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Influence of various levels of growth hormones on rooting of cuttings of casuarina (*Casuarina equisetifolia* L.)

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Abstract
The present investigation entitled "Influence of various levels of growth hormones on rooting of cuttings of Casuarina (*Casuarina equisetifolia* L.)" was conducted at College of Forestry (ACHF), Navsari Agricultural University, Navsari, Gujarat, India. The experiment was laid out in a Completely Randomized Design with eleven different treatments of growth hormones *viz.*, IAA, IBA, NAA and their dual combinations with three repetitions. Among various growth hormones, T_{11} *i.e.* IBA @ 25 ppm + NAA @ 25 ppm took minimum days to sprout (6.67 days) and 50 per cent sprout (9.67 days) whereas days to sprout (12.33 days) and 50 per cent sprout (17.33 days) were delayed in Control treatment. The highest values of root length (6.82 cm), number of primary roots (9.13), increment in shoot length (7.52 cm), survival (61.11 %) and length based root: shoot ratio (0.69) were observed in T_{11}: IBA @ 25 ppm + NAA @ 25 ppm. Furthermore, lower values of above all parameters were recorded in Control.

Keywords: Influence, hormones, cuttings, casuarina, *Casuarina equisetifolia* L.

1. Introduction

Casuarina (*Casuarina equisetifolia* L.) is a subtropical tree commonly found in Australia, Southeast Asia and the Pacific islands (Wilson and Johnson, 1989) [18]. These trees are most prevalent in China and India where they are used for a number of purposes including providing trees for purely aesthetic purposes, wind belts, and sand protection in coastal areas, as well as wood pulp, medicine, tanning, and dyes (Doran and Hall, 1983; Pan and Li, 1996 and Zhong *et al.*, 2005) [5, 11, 20].

C. equisetifolia L. is the most widely planted species of Casuarina in India and introduced from Indonesia. *Casuarina* is a large fast growing evergreen tree with graceful appearance, resembles a feathery conifer belongs to family Casuarinaceae. Bole is long and cylindrical. In rare cases and in the interiors, there are instances of developing thick branches. In natural state it is gregarious, forming pure crops with little or no under growth except grass and sporadic shrubs. The tree attains height up to 40 m with diameter of 60 cm (180 cm girth) often, buttressed at the base. It is short lived; its natural span of life seldom exceeds 50 years. In less favorable localities, it turns misshapen and hollow beyond 25 years of age.

Clonal strategy is an excellent approach to eliminate inbreeds, provide adapted clones, mass produce valuable genotypes, control genetic diversity and more important, help in producing yield in plantation programmes. Since, considerable variations are observed in plantations raised through seeds, clonal forestry is the answer for mass production of end-use specific uniform planting materials. Casuarina is amenable for vegetative propagation. Rooting of cladode cuttings is the widely practiced method of vegetative propagation in *C. equisetifolia* L. Root promoting hormones plays an important role in the success of rooting of cuttings. The most commonly used growth regulators are auxins; among them substances most commonly used for better rooting in cuttings of various plants are indole butyric acid (IBA), indole acetic acid (IAA) and naphthalene acetic acid (NAA) with varied concentration (Hiral and Patel, 2018) [6].

2. Materials and Methods

The present investigation entitled "Influence of various levels of growth hormones on rooting of cuttings of Casuarina (*Casuarina equisetifolia* L.)" was conducted during 2019-2020 at

College of Forestry, Navsari Agricultural University (NAU), Navsari, Gujarat, India. The details of materials used, methods followed and the techniques adopted during the period of experimentation are narrated below.

The experiment was laid out in Completely Randomized Design with three repetitions and different eleven treatments. The experimental material was obtained from Instructional Farm, Navsari Agricultural University, Navsari. The cuttings were taken from the 10 years old clone of Casuarina (*Casuarina equisetifolia* L.) and cuttings were prepared having length of 10 cm and diameter 1-2 mm. Cuttings of new sprouted tips treated with different growth hormones were grown in root trainers containing 60 cells having capacity of 50 CC and filled with vermiculite as growing media in mist chamber where temperature and relative humidity were controlled with ≥ 35 ^{0}C and ≥ 78 %, respectively.

The various growth hormones *viz*., IAA (Indole Acetic Acid), IBA (Indole Butyric Acid) and NAA (Napthalene Acetic Acid) were brought in powder form. In the laboratory, powdered IAA, IBA and NAA were diluted in alcohol first and then in water and solutions were made as individual and mixture as per concentration required by different treatments.

The treatments were **T_1:** Control (Without water dipping)**, T_2:** Control (Water dipping), **T_3:** IAA @ 25 ppm**, T_4:** IAA @ 50 ppm**, T_5:** IBA @ 25 ppm**, T_6:** IBA @ 50 ppm**, T_7:** NAA @ 25 ppm**, T_8:** NAA @ 50 ppm**, T_9:** IAA @ 25 ppm + IBA @ 25 ppm**, T_{10}:** IAA @ 25 ppm + NAA @ 25 ppm, and **T_{11}:** IBA @ 25 ppm + NAA @ 25 ppm.

