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Impact of Bio-fertilizer on Seedling Vigour in Cashew (*Anacardium occidentale* L.)

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ABSTRACT

An experiment was carried out to study the effect of bio-fertilizers on pre sowing seed treatment of cashew nut under different environment conditions. The study at 120 days after sowing reveal that pre-sowing treatment with 48 hrs water soaking + 100 ppm GA_3 + VAM recorded minimum days for germination, maximum germination percentage, number of leaves, intermodal length, seedling height and seedling girth. The four varieties showed a wide variation among themselves with respect to the growth and root characters. However, variety BPP-8 recorded minimum days to germination (18.66) and dry matter of shoot percentage (36.15). Between the conditions, mist condition was superior to the open condition in the present study. The study concluded that seed treatment of 48 hrs water soaking + 100 ppm GA_3 + VAM was found to be the best treatment in producing vigorous seedlings in different varieties of cashew under mist condition.

Key words: *Growth regulators, Bio-fertilizers, Seed treatments, Seedling vigour, Cashew seedling*

INTRODUCTION

Cashewnut (*Anacardium occidentale* L.) is a tropical evergreen hardy tree crop originated from South and Central America. This crop was introduced in to India during the 16th century as a soil conservation crop. Among the major horticultural and plantation crops, cashew plays an important role in earning the foreign exchange through export. India is the major producer of cashewnut contributing around 60% of the world's cashewnut production. Production of healthy grafted planting material throughout the year is of prime importance for boosting up the nut production in the country. However, cashew being recalcitrant in nature, year round production of healthy grafted planting material becomes difficult as the viability deteriorates rapidly on storage.

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Improving the quality of seed is an approach which is likely to produce significant benefits in all circumstances without any significant increase in risk. Seed germination enhancement technologies based on pre-sowing seed infusion have attracted considerable interest in both seed physiological research and seed industry, where they have been commercialized. Application of *Azospirillum* and VAM increased germination percentage of nuts and plant growth and reduced the incidence of fungal diseases in the nursery[6,8]. Phosphorus solubilizing bacteria are capable of solubilizing unavailable form of phosphorus into available form and make it available to plants[9]. Therefore, the study was conducted to find out suitable bio-fertilizers treatment on germination and seedling vigour of cashew nut under different environments.

MATERIAL AND METHODS

The present investigation was conducted at College of Horticulture, Rajendranagar, Hyderabad. The experiment was laid out on Completely Randomized Block Design with seven treatments, four varieties (BPP-5, BPP-8, VRI-2, and H-1), two conditions and three replications. The experimental site is situated at latitude of $17^0$20' N and longitude of $78^0$25'E, an altitude of 530.38 meters above mean sea level. The treatments *viz.,* T_1 (Phosphorus Solubilizing Bacteria), T_2 (*Azospirillum*), T_3 (Vesicular Arbuscular Mycorrhizae), T_4 (48 hrs water soaking + 100 ppm GA_3 + PSB), T_5 (48 hrs water soaking + 100 ppm GA_3 + *Azospirillum*), T_6 (48 hrs water soaking + 100 ppm GA_3 + VAM), T_7 served as a control without any treatment impose. Per-treated cashew seeds were sown in polythene bag size 25 x 15 cm and 300 gauge thickness which were filled with 2/3rd of the potting mixture and cashew seeds were sown vertically with the tip facing upward and the seeds are covered with 1/3rd of the potting mixture. The biofertilizer *viz.*, *Azospirillum*, PSB and VAM are applied as paste per kg of seed by preparing 10g in 20 ml of water. The first emergence of plumule was considered and recorded as days of germination. The percentage of germination was calculated as per Stephan[13]. The observation *viz.,* seedling height (cm), seedling girth (cm), number of leaves and intermodal length (cm) were recorded at 120 days of sowing. Dry matter % of shoot and dry matter % of root were recorded at 120 days of sowing by keeping in brown paper bags and dried in hot air oven at 70^0 C temperatures till constant weight was obtained. Each dried sample was then weighed on an electronic pan balance and average dry weight of shoot/ root was calculated of each shoot/root. Divide the weight of the dry shoot/root by the weight of the fresh shoot/root and multiply by 100 to get percentage. Statistical analysis was done by using OPSTAT software package.

