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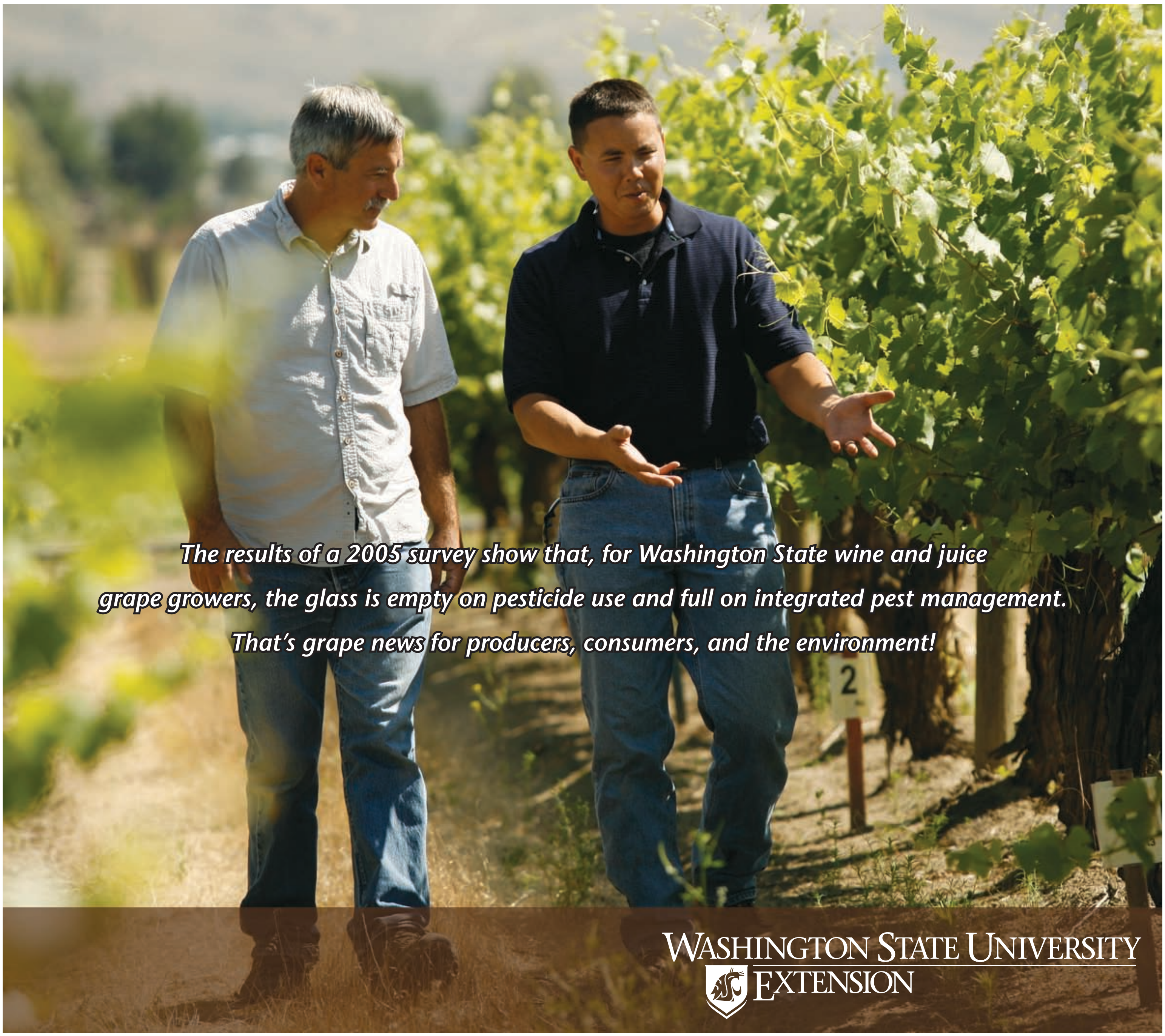
Survey SAYS: Great Grapes!

An IPM Success Story

CREATIVITY RESEARCH PRACTICALITY APPLICATION



The results of a 2005 survey show that, for Washington State wine and juice grape growers, the glass is empty on pesticide use and full on integrated pest management. That's grape news for producers, consumers, and the environment!

WASHINGTON STATE UNIVERSITY EXTENSION

This publication authored with pride by Holly Ferguson, Sally O'Neal, and Douglas Walsh, WSU Prosser IAREC

What would you call an 84% reduction in insecticide use and a 73% reduction in fungicide use over the course of a decade? We call it GRAPE NEWS! WSU Research and Extension is proud of the part we have played in this reduction. But IPM (integrated pest management) is more than just reducing pesticide use. Our survey also showed that over 80% of grape growers surveyed scout for pests regularly and that over half use economic thresholds or disease forecasting models. Kudos to our state's forward-thinking growers.

This publication and the 2005 survey were supported in part by the Washington Wine Industry Foundation and the Washington Association of Wine Grape Growers. We also thank Gary Grove, Kevin Corliss, Rick Hamman, and Catherine Daniels for their valuable editorial assistance and Mercy Olmstead for assisting in distributing the survey. Special thanks to Chateau Ste. Michelle and Ron Wight for providing many of the photos. The grape mealybug photo on page 4 (far right) is courtesy of USDA-ARS, Bugwood.org.

how grape thou art

When we set out to survey the grape growers of Washington State on their pest management practices in October 2005, we had no idea we were tracking an absolute phenomenon in integrated pest management adoption. When the data were compared with pest management practices recorded in the mid 1990s, the results were astonishing.

How does an industry reduce its insecticide/miticide use by 84%? Its fungicide use by 73%? Motivation and teamwork. This bulletin summarizes data from our 2005 survey, compares it to data collected in the 1990s, and analyzes the reasons behind this impressive adoption of new, safer, more integrated pest management strategies.

What a difference a decade makes. In ten short years, entirely new practices have evolved for dealing with major grape pests. Powdery mildew and cutworm are approached with a completely different set of practices and tools. A new herbicide treatment paradigm now enables growers to deal with suckers, those unwanted shoots that rob fruit-bearing vines of vital nutrients, without costly hand labor.

It takes a true partnership between research and industry to bring about such wholesale change in so short a time. The industry was motivated, and Washington State University Research and Extension answered the challenge.

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the data

In October 2005, a ten-page questionnaire was mailed to grape growers throughout Washington State using confidential mailing lists of the Washington Association of Wine Grape Growers and the Washington State Grape Society. The survey queried growers on the type and severity of their pest problems, their pesticide usage, their use of IPM practices, and their pest management information sources. The result was the first comprehensive survey of chemical and non-chemical pest management practices used by wine and juice grape growers in Washington State.

This report summarizes the data gleaned from our 2005 survey, ranking the arthropod, weed, and disease pests identified by the growers and detailing the pest management strategies they employed. Data from earlier surveys and application records are used to track changes in pest management practices over time.

The data collected in 2005 were compared with and contrasted to data gathered earlier by WSU Extension personnel (Morrell and Schreiber 1998) and by the Washington Agricultural Statistics Service (WASS 2002, 2006). The 1998 WSU Extension publication covered the impact of pesticide use on Pacific Northwest wine and juice grapes using pesticide application records from 1992 to 1994; it did not address cultural practices or IPM adoption. WASS conducts a survey of grape agrichemical usage every two years; however its information is limited to summaries of major pesticide use. It does not separate wine grape and juice grape pesticide usage and, like the 1998 WSU publication, it provides no information on non-chemical pest management practices.

ASSESS REVIEW VERIFY ANALYZE

survey respondents

Washington State ranks as the number 1 state in the nation in the production of Concord and Niagara grapes (juice grapes) and is the number 2 state in wine grape and total grape production. Both the wine grape and the juice grape industries experienced significant economic growth in Washington from 1994 to 2005. Wine grape acreage increased 118%, from 12,862 to 28,000 acres. Juice grape acreage increased 18%, from 22,000 to 26,000 bearing acres. Growers responding to the survey represented production and pest management practices on 3,912.5 acres of Concord grapes, 66.6 acres of Niagara grapes and 6,273.83 acres of wine grapes. This represents approximately 15% of the juice grape acreage and 22% of the wine grape acreage in Washington State.

Growers responded from all appellations of the state at the time of the survey. An appellation, also called an American Viticultural Area (AVA), is defined as a wine grape-growing region distinguished by name, climate, soil, and physical characteristics from other growing regions. In 2005, there were seven AVAs in Washington State: Columbia Gorge, Columbia Valley, Horse Heaven Hills, Puget Sound, Walla Walla Valley, Yakima Valley, and Red Mountain. At this writing there are nine appellations with the recent additions of Rattlesnake Hills and Wahluke Slope. In 1994, there were only four appellations—the Columbia Valley, Yakima Valley, Walla Walla Valley, and Puget Sound. While most of the 2005 survey respondents were from the Yakima Valley (54%), most of the reported wine acreage was in the Horse Heaven Hills area near Paterson (3,939 acres, 63% of reported wine grape acreage). The remainder of the wine grape acreage represented was located mostly in the Columbia Valley (18%), the Walla Walla Valley (9%), and the Yakima Valley (8%), all in eastern Washington. Most of the reported Concord juice grape acreage was located in the Walla Walla Valley in the southeastern part of the state (2,383 acres, 61% of reported Concord grape acreage). The rest of the reported Concord juice grape acreage was located in the Yakima Valley (36%) and the Columbia Valley (3%), with the exception of a small 2-acre parcel west of the Cascades. All of the reported Niagara juice grape acreage was in the Yakima Valley region.

Map and table below show percentage of 2005 survey respondents and respective grape acreage reported within specific American Viticultural Areas (AVAs) in Washington State

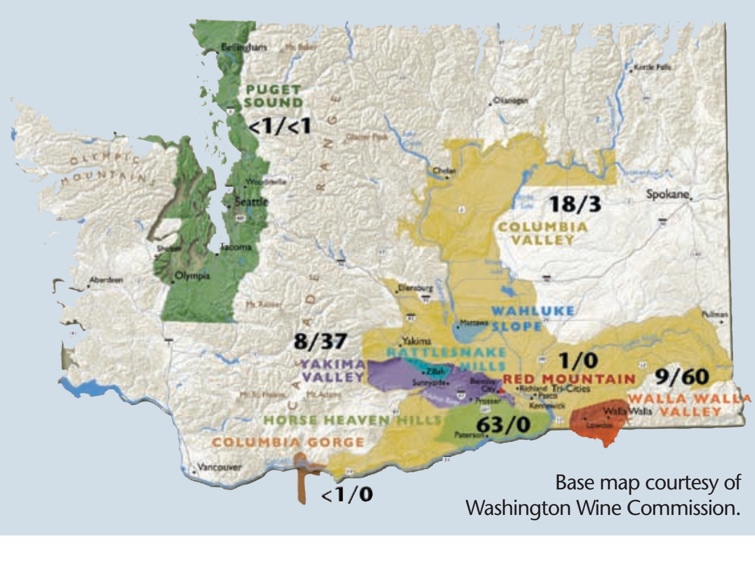
TABLE 1

AVA	%*	Number of Acres: Wine Grapes	Concord Grapes	Niagara Grapes
Columbia Gorge	4	30.00	--	--
Columbia Valley	10	1,127.80	111.80	--
Horse Heaven Hills	7	3,939.00	--	--
Puget Sound	4	15.00	2.00	--
Walla Walla Valley	10	545.90	2,383.00	--
Yakima Valley	54	504.48	1,415.70	66.60
Red Mountain	4	77.00		
Other†	11	33.65		
Total		**6,272.83**	**3,912.50**	**66.60**

* Percentage of survey respondents. Numbers do not add up to 100 because some growers had grapes in more than one AVA.

