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EFFECT OF DIFFERENT DOSES OF BIO-REGULATORS AND BIO-WASTE ON SEED GERMINATION AND VIGOUR AND GROWTH OF TAMARIND (*TAMARINDUS INDICA* L.) SEEDLING

Nitin Yadav[1], Rajesh Tiwari[2], Rajesh Jatav[2*] and Narendra Vasure[2]
[1]Jawaharlal Nehru Krishi Vishwa Vidyalaya Jabalpur, Madhya Pradesh, 482004, India
[2]Rajmata Vijayaraje Scindia Agricultural University, Gwalior, Madhya Pradesh, 474002, India
*Corresponding author E- Mail: rajeshjatavhorti@gmail.com
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ABSTRACT

A study titled "Effect of different doses of Bio-regulators and Bio-waste on seed germination and vigour & growth of Tamarind (*Tamarindus indica* L.) seedling" was undertaken at the Department of Horticulture, College of Agriculture, Rewa (Madhya Pradesh) during the academic year 2021–22. The primary aim was to assess effect of different concentrations of growth-promoting substances (GA_3 and Thiourea) and bio-waste materials (Cow Urine) influence seed germination and early growth stages of tamarind seedlings. The experiment followed a Randomized Block Design (RBD) with three replications and included ten treatment combinations. These treatments involved three concentrations each of Thiourea (1%, 2%, 3%), GA_3 (100, 200, 300 ppm), and Cow Urine (10%, 20%, 30%). Data were collected on various growth and germination parameters. Among all treatments, T_7 (GA_3 at 300 ppm) emerged as the most effective, showing superior performance across nearly all measured parameters. This treatment significantly reduced the time for germination initiation and completion and resulted in the highest germination percentage, maximum seedling height and shoot diameter, greatest number of leaves, highest fresh and dry biomass of leaves, largest leaf area, strongest seedling vigour, and longest roots. It also recorded the maximum fresh and dry root weights, highest survival rate, and yielded the best economic returns in terms of gross and net income and B:C ratio. Conversely, the control treatment (T_1) where seeds were soaked in distilled water for 24 hours consistently recorded the lowest values for all observed parameters.
***Keywords* :** Tamarind, Seed, Germination, Seedlings, Bio-Regulators and Bio-Waste.

Introduction

Tamarind (*Tamarindus indica* L.) has a wide geographical distribution in the subtropics and semiarid tropics and is cultivated in numerous regions. It is a member of the dicotyledonous family Fabaceae, subfamily Caesalpiniodeae and native to Tropical Africa.

Tamarind is generally propagated through seed. It seeds exhibit poor germination percentage even if exposed to favourable conditions of germination. It may be due to morphological factor such as hard, thick testa or due to incorrect storage or handling (secondary dormancy). Germination of tamarind seed can be accelerated by overcoming the hard seedness through acid or mechanical scarification and soaking in hot water. Hard seed with tough and impermeable seed coat discourage the easy germination and take more time to full grown rootstock for further operations hence, scarification is necessary. It increases the embryo growth potential, reduces the germination time and weakening of the seed coat and promote percentage of germination cow urine which was in use as a growth regulator. 10-20 percent cow urine for different hours soaking treatment is effective for breaking dormancy and increasing germination and seedling growth tamarind.

The use of plant growth regulators in proper concentration with scarification may regulate growth behaviour in many fruit crops and pre-sowing treatment of growth regulators could lead to increase seed germination and enhancement of seedling growth. Seed, without use of growth regulators showed poor response for germination and its growth. Gibberellin acid and thiourea enhance the germination, growth and survival of seedlings. These chemicals are used for weakening of the seed coat so that the radical of the seedling can break through the seed coat. GA3 induced the synthesis of amylase and other hydrolytic enzymes during the early stages of seed germination. Gibberellins controls mobilization of starch which acts as a respiratory substrate leading to immediate enhancement in cell elongation. Gibberellins and thiourea also help in enhancing the availability of reserved mineral elements which promote the germination process. The seed soaked in GA3 and thiourea resulted in high germination and shoot length.

