Research Article

Effect of IBA on Rooting and Seedling Growth of *Ginkgo Biloba* L. Stem Cuttings under Temperate Conditions of Kashmir

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Abstract

The present investigation entitled "Effect of IBA on stem cuttings of *Ginkgo biloba* L. under temperate conditions of Kashmir was carried out at Faculty of Forestry, Benihama, Ganderbal J&K. Softwood cuttings of both male and female trees of *Ginkgo biloba* were collected in February-March and were treated with different concentrations of Indole 3-butyric acid (IBA). Vegetative propagation of *Ginkgo biloba* stem cuttings revealed that 300ppm IBA have shown maximum sprouting (91.18%), survival (87.29%), rooting percent (74.77), shoot length (21.07cm), collar diameter (5.93mm), leaf area per plant (71.12cm²), and total biomass(3.10g) in female trees. Results of the present investigation have led to the conclusion that female cutting performed better than male cuttings in terms of growth and biomass production.

Keywords: IBA**,** *Ginkgo biloba*, Kashmir, Vegetative propagation

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Introduction

The state of Jammu and Kashmir lies in Western Himalayas which has been recognized as floristically under explored by the Botanical Survey of India [1]. Jammu and Kashmir is a hilly state with an area of 2,22,236 Km^2 [2]. Biogeographically, it comprises of three district provinces: the subtropical Jammu, the predominantly temperate Kashmir, and the cold-arid Ladakh. About $2/3^{rd}$ of the state's total area is recorded under forest and substantial part of this is non-conducive for the growth, being under permanent snow, glaciers and cold deserts [2]. *Ginkgo biloba* L. the sole survivor of the ancient family of Ginkgoaceae is the world's oldest tree. Also known as Maidenhair tree, Ginkgo is a monotypic genus native to China [3, 4]. *Ginkgo biloba* was admitted as a living fossil of Jurassic period that emphasizes its relic position [5]. *Ginkgo biloba*, which is not closely related to any other living plant, is generally classified in its own division the Ginkgophyta. Ginkgo is a hardy tree, tolerating a variety of climate and soil types. It can grow well in climates with a mean annual temperature from 8 to 20℃ and can tolerate a minimum temperature of -20℃ and annual rainfall ranging from 840 to 1400mm. The tree can survive for a short period at seasonal extreme temperature of 40℃ and -30℃ in China [6, 7]. The Ginkgo tree is grown in many regions of the world, now cultivated extensively in Asia, Europe, North America, New Zealand and Argentina.

The species is cultivated commercially for obtaining leaves which are known to contain a wide variety of medicinally active chemicals, most notably terpinoides and flavonoides [8]. Ginkgo leaf extracts are used for many pharmaceutical purposes. The leaves of this species are extensively used in the form of a concentrated standardized *Ginkgo biloba* Extract (GBE) in different countries of the world (particularly in China, Europe, France and Germany) as a source of herbal medicine. This extract is taken internally for the treatment of cerebral and peripheral vascular diseases, as well as to alleviate some of the ailments associated with ageing, including dizziness, ringing in the ears and short term memory loss deterioration.

Ginkgo biloba L. was listed as a rare species in the IUCN 1997 red list of threatened plants and listed in the red list of endangered plant species. Because of it is high medicinal value the species has been exploited by pharmaceutical industries all over the world. The demand for *Ginkgo biloba* in the world is increasing from 26-36% every year. So, there is urgent need to cultivate *Ginkgo biloba* at large scale [9]. The species is sparely distributed in some parks of Kashmir valley and till date no concrete efforts have been made for *ex-situ* conservation of this species of highest medicinal value.

Vegetative or asexual propagation; a most convenient, easiest and economical method of propagation [10-12] used to produce a plants of identical genotype has also been least studied for this species. Propagation by vegetative means assumes importance when desirable biotypes need to be multiplied in short span of time. Most ornamentals, green house crops and numerous fruit and forest trees are propagated through cutting and grafting [13]. Vegetative

propagation of selected trees is the most efficient way to increase the production of quality wood and the number of disease-resistant individuals [14].

Materials and methods

The present study was conducted in the Faculty of Forestry, SKUAST-Kashmir, Benhama village (Tehsil- Lar, District- Ganderbal). The site lies on the southern aspect at $34^0$16'44"N and $74^0$46'31"E. The study area is located at an elevation of 1783m (5850 feet) above the mean sea level. The study area has temperate climate experiencing four distinct seasons: a severe winter (December to Febuary), a cold spring (March to May), a mild summer (June to August) and a pleasant autumn (September to November). The site falls in a mid to high altitude characterized by hot summer and very cold winters.. The average precipitation is 690 mm most of which is received from December to April in the form of snow and rains

In order to work out vegetative propagation, Softwood cuttings of both male and female trees of *Ginkgo biloba* were collected in February-March. The final cuttings were prepared (16-20 cm length and pencil thickness diameter) with 4-5 buds. Cuttings were treated with different concentrations of Indole 3-butyric acid (IBA) by dipping their basal portion in the solution for half an hour. One untreated set of cuttings served as control. The different IBA concentrations (ppm) used were T_1=Control, T_2=100, T_3=200, T_4=300, T_5=400 and T_6=500. The design of the experiment was CRD with three replications and 50 cuttings per treatment per replication were used.