† North Okanogan, Lake Roosevelt, Lake Chelan, Clark County.

Map shows percentages of reported acreage (wine grape/juice grape) from the various AVAs recognized in 2005. Rattlesnake Hills was not recognized as an AVA until 2006; responses from this region were included in Yakima Valley.



Base map courtesy of Washington Wine Commission.

Drip irrigation, as shown at top, was predominant in wine grapes. Furrow irrigation, shown immediately above, has fallen out of favor for a variety of reasons; it was reported on only 5% of the total grape acreage. Sprinkler irrigation, as shown below, was the most popular method in juice grapes.

production practices

Fifty percent of the survey respondents reported that they were full-time grape growers, and 44% said they maintained part-time farming operations. Twenty-nine percent of the survey respondents described themselves as conventional producers, 10% described themselves as organic producers, and 7% described themselves as being in transition to organic. As a write-in response, 4% said they were practicing sustainable farming.

Growers reported using several methods of irrigation. Most of the reported grape acreage (57%) was irrigated by drip systems. Drip irrigation was predominant in wine grapes. Impact sprinkler irrigation was used on 35% of the total acreage and was the predominant irrigation technique used on juice grapes. Furrow (also known as "rill") irrigation was used on approximately 5% of the total grape acreage. Other methods of irrigation reported included microsprinklers, center pivot systems, and rotator sprinklers.

Although wine grape acreage has increased substantially over the past 10 years, yields per acre have decreased over the same time period. In 1997, the yield for wine grapes was 4.77 tons per acre while in 2005, the state average for tons per acre, according to WASS, had decreased to 3.93. Respondents to our 2005 survey reported a higher average (but still down slightly from the 1997 numbers) of 4.5 tons of wine grapes per acre. The decrease in yield reflects the adoption of deficit irrigation systems that have been documented as improving grape and subsequently wine quality. Winemakers also prefer yields of 3.5 tons/acre or less. Yield from juice grape vineyards can fluctuate substantially among years. In 1996, yields averaged 4 tons per acre and in 2005 record yields of 11.7 tons per acre were documented.

pests

Survey respondents were asked to estimate the severity of the arthropod, weed, and disease pest problems in their vineyards using the following index:

1 = **SEVERE PROBLEM** *limits where grapes can be grown*

2 = **SEVERE PROBLEM** *decreases yield significantly*

3 = **MODERATE PROBLEM** *decreases yield somewhat*

4 = **MINOR PROBLEM** *decreases yield slightly*

5 = **PRESENT** *but not problematic*

6 = **NOT PRESENT** *or unsure if present*

The results of the pest severity ratings are shown in Tables 2-4. In order to standardize the severity ratings, weighted averages were calculated for each pest for wine, Concord, and Niagara grapes separately. To obtain a weighted average, rating scores reported by each grower were multiplied by the fraction their acreage represented of the total acreage of that variety surveyed. These products were totaled to obtain a sum-product of the weighted ratings, which was divided by the proportion of total acreage responding. The number in parentheses adjacent to the rating is the percentage of total acreage within the variety responding to the question. Note that while certain vertebrates (most notably birds, rodents, and deer) are known to be pests in grape vineyards, they were considered beyond the scope of this survey.

The [arthropod] pests with the worst severity ratings were leafhoppers, cutworms, and grape mealybugs.

arthropods/mollusks

Arthropods can directly reduce grape yield by feeding on buds, shoots, or fruit (cutworms, black vine weevil, flea beetles), by sucking on plant juices (leafhoppers, thrips, spider mites, scales), or by feeding on roots (grape phylloxera, root weevils, June beetles). Some arthropods (e.g., grape mealybugs, hornworms, and multicolored Asian lady beetles) and slugs (which are mollusks) are also potential food contaminants of the fruit at harvest.

The grape mealybug problem merits a separate discussion. As a direct pest, grape mealybug is merely a nuisance, creating damage that can contribute to sooty mold on clusters in cases of severe infestations. However, grape mealybug is a documented vector for grapevine leafroll disease, a progressive and untreatable condition resulting from infestation by a topsovirus or complex of topsoviruses. Grapevine leafroll is discussed further in the Diseases section. Mealybugs in leafroll-infected vineyards are treated like a quarantine pest (i.e., a zero-population treatment threshold is observed).

The results of pest severity ratings are shown in Table 2. In wine grapes, cutworms were given the worst rating: 2.8 overall. This indicates that survey respondents perceived that cutworm feeding on buds causes a significant decrease in yield. Mealybugs, leafhoppers, and wireworms were rated of secondary importance at 3.0, 3.1, and 3.6, respectively. Pests of minor importance in wine grapes were flea beetles (4.7) and hornworms (5.3). Pests not considered important to grower respondents were slugs, June beetles, and root weevils. Both thrips and spider mites were rated 4.0, indicating that they are a minor problem when present, but only one (in the case of thrips) or two (in the case of mites) growers indicated their presence.

Concord grape growers reported fewer arthropod problems. The worst severity rating (3.6) was given to leafhoppers, but this rating was compiled from only 6% of the Concord grape acreage representatives. In contrast to their high importance in wine grapes, cutworms were assigned a rating of 4.6, indicating this pest was perceived to be of only minor importance. Pests rated as not important or not present in Concord grapes were flea beetles and June beetles (both 5.3), wireworms (5.8), grape phylloxera (5.9), and hornworms, sage weevils, slugs, and root weevils (all rated 6.0).

The arthropod/mollusk pest problem with the worst severity rating in Niagara grapes was cutworms at 4.7, though this rating indicated that cutworms were a very minor problem for the four Niagara grape growers responding to the survey. Grape mealybugs were rated as a minor problem in Niagara grapes as well. None of the other invertebrate pests in the survey were deemed problematic to the Niagara grape growers.

Overall across varieties, the pests with the worst severity ratings were leafhoppers, cutworms, and grape mealybugs. Pest severity ratings were, on the average, worse in wine grapes, at 4.6, compared with 5.5 for Concord and 5.7 for Niagara grapes. This indicates either that wine grapes are more susceptible to pests of this nature or that damage by chewing and sucking pests is more economically significant in wine grapes, which have less foliage than juice grapes.

TABLE 2

Arthropod/ Mollusk*	Average Severity Rating by Grape Variety (% Variety Acreage Responding)			Overall Rating of Pest
	Wine	Concord	Niagara	
Cutworms	2.8 (99)	4.9 (96)	4.7 (100)	4.1
Grape Mealybugs	3.0 (99)	5.6 (96)	4.9 (100)	4.5
Leafhoppers†	3.1 (14)	3.6 (6)	n.d.	3.4
Wireworms	3.6 (82)	5.8 (89)	5.8 (83)	5.1
Flea Beetles	4.7 (85)	5.3 (88)	6.0 (83)	5.3
Hornworms	5.3 (95)	6.0 (88)	6.0 (83)	5.8
Sage Weevils	5.3 (82)	6.0 (88)	6.0 (83)	5.8
Grape Phylloxera	6.0 (85)	5.9 (88)	6.0 (83)	6.0
Slugs	6.0 (82)	6.0 (88)	6.0 (83)	6.0
June Beetles	6.0 (82)	5.3 (88)	6.0 (83)	5.8
Root Weevils	6.0 (82)	6.0 (88)	6.0 (83)	6.0
Spider Mites†	4.0 (1)	--	--	4.0
Thrips†	4.0 (<1)	2 (4)	2 (9)	--
Overall by Variety	**4.6**	**5.5**	**5.7**	

* Other insects noted by growers were: yellow jackets and multicolored Asian lady beetles.

† Write-in. Spider mites and thrips were rated by one or two growers only.

weeds

Weeds are undesirable in the vineyards. Weeds within the row can interfere with vine growth (particularly in the case of young, establishing vines) by competing for water, sunlight, and nutrients; weeds between rows interfere with vineyard operations and serve as hosts for arthropod and vertebrate pests. But the greatest challenge presented by weeds is that they are harvest contaminants, introducing unwanted material into harvested grapes. Grape growers sometimes call weeds and other contaminants "MOG," short for "Material Other than Grapes."

Weeds were grouped into four broad categories in the survey: perennial broadleaf, perennial grass, annual broadleaf, and annual grass. Results are shown in Table 3. Grapevine suckers were not listed as a weed pest in this section of the survey, although they were cited as an herbicide target by many growers (see Pesticide Usage section, specifically pp. 13, 15, and 18).

Weeds were rated as a more severe pest problem in wine grapes (3.8 overall) than in juice grapes (4.1 and 4.5 for Concord and Niagara, respectively). In general, broadleaf weeds were rated as a more severe problem in vineyards than annual grass weeds. Perennial broadleaf weeds (e.g., dandelion) were given the worst severity rating in wine grapes (3.5), though perennial grass weeds (e.g., Bermudagrass, 3.7) and annual broadleaf weeds (e.g., puncturevine, 3.9), had only slightly less severe ratings. All weed types were rated as minor or moderate pest problems. Annual grass weeds (e.g., barnyardgrass) were rated as a minor pest (4.1) in wine grapes. In Concord grapes, perennial broadleaf weeds received a moderate severity rating (3.9). All other categories of weeds were considered minor problems in Concord grapes. For Niagara grapes, all types of weeds were considered minor problems with little effect on yield. Perennial broadleaf weeds were rated the worst at 4.2.

TABLE 3

Weed Type	Average Severity Rating by Grape Variety (% Variety Acreage Responding)			Overall Rating
	Wine	Concord	Niagara	
Perennial Broadleaf	3.5 (86)	3.9 (96)	4.2 (100)	3.9
Perennial Grass	3.7 (87)	4.3 (97)	5.0 (100)	4.3
Annual Broadleaf	3.9 (98)	4.0 (97)	4.3 (100)	4.1
Annual Grass	4.1 (99)	4.1 (98)	4.4 (100)	4.2
Overall by Variety	**3.8**	**4.1**	**4.5**	

* Specific weeds noted by growers were: dandelion, puncturevine, and Russian thistle.

Weeds can be a harvest contaminant, introducing unwanted "MOG" into harvested grapes.

TABLE 4

Disease	Average Severity Rating by Grape Variety (% Variety Acreage Responding) Wine	Concord	Niagara	Overall Rating
Powdery Mildew	2.9 (100)	5.2 (92)	6.0 (100)	4.7
Grape Leafroll Virus	2.9 (98)	5.9 (94)	6.0 (100)	4.9
Nematode-Related	3.9 (86)	5.9 92)	6.0 (100)	5.3
Crown Gall	4.3 (99)	5.9 (92)	6.0 (100)	5.4
Botrytis	4.4 (98)	5.3 (92)	6.0 (100)	5.2
Eutypa	no data	3.1 (67)	no data	3.1
Overall by Variety	**3.7**	**5.2**	**6.0**	

diseases

Survey respondents were given the opportunity to rate five diseases (Table 4). Additionally, Eutypa dieback was written in by a few Concord grape growers.

