SEEDLING INVIGORATION THROUGH PLANT GROWTH SUBSTANCES IN TEAK (*TECTONA GRANDIS*)

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Received April 1994

SWAMINATHAN, C. & SRINIVASAN, V.M. 1996. Seedling invigoration through plant growth substances in teak (*Tectona grandis*). Influence of plant growth substances, viz. GA, IBA, IAA at two levels as promoters of germination and seedling growth on teak was studied. Slurry treatment method was adopted and growth of seedlings monitored for six months. Observations recorded on growth attributes revealed that GA at higher concentration enhanced growth of shoot characteristics as well as root length. At the lower concentration of 50 ppm, IBA influenced below ground biomass barring root length, and IAA produced elongated internodes.

Key words: Teak - seedlings - IAA - IBA - GA - stump - collar

SWAMINATHAN, C. & SRINIVASAN, V.M. 1996. Rangsangan anak benih melalui bahan-bahan pertumbuhan tumbuh-tumbuhan di dalam jati (*Tectona grandis*). Pengaruh bahan-bahan pertumbuhan iaitu GA, IBA, IAA pada dua peringkat sebagai penggalak bagi percambahan dan pertumbuhan anak benih ke atas jati telah dikaji. Pemerhatian yang direkodkan ke atas sifat-sifat pertumbuhan menunjukkan bahawa GA pada kepekatan yang lebih tinggi meningkatkan pertumbuhan ciri-ciri pucuk dan kepanjangan akar. Pada kepekatan yang lebih rendah iaitu 50 ppm IBA mempengaruhi biojisim di bawah tanah sekiranya kepanjangan akar, dan IAA menghasilkan ruas yang lebih panjang.

Introduction

Teak (*Tectona grandis*), the most important timber tree of India, is one of the species recommended for plantation forestry. Teak seedlings are kept in the nursery for a period of one year and stumps prepared and outplanted. If the seedlings are invigorated, the nursery age could be reduced without compensating for vigour and quality of seedlings. Seedling invigoration can be achieved through exogenous application of plant growth substances, which have marked influence on seedling growth as regulated by endogenous level of harmones (Dawson 1965). Over the past several years it has become increasingly evident that plant growth substances, organic compounds other than nutrients which are known to affect the physiological processes of plant even in small concentrations, control rate of growth and pattern of differentiation in plants, acting as chemical signals. Influence of these substances as promoters of germination and seedling growth on a number of species is very well documented (Mehrotra *et al.* 1968, Webb & Wood 1980, Thomas 1981, Mehanna *et al.* 1985). Among the growth substances, gibberellins and auxins are promotive for many growth parameters

(Saxena & Maheswari 1979, Varma & Tandon 1988, Singh 1989a). Unnikrishnan and Rajeev (1990) observed that different concentrations of IAA and GA pretreatments boosted germination and emergence of healthy sprouts in teak. Screening of these substances is mainly done based on their externally observable effects on plant and plant organs, which vary with species, age and the concentration of the substance itself. The present investigation aims at screening suitable plant growth substances and their optimum concentrations for better seedling growth in teak.

Materials and methods

The experiment was conducted at the Forest College campus Mettupalayam (11° 1 9'N and 77 ° 56'E, 300 m a.s.l.). Seeds were collected from the teak seed production area in Topslip, Tamil Nadu and the age of the mother trees was 50 years. Seeds were stored at room temperature in gunnybags and were pretreated by soaking in cold water for six days before sowing in nursery beds. Two-month-old seedlings were pricked out from the teak nursery beds and stumps prepared by severing lateral roots and shoot leaving one inch from the collar region. Slurry treatment method was adopted and the stumps were given the following treatment for 24 h: gibberellic acid (GA), indole acetic acid (IAA), and indole-3-butryic acid (IBA), each at two levels of concentration, viz. 50 and 100 ppm, cow's urine 1:10 dilution and water soaking served as control. Treated stumps were planted in polypots of 25 × 13 cm size filled with a mixture of red soil: sand: farm yard manure (fym) at 3:1:1 ratio. The treatments were set up in a randomised block design, each replicated thrice. Thirty seedlings constituted a treatment. Observations on growth parameters were recorded six months after the treatments and were subjected to statistical analysis (Panse & Sukhatme 1967) and means were compared using Duncan's multiple range test.

Results and discussion

The data recorded on the effect of exogenous application of plant growth substances on teak are presented in Table 1 and Figures 1 and 2, showing a varied response of growth parameters to different growth substances at the two levels studied.

