# Wine Grape-vine tolerance to Chlorsulfuron and Metsulfuron methyl herbicides

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## Summary

**Twenty two varieties of grape-vines (*Vitis vinifera* L.) grown in gravely sands/clay tolerated up to 25 g ha$^{-1}$ of Ally$^R$ and 100 g ha$^{-1}$ of Glean$^R$ applied pre-bud-burst. On Cabernet Sauvignon, rates of 120 and 180 g ha$^{-1}$ of Ally were phytotoxic and 180 g ha$^{-1}$ of Glean was tolerated. There was no difference between overall and directed spraying of herbicides. Grape yield loss due to Ally phytotoxicity followed the relationship;**

**% yield loss = 100 - exp(5.37 - 0.016×rate)**

**giving a predicted 'zero yield loss' at 48 g ha$^{-1}$ of Ally. Vines affected by Ally had recovered by the following season.**

### Introduction

Sorrel (*Rumex acetocella* L.), Dock (*Rumex pulcher* L. and *R. crispus* L.) and Doublegee (*Emex australis* Steinh.) are troublesome weeds in West Australian vineyards. Cultural and herbicidal controls have been uneconomic and/or ineffective and sometimes phytotoxic. Two related herbicides, Glean (chlorsulfuron) and Ally (metsulfuron methyl), have a combined spectrum that covers the above weeds, and most common weeds of vineyards (DuPont 1987a,b). Warmund (1984) has reported phytotoxic effects on Chancellor grape-vines with heavy applications of Glean after bud-burst. No data on the effects of Ally on grape-vines was found in C.A.B. abstracts. Herbicide residue data for grapes are not available (Addenbrooke pers. comm.). If both these herbicides are not phytotoxic to grape-vines and they are registered then vignerons would have more effective herbicides to control winter weeds. To test the pre-bud-burst tolerance of grape-vines, to Glean and Ally, a series of three experiments were conducted testing rates of herbicide, methods of application and varietal sensitivities.

## Materials and methods

### *Site*

The experiments were conducted on the Mt Barker Agricultural Research Station vineyard in the south west of Western Australia (Latitude 34° 38'S, Longitude 117° 40'E). It has a Mediterranean climate, and had an annual rainfall of 677 mm, 570 mm and 710 mm in 1982, 1983 and 1984 respectively. The soil is a lateritic podzolic (Stace *et al.* 1972) classified as a Bangalup sand (Boehm and Pym 1950, Smith 1951). Its Northcote classification is Dy5.61. The calcium chloride pH is between 5.2 and 5.3 to a depth of 50 cm. The top 10 cm is a loamy sand grading into a yellow/orange loamy sand with ironstone nodules to 45 cm and a mottled yellow/orange sandy clay deeper than 45 cm.

### *Vines*

Experiments 1 and 2 were conducted on a block of Cabernet Sauvignon vines planted in spring 1975 and used for an irrigation trial until 1982. Individual panels of five vines were allocated to treatments so that each replicate had exactly the same history.

Experiment 3 was conducted on a block planted as a variety trial. Cabernet Sauvignon, Zinfandel, Pinot Noir, Chenin Blanc, Semillon, Traminer, Sylvaner and Colombard were planted in spring 1975. Sauvignon Blanc, Merlot and Riesling were planted in spring 1976. Four clones of Chardonnay were planted in spring 1977. Cabernet Franc, Pinot Meunier, Muller Thurgau, Malbec, Shiraz, Verdelho and Pinot Noir were planted in spring 1978.

All vines were planted at 1.83 m spacings in rows 3.66 m apart. A directed application of paraquat and diquat mixture was applied twice a year to all vines to keep weed levels low.

### *Spraying*

Herbicides were applied with an air pressurised hand held "Rega" wand with a single 1 mm cone nozzle operated at 150 Kpa pressure. A uniform volume of spray applied at 1000 L ha$^{-1}$ was achieved by spraying an area of 2 m x 2 m around each vine three times for a set time. The weather was fine and mild at each spraying.

### *Phytotoxicity*

The following protocol was used for visually rating phytotoxicity:-

0 = No symptoms.

1 = Very slight - symptoms only apparent after careful observation and on a few leaves only.

2 = Slight - symptoms obvious at first glance, but no reduction in growth or vigor of vine.

3 = Moderate - widespread symptoms, some reduction in growth or vigor of the vine.

