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The Vegetative Propagation Possibilities of Black Alder [*Alnus glutinosa* subsp. *barbata* (C. A. Mey.) Yalt.] by Softwood Cuttings

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Abstract: In this study, the collecting date of softwood cuttings, rooting media, ortet age and cutting type were investigated on *Alnus glutinosa* subsp. *barbata* (C. A. Mey.) Yalt. Rooting media and cutting type showed no significant effect on the rooting percentage (RP), ramet height (RH) and rootlet number (RN) while ortet age showed significant effect on these parameters. The highest RP as 56.7 and 48.3% were obtained for the tip cuttings and basal cuttings of 1+0 aged ortets, respectively, while the lowest RP as 0%, was obtained for the tip cuttings of 2+0 aged ortets. Determining of the lower RP for the cuttings of 2+0 aged ortets than the cuttings of the older ortets can be explained together with the ortet genetic character. The highest RH (18.3 cm) was obtained for the tip cuttings of the 1+0 aged ortets and RN (8.3 number) was obtained for the basal cuttings of the same ortets. The highest mean RP were obtained for the cuttings of 1+0 aged seed originating ortets and physiologically 1+0 aged sprout originating ortets as 41.35 and 35.55%, respectively. Based on the results of this study, basal cuttings of the young ortets, collected in the middle of the June should be used in the autovegetative propagation of *Alnus barbata*.

Key words: *Alnus glutinosa* sub sp. *barbata*, rooting, ramet, breeding program, rootlet

INTRODUCTION

Alnus glutinosa (L.) Gaertn. belongs to the genus *Alnus* the family *Betulaceae* which comprises about 36 species (Krstinic, 1994). It has a very large range of natural distribution. Such large range in combination with relatively small isolated populations inside it ensures a very marked genetic variability (Weisgerber, 1974).

The black alder becomes a more and more interesting forest tree species due to its multiple uses both in the forestry and in the agroforestry. Owing to symbiotic actinomycetes, it is known as a meliorative species. However, this species proved to be very suitable for tree cultivation either in the form of pioneer plantations or in mixed plantations (Hansen and Dawson, 1982; Heilman and Stettler, 1983). In addition, *Alnus* genus is pioneers of the riparian zone (Francis *et al*., 2005); and it could be an effective land rehabilitation strategy of degraded land (Semval *et al*., 2003).

For the faster growing character than the other six taxa, *A. glutinosa* subsp. *barbata* is an economically valuable one among the other naturally distributed black alder taxa in Turkey. In Eastern Blacksea region, the pure forests of this taxon cover an area of 43853 ha; mixed forests also cover an area of 63694 ha. In spite of little proportion (app. 1%) of this taxon's forest in Turkey's forest area (Saracolu, 1998), fast growing character, high biological regeneration ability raise its importance, especially for the region. Also, this taxon is used in the region prevalently, by the local public. At the same time, there are vast suitable potential plantation areas in the region (Cetin, 1988; Ayan *et al.,* 1998).

There are rather limited studies on the autovegetative propagation of the *Alnus barbata*. And also; contradictory data were given about the vegetative propagation possibilities of the different alder species. For instance; difficulties in propagation of alder with the cuttings were expressed based on Powell's (1965) study (Atasoy and Kucuk, 1986). Having been reached to the unsuccessful results in vegetative propagation of *Alnus nepalensis* D. Don. which naturally distributed in India, Nepal and Burma, justified the above finding (Anonymous, 2002a). As for *Alnus rubra* Bong. the rooting of the cuttings were not easily. Also, as a study result, in which, different provenances, cutting collect dates and phytohormones were tested, the highest rooting rate was obtained as 67.9% in the propagation of the *Alnus maritime* (Marsh.) Nutt. by using softwood

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cuttings (Anonymous, 2002b). Despite of these, the propagation of alder species using both in-vitro techniques and autovegetative propagation were claimed as possible (Gulbaba *et al*., 2000). Furthermore, the autovegetative propagation was expressed for *Alnus incana* (Francis *et al*., 2005). In Turkey, in the first scientific study on the propagation of *Alnus barbata* with cuttings, the presence of rooting ability was stated in spite of many difficulties, originating from biology and growing conditions (Atasoy and Kucuk, 1986).

