

**Relationships Among Spreader-Sticker Application, Blossom Cap Retention, Berry Scarring, Thrips Populations, and Botrytis Bunch Rot in 'Chardonnay' Grapes, and A Survey of Pesticide Use and Pest Severity in Virginia Vineyards in 1990 and 1991**

by

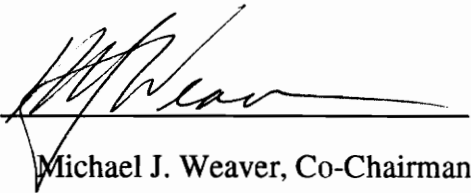
Natalia Martinez

Thesis submitted to the Faculty of the  
Virginia Polytechnic Institute and State University  
in partial fulfillment of the requirements for the degree of  
**MASTER OF SCIENCE**  
in  
Plant Pathology, Physiology, and Weed Science

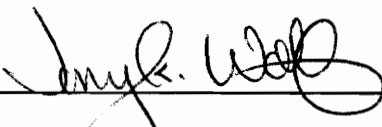
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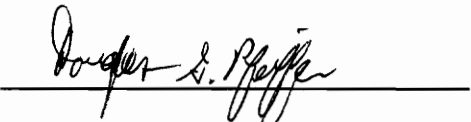
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December, 1992

Blacksburg, Virginia

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Natalia Martinez

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(ABSTRACT)

A field study was conducted in 1991 to determine whether high rates of cap retention in 'Chardonnay' grapes contributed to increased levels of Botrytis bunch rot (*Botrytis cinerea* Pers.), and whether spreader-sticker application enhanced cap retention. At bloom, the sticker Nu-Film 17<sup>®</sup>, or water (control), was sprayed onto single clusters at diluted ( 0.63 ml / L ) and concentrated ( 1.26 ml / L ) label rates. After fruit set, some clusters were cleaned of caps and other flower parts with pressurized air. Cap and debris retention, berry scarring, and Botrytis rot were evaluated throughout the season. The spreader-sticker application increased debris retention only slightly. Removal of caps and debris had no effect on scarring, but reduced Botrytis bunch rot. The role of flower thrips *Frankliniella tritici* (Fitch) in causing scarring and in increasing Botrytis rot in Chardonnay grapes was explored in 1992. The insecticide methomyl (Lannate<sup>®</sup>) at a labeled rate (0.9 ml per 377 ml water per vine), or water (control), was sprayed onto selected vines twice at bloom. Berry scarring and Botrytis bunch rot were evaluated at mid-season and at harvest. The insecticide treatment reduced scarring, but did not affect

Botrytis rot incidence. A survey of Virginia grape growers was conducted for 1990 and 1991, to collect information on pest and disease severity and chemical and non-chemical pest control methods. In growers' opinions, black rot, Japanese beetle, and annual grasses were the most severe disease, insect, and weed problems respectively. Pesticides most commonly used were captan, glyphosate, and carbaryl.

## Acknowledgements

The author wishes to express appreciation to the following:

- Dr. Michael J. Weaver, for serving as co-chairperson of my advisory committee and for providing an assistantship, his guidance in the pesticide survey studies, and for his most appreciated encouragement throughout this endeavor.
- Dr. Anton B. Baudoin, for serving as co-chairperson of my advisory committee, his guidance and useful suggestions, for helping in the field experiments, for providing valuable advice on the statistics of this research, and for his helpful corrections of my English writing.
- Dr. Tony K. Wolf, for serving as a member of my advisory committee, for providing his skillful technical knowledge in viticulture, for his generous time and help during the duration of the field experiments and for allowing me to use the facilities at the Winchester Agricultural Experiment Station for ratings after harvest, and for his valuable moral support.
- Dr. Douglas G. Pfeiffer, for his willingness to serve as a member of my advisory committee and for his very useful advice in entomology, viticulture, and pesticide usage surveys for this project, and for his collaboration for transportation to and from the vineyard.
- Mr. Paul Mierzejewski, the Seagram Wine Company of Canada, and everybody at Ivy Creek Farms, for allowing me to set up my Chardonnay plots with free access, collaborating with my research in various technical ways, all making possible this study.
- Virginia grape growers, for their support and willingness to provide information concerning pest severity and pesticide use requested in the surveys mailed to them for the 1990 and 1991 growing seasons.
- The U. S. Department of Agriculture (USDA) and its National Agricultural Pesticide Impact Assessment Program (NAPIAP) for providing the funds for the survey of Virginia grape growers.
- The Virginia Wine Growers Advisory Board for providing partial financial support for the field experiments with Chardonnay done during 1992.

Mr. Eric Day, Entomology diagnostician, VPI & SU, for his help in thrips identification and for requesting the species verification from the USDA Systematic Entomology Laboratory.

Ms. M. Kay Cook and Mr. Jim Furr. for their valuable help in rating and recording data after harvest at the Winchester Agricultural Experiment Station in Virginia in 1991 and setting up a treatment during 1992.

Ms. Maria Angela Martinez for her kind help during labeling of the experimental trials and setting up the treatments during 1992.

Ms. Valerie Vachiani and Mr. Basem Alsayed for their valuable help translating french and arabic literature for my bibliographic review.

The American Society for Enology and Viticulture-Eastern Section, for their generosity in awarding me one of their 1991 annual student scholarships, a great encouragement and support while pursuing my degree.

The Graduate Student Assembly (GSA), VPI & SU, for awarding me a Graduate Research and Development Grant in 1991, supporting my research expenses.

Dr. Clint Coakley and Mr. Matt Petrelli, Statistics Consultants, VPI & SU, for their assistance with some of the statistical analysis for this project.

The Chemical, Drug and Pesticide Unit personnel and their families, for their kind, patience, and extraordinary moral support every day during these years working with them.

The Plant Pathology, Physiology, and Weed Science Department, Dr. Laurence D. Moore, faculty, staff, and fellow graduate students for their support and friendship.

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## Chapter 1

### **Relationships Among Spreader-Sticker Application, Blossom Cap Retention, Berry Scarring, and Botrytis Bunch Rot in 'Chardonnay' Grapes**

#### **INTRODUCTION**

Botrytis bunch rot, caused by the fungus *Botrytis cinerea* Pers., causes significant losses in Virginia vineyards in some years. 'Chardonnay', the most widely planted grape cultivar in the state, is moderately to highly susceptible to this disease (Coley-Smith *et al.*, 1980; Jackson and Schuster, 1987). Although Botrytis rot symptoms usually appear in mature berries following wet and cool weather late in the season (Flaherty *et al.*, 1982; Pearson and Goheen, 1988), "early Botrytis rot" in grapes as defined by McClellan and Hewitt (1973) may appear at or shortly after véraison in the absence of rain. Such early-season Botrytis rot has been demonstrated in different viticultural areas and several grape varieties such as 'Merlot', 'Grenache', 'Grey Riesling', Chardonnay, 'Traminer', 'Shiraz', and 'Gamay' (Jermini *et al.*, 1986; McClellan and Hewitt, 1973; Nair and Parker, 1985; Pezet and Pont, 1986). McClellan and Hewitt (1973) also provided evidence that infection of the grape flower occurs at bloom through the stigma of the flower and that the fungus remains latent in the stylar end of the grape until rot develops later in the season. Flower parts such as the stigma, the canal of the style, and the stamens are described as the first sites for Botrytis infection in the flower (McClellan and Hewitt, 1973; Najjar, 1985). Pezet and Pont (1986) conducted a histological and autoradiographic study in which they inoculated grape vines at full bloom with <sup>14</sup>C-labeled conidia of *B. cinerea* and showed recovery of radioactivity inside the mature berries. Further studies have shown that

germination and berry surface colonization by *B. cinerea* are markedly stimulated by grapevine pollen (Lehoczky, 1975). The nature of the resistance of immature grapes to *B. cinerea* has been studied by several investigators (Hill *et al.*, 1981; Pezet, 1988; Jeandet and Bessis, 1989; Padgett and Morrison, 1990). Those studies have detected antifungal phytoalexins and a variety of tannins, acids, and phenols in berries. Those compounds could explain why the fungus remains latent and then resumes growth when their concentrations decline as the berry matures. However, other authors (Savage and Sall, 1981) were unable to detect latent infections within the berries and suggested that organic debris colonized by the fungus was the source of inoculum for subsequent infections.

Grape blossom buds are enclosed by fused petals forming a corolla (cap or calyptra), in which each petal detaches from the sepals at the base during bloom (Pratt, 1971; De la Harpe, 1982). This differs from most other flowers where the petals separate at the tip in a so-called star flower. In some grape cultivars shedding caps remain attached to the berry through the stigma after anthesis. High rates of blossom cap retention have been observed in Chardonnay grapes (Fig. 1.1). Caps, stamens (anthers and filaments), and other debris (*e.g.* non-pollinated flowers, aborted berries, pollen, *etc.*) retained around the berry and inside the cluster, may serve as initial nutrient sources for *Botrytis* (McClellan and Hewitt, 1973; Kamoen *et al.*, 1985; Pezet and Pont, 1986). Only one report involved the removal of organic debris; in this one-year, one-site study in Switzerland, debris removal with a blower at three different stages (50-80% flowering, end of flowering, and when berries began to touch) reduced *Botrytis* by about one-third (Jermini *et al.*, 1986).

Some researchers have studied the effect of surfactants on cracking of apples (Byers *et al.*, 1990) or on properties of berry wax which affect susceptibility of grapes to *B. cinerea* (Marois *et al.*, 1987), but no studies have evaluated whether cap and organic

debris retention in grape clusters may be promoted by spreader-stickers applied as adjuvants in pesticide sprays.

Not all *Botrytis* infections originate at bloom time. Infection has been shown to occur through stomata in the young grape berry, lenticels, and large numbers of natural perforations in the cuticle of grape berries (Blaich *et al.*, 1984; Blanke and Leyhe, 1988). Berry scarring might increase the incidence of *Botrytis* bunch rot, perhaps by increasing direct penetration of the fungus through microfissures caused by the scars in the berry surface. Berry scarring may be caused by powdery mildew, pesticides such as captan and sulfur (Pearson and Goheen, 1988), but also by abrasion by sticking caps, and by thrips (Insecta: Thysanoptera) (Jensen, 1973 and 1975; Yokoyama, 1977; McNally *et al.*, 1985 *a, b*; Luvisi, 1992).

The objectives of this project were to determine: (1) whether cap retention by developing berries of Chardonnay grapes will increase *Botrytis* bunch rot incidence, (2) whether application of spreader-sticker promotes cap/debris retention, (3) whether berry scarring and/or total debris accumulation on grape clusters will increase the incidence of *Botrytis*, and (4) whether populations of flower thrips are related to berry scarring and *Botrytis* bunch rot.

## **MATERIALS AND METHODS**

Field experiments were conducted in 1991 and 1992 at Ivy Creek Farms, a vineyard in central Virginia, using the grape cultivar Chardonnay (*Vitis vinifera* L.). The 1991 test was conducted in two north-south oriented rows (spaced 3.7 m apart) of ten-year-old vines, spaced 2.1 m apart in the row. The vines were trained to an "open lyre" divided canopy system (Fig. 1.2) (Carbonneau and Huglin, 1982), consisting of two bilateral, parallel, horizontal cordons 1.2 m apart 1 m above the ground, with the shoots positioned

upright for growth. Shoots were thinned to 19 shoots per m of canopy. The basal-most flower clusters of shoots of uniform length (average 30 cm) were selected and tagged. Vines and flower clusters were visually screened to be free of any damage or disease. The vineyard's normal pesticide program was followed throughout the season, including the experimental plot. Disease control sprays included nine applications of mancozeb, seven of wettable sulfur, seven of myclobutanil, two of basic copper sulfate, and one of captan. Benomyl was sprayed once during full bloom. Iprodione was sprayed when berries were about pea size, and a second time three weeks before harvest. The insecticide carbaryl was applied once during midseason. Canopy management practices such as leaf pulling and shoot pruning were carried out as well by the grower.

The experiment to study thrips and scarring was conducted in 1992 in the same vineyard but on head-trained and cane-pruned Chardonnay vines. In this system, head height was approximately 1.5 m above ground level and catch wires were used to maintain a relatively thin canopy. Vines and clusters were selected as in 1991. The disease control sprays varied slightly: eleven mancozeb, seven myclobutanil, six sulfur, two basic copper sulfate, and two captan applications were made. Benomyl was sprayed once at full bloom. Iprodione was sprayed a month after full bloom, and a second time two weeks before harvest. The insecticide carbaryl was applied three times. Canopy management practices were performed as in 1991.

**Treatments.** For the 1991 study, a randomized complete block experimental design was used, where a vine constituted a block and a cluster was the experimental unit. There were 20 blocks (replications) divided over two adjacent vine rows. Nine blossom clusters on the east-half of the canopy of each vine were selected. The nine treatments were combinations of three variables (Table 1.1):

(1) At mid-bloom (50% flowers opened) clusters were sprayed with a spreader-sticker (Nu-Film 17®, Miller Chemical & Fertilizer Corporation, Hanover, PA.) at two labeled rates, concentrated 1.26 ml/L (= 16 oz/100 gal) and diluted 0.63 ml/L (= 8 oz/100 gal), and with water as a control. All clusters were sprayed until run-off using a hand sprayer.

(2) At full bloom, caps and other debris were mechanically removed in a second set of three spreader-sticker treatments, using compressed air (827 kPa= 120 psi). A comparison of cleaned and non-cleaned grape clusters is shown in Figs. 1.3 and 1.4.

(3) Clusters in a third set of three spreader-sticker treatments were enclosed in white paper bags after cap removal, to isolate them from pesticides and possible adjuvants applied by the grower and avoid possible scarring by those chemicals. Bags were checked periodically for damage and replaced if necessary. Bags were removed after one month.

The summer of 1991 was warmer and drier than average, with high temperatures around 35°C and low precipitation (Fig. 1.5) and early *Botrytis* incidence was very low. Therefore, an attempt to promote infection was made in early June; 2.23 liter suspension of spores (final concentration =  $2 \times 10^4$  spores per ml) was prepared by rinsing conidia from potato dextrose agar plates inoculated with two isolates of *B. cinerea* (from lemon and from pear fruit), provided by Dr. A. Baudoin (PPWS, VPI & SU). Clusters in ten vines were sprayed with the spore suspension, and clusters in the other ten vines were sprayed until run-off with distilled water as a control. Paper bags covering clusters were carefully cut and the enclosed clusters were sprayed. The wet clusters were enclosed in clear plastic bags; after 24 h the plastic bags were removed and the paper bags were sealed again with tape. There was no evidence of heat stress or mechanical injury due to the plastic bagging. The temperatures during the 24-hour period of plastic bagging were around 13°C during the evening, with a maximum of about 24°C during the day. When

the first berries infected with Botrytis rot were detected, samples were collected for microscopic examination and isolation of the pathogen on potato dextrose agar (Difco®) plates incubated at 25°C, in order to confirm its identity.

For the 1992 growing season, a repetition of the 1991 study without the bagging treatment and using another trellis system was planned, together with a separate trial to study thrips relationships with berry scarring. Unfortunately, shortly after cap removal, hail and strong winds caused serious fruit injury and blew away most flower debris from the experimental clusters, and the experiment was terminated. The thrips field trial was not significantly affected and was continued as planned. A randomized complete block experimental design was used for the thrips study, where each vine constituted an experimental unit, and clusters on the vine were the sample units. Five replications were used for this study. To determine whether berry scarring was related to the population of flower thrips, two treatments were applied at 10% bloom and full bloom:

(1) The insecticide methomyl was sprayed onto five randomly selected vines at a labeled rate of 0.9 ml of Lannate® L, 24% w/v a.i. (E. I. Du Pont Inc. Wilmington, DE), dissolved in 377.5 ml water per vine (= 1 pint in 50 gallons of water, per acre). In the vineyard there were about 519 vines per 0.4 hectare (1 acre).

(2) Water (378 ml = 0.1 gal per vine) was sprayed onto the remaining five randomly selected vines. Treatment sprays were applied at mid-bloom and full-bloom to selected vines and a buffer zone of a half-vine on each side. Half of the spray volume was applied to the east side of the vine and the other half to the west side, to assure even distribution of the treatments.

**Data collection.** For the 1991 experiment, plots were rated four times starting one month after the treatments were applied. Observations were recorded for each cluster as follows: number of berries with retained cap, number of berries with scars (any size), and

number of berries infected with Botrytis. In addition, total amount of debris around the cluster was estimated visually using a scale from zero (none) to five (highest accumulation). The total number of berries per cluster was recorded at harvest time, where all clusters were collected and individual berries detached for the fourth or last rating. The same rating procedure was followed for the 1992 experiment, when clusters arbitrarily selected from a 0.5 m area at the vine center were observed for berry scarring and Botrytis bunch rot at mid season and five days before harvest. Thrips populations were monitored twice during early season and once at midseason, recording the average number of thrips per cluster, by shaking five clusters and counting thrips over a 10x10 cm white paper card.

**Statistical methods.** Analysis of variance (GLM) and correlation (Pearson) were performed with SAS® statistical software. For certain comparisons some treatments were omitted from the analysis. For the comparison of cap removal with no cap removal (Table 1.4), data from clusters with the bagging treatment were excluded; and for the comparison of bagged with non-bagged clusters (Table 1.5), data from clusters with the cap removal treatment were excluded.

## RESULTS

In the 1991 field experiment, the attempt to promote Botrytis infection by inoculating half of the replicates with a spore suspension was not successful. Although Botrytis incidence seemed higher in the inoculated clusters, the difference was not statistically significant (Table 1.2). Therefore inoculated and non-inoculated treatments were pooled for subsequent comparisons.

None of the interactions between the treatment components (bagging, spreader-sticker application, and cap removal) were significant. Therefore, only main effects will be presented.

Application of spreader-sticker did not affect cap retention (Table 1.3). The clusters sprayed with the concentrated solution appeared to have higher cap retention, but differences were not significant. On the other hand, spreader-sticker slightly increased flower debris retention; this was significant in two of three ratings. As with cap retention, debris retention was a little higher among clusters treated with the higher rate of the spreader-sticker than with the lower rate or water. Berry scarring and Botrytis bunch rot were not affected by the spreader-sticker applications.

Removal of caps and organic debris (Table 1.4), had a marginally significant effect on berry scarring, and reduced Botrytis bunch rot significantly at the second, third, and final rating. However, conditions for Botrytis rot were not favorable in 1991, and the total amount of Botrytis rot was very small (1.12% and 5.2% of all berries were the maximum rot levels in any treatment during early and late season respectively).

Bagging increased cap and debris retention, berry scarring, and Botrytis bunch rot (Table 1.5). Spreader-sticker effect was not affected by the bagging treatment (interaction between bagging and spreader-sticker effect was not statistically significant: probability values ranging between 0.12 and 0.97).

During early development of the grape berries, the presence of the fungus *B. cinerea* was noticed and confirmed by isolations. Two sites were commonly colonized: shedding caps retained by the berries (Fig. 1.6) and aborted berries (Fig. 1.7), where typical sporulation could be easily observed. However, attempts to isolate the fungus from sound berries were not successful.

In order to study the relationship between scarring and Botrytis incidence in the 1991 experiment, analysis of partial correlation (Neter *et al.*, 1985) was used. The effect of bagging on Botrytis rot incidence and scarring severity was separated out by regressing both Botrytis rot incidence and berry scarring severity separately against the bagging variable (0 for no bag, 1 for bagged), and calculating the residuals (which measure the sample variation due to both variables). Then the coefficient of partial correlation for the residuals from both regressions was calculated. The resulting correlation between scarring severity and Botrytis rot incidence was not significant, ranging from -0.12 (P=0.11) for small scars to -0.04 (P=0.54) for large scars. This indicates that Botrytis rot incidence was not increased by berry scarring in this experiment.

Thrips present in the vineyard were identified as flower thrips *Frankliniella tritici* (Fitch) by Dr. S. Nakahara of the USDA Systematic Entomology Laboratory. The insecticide methomyl reduced berry scarring significantly at both ratings in the 1992 field test (Table 1.6). Thrips counts (Fig. 1.9) show that one week after the first treatment, the average number of thrips was lower in the insecticide treated clusters. Insecticide applications and reduced scarring did not affect Botrytis bunch rot significantly (Table 1.6). Botrytis incidence during 1992 was very low (6.7% of berries was the highest incidence in any treatment).

## DISCUSSION

One-time removal of caps and other organic debris around the Chardonnay grape clusters reduced Botrytis bunch rot incidence by about 25 percent. These results agree with Jermini *et al.* (1986) who have found that debris removal on 'Merlot' grape clusters reduced Botrytis by about one-third. It also lends support to the hypothesis proposed by Savage and Sall (1981) that organic debris provides initial nutrient sources for Botrytis and therefore increases inoculum for infections. However, repeatability and magnitude of the effect should be confirmed. If the result is confirmed in a future study, practical methods could be developed to remove floral debris, for example running an air blast or other sprayer with pressurized air through the canopy, to remove debris in the clusters. Another method could be to shake the training wires to loosen this organic material. The timing of removal also needs further consideration, since removal is more effective before the bunches close and when debris is dry and more likely to be released from the clusters.