Fungal diseases were reported as severe problems in wine grapes but were rarely considered problematic in juice grapes. This is due to a variety of factors including differences in susceptibility between wine and juice grape varieties to both powdery mildew and Botrytis bunch rots. Powdery mildew affects vine growth and yield and is recognized by a white, powdery coating on foliage and berries, along with discoloration, puckering, and distortion of the leaves. Bunch rot fungi affect the berries from flowers infected during a wet spring. The berries split open, allowing the fungal infection to spread to neighboring berries within the bunch. The incurable, virus-caused grapevine leafroll disease causes leaf curl and leaf discoloration. Fruit on infected vines matures more slowly than fruit on non-infected vines, which complicates harvest logistics. Other bacterial and fungal diseases such as crown gall and Eutypa dieback, respectively, can infect and kill parts or all of the vine following severe winters. The infestation of the majority of vines by the crown gall bacterium drives vineyard retraining decisions following a severe winter.

In wine grapes, powdery mildew and grape leafroll virus were deemed to be the most problematic diseases (2.9); they were considered severe problems by almost all of the respondents. Nematode-related diseases were considered a moderate problem in wine grapes (3.9), while both crown gall and Botrytis bunch rot were noted to be minor problems (4.3 and 4.4, respectively). However, it should be noted that crown gall would perhaps be considered a far more serious problem had this survey taken place following a severe winter. While powdery mildew is perhaps the most manageable disease of grapevines, the costs associated with management represent a significant and perennial fixed input cost.

As previously noted, diseases were less of an issue in juice grapes; the worst severity rating was given to Eutypa dieback (3.1) in Concord grapes (which was written in by 67% of the responding acreage). Other diseases were present but not reported as problematic. One grower indicated that black leaf (a physiological condition, not a disease) was a minor problem in Concord grapes (4). Black leaf is caused by a combination of water stress and overexposure to UVB radiation. No significant problems with disease were indicated by the Niagara grape growers surveyed.

integrated pest management

Pesticide usage is just one small part of the pest management story. By including questions on IPM practices, our 2005 survey gave a more comprehensive picture of the full spectrum of pest management activities employed by our state's wine and juice grape growers.

Previous grape grower pest management practices surveys in Washington State had focused primarily on pesticide usage. In developing and administering this survey we felt that it was important to gather data on the utilization of integrated pest management (IPM) in the vineyards. The survey results indicate widespread awareness and adoption of a range of IPM practices. Results of this part of the survey are summarized in Table 5.

When queried regarding the frequency of certain non-chemical control methods, most growers responded that they often or sometimes employed scouting, mechanical control of weeds, reduced pesticide rates, and economic thresholds (80%, 70%, 60%, and 54%, respectively). Augmentative biological control (i.e., intentional introduction/addition of biocontrol agents to the vineyard ecosystem) was used often or sometimes by a third of the grower respondents. (The survey is not representative of growers that practice passive conservation biological control, i.e., the use of pest control practices designed to avoid injury to beneficial organisms.) More than half

TABLE 5

IPM Practice Utilized[†]	Percent of Growers with Response*			
	Often	Sometimes	Seldom	Never
Field Monitoring (Scouting)	**59**	21	9	6
Mechanical Control of Weeds	**51**	19	9	14
Reduced Pesticide Rates	24	**36**	7	17
Economic Thresholds	23	**31**	7	20
Biological Control	14	17	11	**39**
Integrated Mite Management	7	11	3	**61**
Crop Rotation for Disease Control	3	1	10	**67**

* For these questions, % non-responders ranged from 6 to 19% of the total surveys returned.

[†] Other IPM practices noted were canopy management and heat unit modeling.

of the growers reported never using integrated mite management or crop rotation for disease control (61 and 67%, respectively); this was expected as mites are not a key direct pest in grapes and crop rotation is impractical in perennial vineyard systems.

Wine grape growers frequently employ a variety of techniques designed to increase light and air movement in the canopy. These include cordon suckering, shoot removal, and leafing (strategic removal of some leaves). The resulting openness of the canopy can aid in reduction of rot, mildew, and some leafhopper pressures.

Scouting or monitoring of pests is a keystone of IPM. To gain additional knowledge about scouting practices, we queried grape growers further about the targets and frequency of their scouting practices. The results were better than even the most optimistic IPM advocate could have hoped for. Nearly all of the reported grape acreage was scouted at least once a month, over all varieties. According to the survey respondents, 89% of the wine grape vineyards were scouted 3 to 4 times a month (Table 6). Juice grape vineyards were scouted for pests less frequently, with the vast majority of respondents reporting one to two times per month on average. We speculate that this is a reflection of the relative severity of pest issues between wine and juice grapes.

Some pests were monitored more frequently than others (Table 7). In wine grapes, most growers, and those accounting for the vast majority of the reported acreage, monitored for cutworms and mealybugs, and more than half of the wine grape acreage was monitored for mites, wireworms, and flea beetles. Smaller percentages of wine grape growers monitored for leafhoppers (27%), hornworms (7%), and thrips (9%). More than half of the Concord grape growers monitored for cutworm strikes (65%) and nearly half of them monitored for mealybugs (46%). Smaller

TABLE 6

Grape Type	% Variety Acreage Scouted			
	0*	1-2*	3-4*	>4*
Wine Grapes	0.2	9	**89**	2
Concord Grapes	0.5	**83**	6	6
Niagara Grapes	0	**100**	0	0

* Number of times per month

TABLE 7

Pest Type	% Variety Acreage Monitored (% Variety Respondents Monitoring)		
Arthropod/Mollusk	Wine Grapes	Concord Grapes	Niagara Grapes
Cutworms	98 (73)	34 (65)	100 (80)
Mealybugs	96 (57)	30 (46)	85 (60)
Mites	71 (14)	0 (0)	0 (0)
Wireworms	66 (16)	13 (19)	59 (20)
Flea Beetles	61 (14)	3 (4)	0 (0)
Leafhoppers	19 (27)	9 (15)	9 (20)
Hornworms	16 (7)	0 (0)	0 (0)
Thrips	3 (9)	4 (4)	9 (20)
Grape Phylloxera	0.3 (9)	0.2 (4)	0 (0)
Slugs	0.0 (2)	0.1 (4)	0 (0)
June Beetles	0.1 (4)	0 (0)	0 (0)
Sage Weevil	0.0 (2)	0 (0)	0 (0)
Strawberry Weevil	0.0 (2)	0 (0)	0 (0)
Weed			
Annual Broadleaf	97 (75)	95 (69)	100 (80)
Annual Grass	83 (54)	91 (58)	100 (80)
Perennial Broadleaf	80 (59)	90 (54)	100 (80)
Perennial Grass	71 (50)	84 (46)	83 (60)
Disease			
Powdery Mildew	99 (95)	20 (35)	76 (40)
Botrytis	76 (57)	12 (19)	76 (40)
Crown Gall	72 (36)	8 (12)	17 (20)
Leafroll Virus	86 (34)	11 (19)	17 (20)
Nematode-Related	59 (9)	3 (4)	0 (0)

percentages monitored for wireworms (19%) and leafhoppers (15%). While only five Niagara grape growers participated in the survey, most were actively scouting their vineyards for key pests such as cutworms (100% of reported acreage) and mealybugs (85% of the acreage).

Weeds were a major concern in all vineyards (Table 7). Nearly all of the grape acreage reported in the survey was monitored for all types of weeds. Annual broadleaf weeds were cited more frequently for each grape variety, followed by annual grasses, followed by perennial broadleaf weeds, followed by perennial grasses.

According to the respondents, the disease that was most frequently monitored was powdery mildew, with 99% of the wine grape acreage scouted for this common disease. Other diseases that were commonly monitored in were grapevine leafroll, 86% of wine grape acreage; Botrytis bunch rot, 76%; crown gall, 72%; and nematode-related diseases, 59%. Juice grapes were monitored less frequently, as diseases are less problematic. Thirty-five percent of the Concord grape growers and 40% of the Niagara grape growers monitored for powdery mildew. Botrytis bunch rot was monitored at a similar frequency in Niagara grapes (40% of the growers), though only 19% of the Concord grape growers looked for symptoms and signs of this disease. Low percentages of juice grape acreage were monitored for crown gall, leafroll virus, and nematode-related diseases. Eutypa dieback was written in by two of the Concord grape growers as a disease for which they scouted.

information sources

Where do these growers—these models of IPM adoption—get their pest management information? Not surprisingly, they put the most stock in their own experience. But most pay close attention to Extension, their fellow growers, university publications, and other information sources as well.

Growers were surveyed on the relative importance of various information sources in making pest management decisions. They were asked to rate specific sources as very important, somewhat important, or not important. The results are summarized in Table 8. Growers surveyed responded that the most important information source was their own experience (84%). Other important sources of pest management information included university Extension, fellow growers, and university pest management guides; these were ranked somewhat to very important by 80%, 85%, and 80% of the respondents, respectively. Next in importance were chemical firm representatives and private consultants, ranked as somewhat to very important by 75% and 56% of the respondents, respectively. The least important source reported was corporate scientists; 47% of the respondents rated this source as not important. (This may reflect a perceived lack of access to information from this source, as information generated by corporate scientists likely reaches growers through other channels.) Other information sources deemed very important were: past work associates, winery representatives, WAWGG (the Washington Association of Wine Grape Growers), industry journals, and vineyard supply technical staff.

TABLE 8

Information Source	% of growers with response: Very Important	Somewhat Important	Not Important
Own Experience	84	11	1
University Extension	39	41	7
Other Growers	36	49	7
Private Consultant	33	23	29
Chemical Firm Representative	31	44	17
University Pest Mgmt Guides	30	50	9
Corporate Scientist	3	34	47

Non-response rates ranged from 3 to 16% for these queries.

pesticide usage

Washington State grape growers are making fewer pesticide applications today than in years past. An overwhelming majority of growers responding to the 2005 survey reported that their use of pesticides on grapes had either stayed the same (60%) or decreased (24.3%) over the past five years. A small percentage of the respondents stated that they did not use pesticides (4.3%). The remaining growers responding to this question reported that their pesticide usage had increased (5.7%). It is worth noting that these responses are indicative only of the *number* of pesticide applications. They do not take into consideration pesticide application rates (that may have reduced or increased) nor the fact that some applications are of newer, reduced-risk alternative pesticides.

Two sections follow. The first details the pesticide applications reported by survey respondents; it is organized by crop growth stage. The second section estimates pesticide use statewide by extrapolation, using multipliers that reflect reported acreage as a percentage of overall acreage of that type. The latter section (p. 21) is organized by pesticide type (i.e., insecticide/miticide, herbicide, fungicide).

...by crop growth stage

Growers were asked about their pesticide use in 2005, including dates applied, application methods, number of acres treated, spray volume per acre, target pests, pesticide used, and rate per acre. Summary tables of all pesticides reported by respondents appear in the Appendix, pages 31–32. Both treated and base acres were determined for each pesticide. Treated acres are the reported data and base acres were calculated by dividing the number of treated acres by the number of treatments a block of grapes had received with the same pesticide.

This section is organized by the various stages of vine and fruit development as follows: delayed dormant/bud break (mid-February through April); rapid shoot growth (May); bloom to veraison (June, July); and veraison (August, early September). The timing of these stages is based on the 2005 season in the WSU foundation block at the Irrigated Agriculture Research & Extension Center (IAREC) in Prosser. No pesticide applications were reported during the harvest (mid-September through October) and post-harvest/dormant (November through mid-February) periods. Within each crop stage discussed, pesticide applications are grouped by target pest.

