Special Report 958
March 1996

Survey of Pesticide Applications on Oregon Mint Fields

Agricultural Experiment Station
Oregon State University

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by Rebecca Jepson
and Robert G. Mason

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Authors: Rebecca Jeppson is a graduate teaching assistant in the Department of Statistics at Oregon State University. Robert G. Mason is a professor in the Department of Statistics at Oregon State University.

Acknowledgment: Many thanks to Elena Fairchild, representative from the Oregon Mint Commission, for her consultation and support.

CHAPTER 1

INTRODUCTION

Oregon mint growers harvested an estimated 3.2 million pounds of peppermint oil in 1994, about 43 percent of the nation's 7.4 million pound total. They did this on approximately 44,000 acres, about 41 percent of the national acreage. In all, growers contributed about $50.7 million to the state's economy (Miles, 1995).

This economic contribution comes at the expense of controlling a variety of insects, weeds, and diseases. There is no widespread experimental evidence available to support all the joint cultural practices and pesticide applications currently in use. Limited experiments, trial and error, and anecdotal experience guide chemical application levels in many cases. Moreover, the United States Environmental Protection Agency (EPA) requirement for approval of chemicals narrows considerably the range of possibilities growers have for successful pest control. In order to learn more about the effect of pesticide applications on mint yields, a survey was completed in 1992 among 90 growers selected at random -- 51 in the Willamette Valley and 39 in Central and Eastern Oregon. A copy of the interview schedule is shown as Appendix B.

The face-to-face interviews sought detailed information on five of the largest mint fields each grower was farming. Information was requested about each field's 1992 yield, age of stand, cultural practices applied (tillage, spring and fall flaming, and spring and fall nitrogen applications), and the infestations that were a problem. Once an infestation was identified, questions were asked about the seriousness of the problem, treatments applied, their application rates, and a rating of their effect. A summary of these results is presented in Appendix A.

The purpose of this report is to show the results of a statistical analysis of the impact of cultural practices and pesticide applications and their interactions on mint yields. Results are displayed and discussed for each infestation studied. They are presented first for the Willamette Valley sample, then for central and eastern Oregon growers.

Some of the pesticides studied had no statistical effect or even a negative one on yield. These results should be viewed with much caution. First, pests (insects, diseases, and weeds) are likely to have suppressed yields before pesticides were applied, and we are observing fields that are showing the impact of established pest infestations. The higher seriousness scores that are observed for fields that receive chemical treatments are consistent with this observation. Second, treatment effects that are reported convey what happened the year data were gathered. In many cases time lags should be expected, since treatments must reduce pest levels before one can expect improvement in yields.

CHAPTER 2

WILLAMETTE VALLEY INFESTATIONS

This section will report the results of the statistical analyses on the Willamette Valley fields surveyed. Each section will discuss the results for individual infestations. Tables 2.1, 2.2, and 2.3 display summary statistics, treatment effects, and statistical analyses for all fields studied in the Willamette Valley. Tables of infestations and their severity scores are reported in Appendix A, Tables A-E.

Table 2.1 shows the summary statistics for the total Willamette Valley fields studied. There was an average of about 45 acres per field with an average 1992 yield of 78 lbs./A for those in this survey. The maximum yield was 115 lbs./A, while the minimum yield was 20 lbs./A. The percentage of fields with the age of stand greater than one year was 88 percent. This factor, age of stand (% > 1 yr.), and tillage were used as controls for all statistical analyses, i.e., the other factors were analyzed with the effect of age of stand and tillage already accounted for. Seventy-

Table 2.1: Summary Statistics, Total Willamette Valley Fields Sampled

Summary Statistics	Mean	Standard Deviation	(N)
Number of Acres	45.4	39.5	(232)
1992 Yield (lbs./A)	78.0	18.2	(193)
Maximum Yield (lbs./A)	115.0	---	---
Minimum Yield (lbs./A)	20.0	---	---
Age of Stand (% > 1 yr.)	87.9	30.0	(206)
Fields Tilled (%)	12.7	29.5	(205)
Fields Spring Flamed (%)	72.3	50.0	(202)
Fields Fall Flamed (%)	59.3	50.0	(194)
Spring N (lbs./A)	272.8	66.7	(205)
Fall N (lbs./A)	86.9	52.2	(35)

two percent of the fields were spring flamed, 59 percent were fall flamed, and about 13 percent of the fields were tilled. Spring nitrogen (spring N) was applied at an average of 273 lbs./A and fall nitrogen (fall N) was applied at an average of 87 lbs./A. Table 2.1 also displays the standard deviations and total N for each of these summary statistics.

Table 2.2 displays the mean yield (in lbs./A) for each of the treatment effects. The mean yield for those fields tilled was 75 lbs./A, while those not tilled produced an average of about 78 lbs./A. Fields that had age of stand greater than 1 year averaged 80 lbs./A, and those that were a year or less averaged only 65 lbs./A. This effect, which was statistically significant (see Table 2.3), is reasonable since established fields are expected to yield more than new fields. Those fields spring flamed produced an average of 79 lbs./A, while those not spring flamed produced about 4 lbs./A less. Fall flaming was also shown to be a statistically significant effect on yield. Those fields receiving fall flame produced an average of about 82 lbs/A, and those not fall flamed, 73 lbs./A. Spring N had a positive effect on yields where the average ranged from 72 to 83 lbs./A. Fields that received fall N applications averaged 74 lbs./A, about 5 lbs/A lower than fields that did not receive fall N applications. The fall N by spring flame interaction was a significant factor as well. Fields not receiving spring flame tended to increase in yield as fall N applications increased, while those fields receiving spring flame tended to decrease in yield as the lbs./A of fall N increased. It is important to note that the number of fields receiving fall N by spring flame treatment is low and the results should be interpreted cautiously.

Table 2.2: Treatment Effects, Total Willamette Valley Fields Sampled

Treatment Effects		Mean Yield (lbs./A)	Standard Deviation (lbs./A)	(N)
Tillage		74.7	17.8	(21)
No Tillage		78.4	18.2	(162)
Age of Stand:				
More than 1 year		79.7	16.5	(161)
1 year or less		65.1	24.2	(22)
Spring Flame		79.2	16.6	(129)
Not Spring Flame		75.0	21.4	(54)
Fall Flame		72.9	15.1	(108)
Not Fall Flame		81.5	21.0	(75)
Spring N:				
$0 \leq$ lb./A < 250		71.9	19.3	(45)
$250 \leq$ lb./A < 300		77.1	17.2	(76)
lb./A ≥ 300		83.0	17.4	(75)
Fall N		79.3	17.3	(160)
No Fall N		73.8	23.1	(28)
Fall N by Spring Flame:				
0 lb./A	No	73.8	20.3	(39)
$0 <$ lb./A < 50	No	81.8	17.7	(5)*
$50 \leq$ lb./A < 100	No	72.4	28.1	(10)
lb./A ≥ 100	No	92.5	11.9	(4)#
0 lb./A	Yes	80.6	16.0	(130)
$50 \leq$ lb./A < 100	Yes	68.0	20.2	(4)**
lb./A ≥ 100	Yes	50.0	0.0	(4)+

*ID: Respondents 13, 15, 22, 31, 67
#ID: Respondent 29
**ID: Respondents 2, 11, 72
+ID: Respondent 35

Table 2.3 shows the results of the statistical analysis of the effect on mean yield. As can be seen, the effects of age of stand, fall flame, and spring N had positive effects on mean yield. The fall N by spring flame interaction had a positive effect when spring flame was not present and a negative effect when spring flame was present. Tillage, spring flame, and fall N were not shown to be significant effects. An R^2 of 0.25 means that the statistical model accounted for 25 percent of the variation in yield.

Table 2.3: Statistical Analysis, Total Willamette Valley Fields Sampled

Variable	Effect on Mean Yield	df	F-value	p-value
Tillage	none	1	1.32	0.252
Age of Stand	positive	1	11.71	0.001
Spring Flame	none	1	0.07	0.796
Fall Flame	positive	1	4.59	0.034
Spring N	positive	1	14.63	0.001
Fall N	none	1	0.28	0.594
Fall N by Spring Flame	see Table 2.2	1	16.55	0.001

Overall F = 8.10, p-value < 0.0001 with 7 & 175 df
$R^2 = 0.25$

Only the effects of cultural practices were studied for the model of all fields. Pesticides employed were targeted for specific infestations and the net effects of these chemicals are evaluated in conjunction with the cultural practices displayed in Tables 2.2 and 2.3.

Application rates and an effectiveness rating for chemicals applied to control pests are shown in Appendix A, Table C, p. A-4. The analysis in the following pages represents the results of statistical analyses of cultural and pesticide effects on mint yields. Readers interested in comparing the perceived effectiveness of these chemicals may wish to cross-check statistical results with those in Appendix A.

BINDWEED

The problem of bindweed has been fought with several methods resulting in suppression, but not eradication. Bindweed is a serious problem for mint farmers because it is so widespread and is difficult to control. Growers reported this infestation in about 65 percent of their fields. Several herbicides have been used to fight bindweed including Basagran, Buctril, Gramoxone, and Sinbar (see Table C, Appendix A), all with no significant increases in yield. Other cultural practices studied include tillage, spring flame, fall flame, spring N, and fall N.

Tables 2.4, 2.5, and 2.6 give the summary statistics, treatment effects, and statistical analysis for fields with bindweed. As is shown in Table 2.4, there was an average of about 53

Table 2.4: Summary Statistics, Willamette Valley Fields Sampled with Bindweed

Summary Statistics	Mean	Standard Deviation	(N)
Number of Acres	52.7	40.0	(147)
1992 Yield (lbs./A)	78.4	17.0	(145)
Maximum Yield (lbs./A)	115.0	---	(145)
Minimum Yield (lbs./A)	38.0	---	(145)
Age of Stand (% > 1 yr.)	93.9	24.1	(147)
Fields Tilled (%)	11.6	32.1	(147)
Fields Spring Flamed (%)	81.6	38.8	(147)
Fields Fall Flamed (%)	63.9	48.2	(147)
Unnamed Chemicals (%)	40.8	49.3	(147)
Spring Nitrogen (lbs./A)	275.6	61.8	(146)
Fall Nitrogen (lbs./A)	99.4	52.2	(16)

acres per field having the problem of bindweed. This is about 8 acres more than the overall infestation results (Table 2.1). The average 1992 yield was 78 lbs./A for bindweed-infested fields in this survey. Maximum yield was the same as that reported for overall results (115 lbs./A), while the minimum yield was about 18 lbs./A higher than the overall results (Table 2.1).

Percentage of fields with the age of stand greater than 1 year was 94 percent. Eighty-two percent of all fields received spring flame, 64 percent were fall flamed, and 12 percent of the fields were tilled. These results are all higher than the overall statistics (see Table 2.1). Fields receiving chemical applications account for 42 percent of all fields with bindweed. Forty-one percent of the total sample with bindweed received unnamed chemicals, and about 1 percent received named chemicals. These included Sinbar, Gramoxone, Basagran, and Buctril (Table A3, Appendix A). Spring N was applied at an average of 276 lbs./A and fall N was applied at an average of 99 lbs./A. The fall N application in bindweed-infested fields is 13 lbs./A higher than in the overall average. Table 2.4 also displays the standard deviations and total N for each of these summary statistics.

Table 2.5 shows the mean yield (in lbs./A), standard deviation, and total N for each of the treatment effects. The mean yield for those fields tilled was 78 lbs./A while those not tilled produced an average of 79 lbs./A. Fields that had age of stand greater than 1 year averaged 79 lbs./A, and those that were a year or less averaged 72 lbs./A; about 6 lbs./A higher than the overall average (see Table 2.2). Those fields spring flamed produced an average of 79 lbs./A while those not spring flamed produced about 2 lbs./A less. Fall flaming was shown to have a statistically significant effect on yield; those fields receiving fall flame produced an average of 81 lbs/A and those not fall flamed, 74 lbs./A. This is consistent with the overall results (Table 2.3). Spring N had a positive effect on yield where the average ranged from 69 to 83 lbs./A. Fields that received fall N applications averaged about 65 lbs./A, while those that did not were about 16 lbs./A higher. The fall N by spring flame interaction was a significant effect as well. Fields <u>not</u> receiving spring flame tended to increase in yield as the lbs./A of fall N increased, while those

Table 2.5: Treatment Effects, Willamette Valley Fields Sampled with Bindweed

Treatment Effects		Mean Yield (lbs./A)	Standard Deviation (lbs./A)	(N)
Tillage		78.1	12.9	(17)
No Tillage		79.0	17.4	(124)
Age of Stand:				
More than 1 year		79.4	16.9	(133)
1 year or less		71.5	15.4	(8)
Spring Flame		79.3	17.0	(115)
Not Spring Flame		77.3	16.4	(26)
Fall Flame		81.5	15.6	(92)
Not Fall Flame		74.0	18.1	(49)
Spring N:				
0 ≤ lb./A < 250		69.1	17.5	(28)
250 ≤ lb./A < 300		78.6	15.4	(61)
lb./A ≥ 300		83.1	16.5	(59)
Fall N		65.2	16.3	(128)
No Fall N		80.7	17.6	(14)
Fall N by Spring Flame:				
0 lb./A	No	76.7	15.6	(12)
50 ≤ lb./A < 100	No	72.0	13.3	(4)
lb./A ≥ 100	No	83.3	14.4	(3)*
0 lb./A	Yes	80.9	16.3	(106)
50 ≤ lb./A < 100	Yes	65.0	23.6	(3)#
lb./A ≥ 100	Yes	50.0	0.0	(4)**
Unnamed Chemicals Applied		78.6	16.7	(61)
Unnamed Chemicals not Applied		79.1	16.9	(80)

*ID: Respondent 29
#ID: Respondents 2, 11
**ID: Respondent 35

fields receiving spring flame tended to decrease in yield as the lbs./A of fall N increased. Also note that the number of fields receiving fall N and spring flame treatments is very low in some cases and results should be carefully interpreted because these are fields in which only one grower reported results.

Table 2.6 shows the results of the statistical analysis of the effects on mean yield. As can be seen, the effects of fall flame and spring N were positive on yields. The fall N by spring flame interaction increased yields when spring flame was not present and had a negative effect when spring flame was present. Chemicals applied, age of stand, tillage, spring flame, and fall N were not significant. The effect of fall flame by spring N interaction should be carefully interpreted because the sample sizes for these treatments is quite small in some cases, see Table 2.5.

Table 2.6: Statistical Analysis, Willamette Valley Fields Sampled with Bindweed

Variable	Effect on Yields	df	F-value	p-value
Age of Stand	none	1	0.73	0.394
Tillage	none	1	0.55	0.461
Spring Flame	none	1	0.12	0.733
Fall Flame	positive	1	3.80	0.053
Spring N	positive	1	7.51	0.007
Fall N	none	1	0.41	0.524
Unnamed Chemicals Applied	none	1	0.21	0.645
Fall N by Spring Flame	see Table 2.5	1	11.01	0.001

Overall F = 4.57, p-value < 0.0001 with 8 & 132 df
$R^2 = 0.22$

The "1995 Pacific Northwest Weed Control Handbook" recommends using Sinbar for annual grass and broadleaf weeds in new plantings and established mint; Gramoxone for annual grass and broadleaf weeds in established mint; and Basagran and Buctril for annual broadleaf weeds, among other recommended herbicides (William, pp. 128-131). Bindweed was reported in almost 75 percent of the fields studied, and only about 43 percent of these fields reported using chemical applications, most of which were unnamed chemicals (see Tables A-C, Appendix A). A significant effect of chemical application, named or unnamed, on bindweed was not detected. The results suggest that the best methods for obtaining increased yields in bindweed-infested fields are to provide good growing conditions such as spring N, fall flaming, or some combination of high fall N application with no spring flame, or no fall N application with spring flame.

CUTWORMS

Cutworms were present in almost 79 percent of all fields surveyed in the Willamette Valley, with an average severity score of 6.4 (see Appendix A, Table A). This widespread problem has been addressed with several different control methods. Some of these methods and cultural practices include tillage, spring flame, fall flame, insecticides (Comite, Lannate and Orthene; Table C, Appendix A), spring N, and fall N.

Summary statistics, treatment effects, and statistical analysis for fields with cutworms are given in Tables 2.7, 2.8, and 2.9. As shown in Table 2.7, there was an average of about 53 acres per field containing cutworms. The average 1992 yield was 80 lbs./A for fields in this survey.

Table 2.7: Summary Statistics, Willamette Valley Fields Sampled with Cutworms

Summary Statistics	Mean	Standard Deviation	(N)
Number of Acres	52.5	39.6	(161)
1992 Yield (lbs./A)	79.9	17.6	(160)
Maximum Yield (lbs./A)	115.0	---	(160)
Minimum Yield (lbs./A)	20.0	---	(160)
Age of Stand (% > 1 yr.)	89.4	30.8	(161)
Fields Tilled (%)	10.6	30.8	(161)
Fields Spring Flamed (%)	72.7	44.7	(161)
Fields Fall Flamed (%)	64.6	48.0	(161)
Orthene Applied (%)	77.6	41.8	(161)
Root Weevils (%)	27.3	44.7	(161)
Spring N (lbs./A)	280.0	66.3	(160)
Fall N (lbs./A)	67.8	33.1	(26)

Maximum yield was the same as that reported for the overall results (115 lbs./A) and so was the minimum (20 lbs./A). Percentage of fields with the age of stand greater than one year was 89 percent. Spring flame was applied to 73 percent of all fields, 64 percent were fall flamed, and 11 percent of the fields were tilled. These results are all higher than the overall statistics (see Table

2.1). Fields receiving chemical applications account for 80 percent of all fields with cutworms. Seventy-eight percent of the total sample with cutworms received Orthene, which is one of the chemicals recommended for use on cutworms in the "1995 Pacific Northwest Insect Control Handbook" (Fisher, p. 113). Spring N was applied at an average of 280 lbs./A, while fall N was applied at an average of 68 lbs./A. Also displayed in Table 2.7 are the standard deviations and total N (number of fields) for each of these summary statistics.

Mean yield (in lbs./A), standard deviation, and total N for each of the treatment effects are listed in Table 2.8. Tilled fields produced an average of 77 lbs./A, and those not tilled had a mean yield of 81 lbs./A. Fields that had age of stand greater than 1 year averaged 81 lbs./A while those that were a year or less in age averaged 14 lbs./A less. Spring flamed fields produced an average of 81 lbs./A while those not spring flamed had a mean yield of 78 lbs./A. Those fields receiving fall flame produced an average of 82 lbs/A and those not fall flamed, 76 lbs./A. This is consistent with the results for the overall statistics (Table 2.2). Yields for spring N-applied fields ranged from 74 to 82 lbs./A, which was a significant effect on mean yield. Fall N-applied fields averaged about 73 lbs./A versus 82 lbs./A without fall N. The fall N by spring flame interaction was significant. Fields not receiving spring flame increased in yield as the lbs./A of fall N increased, while those fields receiving spring flame decreased in yield as the lbs./A of fall N increased. The number of fields receiving fall N and spring flame treatments is very low in some cases and results should be carefully interpreted because these are fields in which one or two growers reported results. Orthene applications increased yields by 17 lbs./A.

Table 2.8: Treatment Effects, Willamette Valley Fields Sampled with Cutworms

Treatment Effects		Mean Yield (lbs./A)	Standard Deviation (lbs./A)	(N)
Tillage		77.3	17.6	(17)
No Tillage		80.3	17.6	(138)
Age of Stand:				
More than 1 year		81.3	16.0	(140)
1 year or less		67.3	25.7	(15)
Spring Flame		80.5	16.4	(115)
Not Spring Flame		78.2	20.9	(40)
Fall Flame		81.9	15.2	(99)
Not Fall Flame		76.5	20.9	(54)
Spring N:				
$0 \leq$ lb./A < 250		74.4	18.9	(30)
$250 \leq$ lb./A < 300		79.6	16.2	(63)
lb./A ≥ 300		82.4	17.8	(69)
Fall N		73.0	16.2	(131)
No Fall N		81.5	23.2	(25)
Fall N by Spring Flame:				
0 lb./A	No	78.0	17.9	(22)
$0 <$ lb./A ≤ 50	No	79.7	19.8	(4)
$50 <$ lb./A < 100	No	72.4	28.1	(10)
lb./A ≥ 100	No	90.0	13.2	(3)*
0 lb./A	Yes	82.0	15.9	(106)
$50 \leq$ lb./A < 100	Yes	68.0	20.0	(4)#
lb./A ≥ 100	Yes	50.0	0.0	(3)**
Orthene Applied		81.7	16.8	(139)
Orthene not Applied		64.6	19.5	(16)
Root Weevils a problem		80.2	17.0	(44)
Root Weevils not a problem		80.0	17.9	(111)

*ID: Respondent 29
#ID: Respondents 2, 11, 73, 73
**ID: Respondent 35

Results of the statistical analysis of the effects on mean yield are given in Table 2.9. The effects of age of stand, spring N, and Orthene applications were positive on mean yield. The fall N by spring flame interaction increased yields when spring flame was not present, and had a negative effect when spring flame was present. Tillage, spring flame, fall flame, fall N, and root weevil presence were not significant. The effect of fall N by spring flame interaction should be carefully interpreted because the sample sizes for these treatments are quite small in some cases (Table 2.8).

Table 2.9: Statistical Analysis, Willamette Valley Fields Sampled with Cutworms

Variable	Effect on Yields	df	F-value	p-value
Age of Stand	positive	1	10.03	0.001
Tillage	none	1	0.57	0.451
Spring Flame	none	1	0.47	0.494
Fall Flame	none	1	0.46	0.497
Spring N	positive	1	5.90	0.016
Fall N	none	1	0.01	0.936
Root Weevil	none	1	1.55	0.215
Orthene Applied	positive	1	6.30	0.013
Fall N by Spring Flame	see Table 2.8	1	3.91	0.049

Overall F = 4.29, p-value < 0.0001 with 9 & 145 df
$R^2 = 0.21$

The "1995 Pacific Northwest Insect Control Handbook" recommends using Lannate, Orthene, and *Bacillus thuringiensis* for cutworms in mint (Fisher, p. 113). About 79 percent of the fields surveyed reported problems with cutworms (Table A, Appendix A). Of these fields, about 90 percent received a chemical application, most of which was Orthene (Tables B2 and C, Appendix A). This gives a large sample size to interpret the effect of chemical applications. The results of this study suggest that the best method for fighting cutworms is an application of Orthene combined with good cultural practices.

NEMATODES

The root-lesion nematode feeds internally on plant roots, stunting root and plant growth and can also promote verticillium wilt infestation (Lacy, et. al., p. 9). Nematodes were present in about 66 percent of the fields surveyed in this study with an average severity score of 6.4 (Table A, Appendix A). Cultural practices and pesticides studied on nematode-infested fields include tillage, spring flame, fall flame, spring N, fall N, and chemical applications (Vydate, Dyfonate, and unknown chemicals; Table C, Appendix A). Tables 2.10, 2.11, and 2.12 give the summary statistics, treatment effects, and statistical analyses for those fields reporting nematodes.

Summary statistics for fields with nematodes are reported in Table 2.10. The average number of acres per field was 57, with an average yield of about 79 lbs./A. The maximum yield was 110 lbs./A while the minimum yield was 30 lbs./A. Ninety-five percent of the stands were aged greater than one year and about 13 percent of the fields had been tilled. Spring flaming was reported on 74 percent of the fields (17 percent higher than overall results), and 61 percent of the

Table 2.10: Summary Statistics, Willamette Valley Fields Sampled with Nematode

Summary Statistics	Mean	Standard Deviation	(N)
Number of Acres	57.0	40.1	(137)
1992 Yield (lbs./A)	79.1	16.8	(137)
Maximum Yield (lbs./A)	110.0	---	(137)
Minimum Yield (lbs./A)	30.0	---	(137)
Age of Stand (% > 1 yr.)	94.9	22.1	(137)
Fields Tilled (%)	13.1	33.9	(137)
Fields Spring Flamed (%)	74.5	43.7	(137)
Fields Fall Flamed (%)	61.2	48.9	(137)
Vydate Applied (%)	83.9	36.8	(137)
Verticillium Wilt (%)	76.6	42.4	(137)
Spring N (lbs./A)	230.7	61.5	(137)
Fall N (lbs./A)	70.2	39.4	(14)

fields were fall flamed. About 85 percent of the fields with nematodes received Vydate applications. Spring N was applied at an average of 231 lbs./A to 137 fields, while fall N averaged about 70 lbs./A on only 14 fields.

A summary of the treatment effects, including mean yield (in lbs./A), standard deviation, and total N is given in Table 2.11. Tilled fields produced an average of 73 lbs./A, and those not tilled had a mean yield of almost 80 lbs./A. Fields more than 1 year old averaged about 80 lbs./A while those that were a year old or less averaged 68 lbs./A. Those fields spring flamed produced an average of 79 lbs./A, and those not spring flamed yielded about the same. Fields receiving fall flame produced an average of 82 lbs/A and those not fall flamed, 76 lbs./A. This is consistent with the results for the overall statistics (Table 2.2). Spring N applications had a positive effect on yield; averages ranged from 75 to 83 lbs./A. Fall N applications had a positive effect as well; fields not receiving fall N averaged 79 lbs./A and those receiving fall N, 84 lbs./A. Fields receiving Vydate applications gave an average yield of about 79 lbs./A, while those not receiving any Vydate applications averaged about 83 lbs./A. Fields with verticillium wilt problems averaged about 4 lbs./A less than fields without wilt. The fall N by spring flame interaction was <u>not</u> a significant effect. (This is not consistent with the overall results reported in Table 2.2.) Fields tended to increase in yield as the lbs./A of fall N increased for fields with <u>no</u> spring flame, while fields receiving spring flame seemed not to be affected by an increase in fall N. It should be noted that the number of fields receiving fall N and spring flame treatments is very low in some cases and results should be carefully interpreted because these are fields in which only one or two growers reported results.