RESULTS AND DISCUSSION

The result revealed that the mist condition recorded superior than the open conditions throughout the study period. Among the different treatments, treatment imposed with 48 hrs water soaking + 100 ppm GA_3 + VAM (T_6) resulted minimum days of seeds germination 18.00 days under mist condition compared to open condition 19.42 days (table 1). Among the variety, BPP-8 recorded significantly minimum days to germinate (18.66 days) in mist condition followed by BPP-5 (18.95 days) than the other varieties. Similarly, the germination percentage also recorded the similar trend. The maximum germination percentage was recorded by T_6 (81.67) followed by 48 hrs water soaking + 100 ppm GA_3 + PSB (T4) (77.50) and minimum was recorded in control (64.16). However among the variety, VRI-2 recorded the highest germination percentage (76.19) compared to the other varieties under mist condition. The higher rate of germination might be due to combined effect of water, GA_3 and VAM that might have accelerated the early germination. Moreover, the mist

condition provides higher per cent of humidity and temperature as compared to open condition which might have hasten the faster seed germination and seedling growth. The results are also supported by Amoah[1] and Sivasubramaniam *et al*[12], where cashew seeds treated with water soak for 48 hours and GA_3 at 100 ppm gave better germination and growth.

There were significant differences recorded in seedling height and seedling girth among the treatments and the variety under mist condition than the open condition. significantly highest seedling height and seedling girth were recorded by pre-sowing treatments with 48 hrs water soaking + 100 ppm GA_3 + VAM (T_6) (26.26 cm and 3.17 cm, respectively) compared to lowest recorded in control (17.74 cm and 2.62 cm, respectively) (Table 2). Among the variety, BPP-5 has recorded highest seedling height and seedling girth (21.86 cm and 3.03 cm, respectively) followed by BPP-8 (21.43 cm and 2.94 cm, respectively) under mist condition. Significantly number of leaves and internodal length were recorded higher under mist condition than the open condition (Table 3). Among the treatments, 48 hrs water soak + 100 GA_3 ppm + VAM treatment recorded higher number of leaves (22.22) and higher intermodal length (8.84 cm) followed by treatment 48 hrs water soaking + 100 ppm GA3+ PSB (T_4) (20.58 and 7.29 cm, respectively) under mist condition. Among the varieties, BPP-5 recorded maximum number of leaves (19.72) and minimum was recorded in variety H-1 (19.31). However, the variety BPP-8 recorded higher intermodal length (7.15 cm) followed by VRI-2 (7.13 cm) under mist condition. Dry matter percentage of shoot and root were also recorded highest under mist condition than the open condition. The highest dry matter percentage of shoot and root were recorded by treatment 48 hrs water soaking + 100 ppm GA_3+ PSB (36.43 and 42.51, respectively) which was on par with treatment 48 hrs water soaking + 100 ppm GA_3+ VAM (35.98 and 40.97, respectively) (Table 4). Among the variety, BPP-8 recorded higher dry matter of shoot (36.15%) followed by BPP-5 (33.46%). However, variety H-1 recorded higher dry matter of root (39.00%) and lowest was recorded by BPP-5 (34.23%).

The increase of growth parameters over the control might be owing to combined application of bio-fertilizers and GA_3. Mycorrhizal colonization of roots results in an increase in root surface area for nutrient acquisition. The extrametrical fungal hyphae can extend several centimeters into the soil and absorb large amounts of nutrients for the host root which might have further contributed to higher photosynthesis and bio- chemical activities[5]. The significant increase in internodal length with GA_3 and water soaking was also supported by Nabil *et al*[7]. The increased in fresh weight of seedling might be due to enhancement of shoot length and number of leaves and stem girth by GA_3. As fresh weight increased, it simultaneously increased the dry matter % of shoot in rangpur lime[3]. GA_3 also play an important role in promoting stem and shoot elongation through the increase of cell division and cell elongation in plant. Inoculation of VAM significantly increased the root of cashew seedlings compared to its counterpart without VAM inoculation also observed by Ibiremo *et al*[4] and Trisilawati[14]. Similar result was also reported by earlier findings of Ananthakrishnan *et al*[2], Shankarappa *et al*[10] and Sivaprasad *et al*[11] in cashew.