The germination of tamarind seeds is also accelerated by soaking in cow urine at different concentrations or cow dung solution (500 g in 10 L) for 24 hours, in which germination is occurred more than doubled. The prices of growth regulators have gone sky high so to overcome this crisis some alternatives for growth regulators are easy to access and cheap. This has diverted the attention once again towards the chemical, cow urine which was in use as a growth regulator. Cow urine proving feasible may bring a breakthrough in the present context as it is free of cost and easily available through it is not much consistent. Cow urine contains Iron, urea, Uric acid, estrogen and progesterone which affect the inhibitory responses to seed germination, shoot growth and seedling vigour.

Material and Methods

The present investigation was conducted at Experimental Field, Department of Horticulture, College of Agriculture, Rewa (M.P.). The experiment was laid out in the Randomized Block Design with three replications comprised of ten treatment combinations involving thiourea (1%, 2% and 3%), GA_3 (100, 200 and 300 ppm) and cow urine (10%, 20% and 30%). Tamarind seeds were soaking with different treatments before sowing to breaking the seed dormancy. The study comprised ten different treatment methods aimed at assessing their impact on tamarind seed germination and early growth. The first treatment (T_1) served as the control, where seeds were soaked in distilled water for 24 hours. Treatments T_2, T_3 and T_4 involved the use of Thiourea at three concentration levels: 1%, 2%, and 3%. Treatments T_5, T_6, and T_7 consisted of soaking seeds in Gibberellic Acid (GA_3) solutions at concentrations of 100 ppm, 200 ppm, and 300 ppm, respectively. The remaining treatments, T_8, T_9 and T_{10}, used cow urine at 10%, 20%, and 30% concentrations to test its effectiveness as a natural growth stimulant. These varied pre-sowing treatments were designed to investigate their potential role in enhancing germination percentage and improving the vigour of tamarind seedlings.

As experimental material well-ripened, healthy, and disease-free tamarind fruits were selected for seed extraction. To identify viable seeds, the extracted seeds were placed in water. Non-viable or dead seeds, being lighter, floated on the surface, while the viable ones sank to the bottom and were chosen for sowing. These selected seeds were then thoroughly rinsed with tap water and allowed to air dry in the shade for about 20 minutes.

To prepare Gibberellic Acid (GA_3) solutions of 100, 200, and 300 ppm, 100 mg, 200 mg, and 300 mg of GA_3 were precisely weighed using an electronic balance. The measured quantities were individually transferred into separate glass beakers using a soft brush. A few drops of 95% ethyl alcohol were added to each beaker to facilitate the dissolution of the GA_3. Once dissolved, 100 ml of distilled water was added to each beaker to obtain the desired concentrations. For the preparation of thiourea solutions at 1%, 2%, and 3%, exactly 1 g, 2 g, and 3 g of thiourea were measured and placed into separate labelled beakers. Each sample was then diluted with 100 ml of distilled water to create the respective concentrations. To make 10%, 20%, and 30% cow urine solutions, 10 ml, 20 ml, and 30 ml of fresh cow urine were measured and poured into separate beakers. These were then diluted with 90 ml, 80 ml, and 70 ml of distilled water, respectively, to achieve the required solution strengths.

Seeds were treated with the thiourea, GA3 and cow urine solution for each treatment as per details of treatments given above. After that the seeds were sown in polythene bags of length 20 cm and diameter of 30 cm filled with a mixture of soil and vermicompost in the ratio of 3:1. Healthy and well developed seeds were selected and treated as per the treatments and sown in poly bags. One seed were hand dipped at 1.2 cm depth in each poly bags. Watering and other operation were done as per requirements. Optimum moisture of germinating media was maintained during the period of seed germination.

To evaluate different traits, five plants were randomly selected from each treatment in every replication. The mean of these five plants was calculated and used as the final value for each recorded parameter. The data collected for each trait were statistically examined using the Analysis of Variance (ANOVA) technique, based on the methodology proposed by Panse and Sukhatme in 1985.

Results and Discussion

Days taken to start germination and Days taken to complete germination

It was revealed that the different doses of bio-regulators and bio-waste were significantly affected days taken to start germination in tamarind [Table 1]. It was recorded that the minimum days taken to start germination (5.00) was found in treatment T_7 (GA_3 @ 300 ppm) and it was superior treatment as compared to other treatment of bio-regulators and bio-waste. It was at par to treatments T_3, T_4, T_5, T_6 and T_{10}. However, the maximum days taken to start germination (8.00) was noted in control (seeds soaking with distilled water for 24 hours) treatment T_1.