Applications of the spreader-sticker Nu-Film 17® increased retention of organic debris, but had very little effect on cap retention. The sticking effect would be expected from the concept that in addition to grape flower and berry exudates (such as complex sugars, acids, and waxes) (Pratt, 1971; Padgett and Morrison, 1990), the presence of compounds like spreader-stickers could increase the adherence of caps on the berries and debris in the cluster. The study of the spreader-sticker effect needs to be repeated as well, to verify the magnitude of the effect and the reproducibility of results obtained during 1991. If future results confirm a correlation between spreader-sticker application and floral debris retention, and lower Botrytis development is observed when less debris is present, then generous use of spreader-stickers may be contraindicated.

Bagging clusters affected all variables tested during the 1991 experiment. The increase in cap and debris retention due to bagging was likely due to protection from

environmental factors such as rain and wind. Scarring was increased significantly as well, possibly due to mechanical abrasion by persisting caps or perhaps as a result of high thrips populations present around clusters where they might oviposit and feed under retained caps as previously described (Jensen, 1973; McNally *et al.* 1985 *a, b*). Scarring was produced neither by pesticide sprays since the bags protected the clusters from those external agents, nor by powdery mildew since no signs of this disease were observed. As expected, Botrytis bunch rot increased also, possibly as a consequence of increased humidity or due to more debris or more scars inside the bags. The bagging treatment did not change the effect of spreader-sticker and because of the difficulties in interpreting the results, it is simpler to omit bagging of the clusters in future tests.

Scarring on the surface of Chardonnay grape berries did not show any effect on Botrytis incidence during the experiment conducted in 1991. This is contrary to our assumption that severe scarring often seen in Chardonnay (Fig. 1.8) could intensify the incidence of Botrytis bunch rot, perhaps by increasing direct penetration of the fungus through microfissures, or by increased berry cracking at the edges of the scars. In the experiment conducted in 1992, clusters from vines where thrips were reduced by insecticide applications had much less scarring than control clusters, but there was no decrease in Botrytis incidence. No research on berry scarring in Chardonnay grapes has been reported, obviously due to the lack of importance of scarring in these grapes which are only marketed for wine making. However, several studies in table grapes suggest a correlation between scarring and bunch rot. For example, Luvisi (1992) reported an experiment in 'Redglobe' table grapes where methomyl and other insecticides were used to examine relationships among thrips populations, berry scarring, and decay development. Although some reduction of scarring and decay was observed, results did not correlate between thrips control and scarring, and data were obtained collecting samples only from

the lower portion of the cluster. In contrast, my method of counting the number of scars on all berries in each cluster gives me strong confidence in my results on berry scarring. Flaherty *et al.* (1982) report that severe scarring caused by thrips on 'White Malaga' grapes usually causes berries to split and crack as they grow. These authors also mention the importance of pesticide treatments to reduce western flower thrips *F. occidentalis* (Pergande) in 'Italia' table grapes, to avoid severe halo spotting leading to bunch rot. Although neither the 1991 nor the 1992 test showed a relation between scarring and Botrytis rot incidence in Chardonnay the study should be repeated to confirm this result, especially if future weather conditions in Virginia are more suitable to Botrytis bunch rot and also, because it was not demonstrated whether all berry scars were due only to thrips or if abrasion by retained caps is another cause of scarring. In addition, future studies should consider monitoring populations of thrips within the clusters more precisely. Ideally clusters should be checked frequently within the days immediately following the treatments to provide more information about the effectiveness of methomyl against flower thrips.

Future studies on the effect of floral debris on Botrytis bunch rot incidence should attempt to develop practical means for debris removal, taking also into account the microenvironment provided by different training systems, the evaluation of other grape varieties such as Merlot (with high cap retention) or 'Riesling' (with compact clusters and susceptibility to Botrytis), and should also consider the effect of other geographical areas.

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**Table 1.1** Treatments used in the 1991 study.

|                            | NO BAG       | NO BAG             | BAG                |
|----------------------------|--------------|--------------------|--------------------|
|                            | CAPS REMOVED | NO CAPS<br>REMOVED | NO CAPS<br>REMOVED |
| CONTROL<br>(Water)         | <b>A</b>     | <b>D</b>           | <b>G</b>           |
| Nu-Film 17®<br>(1.26 ml/L) | <b>B</b>     | <b>E</b>           | <b>H</b>           |
| Nu-Film 17®<br>(0.63 ml/L) | <b>C</b>     | <b>F</b>           | <b>I</b>           |

**Table 1.2** Effect of *Botrytis cinerea* inoculation on Botrytis bunch rot levels observed throughout the 1991 season.

| Rating date | Treatment                               |                    | P-value <sup>c</sup> |
|-------------|---|--------------------|----------------------|
|             | <i>B. cinerea</i> inoculum <sup>a</sup> | Water <sup>b</sup> |                      |
| 10 June     | 0.31 <sup>d</sup>                       | 0.21               | 0.50                 |
| 24 June     | 0.49                                    | 0.37               | 0.42                 |
| 3 July      | 1.13                                    | 0.98               | 0.58                 |
| 8 August    | 2.73                                    | 2.65               | 0.91                 |

a Vines 11 to 20 (replicates) were sprayed until run-off with Botrytis suspension.

b Vines 1 to 10 (replicates) were sprayed until run-off with water as a control.

c Probability values that difference was due to chance.

d Average percentage of Botrytis bunch rot.

**Table 1.3** Effect of spreader-sticker application on cap retention, debris rating, berry scarring, and Botrytis bunch rot (1991).

| Variable                          | Rating date | Water | Rate of Nu-Film 17® |           | P-value <sup>g</sup> |
|-----------------------------------|-------------|-------|---------------------|-----------|----------------------|
|                                   |             |       | 0.63 ml/L           | 1.26 ml/L |                      |
| % Cap retention <sup>a</sup>      | 10 June     | 3.9   | 4.0                 | 4.7       | .46                  |
|                                   | 24 June     | 1.7   | 1.8                 | 2.1       | .43                  |
|                                   | 3 July      | 1.0   | 0.9                 | 1.0       | .86                  |
| Debris amount <sup>b</sup>        | 10 June     | 2.1   | 2.4                 | 2.6       | <b>.03</b>           |
|                                   | 24 June     | 2.1   | 2.3                 | 2.5       | .20                  |
|                                   | 3 July      | 1.9   | 1.9                 | 2.3       | <b>.05</b>           |
| % Scarring <sup>c</sup>           | 10 June     | 3.4   | 3.3                 | 3.7       | .61                  |
|                                   | 24 June     | 4.9   | 5.5                 | 5.4       | .60                  |
|                                   | 3 July      | 5.7   | 6.2                 | 6.7       | .47                  |
|                                   | 8 August    | 62    | 60                  | 61        | .87                  |
| % Small scars <sup>d</sup>        | 8 August    | 43    | 42                  | 42        | .78                  |
| % Large scars <sup>e</sup>        | 8 August    | 18    | 18                  | 19        | .98                  |
| % Botrytis bunch rot <sup>f</sup> | 10 June     | 0.3   | 0.2                 | 0.3       | .69                  |
|                                   | 24 June     | 0.3   | 0.5                 | 0.5       | .28                  |
|                                   | 3 July      | 1.1   | 0.9                 | 1.2       | .43                  |
|                                   | 8 August    | 2.6   | 2.6                 | 2.9       | .86                  |

a Average percent of berries per cluster with caps.

b Average amount estimated visually on a scale of 0 (no debris) to 5 (greatest amount of debris).

c Average percent of berries per cluster with scars of any size.

d Average percent of berries per cluster with only scars smaller than 5 mm.

e Average percent of berries per cluster with scars greater than 5 mm.

f Average percent of berries per cluster with Botrytis bunch rot.

g Probability values that differences were due to chance.

**Table 1.4** Effect of cap and debris removal on berry scarring and Botrytis bunch rot (1991).

| Variable                          | Rating date | Treatment          |                | P-value <sup>g</sup> |
|-----------------------------------|-------------|--------------------|----------------|----------------------|
|                                   |             | debris not removed | debris removed |                      |
| % Cap retention <sup>a</sup>      | 10 June     | 4.5                | 0.1            | Not calc.            |
|                                   | 24 June     | 1.4                | 0.1            | Not calc.            |
|                                   | 3 July      | 1.0                | 0.0            | Not calc.            |
| Debris amount <sup>b</sup>        | 10 June     | 3.3                | 0.1            | Not calc.            |
|                                   | 24 June     | 3.1                | 0.2            | Not calc.            |
|                                   | 3 July      | 2.4                | 0.1            | Not calc.            |
| % Scarring <sup>c</sup>           | 10 June     | 2.6                | 3.5            | .07                  |
|                                   | 24 June     | 3.7                | 4.7            | .10                  |
|                                   | 3 July      | 4.3                | 5.4            | .14                  |
|                                   | 8 August    | 5.7                | 5.7            | .90                  |
| % Small scars <sup>d</sup>        | 8 August    | 4.3                | 4.3            | .92                  |
| % Large scars <sup>e</sup>        | 8 August    | 1.3                | 1.4            | .74                  |
| % Botrytis bunch rot <sup>f</sup> | 10 June     | 0.1                | 0.0            | .17                  |
|                                   | 24 June     | 0.4                | 0.0            | <b>.0005</b>         |
|                                   | 3 July      | 0.7                | 0.1            | <b>.0007</b>         |
|                                   | 8 August    | 2.6                | 1.1            | <b>.02</b>           |

a Average percent of berries per cluster with caps.

b Average amount estimated visually on a scale of 0 (no debris) to 5 (greatest amount of debris).

c Average percent of berries per cluster with scars of any size.

d Average percent of berries per cluster with only scars smaller than 5 mm.

e Average percent of berries per cluster with scars greater than 5 mm.

f Average percent of berries per cluster with Botrytis bunch rot.

g Probability values obtained that difference was due to chance.

**Table 1.5** Effect of flower cluster bagging on cap retention, debris rating, berry scarring, and Botrytis bunch rot (1991).

| Variable                          | Rating date | Treatment |        | P-value <sup>g</sup> |
|-----------------------------------|-------------|-----------|--------|----------------------|
|                                   |             | Bag       | No bag |                      |
| % Cap retention <sup>a</sup>      | 10 June     | 8.0       | 4.5    | <b>.0001</b>         |
|                                   | 24 June     | 4.2       | 1.4    | <b>.0001</b>         |
|                                   | 3 July      | 1.9       | 1.0    | <b>.0001</b>         |
| Debris amount <sup>b</sup>        | 10 June     | 3.8       | 3.3    | .07                  |
|                                   | 24 June     | 3.7       | 3.1    | <b>.012</b>          |
|                                   | 3 July      | 3.6       | 2.4    | <b>.0001</b>         |
| % Scarring <sup>c</sup>           | 10 June     | 4.4       | 2.6    | <b>.0001</b>         |
|                                   | 24 June     | 7.3       | 3.7    | <b>.0001</b>         |
|                                   | 3 July      | 8.8       | 4.3    | <b>.0001</b>         |
|                                   | 8 August    | 68        | 57     | <b>.0002</b>         |
| % Small scars <sup>d</sup>        | 8 August    | 40        | 43     | .21                  |
| % Large scars <sup>e</sup>        | 8 August    | 28        | 13     | <b>.0001</b>         |
| % Botrytis bunch rot <sup>f</sup> | 10 June     | 0.7       | 0.1    | <b>.003</b>          |
|                                   | 24 June     | 0.9       | 0.4    | <b>.052</b>          |
|                                   | 3 July      | 2.3       | 0.7    | <b>.0001</b>         |
|                                   | 8 August    | 4.4       | 2.5    | <b>.018</b>          |

a Average percent of berries per cluster with caps.

b Average amount estimated visually on a scale of 0 (no debris) to 5 (greatest amount of debris).

c Average percent of berries per cluster with scars of any size.

d Average percent of berries per cluster with only scars smaller than 5 mm.

e Average percent of berries per cluster with scars greater than 5 mm.

f Average percent of berries per cluster with Botrytis bunch rot.

g Probability values obtained that difference was due to chance.

**Table 1.6** Effect of methomyl application on berry scarring and Botrytis bunch rot (1992).

| Variable                          | Rating date | Treatment |          | P-value <sup>a</sup> |
|-----------------------------------|-------------|-----------|----------|----------------------|
|                                   |             | Water     | Methomyl |                      |
| % Scarring <sup>b</sup>           | 21 July     | 16.7      | 8.8      | <b>.0075</b>         |
|                                   | 14 August   | 24.0      | 16.7     | <b>.0105</b>         |
| % Botrytis bunch rot <sup>c</sup> | 21 July     | 0.54      | 0.51     | .92                  |
|                                   | 14 August   | 0.94      | 0.69     | .51                  |

<sup>a</sup> Probability values obtained that differences were due to chance.

<sup>b</sup> Average percent of berries per cluster with scars > 5 mm.

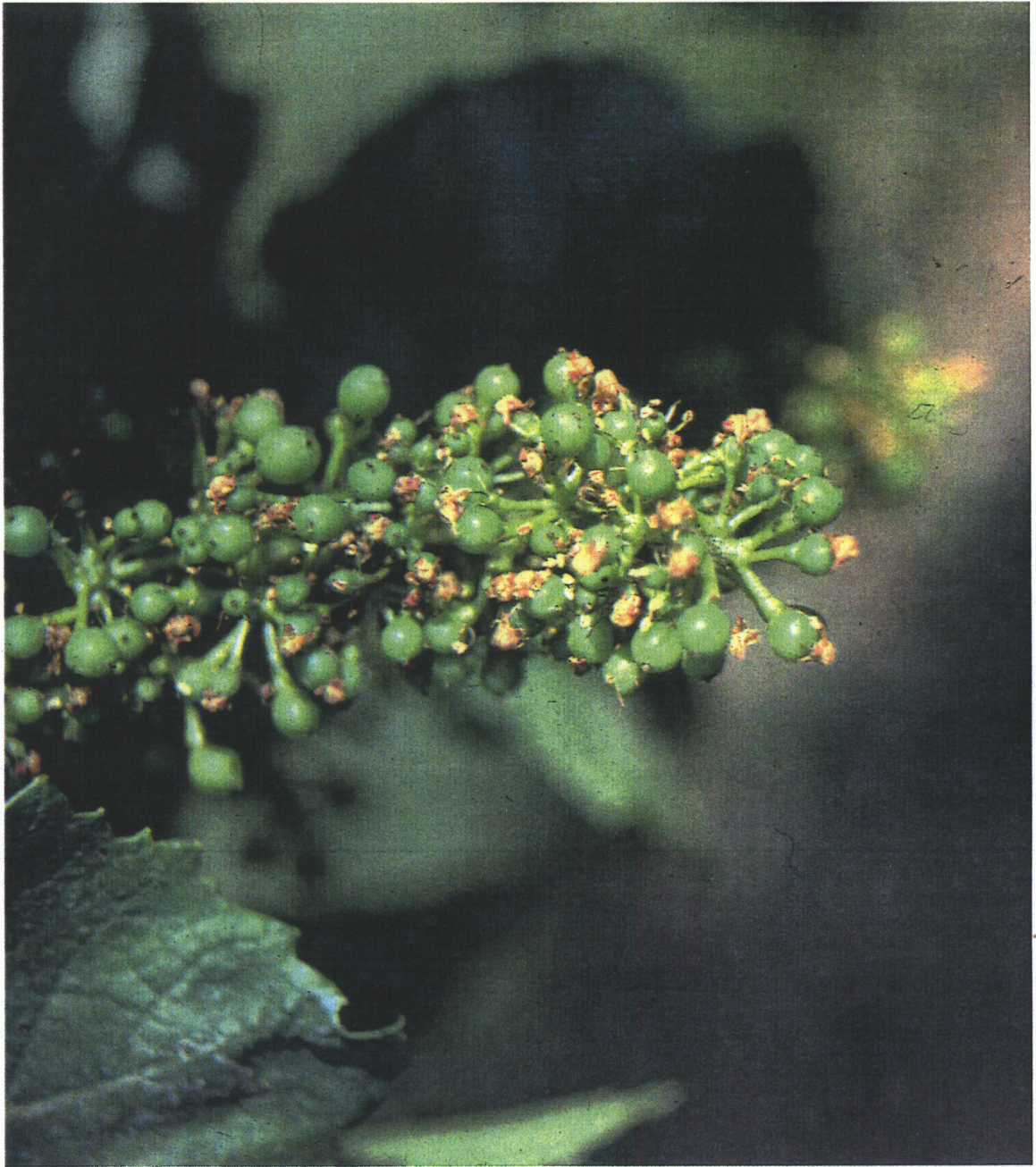
<sup>c</sup> Average percent of berries per cluster with Botrytis bunch rot.