Table 1. Effect of bio-fertilizer on days to germination and germination percentage of cashewnut under different environments at 120 days after sowing

Treatment	Days to germination										Germination (%)									
	Mist condition (A_1)					Open condition (A_2)					Mist condition (A_1)					Open condition (A_2)				
	V1	V2	V3	V4	Mean	V1	V2	V3	V4	Mean	V1	V2	V3	V4	Mean	V1	V2	V3	V4	Mean
T_1	19.33	18.33	19.66	20.66	19.50	20.00	19.66	20.00	21.00	20.17	73.33	63.33	80.00	60.00	69.17	36.66	53.33	60.00	76.66	56.66
T_2	19.66	20.00	20.33	20.66	20.16	21.00	21.00	21.00	21.00	21.00	80.00	66.66	76.66	80.00	75.83	40.00	50.00	86.66	73.33	62.50
T_3	18.33	19.66	20.33	22.33	20.16	20.00	20.00	20.66	22.66	20.83	66.66	46.66	63.33	73.33	62.50	30.00	40.00	70.00	63.33	50.83
T_4	17.33	16.33	19.33	20.66	18.41	19.00	18.00	19.66	21.00	19.42	76.66	63.33	86.66	83.33	77.50	40.00	60.00	86.66	70.00	64.17
T_5	19.66	19.66	20.66	20.66	20.16	21.33	20.33	21.00	21.33	21.00	63.33	66.66	73.33	76.66	70.00	30.00	40.00	73.33	73.33	54.17
T_6	17.00	16.00	19.00	20.00	18.00	19.00	18.66	19.33	20.00	19.25	86.66	70.00	80.00	90.00	81.67	63.33	80.00	86.66	76.66	76.66
T_7	21.33	20.66	21.66	24.00	21.91	22.00	21.30	22.00	24.66	22.49	63.33	53.33	73.33	66.66	64.16	23.33	36.66	56.66	40.00	39.16
Mean	18.95	18.66	20.14	21.28		20.33	19.85	20.52	21.66		72.85	61.42	76.19	75.71		37.62	51.43	74.28	67.62	
	A	V	T	A xV	A x T		V x T		A x V x T		A	V	T	A xV	A x T		V x T		A x V x T	
SEm±	0.12	0.17	0.23	0.25	0.33		0.46		0.66		1.98	2.81	3.72	3.97	5.26		7.44		10.52	
CD (P=0.05)	0.35	0.49	0.65	NS	NS		NS		NS		5.57	7.87	10.42	11.14	NS		NS		NS	

NS= Non Significant, A= Condition

Treatment (T)

T_1=Phosphorus Solubilizing Bacteria (PSB)

T_2=*Azospirillum*

T_3=Vesicular Arbuscular Mycorrhizae (VAM)

T_4= 48 hrs water soaking + 100 ppm GA_3+ PSB

T_5= 48 hrs water soaking + 100 ppm GA_3 + *Azospirillum*

T_6= 48 hrs water soaking + 100 ppm GA_3 + VAM

T_7=Control

Variety (V)

V_1=BPP-5

V_2=BPP-8

V_3=VRI-2

V_4=H-1

Table 2. Effect of bio-fertilizer on seedling height and seedling girth of cashewnut under different environments at 120 days after sowing

