# EFFECT OF GROWTH REGULATORS ON SEED VIABILITY, GERMINATION AND VIGOUR OF SEEDLINGS OF MANGIUM [*Acacia mangium* (Willd)] AND ROSEWOOD [*Dalbergia latifolia* (Roxb)]

By

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## THESIS

Submitted in partial fulfilment of the requirement for the degree of

## Master of Science in Forestry

Faculty of Agriculture
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VELLANIKKARA, THRISSUR - 680 656
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2000

*Dedicated*

*to*

*My Beloved & Devoted Parents*

# DECLARATION

I hereby declare that the thesis entitled "EFFECT OF GROWTH REGULATORS ON SEED VIABILITY, GERMINATION AND VIGOUR OF SEEDLINGS OF MANGIUM[*Acacia mangium* (Willd)] AND ROSEWOOD [*Dalbergia latifolia* (Roxb)]" is a bonafide record of research work done by me during the course of research and that this thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title of any other University or Society.

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# CERTIFICATE

We, the undersigned members of the Advisory Committee of Sri. R. Vinayan a candidate for the degree of **Master of Science in Forestry**, agree that this thesis entitled **"EFFECT OF GROWTH REGULATORS ON SEED VIABILITY, GERMINATION AND VIGOUR OF SEEDLINGS OF MANGIUM [*Acacia mangium* (Willd)] AND ROSEWOOD [*Dalbergia latifolia* (Roxb)]"** may be submitted by **Sri. R. Vinayan** in partial fulfilment of the requirement for the degree.

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# Introduction

# INTRODUCTION

Plant growth regulators are known to induce seed germination and promote seedling growth. Extensive studies have been done in various commercial plant species, particularly agricultural crops,on the use of growth regulators for inducing seed germination and enhancing seeding growth in the nursery. In commercial crop production, where growth and high yields are the two main considerations, use of various growth regulator were proved to be very promising. Rapid, uniform and earlier germination along with vigorous seedlings are the pre requisites for obtaining good quality seedlings in the nursery. Use of growth regulators is very important for the large scale multiplication of forest tree species through seeds, particularly for extensive planting programmes in social and agroforestry programmes.

*Mangium (Acacia mangium)* and *rosewood (Dalbergia latifolia)* are two important commercial tree species widely used for large scale planting programmes in degraded forest land, waste land and even farm land in the country. The two species provide valuble timber and is used for furniture making and building constructions. Some nursery studies and observations indicate that low germination and slow seedling growth are the major problems encountered in the seed propagation of the above two species. Moreover, in these species storage of seeds also becomes inevitable as there is a large interval between seed collection and sowing.

Germination of seeds in the above two species are reported to be inhibited by hard and water impermeable seed coat. While this assure good seed longevity, it makes germination slow, unpredictable and difficult. Therefore, it is necessary to use some pre-treatment that will make the testa permeable to moisture.

Various growth regulators have been found to be effective in breaking seed dormancy and promoting germination in trees species. Hence, the present series of studies were undertaken in College of Forestry to understand the most ideal growth regulators and its concentration for better seed germination and subsequent seedling growth in the nursery. This information is very valuable in forestry as seed propagation is still mainly resorted to in most of the tree species for their commercial propagation.

# Review of Literature

# REVIEW OF LITERATURE

Seeds of various tree species fail to germinate when placed under conditions like adequate water supply, suitable temperature, optimum light and normal gaseous composition of the air which are normally regarded as favourable for germination. Such seeds possessed viability but are considered to be in a state of dormancy and hence can be forced to germinate only by special treatments.

Most of the forest tree seeds are reported to exhibit some amount of dormancy. Presence of dormancy leads to delayed and staggered germination. In commercial crop production, where high yields and uniform seedlings are the important considerations, slow and variable seedlings could be a major set back (Dunlap and Barnett, 1982). Rapid, uniform, early and complete germination are the major, pre-requisites for achieving good plant populations from the seeds. Plant growth regulators were proved to be very effective in achieving the above objectives.

Most of the plant growth regulator research has focused on herbaceous species, and only limited attention have been paid on this aspect with regard to forest tree seeds. Of the relatively small number of papers that have been published on tree seeds, the majority are related to angiospersms, usually those that bear edible fruits or nuts. The limited information on the effect of different growth regulators and their concentrations in breaking dormancy of tree seeds have been reviewed here under.

## 2.1 Role of plant growth regulators on seed germination and seedling vigour

In the past years there has been an attempt to reveal the mechanism controlling germination of seeds. However, as mentioned earlier most of these studies have forested on herbaceous crops and hence there is a thorough need for similar studies in tree seeds.

Leadem (1987) reported that germination of tree seeds is controlled by a variety of external and internal factors. Plant growth regulators figure prominently among these factors but the range of mechanism by which such control is mediated may vary considerably from physical to metabolic. Prasad and Kandya (1992) stated that a hard, cutinised seed coat completely prevents the imbibition of water and in some cases also the exchange of gases.

Seed germination may be reduced by the presence of impermeable seed coats which restrict the availability of water and gasses to inner parts of the seed. The growth regulators can penetrate into the seed at their optimum concentrations (Tinus, 1982) and may enhance the rate of metabolism during germination (Verma and Tandon, 1988).

Deyivry (1990) in his new approach to hormonal regulation of dormancy and germination has concluded the role played by hormones through series of works related to isolation of hormones - deficient or hormone - insensitive mutants; possible use of hormone synthesis inhibitors; improved understanding of hormone biosynthesis and metabolism pathway and mechanism regulating hormone and compartmentation. He also stated that gibberellins are indispensable for germination and dormancy release treatments can induce either synthesis or a change in sensitivity of the tissue. Hilhorst and Karseen (1992) reported a direct evidence of hormonal involvement through development of hormone - deficient mutants. The role of promoter - inhibitor hormones has also been reported by Karseen and Lacka (1986) in *Arabidopsis thaliana*.

The improvement of seed germination by growth regulators has also been reported in a number of woody plants (Mehanna *et al.*, 1985 and Singh, 1985). Several biochemical studies revealed that growth regulators modulate transcription and/or translation during protein synthesis (Villers, 1971). The mobilization of protein and lipid storage bodies upon specific enzymes which hydrolyse stored molecules and catalyze essential reaction in energy generating cycles result into the production of energy and substrates which in turn provide the structural components essential for the growth and emergence of the embryo (Voland, 1984).

### 2.1.1 Effect of auxins on seed germination and seedling vigour

#### 2.1.1.1 Effect of indole acetic acid (IAA)

Number of workers have investigated the effect of IAA and similar substances on the germination of variety of seeds and have obtained conflicting results. The stimulation or inhibition properties of auxins mainly depends on the concentration and the type of seed used.

Treating the seeds with IAA was reported to be successful in inducing germination. Volna and Dloughly (1956) reported that in *Larix decidua*, both survival and height of the seedlings were highest with a mixture of IAA and nicotinic acid in 1:1 ratio. In their experiment, seeds when treated with 0.1 per cent IAA gave the highest survival percentage, number of roots, seedling height and root length. Formatin (1958) stated that IAA at 0.001 to 100 mg/litre produced positive effects in selected tree species.

Odaric (1960) raised the seedlings of Pinus species by treating seeds with IAA solution for 24 hours. In addition, the young seedlings were also sprayed with 0.0005 per cent IAA solution at weekly intervals. The mean heights recorded by treated two year old seedlings of *Pinus orientalis*, *P. occidentalis* and *P. acerifolia* were 167 cm, 198 cm and 200 cm respectively, which was significantly high compared to control. Enescu (1964) reported that IAA treatment in seeds of *Alnus glutinosa* improved germination when sown during late spring. Increased concentrations of IAA with aqueous extract of *Fraxinus excelsior* induced diverse effect on the germination of *Pinus sylvertris* (Simancik, 1969).

Jura (1968) reported that soaking the seeds of *Larix decidua* for 48 hours in aqueous solution of IAA at a concentration of about 0.01 mg/litre increased seedling yield, but delayed emergence. Similar treatment in *Alnus incana* seeds resulted adverse effect on yield of seedlings but hastened emergence, improved root length and root-collar diameter in relation to height. In *Acer taturicum*, low concentration of

IAA in the cotyledons was found to stimulate the growth of seedlings. However, the embryo containing large quantity of auxin mainly in hypocotyl, inhibited the growth (Nikolaeva *et al.*, 1974). Indole acetic acid was found to be less effective when compared to gibberellic acid (GA) in promoting germination in *Tecomella undulata* seeds (Harsh and Shankhla, 1973). Similar trend was also observed by Tomaszewska (1980) in *Acer platanoides* when seeds were treated with different concentrations of GA with or without IAA. Interestingly in *Acer nikoense*, IAA treated seeds were found to be remained in dormant condition (Stimart, 1983).

Tayal and Sharma (1983) observed that IAA promoted plumule growth at 10 and 100 mg/litre and radicle growth at 10 mg/litre in *Cicer arietinum* seeds. A higher concentration of 500 mg/litre resulted retardation of lateral root development. The length of shoot and root and the branching of seedlings were found to be increased in Leucuena species, when seeds were treated with 10 to 40 ppm of IAA (Olvera and West, 1986). Soaking seeds of *Schima khasiana* in IAA (10 mg/litre) enhanced seed germination (Verma, *et al.*, 1988).

In spruce, maximum germination of seeds was obtained when treated with 36 x $10^{-5}$M, 24 x $10^{-5}$M and 12 x $10^{-5}$M of IAA for 24, 48 and 72 hours respectively (Virendra, 1990). However, the difference between these treatments was not significant.

Seeds of *Melia azadarach,* when soaked in 250 ppm of IAA for 24 hrs resulted better germination percentage as compared to IBA and $GA_3$ (Banerjee, 1998). The effect of pre-treatment on germination of *Alstonia scholaris* seeds indicated that soaking in IAA at 200 ppm resulted the best performance of three to five fold increase in germination and vigour compared to all other treatments (Maitreyee *et al.*, 1997). Singh (1990) showed that IAA increased the germination percentage of *Picea simithiana* seeds.

**2.1.1.2 Effect of indole butyric acid (IBA)**

Bulard (1949) reported that a solution of 10 mg/litre of IBA when used for seed treatment had little or no effect on germination or root growth of *Thuja orientalis*. But, a marked improvement was observed in the development of hypocotyl. He concluded that the concentration is important not only for elongation of cells but also for the proliferation of the meristem. In his another experiment using one and two year stored spruce seeds treated with 1 to 100 mg/litre of IBA resulted 50 to 60 per cent germination compared to 36 per cent in control.

Besides seeds, IBA was also found to be extensively used in rooting of cuttings. Cuttings of *Eucalyptus grandis* dipped in 200 ppm of IBA solution and subsequent foliar spraying greatly increased the survival and rooting in the nursery (Poggiani and Switer, 1974). In Ponderosa pine seedlings, application of IBA at different concentration enhanced the root growth development (Coffman, 1973).

Seeds of *Citrus jambhiri* and *C. karna,* soaked for 24 hours in IBA at 200 to 500 ppm did not result any better germination over control (Singh *et al.,* 1979). Masih and Kumar (1979) reported that *Brassica juncea* seeds soaked in 100 or 200 ppm of IBA for 24 hours increased the height of seedlings along with increased number of branches and leaves. Further, the flower initiation was also found to be induced early. These effects were found to be increased gradually with the increase in IBA concentration from 100 to 200 ppm.

Virendra (1990) obtained maximum early germination in spruce when the seeds were treated with $6 \times 10^{-5}$M and $12 \times 10^{-5}$M of IBA for 24 hours. Singh (1990) showed that IBA increased the germination percentage of *Picea smithiana* seeds.

**2.1.2 Effect of Gibberellins (GA's) on seed germination and seedling vigour**

Gibberellins are also reported to stimulate seed germination in many species of angiosperms and gymnosperms. Over 60 different GA's have been identified but most commonly used exogenous GA forms in forest tree seeds are $GA_3$, $GA_4$ and $GA_7$.

The germination of seeds is frequently associated with increased GA levels. However, a gradual decrease in germinative capacity with increasing concentrations was often observed in *Pinus elliotti* by Kingard (1961). GA at 5 and 10 ppm resulted highest germination in seeds of *Chamaecyparis obtusa*, *Cryptomeria japonica* and *Pinus densiflora* (Sato *et al.*, 1962).

Bachelard (1968) reported that seeds, treated with GA at 50 mg/litre produced vigorous seedlings in *Eucalyptus regnans* and *E. pauciflora*. These seedlings were having more number of leaves and increased shoot elongation, but with less root growth, root/shoot ratio, total dry weight and leaf area. Vogt (1970) reported that GA at 500 ppm improved initial root length, height and number of leaves of individual seedlings in *Quercul rubra*. However, root growth was found to be slightly inhibited. He emphasised the use of GA for the manipulation of root/shoot ratio.

Effect of GA on vigour of seedlings was also observed by Monin (1965) in *Fruxinus pennsylvanica* and Allen *et al.* (1977) in *Quercus ilicifolia*. Spraying one per cent GA in aqueous solution on one year old *Cryptomeria japonica* seedlings and two week old root suckers of *Paulownia fortunei* promoted the growth of the main stem of both species along with stimulation of flowering particularly in *C. japonica* (Ching-Kao, 1976). Harsh and Shanklu (1973) stated that in *Tecomella undulata,* GA at 50 ppm gave 80 per cent germination when the seeds were incubated for 24 hours compared to 47 per cent in control.

Bhatnagar (1980) reported that GA at 10 and 50 ppm increased the germination of *Pinus caribea* and *P. patula* seeds respectively. Shafig (1981) found that time taken for germination was decreased by 8 to 14 days in *Nothofagus obliqua* and 6 to 10 days in *N. procera* when seeds were treated with $GA_3$ at lower concentration. $GA_3$ application was stated to activate the growth of dormant buds in black walnut seedlings (Wood *et al.*, 1981).

Choudari and Chakarwar (1982) reported that in *Citrus limonia*, seeds treated with GA at 40 ppm resulted seedlings of better height and girth with more number of leaves. The root and shoot biomass were also more. More or less similar trend was observed in *Citrus aurantifolia* also. Two year study conducted by Mishra *et al.* (1982) using freshly extracted seeds of *Citrus sinensis* treated with GA at 50 to 200 ppm for 6, 12 and 18 hours reported a seedling height of 50.8 to 51.6 cm. The surface area of leaves was found to be more in seeds treated with 200 ppm GA for 12 hours.

Gibberellins in presence of light is reported to be indispensable for germination of *Acer grisum*, *A. nikoense* and *A. trifolium* seeds (Stimart, 1983). In seedlings of *Tectona grandis* and *Dendrocalamus strictus*, spraying of lower doses of $GA_3$ promoted seedling growth, the optimum dose being 10 ppm for *T. grandis* and 15 ppm for *D. strictus* (Mishra *et al.*, 1984).

Banker (1989) reported that seeds of *Carissa caronda* treated with 25 ppm GA resulted vigorous seedlings having 19.6 cm height compared to 12.2 cm in control. Soaking the seeds of *Schima khasiana* in GA (25 mg/l) enhanced seed germination (Verma *et al.*, 1988). Bal *et al.* (1990) reported that *Pyrus pashia* seeds treated with $GA_3$ at 50 ppm and then stratified at 4.5°C for seven days produced seedlings having maximum collar girth of 1.9 mm. *Michelia champaca* seeds when sown untreated recorded poor germination but treatment with gibberrellic acid ($GA_3$) enhanced both total germination and speed of germination (Bahuguna *et al.*, 1988). In Rakchan

(Daphniphyllum himal(ay)ense), seeds treated with 100 ppm gibberellic acid enhanced the germination (30.4%) compared to all other treatments (Harrison, 1989).

In *Quercus robur* L. seeds, the maximum germination was noticed in 200 ppm $GA_3$ coupled with low temperature treatment for four weeks. Germination recorded was 100 and 96 per cent respectively during 1989 and 1990 compared to 34.7 and 44.0 per cent in control. Low temperature treatment for four weeks have resulted the accumulation of highest amount of endogenous $GA_3$ and IAA. $GA_3$ at 200 ppm coupled with low temperature treatment for two weeks and $GA_3$ at 100 ppm coupled with low temperature treatment for four weeks gave the tallest seedlings with maximum number of leaves having highest leaf index (Youssef *et al.*, 1991).

In an attempt to improve seed germination of ornamental trees, some pre-sowing treatments were tried by Toaima *et al.* (1993). The most effective treatment for *Enterolobium cyclocarpum* was scarification and soaking in 800 ppm $GA_3$ for 48 hrs; for *Poincianu* regia (*Delonix regia*) - scarification and soaking in 400 ppm $GA_3$ for 48 hours; for *Washingtonia filifera* - soaking in 10 per cent $H_2SO_4$ for 10 minutes followed by 200 ppm $GA_3$ for 48 hours; for *Oreodoxa regia* - soaking in 400 ppm $GA_3$ for 48 hours; for *Phoenix canariensis* - scarification and soaking in 400 ppm $GA_3$ for 48 hours and for *Sahal fexana* - soaking in 10 per cent $H_2SO_4$ for 10 minutes followed by 400 ppm $GA_3$.

Richa and Sharma (1994) studied the effect of plant growth regulators like gibberellic acid ($GA_3$) and idole acetic acid (IAA) using stored seeds of bamboos viz., *Thyrsostachys siamensis* and *Dendrocalamus strictus*. In *D. strictus* $GA_3$ at 10 ppm stimulated final germination of seeds and vigour index, while 5 ppm was found to be effective in *T. siamensis*. In these cases auxins appeared to stimulate shoot growth after germination. In *Albizia odoratissima,* GA at 50 and 100 ppm enhanced seed germination (Gopikumar *et al.*, 1994). Sita *et al.* (1996) reported that the percentage of germination in *Emblica officinalis* was maximum with 300 ppm GA. In *Alstonia scholaris,* the seeds treated with $GA_3$ at 100 ppm gave better germination and vigour, which was second best when compared to IAA at 200 ppm (Maitreyee Kundu *et al.*, 1997).

Gibberellic acid (GA) has been proved to have some effect on synthesis and development of chlorophyll in leaves of tree species. Misnev *et al.* (1964) reported that in Oak, chlorophyll content of leaves decreased with increase in concentration of GA used for seed treatment. However, chlorophyll content of leaves of Pyracantha species and Photinia species increased with the increase in foliar application of uniconazole containing 50, 100 and 150 mg/litre of GA (Rober *et al.* 1992). Garg and Kumar (1987) have worked out the relationship between chlorophyll content and productivity in *Euphorbia* lathyris. In their study, four week old seedlings sprayed with 10 ppm $GA_3$, IAA and IBA at 10 ml per plant at weekly interval did not result any significant difference in the content of chlorophyll A or B.

Application of $GA_3$ is known to influence the enzymatic activity in tree seeds (Nickell, 1982 and Bradheer, 1988). $GA_3$ treatment facilitates the release of various enzymes which weaken the tensile strength of the seed coat. Besides it is reported to be responsible for mobilization of nutrients from endosperm to the embryo (Kumar and Purohit, 1986) and cotyledonary expansion which is responsible for the rupture of pericarp (Bradbeer, 1988). Overall, the effectiveness of $GA_3$ treatment in enhancing germination by breaking seed dormancy is reported by various other workers also (Nagaveni and Srimathi, 1980; Singh and Murty, 1987 and Fox *et al.*, 1994).

Subodhairi (1998) conducted germination study in four multipurpose species viz., *Semecarpus anacardium, Olea glandulifera, Ehretia laevis* and *Piltosporum floribundum*. Increased germination was achieved in *P. floribundum* by treatment with $GA_3$ (100 ppm) for 24 hours. Studies on effect of pre-sowing treatment on germination of *Bauhinia vahlii* indicated that soaking in $GA_3$ solution at 500 ppm for 12 hours significantly ($P < 0.05$) enhanced seed germination to 91.73 per cent as against 65.0 per cent in control (Upreti, *et al.* 1997).