Table 2.11: Treatment Effects, Willamette Valley Fields Sampled with Nematodes

Treatment Effects		Mean Yield (lbs./A)	Standard Deviation (lbs./A)	(N)
Tillage		73.1	18.2	(17)
No Tillage		80.3	16.6	(117)
Age of Stand:				
More than 1 year		80.0	16.2	(127)
1 year or less		68.0	24.9	(7)
Spring Flame		79.5	15.5	(100)
No Spring Flame		79.2	20.7	(34)
Fall Flame		81.5	14.2	(83)
No Fall Flame		75.9	20.2	(51)
Spring N:				
$0 \leq$ lb./A < 250		77.9	19.8	(21)
$250 \leq$ lb./A < 300		75.2	16.5	(59)
lb./A ≥ 300		83.4	15.2	(55)
Fall N		83.7	17.0	(119)
No Fall N		78.6	15.9	(13)
Fall N by Spring Flame:				
0 lb./A	No	74.0	20.5	(22)
$0 <$ lb./A ≤ 50	No	76.3	22.7	(3)
$50 <$ lb./A ≤ 100	No	85.0	21.9	(3)
lb./A >100	No	92.5	11.9	(4)*
0 lb./A	Yes	79.2	15.9	(93)
$50 \leq$ lb./A < 100	Yes	78.0	3.6	(3)#
Vydate Applied		78.8	17.5	(114)
Vydate not Applied		83.0	12.5	(20)
Verticillium Wilt a problem		78.6	16.2	(102)
Verticillium Wilt not a problem		82.1	19.1	(32)

*ID: Respondent 29
#ID: Respondents 2, 73

Table 2.12 shows the results of the statistical analysis of the effects on mean yield for fields with nematodes. The effects of age of stand, spring N, and fall N were positive on mean yield. Tillage, spring flame, fall flame, and the fall N by spring flame interaction were not shown to be significant effects. Fields infected with verticillium wilt and those in which Vydate had been applied had significantly lower yields than wilt-free and non-Vydate fields.

Table 2.12: Statistical Analysis, Willamette Valley Fields Sampled with Nematodes

Variable	Effect on Yields	df	F-value	p-value
Age of Stand	positive	1	7.73	0.006
Tillage	none	1	3.22	0.075
Spring Flame	none	1	0.04	0.849
Fall Flame	none	1	1.09	0.151
Spring N	positive	1	9.49	0.003
Fall N	positive	1	12.68	0.005
Vydate	negative	1	3.51	0.063
Verticillium wilt a problem	negative	1	8.17	0.005
Fall N by Spring Flame	none	1	2.64	0.107

Overall F = 4.09, p-value < 0.0001 with 9 & 124 df
$R^2 = 0.229$

The "1995 Pacific Northwest Disease Control Handbook" recommends using crop rotation to corn or other grains, soil fumigation with Telone II, clean planting stock, and Vydate to control nematodes (Koepsell, p. 164). About 66 percent of the fields surveyed reported problems with nematodes. Of these fields, about 25 percent received a chemical application, most of which was Vydate. The results show that Vydate does not have a significant positive effect on mean yields. Some growers have adopted one or more unnamed chemicals, but it is not known what they are and there is no evidence that they improve yields. The other methods suggested by the handbook were not investigated in this study. The statistical results suggest that the age of stand being greater than 1 year and spring and fall N applications are the only significant effects on yield for nematodes. Verticillium wilt seems to depress yields on nematode-infested fields and low yield response to Vydate may reflect only a partial control of nematodes, or the fact that

Vydate is used on the most heavily infested fields and used very little on fields with minor infestations.

PIGWEED

Pigweed is another difficult weed to control. Just over half of the growers in this survey reported fields with pigweed, where the average severity score was 4.9 (Table A, Appendix A). Several herbicides have been used to control pigweed including Basagran, Buctril, Devrinol, Diuron, Goal, Gramoxone, and Sinbar (Table C3, Appendix A), all with seemingly no effect or a negative one. Other factors examined include tillage, spring flame, fall flame, spring N, and fall N. Tables 2.13, 2.14, and 2.15 give the summary statistics, treatment effects, and statistical analysis for fields with pigweed.

As is shown in Table 2.13, there was an average of about 52 acres per field having pigweed infestation. This is about 7 acres more than the overall infestation results (Table 2.1). The average 1992 yield was 78 lbs./A for those fields in this survey. Percentage of fields with the age of stand greater than one year was 93 percent. Eighty-two percent of all fields with pigweed

Table 2.13: Summary Statistics, Willamette Valley Fields Sampled with Pigweed

Summary Statistics	Mean	Standard Deviation	(N)
Number of Acres	51.5	38.7	(106)
1992 Yield (lbs./A)	78.0	17.6	(102)
Maximum Yield (lbs./A)	115.0	---	(102)
Minimum Yield (lbs./A)	30.0	---	(102)
Age of Stand (% > 1 yr.)	93.4	24.9	(106)
Fields Tilled (%)	12.3	33.0	(106)
Fields Spring Flamed (%)	82.1	38.5	(105)
Fields Fall Flamed (%)	66.0	48.0	(102)
Basagran (%)	38.7	48.9	(106)
Buctril (%)	27.4	44.8	(106)
Gramoxone (%)	7.5	26.5	(106)
Sinbar (%)	37.7	48.7	(106)
Spring Nitrogen (lbs./A)	280.5	76.8	(105)
Fall Nitrogen (lbs./A)	87.0	46.1	(15)

received spring flame, 66 percent were fall flamed, and 12 percent of the fields were tilled. These results are all higher than the overall statistics (Table 2.1). Fields receiving chemical applications account for about 77 percent of all fields with pigweed. Forty-one percent of the total sample with pigweed received unnamed chemicals and about 42 percent received named chemicals (Basagran, Buctril, Gramoxone, and Sinbar). Spring N was applied at an average of 281 lbs./A and fall N was applied at an average of 87 lbs./A. Table 2.16 also displays the standard deviations and total N for each of these summary statistics.

Table 2.14 shows the mean yield (in lbs./A), standard deviation, and total N for each treatment effect. The mean yield for those fields tilled was about 78 lbs./A while those not tilled produced about the same. Fields that had age of stand greater than 1 year averaged 79 lbs./A and those stands a year or less in age averaged 68 lbs./A. Table 2.17 also reports the mean yields for fields receiving Basagran, Buctril, Gramoxone, and Sinbar. Those fields spring flamed produced an average of 79 lbs./A while those not spring flamed produced about 5 lbs./A less. Fall flaming was a statistically significant effect on yield; those fields receiving fall flame produced an average of 81 lbs/A and those not fall flamed, 74 lbs./A. This is consistent with the overall results (Table 2.2). Spring-applied nitrogen had a positive effect on yield; the averaged ranged from about 73 to 85 lbs./A. Fields that received fall N averaged about 70 lbs./A, and those that didn't, 80 lbs./A. The fall N by spring flame interaction was significant as well. Fields <u>not</u> receiving spring flame tended to increase in yield as the lbs./A of fall N increased, while those fields receiving spring flame tended to decrease in yield as the lbs./A of fall N increased. Also, the number of fields receiving fall N and spring flame treatments is very low in some cases and results should be carefully interpreted because these are fields in which only one grower reported results.

Table 2.14: Treatment Effects, Willamette Valley Fields Sampled with Pigweed

Treatment Effects		Mean Yield (lbs./A)	Standard Deviation (lbs./A)	(N)
Tillage		74.4	18.5	(13)
No Tillage		77.6	17.6	(89)
Age of Stand:				
More than 1 year		78.8	17.1	(96)
1 year or less		67.8	24.0	(6)
Spring Flame		79.1	17.2	(83)
Not Spring Flame		73.9	19.4	(19)
Fall Flame		80.7	16.2	(71)
Not Fall Flame		72.3	19.7	(31)
Spring N:				
$0 \leq$ lb./A < 250		72.7	16.9	(21)
$250 \leq$ lb./A < 300		74.1	17.0	(40)
lb./A ≥ 300		84.6	16.5	(44)
Fall N		70.2	17.9	(90)
No Fall N		79.7	16.3	(13)
Fall N by Spring Flame:				
0 lb./A	No	68.6	19.8	(12)
$50 \leq$ lb./A ≤ 100	No	76.5	13.3	(4)
0 lb./A	Yes	80.8	17.0	(74)
$50 \leq$ lb./A ≤ 100	Yes	76.0	1.4	(2)#
lb./A >100	Yes	50.0	0.0	(4)**
Basagran Applied		80.5	17.1	(44)
Basagran not Applied		75.6	17.8	(58)
Buctril Applied		84.1	15.1	(29)
Buctril not Applied		75.8	18.2	(73)
Gramoxone Applied		69.7	18.6	(7)
Gramoxone not Applied		78.7	17.5	(95)
Sinbar Applied		75.5	17.2	(36)
Sinbar not Applied		79.6	17.9	(66)

#ID: Respondent 73
**ID: Respondent 35

Table 2.15 shows the results of the statistical analysis of the effects on mean yield. As can be seen, the effects of fall flame and spring N were positive on mean yield. Basagran and Buctril applications had no effect on yields, and Gramoxone and Sinbar were shown to have a negative effect. The fall N by spring flame interaction increased yields when spring flame was not present

Table 2.15: Statistical Analysis, Willamette Valley Fields Sampled with Pigweed

Variable	Effect on Yields	df	F-value	p-value
Age of Stand	none	1	2.41	0.124
Tillage	none	1	0.02	0.899
Spring Flame	none	1	0.24	0.624
Fall Flame	positive	1	5.71	0.019
Spring N	positive	1	6.87	0.019
Fall N	none	1	1.24	0.268
Basagran	none	1	0.05	0.828
Buctril	none	1	2.73	0.102
Gramoxone	negative	1	4.61	0.034
Sinbar	negative	1	3.44	0.067
Fall N by Spring Flame	see Table 2.14	1	8.20	0.005

Overall $F = 3.66$, p-value < 0.0003 with 11 & 90 df
$R^2 = 0.31$

and had a negative effect when spring flame was present. Age of stand, tillage, spring flame, fall N, Basagran, and Buctril were not shown to be significant effects, although Buctril had a marginally positive effect. The effect of fall flame by spring N interaction should be carefully interpreted because the sample sizes for these treatments is quite small in some cases, see Table 2.14.

The "1995 Pacific Northwest Weed Control Handbook" recommends using Sinbar for annual grass and broadleaf weeds in new plantings and established mint; Gramoxone for annual grass and broadleaf weeds in established mint; and Basagran and Buctril for annual broadleaf weeds, among other recommended herbicides (William, pp. 128-131). Pigweed was reported in almost 55 percent of the fields studied, and about 77 percent of these fields reported using chemical applications, most of which were named chemicals (Tables A-C, Appendix A). Basagran and Buctril effects on yields were not shown to be statistically significant, but they did increase yields by 5 and 8 lbs./A, respectively. The results of this study suggest that the best methods for dealing with pigweed are using some combination of high fall N application with no spring flame, or no fall N application with spring flame, spring N applications, and possibly Basagran or Buctril.

RUST

Rust was reported in almost 58 percent of the fields studied in the Willamette Valley with an average severity score of 5.3. The "1995 Pacific Northwest Plant Disease Control Handbook" recommends using flaming or clean plowing to control rust (Koepsell, p. 164). Methods used by the growers in this study include tillage, spring flame, fall flame, and chemical applications (Bravo, Sulphur, and unnamed; Table C, Appendix A). The data for rust-infested fields are discussed in two parts: effects on the total sample of rust-infested fields, and effects on 'chemical-applied' fields vs. 'no-chemical' fields.

Total Sample

As is shown in Table 2.16, there was an average of about 53 acres per field with rust infestation. This is about 9 acres more than the overall infestation results (Table 2.1). The average 1992 yield was 79 lbs./A for those fields in this survey. Maximum and minimum yields were the same as that reported for overall results (115 lbs./A and 20 lbs./A, respectively).

Table 2.16: Summary Statistics, Willamette Valley Fields Sampled with Rust

Summary Statistics	Mean	Standard Deviation	(N)
Number of Acres	53.4	40.0	(120)
1992 Yield (lbs./A)	79.3	19.2	(119)
Maximum Yield (lbs./A)	115.0	---	(119)
Minimum Yield (lbs./A)	20.0	---	(119)
Age of Stand (% > 1 yr.)	83.3	37.4	(120)
Fields Tilled (%)	14.2	35.0	(120)
Fields Spring Flamed (%)	61.7	48.8	(116)
Fields Fall Flamed (%)	55.0	49.9	(116)
Bravo (%)	5.8	28.5	(120)
Unnamed Chemicals (%)	33.3	47.3	(120)
Spring Nitrogen (lbs./A)	276.2	63.9	(120)
Fall Nitrogen (lbs./A)	64.7	31.7	(22)

Percentage of fields with the age of stand greater than 1 year was 83 percent. Sixty-one percent of all fields with rust received spring flame, 55 percent were fall flamed, and 14 percent of the fields were tilled. These results are all higher than the overall infestation statistics (Table 2.1). Thirty-three percent of the total sample with rust received unnamed chemicals and about 6 percent received Bravo. Spring N was applied at an average of 276 lbs./A and fall N was applied at an average of 65 lbs./A. Table 2.19 also displays the standard deviations and total N for each of these summary statistics.

Table 2.17 shows the mean yield (in lbs./A), standard deviation, and total N for each of the treatment effects. The mean yield for those fields tilled was about 75 lbs./A while those not tilled produced an average of 80 lbs./A. Fields that had an age of stand greater than 1 year averaged 82 lbs./A and those that were a year or less in age averaged 63 lbs./A. Bravo-applied fields averaged about 67 lbs./A and fields not receiving Bravo averaged about 80 lbs./A. The same pattern was observed for fields receiving unnamed chemicals. Those fields spring flamed produced an average of 81 lbs./A while those not spring flamed produced about 6 lbs./A less. Fall flaming was shown to be a statistically significant effect on yield; those fields receiving fall flame produced an average of 85 lbs/A and those not fall flamed, 72 lbs./A. This is consistent with the results for the overall infestation results (Table 2.2). Spring N had a positive effect on yield; the average ranged from 75 to 83 lbs./A. Fall N-applied fields averaged 77 lbs./A and those that did not receive fall N applications, 80 lbs./A. The fall N by spring flame interaction was a significant effect as well. Fields <u>not</u> receiving spring flame tended to increase in yield as the lbs./A of fall N increased while those fields receiving spring flame tended to decrease in yield as the lbs./A of fall N increased. Also of import to note, the number of fields receiving fall N by spring flame treatment is very low in some cases and results should be carefully interpreted because these are fields in which only one or two growers reported results. Bravo vs. spring flame and unnamed chemicals vs. spring flame means, for age of stand a year or less and more than 1 year, are also reported in Table 2.17.

Table 2.17: Treatment Effects, Willamette Valley Fields Sampled with Rust

Treatment Effects		Mean Yield (lbs./A)	Standard Deviation (lbs./A)	(N)
Tillage		75.1	18.9	(17)
No Tillage		80.0	19.0	(100)
Age of Stand:				
More than 1 year		82.2	16.3	(99)
1 year or less		62.9	24.4	(18)
Spring Flame		81.4	16.2	(73)
Not Spring Flame		75.6	22.7	(44)
Fall Flame		84.8	14.5	(65)
Not Fall Flame		72.3	21.6	(52)
Spring N:				
$0 \leq$ lb./A < 250		79.5	19.2	(24)
$250 \leq$ lb./A < 300		74.8	18.3	(48)
lb./A ≥ 300		83.4	19.2	(46)
Fall N		77.1	18.0	(97)
No Fall N		80.1	24.1	(21)
Fall N by Spring Flame:				
0 lb./A	No	72.2	21.0	(25)
$0 <$ lb./A ≤ 50	No	79.8	19.8	(4)
$50 <$ lb/A ≤ 100	No	72.4	28.1	(10)
lb./A > 100	No	92.5	11.9	(4)*
0 lb./A	Yes	79.9	16.8	(68)
$50 \leq$ lb./A ≤ 100	Yes	57.5	27.6	(4)#

*ID: Field 29
#ID: Fields 2, 11

Table 2.17 (Continued): Treatment Effects, Willamette Valley Fields Sampled with Rust

Treatment Effects		Mean Yield (lbs./A)	Standard Deviation (lbs./A)	(N)
Bravo Applied		66.5	19.7	(6)
Bravo not Applied		80.0	18.8	(113)
Unnamed Chemicals Applied		76.6	21.3	(40)
Unnamed Chemicals not Applied		80.6	17.8	(79)
Age 1 Year or Less:				
Bravo	Spring Flame			
No	No	63.4	26.6	(12)
No	Yes	63.8	20.8	(2)
Yes	No	54.0	22.6	(5)
Unnamed	Spring Flame			
No	No	61.0	16.8	(7)
No	Yes	54.0	29.4	(2)
Yes	No	65.3	29.4	(10)
Age More Than 1 Year:				
Bravo	Spring Flame			
No	No	82.2	18.5	(28)
No	Yes	82.7	15.9	(71)
Yes	Yes	80.0	---	(1)
Unnamed	Spring Flame			
No	No	81.3	20.8	(12)
No	Yes	83.7	15.1	(58)
Yes	No	82.9	17.3	(16)
Yes	Yes	78.2	18.0	(14)

Table 2.18 shows the results of the statistical analysis of the effects on mean yield. The effects of age of stand, fall flame, and spring N were positive on mean yield, and fall N had a negative effect. The fall N by spring flame interaction increased yields when spring flame was not present, and had a negative effect when spring flame was present. The effect of fall flame by spring N interaction should be carefully interpreted because the sample sizes for these treatments

is quite small in some cases (see Table 2.17). Tillage, spring flame, fall N, Bravo, and unnamed chemicals did not significantly affect yield. The Bravo by spring flame, and unnamed chemicals by spring flame interactions were also not significant. Their means are reported in Table 2.17.

Table 2.18: Statistical Analysis, Willamette Valley Fields Sampled with Rust

Variable	Effect on Yields	df	F-value	p-value
Age of Stand	positive	1	6.57	0.011
Tillage	none	1	0.36	0.548
Spring Flame	none	1	0.28	0.597
Fall Flame	positive	1	6.19	0.014
Spring N	positive	1	3.67	0.058
Fall N	negative	1	4.26	0.041
Bravo	none	1	0.10	0.756
Unnamed Chemicals	none	1	1.10	0.295
Fall N by Spring Flame	see Table 2.17	1	3.24	0.075
Bravo by Spring Flame	see Table 2.17	1	0.01	0.910
Unnamed Chemicals by Spring Flame	see Table 2.17	1	0.38	0.541

Overall F = 3.41, p-value < 0.0001 with 11 & 105 df
$R^2 = 0.26$

Chemical-Applied vs. No Chemical-Applied

Chemical-Applied Fields. Considering all chemical-applied fields, yields averaged nearly 77 lbs./A; the highest yield ever obtained averaged 85.5 lbs./A and the maximum potential yield (the most growers thought could be obtained under ideal conditions) averaged 101.4 pounds. The stand age averaged 3.9 years. Seventeen percent of the fields had been tilled in 1992 and 32 percent spring flamed. Bravo had been applied to 15 percent of the fields and unnamed chemicals to 93 percent. Spring N averaged 259.9 lbs./A and fall N, 17.9 lbs./A.

None of the chemical applications nor any of the cultural applications affected 1992 yields, according to the statistical analysis. Tilled field means were slightly less than the means for untilled fields. Mean yields for Bravo-applied fields were also lower than fields in which Bravo had not been applied. Yields for fields treated with unnamed chemicals were slightly higher than yields for fields in which an unnamed chemical had not been applied. Differences, however, were not large enough to be statistically significant. Yields for fields that had been spring flamed nearly equaled those for fields without spring flaming. Age of stand and spring flaming are correlated. Note that yields were higher for older fields (more than 1 year). The difference between yields for spring flaming and no flaming was not statistically significant among older fields. Level of spring or fall-applied nitrogen did not affect yields either.

The distribution of mint yields by grouped levels of spring N is presented in Table 2.19. Nitrogen effects are limited for the full range of applications, resulting in non-significant yield differences overall. Note that there is little benefit to yields at rates above 250 lbs. N/A.

Table 2.19: Willamette Valley Mint Yields in Rust-Infested, Chemical-Applied Fields by Grouped Levels of Spring N

Lbs. N/A	# of Fields	Mean Yield (lbs./A)	Standard Deviation
≤ 100	2	92.5	24.7
101 - 150	0	0.0	0.0
151 - 200	3	60.7	26.9
201 - 250	17	81.9	17.2
251 - 300	15	71.3	19.8
301 - 350	5	77.2	32.5
> 350	1	82.0	0.0

No-Chemical Fields. For all no-chemical-applied fields, mint yields averaged 80.9 lbs./A, higher than the 76.6 pounds for chemical-applied fields. The highest yields ever obtained averaged 93.6 pounds and the maximum potential yield averaged 99.5 pounds, about the same as fields in which chemicals had been applied. Age of stand averaged 7.8 years, higher than the 3.9 years for fields in which chemicals had been applied. Thirteen percent of the fields had been tilled and 79 percent had been spring flamed. Spring N applications averaged 279.7 lbs./A and fall N averaged 8.6 pounds.

Two variables were statistically associated with 1992 yields: age of stand and level of spring N. Older fields (more than 1 year old) averaged 83.3 lbs./A while one-year fields averaged 52.7 pounds. Age of stand and spring flaming are highly correlated. Note that spring flaming yields differed only slightly when controlled for age of stand. Three out of four growers had spring flamed older stands and achieved the highest yield reported -- 83.7 lbs./A. Fields for the remaining growers did not differ significantly by age-flame differences. Yields responded to spring N levels. Tillage and level of fall N applications did not affect mint yields statistically.

Spring N effects were found for the full range of applications. The distribution of mint yields by grouped nitrogen levels is shown in Table 2.20.

Table 2.20: Willamette Valley Mint Yields in Rust-Infested, No-Chemical Fields by Grouped Levels of Spring N

Lbs. N/A	# of Fields	Mean Yield (lbs./A)	Standard Deviation
≤ 100	5	92.0	10.4
101 - 150	0	0.0	0.0
151 - 200	3	65.0	21.8
201 - 250	13	73.6	16.3
251 - 300	31	77.6	16.7
301 - 350	21	86.4	17.9
> 350	3	104.3	9.3

Conclusion. The results point to few growers using Bravo and there is no evidence that Bravo applications improved yields. Rust is one of the more serious infestations, as noted by the subjective 'seriousness' scale mean. Many growers have adopted one or more unnamed chemicals and there is evidence that some of them may indeed improve yields. Spring flaming remains an important practice to sanitize fields. Its effect is masked in our data by age of stand, which has a stronger impact on yields than flaming, as shown for fields in which no chemicals had been applied. For example, nearly a third of the stands on which rust inhibitors had been applied were 1 year old. Only 8 percent of the non-chemical fields were new plantings.

SPIDER MITES

Spider mites were present in about half of the fields surveyed in the Willamette Valley, with an average severity score of 5.7 (Table A, Appendix A). This does not appear to present as big a problem as some of the other more severe infestations; however, spider mites are hard to detect because they are so small (about the size of a period on this page), which does present a problem for growers. Pesticides and cultural practices used on spider mite-infested fields that were studied in this survey include chemical applications (Comite, Kelthane, and Sulphur), tillage, spring N, fall N, spring flame, and fall flame. The tables in this section give the summary statistics, treatment effects, and statistical summary for fields reporting spider mites.

Table 2.21 gives the summary statistics for fields with spider mites. The average number of acres per field was 63 with an average yield of about 76 lbs./A. The maximum yield was 110 lbs./A (5 lbs./A less than overall results, Table 2.1) while the minimum yield was 20 lbs./A. Eighty-eight percent of the stands were aged greater than 1 year and about 13 percent of the

Table 2.21: Summary Statistics, Willamette Valley Fields Sampled with Spider Mites

Summary Statistics	Mean	Standard Deviation	(N)
Number of Acres	63.0	39.7	(96)
1992 Yield (lbs./A)	75.6	18.1	(94)
Maximum Yield (lbs./A)	110.0	---	(94)
Minimum Yield (lbs./A)	20.0	---	(94)
Age of Stand (% > 1 yr.)	87.6	33.2	(96)
Fields Tilled (%)	12.5	33.2	(96)
Fields Spring Flamed (%)	68.8	46.6	(95)
Fields Fall Flamed (%)	49.0	50.6	(92)
Comite Applied (%)	58.3	49.6	(96)
Kelthane Applied (%)	13.5	34.4	(96)
Spring N (lbs./A)	270.0	59.6	(95)
Fall N (lbs./A)	85.9	55.9	(16)

fields had been tilled. Sixty-nine percent of the fields were spring flamed (12 percent higher than overall results) and 49 percent of them were fall flamed. Chemicals were applied to about 70 percent of the fields, where 58 percent of these received Comite and 14 percent received Kelthane applications. Notice that this adds up to more than 70 percent, so some fields received more than one kind of application. Spring nitrogen was applied at an average of 270 lbs./A, while fall nitrogen was applied at about 86 lbs./A. The 1992 non-mite yield averaged about 80 lbs./A.