The data pertaining to influence of growth hormones on various parameters such as days to sprout (days), days to 50 % sprout (days), root length (cm), number of primary roots, increased shoot length (cm), survival (%) and root: shoot ratio (length basis) were recorded at the end of experiment i.e. after 60 days of planting. The data was analysed as per methods prescribed by (Panse and Sukhatme, 1985) [12] using DOS based software developed by Department of Agricultural Statistics, ACHF, NAU, Navsari.

3. Experimental Results

The data pertaining to influence of growth hormones on various parameters such as days to sprout (days), days to 50 % sprout (days), root length (cm), number of primary roots, increased shoot length (cm), survival (%) and root: shoot ratio (length basis) were recorded at the end of experiment i.e. after 60 days of planting and presented in Table – 1. The effect of different growth hormones on all the parameters studied was found significant.

3.1 Days to sprout (days)

It is evident from Table – 1 that the treatment T_{11} *i.e.* IBA @ 25 ppm + NAA @ 25 ppm took the minimum days to sprout *i.e.* 6.67 days which was statistically at par with treatment T_{10} *i.e.* IAA @ 25 ppm + NAA @ 25 ppm which took 8 days to sprout.

3.2 Days to 50 % sprout (days)

The treatment T_{11}: IBA @ 25 ppm + NAA @ 25 ppm took the minimum days for 50 per cent sprout *i.e.* 9.67 days which was statistically at par with treatment T_9: IAA @ 25 ppm + IBA @ 25 ppm (11.00 days) and T_{10}: IAA @ 25 ppm + NAA @ 25 ppm (11 days) and T_8: NAA @ 50 ppm which took 10.33 days to 50 per cent sprout.

Moreover, the maximum days to sprout and 50 per cent sprout was noted in treatment T_1 *i.e.* Control (without growth hormone) which were 12.33 and 17.33 days, respectively (Table – 1).

3.3 Root length (cm)

Significantly maximum root length was recorded in treatment T_{11}: IBA @ 25 ppm + NAA @ 25ppm (6.82 cm) which was followed by T_9: IAA @ 25 ppm + IBA @ 25 ppm (6.61 cm).

3.4 Number of primary roots

The maximum number of primary roots was found in treatment T_{11}: IBA @ 25 ppm + NAA @ 25 ppm (9.13) which remained at par with T_9: IAA @ 25 ppm + IBA @ 25 ppm (9.00).

3.5 Increased shoot length (cm)

The treatment T_{11}: IBA @ 25 ppm + NAA @ 25 ppm recorded maximum increment in shoot length *i.e.* 7.52 cm which was statistically at par with T_9: IAA @ 25 ppm + IBA @ 25 ppm (7.22 cm). While, the average increment in shoot length was observed 5.56 cm.

3.6 Survival (%)

Significantly maximum survival percentage was observed in treatment T_{11}: IBA @ 25 ppm + NAA @ 25 ppm (61.11 %) which was followed by T_9: Indole Acetic Acid (IAA) @ 25 ppm + Indole Butyric Acid (IBA) @ 25 ppm (55.56 %).

3.7 Root: shoot ratio

The highest value of root: shoot ratio on length basis was found in treatment T_{11}: IBA @ 25 ppm + NAA @ 25 ppm and T_9: IAA @ 25 ppm + IBA @ 25 ppm (0.69) which was statistically at par with and T_{10}: IAA @ 25 ppm + NAA @ 25 ppm (0.67).

However, the lowest value of root length, number of primary roots, increased shoot length, survival percentage and root: shoot ratio (length basis) were recorded in control which were 4.43 cm, 4.11, 3.93 cm, 11.67 % and 0.59, respectively.

4. Discussion

It is common practice to propagate plants by vegetative methods over and above seed propagation for getting true to type and healthy planting materials. Success of vegetative propagation mostly depends upon the ability of plants to form roots on cutting when placed in a favourable environment for rooting. The formation of root primordia (Tissue from which root is able to grow) and development of root can be accelerated in many species of plants by the application of plant growth regulators.

Judicious application of IAA, IBA and NAA either alone or in combination of suitable concentrations has enhanced sound initiation and growth of primary roots, better success and good quality of roots and shoots.

In the present study the influence of various growth hormones *viz.*, IAA, IBA, NAA and their combinations on rooting of Casuarina cuttings differed considerably with respect to various parameters such as days to sprout (days), days to 50 per cent sprout (days), root length (cm), number of primary roots, increased shoot length (cm), survival percentage and root: shoot ratio (length basis). Among different growth hormones, the treatment comprising IBA @ 25 ppm and NAA @ 25 ppm *i.e.*T_{11} provided better performance for all the parameters under study.

The beneficial effect of different levels of growth hormones may be attributed to their role in differentiation of cambial tissue in root primordia and mobilization of nutritional reserve by stimulating the hydrolysis. Higher success percentage may be due to increased level of auxins resulted in earlier completion of physiological processes in rooting and sprouting of cuttings (Damar *et al.*, 2014) [2].