Result revealed that the minimum days taken to complete germination (9.00) was found in treatment T_7 (GA_3 @ 300 ppm) and it was significantly superior treatment as compared to other treatment of bio-regulators and bio-waste. It was at par to treatments T_3 (Thio-Urea @ 2%), T_4 (Thio-Urea @ 3%) and T_6 (GA_3 @ 200 ppm). However, the maximum days taken to complete germination (15.00) was recorded in treatment T_1 (control-seeds soaking with distilled water for 24 hours) [Table 1].

Result revealed that the different doses of bio-regulators and bio-waste were significantly affected days taken to start germination in tamarind and taken minimum days. It might be due to involvement of GA_3 activation of cytological enzymes takes place which increases in cell wall plasticity and better absorption of water and improve the early germination in plants. These results are supported by the findings of Vasantha *et al.* (2014), Patel *et al.* (2017), Patel *et al.* (2018), Dantani *et al.* (2019) and Tondon *et al.* (2019).

Germination percent (%)

It is evident from the data [Table 1] that bio-regulators (like- thiourea and GA_3) and bio-waste (like-cow urine) were significantly influenced the germination percent (%) in tamarind plant. The maximum germination percent (89.03 %) was recorded in treatment T_7 (GA_3 @ 300 ppm) and it was found significantly superior as compared to other treatments. It was at par to treatment T_4 (Thio-Urea @ 3%). However, the minimum germination percent (69.08 %) was noted in treatment T_1 (Control, seeds soaking with distilled water for 24 hours).

These findings may might be due to GA_3 which would have triggered the activity of specific enzymes that promoted early germination, such as α-amylase, which have brought an increase in availability of starch assimilation and cytological enzymes which increases in cell wall plasticity and better absorption of water and improve the germination of plants. These results are also in accordance with the findings of Vasantha *et al.* (2014), Lay *et al.* (2015), Sharma *et al.* (2016), Patel *et al.* (2016), Behera *et al.* (2017), Chiranjeevi *et al.* (2017), Patel *et al.* (2017), Suradinata *et al.* (2017), Patel *et al.* (2018), Tondon *et al.* (2019) and Mistry and Sitapara (2020).

Length of seedling (cm) at 30, 60 and 90 DAS

Data revealed that treatment T_7 (GA_3 @ 300 ppm) was significantly superior as compared to other treatments and influenced the length of seedling (cm) at 30, 60 and 90 DAS in tamarind. It gave the maximum length of seedling (8.70, 18.41 and 26.32 cm) at 30, 60 and 90 DAS and was at par to treatment T_4 (Thio-Urea @ 3%) and T_6 (GA_3 @ 200 ppm) only at 30 DAS, while closely followed by treatment T_4 (Thio-Urea @ 3%) at 60 and 90 DAS. However, the minimum length of seedling (6.91, 13.30 and 18.21 cm) at 30, 60 and 90 DAS was observed in treatment T_1 (Control, seeds soaking with distilled water for 24 hours) [Table 1].

Treatment T_7 (GA_3 @ 300 ppm) was significantly superior as compared to other treatments and influenced the length of seedling (cm) at 30, 60 and 90 DAS in tamarind. It was due to application of different bio-regulators and bio-waste, activated α-amylase which digested the available carbohydrate into simple sugar so that energy and nutrition were easily available to faster growing seedlings. Length of seedlings increased due to application of GA_3 promotes the growth of the plant by the promotion of cell elongation because gibberellins are well known for inter nodal cell elongation. The results are in confirmation with the results achieved by Ramteke *et al.* (2015), Shinde and Malshe (2015), Harsha *et al.* (2017), Patel *et al.* (2017), Patel *et al.* (2018), Dantani *et al.* (2019), Kumar *et al.* (2020), Mistry and Sitapara (2020) and Sodimu *et al.* (2020).

