J. AMER. SOC. HORT. SCI. 117(6):898-901. 1992.

Breaking Bud Dormancy in Grapevines with Garlic Paste

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Additional index words. Vitis spp., forcing culture, budbreak, *Allium sativum*, calcium cyanamide, cuttings, foliar fertilizer

Abstract. **Four dormant grapevine *(Vitis* spp.) cultivars grown under forced conditions were treated immediately after pruning with a paste of fresh garlic, the supernatant of a 20% suspension of $CaCN_2$, and 50% 'Merit' solution a foliar fertilizer, to break bud dormancy. Garlic paste significantly accelerated budbreak and increased the rate of budbreak in three cultivars, but for 'Delaware,' $CaCN_2$ was more effective. Garlic also affected budbreak of cuttings with a single bud of 'Kyoho,' 'Neo Muscat,' or 'Muscat Bailey A' grapes in a deep stage of dormancy. Garlic paste applied to cool 'Muscat of Alexandria' vines immediately after they were pruned in various stages of dormancy (from November to March) accelerated budbreak in the spring when application was made by January. The rate of budbreak was steady, but earlier $CaCN_2$ treatments resulted in a rate of budbreak that was not uniform, although the first budbreak was accelerated. Low concentrations of garlic juice did not promote budbreak of cuttings of 'Muscat of Alexandria'. When garlic paste was applied to various parts of cuttings with two buds, budbreak was accelerated when the upper cross-section was treated, but the overall rate of budbreak was highest when the lower half of the cutting was treated. Chemical name used: calcium cyanamide ($CaCN_2$).**

Many investigations have been made of the termination of bud dormancy in woody plants, including grapes, by the application of chemicals such as mineral oils, dinitro- *o*- cresol (DNOC), calcium cyanamide ($CaCN_2$), hydrogen cyanamide ($H_2C N_2$), thiourea, and plant growth regulators (Broome and Zimmerman, 1976; Iwasaki, 1980; Iwasaki and Weaver, 1977; Kuroi et al., 1963; Nir et al., 1988; Shulman et al., 1983; Weaver et al., 1961, 1968, 1974; Zelleke and Kliewer, 1989). In Japan, supernatants of $CaCN_2$ suspensions have been widely used for stimulating budbreak in various grape cultivars since a report by Kuroi et al. (1963). When 'Muscat of Alexandria' vines in a deeply dormant stage are to be forced, a paste of fresh garlic *(Allium sativum* L.) has been applied to cane cross-sectional surfaces immediately after pruning to stimulate budbreak. This method for breaking bud dormancy in vines with garlic paste was first used in 'Muscat of Alexandria' vines >25 years ago; however, we have no information on the effect of garlic paste on other cultivars because it has been only used for this cultivar.

The purpose of this work was to evaluate the effects of the application of fresh garlic paste on budbreak in five grape cultivars.

Materials and Methods

All vine materials were obtained from grapevines grown at research facilities of the Faculty of Agriculture, Okayama Univ., Japan.

Comparison of chemicals used for breaking dormancy. Dormant canes of 1-year-old 'Kyoho', 'Delaware', 'Neo Muscat'; or 'Muscat of Alexandria' vines were pruned on 15 Dec. 1982 to three buds on each cane. Immediately after pruning, the canes which were at 18C or higher, were treated with: 1) fresh garlic ground into a paste with an iron pestle; 2) supernatant of a 20% suspension of $CaCN_2$; or 3) a 50% solution of 'Merit' (blue type, a foliar fertilizer; main component, N; Eisai Co., Japan); 4) deionized water, applied to the cross-sectional surface (control). The paste of fresh garlic was applied to the cane cross-sectional surface only, while $CaCN_2$ and 'Merit' were applied by brush over the entire surface of each cane except for the cross-sectional surface. Each treatment was replicated on three vines. Budbreak was considered to have occurred when at least one of the three buds showed the typical green of an enlarging bud. Data were evaluated by Duncan's multiple range test.

Garlic paste or $CaCN_2$ applied canes of nonheated vines at several stages of dormancy. Two mature 'Muscat of Alexandria' vines grown in an unheated glasshouse were used. During the dormant period, 12 canes of each vine were pruned to two buds every month, beginning 10 Nov. 1983. Immediately after the canes had been pruned, garlic paste was applied on cane cross-sectional surfaces of six canes and supernatant of 20% $CaCN_2$ was applied over the entire cane except for the cross-sectional surface to six others. Canes were examined for bud sprouting in the spring. Data was evaluated by student's t test in this and the following experiments.

