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Effect of IBA concentrations on rooting and growth of *Ulmus wallichiana* Planchon stem cuttings under temperate conditions of Kashmir

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Abstract
The present investigation entitled, "Effect of IBA concentrations on rooting and growth of *Ulmus wallichiana* Planchon stem cuttings under Temperate conditions of Kashmir" was carried out at Faculty of Forestry SKUAST-K Benehama during the year 2018-19**.** In this research, in order to study the effect of different concentrations of IBA on rooting and survival of *Ulmus wallichiana* cuttings, a study was conducted in a randomized complete block design with four replications. Treatments consisted of five levels of hormones: 0 (control), 500ppm, 1000ppm, 1500ppm, 2000 ppm and 2500ppm of IBA. Results showed that highest rooting (15.00% and 5.37%) root length 10.62cm and 8.62cm were recorded for IBA concentrations of 2000ppm in the hardwood and softwood cuttings respectively. The maximum mean length of shoot 8.12cm and 8.26cm were achieved in concentration of 2000ppm IBA in hardwood and softwood cuttings respectively. Further percentage 10.50% and 4.50% survival was recorded in hardwood and softwood cuttings at 2000ppm IBA treatments. Moreover, greatest sprouting 50.25% in hardwood and 9.75% in softwood was obtained in concentration of 2000ppm IBA, under open field conditions.

Keywords: IBA, stem cuttings, *Ulmus wallichaina*, propagation, rooting

Introduction
Ulmus wallichiana (Planchon) locally known as bren is one of the commonly grown broad leaved tree species in Kashmir Valley and is best known representative of family Ulmaceae and genus Ulmus. *U. wallichiana* is important traditional and endangered plant species of western Himalaya used for treatment of fractured bones in animals as well as human being. The Himalayan Elm grows to 30 m tall, with a broad crown featuring several ascending branches. The bark of the trunk is greyish brown and longitudinally furrowed. The leaves are elliptic-acuminate, less than 13 cm long and 6 cm broad. The samara are usually orbicular, less than 13 mm in diameter. Mostly flowers exist in a clusters form on branches and maximum flowering offers during March- April. (Melville and Heybroek 1971) [13]. A strong fibre is obtained from the inner bark. Plant is used for cordage, slow matches and sandals. Chemical investigation of *U. wallichiana* revealed flavonoids present in stem bark. In IUCN red list *U. wallichiana* falls in vulnerable category. However, *U. wallichiana* falls under critically endangered species in Pakistan as only 44 mature individuals were found in different parts of district Battagram. There are number of threats responsible for decrease in *U. wallichiana* number in western Himalayan which may include deforestation, over exploitation and climate changes. *U. wallichiana* has the potential to prevent and treat osteoporosis, so an attempt should be made to conserve this important plant species with possible ant osteoporosis properties (Batool *et al*., 2014) [3]. In nature the Elm is propagated through seeds, however, seeds of *Ulmus wallichiana* are scarcely available for afforestation due to high incidence of empty seeds and low longevity. Zimmerman and Wilcoxon, (1935) [23] reported that Indole-3-butyric acid (IBA) is a stable indole compound that was effective in the promotion of rooting of cuttings of species on which IAA was not effective. Kanwar *et al.* (1996) [10] tested one year old branches of twenty five year old trees under nursery conditions, under the effect of auxin, season and cuttings position for rooting potential of *Ulmus lavigata.* They reported that growth regulators enhance rooting in the cuttings of *Ulmus lavigata*. Amri *et al.* (2009) [1] studied that IBA treated cuttings produced higher percentage rooting, number of roots and root length than untreated cuttings which revealed a strong IBA influence on rooting ability of stem cuttings in *Dalbergia melanoxylon.* Gangoo *et al.* (2007) [7] tested rooting hormone and found that it had

improved the rooting percentage of the *Buxus wallichiana* hardwood cuttings. The results showed that the combination of IBA and NAA gave best rooting percentage as compared to individual doses of 500 and 1000 ppm and observed that the increase sole doses of IBA and NAA did not show the positive effect on rooting percentage. Aslam *et al*. (2007) [2] revealed that in *Taxus baccata* IBA 500ppm (out of the three auxins IAA, IBA and NAA) performed best regarding rooting of cuttings (76.66%), while control resulted in minimum rooting of 8 per cent only. Lower concentrations (500ppm) of all the three auxins were found to be better than their higher concentrations. Considering the positive influence of IBA on rooting, in the present study, the effect of different concentrations of IBA on rooting and survival of *Ulmus wallichiana* hardwood and softwood stem cuttings were studied).

Materials and Methods

This experiment was performed in open field conditions at Faculty of Forestry; Benhama SKUAST-Kashmir in 2019.The experiment was performed as randomized complete block design, with four replications. The treatments included five concentrations of IBA (0, 500, 1000, 1500, 2000 and 2500ppm). Softwood cuttings were taken from new shoot tips in July whereas hardwood cuttings were taken in February from one year old shoot before new growth starts in spring. Bottom of the cuttings were treated with hormone of IBA at different concentrations, for 1 minute in each concentration, and then cuttings were planted in open field. After one week sampling was done and the interest traits were measured. There traits include the percentage of rooting, root length, shoot length, leaf area and survival percentage. To prevent fungal infection, cuttings were dipped in 1 per cent captan and 1 per cent sucrose prior to planting. The data collected in the field was analyzed using SPSS software.