GA 100 ppm recorded maximum value for root length (RL) (41.9 cm) which was followed closely by IAA 100 ppm (40.5 cm), compared to the control (31.8 cm). Though IBA showed poorer performance than other treatments in all growth substances studied, a gradual increase in root length was observed with the increase in hormonal concentration. Shoot length (SL) followed the same trend as that of root length, with maximum length of shoot (16.5 cm) found in GA 100 ppm, which was closely followed by IAA 100 ppm, in comparison to the control. The percentage increases due to GA 100 ppm on root and shoot elongations over the control were 31.8% and 71.9% respectively. GA, at both levels, was found to increase leaf number. The maximum number of leaves produced in GA 100 ppm

Journal of Tropical Forest Science 8(3): 310 - 316 (1996)

Table 1. Effect of growth substances on growth of teak seedlings

Treatment (ppm)	Root length (cm)	Shoot length (cm)	No. of leaves	Inter-node length (cm)	Collar diameter (cm)	Stump dia-meter (cm)	No. of shoots	No. of secon-dary roots	Root weight (g plant^{-1})
GA 50(T1)	35.3b	12.3bc	8.7ab	1.9ab	0.32c	0.94a	1.4b	2.1b	7.5b
GA 100(T2)	41.9a	16.5a	9.0a	1.4b	0.38a	1.06a	2.1a	2.7b	9.7a
IAA 50(T3)	35.1b	11.7c	6.2abc	2.7a	0.34bc	1.05a	1.6b	2.1b	9.4a
IAA 100(T4)	40.5ab	14.7ab	6.8abc	2.1ab	0.36ab	1.01a	1.7ab	2.6b	8.9b
IBA 50(T5)	33.5b	9.6c	6.2abc	1.6ab	0.35bc	1.08a	1.3b	3.4ab	10.4a
IBA 100(T6)	35.2b	10.3c	5.9abc	1.5b	0.33c	1.05a	1.2b	3.5a	9.9a
Cow's urine(T7)	34.3b	9.9c	5.2bc	1.6a	0.29d	1.02a	1.5b	2.1b	8.9a
Control (T8)	31.8b	9.6c	4.8c	1.7ab	0.29d	0.89a	1.5b	2.0b	5.3c

Values are the means of three replicates. Means followed by same letter in columns for a parameter are not significantly ($p=0.05$) different from each other.

(9.0), which accounted for an increase of 87.5% over the control, was on par with the number produced in GA 50 ppm (8.7). IAA and IBA showed a varied response and the influence was little. A marked influence on collar diameter was observed due to application of GA and IAA at 100 ppm, registering values of 0.38 and 0.36 cm respectively. As the concentration increased a gradual increase in collar diameter over the control was evident in all the three growth substances tried. As regards the number of shoots, GA 100 ppm produced the most number of shoots (2.13), registering an increase of 42% over the control. As the concentration of GA and IAA increased, the number of shoots produced also increased whereas it was the reverse in IBA.

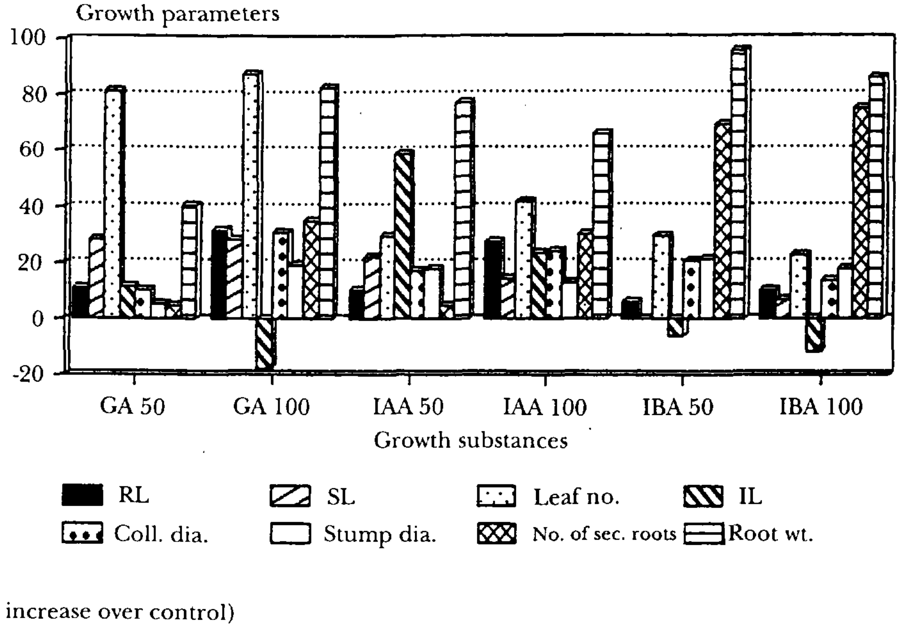

Figure 1. Effect of growth substances on teak seedling growth

The beneficial effect of treatment of stumps with GA is well manifested in shoot characteristics as well as in root length. In the present study, it was noted that GA at 100 ppm level stimulates better shoot growth, leaf number and collar diameter compared to other treatments. GA has been reported for its marked effects on elongation of shoot (Stowe & Yamaki 1957, Brian 1959, Nanda *et al.* 1968) and was considered to be the best for seedling growth (Chavi Singh & Murthy 1987).

