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Y Shiny Maria
PG Scholar,
Department of Fruit Science,
College of Horticulture, Dr. YSR Horticultural University,
Venkataramannagudem, West Godavari, Andhra Pradesh,
India

P Vinaya Kumar Reddy
Assistant Professor,
Department of Fruit Science,
College of Horticulture, Dr. YSR Horticultural University,
Venkataramannagudem,
West Godavari, Andhra Pradesh,
India

M Madhavi
Associate Dean,
Professor and Head, Department of Fruit Science, College of Horticulture, Dr. YSR Horticultural University,
Venkataramannagudem, West Godavari, Andhra Pradesh,
India

DR Salomi Suneetha
Dean of Student Affairs,
Professor and Head, Department of Biochemistry, Dr. YSR Horticultural University,
Venkataramannagudem, West Godavari, Andhra Pradesh,
India

Corresponding Author:
Y Shiny Maria
PG Scholar,
Department of Fruit Science,
College of Horticulture, Dr. YSR Horticultural University,
Venkataramannagudem, West Godavari, Andhra Pradesh,
India

Effect of biofertilizers and growing media on seed germination and seedling vigour of tamarind (*Tamarindus indica* L.)

Y Shiny Maria, P Vinaya Kumar Reddy, M Madhavi and DR Salomi Suneetha

Abstract
The present investigation was carried out to study the "Effect of biofertilizers and growing media on seed germination and seedling vigour of tamarind (*Tamarindus indica* L.)" at College of Horticulture, Dr. Y.S.R. Horticultural University, Venkataramannagudem, West Godavari District in the year 2021-22. The experiment was laid out in a factorial randomized block design (FRBD) with three replications containing of sixteen treatment combinations which consists of two factors *viz*., biofertilizers at four levels (B_0: control, B_1: *Azospirillum*, B_2: PSB and B_3: KRB) and growing media at four levels (M_1: soil, M_2: soil + cocopeat @ 2:1, M_3: soil + vermicompost @ 2:1, and M_4: soil + cocopeat + vermicompost. @ 2:1:1). The treatment combination T_{14} recorded highest in germination parameters like days required for initiation of germination (8.50), maximum germination percentage (99.79) and in growth parameters like height of the seedling(28.75, 50.99, 66.72, and 89.61 cm respectively), number of leaves(11.36, 23.81, 36.22 and 59.42 respectively), stem diameter(1.23, 3.89, 5.36 and 7.26 mm respectively), root length (15.63, 28.41, 37.87 and 44.10 respectively) at 30, 60, 90 and 120 DAS and survival percentage (99.53) at 120 DAS.

Keywords: Biofertilizers, *Azospirillum*, tamarind, PSB, KRB

Introduction
Tamarind (*Tamarindus indica* L.) is a member of dicotyledonous family Fabaceae. The name of tamarind is derived from an Arabic word "Tamarind- E- Hind" meaning "Date of India" popularly known as "Indian Date". Tamarind is a short trunked, multistemmed, large, evergreen or semi-evergreen tree growing up to 30 m with a trunk of about 8 m circumference and a crown diameter of up to 12m. Leaves do not shed intermittently but usually become brown in color and drop out during harsh situations such as hot dry season. The tamarind leaves are pinnate compound leaves with each being oval in shape. Leaflets are also present with most of them being sessile and they usually close at nights. The leaflets are arranged in about 10-18 pairs occurs on a leaf. The width of the flowers extends for about one inch and they are generally white in color with the petals being yellow with red stripes. The buds of the flower are usually pinkish in color. Tamarind trees starts bearing the fruits at the age of 13 to 14 years and continue to produce fruits even after 60 years and some up to 200 years. Tamarind, half the pod weight is contributed by pulp. Tamarind is traditionally propagated from seed. Tamarind produces relatively large seeds with diameter of about 11.0-12.5 mm. They are flattish, shiny brown to blackish, with a rigid impermeable seed coat. Germination of tamarind seed is epigeal. On an average, tamarind seeds begin to germinate about 13 days after sowing and may take a month to complete (Joker, 2000) [3].