Diameter of shoot (cm) at 30, 60 and 90 DAS

It is obvious from the data presented in the [table 1] that the maximum diameter of shoot (4.71, 4.92 and 5.92 cm) at 30, 60 and 90 DAS was found in treatment T_7 (GA_3 @ 300 ppm) and it was found significantly superior as compared to other treatments and was significantly influenced the diameter of shoots in tamarind. It was at par to treatments T_4 (Thio-Urea @ 3%) at 30, 60 and 90 DAS. However, the minimum diameter of shoot (3.90, 4.11 and 5.22 cm) at 30, 60 and 90 DAS was recorded in Control (seeds soaking with distilled water for 24 hours) treatment T_1.

It is obvious from the results, the treatment T_7 (GA_3 @ 300 ppm) was found significantly superior as compared to other treatments and was significantly influenced the diameter of shoots in tamarind. It might be due to the beneficial effect of different bio-regulators like GA_3 was probably due to cell elongation and quicker multiplication of cells after the germination. These results are supported by the findings of Chiranjeevi *et al.* (2017), Desai *et al.* (2017), Patil *et al.* (2017), Patel *et al.* (2018), Dantani *et al.* (2019), Kumar *et al.* (2020) and Sodimu *et al.* (2020).

Number of leaves at 30, 60 and 90 DAS

It was found that various treatments the different doses of bio-regulators and bio-waste were significantly affected number of leaves at 30, 60 and 90 DAS in tamarind [Table 1]. It was recorded that the maximum number of leaves (5.36, 10.11 and 16.31) at 30, 60 and 90 DAS was recorded in treatment T_7 (GA_3 @ 300 ppm) and it was superior treatment as compared to other treatment of bio-regulators and bio-waste. It was at par to treatments T_4 (Thio-Urea @ 3%) at 30 and 90 DAS while closely followed by treatment T_4 (Thio-Urea @ 3%) only at 60 DAS. However, the minimum number of leaves (3.70, 6.90 and 11.30) at 30, 60 and 90 DAS was observed in treatment T_1 (control, seeds soaking with distilled water for 24 hours).

It was recorded that the maximum number of leaves was recorded in treatment T_7 (GA_3 @ 300 ppm) and it was superior treatment as compared to other treatment of bio-regulators and bio-waste. It may be possible due to cell division and enhancing activity of apical meristem which may be promoted by the application of different bio-regulators. Increases in number of leaves might be due to the reason that GA_3 helps in invigoration of physiological process of plant and stimulatory effect of chemicals to form new leaves at a faster rate. The results are also in close conformity with the findings of Vasantha *et al.* (2014), Ramteke *et al.* (2015), Harsha *et al.* (2017), Mishra *et al.* (2017), Patil *et al.* (2017), Jaiswal *et al.* (2018), Patel *et al.* (2018), Mistry and Sitapara (2020) and Sodimu *et al.* (2020).

Fresh and dry weight of leaves (g)

The data revealed that the treatment T_7 (GA_3 @ 300 ppm) was significantly superior as compared to other treatments and influenced the fresh weight of leaves in tamarind [Table 2]. It gave the maximum fresh weight of leaves (5.30 g) and was at par to treatment T_4 (Thio-Urea @ 3%) and T_6 (GA_3 @ 200 ppm). However, the minimum fresh weight of leaves (3.90 g) was noted in treatment T_1 (Control, seeds soaking with distilled water for 24 hours).

Table no. 2 shows that the different bio-regulators (like- thiourea and GA_3) and bio-waste (like-cow urine) were significantly influenced the dry weight of leaves (g) in tamarind plant. The maximum dry weight of leaves (0.78 g) was observed in treatment T_7 (GA_3 @ 300 ppm) and it was found significantly superior as compared to other treatments. It was at par to treatment T_4 (Thio-Urea @ 3%). However, the minimum dry weight of leaves (0.39 g) was recorded in treatment T_1 (Control, seeds soaking with distilled water for 24 hours).

