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Defoliation responses of different grapevine cultivars to postharvest ethephon treatments

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Défoliation induite en différents cépages par un traitement avec de l'éthéphon après la vendange

Résumé. — La défoliation causée par des traitements d'éthephon (0, 500, 2000, 5000 ppm) a été étudiée sur différents cépages *(V. vinifera)*.

Les applications ont été faites le 10 octobre sur les cépages à raisin de table et de cuve ci-après: Barbera, Carignane, Emerald Seedless, Ribier, Ruby Seedless, Thompson Seedless et Flame Tokay.

La concentration de 5000 ppm se révéla la plus efficace. La défoliation des plantes traitées a été très différente selon les cépages: Barbera et Carignane par exemple ont été presque complètement privés des feuilles après 20—30 d du traitement, tandis que le Flame Tokay ne donna qu'une très faible réponse.

Il faut signaler en tout cas que les concentrations les plus fortes d'éthéphon ont causé un retard considerable dans le débourrement du printemps suivant.

Introduction

Several types of actions are known to be within the regulatory control of ethylene. One important effect is the formation of an abscission zone (LEOPOLD and KRIEDEMANN 1978, SCHNEIDER 1979). Ethephon generates ethylene and has been successfully used in grape thinning (WEAVER and POOL 1971), in the induction of berry abscission (WEAVER and POOL 1969, CLORE and FAY 1970, EYNARD 1975) and in vegetative growth control (LAVEE *et al.* 1977).

Defoliation of grapevines subsequent to harvest would facilitate early pruning of the vines, force vines into dormancy in the warm areas and would permit nurserymen to collect cuttings and dig rootings before the natural fall of leaves or before frost occurs in late season.

Many other chemical compounds have been shown to cause leaf abscission, but have been associated with injurious and toxic effects to the vine (WEAVER and POOL 1974). On the contrary, it has been reported that postharvest ethephon treatments usually induce substantial leaf abscission, thereby hastening the natural process of leaf senescence without any apparent damage and have been associated with delayed budbreak and shoot development the following spring (EYNARD *et al.* 1975, EYNARD and MORANDO 1976, QUAGLINO *et al.* 1978). A short delay in shoot growth the following year without any other side effects might be desirable in areas subject to spring frost. Nevertheless, the results were not always uniform, changing particularly as a consequence of the air temperature at application time and the cultivar. Therefore, in order to treat properly, it is important to determine the optimum concentration necessary to induce defoliation among the different cultivars.

The present research was done to determine the different grape cultivar responses in defoliation to postharvest treatments at different concentrations of ethephon.

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Materials and methods

Mature vines of Barbera, Carignane, Emerald Seedless, Ribier, Ruby Seedless, Thompson Seedless and Flame Tokay grown under conventionally accepted practices at the experimental vineyards of the University of California, Davis, were used. Barbera and Carignane were head-trained and spur-pruned (gobelet), and the other cultivars were cordon-trained and spur-pruned. These varieties were chosen because of their wide range of varietal behaviors.

Solutions containing 0, 500, 2000 and 5000 ppm ethephon and a wetting agent, "Regulaid" (1 ml/l), were applied until run-off to the vines with an 8 l Hudson hand sprayer. Treatments were made on October 10 when the foliage was still green and healthy. A randomized complete block design was employed using four single vine replications per treatment.

Applications were made to the vines between 10 a.m. and 1 p.m. in order to limit the influence of the different air temperatures. Observations were made subsequent to treatment at 3—4 d intervals for a 1-month-period. The percentage of yellow and fallen leaves was determined by visual estimation. Evaluation of shoot development was carried out on Barbera, Carignane and Flame Tokay varieties during the following spring. The initial stages of growth were evaluated by the scale described by EYNARD *et al.* (1978), where values of 1, 2, 3 and 4 corresponded to a dormant bud, well-swollen bud, shoot with three unfolding little leaves, and shoot with four well-unfolded leaves. Shoot elongation subsequent to this latter stage was measured.

All data were subjected to an analysis of variance (using angular transformation when necessary) followed by the least significant difference test.