The plants grown in soil enriched with vermicompost exhibit the positive effects on various growth characters like seed germination, seedling vigour index, shoot length, root length, plant fresh weight and plant dry weight (Khare, 2018) [5]. Growing media directly allows seed germination, seedling growth, seedling development and later maintenance of the extensively functional rooting system. A good growing media serves as reservoir for nutrients and water, allows oxygen diffusion to the roots and the atmosphere outside the root substrate. Growing media composition influences seed germination and quality of the seedlings. Biofertilizers add nutrients through the natural processes of nitrogen fixation, solubilising phosphorus, and stimulating plant growth through the production of growth promoting substances.

They are also environment friendly and responsible for continuous availability of nutrients from natural sources. The present investigation was undertaken to study the influence of biofertilizers and growing media on seed germination and seedling growth.

Materials and Methods

The experimental site was located at College of Horticulture, Dr.Y.S.R. Horticultural University, Venkataramannagudem, West Godavari District, Andhra Pradesh, conducted during the year 2021-2022. The experimental field is located at an altitude of 34 meters above mean sea level. The geographical situation is 16.83° N latitude and 81.5° E longitude. It experiences hot humid summer and mild winters

The experimental design selected was factorial randomized block design (FRBD). Sixteen treatments were used including control. 30 seeds were used for each treatment and replicated thrice. The treatment details are as follows T_1 – soil (control), T_2 - soil + *Azospirillum* @ 10g per kg media, T_3 - soil + PSB @ 10g per kg media, T_4 - soil + KRB @ 10g per kg media, T_5 - soil + coco peat, T_6 - soil + coco peat+ *Azospirillum* @ 10g per kg media,T_7 - soil + coco peat+ PSB @ 10g per kg media, T_8 - soil + coco peat + KRB @ 10g per kg media, T_9 -soil + vermicompost T_{10} - soil + vermicompost+ *Azospirillum* @ 10g per kg media, T_{11} - soil + vermicompost+ PSB @ 10g per kg media, T_{12} - soil + vermicompost+ KRB @ 10g per kg media, T_{13} - soil + coco peat + vermicompost, T_{14} - soil + coco peat + vermicompost+ *Azospirillum* @ 10g per kg media, T_{15} - soil + coco peat + vermicompost+ PSB @ 10g per kg media, T_{16} - soil + coco peat + vermicompost+ KRB @ 10g per kg media. Media components of soil, cocopeat, vermicompost and FYM were procured and mixed in different proportions as per the treatments combinations. The quantity of biofertilizers taken for filling the polythene bags was 10 g per kg media. The required quantity of biofertilizers were added to the media, mixed thoroughly and allowed to multiply for 15 days. Then the prepared potting mixture was filled properly into the polythene bags up to the brim. Observations were recorded daily on germination parameters and monthly intervals like 30, 60, 90 and 120 days after sowing for growth parameters like plant height, number of leaves stem girth, root length and survival percentage at 120 DAS. The data collected from five labeled seedlings in each replication of treatment and FRBD was employed to find out the significance among different treatments. Germination percentage and survival percentage was calculated based on the following formulas.

$$\text{Germination (\%)} = \frac{\text{Total number of seeds germinated}}{\text{Total number of seeds sown}} \times 100$$

$$\text{Survival percentage of seedlings} = \frac{\text{Number of survived seedlings}}{\text{Total number of seedlings}} \times 100$$

Results and Discussion

The results showed that there was a significant difference between the media and biofertilizers; seeds sown in T_{14} (soil + cocopeat + vermicompost + *Azospirillum* @ 10 g per Kg media) took the shortest amount of time (8.50 days) to begin germination, and recorded maximum germination percentage (99.79%) followed by (99.52%) in T_{10} (soil + vermicompost + *Azospirillum* @ 10 g per Kg media). The maximum days for initiation of germination (18.00 days) and minimum germination percentage (88.23%) was recorded in T_1 (soil without biofertilizers inoculation). According to Kaur (2017) [4], this may be attributable to the presence of vermicompost in the media, which has a balanced composition of nutrients that aids in plant germination and growth. Additionally, it may be due to the presence of cocopeat, which contains more readily available moisture and some acids that may have aided in better seed germination (Bisla *et al*., 1984) [2].