4 = Severe - severe symptoms, large reduction in growth or vigor of the vine, but no death of canes. May be some tip death.

5 = Very severe - widespread tip death, death of entire canes or vine death.

### *Experiment 1*

This experiment compared various rates of Glean and Ally applied to the soil around winter pruned vines.

Glean was applied at rates of 60 and 180 g (product) per sprayed hectare and Ally at rates of 60, 120 and 180 g (product) per sprayed hectare on August 4, 1982. The spray was carefully applied so that, at most, only the basal 5 cm of the trunk of the vine was contacted with herbicide. The Glean treatments and the lowest Ally treatments were repeated on the same vines on August 1, 1983. Bud-burst occurred in the first week of September in 1982 and 1983.

The vines were pruned to two bud spurs in July 1982, 1983 and 1984 which was four weeks before spraying in 1982 and 1983. Prunings from each vine were weighed. Grape yield and number of bunches per vine were taken seven and nineteen months after the first spraying. A visual rating of herbicide damage was taken three, four and six months after spraying. Nineteen months after the first spraying the number of leaves showing herbicide phytotoxicity symptoms on each vine were counted and then converted to a phytotoxicity score because all treatments had recovered from severe symptoms.

Sugar concentrations were determined using a refractometer (Weaver, 1976) on the juice of grapes harvested seven months after spraying.

The design was a randomized complete block with four blocks of six treatments. Each plot had three treated vines with two buffer vines between each plot. All measurements were taken from individual vines and kept separate for analysis. Analysis of variance was used to determine treatment effects. The initial pruning weight was used as a covariate for the later pruning weights, grape yield and number of bunches.

### *Experiment 2*

This experiment compared overall versus directed application of Glean and Ally.

The vines were unpruned to allow maximum exposure to herbicide. One sub-plot was sprayed from above so that all canes and the ground beneath received herbicide. The other was sprayed as in a normal commercial ground directed application, in which the

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**Footnote:-** $^R$ Ally and Glean are registered trade marks of DuPont de Nemours & Co. Inc.

**Table 1 The effect of directed herbicide treatments on pruning weight, fruit yield (g/vine) and number of bunches per vine.**

| Herbicide | Rate g ha-1 | Application date 1982 | 1983 | 1983^A Pruning weight | Fruit yield | No. of bunches | 1984^A Pruning weight | Fruit yield | No. of bunches |
|---|---|---|---|---|---|---|---|---|---|
| Glean | 60 | 4.viii | 1.viii | 1582 b | 2482 b | 60 b | 1782 b | 1541 a | 48 a |
| Glean | 180 | 4.viii | 1.viii | 1663 b | 3127 b | 66 b | 1927 c | 1777 a | 50 a |
| Ally | 60 | 4.viii | 1.viii | 1729 b | 2955 b | 69 b | 1867 bc | 1860 ab | 59 a |
| Ally | 120 | 4.viii | 1.viii | 1024 a | 664 a | 20 a | 1506 a | 2675 bc | 86 b |
| Ally | 180 | 4.viii | - | 877 a | 307 a | 11 a | 1567 abc | 2791 c | 82 b |
| Nil | 0 | - | - | 1601 b | 2780 b | 60 b | 1399 a | 1663 a | 51 a |

^A Means of 4 replicates of 4 vines adjusted for covariate. Means in each column followed by the same letter not significantly different ($P<0.05$)

**Table 2 Herbicide phytotoxicity ratings at various times after the initial directed herbicide treatments were applied.**

| Herbicide | Rate g ha$^{-1}$ | Application date 1982 | 1983 | Phytotoxicity rating^A 3 mths (after first spray) | 4 mths | 6 mths | 19 mths |
|---|---|---|---|---|---|---|---|
| Glean | 60 | 4.viii | 1.viii | 0 a | .2 a | .1 a | .1 abc |
| Glean | 180 | 4.viii | 1.viii | 0 a | .4 a | .2 a | .16 bc |
| Ally | 60 | 4.viii | 1.viii | 0 a | .2 a | .3 a | .06 ab |
| Ally | 120 | 4.viii | 1.viii | 3.0 b | 3.6 b | 3.3 b | .02 a |
| Ally | 180 | 4.viii | - | 3.2 b | 3.7 b | 3.5 b | .2 c |
| Nil | 0 | - | - | 0 a | 0 a | 0 a | .07 ab |