Pesticide rates in this section generally refer to amount of formulated product per acre. Percentages refer to percent base acres treated of all variety acreage reported. Rates are given when data were available.

DELAYED DORMANT AND BUD BREAK PERIOD

Insecticides/miticides employed at this time are intended to control overwintering insect and mite pests coming out of diapause before they enter the buds and cause damage. Grapevine suckers and winter annual weeds are common herbicide targets during the early spring. If the spring is unusually wet, treatment for powdery mildew and other diseases may occur during this time period.

CUTWORMS

Chlorpyrifos (Lorsban®) Two growers reported using Lorsban® at 1.5 pints per acre (pts/A). Thirty-five acres of wine grapes (<1%) were treated prior to bud break.

Fenpropathrin (Danitol®) A barrier spray (i.e., spray directed at the base of the vine and trellis where they touch the soil) of fenpropathrin was applied to 3,344.1 wine grape acres (53%) to prevent cutworms from climbing to feed on buds. The average application rate was 10 fluid ounces per acre (fl oz/A).

Petroleum oil (Superior Spray Oil®) Superior Oil was applied to 31.5 wine grape acres (<1%) by one grower at a 1% rate.

LEAFHOPPERS

Dimethoate (unspecified formulation) One juice grape grower with 75 acres (2%) used dimethoate at 1 pt/A.

GRAPEVINE SUCKERS

Paraquat (Gramoxone®) A total of 33.69 wine grape acres (<1%) was treated with a band application of Gramoxone® at 1.7 pts/A.

WEEDS

Carfentrazone-ethyl (Aim®) A few acres of wine grapes (12.8 acres, <1%) were sprayed with Aim® at 1.15 ounces per acre (oz/A).

Glyphosate (Roundup®, others) Juice grapes (1,427.4 base acres or 36%) and wine grapes (2,495.8 base acres or 40%) were treated with glyphosate, primarily to control winter annuals (one grower reported using this chemical to kill a cover crop). Allowing for multiple applications, 1,429.4 juice grape acres and 3,338.2 wine grape acres were treated with glyphosate. While 1.27 quarts per acre (qts/A) was the rate on juice grapes, 1.9 qts/A was the average rate on wine grapes. During this crop period, one Concord grape grower sprayed twice, while the other 8 sprayed only once; likewise 3 out of 14 wine grape growers sprayed twice, making the average number of applications 1.1 and 1.15, respectively.

Norflurazon (Solicam®) Concord grapes (953 acres or 24%) and wine grapes (2.7 acres or <1%) were treated with Solicam® at 1 to 2 pounds per acre (lbs/A).

Oryzalin (Surflan®) A small number of wine grape (19.6 or <1%) and Concord grape (180 or 5%) acres were treated with Surflan®. The average rate on wine grapes was 3.4 qts/A and on Concords, 1.2 qts/A.

Oxyfluorfen (Goal®) Goal® was applied to weeds on 94.94 acres or 2% of wine grapes during this early spring period.

Paraquat (Gramoxone Max®, Gramoxone Inteon®) Less than 1% of wine grapes (20.18 acres) and Concord grapes (2 acres) were treated with a Gramoxone® product at this time, at an average rate of 2.8 pts/A on wine grapes and 2.2 pts/A on Concord grapes.

Simazine (unspecified formulation) Applications of Simazine occurred only during this early spring time period. There were 85.3 (1%) wine grape acres and 953 (24%) Concord grape acres treated at an average rate of 2 qts/A and 0.4 qt/A, respectively.

2,4-D One application of 2,4-D was performed at a rate of 1.5 lbs/A on 3.6 wine grape acres (<1%). This was the only 2,4-D application reported. Wine grapes are very sensitive to 2,4-D, so growers are inclined to choose other products for weed control in the vineyards.

POWDERY MILDEW

Fenarimol (Rubigan®) A few acres (10, <1%) of wine grapes were sprayed twice with Rubigan® during this time. A low rate (2 fl oz/A) was used.

Kresoxim-methyl (Sovran®) A few acres (25, <1%) of wine grapes were treated with Sovran®. A low rate of 4 oz/A was used.

Quinoxyfen (Quintec®) Only five wine grape acres were treated with Quintec® this time of year at a rate of 4 oz/A.

Paraffinic oils (JMS Stylet Oil®, others) Both regular JMS Stylet Oil® and organic JMS Stylet Oil® were applied during the early spring period. A total of 1,144.5 wine grape acres (18%) were treated 1.5 times with JMS Stylet Oil® at a 1.6% rate. One grower reported using organic JMS Stylet Oil® on 114.9 wine grape acres (2%) 1.2 times, using a 1% rate. In addition, an unspecified paraffinic oil was applied to a small block of 14 wine grape acres at a rate of 1.5%.

Sulfur products (Microthiol®, lime sulfur, Kumulus®, sulfur dust, others) Applications of all solid sulfur formulations were grouped together for analysis; liquid lime sulfur applications were analyzed separately. During the early spring period, 929.2 wine grape acres (15%) were treated with wettable sulfur or sulfur dust. Some blocks were treated more than once for an average of 1.03 applications at rates ranging from 4.3 lbs/A (92-98% products) to 5.7 lbs/A (80% products). Lime sulfur solution was used by two of the reporting growers on 16 wine grape acres (<1%).

Tebuconazole (Elite®) One block of 31.5 wine grape acres (<1%) was sprayed with Elite® at 4 oz/A.

UNSPECIFIED TARGET

Metam-sodium (Vapam®) Two wine grape acres (<1%) were fumigated with Vapam® during this early spring period at a rate of 50 gallons per acre (gal/A). The target was unspecified.



RAPID SHOOT GROWTH PERIOD

Pesticides are employed at this late springtime period to control early insect pests (thrips, leafhoppers, mealybugs), grapevine suckers, perennial and winter annual weeds, and diseases (powdery mildew, Botrytis bunch rot).

THRIPS, LEAFHOPPERS, MEALYBUGS

Carbaryl (Sevin®) Only five wine grape acres (<1%) were sprayed with carbaryl at an unspecified rate to control thrips.

Dimethoate (unspecified formulation) Two juice grape growers with 332 acres (8%) and two wine grape growers with 54.5 acres (<1%) reported using dimethoate at 0.8 to 1 pt/A to control leafhoppers and thrips. Of the wine grape acreage, 31.5 acres were treated twice.

Fenpropathrin (Danitol®) A foliar spray of 5.5 fl oz/A fenpropathrin was applied to 26 wine grape acres (<1%) to control thrips.

Imidacloprid (Admire®) This insecticide is generally applied via chemigation to control mealybugs and leafhoppers. Three growers had mealybugs to control on 110 wine grape acres (2%) and an average rate of 1 pt/A was used.

Imidacloprid (Provado®) This formulation is applied as a foliar spray to control mealybugs and leafhoppers. At this crop stage, 171 wine grape acres (3%) were sprayed at an average rate of 0.6 oz/A.

Spinosad (Success®) One grower used Success® on 193 acres (3%) of wine grapes at 6 oz/A to control thrips.

GRAPEVINE SUCKERS

Carfentrazone-ethyl (Aim®) A few blocks of wine grapes (141.5 acres, 2%) were sprayed with the herbicide Aim® specifically for sucker control. The rate per acre was generally 0.1 oz.

Paraquat (Gramoxone®) Gramoxone® was used at 2.1 pts/A in a band application on 101.68 acres (2%).

Oxyfluorfen (Goal®) Goal® was applied to 86.5 acres (1%) of wine grapes at a low average rate of 0.7 pt/A.

WEEDS

Carfentrazone-ethyl (Aim®) A small block of Concord grapes (17 acres, <1%), and a few blocks of wine grapes (346 acres, 6%) were sprayed with Aim® at 0.1 oz/A or with Aim® EW at 1 fl oz/A. Some blocks were treated more than once in a band application.

Diuron (unspecified formulation) Diuron use was reported only during the rapid shoot growth period. Fewer than 1% of Concord grape acres (17) were treated, at a rate of 2 lbs/A.

Glyphosate (Roundup®, others) Juice grapes (268.5 acres or 7%) and wine grapes (363.6 acres or 6%) were treated with glyphosate at average rates of 1.3 qts/A for Concord grapes and 1.9 qts/A for wine grapes.

Norflurazon (Solicam®) Fewer than 1% of Concord grape acres (17) were treated with the herbicide Solicam®, at a rate of 2.5 lbs/A.

Oryzalin (Surflan®) Nine wine grape acres (<1%) were treated with Surflan® at an average rate of 5 qts/A.

Paraquat (Gramoxone®) Commonly used during this late spring period in wine grapes (966.15 base treated acres or 15%), Gramoxone® was applied at an average rate of 2.5 pts/A. A few blocks of wine grapes were sprayed twice. Fewer than 1% of Concord grapes were also sprayed (8.8 acres) at 2.2 pts/A.

Sethoxydim (Poast®) The herbicide Poast® was utilized on a few Concord grape acres (6.8 or <1%). The rate used was 1.25 pts/A.

POWDERY MILDEW, BOTRYTIS BUNCH ROT

Boscalid + pyraclostrobin (Pristine®) Not a widely known fungicide, Pristine® was applied only to two acres, two times, to control both powdery mildew and Botrytis bunch rot. The rate was low, 9.2 oz/A.

Fenarimol (Rubigan®) A large percentage of wine grape acres (3,172.95 or 51%) was sprayed with Rubigan® an average of 1.2 times during late spring. On the average, a moderate rate (3.4 fl oz/A) was used. This product is popular more for its low cost than its superior efficacy.

Myclobutanil (Rally®) Wine grapes (86.5 acres or 1%) were treated with Rally® during the late spring at an average rate of 4.5 oz/A.

Potassium bicarbonate products (Kaligreen®) A few wine grape acres (3.25 or <1%) were treated with Kaligreen® with two acres sprayed twice during May. The rate was 2.3 lbs/A.

Quinoxyfen (Quintec®) Only two wine grape acres (<1%) were treated with Quintec® this time of year at the maximum rate of 6.6 fl oz/A.

Paraffinic oils (JMS Stylet Oil®, others) Both regular JMS Stylet Oil® and organic JMS Stylet Oil® were applied during the late spring period. There were 2,837.2 wine grape acres (45%) treated 1.3 times with JMS Stylet Oil® at a 1.6% dilution. One grower reported using organic JMS Stylet Oil® on 602.01 wine grape acres (10%), 1.5 times, at a 0.9% dilution rate. In addition, Omni® oil was applied to 130.89 wine grape acres (2%), 1.7 times, at a 0.9% dilution rate.

Sulfur products (Microthiol®, Kumulus®, others) During the late spring period, 1,142.84 wine grape acres (18%) were treated with micronized wettable sulfur products. Some blocks were treated more than once; an average of 1.8 applications were made during this period at a rate of 3.9 lbs/A.

Trifloxystrobin (Flint®) One quarter of the reported wine grape acres were sprayed with Flint® during late spring (1,555.51 or 25%), and a few acres were sprayed more than once. The average rate was 2 oz/A.

Triflumizole (Procure®) Procure® was used on 1,723.9 acres of wine grapes (27%) in late spring. The average rate was 4.3 oz/A. Fourteen acres were sprayed twice.