**Fig. 1.1** Chardonnay grape berry cluster showing high blossom cap retention after fruit set.



**Fig. 1.2** Divided canopy training system used in the 1991 experiment.

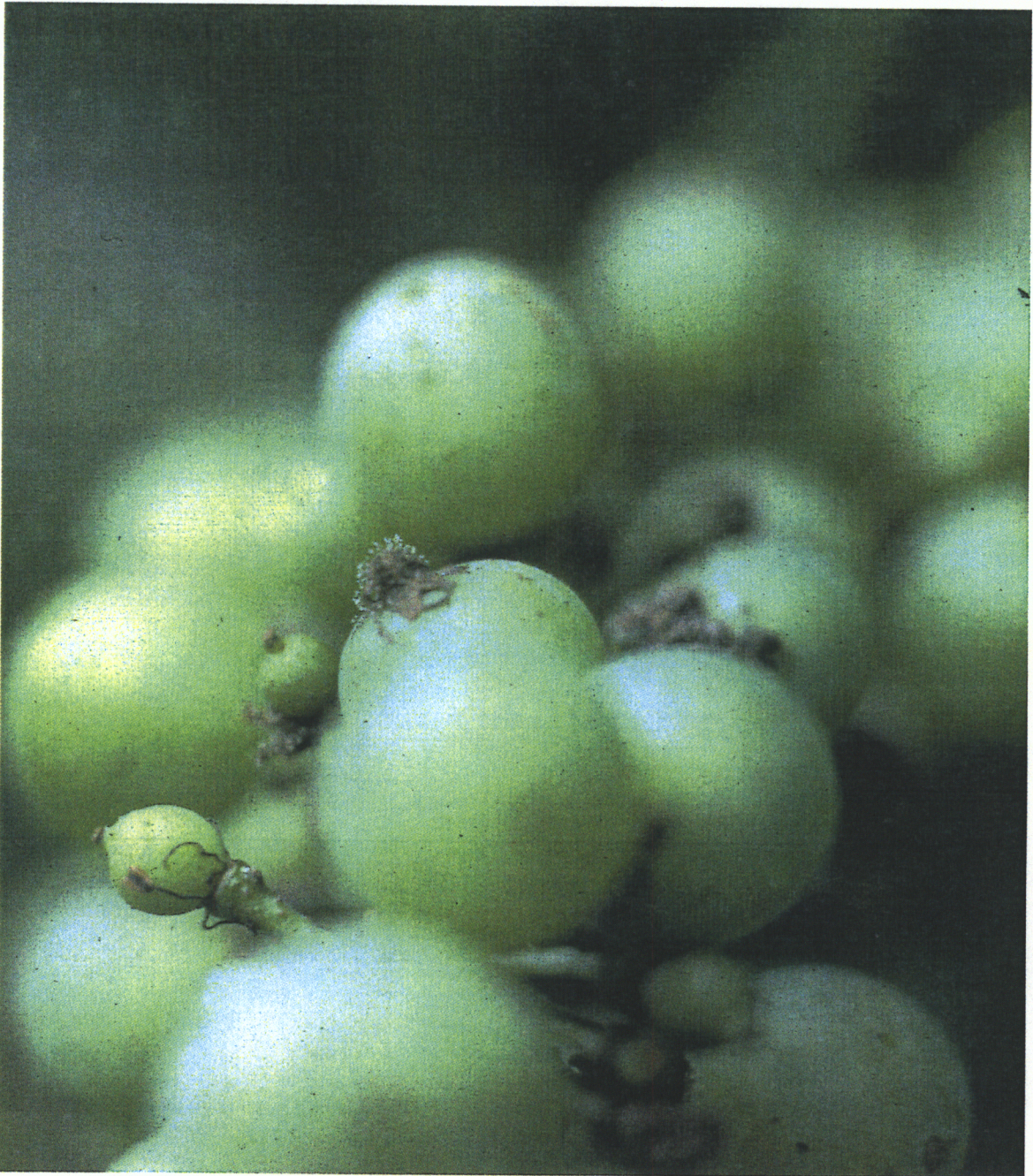


**Fig. 1.3** Chardonnay grape cluster where caps and other flower debris were not removed.

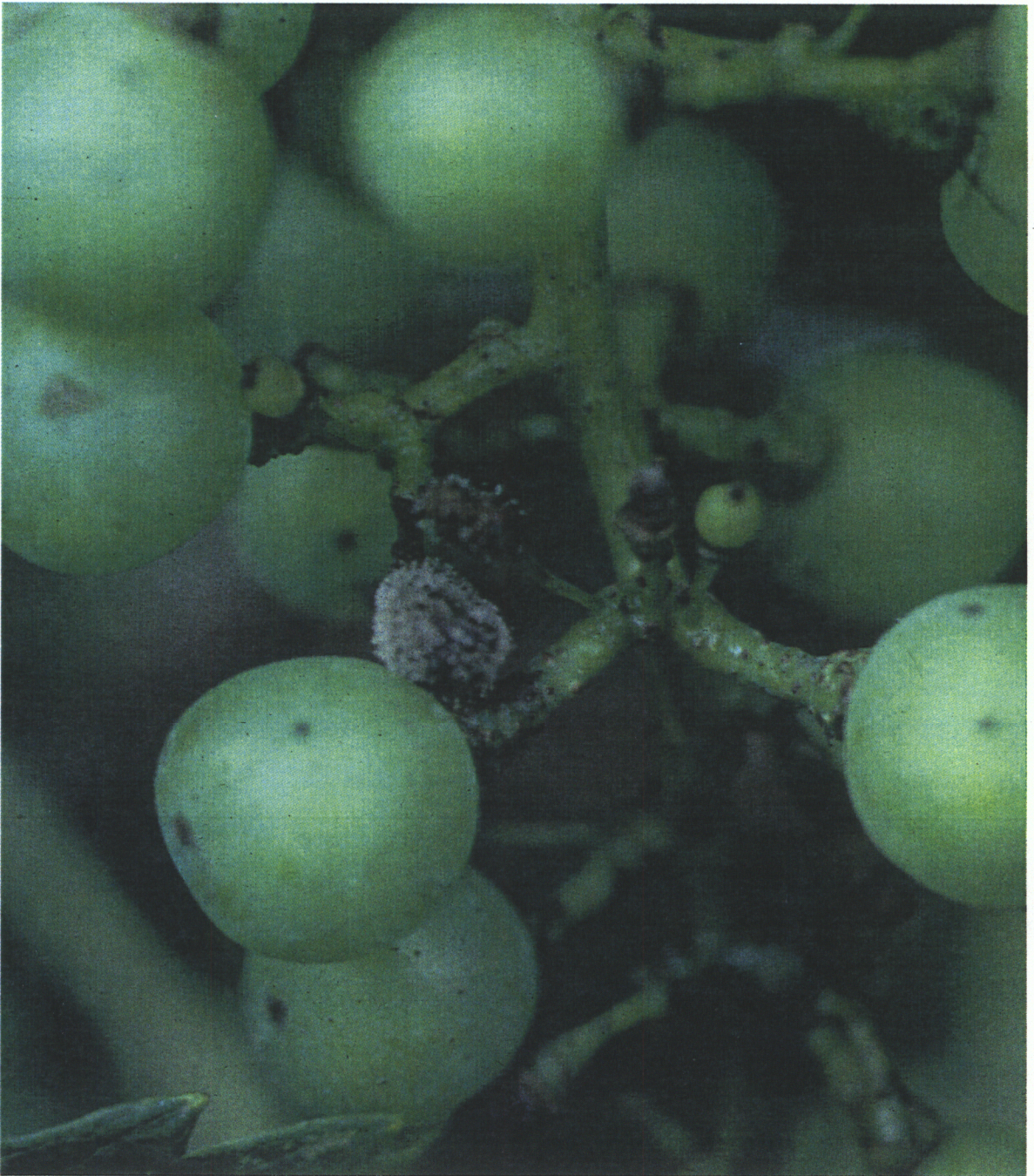


**Fig. 1.4** Chardonnay grape cluster after all residual flower parts were removed by compressed air.

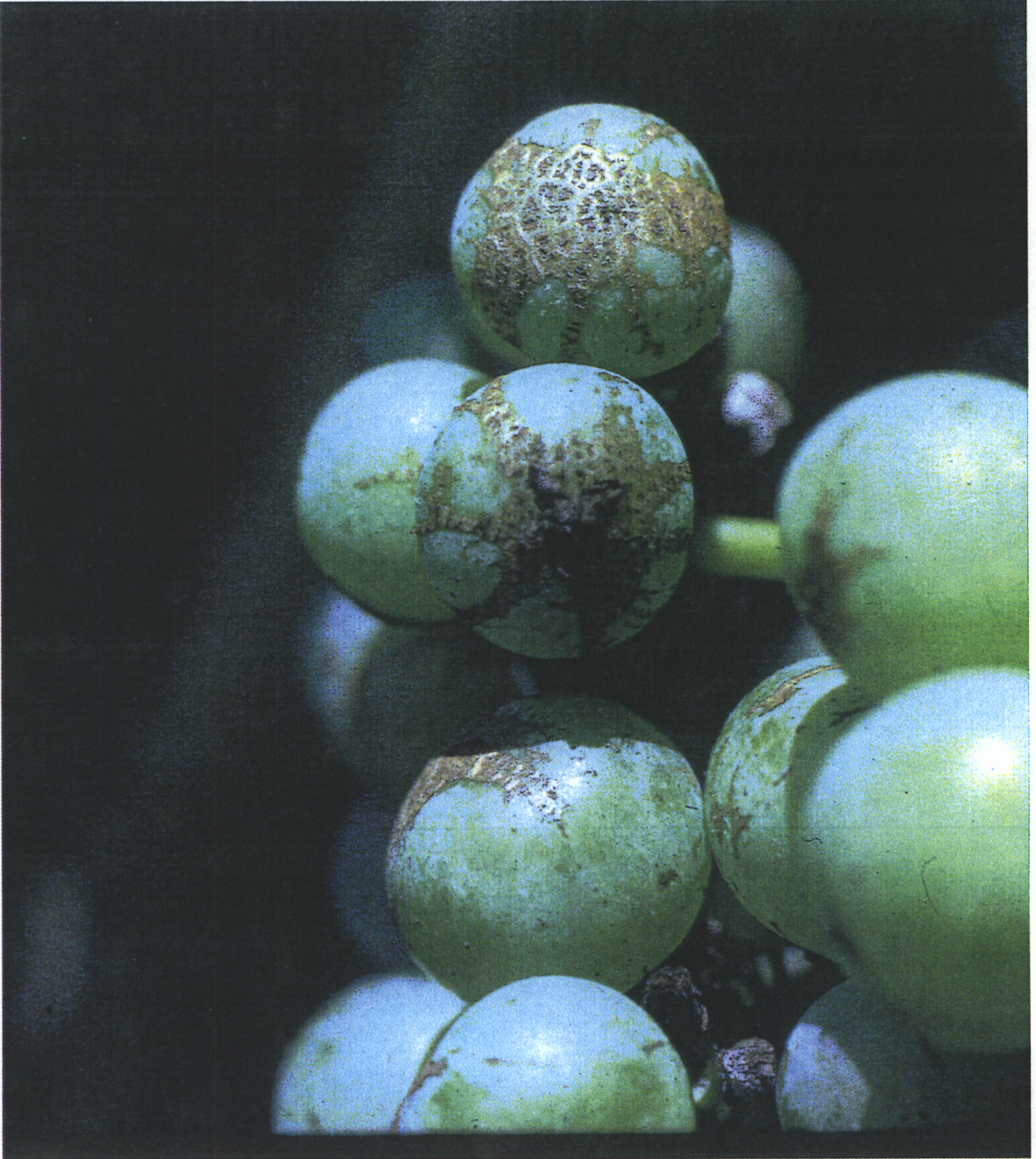




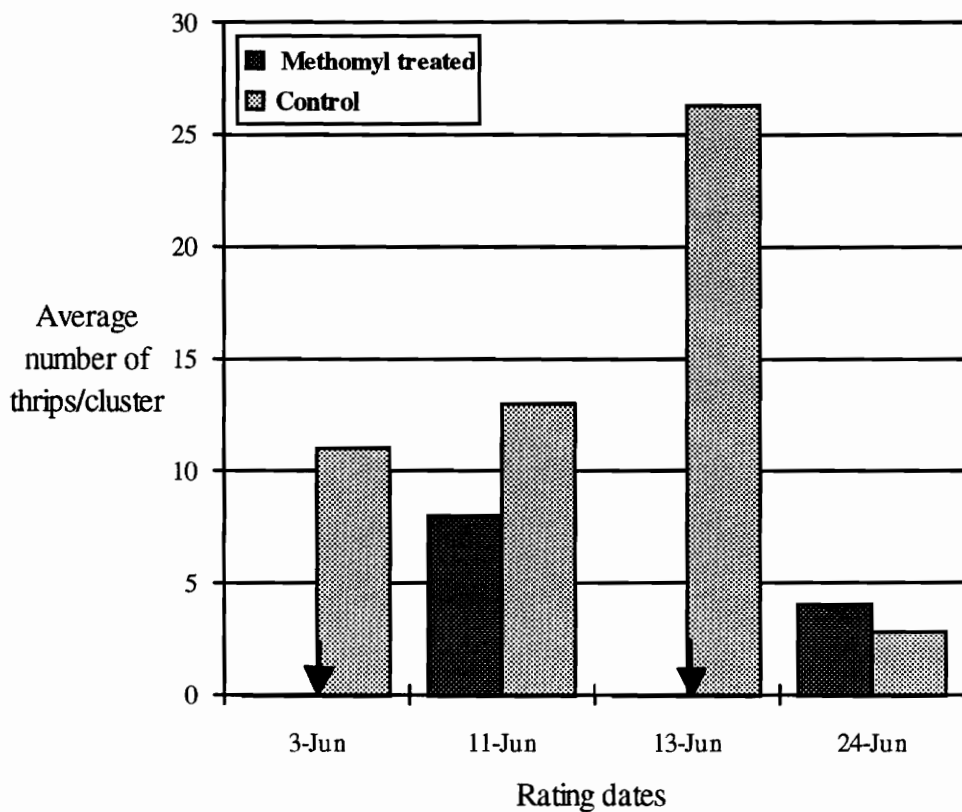
**Fig. 1.6** Retained cap on the berry showing *Botrytis cinerea* sporulation.



**Fig. 1.7** Aborted grape berry completely colonized by *Botrytis cinerea*.



**Fig. 1.8** Chardonnay grape berries showing severe scarring.



**Fig. 1.9.** Flower thrips population monitored during bloom and fruit set in 1992 at Ivy Creek Vineyard. Arrows indicate dates for methomyl sprays. Population numbers on June 3 and June 13 were determined in the vineyard outside of the experimental vines.

## Chapter 2

### A SURVEY OF PESTICIDE USE AND PEST SEVERITY IN VIRGINIA VINEYARDS IN 1990 AND 1991

#### INTRODUCTION

Since the early 1600's until the 1800's several attempts to establish commercial grape growing in Virginia failed. Large vineyard acreages have been abandoned because of continuous disease and insect outbreaks, of which black rot [*Guignardia bidwellii* (Ellis)] and grape phylloxera [*Daktulosphaira vitifoliae* (Fitch) (Homoptera: Phylloxeridae)] were two of the most serious (Winkler *et al.*, 1974; Pfeiffer *et al.*, 1990). In addition, the national prohibition and the economic depression during the early 1900's ruined the wine industry and forced many grape farmers to uproot their vines (Morton, 1985). In Virginia, the current expansion started in the 1970's. In 1969 there were 15 commercial vineyards, with a total of about 50 acres of mainly eastern bunch grapes (Oberle, 1976). By 1981, plantings had increased to 581 acres (Phillips, 1981) and by 1989 to 1,293 acres (Wolf, 1992 *a*). Currently there are more than 40 licensed farm wineries and about 130 commercial vineyards totaling more than 1,400 acres in Virginia (VDACS, 1991). Despite the rapid increase, grape growing is still challenged by low winter temperatures and late-spring and early-fall frosts. In addition, hot humid summers favor disease and insect outbreaks.

Pesticide usage surveys are being conducted nationally by the United States Department of Agriculture (USDA) and the National Agricultural Pesticide Impact Assessment Program (NAPIAP), in response to concerns regarding the regulation of

pesticides by the Environmental Protection Agency (EPA) and the impact of pesticide restrictions on U.S. agriculture. Data obtained on pesticide usage by crop, pest, and pesticide are critical to reliable pesticide assessments. Detailed information has been collected for commodities such as apples, peaches, peanuts, and others in Virginia (Michael J. Weaver, personal communication). Data on grape pests and grape pesticide usage patterns are very scarce and incomplete. The U.S. Census of Agriculture has recorded information on grape production in Virginia since the early 1900's (VDACS, 1985). Surveys of commercial grape acreage and production in Virginia are periodically carried out by the viticulture program of Virginia Tech (Wolf, 1989 and 1992 *a*). A 1987 survey gathered data on insect severities and control practices (Pfeiffer *et al.*, 1990). However, the information presented in this report represents the first comprehensive survey on all grape pests, their severities, and the chemicals used for control.

This study summarizes information obtained from a statewide survey carried out for the 1990 and 1991 growing seasons. This report presents three sets of data: first, grape varieties planted, their average yield per acre, and total acreage planted by county. The second set of data represents disease, weed, and insect severities. The third set provides data on pesticide use, including acres treated, total quantities of pesticides applied, application rates per acre, the number of times the pesticide was applied, the quality of control for each target pest, and alternative control measures attempted. Data about scouting personnel, information sources on pesticide use, use of computer systems for pesticide application record keeping, and the use of protective clothing when applying pesticides are also included. Although each vineyard has different problems, it is useful to have an overview of all vineyards in the state to aid researchers, extension specialists, industry personnel, and the growers themselves in evaluating pesticide use patterns and the economic impact of regulatory actions affecting specific pesticides. Another advantage of

having all the necessary information in one database is that it makes it easier to implement pest management programs which should benefit the grape growers in the state.

## **METHODS**

The growers lists for the 1990 and 1991 Grape Pesticide Use Survey were taken from the names registered with the viticulture program of Virginia Tech during those years (Tony K. Wolf, personal communication). The entire group of growers was surveyed for both years.

A questionnaire was designed in the form of three tables, one for each of the major classes of pesticides (fungicides, herbicides, and insecticides), with lists of pests at the bottom to be filled out with corresponding severity values. For 1991, the format was redesigned as a booklet, and additional questions were included (Appendix A). Although different questionnaires were used, information requested was the same. Questionnaires were mailed at the beginning of the calendar year following the growing season being surveyed. Procedures recommended by Dillman (1978) to maximize the quantity and quality of the responses were considered. For 1990, a follow-up letter along with an extra copy of the survey was sent one month after the initial mailing to increase the number of responses. For 1991, a reminder postcard was mailed after three weeks, and three weeks later a follow-up letter containing another copy of the questionnaire was sent as well.

A computer program that contained an interface similar to the survey format was designed using ObjectVision™ 2.0 for Windows (1991, Borland International, Inc., Scotts Valley, California) to make it easy to input data from the forms into the computer. Paradox® 3.5 (1990, Borland International, Inc., Scotts Valley, California) Database Management Software was used to process both years' data. The data were summarized

from reports generated by the specialized software Quick Reports™ for Windows (1991, Crystal Computer Services, Inc., Vancouver, Canada).

Data on amounts of formulated products used were converted to pounds or gallons of active ingredient. Conversions were based on formulations recommended by the VPI & SU Pest Management Guide for Commercial Grape Production (Pfeiffer *et al.*, 1990-1991) or pesticide labels. Averages of active ingredients for different available formulations were used when needed. This procedure was necessary because none of the respondents provided formulation data.

## **RESULTS AND DISCUSSION**

**Survey Response.** In 1990, 34% of 117 questionnaires mailed out were returned; in 1991, 58% of 110 questionnaires were returned. All vineyard sizes responding were included in the summaries. The difference in response could be attributed to several factors. The 1990 questionnaires were mailed out in late March of the following season, while the 1991 forms were mailed in mid-February; earlier distribution of the surveys may have improved response because grape growers are likely to have more time to complete surveys while vines are still dormant. The difference could also be due to the change in the questionnaire format, because the 1991 version was easier to understand and complete. Also, for the 1991 survey, two follow-up reminders were sent instead of only one. Another two factors might have affected the response level: the length of the survey and the grower's reluctance to reveal actual amounts of pesticides sprayed. Both problems were anticipated and every effort was made to prepare a complete but simple questionnaire, and to assure the growers that their responses would be confidential and to

explain the benefits of the project to them. Perhaps future disease and pesticide usage surveys of grape growers in Virginia will have higher responses, because when we disclose the results from this two-year study, growers will perceive how this information could benefit research and the grape industry in general. Furthermore, growers will see the anonymity of results, increasing overall confidence to respond.

**Grape Acreage Distribution by County.** Present grape acreage in the state of Virginia is about 1,400 acres (Virginia Department of Consumer Services - VDACS, 1991). According to this, 49% and 50% of the Virginia grape acreage is represented in the 1990 and 1991 responses, respectively (Table 2.1). About 28 percent of the counties in Virginia were identified as having grape growers on a small (less than two acres) or on a commercial scale. A closer look at the distribution by county of Virginia grape growers who responded to the surveys (Table 2.1) shows that the responses for 1991 were received from 28 counties, while the 1990 responses were received from 18 counties. According to responses from the 1990 season, the largest acreages were in Fauquier, Madison, and Orange Counties. For the 1991 season the largest acreages were in Fauquier, Loudoun, and Albemarle Counties (Table 2.1). Data published in "Virginia Agricultural Statistics" by VDACS (1992), show that most grapes grown commercially in 1989 were indeed located in these five counties.

**Grape Varieties and Yields.** The distribution of grape varieties among growers during 1990 and 1991 is presented in Fig. 2.1. In both years, the vinifera varieties 'Chardonnay' and 'Cabernet Sauvignon' were the most commonly grown in Virginia. The figure is based on the frequency of the varieties planted by the growers in order to compare both years. For the 1991 growing season, the questionnaire was modified to

obtain more precise data on the number of different varieties. Chardonnay and Cabernet Sauvignon had the majority of the vinifera acreage within the state, followed by 'Riesling', 'Merlot', and 'Pinot noir' (Table 2.2). The most common French-American varieties in 1991 were 'Vidal blanc', 'Seyval blanc', and 'Chambourcin'. In summary, wine grape acreage in Virginia was dominated by white-fruited varieties such as Chardonnay, Riesling, and Seyval blanc. Cabernet Sauvignon, Merlot, Pinot noir, and 'Cabernet franc' seem to be leading the red varieties in popularity. This is in agreement with a previous report by Morton (1985) in her summary of eastern-American viticulture and with the data for 1989 and 1991 reported by Wolf (1992 *a*).

Among the native American varieties, 'Concord' was the most frequently planted and had the largest production, with an average yield of 6.0 tons per acre. Among the vinifera varieties, Merlot had the highest average yield per acre of 4.1 tons, followed by 'Gewurztraminer' with 3.4 tons per acre, and Chardonnay and Riesling each with 2.9 tons per acre. However, the largest total productions were for Chardonnay and Cabernet Sauvignon. The three French-American varieties with the highest average yields per acre were: Seyval blanc with 4.4 tons, 'Rayon d'or' with 4.1 tons, and Chambourcin with 4.0 tons (Table 2.2). Seyval blanc had the largest total production of the French-American varieties during 1991. Several growers had non-bearing acreage, in which case the yield was entered as zero; this acreage was not included in the calculation of average yields per acre. Figures for average yields for a single grape variety are frequently misleading, because some producers may have exceptional yields while others may have crop losses due to disease or insect pest outbreaks, improper meteorological factors, or many other causes. Therefore, when enough information is available it is more appropriate to describe growers' yields as a function of variety and producer's yield ranking (Wolf, 1989), as shown in Table 2.3 for the most representative vinifera and French-American varieties.

Grape production reported for the 1991 growing season was about 1,500 tons, accounting for fifty percent of the state's total acreage in accordance to the response obtained. If these results also represent the non-respondent 50 percent, the total production in the state would approximate 3,000 tons for 1991. This estimated production is in agreement with the 2,818 tons reported by Wolf (1992 *a*) from a parallel survey.

**Pesticide Groups.** Grape growers were asked whether they used any of the pesticide groups or alternative controls, and whether they used computers to file pesticide application records. The last question was asked in 1991 only. The majority of grape growers, regardless of their vineyard's acreage, used chemical pesticides as the main control method for diseases and pests. Approximately 97 percent of growers applied fungicides, 93 percent applied insecticides, and 75 percent applied herbicides. Although the responses were very similar for both years, a slightly smaller percentage of growers reported the use of fungicides, herbicides, and insecticides during 1991 (Fig. 2.2).

No nematicide use was reported in either year, perhaps due to lack of information about nematode severity, as growers indicated in their responses. Soils might not have been sampled for nematodes prior to a vineyard's establishment, and concerns are basically directed at disease, arthropod pest, or weed management. Unexplained vine declines are frequently attributed to nutrient problems or virus infections, and nematodes could often be neglected as the causal or agent vector. However, the extent of damage that certain species of nematodes can cause in grapevines is not completely known (Drake, *et al.*, 1984). In addition, research in this field is often limited by tedious soil sampling procedures needed to test an entire average-sized vineyard.

The percentage of growers using control methods other than pesticides was higher in 1990 (42.5%) than in 1991 (32.8%). The question about computer usage was included only in the 1991 questionnaire, and 12.5% of 64 growers who responded used some level of computerization for pesticide record keeping; this may be an issue of interest in the future. The purpose of knowing the use of computers among growers is the development of a spreadsheet to be distributed to them. Growers could then enter their pesticide spray records and later submit a copy to their extension services; this would speed data processing and eliminate future written surveys, among other benefits.