However, in some cases, $GA_3$ application did not significantly increase germination. The germination behaviour of several seed samples of *Coronilla juncea, C. minima* and *C. Valentina* spp. was studied under controlled conditions. The application of gibberellic acid at different concentrations (125 mg $l^{-1}$ and 500 mg $l^{-1}$ $GA_3$ solutions) did not increase significantly the germination rate in most of the cases (Gonzalez - Metero *et al.*, 1997).

### 2.1.3 Effect of cytokinins on seed germination and seedling vigour

Cytokinins, like other plant growth regulators are also playing various physiological roles in breaking seed dormancy and enhancing germination. Cytokinins are ubiquitous in plants and occur either freely or as structural components of TRNA. Zeatin as a free base and as its ribonucleoside and ribonucieotide have been widely reported as a natural component of seeds (Tomas, 1977). Applied cytokinins usually displays a low activity on dormancy and germination control as compared to GA and ABA, but it is more effective in combination with other promotive treatments like auxins, GA, light, ethylene etc. Stratified seeds of *Picea pungens* were soaked for six hours in 2-3, 4- dichorophenoxy triethylamine (DCPTA) solutions containing 0.1, 1.0, and 10 ppm active ingredient. Results indicated that DCPTA accelerated vegetative development of seedlings and increased pigment contents (Keithyly *et al.*, 1990). Loveys *et al.* (1994) reported that cytokinins did not enhance the germination of *Santalum acuminatum* seeds. However, germination of *Azadirachta indica* seeds was found to be enhanced by kinetin at 200 ppm (Kumaran *et al.*, 1994).

# Materials and Methods

# MATERIALS AND METHODS

The present investigations were carried out in College of Forestry, Kerala Agricultural University, Vellanikkara to find out the effect of plant growth regulators on seed germination and seedling vigour of two commercial tree species viz., *Acacia mangium* Willd (mangium) and *Dalbergia latifolia* Roxb. (rosewood) in the nursery.

The study site lies between 10° 32' N latitude and 76° 26' longitude. The climate is warm humid with an average annual rainfall of 3000 mm. The temperature variation during the day is not wide. The soil is of lateratic origin.

## 3.1 Collection of seeds

Seeds of both the species were collected during the month of June, 1997. Ripened pods of mangium were collected from full grown trees maintained in the Instructional Farm of College of Forestry . The pods were put inside the gunny jute bag and brought to the College. The pods were uniformly spread over cement floor for 3 to 4 days to allow them to dry thoroughly. The seeds were extracted manually by breaking open the pods. *Dalbergia* seeds were collected from Wayanad forest area. Healthy and completely matured seeds were cleaned and dried for 3 to 4 days and used for the study. Seeds were put in clean gunny bags and stored at ambient temperature. The seeds were sown after treating with growth regulators at various concentrations.

### 3.2 Details of growth regulators used

Three different types of growth regulators at varying concentrations were used for seed treatment. Stock solutions of IAA, IBA and GA were prepared by dissolving the required quantity of the chemical in distilled water. The treatment solutions were made by further dilution of the respective stock solutions using distilled water.

The details of the treatments are furnished below:

1) Treating the seeds with IAA (100 ppm) - Treatment : $T_1$

2) Treating the seeds with IAA (250 ppm) - Treatment : $T_2$

3) Treating the seeds with IAA (500 ppm) - Treatment : $T_3$

4) Treating the seeds with $GA_3$ (10 ppm) - Treatment : $T_4$

5) Treating the seeds with $GA_3$ (25 ppm) - Treatment : $T_5$

6) Treating the seeds with $GA_3$ (50 ppm) - Treatment : $T_6$

7) Treating the seeds with BA (100 ppm) - Treatment : $T_7$

8) Treating the seeds with BA (250 ppm) - Treatment : $T_8$

9) Treating the seeds with BA (500 ppm) - Treatment : $T_9$

10) Control (untreated) - Treatment : $T_{10}$

The seeds of *Dalbergia latifolia* were soaked for 30 minutes in respective growth regulator solutions. For control, the seeds were sown as such. However in the case of *A. mangium,* the seeds were dipped in hot water for one minute before socking in growth regulator solutions.

Seventy five seeds of each species were used for each treatment. Seeds were sown in pots filled with sand. Watering was done twice a day. The pots were placed under partial shade. As soon as the germination was completed, representative samples of seedlings were transplanted in white polythene bags filled with sand and soil in equal proportion for studying subsequent growth behaviour. Sowing was continued at monthly intervals for a period of one year or till germination fell less than 10 per cent. The study was laid out in Completely Randomised Design (CRD). Seven hundred and fifty seeds of each species were sown at monthly intervals after imposing various treatments.

## 3.3. After care of the seedlings

The transplanted seedlings were watered daily. Necessary plant protection measures were also adopted.

## 3.4 Main items of observations

### 3.4.1 Seed characteristics

#### 3.4.1.1 Moisture per cent of seeds

Moisture per cent of seeds on wet/fresh weight basis was calculated by using the following formula.

$$\text{Moisture content (\%)} = \frac{\text{Wt. before drying} - \text{Wt. after drying}}{\text{Wt. before drying}} \times 100$$

#### 3.4.1.2 Germination behaviour

Number of seeds germinated on each day and the days taken for germination were recorded. Cumulative germination percentage was calculated for each treatment at the end of the test. Germination value was calculated using the following formula as suggested by Czabator (1962).

$$G.V = \text{Final M.D.G.} \times P.V.$$

where,

G.V. is the germination value.

Final M.D.G. is final mean daily germination (Final M.D.G. is calculated at the cumulative percentage of full seed germination at the end of the test divided by the number of days from sowing to the end of the test).

P.V. is the Peak value ( the maximum mean daily germination recorded at any time during the test).

### 3.4.2 Vegetative growth parameters

#### 3.4.2.1 Height

The height of the seedlings was measured using a scale from the collar portion upto terminal bud and expressed in centimetres.

#### 3.4.2.2 Collar girth

The collar girth of the seedlings was measured with a vernier calliper and expressed in millimeters.

### 3.4.2.3 Number of leaves

Number of leaves produced by individual seedlings was recorded.

All the above biometrical observations were recorded at fortnightly intervals. This was continued for a period of four months. Colour photographs were also taken to depict the variation in growth behaviour of seedlings.

### 3.4.2.4 Leaf area

Leaf area was recorded using standard procedures.

### 3.4.2.5 Chlorophyll content

Chlorophyll content of the leaf was estimated following the method suggested by Starner and Hardley (1967). Leaf samples were collected from the selected plants, cut into pieces; 0.1 gm of the sample was weighed into a mortar and ground with pestle to extract the chlorophyll using 80 per cent acetone. The extract was filtered using Whattman No. 1 filter paper and made up to 25 ml using 80 per cent acetone. The absorbance was read at 663 nm and 645 nm wave length in a spectrophotometer. The chlorophyll `a', chlorophyll `b' and total chlorophyll of each sample was calculated using the following formulae.

Chlorophyll `a' (mg $g^{-1}$ of tissue)

$$= 12.7 \text{ (OD at 663 nm)} - \frac{2.69 \text{ (OD at 645 nm)}}{1000 \times W} \times V$$

Chlorophyll `b' (mg $g^{-1}$ of tissue)

$$= 22.9 \text{ (OD at 645 nm} - \frac{4.68 \text{ (OD at 663 nm)}}{1000 \times W} \times V$$

Total chlorophyll (mg $g^{-1}$ of tissue)

$$= 20.2 \text{ OD at 645 nm} + \frac{8.02 \text{ (OD at 663 nm)}}{1000 \times W} \times V$$

where,

OD - optical density

V - Final volume of 80 per cent acetone extract

W - Fresh weight of tissue in grams

**3.4.2.6 Fresh weight of shoot**

At the end of four months, the seedlings were uprooted from the media. The root and shoot portion of seedlings were separated. The fresh weight of shoot portion was determined separately using a precision balance.

**3.4.2.7 Dry weight of shoot**

The shoot portion was dried in hot air oven at a temperature of 60 to 80°C for about 24 to 48 hours. The dry weight was taken and recorded. The drying and weighing was repeated till constant weights were obtained.

**3.4.3 Root growth parameters**

**3.4.3.1 Length of root**

The length of tap root of individual seedling was measured in centimetres.

### 3.4.3.2 Number of secondary roots

The total number of secondary roots produced by individual seedlings was counted.

### 3.4.3.3 Fresh weight of roots

Roots were separated carefully from the plant, washed well and the weights were recorded separately.

### 3.4.3.4 Dry weight of root

The dry weight was found out after oven drying at 60 to 80°C. This was repeated till constant weights were obtained.

### 3.4.3.5 Shoot/Root ratio

Shoot/Root ratio was recorded separately for various treatments.

### 3.5 Statistical analysis

Treatment means of arc - transformed cumulative germination percentage, final mean daily germination, peak value and germination value were analysed by applying techniques for analysis of variance for CRD (Snedecor and Cochran, 1967). All the biometric observations were also analysed statistically.

# Results

# RESULTS

The present series of investigations were carried out in College of Forestry with an objective of finding out the effect of plant growth regulators on seed germination and seeding vigour of *Acacia mangium* and *Dalbergia latifolia* in the nursery. The salient findings of the studies are furnished below.

## 4.1 Seed characteristics

The observations on weight and moisture content of seeds of *Acacia mangium* and *Dalbergia latifolia* are given in Table 1. *Acacia mangium* seeds recorded a mean weight of 8.37 mg and a moisture content of 5.04 per cent while *D. latifolia* seeds recorded a mean weight of 76.40 mg and a moisture content of 10.16 per cent. The photographs of seeds of *Acacia mangium* and *Dalbergia latifolia* are shown in Plates 1 and 2.

## 4.2 Effect of plant growth regulators on germination behaviour of seeds

Cumulative germination percentage (CGP), final mean daily germination (FMDG), peak value (PV) and germination value (GV) were the four parameters studied in relation to germination characteristics of the seeds treated with various growth regulators. The observations related to above aspects are furnished in Tables 2 to 5.

Plate 1 Seeds of *Acacia mangium* (Willd)

Plate 2 Seeds of *Dalbergia latifolia* (Roxb)


DALBERGIA LATIFOLIA SEEDS


ACACIA MANGIUM SEEDS

Table 1 Seed characteristics of *Acacia mangium* and *Dalbergia latifolia*

| Sl. No. | Period of storage (months) | *Acacia mangium* | | | *Dalbergia latifolia* | | |
|---|---|---|---|---|---|---|---|
| | | Initial weight (mg) | Dry weight (mg) | Moisture content (%) | Initial weight (Mg) | Dry weight (mg) | Moisture content (%) |
| 1 | 0 | 7.87 | 7.47 | 5.36 | 77.87 | 70.80 | 9.89 |
| 2 | 1 | 8.80 | 8.40 | 4.77 | 75.87 | 68.93 | 10.06 |
| 3 | 2 | 8.67 | 8.27 | 4.85 | 73.20 | 66.40 | 10.24 |
| 4 | 3 | 8.13 | 7.73 | 5.19 | 78.67 | 71.2 | 10.45 |
| | Mean | 8.37 | 7.97 | 5.04 | 76.40 | 69.33 | 10.16 |

Table 2 Effect of plant growth regulators on germination behaviour of fresh seeds of *Acacia mangium* and *Dalbergia latifolia*

| Sl. No. | Treatments | *Acacia mangium* | | | | | *Dalbergia latifolia* | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Days taken for germination | Cumulative germination % | Final mean daily germination | Germination value | Peak value | Days taken for germination | Cumulative germination % | Final mean daily germination | Germination value | Peak value |
| 1 | IAA 100 ppm | 5 | 61.33(38.30) | 3.21 | 17.97 | 6.09 | 5 | 33.33(19.51) | 1.85 | 7.93 | 4.16 |
| 2 | " 250 ppm | 5 | 64.67(42.32) | 3.59 | 26.02 | 6.75 | 4 | 29.33(17.18) | 1.63 | 6.93 | 3.97 |
| 3 | " 500 ppm | 5 | 49.33(29.60) | 2.74 | 11.44 | 4.19 | 4 | 34.67(20.30) | 1.93 | 8.59 | 4.44 |
| 4 | GA 10 ppm | 5 | 68.00(46.46) | 3.78 | 22.81 | 4.36 | 6 | 36.00(21.17) | 2.00 | 9.07 | 4.44 |
| 5 | " 25 ppm | 5 | 66.67(42.31) | 3.71 | 22.48 | 4.87 | 5 | 50.67(30.89) | 2.82 | 19.97 | 6.69 |
| 6 | " 50 ppm | 5 | 66.67(42.14) | 3.71 | 22.97 | 6.12 | 5 | 42.67(25.73) | 2.35 | 14.53 | 5.52 |
| 7 | BA 100 ppm | 4 | 72.00(46.91) | 4.01 | 27.40 | 6.70 | 3 | 36.00(21.20) | 2.00 | 10.60 | 5.11 |
| 8 | " 250 ppm | 4 | 51.33(31.01) | 2.86 | 14.10 | 4.84 | 4 | 57.33(35.19) | 3.19 | 26.93 | 8.16 |
| 9 | " 500 ppm | 5 | 60.00(38.83) | 3.34 | 18.06 | 5.02 | 5 | 34.67(20.50) | 1.92 | 8.63 | 4.12 |
| | Control | 5 | 45.33(27.00) | 2.52 | 9.17 | 3.63 | 5 | 60.00(37.17) | 3.33 | 27.28 | 7.99 |
| | SEm± | | 7.68 | 0.51 | 6.15 | 0.83 | | 4.53 | 0.38 | 4.87 | 0.10 |
| | CD (0.05) | | NS | NS | NS | NS | | 13.35* | NS | 14.38* | 2.95* |

* Significant at 5% level NS - Not significant

Values in parentheses are arc-sine transformations

Table 3 Effect of plant growth regulators on germination behaviour of one month old seeds of *Acacia mangium* and *Dalbergia latifolia*

| Sl. No. | Treatments | *Acacia mangium* | | | | | *Dalbergia latifolia* | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Days taken for germination | Cumulative germination % | Final mean daily germination | Germinatio n value | Peak value | Days taken for germination | Cumulative germination % | Final mean daily germination | Germination value | Peak value |
| 1 | IAA 100 ppm | 6 | 56.00(34.20) | 3.11 | 16.04 | 5.03 | 6 | 45.33(27.29) | 2.52 | 10.61 | 3.81 |
| 2 | " 250 ppm | 6 | 59.33(37.05) | 3.29 | 20.20 | 5.85 | 6 | 33.33(19.59) | 1.85 | 6.36 | 3.18 |
| 3 | " 500 ppm | 7 | 60.00(37.82) | 3.33 | 18.26 | 5.07 | 4 | 48.00(29.19) | 2.67 | 14.58 | 5.10 |
| 4 | GA 10 ppm | 7 | 52.00(31.70) | 2.89 | 14.54 | 4.74 | 5 | 18.67(10.78) | 1.04 | 2.17 | 1.97 |
| 5 | " 25 ppm | 8 | 49.33(30.12) | 2.74 | 16.43 | 5.22 | 5 | 24.00(13.89) | 1.33 | 3.05 | 2.29 |
| 6 | " 50 ppm | 6 | 46.67(28.64) | 2.59 | 16.41 | 5.26 | 5 | 20.00(11.60) | 1.11 | 4.52 | 3.38 |
| 7 | BA 100 ppm | 6 | 54.00(32.91) | 3.00 | 17.81 | 5.76 | 4 | 36.00(21.34) | 2.00 | 10.97 | 4.61 |
| 8 | " 250 ppm | 7 | 54.67(33.63) | 3.04 | 19.28 | 6.13 | 5 | 37.33(21.97) | 2.07 | 8.19 | 3.87 |
| 9 | " 500 ppm | 7 | 40.00(23.61) | 2.22 | 9.90 | 4.43 | 5 | 37.33(22.06) | 1.11 | 8.34 | 3.78 |
| | Control | 6 | 34.67(20.37) | 1.92 | 8.36 | 4.00 | 6 | 20.00(11.58) | 1.77 | 3.35 | 2.67 |
| | SEm± | | 6.21 | 0.51 | 5.47 | 1.08 | | 4.43 | 0.39 | 3.21 | 0.89 |
| | CD (0.05) | | NS | NS | NS | NS | | NS | NS | NS | NS |

NS - Not significant
Values in parentheses are arc-sine transformations

Table 4 Effect of plant growth regulators on germination behaviour of two month old seeds of *Acacia mangium* and *Dalbergia latifolia*

| Sl. No. | Treatments | *Acacia mangium* | | | | | *Dalbergia latifolia* | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Days taken for germination | Cumulative germination % | Final mean daily germination | Germinatio n value | Peak value | Days taken for germination | Cumulative germination % | Final mean daily germination | Germination value | Peak value |
| 1 | IAA 100 ppm | 5 | 40.00(24.00) | 2.23 | 10.40 | 4.00 | 5 | 21.33(12.34) | 1.18 | 3.66 | 3.01 |
| 2 | " 250 ppm | 5 | 38.67(22.85) | 2.15 | 8.16 | 3.71 | 6 | 20.00(11.54) | 1.11 | 2.06 | 1.85 |
| 3 | " 500 ppm | 5 | 50.67(30.47) | 2.82 | 16.49 | 5.83 | 5 | 18.67(10.83) | 1.04 | 3.85 | 3.10 |
| 4 | GA 10 ppm | 8 | 46.67(27.93) | 2.60 | 10.60 | 4.00 | 5 | 17.33(10.01) | 0.96 | 2.35 | 2.07 |
| 5 | " 25 ppm | 5 | 37.33(21.97) | 2.08 | 7.52 | 3.56 | 5 | 21.33(12.41) | 1.19 | 4.38 | 2.91 |
| 6 | " 50 ppm | 5 | 40.00(23.65) | 2.23 | 10.99 | 4.83 | 5 | 14.67(8.45) | 0.81 | 1.76 | 2.02 |
| 7 | BA 100 ppm | 5 | 42.67(25.56) | 2.37 | 15.76 | 6.33 | 6 | 14.67(8.44) | 0.82 | 1.64 | 1.87 |
| 8 | " 250 ppm | 5 | 34.67(20.50) | 1.93 | 7.98 | 3.67 | 5 | 32.00(18.84) | 1.78 | 8.34 | 4.00 |
| 9 | " 500 ppm | 5 | 30.67(17.87) | 1.70 | 5.22 | 3.05 | 5 | 17.33(9.99) | 0.96 | 2.50 | 2.44 |
| | Control | 5 | 30.00(17.69) | 1.67 | 5.76 | 2.84 | 7 | 25.33(14.69) | 1.41 | 4.36 | 2.96 |
| | SEm± | | 4.40 | 0.39 | 3.13 | 0.77 | | 2.94 | 0.27 | 2.09 | 0.75 |
| | CD (0.05) | | NS | NS | NS | NS | | NS | NS | NS | NS |

NS - Not significant
Values in parentheses are arc-sine transformations

Table 5 Effect of plant growth regulators on germination behaviour of three month old seeds of *Acacia mangium* and *Dalbergia latifolia*

| Sl. No. | Treatments | *Acacia mangium* | | | | | *Dalbergia latifolia* | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Days taken for germination | Cumulative germination % | Final mean daily germination | Germination value | Peak value | Days taken for germination | Cumulative germination % | Final mean daily germination | Germination value | Peak value |
| 1 | IAA 100 ppm | 10 | 10.00(5.75) | 0.56 | 0.54 | 0.77 | 5 | 14.00(8.06) | 0.77 | 1.47 | 1.94 |
| 2 | " 250 ppm | 7 | 52.00(33.35) | 2.89 | 19.50 | 5.20 | 4 | 12.00(6.91) | 0.67 | 0.96 | 1.42 |
| 3 | " 500 ppm | 8 | 16.00(9.23) | 0.89 | 1.64 | 1.65 | 5 | 13.00(7.67) | 0.74 | 1.64 | 2.10 |
| 4 | GA 10 ppm | 7 | 52.00(31.37) | 2.89 | 33.31 | 11.51 | 5 | 12.00(6.90) | 0.67 | 1.33 | 1.86 |
| 5 | " 25 ppm | 7 | 49.33(29.67) | 2.74 | 13.57 | 4.87 | 5 | 6.67(3.83) | 0.37 | 0.50 | 1.27 |
| 6 | " 50 ppm | 6 | 45.33(27.08) | 2.52 | 13.02 | 5.03 | 6 | 10.67(6.13) | 0.59 | 0.91 | 1.23 |
| 7 | BA 100 ppm | 5 | 50.67(30.57) | 2.81 | 13.18 | 4.60 | 7 | 9.33(5.37) | 0.52 | 1.12 | 1.53 |
| 8 | " 250 ppm | 7 | 37.33(22.04) | 2.07 | 7.57 | 3.47 | 7 | 4.00(2.29) | 0.22 | 0.14 | 0.65 |
| 9 | " 500 ppm | 7 | 46.67(27.86) | 2.59 | 11.06 | 4.24 | 7 | 4.00(2.29) | 0.22 | 0.14 | 0.65 |
| | Control | 7 | 32.00(19.16) | 1.78 | 9.15 | 3.55 | 4 | 9.33(5.38) | 0.52 | 1.04 | 1.36 |
| | SEm± | | 5.69 | 0.47 | 5.49 | 1.36 | | 1.73 | 0.17 | 0.51 | 0.45 |
| | CD (0.05) | | 16.78* | 1.399* | 16.19* | 4.017* | | NS | NS | NS | NS |

* Significant at 5% level NS - Not significant

Values in parentheses are arc-sine transformations

### 4.2.1 Cumulative germination percentage

The data showed that in general, growth regulators did not result any significant effect on cumulative germination percentage or minimum days taken for germination. However, in the case of *A. mangium,* germination studies conducted by using three month old seeds indicated significant difference with regard to this parameter. In the case of three month old seeds (Table 5), the seeds treated with 10 ppm GA recorded higher value for cumulative germination per cent (52%). It was significantly higher compared to cumulative germination per cent of seeds treated with 500 ppm IAA and 100 ppm IAA. It could be seen from the table that the seeds treated with 100 ppm IAA showed lower cumulative germination per cent (10%).