Garlic application on cuttings at two stages of dormancy. Cuttings with a single bud were prepared from 'Kyoho', 'Delaware', 'Neo Muscat', 'Muscat Bailey' , and 'Campbell Early vines on 16 Dec. 1983 and 18 Jan. 1984. Sets of 30 cuttings of each cultivar were used as controls; additional sets of 30 cuttings were treated on their upper cross-sectional surface with garlic paste. Cuttings were planted in a bed of 'Kanumatsuchi' soil (soil for propagation bed) and kept at 18C or higher. Three replications of 10 cuttings were given each treatment.

Garlic application to 'various parts of cuttings. Cuttings with two buds were prepared from 'Muscat of Alexandria' vines on 19 Dec. 1983. Garlic paste was applied to the cutting on: 1) upper cross-sectional surface; 2) upper half of the cutting except for the cross-sectional surface; 3) lower half of the cutting except for the cross-sectional surface; and 4) controls, the upper cross-sectional surface of which was treated with deionized water. Cuttings were planted in a bed of 'Kanumatsuchi' soil and kept at ≥ 18C. Three replications of 10 cuttings were given each treatment.

Application of garlic juice at various concentrations on cuttings. Garlic juice was obtained by grinding of garlic cloves with an iron pestle and then squeezing of the resulting paste through a double layer of gauze. The juice was diluted five or 50 times with deionized water. The upper cross-sections of cut-

Received for publication 27 Apr. 1992. Accepted for publication 21 July 1992. The cost of publishing this paper was defrayed in part by the payment of page charges. Under postal regulations, this paper therefore must be hereby marked *advertisement* solely to indicate this fact.

tings with a single bud obtained from 'Muscat of Alexandria' vines on 12 Dec. 1982 were treated with the undiluted or diluted juice. Cuttings were planted in a bed of 'Kanumatsuchi' soil and kept at 118C. Three replications of 10 cuttings were given each treatment.

Results

Comparison of chemicals used for breaking dormancy. For 'Kyoho', 'Neo Muscat', and 'Muscat of Alexandria' vines, budbreak was significantly accelerated with garlic paste, followed by $CaCN_2$ and 'Merit' solution which gave similar results. Garlic paste significantly increased percent budbreak for 'Kyoho' and 'Neo Muscat' compared to the controls. For 'Delaware' vines, $CaCN_2$ accelerated budbreak compared to the controls, and the percent budbreak was lower with garlic paste or the 'Merit' solution than with water (control) or $CaCN_2$ (Table 1).

Garlic paste or $CaCN_2$ applied canes or nonheated vines at several stages of dormancy. When garlic paste was applied on cane cross-sections of 'Muscat of Alexandria' vines at various stages of dormancy, budbreak in the spring was most accelerated by treatment in January, followed by treatment in November, or December and February; however, treatment in March did not promote budbreak. $CaCN_2$ accelerated budbreak when applied in November, January, or December with the November treatment being the most effective. However, treatment in November resulted in an uneven rate of budbreak (Fig. 1)

Garlic application on cuttings at two stages of dormancy. Garlic paste applied in December (Fig. 1, left) forced buds of 'Kyocho' and 'Neo Muscat' to break 29 and 32 days, respectively, after treatment, whereas control cuttings of these cultivars broke 36 and 37 days later, respectively. Garlic did not accelerate budbreak in 'Campbell Early'. Little difference in the budbreak rate in 'Delaware' and 'Campbell Early' was observed with this treatment, although budbreak was accelerated by garlic. Garlic treatment in January (Fig. 2, right) did not affect the time of budbreak or the percent budbreak in any of the cultivars tested.

Table 1. Effects of applications of garlic paste, supernatants of $CaCN_2$, or 'Merit' foliar fertilizer solution on time of budbreak and the rate of budbreak in 1-year-old vines of four grape cultivars.[z]

Cultivars	Treatment[y]	Days after treatment to first budbreak	Budbreak %
Kyoho	Control	40 a[x]	55.6 b[x]
	Garlic paste	31 c	68.9 a
	$CaCN_2$	33 c	57.6 b
	'Merit' solution	35 bc	56.3 b
Delaware	Control	37 a	66.7 a
	Garlic paste	33 ab	57.1 b
	$CaCN_2$	30 b	69.5 a
	'Merit' solution	36 a	55.5 b
Neo Muscat	Control	40 a	66.2 b
	Garlic paste	30 b	79.8 a
	$CaCN_2$	32 b	66.4 b
	'Merit' solution	33 b	55.7 c
Muscat of Alexandria	Control	50 a	83.3 a
	Garlic paste	39 c	84.4 a
	$CaCN_2$	42 b	66.7 b
	'Merit' solution	41 b	50.0 c

[z]Three vines were used for each treatment, and each vine was a cane with three buds.
[y]Garlic paste was applied to the cane cross-section; $CaCN_2$ and 'Merit' solution were applied to the entire cane except for the cross-section.
[x]Mean separation within each cultivar by Duncan's multiple range test $P = 0.05$.