Results and Discussion

Sprouting percentage was significantly affected by the treatments and cuttings in **Table 1**. Significantly maximum sprouting percentage (91.18%) was recorded in T_4 (IBA @ 300 ppm). Minimum sprouting percentage (86.71%) was recorded under control. There was also a significant difference between sprouting percentage of male and female cuttings. Maximum sprouting percentage of (90.20%) was recorded in female cuttings when treated with (IBA @ 300 ppm) while minimum sprouting percentage (88.34%) was recorded in male cuttings under control. The perusal of Table 1 further depicted that interaction effect of treatments and cuttings on survival percentage was non-significant.

Survival percentage was significantly affected by the treatments and cuttings in Table 1. Maximum survival percentage (87.29%) was recorded in T_4 (IBA @ 300 ppm) and minimum (11.23%) under control. There was also a significant difference between survival percentage of male and female cuttings. Maximum survival percentage (60.49%) was recorded in female cuttings at 300 ppm IBA while minimum survival percentage (51.70%) was recorded in male cuttings under control. The perusal of Table 1 further depicted that interaction effect of treatments and cuttings on survival percentage was also significant. Maximum survival percentage (90.87%) was recorded in T_4 of female cuttings whereas, minimum survival percentage (9.30%) was recorded T_1 of male cuttings.

Rooting percentage was significantly affected by the treatments and cuttings in Table 1. Maximum rooting percentage (74.77%) was recorded in T_4 (IBA @ 300 ppm and minimum (13.03%) under control. There was also a significant difference between rooting percentage of male and female cuttings. Maximum rooting percentage (58.70%) was recorded in female cuttings at 300 ppm IBA while minimum rooting percentage (48.39%) was recorded in male cuttings under control. The perusal of Table 1 further depicted that interaction effect of treatments and cuttings on rooting percentage was also significant. Maximum rooting percentage (80.35%) was recorded in T_4 of female cuttings whereas, minimum rooting percentage (10.02%) was recorded T_1 of male cuttings.

Table 1 Effect of IBA on sprouting, survival and rooting percent of *Ginkgo biloba* stem cuttings

Treatments	Sprouting per cent			Survival per cent			Rooting per cent		
	Male	Female	Mean	Male	Female	Mean	Male	Female	Mean
T_1(control)	86.29	87.13	86.71	9.30	13.17	11.23	10.02	16.04	13.03
T_2(100ppm)	87.55	88.83	88.19	23.48	31.57	27.52	35.68	43.94	39.82
T_3(200ppm)	88.83	91.22	90.03	54.65	72.75	63.70	50.37	70.91	60.64
T_4(300ppm)	90.14	92.23	91.18	83.70	90.87	87.29	69.19	80.35	74.77
T_5(400ppm)	89.11	91.04	90.07	73.48	81.46	77.47	65.81	73.96	69.88
T_6(500ppm)	88.15	90.78	89.46	65.62	73.15	69.38	59.28	67.01	63.14
Mean	88.34	90.20		51.70	60.49		48.39	58.70	
C.D ($P \leq 0.05$)									
Cuttings (C) : 0.57			Cuttings (C) : 2.14			Cuttings (C) : 2.69			
Treatments (T) : 0.99			Treatments (T) : 3.71			Treatments (T) : 4.65			
Interaction (C x T): N/S			Interaction (C x T): 5.24			Interaction (C x T) : 6.58			

Shoot length was significantly affected by the treatments and cuttings in **Table 2**. Maximum shoot length (21.07 cm) was recorded in T_4 (IBA @ 300 ppm) and minimum (14.37 cm) under control. There was also a significant difference between shoot length of male and female cuttings. Maximum shoot length (19.08 cm) was recorded in female cuttings at 300 ppm IBA while minimum shoot length (17.39 cm) was recorded in male cuttings under control. The perusal of Table 2 further depicted that interaction effect of treatments and cuttings on shoot length was non-significant.

Table 2 Effect of IBA on shoot parameters of *Ginko biloba* stem cuttings

Treatments	Shoot length(cm)			Collar diameter(mm)		
	Male	Female	Mean	Male	Female	Mean
T_1(control)	12.83	15.91	14.37	3.54	3.73	3.63
T_2(100ppm)	16.53	18.03	17.28	3.83	4.24	4.03
T_3(200ppm)	16.87	18.70	17.78	4.56	4.60	4.58
T_4(300ppm)	20.17	21.97	21.07	5.66	6.20	5.93
T_5(400ppm)	19.50	20.53	20.02	4.90	5.90	5.40
T_6(500ppm)	18.47	19.37	18.92	4.65	5.27	4.96
Mean	17.39	19.08		4.52	4.99	
C.D ($P \leq 0.05$)						
Cuttings (C) : 0.65		Cuttings (C) : 0.23				
Treatments (T) : 1.13		Treatments (T) : 0.40				
Interaction (C x T) : N/S		Interaction (C x T) : N/S				

Collar diameter was significantly affected by the treatments and cuttings in Table 2. Maximum collar diameter (5.93 mm) was recorded in T_4 (IBA @ 300 ppm). Minimum collar diameter (3.63 mm) was recorded under control. There was also a significant difference between collar diameter of male and female cuttings. Maximum collar diameter (4.99 mm) was recorded in female cuttings at 300 ppm IBA while minimum collar diameter (4.52 mm) was recorded in male cuttings under control.The perusal of Table 2 further depicted that interaction effect of treatments and cuttings on collar diameter was non-significant.