Table 2.22 displays the mean yield (in lbs./A), standard deviation, and total N for each of the treatment effects. Tilled fields produced an average of 74 lbs./A and those not tilled had a mean yield of 78 lbs./A. Fields that had age of stand greater than 1 year averaged 79 lbs./A while those that were a year or less in age averaged 17 lbs./A less. Those fields spring flamed produced an average of 78 lbs./A and those not spring flamed had a mean yield of 75 lbs./A. Fields receiving fall flame produced an average of 79 lbs/A and those not fall flamed, 75 lbs./A. This is consistent with the overall results (Table 2.2). Spring N-applied fields averaged around 76 to 77 lbs./A and fall N-applied fields, 74 lbs./A. Fields that did not receive fall N applications had a mean yield of 78 lbs./A. Fields receiving chemical applications gave an average yield of 76 lbs./A, while those not receiving any chemical applications averaged about 78 lbs./A. The fields that received Comite applications had an average yield of almost 79 lbs./A and those not receiving Comite averaged about 4 lbs./A less. Kelthane-applied fields averaged about 60 lbs./A, while non-Kelthane-applied fields were about 20 lbs./A more, which is a significant negative effect. The fall N by spring flame interaction was <u>not</u> a significant effect. (This is not consistent with the overall results reported in Table 2.2.) Fields tended to decrease in yield as the lbs./A of fall N increased for both fields receiving and not receiving spring flame. It should be noted that the

Table 2.22: Treatment Effects, Willamette Valley Fields Sampled with Spider Mites

Treatment Effects		Mean Yield (lbs./A)	Standard Deviation (lbs./A)	(N)
Tillage		74.1	16.4	(13)
No Tillage		77.5	18.3	(79)
Age of Stand:				
More than 1 year		79.1	15.8	(81)
1 year or less		62.0	25.5	(11)
Spring Flame		78.1	15.0	(63)
No Spring Flame		74.6	23.2	(29)
Fall Flame		79.4	15.0	(46)
No Fall Flame		74.7	20.4	(46)
Spring N:				
0 ≤ lb./A < 250		75.6	18.8	(18)
250 ≤ lb./A < 300		77.1	16.4	(50)
lb./A ≥ 300		76.4	20.4	(28)
Fall N		73.8	16.9	(79)
No Fall N		78.0	24.9	(14)
Fall N by Spring Flame:				
0 lb./A	No	74.5	19.5	(17)
0 < lb./A ≤ 50	No	66.0	19.8	(2)
50 < lb./A < 100	No	56.8	31.3	(5)
lb./A ≥ 100	No	92.5	11.9	(4)*
0 lb./A	Yes	78.5	16.0	(59)
50 ≤ lb./A < 100	Yes	78.5	4.9	(2)#
Comite Applied		78.9	16.6	(51)
Comite not Applied		74.7	19.4	(41)
Kelthane Applied		59.8	23.9	(13)
Kelthane not Applied		79.8	15.2	(79)

*ID: Respondent 29
#ID: Respondents 11, 73

number of fields receiving fall N by spring flame treatment is very low in some cases and results should be carefully interpreted because these are fields in which only one grower reported results.

Table 2.23 shows the results of the statistical analysis of the effects on mean yield for fields with spider mites. As seen, the effect of age of stand was positive on mean yield and the effect of Kelthane was negative. Tillage, spring flame, fall flame, spring N, fall N, Comite, and the fall N by spring flame interaction were not significant effects.

Table 2.23: Statistical Analysis, Willamette Valley Fields Sampled with Spider Mites

Variable	Effect on Yields	df	F-value	p-value
Age of Stand	positive	1	6.26	0.014
Tillage	none	1	1.25	0.268
Spring Flame	none	1	1.92	0.170
Fall Flame	none	1	0.00	0.986
Spring N	none	1	0.01	0.913
Fall N	none	1	0.29	0.592
Comite	none	1	0.04	0.835
Kelthane	negative	1	13.20	0.001
Fall N by Spring Flame	none	1	0.85	0.358

Overall $F = 2.97$, p-value < 0.0042 with 9 & 82 df
$R^2 = 0.25$

The "1995 Pacific Northwest Insect Control Handbook" recommends using Kelthane, dicofol, Omite, Comite, Metasystox, and malathion for spider mites (Fisher, p. 115). About 48 percent of the fields surveyed reported problems with spider mites. Of these fields, about 70 percent of them received a chemical application, usually Comite or Kelthane (Tables A-C, Appendix A). This gives a large sample size to interpret the effect of chemical applications. The results show that Comite does not have a significant effect on mean yields and Kelthane actually has a negative effect. The average infestation seriousness score for fields that received Kelthane applications was 7.62, while those that did not receive Kelthane had an average score of 5.43. This indicates that Kelthane is being applied only when the fields have very severe problems with spider mites. However, Kelthane does not seem to improve yields. This interpretation should be viewed cautiously since there is no control group for comparison purposes. This study suggests that the age of stand being greater than 1 year is the only significant effect when dealing with the problem of spider mites. Age effects may have masked the contribution of Comite applications.

SYMPHYLIDS

Symphylids are a very severe problem for mint growers in western Oregon. In particular, symphylids were reported in 76 percent of the fields studied in the Willamette Valley with a severity score of 5.7 (Table A, Appendix A). Methods studied in this report include tillage, spring flame, fall flame, spring N, fall N, and chemical applications (Dyfonate 10G, Dyfonate, Lorsban, and Vydate; Table C, Appendix A). Tables 2.24, 2.25, and 2.26 give the summary statistics, treatment effects, and statistical analysis for fields reporting symphylids.

Table 2.24 gives the summary statistics for fields in the Willamette Valley with symphylids. Fields averaged 52 acres with a 1992 average yield of 79 lbs./A. The maximum yield for these fields was reported to be 115 lbs./A and the minimum, 30 lbs./A. Ninety-two percent of the fields had an age of stand greater than 1 year, 12 percent were tilled, 75 percent spring flamed, and 64 percent fall flamed. Dyfonate applications were reported on almost 90 percent of the fields where 38 percent were liquid applications and 52 percent were dry. Spring nitrogen

Table 2.24: Summary Statistics, Willamette Valley Fields Sampled with Symphylids

Summary Statistics	Mean	Standard Deviation	(N)
Number of Acres	52.0	39.0	(154)
1992 Yield (lbs./A)	79.2	17.1	(152)
Maximum Yield (lbs./A)	115.0	---	(152)
Minimum Yield (lbs./A)	30.0	---	(152)
Age of Stand (% > 1 yr.)	92.2	26.9	(154)
Fields Tilled (%)	11.7	32.2	(154)
Fields Spring Flamed (%)	74.7	43.7	(154)
Fields Fall Flamed (%)	64.3	48.1	(154)
Dyfonate Liquid (%)	37.7	48.6	(154)
Dyfonate Dry (%)	51.9	50.1	(154)
Spring Nitrogen (lbs./A)	274.8	68.4	(99)
Fall Nitrogen (lbs./A)	91.9	37.4	(13)

averaged 275 lbs./A and fall nitrogen, 92 lbs./A. Table 2.24 also reports standard deviations and N for each of these statistics.

Listed in Table 2.25 are the treatment effects for each of the methods used to control symphylids. Tilled fields in this study produced an average of 74 lbs./A while fields that had not been tilled produced about 80 lbs./A. Fields with age of stand greater than 1 year had a mean yield of 80 lbs./A and those that were a year or less in age, 69 lbs./A. Spring flamed fields averaged 80 lbs./A and those that were not spring flamed, 2 lbs./A less. Fall flamed fields produced an average of about 81 lbs./A and those not fall flamed, 76 lbs./A. These results are all consistent with results from the overall effects, Table 2.2. Spring N had a positive effect on yield; the average ranged from 74 to 83 lbs./A. Fall N-applied fields averaged 77 lbs./A, while those not receiving fall N were about 3 lbs./A higher. Fields that received liquid Dyfonate applications yielded 79 lbs./A. Fields receiving dry Dyfonate yielded 83 lbs./A. The dry Dyfonate had a marginally significant effect on mean yield (see Table 2.26). The fall N by spring flame interaction had a significant effect on yields. Mean yields tended to increase as fall N increased when spring flame was <u>not</u> present. When spring flame was present, mean yields tended to decrease as fall N increased.

Table 2.25: Treatment Effects, Willamette Valley Fields Sampled with Symphylids

Treatment Effects		Mean Yield (lbs./A)	Standard Deviation (lbs./A)	(N)
Tillage		74.5	17.9	(18)
No Tillage		80.2	16.9	(128)
Age of Stand:				
More than 1 year		80.3	16.4	(136)
1 year or less		68.9	23.2	(10)
Spring Flame		80.0	15.9	(110)
Not Spring Flame		78.0	20.5	(36)
Fall Flame		81.4	15.8	(96)
Not Fall Flame		76.0	19.1	(50)
Spring N:				
0 ≤ lb./A < 250		73.6	18.5	(31)
250 ≤ lb./A < 300		78.3	17.8	(62)
lb./A ≥ 300		83.2	14.7	(62)
Fall N		77.3	16.9	(128)
No Fall N		80.1	19.6	(19)
Fall N by Spring Flame:				
0 lb./A	No	73.2	20.4	(24)
0 < lb./A ≤ 50	No	66.0	19.8	(2)
50 < lb./A ≤ 100	No	88.6	16.5	(5)
lb./A > 100	No	92.5	11.0	(4)[#]
0 lb./A	Yes	81.3	15.6	(100)
50 < lb./A ≤ 100	Yes	78.0	3.6	(3)[*]
lb./A >100	Yes	50.0	0.0	(4)[**]
Dyfonate Liquid Applied		79.0	16.2	(58)
Dyfonate Liquid not Applied		79.9	17.7	(88)
Dyfonate Dry Applied		82.8	16.4	(74)
Dyfonate Dry not Applied		76.4	17.2	(72)

[#]ID: Respondent 29
[*]ID: Respondent 73
[**]ID: Respondent 35

Table 2.26 shows the results from the statistical analysis on fields with symphylids in the Willamette Valley. Spring N applications and age of stand had significant positive influence on yields. Dyfonate applications, tillage, spring flame, fall flame, and fall N did not have a significant effect on mean yields. The fall N by spring flame interaction had a positive effect on mean yield when spring flame was not present, and it had a negative effect when spring flame was present.

Table 2.26: Statistical Analysis, Willamette Valley Fields Sampled with Symphylids

Variable	Effect on Yields	df	F-value	p-value
Age of Stand	none	1	3.71	0.056
Tillage	none	1	0.96	0.322
Spring Flame	none	1	0.06	0.804
Fall Flame	none	1	2.07	0.153
Spring N	positive	1	8.31	0.005
Fall N	none	1	2.07	0.152
Dyfonate Liquid	none	1	1.69	0.196
Dyfonate Dry	none	1	2.72	0.102
Fall N by Spring Flame	see Table 2.25	1	14.19	0.001

Overall F = 5.01, p-value < 0.0001 with 9 & 136 df
$R^2 = 0.25$

The "1995 Pacific Northwest Insect Control Handbook" recommends using Telone II, C-17, Dyfonate 4E, or Lorsban 4E for controlling symphylan (Fisher, p. 113). Symphylids were reported in 76 percent of the fields studied, and about 91 percent of these fields reported use of a chemical application, usually Dyfonate of some form (Table C, Appendix A). We can conclude that the age of stand and spring N applications had a significant positive effect on mean yields for fields with symphylids, but none of the chemicals seem to have strong effects. The results of this study suggest that the best methods for dealing with symphylid infestations are spring N, perhaps dry Dyfonate, or some combination of high fall N application with no spring flame, or no fall N application with spring flame.

VERTICILLIUM WILT

"Verticillium wilt, caused by the soil-borne fungus, *Verticillium dahliae*, is the most serious and destructive pest faced by mint growers," (Lacy, et. al., p. 7). Verticillium wilt was present in 64 percent of the fields in the Willamette Valley study with an average severity score of 4.8 (Table A, Appendix A), making it very widespread. Cultural practices used by growers on verticillium wilt-infested fields include tillage, spring flame, fall flame, spring N, fall N, and chemical applications (Vydate; Table C, Appendix A). Tables 2.27, 2.28, and 2.29 give the summary statistics, treatment effects, and statistical analyses for fields reporting verticillium wilt.

Summary statistics for fields with verticillium wilt are reported in Table 2.27. The average number of acres per field was 55 with an average yield of about 79 lbs./A. The maximum yield was 115 lbs./A while the minimum yield was 40 lbs./A (20 lbs./A higher than overall results, Table

Table 2.27: Summary Statistics, Willamette Valley Fields Sampled with Verticillium Wilt

Summary Statistics	Mean	Standard Deviation	(N)
Number of Acres	55.1	41.2	(128)
1992 Yield (lbs./A)	78.5	16.8	(128)
Maximum Yield (lbs./A)	115.0	---	(128)
Minimum Yield (lbs./A)	40.0	---	(128)
Age of Stand (% > 1 yr.)	97.6	15.2	(128)
Fields Tilled (%)	11.0	31.3	(128)
Fields Spring Flamed (%)	81.3	39.2	(128)
Fields Fall Flamed (%)	64.1	48.2	(128)
Nematodes (%)	77.3	42.0	(128)
Mint Variety:			
Todd (%)	48.0	---	(127)
Murray-Mitcham (%)	24.4	---	(127)
Black Mitcham (%)	15.0	---	(127)
Mixed (%)	12.6	---	(127)
Prior Mint Field (%)	37.5	48.6	(120)
Spring N (lbs./A)	277.4	66.85	(128)
Fall N (lbs./A)	90.2	52.9	(20)

2.1). Ninety-eight percent of the stands were aged greater than 1 year and about 11 percent of the fields had been tilled. Spring flaming was reported on 81 percent of the fields (24 percent higher than overall results) and 64 percent of them were fall flamed. About 77 percent of the fields with verticillium wilt also reported having nematodes present. There were four varieties of mint: 48 percent of the fields were the Todd variety, 24 percent Murray-Mitcham, 15 percent Black Mitcham, and 13 percent were a mixed variety. Thirty-eight percent of the fields had also been mint fields prior to this study. Spring N was applied at an average of 277 lbs./A while fall N was applied at about 90 lbs./A. The average non-verticillium wilt yield for 1992 was 77 lbs./A.

A summary of treatment effects, including mean yield (in lbs./A), standard deviation, and total N is given in Table 2.28. Tilled fields produced an average of 79 lbs./A, and those not tilled were the same. Fields that had age of stand greater than 1 year averaged about 79 lbs./A, while those that were a year or younger averaged just 2 lbs./A less, 22 lbs./A higher than overall results (Table 2.2). Spring flamed fields produced an average of 78 lbs./A, and those not spring flamed had a mean yield of 79 lbs./A. Fields receiving fall flame produced an average of 80 lbs/A and those not fall flamed, 76 lbs./A. Spring-applied nitrogen had a positive effect on yield; the averaged ranged from 74 to 84 lbs./A. Fields that received fall N applications averaged about 75 lbs./A and those that did not, 80 lbs./A. Where nematodes were a problem, those fields produced about 77 lbs./A, while those where nematodes were not a problem had yields 7 lbs./A higher. Fields of the Murray-Mitcham mint variety had the highest average yield, 87 lbs./A, of any of the varieties. The Black Mitcham variety gave 80 lbs./A, the Todd variety gave 74 lbs./A, and the mixed variety gave 76 lbs./A. Fields with prior mint history gave an average yield of 77 lbs./A, and the prior field <u>not</u> in mint averaged 2 lbs./A higher. The fall N by spring flame interaction was

Table 2.28: Treatment Effects, Willamette Valley Fields Sampled with Verticillium Wilt

Treatment Effects		Mean Yield (lbs./A)	Standard Deviation (lbs./A)	(N)
Tillage		79.4	13.5	(10)
No Tillage		78.5	17.5	(104)
Age of Stand:				
More than 1 year		78.7	17.2	(111)
1 year or less		76.7	11.5	(3)
Spring Flame		78.4	17.4	(91)
No Spring Flame		79.2	16.0	(23)
Fall Flame		80.0	16.7	(75)
No Fall Flame		75.9	17.7	(39)
Spring N:				
$0 \leq$ lb./A < 250		74.3	19.2	(24)
$250 \leq$ lb./A < 300		76.4	16.3	(52)
lb./A ≥ 300		83.6	15.6	(52)
Fall N		75.1	16.6	(105)
No Fall N		80.0	19.1	(18)
Fall N by Spring Flame:				
0 lb./A	No	76.9	14.7	(13)
$0 <$ lb./A ≤ 50	No	66.0	19.8	(2)
$50 <$ lb./A ≤ 100	No	80.0	17.2	(4)
lb./A >100	No	93.7	12.5	(4)*
0 lb./A	Yes	79.9	16.8	(88)
$50 \leq$ lb./A < 100	Yes	78.0	3.7	(3)#
lb./A >100	Yes	50.0	0.0	(4)**
Varieties:				
Todd		74.4	17.0	(52)
Murray-Mitcham		87.2	16.3	(29)
Black Mitcham		79.8	15.8	(18)
Mixed		75.7	15.0	(16)
Prior Field Mint		77.4	16.1	(41)
Prior Field not Mint		79.3	17.7	(73)
Nematodes a problem		77.3	16.1	(91)
Nematodes not a problem		83.8	20.3	(23)

*ID: Respondent 29
#ID: Respondent 73
**ID: Respondent 35

a significant effect. Fields tended to increase in yield as the lbs./A of fall N increased for fields with no spring flame, while fields receiving spring flame tended to decrease in yield as the fall N increased. It should be noted that the number of fields receiving fall N and spring flame treatments is very low in some cases and results should be carefully interpreted because these are fields in which only one grower reported results.

Table 2.29 shows the results of the statistical analysis of the effects on mean yield for fields with verticillium wilt. The effect of spring N was positive on mean yield, and the effect of nematodes present was negative. Age of stand, tillage, spring flame, fall flame, fall N, mint varieties, and field history were not shown to be significant effects. The fall N by spring flame interaction was a significant effect. Mean yields tended to increase as fall N increased when spring flame was not present, while mean yields tended to decrease with fall N increase when spring flame was present.

Table 2.29: Statistical Analysis, Willamette Valley Fields Sampled with Verticillium Wilt

Variable	Effect on Yields	df	F-value	p-value
Age of Stand	none	1	1.98	0.162
Tillage	none	1	0.0	0.981
Spring Flame	none	1	0.06	0.811
Fall Flame	none	1	1.45	0.231
Spring N	positive	1	6.64	0.011
Fall N	none	1	0.05	0.824
Varieties	none	1	1.83	0.146
Nematodes a problem	negative	1	7.13	0.009
Prior Field Mint	none	1	0.71	0.401
Fall N by Spring Flame	see Table 2.28	1	15.78	0.001

Overall F = 3.97, p-value < 0.0001 with 10 & 104 df
$R^2 = 0.32$

The "1995 Pacific Northwest Disease Control Handbook" recommends using certified planting stock for new plantings, removal from mint production, flaming, and soil fumigation to control verticillium wilt (Koepsell, p. 165). About 64 percent of the fields surveyed reported problems with verticillium wilt (Table A, Appendix A). The statistical results for this study suggest that spring N and some combination of high fall N application with no spring flame, or low fall N application with spring flame, are the only significant methods of promoting yield in verticillium wilt-infested mint fields.

CHAPTER 3

CENTRAL AND EASTERN OREGON INFESTATIONS

This section will report the results of the statistical analyses on the central and eastern Oregon fields surveyed. Each section will discuss the results for individual infestations. Tables 3.1, 3.2, and 3.3 display summary statistics, treatment effects, and statistical analyses for all fields studied in central and eastern Oregon. Tables of infestations and their severity scores are reported in Appendix A, Tables F-J.

Table 3.1 shows the summary statistics for the total central and eastern Oregon fields studied. There was an average of about 37 acres per field having infestations, with an average 1992 yield of 75 lbs./A for those in this survey. The maximum yield was 150 lbs./A while the minimum yield was 20 lbs./A. The percentage of fields with the age of stand greater than 1 year was 90 percent. Age of stand (% > 1 yr.), and tillage were used as controls for all statistical analyses, i.e., the other factors were analyzed with the effect of age of stand and tillage already

Table 3.1: Summary Statistics, Total Central and Eastern Oregon Fields Sampled

Summary Statistics	Mean	Standard Deviation	(N)
Number of Acres	36.5	38.2	(195)
1992 Yield (lbs./A)	75.3	23.5	(154)
Maximum Yield (lbs./A)	150.0	---	---
Minimum Yield (lbs./A)	20.0	---	---
Age of Stand (% > 1 yr.)	87.9	30.0	(165)
Fields Tilled (%)	36.0	46.2	(164)
Fields Spring Flamed (%)	2.6	14.2	(154)
Fields Fall Flamed (%)	18.9	36.2	(159)
Spring N (lbs./A)	244.0	37.9	(166)
Fall N (lbs./A)	57.2	18.6	(56)

accounted for. About 3 percent of the fields were spring flamed, 19 percent were fall flamed, and about 36 percent of the fields were tilled. Spring nitrogen (spring N) was applied at an average of 244 lbs./A, and fall nitrogen (fall N) was applied at an average of 59 lbs./A. Table 3.1 also displays the standard deviations and total N for each of these summary statistics.

Table 3.2 displays the mean yield (in lbs./A) for each of the treatment effects. The mean yield for those fields tilled was 68 lbs./A while those not tilled produced an average of about 12 lbs./A higher. Fields that had age of stand greater than 1 year averaged 78 lbs./A, and those that were a year or less only averaged 58 lbs./A. This effect, which was statistically significant (see Table 3.3), is reasonable since established fields are expected to yield more than new fields. Those fields spring flamed produced an average of 86 lbs./A while those not spring flamed produced about 11 lbs./A less. Fall flaming was also shown to be a statistically significant effect on yield; those fields receiving fall flame produced an average of about 89 lbs/A and those not fall flamed, 73 lbs./A. Fall N was a significant factor as well. Mean yields tended to increase as the pounds per acre of fall N increased. The till by fall N interaction was not a significant effect; mean yields seemed to be the same for increasing levels of fall N when tilling was both present and not present. Mean yields for spring N ranged from the low to high 70s, but spring N was not a statistically significant effect on yields. Also of importance to note, predicted values are used in the statistical analysis for the fall N missing data and results should be interpreted cautiously. Predicted values were employed because a large number (110) of fields were coded "Don't Know" for fall N applications.

Table 3.2: Treatment Effects, Total Central and Eastern Oregon Fields Sampled

Treatment Effects	Mean Yield (lbs./A)	Standard Deviation (lbs./A)	(N)
Tillage	67.7	23.7	(52)
No Tillage	79.8	22.3	(100)
Age of Stand:			
More than 1 year	78.2	22.6	(133)
1 year or less	57.7	21.2	(19)
Spring Flame	85.7	45.2	(4)
Not Spring Flame	75.4	22.8	(148)
Fall Flame	88.5	18.2	(30)
Not Fall Flame	72.5	23.5	(122)
Fall N*:			
0 lb./A	66.6	22.5	(39)
0 < lb./A < 20	65.0	26.4	(20)
20 ≤ lb./A < 30	73.4	24.6	(9)
30 ≤ lb./A < 40	77.6	15.4	(29)
40 ≤ lb./A < 60	80.3	21.8	(32)
lb./A ≥ 60	88.6	25.2	(25)
Till by Fall N*:			
No Till, 0 lb./A	67.6	25.1	(20)
No Till, 0 < lb./A < 20	---	---	(0)
No Till, 20 ≤ lb./A < 30	72.7	26.2	(8)
No Till, 30 ≤ lb./A < 40	77.2	16.0	(27)
No Till, 40 ≤ lb./A < 60	85.0	16.7	(24)
No Till, lb./A ≥ 60	91.7	24.6	(21)
Till, 0 lb./A	67.6	19.7	(17)
Till, 0 < lb./A < 20	65.0	26.4	(20)
Till, 20 ≤ lb./A < 30	79.0	---	(1)
Till, 30 ≤ lb./A < 40	83.0	5.6	(2)
Till, 40 ≤ lb./A < 60	66.4	29.8	(8)
Till, lb./A ≥ 60	73.8	25.8	(4)
Spring N:			
100 ≤ lb./A < 180	72.0	19.8	(13)
180 ≤ lb./A < 220	79.9	17.9	(21)
220 ≤ lb./A < 260	71.6	21.8	(67)
lb./A ≥ 260	77.4	27.8	(53)

*Predicted values are used for Fall N missing data.

