# EFFECT OF FUNGICIDE AND PLANT GROWTH HORMONES ON GERMINATION OF TEAK *(TECTONA GRANDIS)*

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**TIWARI, C. K., SHARMA, S. & VERMA, R. K. 2004. Effect of fungicide and plant growth hormones on germination of teak *(Tectona grandis)*.** The effect of fungicide and plant growth hormones on germination of teak *(Tectona grandis)* seed was studied in a four-factorial experiment (2 × 4 × 7 × 4). The fungicide, ceresan, at two levels, 0 and 0.4%, four growth hormones, 1-naphthyl acetic acid (NAA), indole acetic acid (IAA), gibberellic acid ($GA_3$) and kinetin, with seven concentrations (0, 5, 10, 15, 20, 25 and 30 ppm) and four seed soaking periods (1, 3, 5 and 7 hours) were applied to mechanically extracted seeds from teak fruits before sowing. Presowing seed treatments significantly influenced germination of seeds after seven days. Under fungicide application maximum seed germination was recorded in NAA at 25 ppm, with 3 hours soaking followed by $GA_3$ at 15 ppm, 5 hours and IAA 5 ppm, 5 hours. Longer soaking time (7 hours) did not favour seed germination. Relative cost/benefit ratio of hormone application and economics of seed treatment with fungicide and hormones showed that NAA and IAA, 5 ppm with fungicide were the best treatment, recovering the cost of seeds by a factor of 9.83 times over the control due to enhancement of seed germination. This seed treatment is found suitable for raising teak seedlings in root trainer in modern forest nursery.

Key words: Seed germination – seed treatment – IAA – NAA – $GA_3$ – kinetin

**TIWARI, C. K., SHARMA, S. & VERMA, R. K. 2004. Kesan racun kulat dan hormon pertumbuhan pokok terhadap percambahan pokok jati (*Tectona grandis*). 2004.** Kesan racun kulat dan hormon pertumbuhan pokok terhadap percambahan biji benih pokok jati (*Tectona grandis*) dikaji dalam eksperimen empat faktoran (2 × 4 × 7 × 4). Racun kulat yang diguna ialah ceresan dan diuji pada dua kepekatan iaitu 0% dan 0.4% sementara empat jenis hormon yang diuji ialah asid 1-naftil asetik (NAA), asid indola asetik (IAA), asid giberelik ($GA_3$) serta kinetin, semuanya dalam tujuh kepekatan iaitu 0, 5, 10, 15, 20, 25 dan 30 ppm. Racun kulat dan hormon ini di samping empat tempoh rendaman (1, 3, 5 dan 7 jam) diuji pada biji benih pokok jati yang diekstrak secara mekanik sebelum disemai. Rawatan sebelum penyemaian mempengaruhi percambahan biji benih dengan bererti selepas tujuh hari. Apabila racun kulat digunakan, percambahan biji benih maksimum dicerap pada NAA berkepekatan 25 ppm, dengan rendaman selama 3 jam. Ini diikuti oleh $GA_3$ pada kepekatan 15 ppm, 5 jam dan IAA 5 ppm, 5 jam. Tempoh rendaman yang lebih lama (7 jam) tidak mempengaruhi percambahan. Nisbah kos/faedah relatif bagi penggunaan

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hormon dan aspek ekonomi rawatan biji benih bagi penggunaan racun kulat dan hormon menunjukkan bahawa racun kulat berserta NAA dan IAA pada kepekatan 5 ppm merupakan rawatan terbaik. Faktor pulangan kos biji benih yang dicapai kerana peningkatan percambahan biji benih adalah 9.83 kali ganda berbanding kawalan. Rawatan biji benih ini sesuai untuk membiak anak benih jati dalam tabung mengarah akar di tapak semaian moden.

## Introduction

Teak (*Tectona grandis*) is a major source of high quality timber in India, Indonesia, Myanmar and Thailand. This high value timber had been introduced to tropical regions of Asia, Africa and Central America in the beginning of the 19th century (Wood 1993). Teak bears fruit (drupe) in panicles. Fruits vary in weight and size (1150–2800 fruits $kg^{-1}$). The germination rate of teak seeds also varies and largely depends on age of tree, clone and environmental conditions. Seeds stored for a year exhibit higher germination rate than fresh seed (Troup 1921). Without any treatment a rate of 4.2–37.8% germination has generally been recorded (Prasad & Kandya 1992). Soerianegara and Lemmens (1993) reported less than 50% germination of teak seed without treatment.