The aim of this research is to enhance of propagation possibilities of *Alnus barbata* with the cuttings directed towards the breeding program. For realizing this, the effects of different ortet age, cutting collect dates, cutting types on the rooting ability of softwood cuttings of *Alnus barbata* were investigated.

MATERIALS AND METHODS

Greenhouse characteristics: This research was performed in the automatically controlled greenhouse of Eastern Blacksea Forestry Research Institute during 2000 (Exp. I) and 2002 (Exp. II). In the greenhouse, temperature was regulated as 20-25°C, while humidity as 80-90%. Misting was done automatically with the regulation of hygrostat by regulating the time and duration as suitable to the media and cuttings. And this was regulated as 5 sec per 2 min except for extreme conditions. The heating of rooting media were provided with galvanized wires set in the beds.

Materials: The required material for the propagation test with softwood cuttings were obtained from the 1+0, 2+0, 3+0, 4+0 aged seed originating alder seedlings which had been growed in Maçka-Meryemana Research Nursery. Also, the stump sprouts were gotten from Trabzon-Of Yemişalan village (100 m altitude). The stump sprout cuttings were prepared by using one year-old sprouts of ortets which were 35-40 years-old and 30-40 cm in diameter. The softwood cuttings were gathered in the early morning and carried to greenhouse with icefull boxes. In the same day, cuttings were prepared and planted to the rooting media.

Method

Experiment I. Determination of the collecting date of the softwood cuttings: In this experiment, the cuttings gathered from the sprouts of 1+0 and 2+0 aged seed originating ortets were used. They were taken at two different dates, as the middle of June and the beginning of the July, 2000. As a pretreatment, the bottom of cuttings were soaked into the mixture of 4000 ppm IBA for stimulating the rooting and 10% rate of Benlate (50% Benomyl active substance) in order to prevent decaying for 10 sec (Atasoy and Kucuk, 1986; Kajba, 1998). Both the bottom and tip parts of cuttings were cut smoothly and 2-3 leaves were left on the top of each cutting. In order to reduce the transpiration, the leaf area was reduced by 50-60% with scissors. The cuttings were planted into the rooting media 10 x 10 cm in spacing both Exp. I and II. solution form of compose NPK (9+23+14%) fertilizer which contain high rate of phosphorus and potassium was applied to the all parcels for 2 months with 10 days intervals, in order to induce rooting immediately afterwards the rooting start.

Experiment II. Determination of the rooting media, ortet age, cutting type: The basal and tip cuttings, needed by the test, were obtained from the 1+0, 2+0, 3+0, 4+0 aged seed originating and one year-old stump sprout originating ortets. The same pretreatments were applied in this experiment, too. After planting the cuttings to the rooting media in the greenhouse, in one week's time, the leaf wetness was controlled and misting time regulated. Since the third weeks of the planting, whether the rooting beginned or not was observed every week. In case of the fungus infection, the cuttings were disinfected with Benlate one time in a week. In this study, Barma peat (BP), 60% Barma peat + 40% perlite (0,6 BP+ 0,4 P) and river sand (RS) media (Table 1), all of which appropriateness were proved for alder among the 15 of rooting media, were used (Yahyaoglu *et al*., 2002).

At the end of the experiments, the cuttings were carefully removed from the housing and destructive measurements, such as, rooting percentage (RP, %), ramet height (RH-cm) and rootlet number (RN) were recorded.