**Diseases and fungicides.** In growers' opinions, the most severe grape diseases in Virginia were crown gall [*Agrobacterium tumefaciens* (E. F. Smith & Townsend)], Botrytis bunch rot (*Botrytis cinerea* Pers.), black rot [*Guignardia bidwellii* (Ellis) Viala & Ravaz], and powdery mildew [*Uncinula necator* (Schw.) Burr] in both 1990 and 1991 (Tables 2.4 and 2.5). All diseases were consistently reported by more than 30% of the growers responding in both years. For most diseases, perceived severities were higher in 1990 than in 1991. This is possibly due to the dry and warm weather in 1991, which inhibits most fungal infections. Disease severity of Eutypa dieback [*Eutypa lata* (Pers.:Fr.) Tul. & C. Tul.] was reported to be greater in 1991 than in 1990; this is in agreement with Pearson and Goheen's (1988) description of the slow disease cycle and the development of symptoms after one or two seasons with heavy rainfall. In addition to the diseases listed in Tables 2.4 and 2.5, there was one report of stem necrosis and one report of tomato ringspot in 1990, and one report of black measles, two reports of virus, and two reports of grapevine yellows in 1991; in the case of the black measles and the yellows, their cause is still uncertain in Virginia (Wolf, 1992 *b*). The fungicides used in 1990 and 1991 for each of the diseases are listed in Tables 2.4 and 2.5, respectively. In addition to the question

asking the growers for a list of fungicides used against each disease, growers were also asked about the efficacy (control quality) of each fungicide. A selection of four control quality values were given to the growers to estimate the performance of their applications: 0-24 percent = poor; 25-49 percent = fair; 50-74 percent = good; 75-100 percent = excellent; and whenever the grower did not answer the question, "unknown" was assigned to the response. Depending on the number of growers rating the given fungicide, percentages of growers giving each control rating are presented as well (Table 2.5).

According to the responses received for 1990, 14,894 pounds of fungicide active ingredient (a.i.) were applied to the 685 acres represented, with captan, mancozeb, and myclobutanil the most heavily used (Table 2.6). Similarly, according to the responses received for 1991, 18,489 pounds of fungicide a.i. were applied to the 705 acres represented, with captan, myclobutanil, and mancozeb the most heavily used (Table 2.7). Myclobutanil, triadimefon, benomyl, iprodione, and other fungicides were more heavily used during 1991 than in the previous year. These data do not agree with the growers' report of lower disease severity for 1991 as previously mentioned; perhaps growers applied more fungicides during 1991 and therefore disease severity was lowered, or they simply sprayed more without apparent reason.

Fungicide use in Virginia vineyards is critical to disease control. However, the environmental impact some of these chemicals cause is also of great concern. Recently, Kovach *et al.* (1992) developed a comprehensive method to quantify this impact. The method assigns a value (the environmental impact quotient: EIQ) to each pesticide. The EIQ is based on extensive data and considers effects on applicators, consumers, ground and surface water, non-target organisms, etc. The higher the EIQ value, the greater the risk the chemical poses to the environment. Among the fungicides used by Virginia grape growers, benomyl, Bordeaux mixture, and mancozeb are rated with the highest values by

this method. Benomyl for example, if extensively used, can induce resistance in some fungi such as *B. cinerea*. Furthermore, benomyl severely inhibits reproduction of the natural predator *Amblyseius fallacis* Garman (Acarina: Phytoseiidae); in addition, other effects such as mutagenicity and hazard to wildlife are considered under the Special Review by EPA (EPA, 1992) for this fungicide. Mancozeb is also known to be harmful to beneficial predators (Kovach *et al.*, 1992). Perhaps some growers may not be aware of the various secondary effects fungicides can cause to the environment because they had no access to this information. However, according to several comments in the survey responses, growers might be forced to apply these fungicides because they are among the few or only registered products for their purposes. It is also important to consider the high cost of certain chemicals as a limiting factor for their use.

**Weeds and Herbicides.** According to growers' reports for 1990, the most severe weed problems were caused by annual broadleaf, perennial broadleaf, and annual grasses (Table 2.8). All the weed groups were reported to be moderately severe by 15 percent of the growers responding to the 1990 survey, and about one-third of the growers reported problems with at least one group of weeds. The herbicides used in 1990 for each group of weeds are listed in Table 2.8. Glyphosate was a herbicide used to control all weed categories. During 1991 the most severe groups of weeds were perennial grasses and sedges, and annual grasses (Table 2.9). All the weed groups were reported to be moderately severe by 22 percent of the growers responding to the 1991 survey, and about two-thirds reported problems with at least one class of weeds. The herbicides used in 1991 for each group of weeds are shown in Table 2.9 with the correspondent control ratings. Glyphosate was again a herbicide used to control all weed categories. According to the responses received for 1990, 1,782 pounds of herbicide a.i. were applied to the 685

acres represented, with glyphosate, simazine, and paraquat the most heavily used (Table 2.10). Similarly, according to the responses for 1991, 2,000 pounds of herbicide a.i. were applied to the 705 acres represented, with glyphosate, diuron, and simazine the most heavily used (Table 2.10).

Among the herbicides used by Virginia grape growers, paraquat and fluazifop-P-butyl are rated by Kovach *et al.* (1992) with high EIQ values. Paraquat has been shown to be toxic to the predator *A. fallacis* in the laboratory (Hislop and Prokopy, 1981) and induces higher European red mite densities in the field (Pfeiffer, 1986). Paraquat is heavily used in some vineyards; according to the responses received in 1990, 42% of 685 acres were treated with paraquat; in 1991, 19% of 705 acres were treated with this herbicide. (Table 2.10). Although glyphosate does not have a high EIQ, it is toxic to the predator *A. fallacis*. Both paraquat and glyphosate are toxic to this predator if applied when mites are still in ground cover during winter and spring. Glyphosate is often applied in late summer or fall, when it is more efficiently translocated to weed roots, missing the predator; unlike paraquat, which is often applied early in the season to achieve its burn-down action.

Grapevines could be susceptible to improper herbicide applications, but herbicide use is important to improve vine growth through weed control. Herbicide damage can be reduced or eliminated if the proper chemical and application method is selected. Also, if low application pressures are used for postemergence herbicides, drift can be minimized. Growers should utilize the minimum number of herbicide applications necessary for acceptable weed control. Spot-treatment of herbicides should be utilized if weeds are scattered in the vineyard (Jeffrey F. Derr, personal communication). During both seasons, about 20% of the growers responding to the surveys reported spot applications of herbicides.

**Arthropod Pests, Insecticides and Miticides.** The most severe insect pests reported for 1990 and 1991 were Japanese beetle (*Popillia japonica* Newman), grape berry moth (*Endopiza viteana* Clemens), and yellowjackets (*Vespula* spp.) and other wasps. The most severe mite problem reported was European red mite (*Panonychus ulmi* Koch) (Table 2.11) with a higher perceived severity during 1991 than in 1990. The increase in European red mite severity from 1990 to 1991 could be due to resistance developed to available acaricides, or due to the widespread use of carbaryl, benomyl, and captan, which are damaging to its natural enemy *A. fallacis* or otherwise induce populations of *P. ulmi* (Douglas G. Pfeiffer, personal communication); another explanation for the perceived severity increase from one year to the next could be greater recognition of European red mite by the growers. Among the 24 insect and mite species evaluated, the percentage of growers reporting each species varied considerably, but the most frequently reported in 1990 were Japanese beetle (78%) and grape berry moth (55%). The insecticides used in 1990 for each pest are listed in Table 2.11. The most frequently reported insect species in 1991 were Japanese beetle (91%), yellowjackets and other wasps (59%), and grape berry moth (58%). The insecticides used in 1991 for each pest are listed in Table 2.12. Japanese beetle and grape berry moth were less severe during 1991. This could be the result of increased use of more effective insecticides (*i.e.* azinphos-methyl, parathion, phosmet, *etc.*) or the advent of mating disruption to control grape berry moth, or due to a previous drought season which is known to reduce Japanese beetle populations (Fleming, 1972). Although Japanese beetle was reported by grape growers as their most severe insect pest, it is important to take into account that the grapevine can tolerate relatively high levels of defoliation by this pest, without reducing fruit quality and yield (Boucher and Pfeiffer, 1989). Therefore, since most insecticide applications were directed to control Japanese beetle in both years surveyed, it might be

possible that some insecticide sprays were not justified and control measures could be reduced in future years under low infestations of this pest.

According to the responses received for 1990, 5,628 pounds of insecticide a.i. were applied, with carbaryl, azinphos-methyl, and methoxychlor the most heavily used (Table 2.13). Similarly, according to the responses received for 1991, 3,537 pounds of insecticide a.i. were applied, with carbaryl, azinphos-methyl, and phosmet the most used (Table 2.13). The widespread use of carbaryl in Virginia vineyards is damaging to some natural predators as previously discussed, leading to the increase of secondary pests such as European red mite. Among other insecticides used by Virginia grape growers, parathion, methoxychlor, and azinphos-methyl are rated by the Kovach *et al.* (1992) method with high EIQ values. Parathion and methyl parathion have highly toxic effects for the applicators; presently, methyl parathion is sold in a microencapsulated formulation, which reduces both oral and dermal toxicity to approximately that of carbaryl. Azinphos-methyl has toxic effects in aquatic environments and to vertebrates such as birds (Hooper *et al.*, 1989).

**Alternative Controls.** Grape growers were asked to report any alternative methods (*i.e.* biological controls, cultural practices, *etc.*) they had used in addition to pesticides to control pests. Although a higher percentage of growers responding the survey used alternative control methods during 1990, the response for 1991 involved a much greater variety of methods (Table 2.14). Control practices were grouped into four main categories according to the targeted pest: disease-causing agents, insects, weeds, and vertebrates. Leaf pulling and shoot positioning/training systems were the most widely used alternative control practices in controlling diseases such as *Botrytis* bunch rot and sour rot during both seasons.

The use of pheromones was the most frequent alternative method for controlling insects during both growing seasons. Isomate GBM<sup>®</sup> (Pacific Biocontrol Corporation, Davis, California) was reported as the pheromone-mediated mating disruption preparation used to control grape berry moth, an alternative to the effective but more dangerous (in terms of both human safety and environmental impact) insecticides used. 1990 was a severe year for grape berry moth (Douglas G. Pfeiffer, personal communication) while perceived severity for 1991 was lower. However, there is greater potential for grape berry moth to reach damaging levels because there is a greater number of generations present in Virginia than previously believed. High-risk situations like this can be predicted and controlled if scouting procedures using pheromone traps and fruit evaluations are performed conscientiously.

The most common alternative practice to control weeds in both years was cultivation with a grape hoe. In addition to the need for extra labor in large acreages, potential damage can result from extensive or improper cultivation. Wounding of vine trunks and roots and erosion problems in the vineyard have been observed where this practice is misused (Tony K. Wolf, personal communication).

The use of non-pesticide alternatives to control vertebrates (i.e. birds and deer) such as scare devices (balloons with spots representing large eyes), artificial owls, and electric fences was reported during 1991 (Table 2.14). Most of these practices were reported as providing good control.

**Scouting.** In the personnel category, the grower, family member, or employee was the most frequently reported person to be responsible for vineyard scouting during 1991 (Fig. 2.3). Sampling procedures to detect pests around the field are the first step in maximizing the effectiveness of pesticides and could result in the reduction of pesticide

applications by proper pesticide timing. The Extension Service played an important role as a source of information to help growers, since training in pest detection and identification are critical to proper implementation of control techniques. Results from the surveys show that there is a group of growers who were not able to recognize and quantify severity of some pests (particularly arthropod and nematode pests) around their vineyards.

**Information Sources.** When grape growers were asked where they got most of the information about proper pesticide usage during 1991, the extension specialist was cited as the most frequent source. Two other important sources of information were pesticide dealers and the Virginia Tech Pest Management Guides (Fig. 2.4).

**Protective Clothing.** The questionnaire for the 1991 growing season included a section where growers could report routine precautions taken when handling or applying pesticides. Long sleeved clothing, rubber gloves, goggles or face shield, rubber boots, and respirators, were all used by at least 40 percent of the growers. Long sleeved clothing was the most common piece of protective clothing reported to be used during 1991 (Fig. 2.5).

## CONCLUSIONS

In the development of future pesticide use surveys, it is crucial that growers provide the formulation used in applying the chemicals reported in order to calculate active ingredient quantities more accurately. Some difficulties were encountered when pest severities were rated by the growers according to the scale provided. First, growers could be misinterpreting the question by rating severities that were present after controls were applied, leading to "moderate" or "not important" answers. Another unclear aspect was the rating option of "unknown" severity; the answer could have been used by the respondents to signify that they did not know if the disease or pest was present, that they did not know the severity of the disease or pest, or that their vines were not affected by the disease or pest. Rating options should be clarified to avoid this kind of confusion.

It is clear that grape growers depend strongly on a variety of fungicides to control diseases in their vineyards. Insecticides are needed to a lesser degree and only one or two products are heavily used.

The meaning of environmental impact findings of the pesticides used are important when pest management programs are going to be implemented. Increasing other practices such as scouting, biological and cultural controls, *etc.* are important in reducing pesticide use. Pesticides with the most adverse impacts need to be reduced without compromising yield or quality of the crop. I suggest that more knowledge about the biology of the pests and the mode of action of chemicals have to be made available to the growers, so they can make educated choices about rates and timing of application. Future efforts should emphasize the use of alternative control methods and the awareness of the damage that can be caused to beneficial predators by certain pesticides.

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**TABLE 2.1** Distribution by county of Virginia grape growers responding to the surveys for the 1990 and 1991 growing seasons.

| COUNTY               | 1990           |                    | 1991           |                                |
|----------------------|----------------|--------------------|----------------|--------------------------------|
|                      | NUMBER GROWERS | ACRES              | NUMBER GROWERS | ACRES                          |
| Accomack             | 1              | 2.0                | 1              | 3.0                            |
| Albemarle            | 5              | 59.0               | 8              | 75.4                           |
| Amherst              | 1              | 4.0                | 1              | 4.0                            |
| Augusta              | 1              | 35.0               | 1              | 35.0                           |
| Botetourt            | *              | *                  | 1              | 6.0                            |
| Campbell             | *              | *                  | 1              | 2.3                            |
| Culpeper             | 2              | 0.5                | 2              | 4.0                            |
| Fauquier             | 10             | 188.0              | 10             | 146.0                          |
| Floyd                | *              | *                  | 1              | 26.0                           |
| Fluvanna             | *              | *                  | 1              | 4.0                            |
| Greene               | 2              | 12.8               | 2              | 12.8                           |
| James City           | 1              | 33.3               | 1              | 48.9                           |
| King George          | *              | *                  | 2              | 11.0                           |
| Loudoun              | 7              | 67.3               | 10             | 98.7                           |
| Louisa               | *              | *                  | 1              | 2.8                            |
| Madison              | 1              | 110.0              | 2              | 4.0                            |
| Nelson               | 1              | 4.0                | 3              | 17.5                           |
| Northhampton         | 1              | 5.5                | 1              | 7.5                            |
| Orange               | 2              | 103.0              | 1              | 70.0                           |
| Page                 | 1              | 4.0                | 2              | 6.8                            |
| Patrick              | *              | *                  | 1              | 4.0                            |
| Prince William       | *              | *                  | 1              | 1.5                            |
| Rappahannock         | *              | *                  | 3              | 13.5                           |
| Rockbridge           | 1              | 4.0                | 1              | 3.8                            |
| Rockingham           | 1              | 0.5                | 2              | 10.5                           |
| Shenandoah           | *              | *                  | 1              | 31.5                           |
| Stafford             | 1              | 5.0                | 2              | 9.0                            |
| Westmoreland         | 1              | 47.0               | 1              | 45.0                           |
| <b>TOTAL ACREAGE</b> |                | <b>684.9 (49%)</b> |                | <b>704.5 (50%)<sup>a</sup></b> |

\* No response in the given year.

<sup>a</sup> Percentage when compared with total Virginia grape acreage.

**TABLE 2.2** Average yield per acre and acres planted of grapes (*Vitis vinifera*, French-American hybrids, and native American-Labrusca) in Virginia during 1991 for 64 growers surveyed.

| GRAPE VARIETY      | NUMBER GROWERS REPORTED | TOTAL ACRES | TOTAL PRODUCTION (TONS) | AVERAGE YIELD (TONS PER ACRE) <sup>a</sup> | GROWERS WITH NO YIELD <sup>b</sup> | GROWERS NOT ANSWER YIELD |
|--------------------|-------------------------|-------------|-------------------------|--|------------------------------------|--------------------------|
| Chardonnay         | 42                      | 175.74      | 510.1                   | 2.9  | 2                                  | 2                        |
| Cabernet Sauvignon | 34                      | 83.32       | 203.2                   | 2.8  | 5                                  | 2                        |
| Riesling           | 24                      | 55.33       | 130.5                   | 2.9  | 1                                  | 3                        |
| Vidal blanc        | 14                      | 38.87       | 134.8                   | 3.5  | 3                                  | 1                        |
| Concord            | 2                       | 31.00       | 186.0                   | 6.0  | 0                                  | 1                        |
| Seyval blanc       | 17                      | 29.06       | 123.5                   | 4.4  | 2                                  | 3                        |
| Merlot             | 8                       | 21.19       | 33.6                    | 4.1  | 2                                  | 1                        |
| Pinot noir         | 7                       | 18.07       | 44.9                    | 2.5  | 1                                  | 0                        |
| Cabernet franc     | 12                      | 18.00       | 38.2                    | 2.5  | 3                                  | 1                        |
| Chambourcin        | 9                       | 16.80       | 33.3                    | 4.0  | 3                                  | 1                        |
| Gewurztraminer     | 4                       | 4.44        | 46.5                    | 3.4  | 0                                  | 0                        |
| Semillon           | 2                       | 2.60        | 5.0                     | 2.0  | 0                                  | 0                        |
| Rayon d'or         | 2                       | 0.97        | 4.1                     | 4.1  | 0                                  | 1                        |
| Mixed              | 11                      | 84.00       | 298.9                   | 2.8  | 4                                  | 1                        |
| Other <sup>c</sup> | 16                      | 19.43       | 95.5                    | 4.0  | 0                                  | 1                        |
| Not Specified      | 4                       | 78.00       | n/a                     | n/a  | 0                                  | 4                        |

<sup>a</sup> Bearing acres only.

<sup>b</sup> No yield means that vines were too young (non-bearing acres).

<sup>c</sup> Other varieties include Sauvignon blanc, Chenin blanc, Niagara, Fredonia, De Chaunac, etc.

**TABLE 2.3** Grape yields (tons/acre) during 1991 as a function of variety and producer's yield rankings. Yields are based on bearing vines.

| <b>YIELD RANKING</b>             | <b>CHARDONNAY</b> | <b>RIESLING</b> | <b>CABERNET SAUVIGNON</b> | <b>SEYVAL</b> | <b>VIDAL BLANC</b> | <b>CHAMBOURCIN</b> |
|----------------------------------|-------------------|-----------------|---------------------------|---------------|--------------------|--------------------|
| Top 10%                          | 5.4               | 4.9             | 5.1                       | 8.1           | 5.7                | 7.7                |
| Top 50%                          | 3.5               | 3.5             | 3.3                       | 5.3           | 4.6                | 4.2                |
| Bottom 50%                       | 2.2               | 2.1             | 2.1                       | 3.2           | 2.0                | 3.0                |
| Bottom 10%                       | 1.2               | 1.0             | 0.8                       | 2.0           | 1.0                | 2.0                |
| Number of producers <sup>a</sup> | 38                | 20              | 27                        | 12            | 11                 | 5                  |

<sup>a</sup> Virginia grape growers (58%) responding to the 1991 survey.