The main cause of delay in germination of teak seed is the failure of its germ tube to penetrate the insufficiently softened thick pericarp. Various seed treatment procedures like weathering (mechanical, chemical and biological), soaking in cold or hot water and scorching in light fire have been developed and used from time to time to enhance seed germination (Tewari 1992).

Studies have shown that germination inhibitors present in the fruit tissue are responsible for slow and low germination of teak seed. Removal of seeds from fruits, treatments with growth substances like gibberellins and irradiation with particular spectra are helpful in enhancing germination of teak seed (Dnyansagar & Kothekar 1982, Unnikrishnan & Rajeeve 1990).

Teak seeds extracted from hard fruits are soft and perishable. Such seeds are liable to be attacked by many fungi. Eighteen commonly occurring fungi have been isolated and identified and found to adversely affect germination of teak seed (Tewari 1992). The present study was aimed at enhancing seed germination of teak, particularly genetically superior scarce seeds, through application of fungicide and low concentration of plant growth hormones.

## Materials and methods

Teak fruits were collected from the forest floor of a natural stand (60-year-old trees having 90–120 cm girth) in Betul Forest Division, Madhya Pradesh, India in March till April. The collected fruits were sun dried for 15 days and stored at room temperature (20–30 °C). The seeds were mechanically extracted from the fruits following Prasad and Kandya (1992). Extraction was done in September, just before the experiment, after a storage period of about five months. One kg fruits (2209 fruits) yielded 2187 seeds. Seven concentrations, namely, 0, 5, 10, 15, 20, 25 and

30 ppm each of NAA, IAA, $GA_3$ and kinetin (E Merck®), were prepared in 5 ml of 90% ethyl alcohol and diluted in distilled water. The seeds were divided into four equal parts and soaked in hormone solutions for 1, 3, 5 and 7 hours in each concentration separately. Half of the soaked seeds of each concentration were treated with the fungicide ceresan (phenyl mercury acetate) at a rate of 4 g $kg^{-1}$. A total of 400 treated seeds were placed in 100 ml conical flask and mixed well with the fungicide (in the form of dust). The seeds were then placed in Petri dishes (15 cm diameter) containing moist germination paper and then kept at ambient condition at the laboratory in September. Average day and night temperatures were 30.6 and 22.5 °C and RH values in the morning and evening were 85.7 and 76.2% respectively. After seven days, the number of sprouted seeds with radicles more than 2 mm were counted. The data obtained are presented as percentage of seed germination.

*Economics of seed treatment*

The cost-benefit ratio of three most effective hormones (NAA, IAA and $GA_3$) was calculated by dividing the cost of hormone by the respective germination percentage. Kinetin was excluded due to its less effectiveness and high cost.

*Statistical analyses*

The experiment was four-factorial and conducted in a completely randomised design. The factors were fungicide, hormone, concentration of hormones and seed soaking period ($2 \times 4 \times 7 \times 4$). There were four replications each of 100 seeds. The replicated data were subjected to analysis of variance (ANOVA) and 'F'-values of different factors and their interaction computed using NH analytical software (Statistix, PC, DOS version 2.0, 1987). Duncan's multiple range test was applied for pair-wise comparison. Before the statistical analysis, the data for seed germination percentage were subjected to arcsin transformation for removal of their skewness (Gomez & Gomez 1984).

## Results

### *Effects of fungicide, hormone, hormone concentration and soaking time*

Application of fungicide (F), hormone (H), concentration of hormone (C) and soaking time (T) had significant effects on seed germination. Their interactions, $F \times H \times C$, $F \times H \times T$, $F \times C \times T$ and $F \times H \times C \times T$ were also significant ($p = 0.01$) (Table 1). However, $H \times T$ and $C \times T$ were not significant. The control, i.e. without fungicide and hormones (F0H0), recorded 6.3% seed germination (average of all soaking time) which increased to 10% in 5 ppm, 7.8% in 10 ppm, 10% in 15 ppm, 8.5% in 20 ppm, 8.2% in 25 ppm and 14% in 30 ppm solution (average of four hormones). The corresponding values under fungicide application (F1) of seed germination in the above corresponding concentrations were 44.3, 40.2, 40.4, 39.1, 41.4 and 36.3%. F1 alone significantly increased germination from 6.3 to 17.1%. Under F0, the seed germination values were 9.6% in NAA, 12.7% in IAA, 7.4% in $GA_3$ and 7.2% in kinetin (average of all concentrations and soaking times) which were significantly raised to 46.1, 40.0, 43.1 and 17.3% respectively under F1. The average value of seed germination (F0 and F1) were 27.9% in NAA, 26.4% in IAA and 25.3% in $GA_3$ (Table 2). However, these values did not differ significantly with each other. On the other hand, seed germination differed significantly with kinetin, i.e. 12.3% (Table 2). Germination values were 24.1, 24.3, 22.5 and 21.6% after seeds were soaked for one, three, five and seven hours respectively (average values of both F0 and F1).