Experimental design and statistical evaluations: The collected data were evaluated with the TARIST statistical packet program. Multivariate analysis was used to test the treatment effects on rooting parameters. A completely randomized parcels experimental design using three

Table 1: Treatments applied to the cuttings during the course of the Exp. II

				Cutting No.	
Ortet age	Rooting Media	Treatment	Period	Basal	Tip
1+0	BP			20	10
	0.6 BP + 0.4 P			20	10
	RS			20	10
2+0	BP			20	10
	0.6 BP + 0.4 P	4000 ppm IBA		20	10
	RS	+		20	10
3+0	BP	10% Benlate	10 sec	20	10
	0.6 BP + 0.4 P	(50% Benomyl		20	10
	RS	active		20	10
4+0	BP	substance)		20	10
	0.6 BP + 0.4 P			20	10
	RS			20	10
Sprout (1+0)	BP			20	10
	0.6 BP + 0.4 P			20	10
	RS			20	10

Table 2: Cutting dates, type, ortet ages and rooting level (%) at p<0.05 level

	Collecting date of cuttings (Ortet age)					
	At the middle of June			At the beginning of July		
Cutting type	1+0	2+0	Average	1+0	2+0	Average
Basal	63.33 a	46.66 a	55.00	13.33 a	1.66 a	7.50
Tip	30.00 b	7.33 b	18.67	3.66 b	0.00 a	1.83
Overall mean	46.66	26.99	36.83 a	8.50	0.83	4.67 b

Table 3: Treatment means for assessed rooting parameters*

		Parameters								
	Ortet	RP (%)		Average	RH (cm)		Average	RN		Average
Medium	Age	Basal	Tip	(%)	Basal	Tip	(cm)	Basal	Tip	No.
	1+0	26.7	56.7	41.70	13.8	16.7	15.25	8.3	6.4	7.35
BP	2+0	10.0	0	5.00	12.0	-	6.00	3.0	-	1.50
	3+0	15.0	3.3	9.20	14.7	13.0	13.85	1.4	1.0	1.20
	4+0	13.3	6.6	9.95	11.0	12.0	11.50	1.2	3.5	2.35
	Sprout	33.3	30.0	31.65	14.1	8.6	11.35	3.9	2.6	3.25
	1+0	30.0	40.0	35.00	15.5	18.3	16.90	5.5	8.5	7.00
0.6 BP	2+0	21.7	6.7	14.20	10.5	9.5	10.00	2.0	2.0	2.00
+0.4 P	3+0	15.0	13.3	14.15	16.3	13.5	14.90	3.7	1.8	2.75
	4+0	11.7	3.3	7.50	11.3	10.0	10.65	2.4	1.0	1.70
	Sprout	30.0	26.7	28.35	13.5	12.6	13.05	3.9	3.2	3.55
	1+0	48.3	56.7	52.50	11.0	12.8	11.90	5.1	7.6	6.35
	2+0	8.3	6.7	7.50	7.4	11.5	9.5	5.2	2.0	3.60
RS	3+0	21.7	16.7	19.20	12.0	12.9	12.45	3.7	2.5	3.10
	4+0	20.0	10.0	15.00	10.4	13.0	11.7	2.7	1.3	2.00
	Sprout	26.7	16.7	43.40	11.7	12.4	12.05	6.3	6.7	6.50
Overall mean		22.11	19.56	22.08	12.35	11.79	12.07	3.89	3.34	3.61

*Values are the means of three replications

replicates and 20 basal cutting, 10 upper cutting per replicate and the Student-Newman Keuls multiple range test (p = 0.05) were used for mean separation. In addition, correlations between RP, RH RN and ortet age were compared (Duzgunes, 1963). Before variance analysis, arc-sin transformation was applied to the RP data and logarithmic transformation to the RN.