In case of Casuarina (*C. equisetifolia* L.), it would appear that the cuttings treated with various growth hormones responded differently in their rooting behavior. Warrier and Suganthi (2015) [17] recorded good rooting with IBA @ 100 mg l^{-1}, Ho *et al.* (2010) [7] reported highest rooting in NAA @ 50 ppm and Lundquist and Torrey (1984) [10] noted maximum rooting in IBA @ 25 ppm.

In present experiment, the influence of combined treatment of growth hormones for increasing shoot length, root length, number of primary roots and survival percentage is seen pronounced in comparison to individual hormonal treatment. The similar result was reported by Yusnita *et al*. (2018) [19] in *Syzygium malaccense* (L.) Merr. & Perry stem cuttings with IBA 1000 ppm + NAA 1000 ppm, Umbreen *et al.* (2019) [15] with IBA 1600 ppm + NAA 7000 ppm in *Psidium guajava* L., Hossain *et al.* (2019) [8] in cuttings of *Podocarpus neriifolius* D. Don. were treated with 0.8 per cent IBA solution.

Similar trends of results were also reported by Hiral and Patel (2018) [6] in fig (*Ficus carica*L.), Wani *et al*. (2018) [16] in *Ginkgo biloba* Linn., Delazeri *et al*. (2017) [3] in *Eucalyptus dunnii* Maiden, Azad and Matin (2015) [1] in *Swietenia macrophylla*, Husen *et al*. (2015) [9] in *Morus alba*, Dhiman and Gandhi (2014) [4] in Mysore gum (*Eucalyptus tereticornis*), Singh *et al*. (2011) [14] and Rana *et al.* (1987) [13] in *Dalbergia sissoo*.

Table 1: Influence of various levels of growth hormones on days to sprout (days), days to 50 per cent sprout (days), root length (cm), number of primary roots, increased shoot length (cm), survival (%) and root: shoot ratio (length basis) in cuttings of *Casuarina equiseifolia* L.

Treatments	Days to sprout (days)	Days to 50% sprout (days)	Root length (cm)	Number of primary roots	Increased shoot length (cm)	Survival (%)	Root: shoot ratio (length basis)
T_1: Control	12.33	17.33	4.43	4.11	3.93	11.67 (19.93)	0.59
T_2: Control (water)	11.67	15.67	4.54	4.33	4.15	15.00 (22.76)	0.60
T_3: Indole Acetic Acid (IAA) @ 25 ppm	12.00	15.00	4.62	5.33	4.45	22.78 (28.48)	0.60
T_4: Indole Acetic Acid (IAA) @ 50 ppm	10.67	12.67	5.37	6.67	5.42	39.45 (38.88)	0.62
T_5: Indole Butyric Acid (IBA) @ 25 ppm	11.00	14.33	4.71	6.20	4.69	30.00 (33.16)	0.61
T_6: Indole Butyric Acid (IBA) @ 25 ppm	10.00	13.00	5.67	7.87	5.89	43.89 (41.46)	0.63
T_7: Napthalene Acetic Acid (NAA) @ 25 ppm	9.33	13.00	4.92	6.93	4.67	32.78 (34.85)	0.64
T_8: Napthalene Acetic Acid (NAA) @ 25 ppm	9.00	10.33	5.74	7.87	6.22	47.22 (43.38)	0.65
T_9: Indole Acetic Acid (IAA) @ 25 ppm + Indole Butyric Acid (IBA) @ 25 ppm	8.67	11.00	6.61	9.00	7.22	55.56 (48.18)	0.69
T_{10}: Indole Acetic Acid (IAA) @ 25 ppm + Napthalene Acetic Acid (NAA) @ 25 ppm	8.00	11.00	6.37	8.27	6.97	52.22 (46.26)	0.67
T_{11}: Indole Butyric Acid (IBA) @ 25 ppm + Napthalene Acetic Acid (NAA) @ 25 ppm	6.67	9.67	6.82	9.13	7.52	61.11 (51.40)	0.69
Mean	9.94	13.00	5.44	6.88	5.56	37.42 (37.16)	0.63
S. Em. (±)	0.63	0.89	0.06	0.24	0.15	2.20 (1.33)	0.01
C.D. at 5 %	1.84	2.60	0.18	0.70	0.44	6.46 (3.91)	0.03
C.V. %	10.94	11.83	1.99	6.06	4.66	10.20 (6.21)	3.12

* Figures in parenthesis are transformed values. ANOVA was done on transformed values

Plate I: Growth of *Casuarina equisetifolia* L.as influenced by various growth hormones

5. Conclusion
From the result of experiment and foregoing discussion, it is concluded that among all the concentrations of IAA, IBA, NAA and their combinations, combination of IBA @ 25 ppm + NAA @ 25 ppm was found most effective treatment for inducing rooting and increasing root growth and survival percentage of cuttings. Hence, the quality planting material of Casuarina can be produced by using growth hormones IBA @ 25 ppm + NAA @ 25 ppm.

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