In the case of *D. latifolia,* germination studies using fresh seeds indicated significant difference between treatments. In all the other cases, treatment did not show any significant effect on cumulative germination per cent. In fresh seeds the control treatment recorded higher cumulative germination per cent (60%) (Table 2). However, this is on par with seeds treated with 250 ppm BA, 25 ppm GA and 50 ppm GA. Seeds treated with 250 ppm IAA recorded lower cumulative germination per cent (29.33%) and it significantly differed from control and seeds treated with 250 ppm BA and 25 ppm GA.

The effect of varing period of storage on cumulative germination per cent of seeds of both the species is illustrated in Fig. 1 and 2. For both the species the cumulative germination per cent tend to decrease with increase in storage periods.

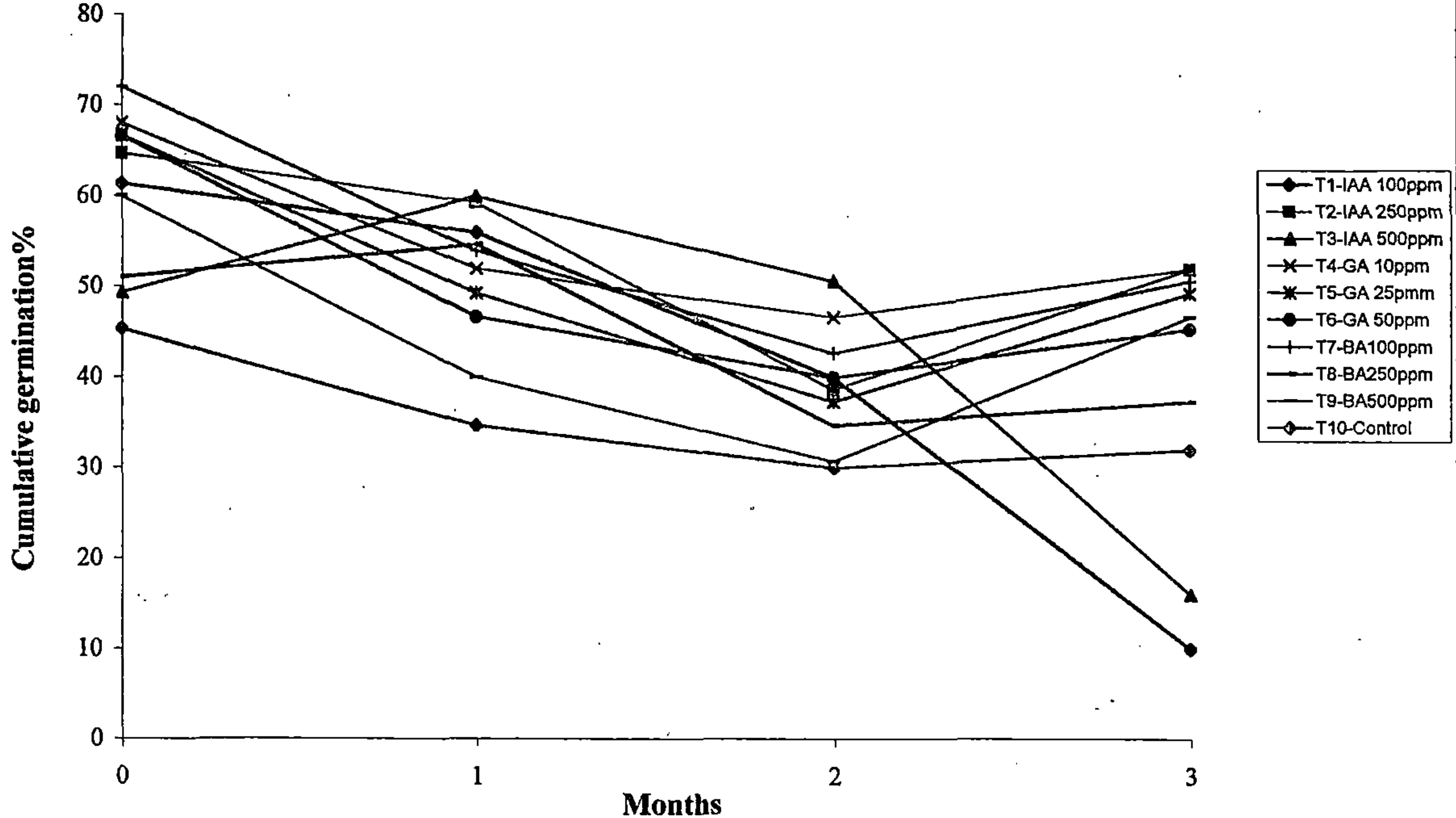



**Fig 1. Effect of plant growth regulators on cumulative germination percentage of *Acacia mangium* seeds stored for varying periods**

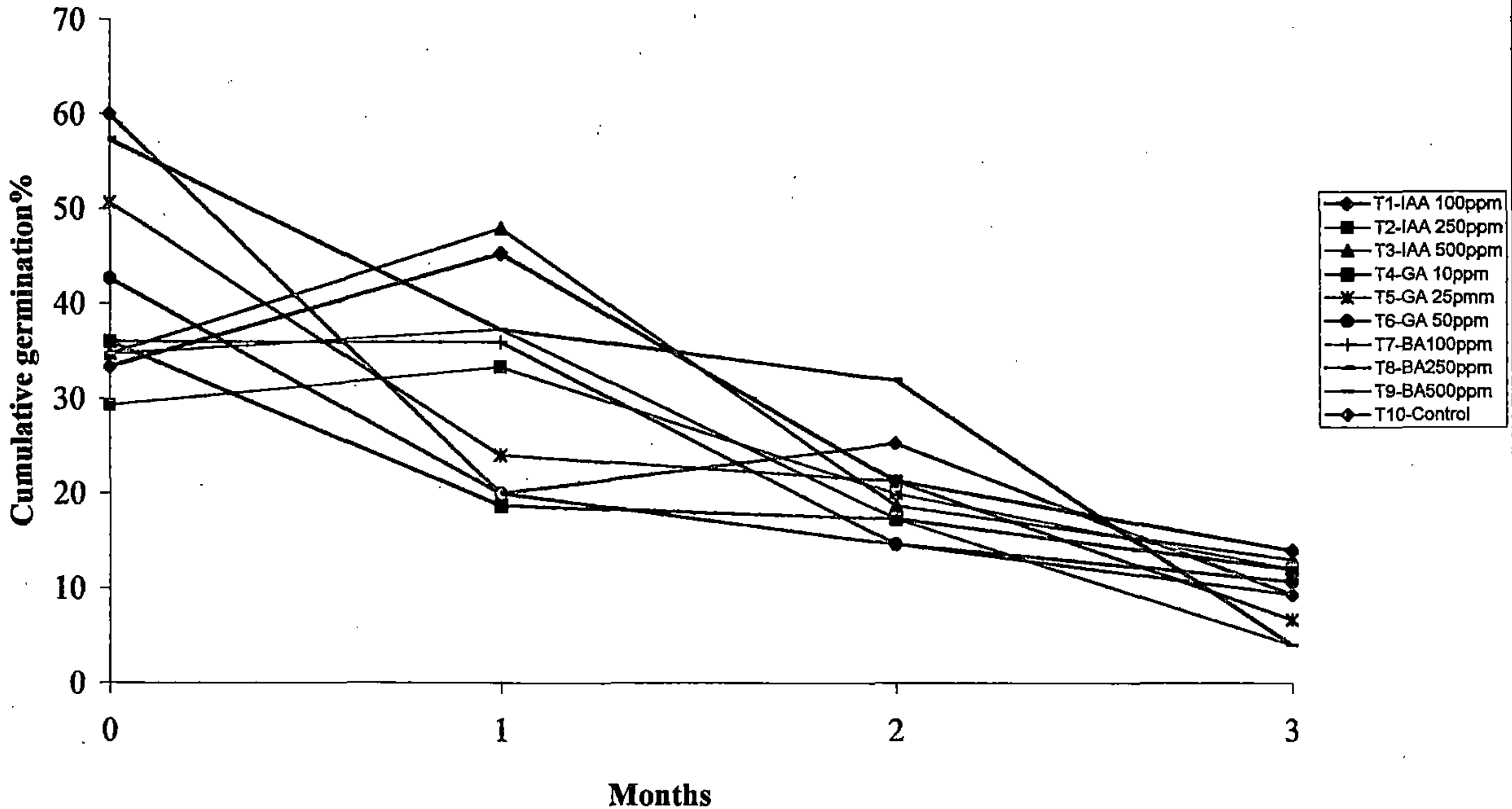



**Fig 2. Effect of growth regulators on cumulative germination percentage of *Dalbergia latifolia* seeds stored for varying periods**

### 4.2.2 Final mean daily germination

The data furnished in above tables also revealed that in *Acacia mangium*, the treatments induced significant differences when three month old seeds were subjected to various treatments. In all other cases, the treatments did not show any significant difference. The three month old seed when treated with 250 ppm IAA and 10 ppm GA showed higher value of 2.89 with regard to final mean daily germination and these treatments were significantly different from IAA 100 and 500 ppm. Seeds treated with 100 ppm IAA had showed lower value for final mean daily germination (0.56).

In *Dalbergia latifolia* this parameter did not vary significantly in any of the ten treatments studied (Tables 2 to 5).

### 4.2.3 Germination value

With regard to this parameter also, in *Acacia mangium,* the treatments showed significant difference when three month old seeds were treated with different treatment solutions. The seeds treated with 10 ppm GA showed higher germination value (33.31) and this is on par with seeds treated with 250 ppm IAA (19.50). Seeds treated with 100 ppm IAA recorded the lowest value (0.54) and differed significantly from seeds treated with 10 ppm GA and 250 ppm IAA (Table 5).

In the case of *Dalbergia latifolia,* the treatments had got significant difference when they were imposed on fresh seeds. In all other cases, the treatments had no effect on germination value. In the case of fresh seeds, treatments like 250 ppm BA, 25 ppm GA, 50 ppm GA and control were on par though they recorded higher germination values. Seeds treated with 250 ppm IAA showed low germination value (6.93). This treatment was significantly different from 250 ppm BA, 25 ppm GA and control (Table 2).

### 4.2.4 Peak value

In *Acacia mangium*, three month old seeds when treated with different treatment solutions revealed a positive effect of treatments on this parameter (Table 5). The seeds treated with 10 ppm GA recorded higher peak germination value (11.51) and was significantly superior compared to other treatments. Seeds treated with 100 ppm IAA recorded lower value (0.77) and was on par with BA 100 (4.60), 250 (3.47) and 500 (4.24) ppm and also with IAA 500 ppm (1.65).

In the case of *Dalbergia latifolia,* treatments differed significantly when fresh seeds were used for the study. No treatment effect was noticed in the case of other seeds. Here the seeds treated with 250 ppm BA, 25 and 50 ppm GA had higher peak values and were on par each other. Seeds treated with 250 ppm IAA showed lower peak value and was found to be significantly different from 250 ppm BA and control.

## 4.3 Effect of growth regulators on growth characteristics of seedlings

The observations on height, girth and number of leaves produced by seedlings due to various growth regulator treatment are tabulated in Tables 6 to 14.

Table 6 Effect of plant growth regulators on height (cm) of seedlings produced from fresh seeds of *Acacia mangium* and *Dalbergia latifolia*

| Sl. No. | Treatments | *Acacia mangium* | | | | | | | | *Dalbergia latifolia* | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Fortnights | | | | | | | | Fortnights | | | | | | | |
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 1 | IAA 100 ppm | 4.31 | 4.86 | 5.63 | 6.36 | 7.10 | 7.94 | 9.09 | 10.30 | 4.69 | 5.23 | 6.18 | 7.18 | 8.36 | 9.09 | 10.13 | 11.07 |
| 2 | " 250 ppm | 7.06 | 7.13 | 7.49 | 7.98 | 8.49 | 8.87 | 9.38 | 9.95 | 5.26 | 5.96 | 6.81 | 7.62 | 8.58 | 9.33 | 9.97 | 10.78 |
| 3 | " 500 ppm | 7.01 | 7.29 | 7.71 | 8.29 | 8.87 | 9.45 | 9.95 | 10.58 | 4.39 | 5.02 | 5.82 | 6.85 | 7.69 | 8.65 | 9.58 | 10.44 |
| 4 | GA 10 ppm | 3.67 | 4.37 | 4.96 | 5.42 | 5.91 | 6.49 | 7.05 | 7.78 | 4.70 | 5.28 | 5.95 | 6.69 | 7.73 | 8.53 | 9.58 | 10.42 |
| 5 | " 25 ppm | 3.60 | 4.42 | 4.89 | 5.38 | 5.82 | 6.36 | 6.98 | 7.60 | 4.77 | 5.53 | 6.11 | 6.71 | 7.49 | 8.11 | 8.82 | 9.40 |
| 6 | " 50 ppm | 5.80 | 8.24 | 9.08 | 11.52 | 13.09 | 15.49 | 17.56 | 19.16 | 3.62 | 4.32 | 4.76 | 5.38 | 6.00 | 6.53 | 7.13 | 7.58 |
| 7 | BA 100 ppm | 6.56 | 8.12 | 9.14 | 11.02 | 12.60 | 14.30 | 15.69 | 17.51 | 3.98 | 4.77 | 5.27 | 5.80 | 6.30 | 6.89 | 7.47 | 8.18 |
| 8 | " 250 ppm | 5.56 | 8.18 | 9.04 | 10.00 | 11.11 | 11.91 | 13.11 | 14.42 | 4.46 | 5.17 | 5.75 | 6.47 | 7.13 | 7.66 | 8.24 | 8.93 |
| 9 | " 500 ppm | 6.29 | 7.41 | 9.18 | 10.84 | 12.56 | 14.33 | 16.62 | 18.91 | 4.18 | 4.96 | 5.39 | 6.02 | 6.62 | 7.20 | 7.73 | 8.29 |
| | Control | 5.80 | 7.32 | 8.73 | 9.78 | 11.93 | 14.07 | 16.02 | 18.29 | 3.39 | 4.20 | 4.80 | 5.33 | 5.91 | 6.49 | 7.09 | 7.68 |
| | SEm± | 1.13 | 1.21 | 1.23 | 1.27 | 1.31 | 1.35 | 1.30 | 1.36 | 0.41 | 0.45 | 0.48 | 0.48 | 0.50 | 0.53 | 0.49 | 0.50 |
| | CD (0.05) | NS | NS | NS | 3.74* | 3.86** | 3.99** | 3.83** | 4.02** | NS | NS | NS | 1.42* | 1.47** | 1.57** | 1.44** | 1.48** |

* Significant at 5% level ** Significant at 1% level NS - Not significant

Table 7 Effect of plant growth regulators on height (cm) of seedlings produced from one month old seeds of *Acacia mangium and Dalbergia latifolia*

| Sl. No. | Treatments | *Acacia mangium* | | | | | | | | *Dalbergia latifolia* | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Fortnights | | | | | | | | Fortnights | | | | | | | |
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 1 | IAA 100 ppm | 5.50 | 8.00 | 10.61 | 13.11 | 16.10 | 19.11 | 22.20 | 25.47 | 6.89 | 7.42 | 7.94 | 8.62 | 9.24 | 9.99 | 11.47 | 12.29 |
| 2 | " 250 ppm | 3.83 | 5.50 | 7.06 | 9.47 | 12.44 | 14.38 | 16.08 | 18.98 | 7.55 | 7.85 | 8.18 | 8.49 | 8.81 | 9.27 | 9.93 | 10.46 |
| 3 | " 500 ppm | 4.78 | 7.12 | 9.30 | 12.02 | 14.33 | 16.37 | 17.99 | 20.58 | 7.39 | 7.67 | 8.06 | 8.40 | 8.73 | 9.17 | 9.54 | 10.05 |
| 4 | GA 10 ppm | 4.49 | 6.03 | 8.09 | 10.35 | 12.91 | 14.47 | 16.40 | 19.10 | 6.47 | 6.79 | 7.20 | 7.57 | 7.99 | 8.44 | 8.80 | 9.14 |
| 5 | " 25 ppm | 5.93 | 7.32 | 9.40 | 11.32 | 12.92 | 14.84 | 16.24 | 18.81 | 6.49 | 6.76 | 7.10 | 7.44 | 7.79 | 8.15 | 8.59 | 9.09 |
| 6 | " 50 ppm | 4.53 | 5.86 | 7.71 | 9.07 | 11.00 | 12.81 | 14.48 | 16.84 | 8.03 | 8.33 | 8.70 | 8.97 | 9.33 | 9.74 | 10.16 | 10.71 |
| 7 | BA 100 ppm | 5.46 | 6.87 | 8.80 | 11.01 | 12.82 | 14.62 | 16.16 | 21.55 | 8.46 | 8.78 | 9.12 | 9.50 | 9.83 | 10.18 | 10.57 | 10.91 |
| 8 | " 250 ppm | 6.05 | 6.95 | 8.49 | 10.15 | 11.76 | 13.21 | 14.96 | 17.31 | 7.48 | 7.72 | 7.97 | 8.19 | 8.51 | 8.90 | 9.24 | 9.69 |
| 9 | " 500 ppm | 6.23 | 7.53 | 8.60 | 10.38 | 11.80 | 13.26 | 14.80 | 17.20 | 6.18 | 6.47 | 6.76 | 6.97 | 7.21 | 7.49 | 7.73 | 8.01 |
| | Control | 5.93 | 6.77 | 7.70 | 9.02 | 10.59 | 12.60 | 14.62 | 16.78 | 8.53 | 8.84 | 9.19 | 9.55 | 9.96 | 10.31 | 10.74 | 11.02 |
| | SEm± | 0.79 | 1.20 | 1.51 | 1.77 | 1.97 | 2.28 | 2.46 | 4.81 | 0.53 | 0.52 | 0.52 | 0.50 | 0.51 | 0.51 | 0.58 | 0.58 |
| | CD (0.05) | NS | NS | NS | NS | NS | NS | NS | NS | 1.57* | 1.53* | 1.55* | 1.48* | 1.50* | 1.52* | 1.71** | 1.72** |