Results and Discussion

The data represented in table 1 revealed that, IBA formulation had exerted a significant influence on sprouting per cent. Maximum sprouting (50.25%) was observed when the cuttings were treated with T_4 (2000ppm IBA) formulation. This was however, closely followed by T_5 (2500ppm IBA) with (40.00%) and T_3 (1500ppm IBA) with (39.00%) and T_2 (2000ppm IBA) with (36.25%). The least per cent sprouting (30.00%) was recorded in T_6 (control). while in softwood cuttings (Table 2), IBA formulations had exerted a significant influence on per cent sprouting. Significantly maximum sprouting (9.75%) was observed when the cuttings were treated with T_4 (2000ppm IBA) formulation. This was however, closely followed by T_5 (2500ppm IBA) with (9.00%) and T_3 (1500ppm IBA) with (7.75%) and T_2 (1000ppm IBA) with (7.50%). The least sprouting (2.50%) was recorded in T_6 (control) being closely preceded by T_1 (500ppm IBA) with (5.75%).

Perusal data presented in table 1 and 2 showed that, IBA formulations exerted a significant influence on rooting per cent of hardwood cuttings of *Ulmus wallichiana*. Maximum rooting (15.00%) was observed when the cuttings were treated with T_4 (2000ppm IBA) formulation. This was however, closely followed by T_5 (2500ppm IBA) with (12.55%) and T_3 (1500ppm IBA) and T_2 (1000ppm IBA) with (12.00%). The least rooting (2.50%) was recorded in control (Table 2). As far as softwood cuttings is concerned IBA formulation of T_4 (2000ppm IBA) resulted highest rooting (5.37%) which was however, closely followed by T_5 (2500ppm IBA) with (4.75%) and T_3 (1500ppm IBA) with (4.50%). The rooting (4.45%) was noticed in T_2 (1000ppm IBA) treatment. The least rooting (2.50%) was noticed in T6 (control) being closely preceded by T_1 (500ppm IBA) with 3.32% rooting (Table 4).

The data presented in table 1 and 2 showed that survival per cent of hard wood cuttings was significantly influenced by IBA formulation. The IBA formulation of T_4 (2000ppm IBA) resulted in highest survival (10.50%) which was, however, closely followed by T_5 (2500ppm IBA) with (10.25%) and T_3 (1500ppm IBA) with (9.50%). The survival (9.37%) was noticed in T_2 (1000ppm IBA) formulation. The least survival (2.50%) was noticed in T_6 (control). Whereas in softwood cuttings, IBA formulation of T_4 (2000ppm IBA) resulted highest survival (4.50%) which was however, closely followed by T_5 (2500ppm IBA) with (4.00%) and T_3 (1500ppm IBA) with (3.97%). The survival (3.55%) was noticed in T_2 (1000ppm IBA) treatment. The least survival (2.50%) was noticed in T6 (control) being closely preceded by T_1 (500ppm IBA) with (3.28%).

The data presented in table 1 and 2 resulted that IBA formulations had exerted a significant influence on shoot length of hardwood cuttings. Significantly maximum shoot length (8.12cm) was observed when the cuttings were treated with T_4 (2000ppm IBA) formulation. This was however, closely followed by T_5 (2500ppm IBA) with (7.65cm) and T_3 (1500ppm IBA) with (6.62cm) and T_2 (1000ppm IBA) with (6.25cm). The least shoot length (3.75cm) was recorded in T6 (control). As far as softwood cuttings is concerned, the IBA formulation of T_4 (2000ppm IBA) resulted highest shoot length (8.26cm) which was however, closely followed by T_5 (2500ppm IBA) with (6.12cm) and T_3 (1500ppm IBA) and T_2 (1000ppm IBA) with (5.00cm) was recorded. The least root length (2.50cm) was noticed in T_6 (control) being closely preceded by T_1 (500ppm IBA) with (3.75cm).

The data given in table 1 showed that root length of hard wood cuttings was significantly influenced by IBA-formulation. The IBA formulation T_4 (2000ppm IBA) resulted highest root length (10.62cm) however, closely followed by T_5 (2500ppm IBA) with (9.87cm) whereas T_3 (1500ppm IBA), T_2 (1000ppm IBA) and T_1 (500ppm IBA) were at par with each other. The least root length (2.50cm) was noticed in T_6 (control). Whereas softwood cuttings is concerned (Table 2), the IBA formulation T_4 (2000ppm) resulted highest root length (8.62cm) which was however, closely followed by T_5 (2500ppm IBA) with (8.50cm) and T_3 (1500ppm IBA) with (8.00cm). The root length (7.25cm) was noticed in T_2 (1000ppm IBA) treatment. The root length (3.50) was noticed in T_6 (control) being closely preceded by T_1 (500ppm IBA) with (7.12cm).

