



Physiological taxonomy of willow species – dormancy, rooting of cuttings, reaction on auxins

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Abstract

Cuttings of six willow species were rooted in water (control) and after auxin (indole-3-acetic acid 150 mg/l) treatment. The intensity of the dormancy was determined by the following data: Root formation, shoot development, and reaction on auxin. Silky, weeping, and pussy willows do not have deep dormancy and were sensitive to auxin. The cuttings of purple, autumn and white willows were less active in the rooting process and less sensitive to auxin. These species do not open their buds in favorite laboratory conditions.

These physiological characteristics – rooting, bud opening, and reaction to auxin could be used as taxonomic features for willow identification. The rooting of poplar was connected with the position of cutting on the mother plant. The highest intensity of rooting was specific for the basal part of the twig of poplar (*Populus nigra*).

Key words: Willow, poplar, cutting, rooting, dormancy, bud opening

Introduction

There are many external factors, which have an influence on the regulation processes in the developing physiological processes (Özalpan, 2002; Palavan-Ünsal, 2002 and 2003). In our experiments the main process of willow and poplar propagation by cuttings depends on the time of rooting of the cuttings and the

position of the cutting on the twig of the mother plant. There are many internal factors, which had an influence on the rooting processes, including active wood formation, dormancy factors, phenolics accumulation and absence of rooting hormones-auxins (Turetskaya, 1961; Turetskaya *et al.*, 1966). It was very important to determine the effects of auxin on the rooting of different willow species for the vegetative propagation.

Materials and methods

Mother plants of willows and poplar were donors of cuttings and grown at the Jennings Center for Environmental Education (JCEE) in Slippery Rock, PA. The mother plants were grown on fabricated soil (Kalevitch *et al.* 2006). The cuttings, 18 cm long, were treated by indole – acetic acid (IAA), 150 mg/l. The rooting process proceeded in the lab at 25°C during 2 weeks. We selected the time (October 2004) when growth of the mother shoots stops and dormancy develops.

Results

Plant growth is a process based on the rhythmic phenomena. In our experiments with willow and poplar shoots in JCEE we observed the dependence of the shoot elongation process with the process of wood formation. The process of stem elongation of *Populus nigra* and *Salix rubra* was more intensive in the period of May and June. In July, the process of stem elongation was inhibited and the process of differentiation of wood activated.

Six species of willows were compared on their rhythmic of shoot growth. They differ in the process of growth rhythmic inhibition (GRI). White willow was a species with a very intensive GRI while purple willow had a low GRI. The other species, silky, pussy, weeping, and autumn willows, occupy an intermediate position. GRI is a process which is accompanied by the dormancy process and develops with different intensity for various willow species.

Willows were used as donors of cuttings. The experiment was carried out in the fall when rooting is usually not very active.

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Table 1. Rooting of the cuttings of 6 willow species (*Salix spp.*) Experiment started on September 25, 2004 and took place at Alter Lab, Jennings Center for Environmental Education. Data was recorded on October 17, 2004.

Name	Week number C = control A = auxin indole-3-acetic acid, 150 mg/l	Amount of roots per rooting (R)	Amount of shoots per cutting (S)	Ratio of amounts of roots to shoots (R/S)
<i>S. sericea</i> (Marsh silky)	1 C	1.40	0.75	100/100
	1 A	4.00	0.25	285/36
	2 C	1.50	1.80	100/100
	2 A	3.70	0.30	246/17
	3 C	4.30	1.30	100/100
	3 A	4.10	0.40	95/31
<i>S. babylonica</i> (L. weeping)	1 C	0.64	0.57	100/100
	1 A	1.21	0.36	189/61
	2 C	2.60	1.00	100/100
	2 A	3.50	0.07	134/7
	3 C	5.07	1.20	100/100
	3 A	7.90	0.42	158/35
<i>S. rubra</i> (L. Purple)	1 C	0.72	0.16	100/100
	1 A	0.42	0.57	58/100
	2 C	0.59	0.31	100/100
	2 A	0.40	0.25	67/81
	3 C	1.45	0.13	100/100
	3 A	0.75	0.35	51/269
<i>S. discolor</i> (Muhl pussy)	1 C	1.00	0.66	100/100
	1 A	4.00	0.17	400/25
	2 C	1.40	1.30	100/100
	2 A	2.16	0	154/0
	3 C	2.90	1.25	100/100
	3 A	0.08	0.16	2.7/12
<i>S. senissima</i> (Fern autumn)	1 C	0.38	0.30	100/100
	1 A	0.06	0	15/0
	2 C	0.21	0.35	100/100
	2 A	0.50	0	238/0
	3 C	0.41	0.53	100/100
	3 A	0.81	0.10	191/18
<i>S. alba</i> (L. white)	1 C	1.00	0	100/100
	1 A	0.55	0	55/0
	2 C	0.37	0	100/100
	2 A	1.66	0	448/0
	3 C	0.73	0	100/100
	3 A	1.73	0	236/0

Table 2. Rooting of the cuttings of 6 willow species (*Salix spp.*). The second experiment started on October 12, 2004 and took place at Alter Lab, Jennings Center for Environmental Education. Data was recorded on October 26, 2004.