* Significant at 5% level ** Significant at 1% level NS - Not significant

Table 8 Effect of plant growth regulators on height (cm) of seedlings produced from two month old seeds of *Acacia mangium* and *Dalbergia latifolia*

| Sl. No. | Treatments | *Acacia mangium* Fortnights | | | | | | | | *Dalbergia latifolia* Fortnights | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 1 | IAA 100 ppm | 2.81 | 3.89 | 5.29 | 7.11 | 9.02 | 11.64 | 13.96 | 16.71 | 7.63 | 8.75 | 10.35 | 11.30 | 12.43 | 13.05 | 14.03 | 15.10 |
| 2 | " 250 ppm | 2.80 | 4.18 | 5.44 | 7.62 | 10.55 | 13.40 | 16.20 | 19.39 | 8.79 | 10.39 | 11.76 | 12.33 | 13.38 | 13.97 | 14.76 | 15.74 |
| 3 | " 500 ppm | 2.58 | 3.93 | 5.41 | 7.49 | 10.11 | 12.80 | 15.22 | 17.89 | 7.95 | 8.43 | 9.81 | 10.73 | 11.99 | 12.59 | 13.22 | 14.09 |
| 4 | GA 10 ppm | 1.68 | 2.64 | 3.80 | 5.76 | 8.84 | 11.82 | 14.16 | 16.27 | 8.02 | 9.46 | 11.26 | 12.06 | 13.42 | 14.11 | 14.73 | 15.51 |
| 5 | " 25 ppm | 1.60 | 2.58 | 3.77 | 6.60 | 10.17 | 13.33 | 16.17 | 19.56 | 9.38 | 10.38 | 12.62 | 13.33 | 15.55 | 16.10 | 16.77 | 17.56 |
| 6 | " 50 ppm | 1.11 | 2.04 | 3.24 | 5.20 | 7.76 | 9.87 | 12.43 | 15.69 | 9.93 | 11.01 | 12.80 | 13.51 | 14.73 | 15.31 | 15.92 | 16.84 |
| 7 | BA 100 ppm | 1.58 | 3.20 | 4.84 | 7.28 | 10.20 | 12.87 | 15.42 | 17.84 | 9.18 | 9.29 | 11.79 | 12.83 | 14.25 | 14.82 | 15.40 | 16.18 |
| 8 | " 250 ppm | 1.73 | 2.60 | 4.16 | 6.45 | 8.91 | 11.51 | 14.93 | 18.13 | 9.82 | 10.68 | 11.45 | 12.67 | 13.67 | 14.36 | 15.11 | 15.92 |
| 9 | " 500 ppm | 1.16 | 2.24 | 3.35 | 5.29 | 7.56 | 10.52 | 13.69 | 16.67 | 8.22 | 9.36 | 11.64 | 12.54 | 13.18 | 13.64 | 14.29 | 15.22 |
| | Control | 2.33 | 3.53 | 5.30 | 7.62 | 10.71 | 13.82 | 16.58 | 19.53 | 8.42 | 9.10 | 10.28 | 11.03 | 11.88 | 12.31 | 12.94 | 13.83 |
| | SEm± | 0.28 | 0.34 | 0.53 | 0.74 | 1.01 | 1.32 | 1.51 | 1.70 | 0.82 | 0.84 | 0.85 | 0.83 | 0.91 | 0.91 | 0.90 | 0.89 |
| | CD (0.05) | 0.8115** | 0.9989** | 1.56* | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |

* Significant at 5% level ** Significant at 1% level NS - Not significant

Table 9 Effect of plant growth regulators on girth (mm) of seedlings produced from fresh seeds of *Acacia mangium* and *Dalbergia latifolia*

| Sl. No. | Treatments | *Acacia mangium* | | | | | | | | *Dalbergia latifolia* | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Fortnights | | | | | | | | Fortnights | | | | | | | |
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 1 | IAA 100 ppm | 0.59 | 0.66 | 0.74 | 0.82 | 0.92 | 1.06 | 1.16 | 1.25 | 0.75 | 0.88 | 1.10 | 1.30 | 1.31 | 1.34 | 1.36 | 1.38 |
| 2 | " 250 ppm | 0.72 | 0.81 | 0.93 | 1.03 | 1.11 | 1.21 | 1.29 | 1.37 | 0.81 | 1.04 | 1.23 | 1.44 | 1.48 | 1.51 | 1.55 | 1.56 |
| 3 | " 500 ppm | 0.65 | 0.73 | 0.83 | 0.94 | 1.05 | 1.14 | 1.22 | 1.30 | 0.71 | 0.88 | 1.05 | 1.21 | 1.24 | 1.27 | 1.30 | 1.32 |
| 4 | GA 10 ppm | 0.49 | 0.58 | 0.68 | 0.77 | 0.88 | 0.97 | 1.06 | 1.15 | 0.67 | 0.79 | 0.91 | 1.24 | 1.27 | 1.30 | 1.33 | 1.35 |
| 5 | " 25 ppm | 0.51 | 0.61 | 0.72 | 0.82 | 0.94 | 1.08 | 1.19 | 1.30 | 0.76 | 0.96 | 1.17 | 1.36 | 1.39 | 1.42 | 1.44 | 1.46 |
| 6 | " 50 ppm | 0.63 | 0.74 | 0.85 | 1.00 | 1.12 | 1.25 | 1.35 | 1.46 | 0.68 | 0.86 | 0.98 | 1.12 | 1.16 | 1.20 | 1.24 | 1.28 |
| 7 | BA 100 ppm | 0.64 | 0.75 | 0.87 | 0.97 | 1.11 | 1.22 | 1.32 | 1.41 | 0.80 | 1.05 | 1.17 | 1.33 | 1.40 | 1.40 | 1.44 | 1.47 |
| 8 | " 250 ppm | 0.60 | 0.70 | 0.81 | 0.91 | 1.03 | 1.13 | 1.25 | 1.42 | 0.71 | 0.93 | 1.35 | 1.63 | 1.67 | 1.71 | 1.75 | 1.79 |
| 9 | " 500 ppm | 0.66 | 0.78 | 0.89 | 0.99 | 1.11 | 1.20 | 1.28 | 1.37 | 0.86 | 1.07 | 1.25 | 1.49 | 1.53 | 1.56 | 1.61 | 1.66 |
| | Control | 0.59 | 0.71 | 0.83 | 0.93 | 1.02 | 1.12 | 1.20 | 1.32 | 0.78 | 1.07 | 1.12 | 1.24 | 1.29 | 1.33 | 1.38 | 1.43 |
| | SEm± | 0.07 | 0.08 | 0.09 | 0.09 | 0.09 | 0.08 | 0.08 | 0.07 | 0.04 | 0.07 | 0.07 | 0.09 | 0.09 | 0.09 | 0.09 | 0.60 |
| | CD (0.05) | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | 0.2069* | 0.2761* | 0.2788* | 0.2664* | 0.2569* | NS |

* Significant at 5% level NS - Not significant

Table 10 Effect of plant growth regulators on girth (mm) of seedlings produced from one month old seeds of *Acacia mangium* and *Dalbergia latifolia*

| Sl. No. | Treatments | *Acacia mangium* Fortnights | | | | | | | | *Dalbergia latifolia* Fortnights | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 1 | IAA 100 ppm | 0.97 | 1.17 | 1.37 | 1.55 | 1.80 | 2.11 | 2.41 | 2.73 | 1.44 | 1.47 | 1.49 | 1.53 | 1.57 | 1.62 | 1.67 | 1.79 |
| 2 | " 250 ppm | 0.85 | 1.05 | 1.18 | 1.35 | 1.50 | 1.65 | 1.80 | 2.04 | 1.39 | 1.42 | 1.45 | 1.49 | 1.53 | 1.57 | 1.61 | 1.75 |
| 3 | " 500 ppm | 0.96 | 1.14 | 1.32 | 1.55 | 1.83 | 2.07 | 2.37 | 2.57 | 1.35 | 1.38 | 1.41 | 1.46 | 1.50 | 1.54 | 1.59 | 1.67 |
| 4 | GA 10 ppm | 0.83 | 1.09 | 1.29 | 1.45 | 1.64 | 1.87 | 2.07 | 2.33 | 1.21 | 1.25 | 1.28 | 1.32 | 1.35 | 1.40 | 1.44 | 1.64 |
| 5 | " 25 ppm | 0.78 | 0.94 | 1.17 | 1.43 | 1.71 | 1.95 | 2.13 | 2.39 | 1.26 | 1.30 | 1.34 | 1.40 | 1.44 | 1.49 | 1.53 | 1.59 |
| 6 | " 50 ppm | 0.83 | 0.99 | 1.20 | 1.46 | 1.72 | 1.96 | 2.23 | 2.51 | 1.40 | 1.44 | 1.49 | 1.52 | 1.57 | 1.61 | 1.65 | 1.73 |
| 7 | BA 100 ppm | 0.65 | 0.75 | 0.88 | 1.10 | 1.34 | 1.62 | 1.77 | 2.05 | 1.34 | 1.39 | 1.42 | 1.47 | 1.52 | 1.58 | 1.62 | 1.68 |
| 8 | " 250 ppm | 0.60 | 0.76 | 0.92 | 1.18 | 1.50 | 1.66 | 1.82 | 2.10 | 1.46 | 1.49 | 1.52 | 1.55 | 1.57 | 1.61 | 1.64 | 1.68 |
| 9 | " 500 ppm | 0.54 | 0.65 | 0.79 | 0.95 | 1.21 | 1.44 | 1.61 | 1.89 | 1.48 | 1.51 | 1.54 | 1.57 | 1.59 | 1.62 | 1.65 | 1.70 |
| | Control | 0.52 | 0.67 | 0.82 | 0.97 | 1.22 | 1.43 | 1.64 | 1.85 | 1.45 | 1.48 | 1.52 | 1.56 | 1.60 | 1.65 | 1.68 | 1.72 |
| | SEm± | 0.05 | 0.06 | 0.08 | 0.11 | 0.15 | 0.18 | 0.20 | 0.23 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.09 | 0.09 |
| | CD (0.05) | 0.1584** | 0.1668** | 0.2361** | 0.3129** | 0.4495* | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |

* Significant at 5% level ** Significant at 1% level NS - Not significant

Table 11 Effect of plant growth regulators on girth (mm) of seedlings produced from two month old seeds of *Acacia mangium* and *Dalbergia latifolia*

| Sl. No. | Treatments | *Acacia mangium* Fortnights | | | | | | | | *Dalbergia latifolia* Fortnights | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 1 | IAA 100 ppm | 0.57 | 0.65 | 0.76 | 0.89 | 1.02 | 1.13 | 1.33 | 1.53 | 1.02 | 1.12 | 1.27 | 1.33 | 1.42 | 1.47 | 1.53 | 1.61 |
| 2 | " 250 ppm | 0.70 | 0.83 | 0.97 | 1.14 | 1.36 | 1.56 | 1.74 | 1.89 | 0.86 | 0.98 | 1.16 | 1.27 | 1.42 | 1.48 | 1.53 | 1.59 |
| 3 | " 500 ppm | 0.66 | 0.74 | 0.89 | 1.04 | 1.26 | 1.43 | 1.59 | 1.81 | 0.99 | 1.09 | 1.16 | 1.21 | 1.26 | 1.32 | 1.36 | 1.41 |
| 4 | GA 10 ppm | 0.65 | 0.74 | 0.85 | 1.01 | 1.18 | 1.32 | 1.51 | 1.76 | 0.98 | 1.07 | 1.14 | 1.24 | 1.31 | 1.39 | 1.50 | 1.63 |
| 5 | " 25 ppm | 0.67 | 0.76 | 0.86 | 0.98 | 1.13 | 1.28 | 1.42 | 1.78 | 1.23 | 1.29 | 1.36 | 1.42 | 1.48 | 1.53 | 1.60 | 1.65 |
| 6 | " 50 ppm | 0.49 | 0.53 | 0.59 | 0.65 | 0.73 | 0.80 | 0.90 | 1.15 | 1.08 | 1.13 | 1.24 | 1.34 | 1.40 | 1.49 | 1.63 | 1.82 |
| 7 | BA 100 ppm | 0.72 | 0.81 | 0.78 | 1.01 | 1.12 | 1.26 | 1.41 | 1.67 | 1.18 | 1.25 | 1.28 | 1.33 | 1.39 | 1.45 | 1.50 | 1.48 |
| 8 | " 250 ppm | 0.91 | 1.04 | 1.15 | 1.28 | 1.42 | 1.55 | 1.67 | 1.82 | 0.97 | 1.07 | 1.14 | 1.19 | 1.25 | 1.29 | 1.36 | 1.43 |
| 9 | " 500 ppm | 0.69 | 0.74 | 0.83 | 0.94 | 1.05 | 1.15 | 1.28 | 1.47 | 1.10 | 1.15 | 1.24 | 1.29 | 1.34 | 1.40 | 1.45 | 1.53 |
| | Control | 0.83 | 0.93 | 1.04 | 1.16 | 1.29 | 1.45 | 1.63 | 1.83 | 1.02 | 1.09 | 1.21 | 1.32 | 1.41 | 1.49 | 1.57 | 1.66 |
| | SEm± | 0.07 | 0.09 | 0.09 | 0.11 | 0.12 | 0.14 | 0.16 | 0.21 | 0.09 | 0.09 | 0.07 | 0.07 | 0.08 | 0.08 | 0.08 | 0.09 |
| | CD (0.05) | 0.2143* | 0.2559* | 0.2764* | 0.3164* | 0.3676* | 0.4134* | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |

* Significant at 5% level NS - Not significant

Table 12 Effect of plant growth regulators on leaves (No.) produced by seedlings from fresh seeds of *Acacia mangium* and *Dalbergia latifolia*

| Sl. No. | Treatments | *Acacia mangium* | | | | | | | | *Dalbergia latifolia* | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Fortnightly | | | | | | | | Fortnightly | | | | | | | |
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 1 | IAA 100 ppm | 3.44 | 3.67 | 4.67 | 5.45 | 6.45 | 7.45 | 8.22 | 9.44 | 2.33 | 3.67 | 4.33 | 5.56 | 7.11 | 8.45 | 9.45 | 10.56 |
| 2 | " 250 ppm | 3.56 | 4.22 | 5.22 | 6.00 | 7.00 | 8.00 | 8.89 | 10.00 | 2.45 | 3.89 | 4.67 | 5.56 | 6.56 | 8.11 | 9.22 | 10.00 |
| 3 | " 500 ppm | 3.56 | 4.56 | 5.44 | 6.44 | 7.56 | 8.22 | 9.22 | 10.22 | 1.89 | 3.45 | 4.33 | 5.11 | 6.11 | 7.11 | 8.22 | 9.22 |
| 4 | GA 10 ppm | 3.56 | 4.56 | 5.56 | 6.45 | 7.45 | 8.33 | 9.33 | 10.33 | 2.00 | 3.89 | 4.89 | 5.33 | 6.22 | 7.22 | 8.22 | 9.22 |
| 5 | " 25 ppm | 3.56 | 4.67 | 5.67 | 6.67 | 7.67 | 8.67 | 9.67 | 10.67 | 2.00 | 4.44 | 4.67 | 5.89 | 7.00 | 8.11 | 9.33 | 10.66 |
| 6 | " 50 ppm | 3.89 | 4.89 | 5.89 | 6.89 | 8.00 | 9.00 | 10.00 | 11.00 | 2.11 | 3.22 | 4.00 | 5.11 | 6.33 | 7.67 | 8.78 | 9.89 |
| 7 | BA 100 ppm | 3.78 | 4.89 | 5.78 | 6.66 | 7.66 | 8.66 | 9.66 | 10.44 | 2.00 | 4.78 | 4.78 | 5.56 | 6.89 | 7.89 | 8.89 | 9.89 |
| 8 | " 250 ppm | 3.67 | 4.78 | 5.78 | 6.55 | 7.44 | 8.44 | 9.44 | 10.22 | 2.00 | 4.33 | 4.78 | 6.00 | 7.67 | 9.00 | 9.56 | 10.56 |
| 9 | " 500 ppm | 3.78 | 4.78 | 5.56 | 6.44 | 7.56 | 8.56 | 9.56 | 10.56 | 2.00 | 4.33 | 4.67 | 5.78 | 6.66 | 7.66 | 8.78 | 9.67 |
| | Control | 3.67 | 4.78 | 5.78 | 6.56 | 7.56 | 8.67 | 9.67 | 10.67 | 1.78 | 4.00 | 4.44 | 5.33 | 6.33 | 7.44 | 8.44 | 9.44 |
| | SEm± | 0.32 | 0.35 | 0.34 | 0.32 | 0.33 | 0.34 | 0.31 | 0.28 | 0.15 | 0.42 | 0.31 | 0.50 | 0.52 | 0.53 | 0.53 | 0.51 |
| | CD (0.05) | NS | NS | NS | NS | NS | NS | 0.9077* | 0.815* | NS | NS | NS | NS | NS | NS | NS | NS |

* Significant at 5% level NS - Not significant

Table 13 Effect of plant growth regulators on leaves (No.) produced by seedlings from one month old seeds of *Acacia mangium* and *Dalbergia latifolia*

| Sl. No. | Treatments | *Acacia mangium* Fortnights | | | | | | | | *Dalbergia latifolia* Fortnights | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 1 | IAA 100 ppm | 4.44 | 5.00 | 5.67 | 6.33 | 6.67 | 7.11 | 7.56 | 7.89 | 4.44 | 5.22 | 5.56 | 5.10 | 6.33 | 6.56 | 7.44 | 8.44 |
| 2 | " 250 ppm | 4.56 | 5.11 | 5.45 | 6.11 | 6.67 | 7.00 | 7.33 | 7.89 | 4.67 | 5.00 | 5.22 | 5.56 | 5.78 | 6.22 | 6.89 | 7.78 |
| 3 | " 500 ppm | 3.45 | 4.33 | 5.33 | 6.22 | 6.78 | 7.56 | 8.00 | 8.67 | 4.56 | 5.00 | 5.67 | 5.89 | 6.44 | 7.22 | 8.33 | 9.44 |
| 4 | GA 10 ppm | 3.11 | 3.89 | 4.78 | 5.22 | 5.44 | 6.11 | 6.44 | 6.78 | 4.89 | 5.33 | 6.00 | 6.55 | 7.44 | 8.33 | 8.44 | 9.33 |
| 5 | " 25 ppm | 3.00 | 3.89 | 4.22 | 4.62 | 4.89 | 5.22 | 5.33 | 5.44 | 4.67 | 5.11 | 5.89 | 6.78 | 7.11 | 7.78 | 8.45 | 9.45 |
| 6 | " 50 ppm | 3.11 | 3.89 | 4.67 | 5.44 | 6.00 | 6.33 | 6.78 | 7.00 | 5.33 | 5.67 | 6.33 | 6.89 | 7.67 | 8.22 | 9.22 | 9.89 |
| 7 | BA 100 ppm | 2.44 | 3.22 | 3.89 | 4.33 | 4.56 | 5.22 | 5.56 | 6.22 | 5.44 | 6.00 | 6.56 | 7.22 | 7.89 | 8.22 | 8.89 | 9.78 |
| 8 | " 250 ppm | 2.56 | 3.33 | 3.89 | 4.67 | 5.44 | 5.89 | 6.67 | 7.11 | 4.45 | 4.78 | 5.45 | 6.45 | 7.34 | 7.89 | 8.56 | 9.45 |
| 9 | " 500 ppm | 2.78 | 3.56 | 4.22 | 4.89 | 5.44 | 6.11 | 6.67 | 7.33 | 3.78 | 4.78 | 5.22 | 6.11 | 7.11 | 7.78 | 8.33 | 9.33 |
| | Control | 2.00 | 2.78 | 3.78 | 4.22 | 4.89 | 5.56 | 5.89 | 6.22 | 5.56 | 6.22 | 6.67 | 7.45 | 8.00 | 8.78 | 9.00 | 10.33 |
| | SEm± | 0.29 | 0.26 | 0.29 | 0.37 | 0.42 | 0.50 | 0.57 | 0.67 | 0.42 | 0.36 | 0.43 | 0.47 | 0.49 | 0.48 | 0.50 | 0.49 |
| | CD (0.05) | 0.7336** | 0.7711** | 0.8668** | 1.10** | 1.29** | 1.48* | NS | NS | NS | NS | NS | NS | NS | 1.40* | NS | NS |

