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Central Oregon Agricultural Research Center Annual Report, 1995

Agricultural Experiment Station
Oregon State University

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COVER PHOTO: (L to R), Dale Coats (COARC research assistant), Fred Crowe (COARC superintendent) and Marvin Butler (Jefferson County Extension agent) standing near a wheel rake utilized in the Kentucky bluegrass post-harvest residue management research project. The wheel rake was developed by Rears Manufacturing to rake grass seed straw into a wind row, which is then removed by baling. Dale Coats, who primarily conducted the work on this research project, died in a boating accident in 1995.

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UPDATE, 1995: Drought & Rain, Sugar Beets, Potato Late Blight, Death of Dale Coats

Fred Crowe, Superintendent COARC

1995 was marked by unusual weather, the success of the first commercial sugar beet crop in central Oregon, great difficulty with the potato crop locally and elsewhere in the Pacific Northwest, and the death of a COARC employee.

DROUGHT & RAIN: The winters of 1993-94 and 1994-95 left lean snow packs and limited irrigation water. In contrast to 1994, however, 1995 was consistently cool with frequent rains. This allowed most growers plenty of irrigation water for crop needs for the acres planted. Due to its high proportion of Crooked River water rights, the COARC allocation was well short of field research needs in 1995, which was only partially relieved by regular precipitation. The COARC is grateful to those farmers who donated water to this research center to allow field research projects to be completed during 1995.

SUGAR BEETS: Roughly 1,500 acres of sugar beets were planted in central Oregon in 1995. Reports indicate that sugar content was high and yields were very respectable. As with any new crop with potentially sizable acreage, this should expand the cropping selection for central Oregon farmers. The biggest threat to sustained sugar beet production seems to be political, involving governmental sugar price supports.

POTATO: With unusually frequent rainfall, potato late blight emerged as a serious problem for central Oregon potato growers. Growers experienced yield and quality losses in the field and increased costs of disease control. They also face a high potential for in-storage tuber decay and questions about usage of potentially-infected seed.

Potato late blight has increased in aggressiveness throughout much of the world, including the Pacific Northwest. During wet weather, the fungal pathogen produces spores which become airborne or splash around. Spores infect leaves and stems causing large dead spots, and which can even be washed into the soil to infect tubers. The severe epidemic of 1995 in the Pacific Northwest including central Oregon resulted from several causes.

*Rain was unusually frequent in 1995. Frequent rains and high humidity are absolutely required for the potato late blight fungus to aggressively complete its life cycle. Unfortunately, when conditions are conducive, this fungus can spread extremely rapidly.

*The new strains of this pathogen, which have been identified elsewhere in the Pacific Northwest in recent past years, somehow made their way into central Oregon. This likely occurred on seed potatoes, or from movement of spores in large air masses which moved into central Oregon in the spring/early summer. Introduction of the disease into central Oregon was inevitable, as this disease is now well established in much of the Pacific Northwest. New strains are arising more frequently than in the past few years than in the years since the great Irish and European potato famines of the mid-1800's. This is due to the recent arrival of a second mating type of the pathogen from southern Mexico. It is somewhat discouraging to realize that for 150 years potato growers in northern latitudes were fighting a highly competent pathogen which in reality had one hand tied behind its back. With two mating types, it is coming out swinging with both hands.

*The new strains now present throughout North America and northern Europe have a greater capacity to survive under marginal conditions than do the older strains. Thus, the epidemic in central Oregon and elsewhere was characterized by short periods of rapid spread interspersed by non-rainy and low humidity periods in which the fungus maintained only limited activity on lower leaves. It also occasionally flared up during irrigations. The older strains may not have persisted during the 1995 dry periods. In contrast to the older strains, the new strains also seem to attack and persist better on stems better than leaves. Single stem lesions may kill the entire petiole of leaves.

*Under conditions ideal for activity of the pathogen, it is nearly uncontrollable by even the best fungicides. Even worse, the newer strains have substantial resistance to the old standby fungicide Ridomil. Even worse yet, early in the season the newer and better fungicides were in such high demand regionally that local ag products dealers had difficulty obtaining these new products when late blight was first identified and the products were first needed. Even worse again is the simple fact that, when late blight is anticipated, coverage of foliage must be complete starting from the beginning of emergence, and continuing through the entire season. Once the disease had started in a field, and in spite of periodic dry periods, coverage of all foliage throughout the canopy and control of late blight clearly was difficult for local growers to achieve in 1995.

Clearly, potato researchers and extension agents throughout the Pacific Northwest will be highly focused on late blight control programs in the immediate future. As evidence of this, roughly half of the topics on the 1996 state potato conventions in Oregon, Idaho and Washington address late blight issues. In spite of the new strains, a return to normal dry weather in central Oregon should suppress most late blight activity. With better fungicides and prompt, careful applications, local growers should be able to prevent late blight under all but the wettest years, such as 1995. With the foothold late blight established in 1995, however, it likely will likely recur at low levels locally for many years, and may flare again into high activity in years when rainfall again is frequent and if growers lower their guard.

DEATH OF DALE COATS: Dale Coats, Research Assistant with the COARC, drowned following a boating accident in the Prineville Reservoir on Memorial Day weekend in 1995. Dale had been employed by OSU since 1987 (???). In the late 1980's, local grass seed growers provided funds for Dale to return to OSU to earn a Masters Degree while conducting research on alternatives to open-field burning for post-harvest removal of grass residue. Between and after taking classes to meet degree requirements, Dale conducted his thesis work in central Oregon while retaining his RA status and assisting on other projects. Dale was well known amongst OSU and USDA scientists and extension personnel, and his research project brought Dale into contact with many people in the bluegrass seed industry, including farmers, seedsmen, and public employees in central Oregon and Union County, Oregon, in addition to Idaho, Washington, Canada and other countries. He was universally liked, and he was appreciated for the wealth of information and professional knowledge he had accumulated on bluegrass seed production. He is missed by all that knew him.

Station Staff in 1995

State-supported staff:

Dr. Fred Crowe, Superintendent, and Associate Professor of Botany & Plant Pathology

Dr. Alan Mitchell, Assistant Professor of Crop and Soil Science (75% research and 25% extension on soil and water issues)

Mylen Bohle, Assistant Professor, Crook County Extension (75% extension and 25% research on forages)

Marvin Butler, Assistant Professor, Jefferson County Extension (75% extension and 25% research on mint, grass seed and specialty crops)

Steve James, Senior Research Assistant (75% research and 25% extension of potatoes)

Dale Coats, Research Assistant

Pat Foltz, Bio-Science Research Supervisor

Peter Tomseth, Bio-Science Research Technician

Tom Garman, Bio-Science Research Technician

Sylvia McCallum, Bio-Science Research Technician

Kelli Muskopf, Office Coordinator

Other staff, supported on grant funds:

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Joy Light, Research Assistant

Margie Durette, Student Technician

Kyle Turner, Student Technician

Jessica Jacks, Student Technician

Kern Buckner, Student Technician

Curtis Gibson, Student Technician

Tara Foltz, Student Technician

Sam Crow, Student Technician

Alvin Crocker, Irrigation

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Madras, Oregon
1995 Water Year
(Source AgriMet)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL
AIR TEMP. (°F)													
AVE. MAX. TEMP.	61	46	43	40	50	52	56	68	72	82	80	78	
AVE. MIN. TEMP.	36	29	27	29	33	31	34	41	45	52	48	47	
MEAN TEMP.	49	37	35	34	41	42	45	54	59	67	64	62	
AIR TEMPERATURE (No. of Days)													
MAX. 90 OR ABOVE	0	0	0	0	0	0	0	0	0	4	4	5	
MAX. 32 OR BELOW	0	0	3	7	2	0	0	0	0	0	0	0	
MIN. 32 OR BELOW	14	23	23	24	17	12	2	0	0	0	0	0	
MIN. 0 OR BELOW	0	0	0	0	0	0	0	0	0	0	0	0	
GROUND TEMP. (°F at 4")													
AVE. MAXIMUM	52	42	39	37	44	43	47	54	61	66	65	62	
AVE. MINIMUM	50	40	38	36	42	41	44	51	57	63	61	59	
GROUND TEMP. (°F AT 8")													
AVE. MAXIMUM	53	43	40	38	44	43	46	53	60	65	64	61	
AVE. MINIMUM	52	42	39	37	43	42	45	51	58	63	62	60	
PRECIPITATION (inches)													
MONTHLY TOTAL	1.00	0.80	0.22	3.35	1.06	0.55	1.74	1.24	1.41	1.97	0.13	0.39	13.86
EVAPOTRANSPIRATION (inches)													
AVE. PER DAY	0.10	0.04	0.03	0.02	0.05	0.09	0.12	0.20	0.24	0.29	0.26	0.19	
WINDAGE (miles)													
AVE. PER DAY	150	185	176	131	134	177	142	133	121	127	127	116	
SOLAR RADIATION (langleys)													
AVE. PER DAY	262	140	102	94	193	301	366	511	525	565	526	388	
HUMIDITY (percent relative humidity)													
AVE. PER DAY	62	69	68	77	72	59	62	60	61	58	52	56	

GROWING SEASON	**Last Date Before July 15**	**First Date After July 15**	**Total Number of Days Between Temp. Minimums**
AIR TEMP. MIN.			
32° or below	May 13	Oct 5	145
28° or below	April 21	Oct 19	181
24° or below	April 19	Oct 22	186

Powell Butte, Oregon
1995 Water Year
(Source AgriMet)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL
AIR TEMP. (°F)													
AVE. MAX. TEMP.	60	42	41	42	52	51	55	64	69	79	76	74	
AVE. MIN. TEMP.	32	26	25	28	29	28	30	36	41	47	42	42	
MEAN TEMP.	46	35	34	35	40	40	43	51	56	63	60	58	
AIR TEMPERATURE (No. of Days)													
MAX. 90 OR ABOVE	0	0	0	0	0	0	0	0	0	0	0	1	
MAX. 32 OR BELOW	0	1	4	7	3	0	0	0	0	0	0	0	
MIN. 32 OR BELOW	22	25	20	20	15	24	18	9	1	0	1	0	
MIN. 0 OR BELOW	0	0	0	0	2	0	0	0	0	0	0	0	
GROUND TEMP. (°F at 4")													
AVE. MAXIMUM	52	40	37	37	43	45	49	58	64	68	66	62	
AVE. MINIMUM	48	39	35	35	40	39	43	51	58	63	60	58	
GROUND TEMP. (°F at 8")													
AVE. MAXIMUM	51	40	37	35	40	42	45	52	58	61	60	57	
AVE. MINIMUM	48	38	36	34	38	39	42	48	54	56	56	54	
PRECIPITATION (inches)													
MONTHLY TOTAL	0.67	1.08	0.23	2.61	0.60	0.98	1.58	0.71	1.32	0.97	0.19	0.82	11.76
EVAPOTRANSPIRATION (inches)													
AVE. PER DAY	0.10	0.04	0.04	0.02	0.06	0.08	0.12	0.18	0.22	0.27	0.25	0.18	
WINDAGE (miles)													
AVE. PER DAY	118	144	151	136	121	144	122	112	102	116	112	94	
SOLAR RADIATION (langleys)													
AVE. PER DAY	256	143	106	110	203	294	379	481	495	537	525	383	
HUMIDITY (percent relative humidity)													
AVE. PER DAY	64	74	70	83	74	63	67	65	65	61	56	59	

GROWING SEASON	**Last Date Before July 15**	**First Date After July 15**	**Total Number of Days Between Temp. Minimums**
AIR TEMP. MIN.			
32° or below	June 6	Oct 1	117
28° or below	May 18	Oct 13	148
24° or below	April 21	Oct 19	181

MINT INDUSTRY RESEARCH COUNCIL PEPPERMINT VARIETY TRIAL, 1994-95, COARC-MADRAS

Fred Crowe

Abstract

Field performance, including oil character, of six peppermint varieties/selections, established from a common source of rooted cuttings in 1994, were compared in their first full production season in 1995 in central Oregon. The experimental design was a randomized split-block design, and was situated on land with no prior peppermint production and without significant verticillium wilt infestation. In the late fall of 1994, microsclerotia of *Verticillium dahliae* were uniformly infested on plots in half of the trial, and half was left non-infested.

Mean oil yields among varieties/selections were not statistically separable, although 'Black Mitcham' yielded the lowest dry weight and highest oil per unit dry weight.

As for much Madras area peppermint in 1995, oil from the variety trial generally was considered to have a somewhat immature character, suggesting harvest was a little early for optimal local character. Entrees fell into four groups: (1) 'Murray', Todd's', and 'M83-7' were near the average for each component reported; (2) 'Black Mitcham' had the lowest total ketones, menthone, and esters, and highest menthofuran; (3) 'Robert's had the lowest pulegone and the highest esters; (4) 'T84-5' had the lowest total menthol, menthol, the highest total ketones and menthone, and also had low esters. The import of these differences awaits industry discussion. Considerations should include the reliability of one year's data, a single region of performance, potential difference in research vs. commercial still performance, and the apparent early harvest in 1995.

Powdery mildew incidence was greater throughout the season on 'Black Mitcham', and was consistently the least on 'M83-7', 'Murray', and 'T84-5'. 'Todd's' and 'Robert's' were intermediate with respect to powdery mildew incidence.

As expected, wilt levels were substantially higher in infested vs. non-infested plots. Prior to harvest, an average of 11.6 wilt strikes accumulated per 160 ft^2 plot for infested plots in contrast to an average of only 0.2 strikes per noninfested plot. The mean number of strikes per plot were 19.0, 16.8, 12.0, 9.8, 6.0 and 6.0 for 'Robert's', 'Black Mitcham', 'Todd's', 'M83-7', 'Murray' and 'T84-5', respectively, which were not statistically separable ($p \leq 0.05$). Based on the applied inoculum level, this moderate amount of wilt was as expected for all varieties/selections other than 'Black Mitcham', which showed less wilt symptoms than expected. A statistically significant interaction ($p \leq 0.05$) between percent spring ground cover and wilt infestation indicated that the 'Todd's' and 'Murray' varieties over-wintered as well in wilt-infested soil as in non infested soil. The other entries had slightly reduced stand in infested plots compared to non-infested plots.

Introduction

'Black Mitcham' is an old variety of peppermint. The oil character of 'Black Mitcham' sets the standard for commercial peppermint oil character, which other varieties must match (Roberts, 1994). 'Murray Mitcham' and 'Todd's Mitcham' (released in the 1970s) are irradiated selections of 'Black Mitcham' that retain traditional oil character, but have higher wilt tolerance (Horner & Melouk, 1976a,b, Horner & Melouk, 1977, Todd *et al.*, 1977, Roberts, 1994). Peppermint growers consider 'Murray' and 'Todd's' to be somewhat more difficult to grow than 'Black Mitcham'. Growers commonly state that 'Black Mitcham' is more vigorous than the wilt-tolerant varieties, and that the latter are more variable in performance from region to region, within regions, and even within individual fields. 'M' and 'T' selections listed below are further irradiated forms of either 'Murray' or 'Todd's' (Roberts, 1994). Prior to 1995, experimental designs had not been employed to utilize statistical measures of comparison among varieties with respect to yield, growth, disease susceptibility, vigor, etc. (Roberts, 1994, and also see similar reports in earlier years). In 1994-1995, the Oregon State University Central Oregon Agricultural Research Center participated along with other universities in establishing replicated and randomized field trials in various peppermint producing regions of the United States.

Methods and Materials

Plots were planted as rooted cuttings of six peppermint varieties or selections in 1994 in a randomized block experimental design, initially with eight replications. Varieties/selections included 'Black Mitcham', 'Murray' (redefined), 'Todd's', 'M83-5' (or 'Robert's), 'M83-7', and 'T84-5'. Rooted cuttings were received from Plant Technologies, Inc., Albany, OR, on June 6, 1994 and planted June 7, 1994. Plots were 20' x 8'. Plants were spaced 16 inches apart along five rows per plot with 20-inch row spacing. In spite of irrigation, high, hot and dry winds soon after planting resulted in some plant loss, which was supplemented with additional plants. Thus, additional rooted cuttings of 'Black Mitcham', 'Todd's', and 'Murray', and mother bed rhizomes of 'M83-7' and 'T84-5', were received and planted on July 19, 1994. Additional rooted cuttings of 'M83-5' were received and planted on August 9, 1994. After fall dormancy, all plots were rototilled to redistribute rhizomes within each plot on November 1, 1994, and simultaneously the plots on one half of the trial were infested with a uniform background of 2.0 microsclerotia/gm soil of *Verticillium dahliae*. The isolates of the pathogen used were taken from the same field of diseased 'Todd's' peppermint in central Oregon, and were proven to be pathogenic in laboratory stem inoculation tests. As of November 1994, the experimental design became a split block, and within each split block varieties were randomized within four replications.

Peppermint was managed for irrigation, fertility, and pests as per local commercial practices, which are not further specified here unless noted. Field notes were taken throughout 1994 and 1995, and are summarized as tabulated data below. Peppermint was swathed with a plot harvester, and about 10 lb of fresh hay per plot was air-dried in loosely-packed gunny sacks prior to distillation. As well as possible, distillation was as per industry standards (Hughes 1952), but using mini-stills located at the COARC. Oil from each plot was collected into vials that were topped off with nitrogen gas and stored in refrigerated darkness prior to shipping to Wm. Leman, Inc., Bremerton IN, for oil compositional analysis by standard gas chromatography. Nitrogen status of soil or peppermint stems from plots was determined several weeks prior to harvest.

Results and Discussion

Data below are means of eight replications (1994) or four or eight replications in the split block trial (1995). Table 1 shows various growth measurements for 1994 and 1995, and disease ratings for 1995. Table 2 shows growth and disease at harvest, along with harvest data for 1995. Table 3 shows oil character data for 1995.

Growth and development: Data from 1994 was considered of secondary importance, as rooted cuttings were getting established irregular establishment resulted in irregular growth, and infestation with verticillium occurred after the season had ended. As shown in Table 1, from the original planting of rooted cuttings, 'T84-5' required fewer re-plants than either 'Murray' or 'Todd's', which in turn required fewer replants than other varieties/selections ($p \leq 0.05$). 'T84-5' and 'Todd's' suffered greater soil line stem breakage (thought to result from an excessive top growth development compared to rooted cutting stem strength) than the other varieties/selections ($p \leq 0.05$), although all plants recovered. All varieties/selections seemed to tiller well late in the season 1994. Fall tillage in 1994 was used to redistribute rhizomes in an attempt to equalize spring stand density, due to rooted cutting establishment irregularities during 1994.

There were statistically significant differences ($p \leq 0.05$) among varieties with respect to ground cover ratings on May 12, 1995, including a sizable difference in ground cover between infested and non-infested plots. This test could not be directly compared statistically. There also was a statistically significant interaction ($p \leq 0.05$) between variety and infestation. In other words, the percentage of ground cover was different among varieties, and at least some varieties responded differently in infested vs. non-infested plots. Overall, 'Todd's' had the highest percent of cover, and 'M83-7' the least. The overall means and statistical ratings are shown in Table 1, but this observation may be further clarified by looking at the means for both infested and non-infested plots separately as shown in Table 2.

It seems as if the percentage ground cover was reduced in the infested plots of all varieties/selections. The exceptions were the 'Todd's' variety, which had the identical rating in both infested and non infested parts of the trial, and 'Murray', which seemed minimally reduced. Although seasonal disease ratings will be discussed later, spring stand ratings might be as critical a measure of verticillium effect as is seasonal disease, especially following a severe winter (Crowe 1994).

Pre-harvest stem height differences among varieties/selections were measured on several dates (Table 1). Stem heights were greater throughout the season on infested vs. non-infested plots. This could not be statistically evaluated due to the split-plot design, but this data is similar to that found in other verticillium trials in central Oregon (Crowe, 1994)). The cause and importance of this effect-response is not clear. On July 17, 1995 more branches were measured

on 'Black Mitcham' and 'M83-7', and fewer were measured on 'Murray' than other varieties/selections, but the differences were not separable statistically ($p \leq 0.05$). Possibly, a greater number of samples may have demonstrated statistically significant differences. Also on July 17, 1995, as shown in Table 1 'Black Mitcham' was advanced over all other varieties in early bud development ($p \leq 0.05$).
'Black Mitcham' was consistently lighter green throughout the season. Soil and petiole analyses for nitrogen indicated that nitrogen usage was comparable among varieties during 1995, and this data is not included. Except as noted above, growth visually was comparable on all varieties until late July, when 'Black Mitcham' both lodged uniformly and produced vigorous secondary growth. Other varieties were irregular in lodging and secondary growth. Note the lodging rating on July 25, 1995 (Table 1), and the lodging and secondary growth (rated as a combined character) rating on August 7, 1995 (Table 2). The data for August 7, 1995 is shown in Table 3.