RESULT AND DISCUSSION

Experiment I: From Table 2 it was determined that collecting date and cutting type had statistically significant (p<0.01) effect on RP (F = 17.429, F = 14.172, respectively). Between the cuttings of 1+0 and 2+0 aged ortets, there was no significant difference (F = 1.779 ns) in RP. For the middle June collected cuttings and basal cuttings, the higher rooting capability was determined when compared the beginning of July collected and tip ones, respectively. Also, with respect to the overall mean of RP, the middle June collected cuttings indicated nine times superiority than the beginning of the July collected ones (Table 2). This result was confirmed by the other study in which the beginning of the summer collecting was suggested for broadleaves (Urgenc, 1982). It was determined that there was four and two times superiority in point of the RP, RN respectively, for the basal cuttings than tip cuttings, in their propagation test by using hardwood cuttings (Yahyaoglu *et al*., 2002) The bigger number of thick and fine rootlets were gotten for the basal cuttings than tip cuttings on the propagation of the *Fraxinus angustifolia* Vahl. by using hardwood cuttings (Çiçek, 2005). Also, the studies carried out on plane tree (*Platanus occidentalis* L.) (Abdullah *et al*., 1988), on maple (*Acer pseudoplatanus* L.) (Williams *et al*., 1991), on elm (*Ulmus laevigata*) (Kanwar *et al*., 1996) justified the superiority of the basal cuttings than tip cuttings with regard to root forming. It was explained that the tip cuttings with terminal buds should be preference while using softwood cuttings, contrary to this the basal cuttings without terminal buds for the hard cuttings (Urgenc, 1982).

Experiment II: As to statistical assessments Table 3 it was determined that rooting media and cutting type factors had no significant effect on the RP, RH and RN parameters. This finding about the rooting media suited to the former researches (Yahyaoglu *et al*., 2002). Also, ortet age had statistically significant effect on RP (p<0.01, F = 4.757), RH (p<0.05, F = 3.257) and RN (p<0.001, F = 13.384) (Table 4). All of cuttings showed the RP of 0%-56.7%. The highest RP was obtained from the tip (56.7%) and basal (48.4%) cuttings of 1+0 aged ortets. The lowest (0%) RP was obtained from the tip cuttings of 2+0 aged ortets (Table 3). In the tip cuttings of 1+0

Table 4: The comparison of ortet ages according to RP, RN and RH*

Ortet age	RP (%)	RH (cm)	RN**
1+0	41.35a	14.68a	0.79a
2+0	24.52b	10.68b	0.37c
3+0	26.78b	13.86a	0.30c
4+0	23.82b	11.94ab	0.27c
Sprout (1+0)	35.55ab	12.24ab	0.60b

*For each character, mean values with the same letters are not significantly different at p<0.05 level, **Rootlet numbers were given as logarithmic value

aged ortets, the highest RH (18.3 cm) was obtained. Also, the highest RN (8.3 number) was obtained for the basal cuttings of the same ortets. The lower RP of the cuttings of 2+0 aged ortets than the cuttings of the older ortets can be explained together with genetic character of the ortets.

According to the multiple test results of overall mean, the highest RP were obtained for the cuttings of 1+0 aged seed originating ortets (41.35%) and 1+0 aged sprout originating ortets (35.55%) (Table 4).

The ortet age affects the RP drastically and among the ortet ages used in this study, the cuttings of 1+0 aged seed originating ortets revealed the highest rooting success while the rooting success decrease clearly beginning from the 2+0 aged ortets (Table 4). It was claimed that black alder had evident genetic rooting ability character and successful rooting was not depend only upon the physiological condition of the cuttings, but to a great extent upon the age of ortets (Krstinic, 1994). Together with the ortet age increasing, the falling down of the success of the rooting capacity were alleged for black alder (Kajba, 1993). These findings are supported by this study finding, too. Also, the rooting success of the softwood cuttings pretreated with 4000 ppm of IBA of the 1+0, 2+0 aged ortets were determined as 39% and 22%, respectively. The relative low of the success was connected with the high phenol content of the A. *glutinosa* (Krstinic, 1994). Nevertheless, in the same study (Krstinic, 1994), it was claimed that rooting of adult black alder trees could be markedly improved by the use of secondary cuttings from ramets obtained by grafting of plus trees. In this research, after the multiple test, having been obtained the highest RP in the cuttings of 1+0 aged sprout originating ortets (35.55%) together with the cuttings of 1+0 aged seed originating ortets (41.35%) justified the above finding. Providing of the well results in the both softwood and hardwood black alder cuttings could be possible by collecting the cuttings from the ortets up to two years old (Krstinic, 1994). It was noticed that the rooting capacity was better in the softwood and hardwood cuttings of the branch sprout, collected from young trees (10-15 age group), than the older ones (Atasoy and Kucuk, 1986).