* Significant at 5% level ** Significant at 1% level NS - Not significant

Table 14 Effect of plant growth regulators on leaves (Nos.) produced from two month old seeds of *Acacia mangium* and *Dalbergia latifolia*

| Sl. No. | Treatments | *Acacia mangium* | | | | | | | | *Dalbergia latifolia* | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Fortnights | | | | | | | | Fortnights | | | | | | | |
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 1 | IAA 100 ppm | 2.33 | 3.67 | 5.22 | 7.34 | 8.89 | 10.78 | 12.00 | 13.22 | 4.00 | 4.55 | 6.67 | 7.00 | 8.00 | 8.89 | 9.56 | 9.78 |
| 2 | " 250 ppm | 2.67 | 3.89 | 5.22 | 7.22 | 8.55 | 9.67 | 10.78 | 11.78 | 4.22 | 5.11 | 7.00 | 7.45 | 8.22 | 9.22 | 10.11 | 10.22 |
| 3 | " 500 ppm | 2.67 | 4.33 | 5.55 | 7.55 | 9.89 | 11.56 | 13.11 | 15.66 | 4.00 | 4.45 | 5.33 | 6.78 | 7.89 | 8.78 | 9.34 | 9.34 |
| 4 | GA 10 ppm | 2.22 | 3.45 | 4.89 | 6.78 | 9.00 | 10.78 | 12.22 | 14.00 | 3.89 | 4.67 | 6.00 | 6.67 | 7.55 | 8.83 | 8.89 | 8.89 |
| 5 | " 25 ppm | 2.56 | 4.11 | 5.55 | 7.22 | 8.78 | 10.67 | 12.56 | 14.78 | 4.45 | 5.34 | 7.55 | 8.11 | 9.11 | 10.22 | 10.33 | 10.44 |
| 6 | " 50 ppm | 2.56 | 4.22 | 5.89 | 7.45 | 9.22 | 11.22 | 13.44 | 15.55 | 4.55 | 5.78 | 6.89 | 8.22 | 9.34 | 10.22 | 10.56 | 10.78 |
| 7 | BA 100 ppm | 2.11 | 3.67 | 4.78 | 6.55 | 8.89 | 11.22 | 13.89 | 17.00 | 4.56 | 5.11 | 6.67 | 7.56 | 8.67 | 9.56 | 10.00 | 10.00 |
| 8 | " 250 ppm | 2.11 | 3.44 | 4.55 | 5.89 | 8.11 | 10.22 | 12.00 | 14.11 | 4.78 | 5.67 | 6.33 | 7.34 | 8.33 | 9.67 | 10.33 | 10.67 |
| 9 | " 500 ppm | 1.78 | 3.33 | 4.33 | 5.78 | 8.00 | 10.00 | 12.11 | 14.67 | 3.89 | 5.33 | 6.22 | 6.99 | 8.11 | 9.11 | 9.78 | 9.78 |
| | Control | 1.89 | 3.00 | 4.11 | 6.11 | 8.33 | 10.44 | 12.56 | 15.22 | 3.66 | 4.67 | 5.67 | 6.55 | 7.89 | 9.00 | 9.56 | 9.56 |
| | SEm± | 0.17 | 0.33 | 0.30 | 0.28 | 0.35 | 0.48 | 0.75 | 1.03 | 0.26 | 0.35 | 0.47 | 0.49 | 0.53 | 0.48 | 0.40 | 0.40 |
| | CD (0.05) | 0.4876** | NS | 0.8996** | 0.8221** | 1.04* | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |

* Significant at 5% level ** Significant at 1% level NS - Not significant

### 4.3.1 Height

In *Acacia mangium,* the treatment did not induce any significant effect upto first three fortnights when fresh seeds were used. But from third fortnights onwards the treatments showed significant effect on height of seedlings (Table 6). During the fourth fortnight, treating with 50 ppm GA produced maximum height (11.52 cm) and significantly differed from treatments like 100 ppm IAA, 10 ppm GA and 25 ppm GA. The treatment $T_5$ (25 ppm GA) recorded lower value for height (5.38 cm). More or less similar trend was noticed during $5^{th}$ fortnight also. It could be seen from the table that 25 ppm GA recorded lower height (5.82 cm) during fifth fortnight. Similar trend was followed in sixth, seventh and eighth fortnights also. But seedlings produced from one month old seeds of *Acacia mangium* did not show any significant difference with respect to height of seedlings (Table 7). It is also interesting to note that seedlings obtained from two months old seeds when treated with different treatments solutions showed significant effect from first to third fortnights only. During the remaining period, the treatments did not have any significant effect on height of seedlings (Table 8). During the first fortnight, treating the seeds with 100 ppm IAA recorded higher value (2.81 cm) and this was on par with treatments of 250 and 500 ppm IAA and control. The treatment $T_6$ (50 ppm GA) recorded the lowest value (1.11 cm) for height. In second and third fortnights, treating seeds with 250 ppm IAA recorded the highest values of 4.18 cm and 5.44 cm respectively. However, this was on par with 100 and 500 ppm of IAA, 100 ppm of BA and control. Effect of treatments on height of *Acacia mangium* seedlings is also depicted in Figures 3,5 and 7 and Plates 3 and 4.

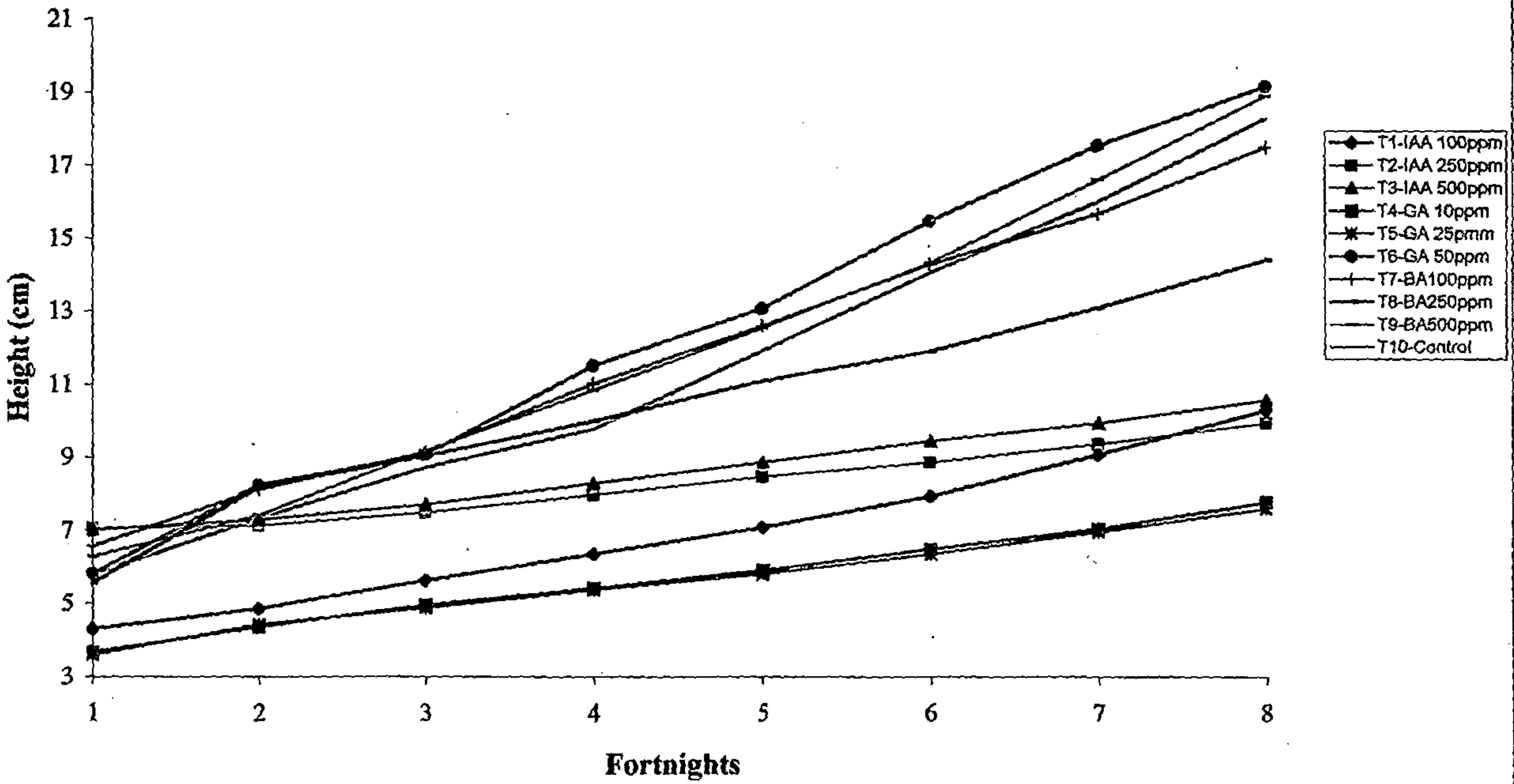



**Fig. 3 Effect of plant growth regulators on height of seedlings of *Acacia mangium* produced from fresh seeds**

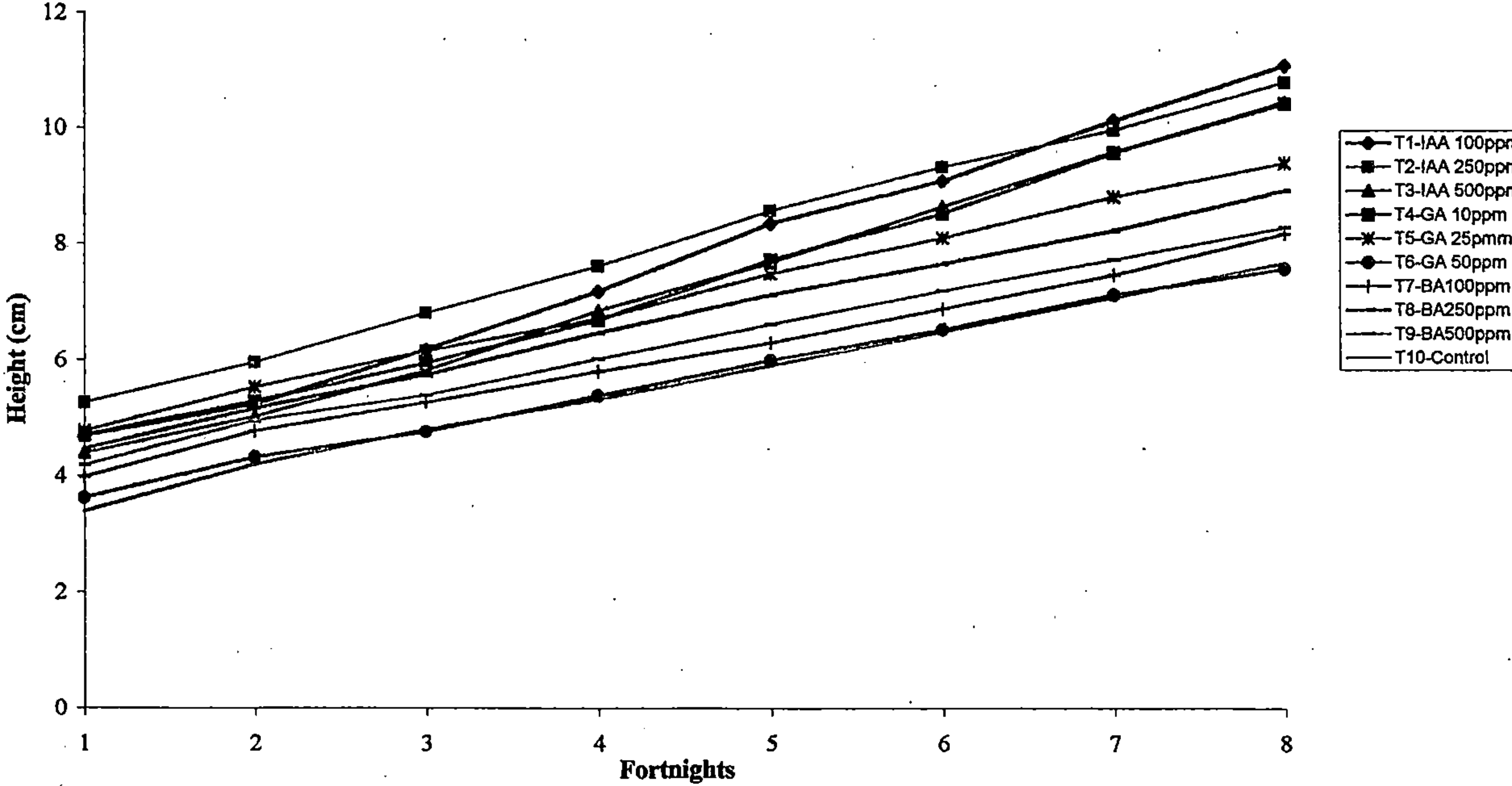



**Fig. 4 Effect of plant growth regulators on height of seedlings of *Dalbergia latifolia* produced from fresh seeds**

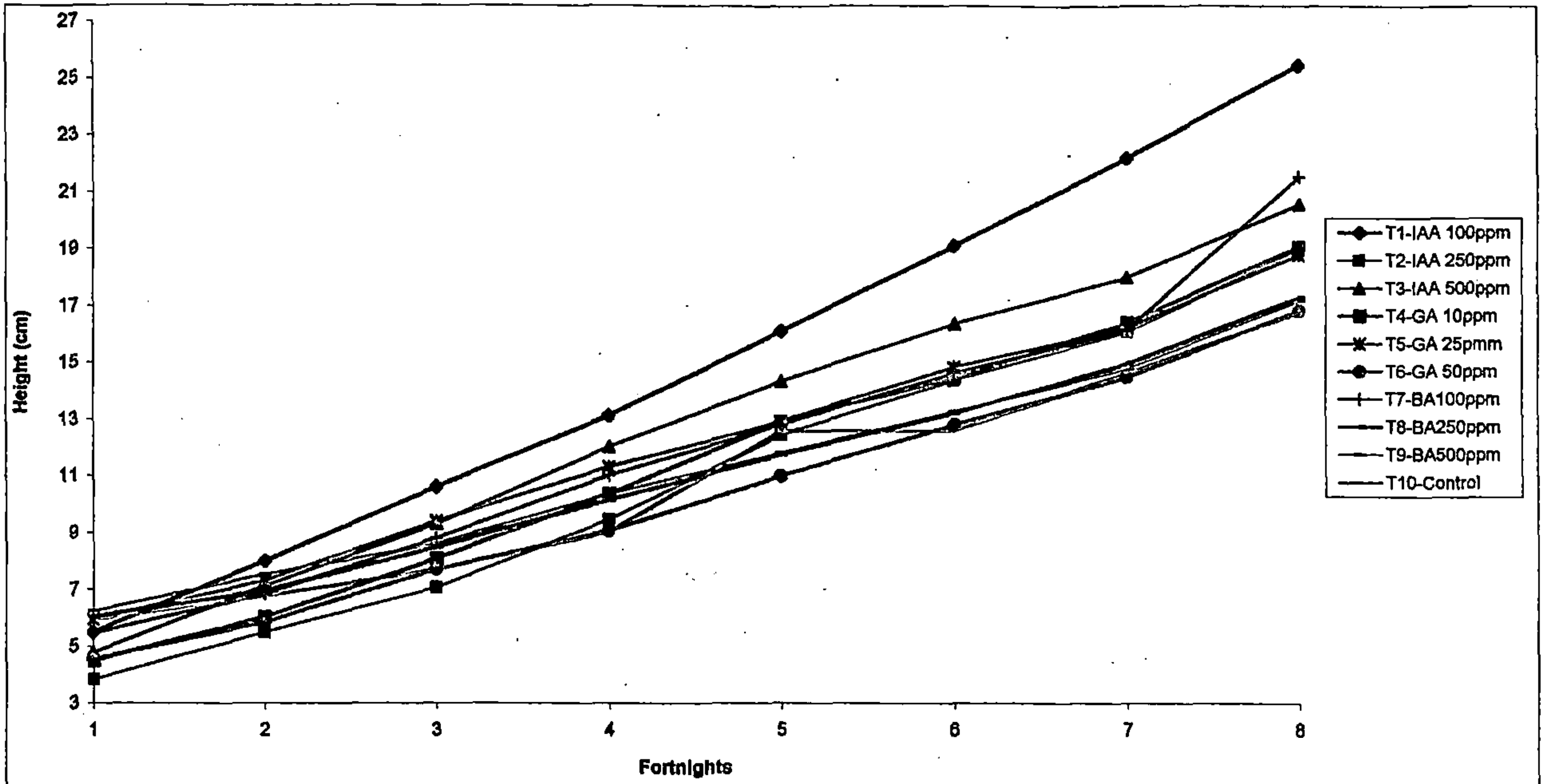



**Fig.5 Effect of plant growth regulators on height of seedlings of *Acacia mangium* produced from one month old seeds**

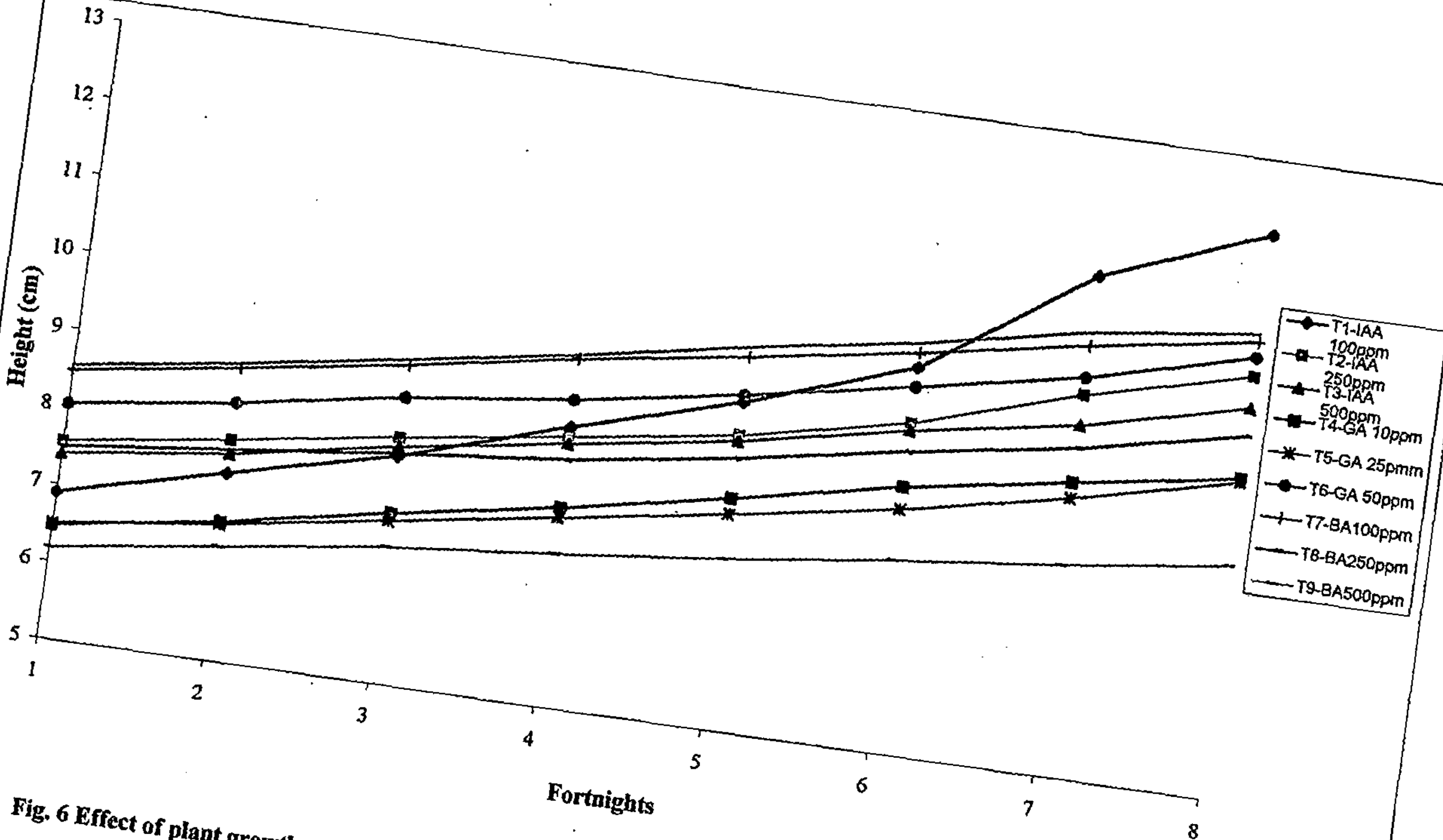



**Fig. 6 Effect of plant growth regulators on height of seedlings of *Dalbergia latifolia* produced from one month old seeds**