This section details the actual pesticide applications reported by survey respondents; it is organized by crop growth stage: delayed dormant/bud break, p. 13; rapid shoot growth, p. 15; bloom to veraison, p. 17; and veraison, p. 20.

The section beginning on p. 21 estimates pesticide use statewide by extrapolation of survey data by grape type. The statewide estimate section is organized by pesticide type (i.e., insecticide/miticide, herbicide, fungicide).

BLOOM TO VERAISON PERIOD

These pesticide applications were implemented during the period beginning just before bloom and continuing through fruit development to veraison (i.e., ripening). Generally, these sprays occurred during June and July, with some occurring in early August. Summertime was when the greatest pesticide use occurred. Common targets were spider mites, leafhoppers, mealybugs, thrips, weeds, powdery mildew, and Botrytis bunch rot.

SPIDER MITES

Bifenazate (Acramite®) A total of 420.96 wine grape acres (7%) were treated with Acramite® during the summer at a rate of 0.76 lbs product/A.

Fenpyroximate (FujiMite®) Fourteen wine grape acres (<1%) were treated with Fujimite® during the summer at a rate of 1 qt/A.

Potassium laurate (M-Pede®) A single grower treated eight wine grape acres (<1%) with M-Pede® with two targets: spider mites and powdery mildew. The rate was 1%. More acres were treated with M-Pede® for powdery mildew alone, and this use is reported on the next page, under the heading "Powdery Mildew/ Botrytis Bunch Rot."

Propargite (Omite®) One wine grape grower with 33.01 acres (<1%) used Omite® at a rate of 5.6 lbs/A.

THRIPS, LEAFHOPPERS, MEALYBUGS

Acetamiprid (Assail®) A total of 96.5 wine grape acres (2%) was treated with Assail® to control leafhoppers. The average rate was low at 0.8 oz/A.

Azadirachtin (Aza-Direct®) One wine grape grower used Aza-Direct® to control leafhoppers on 406.83 acres (6%) at an average rate of 1.7 pts/A. An average of 1.3 applications was made to this acreage during the summer.

Buprofezin (Applaud®) Two wine grape growers utilized Applaud® (138.68 acres or 2%) to control leafhoppers and mealybugs at a rate of 11 oz/A.

Carbaryl (Sevin®) A total of 58.13 base wine grape acres (1%) were sprayed with carbaryl to control leafhoppers at 1.25 qts/A. Four acres were sprayed twice during the summer.

Dimethoate (unspecified formulation) One wine grape grower with 3.6 acres (<1%) reported using dimethoate at 1 pt/A to control leafhoppers.

Dinotefuran (Venom®) A few wine grape acres (31.5 or <1%) were sprayed with this new insecticide to control unspecified insects. The rate was 1.1 lb/A.

Fenpropathrin (Danitol®) A foliar spray of 5.6 fl oz/A was applied to 26 wine grape acres (<1%) to control leafhoppers.

Imidacloprid (Admire®) This insecticide is generally applied via chemigation to control mealybugs and leafhoppers. Three growers had mealybugs to control on 77.58 wine grape acres (1%) and used a low rate of 8.3 oz/A.

Imidacloprid (Provado®) This formulation of imidacloprid is applied as a foliar spray. Most commonly, leafhoppers were the target, though mealybugs, thrips, and flea beetles were targeted by some growers. There were 1,727.52 wine grape acres (32%) treated at an average rate of 0.8 oz/A. Some acres (32.25) were treated twice. There were 156 juice grape acres (4%) sprayed with Provado® at a rate of 0.5 oz/A.

Spinosad (Success®) A few wine grape acres (8.68 or <1%) were sprayed with 7.4 oz/A of Success® against an unspecified target insect.

GRAPEVINE SUCKERS

Carfentrazone-ethyl (Aim®): A few blocks of wine grapes (108 acres or 2%) were sprayed with the herbicide Aim® to control suckers. The rate per acre was either 0.1 oz of Aim® or 1 oz of Aim® EW.

Oxyfluorfen (Goal®) Goal® was applied to a few wine grapevines during the summer to control suckers. A total of 53 acres (<1%) received Goal® at a low average rate of 0.8 pt/A.

Paraquat (Gramoxone®) Gramoxone® was applied to suckers in 55 acres of wine grapes (<1%) at a rate of 2 pts/A.

WEEDS

Carfentrazone-ethyl (Aim®) A small block of Concord grapes (20.5 acres or <1%) and several blocks of wine grapes (325.9 acres or 5%) were sprayed with the herbicide Aim®. The rate per acre was either 0.1 oz of Aim® or 1 oz of Aim® EW and 5.85 wine grape acres were treated twice.

Glyphosate (Roundup®, others) Concord grapes (1,376 acres or 35%) and wine grapes (440.28 or 7%) were treated with glyphosate. The Concord grape acreage was sprayed an average 1.5 times and the wine grapes an average 1.03 times. An average rate of 1.6 qts/A for Concord grapes and 1.8 qts/A for wine grapes was used.

Oryzalin (Surflan®) Two Concord grape acres (<1%) were treated with Surflan® at a rate of 1.9 qts/A.

Paraquat (Gramoxone®) Gramoxone® was sprayed in wine grapes (1,139.8 base treated acres or 18%) at an average rate of 1.8 pts/A. There were 1.3 applications made in this wine grape acreage. Concord grapes were sprayed as well (287.3 acres or 7%), at 2 pts/A.

Sethoxydim (Poast®) The herbicide Poast® was utilized on a few Concord grape acres (6.8 or <1%) at 1 pt/A.

POWDERY MILDEW, BOTRYTIS BUNCH ROT

Azoxystrobin (Abound®) One wine grape grower used Abound® on 25.08 acres at a rate of 11.8 fl oz/A.

***Bacillus subtilis* (Serenade®)** This biopesticide was sprayed on 8.65 wine grape acres at or near the maximum rate. Of this acreage, 2.5 acres were sprayed twice more. The primary target was powdery mildew, although one grower targeted bunch rot as well.

Boscalid + pyraclostrobin (Pristine®) Pristine® was applied to 483.2 wine grape acres (8%) an average 1.4 times to control both powdery mildew and Botrytis bunch rot. The rate was low, at 9.4 oz/A.

Cyprodinil (Vangard®) Vangard® was only used during the summertime on 254.78 wine grape acres (4%) at an average rate of 9.1 oz/A. Six acres were treated twice with Vangard®.

Fenarimol (Rubigan®) Eight percent of wine grape acres (471.68) were sprayed with Rubigan® an average of 1.7 times during the summer. On the average, a moderate rate (4.1 fl. oz/A) was used.

Fenhexamid (Elevate®) Elevate® was only used during the summertime on 221.21 wine grape acres (4%); 21 of those acres were treated twice.

Kresoxim-methyl (Sovran®) There were 821.6 wine grape acres (13%) treated with Sovran® during the summer at a rate of 5.2 oz/A.

Myclobutanil (Rally®) Four percent of wine grape acres (235.08) were treated with Rally® an average of 1.4 times at a rate of 4.5 oz/A during the summertime bloom through veraison period.

Paraffinic oils (JMS Stylet Oil®, others) Both regular JMS Stylet Oil® and organic JMS Stylet Oil® were applied during the summertime. A total of 930.58 wine grape acres (15%) were treated an average two times with JMS Stylet Oil® at a 1.3% dilution. One grower reported using organic JMS Stylet Oil® on 667.17 wine grape acres (11%), 1.2 times, at a 1.1% dilution rate. In addition, Omni® Oil was applied to 56 wine grape acres (<1%), at a 1% dilution rate.

Potassium bicarbonate products (Kaligreen®, Milstop®) A few wine grape acres were treated with Kaligreen® or Milstop® (121.72 or 2%). An average of 2.2 applications were made during the summer and the rate was 3 lbs/A.

Potassium laurate (M-Pede®) Of the 49.75 wine grape acres (<1%) treated with M-Pede® at the maximum labeled rate, 40 acres were treated twice.

Pyrimethanil (Scala®) Scala® was applied only during the summertime on 42.5 wine grape acres, with four acres treated twice.

Quinoxyfen (Quintec®) The greatest number of Quintec® applications occurred during the summertime. A total of 2,603.89 wine grape acres (42%) were treated with an average of 4.5 fl oz/A. There were 26.42 acres sprayed twice.

Sulfur products (Microthiol®, Kumulus®, others) During the summertime, 970.85 wine grape acres (15%) were treated with micronized wettable sulfur products. Some blocks were treated more than once; there were approximately 2.3 applications made at a rate of 3.3 lbs/A.

Tebuconazole (Elite®) Sixty-two acres of wine grapes (<1%) were treated with Elite® during the summertime.

Triadimefon (Bayleton®) A few wine grape acres (5.88 or <1%) were treated with Bayleton® at 4.1 oz/A.

Trifloxystrobin (Flint®) Nearly 3,000 of the reported wine grape acres were sprayed with Flint® during the summer (2,833.02 or 45%), with some acreage sprayed more than once. The average rate was 2 oz/A.

Triflumizole (Procure®) Procure® was used an average of 1.4 times during the summer on 1,369.66 base acres (22%) of wine grapes. The average rate was 6.1 oz/A.

Summertime—bloom through veraison—is when the greatest amount of pesticide use occurs.

VERAISON PERIOD

Veraison is defined as when the grape berries begin to ripen and change in color, consistency, volume, weight, and sugar content. In most grape-growing regions of Washington, veraison typically begins in early- to mid-August. Very few pesticide applications were performed during this time because of the imminence of harvest.

LEAFHOPPERS

Imidacloprid (Provado®) Growers used Provado® on 5.5 wine grape acres (<1%) at a rate of 0.75 oz/A during the veraison period. This formulation of imidacloprid is applied as a foliar spray.

WEEDS

Glyphosate (Roundup®, others) A few Concord grape acres (8 or <1%) and a few wine grape acres (8 or <1%) were treated with glyphosate during the early fall prior to harvest at an average rate of 1.2 qts/A for Concord grapes and an unspecified rate for wine grapes.

POWDERY MILDEW, BOTRYTIS BUNCH ROT

Bacillus subtilis **(Serenade®)** This biopesticide was sprayed on 60.27 wine grape acres at the maximum labeled rate. Serenade® can be applied to fruit up to and including the day of harvest.

Fenarimol (Rubigan®) Ten wine grape acres (<1%) were sprayed with Rubigan® at a low (2 fl oz/A) rate.

Potassium bicarbonate products (Kaligreen®) Three wine grape acres were treated with Kaligreen® (<1%) at 3 lbs/A just prior to harvest.

Sulfur products (Microthiol®, Kumulus®, others) Three wine grape acres were treated with micronized sulfur during veraison at 3 lbs/A.

Thiophanate-methyl (Topsin®) This is the only time period in which Topsin® was used. Twelve wine grape acres were treated at 1 lb/A.

Triflumizole (Procure®) Seven acres were reported to be treated with Procure® at 8 oz/A.

pesticide usage

...statewide estimates

The data gathered from the surveys were assumed to be representative of the entire state. Utilizing multipliers reflective of the acreage reported in relationship to state totals, statewide estimates were calculated for the following: base and percent acres treated, application rate (in pounds of active ingredient per acre unless stated otherwise), number of applications per year, and total pounds active ingredient applied per year. These state estimates are reported in the next few pages. The pounds active ingredient per year were divided by the total base acres treated to get an index number to facilitate the comparison of pesticide use in 2005 with that of 1992–1994. Information on pesticide registrations was obtained from the databases of Washington State Pest Management Resource Services, http://wsprs.wsu.edu, which include the Pesticide Information Center Online (PICOL) and the Pesticide Notification Network (PNN).

