Vitis **13**, 23—29 (1974)

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The effects of growth regulators, temperature, and drying on Vitis vinifera buds

by

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Die Wirkung von Wachstumsregulatoren, Temperatur und Trocknen auf Knospen von Vitis vinifera

Z u s a m m e n f a s s u n g . — 1.000 ppm BA beschleunigte die Beendigung der Knospenruhe von Stecklingen der Sorte „St. Emilion", während 2.000 ppm Ethephon und 20, 200 oder 2.000 ppm Morphaktin die Knospenruhe merklich verzögerten. Bei Knospen außerhalb der Dormanz beschleunigten 20 oder 200 ppm SADH die Zeit des Austriebs, 1.000 ppm ABA dagegen verzögerte den Austrieb. Basale Behandlung des Holzes mit ABA war weniger wirksam als das Tauchen ganzer Stecklinge. BOA, Ethephon, KGA_3 und ein Morphaktin verzögerten alle den Austrieb nichtruhender Knospen, zumindest in hohen Konzentrationen. BOA war bei der Verzögerung des Austriebs wirksam. Wenn dormante Stecklinge 6 bis 24 Stunden lang Temperaturen von 38 bis 49 °C ausgesetzt wurden, beschleunigten viele Behandlungen die Beendigung der Knospenruhe. 5 Tage dauerndes Trocknen ruhender Stecklinge bei 24—27 °C brach sehr wirksam die Ruhe; nach 20tägigem Trocknen jedoch wuchsen keine Stecklinge mehr.

Introduction

Growth regulators significantly affect termination of rest in buds of *Vitis vinifera*. 6-Benzylamino purine (BA) and SADH (succinic acid-2,2-dimethylhydrazide) markedly hasten termination of rest, whereas chlormequat [(2-chloroethyl)trimethylammonium chloride] and potassium gibberellate (KGA_3) markedly delays it (Weaver *et al.* 1968). Naphthaleneacetic acid (NAA) usually results in some delay (Weaver *et al.* 1961). The purpose of one set of experiments was to determine the effect of various other growth regulators on termination of rest in buds. We were interested both in hastening and in postponing termination of rest. In addition, one experiment was concerned with delaying growth of non resting buds.

Numerous studies have been made on the effect of cold storage treatment on termination of rest in grape buds (Weaver *et al.* 1961), but little information is available on the effect of heat treatment. One objective of our study was to determine the optimum temperature and optimum length of exposure to heat for producing the most rapid termination of rest. In another experiment, the effect of drying cuttings on termination of rest was studied.

Materials and Methods

Cuttings of 'St. Emilion' 14 to 16 inches long were obtained from vines in a University of California vineyard at Davis. Thirty cuttings were used per treatment. In growth-regulator treatments, the cuttings were usually immersed for 30 min in one of the following solutions: ABA (abscisic acid) or a morphactin IT 3456 (methyl-2-chloro-9-hydroxyfluorene-9-carboxylate) at 10, 100, or 1,000 ppm; SADH, chlormequat, ethephon [(2-chloroethyl)phosphonic acid], or KGA_3 at 20, 200, or 2,000 ppm; or BOA (benzothiazole-2-oxyacetic acid) at 200 or 2,000 ppm. In the heat treatments, cuttings were enclosed in a polyethylene bag and submerged in a circulating water bath, care being taken to ensure that water did not enter the bag. To study

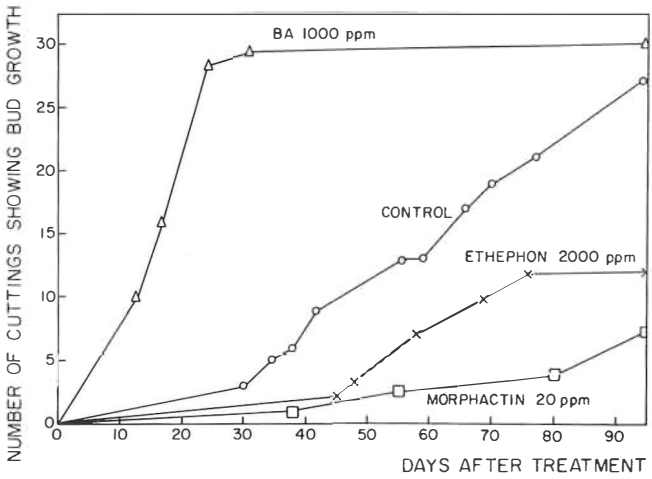

Fig. 1: Effect of BA, ethephon, and morphactin on termination of bud rest. Ethephon at 20 and 200 ppm gave results similar to those of the control, and morphactin at 200 and 2000 ppm resulted in no termination of rest (not shown). Cuttings obtained on November 14, 1969.