The results indicate that the treatment T_7 (GA_3 @ 300 ppm) was significantly superior as compared to other treatments and influenced the fresh & dry weight of leaves in tamarind. It gave the maximum fresh & dry weight of leaves. These findings may be due to cell division and enhancing activity of apical meristem which may be promoted by the different bio-regulators. The increase in fresh & dry of leaves might be due to the reason that GA_3 helps in invigoration of physiological process of plant and stimulatory effect of chemicals to form new leaves at a faster rate. These results are also in accordance with the findings of Vasantha *et al.* (2014), Harsha *et al.* (2017), Patel *et al.* (2017), Suradinata *et al.* (2017), Jaiswal *et al.* (2018), Patel *et al.* (2018), Kumar *et al.* (2020) and Mistry and Sitapara (2020).

Leaf area (cm^2)

Data showed that various treatments of bio-regulators (like- thiourea and GA_3) and bio-waste (like-cow urine) were significantly influenced the leaf area (cm^2) in tamarind [Table 2]. The maximum leaf area (700.62 cm^2) was recorded in treatment T_7 (GA_3 @ 300 ppm) and it was found significantly superior as compared to other treatments. It was at par to treatment T_4 (Thio-Urea @ 3%). However, the minimum leaf area (400.48 cm^2) was recorded in treatment T_1 (Control, seeds soaking with distilled water for 24 hours).

Results showed that various treatments of bio-regulators (like- thiourea and GA_3) and bio-waste (like-cow urine) were significantly influenced the leaf area

(cm^2) in tamarind [Table 2]. The maximum leaf area was recorded in treatment T_7 (GA_3 @ 300 ppm) and it might be due to the reason that GA_3 helps in invigoration of physiological process of plant and stimulatory effect of chemicals to form new leaves at a faster rate which increase in leaf area of plant leaves. These results are supported by the findings of Wheeler and Humphries (2013), Vijendra Kumar *et al.* (2014), Ramteke *et al.* (2015), Patel *et al.* (2017), Jaiswal *et al.* (2018) and Patel *et al.* (2018).

Seedling vigour index

Table 2 revealed that the different doses of bio-regulators and bio-waste were significantly affected seedling vigour index in tamarind. It was recorded that the maximum seedling vigour index (4240) was recorded in treatment T_7 (GA_3 @ 300 ppm) and it was superior treatment as compared to other treatment of bio-regulators and bio-waste. However, the minimum seedling vigour index (2170) was observed in treatment T_1 (control, seeds soaking with distilled water for 24 hours).

This result might be due to increased germination and length of seedling which have contributed to higher seedling vigour index. The results are in confirmation with the results achieved by Al-Hawezy Shabaq Muhamad Nafea (2013), Vasantha *et al.* (2014), Vijendrakumar *et al.* (2014), Patel *et al.* (2017), Patel *et al.* (2018) and Mistry and Sitapara (2020).

Length of roots (cm)

It is obvious from the data presented in the table that the treatment T_7 (GA_3 @ 300 ppm) was significantly superior as compared to other treatments and influenced the length of roots in tamarind [Table 2]. It gave the maximum length of roots (21.32 cm). However, the minimum length of roots (13.20 cm) was recorded in treatment T_1 (Control, seeds soaking with distilled water for 24 hours).

It is obvious from the result that the maximum length of roots was recorded in GA_3 @ 300 ppm. It could be possible the absorbed more food material and might be increased the physiological activities of seedlings, which was essential for cell division or cell enlargement or both, because growth of the plant occurs by two processes i.e. cell division by mitosis which add new cells and elongation of already existing cells by enlargement of the vacuoles. The results are also in close conformity with the findings of Sharma (2014), Vasantha *et al.* (2014), Ramteke *et al.* (2015), Shinde and Malshe (2015), Patel *et al.* (2017), Patil *et al.* (2017), Patel *et al.* (2018) and Kumar *et al.* (2020).

Fresh and Dry weight of roots (g)

The data revealed that the different bio-regulators (like- thiourea and GA_3) and bio-waste (like-cow urine) were significantly influenced the fresh weight of roots in tamarind plant [Table 2]. The maximum fresh weight of roots (4.25 g) was noted in treatment T_7 (GA_3 @ 300 ppm) and it was found best treatment as compared to other treatments. It was at par to treatment T_4 (Thio-Urea @ 3%) and T_6 (GA_3 @ 200 ppm). However, the minimum fresh weight of roots (3.30 g) was observed in treatment T_1 (Control, seeds soaking with distilled water for 24 hours).