**Table 1** Analysis of variance of data on teak seed germination from a four-factorial experiment in a complete randomised design with four replications

| Source | DF | SS | MS | F |
|---|---|---|---|---|
| Fungicide(F) | 1 | 112090 | 112090 | 1805.7** |
| Plant growth hormones(H) | 3 | 16367 | 5455.5 | 87.9** |
| Concentration of hormones (C) | 6 | 12300 | 2050.0 | 33.0** |
| Seed soaking time (T) | 3 | 952.4 | 317.5 | 5.1** |
| Replication (R) | 3 | 254.0 | 84.7 | 1.4ns |
| F × H | 3 | 12099 | 4032.9 | 65.0** |
| F × C | 6 | 4419.5 | 736.6 | 11.9** |
| F × T | 3 | 1014.7 | 338.2 | 5.5** |
| H × C | 18 | 19895 | 1105.3 | 17.8** |
| H × T | 9 | 983.5 | 109.3 | 1.1ns |
| C × T | 18 | 1725.6 | 95.9 | 1.0ns |
| F × H × C | 36 | 25412 | 705.9 | 11.4** |
| F × C × T | 36 | 4722.5 | 131.2 | 2.1** |
| F × H × T | 18 | 3754.4 | 208.6 | 3.7** |
| F × H × C × T | 108 | 9975.5 | 92.4 | 1.5** |
| F × H × C × T × R (Error) | 669 | 41531 | 62.1 | |
| Total | 895 | 244900 | | |

** Significant at p = 0.01, ns = not significant

**Table 2** Interaction of fungicide (F) and hormone (H) with percentage germination of teak seed

| Fungicide | Hormone | | | | |
|---|---|---|---|---|---|
| | NAA | IAA | $GA_3$ | Kinetin | Mean |
| F0 | 9.6de | 12.7d | 7.4e | 7.2e | 9.2b |
| F1 | 46.1a | 40.0b | 43.1a | 17.3c | 36.6a |
| Mean | 27.9w | 26.4w | 25.3w | 12.3x | |

LSD ($p < 0.05$) F = 1.29, H = 1.82, F × H = 2.068

Values in columns and rows followed by the same letter are not significantly different at p = 0.05.

### *Interaction of hormone and fungicide*

Under fungicide application, NAA, $GA_3$ and IAA improved germination more than kinetin (Table 2). However, without fungicide application, IAA and NAA showed statistically the same germination rate, but the former was significantly higher than kinetin and $GA_3$. Higher seed germination was observed when $GA_3$ was applied with fungicide.

### *Interaction of fungicide and concentration of hormone*

Application of hormones significantly enhanced seed germination regardless of fungicide application (Table 3). Concentrations of hormones had significant interactions with fungicide application. Maximum seed germination was observed with 30 ppm hormones without fungicide application and 5 ppm hormones with fungicide which were 122.2 and 156.7% respectively more than that obtained in the control, i.e. F0H0 (Table 3).

**Table 3** Interaction of fungicide (F), hormone (H) and hormone concentration (C) with germination of teak seed

| Fungicide | Hormone | Concentration (ppm) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 0 | 5 | 10 | 15 | 20 | 25 | 30 |
| F0 | NAA | 5.1l | 9.3j | 9.7j | 12.5j | 11.6j | 11.6j | 11.9j |
| | IAA | 7.4k | 6.8k | 4.4mn | 11.6j | 9.7kl | 10.9kl | 33.4il |
| | $GA_3$ | 6.8kl | 6.5kl | 8.1jk | 7.8jk | 8.1jk | 7.8jk | 7.8jk |
| | Kinetin | 5.6l | 17.5li | 9.1kl | 8.1jk | 4.7lm | 2.5mn | 2.8mn |
| F1 | NAA | 18.7hi | 39.4ef | 44.7de | 47.6cde | 53.4cd | 66.6a | 48.9cd |
| | IAA | 17.5li | 55.6bc | 38.8ef | 33.4fg | 41.6ef | 45.0de | 49.4cd |
| | $GA_3$ | 16.4i | 52.2cd | 51.9cd | 65.6ab | 42.5def | 41.9ef | 40.0ef |
| | Kinetin | 15.9i | 28.8gh | 25.6gh | 15.0i | 18.8h | 12.2i | 7.1jk |

LSD ($p = 0.05$); $F \times H \times C = 5.47$
Values in columns and rows followed by the same letter are not significantly different at $p = 0.05$.

