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Propagation of *Quercus robur* L. (English Oak) by stem cuttings in Western Himalayas (Kashmir)

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Abstract

Two experiments were conducted for propagation of *Quercus robur* L. by stem cuttings in Kashmir valley. First experiment which includes: hardwood cuttings were treated with Indolebutyric acid(IBA)having concentrations of 5,000, 10,000, 15,000, and 20,000 ppm in talc and Naphthalene acetic acid (NAA) having concentrations of 500, 1,000 and 1,500 ppm in talc while the second experiment i.e. softwood cuttings were taken and treated with Indolebutyric acid (IBA) having concentrations of 5,000, 10,000, 15,000, 20,000 ppm quick-dipped for 5-seconds and Naphthalene acetic acid (NAA) having concentrations of500, 1,000 and 1,500 ppm dipped for 24 hours and in both (nontreated) as control and placed under mist conditions. It was found that English Oak can be propagated through cuttings and auxin treatment is imperative and Indolebutyric acid (IBA) with concentration of 10,000 ppm showed best results with highest recorded rooting of 51.30 per cent in case of softwood cuttings and for hardwood cuttings also, Indolebutyric acid (IBA) with concentration of 10,000 ppm showed good results with highest recorded rooting of 29.70 per cent. However, control and NAA-treatments in both softwood and hardwood cuttings could not induce rooting at all.

Keywords: *Auxin*, *english oak*, *rooting*, *softwood and hardwood cuttings*

Introduction

Quercus robur L. commonly known as English Oak belongs to family Fagaceae and a member of white oak section. English oak, locally known as Palaekul, is a large deciduous tree with spreading crown, a short sturdy trunk and deeply fissured grey brown bark.It can live in excess of 1,000 years and can grow to well over 30 m. Wood of English Oak has long been used for boat building, docks and harbours, railway wagons, ladders, furniture and cabinet making (Gasson, 1987).The presence of oaks on a landscape scales in intricately linked to ecosystem function and forest health (Johnson *et al*., 2002). *Quercus robur* L. is valued for its importance to insects and other wildlife. Acorns are rich in starch and fats and are eaten by small mammals and a number of birds. Jays and squirrels are extremely important in dispersing acorns away from the parent trees; they bury them for later consumption and many of these acorns germinate (White, 1995). Oak tree has a long history of a medicinal use. English Oak, King of trees is used as a shade tree as well as for aesthetic values in large landscapes (Mabey,1996).The rooting of various species of Oaks proved to be difficult and the progress in vegetative propagation has been slow. Studies have indicated that stem cuttings of Oaks root poorly by vegetative propagation (Flemer, 1962; Drew and Dirr, 1989; McGuigan *et al.,*1996; Zaczek *et al.,* 1997).Therefore, the present research was conducted to study the rooting patterns for propagation of the species by stem cuttings.

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Material and Methods

The research was conducted in Faculty of Forestry of Sher-e-Kashmir University of Agricultural Sciences and Technology, Kashmir (SKUAST-Kashmir) during the years 2011-2012. Both hardwood and softwood stem cuttings of English Oak were employed for the purpose. Stem tissue of hardwood cuttings was firm, matured and a distinct snapping sound was noted when broken. Hardwood cuttings were collected (22ndFebruary 2011) from both mature healthy plants of age 5-20 years old at the Shalimar Campus, SKUAST-Kashmir,using hand pruning shears and kept under soil were then taken out (1stMarch 2011) and kept in moist plastic bags and transported to the forestry greenhouses, faculty of agriculture and regional research station, Wadura, Kashmir. The cuttings were then trimmed

