SOME FACTORS IN THE DEVELOPMENT OF CALLUS IN POPLAR CUTTINGS ¹

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ABSTRACT

The effect of temperature, moisture content of the cutting, and location within the shoot and cutting on callus production were investigated in *Populus trichocarpa* Torr. and Gray, *P. canadensis* Moench 'Regenerata', and *P. canadensis* 'Robusta Bachelieri'. Callus production increased with temperature and moisture content although not to the same extent in the three varieties. Cuttings from the base of the shoot produced more callus than those from the upper part. The latter cuttings produced more callus from the end which had been lowermost in the parent shoot than that which had been uppermost. However, cuttings from the base of the shoot showed this difference between ends of cuttings only in *P. 'Regenerata'*.

INTRODUCTION

From investigations into the development of adventitious roots in poplar cuttings it appears that some roots arise from callus tissue (Bier 1961, Bloomberg 1963). To learn more about the factors which influence callus formation, and therefore root development as well, experiments were carried out to determine the effects of temperature, moisture content of the shoot, and location within the shoot and within the cutting on the amount of callus tissue produced in cuttings of *Populus trichocarpa* Torr. and Gray, *P. canadensis* Moench 'Regenerata', and *P. canadensis* 'Robusta Bachelieri'.

Methods used to prepare cuttings were the same as those reported in a previous paper (Bloomberg 1963). Briefly, cuttings were made from vigorous 8-month-old shoots, approximately 7 feet long, collected in November. In each shoot, cuttings were taken from the region extending from the ground to a point one-quarter of the way up each shoot and from the region between the mid-point of the shoot and a point three-quarters of the way up the shoot. These were designated as basal and upper cuttings respectively.

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The moisture content of the cuttings was brought to 50 or 100% of saturation and they were incubated at 5, 15, or 25° C. in polyethylene bags. After 21 days, callus was excised from the ends of cuttings, dried to constant weight at 75-80° C., and the weight expressed as milligrams per centimeter of circumference of the ends.

The experiments were factorial in design with 12 replications for each factor. A total of 72 cuttings was used. The data were statistically analysed after a transformation to log x which was used to correct heterogeneity of error. The values in Tables 1 and 2 must therefore be converted to log x in order to test for significant differences. All differences referred to are significant at the 5 or 1% level of probability.

RESULTS

In *P. trichocarpa* and *P. 'Regenerata'* more callus was produced by cuttings with a moisture content of 100% saturation than by those with 50%; the ratio was 10 to 1 in *P. trichocarpa* and 3 to 1 in *P. 'Regenerata'* (Table 1).

TABLE 1

EFFECT OF MOISTURE CONTENT IN POPLAR CUTTINGS ON THE DEVELOPMENT OF CALLUS

Variety	Moisture content % saturation	Weight of callus mg/cm of circumference
<i>P. trichocarpa</i>	50	9.4 ** ¹
	100	126.0
<i>P. 'Regenerata'</i>	50	18.4 **
	100	61.3
<i>P. 'Robusta'</i>	50	66.6
	100	84.2
LSD Moisture contents		.3790

¹ ** Indicates a highly significant difference between the adjacent values.

Moisture content had no significant effect on callus production in *P. 'Robusta'*. Callus was produced at 15 and 25° C. but not at 5° C. In *P. trichocarpa*, four times as much callus was produced at 25° as at 15° C., but in the hybrids there was no significant difference in this respect. At these temperatures, cuttings from the basal region of the shoot in all varieties produced more callus than those from the upper region (Table 2). In all cuttings from the upper region of the shoot, the end of the cutting which had been lowermost in the parent shoot produced significantly more callus than the uppermost end; however, except for *P. 'Regenerata'* (Table 2), cuttings from the lower shoot showed no difference in this respect. Based on average values for all factors, *P. 'Robusta'* produced more callus (41.7 mg) than either *P. trichocarpa* or *P. 'Regenerata'* (33.6 mg each).

The findings agree generally with those of Swingle's studies (1929) on the effect of temperature, moisture and polarity of callus formation in willow

TABLE 2
EFFECTS OF SHOOT REGION AND END OF CUTTING ON THE
DEVELOPMENT OF CALLUS IN POPLARS

Variety	Shoot region	End of cutting		
		Upper	mg callus/cm circumference	Lower
<i>P. trichocarpa</i>	upper	10.2 **	** ¹	21.0 **
	basal	70.5		84.7
<i>P. 'Regenerata'</i>	upper	3.9 **	**	54.1 **
	basal	52.8	**	112.9
<i>P. 'Robusta'</i>	upper	37.1 **	**	138.7 **
	basal	85.7		71.2

LSD shoot regions and ends .1456

¹ ** Indicates a highly significant difference between the adjacent values.

and apple cuttings, and with the observations of Bier (1961) regarding the presence of callus in *P. 'Robusta'* cuttings. The effects of the different factors on callus production were generally similar to their effects on adventitious root production (Bloomberg 1958, 1963). Therefore it appears that conditions which favor callus development also favor root production. Although *P. trichocarpa* was the least sensitive to temperature and moisture variation with respect to root production, this species was the most sensitive in terms of callus production. It can be inferred that under certain conditions in the field, *P. trichocarpa* will produce fewer callus-borne roots than the hybrids and may, in fact, be less dependent on them than on roots which do not arise from callus.

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REFERENCES

- BIER, J. E. 1961. The relation of bark moisture content to the development of canker diseases caused by native, facultative parasites. 5. Rooting behaviour and disease vulnerability in cuttings of *Populus trichocarpa* Torr. and Gray, and *P. 'Robusta'*. Can. J. Botany 39, 145-154.
- BLOOMBERG, W. J. 1958. Root formation of black cottonwood cuttings in relation to region of parent shoot. For. Chron. 35, 13-17.
- BLOOMBERG, W. J. 1963. The significance of initial adventitious roots in *Populus* and the effect of certain factors on their development. Forestry Chron. 39, 279-289.
- SWINGLE, C. F. 1929. A physiological study of rooting and callusing in apple and willow. J. Agr. Research, 39, 81-128.