PROPAGATION OF WILLOWS BY CUTTINGS

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ABSTRACT

The rooting capacity of a total of 107 **Salix** taxa was tested. Most taxa rooted readily in two types—over the entire cutting surface, or concentrated at the lower end. Rooting was normally rapid, taking place in 15 to 18 days. Easy-to-root species rooted when cuttings were one or more years old, but poorly-rooting species survived only when older and thicker cuttings were used. Cuttings of almost any size can be used. No difference in type of rooting was related to the sex of the parent.

INTRODUCTION

Willows possess an excellent capability of being propagated vegetatively by cuttings. In this respect, there is hardly any other genus among those referred to as "woody" which compares with *Salix*.

Willows have been grown from cuttings since time immemorial, for the production of osiers. However, instructions handed down from the past on how practically to handle cuttings for laying out osier plantations are of limited value, because, firstly, they refer to a very limited range of species; and secondly, the physiologico-ecological conditions are not indicated with sufficient accuracy.

The unusual progress and expansion in knowledge of the physiology of plants which have been made during the latest decades have meant, among other things, a significant contribution to the recognition of the origin of the adventitious roots developed on the cuttings. This has resulted in the elucidation of the intricate correlations associated with the formation of these roots. In this paper, the object is to deal with problems associated with the propagation of willows by cuttings from a different angle—that of the genus *Salix* as a whole.

Up to now, the capacity of willows to strike roots has been studied on material of a very limited range. Only the common willow species have been used for experimental work, presumably not more than 10 species and crosses that are of importance for the production of osiers. But the genus *Salix* includes a large number of species; at least three hundred of them are known to exist in the world. Therefore, the task is to propagate by cuttings the largest possible number of species of this genus.

EXPERIMENTAL PROGRAMME

Material

To undertake a project of such extent as outlined above required a sufficient number of willow species available. This condition was met when the Salicetum was established, i.e., a large collection of living willows in the Arboretum controlled by the Brno School of Forestry, Brno, Czechoslovakia. A range of willows from Europe, Asia, and America has gradually been collected in the Salicetum. Even some subtropical willows from Central America, South America, Africa, and India have been obtained; these are grown in the greenhouse. The collection also includes small-size willow species from arctic and alpine situations and these are cultivated in the Alpinum. At present, there are nearly 350 taxa of the genus *Salix* in the collection, with roughly one-half of these being pure species. Accordingly, the collection presents a spectrum of species of the *Salix* genus. However, some species from the Himalayas, China, and Japan are not represented.

Methods

The rooting capacity of winter cuttings of a total of 107 taxa was tested in a water trial. The selection was made to give the best possible comparison between the cuttings used. Observations are mainly confined to the following factors: age of the cuttings, size of the cuttings, cutting surface, sex, and mode of storage. Rooting capacity was also tested in an analogous series of summer cuttings. The effects of the time of sampling the cuttings during the growing season were observed to a limited extent. Rooting capacity was also tested in branches touching the ground and left unseparated from the plant. Species producing root shoots were re-examined. Separate observations of rooting were made with cuttings of the small-size arctic and alpine willow species.

A number of useful and interesting findings resulted from the routine horticultural work associated with planting, transplanting, and treating the willows in the collection. During this period, good contacts were also kept with institutions using willows in their field work; and their experiences were included in our records. No growth-stimulating compounds were applied in the experiments.

RESULTS

General Rooting Capacity

Although cuttings of the overwhelming majority of *Salix* species strike root readily there is a range from ready rooting to poor rooting. Related species show similar features in rooting capacity. There are very few species that do not strike root at all. Within one and the same species both non-rooting and rooting clones may exist.

Type of Rooting

The formation of adventitious roots was found to follow two patterns: the roots were either roughly distributed over the entire surface of the cutting (diffuse type) or were concentrated at the circumference of the lower cutting surface (basal type) (Figs. 1 and 2). The former was by far the most common, and also included the better-rooting species, while the latter was characteristic of the poorly rooting species. In crosses where both types of rooting were represented in the parent plants, the patterns of rooting were mixed. The crowd of roots in superimposed rows correspond to the occurrence of wood slots; in these the roots arise.

FIG. 1—The diffuse type of rooting (**Salix cordata** Muehl).

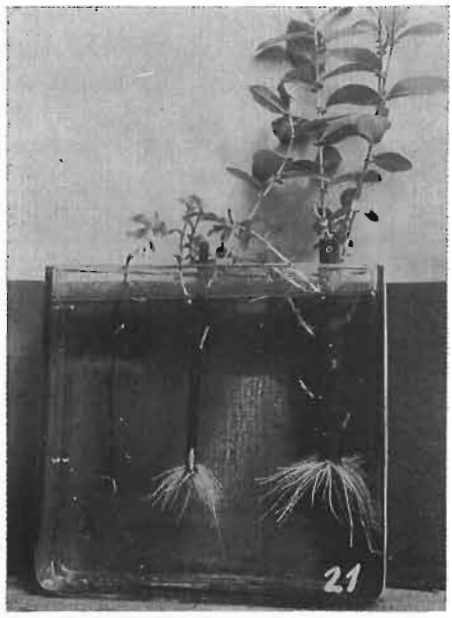

FIG. 2—The basal type of rooting.

Rate of Rooting

The cuttings sampled during the period of rest at lower temperatures (−10°C) and transported to a warm place struck root generally in 15-18 days (this applies to some 50% of the studied taxa). Poorly-rooting species, on the other hand, were slow to root, sometimes taking up to 60 days.