^A Means of 4 replicates of 4 vines.
Means in each column followed by the same letter not significantly different ($P<0.05$)

**Table 3 The effects of various herbicide treatments on pruning weight and fruit yield (g/vine) and the number of bunches per vine.**

| Herbicide | Rate g ha$^{-1}$ | Application date 1982 | 1983 | 1983^A Pruning weight | Fruit yield | No. of bunches | 1984^A Pruning weight | Fruit yield | No. of bunches |
|---|---|---|---|---|---|---|---|---|---|
| Glean | 60 | 4.viii | 1.viii | 2031 a | 5692 a | 106 c | 2088 a | 2344 b | 72 a |
| Glean | 120 | 4.viii | 1.viii | 1958 a | 5205 a | 107 c | 2109 a | 2776 b | 87 ab |
| Glean | 180 | 4.viii | 1.viii | 1501 b | 4413 a | 82 b | 1734 a | 2259 b | 77 a |
| Ally | 60 | 4.viii | 1.viii | 1979 a | 4499 a | 87 bc | 2207 a | 2412 b | 77 a |
| Ally | 120 | 4.viii | 1.viii | 1625 b | 1284 b | 33 a | 1776 a | 3100 a | 87 ab |
| Ally | 180 | 4.viii | - | 1461 b | 1267 b | 33 a | 2071 a | 3664 a | 105 b |
| Nil | 0 | - | - | 1979 a | 5707 a | 94 bc | 1946 a | 2406 b | 76 a |

^A means of 3 replicates of 4 vines adjusted for covariate.
Means in each column followed by the same letter not significantly different ($P<0.05$)

**Table 4 Herbicide phytotoxicity ratings at various times after the initial herbicide treatments**

| Herbicide | Rate g ha$^{-1}$ | Application date 1982 | 1983 | Phytotoxicity rating* 3mths (after the first spray) | 4mths | 6mths | 19mths |
|---|---|---|---|---|---|---|---|
| Glean | 60 | 4.viii | 1.viii | 0 a | 0.3 a | 0.1 a | 0.04 a |
| Glean | 120 | 4.viii | 1.viii | 0.17a | 0.5 ab | 0.9 b | 0.09 a |
| Glean | 180 | 4.viii | 1.viii | 0 a | 1.7 c | 1.9 c | 0.12 a |
| Ally | 60 | 4.viii | 1.viii | 1.3 b | 1.1 bc | 0.9 b | 0.07 a |
| Ally | 120 | 4.viii | - | 2.2 c | 2.6 d | 1.7 c | 0.15 a |
| Ally | 180 | 4.viii | - | 3.6 d | 3.5 e | 3.2 d | 0.11 a |
| Nil | 0 | - | - | 0 a | .1 a | 0 a | 0.11 a |

* means of 3 replicates of 4 vines averaged over method of application.
means in each column followed by the same letter not significantly different ($p<0.05$)

basal 150 mm or so of the vine trunk and occasional low hanging canes received herbicide. Glean and Ally were applied at rates of 60, 120 and 180 g (product) per sprayed hectare on August 4, 1982. The Glean and lowest Ally treatments were reapplied to the same plots on August 1, 1983. The vines were pruned eight days after each spraying and in July, 1984.

A split plot randomized block design was used with three blocks of eight treatments. Each plot had two by two-vine sub-plots. There was one buffer vine between each plot. All other details were the same as in Experiment 1.

*Experiment 3*

This experiment compared the reaction of various varieties to Glean and Ally.

The block of vines for the experiment had 44 rows of 20 vines. Each row was a single variety and there were 22 varieties or clones replicated twice. Four sets of five consecutive vines were used for the herbicide treatments. Two vines from each set were chosen for spraying and individually paired with two control vines of similar size from the same set.

An area of 2 m x 2 m under each treated vine was sprayed as a commercial ground directed application. The herbicide treatments were 10 and 25 g (product) per sprayed hectare of Ally, applied on September 18, 1985 and 40 and 100 g (product) per sprayed hectare of Glean applied on August 23, 1985.

Visual ratings of phytotoxicity were taken on October 9 and November 5, 1985 and a visual rating of grape production was taken in January, 1986.