In addition to large differences between the non-infested and infested plot data, varietal response varied significantly ($p \leq 0.05$), and there was a significant interaction ($p \leq 0.05$) between variety and infestation. Essentially, 'Black Mitcham' did not respond adversely to the factor that caused poorer development in the non-infested half than in the infested half of the trial. The responsible factor was likely not infestation itself, but rather an irregular watering pattern that occurred about the first of August on all plots, and persisted somewhat longer on the non-infested side of the trial area. Nevertheless, all varieties except 'Black Mitcham' responded poorly to this condition on the dry non-infested side of the trial. This was an interesting effect in itself and may explain growers' experience and preference for 'Black Mitcham'.

<u>Yield:</u> Means for harvested oil and hay yields are shown in Table 4. In spite of the near-harvest lodging and secondary growth differences described immediately above, no statistical differences ($p \leq 0.05$) were found among varieties/selections with respect to oil or dry weight hay yields, nor for the amount of oil per unit dry hay weight. Nevertheless, 'Black Mitcham' was the highest oil yielder and lowest hay yielder and consequently had the highest proportion of oil per unit dry weight. 'Robert's' was quite close to yielding the same as 'Black Mitcham'. Although leaf age and branching were not measured specifically, part of the lodging/secondary growth rating for August 7, 1995 included a visual estimate of such differences. At that time, 'Black Mitcham' had a greater proportion of leaves in various stages of development, whereas other varieties had a higher proportion of older leaves.

<u>Oil character:</u> Oil character as determined by Wm. Leman, Inc., was limited to the following components: total heads, total ketones, total menthol, menthofuran, menthone, menthol, esters, and pulegone. Data are listed in Table 5. As for much Madras area peppermint in 1995, oil from the variety trial generally was considered to have a somewhat immature character, suggesting harvest was a little early for optimal local character. For all varieties/selections, total heads averaged 9.7 percent, total ketones averaged 29.4 percent, total menthol averaged 41.5 percent, menthofuran averaged 5.7 percent, menthone averaged 24.4 percent, menthol averaged 33.4 percent, esters averaged 5.1 percent, and pulegone averaged 1.4 percent. 'Murray', 'Todd's', and 'M83-7' were near the average for each component reported. 'Black' had the lowest total ketones (26.5 percent), menthone (21.8 percent), and esters (4.6 percent), and highest menthofuran (7.4 percent), $p \leq 0.05$. 'Robert's had the lowest pulegone (1.14 percent)

and the highest esters (5.6 percent), $p \leq 0.05$. 'T84-5' had the lowest total menthol (39.3 percent), menthol (31.6 percent), the highest total ketones (32.5 percent) and menthone (27.4 percent), and also had low esters (4.8 percent), $p \leq 0.05$.

Disease ratings--Verticillium: Note comments on ground cover above. As noted in other years (Crowe, 1994), the effect of verticillium on winter survival may be at least as important as the effect of verticillium during the growing season.

During the growing season, verticillium wilt appeared early on a few plants. Verticillium was rated on July 17, 1995; July 26, 1995 (Table 1); and on August 7, 1995 (Table 4). Wilt increased with each time period, but the relative rating by variety was similar among dates. The amount of wilt recorded was moderate, and well below the amount considered to be near "wilt out". The initial inoculum level was expected to produce about as many wilt strikes in 'Todd's' as were actually measured, with other moderately-tolerant varieties expected to be similar to 'Todd's'. The amount of wilt observed on 'Black Mitcham' was much less than expected for this susceptible variety. We have no ready explanation for the limited wilt on 'Black Mitcham', but wilt incidence could increase disproportionally on this variety in future years.

Disease ratings--Powdery mildew: In central Oregon, mildew rarely causes enough plant damage to warrant treatment, and mildew in this trial was never treated. Nevertheless, mildew is a problem in some other parts of the United States., and this trial showed varietal differences of interest. Ratings for 1994 and 1995 are shown on Table 1. The incidence of mildew consistently was higher on 'Black Mitcham' than other varieties, and least on 'M83-7' and 'Murray', in comparison to the other varieties/selections ($p \leq 0.05$).

In general, this first attempt at a replicated, randomized variety trial was successful, except for irrigation management problems. All varieties were managed identically, as there is insufficient information to know whether the optimal management practice for one variety is different than that for another. No apparent differences in nitrogen utilization occurred. On the other hand, the one irregular management factor that did occur (irrigation deficiency on the non-infested half of the trial area near harvest) seemed to result in greatly different growth among all varieties/selections except 'Black Mitcham'. This suggests that water management might need to be watched more closely on other varieties than on 'Black Mitcham', which might be addressed in another study. 'Black Mitcham' seemed to have a slight, but non-statistically significant ($p \leq 0.05$) advantage in oil yield and in oil yield per unit dry weight in this first full production season.

The reason for an apparent deficiency of wilt symptoms on 'Black Mitcham' this first year is unexplained, but 1995 was not a severe wilt year with respect to weather stresses.

An important comparison among varieties/selections is oil character. Differences in this respect were abundant in 1995 in this trial. The import of these differences awaits industry discussion. It has long been suspected that there are differences between research and commercial stills with respect to oil character, and we have recently documented such differences (Mitchell & Crowe 1995). The extent to which variety trials and research stills are suitable for acceptance or rejection of new varieties will await further industry discussion, more variety trial experience, and possible improvements in mini-still design and operation. Considerations for 1995 should also include the reliability of one year's data, a single region of performance, the apparent early harvest in 1995, and possibly the moisture stress imposed prior to harvest. Further, these data must be compared with that from other regions.

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TABLE 1: Growth and Disease, June 1994, through July, Madras OR, 1995 (Pre-harvest)[1]

Variety	% Stand Rooted Cuttings 7/11/94	Main Stem Breakage[2] 10/8/94	% Powdery Mildew[3] 10/8/94	% Ground Cover 5/12/95	% Powdery Mildew[3] 6/27/95	Main Stem Height (cm) 6/27/95
Murray	82.4 b	1.1 a	9.4 b	67.6 ab	0.6 b	36.8 ab
Todd's	78.3 b	2.5 b	3.1 a	73.8 b	2.5 bc	37.3 ab
Black	66.7 c	1.4 a	22.4. c	62.5 ab	5.1 c	32.6 a
Robert's (M83-5)	65.7 c	1.5 a	5.0 a	68.2 ab	1.3 b	35.3 ab
M83-7	60.4 c	1.6 a	11.3 b	57.5 a	0 a	36.5 ab
T84-5	91.9 a	3.0 b	5.0 a	63.5 ab	0 a	39.3 b
Non-infested[4]				69.6	2.3	34.7
Infested[4]				62.9	0.8	37.8
Interactions[5]	NA[6]	NA	NA	$p \leq 0.05$	NS[6]	NS

Variety	Main Stem Height (C) 7/17/95	Branch Develop ment[8] 7/17/95	Bud Developm ent[9] 7/17/95	Verticillium Strikes/Plot (Infested Plots Only[10]) 7/17/95	% Lodging 7/25/95	Verticillium Strikes/Plot (Infested Plots Only[10]) 7/25/95
Murray	55.1 ab	1.3	0.04 a	2.8 a	28.8 a	4.5 a
Todd's	58.5 ab	2.0	0.09 a	5.0 ab	35.0 ab	9.0 b
Black	53.8 a	3.1	0.23 b	8.5 b	68.8 b	14.3 c
Robert's (M83-5)	57.1 ab	2.0	0.03 a	8.0 b	22.5 a	15.0 c
M83-7	55.5 ab	3.0	0.08 a	4.5 ab	36.3 ab	7.5 ab
T84-5	60.5 b	2.8	0.06 a	1.8 a	35.0 ab	4.5 a
Non-infested[4]	53.0		1.5	0.1		0.1
Infested[4]	60.4		2.9	5.3		9.1
Interactions[5]	NS	NS	NS	$p \leq 0.05$	NS	$p \leq 0.05$

1. Means not followed by a letter are not statistically separable, $p \leq 0.05$. Means followed by the same letter are grouped similarly, and are statistically separable from means followed by different letters, $p \leq 0.05$. In 1994, there were 8 non-infested replications per variety in a simple experimental design. In the fall of 1995, inoculum of *Verticillium dahliae* was added to half of the trial, creating a split-plot design, with 4 replications per variety in each half of the trial.
2. Main stems per plot were rated for soil-line breakage/canker. Such breakage is thought by F. Crowe to result from top-heavy foliage development. Plants typically proliferate below the break without continued problems.
3. Estimated area covered by mildew on third and fourth mature leaves from the main stem apex, from ten plants per plot.
4. Means for all non-infested and infested plots cannot be compared statistically due to experimental design, however, the means are shown if the PI considers them substantially different. See text for discussion.
5. A statistically significant interaction indicates a different response pattern occurred among varieties in infested vs. non-infested plots. Any such interactions are discussed in the text.
6. NA = Not Applicable -- the trial was not split at this time.
7. NS = Not statistically significant, $p \leq 0.05$.
8. The number of branches with mature leaves was determined for 10 plants per plot.
9. Plants were rated 1.0 if a bud was developing on the main stem, and 0 if not; 10 plants per plot were rated.
10. Variety means are shown only for the four infested replications, because nearly no disease appeared in non-infested plots.

TABLE 2: Ground cover data for interaction of variety vs wilt infestation, peppermint variety trial, Madras OR, 1995

	Ground cover ratings (% of plot covered) on 5/12/95					
	'Murray'	'Todd's'	'Black'	'Robert's'	'M83-7'	'T84-5'
non-infested	68.8	73.8	67.5	73.8	62.5	71.3
infested	66.3	73.8	57.5	62.5	52.5	65.0
average	67.6	73.8	62.5	68.2	57.5	63.5

TABLE 3: Lodging/growth data for interaction of varieity vs Wilt infestation, peppermint variety trial, Madras OR, 1995

	Lodging/Secondary Growth Rating (% of rating for highest performing plots) , 8/7/95					
	'Murray'	'Todd's'	'Black'	'Robert's'	'M83-7'	'T84-5'
non-infested	58.8	68.8	100	67.5	43.3	72.5
infested	13.9	41.3	93.8	32.5	26.3	35.0
average	36.4	55.1	96.9	50.0	34.8	53.8

TABLE 4: Development, disease and yields at harvest, peppermint variety trial, Madras OR, 1995[1]

Variety	Verticillium Strikes (Infested Plots Only[2])	% Lodging/secondary growth rating[3]	Harvest Dry Wt (lb/ac)	Harvest Oil Yield (lb/ac)	Harvest Oil/Dry Wt. Ratio (x100)
	8/7/95	8/7/95	8/8/95	8/8/95	8/8/95
Murray	6.0	36.3 b	5651	56	1.05
Todd's	12.0	55.1 b	4836	60	1.29
Black	16.8	96.9 a	4680	66	1.41
Robert's (M83-5)	19.0	50.0 b	4893	65	1.36
M83-7	9.8	34.8 b	4957	62	1.31
T84-5	6.0	53.8 b	5498	58	1.12
Non-infested[4]	0.2	40.5			
Infested[4]	11.6	68.5			
Interactions[5]	$p \leq 0.05$	$p \leq 0.05$	NS[6]	NS	

1. Means not followed by a letter are not statistically separable, $p \leq 0.05$. Means followed by the same letter are grouped similarly, and are statistically separable from means followed by different letters, $p \leq 0.05$. In 1994, there were 8 non-infested replications per variety in a simple experimental design. In the fall of 1995, inoculum of *Verticillium dahliae* was added to half of the trial, creating a split-plot design, with 4 replications per variety in each half of the trial.
2. Variety means are shown only for the four infested replications, because nearly no disease appeared in non-infested plots.
3. See text for explanation.
4. Means for all non-infested and infested plots cannot be analyzed statistically due to experimental design, however, the means are shown if the PI considers them substantially different. See text for discussion.
5. A statistically significant interaction indicates a different response pattern occurred among varieties in infested vs. non-infested plots. Any such interactions are discussed in the text.
6. NS = Not statistically significant, $p \leq 0.05$.

TABLE 5: Percent composition of peppermint oil at harvest, peppermint variety trial, Madras OR, 1995[1]

Variety	Total Heads	Total Ketones	Total Menthol	Mentho-furan	Menthone	Menthol	Esters	Pulegone
Murray	10.0	29.1 b	41.8 a	5.1 b	24.1 b	33.4 b	5.4 ab	1.30 b
Todd's	9.0	29.3 b	42.4 a	5.3 b	24.2 b	34.2 b	5.3 ab	1.46 b
Black	9.4	26.5 c	41.9 a	7.4 a	21.8 c	34.5 b	4.6 b	1.55 b
Robert's (M83-5)	10.0	29.3 b	42.2 a	5.2 b	24.5 b	33.7 b	5.6 a	1.14 a
M83-7	10.0	29.7 b	41.2 a	5.4 b	24.5 b	33.3 b	5.1 ab	1.45 b
T84-5	9.6	32.5 a	39.3 b	6.2 b	27.4 a	31.6 a	4.8 b	1.54 b
Non-infested[2]			42.0	5.4			5.4	
Infested[2]			41.0	6.1			4.9	
Interactions[3]	NS[4]	NS	NS	NS	NS	NS	NS	NS

1. Means not followed by a letter are not statistically separable, $p \leq 0.05$. Means followed by the same letter are grouped similarly, and are statistically separable from means followed by different letters, $p \leq 0.05$. In 1994, there were 8 non-infested replications per variety in a simple experimental design. In the fall of 1995, inoculum of *Verticillium dahliae* was added to half of the trial, creating a split-plot design, with 4 replications per variety in each half of the trial.
2. Means for all non-infested and infested plots cannot be analyzed statistically due to experimental design, however, the means are shown if the PI considers them substantially different. See text for discussion.
3. A statistically significant interaction indicates a different response pattern occurred among varieties in infested vs. non-infested plots. Any such interactions are discussed in the text.
4. NS = Not statistically significant, $p \leq 0.05$.

FIELD PERFORMANCE OF PEPPERMINT PLANTS REGENERATED FROM MERISTEM TIP CULTURE, AND EVALUATION OF VIRUS INFECTION

Fred Crowe, Steven Lommel, and Alan Mitchell

Abstract

Visually, 'Black Mitcham' peppermint originating from meristem tip culture appeared identical to non-meristemmed 'Black Mitcham' in the field in 1995, the third full production year in the COARC field trial of meristemmed mint. Although extensive measurements of height, branching, leaf number, etc. were not made in 1995 compared to past years, a measure of height and branching in late June indicated no differences between meristemmed and non-meristemmed plants. Measurements of nitrogen and water usage also were comparable for meristemmed and non-meristemmed plants in 1995. Nevertheless, meristemmed 'Black Mitcham' continued to have lower yields at harvest compared to peppermint in plots planted with non-meristemmed 'Black Mitcham'. Although the dry weight of hay was comparable (only slightly higher in meristemmed plots), oil yield for meristemmed 'Black Mitcham' was only 78 percent of oil yield of non-meristemmed 'Black Mitcham', and the oil yield per unit of dry weight was substantially enhanced for non-meristemmed mint over that for meristemmed mint.

The exceptional vigor observed in meristemmed 'Black Mitcham' in COARC field plots in 1993 lessened during 1994, and was not present at all in 1995. The only parameters that remained constant over these three years were oil yield (non-meristemmed peppermint continues to outperform meristemmed peppermint by 20 percent or more) and oil yield per unit of dry weight.

Plant growth differences in the greenhouse in North Carolina seem to mirror growth in the field in central Oregon, in that meristemmed and non-meristemmed plants are more similar in growth (e.g. stem length, leaf area) now than a year or more ago. Tests indicated a very low concentration of virus can now be detected in meristemmed material, both in material sent previously and material supplied in early spring 1995. Specifically, there are wide differences in the amounts of local lesions that appear on sap-inoculated indicator plants from these sources, indicating wide sap concentration differences. Although actual transmission of virus back into meristemmed peppermint cannot be totally excluded as a possibility, this is not likely from what is known of this class of virus (extremely slow growing, no known vectors, not spread by contact, etc.). These field and greenhouse observations are much more consistent with the probability that some virus was retained during the original meristem tip culture process, and that virus titer (concentration in plant) is only slowly re-establishing itself in the meristemmed plants. In other words, although the meristemmed plants initially appeared virus-free and behaved virus-free, they were not truly virus-free. Presumably, gradual increase of the virus in plants in both field and greenhouse explains the gradual loss of plant vigor.

This virus continues to seem similar to other Capilloviruses, which are relatively unfamiliar and unstudied plant viruses. These are known to exist in low concentration, are very slow growing and are difficult to handle. This one from peppermint is proving very difficult to purify in

quantity. This has slowed characterization and antibody development, although we are making progress.

Introduction

Meristem tip culture is a process in which a small part of differentiating plant tissues at the tip of the growing point of a bud is regenerated into a complete plant in a sterile environment and with the assistance of a supply of nutrients and plant hormones (Murashige and Skoog, 1962). Meristem tip culture generally preserves the genetic identity of the plant type and is not a cause of genetic variability, as may be seen for processes in which only undifferentiated embryonic cells or differentiated single cells (which revert to an undifferentiated state) are regenerated back into mature plants (Karp, 1991, Caligari and Shohet, 1992). Systemic plant pathogens move most quickly into growing point regions of plants via sugar-conducting tissues (phloem) or via water conducting tissues (xylem), and lag in their cell to cell movement into the rapidly growing tip because phloem and xylem are not yet differentiated. Thus, meristem tip culture commonly is used to regenerate propagation stock that is free of systemic pathogens. The meristem tip culture process requires some skill to avoid carrying along infected tissues, and pathogens vary in their ability to penetrate into the critical tissues to be taken during the process. Commonly, additional steps are included in the process that further limit systemic movement of pathogens, and/or which reduce the concentration or growth of pathogens in the plant. Such additional steps may include heat-treatment or treatment with chemicals that actively suppress pathogen growth. Thus, successful production of pathogen-free propagation stock requires experience with the plant materials and pathogens involved, and a means of verification that regenerated plants are indeed pathogen-free (Wright, 1988).

Commonly, systemic plant pathogens cause at least a reduction in growth if not stronger, debilitating symptoms, although some viruses may only weakly affect plant growth. Meristem tip culture of peppermint has been reported on a number of times (Geslot, *et al.*, 1989, Holm, *et al.*, 1991, Mariska, 1987, Repcakova, *et al.*, 1986, Rodov and Davidov, 1987), but in none of these reports were growth differences or pathogens discussed, which suggests that none were observed. Field observations from the early 1990s, noted that commercially-meristemmed 'Black Mitcham' peppermint in Montana grew more vigorously than rootstock propagated more traditionally. In light of this, we acquired rooted cuttings of both meristemmed and non-meristemmed 'Black Mitcham', each from a different commercial greenhouse propagator, but for which each had a common original source or propagation stock. We began to compare these materials in 1992-93 in the field, and at the same time wished to pursue the hypothesis that some systemic pathogen may have been eliminated by the commercial meristem tip culture process. Our field trials from 1993 and 1994 confirmed Montana grower observations of strong growth enhancement and increased hay yield in meristemmed 'Black Mitcham', but also supported growers' experience that meristemmed 'Black Mitcham' under-performed with respect to oil yield (Crowe, *et al.*, 1995).

Systemic plant pathogens include many viruses, some bacteria (including highly fastidious types that do not grow free of plant cells), and a few fungi. As a virus or viruses seemed most likely to be involved, this group was first considered. Last year we reported: finding double-stranded virus RNA (proof of presence of most plant viruses) from non-meristemmed peppermint, but which could not be detected from meristemmed peppermint, electron microscope pictures of a virus from meristemmed peppermint that could not be seen in non-meristemmed peppermint, and positive responses (local lesions) from sap-inoculated indicator plants using non-meristemmed 'Black Mitcham' but not meristemmed peppermint, when sap from these two sources were rubbed into the indicator plants. Only one virus seemed to be present (Crowe, *et al.*, 1995). We considered these steps proof that a virus was present in non-meristemmed 'Black Mitcham' in our test plots, that absent from meristemmed 'Black Mitcham' in adjacent plots. These steps do not constitute proof that the virus detected was responsible for the growth differences, as (at least theoretically) other undetected agents could be involved. In 1995, it was proposed to purify the virus, develop antiserum to it for diagnostic use, and confirm Koch's postulates by re-inoculating virus-free peppermint to assess the response of re-infection, i.e., would such reintroduction cause the mint to lose vigor and enhance oil yield?

Methods and Materials

Plots established in 1992 from rooted cuttings were continued through 1995. Sources of 'Black Mitcham' are described in previous reports (Crowe, *et al.,* 1995). In 1993 and 1994, nitrogen usage was greater for meristemmed than non-meristemmed 'Black Mitcham', as determined by petiole and soil nitrogen analyses. In 1995, nitrogen use again was monitored. All other field management was similar for both meristemmed and non-meristemmed 'Black Mitcham'. Plots were harvested and mint was distilled as per earlier years (Crowe, *et al.,* 1995). Plots were not further divided into additional treatments as in 1994, and there was only one time of harvest.

Oil was distilled in mini-stills from dry, long-stemmed hay (Hughes, 1952), oil was collected into vials, and topped off with nitrogen then refrigerated prior to shipment to Wm. Leman, Inc, Bremerton, IN, for compositional analysis.

