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Research Note

Adult leaves of grapevine cuttings stimulate rhizogenesis

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K e y w o r d s : V. vinifera, rhizogenesis, foliar stimulus.

Introduction: Very few studies with grapevines have investigated the stimulating role of shoot organs on rhizogenesis. JULLIARD (1963, 1973) and BOUARD (1966), showed that young shoots growing from buds of cuttings stimulate the formation of adventious roots. According to JULLIARD (1973), it is the terminal bud that plays a decisive role in this stimulation, while the leaves have almost no influence.

Within the context of research on morphogenetic correlations in *Vitis vinifera* (FOURNIOUX 1995), we have analysed, in particular, the endogenous factors which contribute to the stimulation of the rhizogenesis of hardwood cuttings. In this paper we present evidence, that contrary to the conclusions of JULLIARD (1973), a stimulus of foliar origin plays an important role in the formation and growth of the roots of cuttings.

Materials and methods: P l a n t m a t e r i a l : This study was performed with the cultivar Pinot noir (clone 113). Twelve cultivars were tested (see Table) to demonstrate the general validity of our results. Cuttings were taken from the median part of the canes (between the 5th and the 15th node from the base) harvested in the vineyard in winter. Cuttings had one bud and 7 cm of internode below; the diameter was 8-11 mm.

C u l t u r e c o n d i t i o n s : For experiments in which the final state of rooting of the cuttings was only estimated, cuttings were rooted in pots containing a 50:50 (v/v) mixture of sandy gravel and peat. They were watered with a nutrient solution, the composition of which has previously been published (FOURNIOUX 1996). For experiments in which the rooting kinetics was followed by counting neoformed roots at regular intervals, the cuttings were grown in transparent 250 ml glass flasks filled with water. Each cutting was inserted through a slit in the soft plastic cover, which rested on the lip of the flask, allowing its easy removal, along with the cutting, in order to replenish or renew the water.

All cuttings were grown in a chamber with controlled environment at 25/22 °C day/night with a photoperiod of 16 h and 80 $\mu mol \cdot m^{-2} \cdot s^{-1}$ photosynthetic photon flux density at the cuttings. As light source we used fluorescent tubes (TL 33, PHILIPS). Rel. humidity was maintained at 80 % by a Defensor 505 humidifier connected to a sensor.

T r e a t m e n t s : Four treatments were employed. A: total defoliation, the leaves were removed regularly twice a week, as they separate from the apex, so that the shoot is permanently deprived of leaves. B: defoliation to have two adult leaves at the base of the shoot; the shoot was regularly defoliated, as for A. C: defoliation to have two young leaves near the apex. D: tip-removal above two adult leaves at the base of the shoot. Some of these treatments induced growth of axillary buds; these buds were immediately removed. Each treatment consisted of 30 replicate cuttings selected for uniformity. Each experiment with a control (30 untreated cuttings) was repeated twice.

M e a s u r e m e n t s a n d s t a t i s t i c a l a n a l y s i s : During the experiment the number of roots of the flasks-grown cuttings was followed. For cuttings grown in flasks and in pots the final state of rooting was estimated (after about 60-80 d of growth depending on the trial) by the mean number of roots per cutting and the mean fresh weight of total roots. These means were calculated from 30 measurements.

Results: E f f e c t s o f t r e a t m e n t s : In the first experiment, the effects of the 3 defoliation treatments A, B and C and the decapitation treatment (D) were compared. These treatments were applied to 2 groups of the Pinot noir cuttings: one grown in glass flasks, the other in pots; the cuttings still had no roots and shoot length was ca. 5 cm (4 or 5 leaves).

Rhizogenesis was markedly diminished by the 2 treatments (Figure), either by total defoliation (treatment A) or by defoliation which retained two young leaves only (treat-

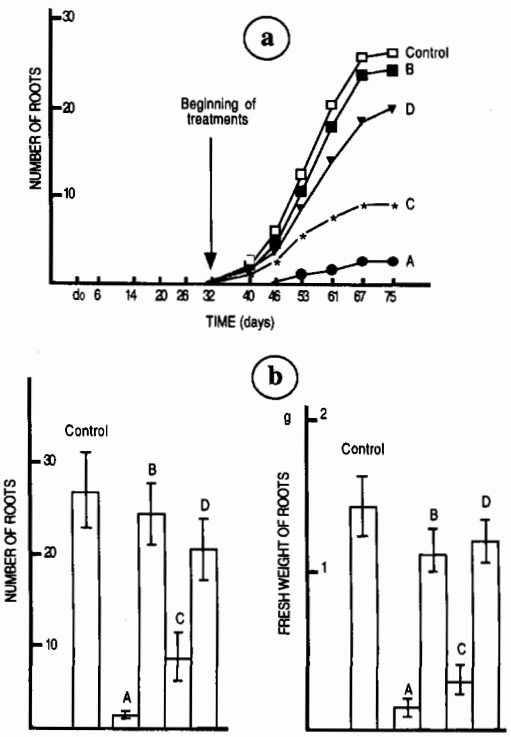

Figure: Effects of defoliation and decapitation of shoots of Pinot noir cuttings on their rooting. **a:** Cuttings grown in glass flasks. Mean number of roots formed after defoliation. d_0 is the first day of cultivation of the cuttings. Each point represents the mean value of 30 measurements. **b:** Pot-grown cuttings; standard errors are given by vertical bars.
A: total defoliation, B: two adult leaves retained at the shoot base, C: two young leaves retained near the apex, D: decapitation, two leaves retained at the base of the shoot.