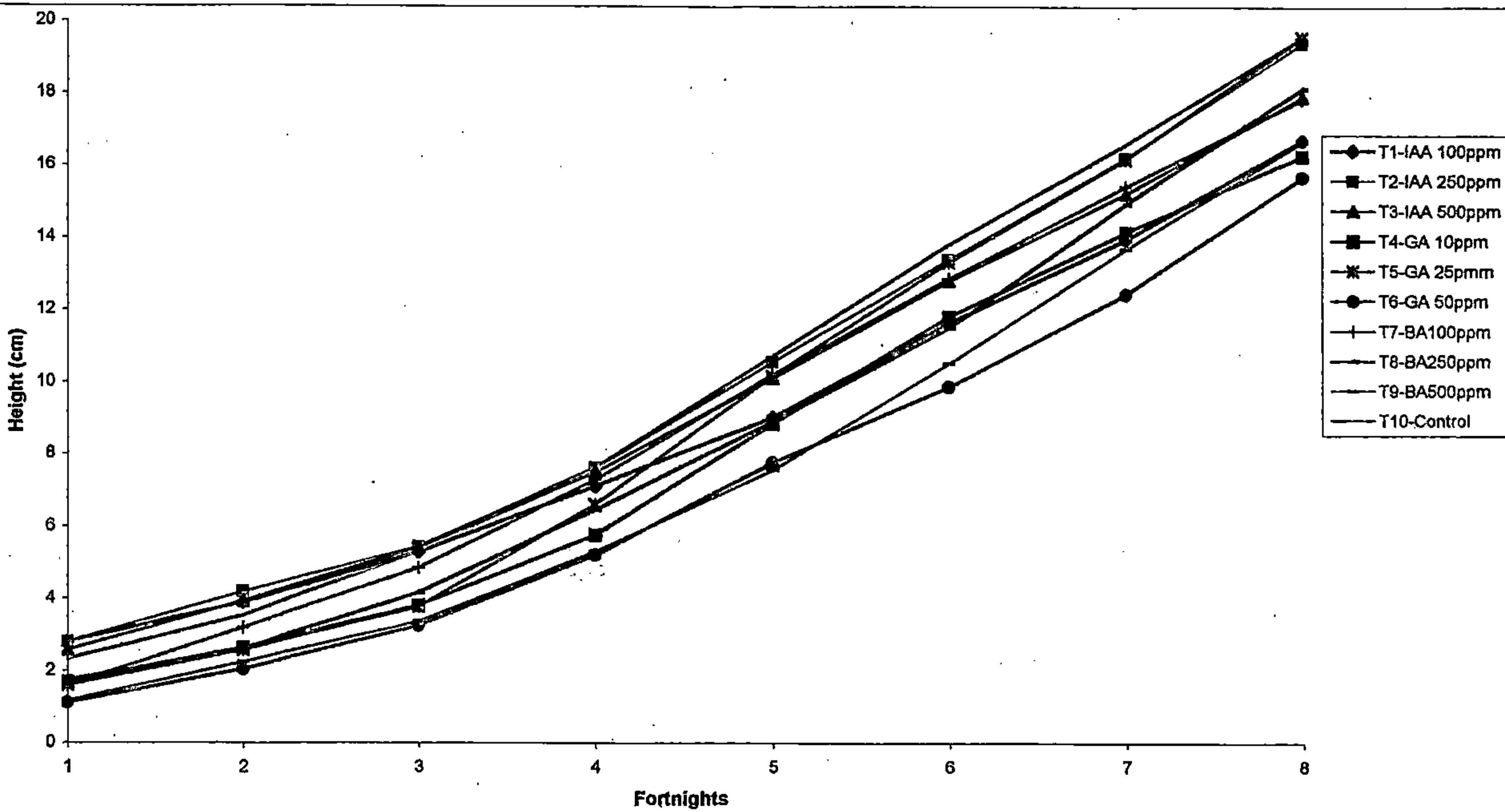



**Fig. 7 Effect of plant growth regulators on height of seedlings of *Acacia mangium* produced from two months old seeds**

Plate 3 Three month old seedlings of *Acacia mangium* as influenced by various plant growth regulator treatments

$T_1$ - IAA 100 ppm

$T_2$ - IAA 250 ppm

$T_3$ - IAA 500 ppm

$T_4$ - GA 10 ppm

$T_5$ - GA 25 ppm

Plate 4 Three month old seedlings of *Acacia mangium* as influenced by various plant growth regulator treatments

$T_6$ - GA 50 ppm

$T_7$ - BA 100 ppm

$T_8$ - BA 250 ppm

$T_9$ - BA 500 ppm

$T_{10}$ - Control


T1 T2 T3 T4 T5


T6 T7 T8 T9 T10

In the case of *Dalbergia latifolia,* seedlings produced from fresh seeds did not show any significant effect of treatments on height of seedlings during the first three fortnights. But from fourth fortnight onwards, treating seeds with 250 ppm IAA produced more height (7.62 cm) while control recorded the minimum height of 5.33 cm (Table 2). Similar trend was observed in fifth, sixth, seventh and eight fortnights also (Fig. 4,6 & 8). In the case of seedlings produced from one month seeds, the treatment differed significantly with regard to height during all the fortnights. During the first fortnight, the treatments like 100 ppm BA, 50 ppm GA, 250 ppm IAA, 250 ppm BA and 500 ppm IAA were found to be on par with respect to height of seedlings and these treatments produced tallest seedlings. Treating seeds with 500 ppm BA recorded the lowest value (6.18 cm) (Table 7). Almost, a similar trend was followed up to sixth fortnight. But on seventh and eights fortnights, the first treatment (100 ppm IAA) recorded more heights of 11.47 cm and 12.29 cm respectively and 500 ppm BA recorded lower values of 7.73 cm and 8.01 cm respectively. However, the seedlings produced from two month old seeds showed no significant effect on height of seedlings as is evident from the data furnished in Table 8. Effect of treatments on height of seedlings of *Dalbergia latifolia* is also depicted in Plates 7 and 8.

### 4.3.2 *Girth*

Seedlings of *A. mangium,* produced from fresh seeds did not record any significant effect on girth of seedlings during the entire period of observation (Table 9). But the seedlings produced from one month old seeds showed significant

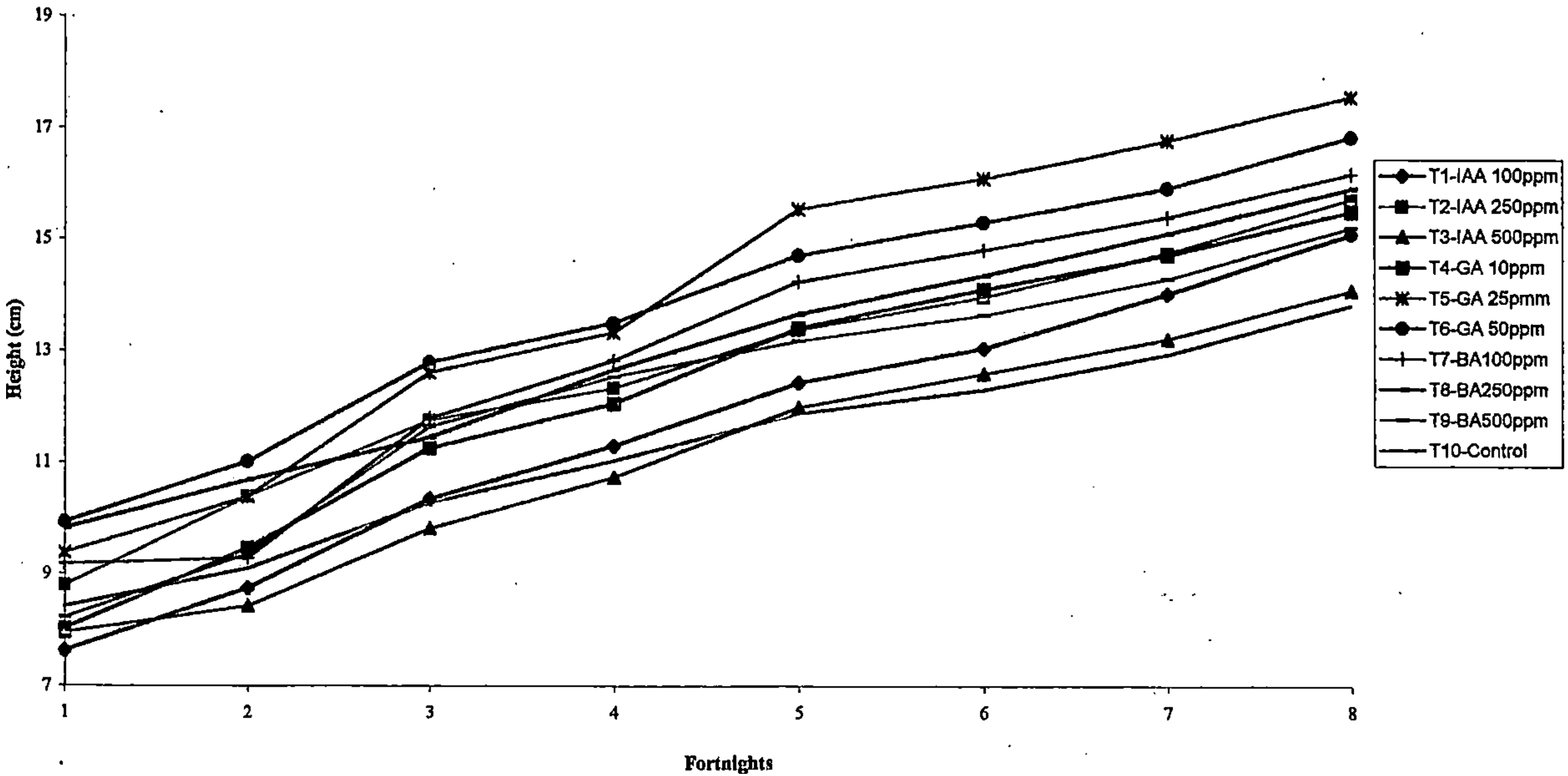



**Fig. 8 Effect of plant growth regulators on height of seedlings of *Dalbergia latifolia* produced from two month old seeds**

Plate 7 Three months old seedlings of *Dalbergia latifolia* as influenced by various plant growth regulator treatments

| | | |
|---|---|---|
| $T_1$ | - | IAA 100 ppm |
| $T_2$ | - | IAA 250 ppm |
| $T_3$ | - | IAA 500 ppm |
| $T_4$ | - | GA 10 ppm |
| $T_5$ | - | GA 25 ppm |

Plate 8 Three months old seedlings of *Dalbergia latifolia* as influenced by various growth regulator treatments

| | | |
|---|---|---|
| $T_6$ | - | GA 50 ppm |
| $T_7$ | - | BA 100 ppm |
| $T_8$ | - | BA 250 ppm |
| $T_9$ | - | BA 500 ppm |
| $T_{10}$ | - | Control |


DALBERGIA LATIFOLIA
T1
T2
T3
T4
T5


DALBERGIA LATIFOLIA
T6
T7
T8
T9
T10

effect of treatments on girth of seedlings from first to fifth fortnights. In first fortnight, treatment $T_1$ (100 ppm IAA) produced higher girth (0.97 mm) and was on par with treatments 250 and 500 ppm IAA and 10 and 50 ppm GA. The control recorded the best girth (0.52 mm). Similarly from second fortnight, treating seeds with 100 ppm IAA produced maximum girth (1.17 mm) while 500 ppm BA recorded the minimum value (0.65 mm) and this was on par with control (Table 10). In third, fourth and fifth fortnights, more or less similar trend was observed. The treatments exerted significant effect on girth of seedlings produced from two month old seeds from first to sixth fortnights. In first and second fortnights, various treatments viz. 250 ppm BA, 100 ppm BA and 250 ppm IAA form a homogenous group and produced comparatively maximum girth (Table 11). Similar trend was observed in remaining fortnights also.

In the case of *Dalbergia latifolia,* seedlings produced from fresh seeds were found to be influenced by different treatments with respect to girth of seedlings. Here, treatments recorded pronounced effect on girth from third to seventh fortnights. In third fortnight, treating the seeds with 250 ppm BA had produced higher value (1.35 mm) for girth and this was on par with treatments like 100 and 500 ppm BA, 250 ppm IAA and 25 ppm GA. GA at 10 ppm recorded the lowest value for girth (Table 9). More or less similar trend was observed in subsequent fortnights also. However, the seedlings obtained from one month and two month old seeds of *Dalbergia latifolia*, did not record any variation in girth for various treatments through out the study period (Tables 10 and 11).

### 4.3.2 Number of leaves

In *Acacia mangium,* seedlings produced from fresh seeds recorded significant effect of treatments on number of leaves from seventh fortnights onwards. During seventh and eighth fortnights treatment $T_6$ (50 ppm GA) recorded higher values of 10 and 11 respectively for number of leaves which was significantly different from other treatments like 100 and 250 ppm IAA (Table 12). In both the cases, treatment $T_1$ (100 ppm IAA) recorded the lowest values of 8.22 and 9.44 respectively. In the case of seedlings produced from one month old seeds, treatments had got significant effect from first to sixth fortnights. No difference was noticed from seventh fortnight onwards (Table 13). In the first fortnight, treatments like 250 ppm and 100 ppm IAA recorded higher values of 4.56 and 4.44 respectively and they were on par with each other. Treating the seeds with 250 ppm BA and also control recorded the lowest values of 2.56 and 2.00 respectively with regard to number of leaves. More or less similar trend had been observed in other fortnights also. Again in the case of seedlings produced from two month old seeds, the treatments had got significant effect on number of leaves from first to fifth fortnights (Table 14). During the first fortnight treating the seeds with 250 and 500 ppm IAA gave higher values (2.67) for number of leaves and this was followed by other treatments like 25 ppm GA (2.56), 100 ppm IAA (2.33) and 10 ppm GA (2.22). Treatment of 500 ppm BA recorded the lowest (1.78). But during third fortnight, treating with 50 ppm GA recorded higher values (5.89) and this was on par with treatments like 500 ppm IAA, 25 ppm GA, 250 ppm IAA and 100 ppm IAA. The control showed lower value (4.11). In fourth and fifth fortnights the treatment 500 ppm IAA recorded the maximum leaf number while 500 ppm BA recorded the minimum.

In the case of *Dalbergia latifolia,* seedlings obtained from fresh seeds failed to show any significant effect of treatments on number of leaves produced during the entire study period (Table 12). But in the case of seedlings produced from one month old seeds, the treatments produced significant effect particularly in sixth fortnight (Table 13). Here all the treatment except 250 ppm IAA produced more leaf number as is evidenced from the data furnished in Table 13. When the seeds of two month old were used for the study, no significant difference was observed between different treatments with regard to leaf production (Table 14).

## 4.4 Effect of growth regulators on chlorophyll content of seedlings

Chlorophyll \`a', chlorophyll \`b' and total chlorophyll are the three fractions of chlorophyll analysed in the seedlings and the results are tabulated in Table 15.

### 4.4.1 Chlorophyll \`a'

In both *Acacia mangium* and *Dalbergia latifolia* treatments could not exert any significant effect on chlorophyll \`a' content of seedlings produced from both fresh and stored seeds.

### 4.4.2 Chlorophyll \`b'

A perusal of data clearly indicate that in both the species the treatments did not exert any significant effect on chlorophyll \`b' content of seedlings.

### 4.4.3 Total chlorophyll

With regard to total chlorophyll content also, data furnished in table 15, indicate that all the treatments were on par. In any of the cases, no uniform trend could be seen on the effect of treatments on total chlorophyll content of seedlings.