In the laboratory, various methods were used in an attempt to increase the concentration of the virus in the sap of either peppermint or non-peppermint species. High plant concentration facilitates purification of virus and production of animal antibodies toward development of a reliable antiserum for virus detection.

In mid-1995, additional field-grown material from Oregon field plots was supplied to the lab in North Carolina for inspection and determination of virus infection status as per techniques described earlier (Crowe, *et al.*, 1995). It was thought that field-grown meristemmed material might be re-infected based on reduction in vigor in 1994 and early 1995.

Results

Nitrogen usage on meristemmed and non-meristemmed 'Black Mitcham' was comparable in 1995. On this basis, fertility was kept identical for both treatments in 1995. Stem height and branching number (determined as per Crowe, *et al.*, 1995) were evaluated in the third week of June 1995, and no differences were observed. In general, all casual observation suggested growth was identical for both treatments.

Harvest was August 8, 1995. Harvest data is shown in Table 1. As in past years, meristemmed peppermint had less total oil and less oil per unit of dry harvested hay, although the trend toward more dry matter for meristemmed peppermint was reduced over previous years. Oil characters evaluated are shown in Table 2, along with percentage composition. No statistically significant differences ($p<0.05$) were found between meristem and non-meristemmed 'Black Mitcham' for any component.

This virus continues to seem similar to other Capilloviruses, which are a group of relatively unfamiliar viruses. These are known to exist in low concentration and are difficult to work with. Dr. Lommel's lab is finding it a much more tedious and complicated procedure than normal to obtain sufficient virus to generate an antibody. In the event that we cannot obtain enough pure virus, we can cDNA clone the viral nucleic acid from a minimal amount of genomic RNA or from dsDNA (Jelkmann, *et al.,* 1989), which we have already established that we can obtain. The viral capsid protein gene will be identified in the clone and then overexpressed in a bacterial expression system (Giesman-Cookmeyer and Lommel, 1993). We can then obtain unlimited amounts of viral protein to immunize rabbits and create a virus-specific antibody.

Plant growth differences in the greenhouse seem to mirror growth in the field in central Oregon in that, compared to a year or more ago, meristemmed peppermint is becoming less vigorous and smaller-leafed (more like non-meristemmed peppermint held in the same greenhouse). It appears as if a very low concentration of this virus is showing up in meristemmed material, both the material sent previous to 1995 and in material supplied in early spring 1995. Specifically, there still are distinct differences in the amounts of local lesions that appear on sap-inoculated plants from meristemmed vs. non-meristem plants. This indicates that a wide sap concentration difference persists between meristemmed and non-meristemmed 'Black Mitcham' (even though the most concentrated is still quite low for purposes of purification). Capilloviruses are not known to be transmitted by arthropod vectors nor by mechanical means. As stated earlier, they seem to grow very slowly in all known hosts. Most likely, the finding that a trace of virus is appearing in meristemmed plants suggests that the original meristem tip culture process failed to eliminate all of the virus, and that it is slowly increasing again in these plants.

The finding that our meristemmed plants are not likely truly virus-free complicates eventual confirmation of the hypothesis that the detected Capillovirus in fact causes the observed reduction in vigor and increased oil yields for non-meristemmed plants in contrast to the distinctive growth of the meristemmed plants. This is because we have no verified virus-free material to infect with the virus, nor is there additional material to leave virus-free for comparison purposes. Discussion of this situation, and potential resolution, will be addressed in the 1996 grant proposals.

Discussion

We remain confident that a virus has been detected in non-meristemmed 'Black Mitcham' peppermint, and that it may exist in our meristemmed material at a much reduced concentration. It seems likely that a small amount of virus remained in the original meristem tip cultured 'Black Mitcham', and this trace was propagated through to the rooted cuttings used in the field plantings, which were themselves the source of lab material used for virus detection. We argue that the original trace was enough less than the amount "normally" occurring in non-meristemmed 'Black Mitcham' to account for the strong growth and performance differences seen during 1993, but that this trace has been increasing during 1994 and 1995. With this increase, the growth differences seen in 1993 have subsided substantially, although oil yield remains quite different. Nevertheless, this argument needs to be confirmed by completion of Koch's postulates, where we re-insert the virus into truly virus-free mint to re-establish symptomology.

Associating the presence of this difficult-to-handle virus with enhanced field performance of 'Black Mitcham' peppermint implies that its presence is an advantage to the peppermint industry. Our own tests to try to enhance performance of meristemmed 'Black Mitcham' suggests it is better harvested earlier in the season than non-meristemmed peppermint (Crowe, *et al.*, 1995). This was demonstrated even better by Leon Welty in Montana in 1994 and 1995 (Leon Welty, Montana State Univ., personal communication). It may prove important to ascertain the virus infection status and virus-free performance of other peppermint varieties and spearmint. May be especially important to ascertain the virus status of any mint regenerated from meristem tip culture (perhaps there are other pathogens one might wish to eliminate by this process!), or from single cell culture in various biotechnology applications. For these reasons, we still believe it important to develop an antiserum tool for rapid, easy, and positive detection and to characterize this virus.

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TABLE 1: Harvest data for meristem and non-meristem, COARC 1995

Treatment	Dry Weight lb/a	Oil Yield lb/a	Oil/Dry Wt. Ratio x 100
Non-meristem	5,688	72.9	1.36
Meristem	5,430	56.9	0.99
Stat. Sig.[1]	NS	$p<0.06$	$p<0.04$

1. Statistical significance level: NS = not significant at 10% level or lower; other p levels listed.

TABLE 2: Oil composition from meristem and non-meristem peppermint, COARC 1995

Treatment	Total Heads	Total Ketones	Total Menthol	Mentho furan	Menthone	Menthol	Esters	Pulegone
Non-meristem	8.8	30.2	39.6	22.0	25.6	32.3	4.5	1.2
Meristem	8.9	28.6	41.4	21.0	24.1	33.8	3.9	1.3
Stat. Sig.[1]	NS	NS	NS	NS	NS	NS	NS	NS

1. Statistical significance level: NS = not significant at 10% level or lower.

PEPPERMINT INTERCROP SCREENING TRIALS

Alan Mitchell

Abstract

This report summarizes a project that investigated relay intercropping of peppermint to reduce nitrate leaching. The project was funded by the Oregon Department of Environmental Quality, in order to evaluate different crops for their potential as intercrops, both for their fall and spring nitrogen (N) uptake. Three experiments are described as the screening trial, cereal trial, and the sudan trial. 'Monida' oats and 'Humis' rape both extracted fair rates of fall N, and did not create removal problems. Only Monida oats, with no winter survival, produced an acceptable peppermint oil yield. Sprinkler irrigation appears to be more desirable than furrow irrigation for the germination of intercrops. Other recommendations are given.

Introduction

Relay intercropping is defined as growing two or more crops simultaneously during part of the life cycle of each (Andrews and Kassam, 1976). Peppermint relay intercropping was studied for the first time by the author using rye (*Secale cereale*) in 1993 (Mitchell, 1994). The study showed that less than full-cover rye could be planted into an existing peppermint crop, and have no adverse effects on subsequent mint yield the following summer. Spring mulching with rye had been practiced previously in the Midwest, where single rows spaced 6 to 10 ft. apart have been used to prevent wind erosion in the spring. Rye rows are either chopped out later, or left to mature and decay during the summer.

Cover cropping, in contrast, is the practice of planting off-season crops after harvest. Elsewhere in the Pacific Northwest, cover crops have been planted between vegetable and potato crops in the fall, then plowed under in the spring (Edwards, 1986; Peache and William, 1994). Because peppermint is grown perennially, usually in five-year rotations, cover crops, as defined, can only be beneficial before and after the rotation. Here we test intercropping of peppermint, which will leave the perennial crop in place. The use of intercrops to remove excess soil N is an innovation. As suggested by the earlier study (Mitchell, 1994), other benefits may result, including allelopathy (weed suppression) (Al-Khatib and Boydston 1994), the production of plant exudates toxic to nematodes, and habitat for beneficial insects.

In July and August 1994, five trials were initiated with different crops following peppermint harvest, but these were later reduced to three trials because of poor sudan germination. The trials consisted of three experiments: 1) a general *screening trial* with 9 different plant species and 2 planting dates, 2) a *cereal trial* with 10 different cereals and 2 seeding rates, and 3) a *sudan trial* with 2 planting dates. The experiments measured soil N at planting and in the fall, plant N uptake, peppermint regrowth characteristics, and subsequent peppermint yield in August 1995. Chosen crops are listed in Table 1. The trials will be described in further detail below.

Table 1. Crops selected for screening and cereal trial, Madras, Oregon, 1994.

	Beneficial Characteristics	*Winterhardy*
Screening trial		
sudan	halophyte, rapid growth, C4 plant, possible nematode toxins	no
'Wheeler' rye	nematode toxin, symphylan toxin as good as Dyfonate.	very
marigold		no
crimson clover	removes and fixes N, usually meant for plowdown	yes
annual ryegrass	good competition against weeds	yes
hairy vetch	removes and fixes N, usually meant for plowdown	yes
'Gwen' barley	feed barley, early to mid maturity, small head, rough-awned	very
'Humis' rape	Used in potato trial at Hermiston for weed suppression	low
quinoa	halophyte, grown as high-protein grain in Andes	no
Cereal Trial		
'Wheeler' rye	nematode toxin, symphylan toxin as good as Dyfonate	very
common rye,	allelopathy, easy to obtain	yes
K-2 rye	allelopathy, stands very erect, used in 1993 study	yes
'Micah' barley	weed suppression, used in earlier cover crop trials	yes
'Gwen' barley	feed barley, early to mid maturity, small head, rough-awned	very
'Belford' barley	feed barley, performed well in central Oregon trials	low
'Adams' wheat	soft white spring wheat	yes
'Gene' wheat,	soft white winter wheat, awnless, early maturity, short	low
'Monida' oats	rapid fall growth, used for feed	no
annual ryegrass	good competition against weeds	yes

Methods

Screening Trial

The *screening trial* consisted of forage, cereal, brassica (rape), and sorghum (sudan) crops planted into established peppermint that was furrow irrigated. The objective of this trial was to screen crops for intercrop potential.

The screening trial consisted of three replicates of 25 by 7.5-ft. plots. Two planting dates were applied as strip treatments within the randomized block design. The first planting was hand broadcast into a peppermint 'Black Mitcham' field on July 22, prior to harvest. This planting did not have good germination before harvest, but several plants emerged later.

The second planting was broadcast planted by hand on August 17 following an August 13 harvest. On August 18, the field was rotary corrugated to cover the seeds with 0.5 inches of soil. After the August 20-21 flood irrigation, the soil beds between the furrows were inadequately soaked, and sprinkler irrigation was used on August 30, and in September. By September 6, most plots of the second planting had germinated.

The first 32° F frost occurred October 12, the first 28° F frost on October 13, and the first 24° F frost on November 3, 1994.

Plant sampling occurred from October 31 to November 8. Samples (1 $ft^{2)}$ were taken from each plot and plants were separated into cover plant, cover root, mint old biomass (originating before harvest), new mint growth, and mint rhizomes. Three soil cores were taken from the bed and composited for two depths: 0 to 12 inches, and 12 inches to hardpan.

On April 1, 1995, cover plants and mint rhizomes were again sampled from each plot, and plant total Kjeldahl nitrogen (TKN) was determined on all samples.

Peppermint was harvested on August 9, 1995 with at forage plot harvester from a 3.33 by 25 foot area. Peppermint oil was distilled from samples at a research distillery at COARC.

Cereal Trial

The cereal trial was planted into a stand of peppermint 'Murray Mitcham'. Treatments were two seeding rates of 10 different cereals, as listed in Table 1. On September 13, 1994, the field was rototilled to 3 inches, because soil compaction prevented direct seeding. On September 14, plots (5-ft wide with six 1-ft rows) were planted with a experimental grain planter. Plot size was 20 ft. by 5 ft. The 'full' seeding rate was 100 lb/a, a recommended rate for winter grain, and the 'half' rate was 50 lb/a. There were two replicates of each seeding rate for all 10 cereals. Borders were planted with Micah barley. One treatment, the K-2 rye was planted by hand a week later on September 20 (the delay resulting from seed availability). Germination was good for all crops with the exception of the Micah barley.

On November 10, soil and plant samples were taken from 1-ft^2 quadrates. The samples were 3 inches deep, and were washed and separated into two categories: rhizomes and mint plants, and cereal plants. Dry weights and plant TKN were determined for each plot. Soil samples were taken in increments of 0 to 12 inches and 12 to 18 inches.

In early spring 1995, the plants and soils were sampled in a like manner. The March 15, 1995 sampling included rhizomes and plants together, since the plants had not yet emerged. The Monida oats were all winter killed, and there were weak stands of Belford and Micah barley. On April 21, 1995, all cereal plots were mowed with a Jari mower, such that one row was left standing to test for the effects of wind protection. Complete removal of the cereal occurred on June 4, 1995. Harvest occurred on August 9, 1995 as outlined above for an 3.33 by 20 foot area.

Sudan Trial

The *sudan trial* was designed to compare different planting dates of sudan and different tillage treatments. Sudan was planted at two times. The first was hand broadcasted on July 14, 1994 into peppermint 'Murray Mitcham' prior to harvest. Unfortunately, the first planting did not germinate. A second planting occurred on August 18, following an August 13 harvest, and was hand broadcast, then covered with soil from a rotary corrugator.

Planting rate was 20 lb/a. Plot size was 20 ft by 10 ft. On August 31, soil samples were taken at three depth increments: 0 to 6 inches, 6 to 12 inches, and 12 to 24 inches. Four cores were taken in each plot.

The seeding rate was not adequate for a full stand, hence, the tillage and removal treatments were not imposed. On October 24, 1994, plants and soils were sampled in replicates 1 and 2. The first planting date treatment was used as a non-planted control to compare the sudan-planted and non-sudan peppermint. Plants were divided into rhizomes, dry peppermint stems, plant growth since harvest, and old leaves plus duff. Sudan upper growth and roots were also measured in the sudan plants from three quadrates. No subsequent yield data was taken.

Results

Screening Trial

The first planting (July 22) did not result in germination either before or after harvest, and consequently plant and soil measurements were not taken. However some plots germinated later. For the second planting (August 17), only the sudan and quinoa had less than good germination, attributed to inadequate seeding rates. The sudan seed source had poor germination rate, and did not perform well in the furrow-irrigated screening trial. The sprinkler-irrigated sudan trial had better germination. The quinoa was planted at a low rate due to limited supply. These rates were reflected in the poor fall dry matter yield as indicated in Table 2. The low marigold yield was not due to poor germination, but rather to the poor growth in the fall, and the October frosts killed the small plants and made plant sampling impossible.

The fall yield and nitrogen uptake are given in Table 2. Due to high variability of plant population, there was no significant difference in yield, nevertheless, yield and N uptake are given for each crop. Rape had the highest N uptake at 64 lb/a, and, the majority took up 28 to 44 lb/a, with the exception of sudan, marigold, and quinoa, which all had poor germination. The control treatment had 38 lb N/a, consisting of dandelion (*Taraxacum officindle*) that invaded many of the plots. Results from the cereal and sudan trials, which follow, will show that there is more potential for N uptake than indicated here.

Regrowth of peppermint was measured as 1) residual dry matter from harvest, 2) new stems and leaves, and 3) rhizomes. None of the components were statistically different among treatments, and the means are given in Table 2.

In comparison, the rape 'Humis' performed well for removing N from the soil. The seeding rate of 5 lb/a may need to be increased in order for the rape to extract N at its full potential. Sprinkle irrigating may also improve fall growth of rape. There was moderate winter survival, 1,300 lb/a, in the mild winter of 1995, but we do not anticipate a cover crop removal problem. Rape could probably be removed by flail chopping or grazing in the spring. The high TKN content of rape (3.5 percent) results in a low carbon-nitrogen ratio, and means rape should quickly decompose within the following growing season, and N should be available for mint uptake.

Table 2. Screening Trial Fall Yield and N Data, Madras, Oregon 1994-1995.

Crop	Seed	Fall DM	TKN	N uptake	Root	TKN	Root N Uptake	Total N Uptake
	(lb/a)	(lb/a)	%	(lb/a)	(lb/a)	%	(lb/a)	(lb/a)
Sudan Grass	20	264	3.4	6	505	1.2	6	12
Wheeler Rye	100	1174	2.4	30	1020	1.4	14	44
Marigold	5	0	--	--	0	--	0	--
Crimson Clover	20	1071	2.5	30	527	2.7	14	44
Annual Ryegrass	15	1135	2.4	21	445	1.6	7	28
Hairy Vetch	30	1030	2.8	16	504	2.6	13	29
Barley 'Gwen'	100	1254	2.3	29	803	1.1	9	36
Rape 'Humis'	5	1135	3.5	52	341	3.5	12	64
Quinoa	2	959	3.6	38				38

Peppermint components (averaged)

	Dry Matter	TKN	N uptake	
	(lb/a)	%	(lb/a)	
Old residual stems + leaves		1328	0.89	11.8
New mint stems + leaves	2453	1.32	32.4	
Mint rhizomes	2165	1.01	21.9	

Plants varied in their winterhardiness as indicated by the spring dry matter and soil N data (Table 3). The cereal (rye, barley) and legume crops (clover, vetch) increased in dry matter over the winter, while rape lost dry matter, and sudan, marigold, and quinoa were not winterhardy.

Soil nitrogen sampled on September 9, 1994 averaged 6 lb N/a across all plots, which is a relatively small amount in the soil after harvest. In November, the soil N level increased to 20 lb N/a, indicating mineralization of N from soil organic matter occurred in the interim. A calculation of mineralized N for Wheeler Rye showed an increase of 14 lb N/a in the soil, 32 lb/a in the new mint, and 44 lb N/a in the intercrop and its roots. The grand total was 90 lb N/a mineralized in September and October. Other crops extracted more and less nitrogen (Table 2), but this had no statistically significant effect on the measured soil N in the field.

Oil and dry matter yield were not significantly different among treatments. The mean oil yield was 32 lb/a, indicative of the poor yield of the field.

Cereal Trial

Seeding rates of 50 and 100 lb/a did not influence either fall dry matter or plant N uptake, hence the data herein will reflect the averages over both seeding rates. The herbicide terbicil (Sinbar) had a manifest effect on parts of the plots where plants germinated, then died. This effect ran in strips through the trial where there was a possible overlap of Sinbar that had been applied in the spring of 1993. The presence of the strips was manifest in a significant block effect on dry matter.

Dry matter yield and N uptake in the fall differed by treatment at the 0.10 significance level, as listed in Table 4, but mean comparisons were not made. March dry matter and plant N were significantly different among treatments (Table 4). Micah barley had significantly less dry matter than the other cereals in Fall and March because of poor germination, unlike other trials where it performed well (Murray and McGrath, 1992). K-2 rye fall dry matter was low due to a later planting than the others. Monida oats, and Belford and Gwen barley were best at extracting fall N. Monida oats and Belford barley had poor winter survival, which may be beneficial for extracting fall N, while avoiding potential removal problems the following spring.

K-2, Wheeler, and Cereal rye had excellent winter survival and regrowth, as did Gwen barley. These would likely result in removal problems if one was counting on a peppermint crop. If cover cropping were done at the end of a mint rotation, these would work well, and could be plowed down prior to planting in the spring, or taken as a hay or grain crop in the summer. However, if these cereals were used as a relay intercrop, they would need to be sprayed out in the spring, or else planted as windbreaks in wider strips.

Mint rhizomes were statistically unaffected by the cereal species in the fall, with an average of 820 lb/a (Table 5). Rhizome N uptake was also identical among treatments, averaging 19 lb N/a (Table 5). But in the spring, there was a significant cereal effect on mint rhizomes with 'Adams' wheat and cereal rye lower than the others (Table 5). The overall poor yields,

Table 3. Screening trial spring intercrop dry matter and N data, sampled April 1, and August peppermint dry matter and oil yield, 1995, Madras, Oregon.

Crop	Spring Dry Matter	TKN	N plant	August Peppermint Dry Matter	Oil Yield
	(lb/a)	%	(lb/a)	(lb/a)	
(lb/a)					
Sudan Grass	0		0	2593	36
Wheeler Rye	5325	2.4	75	1587	34
Marigold	0		0	2518	32
Crimson Clover	2504	2.5	72	2596	34
Annual Ryegrass	2383	2.4	31	2462	29
Hairy Vetch	1996	2.8	79	1243	11
Barley 'Gwen'	3620	2.3	90	3788	35
Rape 'Humis'	1308	3.5	41	2450	37
Quinoa	0		0	3106	34
Control (no cover crop)	1093*	3.6	30	3059	35
Mint stems and rhizomes	2033	1.47	29		

Table 4. Cereal trial dry matter and N uptake, sampled in November 1994 and March 1995, Madras, Oregon. Column values followed by the same letter are not significantly different for Duncan's test at 0.05.