### *Interaction of hormones and their concentrations*

The best concentration for seed germination was IAA at 30 ppm (41.4%) and NAA at 25 ppm (39.1%) followed by $GA_3$ at 15 ppm (36.7%) and IAA at 20 ppm (25.6%) (Table 3). Among the four hormones tried NAA showed significant increase in germination up to 25 ppm and slight decrease in 30 ppm.

*Interaction of fungicide, hormones and their concentrations*

Without fungicide application, IAA at 30 ppm produced maximum germination that was 351.4% more than the control. Under fungicide application, 25 ppm NAA and 15 ppm $GA_3$ showed maximum seed germination. Very little influence of kinetin was observed on germination (Table 3).

*Interaction of fungicide, hormones, their concentrations and soaking times*

Under F0, IAA 30 ppm produced maximum seed germination after five hours of soaking followed by three and seven hours (Table 4). NAA produced 22.2% germination in 15 ppm with one hour soaking, which was not statistically different from 20 ppm and 30 ppm after one hour and kinetin 5 ppm after three and five hours. Under F1, maximum seed germination (72%) was recorded in $GA_3$ 15 ppm, five hours soaking which was statistically the same as those recorded in IAA, 5 ppm, one to five hours, 10 ppm, one hour; NAA 20 ppm, seven hours, 25 ppm, one to seven hours; and $GA_3$, 5 ppm, five hours, 15 ppm, one to seven hours (Table 4).

*Economics of seed treatment*

$GA_3$ had significantly higher value for cost-benefit ratio than NAA and IAA in all concentrations and soaking times. IAA and NAA, both at 5 ppm with 1–7 hours soaking, had the lowest cost benefit ratio (Table 5(a)). Based on IAA 5 ppm, results showed that the treatment had helped in recovery of seed cost by a factor of 9.83 times over the control (Table 5(b)).

## Discussion

Application of fungicide significantly enhanced seed germination. Seeds are a rich source of nutrition and this makes them prone to infestation by many fungi, present either on the seed surface or in the environment as contaminants. During germination, such fungi spread their mycelium and colonise the seed. The mycotoxins produced by fungi either spoil the seed or reduce the rate of seed germination. Tewari (1992) has reported many fungi associated with teak seeds. In this study, ceresan applied just before sowing stopped the growth of fungi, thereby, enhancing seed germination significantly. Phytohormones break seed dormancy and enhance germination (Tomaszewska 1980). In the present study we have selected low concentrations of hormones to induce germination of bare seeds obtained from teak fruits. All hormones applied at low doses (0–30 ppm) enhanced seed germination. Many works attribute enhancement in germination of various tree seeds to the presence of phytohormones. For example, Bhatnagar (1980) reported that 10 ppm $GA_3$ increased percentage germination of *Pinus caribaea* seeds. Olvera and West (1986) found that $GA_3$ at 10 ppm and IAA

**Table 4** Interaction of fungicide (F), soaking time (T), hormones (H) and hormonal concentration (C) with germination (percentage) of teak seed