Table 3.3 shows the results of the statistical analysis of the effects on mean yield. As can be seen, the effects of age of stand, fall flame, and fall N had increased yields. Tillage, spring flame, spring N, and the till by fall N interaction were not shown to be significant effects. An R^2 of 0.28 means that the statistical model accounted for 28 percent of the variation in yield.

Table 3.3: Statistical Analysis, Total Central and Eastern Oregon Fields Sampled

Variable	Effect on Mean Yield	df	F-value	p-value
Tillage	none	1	0.51	0.474
Age of Stand	positive	1	14.35	0.002
Spring Flame	none	1	0.11	0.745
Fall Flame	positive	1	4.50	0.036
Spring N	none	1	0.56	0.457
Fall N	positive	1	10.02	0.001
Till by Fall N	none	1	2.22	0.139

Overall $F = 8.13$, p-value < 0.0001 with 7 & 144 df
$R^2 = 0.28$

As with the Willamette Valley fields, chemical treatments are not considered in the overall model for central and eastern Oregon fields. They are analyzed and the results presented for the individual infestations.

Application rates and an effectiveness rating for chemicals applied to control pests are shown in Appendix A, Table H, p. A-16. The following pages report the results of statistical analyses of cultural and pesticide effects on mint yields. Readers interested in comparing the perceived effectiveness of these chemicals may wish to cross-check statistical results with those in Appendix A.

CUTWORMS

Cutworms were present in almost 54 percent of all fields surveyed in central and eastern Oregon, with a severity score of 5.4 (Table F, Appendix A). Cultural practices and pesticides in use on cutworm-infested fields that were studied include tillage, spring flame, fall flame, insecticides (Lannate, Lorsban, and Orthene; Table H, Appendix A), spring N and fall N.

Summary statistics, treatment effects, and statistical analysis for fields with cutworms are given in Tables 3.4, 3.5, and 3.6. As shown in Table 3.4, there was an average of about 47 acres per field containing cutworms. This is about 10 acres more than the overall results (Table 3.1). The average 1992 yield was 75 lbs./A for those fields with cutworms. Maximum yield was 36 lbs./A less than that reported for the overall results at 114 lbs./A, while the minimum yield was the same as the overall results (20 lbs./A). Percentage of fields with the age of stand greater than 1 year was 91 percent. While none of the fields received spring flaming, 13 percent were fall flamed, and 38 percent of the fields were tilled. Thirty percent of the total sample with cutworms

Table 3.4: Summary Statistics, Central and Eastern Oregon Fields Sampled with Cutworms

Summary Statistics	Mean	Standard Deviation	(N)
Number of Acres	46.6	35.3	(90)
1992 Yield (lbs./A)	74.6	21.1	(80)
Maximum Yield (lbs./A)	114.0	---	---
Minimum Yield (lbs./A)	20.0	---	---
Age of Stand (% > 1 yr.)	91.1	28.6	(90)
Fields Tilled (%)	38.2	48.9	(89)
Fields Spring Flamed (%)	0.0	---	(0)
Fields Fall Flamed (%)	13.3	34.2	(90)
Lorsban Applied (%)	27.8	45.0	(90)
Orthene Applied (%)	30.0	46.1	(90)
Root Weevils (%)	37.8	48.8	(90)
Spring N (lbs./A)	247.2	31.3	(90)
Fall N (lbs./A)	26.0	23.5	(47)

received Orthene and 28 percent received Lorsban, which are both chemicals recommended for use on cutworms in the "1995 Pacific Northwest Insect Control Handbook" (Fisher, p. 113). Spring N was applied at an average of 247 lbs./A while fall N was applied at an average of 26 lbs./A. Root weevil infestation was a problem in 38 percent of all fields with cutworms. Also displayed in Table 3.7 are the standard deviations and total N for each of these summary statistics.

Mean yield (in lbs./A), standard deviation, and total N for each of the treatment effects are listed in Table 3.5. Tilled fields produced an average of 65 lbs./A, and those not tilled had a mean yield 15 lbs./A higher. Fields that had age of stand greater than 1 year averaged 76 lbs./A, while those that were a year or less averaged about 67 lbs./A. Those fields receiving fall flame produced an average of 86 lbs/A and those not fall flamed, 73 lbs./A. This is consistent with the overall results (Table 3.2). Fields receiving fall N treatments tended to increase in yield as the fall N application increased, but it was not a significant increase. The spring N applied fields tended to decrease in yield as spring N application increased, but this was not a significant decrease. Lorsban and Orthene applications had a significant positive effect on mean yields. Fields receiving Lorsban averaged 78 lbs./A, while those without Lorsban were 73 lbs./A. Orthene-applied fields averaged about 86 lbs./A and those with no Orthene application, 70 lbs./A. Fields where root weevil infestation was a problem had a mean yield about 78 lbs./A and where it was <u>not</u> a problem, 73 lbs./A.

Table 3.5: Treatment Effects, Central and Eastern Oregon Fields Sampled with Cutworms

Treatment Effects	Mean Yield (lbs./A)	Standard Deviation (lbs./A)	(N)
Tillage	65.0	24.7	(29)
No Tillage	80.2	16.6	(50)
Age of Stand:			
More than 1 year	75.6	21.0	(72)
1 year or less	65.7	21.8	(7)
Fall Flame	86.2	12.8	(12)
Not Fall Flame	72.6	21.8	(67)
Fall N*:			
0 lb./A	66.9	22.7	(27)
0 < lb./A < 20	73.5	15.4	(13)
20 ≤ lb./A < 40	72.5	20.8	(14)
lb./A ≥40	84.1	19.1	(26)
Spring N:			
100 ≤ lb./A < 180	89.4	15.2	(5)
180 ≤ lb./A < 220	77.4	18.5.1	(9)
220 ≤ lb./A < 260	75.1	7.8	(36)
lb./A ≥260	70.5	25.3	(30)
Lorsban Applied	78.2	21.4	(25)
No Lorsban Applied	73.0	21.1	(54)
Orthene Applied	85.6	16.9	(24)
No Orthene Applied	69.9	21.2	(55)
Root Weevil infestation a problem	77.6	21.1	(30)
Root Weevil infestation not a problem	72.9	21.2	(49)

*Predicted values are used for Fall N missing data.

Results of the statistical analysis of the effects on mean yield are given in Table 3.6. The effects of Lorsban and Orthene were positive on mean yield and tillage had a negative effect. Age of stand, fall flame, spring N, fall N, root weevils, and till by fall N were not statistically significant effects.

Table 3.6: Statistical Analysis, Central and Eastern Oregon Fields Sampled with Cutworms

Variable	Effect on Yields	df	F-value	p-value
Tillage	negative	1	5.99	0.017
Age of Stand	none	1	2.38	0.127
Fall Flame	none	1	1.71	0.196
Spring N	none	1	0.19	0.663
Fall N	none	1	0.01	0.937
Lorsban	positive	1	2.83	0.097
Orthene	positive	1	5.03	0.028
Root Weevil	none	1	0.10	0.748
Till by Fall N	none	1	0.27	0.604

Overall F = 3.32, p-value < 0.002 with 9 & 69 df
$R^2 = 0.302$

The "1995 Pacific Northwest Insect Control Handbook" recommends using Lannate, Orthene, and *Bacillus thuringiensis* for cutworms in mint (Fisher, p. 113). Fifty-four percent of the fields studied in central and eastern Oregon reported cutworm infestations, and 53 percent of these received chemical applications (Tables F-H, Appendix A). The results of this study suggest that the best method for fighting cutworms is either an Orthene or Lorsban application.

Besides analyses to see which methods produced significant effects for fields with cutworms, the seriousness score was also tested to see if it was significantly different for the effects of Lorsban, Orthene, and root weevils. These results are summarized in Table 3.7. Both Lorsban- and Orthene-applied fields had significantly higher seriousness scores than those in which chemicals were <u>not</u> applied. Lorsban and Orthene applications had positive effects on mean yield, even though the seriousness of cutworms was lower for fields in which chemicals were <u>not</u> applied. This confirming evidence underscores the possibility that the chemicals were applied to severely infested fields <u>and</u> their application improved mint yields. Root weevil infestation did not have a significant effect on seriousness scores.

Table 3.7: Cutworm Seriousness Scores in Central and Eastern Oregon Fields Sampled

Treatment/Infestation	Mean* Seriousness Score	t-value	df	p-value	(N)
Lorsban Applied	7.35	5.23	63	0.0001	(25)
No Lorsban Applied	4.59				(64)
Orthene Applied	6.46	2.40	87	0.0181	(27)
No Orthene Applied	4.89				(62)
Root Weevil Infestation	5.67	0.74	87	0.458	(33)
No Root Weevil Infestation	5.19				(56)

*On a scale from 0 to 10, where 0 is 'hardly noticed' and 10 is 'very serious'.

GROUNDSEL

Ninety-two percent of the growers in this survey reported fields with groundsel where the average severity score was 7.5 (Table F, Appendix A). Several herbicides have been used to control groundsel, including Basagran, Buctril, Goal, Gramoxone, Sinbar, and Stinger (see Table H, Appendix A). Other effects under study on groundsel-infested fields include tillage, fall flame, spring N, and fall N. Tables 3.8, 3.9, and 3.10 give the summary statistics, treatment effects, and statistical analysis for fields reporting groundsel in central and eastern Oregon.

As displayed in Table 3.8, there was an average of about 42 acres per field with groundsel infestation. This is about 5 acres more than the overall results (Table 3.1). The average 1992 yield was 76 lbs./A for fields with groundsel. Maximum yield was 150 lbs./A, while the minimum yield was 20 lbs./A. Percentage of fields with the age of stand greater than 1 year was 89 percent. None of the fields with groundsel received spring flaming, but 20 percent were fall flamed, and 38

Table 3.8: Summary Statistics, Central and Eastern Oregon Fields Sampled with Groundsel

Summary Statistics	Mean	Standard Deviation	(N)
Number of Acres	42.0	37.2	(154)
1992 Yield (lbs./A)	75.5	23.8	(143)
Maximum Yield (lbs./A)	150.0	---	---
Minimum Yield (lbs./A)	20.0	---	---
Age of Stand (% > 1 yr.)	89.0	31.4	(154)
Fields Tilled (%)	37.5	48.6	(152)
Fields Spring Flamed (%)	0.0	---	(0)
Fields Fall Flamed (%)	19.5	39.8	(154)
Basagran Applied (%)	51.3	50.0	(154)
Buctril Applied (%)	68.2	46.7	(154)
Goal Applied (%)	18.8	39.2	(154)
Gramoxone Applied (%)	24.0	42.9	(154)
Spring Nitrogen (lbs./A)	249.0	31.6	(154)
Fall Nitrogen (lbs./A)	29.7	32.0	(91)

percent of the fields were tilled. Fifty-one percent of the fields received Basagran applications, 68 percent Buctril, 19 percent Goal, and 24 percent Gramoxone. Spring N was applied at an average of 249 lbs./A and fall N was applied at an average of 30 lbs./A. Also displayed in Table 3.23 are the standard deviations and total N for each of these summary statistics.

Table 3.9 reports the mean yield (in lbs./A), standard deviation, and total N for each of the treatment effects. The mean yield for those fields tilled was about 68 lbs./A while those not tilled produced an average of 81 lbs./A. Fields that had age of stand greater than 1 year averaged 79 lbs./A, and those that were a year or less averaged 55 lbs./A. Fall flamed fields produced an average of 89 lbs./A, and those not fall flamed, 72 lbs./A. Fall N applications had a significantly positive effect on mean yields; mean yield tended to increase as the fall N application increased. While mean yields tended to decrease as the rate of spring N increased, this was not shown to be a significant effect on mean yield. The average yield for fields that received Basagran applications was about 74 lbs./A, and those not receiving a Basagran application, 77 lbs./A. Buctril-applied fields averaged almost 76 lbs./A, while no-Buctril-applied fields were about the same. Fields receiving Goal had a mean yield of about 82 lbs./A, and those not receiving Goal, 75 lbs./A. The average yield for fields that received Gramoxone was about 80 lbs./A, and for those not receiving Gramoxone, 75 lbs./A. Both Goal and Gramoxone had a significant positive effect on mean yield. The till by fall N interaction did not have a significant effect on mean yield, which ranged from about 30 to 90 lbs./A.

Table 3.9: Treatment Effects, Central and Eastern Oregon Fields Sampled with Groundsel

Treatment Effects	Mean Yield (lbs./A)	Standard Deviation (lbs./A)	(N)
Tillage	67.6	23.9	(51)
No Tillage	80.5	22.5	(90)
Age of Stand:			
More than 1 year	78.5	22.7	(125)
1 year or less	54.9	21.0	(16)
Fall Flame	88.5	18.2	(30)
Not Fall-Flame	72.4	24.0	(111)
Fall N*:			
0 lb./A	67.2	22.4	(40)
0 < lb./A < 20	66.1	26.5	(14)
20 ≤ lb./A < 30	74.2	19.5	(24)
30 ≤ lb./A < 40	76.4	24.6	(11)
lb./A ≥ 40	84.3	23.3	(54)
Spring N:			
100 ≤ lb./A < 180	83.7	19.5	(6)
180 ≤ lb./A < 220	78.8	17.6	(20)
220 ≤ lb./A < 260	72.1	22.1	(64)
lb./A ≥ 260	77.4	27.9	(53)
Basagran Applied	74.3	22.0	(71)
Basagran not Applied	77.4	25.4	(70)
Buctril Applied	75.6	25.9	(101)
Buctril not Applied	76.4	17.4	(40)
Goal Applied	82.0	22.0	(23)
Goal not Applied	74.6	24.0	(118)
Gramoxone Applied	79.8	21.4	(31)
Gramoxone not Applied	74.7	24.3	(110)

*Predicted values used for Fall N missing data.

Table 3.10 shows the results of the statistical analysis of the effects on mean yield. As can be seen, age of stand, fall N, Goal, and Gramoxone effects were positive on mean yield. Tillage, fall flame, spring N, Basagran, Buctril, and the till by fall N interaction were not significant.

Table 3.10: Statistical Analysis, Central and Eastern Oregon Fields Sampled with Groundsel

Variable	Effect on Yields	df	F-value	p-value
Tillage	none	1	1.06	0.305
Age of Stand	positive	1	21.76	0.001
Fall Flame	none	1	2.49	0.117
Spring N	none	1	1.34	0.249
Fall N	positive	1	15.05	0.001
Basagran	none	1	1.81	0.181
Buctril	none	1	3.43	0.067
Goal	positive	1	3.74	0.056
Gramoxone	positive	1	4.77	0.031
Till by Fall N	none	1	2.09	0.151

Overall F = 7.01, p-value < 0.0001 with 10 & 140 df
$R^2 = 0.35$

The "1995 Pacific Northwest Weed Control Handbook" recommends using Sinbar for annual grass and broadleaf weeds in new plantings and established mint; Gramoxone for annual grass and broadleaf weeds in established mint; and Basagran and Buctril for annual broadleaf weeds, among other recommended herbicides (William, pp. 128-131). As stated earlier, groundsel was reported in about 92 percent of the fields studied, many of which used the recommended chemicals. The results of this study suggest that Goal and Gramoxone do significantly improve yields.

NEMATODES

The root-lesion nematode feeds internally on the plant root, stunting root and plant growth, and can also cause more severe verticillium wilt symptoms (Lacy, et. al., p. 9). Nematodes were present in about 80 percent of the fields surveyed in this study with an average severity score of 6.5 (Table F, Appendix A). Production methods used by the growers on nematode-infested fields include tillage, spring flame, fall flame, spring N, fall N, and chemical applications (Vydate; Table H, Appendix A). Tables 3.11 through 3.13 give the summary statistics, treatment effects, and statistical analyses for those fields reporting nematode infestation.

Summary statistics for fields with nematodes are reported in Table 3.11. The average number of acres per field was 46, with an average yield of about 75 lbs./A. The maximum yield was 111 lbs./A while the minimum yield was 20 lbs./A. Ninety percent of the stands were aged greater than 1 year, and about 39 percent of the fields had been tilled. Spring flaming was reported on 2 percent of the fields, and 20 percent of them were fall flamed. About 56 percent of the fields with nematodes received Vydate applications. Spring N was applied at an average of

Table 3.11: Summary Statistics, Central and Eastern Oregon Fields Sampled with Nematodes

Summary Statistics	Mean	Standard Deviation	(N)
Number of Acres	45.5	39.4	(133)
1992 Yield (lbs./A)	74.7	20.8	(122)
Maximum Yield (lbs./A)	111.0	---	---
Minimum Yield (lbs./A)	20.0	---	---
Age of Stand (% > 1 yr.)	90.0	30.0	(133)
Fields Tilled (%)	38.6	48.9	(133)
Fields Spring Flamed (%)	2.2	14.9	(133)
Fields Fall Flamed (%)	19.5	39.5	(132)
Spring N (lbs./A)	247.5	32.0	(133)
Fall N (lbs./A)	25.4	28.4	(70)
Vydate Applied (%)	55.6	49.9	(133)
Verticillium Wilt (%)	85.0	35.9	(133)

248 lbs./A, while fall N was applied at about 25 lbs./A. Eighty-five percent of the fields with nematodes also reported verticillium wilt infestation.

Table 3.12 gives a summary of the treatment effects, including mean yield (in lbs./A), standard deviation, and total N. Tillage had a significantly negative effect on yield. The mean yield for fields tilled was 68 lbs./A while those not tilled produced an average about 11 lbs./A higher. Fields with stands aged greater than 1 year averaged 77 lbs./A, and those that were a year or less only averaged 61 lbs./A. This effect, which was statistically significant (Table 3.6), is reasonable since established fields are expected to yield more than new fields. Those fields spring flamed produced an average of 66 lbs./A, while those not spring flamed produced about 9 lbs./A more. Fall flaming was also shown to be a statistically significant effect on yield; those fields receiving fall flame produced an average of about 85 lbs/A, and those not fall flamed, 72 lbs./A. Fall N was a significant factor as well; mean yields tended to increase as the lbs./A of fall N increased. The till by fall N interaction was not a significant effect; mean yields seemed to be the same for increasing levels of fall N when tilling was both present and not present. Mean yields for spring N ranged from the mid-70s to mid-80s, but spring N was not a statistically significant effect. Vydate and verticillium wilt both had a significant negative effect on mean yield. Fields receiving Vydate applications averaged about 72 lbs./A, while those not receiving Vydate were about 79 lbs./A. This may indicate that fields receiving Vydate applications were severely infested, and the chemical, though not apparent, only partially improved yields. Verticillium wilt-infested fields averaged about 75 lbs./A and those not infested, 79 lbs./A. Also of importance to note, predicted values are used in the statistical analysis for the fall N missing data and results should be cautiously interpreted.

Table 3.12: Treatment Effects, Total Central and Eastern Oregon Fields Sampled with Nematodes

Treatment Effects	Mean Yield (lbs./A)	Standard Deviation (lbs./A)	(N)
Tillage	68.1	22.1	(46)
No Tillage	79.3	17.8	(76)
Age of Stand:			
More than 1 year	76.5	20.4	(110)
1 year or less	61.2	17.2	(22)
Spring Flame	66.0	27.0	(3)
Not Spring Flame	75.3	20.5	(119)
Fall Flame	84.8	14.7	(26)
Not Fall Flame	72.4	21.2	(96)
Fall N*:			
0 lb./A	68.9	20.0	(35)
$0 <$ lb./A < 20	83.2	17.0	(16)
$20 \leq$ lb./A < 30	64.4	28.4	(19)
$30 \leq$ lb./A < 40	76.1	15.2	(20)
lb./A ≥ 40	82.0	17.3	(33)
Spring N:			
$100 \leq$ lb./A < 180	83.7	19.5	(6)
$180 \leq$ lb./A < 220	79.6	17.8	(19)
$220 \leq$ lb./A < 260	73.6	17.9	(53)
lb./A ≥ 260	73.2	25.1	(45)
Vydate Applied	72.1	22.6	(68)
Vydate not Applied	78.8	17.1	(54)
Verticillium Wilt Infestation	74.7	21.1	(111)
No Verticillium Wilt Infestation	78.6	15.4	(11)

*Predicted values are used for Fall N missing data.

Table 3.13 shows the results of the statistical analysis of the effect on mean yield for fields with nematodes. As seen in the table, the effects of age of stand, fall flame, and fall N had positive effects. Tillage, Vydate, and verticillium wilt infestation had negative effects. Spring flame, spring N, and the till by fall N interaction were not significant.

Table 3.13: Statistical Analysis, Total Central and Eastern Oregon Fields Sampled with Nematodes

Variable	Effect on Mean Yield	df	F-value	p-value
Tillage	negative	1	3.52	0.062
Age of Stand	positive	1	10.52	0.001
Spring Flame	none	1	0.47	0.494
Fall Flame	positive	1	2.69	0.104
Spring N	none	1	0.00	0.945
Fall N	positive	1	4.19	0.046
Vydate	negative	1	4.06	0.046
Verticillium Wilt	negative	1	4.78	0.031
Till by Fall N	none	1	0.01	0.917

Overall $F = 4.08$, p-value < 0.0002 with 9 & 112 df
$R^2 = 0.25$

The "1995 Pacific Northwest Disease Control Handbook" recommends using crop rotation to corn or other grains, soil fumigation with Telone II, clean planting stock, and Vydate to control nematodes (Koepsell, p. 164). About 35 percent of the fields surveyed reported problems with nematodes. Of these fields, about 56 percent of them received a Vydate application. The results show that Vydate had a significantly negative effect on mean yields. The average infestation seriousness score for fields receiving Vydate applications was 5.80, and for fields not receiving Vydate it was 4.10. This may indicate that fields receiving Vydate applications were severely infested and the chemical only partially improved yields. The other methods suggested by the handbook were not investigated in this study. The statistical results for this study suggest that the age of stand being greater than 1 year, fall flaming, and fall N application had the only significantly beneficial yield effects in nematode-infested fields.

PIGWEED

The problem of pigweed has been fought with several methods resulting in little success. Sixty-four percent of the growers in this survey reported fields with pigweed where the average severity score was 6.7 (Table F, Appendix A). Several herbicides have been used to control pigweed including Basagran, Buctril, Goal, Gramoxone, Sinbar, and Stinger (see Table H, Appendix A). Other effects studied include tillage, spring flame, fall flame, spring N, and fall N. Tables 3.14, 3.15, and 3.16 give the summary statistics, treatment effects, and statistical analysis for fields with pigweed in central and eastern Oregon.

As displayed in Table 3.14, there was an average of about 45 acres per field reporting pigweed infestation. This is about 8 acres more than the overall infestation results (Table 3.1). The average 1992 yield was 71 lbs./A for those fields with pigweed. Maximum yield was 114 lbs./A, while the minimum yield was 20 lbs./A. Percentage of fields with the age of stand greater than 1 year was 88 percent. None of the fields with pigweed received spring flaming, but 24

Table 3.14: Summary Statistics, Central and Eastern Oregon Fields Sampled with Pigweed

Summary Statistics	Mean	Standard Deviation	(N)
Number of Acres	45.2	34.4	(107)
1992 Yield (lbs./A)	71.3	21.4	(96)
Maximum Yield (lbs./A)	114.0	---	---
Minimum Yield (lbs./A)	20.0	---	---
Age of Stand (% > 1 yr.)	87.9	32.8	(107)
Fields Tilled (%)	42.0	49.6	(105)
Fields Spring Flamed (%)	0.0	---	(0)
Fields Fall Flamed (%)	12.1	32.8	(107)
Basagran Applied (%)	68.8	46.8	(107)
Buctril Applied (%)	60.7	49.1	(107)
Sinbar Applied (%)	60.7	49.1	(107)
Spring Nitrogen (lbs./A)	247.4	31.8	(107)
Fall Nitrogen (lbs./A)	23.5	29.7	(53)

percent were fall flamed, and 42 percent of the fields were tilled. Sixty-eight percent of the fields received Basagran applications, and both Buctril and Sinbar were applied to 61 percent of the fields (not necessarily the same 61 percent). Spring N was applied at an average of 247 lbs./A, and fall N was applied at an average of 24 lbs./A. Table 3.11 also displays the standard deviations and total N for each of these summary statistics.

Table 3.15 shows the mean yield (in lbs./A), standard deviation, and total N for each treatment effect. The mean yield for those fields tilled was about 67 lbs./A while those not tilled produced an average of 75 lbs./A. Fields that had age of stand greater than 1 year averaged 73 lbs./A, and those that were a year or less averaged 64 lbs./A. The average yield for fields that received Basagran applications was about 70 lbs./A, and those not receiving a Basagran application, 75 lbs./A. Buctril-applied fields averaged almost 69 lbs./A, while no-Buctril-applied fields averaged 77 lbs./A. Fields receiving Sinbar had a mean yield of about 70 lbs./A, and those not receiving Sinbar, 74 lbs./A. Fall flamed fields produced an average of 78 lbs./A, and those not fall flamed, 71 lbs./A. Fall N applications had a significantly positive effect on mean yields; mean yield tended to increase as the fall N application increased. While mean yields tended to decrease as the rate of spring N increased, this was not shown to be a significant effect.