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ment C). On the other hand, in the presence of two adult leaves (treatments B and D) a larger root system was formed. These results indicate that adult leaves of shoots of cuttings play a role in stimulating rhizogenesis.

Under both culture conditions (flasks and pots), retaining two adult leaves and removing the apex (treatment D), led to a more intensive rooting compared to experiments where only the apex was present (treatment A). This shows that adult leaves play a more important role in rhizogenetic stimulation than the terminal bud. Nevertheless, a comparison of the results of treatments B and D indicates that the terminal bud has a certain influence. Under both culture conditions, the number of roots was greater in treatment B (shoot tips plus two adult leaves) than in treatment D (shoot tip removed). The fact that the apex effect was only clearly detected in the presence of adult leaves suggests that the stimulus of the apex acts only synerg-istically with the foliar stimulus.

Effects of light: To study the effect of light perceived by the leaves cuttings were cultured at "full light" (80 $\mu mol \cdot m^{-2} \cdot s^{-1}$, control), "shaded" by a fine mesh above the cuttings (5 $\mu mol \cdot m^{-2} \cdot s^{-1}$) and in total darkness.

After 70 d the mean number (± standard error) of roots per cutting was 24 ± 7 (control), 18 ± 6 (shaded) and 8 ± 4 (darkness). The values of the mean fresh weight were: 2.3 g (control), 0.9 g (shaded) and 0.2 g (darkness). These data show, that in darkness rhizogenesis was markedly reduced and that compared to the control, shading caused a distinct decrease in the average weight of roots as well; root number was less affected. Obviously low light intensity diminishes the extension of the root system more than the initiation of roots.

To verify these results the experiments were repeated with Cabernet franc, Carignan, Clairette, Gewürztraminer, Grenache, Merlot, Mourvèdre, Piquepoul, Riesling, Syrah and Trebbiano. The treatments A, B, C and D started before the formation of the first roots. 7 weeks later, we compared the rooting of these cuttings with a control of each variety (Table). It appears that, for the 12 cultivars studied, the treatments had the same effects as for Pinot noir: With or without apex the presence of two adult leaves led to the development of a root system which is comparable to that of the control cuttings. Total defoliation and tip removal always caused severe reductions of root weight. The depressive effects of these two treatments on root number is cultivar specific.

Table

Effects of treatments A, B, C and D (see Figure) on the rhizogenesis of 12 cultivars. N and W are mean root numbers (± SE) and mean weight of roots per cutting, respectively (n = 30)

	Control		Treatments							
			A		B		C		D	
	N	W(g)	N	W(g)	N	W(g)	N	W(g)	N	W(g)
Cabernet franc	23±7	2.8	10±3	0.4	19±4	2.6	12±3	0.7	17±4	2.1
Cabernet Sauvignon	28±5	3.4	13±3	0.4	22±6	2.9	17±4	0.9	20±6	2.7
Carignan	19±6	3.1	7±3	0.8	21±6	3.8	11±3	0.9	23±7	4.3
Clairette	13±4	1.2	3±2	0.1	10±3	0.9	6±2	0.2	8±3	1.1
Gewürztraminer	18±4	1.3	4±2	0.1	16±4	1.1	8±2	0.2	20±5	1.2
Grenache noir	22±5	3.2	12±4	0.8	21±6	2.4	15±4	0.8	16±4	2.8
Merlot	28±6	2.6	6±2	0.2	25±7	2.0	12±3	0.6	23±6	2.7
Mourvèdre	21±6	3.3	5±2	0.3	17±4	2.8	10±3	0.9	19±4	2.8
Piquepoul	17±4	1.6	6±3	0.1	14±3	0.9	5±2	0.1	15±3	1.3
Riesling	18±4	1.1	7±3	0.1	20±6	0.8	8±2	0.1	15±3	1.2
Syrah	26±6	2.7	12±3	0.7	20±5	2.1	17±4	1.1	24±3	2.7
Trebbiano	20±5	1.8	7±4	0.3	18±6	1.2	7±3	0.6	16±4	1.1

Discussion: Our results clearly indicate that the shoot apex of vine cuttings is not the essential organ to stimulate rhizogenesis as was suggested by JUILLARD (1973).

As far as the influence of adult leaves on root growth is concerned, it is probable that a trophic influence is involved. The positive influence of light perceived by the shoots of cuttings on rooting is a strong argument for this idea. It is possible that photosynthetic assimilates produced by the first leaves developing on a shoot are the trophic elements necessary for root extension. However, this trophic influence of leaves may be only one element out of three forming the "rhizocaline complex" which was assumed to be synthesized in the leaves (BOUILLENNE 1964). More research is necessary to fully elucidate the stimulation of rhizogenesis of grape roots by the leaves of cuttings.

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