Name	Week number C = control A = auxin indole-3-acetic acid, 150 mg/l	Amount of roots per rooting (R)	Amount of shoots per cutting (S)	Ratio of amounts of roots to shoots (R/S)
<i>S. sericea</i> (Marsh silky)	1 C 1 A	3.60 11.50	1.40 0.87	100/100 319/62
<i>S. babylonica</i> (L. weeping)	1 C 1 A	3.71 3.63	0.20 0.30	100/100 97/150
<i>S. rubra</i> (L. Purple)	1 C 1 A	0.83 4.63	0 0	100/100 0
<i>S. discolor</i> (Muhl pussy)	1 C 1 A	0.70 2.37	0.22 0.75	100/100 338/340
<i>S. senissima</i> (Fern autumn)	1 C 1 A	0 0	0 0	0 0
<i>S. alba</i> (L. white)	1 C 1 A	0 0	0 0	0 0

Table 3. Comparative data on the rooting of willow cuttings from 2 experiments started on September 25, 2004 and October 12, 2004.

Name	Week 1 C = control A = auxin indole-3-acetic acid, 150 mg/l	Amount of roots per rooting (R)	Amount of shoots per cutting (S)	Ratio of amounts of roots to shoots (R/S)
<i>S. sericea</i> (Marsh silky)	Exp. 2 C 2 A	3.60 11.50	1.40 0.87	100/100 319/62
	Exp. 1 C 1 A	1.40 4.00	0.75 0.25	100/100 285/36
<i>S. babylonica</i> (L. weeping)	Exp. 2 C 2 A	3.71 3.63	0.20 0.30	100/100 97/150
	Exp. 1 C 1 A	0.64 1.21	0.57 0.36	100/100 189/61
<i>S. rubra</i> (L. Purple)	Exp. 2 C 2 A	0.83 4.63	0 0	100/100 0
	Exp. 1 C 1 A	0.72 0.42	0.16 0.57	100/100 58/100
<i>S. discolor</i> (Muhl pussy)	Exp. 2 C 2 A	0.70 2.37	0.22 0.75	100/100 338/340
	Exp. 1 C 1 A	1.00 4.00	0.66 0.17	100/100 400/25
<i>S. senissima</i> (Fern autumn)	Exp. 2 C 2 A	0 0	0 0	0 0
	Exp. 1 C 1 A	0.38 0.06	0.30 0	100/100 15/0
<i>S. alba</i> (L. white)	Exp. 2 C 2 A	0 0	0 0	0 0
	Exp. 1 C 1 A	1.00 0.55	0 0	100/100 55/0

Table 4. Rooting and bud opening of willow cuttings in the fall 2004 (F) and in the spring 2005 (S)

Samples of willows	Fall (F) or Spring (S)	Roots on One Cutting			Open Buds on One Cutting		
		Water	IAA	Ratio of IAA to Water (%)	Water	IAA	Ratio of IAA to Water (%)
Silky	F	10.1	15.3	151	1.8	1.3	72
	S	7.1	5.8	81	4.0	2.8	70
Autumn	F	0	0	0	0	0	0
	S	0	0	0	0	0	0
Red	F	1.8	15.3	151	0	0.2	0
	S	6.6	5.7	86	2.4	1.9	79
White	F	0.8	1.8	225	0	0	0
	S	5.2	9.0	173	1.6	1.9	118
Weeping	F	8.9	9.6	107	8.9	9.6	107
	S	5.2	9.0	173	0.8	1.1	132
Pussy	F	2.2	8.5	386	0.3	1.1	300
	S	4.9	11.7	238	1.7	1.8	107

Two willow species, *Salix sericea* and *Salix discolor*, could be used for rooting in the fall because they do not have dormancy. The other willows are dormant and do not form roots or develop shoots.

Auxin, IAA, stimulates the rooting of the cuttings of silky and pussy willows but does not have an effect on the rooting of the cuttings of white, autumn, weeping and purple willows.

The second experiment confirms that auxin has a stimulating effect on the fall rooting of the cuttings of silky willow and pussy willow.

Different willow species have a specific reaction on IAA in the case of bud opening. Spring cuttings of weeping willow had less open buds than the fall ones. The other species have more open buds in the spring. IAA stimulates bud opening for pussy willow in the fall whereas the other species have the opposite reaction.

Discussion and conclusion

Willow species have different capability of rooting and shooting in our experiments when plants grow on fabricated soils (Kefeli, 2007; Kefeli and Dunn, 2007).

Some species like autumn willow are not able to form roots and shoots on their cuttings in the fall or in

the spring. Some, like white and red willows, do not open buds on their cuttings in the fall. Pussy willow is able to form roots and open buds in the fall and in the spring. Pussy and weeping willows have a positive reaction (active rooting) on the auxin (IAA, 150 mg/l). It confers to the theory of hormone – inhibitors relations (Kefeli and Kadyrov, 1971; Tretjakov, 2002). Thus, such differences in the growth and regeneration properties could be used as additional characteristics for willow taxonomy.

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