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RESPONSE OF SOAKING TIME AND CHEMICALS ON GERMINATION AND GROWTH OF TAMARIND (*TAMARINDUS INDICA* L.)

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Abstarct

An experiment was conducted to study the effect of soaking time and chemicals on germination and growth of tamarind (*Tamarindus indica* L.) at Regional Horticultural Research Station, ASPEE College of Horticulture & Forestry, Navsari Agricultural University, Navsari during the year 2016. The treatment comprised of two soaking time *viz*., 12 hours and 24 hours and nine different seed treatment chemicals *viz*., KNO_3 @ 1 and 2 %, GA_3 @ 100 and 200 mgl^{-1}, NAA @ 100 and 200 mgl^{-1}, Thiourea 2 % and 4 % and Control (without chemical). The experiment was laid out in Completely Randomized Design with two factors repeated three times. The experimental findings revealed that soaking the seeds in GA_3 @ 200 mg l^{-1} for 24 hours recorded minimum number of days for germination (9.83, 13.59 days), maximum germination percentage (94.17, 84.26 %). Similarly maximum seedling height (71.33, 56.92 cm), number of leaves per seedling (62.33, 47.48), number of leaflets/leaf (1216.67, 904.63), stem diameter (3.92, 3.57 mm), leaf area (1116.42, 831.12 cm^2), fresh weight of shoot (26.37, 21.56 g), fresh weight of root (6.90, 6.12 g), dry weight of shoot (8.67, 6.22 g), dry weight of root (5.07, 3.19 g), longest root length (40.67, 35.49 cm), root : shoot ratio (3.82, 3.54), vigour index-I (10548.33, 7861.63 cm), vigour index-II (1293.17, 804.85 g), and survival percentage (100.00, 96.93 %) at 180 days after sowing was also observed with GA_3 @ 200 mg l^{-1} for 24 hours.

Key words : Germination, GA_3, KNO_3, NAA, soaking time, Tamarind and thiourea.

Introduction

Tamarind (*Tamarindus indica* L.) is a member of dicotyledonous family Fabaceae and belongs to the sub family Caesalpinoideae. The name of tamarind is derived from an Arabic word "Tamarind- E-Hind" meaning "Date of India" popularly known as "Indian Date". The tamarind is a long-lived, medium-growth, bushy tree which attains a maximum crown height of 12 to 18 metres. Tamarind is native of the Dry Savanna of Tropical Africa and probably some parts of South India. It is cultivated throughout the tropics and subtropics of the world and has become naturalized at many places. India is the main producer and consumer of tamarind in the world. Tamarind fruit pulp which is sweetish and acidic in taste is used for serving curries, chutneys, sauces and soups. It is rich in Vitamin C and protects against Vitamin C deficiency. Pulp has several medicinal properties also.

Tamarind is traditionally propagated by seed; tamarind produces relatively large, flattish, shiny brown to blackish seed with a hard impermeable seed coat. Tamarind seeds take long time to germinate after sowing and sometime take a month to complete (Joker, 2000). The main disadvantage of seed propagation is freshly harvested tamarind seeds exhibit poor germination even if exposed to favorable conditions for germination owing to seed dormancy. It has been reported that pre-sowing seed treatment with chemicals like GA_3, KNO_3, NAA and thiourea improved the seed germination and seedling growth in many crops. The present investigation was

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therefore, undertaken to study the response of soaking time and chemicals on germination and growth of tamarind.

Materials and methods

The present investigation was carried out during 2016 at Regional Horticultural Research Station, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari. The treatment comprised of two soaking time *viz*., 12 hours and 24 hours and nine different seed treatment chemicals *viz*., KNO_3 @ 1 % (C_1), KNO_3 @ 2 % (C_2), GA_3 @ 100 mgl^{-1} (C_3), GA_3 @ 200 mgl^{-1} (C_4), NAA @ 100 mgl^{-1} (C_5), NAA @ 200 mgl^{-1} (C_6), Thiourea 2 % (C_7), Thiourea 4 % (C_8) and Control (without- chemical) (C_9) were evaluated in completely randomized design with three repetition. Uniform and healthy seeds were selected and used for the experiment. After imposing treatments, seeds were sown in polythene bags size of 6" × 8" size of 50 micron, previously filled with prepared medium of red soil + FYM + sand + cocopeat (2:1:1:1) at 1-1.5 cm deep and kept in net house. To maintain proper moisture through out the experimental period, regular watering was done. Observations were recorded daily for germination parameters. Growth parameters like seedling height, number of leaves per seedling and stem diameter were recorded at two months interval at 60, 120 and 180 days after sowing. Whereas other growth parameters such as number of leaflets/leaf, longest root length, root : shoot ratio, leaf area, fresh weight of shoot, fresh weight of root, dry weight of shoot, dry weight of root, vigour index – I, vigour index – II and survival percentage were recorded at 180 days after sowing. The data recorded during the course of investigation were subjected to statistical analysis following standard procedure described by Panse and Sukhatme (1967).