## Results

*Experiment 1*

No loss in fruit yeild or pruning weight and no unacceptable visual phytotoxicity occured when up to 180 g ha$^{-1}$ of Glean or 60 g ha$^{-1}$ of Ally was applied. Higher rates of Ally caused severe visual phytotoxicity and reductions in fruit yield, number of bunches, size of bunches and pruning weights. In the season after spraying these vines recovered and produced more fruit. (Tables 1 and 2). There were no significant differences in grape sugar concentrations.

*Experiment 2*

There were no significant differences in fruit or vegetative weights or number of bunches produced following overhead versus directed spraying. As in Experiment 2, rates of Ally above 60 g ha$^{-1}$ cause reductions in fruit and bunch production in the season of spraying followed by compensatory production the following year (Table 3). Pruning weights were reduced by rates of Ally above 60 g ha$^{-1}$, and 180 g ha$^{-1}$ of Glean (Table 3).

Visual symptoms of phytotoxicity were just detectable in the 6 months after the application of 60 g $ha^{-1}$ of Ally or 120 g $ha^{-1}$ of Glean ( Table 4). There were no significant differences in the grape sugar concentrations between treatments.

By combining the grape yield data for the Ally treatments from Experiments 1 and 2 the following model describes the relationship between the rate of Ally applied and the percentage loss of yield in the season of spraying.

**% Yield loss = 100 - exp(5.37 - 0.016×rate)**
**(% var = 89.6%[A])**

Thus under this model the 'no effect' level of Ally applied pre-bud-burst is 47.8 g $ha^{-1}$ as shown graphically in Figure 1. The 'no effect' level for Glean was greater than 180 g $ha^{-1}$, the highest rate applied.

*Experiment 3*

None of the vines showed phytotoxicity symptoms when observed two, three or eight months after spraying.

There were no significant differences in the visual estimates of grape yield between sprayed and unsprayed vines.

## Discussion

Cabernet Sauvignon displayed acceptable tolerance of both Glean and Ally herbicides when applied as a directed spray or as an overall spray to vines before bud-burst. The recommended rate of Glean is 15-20 g $ha^{-1}$ and Ally is 5-10 g $ha^{-1}$. Six times these rates applied for two successive years caused no visual phytotoxicity or loss in production or quality of Cabernet Sauvignon vines. No visual reduction in growth or grape production of 21 other varieties and clones of grapevines were observed when 4 times recommended rates as directed sprays were applied. Previous work with Glean applied to 9 year old Chancellor grape-vines showed reduced vegetative growth with rates above 93 g (product) per hectare and reduced berry weights with rates above 47 g $ha^{-1}$ (Warmund 1984). The phytotoxicity noted was most probably attributable to the application of Glean well after bud-burst, much later than in our experiments. Further research is required to determine the relationship between time of application and phytotoxicity.

At twelve times the recommended rate, Ally caused a severe visual phytotoxicity and loss of production. Ten weeks after spraying the symptoms were a veinal chlorosis spreading to whole leaf chlorosis (Figure 2). Sinuses of the leaf were deeper giving the leaf a fingered appearance and the lamina buckled along the major leaf veins. The canes appeared to be stiffer. The internode length was decreased giving the whole vine a compact appearance (Figure 3). Warmund