| Fungicide | Soaking time (hour) | Hormone | Concentration of hormone (ppm) 0 | 5 | 10 | 15 | 20 | 25 | 30 |
|---|---|---|---|---|---|---|---|---|---|
| F0 | 1 | NAA | 9.1q | 14.5o-q | 10.2pq | 22.2m-o | 18.3m-n | 8.2q | 16.3n-q |
| | | IAA | 4.6q | 7.6p | 13.2pq | 16.4n-q | 11.9pq | 0.0q | 17.5n-p |
| | | $GA_3$ | 5.5q | 3.2q | 5.0q | 8.0q | 8.0q | 7.3q | 9.6q |
| | | Kinetin | 4.6q | 14.8pq | 1.0q | 6.7q | 1.9q | 5.5q | 6.0q |
| | 3 | NAA | 8.2q | 6.1q | 7.2q | 9.4q | 11.2pq | 7.3q | 10.2q |
| | | IAA | 9.0q | 3.9q | 8.9q | 13.6pq | 8.6q | 17.6n-p | 39.3il |
| | | $GA_3$ | 9.7q | 8.4p | 9.3q | 4.5q | 8.6q | 7.9q | 9.1q |
| | | Kinetin | 5.1q | 22.2mn | 9.6q | 2.9q | 9.4q | 6.7q | 5.5q |
| | 5 | NAA | 0.0q | 11.3q | 10.4q | 7.3q | 7.2q | 5.2q | 9.2q |
| | | IAA | 9.1q | 7.3q | 7.3q | 8.6q | 7.6q | 11.6pq | 43.5il |
| | | $GA_3$ | 6.9q | 3.0q | 5.5q | 5.9q | 6.7q | 11.2pq | 8.8q |
| | | Kinetin | 3.5q | 20.0mn | 16.5n-q | 16.5n-q | 5.0q | 6.0q | 0.0q |
| | 7 | NAA | 3.2q | 5.4q | 4.2q | 15.0o-q | 15.0pq | 8.6q | 8.4q |
| | | IAA | 4.9q | 8.2q | 10.4q | 11.0q | 8.6q | 13.6pq | 32.1lm |
| | | $GA_3$ | 5.7q | 11.2pq | 8.3q | 8.7q | 7.9q | 4.5q | 8.7q |
| | | Kinetin | 9.8q | 12.9pq | 7.8q | 1.3q | 0.0q | 0.0q | 0.0q |
| F1 | 1 | NAA | 19.6n-p | 39.8ik | 38.6ik | 46.2h-k | 55.3d-g | 61.6a-g | 55.3d-g |
| | | IAA | 17.5n-p | 62.8a-g | 66.8a-f | 34.7l | 38.6kl | 45.0h-k | 38.6kl |
| | | $GA_3$ | 18.9op | 39.7il | 59.0c-g | 67.1a-f | 41.2h-k | 41.2h-k | 41.0h-k |
| | | Kinetin | 14.3op | 37.4kl | 33.6kl | 18.4n-p | 22.2m-o | 21.1m-o | 10.8o-q |
| | 3 | NAA | 20.8m-o | 37.2k-l | 41.2hk | 46.2h-k | 47.9h-k | 71.8a-f | 46.2h-k |
| | | IAA | 16.7o-q | 65.3a-g | 27.3mn | 26.7mn | 41.2h-k | 50.0gi | 56.6d-g |
| | | $GA_3$ | 14.7pq | 53.8f-g | 34.9lm | 63.8a-g | 35.2l | 44.9h-k | 37.1k-l |
| | | Kinetin | 19.7n-p | 11.7pq | 13.7n-q | 14.5n-q | 7.9pq | 6.1q | 7.1pq |
| | 5 | NAA | 15.9o-q | 47.4h-k | 48.8h-j | 49.0h-j | 48.1h-j | 64.1a-f | 51.2g-h |
| | | IAA | 17.5n-p | 68.4a-f | 33.6l | 32.1l | 46.2h-k | 41.0h-k | 50.0gi |
| | | $GA_3$ | 15.8o-q | 62.8a-g | 60.2b-g | 72.0a-f | 43.6h-k | 41.2h-k | 38.6il |
| | | Kinetin | 20.3m-o | 32.4l | 31.0lm | 13.2o-q | 11.9pq | 10.8pq | 5.0q |
| | 7 | NAA | 18.4n-p | 32.4lm | 50.0g-l | 49.5g-I | 62.6a-g | 70.4a-f | 43.1h-k |
| | | IAA | 18.2n-p | 27.0mn | 27.0mn | 30.8lm | 39.5il | 43.7h-k | 52.5g |
| | | $GA_3$ | 16.0o-q | 52.5g | 52.3g | 61.8a-g | 48.8h-j | 40.0il | 42.2hk |
| | | Kinetin | 9.2pq | 32.4l | 23.6mn | 11.9pq | 31.0lm | 9.6pq | 5.0q |