The Seedling vigour index was calculated using the following formula:

1. Vigour index-I (cm) = Mean seedling length × germination %
2. Vigour index-II (g)= Dry weight of seedling × germination %

Results and discussion

Germination Attributes

Days required for germination

The minimum number of days for seed germination 13.59 and 9.83 respectively was recorded when tamarind seeds soaked for 24 hours and treated with GA_3 200 mgl^{-1} (table 1). It might be due to the involvement of GA_3 in the activation of cytological enzymes along with increase in cell wall plasticity and better water absorption (Stewart and Freebairn, 1969). Similar results was reported by Vasantha *et al.* (2014) in tamarind.

Germination percentage (%)

Among the soaking time, 24 hours soaking time and GA_3 200 mgl^{-1} showed significantly highest germination percentage (84.26 % and 94.17 %, respectively). The minimum germination percentage was recorded in 12 hrs soaking time and without chemical-control 81.11 % and 73.33 % (table 1). It might be due to the GA_3 acts directly on embryo relieving them from dormancy through promoting protein synthesis and elongation of coleoptiles and leaves also helps in the production of ethylene. This ethylene invokes the synthesis of hydrolases, especially amylase, which favours the seed germination. Thus, the enhanced enzymatic reactions along with the suppression of inhibitors by these growth substances might have acted in faster germination (Stewart and Freebairn, 1969). The results of study are in close agreement with the findings of Muralidhara *et al*. (2015) and Venkatrao and Reddy (2005) in mango.

Growth attributes

Seedling height (cm)

The Maximum seedling height was observed with 24 hours soaking time (15.83, 31.09 and 56.92 cm, respectively) and GA_3 @ 200 mgl^{-1} (17.25, 41.56 and 71.33 cm, respectively) at 60, 120 and 180 DAS which was at par with the treatments GA_3 @ 100 mgl^{-1}, KNO_3 @ 2 %, NAA @ 100 mgl^{-1} and Thiourea 4 %. While minimum seedling height was recorded in without chemical-control (table 1). It might be due to soaking tamarind seeds for 24 hours may have accelerated the hydrolysis of complex sugar into simple sugars which are than utilized in the synthesis of auxins and proteins. It is a well known fact that proteins are utilized in the production of new tissues and that auxins promote growth. This probably explains the higher values recorded for various growth parameters under 24 hours soaking time. The increase in seedling height with GA_3 treatment was due to the fact that this hormone increased osmotic uptake of nutrients, causing cell elongation and thus increased height of the plant (Shanmugavelu, 1966). Such type of finding are also reported by Nimbalkar, *et al.* 2012 in karonda.

Number of leaves/seedling

Among the soaking time and different seed treatment chemicals, 24 hours soaking time (7.00, 24.16 and 47.48 mm, respectively) and GA_3 @ 200 mgl^{-1} (9.02, 34.03 and 62.33 mm, respectively) recorded the maximum number

Table 1: Response of soaking time and chemicals on days required for germination, germination percentage, seedling height, number of leaves/seedling and stem diameter of tamarind seedling.