Table 15 Effect of plant growth regulators on chlorophyll content (mg/g$^{-1}$) of seedlings of *Acacia mangium* and *Dalbergia latifolia*

| Sl. No. | Treatments | *Acacia mangium* | | | | | | | | | *Dalbergia latifolia* | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Seedlings produced from fresh seeds | | | Seedlings produced from one month old seeds | | | Seedlings produced from two month old seeds | | | Seedlings produced from fresh seeds | | | Seedlings produced from one month old seeds | | | Seedlings produced from two month old seeds | | |
| | | Chl 'a' | Chl 'b' | Total Chl | Chl 'a' | Chl 'b' | Total Chl | Chl 'a' | Chl 'b' | Total Chl | Chl 'a' | Chl 'b' | Total Chl | Chl 'a' | Chl 'b' | Total Chl | Chl 'a' | Chl 'b' | Total Chl |
| 1 | IAA 100 ppm | 6.27 | 3.96 | 5.03 | 6.74 | 3.97 | 5.15 | 7.22 | 6.17 | 7.22 | 6.31 | 3.72 | 4.82 | 4.76 | 2.28 | 3.17 | 7.86 | 5.16 | 6.47 |
| 2 | " 250 ppm | 3.45 | 2.77 | 3.29 | 4.93 | 2.93 | 3.79 | 5.35 | 6.05 | 6.66 | 6.52 | 4.29 | 5.38 | 6.27 | 3.98 | 5.04 | 6.77 | 4.61 | 5.72 |
| 3 | " 500 ppm | 3.74 | 2.74 | 3.33 | 5.51 | 3.21 | 4.18 | 6.02 | 5.83 | 6.63 | 6.09 | 4.05 | 5.06 | 6.26 | 4.08 | 5.13 | 5.91 | 4.02 | 4.99 |
| 4 | GA 10 ppm | 3.59 | 2.45 | 3.04 | 6.72 | 3.89 | 5.07 | 5.83 | 5.70 | 6.46 | 6.46 | 4.50 | 5.56 | 7.39 | 4.56 | 5.82 | 5.52 | 4.45 | 5.29 |
| 5 | " 25 ppm | 4.32 | 2.94 | 3.65 | 7.00 | 4.10 | 5.32 | 4.93 | 5.40 | 5.98 | 6.87 | 4.58 | 5.72 | 6.56 | 4.19 | 5.30 | 7.17 | 4.97 | 6.14 |
| 6 | " 50 ppm | 4.33 | 3.08 | 3.80 | 4.92 | 3.02 | 3.94 | 3.09 | 4.32 | 4.58 | 6.79 | 4.35 | 5.50 | 7.12 | 4.49 | 5.70 | 6.47 | 4.21 | 5.29 |
| 7 | BA 100 ppm | 3.55 | 2.47 | 3.05 | 7.59 | 4.40 | 5.73 | 2.04 | 3.61 | 3.70 | 6.02 | 4.01 | 5.01 | 7.76 | 5.11 | 6.40 | 4.29 | 2.90 | 3.61 |
| 8 | " 250 ppm | 4.32 | 2.64 | 3.38 | 5.76 | 3.31 | 4.32 | 2.12 | 3.51 | 3.63 | 5.34 | 3.32 | 4.23 | 5.80 | 3.54 | 4.54 | 4.88 | 3.09 | 3.92 |
| 9 | " 500 ppm | 6.37 | 3.97 | 5.06 | 4.72 | 2.68 | 3.52 | 1.79 | 4.23 | 4.19 | 6.44 | 4.14 | 5.22 | 5.74 | 3.50 | 4.49 | 7.13 | 4.79 | 5.96 |
| 10 | Control | 8.35 | 5.40 | 6.80 | 5.50 | 3.20 | 4.16 | 1.21 | 3.06 | 3.01 | 7.47 | 5.03 | 6.27 | 5.40 | 3.84 | 4.71 | 9.55 | 6.22 | 7.82 |
| | SEm± | 1.09 | 0.69 | 0.85 | 0.77 | 0.46 | 0.59 | 1.46 | 0.86 | 1.10 | 0.94 | 0.62 | 0.77 | 1.52 | 0.96 | 1.21 | 1.03 | 0.74 | 0.90 |
| | CD (0.05) | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |

NS - Not significant

### 4.5 Effect of growth regulators on shoot characteristics

Leaf area, shoot fresh and dry weights were the three parameters studied in the present investigation and the observations on these characteristics of *Acacia mangium* and *Dalbergia latifolia* are given in Table 16.

#### 4.5.1 Leaf area

In *Acacia mangium,* seedlings produced from fresh seeds, after treating with 100 ppm IAA, produced higher leaf area of 19.5 $cm^2$ which was immediately followed by treatments like 25 ppm GA (14.33 $cm^2$), 250 ppm BA (13.83 $cm^2$) and 500 ppm IAA (13.50 $cm^2$). Seed treatment with 100 ppm BA resulted the lowest value (8.83 $cm^2$) for leaf area and this was on par with control (9 $cm^2$). In the case of seedlings produced from one month old seeds, the treatment $T_1$ (100 ppm IAA) produced the more leaf area (17.17 $cm^2$) while control produced the least (9.17 $cm^2$). The data also revealed that seedlings produced from two month old seeds treated with 100 ppm IAA resulted the highest value for leaf area (19 $cm^2$) and this was on par with 25 ppm GA (14.50 $cm^2$). In this case, treating the seeds with 100 ppm BA produced the lowest value (8 $cm^2$) for leaf area and which was followed by control (8.67 $cm^2$).

In the case of *Dalbergia latifolia,* in any of the cases, the treatments had not exerted any significant effect on leaf area of seedlings. However, here also all the growth regulator treatments recorded a slight positive effect on leaf area compared to control.

Table 16 Effect of plant growth regulators on shoot characteristics of seedlings of *Acacia mangium* and *Dalbergia latifolia*

| Sl. No. | Treatments | *Acacia mangium* | | | | | | | | | *Dalbergia latifolia* | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Seedlings produced from fresh seeds | | | Seedlings produced from one month old seeds | | | Seedlings produced from two month old seeds | | | Seedlings produced from fresh seeds | | | Seedlings produced from one month old seeds | | | Seedlings produced from two month old seeds | | |
| | | Leaf area ($cm^2$) | Shoot fresh wgt. (gm) | Shoot dry wgt. (gm) | Leaf area ($cm^2$) | Shoot fresh wgt. (gm) | Shoot dry wgt. (gm) | Leaf area ($cm^2$) | Shoot fresh wgt. (gm) | Shoot dry wgt. (gm) | Leaf area ($cm^2$) | Shoot fresh wgt. (gm) | Shoot dry wgt. (gm) | Leaf area ($cm^2$) | Shoot fresh wgt. (gm) | Shoot dry wgt. (gm) | Leaf area ($cm^2$) | Shoot fresh wgt. (gm) | Shoot dry wgt. (gm) |
| 1 | IAA 100 ppm | 19.50 | 2.95 | 1.69 | 17.17 | 2.91 | 1.66 | 19.00 | 3.09 | 1.75 | 5.50 | 0.19 | 0.11 | 6.50 | 0.31 | 0.19 | 6.00 | 0.51 | 0.29 |
| 2 | " 250 ppm | 11.17 | 2.29 | 1.45 | 11.00 | 2.25 | 1.38 | 10.33 | 2.32 | 1.47 | 8.17 | 0.34 | 0.16 | 8.33 | 0.36 | 0.23 | 8.67 | 0.42 | 0.22 |
| 3 | " 500 ppm | 13.50 | 1.52 | 0.80 | 12.83 | 1.46 | 0.76 | 11.83 | 1.53 | 0.79 | 9.00 | 0.18 | 0.09 | 8.33 | 0.24 | 0.16 | 8.83 | 0.73 | 0.42 |
| 4 | GA 10 ppm | 9.50 | 2.51 | 1.36 | 9.33 | 2.47 | 1.32 | 10.83 | 2.18 | 1.17 | 6.50 | 0.23 | 0.11 | 7.33 | 0.29 | 0.17 | 7.33 | 0.72 | 0.40 |
| 5 | " 25 ppm | 14.33 | 2.14 | 1.29 | 13.33 | 2.10 | 1.23 | 14.50 | 2.04 | 1.26 | 7.33 | 0.29 | 0.15 | 7.83 | 0.36 | 0.22 | 7.83 | 0.40 | 0.22 |
| 6 | " 50 ppm | 10.67 | 1.58 | 0.84 | 10.83 | 1.55 | 0.82 | 12.33 | 1.16 | 0.70 | 5.83 | 0.14 | 0.06 | 6.83 | 0.27 | 0.17 | 6.67 | 0.53 | 0.30 |
| 7 | BA 100 ppm | 8.83 | 1.56 | 0.94 | 9.17 | 1.50 | 0.88 | 8.00 | 1.31 | 0.76 | 8.33 | 0.26 | 0.12 | 8.83 | 0.16 | 0.10 | 8.67 | 0.55 | 0.30 |
| 8 | " 250 ppm | 13.83 | 2.05 | 1.24 | 13.33 | 1.93 | 1.17 | 13.17 | 1.88 | 1.08 | 6.00 | 0.35 | 0.17 | 7.00 | 0.38 | 0.26 | 7.00 | 0.80 | 0.43 |
| 9 | " 500 ppm | 9.83 | 1.74 | 1.16 | 9.67 | 1.70 | 1.09 | 9.00 | 1.59 | 1.09 | 6.50 | 0.28 | 0.12 | 7.17 | 0.20 | 0.11 | 7.17 | 0.48 | 0.26 |
| 10 | Control | 9.00 | 1.15 | 2.17 | 9.17 | 1.97 | 1.06 | 8.67 | 1.78 | 0.96 | 5.67 | 0.16 | 0.07 | 6.50 | 0.21 | 0.12 | 6.17 | 0.64 | 0.34 |
| | SEm± | 2.06 | 0.32 | 0.23 | 1.59 | 0.32 | 0.23 | 1.94 | 0.28 | 0.20 | 1.71 | 0.07 | 0.03 | 1.45 | 0.05 | 0.03 | 1.40 | 0.31 | 0.16 |
| | CD (0.05) | 6.09* | NS | NS | 4.20* | NS | NS | 5.73* | 0.8326** | 0.5949* | NS | NS | NS | NS | NS | 0.0971* | NS | NS | NS |

* Significant at 5% level ** Significant at 1% level NS - Not significant

### 4.5.2 Shoot fresh weight

In *Acacia mangium,* seedlings produced from both fresh and one month old seeds after imposing various treatments did not show any significant difference with regard to shoot fresh weight. But in the case of seedlings produced from two month old seeds, the treatment $T_1$ (100 ppm IAA) produced highest shoot fresh weight (3.09 g) which was on par with treatment 250 ppm IAA (2.32 g). The treatment $T_6$ (50 ppm GA) recorded the lowest value (1.16 g) for shoot fresh weight and this was followed by 100 ppm BA (1.31 g). The control treatment recorded a mean fresh shoot weight of 1.78 g.

In the case of *Dalbergia latifolia,* the treatments did not show any significant effect on shoot fresh weight of seedlings produced from fresh and stored seeds. A perusal of the data revealed that treating the seeds with IAA 100 ppm produced shoot fresh weight of 0.19 g, 0.31 g and 0.51 g respectively for fresh, one and two month old stored seeds.

### 4.5.3 Shoot dry weight

The data furnished in table 16 indicate that in *Acacia mangium,* seedlings produced from both fresh and one month old seeds recorded no significant difference between treatments with regard to shoot dry weight. But in the case of seedlings produced from two month old seeds, the treatment $T_1$ (100 ppm IAA) produced maximum shoot dry weight (1.75 g) which was on par with treatments like 250 ppm IAA (1.429), 25 ppm GA (1.26 g) and 10 ppm GA (1.17 g). The treatment $T_6$ (50 ppm GA) recorded the lowest value (0.70 g) and this was on par with control (0.96 g).

In the case of *Dalbergia latifolia,* seedlings produced from fresh seeds and two month old seeds, the treatments did not show any significant effect on shoot dry weight. But in the case of seedlings produced from one month old seeds, the treatments $T_8$ (250 ppm BA) produced the maximum shoot dry weight (0.26 g) followed by IAA 250 ppm (0.23 g) and GA 25 ppm (0.22 g) and this was also on par with control.

### 4.6 Effect of plant growth regulators on root characteristics

Observations on various root growth characteristics like number of roots, root length, fresh and dry weights of roots and root/shoot ratio are given in Tables 17 and 18.

#### 4.6.1 Root number

In *Acacia mangium* treatments did not manifest any significant effect on root numbers when fresh or stored seeds were used (Table 17).

However, in the case of *Dalbergia latifolia* treatments recorded a significant effect on root numbers of seedlings produced from fresh seeds. Here, treating seeds with 100 ppm IAA produced more number of roots (9.5) and was significantly different from all other treatments. Untreated seeds produced the least (2.83). In other two sets of studies, the treatments did not exert any effect on number of roots of seedlings (Table 18).

Table 17 Effect of plant growth regulators on root characteristics of seedlings of *Acacia mangium*

| Sl. No. | Treatments | Seedlings produced from fresh seeds | | | | | Seedlings produced one month old seeds | | | | | Seedlings produced two month old seeds | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Root number | Root length (cm) | Root fresh wgt. (gm) | Root dry wet. (gm) | Root/shoot ratio | Root number | Root length (cm) | Root fresh wgt. (gm) | Root dry wet. (gm) | Root/shoot ratio | Root number | Root length (cm) | Root fresh wgt. (gm) | Root dry wet. (gm) | Root/shoot ratio |
| 1 | IAA 100 ppm | 9.83 | 14.20 | 1.19 | 0.66 | 2.49 | 9.00 | 13.17 | 1.16 | 0.64 | 2.54 | 9.50 | 13.83 | 1.20 | 0.67 | 2.56 |
| 2 | " 250 ppm | 10.00 | 20.65 | 1.16 | 0.69 | 2.09 | 9.00 | 19.33 | 0.97 | 0.63 | 2.21 | 10.33 | 19.68 | 1.18 | 0.68 | 2.19 |
| 3 | " 500 ppm | 9.83 | 20.75 | 0.78 | 0.46 | 1.89 | 8.83 | 18.67 | 0.76 | 0.42 | 1.96 | 9.67 | 20.43 | 0.76 | 0.43 | 1.96 |
| 4 | GA 10 ppm | 9.17 | 19.33 | 1.16 | 0.68 | 1.94 | 8.17 | 17.83 | 1.14 | 0.63 | 2.04 | 8.67 | 18.33 | 1.21 | 0.66 | 1.75 |
| 5 | " 25 ppm | 10.33 | 17.75 | 0.95 | 0.53 | 2.60 | 9.33 | 16.00 | 0.93 | 0.51 | 2.64 | 10.17 | 16.87 | 0.95 | 0.53 | 2.55 |
| 6 | " 50 ppm | 8.67 | 20.07 | 0.76 | 0.40 | 2.11 | 9.00 | 18.03 | 0.73 | 0.84 | 1.94 | 8.17 | 20.15 | 0.68 | 0.39 | 1.80 |
| 7 | BA 100 ppm | 9.33 | 18.40 | 0.86 | 0.56 | 1.65 | 9.67 | 16.67 | 0.80 | 0.54 | 1.56 | 9.00 | 17.33 | 0.86 | 0.54 | 1.39 |
| 8 | " 250 ppm | 10.17 | 17.88 | 0.89 | 0.51 | 2.37 | 8.50 | 16.17 | 0.86 | 0.49 | 2.32 | 9.67 | 16.67 | 0.90 | 0.47 | 2.29 |
| 9 | " 500 ppm | 8.17 | 10.85 | 0.87 | 0.52 | 2.25 | 9.67 | 10.33 | 0.83 | 0.51 | 2.18 | 8.33 | 10.50 | 0.83 | 0.49 | 2.27 |
| 10 | Control | 9.67 | 17.92 | 0.87 | 0.50 | 2.17 | 9.50 | 16.17 | 0.84 | 0.51 | 1.98 | 9.17 | 17.00 | 0.79 | 0.42 | 2.24 |
| | SEm± | 0.67 | 2.03 | 0.09 | 0.06 | 0.34 | 0.75 | 1.74 | 0.11 | 0.15 | 0.40 | 0.56 | 1.96 | 0.09 | 0.05 | 0.35 |
| | CD (0.05) | NS | NS | 0.2571** | NS | NS | NS | NS | NS | NS | NS | NS | 5.78* | 0.2797** | 0.1521** | NS |

* Significant at 5% level ** Significant at 1% level NS - Not significant

Table 18 Effect of plant growth regulators on root characteristics of *Dalbergia latifolia*

| Sl. No. | Treatments | Seedlings produced from fresh seeds | | | | | Seedlings produced one month old seeds | | | | | Seedlings produced two month old seeds | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Root number | Root length (cm) | Root fresh wgt. (gm) | Root dry wet. (gm) | Root/shoot ratio | Root number | Root length (cm) | Root fresh wgt. (gm) | Root dry wet. (gm) | Root/shoot ratio | Root number | Root length (cm) | Root fresh wgt. (gm) | Root dry wet. (gm) | Root/shoot ratio |
| 1 | IAA 100 ppm | 9.50 | 18.87 | 0.43 | 0.32 | 0.57 | 12.50 | 47.33 | 0.68 | 0.50 | 0.45 | 12.33 | 45.67 | 1.81 | 0.98 | 0.57 |
| 2 | " 250 ppm | 5.50 | 23.12 | 0.85 | 0.38 | 0.51 | 9.00 | 27.33 | 0.65 | 0.44 | 0.87 | 13.00 | 36.17 | 1.81 | 0.99 | 0.41 |
| 3 | " 500 ppm | 4.33 | 18.15 | 0.55 | 0.32 | 0.32 | 9.33 | 31.42 | 0.54 | 0.35 | 0.80 | 9.83 | 30.67 | 1.03 | 0.67 | 1.04 |
| 4 | GA 10 ppm | 5.00 | 25.32 | 0.76 | 0.44 | 0.38 | 9.00 | 31.17 | 0.59 | 0.38 | 0.49 | 10.00 | 34.52 | 1.92 | 1.11 | 0.34 |
| 5 | " 25 ppm | 5.83 | 26.90 | 0.80 | 0.53 | 0.39 | 10.50 | 37.00 | 0.48 | 0.32 | 0.94 | 0.83 | 33.52 | 1.11 | 0.56 | 0.56 |
| 6 | " 50 ppm | 3.33 | 15.87 | 0.26 | 0.12 | 0.45 | 8.67 | 33.00 | 0.67 | 0.39 | 1.04 | 9.00 | 32.87 | 0.92 | 0.52 | 0.56 |
| 7 | BA 100 ppm | 6.00 | 25.50 | 0.68 | 0.41 | 0.33 | 7.50 | 25.73 | 0.92 | 0.55 | 0.25 | 8.67 | 24.85 | 0.94 | 0.51 | 0.59 |
| 8 | " 250 ppm | 6.33 | 28.60 | 1.35 | 1.07 | 0.74 | 8.33 | 42.77 | 1.34 | 0.94 | 0.41 | 9.17 | 42.60 | 2.42 | 1.82 | 0.29 |
| 9 | " 500 ppm | 3.83 | 28.58 | 0.81 | 0.60 | 0.26 | 6.17 | 14.50 | 0.63 | 0.27 | 0.94 | 9.83 | 28.25 | 2.00 | 1.16 | 0.43 |
| 10 | Control | 2.83 | 24.73 | 0.45 | 0.22 | 0.32 | 7.00 | 22.67 | 0.66 | 0.44 | 0.33 | 8.67 | 31.50 | 2.25 | 1.41 | 0.34 |
| | SEm± | 1.04 | 3.35 | 0.18 | 0.13 | 0.19 | 1.21 | 5.15 | 0.19 | 0.14 | 0.19 | 1.09 | 3.60 | 0.93 | 0.55 | 0.19 |
| | CD (0.05) | 3.06* | NS | 0.5287* | 0.383** | NS | NS | 15.2* | NS | NS | 0.5571* | NS | 10.62* | NS | NS | NS |

* Significant at 5% level   ** Significant at 1% level   NS - Not significant

### 4.6.2 Root length

Data furnished in table 17 and 18 indicate that in the case of *Acacia mangium* treatments did not differ significantly in relation to this parameter when fresh and one month old seeds were used. But in the case of seedlings produced from two month old seeds, the treatment 500 ppm IAA produced the longest root (20.43 cm) followed by GA 50 ppm (20.15 cm). Treating seeds with 500 ppm BA produced the shortest root (10.5 cm). Effect of treatments on root growth of *Acacia mangium* seedlings is also depicted in Plates 5 and 6.

In *Dalbergia latifolia*, treatments did not produce any significant effect on root length when fresh seeds were used. But in the case of one month old stored seeds, seedlings produced after treating with 100 ppm IAA produced the longest root (47.33 cm) and this was on par with treatments like 250 ppm BA (452.77 cm), 25 ppm GA (37 cm) and 50 ppm GA (33 cm). Like earlier case, the treatment $T_9$ (500 ppm BA) produced the shortest root (14.50 cm) and this was on par with control. In the case of two month old seeds also, IAA 100 ppm proved its superiority compared to other treatments in producing longest roots (45.67 cm). In control, root length was only 31.50 cm. Effect of treatments on root growth of *Dalbergia latifolia* seedlings is also depicted in Plates 9 and 10.