The increased number of shoots in GA 100 ppm is in accordance with the finding of Nanda *et al.* (1968) who reported that GA stimulated sprouting of buds and subsequent elongation. The plausible reasons for promotion of shoot growth by GA may be ascribed to induced cell elongation without causing increased cell wall softening (Cleland *et al.* 1968) and the known fact of GA inducing the synthesis of enzymes. It is possible that osmotic concentration of cells growing in response to the exogeneous gibberellin supply may be increased by the activity of such enzymes (Singh *et al.* 1985). The effect of GA on root growth is still controversial and most of the reports in the literature indicate that gibberellins inhibit root growth (Stowe & Yamaki 1957, Nanda *et al.* 1968, Nanda & Jain 1972), have no effect at all (Blakely *et al.* 1972), or retarded root growth (Kumar & Baijal 1978). However, the positive effect of GA on root growth as observed in this study is in accordance with that reported by Chavi Singh and Murthy (1987). Observations recorded on below ground biomass indicated that IBA enhanced root parameters. Maximum number of secondary roots (3.4/3.5) was recorded in IBA at both levels of concentrations, indicating that increase in concentration gave no further response. The stump diameter, which decides the quality of seedlings, was greater in the order of IBA 50 > GA 100 > IBA 100. IBA 50 registered 21% increase in stump diameter over the control. But the trend was reverse as the concentration increased to 100 ppm. Nearly one hundred percent increase was noticed for root weight in IBA 50 over the control. A substantial increase in root weight was seen as the concentration of GA increased and concentration IAA decreased. The lower concentration of IBA was promotive, indicating that higher concentration is not useful in enhancing root growth in this species. Better root biomass production due to IBA 50 may be ascribed to synthesis and activation of different enzyme systems responsible for promotive effects, and inhibition at higher concentration may be due to high levels of endogenous auxins in the plant. The findings are in aggreement with those of Laloray and Rai (1962) and Choe (1972) who reported promotion in the total length of seedlings at lower concentrations and reduction at higher concentrations of auxins in some other species. Promotion of more lateral roots due to IBA was observed in teak in this study. However, IAA gave the same response in cassia (Singh 1989b).

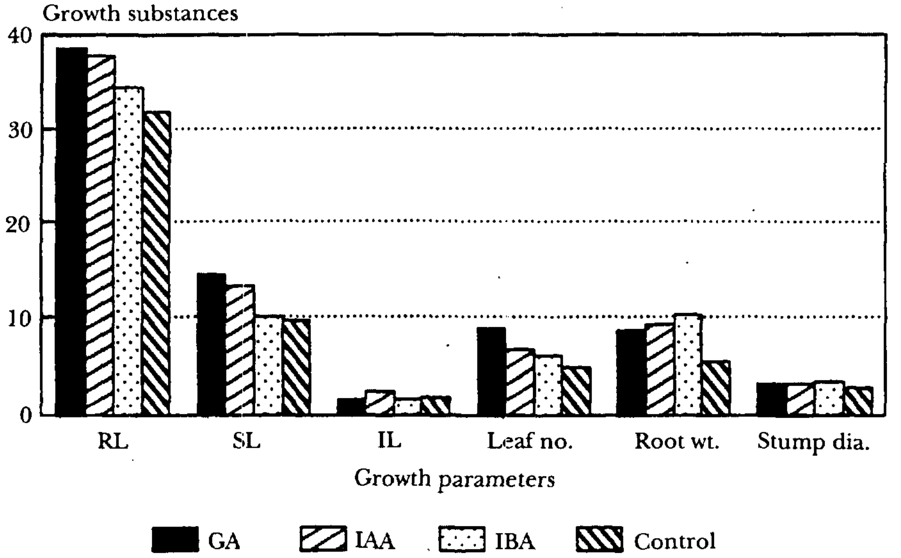

Figure 2. Comparative performance of growth substances on teak seedling growth

Internode length (IL), which decides the development of a seedling, was influenced by application of IAA 50 ppm registering a maximum length of 2.7 cm. But a smaller increase was observed as the concentration increased to 100 ppm,. also reported by Choe (1972). In contrast to this study, Mertz and Lutz (1975) observed increased internode length due to GA application on pea seedlings.

From the results, it may be concluded that for teak, GA is the best growth substance to enhance growth of shoot characteristics, IBA at lower concentration influences below ground biomass barring root length, and for better internode length, IAA (at 50 ppm) is more suitable. In general, seedlings with better root characteristics are preferred for afforestation programmes as they survive better.