Table 3.15: Treatment Effects, Central and Eastern Oregon Fields Sampled with Pigweed

Treatment Effects	Mean Yield (lbs./A)	Standard Deviation (lbs./A)	(N)
Tillage	66.7	23.2	(38)
No Tillage	75.2	19.4	(56)
Age of Stand:			
More than 1 year	73.0	21.1	(82)
1 year or less	63.9	22.2	(12)
Fall Flame	77.7	12.7	(13)
Not Fall Flame	70.9	22.3	(81)
Fall N*:			
0 lb./A	65.8	23.9	(37)
$0 <$ lb./A < 20	72.4	17.7	(20)
$20 \leq$ lb./A < 40	71.1	14.1	(16)
lb./A ≥ 40	79.5	22.7	(23)
Spring N:			
$100 \leq$ lb./A < 180	91.7	0.6	(3)
$180 \leq$ lb./A < 220	77.8	17.6	(13)
$220 \leq$ lb./A < 260	70.1	19.3	(46)
lb./A ≥ 260	68.7	25.2	(34)
Basagran Applied	70.1	23.2	(62)
Basagran not Applied	75.0	17.0	(32)
Buctril Applied	68.7	22.9	(59)
Buctril not Applied	77.0	17.3	(35)
Sinbar Applied	70.1	21.4	(55)
Sinbar not Applied	74.1	21.2	(39)

*Predicted values used for Fall N missing data.

Table 3.16 shows the results of the statistical analysis of the effects on mean yield. As seen, the effects of fall N, Sinbar, and age of stand were positive on mean yield, and tillage had a significantly negative effect. Fall flame, spring N, Basagran, Buctril, and the fall N by Sinbar interaction were not significant. Sinbar applications were associated with low mint yields. However, Sinbar was applied primarily to fields that had not received fall N applications, and it is not known if low yields occurred from lack of fall nitrogen or from Sinbar. There is much confounding between fertilizer levels and Sinbar application, as well as problems with low sample sizes for this joint comparison. The response of mint yields to Sinbar in the presence or absence of fall nitrogen should be investigated experimentally.

Table 3.16: Statistical Analysis, Central and Eastern Oregon Fields Sampled with Pigweed

Variable	Effect on Yields	df	F-value	p-value
Tillage	negative	1	4.70	0.033
Age of Stand	positive	1	4.94	0.029
Fall Flame	none	1	1.87	0.176
Spring N	none	1	0.30	0.587
Fall N	positive	1	6.33	0.014
Basagran	none	1	0.81	0.372
Buctril	none	1	1.57	0.214
Sinbar	negative	1	5.28	0.024
Fall N by Sinbar	none	1	0.93	0.337

Overall F = 2.27, p-value < 0.025 with 9 & 84 df
$R^2 = 0.195$

The "1995 Pacific Northwest Weed Control Handbook" recommends using Sinbar for annual grass and broadleaf weeds in new plantings and established mint; Gramoxone for annual grass and broadleaf weeds in established mint; and Basagran and Buctril for annual broadleaf weeds, among other recommended herbicides (William, pp. 128-131). Pigweed was reported in about 64 percent of the fields studied, 81 percent of which used chemicals (Tables F-G2, Appendix A). The results of this study suggest that these chemicals do not significantly improve yields. Fall N applications and stands greater than 1 year were the only variables associated with improved yields.

The infestation seriousness score was also investigated for fields with pigweed to see if it was significantly different for the effects of Basagran, Buctril, and Sinbar. These results are summarized in Table 3.17. All three effects had significantly lower seriousness scores when the chemicals were not applied. Although Basagran and Buctril seemingly had no effect on mean yields, the seriousness of pigweed in these fields was lower for fields in which the chemicals were not applied. These results may explain grower motivation more than chemical effects. Growers, understandably, invest in chemical controls when fields are severely infested. Low yields associated with fields in which chemicals are applied may reflect the seriousness of the infestation; the chemicals may have prevented even lower yields than those observed. Without an adequate control group in which treatments are randomized, it is not known which one of several explanations for lower yields should prevail.

Table 3.17: Pigweed Seriousness Scores in Central and Eastern Oregon Fields Sampled

Treatment/Infestation	Mean* Seriousness Score	t-value	df	p-value	(N)
Basagran Applied	7.14	3.42	100	0.0001	(72)
No Basagran Applied	5.45				(30)
Buctril Applied	7.30	3.84	100	0.0002	(63)
No Buctril Applied	5.56				(39)
Sinbar Applied	7.42	4.69	100	0.0001	(64)
No Sinbar Applied	5.33				(38)

*On a scale from 0 to 10, where 0 is 'hardly noticed' and 10 is 'very serious'.

POWDERY MILDEW

Powdery mildew is a fungal disease that is widespread among central and eastern Oregon mint fields. Almost 79 percent of the fields studied had powdery mildew with an average infestation seriousness score of 7.3 (Table F, Appendix A). Sulphur applications were the only chemicals applied to these fields (Table H, Appendix A). Tables 3.18 through 3.20 explore the summary statistics, treatment effects, statistical analyses, and infestation seriousness scores for fields in central and eastern Oregon reporting powdery mildew.

Table 3.18 gives the summary statistics for fields with powdery mildew. There was an average of about 40 acres per field reporting powdery mildew infestation with an average 1992 yield of 74 lbs./A for those fields in this survey. Maximum yield was 114 lbs./A, while the minimum yield was 20 lbs./A. Percentage of fields with the age of stand greater than 1 year was 88 percent. None of the fields received spring flaming, but 19 percent were fall flamed, and 35 percent of the fields were tilled. Eighty-seven percent of the fields received sulphur applications.

Table 3.18: Summary Statistics, Central and Eastern Oregon Fields Sampled with Powdery Mildew

Summary Statistics	Mean	Standard Deviation	(N)
Number of Acres	40.2	31.9	(132)
1992 Yield (lbs./A)	74.2	22.2	(125)
Maximum Yield (lbs./A)	114.0	---	---
Minimum Yield (lbs./A)	20.0	---	---
Age of Stand (% > 1 yr.)	87.9	32.8	(132)
Fields Tilled (%)	35.1	47.9	(131)
Fields Spring Flamed (%)	0.0	---	(0)
Fields Fall Flamed (%)	18.9	39.3	(132)
Sulphur Applied (%)	87.1	33.4	(132)
Spring Nitrogen (lbs./A)	244.6	27.8	(78)
Fall Nitrogen (lbs./A)	30.3	33.6	(132)

Spring N was applied at an average of 245 lbs./A, and fall N was applied at an average of 30 lbs./A. Table 3.15 also displays the standard deviations and total N for each of these summary statistics.

Table 3.19 gives a summary of the treatment effects, including mean yield (in lbs./A), standard deviation, and total N. Tillage had a significantly negative effect on yield. The mean yield for those fields tilled was 68 lbs./A, while those not tilled produced an average yield about 10 lbs./A higher. Fields that had age of stand greater than 1 year averaged 77 lbs./A, and those that were a year or less only averaged 57 lbs./A. This effect, which was statistically significant (Table 3.20), is reasonable since established fields are expected to yield more than new fields. Fall flaming produced a mean yield of about 84 lbs/A, and fields not fall flamed produced 72 lbs./A. Mean yields ranged from 61 to 81 lbs./A for fields receiving fall N applications. The till by fall N interaction was not a significant effect; mean yields seemed to be the same for increasing levels of fall N when tilling was both present and not present. Mean yields for spring N ranged from the low-70s to the mid-80s, but spring N was not a statistically significant effect on yields. Sulphur had a positive effect on mean yield; sulphur-applied fields had an average yield of about 77 lbs./A, while non-sulphur fields averaged about 61 lbs./A. Also of importance to note, predicted values are used in the statistical analysis for the fall N missing data and results should be cautiously interpreted.

Table 3.19: Treatment Effects, Total Central and Eastern Oregon Fields Sampled with Powdery Mildew

Treatment Effects	Mean Yield (lbs./A)	Standard Deviation (lbs./A)	(N)
Tillage	68.2	24.1	(44)
No Tillage	78.0	20.1	(80)
Age of Stand:			
More than 1 year	77.1	20.8	(108)
1 year or less	57.2	23.0	(16)
Fall Flame	84.4	14.8	(25)
Not Fall Flame	72.0	22.9	(99)
Fall N*:			
0 lb./A	61.4	25.0	(33)
0 < lb./A < 20	81.0	10.9	(5)
20 ≤ lb./A < 30	75.2	21.3	(22)
30 ≤ lb./A < 40	78.1	16.6	(20)
lb./A ≥ 40	80.6	20.3	(45)
Spring N:			
100 ≤ lb./A < 180	85.7	17.0	(8)
180 ≤ lb./A < 220	80.6	17.7	(18)
220 ≤ lb./A < 260	73.0	21.7	(57)
lb./A ≥ 260	70.9	24.8	(42)
Sulphur Applied	76.7	20.3	(107)
Sulphur not Applied	60.9	27.9	(17)

*Predicted values are used for Fall N missing data.

Table 3.20 shows the results of the statistical analysis of the effect on mean yield for fields with powdery mildew. As seen in the table, the effects of age of stand and sulphur had positive effects on mean yield, and tillage had a negative effect. Fall flame, spring N, fall N, and the till by fall N interaction were not shown to be significant effects.

Table 3.20: Statistical Analysis, Total Central and Eastern Oregon Fields Sampled with Powdery Mildew

Variable	Effect on Mean Yield	df	F-value	p-value
Tillage	negative	1	3.43	0.067
Age of Stand	positive	1	14.65	0.001
Fall Flame	none	1	2.84	0.095
Spring N	none	1	1.48	0.227
Fall N	none	1	1.51	0.222
Sulphur	positive	1	3.51	0.064
Till by Fall N	none	1	0.00	0.988

Overall $F = 6.14$, p-value < 0.0001 with 7 & 116 df
$R^2 = 0.27$

The "1995 Pacific Northwest Disease Control Handbook" recommends using clean plowing and sulphur applications to control powdery mildew (Koepsell, p. 164). About 79 percent of the fields surveyed reported problems with powdery mildew. Of these fields, about 87 percent of them received a sulphur application that had a significantly positive effect on mean yields. The effect of clean plowing was not investigated. The statistical results for this study suggest that the age of stand being greater than 1 year, sulphur applications, and fall flaming are beneficial in the presence of powdery mildew.

SPIDER MITES

Spider mites were present in almost 95 percent of the fields surveyed in central and eastern Oregon, with an average severity score of 8.0 (Table F, Appendix A). This is a serious problem for growers in central and eastern Oregon. Production methods used by the growers in this survey on spider mite infested-fields include chemical applications (Comite, Kelthane, Malathion, Metasystox R, Orthene, and Sulphur; Table H, Appendix A), tillage, spring N, fall N, and fall flame. The tables in this section give the summary statistics, treatment effects, and statistical summary for fields reporting spider mites.

Table 3.21 gives the summary statistics for fields with spider mites. The average number of acres per field was 42, with an average yield of about 75 lbs./A. The maximum yield was 150 lbs./A and the minimum yield was 20 lbs./A (same as the overall results, Table 3.1). Eighty-nine percent of the stands were aged greater than 1 year, and about 38 percent of the fields had been tilled. None of the fields were spring flamed; however, 19 percent of them were fall flamed.

Table 3.21: Summary Statistics, Central and Eastern Oregon Fields Sampled with Spider Mites

Summary Statistics	Mean	Standard Deviation	(N)
Number of Acres	42.2	37.2	(159)
1992 Yield (lbs./A)	75.4	23.5	(147)
Maximum Yield (lbs./A)	150.0	---	---
Minimum Yield (lbs./A)	20.0	---	---
Age of Stand (% > 1 yr.)	88.7	34.8	(159)
Fields Tilled (%)	38.2	48.7	(157)
Fields Spring Flamed (%)	0.0	---	(0)
Fields Fall Flamed (%)	18.9	39.2	(159)
Sulphur Applied (%)	32.1	46.9	(159)
Comite Applied (%)	92.4	26.5	(159)
Spring N (lbs./A)	247.7	33.4	(159)
Fall N (lbs./A)	30.2	31.8	(95)

Sulphur was applied to 32 percent of the fields and Comite to 92 percent. Spring nitrogen was applied at an average of 248 lbs./A, while fall nitrogen was applied at about 30 lbs./A.

Table 3.22 reports the mean yield (in lbs./A), standard deviation, and total N for each of the treatment effects. Tilled fields produced an average of 68 lbs./A, and those not tilled had a mean yield of 80 lbs./A. Fields that had age of stand greater than 1 year averaged 78 lbs./A, while those that were a year or less in age averaged 56 lbs./A. Fields receiving fall flame produced an average of 89 lbs/A, and those not fall flamed, 73 lbs./A. This is consistent with the overall infestation results (Table 3.2). The fields that received sulphur applications had an average yield of almost 72 lbs./A, and those not receiving sulphur averaged about 5 lbs./A more. Comite applied fields averaged about 77 lbs./A, while fields receiving no Comite application produced about 30 lbs./A less. This was a significant, positive effect. Fall-applied nitrogen was also a significant positive effect on yield. As the amount of fall N applied increased, the mean yield tended to increase. The till by fall N interaction was a positive effect when till was present, and had a negative effect when till was not present. That is, when till was present, an increase in fall N tended to increase mean yield, but when till was not present, an increase in fall N tended to decrease mean yield. Mean yields from spring N applied fields ranged from the mid-70s to the mid-80s.

Table 3.22: Treatment Effects, Central and Eastern Oregon Fields Sampled with Spider Mites

Treatment Effects	Mean Yield (lbs./A)	Standard Deviation (lbs./A)	(N)
Tillage	68.0	23.5	(53)
No Tillage	80.3	22.2	(92)
Age of Stand:			
More than 1 year	78.4	22.7	(128)
1 year or less	56.3	19.6	(17)
Fall Flame	88.5	18.2	(30)
No Fall Flame	72.5	23.5	(115)
Fall N*:			
0 lb./A	68.4	22.1	(56)
$0 <$ lb./A < 20	70.6	19.3	(21)
$20 \leq$ lb./A < 30	58.2	30.1	(6)
$30 \leq$ lb./A < 40	82.4	18.1	(14)
lb./A ≥ 40	85.4	23.4	(50)
Sulphur Applied	72.2	19.3	(43)
Sulphur not Applied	77.3	24.9	(102)
Comite Applied	77.4	22.6	(137)
Comite not Applied	47.7	18.7	(8)
Till by Fall N*:			
No Till / 0 lb./A	69.7	23.7	(19)
No Till / $0 <$ lb./A < 20	70.7	19.3	(21)
No Till / $20 \leq$ lb./A < 30	73.0	25.4	(2)
No Till / $30 \leq$ lb./A < 40	82.3	19.6	(12)
No Till / lb./A ≥ 40	90.6	19.6	(38)
Till / 0 lb./A	69.8	21.4	(35)
Till / $0 <$ lb./A < 20	---	---	(0)
Till / $20 \leq$ lb./A < 30	50.7	22.8	(4)
Till / $30 \leq$ lb./A < 40	83.0	5.7	(2)
Till / lb./A ≥ 40	68.8	27.5	(12)
Spring N:			
$100 \leq$ lb./A < 180	85.7	17.0	(8)
$180 \leq$ lb./A < 220	78.8	17.6	(20)
$220 \leq$ lb./A < 260	72.3	21.1	(66)
lb./A ≥ 260	76.5	28.4	(53)

*Predicted values are used for Fall N missing data.

Table 3.23 shows the results of the statistical analysis of the effects on mean yield for fields with spider mites. As displayed, the effects of age of stand, fall N, and Comite were positive on mean yield. The till by fall N interaction tended to have a positive effect on mean yield when till was not present, and tended to have a negative effect on mean yield when till was present. Tillage, fall flame, spring N, and sulphur were not shown to be significant effects.

Table 3.23: Statistical Analysis, Central and Eastern Oregon Fields Sampled with Spider Mites

Variable	Effect on Yields	df	F-value	p-value
Tillage	none	1	0.87	0.352
Age of Stand	positive	1	20.04	0.001
Fall Flame	none	1	2.49	0.117
Spring N	none	1	0.00	0.952
Fall N	positive	1	7.97	0.006
Sulphur	none	1	0.22	0.638
Comite	positive	1	9.24	0.003
Till by Fall N	see Table 3.20	1	6.02	0.015

Overall $F = 9.89$, p-value < 0.0001 with 8 & 136 df
$R^2 = 0.368$

The "1995 Pacific Northwest Insect Control Handbook" recommends using Kelthane, Dicofol, Omite, Comite, Metasystox, and Malathion for spider mites (Fisher, p. 115). About 95 percent of the fields surveyed reported problems with spider mites. Of these fields, 93 percent of them received chemical applications, most of which were Comite or sulphur (Tables F-H, Appendix A). The results show that sulphur does not have a significant effect on mean yields, but Comite has a positive one. This study also suggests that where the age of stand is greater than 1 year, and there is a high fall N application in combination with no till, these factors will have a positive effect on mean yield when controlling for spider mites in central and eastern Oregon.

VERTICILLIUM WILT

"Verticillium wilt, caused by the soil-borne fungus, *Verticillium dahliae*, is the most serious and destructive pest faced by mint growers," (Lacy, et. al., p. 7). Verticillium wilt was present in 74 percent of the fields in the central and eastern Oregon study with an average severity score of 4.8 (Table F, Appendix A), making it very widespread. Production methods used by the growers on verticillium wilt-infested fields include tillage, fall flame, spring N, and fall N. Tables 3.24, 3.25, and 3.26 give the summary statistics, treatment effects, and statistical analyses for those fields reporting verticillium wilt.

Summary statistics for fields with verticillium wilt are reported in Table 3.24. The average number of acres per field was 40 with an average yield of about 75 lbs./A. The maximum yield was 114 lbs./A while the minimum yield was 20 lbs./A. Ninety-two percent of the stands were aged greater than 1 year and about 36 percent of the fields had been tilled. Spring flaming was not reported on any of the fields with verticillium wilt, but 23 percent of them were fall flamed.

Table 3.24: Summary Statistics, Central and Eastern Oregon Fields Sampled with Verticillium Wilt

Summary Statistics	Mean	Standard Deviation	(N)
Number of Acres	40.4	29.2	(125)
1992 Yield (lbs./A)	75.2	22.2	(124)
Maximum Yield (lbs./A)	114.0	---	---
Minimum Yield (lbs./A)	20.0	---	---
Age of Stand (% > 1 yr.)	92.1	27.1	(126)
Fields Tilled (%)	36.0	48.2	(125)
Fields Spring Flamed (%)	0.0	---	(0)
Fields Fall Flamed (%)	23.0	42.3	(126)
Nematodes (%)	90.0	30.5	(126)
Prior Mint Field (%)	46.0	50.0	(126)
Spring N (lbs./A)	248.8	33.7	(126)
Fall N (lbs./A)	34.1	30.1	(71)

About 90 percent of the fields with verticillium wilt also reported having nematode infestation as well. Forty-six percent of the fields had also been mint fields prior to this study. Spring N was applied at an average of 249 lbs./A, while fall N was applied at about 34 lbs./A.

A summary of the treatment effects, including mean yield (in lbs./A), standard deviation, and total N is given in Table 3.25. Tilled fields produced an average of 67 lbs./A, and those not tilled, 81 lbs./A indicating that tillage had a significant negative effect on yield. Fields that had age of stand greater than 1 year averaged about 78 lbs./A, while those that were a year or younger in age averaged 19 lbs./A less, which is consistent with the overall results (Table 3.1). Fall flamed fields produced an average of 87 lbs/A, and those not fall flamed, 73 lbs./A. Age of stand and fall flaming were both significant positive effects on mean yield. Fall nitrogen application had a moderately significant effect where the mean yields for those fields ranged from about 66 to 82 lbs./A. Where nematode infestation was a problem, fields produced about 75 lbs./A, while fields free of nematode infestations had yields 13 lbs./A higher. Fields that were planted with the Black Mitcham mint variety had the highest average yield, 82 lbs./A, of any of the varieties. The Murray-Mitcham variety yielded 68 lbs./A, and the Todd and mixed varieties both yielded 78 lbs./A. Fields producing mint in consecutive years gave an average yield of 76 lbs./A, and fields producing crops other than mint in prior years averaged about the same. Spring nitrogen applied fields had average yields ranging from about 74 to 84 lbs./A.

Table 3.25: Treatment Effects, Central and Eastern Oregon Fields Sampled with Verticillium Wilt

Treatment Effects	Mean Yield (lbs./A)	Standard Deviation (lbs./A)	(N)
Tillage	67.3	24.7	(44)
No Tillage	80.9	18.1	(78)
Age of Stand:			
More than 1 year	77.6	21.5	(112)
1 year or less	58.6	15.2	(10)
Fall Flame	86.6	15.0	(29)
No Fall Flame	72.7	22.4	(93)
Fall N*:			
0 lb./A	67.7	20.9	(28)
0 < lb./A < 20	66.1	25.4	(19)
20 ≤ lb./A < 30	78.2	23.5	(16)
30 ≤ lb./A < 40	76.7	16.3	(17)
lb./A ≥ 40	82.4	20.7	(45)
Spring N*:			
100 ≤ lb./A < 180	83.7	19.5	(6)
180 ≤ lb./A < 220	79.6	17.4	(19)
220 ≤ lb./A < 260	73.9	20.9	(53)
lb./A ≥ 260	74.1	25.2	(47)
Mint Variety:			
Todd	78.2	21.5	(52)
Murray-Mitcham	67.9	22.4	(37)
Black Mitcham	82.2	18.9	(19)
Mixed	77.6	21.6	(15)
Prior Field Mint	75.7	21.1	(56)
Prior Field not Mint	76.3	22.2	(66)
Nematode Infestation	74.7	21.6	(110)
No Nematode Infestation	88.2	22.9	(12)

*Predicted values are used for Fall N missing data.

Table 3.26 shows the results of the statistical analysis of the effects on mean yield for fields with verticillium wilt. The effects of age of stand, fall flame, and fall N were positive on mean yield, and the effect of tillage was negative. Spring N, prior crop in mint, nematode infestation, and the till by fall N interaction were not shown to be significant effects. Mint variety was a significant effect where the Black Mitcham had the highest yield, and Murray-Mitcham the lowest yield.

Table 3.26: Statistical Analysis, Central and Eastern Oregon Fields Sampled with Verticillium Wilt

Variable	Effect on Yields	df	F-value	p-value
Age of Stand	positive	1	4.04	0.047
Tillage	negative	1	7.26	0.008
Fall Flame	positive	1	5.14	0.025
Spring N	none	1	0.44	0.507
Fall N	positive	1	3.35	0.070
Variety	see Table 3.28	1	2.76	0.046
Nematode Infestation	none	1	0.71	0.402
Prior Field Mint	none	1	0.35	0.554
Till by Fall N	none	1	0.02	0.879

Overall $F = 4.51$, $p\text{-value} < 0.0001$ with 11 & 110 df
$R^2 = 0.311$

The "1995 Pacific Northwest Disease Control Handbook" recommends using certified planting stock for new plantings, removal from mint production, flaming, and soil fumigation to control verticillium wilt (Koepsell, p. 165). About 74 percent of the fields surveyed reported problems with verticillium wilt. The statistical results for this study suggest that an older stand, fall flaming, fall N application, and the Black Mitcham mint variety are significant positive effects on yield in verticillium wilt-infested fields.

The infestation seriousness score was investigated for fields that reported nematode infestation in addition to the verticillium wilt infestation. These results are summarized in Table 3.27. Although nematode infestation was not a significant effect on mean yield, the seriousness of verticillium wilt was significantly lower when nematode infestation was <u>not</u> present. These results demonstrate the effect of nematode infestation on wilt seriousness scores, and the importance of controlling nematodes on mint fields that are infected by wilt.

Table 3.27: Verticillium Wilt Seriousness Scores in Central and Eastern Oregon Fields Sampled

Treatment/Infestation	Mean* Seriousness Score	t-value	df	p-value	(N)
Nematode Infestation	6.67	8.32	23	0.001	(109)
No Nematode Infestation	2.88				(12)

*On a scale from 0 to 10, where 0 is 'hardly noticed' and 10 is 'very serious'.

CHAPTER 4

SUMMARY AND CONCLUSIONS

This study of 90 mint growers (51 in the Willamette Valley and 39 in central and eastern Oregon) sought to estimate the cultural practices and chemical applications that improved mint yields in the state. Through face-to-face interviews, information was gathered about yields, age of stand, tillage, flaming, and nitrogen and chemical applications for each grower's field. Growers were also asked about specific pest infestations and their severity, and asked to estimate how effective chemical applications, if any, were in controlling the pests identified.

A statistical model, associated with the major pests identified, tested the joint effects of cultural practices (tillage, spring and fall flaming, and spring and fall nitrogen applications) as well as chemicals applied for pest control. Age of stand was included in the model as a control variable, since yields on established fields (more than 1 year old) are generally higher than newly-planted fields.

The results show the impact of chemical applications in association with cultural applications and age of stand. They are summarized first for Willamette Valley fields, then for central and eastern Oregon fields.

Willamette Valley Fields.

For **bindweed**-infested fields, fall flaming and spring N improve yields where severe infestations are observed. When infestations are not severe, high levels of fall-applied N with no spring flame, or <u>no</u> fall-applied N with spring flame, seem to be effective. Some growers report using one or more unnamed chemicals, but there is no evidence they increase yields.