Table 1

Percent defoliation caused by postharvest treatment of different concentrations of ethephon

Pourcentage de défoliation causée par des traitements d'éthéphon en différentes concentrations après la vendange

Cultivar	d after treatment	Ethephon treatment (ppm)			
		0	500	2000	5000
Barbera	17	0 C [1])	0 C	11.25 B	46.25 A
	30	0 C	1.50 C	30.50 B	85.00 A
Carignane	17	0 B	2.50 B	3.00 B	40.00 A
	30	1 B	10.00 B	13.75 B	83.75 A
Emerald Seedless	17	0 a	0 a	0 a	0 a
	30	0 B	0 B	3.50 B	60.00 A
Ribier	17	0 a	0 a	0 a	0 a
	30	0 B	0 B	0 B	7.50 A
Ruby Seedless	17	0 a	0 a	0 a	0.50 a
	30	0 a	1.00 a	1.00 a	7.50 a
Thompson Seedless	17	0 B	2.50 B	2.50 B	38.75 A
	30	1 B	15.00 B	23.75 AB	66.50 A
Flame Tokay	17	0 a	0 a	0 a	0 a
	30	0 a	0 a	2.00 a	6.50 a

[1]) Mean values within rows followed by the same capital letter and means within rows followed by the same small letter are not significantly different at $P \leq 0.01$ and $P \leq 0.05$ by the LSD test, respectively.

Results

Ethephon at 5000 ppm caused the most defoliation (Table 1), resulting in 60—85 % defoliation in Emerald Seedless, Thompson Seedless, Carignane and Barbera. Ethephon at 2000 ppm was associated with little defoliation, 10—30 % after 1 month, in Carignane, Thompson Seedless and Barbera. There were no observable effects due to ethephon on the other cultivars. The 500 ppm treatment was practically ineffective as a defoliant in all the varieties treated.

The defoliation response of the highest concentration of ethephon was variable among the cultivars (Table 2). This treatment was most effective in Barbera and Carignane, and resulted in more than 70 % defoliation in 20 d, causing almost complete defoliation after 1 month from the date of application.

Ethephon hastened defoliation in Thompson Seedless and Emerald Seedless which was characteristically preceded in both varieties by a strong yellowing of leaves. However, the defoliation occurred earlier in Thompson Seedless than in Emerald Seedless even at the same concentration range. About 60 % of the leaves had abscised 1 month subsequent to the treatment.

Ethephon also at 5000 ppm was practically ineffective as a defoliant on Ruby Seedless, Ribier and especially Flame Tokay. In these cultivars the defoliation remained below 10 % 1 month after the sprays were applied.

After treatment with ethephon, the older leaves at the basal part of the shoots were the first to abscise and usually the blades would fall first, leaving the petioles intact.

Leaf coloration and senescence symptoms associated with ethephon treatments were different among the various varieties. With Barbera and Carignane defoliation first began at the top of the vines. Prior to leaf fall, the leaves became desiccated and necrotic and exhibited curling. Thompson Seedless and Emerald Seedless, however, first showed a strong yellowing of the leaves and subsequently defoliated. In Ribier and Flame Tokay, the leaves became a yellowish-red color especially at the top of the vine. In Flame Tokay there was a yellowing and reddening of leaves followed by a desiccated appearance. With Ruby Seedless, the normal development of a yellow color occurred on the leaves.

The delay in shoot development during the following spring was considerable for vines treated with 2000 and 5000 ppm (Table 3).

Table 2

The effect of postharvest applications of etephon at 5000 ppm on seven different varieties at four dates after treatment

Effets d'une application d'éthéphon après la vendange (concentration de 5000 ppm) sur sept différents cépages observés 13, 17, 23 et 30 d après le traitement

Cultivar	% yellow leaves after 13 d	% defoliation after 17 d	% defoliation after 23 d	% defoliation after 30 d
Barbera	31.25	46.25	75.00	85.00
Carignane	45.00	40.00	77.50	83.75
Emerald Seedless	70.00	0.00	5.25	60.00
Ribier	4.00	0.00	1.50	7.50
Ruby Seedless	30.00	0.50	1.00	7.50
Thompson Seedless	67.50	38.75	57.50	66.50
Flame Tokay	8.75	0.00	0.75	6.25

Table 3

Shoot development subsequent to autumn applications of ethephon treatments · Development in March evaluated according to a scale 1, 2, 3 and 4 corresponds to a dormant bud, well-swollen bud, shoot with three unfolding little leaves, shoot with four well-unfolded leaves · In April, shoot elongation was determined by measuring shoot growth (cm)

Développement des sarments au printemps suivant les traitements d'éthéphon · Les niveaux de développement au mois de Mars – estimés par une échelle de valeurs de 1 à 4 – correspondent respectivement à bourgeon d'hiver, pointe verte, trois petites feuilles en train de se développer, quatre feuilles étalées · Au mois d'Avril, le développement fut déterminé par la longueur des sarments (cm)

