied in the poly bag containing soil (2 – 3 cm below the soil surface), according to the treatment details.

Treatment details :

T_1: control

T_2: *Azotobacterchroococcum*

T_3: *Bacillus megaterium*

T_4: *Glomus fasciculatum*

T_5: *Pseudomonas fluorescens*

T_6: *Trichoderma viride*

T_7: *Azotobacterchroococcum + Bacillus megaterium*

T_8: *Azotobacter chroococcum + Glomus fasciculatum*

T_9: *Azotobacter chroococcum + Pseudomonas fluorescens*

T_{10}: *Azotobacterchroococcum + Trichoderma viride*

T_{11}: *Bacillus megaterium + Glomus fasciculatum*

T_{12}: *Bacillus megaterium + Pseudomonas fluorescens*

T_{13}: *Bacillus megaterium + Trichoderma viride*

T_{14}: *Pseudomonas fluorescens + Trichoderma viride*

T_{15}: *Glomusfasciculatum+ Trichodermaviride*

Healthy and vigorously grown seedlings having single main stem were selected for grafting. Seventy five days old seedling grown in the centre of polythene bag were used.

Cashew seedlings (root stocks) grown for 75 days were selected for grafting. Grafting was done by soft wood method. The stock plant with new terminal growth was decapitated at a height varying from 10 - 18 cm from soil surface of poly bags and a vertical split of about 3 to 4 cm was made using a sharp knife and the care was also taken to retain 2 – 4 leaves well below the grafting point. A scion of 8 – 10 cm length was taken and the basal end was cut into a wedge form (3 – 4 cm long) and the stock in such a way that at least one side of the scion cambium makes satisfactory contact with the cambium of root stock. The inserted portion was wrapped firmly with 1.5 cm wide and 30 cm long, 100 gauge white transparent polyethylene strip, so as to keep the stock and scion parts in firm contact and to prevent water entering into the grafted portion. A Pepsi poly tube was inserted over the scion to create higher humidity around the grafted portion.

OBSERVATIONS AND ANALYSIS

The germination percentage of cashew seed nut was found maximum in the treatment receiving *Bacillus megaterium* and*Pseudomonasfluorescens*. The treatments which received two PGPR microorganisms gave significantly higher germination percentage when compared with the treatments receiving single inoculation or uninoculated control. The results of the percent study are in conformity with the earlier findings of Kumar (1997) in cashew nut, Rakesh Kumar (2004) in chickpea, Podile and Lakshmi (1998) in pigeon pea, Strobel and Nachmias (1985) in almond.

The maximum plant height at 45 DAS was obtained in the treatment receiving *Bacillus megaterium* and *Glomusfasciculatum* followed by the treatment which

received *Glomusfasciculatum* and *Trichodermaviride* and *Bacillus megaterium* with *Trichodermaviride*. At 75 DAS also, the treatment which received *Bacillus megaterium* with *Glomusfasciculatum* followed by the treatment receiving *Azotobacterchroococcum* with *Trichodermaviride* and *Azotobacterchroococcum* with *Bacillus megaterium* recorded maximum plant height. At 45 DAG also, the maximum plant height was obtained in the dual PGPR microorganisms inoculated treatments. Minimum plant height at different intervals was observed

Table 1: Effect ofapplication of PGPRM on percent germinationand plant height ofcashew seedlings under poly house condition.

Treatments	Germination (%)	Plant height (cm)		
		Root stock		Graft
	30 DAS	45 DAS	75 DAS	45 DAG
T_1 – Control	70.33 ^{l}	25.00 ^{b}	27.28 ^{f}	24.83 ^{e}
T_2 - *Azotobacterchroococcum*	89.12 ^{b}	26.31 ^{ab}	27.41 ^{f}	25.62 ^{cde}
T_3 - *Bacillus megaterium*	81.22 ^{h}	25.83 ^{ab}	27.63 ^{ef}	25.72 ^{bcde}
T_4- *Glomusfasciculatum*	80.58 ^{i}	26.25 ^{ab}	27.94 ^{def}	25.83^{bcde}
T_5 - *Pseudomonas fluorescens*	78.99 ^{j}	25.75 ^{ab}	28.34 ^{cdef}	26.02^{bcde}
T_6 - *Trichodermaviride*	77.35 ^{k}	27.66 ^{ab}	27.97 ^{def}	25.62 ^{cde}
T_7 - *Azotobacterchroococcum* + *Bacillus megaterium*	85.66 ^{e}	28.17 ^{ab}	30.35 $^{a b}$	27.00 ^{ab}
T_8 - *Azotobacterchroococcum* + *Glomusfasciculatum*	83.99 ^{f}	28.33^{ab}	30.25 $^{a b}$	28.09 ^{a}
T_9 - *Azotobacterchroococcum* + *Pseudomonafluorescens*	81.33 ^{h}	27.00 ^{ab}	27.46 ^{f}	26.38 ^{bcd}
T_{10} - *Azotobacterchroococcum* + *Trichodermaviride*	88.14 ^{cd}	27.91 ^{ab}	30.51^{a}	28.08 ^{a}
T_{11} - *Bacillus megaterium* + *Glomusfasciculatum*	87.69 ^{d}	28.75 ^{a}	30.67 ^{a}	27.92 ^{a}
T_{12} - *Bacillus megaterium* + *Pseudomonas fluorescens*	90.89 ^{a}	26.93 ^{ab}	29.29 ^{abcde}	26.50 ^{bc}
T_{13} - *Bacillus megaterium* + *Trichodermaviride*	83.29 ^{g}	28.39 ^{ab}	29.67^{abcd}	26.42 ^{bc}
T_{14} - *Pseudomonas fluorescens*+ *Trichodermaviride*	86.17 ^{e}	27.90 ^{ab}	28.67 ^{bcdef}	25.04 ^{de}
T_{15} - *Glomusfasciculatum*+ *Trichodermaviride*	88.66 ^{bc}	28.48 ^{ab}	30.02 ^{abc}	27.77 ^{a}
CD (P = 0.05)	1.20	2.25	1.18	0.87