Crop	Fall Dry Matter	TKN	Fall Fall N Uptake	March Dry Matter	Plant N	March
	(lb/a)	%	(lb/a)	(lb/a)	(lb/a)	
Oats 'Monida'	2842	4.2	119	70 e	0 c	
Barley 'Belford'	2447	4.1	101	756 de	24 bc	
Barley 'Gwen'	2437	5.0	121	4258 ab	128 a	
Rye 'Wheeler'	2300	3.8	88	3656 abcde	72 abc	
Wheat 'Adams'	1914	4.4	85	1137 bcde	33 abc	
Wheat 'Gene'	1797	4.5	80	3687 abcd	97 abc	
Rye, Cereal	1739	4.9	85	2838 abcde	59 abc	
Annual Ryegrass	1689	4.0	68	2394 abcde	50 abc	
Rye, K-2	1562	5.1	79	4754 a	131 a	
Barley 'Micah'	1367	4.5	61	801 cde	26 bc	
Mint rhizomes	820	2.29	19	95		

Table 5. Rhizome dry matter and later peppermint dry matter and oil yields, Cereal Trial, Madras, Oregon, 1994-1995. Peppermint data is for the half-rate seeding treatments. Column values followed by the same letter are not significantly different for Duncan's test at 0.10.

Crop	Rhizome Dry Matter Nov. 94	Rhizome Dry Matter Mar. 95	Aug. 95 Peppermint Dry Matter	Aug. 95 Peppermint Oil Yield
	(lb/a)	(lb/a)	(lb/a)	(lb/a)
Annual Ryegrass	789	158 a	0 b	0 b
Rye, K-2	866	137 ab	660 b	3 b
Wheat 'Gene'	883	125 ab	1307 ab	11 b
Barley 'Micah'	854	108 ab	744 ab	12 b
Oats 'Monida'	775	89 ab	**2891 a**	**51 a**
Barley 'Gwen'	852	79 ab	0 b	0 b
Rye 'Wheeler'	746	74 ab	493 b	3 b
Barley 'Belford'	708	70 ab	1417ab	21 b
Wheat 'Adams'	729	55 b	849ab	13 b
Rye, Cereal	1000	55 b	440 b	4 b
mean	820	95		
significance	NS	0.10	0.01	0.01

with the exception of Monida oats, suggests competition or allelopathy was excessive.

The low rhizome mass of the cereal trial resulted from rototilling, which cut the rhizomes into smaller pieces that evidently did not survive well over winter. Overall, there were large decreases in rhizomes over winter--the average decreased from 820 to 95 lb/a (Table 5). This was not enough to produce a good yield of peppermint when other competition existed. This is in contrast to the screening-trial rhizome mass of 2,165 and 2,030 lb/a in Fall and Spring (Tables 2 and 3), respectively.

November soil nitrate sampling was low (5 lb N/a) in all treatments. There were no differences among the cereal treatments or plant densities.

In general, the planting density was too high and the cereals were more competitive than the peppermint in the spring. The only exception was Monida oats, which did not survive the winter to compete in the spring. Peppermint oil yield was only acceptable for the Monida oats that had 51 lb/a (Table 5).

Sudan Trial

The sudan trial was plagued with poor germination, although the late planting date may have also reduced growth. Results showed the sudan trial produced significantly less new peppermint growth. Comparison with a non-planted control shows that sudan extracted only 15 lb/a of N. Interestingly, the sudan treatment produced 1,728 lb/a of new plants with 25 lb N/a while the control had 3,116 lb/a of new plants with 41 lb N/a. In other words, sudan caused a significant reduction in peppermint N uptake of 16 lb N/a. Lower growth is attributed to the effects of the rotary corrugator that was used in planting to cover the seeds. The fall new growth was reduced, but rhizomes mass was greater under this treatment. This increase in rhizome mass was expected from the corrugator, which buried the plants.

The soil N data did not differ by treatment, with the initial amount at 21 lb/a available in the top foot and the field soil N at 8 lb N/a (data not shown). This was a reduction of 13 lb N/a, and 41 lb N/a were extracted by the sudan and no-sudan control. The difference of 28 lb N/a can be attributed to soil mineralization.

In order for sudan to be a viable fall intercrop for peppermint, the seedling rate would need to be increased to several times the 20 lb/a rate used here. Because the sudan is susceptible to cooler weather, one option would be to plant earlier. However, earlier plantings depend on an earlier harvest that may not be practical. Sudan does not compare well with Monida oats (119 lb/a of N removed), which also winter kills.

Conclusions and Recommendations

1. Sprinkler irrigation appears to be more desirable than furrow irrigation for the germination of intercrops. While this conclusion may be limited to our soil and crop conditions at the Madras site, it is important to consider.

2. Rape extracted the most N in the screening trial. We recommend a seeding rate slightly higher than the 5 lb/a used here. Rape may be advantageous because its removal may be less problematic than for winterhardy cereals.

3. Monida oats and Belford barley were effective at removing N in the fall and were not winterhardy. Belford barley had limited survival, and Monida oats none at all. These crops appear to be good options for avoiding spring crop removal while extracting N. The fall and spring rhizome mass was unaffected by these treatments. Only the Monida Oats had acceptable peppermint oil yield.

4. Cereals planted at 50 lb/a into a tilled peppermint field grew as well as higher density plantings.

5. If rye or other winterhardy cereals are to be used, they should probably be planted at rates lower than 50 lb/a and with wider spacings than the 12-inch rows used here.

6. Sudan may have no advantage over Monida oats as a crop that will winter kill. Sudan may be allelopathic to peppermint when grown simultaneously as an intercrop.

7. Preharvest planting of crops was detrimental to germination and growth. The best practices were to plant and irrigate as soon as possible after harvest.

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PEPPERMINT PERFORMANCE AND WILT INCIDENCE, AS INFLUENCED BY SELECTED CULTURAL RESEARCH PARACTICES AND INOCULUM DENSITY OF *VERTICILLIUM DAHLIAE*

Fred Crowe

Abstract

In 1995, a new soil assay, the "Harris assay", was used to determine the 1994 summer inoculum density of microsclerotia (MS) of *Verticillium dahliae* from the field trial at the COARC, Powell Butte. The field for the trial had been (a) artificially infested with a range of infestation levels of *V. dahliae* in 1989, (b) planted with 'Todd's' peppermint in 1990, (c) managed with either tillage without flaming or with flaming without tillage for three production seasons through 1993 until peppermint in the highest initial infestation "wilted out", and (d) removed from peppermint in the spring of 1994 (while irrigation was continued). From initial infestation in 1989 at 0. 0.01, 0.1, 1.0 and 5.0 MS/g soil, plots that been flamed but not tilled in 0-1993 were assayed in the summer of 1994 to be 0.37, 0.02, 0.00, 0.12, and 0.74 MS/g soil, respectively. Plots that had been tilled but not flamed in1990-1993 were assayed to be 0.79, 0.07, 0.26, 5.70, and 18.60 MS/g soil, respectively. The reliability of the Harris assay is discussed relative to assays used previously, and to wilt disease and mint performance during 1990-1993.

The higher recovery of MS from initially non-infested plots in which wilt never occurred seems anomalous and likely represents MS from a strain of *V. dahliae* nonpathogenic to peppermint, one which does not appear to have been recovered from plots in which the peppermint strain of *V. dahliae* was added.

Based on the Harris assay data, it appears as if flaming without tillage resulted in a drop in inoculum density for most initial inoculum levels, whereas tillage without flaming resulted in a three-to-sevenfold increase over initial infestation levels. In general, the "Horner" hypothesis, at times questioned during 1990-93 because results of previous assays was confusing, seems to be confirmed by these latest results. Not only did flaming without tillage result in less wilt in all but the highest infestation levels compared to tillage without flaming, it also resulted in less carryover of soil inoculum of *V. dahliae*, and perhaps an actual lowering of soil inoculum. These results also seem to suggest that the high proportion of "wilt out" seen at the highest infestation level in flamed but not tilled plots resulted largely from a combination of reduced stand together with carryover of infection within rhizomes, rather than from re-infection from soil. "Wilt out" in tilled but not flamed plots probably resulted from these sources in addition to increasing soil inoculum.

Peppermint was killed from plots in 1994, but the integrity of plots was maintained and plots were kept irrigated to allow MS to be released into soil from decaying peppermint. Plots are ready for replanting of a second peppermint crop to determine the impact of residual inoculum from the first crop. Plots may be split to test some additional parameter.

Introduction

On this long-term project, readers are referred to reports of progress on this project from 1990 through 1994 (Crowe, 1992, 1993, 1994, 1995). The initial intent was several-fold: (1) To determine the general ranges of infestation of microsclerotia (MS) of peppermint strains of *V. dahliae* that induce various levels of verticillium wilt, and thus the type of soil assay most likely to detect these ranges, (2) to determine whether the "Horner" model of tillage vs. flaming that had been worked out for the Willamette Valley [i.e. tillage worsens wilt by incorporation of MS and increasing soil inoculum, flaming kills inoculum in the stem and keeps wilt from increasing (Horner and Dooley 1965, and McIntyre and Horner 1973)] could be applied to a moderately tolerant variety such as 'Todd's' in central Oregon (3) to determine whether winter damage of consistently untilled peppermint might be more adverse to production in central Oregon than damage due to wilt aggravated by tillage, (4) to determine actual changes in soil inoculum levels of MS over time, which had only been assumed previously but not measured, using soil assays proven useful in other regions, and (5) to serve as a basis for evaluation of inoculum density and "wilt potential" in commercial field soils using the inoculum density vs. disease loss relationships determined from this field trial.

Plots at the COARC, Powell Butte field were fumigated with methyl bromide in 1987, and the widely used wet sieving version of the "Butterfield" soil assay (Butterfield and DeVay, 1997, Joaquim *et al.*, 1988, Nicot and Rouse, 1987) in 1989 suggested that few MS of *V. dahliae* were present. Field history suggested that any MS present likely were associated with potatoes and not with peppermint. Points 1, 2, and 3 were largely assessed during 1990-1993, following uniform infestation of large field plots and planting of 'Todd's' peppermint in the spring of 1990. In general, wilt incidence increased on tilled but not flamed peppermint, and remained static on flamed but not tilled peppermint for all initial levels of infestation (0, 0.01, 0.1, 1.0 and 5.0 MS/g soil), except at the highest level of initial infestation (5.0 MS/g soil). At the highest initial level, peppermint "wilted out" for both tilled and flamed plots during the third year, as defined by great reduction in stand and yield compared to other treatments. The pattern of "wilt out" was different in the highly infested flamed plots (lowered spring stand, moderately high seasonal wilt symptoms) vs. "wilt out" in tilled plots (stand uniformly maintained near 100 percent by rootstock redistribution each spring, but very high incidence of seasonal wilt symptoms).

A major stand decline occurred in highly infested flamed but not tilled plots in the winter cold periods of 1990-91. In this treatment combination, the peppermint never really recovered full stand, perhaps due to in-season activity by *V. dahliae*. The winter injury likely was associated with lack of winter hardiness on wilt-infected rhizomes in the fall of 1990. Lack of winter hardiness was never observed at initially lower levels of infestation. Undoubtedly, the winter kill also occurred in the highly infested plots that were spring tilled, but any such winter kill was obscured by redistribution of surviving rhizomes.

The above results suggested that for the 'Todd's' variety of peppermint, the economically-acceptable inoculum density level of MS, assuming uniformity of distribution, was between

1.0 and 5.0 MS/g soil, as long as peppermint was flamed and not tilled. Further, most winter damage on untilled peppermint would result on fields that were already highly infested with *V. dahliae*. The data suggested, as had C.E. Horner (Horner and Dooly, 1965 and 1966. McIntyre and Horner, 1973), that inoculum density was not increasing greatly in flamed and untilled plots, and that it could even be dropping if much of the year-to-year wilt incidence was resulting from carryover of *V. dahliae* through active rhizome infections rather than new infections through roots, as suggested by Nelson (1950). The wilt data also suggested that inoculum density for tilled peppermint might be a "moving target", assuming inoculum was building up due to tillage along with the increase in incidence of wilt symptoms (although carryover in rhizomes also could complicate this argument). Because of the problems encountered with several standard soil assays for MS during 1990-1993, these questions and points 4 and 5 above could not be addressed. Nor could these standard soil assays be assessed in growers' fields without some measure of inoculum density vs yield losses, because the results from growers' fields could not be interpreted against any standard (ignoring the fact that other strains of *V. dahliae* also were likely present in growers' fields, which further complicates the interpretation). In 1994, it was proposed that yet another assay be attempted that had proven useful in England on cooler soil where standard assays had failed (Harris, *et al.*, 1993). This Harris assay seemed to provide reasonable data on a limited series of tests in 1994. Data from 1995 is included below.

As an alternative to dependency on soil assays to verify that soil inoculum had increased, and to avoid confusing infected rhizome carryover with root infections from MS, it was proposed in 1993 that the peppermint in the Powell Butte trial be killed, that peppermint roots and rhizomes be allowed to decay for a period of time, and that the plots be replanted to peppermint for evaluation of wilt on the subsequent crop. For cotton, it takes one to two years (Huisman and Ashworth 1976) and for potatoes, it takes about two years (Davis and Huisman, personal communication), before MS become released into soil from decaying stems, so this period of time was allotted prior to peppermint replanting. As described below, these plots are now ready for replanting as proposed.

Methods

Readers are referred to previous reports for details of trial and plot establishment, and for peppermint performance, from 1989-1994 (Crowe 1992, 1993, 1994, 1995). Briefly, the trial area was fumigated with methyl bromide during 1987. Using the Butterfield wet sieving assay, a commonly used and successful standard soil assay used to assess inoculum levels in the soil in many regions (Butterfield and DeVay, 1997, Joaquim, *et al.*, 1988, Nicot and Rouse 1987), no MS were detected from this soil prior to artificial infestation. Previous field history included many years of potatoes, but no peppermint. MS from peppermint isolates collected from diseased peppermint and proven pathogenic to peppermint, were produced in the laboratory on a cellophane-pectate agar. MS were harvested and mixed with sand, and the MS-sand mixture was used to infest large plots 8 inch deep at the COARC, Powell Butte field in the fall of 1989. Infestation rates were 0 (no added sclerotia), 0.01, 0.1, 1.0 and 5.0 MS/g soil. From the beginning, it was argued that disease incidence and peppermint performance should logically be based on recovered amounts rather than introduced amounts. In the early spring of 1990, the Butterfield soil assay again was used to determine an inoculum density. In the spring of 1990, the recovered amount using the Butterfield assay, which correlated well with the amount known to be infested. No problems were perceived with the assay at that time. However, beginning later in 1990, and persisting through 1994, recoveries using the Butterfield assay, and several variations of it, always measured a much lower than expected number of colony forming units (CFU). Between 1992-1994 the CFU measured by this assay were consistently 0 for every level of initial infestation and peppermint treatment, which suggested that inoculum had disappeared from the soil or that the assays had become unreliable. It was confusing for several years to decide how to interpret these results. In the Butterfield assay and its variations, soil is either directly plated onto growth media that are semi-selective, or the soil is first sieved to concentrate the size fraction that includes MS. Semi-selective media allow the growth of some but not all organisms. Usually the organism of interest is enough favored to allow quantification of its population. It appeared that, beginning in mid-1990, a fusarium fungus was over-growing the assay plates of the media used from either straight or sieved soil, and that this fusarium precluded growth of *V. dahliae*. Powell Butte soil was sent to a number of other labs that use variations on the Butterfield assay, or even other assays, during 1990-1993 to determine if MS could be quantified in those labs, but none were successful.

The Harris assay (Harris, *et al.*, 1993) was first tested in 1994 on a limited range of plot treatments. The data generated seemed to fit within expected relative ranges, so soil was resampled from all plots in August of 1994 and assayed with the Harris assay. Some samples again were assayed with the Butterfield technique for comparison. Sampling was comparable to earlier sampling. Two sub-samples were collected from each plot. Each sub-sample was composed of 30 one-inch soil cores taken randomly from the plot area and to 10 inches soil depth. Cores within sub-samples were mixed well, air-dried, and ground in a meat grinder if necessary to break clods and re-mix samples were stored to air-dry for at least 30 days to eliminate condial spores of *V. dahliae*. [These spores are the ones that move within the plant, and they do not persist in soil.] The main differences between the Harris assay and that of Butterfield are minor in concept, but it seems as if *V. dahliae* is highly responsive to seemingly subtle variations in assays. These subtleties are not described in detail here. Results from the 1994 sampling are shown in Table 1.

Results and Discussion

Again, readers are referred to results of previous reports (Crowe, 1992, 1993, 1994, 1995) on peppermint performance and disease incidence resulting from initial infestations of MS of *V. dahliae*.

Table 1 shows the original infestations in MS/g soil, and amounts of *V. dahliae* in colony forming units (CFU) recovered early in 1990 by the Butterfield assay and in 1994 by the Harris assay. Colonies on assay growth medium plates are initiated from MS, as long as conidia and any hyphae (moldy growth) is not present. Recovery efficiency for the Butterfield and Harris assays has not been determined for either lab or naturally-produced inoculum, so the three figures are not comparable with certainty. Not included in the table were zero recoveries for all sample dates beginning in fall, 1990 through 1994 while the Butterfield technique was continued in use, or when the Anderson Air Sampler was used in conjunction with the Butterfield growth medium.

The recovery of MS from plots in 1994 that had received no added pathogenic MS in 1989 was higher than from the plots initially infested at 0.01 and 0.1 MS/g soil, even though not wilt occurred in "non-infested" plots. This result seems anomalous and these CFU may represent MS from a strain of *V. dahliae* nonpathogenic to mint, one which does not appear to have been recovered from plots in which the mint strain of *V. dahliae* was added. This suggests some unanticipated relationship between populations of strains. The failure of standard soil assays to detect any MS from mid-1990 through 1994 begs the question whether low pre-infestation estimates were reliable during 1989. In fact, they may not have been. Further, the high correlation between the spring 1990 assay of MS with the calculated infestation rate might be questioned since the standard methods were used which later proved unreliable. It is possible in the first few winter months, that the recently-infested, laboratory-produced sclerotia had not become highly associated with the soil organisms that later overgrew the standard assay media and precluded normal growth of *V. dahliae* during later 1990 through 1994 Or that production of peppermint itself caused a shift in soil micro flora that overcame the assay. If so, the standard assays might have in fact worked quite will for at least a few months after infestation or peppermint planting, only to eventually fail as experienced.

Even though there are questions about efficiency of assays and how the infestation levels in plots changed during the three to four peppermint production years of the trial, the Harris assay certainly demonstrates a strong relative difference in inoculum levels based on tillage vs. flaming at the endpoint of 1994. Essentially all anticipated changes were seen to have occurred as per the Horner model. Inoculum stayed low (perhaps even dropped) with a regime of flaming without tillage, and inoculum increased with a regime of tillage without flaming. And these relative levels seem well associated with the disease incidence and peppermint performance generally (Crowe, 1992, 1993, 1994, 1995).

It remains to be determined how universal the Harris assay proves to be. It may prove most useful in demonstrating relative differences in *V. dahliae* MS populations among treatments in research trials. Recent worldwide comparisons among several *V. dahliae* assays, using identical soil samples that were divided among 13 different laboratories, indicated that within-lab results were consistent, but between-lab results were rather variable (Termordhuizen, 1995). This would suggest that different labs might communicate different levels of infestation, which would complicate interpretation with respect to disease incidence. Further, in potatoes, it seems as if even the same inoculum densities can result in a wide variation of wilt when they occur in different soil types (J. Davis, University of Idaho, personal communication), which would further complicate interpretation. These findings make it more doubtful that a commercially useful test can be devised for determination of the wilt potential in growers' fields, even though assays might be very useful research tools. And the issue of strain identification of the CFU recovered remains, in addition.

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TABLE 1: Inoculum infested and recovered from COARC, Powell Butte, 1989-1994[1].

	Colony Forming Units of *Verticillium Dahliae* per Gram of Soil[2]								
				1994, Harris Assay[3]					
1989, Initial Infestation[4]	1990, Butterfield Assay[5]			Flaming Without Tillage[6]			Tillage Without Flaming[7]		
MS/g	Sub-A	Sub-B	**(A+B)/2**	Sub-A	Sub-B	**(A+B)/2**	Sub-A	Sub-B	**(A+B)/2**
0 (no added MS)	--[8]	--	--	0.4	0.34	**0.37**	0.84	0.84	**0.79**
0.01	--	--	--	0.04	0	**0.02**	0.10	0.04	**0.07**
0.1	--	--	--	0	0	**0**	0.28	0.24	**0.26**
1.0	1.4	1.0	**1.2**	0.20	0.04	**0.12**	5.16	5.24	**5.70**
5.0	6.0	6.6	**6.3**	0.68	0.80	**0.74**	17.96	19.24	**18.60**

1. Plots were planted to 'Todd's' peppermint in February, 1990, and peppermint was killed in March, 1994. Soil assays using the Butterfield technique yielded no colony forming units between mid-1990 and 1994, or so few that the assay was discounted.
2. Recovery is expressed as the number of colonies of *V. dahliae* which were discernable amongst soil residue on petri plates, per gram of soil represented. Assay does not distinguish among pathogenic strains of *V. dahliae*.
3. Means are from five replications, after plots were split for flaming and tillage. Soil samples were taken in August, 1994. Soil assay was as per Harris,*et al.* 1993. Ten grams soil were assayed from 30 cores per sub-sample per plot for 0, 0.01and 0.1 MS/g initial infestation, and five grams soil were assayed from 30 cores per sub-sample per plot for 1.0 and 5.0 MS/g initial inoculum.
4. Microsclerotia (MS) were uniformly applied and tilled into test plot soil in December 1989, as calculated from the MS per unit volume recovered from cellephane agar in the laboratory and the number of grams of soil contained in 8 inches depth of 10'x80' test plots.
5. Means are from 10 replications, prior to plots being split. Plots were sampled on Februay 14, 1990. Soil was assayed as per Butterfield, *et al.,* 1977. Thirty soil cores taken to 8" were combined per sub-sample. Sub-sample data represents the average number of CFU found on 20 plates on each of which seived residue from 1 gm soil was placed.
6. Plots were propane flamed following harvest in 1990, 1991, 1992 and 1993, but not tilled 1990-1993.
7. Plots were tilled in the February of 1991, 1992 and 1993, but not flamed 1990-1993.
8. Soil not assayed at lowest initial infestations.