Difference in the Onset of Root and Shoot Growth

Some 50% of the tested taxa began sprouting simultaneously both roots and shoots, whether or not the cutting had at its top a well-developed bud. About 10% of the species began developing roots slightly later than shoots. In 40% of the species the sprouting commenced on shoots first, with the striking of the roots being delayed as much as 15 days. This interval was found still greater with the poorly-rooting species. It is clear that if the formation of roots lags behind the growth of shoots a disadvantageous water balance results which may ultimately lead to withering of the cutting.

Age of the Cutting

Readily-rooting willow species display good growth no matter whether the cutting is one or more years old. The poorly-rooting species are capable of surviving only if thicker, and so cuttings several years old are used for planting. About one-third of the species examined showed poorer results when one-year-old and thin cuttings were used. It is concluded that older and thicker cuttings always give better results. Nutrient reserves are assumed to be the decisive factor.

Size of Cuttings

Provided sufficient supplies of moisture are available, even quite short cuttings are capable of rooting well (some cuttings examined were 3 cm in length). In practice, however, the cutting which reaches a depth in the soil where there are sufficient supplies of moisture is most likely to survive. The high-rooting species are able to grow when the "pole", or even the "stem" size of the cutting is used. To prove this, we experimentally planted a "giant cutting" of the head-type willow, 70 cm in diameter, and the trial proved successful (Figs. 3 and 4).

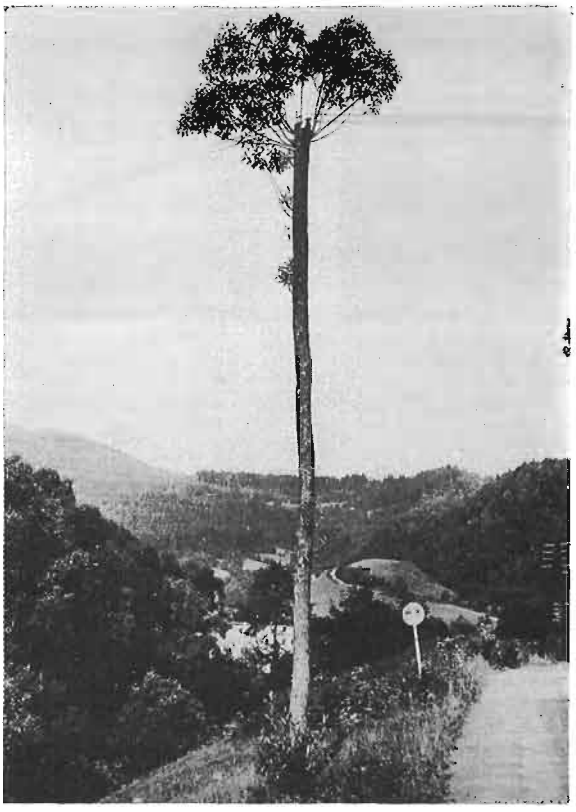

FIG. 3—The rooted stem of **Salix fragilis** L.

Cutting Surface

In practice, much importance has been attached to the requirement of making a smooth cut with a sharp knife. However, this claim could not be demonstrated in our experiments. The experimental cuttings, whether cut with scissors, with a saw or an axe, all gave identical results. Even hand-broken "cuttings" displayed equally good rooting.

Location of the Cutting in the Soil

When planted upside down, willow cuttings either do not strike at all or develop monstrous formations. Correctly orientated cuttings grow well whether planted in a

FIG. 4—Three-year-old adventitious roots on a stem of **Salix alba** L. which is 70 cm in diameter.

vertical or oblique position, and they do so even when placed almost horizontally in the soil. However, there is a risk that the cutting will dry out if planted horizontally and at shallow depth. In the alpine willow species which are characterised by prostrate growth, the vertical position appears to be disadvantageous; in such cases a leafy shoot is sent off from the bottom part, the roots being formed higher on the cutting. It sometimes happens that a shoot formed below ground level will fail to force its way to the surface.

Effects of Sex

Our experiments showed no differences attributable to sex in the type of rooting, the onset of sprouting, or the amount of root matter produced. Nevertheless, pistilate specimens are known to survive better when exposed to stress conditions. Despite every effort made to have in our collection both sexes of each of the willow species represented, pistilate individuals now predominate.

Winter Storage

The parallel series of willows sampled in frosty weather and then stored for as much as 65 days showed no material variations in the mode of rooting. Another, less numerous, group of cuttings was experimentally stored in an icebox for a period of 10 months and no reduction in rooting capacity resulted. On the other hand, an increase in the ambient temperature, variations in humidity, and the reverse position of storing the cuttings caused essential changes.

CONCLUSIONS

The result of our research carried out on the rooting capacity of willow cuttings and presented in this paper suggests a number of potential, hitherto neglected applications of willow species to the following aims: consolidation of the banks of water courses and of reservoirs; afforestation of unproductive areas; plantation of greenery in dwelling estates; cultivation of osier willows; plantation of selected species offering

food for bees; and laying out plantations of decorative species in which to cut "pussy willows". The entire complex of problems associated with the propagation of willows from cuttings reveals the genus *Salix* to be highly plastic and diversiform and, due to the abundance of its species and the multiplicity, it offers itself as a "model genus" upon which to study vegetative propagation.