Note: PGPRM = Plant Growth Promoting Rhizo microorganisms.
DAS = days after sowing. DAG = Days After Grafting.

Table 2: Effect of inoculation of PGPRM on development of leaves ofcashew seedlings under poly house condition.

Treatments	No of leaves /seedling		
	Root stock		Graft
	45 DAS	75 DAS	45DAG
T_1 – Control	7.00 ^{d}	8.00 ^{de}	5.33 ^{c}
T_2 - *Azotobacterchroococcum*	7.75 ^{abcd}	8.67 ^{abcd}	5.67 ^{bc}
T_3 - *Bacillus megaterium*	7.42 ^{bcd}	8.75 ^{abc}	6.33 $^{a b}$
T_4- *Glomusfasciculatum*	7.83 ^{abcd}	7.83 ^{e}	5.67 ^{bc}
T_5 - *Pseudomonas fluorescens*	7.25 ^{cd}	8.67 ^{abcd}	5.84^{abc}
T_6 - *Trichodermaviride*	7.42 ^{bcd}	8.67 ^{abcd}	6.49 ^{a}
T_7 - *Azotobacterchroococcum* + *Bacillus megaterium*	8.08 ^{abc}	8.83 ^{abc}	6.42 $^{a b}$
T_8 - *Azotobacterchroococcum* + *Glomusfasciculatum*	7.83 ^{abcd}	9.08 ^{a}	6.50 ^{a}
T_9 - *Azotobacterchroococcum* + *Pseudomonafluorescens*	8.41 $^{a b}$	8.92 $^{a b}$	6.33^{ab}
T_{10} - *Azotobacterchroococcum* + *Trichodermaviride*	8.00 ^{abcd}	8.17 ^{cde}	6.17^{ab}
T_{11} - *Bacillus megaterium* + *Glomusfasciculatum*	8.16 ^{abc}	8.67 ^{abcd}	6.42^{ab}
T_{12} - *Bacillus megaterium* + *Pseudomonas fluorescens*	7.83 ^{abcd}	8.92 $^{a b}$	6.25^{ab}
T_{13} - *Bacillus megaterium* + *Trichodermaviride*	8.00 ^{abcd}	8.25^{bcde}	6.33^{ab}
T_{14} - *Pseudomonas fluorescens*+ *Trichodermaviride*	8.17 ^{abc}	9.00 ^{a}	5.92^{abc}
T_{15} - *Glomusfasciculatum*+ *Trichodermaviride*	8.58 ^{a}	8.25 ^{bcde}	6.33 $^{a b}$
CD (P = 0.05)	0.65	0.45	0.50

Note: PGPRM = Plant Growth Promoting Rhizo microorganisms.
DAS = days after sowing. DAG = Days After Grafting.

in control. Similar results of increased plant height, number of leaves and leaf area per seedling in avocado seedlings by inoculation of *Glomusfasciculatum* at the rate of 2.5g per seedling was reported by Dharmaraj and Irulappan (1982). Kumar (1998) also obtained increased height and stem girth of cashew seedlings treated with biofertilizers as compared to the uninoculated seedlings. Three fold increase in citrus plant height by inoculation with *Glomusfasciculatum* was reported by Menge(1977).

The maximum number of leaves per seedling at 45 DAS was recorded in the treatment inoculated with *Glomusfasciculatum* with *Trichodermaviride* followed by the treatment inoculation with *Azotobacterchroococcum* with *Pseudomonas fluorescens*and the treatment which received *Pseudomonas fluorescens* with *Trichodermaviride*. At 75 DAS also maximum number of leaves per seedling was obtained in the treatmentswhich received dual inoculation. Similarly at 45 DAG also the treatments receiving *Azotobacterchroococcum* with *Glomusfasciculatum* followed by *Trichodermaviride* alone inoculated treatments and *Bacillus megaterium* with *Glomusfasciculatum* receiving treatments recorded maximum number of leaves. The least number of leaves per seedling was noticed in the control treatment. The present investigations are in accordance with the reports of Reddy and Bhagyaraj (1994) who obtained increased plant height, stem girth and leaf number per mango root stock inoculated with VAM fungi as compared to uninoculated mango rootstock. Increased seedling height, number of leaves and leaf area of avocado seedlings was reported by Dharmaraj and Irulappan (1982).

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