Treatments	Days required for germination	Germination percentage (%)	Seedling height (cm)			No. of leaves per seedling			Stem diameter (mm)		
			60 DAS	120 DAS	180 DAS	60 DAS	120 DAS	180 DAS	60 DAS	120 DAS	180 DAS
Soaking time											
S_1 : 12 hrs	16.96	81.11	14.14	29.49	55.07	6.36	19.58	39.55	1.55	2.34	3.46
S_2 : 24 hrs	13.59	84.26	15.83	31.09	56.92	7.00	24.16	47.48	1.69	2.68	3.57
S.Em. ±	0.24	0.6001	0.1683	0.2955	0.5473	0.068	0.2591	0.5649	0.0196	0.0248	0.0278
C.D. at 5 %	0.6889	1.7226	0.4831	0.8483	1.5711	0.1952	0.7438	1.6216	0.0563	0.0712	0.0798
Seed treatment chemicals											
C_1 : KNO_3 @ 1 %	14.00	84.17	14.15	33.88	61.75	7.07	23.72	44.25	1.48	2.53	3.73
C_2 : KNO_3 @ 2 %	13.66	85.00	15.18	33.53	64.30	7.20	24.62	54.35	1.80	2.58	3.57
C_3 : GA_3 @ 100 mgl^{-1}	12.16	86.67	15.81	38.01	65.61	7.45	25.60	58.67	2.27	2.65	3.67
C_4 : GA_3 @ 200 mgl^{-1}	9.83	94.17	17.25	41.56	71.33	9.02	34.03	62.33	2.38	2.70	3.92
C_5 : NAA @ 100 mgl^{-1}	15.83	81.67	15.30	24.98	51.25	6.63	19.50	37.23	1.40	2.48	3.57
C_6 : NAA @ 200 mgl^{-1}	16.66	79.17	14.61	25.05	49.36	6.30	21.30	38.60	1.40	2.53	3.60
C_7 : Thiourea 2 %	15.83	80.00	14.35	28.15	49.35	5.60	17.30	39.43	1.30	2.52	3.68
C_8 : Thiourea 4 %	16.50	80.00	15.00	26.38	48.50	5.78	17.52	31.42	1.27	2.50	3.13
C_9 : Control (without chemical)	23.00	73.33	13.26	21.08	42.53	5.03	13.25	26.57	1.25	2.07	2.80
S.Em. ±	0.5092	1.2729	0.357	0.6268	1.1609	0.1442	0.5497	1.1984	0.0417	0.0527	0.0591
C.D. at 5 %	1.4617	3.6539	1.0248	1.7993	3.3324	0.4139	1.578	3.4401	0.1197	0.1513	0.1697
Interaction S × C											
S.Em. ±	0.7201	1.8002	0.5049	0.8864	1.6418	0.204	0.7773	1.6948	0.0589	0.0745	0.0835
C.D. at 5 %	2.0671	5.1676	1.4494	2.5445	4.7129	0.5856	2.2313	4.865	0.1691	0.2139	0.2397
C.V. %	8.16	3.77	5.83	5.07	5.08	5.29	6.16	6.72	6.31	5.15	4.11

DAS - Days after sowing

Table 2: Response of soaking time and chemicals on number of leaflets / leaf, longest root length, root : shoot ratio, leaf area, seedling biomass, seedling vigour and survival percentage of tamarind seedling.

Treatments	No. of leaflets / leaf	Longest root length (cm)	Root : Shoot ratio	Leaf area (cm^2)	Fresh weight of shoot (g)	Fresh weight of root (g)	Dry weight of shoot (g)	Dry weight of root (g)	Vigour index – I (cm)	Vigour index – II (g)	Survival percentage (%)
Soaking time											
S_1 : 12 hrs	739.68	34.28	3.25	652.29	18.12	5.54	6.05	2.89	7302.37	738.57	94.76
S_2 : 24 hrs	904.63	35.49	3.54	831.12	21.56	6.12	6.22	3.19	7861.63	804.85	96.93
S.Em. ±	11.9175	0.3303	0.0532	8.5757	0.271	0.09	0.0593	0.0283	79.6187	7.6591	0.6178
C.D. at 5 %	34.21	0.9481	0.1527	24.6172	0.7779	0.2584	0.1702	0.0812	228.5511	21.986	1.7734
Seed treatment chemicals											
C_1 : KNO_3 @ 1 %	1069.33	35.27	3.33	907.34	18.47	5.55	6.78	3.38	8171.17	855.33	96.94
C_2 : KNO_3 @ 2 %	1007.33	35.33	3.50	895.43	21.08	6.02	6.95	3.55	8479.50	893.25	98.03
C_3 : GA_3 @ 100 mgl^{-1}	1072.50	38.38	3.45	982.22	23.53	6.83	7.65	4.27	9015.50	1032.67	100.00
C_4 : GA_3 @ 200 mgl^{-1}	1216.67	40.67	3.82	1116.42	26.37	6.90	8.67	5.07	10548.33	1293.17	100.00
C_5 : NAA @ 100 mgl^{-1}	596.50	34.60	3.49	627.79	20.40	5.85	5.62	2.38	7016.75	654.25	95.90
C_6 : NAA @ 200 mgl^{-1}	620.90	33.62	3.05	632.25	17.42	5.68	4.97	2.20	6571.08	567.58	96.87
C_7 : Thiourea 2 %	629.83	33.38	3.27	634.96	18.37	5.67	5.07	2.38	6622.08	598.83	94.72
C_8 : Thiourea 4 %	711.17	32.02	3.40	480.42	18.53	5.47	4.98	2.23	6442.75	577.33	93.69
C_9 : Control (without chemical)	475.17	30.70	3.22	398.47	14.40	4.48	4.55	1.90	5370.83	473.00	86.48
S.Em. ±	25.2809	0.7007	0.1128	18.1918	0.575	0.191	0.1258	0.0601	168.8967	16.2475	1.3105
C.D. at 5 %	72.5706	2.0114	0.3238	52.2208	1.6506	0.5483	0.3611	0.1725	484.8299	46.6396	3.7619
Interaction S × C											
S.Em. ±	35.7526	0.9909	0.1595	25.7272	0.8131	0.2701	0.178	0.085	238.8561	22.9774	1.8533
C.D. at 5 %	102.6304	2.8444	0.4579	73.8517	2.3341	NS	0.511	0.244	685.6533	65.9583	NS
C.V. %	7.53	4.92	8.14	6.01	7.1	8.03	5.02	4.84	5.46	5.16	3.35

of leaves/seedling at 60, 120 and 180 DAS (table 1). The increase in number of leaves per seedling might be due to activity of GA_3 at the apical meristem resulting in more synthesis of nucleoprotein responsible for increasing leaf initiation (Sen and Ghunti, 1976). The observation analogues to these findings were reported by Jadhav *et al*. (2015) in custard apple.