SURVIVAL OF VERTICILLIUM WILT IN PEPPERMINT STEMS FOLLOWING PROPANE FLAMING AT VARIOUS GROUND SPEEDS, 1995

Marvin Butler, Fred Crowe, Dana Gregg and Mark Hagman

Abstract

Evaluation of propane flaming ground speeds from 2 mph to 4 mph were evaluated on a fifth-year commercial field of `Murray mitcham' peppermint near Culver, Oregon. Three-inch samples from 15 stems per plot having visual symptoms of verticillium wilt were collected prior to flaming. Stems were tagged and a re-sampled after flaming. Control of verticillium wilt was significantly higher at 2 and 2½ mph than for untreated plots. There were no significant differences between flaming at 3 to 4 mph and not flaming.

Introduction

During the 1960's Oregon State University plant pathologist, C. E. Horner evaluated post-harvest propane flaming as a method to control verticillium wilt in peppermint in the Willamette Valley. He reported that an internal stem temperature of 60 ^{0}F was necessary to kill 85-100 percent of *Verticillium dahliae* in infected stems. The propane flaming recommendation to achieve this temperature was 2½ to 3 mph at 30 psi, 10 to 12 inches above the ground.

Evaluation of propane flaming speeds from 2 to 5 mph conducted in central Oregon during 1993 was inconclusive, but appeared to indicate that speeds above 2½ mph may not provide adequate control of verticillium wilt.

Methods and Materials

Evaluation of propane flaming speeds from 2 to 4 mph was conducted during August 1995 on a fifth year field of `Murray mitcham' peppermint near Culver, Oregon. The 30 ft x 30 ft plots were replicated 3 times in a randomized complete block design. Fifteen stems per plot that exhibited symptoms of verticillium wilt were tagged with a spot of florescent orange paint and a golf tee at the stem base with individual identification. Three-inch stem samples were taken 3 inches above the ground from each tagged stem August 4, prior to harvest. Flaming was conducted on August 14, followed by collection of the remaining 3 inch stems from tagged plants on August 15. These paired samples from the same stem were evaluated to determine the percent reduction in verticillium wilt.

Stem sections from pre- and post-flaming samples were stored temporarily under refrigeration, then surface disinfected with 10 percent household bleach in water. Three one-millimeter high sub-sections per stem were placed onto sterile plain agar in petri plates in the laboratory. Stem sub sections and surrounding agar were visually screened for fungal structures characteristic of verticillium wilt after one to two weeks. Any stem sub-section with presence of verticillium wilt was sufficient for the stem to be labelled as infected with the pathogen.

Flaming was conducted with a Rears 30 ft flamer operated at 40 psi, with covers 12 inches above the ground in front and 8-9 inches in the back.

Results and Discussion

Control of verticillium wilt was significantly higher at 2 and 2½ mph than for peppermint that was not flamed (Table 1). There were no statistical differences between flaming at 3 to 4 mph and not flaming. Percent verticillium wilt control was 56 to 59 percent, which is quite low compared to 90 to 94 percent control for the same speeds in the 1993 evaluation.

Using florescent paint and golf tees for tagging stems, and the use of the same stem for both the pre- and post-flaming samples were significant refinements in the evaluation process. It appears that additional evaluation is needed to explain variability in control for different years and locations.

Table 1. Percent control of verticillium wilt in stems by flaming at speeds from 2 mph to 4 mph near Culver, Oregon, 1995.

Treatments	Reduction of verticillium wilt in infected stems
(tractor speed)	(percent control)
2 mph	56 a
2½ mph	59 a
3 mph	50 ab
3½ mph	41 ab
4 mph	44 ab
Untreated	16 b

[1] Mean separation with the T-method at $P \leq 0.05$

PEPPERMINT RHIZOME HEALTH AS MEASURED BY ETIOLATED GROWTH

Alan R. Mitchell and Eric A. Rechel

Abstract

Etiolated growth of peppermint (*Mentha piperita*) rhizomes was investigated as a means to determine vigor. A procedure was developed for measuring etiolated growth and non-structural biomass (NSB). NSB declined from 467 g/kg in April to 314 g/kg in August. Rhizome mass, measured at regular intervals throughout the season on separate plots, showed a gradual increase until harvest in August.

Introduction

Etiolated growth is the growth of plants in the dark, and it can be used as a measure of regrowth. The amount of reserves a plant has available for regrowth is called non-structural biomass (NSB), and can be used to infer the vigor, or health, of the rhizomes. Etiolated growth has been used to characterize alfalfa regrowth potential (Rechel, 1993) and sod reserves (Burton, 1995). This method is being developed in order to measure the efficacy of fall cultural practices on the health of peppermint plants in the fall. It may also have use for comparing rhizome vigor that is diseased or pest-infested. The objective of this study was to develop the etiolated growth method estimating NSB for peppermint. Peppermint rhizome growth was also measured monthly from seperate field plots.

Methods

On April 13, 1995, four 3 ft. x 30 ft plots at the Central Oregon Agricultural Research Center (COARC) in Madras, were chosen from an established field of peppermint 'Murray Mitcham'. The field was planted in March 1994 and had never been harvested. Plots were selected by visual inspection for uniform stand density.

Samples were taken from randomly selected areas of each of four replications. Samples were dug from 1 x 2.5 ft rectangles to a depth of 4 inches that included rhizomes at least 10 inches in length. Soil was washed from the samples, then eight rhizomes of at least 30-cm length were chosen from the sample. Four additional rhizomes (5 to 15 cm long) were also taken from the sample and freeze-dried for fructan analysis. Three additional rhizomes (15 to 23 cm long) were also taken for determination of moisture content. Fine roots and green stems were removed from all rhizomes. From each of the first eight rhizomes chosen, a 23-cm segment was removed. A 3-cm segment was cut from each of these, and fresh and oven-dry weight was determined. Fresh weight were determined for the remaining 20-cm segment that was to be tested for etiolated growth. The 3- and 20-cm segments were tagged with the same plot and plant number for future reference and calculations.

The 20-cm segments were treated with PCNB, pentachloronitrobenzene, to prevent fungal

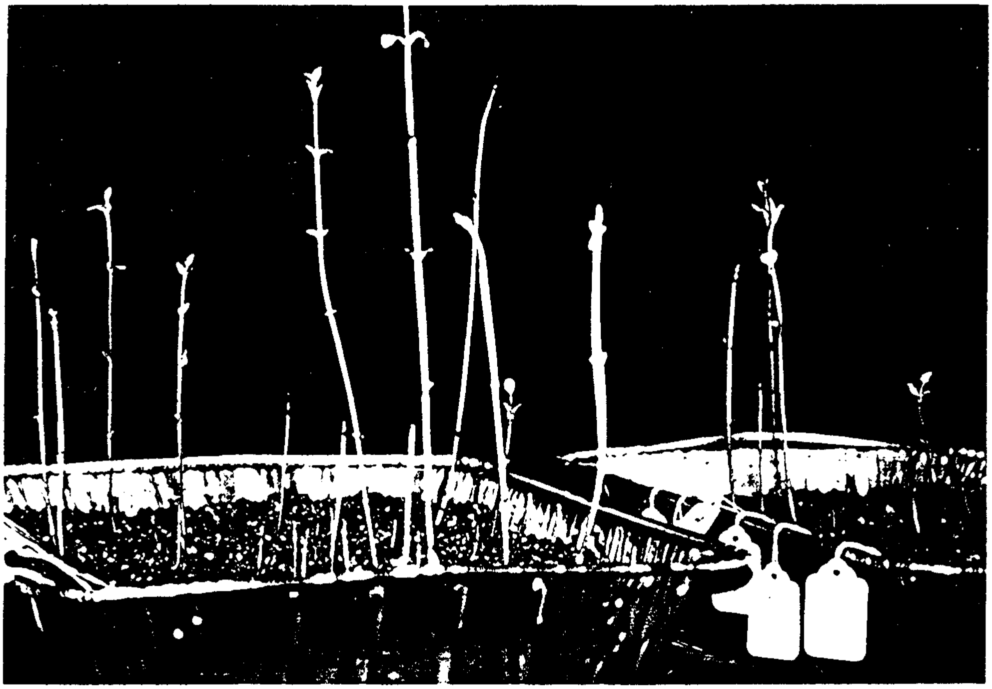

Figure 1. Etiolated growth of peppermint, Madras, Oregon, 1995.

growth during the experiment. Rhizomes were placed in a 1-liter beaker with 6.0 g/l PCNB and distilled water for five minutes while stirring slowly. The 20-cm segments were then placed 1 cm deep in moist vermiculite located in the dark at room temperature. From the 3 rhizomes selected for determining percent moisture, a segment no greater than 23 cm was removed. A 3-cm segment was cut from this and fresh and oven dry weight determined for this and the remaining segment. The length of the long segment was also recorded.

Etiolated rhizomes were observed periodically until growth ceased. The endpoint was usually manifest by blackening of the tip of the etiolated stem, and usually took four to five weeks. The plants were then separated into either rhizomes or etiolated growth, and the NSB was calculated as the difference between the initial and final dry matter divided by the final dry matter. Visual estimates of black decay on the rhizome were noted. The etiolated growth is shown in Figure 1.

Sampling was repeated in like manner on May 25, June 20, July 20, and on Aug 14, the day after harvest. Sampling also occurred on Sep 14, during post-harvest regrowth, and on October 12. Periodic sampling occurred throughout the season in order to include the variation in NSB in the rhizomes and to validate the method.

Etiolated growth will be compared to other methods of estimating NSB, such as analyzing for fructans or sugars. Earlier, thin layer chromatography (TLC) analysis was used to verify fructan as the major storage carbohydrate. Freeze-dried rhizomes from each of the sampling dates and replicates will be used for sugar analysis. Unfortunately, this data is not available at the time of this report.

For the data on peppermint growth, samples were taken at 14-day intervals from 0.093-m^2 areas of field 16 at COARC. Components were separated into rhizomes, dead rhizomes, stem-plus-leaves, and fallen leaves.

Results

The NSB declined from 467 g/kg in April to 314 g/kg in August in an approximately linear fashion (Figure 2). Each of the four sampling areas, or replications, is plotted to show the variation between locations. The declining NSB can be attributed to the plant directing more NSB to plant growth as the season progresses. We could anticipate an increase in NSB sometime in the late fall or winter as the plant redirects NSB for survival.

The coefficient of variation (CV) is a measure of the variability of the samples, and is equal to the standard deviation divided by the mean. The CV for each replication varied between 10 and 33 percent, and was usually 15 to 20 percent. This means that the method contains some inherent error, but that error can be minimized so that treatment differences may be distinguishable.

The etiolated growth (Figure 3) also declines during the growing season, but takes an upward turn for the August 14 sampling. We have no explanation for this at this time.

Peppermint growth, including rhizome mass, is shown in Figure 4 for a tilled field at the COARC. Because the field was tilled during the winter, the rhizomes mass at about 300 g/m^2 is lower than an established field. The rhizome mass increased before harvest, possibly in response to shorter day lengths and flowering. Then rhizome mass decreased after harvest, and recovered by September.

In conclusion, the etiolated growth appears promising for measuring the NSB and vigor of rhizomes. More measurements are planned to refine the method and test its usefulness in other applications.

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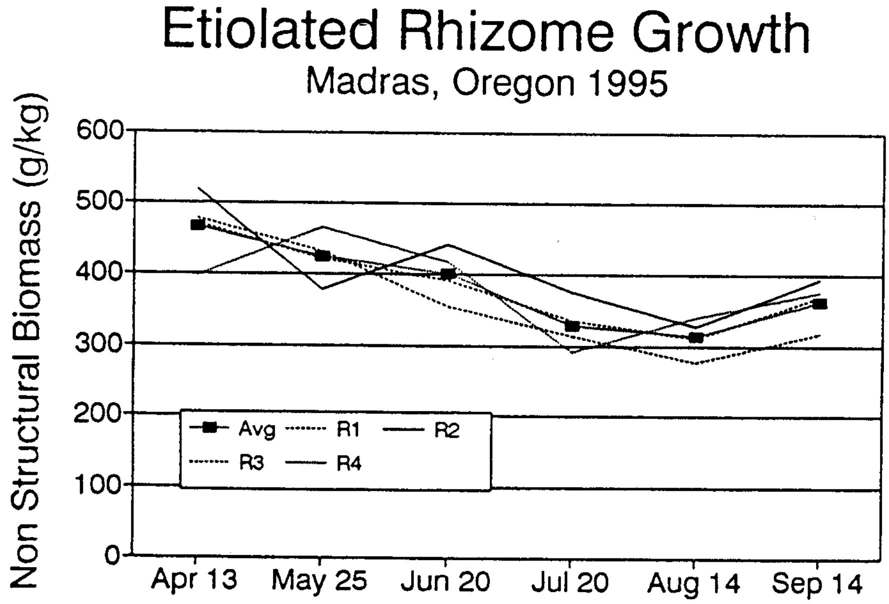

Figure 2. Non-structural biomass of peppermint rhizomes, Madras, Oregon, 1995.

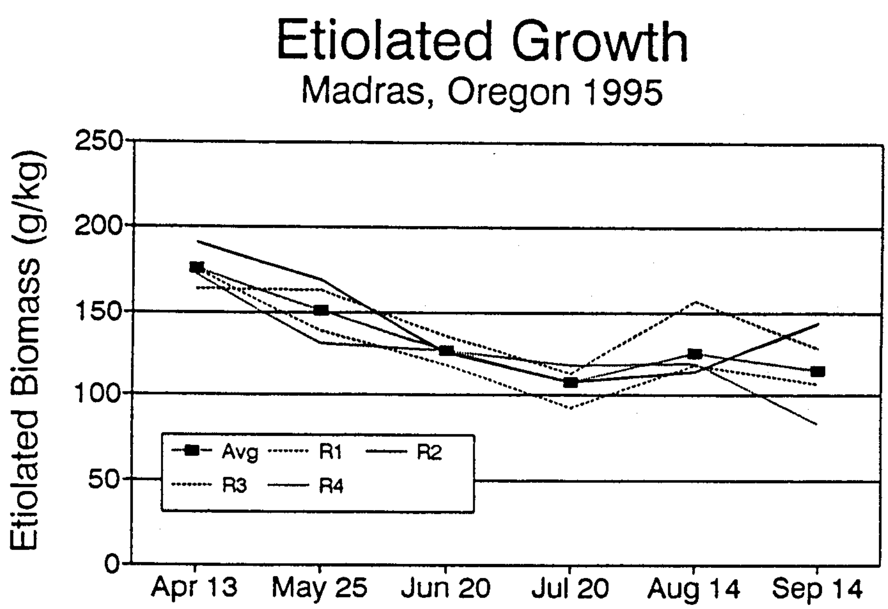

Figure 3. Etiolated biomass of peppermint rhizomes, Madras, Oregon, 1995.

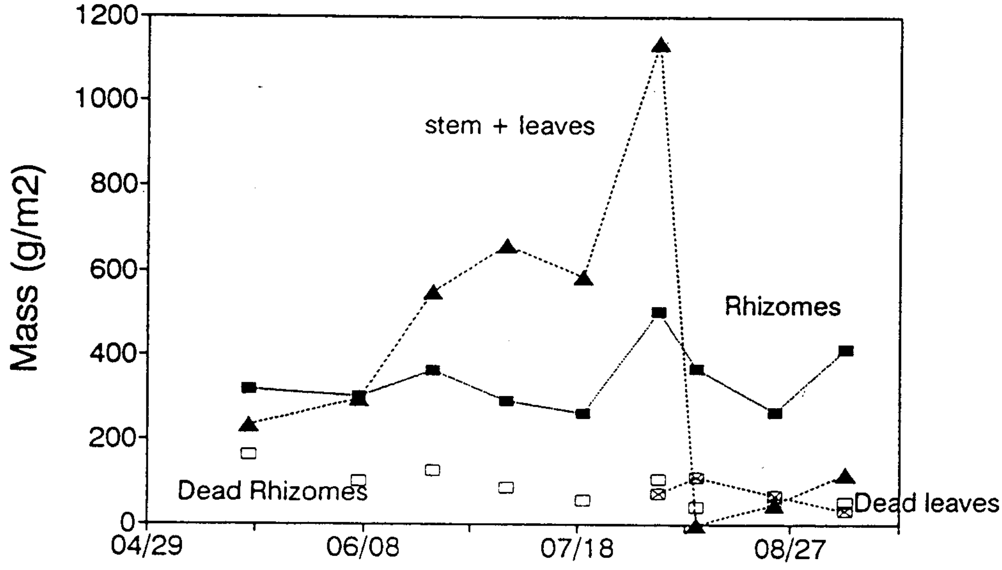

Figure 4. Peppermint growth by rhizomes, stems-and-leaves, dead rhizomes, and dead leaves, Murray Mitcham field 16, Madras, Oregon, 1995.

Update
Response of Six Potato Cultivars to Drought and Potato Early Dying

Mary L. Powelson and Meghan Arbogast

Potato early dying (PED), caused by the soilborne fungus *Verticillium dahliae,* is a major constraint to potato production in the irrigated fields of the Pacific Northwest. Traditionally, this disease has been controlled by soil fumigation. Recently, cultivars with resistance to this disease have been released. In addition, modification of irrigation practices early in the season has resulted in significant disease suppression.

Our laboratory has a continuing interest on the effect of moisture on disease development, particularly its management for disease suppression. We have shown that PED is favored by moist soils. If, however, soil moisture is maintained at 65 percent available soil moisture (mild drought stress) between emergence and tuber initiation, the disease is suppressed and yields are enhanced in the cultural variety (cv) Russet Burbank. This mild drought stress during the time frame when most root infections are occurring enhanced host resistance to this disease.

Drought is defined as a shortage of water sufficient to adversely affect crop production. It can be caused by either lack of soil water or blockage of its transport by a pathogen. In potato infections of *Verticillium,* the plant responds to a limitation in water in a variety of ways. The end result is reduced growth and lower yields.

We are interested in exploring the relationship between drought tolerance and resistance to PED for several reasons. First, some potato cultivars are both drought tolerant and resistant to PED, some are drought tolerant, and a very few are resistant to PED. It is the combination of tolerance and resistance that is of interest to us. Second, a goal is to provide a tool that will simplify breeders' efforts to identify germplasm resistant to PED. Third, water management guidelines for suppression of PED in a diversity of potato cultivars may be developed.

Field plots were established at the Central Oregon Agricultural Research Center in May 1995. The experimental design was a split-plot randomized block with three factorial treatments replicated six times. Treatments include six potato cultivars, three irrigation levels, and two inoculum densities of *Verticillium*. Irrigation levels were established using line-source irrigation. Various disease and plant growth parameters were measured during the season to provide information on response of the cultivars to both moisture and disease. These data are currently being analyzed. The experiment will be repeated in 1996.

USING ADMIRE AND TEMIK TO CONTROL APHIDS ON RUSSET BURBANK POTATOES

Steven R. James and Gary L. Reed

Abstract

A field experiment to evaluate long-term aphid control on potatoes was planted at the Madras site of Central Oregon Agricultural Research Center in 1995. Treatments included Admire at 18.9, 16.0, and 13.1 ounces of product per acre, Temik at 20 pounds of product per acre, and an untreated check. Aphids were collected weekly by beating cloth and green tile traps from 41 days after planting to 110 days after planting. In beating cloth samples, the high rate of Admire (18.9 oz/a) controlled wingless aphids for 103 days, the low rate of Admire (13.1 oz/a) for 97 days, and Temik controlled aphids for 71 days after application. There were fewer winged aphids collected by beating cloths from plots treated with Temik than either the Admire or check treatments. The number of aphids collected from green tile traps were variable and not correlated with beating cloth samples.