Fields infested with **cutworms** performed best when the age of the stand was greater than 1 year and when Orthene was applied. Also, increased spring-applied nitrogen is effective when the infestation is quite severe. When the infestation is not so severe, fall-applied nitrogen with no spring flame, or no fall-applied nitrogen with a spring flame seems to improve yields.

Nematode-infested fields responded to spring nitrogen applications. Mature stands (greater than 1 year) had higher yields than newly-established fields. Fall-applied nitrogen was associated with reduced yields. Some growers applied Vydate, and there is statistical evidence that this chemical is associated with low yields compared to fields that received no Vydate. The presence of wilt reduced yields somewhat.

Basagran applications improved yields in **pigweed**-infested fields by about 5 lbs./A, and Buctril applications by about 8 lbs./A, although the difference is not statistically significant. Gramoxone and Sinbar applications were associated with lower mint yields. Pigweed-infested fields responded to fall flaming and spring-applied nitrogen. A high level of fall-applied nitrogen and no spring flaming, or no fall N with spring flaming, were also associated with improved yields.

Chemicals applied to **rust**-infected fields did not significantly improve mint yields. This includes Bravo, which a few growers used, and unnamed chemicals, which about a third of the sample reported using. Fall flaming remains an important practice to sanitize fields. Age of stand also has a strong influence on yields.

Spider mite-infested fields had higher yields in established stands and responded to applications of Comite. Applications of Kelthane were associated with reduced yields. Cultural practices, such as flaming and nitrogen applications, had no significant effect on yields from infested fields. Comite increased yields slightly, but the difference is not statistically significant.

Symphylid-infested fields responded to spring-applied nitrogen, and somewhat to dry Dyfonate applications. Also, there was an increase in yields from fall nitrogen with no spring flaming. There is no statistical evidence that liquid Dyfonate improved mint yields.

Yields for fields with **verticillium wilt** improved from applications of spring nitrogen, and from fall N when spring flaming was not present. The presence of nematodes weakened mint stands so that yields did not respond to nitrogen or flaming. In verticillium wilt infected fields, the Murray-Mitcham variety produced 7 to 13 lbs./A more than other varieties, although mint variety as a factor affecting yield was only marginally significant.

Central and Eastern Oregon Fields.

Central and eastern Oregon mint fields were managed differently than those in the Willamette Valley. For instance, acreage size averaged about 10 acres less, but yields averaged about the same per acre. About three times as many fields were tilled (36 percent) compared to 13 percent for those in western Oregon. Flaming was less prevalent (3 percent spring flame and 19 percent fall flame compared to 72 percent spring flame and 59 percent fall flame in Willamette Valley fields.) The rate of spring and fall N was slightly lower. Moreover, the effect of chemicals on mint yields for the several infestations studied differed as well.

Cutworm-infested fields responded to Lorsban and Orthene applications. Yields were depressed about 15 lbs./A on tilled fields. Age of stand, flaming, and differences in nitrogen applications were not related to yields.

Fields with **groundsel** had higher yields when the age of stand was greater than 1 year. Fall nitrogen applications improved yields, as did Goal and Gramoxone. Many growers reported using Basagran, but there is no evidence that this chemical improved yields. Yields were lower when Basagran was applied, and when Goal or Gramoxone were not applied.

Nematode-infested fields responded somewhat to fall flaming. Fall-applied nitrogen improved yields as well. Yields were also higher for stands that were older than 1 year. Tillage, Vydate applications, and the presence of verticillium wilt were associated with reduced yields on nematode-infested fields.

Fields infested with **pigweed** responded to fall applications of nitrogen, and yields were higher in established stands. There is no evidence that Basagran, Buctril, or Sinbar applications improved yields.

Powdery mildew-infested fields responded to sulphur applications. This chemical, and fields being more than a year old, are the only variables that showed yield improvement in fields that were infested with this disease.

Spider mite infestations were successfully fought with Comite applications, and fall nitrogen (when tillage was not present) improved yields. Older stands were able to produce higher yields than new plantings. Few growers used sulphur, and there is no evidence that sulphur improved yields.

The Black Mitcham variety yielded 4 to 14 lbs./A higher compared to other varieties in **verticillium wilt**-infested fields. (Murray-Mitcham had the lowest yield--67 lbs./A.) Fall flaming and fall applications of nitrogen were also effective. Older stands had higher yields as well, compared to fields less than a year old. The presence of nematodes reduced yields about 14 lbs./A; however, the production of mint as the previous crop yielded about the same as fields that had grown different crops.

The results for both regions of the state show that cultural practices - fall and spring flaming or nitrogen applications - improved mint yields for most infestations. Pesticide applications were effective in many instances as well, but several infestations did not show improved yields from chemicals. These included bindweed, nematodes, rust, and verticillium wilt in the Willamette Valley; and nematodes, pigweed and verticillium wilt in central and eastern Oregon. The analysis suggests that chemical applications are applied after pests have established themselves and yields have diminished. Reported treatment effects cover only the 1992 year in which the data were collected. We have no information regarding the start of pesticide applications or how long they have been applied. Nor do we have information about the impact of these pesticides on pest populations. The results tell one only about the annual effects of different treatments--cultural and chemical--on yields. In that vein, they may be useful for planning experiments that are designed to show the impact of chemical applications on pest levels as well as on yields. The results also underscore the role of cultural practices in keeping mint stands strong and healthy as a strategy for fighting insect, disease, and weed infestations.

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APPENDIX A

Mint Infestation Data Tables

Reading the Mint Grower Survey Data Tables

The report up to now has presented summary statistics for the more troublesome pests infecting mint fields in the state. Additional information, showing greater detail, is presented in these appendices for those who wish to study the data in greater detail.

Information from the 1992 Mint Growers' Survey produced a large data set with several thousand observations. The summary analysis is grouped into two chapters, one for Willamette Valley fields and one for central and eastern Oregon fields. Tables that summarize these data are shown in the pages to follow where Tables A-E describe infestations and chemical treatments for Willamette Valley fields, and Tables F-J for central and eastern Oregon fields.

A total of 90 growers participated in the study, 53 from the Willamette Valley and 39 from central and eastern Oregon. Growers reported information on slightly more than four fields each, giving a data base of 208 fields for Willamette Valley growers, and 168 fields for central and eastern Oregon growers.

Table A (Willamette Valley) and Table F (central and eastern Oregon) show the average severity score for each infestation reported, the number, and the percent of fields having that infestation. Taking Table A as an example, note that the overall severity average is 5.4, near the midpoint of an 11-point scale (from 0 to 10). The severity means for each infestation are distributed down the second column. About half are above the 5.4 average and half are below the average. The third column shows the number of fields in which this infestation occurred. The last column shows the percent of fields in which that particular infestation was reported. Note that the number of fields total more than 208 and 100 percent in Table A. This is because each field had more than one infestation, so multiple observations should be expected for all the tables. The same case holds for Table F for central and eastern Oregon fields.

Now, turn to Table B2. This table reports the severity means and fields in which an infestation occurred, but no chemical was applied. Chemicals may not have been applied for two reasons: 1) the infestation was so mild that chemical treatments were not required, or 2) there is no treatment available that controls the infestation. One gets a hint of the situation by comparing the severity means and number of fields for all the fields studied (Table A), and for those in which no treatment was applied (Table B2) for the Willamette Valley, and Table F and Table G2 for central and eastern Oregon.

With a few exceptions, most of the severity means are less for Table B2 than for Table B1, indicating that mild infestations are the explanation in many cases. Bindweed is a good example. Growers for 72 percent of the fields reported bindweed infestations (Table A), yet the severity mean for fields that had not received any treatment (Table B2) is less than the mean shown in Table A (4.2 versus 4.9). Bindweed infestations were reported on 41 percent of the untreated fields (Table B2).

For central and eastern Oregon fields, Table F and G2 comparisons hint otherwise for bindweed infestations. For example, only four fields were treated for bindweed, and the similar scores for treated and untreated fields suggest that the chemicals employed may not work very well for that part of the state. Only 11.9 percent of the fields had bindweed (Table F), so the weed is not as prevalent as other infestations, compared to Willamette Valley fields.

Note that some infestations (black stem and verticillium wilt are examples) have low severity ratings, but no chemicals were applied to any fields in both areas. (An exception, Vydate, was applied to one Willamette Valley field.) This suggests that there is no chemical treatment available that controls either disease, and growers simply plow their fields when infestations become severe. Low severity scores may reflect the fact that the infestations have not yet become too severe on these fields.

Growers also reapplied (or applied more than one chemical) to the same field to control pests in 1992. Adjusting for the number of fields receiving no chemicals, Willamette Valley growers applied chemicals to an average of 6.17 fields, and central and eastern Oregon growers to an average of 5.18 fields. Recalling that each grower reported data on about four fields, this shows that each grower reapplied chemicals, on the average, to about two fields in the Willamette Valley and to about one field in central and eastern Oregon.

One can study the information in Tables C and D (for Willamette Valley fields) and Tables H and I (for central and eastern Oregon fields) to locate the infestations requiring reapplication of chemicals. Using the example of bindweed, note that the number of applications in Table C totaled 156 fields. Table A data, however, show that bindweed infestations were reported for only 151 fields. The additional five fields represent chemical reapplications. One field in central and eastern Oregon was a chemical reapplication (Table H).

Tables C, D, H, and I report the details of infestations, chemicals, rate of chemical application, their effect on controlling the infestation, the number of times a chemical was used, the percent of a chemical that was applied per infestation, and how the chemical was applied. Chemicals in bold face are dry formulations, and light face chemicals are liquid. Tables C and H report the chemicals sorted by infestations, and Tables D and I report the infestations sorted by chemicals.

Tables E and J aggregate the data for the chemicals across all infestations, providing overall summaries of application rates, effects, etc. for each chemical.

Finally, when studying the tables, keep in mind that many of the observations are on very few applications and caution should be taken when drawing inferences from them. The flea beetle infestation reported in Table F is an example. It received the highest possible severity rating, 10, but was reported on only two fields. No chemicals were applied. Before concluding that flea beetles represent an intractable problem that requires further study, one should learn how widespread the infestation is, for our data suggest that it may be a localized problem.

Table A: Average Infestation Severity Score, 208 Willamette Valley Mint Fields

Infestation	Mean Severity Score*	Number of Fields (N)	Percent (%)
Bedstraw	4.7	8	3.8
Bindweed	4.9	151	72.6
Black Stem	3.3	33	15.9
Bluegrass	5.7	11	5.3
Cuc Beetle	4.7	3	1.4
Cutworms	6.4	164	78.8
Dandelion	3.9	100	48.1
Flea Beetle	4.7	4	1.9
Foxtail	4.7	5	2.4
Grasshopper	7.3	3	1.4
Groundsel	7.4	185	88.9
Looper	7.9	4	1.9
Millet	6.4	15	7.2
Msc Disease	3.1	1	0.5
Msc Weeds	4.0	73	35.1
Nematodes	6.4	138	66.3
Powdery Mildew	3.9	61	29.3
Painted Lady	7.9	14	6.7
Pigweed	4.9	110	52.9
Quackgrass	3.6	49	23.6
Root Borer	5.8	113	54.3
Root Weevil	5.1	50	24.5
Rust	5.3	120	57.7
Ryegrass	5.8	36	17.3
Salsify	3.3	32	15.4
Slugs	5.1	73	35.1
Sorrell	3.2	20	9.6
Spider Mites	5.7	99	47.6
St. Johnswort	2.7	8	3.8
Symphylids	6.3	158	76.0
Thistle	3.8	119	57.2
Tom Spot Virus	NA	2	0.5
Verticillium Wilt	4.8	133	63.9
Overall Average	5.4		

*Severity scores range from 0 to 10; where 0 is 'hardly noticed', 10 is 'very severe', and NA refers to no answer.

Table B1: Average Infestation Severity Scores for Willamette Valley Mint Fields in Which Chemicals Were Applied

Infestation	Mean Severity Score*	Number of Fields (N)	Percent (%)
Bedstraw	7.1	3	1.4
Bindweed	5.7	65	31.2
Bluegrass	5.1	7	3.4
Cutworms	6.8	148	71.2
Dandelion	4.3	52	25.0
Flea Beetle	4.7	4	1.9
Foxtail	6.3	2	1.0
Grasshopper	7.3	3	1.4
Groundsel	7.7	159	76.4
Looper	7.9	4	1.9
Millet	6.1	12	5.8
Msc Weeds	4.1	45	21.6
Nematodes	6.8	116	55.8
Powdery Mildew	5.9	21	10.1
Painted Lady	8.6	6	2.9
Pigweed	5.3	86	41.3
Quackgrass	3.8	33	15.9
Root Borer	6.7	81	38.9
Root Weevil	6.4	30	14.4
Rust	7.8	44	21.2
Ryegrass	6.0	32	15.4
Salsify	3.9	11	5.3
Slugs	6.9	11	5.3
Sorrell	4.3	4	1.9
Spider Mites	7.0	67	32.2
St. Johnswort	1.6	2	1.0
Symphylids	6.5	144	69.2
Thistle	4.0	91	43.7
Verticillium Wilt	4.7	1	0.5
Overall Average	6.2		

*Severity scores range from 0 to 10; where 0 is 'hardly noticed', 10 is 'very severe', and NA refers to no answer.

Table B2: Average Infestation Severity Scores for Willamette Valley Mint Fields in Which No Chemicals Were Applied

Infestation	Mean Severity Score*	Number of Fields (N)	Percent (%)
Bedstraw	3.8	5	2.4
Bindweed	4.2	86	41.3
Black Stem	3.3	33	15.9
Bluegrass	7.9	4	1.9
Cuc Beetle	4.7	3	1.4
Cutworms	3.2	16	7.7
Dandelion	3.6	48	23.1
Foxtail	3.7	3	1.4
Groundsel	5.8	28	13.5
Millet	7.9	3	1.4
Msc Disease	3.1	1	0.5
Msc Weeds	3.8	28	13.5
Nematodes	4.2	20	9.6
Powdery Mildew	2.9	40	19.2
Painted Lady	7.3	8	3.8
Pigweed	3.3	24	11.5
Quackgrass	3.1	16	7.7
Root Borer	3.5	32	15.4
Root Weevil	4.0	20	9.6
Rust	3.9	76	36.5
Ryegrass	4.2	4	1.9
Salsify	3.0	21	10.1
Slugs	4.7	62	29.8
Sorrell	2.9	16	7.7
Spider Mites	3.1	32	15.4
St. Johnswort	2.9	6	2.9
Symphylids	4.6	14	6.7
Thistle	3.0	28	13.5
Tom Spot Virus	NA	2	1.0
Verticillium Wilt	4.8	132	63.5
Overall Average	4.0		

*Severity scores range from 0 to 10; where 0 is 'hardly noticed', 10 is 'very severe', and NA refers to no answer.

Table C: Summary of Chemical Effects on Willamette Valley Mint Infestations
(Chemical by Infestation)

Infestation	Chemical	Rate of Application	Effect	Number of Applications		How Applied			
						Air	Ground	Irrigation	NA
		Mean	Mean	N	% N	N	N	N	N
Bedstraw	Basagran	24.0	6.0	1	10		1		
	Goal	8.0	7.0	1	10		1		
	Sinbar	24.0	7.0	2	20		2		
	Surfactant	32.0	6.0	1	10		1		
	None Used	0.0	0.0	5	50				
Bindweed	Basagran	32.0	4.0	1	1		1		
	Buctril	NA	7.0	1	1		1		
	Gramoxone	NA	7.0	1	1		1		
	Sinbar	32.0	5.5	2	1		2		
	Surfactant	32.0	4.0	1	1		1		
	None Used	0.0	0.0	86	5				
	DK/NA	26.6	6.5	64	41		63		1
Black Stem	None Used	0.0	0.0	33	100				
Bluegrass	**Diuron**	24.0	2.0	2	18		2		
	Poast	32.0	8.0	1	9		1		
	Sinbar	28.0	6.0	4	36		4		
	None Used	0.0	0.0	4	36				
Cuc Beetle	None Used	0.0	0.0	3	100				
Cutworms	Comite	40.0	8.0	1	1	1			
	Lannate	16.0	7.0	3	2	3			
	Orthene	21.0	8.0	152	88	101	51		
	None Used	0.0	0.0	16	9				
Dandelion	Buctril	24.0	6.0	1	1		1		
	Diuron	40.0	5.0	1	1		1		
	Goal	20.8	7.3	15	14		15		
	Gramoxone	32.0	5.9	8	7		8		
	Sinbar	26.0	8.3	4	4		4		
	Stinger	7.1	7.4	28	26		28		
	None Used	0.0	0.0	48	44				
	DK/NA	NA	4.5	4	4		4		
Flea Beetle	Malathion	32.0	5.0	2	50		2		
	Orthene	21.0	9.0	2	50	1			1
Foxtail	**Sinbar**	32.0	4.0	2	40		2		
	None Used	0.0	0.0	3	60				

Chemicals in **bold face** are dry; light face, liquid. Application rates are ounces per acre. Effect scale ranges from 0 to 10, where 0 = not at all effective and 10 = completely effective.

Table C (Continued): Summary of Chemical Effects on Willamette Valley Mint Infestations
(Chemical by Infestation)

Infestation	Chemical	Rate of Application	Effect	Number of Applications		How Applied			
						Air	Ground	Irrigation	NA
		Mean	Mean	N	% N	N	N	N	N
Groundsel	Basagran	31.2	6.5	40	10		40		
	Buctril	17.8	8.2	157	39		157		
	Devrinol	77.0	7.0	4	1		4		
	Direx	32.0		1	0		1		
	Diuron	40.0	7.5	2	1		2		
	Goal	22.2	8.2	37	9		37		
	Gramoxone	24.9	8.5	77	19		77		
	Sinbar	23.3	7.3	35	9		35		
	Stinger	6.0	7.5	4	1		4		
	Surfactant	18.7	8.0	6	2		6		
	Vydate	64.0	5.0	1	0		1		
	None Used	0.0	0.0	28	7				
	DK/NA	32.0	8.7	6	2		6		
Grasshopper	**Orthene**	18.5	10.0	4	100	2	2		
Looper	**Orthene**	20.3	10.0	4	100	2	1		1
Millet	Basagran	32.0	8.0	1	6		1		
	Poast	29.6	6.0	10	63		10		
	Sinbar	28.0	8.0	2	13		2		
	None Used	0.0	0.0	3	19				
Msc Weeds	Basagran	32.0	6.0	2	2		2		
	Buctril	8.0	8.0	1	1		1		
	Diuron	24.0	2.0	1	1		1		
	Goal	16.0	8.0	1	1		1		
	Gramoxone	20.6	6.0	5	6		5		
	Poast	32.0	5.5	15	17		15		
	Sinbar	32.0	5.4	8	9		8		
	Stinger	8.0	8.0	1	1		1		
	Surfactant	28.0	7.2	4	5		4		
	None Used	0.0	0.0	28	33				
	DK/NA	31.6	5.8	20	23		19		1
Msc Disease	None Used	0.0	0.0	1	100				
Nematodes	Buctril	16.0	7.0	1	1		1		
	Dyfonate	64.0	5.0	1	1		1		
	Vydate	82.8	5.8	119	83		116	3	
	None Used	0.0	0.0	20	14				
	DK/NA	96.0	7.0	2	1		2		
Powdery Mildew	**Sulphur**	37.9	6.7	21	34	2	18		1
	None Used	0.0	0.0	40	66				

Chemicals in **bold face** are dry; light face, liquid. Application rates are ounces per acre. Effect scale ranges from 0 to 10, where 0 = not at all effective and 10 = completely effective.

Table C (Continued): Summary of Chemical Effects on Willamette Valley Mint Infestations
(Chemical by Infestation)

Infestation	Chemical	Rate of Application	Effect	Number of Applications		How Applied			
						Air	Ground	Irrigation	NA
		Mean	Mean	N	% N	N	N	N	N
Painted Lady	Malathion	NA	4.0	1	7	1			
	Orthene	19.0	9.8	5	36		5		
	None Used	0.0	0.0	8	57				
Pigweed	Basagran	31.5	5.5	45	28		44		1
	Buctril	16.5	4.4	31	19		31		
	Devrinol	96.0	6.0	1	1		1		
	Diuron	16.0	8.0	1	1		1		
	Goal	28.0	8.5	2	1		2		
	Gramoxone	22.3	5.4	9	6		9		
	Sinbar	24.2	5.8	40	25		39		1
	Surfactant	18.7	7.3	6	4		6		
	None Used	0.0	0.0	24	15				
	DK/NA	33.5	7.5	2	1		2		
Quackgrass	Gramoxone	25.3	3.0	4	7		4		
	Poast	32.0	3.4	5	9		5		
	Sinbar	32.0	5.7	10	18		10		
	Surfactant	32.0	2.0	1	2		1		
	None Used	0.0	0.0	16	28				
	DK/NA	32.0	5.7	21	37		21		
Root Borer	Biovector	3.0	9.0	2	2			2	
	Lorsban	62.8	6.5	79	70		54	25	
	None Used	0.0	0.0	32	28				
Root Weevil	Biovector	3.0	5.0	1	2			1	
	Orthene	62.8	7.4	29	57	5	24		
	None Used	0.0	0.0	21	40				
	DK/NA	NA	NA	1	2				1
Rust	Bravo	48.0	5.1	10	7		10		
	Sulphur	64.0	4.0	2	1		2		
	None Used	0.0	0.0	76	52				
	DK/NA	30.3	7.3	59	40		58		1
Ryegrass	**Devrinol**	32.0	9.0	1	2		1		
	Goal	16.0	8.0	1	2		1		
	Gramoxone	30.4	7.9	10	20		10		
	Poast	30.6	7.1	17	35		17		
	Sinbar	25.8	6.7	13	27		13		
	Surfactant	32.0	7.5	2	4		2		
	None Used	0.0	0.0	4	8				
	DK/NA	32.0	1.0	1	2		1		

Chemicals in **bold face** are dry; light face, liquid. Application rates are ounces per acre. Effect scale ranges from 0 to 10, where 0 = not at all effective and 10 = completely effective.

Table C (Continued): Summary of Chemical Effects on Willamette Valley Mint Infestations (Chemical by Infestation)

Infestation	Chemical	Rate of Application	Effect	Number of Applications		How Applied			
						Air	Ground	Irrigation	NA
		Mean	Mean	N	% N	N	N	N	N
Salsify	Goal	21.3	8.0	3	8		3		
	Gramoxone	24.0	8.0	2	5		2		
	Sinbar	21.3	8.0	3	8		3		
	Stinger	6.7	6.9	8	21		8		
	None Used	0.0	0.0	21	55				
	DK/NA	6.0	1.0	1	3		1		
Slugs	**Slug Bait**	323.6	7.2	10	14		10		
	None Used	0.0	0.0	62	84				
	DK/NA	NA	7.5	2	3		2		
Sorrell	**Sinbar**	20.0	2.0	2	10		2		
	Stinger	10.3	6.0	3	14		3		
	None Used	0.0	0.0	16	76				
Spider Mites	Comite	36.2	7.7	57	53	22	34		1
	Kelthane	28.7	7.1	13	12	6	7		
	Sulphur	80.0	6.2	5	5	3	2		
	None Used	0.0	0.0	32	30				
St. Johnswort	Buctril	NA	7.0	1	10				1
	Gramoxone	NA	7.0	1	10				1
	Sinbar	NA	7.0	1	10				1
	None Used	0.0	0.0	6	60				
	DK/NA	NA	NA	1	10		1		
Symphylids	**Dyfonate 10G**	317.3	7.0	82	50	1	80		1
	Dyfonate	69.5	6.4	64	39		63	1	
	Lorsban	85.3	4.0	3	2		3		
	Vydate	64.0	5.0	2	1		2		
	None Used	0.0	0.0	14	8				
T. Spt. Virus	None Used	0.0	0.0	2	100				
Thistle	Basagran	32.0	3.5	10	8		9		1
	Gramoxone	32.0	NA	1	1		1		
	Sinbar	8.0	9.0	2	2		2		
	Stinger	8.1	6.9	80	61		79		1
	None Used	0.0	0.0	28	21				
	DK/NA	10.7	8.3	10	8		9		1
Verticillium Wilt	Vydate	64.0	NA	1	1				1
	None Used	0.0	0.0	132	99				

Chemicals in **bold face** are dry; light face, liquid. Application rates are ounces per acre. Effect scale ranges from 0 to 10, where 0 = not at all effective and 10 = completely effective.