**TABLE 2.4** Diseases, their severities <sup>a</sup>, and chemicals used for their control during 1990.

|   |  |   |   |
|---|--|---|---|
| <b>ANTHRACNOSE</b><br><u>Control Chemicals</u>                            | Average Severity: 3.00<br>basic copper sulfate(1) <sup>d</sup>                                 | # Growers reported: 13 (33%) <sup>b</sup><br>Bordeaux mixture (1)                                       | Unknown: 12 (30%) <sup>c</sup><br>mancozeb (1)  |
| <b>BLACK ROT</b><br><u>Control Chemicals</u>                              | Average Severity: 2.18<br>mancozeb (28)<br>myclobutanil (19)<br>benomyl (6)<br>lime sulfur (1) | # Growers reported: 32 (80%)<br>captan (24)<br>ferbam (13)<br>basic copper sulfate (5)<br>iprodione (1) | Unknown: 2 (5%)<br>triadimefon (24)<br>Bordeaux mixture (9)<br>copper oxychloride sulfate (1) |
| <b>BOTRYTIS</b><br><b>BUNCH ROT</b><br><u>Control Chemicals</u>           | Average Severity: 2.17<br>iprodione (20)<br>captan (2)   | # Growers reported: 30 (75%)<br>benomyl (13)<br>myclobutanil (1)  | Unknown: 3 (8%)<br>Bordeaux mixture (3)<br>copper oxychloride sulfate (1)                     |
| <b>CROWN GALL</b><br><u>Control Chemicals</u>                             | Average Severity: 2.07<br>none   | # Growers reported: 27 (68%)  | Unknown: 4 (10%)  |
| <b>DOWNY MILDEW</b><br><u>Control Chemicals</u>                           | Average Severity: 2.47<br>captan (32)<br>basic copper sulfate (5)<br>myclobutanil (2)          | # Growers reported: 30 (75%)<br>mancozeb (28)<br>triadimefon (4)<br>ferbam (1)                          | Unknown: 3 (8%)<br>Bordeaux mixture (8)<br>copper oxychloride sulfate (2)                     |
| <b>EUTYPA DIEBACK</b><br><u>Control Chemicals</u>                         | Average Severity: 2.86<br>Bordeaux mixture (1)   | # Growers reported: 14 (35%)<br>myclobutanil (1)  | Unknown: 13 (33%)   |
| <b>PHOMOPSIS CANE</b><br><b>AND LEAF SPOT</b><br><u>Control Chemicals</u> | Average Severity: 2.44<br>captan (11)<br>Bordeaux mixture (2)                                  | # Growers reported: 18 (45%)<br>mancozeb (11)<br>basic copper sulfate (1)                               | Unknown: 12 (30%)<br>benomyl (3)<br>ferbam (1)  |
| <b>POWDERY</b><br><b>MILDEW</b><br><u>Control Chemicals</u>               | Average Severity: 2.32<br>triadimefon (22)<br>benomyl (14)<br>captan (3)<br>iprodione (1)      | # Growers reported: 31 (78%)<br>sulfur (20)<br>Bordeaux mixture (9)<br>basic copper sulfate (2)         | Unknown: 2 (5%)<br>myclobutanil (19)<br>mancozeb (4)<br>copper oxychloride sulfate (2)        |
| <b>SOUR ROT</b><br><u>Control Chemicals</u>                               | Average Severity: 2.48<br>iprodione (2)  | # Growers reported: 23 (58%)  | Unknown 4 (10%)   |

<sup>a</sup> Severity evaluated by growers according to the following values: 1=High, 2=Moderate, 3=Not important.

<sup>b</sup> Percentages are calculated taking the 40 responses for 1990 as the 100%.

<sup>c</sup> Number of growers who reported unknown severity.

<sup>d</sup> Number of growers using each fungicide.

**TABLE 2.5** Diseases, their severities <sup>a</sup>, chemicals used and their quality of control during 1991.

|                          |                                 |   |                                |
|--------------------------|---------------------------------|---|--------------------------------|
| <b>ANTHRACNOSE</b>       | Average Severity: 2.91          | # Growers reported: 23 (36%)                                | Unknown: 18 (28%) <sup>b</sup> |
| <u>Control Chemicals</u> | <u># growers using chemical</u> | <u>Control quality</u> <sup>c</sup>                         |                                |
| captan                   | 2                               | excellent 100%  |                                |
| Bordeaux mixture         | 1                               | excellent 100%  |                                |
| mancozeb                 | 1                               | excellent 100%  |                                |
| basic copper sulfate     | 1                               | excellent 100%  |                                |
| <b>BLACK ROT</b>         | Average Severity: 2.47          | # Growers reported: 51 (80%)                                | Unknown: 1 (2%)                |
| <u>Control Chemicals</u> | <u># growers using chemical</u> | <u>Control quality</u>                                      |                                |
| triadimefon              | 42                              | fair 4%, good 38%, excellent 48%, unknown 10%               |                                |
| captan                   | 34                              | fair 9%, good 38%, excellent 38%, unknown 15%               |                                |
| mancozeb                 | 34                              | fair 9%, good 35%, excellent 50%, unknown 6%                |                                |
| myclobutanil             | 28                              | fair 7%, good 21%, excellent 54%, unknown 18%               |                                |
| ferbam                   | 25                              | good 44%, excellent 48%, unknown 8%                         |                                |
| Bordeaux mixture         | 11                              | poor 10%, good 45%, excellent 45%                           |                                |
| benomyl                  | 8                               | poor 12%, fair 25%, good 50%, excellent 13%                 |                                |
| basic copper sulfate     | 8                               | fair 38%, good 12%, excellent 38%, unknown 12%              |                                |
| sulfur                   | 5                               | good 60%, excellent 40%                                     |                                |
| iprodione                | 2                               | good 50%, excellent 50%                                     |                                |
| <b>BOTRYTIS</b>          |                                 |   |                                |
| <b>BUNCH ROT</b>         | Average Severity: 2.54          | # Growers reported: 46 (72%)                                | Unknown: 2 (3%)                |
| <u>Control Chemicals</u> | <u># growers using chemical</u> | <u>Control quality</u>                                      |                                |
| iprodione                | 32                              | poor 3%, fair 18.5%, good 22%, excellent 38%, unknown 18.5% |                                |
| benomyl                  | 9                               | poor 11%, fair 11%, good 11%, excellent 45%, unknown 22%    |                                |
| captan                   | 4                               | good 100%   |                                |
| triadimefon              | 3                               | good 67%, excellent 33%                                     |                                |
| Bordeaux mixture         | 3                               | good 67%, excellent 33%                                     |                                |
| ferbam                   | 2                               | good 100%   |                                |
| myclobutanil             | 2                               | good 50%, unknown 50%                                       |                                |
| mancozeb                 | 1                               | good 100%   |                                |
| basic copper sulfate     | 1                               | excellent 100%  |                                |
| <b>CROWN GALL</b>        | Average Severity: 2.40          | # Growers reported: 45 (70%)                                | Unknown: 5 (8%)                |
| <u>Control Chemicals</u> | none                            |   |                                |

<sup>a</sup> Severity evaluated by growers according to the following values: 1=High, 2=Moderate, 3=Not important.

<sup>b</sup> Number of growers who reported unknown severity.

<sup>c</sup> Percentages for each category (poor, fair, good, and excellent) are based in the number of growers who estimated the quality of control of the chemical in the correspondent category.

**TABLE 2.5** (Continuation)

|                                     |                                 |   |                   |
|-------------------------------------|---------------------------------|---|-------------------|
| <b>DOWNY MILDEW</b>                 |                                 |   |                   |
|                                     | Average Severity: 2.63          | # Growers reported: 41 (64%)                            | Unknown: 6 (9%)   |
| <u>Control Chemicals</u>            | <u># growers using chemical</u> | <u>Control quality</u>                                  |                   |
| captan                              | 31                              | fair 2.5%, good 39%, excellent 56%, unknown 2.5%        |                   |
| mancozeb                            | 28                              | fair 11%, good 25%, excellent 57%, unknown 7%           |                   |
| basic copper sulfate                | 10                              | fair 30%, good 10%, excellent 40%, unknown 20%          |                   |
| Bordeaux mixture                    | 9                               | good 56%, excellent 44%                                 |                   |
| ferbam                              | 6                               | good 16.5%, good 67%, unknown 16.5%                     |                   |
| triadimefon                         | 5                               | fair 20%, good 40%, excellent 40%                       |                   |
| myclobutanil                        | 4                               | fair 25%, good 25%, excellent 50%                       |                   |
| sulfur                              | 2                               | good 100%   |                   |
| copper hydroxide                    | 1                               | excellent 100%  |                   |
| iprodione                           | 1                               | good 100%   |                   |
| <hr/>                               |                                 |   |                   |
| <b>EUTYPA DIEBACK</b>               |                                 |   |                   |
|                                     | Average Severity: 2.59          | # Growers reported: 34 (53%)                            | Unknown: 12 (19%) |
| <u>Control Chemicals</u>            | <u># growers using chemical</u> | <u>Control quality</u>                                  |                   |
| captan                              | 1                               | excellent 100%  |                   |
| <hr/>                               |                                 |   |                   |
| <b>PHOMOPSIS CANE AND LEAF SPOT</b> |                                 |   |                   |
|                                     | Average Severity: 2.71          | # Growers reported: 35 (55%)                            | Unknown: 11 (17%) |
| <u>Control Chemicals</u>            | <u># growers using chemical</u> | <u>Control quality</u>                                  |                   |
| captan                              | 7                               | good 28.5%, excellent 43%, unknown 28.5%                |                   |
| mancozeb                            | 7                               | poor 14%, fair 14%, good 43%, excellent 29%             |                   |
| Bordeaux mixture                    | 4                               | good 50%, excellent 50%                                 |                   |
| ferbam                              | 1                               | excellent 100%  |                   |
| <hr/>                               |                                 |   |                   |
| <b>POWDERY MILDEW</b>               |                                 |   |                   |
|                                     | Average Severity: 2.60          | # Growers reported: 48 (75%)                            | Unknown: 2 (3%)   |
| <u>Control Chemicals</u>            | <u># growers using chemical</u> | <u>Control quality</u>                                  |                   |
| triadimefon                         | 45                              | fair 9%, good 31%, excellent 51%, unknown 9%            |                   |
| sulfur                              | 35                              | fair 3%, good 37%, excellent 49%, unknown 11%           |                   |
| myclobutanil                        | 31                              | fair 10%, good 22%, excellent 48%, unknown 20%          |                   |
| benomyl                             | 19                              | poor 5%, fair 16%, good 26%, excellent 37%, unknown 16% |                   |
| Bordeaux mixture                    | 9                               | good 56%, excellent 44%                                 |                   |
| mancozeb                            | 7                               | fair 14%, good 57%, excellent 29%                       |                   |
| basic copper sulfate                | 7                               | good 28.5%, excellent 43%, unknown 28.5%                |                   |
| captan                              | 5                               | good 100%   |                   |
| ferbam                              | 3                               | good 67%, unknown 33%                                   |                   |
| dinocap                             | 1                               | unknown 100%  |                   |
| copper hydroxide                    | 1                               | excellent 100%  |                   |
| iprodione                           | 1                               | good 100%   |                   |
| <hr/>                               |                                 |   |                   |
| <b>SOUR ROT</b>                     |                                 |   |                   |
|                                     | Average Severity: 2.54          | # Growers reported: 33 (52%)                            | Unknown 12 (19%)  |
| <u>Control Chemicals</u>            | <u># growers using chemical</u> | <u>Control quality</u>                                  |                   |
| iprodione                           | 4                               | poor 25%, fair 50%, excellent 25%                       |                   |
| captan                              | 2                               | good 100%   |                   |
| ferbam                              | 1                               | good 100%   |                   |

**TABLE 2.6** Fungicides applied in Virginia vineyards during 1990.

| <b>FUNGICIDE</b>           | <b>PERCENTAGE<br/>ACRES<br/>TREATED <sup>a</sup></b> | <b>AVERAGE<br/>RATE PER<br/>ACRE<br/>(Pounds/A)</b> | <b>AVERAGE<br/>NUMBER OF<br/>APPLICATIONS</b> | <b>TOTAL AMOUNT<br/>OF CHEMICAL<br/>APPLIED<br/>(Pounds a.i.)</b> |
|----------------------------|--|---|---|---|
| captan                     | 88%  | 2.73  | 4.11  | 3,806.5   |
| mancozeb                   | 85%  | 2.35  | 4.47  | 5,034.1   |
| myclobutanil               | 75%  | 0.41  | 3.48  | 188.0   |
| triadimefon                | 53%  | 0.22  | 4.14  | 133.8   |
| sulfur                     | 42%  | 3.48  | 3.74  | 2,804.5   |
| benomyl                    | 37%  | 0.84  | 2.33  | 308.2   |
| iprodione                  | 34%  | 1.43  | 2.65  | 561.8   |
| ferbam                     | 28%  | 2.26  | 2.67  | 746.2   |
| Bordeaux mixture           | 20%  | 4.77  | 2.91  | 146.2   |
| basic copper sulfate       | 11%  | 4.59  | 3.75  | 1,121.1   |
| copper oxychloride sulfate | 3%   | 2.00  | 2.00  | 44.0  |

<sup>a</sup> Percentage out of 685 acres represented in the survey.

**TABLE 2.7** Fungicides applied in Virginia vineyards during 1991.

| <b>FUNGICIDE</b>     | <b>PERCENTAGE<br/>ACRES<br/>TREATED <sup>a</sup></b> | <b>AVERAGE<br/>RATE PER<br/>ACRE<br/>(Pounds/A)</b> | <b>AVERAGE<br/>NUMBER OF<br/>APPLICATIONS</b> | <b>TOTAL AMOUNT<br/>OF CHEMICAL<br/>APPLIED<br/>(Pounds a.i.)</b> |
|----------------------|--|---|---|---|
| captan               | 80%  | 2.71  | 3.87  | 2,959.0   |
| myclobutanol         | 78%  | 0.33  | 3.34  | 188.7   |
| mancozeb             | 77%  | 3.86  | 4.55  | 6,538.1   |
| triadimefon          | 71%  | 0.20  | 3.53  | 196.9   |
| sulfur               | 60%  | 2.68  | 3.77  | 4,769.1   |
| iprodione            | 45%  | 1.46  | 2.05  | 426.3   |
| benomyl              | 41%  | 0.85  | 2.33  | 335.4   |
| ferbam               | 37%  | 2.50  | 2.44  | 974.9   |
| basic copper sulfate | 26%  | 2.91  | 3.19  | 1,786.8   |
| Bordeaux mixture     | 25%  | 4.50  | 3.43  | 289.4   |
| dinocap              | 0.4%   | 0.50  | 1.00  | 0.3   |
| copper hydroxide     | 0.2%   | 8.00  | 4.00  | 24.4  |

<sup>a</sup> Percentage out of 705 acres represented in the survey.

**TABLE 2.8** Weed groups, their severities <sup>a</sup>, and chemicals used for their control during 1990.

|   |  |  |
|---|--|--|
| <b>ALL</b><br><u>Control Chemicals</u>                          | Average Severity: 2.00<br>glyphosate (16) <sup>c</sup><br>oryzalin (1) | # Growers reported: 6 (15%) <sup>b</sup><br>paraquat (4)<br>simazine (2)       |
| <b>ANNUAL BROADLEAF WEEDS</b><br><u>Control Chemicals</u>       | Average Severity: 1.82<br>simazine (9)<br>paraquat (1)                 | # Growers reported: 17 (43%)<br>diuron (3)<br>oryzalin (1)<br>glyphosate (2)   |
| <b>ANNUAL GRASSES</b><br><u>Control Chemicals</u>               | Average Severity: 1.94<br>simazine (4)<br>diuron (2)                   | # Growers reported: 17 (43%)<br>glyphosate (4)<br>paraquat (1)<br>oryzalin (3) |
| <b>PERENNIAL BROADLEAF WEEDS</b><br><u>Control Chemicals</u>    | Average Severity: 1.84<br>glyphosate (3)                               | # Growers reported: 19 (48%)<br>simazine (2)                                   |
| <b>PERENNIAL GRASSES AND SEDGES</b><br><u>Control Chemicals</u> | Average Severity: 2.06<br>glyphosate (3)<br>diuron (1)                 | # Growers reported: 17 (43%)<br>oryzalin (2)<br>simazine (1)<br>sethoxydim (2) |
| <b>SPECIAL PERENNIAL WEEDS</b><br><u>Control Chemicals</u>      | Average Severity: 2.33<br>glyphosate (2)                               | # Growers reported: 12 (30%)<br>Unknown: 1 (3%) <sup>d</sup>                   |

<sup>a</sup> Severity evaluated by growers according to the following values: 1=High, 2=Moderate, 3=Not important.

<sup>b</sup> Percentages are calculated taking the 40 responses for 1990 as the 100%.

<sup>c</sup> Number of growers using each herbicide.

<sup>d</sup> Number of growers who reported unknown severity.

**TABLE 2.9** Weed groups, their severities <sup>a</sup>, chemicals used and their quality of control during 1991.

|                            |                                 |  |                 |
|----------------------------|---------------------------------|--|-----------------|
| <b>ALL</b>                 | Average Severity: 2.29          | # Growers reported: 14 (22%)                             |                 |
| <u>Control Chemicals</u>   | <u># growers using chemical</u> | <u>Control quality</u> <sup>b</sup>                      |                 |
| glyphosate                 | 28                              | fair 18%, good 39%, excellent 32%, unknown 11%           |                 |
| paraquat                   | 8                               | fair 12%, good 38%, excellent 25%, unknown 25%           |                 |
| simazine                   | 7                               | fair 14%, good 29%, excellent 43%, unknown 14%           |                 |
| oryzalin                   | 7                               | fair 57%, excellent 43%                                  |                 |
| diuron                     | 4                               | fair 25%, good 50%, unknown 25%                          |                 |
| <b>ANNUAL BROADLEAF</b>    |                                 |  |                 |
| <b>WEEDS</b>               | Average Severity: 2.00          | # Growers reported: 41 (64%)                             |                 |
| <u>Control Chemicals</u>   | <u># growers using chemical</u> | <u>Control quality</u>                                   |                 |
| simazine                   | 7                               | poor 14%, fair 29%, good 29%, excellent 14%, unknown 14% |                 |
| glyphosate                 | 6                               | poor 33%, good 50%, excellent 17%                        |                 |
| diuron                     | 2                               | good 50%, excellent 50%                                  |                 |
| <b>ANNUAL GRASSES</b>      |                                 |  |                 |
| <b>WEEDS</b>               | Average Severity: 1.90          | # Growers reported: 40 (63%)                             |                 |
| <u>Control Chemicals</u>   | <u># growers using chemical</u> | <u>Control quality</u>                                   |                 |
| glyphosate                 | 6                               | poor 16.3%, good 50%, excellent 16.3%, unknown 16.3%     |                 |
| oryzalin                   | 6                               | poor 16%, fair 34%, good 34%, unknown 16%                |                 |
| simazine                   | 5                               | fair 20%, good 40%, excellent 20%, unknown 20%           |                 |
| diuron                     | 2                               | good 50%, excellent 50%                                  |                 |
| napropamide                | 1                               | excellent 100%   |                 |
| sethoxydim                 | 1                               | good 100%  |                 |
| <b>PERENNIAL BROADLEAF</b> |                                 |  |                 |
| <b>WEEDS</b>               | Average Severity: 2.20          | # Growers reported: 35 (55%)                             | Unknown: 3 (5%) |
| <u>Control Chemicals</u>   | <u># growers using chemical</u> | <u>Control quality</u>                                   |                 |
| simazine                   | 4                               | poor 25%, fair, 25%, good 25%, excellent 25%             |                 |
| glyphosate                 | 3                               | poor 33%, good 33%, unknown 33%                          |                 |
| diuron                     | 1                               | good 100%  |                 |
| paraquat                   | 1                               | good 100%  |                 |
| <b>PERENNIAL GRASSES</b>   |                                 |  |                 |
| <b>AND SEDGES</b>          | Average Severity: 1.79          | # Growers reported: 44 (69%)                             | Unknown: 2 (3%) |
| <u>Control Chemicals</u>   | <u># growers using chemical</u> | <u>Control quality</u>                                   |                 |
| glyphosate                 | 4                               | good 50%, unknown 50%                                    |                 |
| oryzalin                   | 4                               | poor 25%, good 50%, unknown 25%                          |                 |
| sethoxydim                 | 3                               | good 67%, excellent 23%                                  |                 |
| diuron                     | 1                               | good 100%  |                 |
| paraquat                   | 1                               | good 100%  |                 |
| simazine                   | 1                               | good 100%  |                 |
| <b>SPECIAL PERENNIAL</b>   |                                 |  |                 |
| <b>WEEDS</b>               | Average Severity: 2.29          | # Growers reported: 34 (53%)                             | Unknown: 3 (5%) |
| <u>Control Chemicals</u>   | <u># growers using chemical</u> | <u>Control quality</u>                                   |                 |
| glyphosate                 | 2                               | unknown 100%   |                 |

<sup>a</sup> Severity evaluated by growers according to the following values: 1=High, 2=Moderate, 3=Not important.

<sup>b</sup> Percentages for each category (poor, fair, good, and excellent) are based in the number of growers who estimated the quality of control.

**TABLE 2.10** Herbicides applied in Virginia vineyards during 1990 and 1991.

| <b>HERBICIDE</b>  | <b>PERCENTAGE<br/>ACRES<br/>TREATED <sup>a</sup></b> | <b>AVERAGE<br/>RATE PER<br/>ACRE<br/>(Pounds a.i.)</b> | <b>AVERAGE<br/>NUMBER OF<br/>APPLICATIONS</b> | <b>TOTAL AMOUNT<br/>OF CHEMICAL<br/>APPLIED<br/>(Pounds a. i.)</b> |
|-------------------|--|--|---|--|
| <b>1990</b>       |  |  |   |  |
| glyphosate        | 60%  | 0.90   | 1.67  | 419.3  |
| simazine          | 53%  | 1.47   | 1.38  | 719.7  |
| paraquat          | 42%  | 0.31   | 1.67  | 153.6  |
| diuron            | 15%  | 2.87   | 1.33  | 366.4  |
| oryzalin          | 11%  | 1.22   | 1.14  | 113.3  |
| sethoxydim        | 2%   | 0.21   | 1.50  | 8.5  |
| fluazifop-P-butyl | 0.1%   | 0.75   | 2.00  | 0.8  |
| <b>1991</b>       |  |  |   |  |
| glyphosate        | 55%  | 1.16   | 1.79  | 624.0  |
| diuron            | 27%  | 2.88   | 1.25  | 622.4  |
| simazine          | 25%  | 1.85   | 1.28  | 479.8  |
| paraquat          | 19%  | 0.31   | 2.30  | 84.4   |
| oryzalin          | 9%   | 1.64   | 1.27  | 171.2  |
| sethoxydim        | 1.4%   | 0.29   | 2.00  | 6.2  |
| napropamide       | 0.2%   | 8.00   | 1.00  | 12.0   |

<sup>a</sup> Percentage out of 685 acres and 705 acres represented in the surveys for 1990 and 1991 respectively.