Wirkung von BA, Ethephon und Morphaktin auf die Beendigung der Knospenruhe. Die Ergebnisse nach Behandlung mit Ethephon 20 oder 200 ppm wichen nicht wesentlich von der Kontrolle ab, Morphaktin 200 oder 2.000 ppm verhinderte die Beendigung der Ruhe (nicht dargestellt). Stecklingsholz geerntet am 14. November 1969.

the effect of drying on termination of rest, cuttings were kept in air under diffuse light (10 f. c.) for various periods of time at 24—27 °C.

After all treatments, the cuttings were placed in containers under diffuse light (10 f. c.) at 24—27 °C and the bottom 3 or 4 inches of the cuttings were covered with water. Cuttings were observed for bud growth two times per week. A cutting was considered to have terminated rest when the green color of an enlarging bud became visible.

Experimentation and Results

Effect of growth regulators on termination of rest

Cuttings were obtained on November 14, 1969. The BA at 1,000 ppm markedly hastened termination of rest (Fig. 1). Ethephon at 20 and 200 ppm (not shown on graph) gave about the same results as the control, but the compound at 2,000 ppm markedly delayed termination of rest. Morphactin at 20 ppm also delayed termination of rest, and no buds grew in the 200- or 2,000-ppm treatments.

Delaying growth of non resting buds with growth regulators

Cuttings obtained January 23, 1971, when the rest of buds was already broken, were treated by immersion in growth regulator, except in one treatment with ABA, only the basal 3—4 inches of the cuttings were treated. SADH at 20 and 200 ppm markedly hastened time of bud break (Table 1). ABA at 1,000 ppm had sharply reduced bud break when measured 34 days after treatment, with the basal procedure being less effective. The chlormequat had little effect on time of bud break, but the BOA, ethephon, KGA_3, and morphactin treatments all delayed it, at least when used at the highest concentration. BOA was the most effective in delaying bud breaks; no buds broke at either concentration used even after 69 days.

Table 1

Effect of growth regulators on delaying break of nonresting buds
Wirkung von Wachstumsregulatoren auf die Verzögerung des Austriebs nichtruhender Knospen

Treatments	Number of cuttings showing bud burst[1]) After 34 days	After 69 days
Control	17	22
ABA 10	15	24
100	8	26
1000	0	21
ABA (basal treatment)		
10	20	27
100	22	29
1000	9	25
SADH 20	28	30
200	24	22
2000	11	19
BOA 200	0	0
2000	0	0
Chlormequat 20	21	28
200	21	27
2000	13	21
Ethephon 20	26	28
200	25	30
2000	0	11
KGA_3 20	14	25
200	3	20
2000	0	0
Morphactin 10	8	21
100	2	12
1000	3	5

[1]) Thirty cuttings in each treatment.

Effect of temperature and exposure time on termination of rest

Cuttings were collected on November 13, 1970, and stored in moist sawdust in the dark at 24—27 °C. On November 22 the cuttings were wrapped in polyethylene bags and immersed in preheated circulating water baths at 38, 41, 43, 46, and 49 °C for 6, 12, 18, and 24 hr. Observations on bud breaks were made through March 9, 1971.

No buds of control cuttings broke during the experiment (Table 2). In the 38 °C treatment, some buds grew at all lengths of exposure, but the most buds broke with the 18- and 24-hr exposures. Seventy-five days after treatment at 41 °C, bud break in the 18- and 24-hr exposures was greater than in corresponding times at 38 °C. At 43 °C, the number of cuttings with bud break increased up to the 18-hr exposure, but afterward decreased. The trend of bud break was similar at 46 °C to that

Table 2

Effect of heat on breaking rest of grape cuttings
Wirkung von Hitze auf das Brechen der Ruhe von Rebstecklingen