Table D: Summary of Chemical Effects on Willamette Valley Mint Infestations
(Infestation by Chemical)

Chemical	Infestation	Rate of Application	Effect	Number of Applications		How Applied			
						Air	Ground	Irrigation	NA
		Mean	Mean	N	% N	N	N	N	N
Basagran	Bedstraw	24.0	6.0	1	1		1		
	Bindweed	32.0	4.0	1	1		1		
	Groundsel	31.2	6.5	40	40		40		
	Millet	32.0	8.0	1	1		1		
	Msc Weeds	32.0	6.0	2	2		2		
	Pigweed	31.5	5.5	45	45		44		1
	Thistle	32.0	3.5	10	10		9		1
Biovector	Root Borer	3.0	9.0	2	67			2	
	Root Weevil	3.0	5.0	1	33			1	
Bravo	Rust	48.0	5.1	10	100		10		
Buctril	Bindweed	NA	7.0	1	1		1		
	Dandelion	24.0	6.0	1	1		1		
	Groundsel	17.8	8.2	157	81		157		
	Msc Weeds	8.0	8.0	1	1		1		
	Nematodes	16.0	7.0	1	1		1		
	Pigweed	16.5	4.4	31	16		31		
	St. Johnswort	NA	7.0	1	1				1
Comite	Cutworms	40.0	8.0	1	2	1			
	Spider Mites	36.2	7.7	57	98	22	34		1
Devrinol	Groundsel	77.0	7.0	4	67		4		
	Pigweed	96.0	6.0	1	17		1		
	Ryegrass	32.0	9.0	1	17		1		
Direx	Groundsel	32.0	NA	1	100		1		
Diuron	Bluegrass	24.0	2.0	2	29		2		
	Dandelion	40.0	5.0	1	17		1		
	Groundsel	40.0	7.5	2	29		2		
	Msc Weeds	24.0	2.0	1	17		1		
	Pigweed	16.0	8.0	1	17		1		
Dyfnt 10G	Symphylids	317.3	7.0	82	100	1	80		1
Dyfonate	Nematodes	64.0	5.0	1	2		1		
	Symphylids	69.5	6.4	64	98		63	1	
Goal	Bedstraw	8.0	7.0	1	2		1		
	Dandelion	20.8	7.3	15	25		15		
	Groundsel	22.2	8.2	37	62		37		
	Msc Weeds	16.0	8.0	1	2		1		

Chemicals in **bold face** are dry; light face, liquid. Application rates are ounces per acre. Effect scale ranges from 0 to 10, where 0 = not at all effective and 10 = completely effective.

Table D (Continued): Summary of Chemical Effects on Willamette Valley Mint Infestations (Infestation by Chemical)

Chemical	Infestation	Rate of Application	Effect	Number of Applications		How Applied			
						Air	Ground	Irrigation	NA
		Mean	Mean	N	% N	N	N	N	N
Goal (Continued)	Pigweed	28.0	8.5	2	3		2		
	Ryegrass	16.0	8.0	1	2		1		
	Salsify	21.3	8.0	3	5		3		
Gramoxone	Bindweed	NA	7.0	1	1		1		
	Dandelion	32.0	5.9	8	7		8		
	Groundsel	24.9	8.5	77	65		77		
	Msc Weeds	20.6	6.0	5	4		5		
	Pigweed	22.3	5.4	9	8		9		
	Quackgrass	25.3	3.0	4	3		4		
	Ryegrass	30.4	7.9	10	8		10		
	Salsify	24.0	8.0	2	2		2		
	St. Johnswort	NA	7.0	1	1				1
	Thistle	32.0	NA	1	1		1		
Kelthane	Spider Mites	28.7	7.1	13	100	6	7		
Lannate	Cutworms	16.0	7.0	3	100	3			
Lorsban	Root Borer	62.8	6.5	79	96		54	25	
	Symphylids	85.3	4.0	3	4		3		
Malathion	Flea Beetle	32.0	5.0	2	67		2		
	Painted Lady	NA	4.0	1	33	1			
Orthene	Cutworms	21.0	8.0	152	77	101	51		
	Flea Beetle	21.0	9.0	2	1	1			1
	Grasshopper	18.5	10.0	4	2	2	2		
	Looper	20.3	10.0	4	2	2	1		1
	Painted Lady	19.0	9.8	5	3		5		
	Root Weevil	20.2	7.4	29	15	5	24		
Poast	Bluegrass	32.0	8.0	1	2		1		
	Millet	29.6	6.0	10	21		10		
	Msc Weeds	32.0	5.5	15	31		15		
	Quackgrass	32.0	3.4	5	10		5		
	Ryegrass	30.6	7.1	17	35		17		
Sinbar	Bedstraw	24.0	7.0	2	2		2		
	Bindweed	32.0	5.5	2	2		2		
	Bluegrass	28.0	6.0	4	3		4		
	Dandelion	26.0	8.3	4	3		4		
	Foxtail	32.0	4.0	2	2		2		
	Groundsel	23.3	7.3	35	27		35		
	Millet	28.0	8.0	2	2		2		

Chemicals in **bold face** are dry; light face, liquid. Application rates are ounces per acre. Effect scale ranges from 0 to 10, where 0 = not at all effective and 10 = completely effective.

Table D (Continued): Summary of Chemical Effects on Willamette Valley Mint Infestations
(Infestation by Chemical)

Chemical	Infestation	Rate of Application	Effect	Number of Applications		How Applied			
						Air	Ground	Irrigation	NA
		Mean	Mean	N	% N	N	N	N	N
Sinbar	Msc Weeds	32.0	5.4	8	6		8		
(Continued)	Pigweed	24.2	5.8	40	31		39		1
	Quackgrass	32.0	5.7	10	8		10		
	Ryegrass	25.8	6.7	13	10		13		
	Salsify	21.3	8.0	3	2		3		
	Sorrell	20.0	2.0	2	2		2		
	St. Johnswort	NA	7.0	1	1				1
	Thistle	8.0	9.0	2	2		2		
Slug Bait	Slugs	323.6	7.2	10	100		10		
Stinger	Dandelion	7.1	7.4	28	23		28		
	Groundsel	6.0	7.5	4	3		4		
	Msc Weeds	8.0	8.0	1	1		1		
	Salsify	6.7	6.9	8	6		8		
	Sorrell	10.3	6.0	3	2		3		
	Thistle	8.1	6.9	80	65		79		1
Sulphur	P. Mildew	37.9	6.7	21	75	2	18		1
	Rust	64.0	4.0	2	7		2		
	Spider Mites	80.0	6.2	5	18	3	2		
Surfactant	Bedstraw	32.0	6.0	1	5		1		
	Bindweed	32.0	4.0	1	5		1		
	Groundsel	18.7	8.0	6	29		6		
	Msc Weeds	28.0	7.2	4	19		4		
	Pigweed	18.7	7.3	6	29		6		
	Quackgrass	32.0	2.0	1	5		1		
	Ryegrass	32.0	7.5	2	10		2		
Vydate	Groundsel	64.0	5.0	1	1		1		
	Nematodes	82.8	5.8	119	97		116	3	
	Symphylids	64.0	5.0	2	2		2		
	Vert. Wilt	64.0	NA	1	1				1
None Used	Bedstraw	0.0	0.0	5	1				
	Bindweed	0.0	0.0	86	11				
	Blackstem	0.0	0.0	33	4				
	Bluegrass	0.0	0.0	4	0				
	Cuc Beetle	0.0	0.0	3	0				
	Cutworms	0.0	0.0	16	2				
	Dandelion	0.0	0.0	48	6				
	Foxtail	0.0	0.0	3	0				
	Groundsel	0.0	0.0	28	3				
	Millet	0.0	0.0	3	0				

Chemicals in **bold face** are dry; light face, liquid. Application rates are ounces per acre. Effect scale ranges from 0 to 10, where 0 = not at all effective and 10 = completely effective.

Table D (Continued): Summary of Chemical Effects on Willamette Valley Mint Infestations (Infestation by Chemical)

Chemical	Infestation	Rate of Application	Effect	Number of Applications		How Applied			
						Air	Ground	Irrigation	NA
		Mean	Mean	N	% N	N	N	N	N
None Used (Continued)	Msc Weeds	0.0	0.0	28	3				
	Msc Disease	0.0	0.0	1	0				
	Nematodes	0.0	0.0	20	2				
	P. Mildew	0.0	0.0	40	5				
	Painted Lady	0.0	0.0	8	1				
	Pigweed	0.0	0.0	24	3				
	Quackgrass	0.0	0.0	16	2				
	Root Borer	0.0	0.0	32	4				
	Root Weevil	0.0	0.0	21	3				
	Rust	0.0	0.0	76	9				
	Ryegrass	0.0	0.0	4	0				
	Salsify	0.0	0.0	21	3				
	Slugs	0.0	0.0	62	8				
	Sorrell	0.0	0.0	16	2				
	Spider Mites	0.0	0.0	32	4				
	St. Johnswort	0.0	0.0	6	1				
	Symphylids	0.0	0.0	14	2				
	T. Spt. Virus	0.0	0.0	2	0				
	Thistle	0.0	0.0	28	3				
	Vert. Wilt	0.0	0.0	132	16				
DK/NA	Bindweed	26.6	6.5	64	33		63		1
	Dandelion	NA	4.5	4	2		4		
	Groundsel	32.0	8.7	6	3		6		
	Msc Weeds	31.6	5.8	20	10		19		1
	Nematodes	96.0	7.0	2	1		2		
	Pigweed	33.5	7.5	2	1		2		
	Quackgrass	32.0	5.7	21	11		21		
	Root Weevil	NA	NA	1	1				1
	Rust	30.3	7.3	59	30		58		1
	Ryegrass	32.0	1.0	1	1		1		
	Salsify	6.0	1.0	1	1		1		
	Slugs	NA	7.5	2	1		2		
	St. Johnswort	NA	NA	1	1		1		
	Thistle	10.7	8.3	10	5		9		1

Chemicals in **bold face** are dry; light face, liquid. Application rates are ounces per acre. Effect scale ranges from 0 to 10, where 0 = not at all effective and 10 = completely effective.

Table E: Summary of Chemical Data for Willamette Valley Mint Fields

Chemical	Rate of Application	Effect	Number of Applications		How Applied			
					Air	Ground	Irrigation	NA
	Mean	Mean	N	% N	N	N	N	N
Basagran	31.4	5.7	100	4		98		2
Biovector	3.0	7.0	3	0			3	
Bravo	48.0	5.1	10	0		10		
Buctril	17.6	7.7	193	8		192		1
Comite	36.3	7.7	58	2	23	34		1
Devrinol	72.7	7.2	6	0		6		
Direx	32.0	NA	1	0		1		
Diuron	29.6	5.1	7	0		7		
Dyfonate 10G	317.3	7.0	82	3	1	80		1
Dyfonate	69.4	6.4	65	3		64	1	
Goal	21.4	7.9	60	2		60		
Gramoxone	25.5	7.7	118	5		117		1
Kelthane	28.7	7.1	13	1	6	7		
Lannate	16.0	7.0	3	0	3			
Lorsban	63.6	6.4	82	3		57	25	
Malathion	32.0	4.7	3	0	1	2		
Orthene	20.7	8.0	196	8	111	83		2
Poast	31.0	6.0	48	2		48		
Sinbar	25.3	6.4	130	5		128		2
Slug Bait	323.6	7.2	10	0		10		
Stinger	7.8	7.0	124	5		123		1
Sulphur	48.0	6.4	28	1	5	22		1
Surfactant	23.6	7.0	21	1		21		
Vydate	82.2	5.8	123	5		119	3	1
None Used	0.0	0.0	812	33				
DK/NA	28.6	6.7	194	8		189		5

Chemicals in **bold face** are dry; light face, liquid. Application rates are ounces per acre. Effect scale ranges from 0 to 10, where 0 = not at all effective and 10 = completely effective.

Table F: Average Infestation Severity Score, 168 Central and Eastern Oregon Mint Fields

Infestation	Mean Severity Score*	Number of Fields (N)	Percent (%)
Aphids	5.4	11	6.5
Bindweed	4.3	20	11.9
Black Stem	4.0	44	26.2
Bluegrass	6.3	11	6.5
Cutworms	5.4	90	53.6
Dandelion	3.1	14	8.3
Flea Beetle	10.0	2	1.2
Foxtail	4.5	47	28.0
Grasshopper	6.3	1	0.6
Groundsel	7.5	154	91.7
Kochia	7.1	47	28.0
Lambsqrter	8.5	59	35.1
Looper	5.6	24	14.3
Millet	1.6	1	0.6
Msc Weeds	7.6	32	19.0
Nematodes	6.5	133	79.2
Powdery Mildew	7.3	132	78.6
Painted Lady	8.4	3	1.8
Pigweed	6.7	108	64.3
Purple Mustard	7.6	7	4.2
Quackgrass	4.5	60	35.7
Root Borer	3.8	7	4.2
Root Weevil	5.7	46	27.4
Rust	5.5	2	1.2
Ryegrass	3.1	1	0.6
Salsify	4.9	24	14.3
Slugs	1.6	2	1.2
Sorrell	9.4	1	0.6
Spider Mites	8.0	159	94.6
Symphylids	2.4	8	4.8
Thistle	4.7	21	12.5
Thrips	4.2	3	1.8
Tom Spot Virus	5.7	5	3.0
Verticillium Wilt	4.8	125	74.4
Overall Average	6.3		

*Severity scores range from 0 to 10; where 0 is 'hardly noticed', 10 is 'very severe', and NA refers to no answer.

Table G1: Average Infestation Severity Scores for Central and Eastern Oregon Mint Fields in Which Chemicals Were Applied

Infestation	Mean Severity Score*	Number of Fields (N)	Percent (%)
Aphids	5.8	9	5.4
Bindweed	3.1	4	2.4
Bluegrass	6.1	7	4.2
Cutworms	8.0	48	28.6
Dandelion	4.1	5	3.0
Foxtail	5.1	15	8.9
Grasshopper	6.3	1	0.6
Groundsel	7.8	140	83.3
Kochia	7.3	44	26.2
Lambsqrter	8.5	56	33.3
Looper	8.1	8	4.8
Msc Weeds	7.5	26	15.5
Nematodes	8.0	74	44.0
Powdery Mildew	7.8	115	68.5
Painted Lady	8.4	3	1.8
Pigweed	7.2	88	52.4
Purple Mustard	8.6	4	2.4
Quackgrass	4.7	30	17.9
Root Borer	4.7	2	1.2
Root Weevil	7.7	20	11.9
Ryegrass	3.1	1	0.6
Salsify	6.6	9	5.4
Sorrell	9.4	1	0.6
Spider Mites	8.4	148	88.1
Thistle	5.4	11	6.5
Overall Average	7.6		

*Severity scores range from 0 to 10; where 0 is 'hardly noticed', 10 is 'very severe', and NA refers to no answer.

Table G2: Average Infestation Severity Scores for Central and Eastern Oregon Mint Fields in Which No Chemicals Were Applied

Infestation	Mean Severity Score*	Number of Fields (N)	Percent (%)
Aphids	3.9	2	1.2
Bindweed	4.6	16	9.5
Black Stem	4.0	44	26.2
Bluegrass	7.1	4	2.4
Cutworms	2.5	42	25.0
Dandelion	2.6	9	5.4
Flea Beetle	10.0	2	1.2
Foxtail	4.1	33	19.6
Groundsel	4.1	14	8.3
Kochia	4.2	3	1.8
Lambsqrter	9.4	3	1.8
Looper	4.6	16	9.5
Millet	1.6	1	0.6
Msc Weeds	8.5	6	3.6
Nematodes	4.6	59	35.1
Powdery Mildew	4.0	17	10.1
Pigweed	3.9	20	11.9
Purple Mustard	6.3	3	1.8
Quackgrass	4.3	30	17.9
Root Borer	3.5	5	3.0
Root Weevil	4.3	26	15.5
Rust	5.5	2	1.2
Salsify	3.7	15	8.9
Slugs	1.6	2	1.2
Spider Mites	3.0	11	6.5
Symphylids	2.4	8	4.8
Thistle	4.1	10	6.0
Thrips	4.2	3	1.8
Tom Spot Virus	5.7	5	3.0
Verticillium Wilt	4.8	125	74.4
Overall Average	4.3		

*Severity scores range from 0 to 10; where 0 is 'hardly noticed', 10 is 'very severe', and NA refers to no answer.

Table H: Summary of Chemical Effects on Central and Eastern Oregon Mint Infestations
(Chemical by Infestation)

Infestation	Chemical	Rate of Application	Effect	Number of Applications		How Applied			
						Air	Ground	Irrigation	NA
		Mean	Mean	N	% N	N	N	N	N
Aphids	Malathion	16.0	8.0	3	27	3			
	Metasystox R	26.5	7.5	2	18	2			
	Orthene	21.0	7.7	4	36	3	1		
	None Used	0.0	0.0	2	18				
Bindweed	Basagran	NA	0.0	1	5				1
	Sinbar	NA	2.0	2	10				2
	None Used	0.0	0.0	16	76				
	DK/NA	NA	5.0	2	10		1		1
Black Stem	None Used	0.0	0.0	44	100				
Bluegrass	Basagran	41.6	5.8	5	16		5		
	Buctril	7.2	6.3	6	19		6		
	Goal	16.0	4.0	2	6		1		1
	Gramoxone	26.7	3.3	3	9		2		1
	Sinbar	9.7	4.9	7	22		6		1
	Surfactant	29.6	5.4	5	16		5		
	None Used	0.0	0.0	4	13				
Cutworms	Lannate	64.0	5.0	1	1	1			
	Lorsban	46.8	8.2	25	24	1	21	1	2
	Orthene	20.9	6.2	27	26	22	4		1
	Surfactant	10.9	7.8	9	9	2	6		1
	None Used	0.0	0.0	42	40				
Dandelion	Basagran	40.0	3.5	2	10		2		
	Buctril	2.0	6.0	1	5		1		
	Sinbar	16.0	2.7	3	15		3		
	Stinger	8.0	4.0	3	15		3		
	Surfactant	40.0	3.5	2	10		2		
	None Used	0.0	0.0	9	45				
Flea Beetle	None Used	0.0	0.0	2	100				
Foxtail	Basagran	43.2	4.0	4	6		4		
	Buctril	5.2	3.8	5	7		5		
	Goal	16.0	6.0	1	1		1		
	Gramoxone	32.0	4.3	3	4		3		
	Poast	28.6	7.3	8	11	1	7		
	Sinbar	15.5	4.4	8	11		7		1
	Surfactant	32.0	4.1	10	14	2	7		1
	None Used	0.0	0.0	32	45				

Chemicals in **bold face** are dry; light face, liquid. Application rates are ounces per acre. The effect scale ranges from 0 to 10, where 0 = not at all effective and 10 = completely effective.

Table H (Continued): Summary of Chemical Effects on Central and Eastern Oregon Mint Infestations (Chemical by Infestation)

Infestation	Chemical	Rate of Application	Effect	Number of Applications		How Applied			
						Air	Ground	Irrigation	NA
		Mean	Mean	N	% N	N	N	N	N
Groundsel	Basagran	44.0	6.1	86	20	2	80		4
	Buctril	10.2	6.6	127	29	3	120		4
	Goal	19.3	7.3	27	6		24		3
	Gramoxone	26.7	7.2	37	8		34		3
	Sinbar	13.8	6.0	77	18	2	69		6
	Stinger	7.6	7.5	8	2		7		1
	Surfactant	35.7	6.1	61	14	3	53		5
	None Used	0.0	0.0	14	3				
Grasshopper	**Orthene**	21.0	6.0	1	100	1			
Kochia	Basagran	44.2	6.2	38	31	2	36		
	Buctril	8.8	6.4	48	39	2	46		
	Devrinol	32.0	4.0	1	1		1		
	Goal	10.7	8.7	3	2		3		
	Gramoxone	28.0	5.0	2	2		2		
	Sinbar	13.0	6.6	22	18	2	20		
	Surfactant	28.0	4.3	7	6		7		
	None Used	0.0	0.0	3	2				
Lambsqrtr	Basagran	47.6	5.1	53	21	1	50		2
	Buctril	6.8	4.8	63	25	1	59		3
	Diuron	32.0	4.0	1	0		1		
	Goal	13.6	8.0	5	2		4		1
	Gramoxone	5.3	5.3	3	1		3		
	Poast	24.0	3.0	2	1		2		
	Sinbar	14.2	4.9	54	22	1	51		2
	Stinger	8.0	6.5	2	1		2		
	Surfactant	36.6	4.9	63	25	1	58		4
	None Used	0.0	0.0	3	1				
Looper	Lannate	64.0	6.0	1	4	1			
	Orthene	21.4	5.7	7	27	3	4		
	Sulphur	64.0	6.0	1	4	1			
	Surfactant	2.0	6.0	1	4	1			
	None Used	0.0	0.0	16	62				
Millet	None Used	0.0	0.0	1	100				
Msc Weeds	Basagran	48.0	6.5	10	13	1	9		
	Buctril	8.7	6.8	18	23	1	17		
	Devrinol	32.0	4.0	1	1		1		
	Goal	9.6	8.8	5	6		5		
	Gramoxone	28.0	5.0	2	3		2		

Chemicals in **bold face** are dry; light face, liquid. Application rates are ounces per acre. The effect scale ranges from 0 to 10, where 0 = not at all effective and 10 = completely effective.

Table H (Continued): Summary of Chemical Effects on Central and Eastern Oregon Mint Infestations (Chemical by Infestation)

Infestation	Chemical	Rate of Application	Effect	Number of Applications		How Applied			
						Air	Ground	Irrigation	NA
		Mean	Mean	N	% N	N	N	N	N
Msc Weeds	Poast	28.6	7.7	8	10		8		
	Sinbar	19.4	7.0	16	20	1	15		
	Stinger	8.0	7.0	2	3		1		1
	Surfactant	34.0	5.6	10	13	1	9		
	None Used	0.0	0.0	6	8				
	DK/NA	NA	9.0	2	3		2		
Nematodes	Surfactant	5.0	4.8	5	4	1	4		
	Vydate	78.7	5.5	76	54	7	40		29
	None Used	0.0	0.0	59	42				
Powdery Mildew	**Sulphur**	61.6	7.5	164	91	95	66		3
	None Used	0.0	0.0	17	9				
Painted Lady	**Orthene**	NA	9.3	3	100	3			
Pigweed	Basagran	42.4	6.6	78	24	1	71		6
	Buctril	7.5	6.5	82	25	2	76		4
	Goal	5.7	7.0	3	1		3		
	Gramoxone	24.8	8.0	4	1		4		
	Sinbar	13.9	6.8	72	22	1	66		5
	Stinger	8.0	7.3	4	1		3		1
	Surfactant	36.6	6.9	63	19	2	55		6
	None Used	0.0	0.0	20	6				
Purple Mustard	Buctril	9.3	5.7	3	30		2		1
	Sinbar	21.3	7.3	3	30		3		
	Surfactant	32.0	5.0	1	10				1
	None Used	0.0	0.0	3	30				
Quackgrass	Basagran	43.6	4.9	8	7		8		
	Buctril	7.2	4.4	10	8		10		
	Goal	16.0	5.0	1	1				1
	Gramoxone	24.0	4.0	3	3		2		1
	Poast	27.2	5.8	5	4		4		1
	Sinbar	15.7	5.4	29	25		21		8
	Surfactant	33.6	5.5	26	22		19		7
	None Used	0.0	0.0	30	25				
	DK/NA	32.0	6.2	6	5		4		2
Root Borer	Lorsban	48.0	2.0	2	29		2		
	None Used	0.0	0.0	5	71				
Root Weevil	**Orthene**	21.6	6.2	30	54	14	14		2
	None Used	0.0	0.0	26	46				

Chemicals in **bold face** are dry; light face, liquid. Application rates are ounces per acre. The effect scale ranges from 0 to 10, where 0 = not at all effective and 10 = completely effective.

Table H (Continued): Summary of Chemical Effects on Central and Eastern Oregon Mint Infestations (Chemical by Infestation)

Infestation	Chemical	Rate of Application	Effect	Number of Applications		How Applied			
						Air	Ground	Irrigation	NA
		Mean	Mean	N	% N	N	N	N	N
Rust	None Used	0.0	0.0	2	100				
Ryegrass	Poast	24.0	8.0	1	100		1		
Salsify	Basagran	44.0	5.7	4	9		4		
	Buctril	5.3	5.3	6	13		6		
	Goal	32.0	5.0	1	2		1		
	Gramoxone	24.0	5.0	2	4		2		
	Sinbar	13.1	4.8	7	16		7		
	Stinger	8.0	5.7	3	7		3		
	Surfactant	31.3	5.4	6	13		6		
	None Used	0.0	0.0	15	33				
	DK/NA	NA	10.0	1	2				1
Slugs	None Used	0.0	0.0	2	100				
Sorrell	Basagran	48.0	1.0	1	20		1		
	Buctril	2.0	1.0	1	20		1		
	Sinbar	8.0	1.0	1	20		1		
	Stinger	8.0	1.0	1	20		1		
	Surfactant	48.0	1.0	1	20		1		
Spider Mites	Comite	39.8	6.8	199	56	118	74		7
	Kelthane	NA	8.0	1	0	1			
	Malathion	16.0	6.5	4	1	4			
	Metasystox R	38.0	5.0	5	1	4	1		
	Orthene	21.0	7.0	3	1	1	1		1
	Sulphur	64.0	6.1	67	19	34	28		5
	Surfactant	3.6	6.2	68	19	32	30		6
	None Used	0.0	0.0	11	3				
Symphylids	None Used	0.0	0.0	8	100				
T. Spt. Virus	None Used	0.0	0.0	5	100				
Thistle	Basagran	48.0	6.0	1	4		1		
	Buctril	2.0	6.0	1	4		1		
	Sinbar	16.0	3.0	2	8		2		
	Stinger	8.0	6.9	7	27		6		1
	Surfactant	48.0	5.5	2	8		2		
	None Used	0.0	0.0	10	38				
	DK/NA	24.0		3	12		2		1
Thrips	None Used	0.0	0.0	3	100				
Vert. Wilt	None Used	0.0	0.0	125	100				

Chemicals in **bold face** are dry; light face, liquid. Application rates are ounces per acre. The effect scale ranges from 0 to 10, where 0 = not at all effective and 10 = completely effective.