### 4.6.3 Root fresh weight

In *Acacia mangium,* the seedlings produced from fresh seeds treated with 100 ppm IAA produced higher root fresh weight (1.19 g) while 50 ppm GA

Plate 5 Shoot and root development of seedlings of *Acacia mangium* as influenced by various plant growth regulator treatments

| | | |
|---|---|---|
| $T_1$ | - | IAA 100 ppm |
| $T_2$ | - | IAA 250 ppm |
| $T_3$ | - | IAA 500 ppm |
| $T_4$ | - | GA 10 ppm |
| $T_5$ | - | GA 25 ppm |

Plate 6 Shoot and root development of seedlings of *Acacia mangium* as influenced by various plant growth regulator treatments

| | | |
|---|---|---|
| $T_6$ | - | GA 50 ppm |
| $T_7$ | - | BA 100 ppm |
| $T_8$ | - | BA 250 ppm |
| $T_9$ | - | BA 500 ppm |
| $T_{10}$ | - | Control |


ACACIA MANGIUM
T6
T7
T8
T9
T10

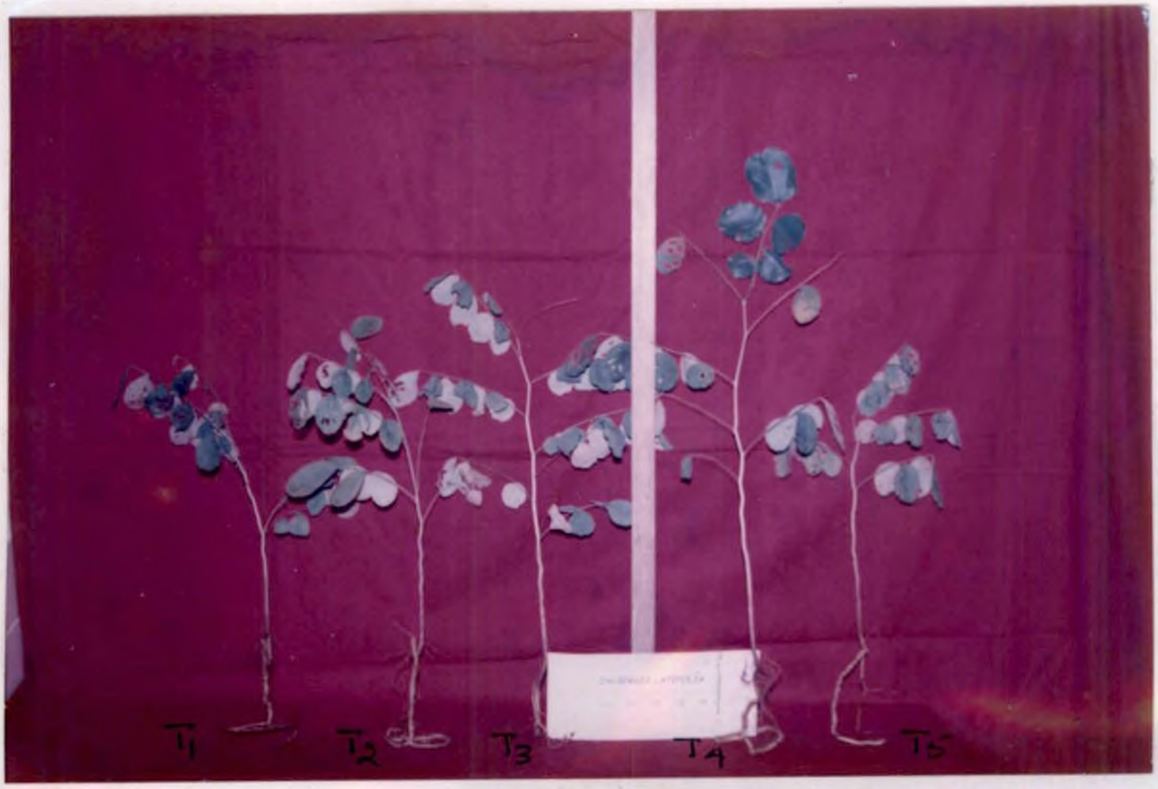

ACACIA MANGIUM
T1
T2
T3
T4
T5

Plate 9 Shoot and root development of seedlings of *Dalbergia latifolia* as influenced by various plant growth regulator treatments

| | | |
|---|---|---|
| $T_1$ | - | IAA 100 ppm |
| $T_2$ | - | IAA 250 ppm |
| $T_3$ | - | IAA 500 ppm |
| $T_4$ | - | GA 10 ppm |
| $T_5$ | - | GA 25 ppm |

Plate 10 Shoot and root development of seedlings of *Dalbergia latifolia* as influenced by various plant growth regulator treatments

| | | |
|---|---|---|
| T6 | - | GA 50 ppm |
| T7 | - | BA 100 ppm |
| T8 | - | BA 250 ppm |
| T9 | - | BA 500 ppm |
| T10 | - | Control |


T1
T2
T3
T4
T5


T6
T7
T8
T9
T10

produced the lowest (0.76 g) and this was also on par with control. In the case of seedlings obtained from two month old seeds, treating with 10 ppm GA and 100 ppm IAA resulted highest values of 1.21 g and 1.20 g respectively, which was followed by 250 ppm IAA (1.18 g) and 25 ppm GA (0.95 g). Rest of the treatments did not vary significantly.

In *Dalbergia latifolia* seedlings produced from fresh seeds, the treatment $T_8$ (250 ppm BA) had resulted higher value (1.35 g) for root fresh weight and this was on par with the treatment $T_2$ (250 ppm IAA) where the fresh weight was (0.85 g). The data showed that treating seeds with 50 ppm GA has got least effect (0.26 g) with regard to this parameters (Table 17). No statistical difference could be observed between this treatment and control.

**4.6.4 Root dry weight**

In *Acacia mangium*, the treatments did not manifest any significant effect on root dry weight when fresh and one month old seeds were used. But in the third set ie., the seedlings produced from two month old seeds, the treatment $T_2$ (250 ppm IAA) produced maximum root dry weight (0.68 g) and this was on par with other treatments like 100 ppm IAA (0.67 g), 10 ppm GA (0.66 g), 100 ppm BA (0.54 g) and 25 ppm GA (0.53 g). The treatment $T_6$ (GA 50 ppm) recorded the lowest value (0.39 g) which was on par with control (0.42 g).

However, in *Dalbergia latifolia,* treatments recorded significant effect on seedlings produced from fresh seeds. Here, treating seeds with 250 ppm BA resulted higher value for root dry weight (1.07 g) and this differed significantly from all other treatments. Though the GA 50 ppm resulted lower value (0.12 g) this did not differ significantly from control. In other two sets of studies, the treatments did not show any significant effect on root dry weight of seedlings.

# Discussion

# DISCUSSION

Lot of information is available on the use of plant growth regulators on seed germination and seedling vigour of various crop species in the nursery. Breaking the dormancy of seeds ensures quick germination and uniform growth of nursery stock which are absolutely necessary for successful artificial regeneration on commercial scale. Use of proper concentration of growth regulators can not only maximise germination but also enhances the chances of producing uniform and good quality seedlings in the nursery. However, there seems to be no systematic work done on the use of growth regulators on enhancing seed germination in forest tree species. Hence, the present series of studies were taken up in the College of Forestry, Vellanikkara, with a view to gather information which would guide the nursery personnel or farmer to produce good quality planting stocks of *Acacia mangium* and *Dalbergia latifolia.*

## 5.1 Effect of plant growth regulators on germination behaviour of seeds

The study revealed that in *Acacia mangium*, the seeds treated with different concentrations of GA resulted better germination followed by BA and IAA. The fresh seeds of *Acacia mangium* when treated with 10 ppm GA and 100 ppm BA produced high cumulative germination of 68 per cent and 72 per cent respectively. This was followed by GA 25 ppm and 50 ppm. In the case of one month old *Acacia mangium* seeds, 10 ppm GA produced 52 per cent cumulative germination per cent. On subsequent germination studies using stored seeds, the cumulative germination per cent went on decreasing. However, the seeds of *Acacia mangium* when treated with

10 ppm GA produced more or less high germination per cent. The fresh seeds of *Acacia mangium* when treated with 10 ppm GA and 100 ppm BA, produced high values for final mean daily germination (3.78 and 4.00 respectively). This treatment was followed by 250 ppm IAA. This trend was more or less similar in subsequent germination studies also using stored seeds of *Acacia mangium*. However, 10 ppm GA produced more or less high final mean daily germination. Chandra and Chauhan (1977) also recommended soaking of *Picea smithiana* seeds in 100 ppm GA for early and better germination. Sandberg (1988) reported that when seed lots of Norway spruce (*Picea abies*) and scots pine (*Pinus sylvestris*) were treated with different growth regulators like IAA, IBA, kinetin and gibberellins, the rate of germination in both the species was found to be stimulated when treated with gibberellins. In another study using stored bamboo seeds (*Dendrocalamus strictus*) $GA_3$ at 10 ppm stimulated final germination and vigour index (Richa *et al.*, 1994). In the present study, germination values of 27.40, 26.02 and 22.81 respectively were recorded when fresh seeds of *Acacia mangium* were treated with 100 ppm BA, 250 ppm IAA and 10 ppm GA. $GA_3$ soaking treatment is reported to enhance seed germination percentage in *Bauhinia vahlii* seeds (Upreti *et al.*, 1997). Effectiveness of $GA_3$ treatment for enhancing seed germination is also reported in other species ( Nagaveni and Srimathi, 1980; Singh and Murthy, 1987; Fox *et al.*, 1994). Gopikumar and Muktan (1994) also reported better gemination and vigour when seeds of *Albizia odoratissima* were treated with GA and IBA.

Although germination of seeds was found to be influenced by exogenous application of GA, in some species it has been reported to have no effect or even negative effect. Brentzloff and Pellett (1978) reported that stratification promoted germination effectively than $GA_3$ in *Carpinus caroliniana* seeds. Other treatment like partial removal of seed coat was reported to accelerate germination in Grevillea species (Dupee and Clemens, 1982).

In the case of *Dalbergia latifolia,* seed treatment did not show any significant effect on cumulative germination per cent, final mean daily germination, and germination values. Interestingly in fresh seeds it was found that control treatment recorded higher cumulative germination per cent (60%), final mean daily germination (3.33) and germination value (27.28). However, stored seeds of *Dalbergia latifolia* showed better germination when treated with different concentrations of IAA, BA and GA solutions. In the case of one month old seeds of *Dalbergia latifolia,* 500 ppm IAA, 250 and 500 ppm BA recorded high cumulative germination per cent. In further studies using stored seeds of *Dalbergia latifolia* the different concentrations of IAA enhanced the germination of seeds. Banerjee (1998) reported that seeds of *Melia azadarach* when soaked in 250 ppm of IAA for 24 hrs. have been found to give better germination percentage as compared to other concentrations of IBA and $GA_3$. In another study using *Cassia fistula* and *Bauhnia purpurea* growth regulators like IAA and IBA have increased germination percentage and reduced mean number of days compared to untreated seeds (kumar *et al.*, 1991). Maximum germination was obtained in spruce, when seeds were treated with IAA (Virendra, 1990). The effect of pre-treatment on germination of *Alstonia scholaris* seed indicated that soaking in IAA at 200 ppm out performed others recording three to five fold increase in germination and vigour (Maitreyee *et al.*, 1997). Singh (1990) showed that IAA and IBA increased germination percentage of *Picea smithiana* seeds.

In the present study, the overall germination percentage of stored seeds of *Dalbergia latifolia* were low when compared to stored seeds of *Acacia mangium*, when treated with different concentrations of plant growth regulators. This may be due to the fact that *Dalbergia latifolia* seeds are recalcitrant and its viability is lost after keeping it for two or three months.

The role of plant growth regulators in induction and breaking dormancy in many tree seeds is attributed due to its effects on seed coat permeability, its nullifying effect on inhibitors, light and phytochrome effects and metabolic changes (Khan, 1977). The growth regulators at proper concentrations are considered to penetrate the seed (Tinus, 1982) and may enhance the rate of metabolism during germination (Verma and Tandon, 1988). Poor penetration of seed coat by growth regulators have affected germination. The impenetrability of seed coat to hormone was cited as a reason for the ineffectiveness of exogenous GA in relieving dormancy of *Pinus lambertiana* (Taylor and Wareing, 1979). Khan (1975) indicated the possible interactions between $GA_3$, inhibitors and cytokinins in regulating seed germination of tree seeds in terms of primary, preventive and permissive roles respectively through his study using herbaceous crop seeds. However, a more direct approach in determining the role of plant growth regulators *in vivo* by examining endogenous levels of hormones and relating these changes to changes in seed dormancy status might facilitate our understanding of its actual role. Light may promote germination hy enhancing the synthesis of endogenous plant growth regulators such as $GA_4$. The importance of light quality and the involvement of phytochrome on germination and hormone levels was demonstrated in *Pinus sylvestris* by Kopcewicz (1972).

Based on the assumption that breaking of dormancy and onset of germination may involve the synthesis of specific proteins and enzymes, several direct biochemical studies have been made to find out the effects of GA on protein and nucleic acid synthesis during germination. Several biochemical studies have revealed that growth regulators modulate transcription or translation during protein synthesis (Villers, 1971). The mobilization of protein and lipid storage bodies upon specific enzymes may hydrolyze stored moleculer and catalyze essential reaction in energy generating cycles resulting the production of energy and substrates which inturn provide the structural components essential for the growth and emergence of the embryo. Application of $GA_3$ released *corylus avellana* seeds from dormancy by stimulating DNA synthesis (Pinfield and Stobart, 1969). It was suggested that GA induced germination in *corylus* is due to depression of certain specific genes, allowing the production of mRNAs for protein which are essential for germination (Jarvis *et al.*, 1968).

### 5.2 Effect of plant growth regulators on growth characteristics of seedlings

Plant growth and development are also greatly influenced by growth regulators. In the present study statistical analysis of the data indicated that IAA, GA and BA influenced the height, girth, leaf production and shoot charactors of *seedlings of Acacia mangium* in the nursery. Maximum height growth of 19.16 cm, girth of 2.51 mm and leaf number of 11.00 were recorded when seeds were treated with 50 ppm GA. The shoot charactors like leaf area, shoot fresh weight and dry weights were greatly influenced by 25 ppm GA. Maximum leaf area of 14.33 $cm^2$ and shoot dry weight of 1.29 gm were recorded in 25 ppm GA.

In *Dalbergia latifolia*, the height, girth and leaf productions were influenced by IAA. Maximum height growth of 11.07 cm and leaves of 8.22 were recorded in 100 ppm IAA. However, maximum girth of 1.56 cm was recorded in 250 ppm IAA. In the present study the difference between the effect of various growth regulators on shoot charactors were not significant. Studies by Verma and Tandon (1988) in *Pinus kesiya* and *Schima khasiana* seedlings revealed that GA and IAA were very effective in the nursery. Several literature have suggested that movement of GA basipetally through stem sections could bring about shoot elongation (Kentzer and Libert, 1961, in Helianthus; Michniewicz and Lang,. 1962 Cohen *et al.* 1996 in pisum and in herbaceous crops). Ruddart and Pharis (1966) concluded that like auxins, gibberellins were also involved in induction of apical dominance in redwood trees (Thimann and Skoog, 1934). Yang and Read (1989) reported that $GA_3$ promoted shoot elongation in woody stems.

Different concentrations of growth regulators particularly GA significantly influenced the root growth parameters in *Acacia mangium.* However in *Dalbergia latifolia*, seedlings produced from seeds treated with IAA recorded superior root growth parameters. Such increased root growth parameters might have occurred due to the polar transport of auxins (IAA) which collects at the root tip causing initiation of root primordia deep inside many cell layers of root (Philip, 1971). Increase in number and length of adventitous roots is also reported by Rodhi and Jameson (1991) in *Boutelona gracilis* using 10 ppm IAA. Nevertheless, further detailed investigations are to be carried out to establish its effects on root growth attributes in the nursery.

In both *Acacia mangium* and *Dalbergia latifolia*, treatments could not excert any significant effect on chlorophyll content of seedlings produced from both fresh and stored seeds. However, a slight increase in chlorophyll content in seedlings of GA and IAA treatment would have attributed better growth of seedlings in these treatments. Bruah (1990) also reported better growth and yield of rainfed wheat at a higher chlorophyll content.

# *Summary*

# SUMMARY


Plant growth regulators have been found to enhance seed germination and seedling growth. Use of optimum concentrations of growth regulators are reported not only to enhance germination but also helps to produce uniform seedlings . The use of plant growth regulators will thus help the farmers and other nursery men to produce healthy and even seedlings at the shortest time.

The present study was carried out in the College of Forestry, Kerala Agricultural University, Vellanikkara to find out the ideal growth regulators and the effect of their concentration on seed germination and subsequent seedling growth behaviours. The salient findings of the study are summarized below:

1) The seeds of *Acacia mangium* could be stored for longer periods when compared to *Dalbergia latifolia*. The viability and germination capacity of seeds of *Dalbergia latifolia* were lost when the seeds were stored for one month.

2) The germination percentage of fresh seeds of *Acacia mangium* was 72 per cent, while that of *Dalbergia latifolia* was 60 per cent. But as the storage period increases, the germination percentage in both the species was found to be decreasing. However, this trend was more pronounced in *Dalbergia latifolia*.

3) In *Acacia mangium* the seeds treated with GA and IAA. In this species, showed better germination and also took minimum days for germination. 10 ppm GA and 100 ppm BA were found to be more effective in enhancing the seed germination. In the case of *Dalbergia latifolia*, the seeds treated with IAA showed better germination and also took minimum days for germination.

4) GA at 100 ppm was very effective in promoting seedling height, girth and leaf production in *Acacia mangium.* Higher root and shoot biomass of seedlings were also recorded for GA treatment followed by IAA. In the case of *Dalbergia latifolia* seedlings, the height, girth and leaf production were increased by IAA treatment. Root and shoot biomass of the seedlings were also more when treated with growth regulators compared to control.

5) Chlorophyll content of seedlings was not significantly influenced by growth regulators treatment. However, there was a small increase in chlorophyll content in seedlings of *Acacia mangium* when seeds were treated with GA and *Dalbergia latifolia* when seeds were treated with IAA.

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# EFFECT OF GROWTH REGULATORS ON SEED VIABILITY, GERMINATION AND VIGOUR OF SEEDLINGS OF MANGIUM [*Acacia mangium* (Willd)] AND ROSEWOOD [*Dalbergia latifolia* (Roxb)]

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## ABSTRACT OF THE THESIS

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# ABSTRACT

The present study was undertaken at College of Forestry, Kerala Agricultural University, Vellanikkara, Thrissur to find out the effect of plant growth regultors at varying concentrations on seed germination and seedling vigour of *Acacia mangium* and *Dalbergia latifolia*. Both fresh and stored seeds were treated with different concentrations of IAA, GA and BA. The study revealed that seeds of *Acacia mangium* could be stored for longer periods without deterioration of its viability and germination capacity. The germination percentage of fresh seeds of *Acacia mangium* and *Dalbergia latifolia* were 72 and 60 respectively. But in the case of *Dalbergia latifolia*, the germination percentage of seeds went on decreasing with the increase in storage periods. In *Acacia mangium* the seeds treated with 10 ppm GA and 100 ppm BA showed better germination and also took minimum days for germination. However in *Dalbergia latifolia,* IAA treatment recorded better germination with less number of days taken for germination.

Seedling growth in the nursery showed that GA was highly effective in increasing the height, girth and leaf production of seedlings of *Acacia mangium.* GA at 100 ppm was found to be best in this regard. Higher root and shoot biomass of seedlings were also recorded for GA followed by IAA. Seedlings of *Dalbergia latifolia* recorded better height, girth and leaf production when seeds were treated with 100 ppm, IAA. Root and shoot biomass of the seedlings were more for 250 ppm, IAA in *Dalbergia latifolia.* In both the species the chlorophyll content was not found to be significantly influenced by any of the growth regulator treatment.