The preceding section, pages 12 through 20, detailed the actual pesticide applications reported by 2005 survey respondents.

This section estimates pesticide use statewide and compares the figures to previous data.

insecticides/miticides

Grower-respondents reported using 13 insecticides and three miticides in Washington vineyards during 2005 (Table 9). The most used insecticide was fenpropathrin (Danitol®). We estimate that just over 15,000 wine grape acres were treated with fenpropathrin, almost exclusively for cutworm control. An estimated 2,884 lbs of fenpropathrin were applied in Washington State vineyards in 2005. The foliar formulation of imidacloprid, Provado®, which was second most used, was applied to 8,405 wine grape acres and 1,020 juice grape acres in 2005. This represents 377 lbs of imidacloprid applied. The third most commonly used insecticide was dimethoate. Dimethoate was reported almost exclusively from juice grape vineyards; it was applied to 2,660 juice grape acres and 259 wine grape acres. This represents 1,477 lbs of dimethoate applied in 2005. The fourth most utilized insecticide was azadirachtin, a neem oil derivative that acts as a biological antifeedant, repellant, and insect growth regulator. In 2005, 49 lbs of azadirachtin were applied to 1,816 acres of wine grapes. Bifenazate (Acramite®) was the most used miticide with 714 lbs applied to 1,879 wine grape acres in 2005.

TABLE 9

Insecticide/ Miticide	Variety	State Estimates 2005: Base acres treated (% total)	Avg rate (lb ai/ acre)	Apps/ yr	Total lb ai/ yr	State Estimates Averaged 1992-1994*: Base acres treated (% total)	Avg rate (lb ai/ acre)	Apps/ yr	Total lb ai/ yr
fenpropathrin (Danitol®)	wine	15,045 (54)	0.17	1.1	2,884		not registered		
imidacloprid (Provado®)	wine	8,405 (30)	0.04	1.1	353		no data		
	juice	1,020 (4)	0.02	1.0	24				
dimethoate (various)	wine	259 (<1)	0.43	1.3	147	4,833 (38)	1.30	1.0	6,283
	juice	2,660 (10)	0.50	1.0	1,330	329 (1)	1.30	1.0	428
bifenazate (Acramite®)	wine	1,879 (7)	0.38	1.0	714		not registered		
azadirachtin (Aza-Direct®)	wine	1,816 (6)	0.02	1.3	49		no data		
spinosad (Success®)	wine	900 (3)	0.10	1.0	94		not registered		
buprofezin (Applaud®)	wine	619 (2)	0.48	1.0	298		not registered		
imidacloprid (Admire®)	wine	525 (2)	0.19	1.5	149		not registered		
acetamiprid (Assail®)	wine	431 (1.5)	0.04	1.0	15		not registered		
carbaryl (Sevin®)	wine	282 (1)	1.25	1.3	440	1,660 (13)	2.00	1.0	3,320
	juice		no data			113 (<1)	2.00	1.0	226
chlorpyrifos (Lorsban®)	wine	156 (<1)	0.75	1.0	117	1,314 (10)	1.00	1.0	1,314
	juice		no data			1,073 (5)	1.00	1.0	1,073
Other†	wine	527 (2)	not applicable			762 (6)		no data	
	juice		no data			875 (4)		no data	
Other from 1994§	wine		not applicable			2,694 (21)	varied	varied	3,446
	juice		not applicable			625 (3)	varied	varied	600

* From Morrell and Schreiber, 1998.

† Fewer than 150 acres statewide. 2005 figures include applications of propargite (Omite®), petroleum oil (Superior Oil®), dinotefuran (Venom®), fenpyroximate (FujiMite®), and potassium laurate (M-Pede®). The 1994 figures include petroleum oil, potassium laurate, and propargite only.

§ Includes endosulfan, diazinon, malathion-methoxychlor, malathion, azinphos-methyl, methomyl, BT, vegetable oil, pyrethrins, carbofuran.

These state estimates document a significant improvement when compared to pesticide use reports from 1992–1994. The extensively used insecticides in 1992–1994 in order of acres treated were dimethoate, chlorpyrifos, carbaryl, and endosulfan. The use of dimethoate in Washington State vineyards dropped dramatically after the registrant voluntarily cancelled the registration on grapes in July 2005 due to risk cup issues recognized in the course of implementing the 1996 Food Quality Protection Act. Chlorpyrifos use plummeted to less than 1% of acreage by 2005 because most growers had switched to using fenpropathrin in a low-volume targeted band application for control of climbing cutworms in the spring. Chlorpyrifos and dimethoate use for mealybugs in 1992-1994 was replaced by chemigation with imidacloprid or foliar sprays of buprofezin. Carbaryl use declined as growers chose more effective alternatives to control insects. No respondent reported using endosulfan in 2005.

The shift in type and amount of insecticides and miticides over the last decade is nothing short of remarkable. It represents a wholesale switch by the industry away from broad-spectrum organophosphate, carbamate, or organochlorine insecticides to new alternative and/or reduced-risk, pest-specific chemistries.

herbicides

Applications of eleven herbicides were reported by grape growers in 2005 (Table 10). The most used herbicide in the 2005 survey was glyphosate (Roundup® and others); it is estimated that 12,321 wine grape acres and 11,564 juice grape acres received one to three applications, resulting in approximately 25,442 lbs of glyphosate applied to wine grapes and 24,230 lbs applied to juice grapes. The second most used herbicide was paraquat, a restricted-use product applied to 5,576 acres of wine grapes and 1,891 acres of juice grapes. In total we estimate that 9,325 lbs of paraquat was applied in 2005. Two pre-emergence herbicides, simazine and norflurazon, were applied extensively in juice grape vineyards. A total of 6,229 acres were treated with 2,492 lbs of simazine and 6,340 acres were treated with 11,212 lbs of norflurazon. Much less prevalent in wine grape vineyards, 741 lbs of simazine were applied to 348 acres and 9 lbs norflurazon to 12 acres. We estimate that 2,770 grape acres were treated with 41 lbs of carfentrazone-ethyl in various formulations of the product Aim® in 2005.

In contrast to the insecticides/miticides, most of the major herbicides that were registered for use on grapes in 2005 were also registered in 1992-1994. The earlier survey found glyphosate to be the most applied herbicide, with oryzalin in second place, followed by paraquat, simazine, oxyfluorfen, and norflurazon. While use of oryzalin, simazine, oxyfluorfen, and diuron decreased considerably in 11 years, use of

TABLE 10

		State Estimates 2005				State Estimates Averaged 1992-1994*			
Herbicide	Variety	Base acres treated (% total)	Avg rate (lb ai/acre)	Apps/ year	Total lb ai/year	Base acres treated (% total)	Avg rate (lb ai/acre)	Apps/ year	Total lb ai/year
glyphosate (Glyfos®, Roundup®, others)†	wine	12,321 (44)	1.50	1.37	25,442	6,949 (54)	1.00	1.40	9,729
	juice	11,564 (44)	1.07	1.96	24,230	10,991 (50)	1.00	1.20	13,189
paraquat (Gramoxone®)§	wine	5,576 (20)	0.84	1.59	7,414	3,207 (25)	1.25	1.00	4,009
	juice	1,891 (7)	0.79	1.29	1,911	2,761 (13)	1.25	1.10	3,796
simazine (various)	wine	348 (1)	2.03	1.05	741	2,163 (17)	2.00	1.00	4,326
	juice	6,229 (24)	0.40	1.00	2,492	3,443 (16)	2.00	1.00	6,886
norflurazon (Solicam®)	wine	12 (<1)	0.79	1.00	9	368 (3)	2.36	1.00	868
	juice	6,340 (24)	1.77	1.00	11,212	2,443 (11)	2.36	1.00	5,765
carfentrazone-ethyl (Aim/Aim EW®)	wine	2,525 (9)	0.01	1.82	37	not registered			
	juice	245 (1)	0.02	1.00	5				
oxyfluorfen (Goal®)	wine	1,047 (4)	0.29	1.01	305	2,368 (18)	2.00	1.00	4,736
	juice	not registered				2,111 (10)	2.00	1.00	4,222
oryzalin (Surflan®)	wine	119 (<1)	3.92	1.20	558	2,157 (17)	2.00	1.00	4,314
	juice	1,190 (5)	1.54	1.00	1,829	6,023 (27)	2.00	1.00	12,046
glufosinate (Rely®)	wine	96 (<1)	0.41	1.00	40	no data			
diuron	wine	no data				20 (<1)	2.40	1.00	48
	juice	111 (<1)	1.60	1.00	178	1,934 (9)	2.40	1.00	4,642
sethoxydim (Poast®)	juice	44 (<1)	0.21	2.00	19	9 (<1)	n.d.	1.00	n.d.
2,4-D (various)†	wine	16 (<1)	1.35	1.00	22	53 (<1)	n.d.	1.00	n.d.
	juice	no data				675 (3)	n.d.	1.00	n.d.
Other from 1994	wine	not applicable				124 (1)	varied	1.00	241
	juice	not applicable				1,687 (8)	varied	1.00	3,254

* From Morrell and Schreiber, 1998. † Acid equivalent used for active ingredient calculations. § Cation equivalent used for active ingredient calculations.

glyphosate and norflurazon has increased. It should be pointed out that only three growers—one wine grape grower and two juice grape growers—reported using norflurazon in 2005, so while the quantity in lbs increased, this chemical was not widely used among grape growers. The same level of paraquat usage was reported for both survey time periods.

The increase in glyphosate could be attributed to several factors. First, the patent held by the original registrant termed, leading to the market introduction of substantially less expensive generic glyphosate products. Second, glyphosate is safer for applicators to apply than some other registered herbicides; even carrying reduced-risk status for numerous specialty crop fruits and vegetables. Third, soil-active herbicides such as diuron, simazine, and norflurazon can damage grapevine roots and cause injury or death to vines by leaching into the vine's root zone if not properly selected and applied for the vineyard conditions. Oryzalin is a less hazardous soil-active herbicide but it is not effective against certain mustard and nightshade weed species. Oxyfluorfen is an effective and versatile herbicide, but it is very expensive compared to alternatives that are commercially available.

Based on survey responses, the use of paraquat remained steady from 1994 to 2005. However, it is expected that use of this acutely toxic, restricted-use herbicide will decline in the coming years as more growers choose newer, less hazardous compounds to control weeds and grapevine suckers. For example, an estimated 604 acres were treated with paraquat for sucker control in 2005. The registration of the reduced-risk carfentrazone-ethyl (Aim®) along with the full registration of oxyfluorfen (Goal 2XL®) for sucker control both occurred in 2005, providing growers with two alternatives to paraquat for sucker suppression. A fourth compound, glufosinate-ammonium (Rely®), is also registered for sucker control, but very little use of Rely® was reported during 2005 and none was reported during 1992–1994.

fungicides

Fungicide use was reported on wine grapes only (Table 11). Most of the pesticide inputs to vineyards in Washington were fungicidal because the most important manageable pest of wine grapes is powdery mildew. Mildew management requires a rigorous season-long management program. WSU scientists have developed control programs that include fungicide rotation to delay the onset of fungicide resistance. Most but not all fungicides applied to control powdery mildew can provide bunch rot suppression as well.