Table I: Summary of Chemical Effects on Central and Eastern Oregon Mint Infestations
(Infestation by Chemical)

Chemical	Infestation	Rate of Application	Effect	Number of Applications		How Applied			
						Air	Ground	Irrigation	NA
		Mean	Mean	N	% N	N	N	N	N
Basagran	Bindweed	NA	0.0	1	0				1
	Bluegrass	41.6	5.8	5	2		5		
	Dandelion	40.0	3.5	2	1		2		
	Foxtail	43.2	4.0	4	1		4		
	Groundsel	44.0	6.1	86	30	2	80		4
	Kochia	44.2	6.2	38	13	2	36		
	Lambsqrtr	47.6	5.1	53	18	1	50		2
	Msc Weeds	48.0	6.5	10	3	1	9		
	Pigweed	42.4	6.6	78	27	1	71		6
	Quackgrass	43.6	4.9	8	3		8		
	Salsify	44.0	5.7	4	1		4		
	Sorrell	48.0	1.0	1	0		1		
	Thistle	48.0	6.0	1	0		1		
Buctril	Bluegrass	7.2	6.3	6	2		6		
	Dandelion	2.0	6.0	1	0		1		
	Foxtail	5.2	3.8	5	1		5		
	Groundsel	10.2	6.6	127	34	3	120		4
	Kochia	8.8	6.4	48	13	2	46		
	Lambsqrtr	6.8	4.8	63	17	1	59		3
	Msc Weeds	8.7	6.8	18	5	1	17		
	Pigweed	7.5	6.5	82	22	2	76		4
	Purple Mustard	9.3	5.7	3	1		2		1
	Quackgrass	7.2	4.4	10	3		10		
	Salsify	5.3	5.3	6	2		6		
	Sorrell	2.0	1.0	1	0		1		
	Thistle	2.0	6.0	1	0		1		
Comite	Spider Mites	39.8	6.8	199	100	118	74		7
Devrinol	Kochia	32.0	4.0	1	33		1		
	Lambsqrtr	32.0	4.0	1	33		1		
	Msc Weeds	32.0	4.0	1	33		1		
Diuron	Lambsqrtr	13.6	8.0	5	100		4		1
Goal	Bluegrass	16.0	4.0	2	4		1		1
	Foxtail	16.0	6.0	1	2		1		
	Groundsel	19.3	7.3	27	59		24		3
	Kochia	10.7	8.7	3	7		3		
	Lambsqrtr	5.3	5.3	3	7		3		
	Msc Weeds	9.6	8.8	5	11		5		
	Pigweed	5.7	7.0	3	7		3		
	Quackgrass	16.0	5.0	1	2				1
	Salsify	32.0	5.0	1	2		1		

Chemicals in **bold face** are dry; light face, liquid. Application rates are ounces per acre. The effect scale ranges from 0 to 10, where 0 = not at all effective and 10 = completely effective.

Table I (Continued): Summary of Chemical Effects on Central and Eastern Oregon Mint Infestations (Infestation by Chemical)

Chemical	Infestation	Rate of Application	Effect	Number of Applications		How Applied			
						Air	Ground	Irrigation	NA
		Mean	Mean	N	% N	N	N	N	N
Gramoxone	Bluegrass	26.7	3.3	3	5		2		1
	Foxtail	32.0	4.3	3	5		3		
	Groundsel	26.7	7.2	37	64		34		3
	Kochia	28.0	5.0	2	3		2		
	Lambsqrtr	24.0	3.0	2	3		2		
	Msc Weeds	28.0	5.0	2	3		2		
	Pigweed	24.8	8.0	4	7		4		
	Quackgrass	24.0	4.0	3	5		2		1
	Salsify	24.0	5.0	2	3		2		
Kelthane	Spider Mites	NA	8.0	1	100	1			
Lannate	Cutworms	64.0	5.0	1	50	1			
	Looper	64.0	6.0	1	50	1			
Lorsban	Cutworms	46.8	8.2	25	93	1	21	1	2
	Root Borer	48.0	2.0	2	7		2		
Malathion	Aphids	16.0	8.0	3	43	3			
	Spider Mites	16.0	6.5	4	57	4			
Metasystox R	Aphids	26.5	7.5	2	29	2			
	Spider Mites	38.0	5.0	5	71	4	1		
Orthene	Aphids	21.0	7.7	4	5	3	1		
	Cutworms	20.9	6.2	27	36	22	4		1
	Grasshopper	21.0	6.0	1	1	1			
	Looper	21.4	5.7	7	9	3	4		
	Painted Lady	NA	9.3	3	4	3			
	Root Weevil	21.6	6.2	30	40	14	14		2
	Spider Mites	21.0	7.0	3	4	1	1		1
Poast	Foxtail	28.6	7.3	8	36	1	7		
	Msc Weeds	28.6	7.7	8	36		8		
	Quackgrass	27.2	5.8	5	23		4		1
	Ryegrass	24.0	8.0	1	5		1		
Sinbar	Bindweed	NA	2.0	2	1				2
	Bluegrass	9.7	4.9	7	2		6		1
	Dandelion	16.0	2.7	3	1		3		
	Foxtail	15.5	4.4	8	3		7		1
	Groundsel	13.8	6.0	77	25	2	69		6
	Kochia	13.0	6.6	22	7	2	20		
	Lambsqrtr	14.2	4.9	54	18	1	51		2
	Msc Weeds	19.4	7.0	16	5	1	15		

Chemicals in **bold face** are dry; light face, liquid. Application rates are ounces per acre. The effect scale ranges from 0 to 10, where 0 = not at all effective and 10 = completely effective.

Table I (Continued): Summary of Chemical Effects on Central and Eastern Oregon Mint Infestations (Infestation by Chemical)

Chemical	Infestation	Rate of Application	Effect	Number of Applications		How Applied			
						Air	Ground	Irrigation	NA
		Mean	Mean	N	% N	N	N	N	N
Sinbar	Pigweed	13.9	6.8	72	24	1	66		5
(Continued)	Purple Mustard	21.3	7.3	3	1		3		
	Quackgrass	15.7	5.4	29	10		21		8
	Salsify	13.1	4.8	7	2		7		
	Sorrell	8.0	1.0	1	0		1		
	Thistle	16.0	3.0	2	1		2		
Stinger	Dandelion	8.0	4.0	3	10		3		
	Groundsel	7.6	7.5	8	27		7		1
	Lambsqrtr	8.0	6.5	2	7		2		
	Msc Weeds	8.0	7.0	2	7		1		1
	Pigweed	8.0	7.3	4	13		3		1
	Salsify	8.0	5.7	3	10		3		
	Sorrell	8.0	1.0	1	3		1		
	Thistle	8.0	6.9	7	23		6		1
Sulphur	Looper	64.0	6.0	1	0	1			
	P. Mildew	61.6	7.5	164	71	95	66		3
	Spider Mites	64.0	6.1	67	29	64	28		5
Surfactant	Bluegrass	29.6	5.4	5	1		5		
	Cutworms	10.9	7.8	9	3	2	6		1
	Dandelion	40.0	3.5	2	1		2		
	Foxtail	32.0	4.1	10	3	2	7		1
	Groundsel	35.7	6.1	61	18	3	53		5
	Kochia	28.0	4.3	7	2		7		
	Lambsqrtr	36.6	4.9	63	19	1	58		4
	Looper	2.0	6.0	1	0	1			
	Msc Weeds	34.0	5.6	10	3	1	9		
	Nematodes	5.0	4.8	5	1	1	4		
	Pigweed	36.6	6.9	63	19	2	55		6
	Purple Mustard	32.0	5.0	1	0				1
	Quackgrass	33.6	5.5	26	8		19		7
	Salsify	31.3	5.4	6	2		6		
	Sorrell	48.0	1.0	1	0		1		
	Spider Mites	3.6	6.2	68	20	32	30		6
	Thistle	48.0	5.5	2	1		2		
Vydate	Nematodes	78.7	5.5	76	100	7	40		29

Chemicals in **bold face** are dry; light face, liquid. Application rates are ounces per acre. The effect scale ranges from 0 to 10, where 0 = not at all effective and 10 = completely effective.

Table I (Continued): Summary of Chemical Effects on Central and Eastern Oregon Mint Infestations (Infestation by Chemical)

Chemical	Infestation	Rate of Application	Effect	Number of Applications		How Applied			
						Air	Ground	Irrigation	NA
		Mean	Mean	N	% N	N	N	N	N
None Used	Aphids	0.0	0.0	2	0				
	Bindweed	0.0	0.0	16	3				
	Black Stem	0.0	0.0	44	8				
	Bluegrass	0.0	0.0	4	1				
	Cutworms	0.0	0.0	42	8				
	Dandelion	0.0	0.0	9	2				
	Flea Beetle	0.0	0.0	2	0				
	Foxtail	0.0	0.0	32	6				
	Groundsel	0.0	0.0	14	3				
	Kochia	0.0	0.0	3	1				
	Lambsqrtr	0.0	0.0	3	1				
	Looper	0.0	0.0	16	3				
	Millet	0.0	0.0	1	0				
	Msc Weeds	0.0	0.0	6	1				
	Nematodes	0.0	0.0	59	11				
	P. Mildew	0.0	0.0	17	3				
	Pigweed	0.0	0.0	20	4				
	Purple Mustard	0.0	0.0	3	1				
	Quackgrass	0.0	0.0	30	6				
	Root Borer	0.0	0.0	5	1				
	Root Weevil	0.0	0.0	26	5				
	Rust	0.0	0.0	2	0				
	Salsify	0.0	0.0	15	3				
	Slugs	0.0	0.0	2	0				
	Spider Mites	0.0	0.0	11	2				
	Symphylids	0.0	0.0	8	1				
	T. Spt. Virus	0.0	0.0	5	1				
	Thistle	0.0	0.0	10	2				
	Thrips	0.0	0.0	3	1				
	Vert. Wilt	0.0	0.0	125	23				
DK/NA	Bindweed		5.0	2	14		1		1
	Msc Weeds		9.0	2	14		2		
	Quackgrass	32.0	6.2	6	43		4		2
	Salsify	NA	10.0	1	7				1
	Thistle	24.0		3	21		2		1

Chemicals in **bold face** are dry; light face, liquid. Application rates are ounces per acre. The effect scale ranges from 0 to 10, where 0 = not at all effective and 10 = completely effective.

Table J: Summary of Chemical Data for Central and Eastern Oregon Mint Fields

Chemical	Rate of Application	Effect	Number of Applications		How Applied			
					Air	Ground	Irrigation	NA
	Mean	Mean	N	% N	N	N	N	N
Basagran	44.3	6.0	291	11	7	271		13
Buctril	8.4	6.1	371	14	9	350		12
Comite	39.8	6.8	199	8	118	74		7
Devrinol	32.0	4.0	3	0		3		
Diuron	13.6	8.0	5	0		4		1
Goal	15.9	7.2	46	2		41		5
Gramoxone	26.6	6.4	58	2		53		5
Kelthane	NA	8.0	1	0	1			
Lannate	64.0	5.5	2	0	2			
Lorsban	46.9	7.7	27	1	1	23	1	2
Malathion	16.0	7.1	7	0	7			
Metasystox R	34.2	5.7	7	0	6	1		
Orthene	21.3	6.4	75	3	47	24		4
Poast	28.0	7.1	22	1	1	20		1
Sinbar	14.4	5.8	303	11	7	271		25
Stinger	7.9	6.4	30	1		26		4
Sulphur	62.3	7.1	232	9	130	94		8
Surfactant	27.9	5.9	340	13	45	264		31
Vydate	78.7	5.5	76	3	7	40		29
None Used	0.0	0.0	535	20				
DK/NA	28.0	6.8	14	1		9		5

Chemicals in **bold face** are dry; light face, liquid. Application rates are ounces per acre. The effect scale ranges from 0 to 10, where 0 = not at all effective and 10 = completely effective.

APPENDIX B

The Interview Schedule

Hello, I'm__________________. I'm here to ask you a few questions about mint growing in Oregon. You may recall a letter you received from the Oregon Mint Commission recently about the study. We are conducting the survey to learn what kinds of pests and diseases infest mint fields and how well pesticides and other chemicals control them. I want to assure you that all the information you give us is strictly confidential and what you tell us will not be revealed to anyone. The interview is voluntary and if we come to a question you don't care to answer, just say so and we will go on to the next question. Also, you may find it handy to refer to your file to answer some of the questions. Okay?

Contact Result Codes

Make Callbacks:

1- No answer (after 6 rings)
2- Busy signal
3- Answered by recording
4- Too busy, call back later
5- Respondent not available
6- Could not locate
7- Refused/Terminated
8- Other (explain below)
9- INTERVIEW APPT. MADE
10- INTERVIEW COMPLETED

Contact History	Date	Time	Code	Initial	Callback/explain
Callback #1					
Callback #2					
Callback #3					

INTERVIEW SCHEDULED FOR: ________/________ **at** __________**(am)(pm)**

Contact to Interview	Date	Time	Code	Initial	Callback/explain
Callback #1					
Callback #2					

Time interview started:______ **Stopped:** _______

Verified by: ________

1. First, how many total acres, including crop and pasture land, did you farm in 1992?

   TOTAL ACRES ______
   DK/NA . . . 9999

2. How many acres were in crop land?

   CROP ACRES ______
   DK/NA . . . 999

3. And, how many acres of mint did you harvest in 1992?

   MINT ACRES ______
   DK/NA . . . 999

4. Were your mint fields subjected to:

	YES	NO	DK/NA
a. extra low temperatures this year? . . .	1	2	3
b. extra high temperatures this years? . .	1	2	3

5. How about rainfall levels? Were your mint fields subjected to:

	YES	NO	DK/NA
a. extremely low rainfall levels this year?	1	2	3
b. extremely high rainfall levels this year?	1	2	3

6. I would like to ask you a few questions about your mint operation. First, how many individual mint fields did you farm in 1992?

   NUMBER OF INDIVIDUAL MINT FIELDS ______

7. I have several questions I would like to ask you about each mint field, beginning with the largest field and ending with the smallest. How many acres is your largest field?

ACRES. . . ________
DK/NA. . . 999

7a. What is the mint variety?

VARIETY. ________
DK/NA 9

7b. What was the rootstock source?

SOURCE. . ________
DK/NA 9

7c. What was the highest yield you have <u>ever</u> obtained from this field in pounds per acres?

POUND/ACRE ________
DK/NA 999

7d. And, what was your 1992 mint yield for this field?

POUND/ACRE ________
DK/NA 999

7e. What is your best estimate of the <u>maximum</u> mint yield this field is capable of producing?

POUND/ACRE ________
DK/NA 999

→ 7ea. Why do you say that? **(PROBE!)**

What else?

7f. Was mint ever grown in this field prior to this planting?

DK/NA . . . 1
NO 2
YES 3

→ 7g. How many years elapsed between mint plantings?

YEARS BETWEEN PLANTINGS . . ________
DK/NA 99

7h. What is the age of the stand in years?

YEARS ________
DK/NA . . . 99

7i. How many pounds of Nitrogen did you apply per acre to this field in the Spring of 1992? **(RECORD AND ASK)** And, how many pounds of Nitrogen per acre did you apply this fall?

a. SPRING LBS/ACRE . . ________
DK/NA 999

b. FALL LBS/ACRES . . ________
DK/NA 999

7j. How many acres of this field did you flame last spring? **(RECORD AND ASK)** And, how many acres of this field did you flame in this fall?

a. ACRES SPRING FLAME . ________
DK/NA 999

b. ACRES FALL FLAME . . ________
DK/NA 999

7k. Did you till any of this field this year?

DK/NA . . 1
NO . . . 2
YES . . . 3

7l. About how many acres of this field did you till in 1992?

ACRES TILLED. . ________
DK/NA 999

7m. Is irrigation water for this field applied by sprinkler, by flooding, by furrow, or some other method?

SPRINKLER . . . 1
FLOOD 2
FURROW. 3
OTHER. ________
________). 4
DK/NA. 5

7n-o. (not applicable)

7p. Was this field infested with any **insects** this year?

DK/NA **(SKIP TO Q. 7q)** . 1
NO **(SKIP TO Q. 7q)**. . . 2
YES 3

(A). Did you have any (cutworms)? **(RECORD ANSWER IN TABLE BELOW AND IF "YES" ASK):**

(B). Using a scale of 1 to 7, where a "1" is "hardly noticed" and "7" is "very severe", how would you rate the severity of the infestation in this field from (cutworms)? **(RECORD AND ASK):**

(C). What chemicals, if any, did you apply to control this infestation? **(RECORD EACH CHEMICAL USED AND ASK FOR EACH):**

(D). What was the rate of application per acre. **(RECORD AND ASK):**

(E). Using a scale of 0 to 10 where "0" is not at all effective and a "10" is completely effective, how would you rate this treatment in controlling the problem? **(RECORD AND ASK):**

(F). And how was (were) the chemical(s) applied? **(CIRCLE "1" IF GROUND, "2" IF AERIAL OR "3" IF THROUGH IRRIGATION SYSTEM. RECORD FOR EACH CHEMICAL AND REPEAT A THROUGH F FOR ALL EIGHT INSECTS)**

	(A)			(B)	(C)	(D)	(E)	(F)		
						RATE OF	HOW	HOW APPL		
	DK/ NA	NO	YES	SCALE	CHEMICALS	APPLICA.	EFFEC.	G	A	I
1. Cutworms.	1	2	3	______	______	______	______	1	2	3
					______	______	______	1	2	3
2. Spider mites .	1	2	3	______	______	______	______	1	2	3
					______	______	______	1	2	3

(Q. 7p. insects cont'd.)

	(A) DK/ NA	NO	YES	(B) SCALE	(C) CHEMICALS	(D) RATE OF APPLICA.	(E) HOW EFFEC.	(F) HOW APPL G	A	I
3. Root borer .	1	2	3	______	______	______	______	1	2	3
					______	______	______	1	2	3
4. Flea beetle .	1	2	3	______	______	______	______	1	2	3
					______	______	______	1	2	3
5. Slugs . .	1	2	3	______	______	______	______	1	2	3
					______	______	______	1	2	3
6. Root Weevil .	1	2	3	______	______	______	______	1	2	3
					______	______	______	1	2	3
7. Symphy- lids .	1	2	3	______	______	______	______	1	2	3
					______	______	______	1	2	3
8. Other . .	1	2	3	______	______	______	______	1	2	3
(______________)					______	______	______	1	2	3

7q. Did you use any preventive chemicals to control diseases on this field?

DK/NA . . . 1
NO 2
YES 3

7r. Please tell me what preventative chemicals you used to combat diseases on this field and give the rate of application.

CHEMICALS	RATE OF APPLI.
1. ______	______
2. ______	______

7s. Did you have any **diseases** in this field in 92?

DK/NA **(SKIP TO Q. 7t)** . 1
NO **(SKIP TO Q. 7t)**. . . 2
YES 3

(A). Where there any (nematodes)? **(RECORD ANSWER IN TABLE BELOW AND IF "YES" ASK):**

(B). Using a scale of 1 to 7, where a "1" is "hardly noticed" and "7" is "very severe", how would you rate the severity of damage casued by(nematodes)? **(RECORD AND ASK):**

(C). What chemicals, if any, did you apply to control this infestation? **(RECORD EACH CHEMICAL USED AND ASK FOR EACH):**

(D). What was the rate of application per acre. **(RECORD AND ASK):**

(E). Using a scale of 0 to 10 where "0" is not at all effective and a "10" is completely effective, how would you rate this treatment in controlling the problem? **(RECORD AND ASK):**

(F). And how was (were) the chemical(s) applied? **(CIRCLE "1" IF GROUND, "2" IF AERIAL OR "3" IF THROUGH IRRIGATION SYSTEM. RECORD FOR EACH CHEMICAL AND REPEAT A THROUGH F FOR ALL SEVEN DISEASES)**

	(A)			**(B)**	**(C)**	**(D)**	**(E)**	**(F)**		
						RATE OF	**HOW**	**HOW APPL**		
	DK/ NA	**NO**	**YES**	**SCALE**	**CHEMICALS**	**APPLICA.**	**EFFEC.**	**G**	**A**	**I**
1. Nematodes	1	2	3	____	______	______	____	1	2	3
					______	______	____	1	2	3
2. Rust. . .	1	2	3	____	______	______	____	1	2	3
					______	______	____	1	2	3

(Q. 7s. diseases cont'd.)

	(A) DK/ NA	NO	YES	(B) SCALE	(C) CHEMICALS	(D) RATE OF APPLICA.	(E) HOW EFFEC.	(F) HOW APPL G	A	I
3. V. Wilt .	1	2	3	______	______	______	______	1	2	3
					______	______	______	1	2	3
4. Tomato spotted wilt virus .	1	2	3	______	______	______	______	1	2	3
					______	______	______	1	2	3
5. Black stem. .	1	2	3	______	______	______	______	1	2	3
					______	______	______	1	2	3
6. Powdery mildew .	1	2	3	______	______	______	______	1	2	3
					______	______	______	1	2	3
7. Other .	1	2	3	______	______	______	______	1	2	3
(______________)					______	______	______	1	2	3

7t. Did you use any preventive pre-emergence herbicides to control <u>weeds</u> on this field?

DK/NA . . . 1
NO 2
YES 3

→ 7u. Please tell me what preventative chemicals you used to combat weeds on this field and give the rate of application.

	CHEMICALS	**RATE OF APPLI.**
1.	____________	____________
2.	____________	____________

7v. Finally, was there any **<u>weed</u>** infestation in this field this year?

DK/NA **(SKIP TO Q. 8)** . 1
NO **(SKIP TO Q. 8)**. . . 2
YES. 3

→ (A). Was there any (groundsel)? **(RECORD ANSWER IN TABLE BELOW AND IF "YES" ASK):**

(B). Using a scale of 1 to 7, where a "1" is "hardly noticed" and "7" is "very severe", how would you rate the severity of the infestation in this field from (groundsel) **(RECORD AND ASK):**

(C). What chemicals, if any, did you apply to control this infestation? **(RECORD EACH CHEMICAL USED AND ASK FOR EACH):**

(D). What was the rate of application per acre. **(RECORD AND ASK):**

(E). Using a scale of 0 to 10 where "0" is not at all effective and a "10" is completely effective, how would you rate this treatment in controlling the problem? **(RECORD AND ASK):**

(F). And how was (were) the chemical(s) applied? **(CIRCLE "1" IF GROUND, "2" IF AERIAL OR "3" IF THROUGH IRRIGATION SYSTEM. RECORD FOR EACH CHEMICAL AND REPEAT A THROUGH F FOR ALL ELEVEN WEEDS)**

	(A)			**(B)**	**(C)**	**(D)**	**(E)**	**(F)**		
	DK/ NA	**NO**	**YES**	**SCALE**	**CHEMICALS**	**RATE OF APPLICA.**	**HOW EFFEC.**	**HOW APPL G**	**A**	**I**
1. Groundsel	1	2	3	____	____	____	____	1	2	3
					____	____	____	1	2	3
2. Pigweed .	1	2	3	____	____	____	____	1	2	3
					____	____	____	1	2	3

(Q. 7v. weeds cont'd.)

	(A)			(B)	(C)	(D)	(E)	(F)		
	DK/ NA	NO	YES	SCALE	CHEMICALS	RATE OF APPLICA.	HOW EFFEC.	HOW APPL G	A	I
3. Quack-grass .	1	2	3	______	______	______	______	1	2	3
					______	______	______	1	2	3
4. Foxtail .	1	2	3	______	______	______	______	1	2	3
					______	______	______	1	2	3
5. Thistle .	1	2	3	______	______	______	______	1	2	3
					______	______	______	1	2	3
6. Bindweed.	1	2	3	______	______	______	______	1	2	3
					______	______	______	1	2	3
7. Salsify .	1	2	3	______	______	______	______	1	2	3
					______	______	______	1	2	3
8. Sorrell .	1	2	3	______	______	______	______	1	2	3
					______	______	______	1	2	3
9. St. Johns-wort. .	1	2	3	______	______	______	______	1	2	3
					______	______	______	1	2	3
10. Dandelion	1	2	3	______	______	______	______	1	2	3
					______	______	______	1	2	3
11. Other.	1	2	3	______	______	______	______	1	2	3
(______________)					______	______	______	1	2	3

(CHECK PAGE 1, QUESTION 6. IF NO MORE FIELDS SKIP NOW TO LAST PAGE QUESTION 12)

Note of interviewer: Add new pages for Q 7-Q7v(11) for additional fields.

Finally, a few questions about yourself...

12. How many years have you raised mint in Oregon?

YEARS ________
DK/NA 99

13. In what Oregon county or counties is you mint operation located?

OREGON COUNTY ______________________________

____

14. About what percent of your total <u>farm</u> income in <u>1991</u> came from your mint operation?

PERCENT ________
DK/NA. . 999

15. And what percent of your total <u>household</u> income in 1991 came from your mint operation?

PERCENT ________
DK/NA . . 999

16. What was your age on your last birthday?

YEARS ________
DK/NA . 99

17. One final question. Is there anything else you would like to say about problems with raising mint in Oregon? **(PROBE!)**

(THANK YOU FOR YOUR COOPERATION)