Leaf area was significantly affected by the treatments and cuttings in **Table 3**. Significantly maximum leaf area (71.12 cm^2) was recorded in T_4 (IBA @ 300 ppm). Minimum leaf area (14.64 cm^2) was recorded under control. There was also a significant difference between leaf area of male and female cuttings. Maximum leaf area (49.49 cm^2) was recorded in female cuttings at 300 ppm IBA while minimum leaf area (32.6 cm^2) was recorded in male cuttings under control. The perusal of Table 3 further depicted that interaction effect of treatments and cuttings on leaf area was also significant. Maximum leaf area (82.14 cm^2) was recorded in T_4 of female cuttings whereas, minimum leaf area (12.46 cm^2) was recorded T_1 of male cuttings.

Table 3 Effect of IBA on leaf area/plant (cm^2) and total biomass (g) of *Ginkgo biloba* stem cuttings

Treatments	Leaf area			Total biomass		
	Male	Female	Mean	Male	Female	Mean
T_1(control)	12.46	16.82	14.64	1.16	1.15	1.16
T_2(100ppm)	24.34	30.31	27.32	1.36	2.23	1.80
T_3(200ppm)	4.23	46.88	40.55	2.37	2.60	2.48
T_4(300ppm)	60.10	82.14	71.12	3.03	3.17	3.10
T_5(400ppm)	38.40	70.14	54.27	2.73	3.06	2.88
T_6(500ppm)	26.18	50.68	38.43	2.27	2.10	2.63
Mean	32.61	49.49		2.15	2.54	
C.D ($P \leq 0.05$)						
Cuttings (C) : 4.17		Cuttings (C) : 0.31				
Treatments (T) : 7.22		Treatments (T) : 0.54				
Interaction (C x T) : 10.21		Interaction (C x T) : N/S.				

Total biomass was significantly affected by the treatments and cuttings in Table 3. Significantly maximum total biomass (3.10 g) was recorded in T_4 (IBA @ 300 ppm). Minimum total biomass (1.16 g) was recorded under control. There was also a significant difference between total biomass of male and female cuttings. Maximum total biomass (2.54 g) was recorded in female cuttings at 300 ppm IBA while minimum total biomass (2.15 g) was recorded in male cuttings under control. The perusal of Table 3 further depicted that interaction effect of treatments and cuttings on

total biomass was non-significant. The data presented in Table 1 shows that the female cuttings raised under the influence of IBA @ 300 ppm produced the maximum sprouting and survival percentage. The minimum sprouting and survival percentage was found in cuttings raised under controlled conditions the female cuttings performed better than male cuttings in terms of root and shoot parameters the results are in line with [15] in *Ginkgo biloba*. The data presented further depicted that the female cuttings raised under the influence of IBA 300 ppm produced the maximum Rooting percentage (74.77%). Female cuttings performed better than male cuttings. Similar studies were reported by [16] in Scarlet Oak seedlings where they found a huge increase in adventitious root regeneration by auxin treatments as compared to control seedlings. Similarly [17] shared similar results in *Salix planifolia.* The root parameter per rooted female cutting was found higher as compared to male cuttings. The application of IBA may have an indirect influence by enhancing the speed of translocation and movement of sugar to the base of cuttings and consequently stimulate rooting to increase the number and quality of root produced per cutting [18]. Further it has been reported that IBA @ 300 ppm is the best growth regulator to be used for vegetative propagation of Hackberry with enhanced rooting percentage of 21.33% and root length 30.54 cm (19). Maximum rooting percentage and root length per plant was recorded by [15] on application of IBA @ 250 mg/l (85.33% and 13.67 cm).

The results on growth parameters of *Gingko biloba* seeds are summarized in Tables 1-3. It was evident from the result that growth parameters like shoot length (21.07 cm), root length (8.32 cm), collar diameter (5.93 mm), leaf area (71.12 cm^2) and total biomass (3.10 g) increased significantly at 300 ppm IBA and female cuttings performed better than male cuttings. Similar results were shown by (17) on *Salix planifolia* the growth parameters per rooted female cutting was found higher as compared to male cuttings. It has been reported that IBA @ 300 ppm is the best growth regulator to be used for vegetative propagation of Hackberry with average plant height of 37.7 cm and collar diameter 0.5 cm [19].

Effect of different IBA treatment on cuttings of *Ginkgo biloba*

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