The number one product applied to Washington wine grape vineyards in 2005, both in terms of base acres treated and lbs applied, was paraffinic oil. Several paraffinic oil products were reported; applications of all are combined in our summary data. An estimated 20,931 base acres were treated with a total 250,917 lbs paraffinic oil. The second most used active ingredient was trifloxystrobin (Flint®), with 19,592 acres treated and 1,255 lbs applied. Fenarimol (Rubigan®) was third, with 15,078 acres treated and 805 lbs applied. Sulfur products (including micronized, wettable, dust, and water-dispersible granule formulations) could be considered in fourth place based on pounds of active ingredient applied in 2005. The number of acres treated with sulfur products, quinoxyfen (Quintec®), and triflumizole (Procure®) was fairly similar (11,675; 11,633; and 11,230; respectively), although naturally the pounds of sulfur applied far outweighed that of quinoxyfen and triflumizole. Fourteen other fungicides were reported, used on less than 15% of the acreage.

Currently, the options for powdery mildew and bunch rot control are many and diverse as shown by the 2005 survey data, but this was not the case during 1992–1994. Five fungicides were used on wine grapes during this earlier survey period. In order of base acres treated, these fungicides were fenarimol, sulfur, myclobutanil, triadimefon, and iprodione. Growers currently have more efficacious choices than iprodione for bunch rot management in wine grapes and its use has all but disappeared. The largest fungicidal input during 1992–1994 in terms of lbs active ingredient applied per year was sulfur. There are several disadvantages to using sulfur: multiple applications at closely timed intervals are needed in high mildew-pressure situations, it can be phytotoxic at high temperatures and ineffective at low temperatures, it can be hazardous to applicators, and it can be detrimental to beneficial arthropods if overused. But because it is very effective against powdery mildew and no resistance has developed, sulfur continues to be a component in many disease management programs. However, based on the 2005 survey responses, paraffinic oil has replaced sulfur as the major fungicidal protectant used in wine grapes.

Use of the demethylation inhibiting (DMI) fungicides fenarimol, myclobutanil, triflumizole, tebuconazole, and triadimefon decreased over 11 years as multiple new compounds were registered, many with different modes of action. Providing growers with numerous options for powdery mildew and bunch rot management has allowed additional flexibility in following resistance management guidelines.

TABLE 11

Fungicide	State Estimates 2005				State Estimates Averaged 1992-1994*			
	Base acres treated (% total)	Avg rate (lb ai/ acre)	Apps/ year	Total lb ai/year	Base acres treated (% total)	Avg rate (lb ai/ acre)	Apps/ year	Total lb ai/year
paraffinic oil (several products)	20,931 (75)	5.59 (1.5%)	2.14	250,917	none reported			
trifloxystrobin (Flint®)	19,592 (70)	0.06	1.06	1,255	not registered			
fenarimol (Rubigan®)	15,078 (54)	0.03	2.03	805	9,358 (73)	0.05	3.58	1,675
sulfur†	11,675 (42)	3.06	3.12	111,551	8,982 (70)	4.00	3.40	122,155
quinoxyfen (Quintec®)	11,633 (42)	0.08	1.08	970	not registered			
triflumizole (Procure®)	11,230 (40)	0.18	1.45	2,969	no data			
kresoxim-methyl (Sovran®)	3,779 (14)	0.16	1.00	623	not registered			
pyraclostrobin + boscalid (Pristine®)	2,166 (8)	0.22	1.46	710	not registered			
myclobutanil (Rally®)	1,436 (5)	0.11	1.40	227	2,035 (16)	0.10	3.00	611
cyprodinil (Vangard®)	1,137 (4)	0.43	1.29	627	not registered			
fenhexamid (Elevate®)	988 (4)	0.50	1.33	660	not registered			
potassium bicarbonate (Kaligreen®, Milstop®)	557 (2)	2.41	3.00	4,030	not registered			
tebuconazole (Elite®)	417 (1)	0.13	1.00	53	not available			
Bacillus subtilis QST 713 (Serenade®)	302 (1)	0.07	1.50	31	not registered			
potassium laurate (M-Pede®)	222 (<1)	7.00 (2.6%)	1.33	2,073	no data			
pyrimethanil (Scala®)	190 (<1)	0.53	1.33	133	not registered			
azoxystrobin (Abound®)	112 (<1)	0.19	1.00	21	not registered			
lime sulfur	71 (<1)	16.89	1.00	1,207	no data			
thiophanate-methyl (Topsin M®)	54 (<1)	0.70	1.00	38	not registered			
triadimefon (Bayleton®)	26 (<1)	0.13	1.00	3	833 (6)	0.15	1.33	166
iprodione (Rovral®)	No data				393 (3)	1.00	1.63	641

* From Morrell and Schreiber, 1998. † Includes micronized sulfur, wettable sulfur, sulfur dust, and water dispersible granule sulfur.

summary and conclusions

Factors contributing to IPM adoption in Washington grapes:

- *passage of the FQPA;*
- *availability of lower-risk, more specifically targeted pesticides;*
- *emphasis on weather-driven disease management programs;*
- *vigorous Extension outreach;*
- *growers' willingness to explore new options.*

The Washington State grape industry has made enormous improvements in integrated pest management adoption and environmental stewardship over the past decade. Table 12 provides summaries of each type of pesticide used in 1992–1994 and in 2005. By comparing these figures, it is clear that pesticide use has declined in both wine and juice grapes. Insecticide/miticide usage in wine grapes dropped by 84% from 1.28 to 0.2 lb ai/acre, and in juice grapes dropped by 52% from 0.77 to 0.37 lbs ai/acre. The decline in herbicide usage was not as pronounced: a 3% decrease in herbicide inputs was determined in wine grapes and a 10% decrease in juice grapes. Even though fungicide inputs totaled 378,903 lbs ai applied statewide during 2005, this represented a 36% decrease in overall use of fungicides on a per-acre basis (from 5.80 to 3.73 lbs ai per acre). If the paraffinic oil application figures are removed to allow for a more direct comparison between survey years, the lb ai/acre for fungicides applied in 2005 is 1.59 compared to 5.80 in 1992–1994, a 73% reduction in 11 years. In both time periods, fungicides were the most-used control, followed by herbicide and insecticide use, respectively.

TABLE 12

Pesticide Type and Grape Variety	State Estimates 2005			State Averages 1992-1994*		
	Base acres treated**	Total lbs ai/yr	lb ai/acre	Base acres treated†	Total lbs ai/yr	lb ai/acre
Insecticide/miticide						
Wine	30,844	6,173	0.20	11,263	14,363	1.28
Juice	3,680	1,354	0.37	3,015	2,327	0.77
Herbicide						
Wine	22,060	34,568	1.57	17,409	28,271	1.62
Juice	27,614	41,876	1.52	32,077	53,800	1.68
Fungicide						
Wine (oil included)	101,596	378,903	3.73	21,601	125,248	5.80
Wine (no oil incl.)	80,665	127,986	1.59		no oil	

* From Morrell and Schreiber, 1998.

† Numbers reflect the summation of acreage treated with each chemical; thus totals greatly exceed the number of farmed grape acres.

COMPARING ACRES OF PESTICIDE APPLICATION VIA WASS

Washington Agricultural Statistics Service has conducted an agricultural chemical usage survey for grapes every two years since 1997; the last one was in 2005 (WASS 2002, 2006). While the WASS reports provide no comparison of pounds active ingredient applied, they do provide a percentage figure for the amount of total crop acreage that received application of each type of pesticide. Comparing these figures also shows a substantial decline in both herbicide and insecticide usage. In 1997, approximately 90% of grape acres received herbicide applications; this decreased to 65% in 2005. Insecticides were used on approximately 70% of total acres in 1997 and only on 57% in 2005. Fungicide usage on a percent of acres basis increased from 50% of the acreage in 1997 to approximately 58% in 2005. Confounding this comparison is the fact that the petroleum oil (distillate) applications reported by WASS were grouped with the insecticides. While some petroleum oil was applied to control insects, the overwhelming majority of petroleum (paraffinic, mineral) oil applications in grapes are fungicidal treatments to control powdery mildew.

A number of factors, some fortuitous and some the result of considerable forethought, worked together over time to create the current pest management context in Washington vineyards. Some of these are outlined in the paragraphs that follow.

IMPACT OF FQPA

A significant legislative event occurred shortly after the earlier survey data were collected that contributed greatly to these pesticide usage reductions. The Food Quality Protection Act (FQPA) arrived in 1996 with its stated purpose to re-assess food tolerances of all pesticides. Organophosphates (OPs) and other neurotoxic compounds were targeted first. Environmental Protection Agency (EPA) actions following FQPA enactment resulted in lost insecticide registrations on grapes. The grape uses of the OPs azinphos-methyl, dimethoate, and methoxychlor were voluntarily cancelled by their registrants. Other organophosphates such as malathion and malathion-methoxychlor disappeared as the Washington State Department of Agriculture discontinued registering their labels for use in grapes. Carbofuran is another example; this neurotoxic carbamate is known to be poisonous to birds, and even though a tolerance for grapes exists, there are no labels containing carbofuran for use on grapes in Washington State.

EXPANDED ALTERNATIVES

The 1992-1994 study predicted several alternatives for certain pesticides that were targeted for removal from the market. However, in many cases, these alternatives were not available in 2005 or better alternative chemicals or application methods have become available. A good example is the use of chlorpyrifos for control of cutworms in the early spring. The earlier survey predicted that growers would choose carbaryl or methomyl to control cutworms should chlorpyrifos become unavailable. However, even though chlorpyrifos was still available in 2005, the majority of wine grape growers were choosing to apply fenpropathrin (Danitol®), a pyrethroid. This was due to a new application technology that could not be foreseen a decade ago. Rather than applying foliar sprays to control cutworm, growers had adopted a technique developed by WSU Extension researchers whereby an early spring (delayed dormant period) application directed at the base of the vine prevented cutworms from climbing up from the soil to damage buds. This technique used a very low rate of fenpropathrin, making it more economical as well as softer on non-target species. The result was a dramatic, 15-fold reduction in the use of chlorpyrifos (Lorsban®).

TABLE 13-A

Target Pest Group	1992-1994* Active ingredients commonly used	1992-1994* Alternatives used	2005 Active ingredients commonly used	2005 Alternatives used	Since 1994 Registrations lost	Since 1994 Registrations gained
Insects black vine weevil cutworms leafhoppers mealybugs thrips	carbaryl carbofuran chlorpyrifos dimethoate endosulfan	azinphos-methyl diazinon malathion malathion+ methoxychlor methomyl petroleum oil	fenpropathrin imidacloprid	acetamiprid azadirachtin buprofezin carbaryl chlorpyrifos dimethoate	azinphos-methyl† carbofuran‡ dimethoate§ ethion** lindane** methoxychlor** methyl parathion** mevinphos‡	acetamiprid beta-cyfluthrin bifenthrin buprofezin capsaicin cyfluthrin dinotefuran fenpropathrin kaolin methoxyfenozide pyriproxyfen spinosad
Mites	propargite	potassium laurate	bifenazate	fenpyroximate potassium laurate propargite	none	abamectin bifenazate clofentezine etoxazole fenpyroximate hexythiazox pyridaben spirodiclofen

*From Morrell and Schreiber, 1998.