Treatment	Seedling height (cm)										Seedling girth (cm)									
	Mist condition (A_1)					Open condition (A_2)					Mist condition (A_1)					Open condition (A_2)				
	V1	V2	V3	V4	Mean	V1	V2	V3	V4	Mean	V1	V2	V3	V4	Mean	V1	V2	V3	V4	Mean
T_1	21.77	19.20	20.02	19.90	20.22	13.77	13.50	16.48	15.49	14.81	3.03	3.03	2.66	2.70	2.86	2.73	2.92	2.63	2.63	2.73
T_2	23.63	20.21	20.22	20.10	21.04	14.67	13.57	13.59	14.55	14.10	3.16	2.76	3.00	3.00	2.98	2.80	2.90	3.00	2.93	2.91
T_3	21.48	19.41	20.18	21.85	20.73	13.61	13.59	13.70	13.94	13.71	2.90	3.03	2.66	3.13	2.93	2.86	2.70	2.50	3.13	2.80
T_4	22.59	23.78	20.15	21.77	22.07	14.04	16.03	16.18	13.80	15.01	3.03	3.06	3.00	3.13	3.06	2.83	3.03	3.13	3.10	3.02
T_5	20.95	20.76	18.44	21.03	20.30	12.55	12.64	15.64	13.65	13.62	2.95	2.90	3.06	2.83	2.94	2.86	2.90	3.03	2.80	2.90
T_6	26.90	28.05	25.15	24.93	26.26	15.93	16.05	16.17	16.66	16.20	3.23	3.10	3.20	3.16	3.17	2.96	3.03	3.06	3.16	3.05
T_7	15.67	18.59	16.83	19.88	17.74	10.92	12.56	13.39	12.69	12.39	2.90	2.73	2.43	2.43	2.62	2.73	2.66	2.40	2.30	2.52
Mean	21.86	21.43	20.14	21.35		13.64	13.99	15.02	14.40		3.03	2.94	2.86	2.91		2.82	2.88	2.82	2.86	
	A	V	T	A xV	A x T		V x T		A x V x T		A	V	T	A xV	A x T		V x T		A x V x T	
SEm±	0.08	0.12	0.16	0.17	0.23		0.33		0.66		0.05	0.08	0.1	0.11	0.15		0.21		0.3	
CD (P=0.05)	0.25	0.35	0.46	0.5	NS		0.93		1.84		0.16	NS	0.3	NS	0.42		NS		NS	

NS= Non Significant, A= Condition

Treatment (T)

T_1=Phosphorus Solubilizing Bacteria (PSB)

T_2=*Azospirillum*

T_3=Vesicular Arbuscular Mycorrhizae (VAM)

T_4= 48 hrs water soaking + 100 ppm GA_3+ PSB

T_5= 48 hrs water soaking + 100 ppm GA_3 + *Azospirillum*

T_6= 48 hrs water soaking + 100 ppm GA_3 + VAM

T_7=Control

Variety (V)

V_1=BPP-5

V_2=BPP-8

V_3=VRI-2

V_4=H-1

Table 3. Effect of bio-fertilizer on number of leaves and internodal length of cashewnut under different environments at 120 days after sowing

Treatment	Number of leaves										Internodal length (cm)									
	Mist condition (A_1)					Open condition (A_2)					Mist condition (A_1)					Open condition (A_2)				
	V1	V2	V3	V4	Mean	V1	V2	V3	V4	Mean	V1	V2	V3	V4	Mean	V1	V2	V3	V4	Mean
T_1	19.58	17.33	19.29	17.81	18.50	13.22	15.56	16.33	14.52	14.91	6.84	6.62	6.92	6.98	6.84	6.66	6.69	5.56	6.53	6.36
T_2	20.40	19.82	19.72	20.00	19.99	14.04	15.58	16.00	16.51	15.53	6.51	6.8	6.63	6.85	6.70	6.62	6.57	6.46	6.49	6.54
T_3	19.85	17.50	19.71	17.45	18.63	15.01	15.84	15.59	14.87	15.33	6.78	6.87	6.79	6.66	6.78	6.71	5.72	5.74	5.65	5.96
T_4	20.29	21.11	20.22	20.69	20.58	13.32	18.01	16.66	17.33	16.33	7.39	7.39	7.31	7.05	7.29	6.88	6.35	7.11	6.93	6.82
T_5	19.97	17.63	19.16	19.70	19.12	14.85	15.43	16.05	15.65	15.50	6.82	6.67	6.63	6.52	6.66	6.03	5.74	5.71	5.56	5.76
T_6	21.46	23.38	21.92	22.11	22.22	16.67	18.66	17.43	18.19	17.74	9.09	9.13	9.06	8.09	8.84	8	7.85	7.89	8.04	7.95
T_7	16.52	17.26	15.40	17.38	16.64	12.65	13.72	13.03	13.17	13.14	6.4	6.59	6.59	6.24	6.46	5.43	5.48	5.14	5.44	5.37
Mean	19.72	19.15	19.35	19.31		14.25	16.11	15.87	15.75		7.12	7.15	7.13	6.91		6.62	6.34	6.23	6.38	
	A	V	T	A xV	A x T		V x T		A x V x T		A	V	T	A xV	A x T		V x T		A x V x T	
SEm±	0.08	0.12	0.16	0.17	0.23		0.33		0.66		0.05	0.08	0.1	0.11	0.15		0.21		0.3	
CD (P=0.05)	0.25	0.35	0.46	0.5	NS		0.93		1.84		0.16	NS	0.3	NS	0.42		NS		NS	