The data revealed that the different bio-regulators (like- thiourea and GA_3) and bio-waste (like-cow urine) were significantly influenced the dry weight of roots in tamarind plant [Table 2]. The maximum dry weight of roots (1.10 g) was noted in treatment T_7 (GA_3 @ 300 ppm) and it was found best treatment as compared to other treatments. It was at par to treatment T_4 (Thio-Urea @ 3%) and T_6 (GA_3 @ 200 ppm). However, the minimum dry weight of roots (0.90 g) was observed in treatment T_1 (Control, seeds soaking with distilled water for 24 hours).

It was recorded from the result that the maximum fresh & dry weight of roots was found in treatment T_7 (GA_3 @ 300 ppm) and it was found significantly superior as compared to other treatments and was significantly influenced the fresh weight of roots in tamarind. It might be due to application of bio-regulators like GA_3 might have resulted in more production of photosynthesis and their translocation through phloem to the root zone, which might be responsible for improving the root growth and weight. These results are also in accordance with the findings of Vijendrakumar *et al.* (2014), Desai *et al.* (2017), Harsha *et al.* (2017), Patel *et al.* (2017), Patil *et al.* (2017), Patel *et al.* (2018), Kumar *et al.* (2020) and Mistry and Sitapara (2020).

Survival percentage (%)

The data revealed that the different bio-regulators (like- thiourea and GA_3) and bio-waste (like-cow urine) were significantly influenced the survival percentage of tamarind seedlings [Table 2]. The maximum survival percentage (81.48 %) was noted in treatment T_7 (GA_3 @ 300 ppm) and it was found best treatment as compared to other treatments. However, the minimum survival percentage (55.84 %) was observed in treatment T_1 (Control, seeds soaking with distilled water for 24 hours).

The data revealed that the different bio-regulators (like-thiourea and GA_3) and bio-waste (like-cow urine) were significantly influenced the survival percentage of tamarind seedlings. The maximum survival percentage (81.48 %) was noted in treatment T_7 (GA_3 @ 300 ppm) and it was found best treatment as compared to other treatments. However, the minimum survival percentage (55.84 %) was observed in treatment T_1 (Control, seeds soaking with distilled water for 24 hours). This is might be due to increased germination and seedling vigour index which have contributed to higher survival percentage. The results are also in close conformity with the findings of Ramteke *et al.* (2015), Patel *et al.* (2017), Patel *et al.* (2018), Tondon *et al.* (2019) and Kumar *et al.* (2020).

Economics of the treatments

It was evident from the data that the treatment the maximum gross returns (326 Rs/Treatment), net returns (219.33 Rs/Treatment) and B:C (2.1:1) was recorded in treatment T_7 (GA_3 @ 300 ppm). However, the minimum gross returns (223.33 Rs/Treatment), net returns (130 Rs/Treatment) and B:C ratio (1.4:1) was recorded in control (seeds soaking with distilled water for 24 hours) treatment T_1 [Table 2]. These results are in confirmation with the results achieved by Vasantha *et al.* (2014), Harsha *et al.* (2017), Patel *et al.* (2017), Patil *et al.* (2017) and Patel *et al.* (2018).

Conclusion

Based on the present findings it can be concluded that the different doses of bio-regulators (like- thiourea and GA_3) and bio-waste (like- cow urine) were significantly influenced the different parameters in tamarind. Treatment T_7 (GA_3 @ 300 ppm) was found the best treatment for seed germination and growth of tamarind as compared to all other treatments of bio-regulators and bio-waste and it gave the maximum germination (%), length of seedling at 30, 60 and 90 DAS (cm), diameter of shoot at 30, 60 and 90 DAS (cm), no. of leaves at 30, 60 and 90 DAS, fresh weight of leaves (g), dry weight of leaves (g), leaf area (cm^2), seedling vigour index, length of roots (cm), fresh weight of roots (g), dry weight of roots (g) and survival percentage (%) were recorded in treatment T_7 (GA_3 @ 300 ppm). However, the minimum parameters were observed in control (seeds soaking with distilled water for 24 hours). While the minimum days taken to start germination and complete germination were found in treatment T_7 (GA_3 @ 300 ppm) and maximum days taken to start germination and complete germination were noted in control (seeds soaking with distilled water for 24 hours).