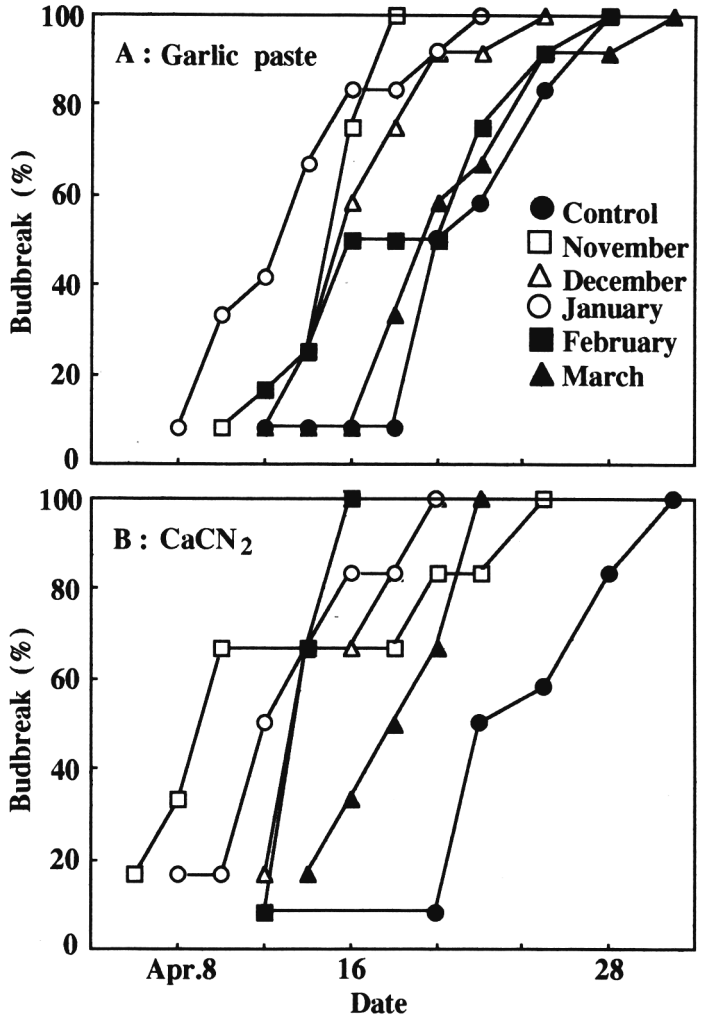

Fig. 1. Budbreak in the spring of nonheated 'Muscat of Alexandria' grapevines treated with garlic paste **(A)** or $CaCN_2$ **(B)** at various stages of dormancy.

Garlic application to various parts of cuttings. In all cases, the number of days to initial budbreak after treatment was shorter for upper buds than for lower ones, and the percent budbreak of upper buds was higher than that of lower ones (Fig. 3). Garlic paste applied to the upper cross-sectional surface of cuttings accelerated budbreak, but with this treatment, the overall rate of budbreak was lower than that observed in any other treatment, because the lower buds of the cuttings did not all break. The higher percentage of budbreak achieved with the lower buds when garlic paste was applied to the lower half of the cuttings, gave the highest percent budbreak overall.

Application of garlic juice at various concentrations on cuttings. Undiluted garlic juice accelerated budbreak, but the percent budbreak tended to be lower with this juice than with the other treatments (Fig. 4). Juice diluted to five or 50 times did not accelerate budbreak.

Discussion

In Japan, forcing culture of grapes in greenhouses is widespread. Hydrogen cyanamide can be used to break bud dor-