Temperature and time of exposure		Number of cuttings showing bud burst[2])	
°C	(hr)	After 36 days	After 75 days
24—27	24 (control)	0	0
38	6	2	7
	12	1	3
	18	4	12
	24	5	11
41	6	1	6
	12	2	3
	18	6	16
	24	5	17
43	6	1	5
	12	6	16
	18	16	25
	24	11	11
46	6	1	7
	12	1	10
	18	19	21
	24	2	2
49	6	14	14
	12	5	5
	18	0	0
	24	0	0

[2]) Thirty cuttings in each treatment.

at 43 °C. At 49 °C, 14 cuttings had terminated rest after a 6-hr exposure, but no buds broke after 18 or 24 hours of exposure.

Effect of drying on termination of rest of cuttings

In one experiment, cuttings were obtained from the vineyard on December 2, 1969. Drying 5 days was very effective in breaking rest, but after 20 days of drying no buds grew (Fig. 2).

In a second experiment, cuttings were collected on November 13, 1970, at which time most of the leaves were still on the vines. Cuttings were dried 0, 2, 4, 6, 8, 10, 12, 14, or 16 days. The initial weight of one set of 30 cuttings and the weights after various times of drying, were recorded. Observations on bud break began November 20, 1970, and were concluded April 23, 1971.

The data (Fig. 3) indicate that from 2 to 8 days of drying resulted in the greatest increase in the number of cuttings that broke rest when counted after 44 days. After 132 days post treatment, 8 days of drying had resulted in most bud break. Water loss was rapid during the first 4 days, after which the rate of loss was slower.

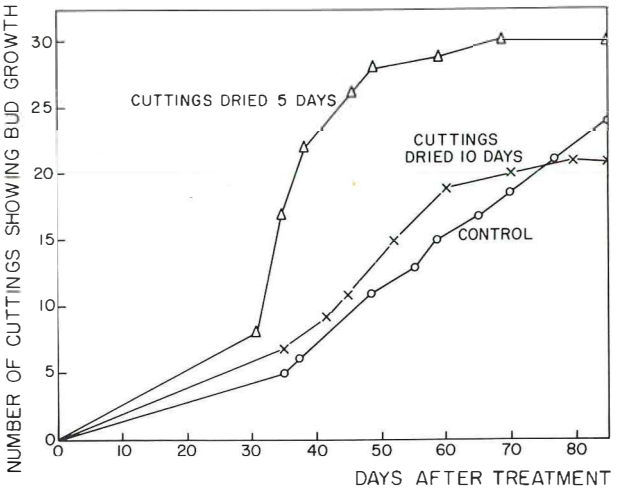

Fig. 2: Effect of drying cuttings on termination of bud rest. Drying for 20 days (not shown) prevented all bud break. Cuttings obtained from vineyard on December 2, 1969.
Wirkung des Trocknens auf die Beendigung der Knospenruhe von Stecklingen. 20 Tage langes Trocknen (nicht dargestellt) verhinderte den Austrieb vollständig. Stecklingsholz der Rebanlage geerntet am 2. Dezember 1969.

Discussion

The fact that high levels of ethephon and morphactin delayed termination of rest is not surprising, as these compounds have also been shown to inhibit shoot growth of grapes (Weaver and Pool 1969).

SADH, which has been shown by Weaver *et al.* (1968) to hasten termination of rest of grape buds, hastens growth of non resting buds in the present study. In contrast, Raese (1971) found that sprays of 50% oil with 2% SADH delayed bloom on 5-year-old tung trees approximately 2 weeks.

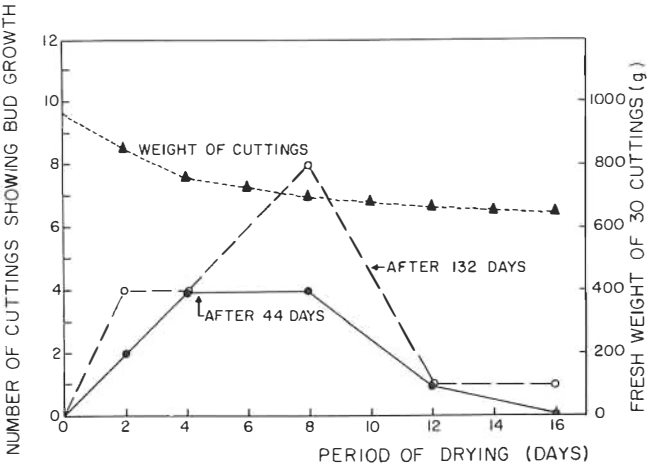

Fig. 3: Effect of drying cuttings at 24—27 °C on water loss and termination of bud rest. Cuttings obtained from vineyard on November 13, 1970.
Wirkung des Trocknens bei 24—27 °C auf den Wasserverlust und die Beendigung der Knospenruhe bei Stecklingen. Stecklingsholz in der Rebanlage geerntet am 13. November 1970.