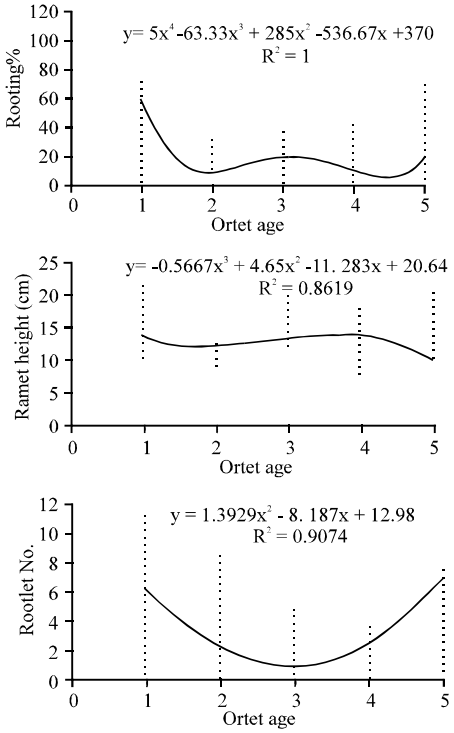

Fig. 1: The relation between ortet age with RP, RH and RN *, *Ortet ages as 1, 2, 3, 4, 5 pointed to the 1+0, 2+0, 3+0, 4+0 aged seed originating and stump sprout originating ortets, respectively

At p<0.05 level, polynomial relations as 4th, 3rd and 2nd degree determined between the ortet age and RP, RH and RN (R^2= 1, R^2= 0.8619 and R^2= 0.9074), respectively. Related formulas were given on Fig. 1.

Based on the results of the present study, the following proposals can be put forward about autovegetative propagation of the *Alnus barbata* 1) Cutting collect date is an important factor on rooting. The June middle collected cuttings should be preferred to the July beginning collected ones owing to the quite high rooting capability. 2) Because of no difference among the rooting media with regard to the assessed rooting parameters (RP, RH, RN), the more economical one should be preferred. 3) Basal cuttings should be preferred to tip ones because of high rooting performance. 4). For propagating of *Alnus barbata* by cuttings, 1+0 aged ortets or physiologically regenerated stump and root sprouts should be used as cutting material. This means that, the young ortets must be used in the autovegetative propagation. 5) In spite of no investigation on the genetic capability of the ortets in these experiments, when the obtained data are evaluated, the importance of the ortet on the rooting ability can be easily understandable.

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REFERENCES

Abdullah, Y.S., M.O. Abdullah and J. Al-Ashoo, 1988. Effect of tree age, cutting length and their distance from the base of shoots on the propagation of *Platanus occidentalis* L. seedlings. Mesopotamia J. Agric., 20: 221-236.

Anonymous, 2002. *Alnus nepalensis*: A multipurpose tree for the tropical highlands. http://www.winrock.org/forestry/factpub/FACTSH/A_nepalensis.html.

Anonymous, 2002. Propagation of *Alnus maritime* from softwood cuttings. http://www.ashs.org/events/ashs99/sessions/ps3.html.

Atasoy, H. and M. Kucuk, 1986. Kizilagac (*Alnus glutinosa* (L.) Gaetern.) celiklerinin koklendirilmesi uzerine calismalar. OAE, Teknik Raporlar Serisi, No. 38, Ankara.

Ayan, S., F. Ulu, V. Gercek and Z. Olmez, 1998. Orta ve dogu karadeniz'deki aluviyal ve koluviyal topraklar ile taskin yataklarindan kizilagac plantasyonuna uygun potansiyel alanlar. Proceedings of the Dogu Karadeniz Bolgesinde Orman Mulkiyet Sorunlari Sempozyumu, Ekim 8-10, 1998, Trabzon, pp: 453-461.