In the interactions, media T_{14} (soil + coco peat + vermicompost + *Azospirillum* @ 10 g per Kg media) showed maximum seedling height (28.75, 50.99, 66.72, and 89.61 cm respectively), and highest numbers of leaves per seedling (11.36, 23.81, 36.22 and 59.42 respectively) at 30, 60, 90 and 120 DAS whereas seedlings grown in T_1 (soil without biofertilizers inoculation) showed minimum seedling height (15.36, 23.98, 30.95, and 43.95 cm respectively) and minimum number of leaves per seedling (6.25, 15.62, 22.43 and 32.52 respectively) at 30, 60, 90 and 120 DAS.

Girth of the stem was maximum (1.23, 3.89, 5.36 and 7.26 mm respectively) at 30, 60, 90 and 120 DAS in the treatment T_{14} (soil + cocopeat + vermicompost + *Azospirillum* @ 10 g per Kg media). It was minimum (0.62, 1.56, 2.05 and 4.22 respectively) when seeds were sown in soil without inoculation (T_1). The better scion girth might also be attributed to high rate of nitrogen mineralization with increase in the number of roots giving the plant ability to scavenge enhanced nutrients from biofertilizers and vermicompost added soil for growth and development (Poonia *et al*., 2018) [6].

The maximum root length of tamarind seedlings (15.63, 28.41, 37.87 and 44.10 cm respectively) at 30, 60, 90 and 120 DAS was recorded with T_{14} (soil + cocopeat + vermicompost + *Azospirillum* @ 10 g per Kg media). While the lowest root length (8.57, 15.52, 24.64 and 33.82 cm respectively) was recorded in media with soil and without inoculation of biofertilizers (T_1) at 30, 60, 90 and 120 DAS. Media which is having cocopeat and vermicompost improves the physical and a biological property of the soil that helps in easy penetration of roots into the soil to absorb the available nutrients there by improves the root growth (Bharadwaj, 2014). Maximum survival percent of seedlings (99.53) was recorded with T_{14} (soil + cocopeat + vermicompost + *Azospirillum* @ 10 g per Kg media). Whereas, the minimum (85.56) survival percent was recorded in soil without inoculation (T_1). Vermicompost with cocopeat may improve soil porosity, water content, pore of drainage, soil permeability and water availability, whereas weight of soil may decrease, this helps to improve and air flow in the soil.

Table 1: Effect of biofertilizers and media on seed germination characters of tamarind (*Tamarindus indica* L.)

Treatments	Initiation of germination (days)	Germination percentage (%)	Survival percentage (%)
T_1	18.00	88.23	85.56
T_2	14.66	95.28	92.50
T_3	16.50	95.76	89.65
T_4	16.50	93.90	91.60
T_5	17.00	90.50	87.54
T_6	14.50	98.27	93.61
T_7	14.00	97.00	94.29
T_8	15.50	96.66	93.29
T_9	13.00	98.27	94.68
T_{10}	9.50	99.73	98.54
T_{11}	11.50	99.34	97.45
T_{12}	12.50	99.00	96.68
T_{13}	13.00	98.27	95.59
T_{14}	8.50	99.79	99.53
T_{15}	10.50	99.52	98.42
T_{16}	9.50	99.34	97.65
SE m±	0.34	0.369	0.45
CD @5%	0.99	1.071	1.32

Table 2: Effect of biofertilizers and media on seedling height and number of leaves tamarind (*Tamarindus indica* L.)