NS= Non Significant, A= Condition

Treatment (T)

T_1=Phosphorus Solubilizing Bacteria (PSB)

T_2=*Azospirillum*

T_3=Vesicular Arbuscular Mycorrhizae (VAM)

T_4= 48 hrs water soaking + 100 ppm GA_3+ PSB

T_5= 48 hrs water soaking + 100 ppm GA_3 + *Azospirillum*

T_6= 48 hrs water soaking + 100 ppm GA_3 + VAM

T_7=Control

Variety (V)

V_1=BPP-5

V_2=BPP-8

V_3=VRI-2

V_4=H-1

Table 4. Effect of bio-fertilizer on dry matter of shoot and dry matter of root percentage of cashewnut under different environments at 120 days after sowing

Treatment	Dry matter of shoot (%)										Dry matter of root (%)									
	Mist condition (A_1)					Open condition (A_2)					Mist condition (A_1)					Open condition (A_2)				
	V1	V2	V3	V4	Mean	V1	V2	V3	V4	Mean	V1	V2	V3	V4	Mean	V1	V2	V3	V4	Mean
T_1	34.13	35.91	33.8	29.98	33.46	27.46	29.28	31.82	30.45	29.75	31.26	34.78	38.71	36.11	35.22	36.85	33.36	33.66	34.62	34.62
T_2	32.04	34.18	31.98	31.74	32.49	31.17	27.73	30.29	30.75	29.99	33.79	32.22	35.99	38.54	35.14	33.81	35.00	33.55	36.41	34.69
T_3	34.07	36.35	33.47	30.32	33.55	30.68	25.93	30.04	30.78	29.36	36.95	37.16	33.71	38.70	36.63	29.93	35.43	33.51	35.55	33.61
T_4	34.97	37.34	34.22	39.19	36.43	33.33	30.43	32.27	34.03	32.52	34.51	37.27	45.31	52.95	42.51	34.11	36.15	38.83	38.33	36.86
T_5	30.86	38.8	31.35	34.13	33.79	29.82	30.53	31.98	29.15	30.37	36.38	34.21	37.85	32.17	35.15	28.33	37.28	32.68	36.68	33.74
T_6	37.61	37.17	34.29	34.83	35.98	32.01	37.62	33.66	31.68	33.74	42.95	37.51	40.27	43.13	40.97	37.76	44.12	35.16	39.27	39.08
T_7	30.55	33.33	28.37	29.92	30.54	27.08	27.38	29.95	28.3	28.18	23.75	30.47	31.94	31.41	29.39	26.00	31.15	23.31	33.04	28.38
Mean	33.46	36.15	32.50	32.87		30.22	29.84	31.43	30.73		34.23	34.80	37.68	39.00		32.40	36.07	32.96	36.27	
	A	V	T	A xV	A x T		V x T		A x V x T		A	V	T	A xV	A x T		V x T		A x V x T	
SEm±	0.5	0.71	0.94	1.01	1.33		1.89		2.67		0.59	0.84	1.12	1.19	1.58		2.24		3.17	
CD (P=0.05)	1.41	NS	2.65	NS	NS		NS		NS		1.67	2.37	3.14	NS	NS		NS		NS	

NS= Non Significant, A= Condition

Treatment (T)

T_1=Phosphorus Solubilizing Bacteria (PSB)

T_2=*Azospirillum*

T_3=Vesicular Arbuscular Mycorrhizae (VAM)

T_4= 48 hrs water soaking + 100 ppm GA_3+ PSB

T_5= 48 hrs water soaking + 100 ppm GA_3 + *Azospirillum*

T_6= 48 hrs water soaking + 100 ppm GA_3 + VAM

T_7=Control

Variety (V)

V_1=BPP-5

V_2=BPP-8

V_3=VRI-2

V_4=H-1

CONCLUSION

To conclude, the study revealed that treatment with 48 hrs water soaking + 100 ppm GA_3 + VAM recorded the best result to produce vigorous cashew seedling under mist chamber condition.

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