References

BLAKELY, L.M., RODAWAY, S.J., HOLLEN, L.H. & GROKER, S.G. 1972. Control and kinetics of branch root formation in cultured segments of *Haplopappus ravenii*. *Plant Physiology* 50 : 35 - 42.

BRIAN, P.W. 1959. Effect of gibberellin on plant growth and development. *Biological Reiew* (34) : 37 - 81.

CHAVI SINGH & MURTHY, Y.S. 1987. Studies on the effect of various growth regulators on seed germination and seedling growth of *Cassia fistula*. *Acta Botanica Indica* 15 : 206 - 212.

CHOE, H.J. 1972. Effect of presoaking seeds of *Pisum sativum* in GA_3, IAA and kinetin on seedling growth. *Horticultural Science* 7 : 476 - 478.

CLELAND, W.K., THOMPSON, M.L., ROYLE, B.L. & PURUES, W.K. 1968. Simulatory effect of gibberellic acid on elongation growth of intact cucumber hypocotyls. *Nature* 219 : 510 - 511.

DAWSON, M.J. 1965. Effect of seed soaking on growth and development of crop plants (finger millet). *Indian Journal of Plant Physiology* 8 : 52 - 56.

KUMAR, P. & BAIJAL, B.D. 1978. Effect of IAA and GA on sprouting, shoot and root growth of potato. *Crop Physiology and Ecology* 3 : 167 - 170.

LALORAY, M.M. & RAI, V.K. 1962. Growth of the seedling of *Phaseolus mungo* L. as affected by auxins and GA. *Indian Journal of Plant Physiology* 5 : 218 - 219.

MEHANNA, H.T., MARTIN, G.C. & NISWIJIMA, C. 1985. Effect of temperature, chemical treatments and endogenous hormone content in peach seed germination and subsequent seedling growth. *Scientia Horticulturae* 27 : 63 - 73.

MEHROTRA, D.N., SAXENA, H.K., ROY, A.N. & SHIVANATH. 1968. Effect of growth regulators on fruiting and yield of black gram. *Indian Experimental Agriculture* 4 : 329 - 344.

MERTZ, D. & LUTZ, D. 1975. Effect of GA on growth of pea seedling internode. *Phytochemistry* 14 : 37 - 40.

NANADA, K.K. & JAIN, M.K. 1972. Mode of action of IAA and GA_3 on root and shoot growth of epiphyllous buds of *Bryophyllum tubiflorum*. *Journal of Experimental Botany* 23 : 980 - 986.

NANADA, K.K., PURDHIT, A.N. & MEHROTRA, K. 1968. Effect of sucrose, auxins and gibberellic acid on rooting of stem segments of *Populas nigra* under varying light conditions. *Plant and Cell Physiology* 9 : 735 -743.

PANSE, V.G. & SUKHATME, P.V. 1967. *Statistical Methods for Agricultural Workers*. ICAR, New Delhi.

SAXENA, M.C. & MAHESWARI, D.C. 1979. Influence of growth regulators on the seedling growth of ageing soyabean seeds. *Botanic Progress* 2 : 80 - 83.

SINGH, C T. 1989a. Changes in seed germination and seedling growth processes induced by various growth regulators in *Cassia glauca*. *Acta Botanica Indica* 17 : 68 - 75.

SINGH, C.T. 1989b. Influence of different growth regulators on seed germination and seedling growth of *Cassia sophera* L. *Acta Botanica Indica* 17 : 187 - 191.

SINGH, S.S., SHARMA, B.N. & PALIWAL, G.S. 1985. Effect of Niagara and GA_3 on seed germination, early seedling growth and cotyledonary expansion of *Acacia catechu*. *Indian Journal of Forestry* 8(1): 41 - 46.

STOWE, B.B. & YAMAKI, T. 1957. The history and physiological action of gibberellins. *Annual Review of Plant Physiology* 8 : 181 - 216.

THOMAS, T.B. 1981. Seed treatments and techniques to improve germination. *Scientia Horticulturae* 32 : 47 - 59.

UNNIKRISHNAN, K. & RAJEEVE, K.P. 1990. On germination of Indian teak (*Tectona grandis* L.F.). *Indian Forester* 116(12) : 992 - 993.

VARMA, A.N. & TANDON, P. 1988. Effect of growth regulators on germination and seedling growth of *Pinus kesiya* and *Schima khasiana*. *Indian Journal of Forestry* 11 (1) : 32 - 36.

WEBB, S.B. & WOOD, P.J. 1980. *A Guide to Species Selection for Tropical and Subtropical Plantations.* Tropical Forestry Paper 16. University of Oxford, London.