Cultivar	Date	Ethephon treatment (ppm)			
		0	500	2000	5000
Barbera	03/21/81	1.97 Aa [1]	1.98 Aa	1.73 ABb	1.41 Bc
	03/31/81	3.07 A	3.03 A	2.43 B	2.21 B
	04/09/81	9.41 Aa	9.18 ABa	6.64 BCb	4.74 Cb
Carignane	03/21/81	1.41 a	1.38 a	1.25 a	1.31 a
	03/31/81	1.87 ab	1.94 a	1.83 ab	1.68 b
	04/16/81	6.85 a	8.03 a	5.74 a	5.01 a
Flame Tokay	03/21/81	1.52 A	1.49 A	1.28 B	1.24 B
	03/31/81	2.37 A	2.19 A	1.93 B	1.86 B
	04/16/81	9.65 A	8.79 A	6.11 B	5.74 B

[1]) Mean values within rows followed by the same capital letter and means within rows followed by the same small letter are not significantly different at $P \leq 0.01$ and $P \leq 0.05$ by the LSD test, respectively.

Discussion

The differences in response among the different varieties for postharvest ethephon treatments suggested by EYNARD and MORANDO (1976) has been confirmed. Such responses could not be explained by the differences in air temperature at the time of application (QUAGLINO *et al.* 1978), because during the late morning, when the ethephon was sprayed, the differences between the times of application were minimal. Thompson Seedless was the first variety treated and was therefore at the lowest temperature. Thompson Seedless was extremely sensitive to ethephon treatments in terms of the amount of defoliation. On the contrary, the explanation could be due to the different stages of leaf senescence when the treatments were applied. Probably the stimulation caused by exogenous ethylene is much stronger if the natural process of senescence has already started.

It is evident that the stage of senescence of the leaves under the same environmental conditions, as in this experiment, is related to the natural disposition of the different cultivars. In regard to the concentration of ethephon, EYNARD *et al.* (1975) working in the cool climate of northern Italy obtained substantial leaf abscission with ethephon at 2000 ppm 10—15 d after treatment. Although this experiment was performed during the same time period of the year, only the concentration of 5000 ppm was effective and, moreover, a longer period of time was required for the observed results compared to EYNARD *et al.*

This could be easily explained, once again, by the different stages of senescence of the leaves, and in this case is considered to be due mainly to the difference in climates between Italy and California. In the former case, the leaves were approaching the time of natural separation which in northern Italy naturally occurs at the end of October. On the contrary, in the present work carried out in the warm autumn of California, the leaves were very healthy and green when the treatment was applied and, as a consequence, required a higher concentration of ethephon to ellicit a response.

In a climate like that of California, the necessity of using high concentrations of ethephon in order to obtain the desired level of defoliation can result in some effects on the normal development of the vegetation. The concentration of 2000 and 5000 ppm, in fact, caused a considerable delay in shoot growth the following spring which persisted during the season. This may be beneficial in vineyards tending to produce excessive foliage. Excessive foliage not only requires extra maintenance in the vineyard, but produces poor microclimate in the canopy which often leads to an increase in disease, poor budbreak, low wood maturity and insufficiant berry color in certain varieties. The short delay in budbreak may be important in vineyard sites where spring frost is a problem. However, according to the results of EYNARD *et al.* (1975, 1978) and EYNARD and MORANDO (1976), a delay in budbreak could result in negative effects on flowering, fruit-set and crop maturity. The length of delay varied according to the particular variety. This treatment, i.e. the 2000 and 5000 ppm ethephon, if repeated for several years, might weaken some of the treated vines.

The amount of growth inhibition observed in the spring was independent of the effectiveness in defoliation the previous fall. This is shown by the data of the Flame Tokay cultivar, where the application of ethephon in the fall produced a strong growth inhibition the following spring in spite of practically no effect on defoliation.

Summary

The defoliation responses of several grapevine cultivars to postharvest ethephon sprays at 0, 500, 2000, 5000 ppm were observed. Sprays were applied at the beginning of October to vines of Barbera, Carignane, Emerald Seedless, Ribier, Ruby Seedless, Thompson Seedless and Flame Tokay cultivars.

The most effective concentration was 5000 ppm. The defoliation response varied greatly among the varieties. Barbera and Carignane were almost completely defoliated 20—30 d after treatment, whereas Flame Tokay showed no response. However, high concentrations of ethephon resulted in a considerable delay in shoot development the following spring.

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