Stem diameter (mm)

The Maximum stem diameter was observed in 24 hours soaking time 1.69, 2.68 and 3.57 mm and GA_3 200 mg l^{-1} 2.38, 2.70 and 3.92 at 60, 120 and 180 DAS which were significantly superior over all the remaining treatments (table 1). This result is in agreement with the finding of Manekar *et al*. (2011) in aonla.

Number of leaflets/leaf

Pre soaking of tamarind seeds with 24 hours soaking time and GA_3 200 mg l^{-1} gave significantly highest number of leaflets/leaf 904.63 and 1216.67 respectively at 180 DAS. Whereas, the minimum number of leaflets per leaf (475.17) was noted in treatment without chemical-control (table 2).

Longest root length (cm)

Maximum longest root length 35.49 cm and 40.67 respectively was recorded when tamarind seeds soaked for 24 hours soaking time and GA_3 200 mg l^{-1} (table 2) at 180 DAS. The increased in root length in the GA_3 treatment might be due to more production of photosynthates and their translocation through phloem to the root zone, which might be responsible for increasing the root length (Vachhani *et al*. 2014). More or less similar results were also reported by Anburani and Shakila (2010) in papaya.

Root : Shoot ratio

Among the soaking time, 24 hours soaking time (3.54) and GA_3 200 mg l^{-1} (3.82) recorded significantly maximum root : shoot ratio at 180 DAS. Whereas, minimum root : shoot ratio (3.05) was observed in NAA @ 200 mgl^{-1} (table 2). The results of study are in close agreement with the findings of Meshram *et al.* (2015) in acid lime.

Leaf area (cm^2)

Leaf area (table 2) was recorded maximum 831.12 cm^2 and 1116.42 cm^2 when tamarind seeds soaked for 24 hours soaking time and GA_3 200 mgl^{-1} at 180 DAS. Results obtained on this aspect are in agreement with Meshram *et al.* (2015) in acid lime.

Effect on biomass

Shoot and root characters

Maximum fresh and dry weight of shoot was recorded with 24 hours soaking time (21.56 and 6.22 g) and GA_3 200 mg l^{-1} (26.37 and 8.67 g) at 180 DAS. Similarly maximum fresh and dry weight of root was also recorded with 24 hours soaking time (6.12 and 3.19 g) and GA_3 200 mg l^{-1} (6.90 and 5.07 g) at 180 DAS (table 2). It might be due to overall growth of the seedling and increased rate of photosynthesis that lead to the overall assimilation and redistribution of photosynthates within the seedling and hence, resulted in higher fresh weight of shoot and root and higher dry weight of shoot and root. Thus increased growth is a consequence of increased dry matter accumulation. This type of result was also observed by Parmar *et al*. (2016) in custard apple.

Seedling vigour

Among the soaking time and different seed treatment chemicals, 24 hours soaking time (7861.63 and 804.85) and GA_3 200 mg l^{-1} (10548.33 and 1293.17) recorded significantly highest vigour index-I and vigour index-II at 180 DAS. The least vigour index-I and vigour index – II (5370.83 and 473.00) was recorded in without chemical-control (table 2). The increase in vigour index-I and vigour index-II might be due to activity of GA_3 was attributed to enlarged embryos, higher rate of metabolic activity and respiration, better utilization and mobilization of metabolites to growth points and higher activity of enzymes. Enzymatic and hormonal mechanism stimulate metabolic process such as sugar mobilization, protein hydrolysis, oxidation etc. (Earlplus and Lambeth, 1974), which leads to increase in root length, shoot length and seedling dry weight, in turn increase in seedling vigour. The results are in close conformity with findings of Gurung *et al.* (2014) in passion fruit.

Survival percentage

The highest survival percentage (table 2) was observed in 24 hours soaking time (96.93 %), GA_3 200 mg l^{-1} (100.00 %) and GA_3 100 mg l^{-1} (100.00) at 180 DAS which was at par with the treatment KNO_3 @ 2 %, KNO_3 @ 1 % and NAA @ 200 mgl^{-1}. This might be due to the overall performance in relation to growth parameters were good in same treatment which ultimately increased the survival percentage.

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