from the bases to 10-15 cm in length. The bases of cuttings were first dipped into distilled water followed by treatment of the basal 2 cm with 0 ppm (nontreated), 5,000 ppm, 10,000 ppm, 15,000 ppm, 20,000 ppm IBA in talc and 500 ppm, 1,000 ppm, 1,500 ppm NAA in talc (eight treatments). Cuttings were treated after wounding (giving a basal-cut) and slanting at the top end. Cuttings were then placed obliquely in the polybags of size 7″ x 9″ containing a medium of sand and placed in mist-chamber. For the softwood cuttings, cuttings were taken when the new leaves were fully expanded and the stems were soft and succulent. They did not break or snap when pressure was applied. Cuttings were collected (on 30thJune 2011) from healthy plants of age 5-20 years old at the Shalimar Campus, SKUAST-Kashmir, using hand pruning shears and soaked in cold water for overnight. Cuttings were taken out (1stJuly 2011)and kept in moist plastic bags and transported to the forestry greenhouses,faculty of agriculture and regional research station, Wadura, Kashmir. The cuttings were then trimmed from the bases to 10-15 cm in length and all leaves were removed from the lower-third of each cutting. Eight treatments were made by dissolving first IBA and NAA in 50-per cent ethanol for the required concentrations, keeping one treatment as control (nontreated). The basal 2 cm of cuttings were treated with 0 ppm, 5,000 ppm, 10,000 ppm, 15,000 ppm, 20,000 ppm IBA for 5 seconds and 500 ppm, 1,000 ppm, 1,500 ppm NAA for 24 hours. Cuttings were treated after wounding (giving a basal-cut) and air-dried before placement in the medium. Cuttings were then placed obliquely in the polybags of size 7"×9" containing a medium of sand and placed in mist-chamber.Cuttings were maintained at day/night temperatures of 25±4/15±4 ^{o}C. Intermittent mist operated daily (5 sec/10 minutes) during day light hours and natural photoperiod and irradiance were provided. Cuttings were arranged in a randomized complete block design with 15 cuttings per treatment, replicated four times. After 14 weeks, the cuttings were taken out and data was recorded with respect to sprouting percentage (%), rooting percentage (%), sprouted shoot length (cm), diameter of sprouted shoot (mm), number of roots per cutting (≥1 mm) and length of longest root (cm). A cutting having one root (≥1 mm) was considered rooted.

Results And Discussion

In the first experiment, a larger portion of hardwood cuttings died at the end of 14 weeks. Maximum rooting was found in treatment T_2 (IBA@10,000 ppm) with 29.70 per cent rooting(Table-1). Softwood cuttings rooted at much higher percentages with auxin treatment being essential (Table-2). Auxin treatment stimulated rooting and the response was greatest rooting (51.30 per cent) with 10,000 ppm. In cuttings treated with various concentrations of NAA, no sprouting and rooting were observed at all. Also, no sprouting and rooting were observed in cuttings kept as control (nontreated).In hardwood cuttings experiment, the sprouted shoot length (cm), diameter of sprouted shoot (mm), number of roots per cutting and length of longest root (cm) in case of treatment T_2 (IBA @ 10,000 ppm) were found as 5.37 cm, 4.02 mm, 7.75 and 8.75 cm, respectively while as in case of softwood cuttings experiment, treatment T_2 (IBA 10,000 ppm), the sprouted shoot length (cm), diameter of sprouted shoot (mm), number of roots per cutting and length of longest root (cm) were found as 3.92 cm, 2.97 mm, 5.50 and 7.87 cm, respectively. Although basal stem necrosis was extensive for cuttings treated with IBA solutions and cutting mortality was high, we do not feel these were responsiblefor poor rooting of hardwood cuttings. In both experiments,cuttings were damaged to some extent by all IBA treatments. However,roots formed above the damaged basal portion of the stem. Although in the present research, the best rooting (51.30 per cent with IBA 10,000 ppm) in case of softwood cuttings, the authors feel that rooting can be increased further by manipulating environmental conditions (e.g., water relations, shade, etc) during rooting. Results clearly indicate that maximum rooting can be achieved in the softwood cuttings and auxin treatment is imperative. These results are in agreement with the previous reports by Flemer, (1962); Spethmann,(1986); McGuigan *et al*. (1996). Roots of the rooted cuttings were found to be brittle and easily broken byroutine handling. Based on this, the authors recommend rooting *Quercus robur* L. cuttings in small individual containers or in flats with individual cells to avoid damage to roots during transplanting which can result in transplant

Table-1: Effect of plant growth regulators (Auxins) on different growth characteristics of English Oak (*Quercus robur* L.) hard wood cuttings

Auxins	Treatments	Sprouting (%)	Rooting (%)	Sprouted shoot length(cm)	Diameter of sprouted shoot (mm)	Number of roots per cutting	Length of longest root (cm)
Control	T_0 (Distilled water)	-	-	-	-	-	-
IBA	T_1 (5,000 ppm)	14.50 (22.37)	9.63 (18.06)	3.95	3.15	5.00	9.75
IBA	T_2 (10,000 ppm)	52.08 (46.19)	29.70 (33.00)	5.37	4.02	7.75	8.75
IBA	T_3 (15,000 ppm)	27.45 (31.54)	15.03 (22.80)	5.10	3.75	7.50	7.50
IBA	T_4 (20,000 ppm)	19.65 (26.24)	8.75 (17.01)	4.00	3.07	5.75	6.50
NAA	T_5 (500 ppm)	-	-	-	-	-	-
NAA	T_6 (1,000 ppm)	-	-	-	-	-	-
NAA	T_7 (1,500 ppm)	-	-	-	-	-	-
$CD_{0.05}$		**2.02**	**1.98**	**0.47**	**0.35**	**1.16**	**1.79**
Sem±		**0.97**	**0.95**	**0.22**	**0.17**	**0.56**	**0.86**