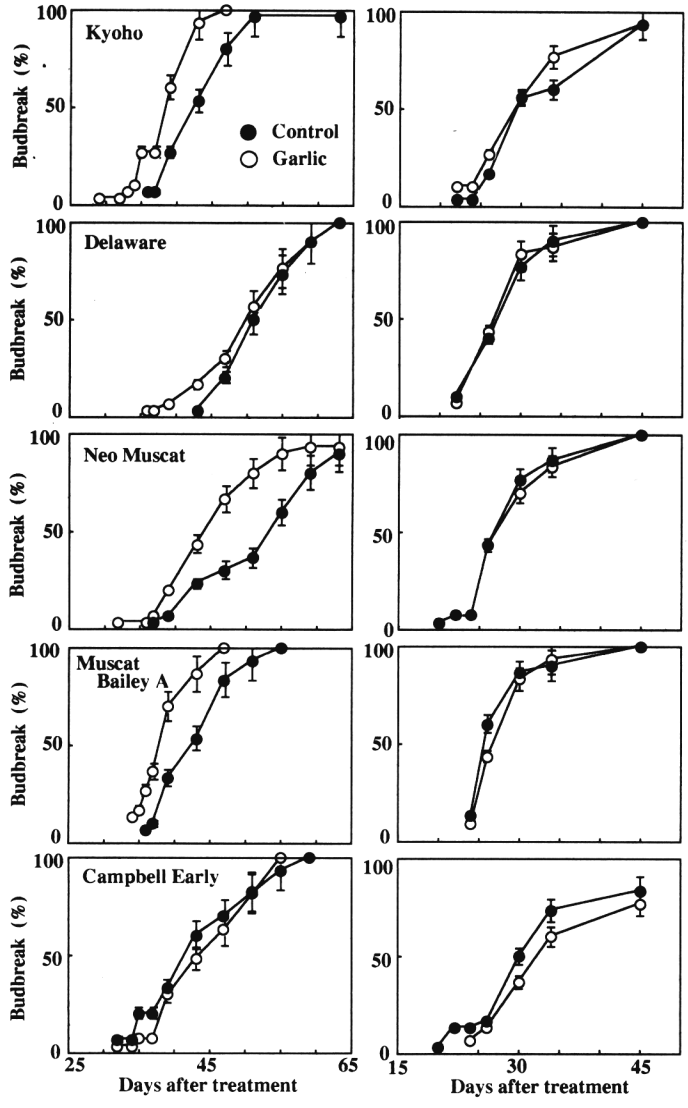

Fig. 2. Effects of application of garlic paste in December (**left**) or January (**right**) on budbreak of one-bud cuttings of five grapevine cultivars. Vertical bars are the SE. n = 3.

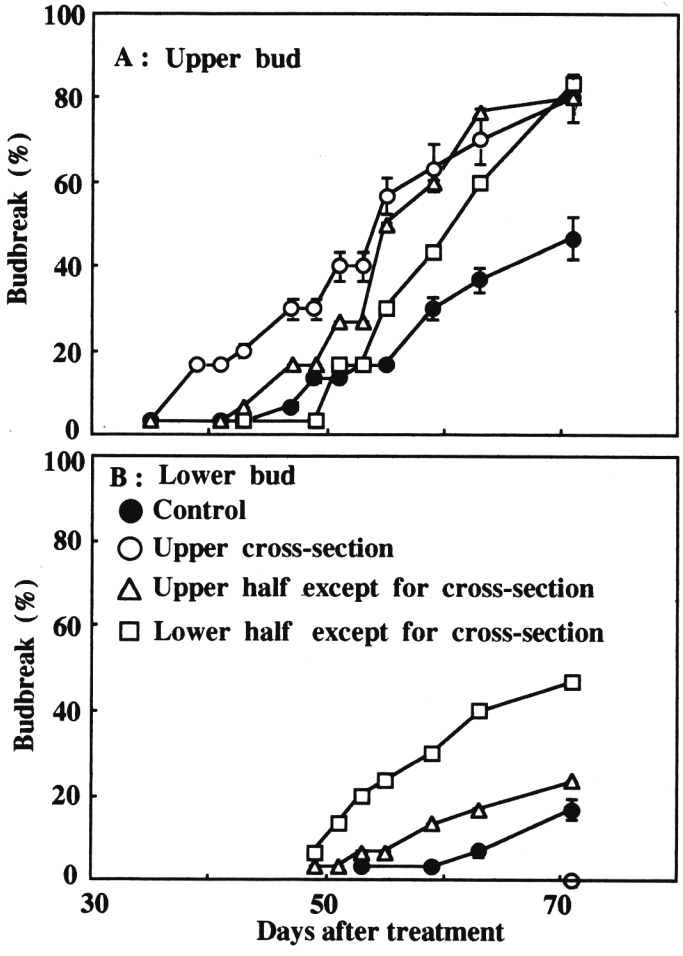

Fig. 3. Effects of application of garlic paste on budbreak of various parts of two-bud cuttings of 'Muscat of Alexandria' grapevines. Percent budbreak in the upper bud only **(A)** and the lower bud only **(B).** Vertical bars are the SE. n = 3.