Treatments	Seedling height (cm)				Number of leaves			
	30	60	90	120	30	60	90	120
T_1	15.36	23.98	30.95	43.95	6.25	15.62	22.43	32.52
T_2	19.52	33.09	45.12	56.14	7.16	16.88	23.96	38.41
T_3	17.53	29.46	33.98	53.28	6.69	16.24	23.24	37.54
T_4	17.94	32.97	39.74	54.25	6.92	16.58	23.75	37.72
T_5	15.84	24.07	31.89	44.52	6.56	15.94	22.85	36.86
T_6	21.24	34.51	45.20	57.35	7.84	17.64	24.86	39.57
T_7	21.97	34.79	48.28	60.46	8.35	18.16	25.43	40.26
T_8	19.68	33.29	44.89	56.30	7.35	17.42	24.54	39.26
T_9	22.41	36.34	53.56	65.38	8.67	19.24	27.42	42.78
T_{10}	28.52	41.53	64.53	84.35	11.24	23.64	36.16	56.58
T_{11}	24.86	40.73	58.79	73.27	9.79	21.62	33.97	48.36
T_{12}	24.51	38.06	56.47	70.23	9.54	20.34	32.67	46.74
T_{13}	22.45	39.87	55.75	67.83	9.39	19.59	29.75	44.52
T_{14}	28.75	50.99	66.72	89.61	11.36	23.81	36.22	59.42
T_{15}	26.67	42.83	63.31	81.10	10.43	22.67	35.58	54.67
T_{16}	26.26	43.93	61.45	74.77	10.19	22.58	34.26	52.84
SE m±	0.078	0.320	0.500	0.662	0.037	0.043	0.081	0.196
CD @5%	0.227	0.929	1.451	1.921	0.106	0.125	0.236	0.568

Table 3: Effect of biofertilizers and media on stem diameter and root length tamarind (*Tamarindus indica* L.)

Treatments	Stem diameter (mm)				Root length (cm)			
	30	60	90	120	30	60	90	120
T_1	0.62	1.56	2.05	4.22	8.57	15.52	24.64	33.82
T_2	0.72	1.89	2.82	4.97	9.78	17.48	26.28	35.52
T_3	0.66	1.72	2.42	4.85	8.86	16.26	25.43	34.35
T_4	0.69	1.85	2.61	4.94	9.42	16.73	25.89	34.79
T_5	0.64	1.67	2.24	4.62	8.74	15.84	24.84	33.89
T_6	0.76	2.16	3.24	5.33	10.86	18.42	27.31	35.23
T_7	0.79	2.28	3.42	5.58	11.54	18.57	26.96	35.78
T_8	0.73	2.05	2.93	5.05	10.36	17.81	26.58	35.82
T_9	0.83	2.67	3.81	5.69	11.85	19.42	27.64	36.10
T_{10}	1.18	3.69	4.95	6.72	15.23	26.56	36.62	42.83
T_{11}	0.96	3.26	4.25	5.94	13.43	23.95	30.63	40.30
T_{12}	0.93	3.14	4.12	5.87	12.78	23.49	29.58	39.20
T_{13}	0.86	2.89	3.93	5.78	12.34	21.83	28.75	37.50
T_{14}	1.23	3.89	5.36	7.26	15.63	28.41	37.87	44.10
T_{15}	1.14	3.67	4.66	6.56	14.57	25.74	32.85	41.50
T_{16}	1.05	3.53	4.47	6.14	13.86	26.82	34.56	41.86
SE m±	0.033	0.025	0.044	0.061	0.245	0.035	0.464	0.052
CD @5%	0.095	0.072	0.128	0.176	0.710	0.102	1.346	0.152

Conclusion

Based on findings, it was found that decrease in number of days to initiation of germination, increase in germination percentage, survival percentage, maximum seedling height, number of leaves, stem diameter and root length were recorded in T_{14} (soil + cocopeat + vermicompost + *Azospirillum* @ 10 g per Kg media) treatment compared to control (T_1).

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