***Figures within parentheses are arc sine transformed values. All data are based on 14 weeks' time-period**

Table-2: Effect of plant growth regulators (Auxins) on different growth characteristics of English Oak (*Quercus robur* L.) soft wood cuttings.

Auxins	Treatments	Sprouting (%)	Rooting (%)	Sprouted shoot length (cm)	Diameter of sprouted shoot (mm)	Number of roots per cutting	Length of longest root (cm)
Control	T_0 (Distilled water)	-	-	-	-	-	-
IBA	T_1 (5,000 ppm)	31.25 (33.97)	26.25 (30.81)	3.57	2.80	3.50	8.70
IBA	T_2 (10,000 ppm)	54.83 (47.77)	51.30 (45.75)	3.92	2.97	5.50	7.87
IBA	T_3 (15,000 ppm)	32.57 (34.79)	25.45 (30.29)	4.07	3.17	6.00	6.30
IBA	T_4 (20,000 ppm)	24.25 (29.44)	14.38 (22.11)	4.02	3.17	6.50	5.75
NAA	T_5 (500 ppm)	-	-	-	-	-	-
NAA	T_6 (1,000 ppm)	-	-	-	-	-	-
NAA	T_7 (1,500 ppm)	-	-	-	-	-	-
$CD_{0.05}$		**2.26**	**2.22**	**0.33**	**0.22**	**1.04**	**1.25**
Sem±		**1.08**	**1.06**	**0.15**	**0.10**	**0.50**	**0.60**

***Figures within parentheses are arc sine transformed values.All data are based on 14 weeks' time-period**

shock. De Klerk *et al.* (1999) summarized the successive developmental phases that occur in the rooting of stem cuttings as dedifferentiation, induction, outgrowth in the stem and outgrowth from the stem. During the initial phase (dedifferentiation), activation of cells (to become competent) by wounding related compounds and auxin takes place, followed by initiation of cell division (to become committed) where auxin stimulates the formation of root meristemoids. During outgrowth in the stem phase, meristemoids develop into typical dome-shaped root primordia (to become determined), and at this stage, auxin (exgenously applied) then becomes inhibitory. Root primordia elongate and develop during the differentiation phase and finally grow out of the stem during the last phase of adventitious rooting process. Results of this study were based on stem cuttings of the plants of age 5-20 years old of English Oak. However, the possibility exists that tree-to-tree variation in rooting may exist for this species as it has been reported for many woody species including *Pseudotsuga menziesii* L. (Brix and Barker, 1973); *Quercus virginiana* Mill.(Morgan, 1985) and the phenomenon of juvenility/maturation is an important factor when propagating many woody speciesby stem cuttings including oaks as reported by some authors that cuttings from young trees are more easily rooted than those from older trees (Borzan*et al*., 1983; Hartmann *et al*., 2002). The first report of possibility of propagation of English Oak through treated hardwood cuttings is evident from the data obtained in this investigation, resembles to propagation through treated hardwood cuttings in various difficult-to-root tree species like hardwood stem cuttings of *Castanopsis sclerophylla* which is an evergreen tree of family Fagaceae rooted (3 %) when treated with Indolebutyric acid (IBA) under intermittent mist condition (Conden and Blazich, 2003). Similarly, Pijut and Moore (2002) had reported the hardwood stem cuttings of 5-and-6 year old *Juglanscinerea* rooted (9%) when treated with a basal dip (10-15 seconds) in IBA placed in a moist medium under intermittent mist condition. Poor rooting ability among plant species has been attributed to the presence of growth inhibitors (Barlow *et al.*, 1961), a lack of or imbalance of hormones or rooting cofactors (Hess,1961), and the presence of physical barriers (Beakbane, 1961). The possibility of producing English Oak through cuttings exists and further research from here needs to be carried out. i.e. juvenility/maturation factor, overwinter survival, clone variations, etc.

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