†Tolerance for grapes still exists. Azinphos-methyl use on grapes was cancelled 8/27/03.

‡Tolerance for grapes still exists though there are no labels for carbofuran or mevinphos in Washington State.

§Tolerance for grapes still exists. Dimethoate use on grapes was cancelled 7/17/05. Growers were allowed to buy and use existing stocks until exhausted; registrants were not allowed to sell product labeled for use on grapes after 7/20/06.

**Tolerances revoked as follows: ethion on 10/26/98, methyl parathion on 1/05/01, methoxychlor on 7/17/02, and lindane on 9/21/05.

MORE POTENCY = FEWER LBS AI

While no fungicide or herbicide registrations were lost on grapes between 1994 and 2005, all pesticide categories (insecticide, fungicide, and herbicide) gained registrations during the same period. This contributed to the reduction in active ingredient applied to grapes as the newer compounds were often more potent, which meant that formulated pesticide could treat more acreage or could be extended over multiple applications. Examples of insecticides effective at low active-ingredient-per-acre (ai/A) rates include fenpropathrin (0.1 lb) and acetamiprid (0.8 oz). Similarly, imidacloprid is effective at 0.56–0.75 oz ai/A, and while it is not new, its use has increased. An example of an herbicide effective at low rates is the newly registered carfentrazone-ethyl, which is effective at 0.03 lb ai/A. Several newly registered fungicides are also effective at low ai/A: trifloxystrobin (0.75–1 oz), azoxystrobin (0.18–0.24 fl oz), and quinoxyfen (0.05–0.06 lb). These amounts are indeed small when compared to the 1994 averages of 3 lbs per acre reported for sulfur and the nearly 4 lbs per acre rate reported for the herbicide oryzalin.

REDUCED RISK PRODUCTS

Many of the newly registered compounds were designated as “reduced-risk” by EPA. To gain reduced-risk status a pesticide must exhibit: low toxicity

TABLE 13-B

Target Pest Group	1992-1994* Active ingredients commonly used	1992-1994* Alternatives used	2005 Active ingredients commonly used	2005 Alternatives used	Since 1994 Registrations lost	Since 1994 Registrations gained
Weeds annual perennial suckers	glyphosate	diuron napropamide norflurazon oryzalin oxyfluorfen paraquat pendimethalin pronamide sethoxydim simazine trifluralin 2,4-D	glyphosate	carfentrazone-ethyl diuron glufosinate norflurazon oryzalin oxyfluorfen paraquat sethoxydim simazine 2,4-D	none	carfentrazone-ethyl flumioxazin oxyfluorfen for suckers pyraflufen-ethyl
Diseases powdery mildew bunch rot	fenarimol sulfur	myclobutanil triadimefon iprodione	paraffinic oil sulfur	azoxystrobin *Bacillus subtilis* cyprodinil fenarimol fenhexamid kresoxim-methyl myclobutanil potassium bicarbonate potassium laurate pyrimethanil pyraclostrobin+ boscalid quinoxyfen tebuconazole thiophanate-methyl triadimefon trifloxystrobin triflumizole	none	azoxystrobin *Bacillus subtilis* cyprodinil fenhexamid kresoxim-methyl potassium bicarbonate potassium laurate pyraclostrobin+boscalid pyrimethanil quinoxyfen tebuconazole thiophanate-methyl trifloxystrobin triflumozole zoxamide

*From Morrell and Schreiber, 1998.

to humans, other mammals, birds, fish, beneficial insects, and other non-target organisms; low potential for groundwater contamination; lower use rates; and low pest resistance potential. The "OP alternative" designation was added in 1999 to indicate pesticides that could be effectively used instead of certain high-risk OPs that were targeted for cancellation. The insecticides/miticides currently registered on grapes that are designated reduced-risk/OP alternative are acetamiprid, bifenazate, buprofezin, dinotefuran, etoxazole, methoxyfenozide, spinosad, clofentezine, and fenpyroximate. In the fungicide category, seven new compounds have been labeled reduced-risk: azoxystrobin, boscalid, fenhexamid, quinoxyfen, pyrimethanil, trifloxystrobin, and zoxamide. Several other pesticides registered on grapes have been designated reduced-risk in other crops: carfentrazone-ethyl, cyprodinil, etoxazole, glufosinate-ammonium, glyphosate, imidacloprid, and pyriproxyfen. As these chemicals pose less danger to non-target organisms, grape growers will be more likely to utilize them in their vineyards once they become familiar with these products and their applications.

AWARENESS & ASSIMILATION

Results of the 2005 survey indicate that the grape growers' collective experience and expanding knowledge base contributed greatly to the reduction in pesticide use in grapes. Grape growers have been able to assimilate vast amounts of pest management information from a number of sources, including other growers, university Extension personnel and publications, chemical company representatives, and private consultants (see page 11). The growers have in turn applied this knowledge in the form of integrated pest management practices in their vineyard systems. The use of field monitoring and economic thresholds by the majority of the grower-respondents to guide their pest management programs factored significantly in the overall pesticide use reductions.

SUSTAINED EFFORT

While the pesticide usage reductions in grapes reported in this document might sound almost too good to be true, they did not occur overnight. They are the result of a decade of focused research and extension and a grower population willing to listen and apply new things for the benefit of their crop, the terroir, human health, and the environment, as well as their bottom-line production and profitability.

LOOKING AHEAD

Pesticide inputs will most certainly continue to decrease slightly in the next five years. Currently, effective pesticides and suitable alternatives are available for the major pests of wine and juice grapes. New pest problems may emerge, necessitating the development of new control program designs with potentially new active ingredients. There are reduced-risk pesticides still in the pipeline that are candidates for registration on grape; these may serve as alternatives to some of the higher-risk pesticides still in use. The potential still exists for registrations to be lost as EPA continues risk assessments. A decrease in fungicide use may be realized as more growers utilize precision bunch rot and powdery mildew computer models that recommend longer spray intervals and eliminate early-season applications. Finally, there is a growing interest in organic grape production and as more growers transition into organic pest control programs, use of conventional pesticides will continue to decline.

Pesticide inputs will most certainly continue to decrease slightly in the next five years.

APPENDIX

Reported Applications of Insecticides, Miticides, and Fumigants Used on Grapes in Washington State 2005

Active ingredient	Formulation	Grape Variety	%*	Base Acres†	Treated Acres
INSECTICIDES/MITICIDES					
fenpropathrin	Danitol® 2.4EC	wine	14	3,370.10	3,396.10
imidacloprid	Provado® 1.6F	wine	23	1,882.67	1,936.27
		Concord	1	117.00	117.00
		Niagara	1	39.00	39.00
dimethoate	various	wine	4	58.10	89.60
		Concord	4	401.00	401.00
		Niagara	1	6.00	6.00
bifenazate	Acramite® 50WS	wine	7	420.96	420.96
azadirachtin	Aza-Direct®	wine	1	406.83	518.80
spinosad	Success®	wine	3	201.68	201.68
imidacloprid	Admire® 2F	wine	6	117.58	187.58
buprofezin	Applaud®	wine	3	138.68	138.68
acetamiprid	Assail®	wine	3	96.50	96.50
carbaryl	Sevin®	wine	6	63.13	67.13
chlorpyrifos	Lorsban® 4E	wine	3	35.00	35.00
propargite	Omite® 30WP	wine	1	33.01	33.01
petroleum oil	Superior Spray Oil®	wine	1	31.50	31.50
dinotefuran	Venom®	wine	1	31.50	31.50
fenpyroximate	FujiMite® 5EC	wine	1	14.00	14.00
potassium laurate	M-Pede®	wine	1	8.00	8.00
TOTAL INSECTICIDES				7,472.24	7,769.31
FUMIGANTS					
metam-sodium	Vapam®		1	2.00	2.00
HERBICIDES					
glyphosate	Roundup®/ Glyfos®	wine	27	2,759.80	4,157.76
		Concord	20	1,763.30	3,203.00
		Niagara	1	6.00	6.00
paraquat	Gramoxone Max®, Gramoxone Inteon®	wine	16	1,249.12	2,409.73
		Concord	10	289.30	298.10
simazine	various	wine	3	78.06	85.29
		Concord	1	953.00	953.00
norflurazon	Solicam®	wine	1	2.70	2.70
		Concord	3	970.00	970.00
carfentrazone-ethyl	Aim®/Aim EW®	wine	4	565.69	919.49
		Concord	3	37.50	37.50
oxyfluorfen	Goal 2XL®	wine	6	234.44	239.79
oryzalin	Surflan®	wine	7	26.60	28.60
		Concord	3	182.00	182.00
glufosinate	Rely®	wine	1	21.49	21.49
diuron	various	Concord	1	17.00	17.00
sethoxydim	Poast®	Concord	1	6.80	13.60
2,4-D	various	wine	1	3.60	3.60
TOTAL HERBICIDES				9,166.40	13,548.65

* Percentage of the survey respondents using this product/ingredient.

† Base acres were determined by dividing the number of treated acres by the number of applications the blocks received.

CONTINUED on back page with FUNGICIDES

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Reported Applications of Pesticides Used on Grapes in Washington State in 2005

Active ingredient	Formulation	% *	Base Acres†	Treated Acres
FUNGICIDES‡				
trifloxystrobin	Flint®	24	4,388.53	4,533.01
paraffinic oil	JMS Stylet Oil®	21	3,636.40	6,613.10
fenarimol	Rubigan® EC	19	3,377.50	4,210.94
quinoxyfen	Quintec®	17	2,605.89	2,637.31
triflumizole	Procure® 50WS	17	2,515.48	3,174.38
sulfur	several	30	2,432.22	5,096.69
paraffinic oil	JMS Organic Stylet Oil®	1	851.18	2,100.68
kresoxim-methyl	Sovran®	7	846.60	846.60
pyraclostrobin+boscalid	Pristine®	19	485.20	520.20
myclobutanil	Rally® 40W	14	321.58	363.46
cyprodinil	Vangard®	10	254.78	260.78
fenhexamid	Elevate® 50WDG	4	221.21	225.09
paraffinic oil	Omni Supreme Spray®	4	200.89	282.72
sulfur dust	not reported	1	183.00	183.00
potassium bicarbonate	Kaligreen®, Milstop®	7	124.72	146.72
tebuconazole	Elite® 45DF	6	93.50	93.50
Bacillus subtilis QST 713	Serenade®	9	67.67	71.42
potassium laurate	M-Pede®	4	49.75	89.75
pyrimethanil	Scala®	4	42.50	46.50
azoxystrobin	Abound®	1	25.08	25.08
lime sulfur	not reported	1	16.00	16.00
thiophanate-methyl	Topsin M®	1	12.00	12.00
triadimefon	Bayleton®	3	5.88	5.88
TOTAL FUNGICIDES			22,757.56	31,554.81

* Percentage of the survey respondents using this product/ingredient.
† Base acres = Treated acres divided by number of applications the blocks received.
‡ All figures refer to wine grapes; no fungicide usage was reported on juice grapes.

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Use pesticides with care. Apply them only to plants, animals, or sites listed on the label. When mixing and applying pesticides, follow all label precautions to protect yourself and others around you. It is a violation of the law to disregard label directions. If pesticides are spilled on skin or clothing, remove clothing and wash skin thoroughly. Store pesticides in their original containers and keep them out of the reach of children, pets, and livestock.