mancy in grape (Kuroi, 1985; Lin and Wang, 1985; Nir et al., 1988; Shulman et al., 1983, 1986; Zelleke and Kliewer, 1989). We previously reported that painting of fresh garlic paste on cane cross-sectional surfaces of 'Muscat of Alexandria' forced in December promotes budbreak (Kubota et al., 1983, 1987), but details of timing and suitable concentrations were not established. Similar results were obtained here for other cultivars. Garlic accelerated budbreak more effectively when treatment was in December rather than in January, suggesting that the deeper the dormancy when garlic was applied, the more pronounced the effect on budbreak. Judging from these findings, it seems that the application of garlic paste on cane cross-sectional surfaces breaks bud dormancy of grapevines more effectively than 'Merit' solution or a supernatant of $CaCN_2$ widely used in Japan. Hosoki et al. (1985) found that garlic paste also breaks bud dormancy in some corms and tubers.

With 'Delaware' vines, $CaCN_2$ accelerated budbreak, although not significantly, and increased the rate of budbreak more than garlic paste. When $CaCN_2$ was applied to canes of nonheated 'Muscat of Alexandria' vines at various stages of dormancy, the earlier application resulted in an uneven rate of budbreak, although budbreak was accelerated at first. This phenomenon of an uneven rate of budbreak has also been observed in the commercial production of 'Muscat of Alexandria' vines. When vines of this cultivar are to be forced from deep dormancy, such as that in November or December, a paste of fresh garlic is commonly used for breaking bud dormancy, not $CaCN_2$. The reasons for different responses by buds of different cultivars to these chemicals are not known. Gibberellic acid, a plant growth regulator, increases percent budbreak in peaches *[Prunus persica* (L.) Batsch] (Donoho and Walker, 1957), but it decreases the emergence rate in grapes (Weaver, 1959).

In the growing of 'Muscat of Alexandria' vines, an undiluted paste of fresh garlic or a paste made by grating garlic together with a small amount of water is often applied to cane cross-sectional surfaces to break bud dormancy. When cuttings of 'Muscat of Alexandria' were treated at three concentrations of garlic juice, only the undiluted juice accelerated budbreak, and the rate of budbreak decreased. The reason for the acceleration of first budbreak and the slower rate of budbreak thereafter is unknown.

Low temperatures during the winter can cause pruned canes to die back. Many grape cultivars are typically pruned to one or two bud spurs. If the cane dies back, the buds on the cane

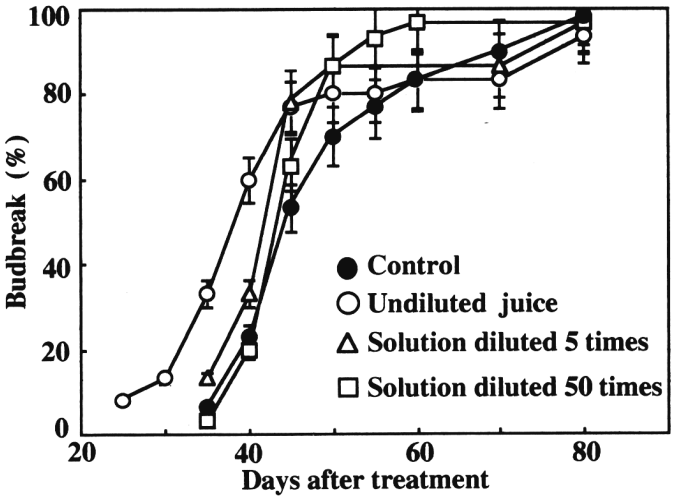

Fig. 4. Effects of garlic juice at different concentrations on budbreak of one-bud cuttings of 'Muscat of Alexandria' grapevine. Vertical bars are the SE. n = 3.

fail to grow in the spring, resulting in a lower yield. Painting of garlic paste on cane cross-sectional surfaces of vines was started to protect against such injury caused by low temperatures. The paste was applied to cane cross-sectional surfaces only, immediately after pruning, while supernatant of $CaCN_2$ was applied over the entire cane except for cross-sectional surfaces. When garlic paste was applied on various parts of cuttings, application on the lower half of the cutting gave the higher rate of budbreak overall, because both buds sprouted. When the garlic was applied on the upper cross-sectional surface of cutting, the lower bud failed to break, although the budbreak of the upper bud was significantly accelerated. The effect of garlic application seemed to be on buds treated with garlic or on nearby buds. Garlic might alleviate the bud dormancy release problem sometimes observed in young vines that are still maturing, or in vines that have had canes pruned. Apical dominance accounted for more apical buds sprouting than basal ones.

This study demonstrates that it is possible to use a paste of fresh garlic instead of a supernatant of $CaCN_2$ suspension or 'Merit' solution to promote budbreak in various grape cultivars.

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