Table 1 : Effect of different doses of bio-regulators and bio-waste on days taken to start germination, Days taken to complete germination, Germination percent (%), Length of seedling (cm) and Diameter of shoot (cm) and number of leaves of tamarind seedling

Treatments	Days taken to start germination	Days taken to complete germination	Germination percent (%)	Length of seedling (cm)			Diameter of shoot (cm)			Number of leaves		
				30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
T_1	8.00	15.00	69.08	6.91	13.30	18.21	3.90	4.11	5.22	3.70	6.90	11.30
T_2	7.00	12.00	76.56	7.69	14.75	20.85	4.18	4.37	5.46	4.42	7.75	12.63
T_3	5.67	10.33	83.60	8.23	17.25	23.77	4.43	4.65	5.65	4.95	8.77	14.92
T_4	5.33	9.67	87.56	8.66	18.12	25.02	4.63	4.84	5.83	5.25	9.76	15.99
T_5	6.33	11.67	78.99	7.95	15.54	21.24	4.24	4.46	5.49	4.55	7.95	13.64
T_6	5.67	10.00	85.56	8.57	17.75	24.81	4.55	4.75	5.74	5.13	9.20	15.43
T_7	5.00	9.00	89.03	8.70	18.41	26.32	4.71	4.92	5.92	5.36	10.11	16.31
T_8	7.67	14.00	71.02	7.20	13.69	19.27	4.01	4.20	5.27	3.95	7.01	11.63
T_9	7.00	13.67	73.59	7.52	14.38	20.04	4.09	4.28	5.33	4.28	7.36	12.09
T_{10}	6.00	11.00	81.62	8.09	16.67	22.36	4.29	4.50	5.56	4.76	8.15	14.52
SEm ±	**0.535**	**0.564**	**0.606**	**0.061**	**0.072**	**0.342**	**0.031**	**0.032**	**0.042**	**0.037**	**0.065**	**0.200**
CD 5%	**1.590**	**1.677**	**1.800**	**0.180**	**0.214**	**1.016**	**0.092**	**0.094**	**0.123**	**0.109**	**0.193**	**0.593**

Table 2 : Effect of different doses of bio-regulators and bio-waste on number of leaves, diameter of shoot, fresh weight of leaves, dry weight of leaves, leaf area, Seedling vigour index, Length of roots (cm), Fresh weight of roots (g), Dry weight of roots (g), Survival percentage (%), Economics of the treatments of tamarind seedling

Treatments	Fresh weight of leaves (g)	Dry weight of leaves (g)	Leaf area (cm^2)	Seedling vigour index	Length of roots (cm)	Fresh weight of roots (g)	Dry weight of roots (g)	Survival percentage (%)	Economics of the treatments
T_1	3.90	0.39	400.48	2170	13.20	3.30	0.90	55.84	1.4:1
T_2	4.56	0.47	506.70	2735	14.87	3.92	0.96	70.28	1.7:1
T_3	5.01	0.60	593.56	3510	18.21	4.09	1.04	76.14	1.9:1
T_4	5.24	0.72	686.56	3947	20.06	4.21	1.08	79.54	2.0:1
T_5	4.64	0.50	550.94	2888	15.32	4.00	0.98	72.05	1.8:1
T_6	5.16	0.65	650.09	3786	19.44	4.13	1.07	79.46	2.0:1
T_7	5.30	0.78	700.62	4240	21.32	4.25	1.10	81.48	2.1:1
T_8	4.09	0.42	453.60	2339	13.65	3.72	0.92	64.89	1.6:1
T_9	4.32	0.44	485.62	2519	14.19	3.86	0.94	67.60	1.7:1
T_{10}	4.95	0.55	580.87	3191	16.75	4.01	1.00	73.67	1.8:1
SEm ±	**0.068**	**0.025**	**8.016**	**34.489**	**0.191**	**0.050**	**0.015**	**0.396**	**1.4:1**
CD 5%	**0.201**	**0.076**	**23.818**	**102.475**	**0.566**	**0.147**	**0.046**	**1.177**	**1.7:1**

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