Introduction

Insect control in potatoes has been challenging since the market withdrawal of Temik (aldicarb) in 1989. Growers have relied on systemic insecticides that are effective for short periods of time early in the growing season, and multiple applications of a foliarly-applied organophosphate for the remainder of the growing season. That practice was expensive, killed beneficial insects, promoted insect resistance to the organophosphates, and did not provide effective control against Potato Virus Y (PVY).

PVY is spread in a non-persistent manner by the green peach aphid, and perhaps more importantly, by various grain aphids (2). Attempts to control the spread of PVY in potato fields with foliarly-applied aphicides have been limited because the aphicides are effective for short periods of time. In a typical 14 day spray schedule, aphids are controlled for less than 48 hours before the insecticide breaks down. Transient aphids are then free to enter the field, probe, and spread PVY until the next insecticide application is made.

Systemic insecticides, including Admire and Temik, have several inherent advantages over foliarly-applied products. Systemics target sucking and chewing insects, provide effective insect control in all plant tissues for extended periods of time, and are generally safe to apply. Foliarly-applied insecticides, on the other hand, kill both harmful and beneficial insects. They are generally effective for only short periods of time, and do not provide control on plant growth that has developed since the last application. An effective integrated approach to insect control includes careful monitoring of insect populations, the application of systemic insecticides, and use of foliarly-applied materials only when necessary.

Admire 2F (imidacloprid) gained an EPA registration for use on potatoes November 18, 1994. Bayer Corporation, the developer and marketer of Admire, claimed the new long-lived systemic insecticide would control Colorado potato beetle, green peach aphid, leafhoppers, and potato flea beetle. Research conducted during 1994 in the Columbia Basin at Hermiston, Oregon demonstrated that Admire applied at planting at 20 oz/acre effectively controlled aphids and Colorado potato beetle for much of the growing season. Similar results were noted for prior years (3).

This experiment was designed to compare the efficacy of Admire on aphids at the highest labeled rate, a mid rate, and the lowest labeled rate in a short growing season location (120 days). Temik was also included in the experiment because of the anticipated reregistration of the product.

Materials and Methods

An experiment to evaluate long-term aphid control on potatoes was planted June 1, 1995 at the Madras site of Central Oregon Agricultural Research Center. Plots measured 36 feet (12 rows) by 50 feet and were arranged in a latin square experimental design with five replications and five treatments. Plots within each column were separated by a six foot unplanted border and plots within each row were separated by a four foot unplanted border. The experiment was planted with certified Russet Burbank seed and fertilized with 920 lb/a of 19-15-15-6 (NPKS) banded to the side and slightly below the seed pieces at planting. The trial area was sprinkler irrigated and managed with cultural practices common in central Oregon.

The three Admire treatments were applied at planting by dribbling the insecticide solution into the furrow behind the planter seed piece drop chute using application equipment manufactured by Custom Ag Products, Benson, MN. The Admire solution and seed pieces were covered with soil after placement in the furrow. Admire treatments included 18.9, 16.0, and 13.1 ounces of Admire per acre and rate variables were achieved by varying the planter ground speed based on prior calibrations.

The application equipment was turned off when planting check treatments. The Temik treatment was banded 3 inches to the side and below the 2 to 4 inch high plants on July 3, 1995 prior to hilling.

Aphids were collected by two methods, beating cloth (27 x 27 inches) and pan traps. Beating cloth samples were obtained by beating plants from five hills from the center six rows of each plot and collecting all aphids on the cloth. Sampling rows and sites were rotated, allowing no area to be sampled more than once in six weeks. The pan traps were made with 2,000 ml clear stryrene-acrylonitrile boxes (VWR# 36212-361) with a tile painted to match the color of the foliage placed in the bottom of the box. The boxes were filled with water to within 1 inch of the top. The tile traps were mounted on adjustable rods and adjusted near the top of the foliage each week throughout the growing season.

Aphids collected from the beating cloth and tile traps were identified as wingless, green peach aphids (GPA), or aphids other than GPA. Plots were sampled weekly from July 12 to September 20, 1995.

Results and Discussion

The number of aphids caught throughout the collection period is summarized in Tables 1-5. Aphid collection commenced on July 12, 1995 when plants were about 10 inches high (41 days after Admire application). Aphid numbers were relatively low for much of the growing season, but a few wingless and winged aphids were collected the first three weeks then, during mid-summer, aphids numbers dropped to near zero. Aphid numbers continued to increase from mid-summer until plants were killed in late September.

Wingless aphids colonize on the plants and may be the best indicator of systemic insecticide efficacy. Wingless aphids were noted weekly in the untreated check treatments, with higher populations early and late in the growing season (Table 1). The first wingless aphids appeared in beating cloth samples from Admire-treated plots 83 days after application. No wingless aphids were noted at the high rate of Admire (18.9 oz/a) until 103 days. Wingless aphids were collected from all treatments 103 days after treatment with Admire. Significant numbers of wingless aphids appeared in plots treated with Temik 70-80 days after the Temik was applied (Temik was applied 32 days later than Admire). The data suggest that Admire controls wingless aphids for about 30 days longer than Temik.

Winged GPA and all other aphids collected from beating cloth samples are summarized in Tables 2 and 3. No GPA were collected during the middle part of the growing season, but a few were noted early and greater numbers were collected late in the growing season. The greatest number of aphids other than GPA were collected during the first part of the collection period and were likely grain aphids leaving nearby maturing wheat fields.

Fewer winged aphids were observed in beating cloth samples from plots treated with Admire and Temik than check plots during the early part of the collection period. Later in the season, the number of winged aphids collected from the Admire treatments did not differ significantly from the untreated check. Fewer winged aphids were observed on plots treated with Temik than the plots treated with Admire during the early and late parts of the collection period. It is possible that this observation is due to a difference between Temik and Admire in the time required to kill the aphids. Apparently, Temik kills aphids relatively rapidly after probing a treated leaf. Admire, on the other hand, is perhaps slower in killing aphids after probing. Press releases by Miles, Inc., indicated that aphids may continue to live for 96 hours after ingesting the insecticide. The aphids are rendered inactive immediately, but remain on the plants for a longer period of time and thus would be collected in beating cloth samples (1).

Green tile traps were placed in each plot to monitor general winged aphid flight activity and to compare the number of aphids trapped with beating cloth samples. Green tiles that approximated the color of the potato canopy were used to sample aphids that would normally be attracted to healthy potato foliage.

Aphids collected from green tile traps are summarized in Tables 4 and 5. There were no statistically significant differences among the treatments for the number of GPA caught in green tile traps except at 103 days after the Admire application. Statistically significant differences for aphids other than GPA were observed among the treatments at 62, 76, 97, and 103 days after the Admire application. No clear trend in aphid numbers among the treatments was apparent at those observation dates.

The total number of aphids collected for each plot from beating cloth samples and green tile traps were compared. There was no correlation (r=0.0575, n=25) between the two methods of collection.

A summary for the entire growing season for each collection method and type of aphid is presented in Table 6. All insecticide treatments provided good control of wingless aphids when compared to the untreated check. Fewer winged aphids were collected from plots treated with Temik than Admire-treated plots or the untreated check. There were no differences among all treatments when the aphids were sampled with green tile traps placed in the plant canopy of each plot.

Table 1. Number of wingless aphids collected from beating cloth samples during the growing season, Madras, OR, 1995.

	Days After Application of Admire										
Treatment	41	48	55	62	69	76	83	90	97	103	110
	-----Number of Aphids-----										
Admire (High)	0	0	0	0	0	0	0	0	0	0.4	1.8
Admire (Med)	0	0	0	0	0	0	0.2	0	0	0.6	2.8
Admire (Low)	0	0	0	0	0	0	0	0	0.4	1.8	5.2
Temik*	0	0	0	0	0	0.2	0	0	0	0.8	11.8
Check	6.4	5.0	3.8	2.2	1.0	0.2	6.2	8.0	8.4	26.0	84.8
LSD--5%	2.0	1.8	1.9	2.0	NS	NS	3.0	2.1	2.9	7.4	18.8

*Temik was banded 32 days after the Admire application.

Table 2. Number of winged GPA collected from beating cloth samples during the growing season, Madras, OR, 1995.

Treatment	Days After Application of Admire										
	41	48	55	62	69	76	83	90	97	103	110
	--------------------------Number of Aphids----------------------------										
Admire (High)	0.6	4.8	0	0	0	0	0.6	0.6	3.2	3.0	10.2
Admire (Med)	0.4	3.0	0.2	0.2	0	0	0.2	0.4	2.0	3.0	6.4
Admire (Low)	0.4	4.6	0.2	0	0	0	0	0.4	1.2	2.4	9.0
Temik*	0	1.0	0	0	0	0	0.2	0	0.2	0.6	2.4
Check	2.6	7.8	0.6	0.4	0	0	0.2	0.4	3.2	2.6	9.6
LSD--5%	1.4	3.7	0.4	NS	NS	NS	NS	NS	2.4	NS	4.9

*Temik was banded 32 days after the Admire application.

Table 3. Number of winged aphids (excluding GPA) collected from beating cloth samples during the growing season, Madras, OR, 1995.

Treatment	Days After Application of Admire										
	41	48	55	62	69	76	83	90	97	103	110
	--------------------------Number of Aphids----------------------------										
Admire (High)	0.4	1.8	0	0	0	0	0	0	0	0	0.6
Admire (Med)	0.6	1.4	0.2	0.2	0	0	0.2	0	0	0.2	0.2
Admire (Low)	0.6	2.2	0.4	0	0	0.2	0	0.2	0.8	0	0.2
Temik*	0.4	0.8	0	0	0	0	0	0	0.2	0	0
Check	1.6	4.4	1.6	0.2	0	0	0.2	0.2	0	0	0.2
LSD--5%	1.1	2.3	1.0	NS	NS	NS	NS	NS	NS	NS	NS

*Temik was banded 32 days after the Admire application.

Table 4. Number of winged GPA collected from green tile traps during the growing season, Madras, OR, 1995.

Treatment	41	48	55	62	69	76	83	90	97	103	110
	Days After Application of Admire										
	--------------------------Number of Aphids--------------------------										
Admire (High)	--	0.6	0	0	0	0	0	0	0.6	0.2	0.6
Admire (Med)	--	0.6	0	0	0	0	0	0.2	0	1.4	0.2
Admire (Low)	--	0.6	0	0.2	0	0	0	0	0.2	0.4	1.4
Temik*	--	0.2	0	0	0	0	0	0.2	0	0	0.2
Check	--	0.2	0.2	0	0	0	0	0	0.8	0.2	1.2
LSD--5%	--	NS	NS	NS	NS	NS	NS	NS	NS	0.9	NS

*Temik was banded 32 days after the Admire application.

Table 5. Number of winged aphids (excluding GPA) collected from green tile traps during the growing season, Madras, OR, 1995.

Treatment	41	48	55	62	69	76	83	90	97	103	110
	Days After Application of Admire										
			-----------------------------Number of Aphids-------------								
Admire (High)	--	2.8	1.6	4.2	3.6	1.0	3.8	1.4	4.6	1.8	1.4
Admire (Med)	--	3.2	1.6	4.0	1.6	0.8	4.6	2.8	3.2	2.6	2.4
Admire (Low)	--	1.8	0.8	4.0	3.2	1.2	3.6	2.0	5.4	3.0	1.6
Temik*	--	3.6	2.8	5.0	3.6	0.2	4.2	1.4	3.6	1.2	1.4
Check	--	3.4	2.4	1.4	2.4	1.2	5.0	1.8	2.2	3.2	1.4
LSD--5%	--	NS	NS	2.7	NS	0.9	NS	NS	2.6	1.7	NS

*Temik was banded 32 days after the Admire application.

Table 6. Summary of all aphids collected from Russet Burbank potatoes by beating cloth and green tile traps throughout the growing season at Madras, OR, 1995.

		Beating Cloth			Green Tile Trap	
		Wingless	Winged		Winged	
Treatment	Rate	All	GPA	Other	GPA	Other
		Number of Aphids				
Admire	18.9 oz/a	2.2	23.0	2.8	2.0	26.2
Admire	16.0 oz/a	3.6	15.8	3.0	2.4	26.8
Admire	13.1 oz/a	7.4	18.2	4.6	2.6	26.6
Temik	20.0 lb/a	12.8	4.4	1.4	0.8	27.0
Check		152.0	27.4	8.4	2.6	24.4
LSD--5%		24.8	9.3	2.6	NS	NS

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CULTURAL AND CHEMICAL TREATMENTS TO REDUCE POWDERY SCAB INFECTION ON POTATOES

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Abstract

Two experiments were conducted to evaluate treatments for reduction of powdery scab infection in potatoes. In the first experiment, several soil amendments (zinc sulfate, zinc oxide, ferrous sulfate, copper sulfate, elemental sulfur), and fungicides (Ziram 76, Aliette, Ridomil 5G) were added to a standard fertilizer mix and banded at planting. A powdered garlic treatment and an untreated check (standard fertilizer only) were included with the soil amendment and fungicide treatments. Powdery scab-free tubers were planted into an experimental plot area known to be infected with powdery scab. Tubers from all treatments were heavily infected with powdery scab. None of the experimental treatments were effective in controlling powdery scab tuber lesions, root galls, or rhizome infection.

In a second experiment, two planting dates (May 18 and June 8, 1994), and five nitrogen fertilization rates (0, 67, 133, 200, 267 lbs N/acre) were evaluated for powdery scab infection and control. Plots were examined twice during the growing season and again at harvest for the presence of powdery scab tuber lesions, root galls, and rhizome infection. Powdery scab tuber infection was significantly reduced in plots planted at the late planting date (June 8). The effect was statistically significant (5 percent) for the first growing season sampling date, but trended similarly for the second sampling date and harvest. The number of powdery scab root galls observed at both sampling dates was also significantly reduced for the late planting date. Although the late planting date reduced powdery scab tuber lesions and root galls, infection remained unacceptably high. The nitrogen fertilizer rates had no effect on powdery scab tuber lesions, root galls, or root lesions.

Introduction

Powdery scab caused by *Spongospora subterranea* (Wallr.) Lagerh. f. sp. *subterranea* Tomlinson, has become a major problem on potatoes in some seed and commercial growing regions in the world (1,3,5,6). In the past few years, powdery scab symptoms were observed on potatoes in areas of the United States where the disease was not known to occur (2,6). Powdery scab has also been detected in a number of seed lots in central Oregon and the Klamath Basin. One seedlot in the Klamath Basin was infected with powdery scab even though the field was planted with early generation nuclear seedstock produced in a greenhouse, and the field itself was virgin ground newly cleared of native vegetation.

Seed lots infected with powdery scab may or may not be certified depending on the regulations of the certifying agency and the degree of infection. In Oregon, any lot of seed potatoes meeting all other standards, but with any powdery scab, may be certified and sold only with the approval (in writing) of the seed purchaser (7).

Potato varieties differ in their susceptibility to powdery scab; generally light-skinned and red-skinned varieties are most susceptible (1,2,4,6,8). Powdery scab has been observed in Oregon on several chipping varieties, reds, Shepody, and Ranger Russet. The trend toward growing varieties other than Russet Burbank may, in part, contribute to increased observations of powdery scab. If this trend continues, powdery scab could become an increasing problem in Oregon.

Powdery scab may be of significant economic importance in light skinned varieties produced for fresh market, due to its effects on quality and grade. Tubers with scab lesions may not be marketable. Under conditions resulting in occurrence of only superficial scab lesions and not deep cankers, powdery scab may not affect the quality of chipping potatoes, since the peeling process will mostly eliminate the superficial scab lesions. Infected tubers may develop dry rot or more cankers in storage and are predisposed to infection by other organisms that cause rot in storage (6).

Materials and Methods

Soil Amendment and Fungicide Experiment

An experiment to evaluate the the effects of five soil amendments and four fungicides on powdery scab infection and control was planted June 8, 1994 in an area known to be infected with powdery scab at the Powell Butte site of Central Oregon Agriculture Research Center. Twenty-five untreated seedpieces of the round, white chipping selection NDO1496-1 were planted 9 inches apart in each of the two plot rows. Seedpieces were free of powdery scab spores and lesions. The soil amendment and fungicide treatments (see Table 1 for treatments and application rates) were mixed with the fertilizer (1,100 lb/acre of 19-15-15-6) and banded to the side and slightly below the seed pieces at planting. An untreated check treatment recieved fertilizer only. The trial area was sprinkler irrigated and managed with cultural practices common in central Oregon. The stand in each plot was recorded on July 6, 1994.

Five hills from one of the two plots rows were dug on August 29 and again on September 12, 1994. Roots and tubers from each hill were carefully removed from the hills and gently washed to remove all soil. The roots from each of the five hills were evaluated (rating scale: 0=no lesions/galls, 4=many lesions/galls) for powdery scab root lesions and root gall formation. All tubers harvested from the five hills in each plot were individually scored and the scores were averaged to obtain a tuber lesion score. The total number of stems for all five hills was recorded and used to calculate the number of stems per hill for each treatment.

The experiment was desiccated with Diquat (1 1/2 pt/a) on September 14, 1994, and the previously unsampled row in each plot harvested October 12, 1994. The tuber production from each plot was weighed and total yield, US No. 1 yield, and tuber size was calculated. An unbiased sample of 20 tubers was rated as described above for tuber scab lesions.

Planting Date by Nitrogen Experiment

In an area adjacent to the first experiment, the effect of two planting dates (May 18 and June 8, 1994), and five nitrogen fertilization rates (0, 67, 133, 200, 267 lbs N/acre), was evaluated for powdery scab infection and control. Plot layout, size, cultivar, management, and irrigation were identical to that described for the first experiment. The fertilizer treatments were banded to the side and slightly below the seed pieces at planting.

Five hills from one of the two plots rows were dug on August 15 and the procedure was repeated again on September 1, 1994. All samples were handled and rated as described for the first experiment.

The experiment was desiccated with Diquat (1 1/2 pt/a) on September 14, 1994, and the previously unsampled row in each plot harvested October 6, 1994. The tuber production from each plot was weighed and total yield, US No. 1 yield, and tuber size were calculated. An unbiased sample of 20 tubers was rated as described above for tuber scab lesions and weighed in air and water to determine specific gravity.

Results and Discussion

Soil Amendment and Fungicide Experiment
Table 1 summarizes the soil amendment and fungicide effects on powdery scab root lesions, root gall formation, and tuber powdery scab lesions. There were no treatment differences for any of the data collected in the experiment. Stand, yield, tuber size, and the number of stems per hill were all unaffected by the treatments as well (data not shown).

Planting Date by Nitrogen Experiment
The effects of two planting dates (early and late) on root lesions, root galls, and tuber lesions are shown in Table 2. The late planting date significantly reduced the number of root galls formed at both the August 15 and September 1 sampling dates. Powdery scab tuber lesions were also significantly decreased by late planting at the August 15 sampling date. Tuber lesions trended lower at the September 1 sampling date and at harvest for the late-planted treatment.

Very few powdery scab lesions were observed at the August 15 sampling date for the late planted treatment. However, by September 1 and harvest, tuber scab lesions from the late planted treatment were nearly equal to the tuber lesion rating observed for the early planted treatment. The data suggests that late planting merely delayed powdery scab tuber lesion formation.

Although late planting slightly reduced and delayed the formation of tuber powdery scab lesions, the degree of infection remained unacceptable based on Oregon seed certification standards.

Nitrogen fertilizer effects on powdery scab root lesions, root galls, and tuber lesions are shown in Table 3. No significant differences were noted at any sampling date or at harvest. There were no significant differences among the nitrogen fertilizer treatments for total yield, US No. 1 yield, specific gravity, tuber size, or the number of stems per hill (data not shown).

Table 1. Soil applied amendments and fungicides to control powdery scab, Powell Butte, Oregon, 1994.

Treatment	Rate	Root Lesions 8/29	Root Lesions 9/12	Root Galls 8/29	Root Galls 9/12	Tuber Lesions 8/29	Tuber Lesions 9/12	Tuber Lesions Hrvst
		---------------------------0-4 Rating*----------------------						
Check		2.0	2.3	1.9	3.0	0.9	1.3	2.4
ZnSO4	15 lb Zn/A	2.3	2.7	2.6	3.3	1.6	2.1	2.7
ZnO	15 lb Zn/A	2.5	2.8	2.2	2.9	1.1	1.8	2.1
Ziram 76	10 lb/A	2.7	2.7	2.7	3.1	1.7	2.3	2.0
FeSO4	15 lb Fe/A	2.2	2.7	1.9	3.4	0.9	1.6	2.1
CuSO4	15 lb Cu/A	2.6	3.0	2.7	3.1	1.4	1.8	1.9
Sulfur	200 lb S/A	2.9	3.0	3.3	3.3	1.3	1.9	2.0
Aliette	10 lb/A	3.0	2.7	2.8	3.0	1.8	1.9	2.2
Ridomil 5G	20 lb/A	3.1	3.4	3.2	3.5	1.5	2.6	2.3
Garlic Powder	50 lb/A	2.8	3.2	3.1	3.3	1.9	2.2	2.6
LSD 5%		NS	NS	NS	NS	NS	NS	NS

* Rating: 0=None, 2=Moderate, 4=Sever

Table 2. Planting date effects on powdery scab, Powell Butte, Oregon, 1994.