**TABLE 2.11** Arthropod pests, their severities <sup>a</sup>, and chemicals used for their control during 1990.

|                               |  |  |
|-------------------------------|--|--|
| <b>AMBROSIA<br/>BEETLE</b>    | Average Severity: 3.00                     | # Growers reported: 6 (15%) <sup>b</sup>             |
| <u>Control Chemicals</u>      | none                                       |  |
| <b>APPLE TWIG BORER</b>       | Average Severity : 3.00                    | # Growers reported: 4 (10%)                          |
| <u>Control Chemicals</u>      | none                                       |  |
| <b>CLIMBING<br/>CUTWORMS</b>  | Average Severity : 2.50                    | # Growers reported: 12 (30%)                         |
| <u>Control Chemicals</u>      | B. t. (2) <sup>c</sup><br>methoxychlor (1) | azinphos-methyl (1)      phosmet (1)<br>carbaryl (1) |
| <b>DROSOPHILA FLIES</b>       | Average Severity : 2.86                    | # Growers reported: 7 (18%)                          |
| <u>Control Chemicals</u>      | none                                       |  |
| <b>EUROPEAN<br/>RED MITE</b>  | Average Severity : 2.78                    | # Growers reported: 9 (23%)                          |
| <u>Control Chemicals</u>      | dicofol (1)                                | fenbutatin-oxide (1)                                 |
| <b>GRAPE<br/>BERRY MOTH</b>   | Average Severity : 2.18                    | # Growers reported: 22 (55%)                         |
| <u>Control Chemicals</u>      | azinphos-methyl (7)<br>methoxychlor (1)    | carbaryl (7)      phosmet (6)<br>parathion (1)       |
| <b>GRAPE<br/>CANE GIRDLER</b> | Average Severity : 3.00                    | # Growers reported: 8 (20%)                          |
| <u>Control Chemicals</u>      | none                                       |  |
| <b>GRAPE CURCULIO</b>         | Average Severity : 3.00                    | # Growers reported: 5 (13%)                          |
| <u>Control Chemicals</u>      | none                                       |  |
| <b>GRAPE<br/>ERINEUM MITE</b> | Average Severity : 3.00                    | # Growers reported: 4 (10%)                          |
| <u>Control Chemicals</u>      | none                                       |  |
| <b>GRAPE<br/>FLEA BEETLE</b>  | Average Severity : 2.87                    | # Growers reported: 15 (38%)                         |
| <u>Control Chemicals</u>      | carbaryl (5)                               | methoxychlor (2)      phosmet (1)                    |
| <b>GRAPE<br/>LEAFFOLDER</b>   | Average Severity : 2.89                    | # Growers reported: 9 (23%)                          |
| <u>Control Chemicals</u>      | carbaryl (2)                               | phosmet (1)  |

<sup>a</sup> Severity evaluated by growers according to the following values: 1=High, 2=Moderate, 3=Not important.

<sup>b</sup> Percentages are calculated taking the 40 responses for 1990 as the 100%.

<sup>c</sup> Number of growers using each insecticide.

**TABLE 2.11** (Continuation)

|  |   |  |
|--|---|--|
| <b>GRAPE<br/>LEAFHOPPER</b><br><u>Control Chemicals</u>                | Average Severity : 2.00<br>carbaryl (3)   | # Growers reported: 1 (3%)<br>phosmet (2)                                      |
| <b>GRAPE<br/>PHYLLOXERA</b><br><u>Control Chemicals</u>                | Average Severity : 2.50<br>endosulfan (4) | # Growers reported: 14 (35%)   |
| <b>GRAPE<br/>PLUME MOTH</b><br><u>Control Chemicals</u>                | Average Severity : 3.00<br>none           | # Growers reported: 3 (8%)   |
| <b>GRAPE<br/>ROOT BORER</b><br><u>Control Chemicals</u>                | Average Severity : 3.00<br>none           | # Growers reported: 4 (10%)  |
| <b>GRAPE<br/>ROOTWORM</b><br><u>Control Chemicals</u>                  | Average Severity : 3.00<br>none           | # Growers reported: 3 (8%)   |
| <b>GRAPE<br/>SKELETONIZER</b><br><u>Control Chemicals</u>              | Average Severity : 3.00<br>none           | # Growers reported: 7 (18%)  |
| <b>GRAPEVINE APHID</b><br><u>Control Chemicals</u>                     | Average Severity : 2.89<br>none           | # Growers reported: 9 (23%)  |
| <b>HORNWORMS</b><br><u>Control Chemicals</u>                           | Average Severity : 2.86<br>none           | # Growers reported: 7 (18%)  |
| <b>JAPANESE BEETLE</b><br><u>Control Chemicals</u>                     | Average Severity : 1.58<br>carbaryl (31)  | # Growers reported: 31 (78%)<br>malathion (1)                      phosmet (1) |
| <b>JUNE BEETLE</b><br><u>Control Chemicals</u>                         | Average Severity : 2.42<br>carbaryl (4)   | # Growers reported: 12 (30%)<br>malathion (1)                                  |
| <b>REDBANDED<br/>LEAFROLLER</b><br><u>Control Chemicals</u>            | Average Severity : 3.00<br>phosmet (2)    | # Growers reported: 8 (20%)<br>azinphos-methyl (1)              carbaryl (1)   |
| <b>ROSE CHAFER</b><br><u>Control Chemicals</u>                         | Average Severity : 3.00<br>none           | # Growers reported: 3 (8%)   |
| <b>YELLOWJACKETS<br/>&amp; OTHER WASPS</b><br><u>Control Chemicals</u> | Average Severity : 2.20<br>malathion (1)  | # Growers reported: 15 (38%)<br>carbaryl (1)                                   |

**TABLE 2.12** Arthropod pests, their severities <sup>a</sup>, chemicals used and their quality of control during 1991.

|                          |                                 |  |
|--------------------------|---------------------------------|--|
| <b>ALL</b>               | Average Severity: 3.00          | # Growers reported: 2 (3%) <sup>b</sup>                  |
| <u>Control Chemicals</u> | <u># growers using chemical</u> | <u>Control quality</u> <sup>c</sup>                      |
| carbaryl                 | 1                               | good 100%  |
| <hr/>                    |                                 |  |
| <b>AMBROSIA</b>          |                                 |  |
| <b>BEETLE</b>            | Average Severity: 2.83          | # Growers reported: 18 (28%)                             |
| <u>Control Chemicals</u> | none                            |  |
| <hr/>                    |                                 |  |
| <b>APPLE</b>             |                                 |  |
| <b>TWIG BORER</b>        | Average Severity: 2.89          | # Growers reported: 9 (14%)                              |
| <u>Control Chemicals</u> | none                            |  |
| <hr/>                    |                                 |  |
| <b>CLIMBING</b>          |                                 |  |
| <b>CUTWORMS</b>          | Average Severity: 2.60          | # Growers reported: 20 (31%)                             |
| <u>Control Chemicals</u> | <u># growers using chemical</u> | <u>Control quality</u>                                   |
| azinphos-methyl          | 4                               | good 25%, excellent 75%                                  |
| methoxychlor             | 2                               | excellent 50%, unknown 50%                               |
| B. t.                    | 1                               | good 100%  |
| carbaryl                 | 1                               | good 100%  |
| <hr/>                    |                                 |  |
| <b>DROSOPHILA</b>        |                                 |  |
| <b>FLIES</b>             | Average Severity: 2.67          | # Growers reported: 2 (3%)                               |
| <u>Control Chemicals</u> | none                            |  |
| <hr/>                    |                                 |  |
| <b>EUROPEAN</b>          |                                 |  |
| <b>RED MITE</b>          | Average Severity: 2.42          | # Growers reported: 19 (30%)                             |
| <u>Control Chemicals</u> | <u># growers using chemical</u> | <u>Control quality</u>                                   |
| dicofol                  | 5                               | fair 20%, good 40%, unknown 40%                          |
| methoxychlor             | 1                               | fair 100%  |
| superior oil             | 1                               | good 100%  |
| <hr/>                    |                                 |  |
| <b>GRAPE</b>             |                                 |  |
| <b>BERRY MOTH</b>        | Average Severity: 2.32          | # Growers reported: 37 (58%)                             |
| <u>Control Chemicals</u> | <u># growers using chemical</u> | <u>Control quality</u>                                   |
| azinphos-methyl          | 13                              | fair 15%, good 39%, excellent 46%                        |
| carbaryl                 | 8                               | poor 12%, fair 12%, good 38%, excellent 25%, unknown 12% |
| phosmet                  | 3                               | excellent 100%   |
| methoxychlor             | 2                               | good 50%, unknown 50%                                    |
| methyl parathion         | 1                               | good 100%  |
| <hr/>                    |                                 |  |
| <b>GRAPE</b>             |                                 |  |
| <b>CANE GIRDLER</b>      | Average Severity: 2.59          | # Growers reported: 22 (34%)                             |
| <u>Control Chemicals</u> | <u># growers using chemical</u> | <u>Control quality</u>                                   |
| azinphos-methyl          | 1                               | excellent 100%   |

<sup>a</sup> Severity evaluated by growers according to the following values: 1=High, 2=Moderate, 3=Not important.

<sup>b</sup> Percentages are calculated taking the 64 responses for 1991 as the 100%.

<sup>c</sup> Percentages for each category (poor, fair, good, and excellent) are based in the number of growers who estimated the quality control of the chemical in the correspondent category.

**TABLE 2.12** (Continuation)

|   |   |  |
|---|---|--|
| <b>GRAPE</b><br><b>CURCULIO</b><br><u>Control Chemicals</u>     | Average Severity: 3.00<br>none                            | # Growers reported: 9 (14%) <sup>a</sup>               |
| <b>GRAPE</b><br><b>ERINEUM MITE</b><br><u>Control Chemicals</u> | Average Severity: 3.00<br>none                            | # Growers reported: 7 (11%)                            |
| <b>GRAPE</b><br><b>FLEA BEETLE</b><br><u>Control Chemicals</u>  | Average Severity: 2.58<br><u># growers using chemical</u> | # Growers reported: 24 (38%)<br><u>Control quality</u> |
| azinphos-methyl   | 3   | excellent 67%, unknown 33%                             |
| carbaryl  | 3   | fair 33%, good 33%, excellent 33%                      |
| methoxychlor  | 2   | excellent 50%, unknown 50%                             |
| <b>GRAPE</b><br><b>LEAFFOLDER</b><br><u>Control Chemicals</u>   | Average Severity: 2.82<br><u># growers using chemical</u> | # Growers reported: 17 (27%)<br><u>Control quality</u> |
| azinphos-methyl   | 1   | excellent 100%   |
| carbaryl  | 1   | good 100%  |
| <b>GRAPE</b><br><b>LEAFHOPPER</b><br><u>Control Chemicals</u>   | Average Severity: 2.54<br><u># growers using chemical</u> | # Growers reported: 24 (38%)<br><u>Control quality</u> |
| carbaryl  | 5   | good 60%, excellent 40%                                |
| azinphos-methyl   | 1   | good 100%  |
| phosmet   | 1   | excellent 100%   |
| <b>GRAPE</b><br><b>PHYLLOXERA</b><br><u>Control Chemicals</u>   | Average Severity: 2.57<br><u># growers using chemical</u> | # Growers reported: 23 (36%)<br><u>Control quality</u> |
| phosalone   | 1   | fair 100%  |
| endosulfan  | 2   | fair 100%  |
| <b>GRAPE</b><br><b>PLUME MOTH</b><br><u>Control Chemicals</u>   | Average Severity: 3.00<br>none                            | # Growers reported: 6 (9%)                             |
| <b>GRAPE</b><br><b>ROOT BORER</b><br><u>Control Chemicals</u>   | Average Severity: 3.00<br>none                            | # Growers reported: 7 (11%)                            |

**TABLE 2.12** (Continuation)

|  |                                 |  |
|--|---------------------------------|--|
| <b>GRAPE<br/>ROOTWORM</b>                  | Average Severity: 3.00          | # Growers reported: 5 (8%)                             |
| <u>Control Chemicals</u>                   | none                            |  |
| <b>GRAPE<br/>SKELETONIZER</b>              | Average Severity: 3.00          | # Growers reported: 10 (16%)                           |
| <u>Control Chemicals</u>                   | none                            |  |
| <b>GRAPEVINE<br/>APHID</b>                 | Average Severity: 2.82          | # Growers reported: 22 (34%)                           |
| <u>Control Chemicals</u>                   | <u># growers using chemical</u> | <u>Control quality</u>                                 |
| carbaryl                                   | 2                               | good 100%  |
| <b>HORNWORMS</b>                           | Average Severity: 2.93          | # Growers reported: 14 (22%)                           |
| <u>Control Chemicals</u>                   | <u># growers using chemical</u> | <u>Control quality</u>                                 |
| carbaryl                                   | 2                               | good 100%  |
| <b>JAPANESE<br/>BEETLE</b>                 | Average Severity: 1.81          | # Growers reported: 58 (91%)                           |
| <u>Control Chemicals</u>                   | <u># growers using chemical</u> | <u>Control quality</u>                                 |
| carbaryl                                   | 52                              | poor 6%, fair 8%, good 40%, excellent 35%, unknown 11% |
| phosmet                                    | 3                               | good 33%, excellent 33%, unknown 33%                   |
| malathion                                  | 1                               | poor 100%  |
| azinphos-methyl                            | 1                               | excellent 100%   |
| <b>JUNE BEETLE</b>                         | Average Severity: 2.56          | # Growers reported: 25 (39%)                           |
| <u>Control Chemicals</u>                   | <u># growers using chemical</u> | <u>Control quality</u>                                 |
| carbaryl                                   | 4                               | excellent 75%, unknown 25%                             |
| <b>REDBANDED<br/>LEAFROLLER</b>            | Average Severity: 2.87          | # Growers reported: 15 (23%)                           |
| <u>Control Chemicals</u>                   | <u># growers using chemical</u> | <u>Control quality</u>                                 |
| carbaryl                                   | 2                               | good 50%, excellent 50%                                |
| azinphos-methyl                            | 1                               | excellent 100%   |
| phosmet                                    | 1                               | excellent 100%   |
| <b>ROSE CHAFER</b>                         | Average Severity: 2.82          | # Growers reported: 11 (17%)                           |
| <u>Control Chemicals</u>                   | <u># growers using chemical</u> | <u>Control quality</u>                                 |
| carbaryl                                   | 2                               | good 50%, excellent 50%                                |
| <b>YELLOWJACKETS<br/>&amp; OTHER WASPS</b> | Average Severity: 2.26          | # Growers reported: 38 (59%)                           |
| <u>Control Chemicals</u>                   | <u># growers using chemical</u> | <u>Control quality</u>                                 |
| carbaryl                                   | 6                               | fair 33%, good 17%, excellent 50%                      |

**TABLE 2.13** Insecticides applied in Virginia vineyards during 1990 and 1991.

| INSECTICIDE      | PERCENTAGE ACRES TREATED <sup>a</sup> | AVERAGE RATE PER ACRE (Pounds/A) | AVERAGE NUMBER OF APPLICATIONS | TOTAL AMOUNT OF CHEMICAL APPLIED (Pounds a. i.) |
|------------------|---------------------------------------|----------------------------------|--------------------------------|---|
| <b>1990</b>      |                                       |                                  |                                |   |
| carbaryl         | 87%                                   | 2.96                             | 3.77                           | 4,193.2   |
| azinphos-methyl  | 26%                                   | 1.65                             | 2.40                           | 158.2   |
| methoxychlor     | 19%                                   | 1.89                             | 1.80                           | 894.0   |
| phosmet          | 13%                                   | 1.31                             | 3.12                           | 158.5   |
| endosulfan       | 9%                                    | 2.00                             | 1.50                           | 106.5   |
| dicofol          | 7%                                    | 1.75                             | 2.00                           | 68.3  |
| parathion        | 7%                                    | 0.38                             | 2.00                           | 20.1  |
| fenbutatin-oxide | 4%                                    | 2.00                             | 1.00                           | 28.0  |
| B. t.            | 2%                                    | 0.45                             | 1.00                           | 0.3   |
| malathion        | 1%                                    | 0.32                             | 1.00                           | 0.8   |
| <b>1991</b>      |                                       |                                  |                                |   |
| carbaryl         | 94%                                   | 2.76                             | 3.67                           | 3,129.9   |
| azinphos-methyl  | 40%                                   | 1.41                             | 2.50                           | 257.3   |
| phosmet          | 7%                                    | 1.12                             | 1.83                           | 73.5  |
| methyl parathion | 5%                                    | 0.25                             | 3.00                           | 12.2  |
| dicofol          | 4%                                    | 1.30                             | 1.20                           | 9.6   |
| methoxychlor     | 3%                                    | 1.55                             | 1.57                           | 37.8  |
| B. t.            | 2%                                    | 0.13                             | 1.00                           | 0.1   |
| endosulfan       | 1%                                    | 2.75                             | 1.50                           | 14.5  |
| superior oil     | 1%                                    | 2.00                             | 1.00                           | 11.0 <sup>b</sup>                               |
| malathion        | 1%                                    | 1.00                             | 1.00                           | 2.1   |
| phosalone        | 0.1%                                  | 0.13                             | 1.00                           | 0.1   |

<sup>a</sup> Percentage out of 685 acres and 705 acres represented in the surveys for 1990 and 1991 respectively.

<sup>b</sup> Amount is expressed in gallons.