Cetin, N., 1988. Dogu karadeniz ormanciliginin ozellikleri. Proceedings of the Dogu Karadeniz Ormanciligi Sempozyumu Teblig Metinleri, Ekim 12-13, 1988, Orman Muhendisleri Odasi Yayin No. 14, Trabzon, pp: 7-12.

Cicek, E., 2005. Vegetative propagation of narrow leaved ash (*Fraxinus angustifolia* Vahl.) by stem cuttings. J. For. Fac., 5: 112-127.

Duzgunes, O., 1963. Bilimsel Aras-Tirmalarda Istatistik Prensipleri ve Metodlari. Ege Universitesi Matbaasi, Izmir.

Francis, R.A., A.M. Gurnell, G.E. Petts and P.J. Edwards, 2005. Survival and growth response of *Populus nigra*, *Salix elaeagnos* and *Alnus incana* cuttings to varying levels of hydric stress. For. Ecol. Manage., 210: 291-301.

Gulbaba, A.G., H. Ozturk and S. Siklar, 2000. Dogu karadeniz bolgesi sakalli kizilagac (*Alnus glutinosa* subsp. *barbata*) genetik islah stratejisi ve program. DOA Dergisi, O.B. Dogu Akdeniz Orm. Aras. Mud., Sayi. 6, Tarsus, pp: 57-86.

Hansen, A.E. and J.O. Dawson, 1982. Effect of *Alnus glutinosa* on hybrids *Populus* height growth in a short-rotation intensively cultured plantation. Forest Sci., 28: 49-59.

Heilman, P. and R.F. Stettler, 1983. Phitomass production in young mixed plantations of *Alnus rubra* and cottonwood in Western Washington. Canadian J. Microbiol., 28: 1007-1013.

Kajba, D., 1993. Possibilities of cloning for the silver birch (*Betula pendula* Roth.) and black alder (*Alnus glutinosa* (L.) Gaertn.). Glas. Sum. Pokuse, 29: 39-76.

Kajba, D., 1998. Species of genus *Alnus* L. suitable for biomass production. Proceedings of the 3rd Scientific Conference on Propagation of Ornamental Plants, October, 3-5, 1998, Sofia, Bulgaria, pp: 53-60.

Kanwar, B.S., S.D. Bhardwaj and G.S. Shamet, 1996. Vegetative propagation of *Ulmus laevigata* by stem cutting. J. Trop. For. Sci., 8: 333-338.

Krstinic, A., 1994. Genetics of Black Alder (*Alnus glutinosa* (L.) Gaertn.). Annales Forestales, 19\2: 33-72.

Saracolu, N., 1998. Stem volume table of alder (*Alnus glutinosa* Gaertn subsp. barbata (C. A. Mey.). Yalt. Turk. J. Agric. For., 22: 215-225.

Semval, R.L., R.K. Maikhuri, K.S. Rao, K.K. Sen and K.G. Saxena, 2003. Leaf litter decomposition and nutrient release patterns of six multipurpose tree species of central Himalaya, India. Biomass Bioenergy, 24: 3-11.

Urgenc, S., 1982. Orman agaclari islahi. I.U. Yayin No. 2836, Orman Fakultesi Yayin No. 293, Istanbul.

Weisgerber, H., 1974. First results of progeny tests with *Alnus glutinosa* (L.) Gaertn. after controlled pollination. Proceedings of the IUFRO Joint Meeting of Working Parties on Population and Ecological Genetics, Breeding Theory and Progeny Testing Session VI, (PPEG'74), Stockholm, pp: 423-438.

Williams, A., G.J. Mayhead and J.E.G. Good, 1991. Vegetative propagation of sycamore (*Acer pseudoplatanus* L.). Quart. J. For., 85: 179-182.

Yahyaoglu, Z., S. Ayan, V. Gercek and A. Sahin, 2002. *Alnus glutinosa* subsp. *barbata* celiklerinde koklendirme denemeleri. Proceedings of the 2nd Ulusal Karadeniz Ormancilik Kongresi, Cilt II, Sayfa, Mayis, 15-18, 2002, Artvin, pp: 423-430.