Treatment	Planting Date	Root Lesions 8/29	Root Lesions 9/12	Root Galls 8/29	Root Galls 9/12	Tuber Lesions 8/29	Tuber Lesions 9/12	Tuber Lesions Hrvst
		---------------------------0-4 Rating*----------------------						
Early	May 18	2.4a	2.3a	2.7a	3.3a	1.0a	1.7a	2.4a
Late	June 8	2.2a	2.3a	2.2b	2.9b	0.1b	1.5a	2.1a

* Rating: 0=None, 2=Moderate, 4=Severe

Table 3. Nitrogen fertilizer effects on powdery scab, Powell Butte, Oregon, 1994.

Treatment	Nitrogen Rate	Root Lesions 8/29	Root Lesions 9/12	Root Galls 8/29	Root Galls 9/12	Tuber Lesions 8/29	Tuber Lesions 9/12	Tuber Lesions Hrvst
		---------------------------0-4 Rating*----------------------						
N0	0 lb N/A	2.1	2.3	2.3	2.9	0.4	1.8	2.2
N1	67 lb N/A	2.4	2.3	2.2	3.2	0.7	1.8	2.4
N2	133 lb N/A	2.5	2.4	2.9	3.2	0.5	1.5	2.1
N3	200 lb N/A	2.1	2.4	2.4	3.3	0.6	1.5	2.2
N4	267 lb N/A	2.5	2.1	2.5	3.1	0.6	1.3	2.3
LSD 5%		NS	NS	NS	NS	NS	NS	NS

* Rating: 0=None, 2=Moderate, 4=Severe

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SUGAR BEET HERBICIDE EVALUATION IN CENTRAL OREGON, 1995

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Abstract

Herbicide trials were conducted on three commercial sugar beet fields in central Oregon during 1995. Post-plant, pre-emergence (PPP) applications included ethofumesate (Nortron, AgrEvo) alone and in combination with pyrazon (Pyramin, BASF). Post-emergence applications included phenmedipham and desmeditham (Betamix, AgrEvo), phenmedipham and desmeditham and ethofumesate (Betamix Progress, AgrEvo), clopyralid (Stinger, DowElanco), ethofumesate (Nortron, AgrEvo), and triflusulfuron (Upbeet, Du Pont) alone and in combination. Treatments, which included Nortron applied PPP, provided the greatest weed control. Common lambsquarters was best controlled with Betamix, redroot pigweed with Betamix or Nortron, hairy nightshade with Nortron or Stinger, redstem filaree with Nortron, and prostrate knotweed with Nortron or Upbeet. Slight to moderate stunting from PPP applications did not adversely affect yields, but inadequate weed control from application of Upbeet alone or in untreated plots significantly reduced yields.

Introduction

The 1995 season is the first year sugar beets have been grown in central Oregon commercially, with 1,600 acres grown under contract with Holly Sugar in Crook, Jefferson and Deschutes Counties. Herbicide trials were conducted at three locations to evaluate Nortron, Betamix, Betamix Progress, Stinger, Upbeet, and Pyramin alone or in combination for control of the weed spectrum found in central Oregon sugar beet fields.

Methods and Materials

Two trials were conducted in the Prineville area, and one near Metolius. Sugar beet varieties were WS 91 at the Mc Phetridge location, Chinook at the Craig location, and Beta 8422 at the Graves location.

Nortron alone, and in combination with Pyramin, was applied post-plant, pre-emergence (PPP). Post-emergence applications were made at the cotyledon stage and followed by a second application a week later at the two-leaf stage. A third application was made to the non-PPP treatments when the sugar beets were at about the six-leaf stage. Herbicides were applied with a CO_2 pressurized, hand-held, boom sprayer at 40 psi and 20 gal/a of water. The 10 ft x 25 ft plots were replicated three times in a randomized complete block design. The crop oil, Scoil, was added at a rate of 1 percent to Upbeet treatments, and LI 700 at 4 oz/100 gal with Betamix Progress applications.

Dates for PPP applications were April 19 at the Graves and Mc Phetridge locations, and April 27 at the Craig location. Post-emergence treatments at the Mc Phetridge location were made on May 5, May 12, and June 19, with exception of the third Upbeet application, which was made on

May 26. The Craig location received post-emergence applications on May 12, May 19, and June 3, while applications at the Graves location were on May 10, May 19, and June 3.

The major weed species at the Mc Phetridge location were common lambsquarters and prostrate knotweed, followed by redstem filaree, hairy nightshade and redroot pigweed. At the Craig location redroot pigweed and hairy nightshade were followed by common lambsquarters in order of importance. Redroot pigweed was the major weed species at the Graves location, followed by common lambsquarters, hairy nightshade, mustards, and prostrate knotweed. Formal evaluations were made at the Craig and Graves locations June 29, and at the Mc Phetridge location on July 5, by rating the percent control of each major weed species.

A 20 ft sample was harvested from the center row of each plot at the Craig location on October 16. This location was chosen because of stunting from both the PPP applications of Nortron and Nortron plus Pyramin. Plot samples were weighed and sub-sampled for evaluation of percent sugar and parts per million nitrate by Holly Sugar.

Results and Discussion

Plots that received Nortron PPP applications had significantly less weeds than those receiving only post-emergence applications. Only two post-emergence applications were necessary following the PPP treatments.

A summary of treatment results at the three locations is provided in Table 1, with specific data for each location in Tables 2-4. Yield data from the Craig location is included in Table 3. Nortron applied PPP followed by Betamix and Upbeet provided the best weed control. Treatments with Betamix appear to provide the greatest control of common lambsquarters. Redroot pigweed was best controlled with treatments containing Betamix or Nortron, while Nortron or Stinger appeared to provide control of hairy nightshade. Nortron appears to be the only material that was consistently effective against redstem filaree. Betamix Progress was not effective against prostrate knotweed, while treatments with Nortron and Upbeet provided control. Although not listed in the tables, Upbeet appears to be important for kochia control.

Nortron applied PPP produced slight stunting of the sugar beets only on the sandy soil at the Craig location. When Pyramin was added to the Nortron PPP application, moderate stunting resulted. Some leaf distortion was found following Stinger applications.

Yield data indicate no adverse effect from slight stunting from Nortron PPP applications, or moderate stunting following the Nortron plus Pyramin PPP applications. The application of Upbeet alone did not provide adequate weed control and significantly reduced yield from the 32 to 35 ton/a range of the other treatments to 21 tons/a, while the untreated plots produced only 7 ton/a. Evaluation of percent sugar and nitrate content revealed no significant differences between treatments. Percent sugar varied from 18.3 to 19.1 and nitrate ranged from 71 to 133 ppm.

Table 1. Summary of sugar beet herbicide trials conducted in central Oregon during 1995 at the Jim Mc Phetridge, Bonnie Craig and Corey Graves farms.

Herbicide Treatments	Application			Percent Control				
	PPP	Post 1,2	Post 3	Lambsquarters	Pigweed	Nightshade	Filaree	Knotweed
Nortron PPP followed by Upbeet + Betamix	3 pts	 ½ oz 1½ pts		99 a	99 a	95 ab	99 a	97 a
Nortron PPP followed by Upbeet + Stinger	3 pts	 ½ oz 3 fl oz		91 a	97 a	94 ab	99 a	100 a
Nortron + Pyramin PPP followed by Betamix Progress	3 pts 4 lbs	 1.2 pts		98 a	98 a	99 a	100 a	96 a
Betamix Progress followed by Betamix Progress + Stinger		1.2 pts	 1.2 pts 2 oz	92 a	95 a	93 ab	80 ab	39 b
Upbeet + Betamix		½ oz 1½ pts	½ oz 2 pts	95 a	96 a	78 ab	22 ab	95 a
Upbeet + Stinger		½ oz 3 fl oz	½ oz 3 fl oz	43 b	75 a	99 a	74 ab	98 a
Upbeet + Stinger + Nortron		½ oz 3 fl oz 4 fl oz	½ oz 3 fl oz 8 fl oz	89 a	76 a	100 a	92 a	100 a
Upbeet		0.5 oz	0.5 oz	18 c	61 a	51 b	73 ab	93 a
Untreated				0 c	0 b	0 c	0 b	0 b

Mean separation with the T-method at $P \leq 0.05$

Table 2. Results of sugar beet herbicide trials conducted during 1995 on the Jim Mc Phetridge farm near Prineville, Oregon.

Herbicide	Application			Percent Control				
Treatments	PPP	Post 1,2	Post 3	Lambsquarters	Pigweed	Nightshade	Filaree	Knotweed
Nortron PPP followed by	3 pts			98 a	100 a	93 ab	97 a	93 a
Upbeet		½ oz						
+ Betamix		1½ pts						
Nortron PPP followed by	3 pts			82 a	100 a	93 ab	98 a	100 a
Upbeet		½ oz						
+ Stinger		3 fl oz						
Nortron	3 pts			95 a	100 a	97 a	100 a	93 a
+ Pyramin PPP followed by	4 lbs							
Betamix Progress		1.2 pts						
Betamix Progress followed by		1.2 pts		80 a	97 a	85 ab	60 ab	57 b
Betamix Progress			1.2 pts					
+ Stinger			2 oz					
Upbeet		½ oz	½ oz	87 a	100 a	90 ab	43 ab	93 a
+ Betamix		1½ pts	2 pts					
Upbeet		½ oz	½ oz	33 b	98 a	100 a	47 ab	95 a
+ Stinger		3 fl oz	3 fl oz					
Upbeet		½ oz	½ oz	85 a	100 a	100 a	83 a	100 a
+ Stinger		3 fl oz	3 fl oz					
+ Nortron		4 fl oz	8 fl oz					
Upbeet		0.5 oz	0.5 oz	13 b	93 a	73 b	50 ab	85 ab
Untreated				0 b	0 b	0 c	0 b	0 b

Mean separation with the T-method at $P \leq 0.05$

Table 3. Results of sugar beet herbicide trials conducted during 1995 on the Bonnie Craig farm near Prineville, Oregon.

Herbicide Treatments	Application			Percent Control			Yield
	PPP	Post 1,2	Post 3	Lambsquarters	Pigweed	Nightshade	Tons/acre[1]
Nortron PPP followed by Upbeet + Betamix	3 pts	 ½ oz 1½ pts		100 a	99 a	96 ab	33 a
Nortron PPP followed by Upbeet + Stinger	3 pts	 ½ oz 3 fl oz		97 a	99 a	98 a	32 a
Nortron + Pyramin PPP followed by Betamix Progress	3 pts 4 lbs	 1.2 pts		100 a	99 a	99 a	34 a
Betamix Progress followed by Betamix Progress + Stinger		1.2 pts	 1.2 pts 2 oz	97 a	94 a	94 a	35 a
Upbeet + Betamix		½ oz 1½ pts	½ oz 2 pts	98 a	94 a	60 b	34 a
Upbeet + Stinger		½ oz 3 fl oz	½ oz 3 fl oz	43 b	67 b	100 a	34 a
Upbeet + Stinger + Nortron		½ oz 3 fl oz 4 fl oz	½ oz 3 fl oz 8 fl oz	83 a	92 a	100 a	35 a
Upbeet		0.5 oz	0.5 oz	0 c	57 b	0 c	21 b
Untreated				0 c	0 c	0 c	7 c

[1] Tons/acre based on lbs per 20 ft of single row per plot

Table 4. Results of sugar beet herbicide trials conducted during 1995 on the Corey Graves farm near Metolius, Oregon.

Herbicide Treatments	Application PPP	Application Post 1,2	Application Post 3	Percent Control Lambsquarters	Percent Control Pigweed	Percent Control Nightshade	Percent Control Filaree	Percent Control Knotweed
Nortron PPP followed by	3 pts			100 a	98 a	96 a	100 a	100 a
Upbeet		½ oz						
+ Betamix		1½ pts						
Nortron PPP followed by	3 pts			95 a	93 a	92 a	100 a	100 a
Upbeet		½ oz						
+ Stinger		3 fl oz						
Nortron	3 pts			98 a	96 a	100 a	100 a	98 a
+ Pyramin PPP followed by	4 lbs							
Betamix Progress		1.2 pts						
Betamix Progress followed by		1.2 pts		99 a	93 a	100 a	99 a	20 b
Betamix Progress			1.2 pts					
+ Stinger			2 oz					
Upbeet		½ oz	½ oz	99 a	93 a	85 a	0 b	97 a
+ Betamix		1½ pts	2 pts					
Upbeet		½ oz	½ oz	53 b	60 b	98 a	100 a	100 a
+ Stinger		3 fl oz	3 fl oz					
Upbeet		½ oz	½ oz	99 a	37 b	100 a	100 a	100 a
+ Stinger		3 fl oz	3 fl oz					
+ Nortron		4 fl oz	8 fl oz					
Upbeet		0.5 oz	0.5 oz	40 b	33 b	80 a	95 a	100 a
Untreated				0 c	0 c	0 b	0 b	0 b

Mean separation with the T-method at $P \leq 0.05$

CONTINUED INVESTIGATION OF FLOODING AS A MEANS OF ALLIUM WHITE ROT CONTROL

UPDATE

Fred Crowe, Harry Carlson, and Don Kirby

The flooding experiments described in the 1994 annual reports were continued in 1995. No data subsequent to that reported in 1994 is available for presentation in the 1995 annual report. Data should be summarized during 1995-96, and a complete final report will be available in 1996 for inclusion in the 1996 annual reports.

USE OF SOIL-APPLIED GARLIC POWDER TO REDUCE INOCULUM OF *SCLEROTIUM CEPIVORUM* AND CONTROL WHITE ROT OF ONIONS AND GARLIC

UPDATE

Fred Crowe, Harry Carlson, and Don Kirby

Germination of sclerotia of *Sclerotium cepivorum,* the Allium white rot fungus, in response to soil-applied petroleum-derived stimulants, lowered populations of sclerotia below economic thresholds (Crowe *et al.,* 1993). Preliminary evidence indicated that garlic powder might effect the same response as petroleum-derived stimulants, but the rates of product applied were either too low (50 lb/ac) or too high (500 plus lb/ac) for determination of the minimum effective dose and for a cost analysis of this rate (F. Crowe and T. Darnell, unpublished). In this follow-up investigation, a narrower range of rates (50, 100, 200, and 400 lbs/ac) and combination of treatment dates (fall and/or spring) were used to elucidate the cost-effectiveness of this treatment

The trial was conducted on a naturally-infested field near Tulelake,CA, on which an onion crop in 1992 experienced heavy losses to white rot. No volunteer onions were present during 1994. Preliminary soil sampling and assays suggested soil populations of sclerotia were at 100 per liter of soil, or more. A commercial grade of garlic powder suspended in water was broadcast over dry soil in 18 ft.x 50 ft. plot areas with a tractor mounted pressure sprayer. This was immediately incorporated 10-inches deep with a power roto spike harrow followed by 6.6-inches of sprinkler irrigation. Treatment was on September 9, 1994, and/or on April 21, 1995. The highest rate attempted (400 lb/ac garlic powder) was rather thick and hard to mix into solution. Soil samples were collected just prior to initial treatment in 1994, and then monthly through the spring of 1995. Onions were seeded on May 24, 1995, and were farmed as per a normal onion crop in the Tulelake Basin.

Fall pre-treatment soil samples from all plots indicated that the trial area was very highly infested, with many plots 10 or more times the level of infestation of previous trials using stimulants (Crowe *et al.,* 1993). Commercially unacceptable levels of white rot occurred in the trial in all plots (10-100 percent plant loss), although at the highest rates of application and frequencies garlic powder reduced incidence of white rot by about half compared to no treatment. This report is only preliminary, as the soil assay data are the more important data in this trial. The soil assay data will indicate the rates of application at which 98-99 percent decline in sclerotium population might be achieved, and how many applications might have been necessary to achieve economic control in this situation. Upon completion of soil assay analyses, it seems likely that the data will suggest that our onion planting in this very highly infested field should have been delayed until after further treatments.

Crowe, F.J., J. Debons, M. Thornton, P. Koepsell, D. McGrath, T. Darnell, M. Davis, J. Laborde, and E.R. Juarez. 1993. Pp 139-156. In COARC Annual Reports, 1990-1992, OSU Agricultural Experiment Station Special Report 922.

EVALUATION OF INSECTICIDES FOR THRIPS CONTROL ON SEEDLING ONIONS, 1995

Marvin Butler, Brad Holliday, and Neysa Farris

Abstract

Five insecticides, imidacloprid (Admire, Bayer), chlorpyrifos (Lorsban, DowElanco), lambda-cyhlothrin (Warrior, ZENECA), bifenthrin (Capture, FMC), and carbofuran (Furadan, FMC) were evaluated for control of onion thrips on seedling onions grown for seed in a commercial field near Madras, Oregon. Materials were applied September 17, 1995, with thrips counts taken prior to application and 1, 6, and 10 days following application. Furadan provided the greatest control, with Admire producing significantly less control, but greater than no treatment. The effectiveness of Lorsban, Capture, and Warrior ranged between the Furadan and Admire.

Introduction

Seed onions are an integral part of the vegetable seed industry in central Oregon, with nearly 400 acres grown annually for a gross income of $1.5 million. Onion thrips are a major insect pest on seed onions grown in the area, with evaluation of insecticides for efficacy against onion thrips an important priority to the industry.

Methods and Materials

The new insecticide, Admire, was compared to Lorsban, Warrior, Capture, Furadan, and untreated plots in a commercial seed onion field near Madras, Oregon. Pre-counts were made on September 14, 1995 by determining the number of thrips present on 15 randomly selected plants from the two center rows of each 10 ft x 20 ft plot. Insecticides were applied with the surfactant Silgard at the rate of 2 pt/100 gal water on September 17, 1995, using a CO_2 pressurized, hand-held, boom sprayer at 40 psi and 20 gal/a of water. Plots were replicated three times in a randomized complete block design. Thrips counts were made 1, 6 and 10 days following application on September 18, 23, and 27.

Results and Discussion

There were no significant differences between the pre-counts of thrips prior to treatment (Table 1). Furadan appeared to take longer than the other materials to reach a maximum kill, but provided the greatest control of the insecticides evaluated. Admire provided significantly less control than Furadan, but significantly greater control than no treatment. Lorsban, Warrior, and Capture were not significantly different from each other, or with either Furadan or Admire on day 10. Additional evaluation is needed to determine if these initial results are representative of the performance of these materials.

Table 1. Results of insecticide trial applied September 17, 1995 to control thrips on seedling onions near Madras, Oregon.

		Average number of thrips/plant			
Treatment	Product/acre	Pre-treatment	Day 1	Day 6	Day 10
Furadan 4 F	3 pt	5.3	1.7 b[1]	0.5 d	0.4 c
Lorsban 4E	4 pt	4.2	1.4 b	2.1 cd	3.6 bc
Capture 2EC	6.4 fl oz	5.8	2.4 b	2.5 bcd	2.7 bc
Warrior 1 EC	3.2 fl oz	6.6	2.7 b	4.2 bc	3.8 bc
Admire 2F	16 fl oz	4.3	3.7 b	5.4 b	5.7 b
Untreated	-----	4.2	6.9 a	10 a	9.8 a

[1] Mean separation with the T-method at $P \leq 0.05$

EVALUATION OF FUNGICIDES FOR CONTROL OF *BOTRYTIS ALLII* IN SEED ONIONS, 1994-1995

Marvin Butler, Fred Crowe, and Brad Holliday

Abstract

Evaluations of a single fall and two spring fungicide applications for control of *Botrytis allii* were conducted in a commercial field of seed onions near Madras, Oregon. Fungicides evaluated include thiophanate methyl (Topsin M, Elf Atochem), iprodione (Rovral, Rhone-Poulenc), vinclozolin (Ronilan, BASF), metalaxyl, chlorothalonil (Ridomil / Bravo, Ciba), TD2350 (Elf Atochem), and CGA-219417 (Ciba). Split-plots were used, with half the plants grown from Topsin M-treated seed and the other half grown with non-treated seed. Topsin M, TD2350, and a combination of the two consistently provided the greatest control. Rovral, Ronilan, Ridomil / Bravo, and CGA-219417 did not provide adequate control of the disease.

Introduction

Vegetable seed production is an integral part of agriculture in central Oregon with near 5,000 acres of production, and a yearly income of $12 million. Onion seed, which includes mostly hybrid varieties, is produced on about 500 acres with a gross return near $2 million. One of the major pests on seed onions is *Botrytis allii*, which attacks onions on the bulb near the soil surface, on the scape, and potentially florets and seed in the umbel. Some varieties appear to be more susceptible to the fungus, which can substantially reduce stands and seed yield.