**TABLE 2.14** Alternative pest control methods used by Virginia grape growers during 1990 and 1991.

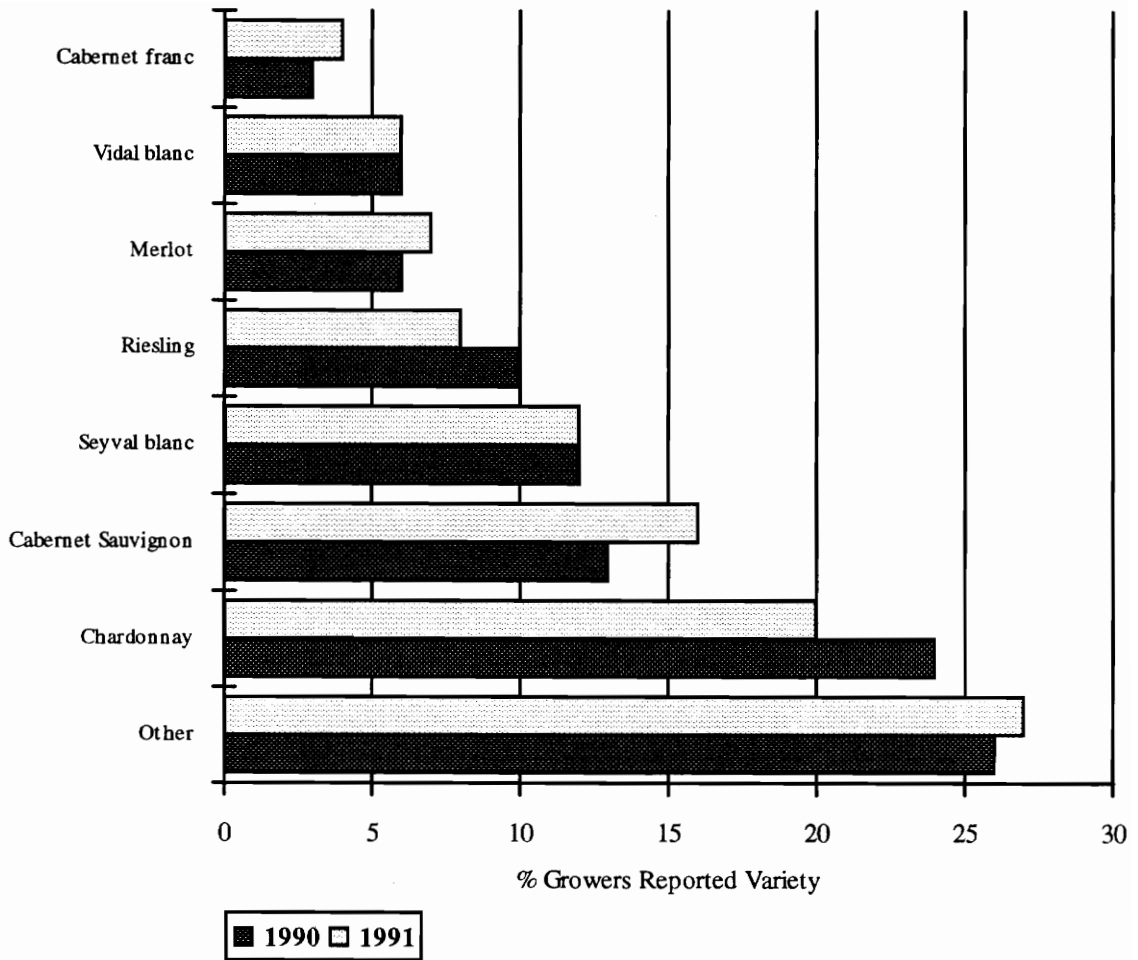
| DISEASE/PEST CONTROLLED           | CONTROL METHOD                        | NUMBER GROWERS | % ACRES TREATED <sup>a</sup> | # TIMES APPLIED | QUALITY OF CONTROL <sup>b</sup>                  |
|-----------------------------------|---------------------------------------|----------------|------------------------------|-----------------|--|
| <b>1990 (40 Growers Response)</b> |                                       |                |                              |                 |  |
| <u>Disease causing agent</u>      | Leaf pulling                          | 7              | 11.0%                        | 7               | NR <sup>c</sup>                                  |
|                                   | Shoot positioning/<br>training system | 2              | 1.0%                         | 2               |  |
|                                   | Cluster thinning                      | 1              | 0.6%                         | 1               |  |
| <u>Insects</u>                    | Mating disruption                     | 2              | 3.0%                         | 2               |  |
|                                   | Pheromone traps                       | 1              | 1.0%                         | 1               |  |
|                                   | Other                                 | 1              | 1.0%                         | 1               |  |
| <u>Weeds</u>                      | Cultivation/ grape hoe                | 16             | 29.0%                        | 16              |  |
| <b>1991 (64 Growers Response)</b> |                                       |                |                              |                 |  |
| <u>Disease causing agent</u>      | Leaf pulling                          | 9              | 11.0%                        | 9               | 67% Good, 22% Excellent, 11% Unknown             |
|                                   | Shoot positioning/<br>training system | 2              | 1.0%                         | 2               | 50% Good, 50% Unknown                            |
|                                   | Shoot thinning                        | 1              | 0.5%                         | 1               | 100% Good  |
|                                   | Cluster thinning                      | 1              | 0.5%                         | 1               | 100% Good  |
|                                   | Lime                                  | 1              | 0.1%                         | 1               | 100% Unknown                                     |
| <u>Insects</u>                    | Mating disruption                     | 4              | 7.0%                         | 4               | 100% Excellent                                   |
|                                   | Pheromone traps                       | 1              | 0.7%                         | 1               | 100% Good  |
|                                   | Cluster thinning                      | 1              | 0.3%                         | 1               | 100% Good  |
|                                   | Cultivation/ grape hoe                | 1              | n/a <sup>d</sup>             | 1               | 100% Good  |
| <u>Vertebrates</u>                | Balloons with eyes/<br>fake owls      | 3              | 3.0%                         | 3               | 67% Good, 33% Fair                               |
|                                   | Electric fence                        | 1              | 2.0%                         | 1               | 100% Excellent                                   |
|                                   | Nets                                  | 1              | 0.1%                         | 1               | 100% Excellent                                   |
|                                   | Other                                 | 2              | 2.0%                         | 2               | 50% Good, 50% Fair                               |
| <u>Weeds</u>                      | Cultivation/ grape hoe                | 8              | 7.0%                         | 8               | 38% Good, 25% Excellent, 25% Unknown<br>12% Fair |
|                                   | Other                                 | 1              | 2.0%                         | 1               | 100% Excellent                                   |
|                                   | Shoot positioning/<br>training system | 1              | 0.3%                         | 1               | 100% Fair  |

<sup>a</sup> Percentage out of 685 acres and 705 acres represented in the surveys for 1990 and 1991 respectively.

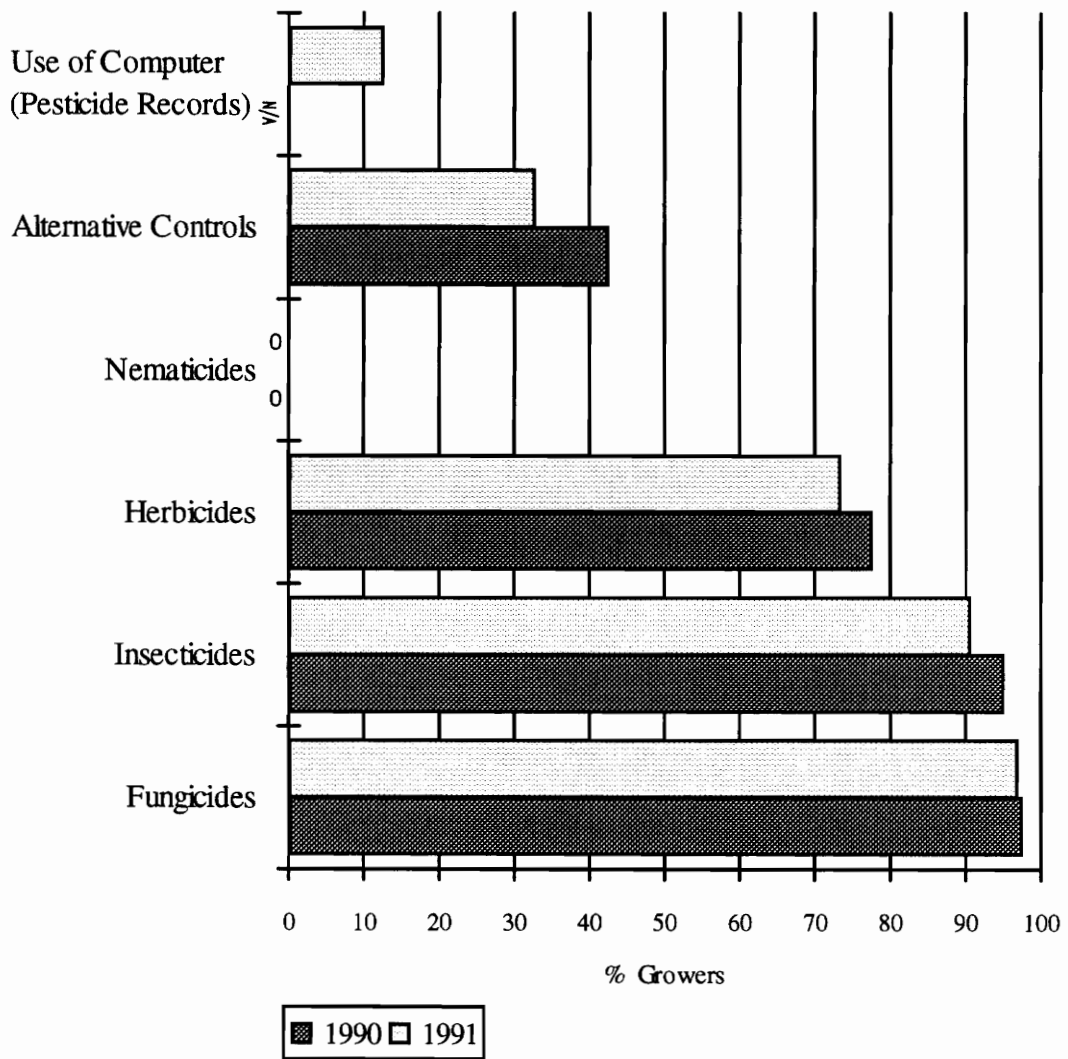
<sup>b</sup> Percentages for each category (poor, fair, good, and excellent) are based in the number of growers who estimated the quality control of the method in the corresponding category.

<sup>c</sup> Quality of control rating was not requested in the 1990 survey questionnaire.

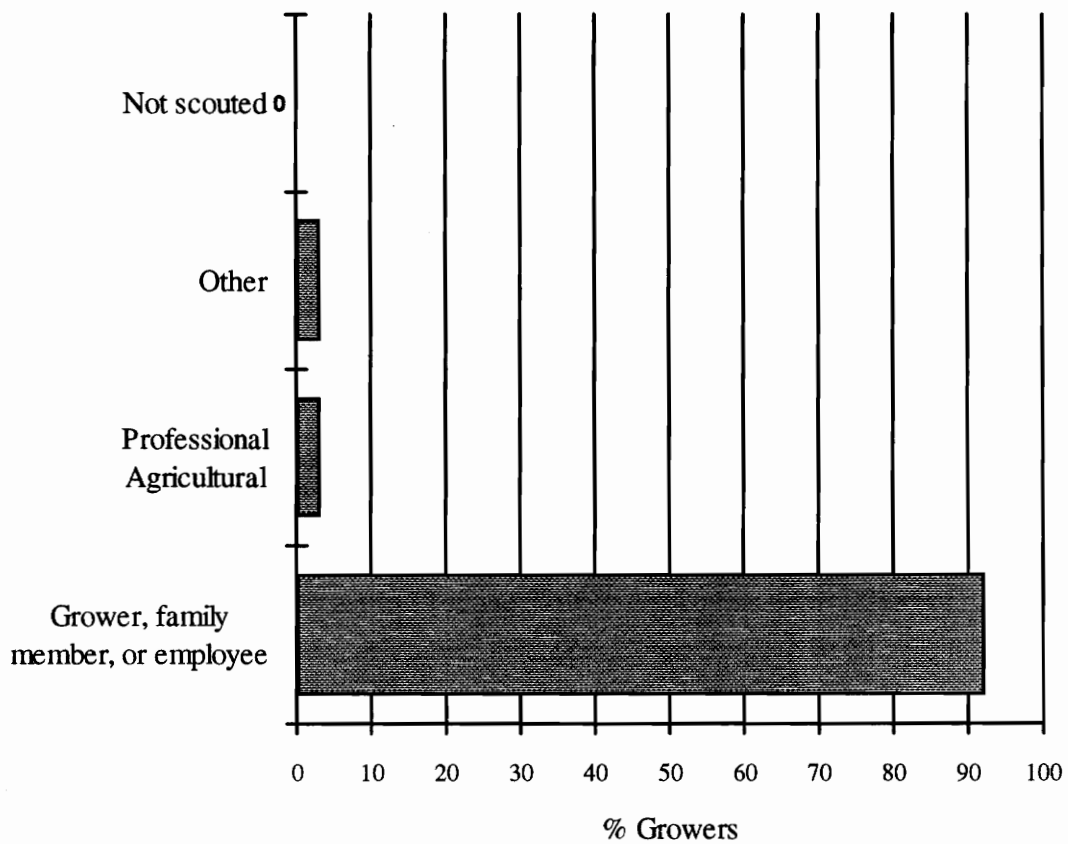
<sup>d</sup> Not answered.



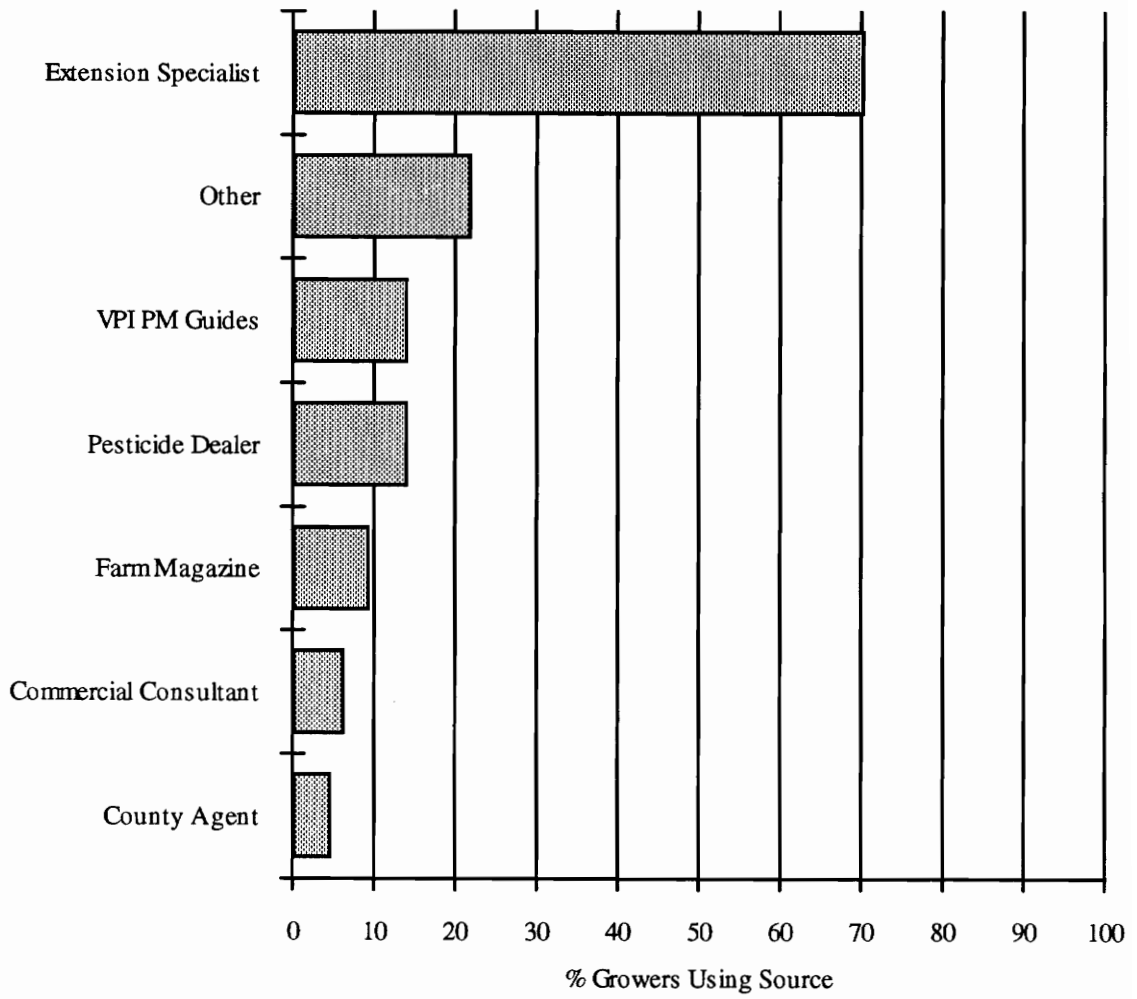
**Fig. 2.1** Percentage of grape varieties among growers in Virginia: 1990 and 1991.



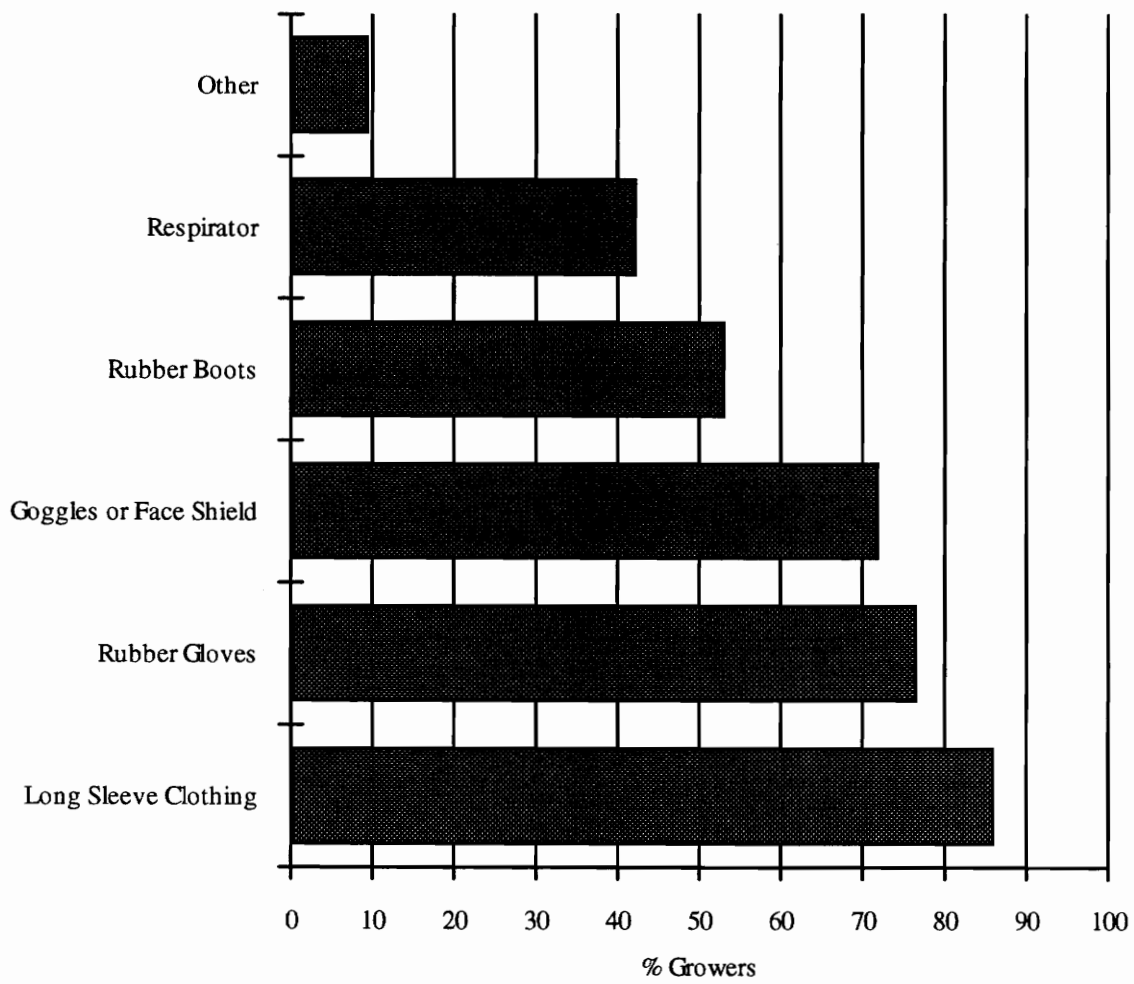
**Fig. 2.2** Pesticide use in Virginia vineyards: 1990 and 1991.



**Fig. 2.3** Personnel who scouted Virginia vineyards in 1991.



**Fig. 2.4** Information sources for pesticide use in Virginia vineyards during 1991.



**Fig. 2.5** Protective clothing used for pesticide application in Virginia vineyards during 1991.

## **APPENDIX A**

Questionnaire forms for pesticide use surveys in Virginia vineyards

# GRAPE PESTICIDE USAGE SURVEY - 1990

**RETURN ADDRESS:**

Chemical, Drug and Pesticide Unit  
Virginia Tech - 139 Smyth Hall  
Blacksburg, VA 24061-0409

County \_\_\_\_\_ Acreage planted \_\_\_\_\_

1. What kind of grape varieties did you cultivate in 1990?
  - a. Vinifera , wine (e.g. Chardonnay) \_\_\_\_\_
  - b. French-American hybrid, wine (e.g. Seyval) \_\_\_\_\_
  - c. American varieties (e.g. Concord) \_\_\_\_\_
  - d. Table \_\_\_\_\_
  
2. What was the average yield per acre in your vineyard last year? \_\_\_\_\_
  
3. Did you use any pesticides on your grape vineyard to control diseases, weeds, insects or mites, during the past 1990 season?  
\_\_\_\_\_ YES\* \_\_\_\_\_ NO\*\*

\*If your answer to #3 was YES, please fill in the following charts with complete information.  
\*\*If your answer to #3 was NO, only fill in the information about "Severity" values of the pests and "Alternative Control Measures" (last column) for each of the following charts on the next few pages.