IBA has been found to be the best rooting hormone in case of many other tree species as reported by Gurumurti and Bhandari (1988) [8], Chandra and Verma (1989) [6], Pal (1992) [16] and Nautiyal & Rawat (1994) [15]. IBA formulations have induced rooting in *Taxus baccata* (Aslam *et al*., 2007) [2], *Taxus wallichiana* (Singh, 2007) ,*Ulmus glabra* (Shahraji *et al*., 2007) [19], *Populus alba* (Ramesh and Khurana, 2007), *Jatropha curcas* (Limbasiya *et al*., 2007) [11], *Terminalia chebula* (Madhwal *et al*., 2008) [12], *Quercus robur* L. (Iqbal *et al*., 2014) and *Morus alba* (Rafeeq *et al*., 2020) [17].

In *Ulmus wallichiana*, hardwood cuttings treated with 2000ppm IBA (T_4) recorded maximum sprouting (50.25%), rooting (13.00%),and survival(10.50%), shoot length (8.12cm) and root length (10.62cm) .Similar trend was observed in softwood cuttings when sprouting (9.75%),

rooting (5.37%), and survival(4.50%), shoot length (8.26cm) and root length (8.62cm) were recorded maximum in cuttings treated with 2000ppm IBA (T_4). These results are in line with the findings of the results of Tomar and Kumar (2018) [21] who also recorded maximum rooting 41.3 per cent with 6000 ppm IBA for Mukteshwar (Nainital) and with 7000 ppm IBA for Munsyari (Pithoragarh) while the minimum rooting, excluding control, was 26.3 per cent for Bijoriya (Bageshwar) at 4000 ppm IBA. He also suggested that without IBA, the rooting success was zero to 2.50 per cent in *Ulmus wallichiana* stem cuttings. Bhat *et al.,* (2007) [4] also reported that maximum rooting, maximum root length and primary root number recorded in cuttings when treated with IBA @200ppm. Further, they recorded that, softwood cuttings did not respond to the plant growth regulators treatment in *Ulmus wallichiana*. Another similar results were observed by Mughal *et al.* (2009) [14] in *Aesculus indica*, as highest rooting success of 50 per cent were observed when cuttings were treated with IBA @ 4000 ppm and cuttings treated with IBA @ 2000 ppm had 25% rooting rate. Further, they recorded that IBA @ 4000 ppm was a better-applied concentration. Hardwood cuttings collected during February before bud burst rooted significantly better than softwood cuttings taken in July in both the species, it might be due to cuttings taken in February contained higher level of sugars and total carbohydrate content, and had peroxidase enzyme activity, but were also low in nitrogen content. All these parameters, excepting N, were found to have positive relationships with rooting response, These findings support the observations of Veierskov *et al*. (1982b) [22], who advocated that the initial carbohydrate content must be sufficient to supply the cutting with energy for optimum rooting. Cuttings of both the species collected in July had comparatively higher nitrogen content and poor rooting. Higher nitrogen content of cuttings taken in July might have stimulated shoot development and had negative effects on rooting through competition for carbohydrate, nutrient, and hormones. Bora (1990) [5] has also reported that high N content has a negative influence on the rooting of cuttings.

Table 1: Effect of IBA concentration on sprouting per cent, rooting per cent survival per cent, shoot length and root length of hardwood stem cuttings of *Ulmus wallichiana.*

IBA Concentration	Sprouting (%)	Rooting (%)	Survival (%)	Shoot length(cm^2)	Root length(cm^2)
T_1 (500ppm)	34.50	10.77	9.00	6.00	8.50
T_2 (1000ppm)	36.25	12.00	9.37	6.25	8.25
T_3 (1500ppm)	39.00	12.00	9.50	6.62	8.10
T_4 (2000ppm)	50.25	15.00	10.50	8.12	10.62
T_5 (2500ppm)	40.00	12.55	10.25	7.65	9.87
T_6 (control)	30.00	2.50	2.50	3.75	2.50
CD($p \leq 0.05$)	4.50	2.51	1.05	1.93	0.76

Table 2: Effect of IBA concentration on sprouting per cent, rooting per cent, survival per cent, shoot length and root length of softwood stem cuttings of *Ulmus wallichiana.*

IBA Concentration	Sprouting (%)	Rooting (%)	Survival (%)	Shoot length(cm^2)	Root length(cm^2)
T_1 (500ppm)	5.75	3.32	3.28	3.75	7.12
T_2 (1000ppm)	7.50	4.45	3.55	5.00	7.25
T_3 (1500ppm)	7.75	4.50	3.97	5.00	8.00
T_4 (2000ppm)	9.75	5.37	4.50	8.26	8.62
T_5 (2500ppm)	9.00	4.75	4.00	6.12	8.50
T_6 (control)	2.50	2.50	2.50	2.50	3.50
CD($p \leq 0.05$)	1.30	0.53	0.85	2.20	1.18

Conclusion

According to the research results, different concentrations of IBA and time of taking cuttings i.e. hardwood and softwood had a large impact on the success of rooting, sprouting and survival in cuttings of *Ulmus wallichiana*. 2000ppm IBA concentration showed best results and thus may be used for the propagation of *Ulmus wallichiana* stem cuttings.

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