Based on our results it appears that individual growth regulators have in general similar effects on both non resting and resting buds, insofar as bud growth is concerned. In our study CCC was an exception, and had little effect on delaying break of resting buds.

The indication is that certain compounds may have commercial value in delaying break of non resting buds. Such a delay would provide considerable protection against frost in California, where spring frosts may occur as late as a month after shoot growth has normally commenced.

In our study, exposure to temperatures of 43 or 46 °C for 18 hr was very effective in terminating bud rest. Pouget (1963) reported that exposure of dormant grape buds for 15, 30, or 60 min to a temperature of 50 °C hastened termination of rest, and that exposure for 1 to 3 min at 60 °C was also effective. Chandler (1960) has reported that 6 hr of high temperature, 44 °—45 °C, was as effective in terminating rest in apple trees as 100 hr of chilling at 4 °C. Some vineyards have buds which burst later than normally, or perhaps fail to grow at all. It is possible that such buds have been heated to too high a temperature, and have been injured or killed. This could have occurred during the hot season of the previous year.

Partial drying of cuttings hastened termination of rest. However, protracted drying resulted in injury to many buds.

Chouard (1951) observed that a dry autumn resulted in earlier bud break in lilacs, chestnuts, and cherries. Rives (private communication) found that the percentage of bud burst in vineyards in areas of Peru where winter cold is insufficient, could be improved by withholding all irrigation after véraison.

Summary

BA at 1,000 ppm hastened termination of bud rest in 'St. Emilion' cuttings, but ethephon at 2,000 ppm and morphactin at 20, 200, and 2,000 ppm markedly delayed rest. With nonresting buds, SADH at 20 and 200 ppm hastened time of bud break, but ABA at 1,000 ppm delayed bud break. A basal treatment of the cuttings with ABA was less effective than immersion of entire cuttings. BOA, ethephon, KGA_3, and a morphactin all delayed bud break of nonresting buds, at least when used at high concentrations. BOA was effective in delaying bud break. When resting cuttings were subjected to temperatures ranging from 38 to 49 °C for 6 to 24 hr, many of the treatments hastened termination of rest. Drying resting cuttings for 5 days at 24—27 °C was very effective in breaking rest; but after 20 days of drying, no cuttings grew.

Literature Cited

Chandler, W. H., 1960: Some studies of rest period in apple trees. Proc. Amer. Soc. Hort. Sci. 76, 1—10.

Chouard, P., 1951: Dormance et inhibitions des graines et des bourgeons, préparation au forçage; thermopériodisme. Centre Doc. Univ., Paris.

Pouget, R., 1963: Recherches physiologiques sur le repos végétatif de la vigne (*Vitis vinifera* L.): La dormance des bourgeons et le méchanisme de sa disparition. Inst. Natl. Rech. Agron. Univ. Bordeaux. PhD Thesis.

Raese, J. T., 1971: Prolonging dormancy of tung trees with spray oil and succinic acid-2,2-dimethylhydrazide.. HortScience 6, 408—410.

Weaver, R. J., McCune, S. B., and Coombe, B. G., 1961: Effects of various chemicals and treatments on rest period of grape buds. Amer. J. Enol. Viticult. 12, 131—142.

— — and Pool, R. M., 1969: Effect of ethrel, abscisic acid and a morphactin on flower and berry abscission and shoot growth in *Vitis vinifera*. J. Amer. Soc. Hort. Sci. **94**, 474—478.
— — , Yeou-Der, K., and Pool, R. M., 1968: Relation of plant regulators to bud rest in *Vitis vinifera* grapes. Vitis **7**, 206—212.

Eingegangen am 15. 1. 1973

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