# SAMPLE SURVEY FORM

Dear Grower: Please follow the examples and directions listed on this sample form below to help you fill in the survey forms.

| Chemical Trade Name ( see reference list below )<br>and Formulation  | Pest(s) controlled<br>with each chemical<br>List the letter(s)<br>according to the list of<br>pests given below  | Acres<br>treated   | Amount<br>used<br>per acre,<br>per spray,<br>(oz. pt. lb.)                     | Method of<br>application<br>1-aerial<br>2-ULV<br>3-backpack air<br>4-post boom                               | Time of<br>application<br>1-dormant<br>2-pre bloom<br>3-bloom<br>4-post bloom  | #<br>treatments<br>per season  | Alternative control(s)<br><br>(Other chemical, cultural or biological control methods which would<br>be used if the mentioned chemical was not available)  |
|--|--|--|--|--|--|--|--|
| <i>Manrate 200 DI</i>  | B, D   | 4  | 1.5 lb   | 2  | 2, 4   | 1  | <i>Captan 50WP and cover remaining mummies with soil</i>   |
| <i>Bordeaux mixture</i>  | A  | 4  | 8 lb   | 1  | 1  | 3  | None.  |
| <i>Princep 80 W</i>  | I, G   | 5  | 2.5 lb   | 1  | 2  | 1  | <i>Cultivation and hand pulling.</i>   |
| <i>Superior Oil (70 sec)</i>   | I  | 4  | 2 gal  | 2  | <i>Bud swell</i>   | 2  | <i>Kelthane (applied at post-bloom stage).</i>   |
| <i>Guthion 35 WP</i>   | K  | 4  | 1.5 lb   | 1  | 1  | 3  | <i>Dipel (B.I.)</i>  |
| <b>DIRECTIONS:</b><br>List chemical trade name or brand name that appears on the label, according to the list of pesticides provided below each chart. For example, mancozeb (common name) has several trade names such as Dithane M-45, Manrate 200, Dithane M 22, etc. | Instead of writing the name of the disease or pest, just refer to the corresponding letter assigned in each list. Do not target to rate the severity of the pests in those lists (at the bottom of each page). | List the number of acres you treated with the pesticide. | List the quantity of the pesticide formulation applied per acre in each spray. | List the number(s) according to the values given. In case you used another type, just write it in the space. | List the # corresponding to the time when you applied the chemical. If you applied at another time, write it in the space. | List the number of times you applied each chemical in the 1990 growing season. | Alternative control(s), refers to another kind of viable method(s) that you would choose in case the selected chemical would not be available.<br><br>When writing the alternatives, please be specific (examples):<br>Chemicals: refer again to the provided list of pesticides.<br>Cultural practices: pruning, soil draining, leaf removal, etc.<br>Biological control: Isomate CBM, <i>Beauveria thuringensis</i> (B.I.), etc.<br>Write those when you would not use another method to control the pest.<br><br>Write Unknown when you do not know which other methods to use. |

**LIST OF PESTICIDES:**

- |                  |          |          |          |              |              |
|------------------|----------|----------|----------|--------------|--------------|
| Bordeaux mixture | Bayleton | Goal     | Poast    | Guthion      | Superior Oil |
| Captan           | Nova     | Princop  | Fuslade  | Imidan       | Other _____  |
| Dithane M 45     | Rubigan  | Roundup  | Sevin    | Kelthane     |              |
| Manrate 200      | Karmax   | Paraquat | Diazinon | Dipel (B.I.) |              |

**LIST OF PESTS:**

- Rate the severity of each pest you had in the 1990 growing season. Fill in with the correspondent value. 1 = high
- |                 |                               |                       |   |
|-----------------|-------------------------------|-----------------------|---|
| A. Anthracnose  | F. Annual grasses             | K. Climbing cutworms  | 1 |
| B. Black rot    | G. Annual broadleaf weeds     | L. European red mite  | 2 |
| C. Crown gall   | H. Perennial grasses & sedges | M. Grape berry moth   | 2 |
| D. Downy Mildew | I. Perennial broadleaf weeds  | N. Grape cane girdler | 4 |
| E. Sour rot     | J. Special perennial weeds    | O. Japanese beetle    | 4 |

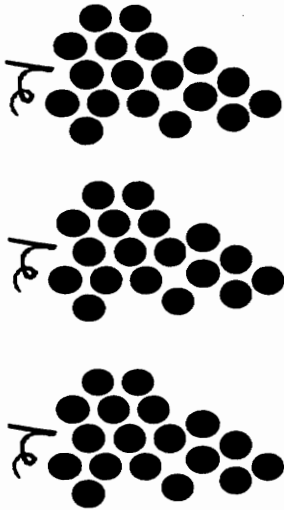
- 2 = moderate  
3 = not important  
4 = unknown







**PESTICIDE USE IN 1991 ON GRAPES:  
A SURVEY OF VIRGINIA PRODUCERS**



This survey is one of several we are conducting to determine the patterns of pesticide use on agricultural crops in Virginia. This type of information is needed to determine the use and importance of pesticides in crop production and assure their continued availability to Virginia producers. Please answer all of the questions. If you wish to comment on any questions or qualify your answers, please feel free to use the space provided at the end of this form. Your comments will be read and taken into account.

Thank you for your help.

Chemical, Drug and Pesticide Unit  
Virginia Cooperative Extension Service  
College of Agriculture and Life Sciences  
Virginia Polytechnic Institute and State University  
139 Smyth Hall  
Blacksburg, VA 24061-0409

**GENERAL INFORMATION**

**Q-1** In which county is your vineyard located? (If more than one, list county in which the majority of your vineyard is located)

\_\_\_\_\_ COUNTY

**Q-2** What is the total number of acres planted?

\_\_\_\_\_ ACRES

**Q-3** List number of acres and average yield per acre of each grape variety you cultivated in 1991:

| VARIETY | ACREAGE | AVERAGE YIELD PER ACRE |
|---------|---------|------------------------|
| _____   | _____   | _____                  |
| _____   | _____   | _____                  |
| _____   | _____   | _____                  |
| _____   | _____   | _____                  |
| _____   | _____   | _____                  |

**Q-4** Who scouted your 1991 vineyard for insects, weeds, diseases, or other plant pests? (Check all those that apply)

- YOURSELF, FAMILY MEMBER, OR EMPLOYEE
- PROFESSIONAL AGRICULTURAL CONSULTANT
- EXTENSION SERVICE
- OTHER (Specify) \_\_\_\_\_
- NOT SCOUTED

**DISEASE INCIDENCE**

**Q-5** Rate the severity of each disease you observed in your vineyard in the 1991 growing season. Fill in with the corresponding value (1 = HIGH; 2 = MODERATE; 3 = NOT IMPORTANT; 4 = UNKNOWN):

| DISEASE                           | SEVERITY VALUE |
|-----------------------------------|----------------|
| A. Anthracnose                    |                |
| B. Black rot                      |                |
| C. Botrytis bunch rot (gray mold) |                |
| D. Crown gall                     |                |
| E. Downy mildew                   |                |
| F. Eutypa dieback (dead arm)      |                |
| G. Phomopsis cane and leaf spot   |                |
| H. Powdery mildew                 |                |
| I. Sour rot                       |                |
| J. other (Specify)                |                |

**DISEASE CONTROL**

**Q-6** Did you use any fungicides and/or bactericides to control diseases in your grape vineyard in 1991? (Circle one)

- 1 YES
  - 2 NO
- Please continue      Please skip to **Q-8**

**Q-7** Which of the following fungicides did you use to control diseases in your grape vineyard in 1991? Please list the acres treated, the disease(s) you were trying to control (list the letters according to list given in **Q-5**), the number of applications, and the rate per acre. Also, please estimate the quality of control obtained by the fungicide applied (0-24% = POOR; 25-49% = FAIR; 50-74% = GOOD; 75-100% = EXCELLENT). A list of fungicides is on the last page of this survey. Please notice that this table continues on the next page.

| FUNGICIDE (Brand Name) | ACRES TREATED | DISEASES YOU WERE TRYING TO CONTROL (List letters from Q-5) | NUMBER OF APPLICATIONS | RATE PER ACRE | QUALITY OF CONTROL |
|------------------------|---------------|---|------------------------|---------------|--------------------|
| Triadimefon (Bayleton) |               |   |                        |               |                    |
| benomyl (Benlate)      |               |   |                        |               |                    |
| Bordeaux mixture       |               |   |                        |               |                    |
| captan (Orthocide)     |               |   |                        |               |                    |
| ferbam (Carbamate WDG) |               |   |                        |               |                    |

Q-7 (Continuation)

| FUNGICIDE<br>(Brand Name)                                | ACRES<br>TREATED | DISEASES YOU<br>WERE TRYING TO<br>CONTROL (List<br>letters from Q-5) | NUMBER OF<br>APPLICATIONS | RATE<br>PER<br>ACRE | QUALITY OF<br>CONTROL |
|--|------------------|--|---------------------------|---------------------|-----------------------|
| iprodione<br>(Rovral)                                    |                  |  |                           |                     |                       |
| Lime sulfur  |                  |  |                           |                     |                       |
| mancozeb<br>(Dithane M-45,<br>Manzate 200,<br>Penncozeb) |                  |  |                           |                     |                       |
| Nova<br>(systhane)                                       |                  |  |                           |                     |                       |
| tri-basic copper   |                  |  |                           |                     |                       |
| wettable sulfur  |                  |  |                           |                     |                       |
| other (Specify)  |                  |  |                           |                     |                       |

WEED PROBLEMS

Q-8 Rate the severity of each group of weeds you observed in your vineyard in the 1991 growing season. Fill in with the corresponding value (1 = HIGH; 2 = MODERATE; 3 = NOT IMPORTANT; 4 = UNKNOWN):

| WEED GROUP  | SEVERITY<br>VALUE |
|---|-------------------|
| A. Annual grasses                                       |                   |
| B. Annual broadleaf weeds                               |                   |
| C. Perennial grasses and sedges                         |                   |
| D. Perennial broadleaf weeds                            |                   |
| E. Special perennial weeds (VA creeper, brambles, etc.) |                   |
| F. other (Specify)                                      |                   |

WEED CONTROL

Q-9 Did you use any herbicides and/or growth regulators to control weeds in your grape vineyard during 1991? (Circle one)

1 YES                      2 NO  
Please continue            Please skip to Q-11

**Q-10** Which of the following herbicides did you use to control weeds in your grape vineyard in 1991? Please list the acres treated, the weed(s) you were trying to control (list the letter(s) according to the list given in Q-8), the number of applications, and the rate per acre. Also please estimate the quality of control obtained by the herbicide applied (0-24% = POOR; 25-49% = FAIR; 50-74% = GOOD; 75-100% = EXCELLENT). A list of herbicides is on the last page of this survey.

| HERBICIDE (Brand Name) | ACRES TREATED | WEEDS YOU WERE TRYING TO CONTROL (List letters from Q-8) | NUMBER OF APPLICATIONS | RATE PER ACRE | QUALITY OF CONTROL |
|------------------------|---------------|--|------------------------|---------------|--------------------|
| diuron (Karmex)        |               |  |                        |               |                    |
| paraquat (Gramoxone)   |               |  |                        |               |                    |
| simazine (Princep)     |               |  |                        |               |                    |
| glyphosate (Roundup)   |               |  |                        |               |                    |
| oryzalin (Surflan)     |               |  |                        |               |                    |
| other (Specify)        |               |  |                        |               |                    |

**INSECT AND MITE PROBLEMS**

**Q-11** Rate the severity of each pest that you observed in your vineyard in the 1991 growing season. Fill in with the corresponding value (1= HIGH; 2= MODERATE; 3= NOT IMPORTANT; 4= UNKNOWN). Please notice that this table continues on the next page.

| INSECT / MITE         | SEVERITY VALUE |
|-----------------------|----------------|
| A. Ambrosia beetle    |                |
| B. Apple twig borer   |                |
| C. Climbing cutworms  |                |
| D. Drosophila flies   |                |
| E. European red mite  |                |
| F. Grape berry moth   |                |
| G. Grape cane girdler |                |
| H. Grape curculio     |                |
| I. Grape erineum mite |                |
| J. Grape flea beetle  |                |
| K. Grape leaf folder  |                |
| L. Grape leafhopper   |                |
| M. Grape phylloxera   |                |
| N. Grape plume moth   |                |
| O. Grape root borer   |                |
| P. Grape rootworm     |                |

**Q-11** (Continuation)

| INSECT / MITE                  | SEVERITY VALUE |
|--------------------------------|----------------|
| Q. Grapeleaf skeletonizer      |                |
| R. Grapevine aphid             |                |
| S. Hornworms                   |                |
| T. Japanese beetle             |                |
| U. June beetle                 |                |
| V. Redbanded leafroller        |                |
| W. Rose chafer                 |                |
| X. Yellowjackets & other wasps |                |
| Y. other (Specify)             |                |

**INSECT/MITE CONTROL**

**Q-12** Did you use any insecticides and/or miticides to control pests in your grape vineyard during 1991? (Circle one)

1 YES                      2 NO  
Please continue        Please skip to Q-14

**Q-13** Which of the following insecticides/miticides did you use to control pests in your grape vineyard in 1991? Please list the acres treated, the pest(s) you were trying to control (list the letter(s) according to the list given in Q-11), the number of applications, and the rate per acre. Also, please estimate the quality of control obtained by the insecticide or miticide applied (0-24% = POOR; 25-49% = FAIR; 50-74% = GOOD; 75-100% = EXCELLENT). A list of insecticides and miticides is on the last page of this survey.

| INSECTICIDE (Brand Name)     | ACRES TREATED | INSECTS OR MITES YOU WERE TRYING TO CONTROL (List letters from Q-11) | NUMBER OF APPLICATIONS | RATE PER ACRE | QUALITY OF CONTROL |
|------------------------------|---------------|--|------------------------|---------------|--------------------|
| carbaryl (Sevin)             |               |  |                        |               |                    |
| B. 1. (DiPel)                |               |  |                        |               |                    |
| azinphosmethyl (Guthion)     |               |  |                        |               |                    |
| dicofol (Kelthane)           |               |  |                        |               |                    |
| malathion (Cythion)          |               |  |                        |               |                    |
| methoxychlor (Marlate)       |               |  |                        |               |                    |
| methyl parathion (PennCap-M) |               |  |                        |               |                    |
| phosmet (Imidan)             |               |  |                        |               |                    |
| endosulfan (Thiodan)         |               |  |                        |               |                    |
| other (Specify)              |               |  |                        |               |                    |

**NEMATODE PROBLEMS**

**Q-14** Rate the severity of each nematode problem that you observed in your vineyard in the 1991 growing season. Fill in with the corresponding value (1= HIGH; 2= MODERATE; 3= NOT IMPORTANT; 4= UNKNOWN):

| NEMATODE GROUP  | SEVERITY VALUE |
|---|----------------|
| A. Citrus nematode ( <i>Tylenchulus</i> spp.)           |                |
| B. Dagger and needle nematodes ( <i>Xiphinema</i> spp.) |                |
| C. Lesion nematodes ( <i>Pratylenchus</i> spp.)         |                |
| D. Root-knot nematodes ( <i>Meloidogyne</i> spp.)       |                |
| E. other (Specify)                                      |                |

**NEMATODE CONTROL**

**Q-15** Did you use any nematicides or fumigants to control nematodes in your grape vineyard during 1991? (Circle one)

1 YES                      2 NO  
Please continue            Please skip to Q-17

**Q-16** Which of the following nematicides or fumigants did you use to control nematodes in your grape vineyard in 1991? Please list the acres treated, the nematode(s) you were trying to control (list the letter(s) according to the list given in Q-14), the number of applications, and the rate per acre. Also, please estimate the quality of control obtained by the nematicide or fumigant applied (0-24% = POOR; 25-49% = FAIR; 50-74% = GOOD; 75-100% = EXCELLENT). A list of nematicides and fumigants is on the last page of this survey.

| NEMATOCIDE (Brand Name)                       | ACRES TREATED | NEMATODES YOU WERE TRYING TO CONTROL (List letters from Q-14) | NUMBER OF APPLICATIONS | RATE PER ACRE | QUALITY OF CONTROL |
|---|---------------|---|------------------------|---------------|--------------------|
| methyl bromide (Meth-O-Gas)                   |               |   |                        |               |                    |
| fenamiphos (Nemacur)                          |               |   |                        |               |                    |
| chloroallyl chloride (Telone II, Telone C-17) |               |   |                        |               |                    |
| other (Specify)                               |               |   |                        |               |                    |

**OTHER INFORMATION**

**Q-17** Did you use anything else besides pesticides to control pests (i.e.: diseases, weeds, insects, etc.) on your grape vineyard in 1991, such as: biological controls, cultural practices, and chemicals other than pesticides? (Circle one)

1 YES                      2 NO  
Please continue            Please skip to **Q-19**

**Q-19** Do you use a computer system to keep your pesticide application records? (Circle one)

1 YES                      2 NO  
Please continue            Please skip to **Q-21**

**Q-18** Please list the alternative control methods, the pest(s) you were trying to control, and how many times the alternative control method was performed. Also please estimate the quality of control obtained by the method used (0-24% = POOR; 25-49% = FAIR; 50-74% = GOOD; 75-100%= EXCELLENT)

| ALTERNATIVE CONTROL METHOD | ACRES | PEST YOU WERE TRYING TO CONTROL | TIMES METHOD WAS REPEATED | QUALITY OF CONTROL |
|----------------------------|-------|---------------------------------|---------------------------|--------------------|
|                            |       |                                 |                           |                    |
|                            |       |                                 |                           |                    |
|                            |       |                                 |                           |                    |
|                            |       |                                 |                           |                    |

**Q-20** Which kind of computer system software do you use? (Circle all that apply)

- |                  |                       |                 |
|------------------|-----------------------|-----------------|
| OPERATING SYSTEM | PROGRAMS              | NAME OF PROGRAM |
| 1 MACINTOSH      | A SPREADSHEETS        | _____           |
| 2 MSDOS          | B DATABASE            | _____           |
| 3 WINDOWS        | C ACCOUNTING SOFTWARE | _____           |
| 4 OS/2           | D OTHER               | _____           |
| 5 OTHER          | _____                 | _____           |

**Q-21** Did you use any of the following as a regular precaution when handling or applying pesticides? (Circle those that apply)

- 1 GOGGLES OR FACE SHIELD \_\_\_\_\_
- 2 RUBBER GLOVES \_\_\_\_\_
- 3 RUBBER BOOTS \_\_\_\_\_
- 4 LONG SLEEVE CLOTHING \_\_\_\_\_
- 5 OTHER (Specify) \_\_\_\_\_

**Q-22** Where do you get most of your information about the proper pesticide to use on your grape vineyard? (Circle one)

- 1 PESTICIDE DEALER \_\_\_\_\_
- 2 EXTENSION SPECIALIST \_\_\_\_\_
- 3 COUNTY AGENT \_\_\_\_\_
- 4 COMMERCIAL CONSULTANT \_\_\_\_\_
- 5 FARM MAGAZINE \_\_\_\_\_
- 6 OTHER (List) \_\_\_\_\_

## COMMONLY USED PESTICIDES ON GRAPES IN VIRGINIA (1991)

### FUNGICIDES

Basic copper sulfate  
Bayleton (triadimefon)  
Benlate (benomyl)  
Bordeaux mixture  
Captan  
COCs (Copper Oxychloride sulfate)  
Copper Count-N  
Dikar (mancozeb/dinocap)  
Dithane M-45 (mancozeb)  
Dithane Z-78 (zineb)  
Ferbam (Carbamate WDG)  
Gallex (cresol-xyleneol)  
Karathane (dinocap)  
Kocide (copper hydroxide)  
Kolospray (sulfur)  
Lime sulfur  
Maneb  
Manzate 200 (mancozeb)  
Nova (sysithane)  
Peniccozeb (mancozeb)  
Rovral (iprodione)  
Rubigan (fenarimol)  
Tenn-cop (copper resinolate)  
Weitable sulfur  
Ziram (Zerlate)

### NEMATOCIDES

Methyl bromide (Meth-O-Gas)  
Nemacur (fenamiphos)  
Telone II (chloroallyl chloride)  
Telone C-17 (chloroallyl chloride)

### HERBICIDES

Casoron (dichlobenil)  
Devrinol (napropamide)  
Dual (metolachlor)  
Fusilade (fluzifop-butyl)  
Goal (oxyfluorfen)  
Karmex (diuron)  
Kerb (pronamide)  
Paraquat (Gramoxone)  
Poast (sethoxydim)  
Princep (simazine)  
Prowl (pendimethalin)  
Roundup (glyphosate)  
Surfline  
Surflan (oryzalin)

### INSECTICIDES

Cythion (malathion)  
Diazinon  
Dibrom (Naled)  
Dif-1 (Bacillus thuringiensis (B.t.))  
Furadan (carbofuran)  
Guthion (azinphos-methyl)  
Imidan (phosmet)  
Kelthane (dieldrin)  
Kryocide (cryolite)  
Lannate (methomyl)  
Lorsban (chlorpyrifos)  
Malate (methoxychlor)  
Nicotine  
Omite (propargite)  
Parathion  
Penncap-M (methyl parathion)  
Phosalone (Zolone)  
Superior oil  
Phosdrin (mevinphos)  
Sevin (carbaryl)  
Thiodan (endosulfan)  
Vendex (fenbutatin-oxide)

Is there anything else you would like to tell us about the use of agricultural chemicals in grapes? If so, please use the space below for that purpose.

Also, any comments you wish to make that you think may help us in future efforts to collect pesticide use information on Virginia crops will be appreciated either in the space below or in a separate letter.

Your contribution to this effort is greatly appreciated. If you would like a summary of the results, please print your name on the back of the return envelope (NOT on this questionnaire). We will see that a result summary is sent to you.

## VITA

The author was born on 6 May 1966 in Bogota, Colombia, South America. She attended Universidad de los Andes in Bogota, Colombia from 1984 to 1987 receiving a Bachelor of Science degree in Microbiology in 1988. For her one-year practical training, she worked at the Center for Microbiological Research (CIMIC) at the Universidad de los Andes in Bogota, participating in microbiological quality control of food and water, in bacteriology research, and teaching. In 1989 she traveled to the United States to learn conversation, comprehension, and writing in English, attending Western Kentucky University at Glasgow, Kentucky for the summer. She began work on a Master's degree at Virginia Polytechnic Institute and State University (VPI & SU), Department of Plant Pathology, Physiology, and Weed Science, in the fall of 1990. She received the opportunity of an assistantship with the Chemical, Drug, and Pesticide Unit while pursuing her degree at VPI & SU. She was awarded the American Society for Enology and Viticulture Eastern Wine Industry Student Scholarship in 1991 and received funding for her research from the Graduate Research Development program of the Graduate School Assembly of VPI & SU in 1991. She is a member of the American Phytopathological Society and of the American Society for Enology and Viticulture.

NATALIA MARTINEZ .