LSD ($p = 0.05$), $F \times T \times H \times C = 10.9$

at 40 ppm were the best concentrations for germination of *Leucaena* seed. A low concentration of 5 ppm $GA_3$ was reported as the best treatment to enhance germination of *Dendrocalamus strictus* and *Thyrostachys siamensis* seeds (Richa & Sharma 1994). Singh (1989) reported longer soaking requirement in low concentration of $GA_3$ for germination of *Picea smithiana* seeds. Results of our study showed that seed germination was suppressed by high doses of kinetin. However, our findings contradict the results by Kumaran *et al.* (1994) who experimented with seeds of *Azadirachta indica.*

**Table 5(a)** Cost benefit ratio*

| Soaking time (T) (hour) | Hormone (H) | Concentration of hormone (C) (ppm) 5 | 10 | 15 | 20 | 25 | 30 |
|---|---|---|---|---|---|---|---|
| 1 | NAA | 2.5a | 5.2a-e | 6.5a-f | 7.2a-g | 8.1a-h | 11.0bi |
| | IAA | 2.6ab | 4.9a-d | 14.2gh | 17.0ij | 18.2h-j | 25.5jk |
| | GA3 | 74.51 | 100.2m | 132.2op | 287.6r | 358.9st | 432.7w |
| 3 | NAA | 2.7ab | 4.9a-d | 6.5a-f | 8.4a-h | 7.0a-g | 13.2di |
| | IAA | 2.5a | 12.0ei | 18.4hi | 15.9h-j | 16.4ij | 17.4ij |
| | GA3 | 54.9kl | 169.5pq | 139.0p | 366.0u | 239.3s | 478.2x |
| 5 | NAA | 2.1a | 4.1a-c | 6.1a-f | 8.3a-h | 7.8a-g | 11.9bi |
| | IAA | 2.4a | 9.8bi | 15.3k-j | 14.2h-j | 20.0jk | 19.7jk |
| | GA3 | 47.11 | 98.21-m | 123.2n | 271.3n | 358.9t | 459.6w |
| 7 | NAA | 3.1a-c | 4.0a-c | 6.1a-f | 6.4a-g | 7.1a-g | 14.1gh |
| | IAA | 6.0a-f | 12.1fi | 16.0hj | 16.6ij | 18.8h-j | 18.7h-k |
| | GA3 | 56.3kl | 113.1m | 143.5p | 242.4n | 369.6u | 420.4v |

*Cost of 1 litre solution of 5–30 ppm divided by respective germination percentage under fungicide application (Cost in Rs/germination %) × 100
LSD (p = 0.05), C × H × T= 7.2

**Table 5(b)** Economics of seed treatment

| | Cost of hormone * for one litre solution (Rs) | Seed cost of seed recovered * Seed germination | Cost recovered* (Rs) |
|---|---|---|---|
| Control | 0.0 | 6.3 | 63.00 (a) |
| IAA, 5 ppm | 1.65 | 68.4 | 684.0 0(b) |

Cost-benefit balance sheet

(i) Extra cost recovered due to treatment over control b – c = Rs 684 – 63 = 621
(ii) Cost of treatment = Rs 1.65
(iii) Benefit due to treatment (i – ii) = Rs 621 – 1.65 = 619.35
(iv) Cost-benefit ratio over control (iii/a) = 619.35/63 = 9.83

*One kg fruits yielded 33.5 g or 2187 seeds having 45 cc volume, which required 50 ml hormonal solution. So, 1 litre solution was sufficient to treat 670 g (33.5 g × 20) or 43 740 seeds. Cost of 20 kg fruits @ Rs 50.00 per kg is Rs 1000.00.

Our study showed that longer soaking time (seven hours) did not favour germination of teak seed. We used extracted seeds that have been kept for a long time, during which time the seeds might have accumulated phytohormones. Soaking provides sufficient moisture for proper wetting of seed coat, which facilitate and induce germination. The extracted seeds were placed on moist germination paper, which contained sufficient moisture required for germination of seeds, so there was less effect of soaking on germination of teak seed. Dabral (1976) also observed insignificant or adverse effect of prolonged soaking period (12–15 hours) on germination of extracted teak seeds. From the study of interaction between fungicide, hormones, hormonal concentration and soaking time and cost benefit study, it is concluded that IAA or NAA at 5 ppm and five hours soaking with application of fungicide (seed dressing with 0.4% ceresan) was the best treatment to maximise germination of teak seed. Seeds treated with the optimum treatment can be sown in root trainers for enhancing germination efficiency and recovering the seed cost by a factor of 9.83 times in comparison with the control. Therefore, the present technique is recommended for raising teak seedlings in modern forest nursery.

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