Footnote:- [A] % var = $R_a^2$

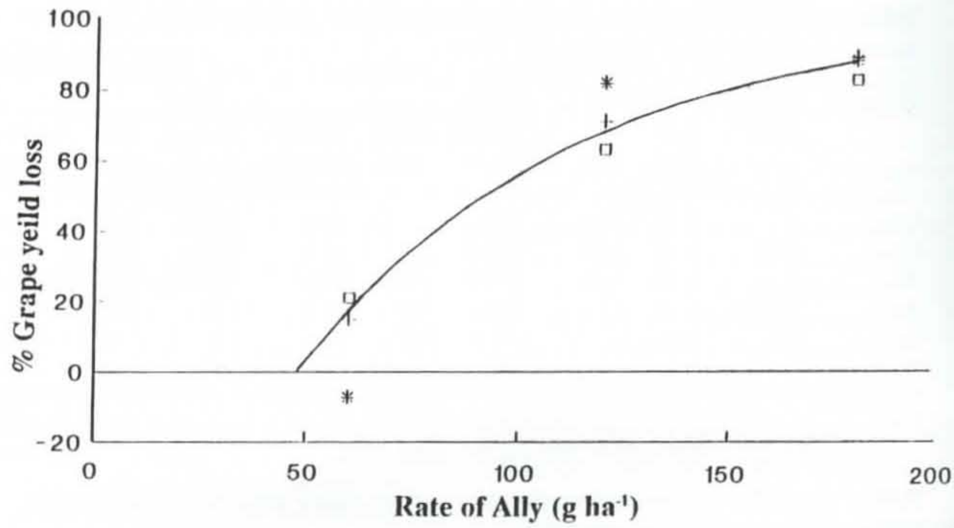


**Figure 1. The relationship between the expected grape yield loss and the rate of Ally applied pre-bud-burst. Legend: (*) Exp 2 overall, (+) Exp 1 directed, (□) Exp 2 directed.**

**Figure 2. Ten weeks after 180 g $ha^{-1}$ of Ally, grapevine leaves show veinal chlorosis and deepened sinuses.**

**Figure 3. Ally phytotoxicity symptoms - reduced internodal length giving the vine a compact appearance.**

(1984) reported reduced internode lengths in Chancellor grape-vines treated with Glean. In our experiments internode length was not noticeably reduced by Glean. At the highest rate of 180 g $ha^{-1}$ Ally, cane tip death occurred and some canes died. No vines died despite the severity of symptoms. The vines the following season appeared normal and affected vines yielded more heavily than untreated vines. Treatments with the worst symptoms in the year of spraying made the most compensatory growth. The Ally (180 g $ha^{-1}$) treatment yielded 90% less in the year of spraying and 70% more in the year after spraying than the controls. The reduction in yield was due to both fewer bunches and smaller bunch size whilst the increase was due to more bunches being produced (Tables 1 and 3).

Thus, while compensatory production is not complete, it will be a great comfort to those vignerons who accidentally overdose their vines. In crops that are costly and time consuming to establish, it is important that the herbicides used have a good margin for error and do not kill the crop when inevitable mistakes occur.

From these experiments it is predicted that up to 48 g $ha^{-1}$ of Ally or more than 180 g $ha^{-1}$ of Glean could be applied annually, before bud-burst without reducing grape production or the sugar concentrations of the grapes. This provides an acceptable margin of safety over recommended use rates.

The severity of symptoms observed suggests that, if Ally is registered for use in vineyards, it should be used judiciously for weeds such as sorrel where it is clearly superior to alternatives. Glean is a candidate for registration in vineyards because it has displayed no serious phytotoxicity in these experiments or in Warmund's (1984) experiments at recommended rates, and it has a broad weed spectrum.

This work was carried out on gravelly loam soil types of pH 5.3, which are typical of the vineyards of the south west of W.A. Both Glean and Ally are more persistent and phytotoxic in alkaline soils (DuPont 1987a, b), research is required to determine grapevine tolerance of these herbicides on those soils where breakdown is slower.

The similar reaction of the grape-vines to both overhead and directed spraying suggests that the major method of entry of these herbicides into the vine before bud-burst is through root absorption. Different soil types, rainfall patterns and times of application are likely to affect results.

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**Appendix 1**

**Monthly Rainfall - Mt Barker Agricultural Research Station**

| | Rainfall (mm) 1982 | 1983 | 1984 | |
|---|---|---|---|---|
| Jan | 9 | 151 | 5 | 4 |
| Feb | 11 | 22 | 29 | 22 |
| March | 12 | 53 | 11 | 18 |
| April | 44 | 12 | 24 | 22 |
| May | 79 | 50 | 37 | 80 |
| June | 104 | 72 | 88 | 82 |
| July | 114 | 91 | 87 | 102 |
| August | 97 | 68 | 71 | 135 |
| Sept | 41 | 39 | 83 | 108 |
| Oct | 46 | 46 | 49 | 25 |
| Nov | 50 | 29 | 42 | 97 |
| Dec | 14 | 37 | 43 | 15 |
| Total | 621 | 677 | 570 | 710 |

**Appendix 2**

**Weather conditions at the time of spraying**

| | | |
|---|---|---|
| Date | 4/8/82 | 1/8/83 |
| Temperature | 16 C | 15.5 C |
| Relative Humidity | 80% | 62% |
| Wind Speed | 0 - 2 Km/h | 0 - 10 Km/h |
| Direction | Variable | NE |
| Rainfall | 182 | 0 |
| Cloud Cover | 0% | 100% |