Methods and Materials

Fungicides evaluated for control of *Botrytis* on seed onions include Topsin M (1 lb/a and 2 lb/a), Rovral (2 lb/a), Ronilan (2 lb/a), Ridomil / Bravo (1 lb/a), CGA-219417 (⅔ lb/a), TD2350 (1 lb/a), and Topsin M (1 lb/a) plus TD2350 (1 lb/a). The study was conducted on a commercial field of hard yellow females and Spanish males (S & L Farm) on the Agency Plains near Madras, Oregon. The 10 ft x 25 ft split-plots were replicated three times in a randomized complete block design, with half the plot planted with Topsin-M-treated seed prior to planting. Fungicides were applied with a CO_2 pressurized, hand-held, boom sprayer with twin-jet 8004 nozzles at 40 psi with 40 gal/a of water. Silwet L-77 at 8 oz/100 gal and R-56 at 1 qt/100 gal was added to all treatments. The fall application was made on September 30, 1994, followed by two spring applications on May 3, and May 13, 1995.

Stand counts were made to determine the extent of winter kill, with pre-counts on November 4 and 6, 1994, and post-counts on April 21, 1995. To determine the percentage of bulbs infected with *Botrytis*, 3 feet of row from untreated seed plots were removed and bulbs examined for lesions and sporulation on June 15-19, 1995. Thirty-plant samples were taken from both plots of treated seed and untreated seed for a second evaluation on July 17-21, 1995. *Botrytis* was considered present if lesions plus sporulation were present on the bulb at the time of sampling, or if sporulation developed within 3 days of storage in plastic bags at room temperature. A visual rating of percent plants with adequate root systems to remain standing was made on July 24, 1995. No evaluation of scape blight was conducted because of relatively little scape blight and a reduced stand due to destructive sampling.

Results and Discussion

There were no significant differences between fall and spring stand counts, or between treated and untreated seed without fungicide applications. The early evaluation of fungicide treatments to plots with untreated seed on June 15-19 indicates the numbered compound TD2350 provided significantly greater control of *Botrytis allii* than non-treatment (Table 1). TD2350 was followed in effectiveness by Topsin M (2 lb/a), the combination of Topsin M (1 lb/a) and TD2350 (1 lb/a), and Topsin M (1 lb/a).

The second evaluation on July 17-21, of fungicide applications to plants from untreated seed indicated the combination of Topsin M (1 lb/a) and TD2350 (1 lb/a) provided the best control, followed by Topsin M (2 lb/a), TD2350 (1 lb/a), and Topsin M (1 lb/a). All of these treatments provided statistically significant control over untreated plots. The top three treatments (Topsin M plus TD2350, Topsin M at 2 lb/a, and TD2350) were also significantly better than either Rovral or Ronilan.

Although there were no significant differences between fungicide applications in the seed-treated plots or the visual rating of percent standing plants on July 24, the trend remained the same. Topsin M, followed by TD 2350, provided the best results.

Rovral, Ronilan, Ridomil / Bravo, and CGA-219417 treatments did not provide adequate control of *Botrytis allii*, or significantly greater control than non-treatment in this trial. However, a single year of data is not adequate to draw conclusions concerning the performance of a product.

It is important to note that many bulb infections did not proceed to kill plants, but only affected yield on weak plants, and contributed to spore production generally. Application of fungicides was directed primarily to developing scapes for scape blight control. Treatment for basal infections would be better directed at the bulb.

Table 1. Incidence of *Botrytis allii* symptoms in seed onions on the Agency Plains near Madras, Oregon following seed treatment with Topsin M, and a single fall application and double spring applications of fungicides on the following dates during 1995.

		Percent infected bulbs			Standing plants
Material	Rate	Untreated seed 15-19 Jun	Untreated seed 17-21 Jul	Treated seed 17-21 Jul	Entire Plot 24 Jul
Topsin M	1 lb	51 ab	65 bcd	71	60
Topsin M	2 lb	43 ab	49 cd	59	70
TD 2350	1 lb	40 b	51 cd	69	67
Topsin M	1 lb				
+ TD 2350	1 lb	55 ab	48 d	52	63
Ridomil/Bravo	1 lb	80 ab	79 abcd	82	60
CGA-219417	_ lb	80 ab	82 abc	78	60
Rovral	2 lb	80 ab	88 ab	96	45
Ronilan	2 lb	79 ab	88 ab	91	45
Untreated	---	84 a	99 a	92	50
				n.s.	n.s.

Mean separation with the T-method at $P \leq 0.05$

EVALUATION OF LAYBY HERBICIDE APPLICATIONS TO SEED CARROTS, 1995

Marvin Butler, Bruce Martens, Les Gilmore and Kurt Feigner

Abstract

Four herbicides, metribuzin (Lexone, Du Pont), bromoxynil (Buctril, Rhone-Poulenc), oxyfluorfen (Goal, Rohm and Haas), and EPTC (Eptam, ZENECA), were applied alone and in combination to plots in commercial seed carrots fields at three locations in central Oregon using a drop nozzle directed at the furrow and base of the plants at layby. Lexone at 1.3 lb provided the greatest overall control of the five major weed species evaluated. Lexone provided the best control of redroot pigweed and common groundsel; Buctril and Goal performed well on hairy nightshade; and kochia control was best achieved with Lexone and Buctril, which along with Goal performed well on mustards. There were no visible symptoms of phytotoxicity or stunting from herbicide application.

Introduction

Carrot seed production is a major component of the central Oregon vegetable seed industry. Of the nearly 5,000 acres of vegetable seed grown in the area, about 1,500 acres are seed carrots with a value of over $5 million. Few herbicides are registered for use on carrots grown for seed, and efficacy data are required as the first step in the registration of new materials.

Methods and Materials

Evaluation of the herbicides, Lexone, Buctril, Goal, and Eptam alone, and in combination, was conducted in commercial seed carrot fields on three commercial farms in central Oregon. Application was made to 3 row x 20 ft replicated plots with a CO_2 pressurized, hand-held, boom sprayer at 40 psi and 20 gal/a of water, using a single 15002 TeeJet nozzle directed at the furrow and base of the plants at layby. Spray Booster-S at 1 qt/100 gal was applied in combination with all herbicides. Sixteen herbicide treatments were applied at the Cloud location June 15, with very few weeds emerged. Application at the S & L location was made on June 23, with weeds mostly 1-2 inches high and some up to 12 inches. At the K & S location, application was made June 29, except for the Eptam applications on July 5, 1995. Many of the weeds were 6 to 18 inches tall at the time of application.

Plots at the Cloud and K & S locations were sprinkler irrigated following herbicide application. S & L Farms furrow irrigated alternate rows following herbicide treatments.

Evaluation of plots for herbicide phytotoxicity and percent weed control by dominant species was conducted July 21 at S & L Farms, July 24 at K & S Farms, and July 25 at Cloud Farms. Groundsel made up nearly 100 percent of the weeds present in untreated plots on Cloud Farms at the time of evaluation. In untreated plots at S & L Farms, 72 percent of the weeds were common groundsel, 19 percent mustards, 6 percent hairy nightshade, and 3 percent redroot pigweed. At K

& S Farms, 70 percent of the weeds in untreated plots were redroot pigweed and 30 percent were hairy nightshade.

Twenty-umbel samples per plot were randomly selected from plots at the S & L and K & S locations for germination testing prior to swathing of the female rows.

Results and Discussion

There were no visible symptoms of phytotoxicity or stunting due to any of the herbicide applications. Because of variability between plots, there was often no significant difference between treatments. A summary of results at the three locations is provided in Table 1, with specific data from each location shown in Tables 2, 3 and 4. Lexone at 1.3 lb provided the greatest overall control of the major weed species, while Eptam generally did not perform satisfactorily. Lexone provided the best control of redroot pigweed, followed by the high rates of Buctril and Goal. For hairy nightshade Buctril and Goal performed well, followed by the high rate of Lexone. The best common groundsel control was achieved by Lexone, followed by Buctril and Goal. This is somewhat unexpected, since Goal followed by Buctril is generally considered to provide better control of groundsel by local industry representatives. However, Goal is sensitive to soil and weather conditions at the time of application. Both Lexone and Buctril provided control of kochia, and along with Goal, performed well on the mustards. The only combination treatment providing greater control than either material alone was Lexone plus Buctril on redroot pigweed.

Results of germination testing at the two locations indicate no detrimental effect from herbicide applications (Table 1).

Table 1. Evaluation of layby herbicide applications on commercial seed carrots at 3 locations near Culver and Madras, Oregon during 1995.

Material	Rate	Redroot Pigweed	Hairy Nightshade	Common Groundsel	Kochia	Mustards	Percent Germination
	(product/a)	----------(percent control)----------					
Lexone	0.3 lb	85 a	65 abc	97 a	100	93	84
Lexone	0.7 lb	98 a	81 abc	99 a	100	100	87
Lexone	1.3 lb	99 a	100 a	100 a	100	100	85
Eptam	4 pt	58 a	48 c	64 a	87	67	88
Eptam	7 pt	70 a	50 bc	47 ab	100	60	87
Buctril	0.5 pt	77 a	87 abc	83 a	100	68	88
Buctril	1 pt	88 a	100 a	93 a	83	90	77
Buctril	2 pt	98 a	99 a	84 a	100	93	84
Goal	1 pt	94 a	100 a	75 a	90	100	75
Goal	2 pt	98 a	99 a	79 a	100	100	78
Goal	4 pt	89 a	64 abc	86 a	67	97	87
Lexone	0.3 lb						
+ Eptam	4 pt	96 a	97 a	97 a	100	100	84
Buctril	1 pt						
+ Goal	1 pt	75 a	100 a	91 a	100	100	86
Buctril	1 pt						
+ Eptam	4 pt	97 a	94 ab	99 a	100	100	85
Buctril	1 pt						
+ Lexone	0.3 lb	100 a	100 a	88 a	100	98	86
Untreated	---	0 b	0 d	0 b	0	0	86

[1] Mean separation with the T-method at $P \leq 0.05$

Table 2. Evaluation of layby herbicide applications on commercial seed carrots (S & L Farms) on the Agency Plains near Madras, Oregon during 1995.

Material	Rate	Redroot Pigweed	Common Groundsel	Hairy Nightshade	Mustards
	(product/a)	-----------------(percent control)-----------------			
Lexone	0.3 lb	93 ab[1]	93 a	67 ab	93 a
Lexone	0.7 lb	100 a	97 a	95 a	100 a
Lexone	1.3 lb	100 a	100 a	100 a	100 a
Eptam	4 pt	67 ab	48 abc	63 ab	67 a
Eptam	7 pt	100 a	27 bc	33 ab	60 a
Buctril	0.5 pt	43 bc	83 a	73 ab	68 a
Buctril	1 pt	80 ab	98 a	100 a	90 a
Buctril	2 pt	95 ab	100 a	97 a	93 a
Goal	1 pt	95 ab	50 abc	100 a	100 a
Goal	2 pt	97 ab	57 ab	97 a	100 a
Goal	4 pt	93 ab	75 ab	60 ab	97 a
Lexone	0.3 lb				
+ Eptam	4 pt	97 ab	97 a	93 a	100 a
Buctril	1 pt				
+ Goal	1 pt	87 ab	87 a	100 a	100 a
Buctril	1 pt				
+ Eptam	4 pt	100 a	98 a	97 a	100 a
Buctril	1 pt				
+ Lexone	0.3 lb	100 a	83 a	100 a	98 a
Untreated	---	0 c	0 c	0 b	0 b

[1] Mean separation with the T-method at $P \leq 0.05$

Table 3. Evaluation of layby herbicide applications on commercial seed carrots (K & S Farms) on the Agency Plains near Madras, Oregon during 1995.

Material	Rate	Redroot Pigweed	Kochia	Hairy Nightshade
	(product/a)	-----------------(percent control)-----------------		
Lexone	0.3 lb	63 ab[1]	100 a	63 ab
Lexone	0.7 lb	93 a	100 a	67 ab
Lexone	1.3 lb	97 a	100 a	100 a
Eptam	4 pt	10 bc	87 a	33 ab
Eptam	7 pt	10 bc	100 a	67 ab
Buctril	0.5 pt	87 a	100 a	100 a
Buctril	1 pt	90 a	83 a	100 a
Buctril	2 pt	100 a	100 a	100 a
Goal	1 pt	87 a	90 a	100 a
Goal	2 pt	97 a	100 a	100 a
Goal	4 pt	73 a	67 a	67 ab
Lexone + Eptam	0.3 lb 4 pt	92 a	100 a	100 a
Buctril + Goal	1 pt 1 pt	70 a	100 a	100 a
Buctril + Eptam	1 pt 4 pt	93 a	100 a	90 ab
Buctril + Lexone	1 pt 0.3 lb	100 a	100 a	100 a
Untreated	---	0 c	0 b	0 b

[1] Mean separation with the T-method at $P \leq 0.05$

Table 4. Evaluation of layby herbicide applications on commercial seed carrots (Cloud Farms) near Culver, Oregon during 1995.

Material	Rate	Redroot Pigweed	Common Groundsel
	(product/a)	---------(percent control)---------	
Lexone	0.3 lb	100 a[1]	100 a
Lexone	0.7 lb	100 a	100 a
Lexone	1.3 lb	100 a	100 a
Eptam	4 pt	98 a	80 a
Eptam	7 pt	100 a	67 a
Buctril	0.5 pt	100 a	83 a
Buctril	1 pt	95 a	87 a
Buctril	2 pt	100 a	67 a
Goal	1 pt	100 a	100 a
Goal	2 pt	100 a	100 a
Goal	4 pt	100 a	97 a
Lexone	0.3 lb		
+ Eptam	4 pt	100 a	97 a
Buctril	1 pt		
+ Goal	1 pt	67 a	95 a
Buctril	1 pt		
+ Eptam	4 pt	99 a	100 a
Buctril	1 pt		
+ Lexone	0.3 lb	100 a	92 a
Untreated	---	0 b	0 b

[1] Mean separation with the T-method at $P \leq 0.05$

EVALUATION OF PRE-EMERGENCE HERBICIDE APPLICATIONS TO SEED CARROTS, 1995

Marvin Butler, Bruce Martens, Al Short, and Kurt Feigner

Abstract

Three herbicides, linuron (Lorox, Du Pont), pendimethalin (Prowl, Cyanamid), and EPTC (Eptam, ZENECA) were applied alone, and in combination, post-plant, pre-emergence in a commercial carrot seed field near Madras, Oregon. Lorox provided excellent control of all six weed species evaluated. Prowl performed well, except for moderate control of buttonweed and weak control on groundsel. Eptam provided inadequate control, with the exception of moderate control of groundsel at 7 pt/a. None of the treatments reduced stand, caused stunting, or were phytotoxic to the crop.

Introduction

Carrot seed production is a major component of the central Oregon vegetable seed industry. Of the nearly 5,000 acres of vegetable seed grown in the area, about 1,500 acres are seed carrots with a value of over $5 million. Few herbicides are registered for use on carrots grown for seed, and efficacy data are required as the first step in the registration of new materials.

Methods and Materials

Evaluation of the herbicides Lorox, Prowl, and Eptam alone, and in combination, was conducted in a commercial seed carrot field in the Mud Springs area near Madras, Oregon. Application was made post-plant, pre-emergence September 8, 1995 to 10 ft x 20 ft replicated plots with a CO_2 pressurized, hand-held, boom sprayer at 40 psi and 20 gal/a of water, using 8002 TeeJet nozzles. The trial area was sprinkler-irrigated several times after planting and prior to application of herbicides, and again four hours after application. Herbicide treatments were evaluated November 2, 1995 for percent control of buttonweed, China lettuce, lambsquarters, common groundsel, flixweed, and purple mustard, as well as reduction in stand, stunting, and phytotoxicity.

Results and Discussion

Average distribution of weed species in the untreated plots was 37 percent buttonweed, 22 percent China lettuce, 13 percent flixweed, 11 percent common groundsel, 10 percent purple mustard, and 7 percent lambsquarters. Lorox provided excellent control of all six species evaluated (Table 1). Prowl performed well on China lettuce, lambsquarters, flixweed, and purple mustard, with moderate control of buttonweed, and weak control of common groundsel. Eptam provided inadequate control, with the exception of 90 percent control of common groundsel at 7 pt/a. No reduction in stand, stunting, or phytotoxicity were visually detected.

Table 1. Evaluation of pre-emergence herbicide application on seed carrots in a commercial field in the Mud Springs area near Madras, Oregon, 1995.

Materials	Rates	Buttonweed	China Lettuce	Lambsquarter	Groundsel	Flixweed	Purple Mustard
	(product/a)	----------------------	----------------------	(percent control)	----------------------	----------------------	----------------------
Lorox	2 lb	100 a[1]	100 a	100 a	100 a	100 a	100 a
Eptam	4 pt	0 b	0 b	67 ab	80 ab	33 b	13 b
Eptam	7 pt	0 b	0 b	0 b	90 a	0 b	57 ab
Lorax	2 lb						
+ Eptam	4 pt	99 a	100 a	100 a	100 a	100 a	100 a
Prowl	2 pt	93 a	100 a	100 a	50 b	100 a	100 a
Untreated	---	0 b	0 b	0 b	0 c	0 b	0 b

[1] Mean separation with the T-method at $P \leq 0.05$

ORTHENE CONTROL OF GREEN PEACH APHID AND CARROT APHID ON SEED CARROTS IN CENTRAL OREGON, 1995

Marvin Butler and Bruce Martens

Abstract

Acephate (Orthene, Valent) was applied to seedling carrots for control of green peach aphid and carrot aphid in a commercial field near Madras, Oregon on October 19, 1995. Aphid counts were taken prior to application, and 4 days after application of Orthene. Average green peach aphids per plant were reduced from 18 to 0.5. Although Orthene provided 100 percent control of carrot aphids, it was not significantly different from untreated plots.

Introduction

An estimated 1,500 acres of carrots were grown for seed in central Oregon during the 1994-1995 season, with a gross income of nearly $4 million. Green peach aphid populations in seedling carrots were unusually high during the fall of 1995. Historically, green peach aphids have not been a serious pest on seed carrots, while carrot aphids have been the major concern during fall and spring months.

Methods and Materials

Orthene 75S was applied at 1.3 lb/a to 10 ft x 20 ft plots replicated three times in a commercial field near Madras, Oregon on October 19, 1995. Application was made using a CO2 pressurized, hand-held boom sprayer at 30 psi and a carrier rate of 20 gal/a of water. Silgard at 8 oz/100 gal, and R-56 at 1 pt/100 gal, water were applied in combination with the Orthene.

Pre-counts were made in both treated and untreated plots prior to the Orthene application. Post-application counts were made October 23, 4 days after treatment. The average number of aphids per plant was determined for both green peach aphids and carrot aphids from five randomly selected plants per plot.

Results and Discussion

Significant control of aphid populations was provided with Orthene 75S applied at 1.3 lb/a on seed carrots in central Oregon (Table 1). Four days after application green peach aphids per plant were 0.5 compared to 22 in the untreated plots, and no carrot aphids were found after the Orthene application compared to six per plant in the untreated plots.

As a result of this research, and with the cooperation of Mike Weber at Central Oregon Seed, Inc., the special local need, 24 (c), label for Orthene 75S on seed carrots was expanded to include green peach aphid as well as lygus bug for contracting growers.

Table 1. Average green peach aphid and carrot aphid populations per carrot plant prior to, and after, application of Orthene on October 19, 1995 near Madras, Oregon.

		Pre-treatment		Four-day count	
Treatment	Rate	Green peach	Carrot aphid	Green peach	Carrot aphid
	(product/a)	---------------(average number of aphids/plant)---------------			
Orthene 75S	1.3 lb/a	18	7	0.5 a[1]	0 a
Untreated	-----	17	8	22 b	6 a

[1] Mean separation with the T-method at $P \leq 0.05$

EVALUATION OF INSECTICIDES FOR CONTROL OF CARROT APHID AND GREEN PEACH APHID ON SEEDLING CARROTS, 1995

Marvin Butler and Bruce Martens

Abstract

Insecticides evaluated for control of carrot aphid and green peach aphid on seedling carrots included Admire-treated seed, and foliar application of imidacloprid (Admire, Bayer), fenvalerate (Asana, Du Pont), and chlorpyrifos (Lorsban, DowElanco). Foliar applied Admire significantly reduced total aphid numbers compared to untreated plots, while the effect of the other materials on aphid numbers was not significantly different from untreated plots. The proportion of green peach aphids and carrot aphids was not affected by insecticide treatments.

Introduction

An estimated 1,500 acres of carrots were grown for seed in central Oregon during the 1994-1995 season, providing a gross income of nearly $4 million. Fall aphid control on seedling carrots is important in maintaining strong plants going into the winter months. During the 1995 season green peach aphid populations have been extraordinarily high on seedling carrots. Carrot aphids have historically been the major concern.

Methods and Materials

A portion of seed planted in a commercial field on the Agency Plains near Madras, Oregon was treated with Admire insecticide. Foliar applications of Admire, Asana, and Lorsban were made to 10 ft x 20 ft plots replicated three times. Insecticides were applied October 9, 1995 when carrots were 2 inches tall using a CO_2 pressurized, hand-held, boom sprayer with TeeJet XR8002 nozzles at 30 psi and 20 gal/a of water. Silgard at 1½ pt/100 gal was applied in combination with insecticides.

Treatments were evaluated on October 17, 8 days after application, and October 27, 1995, 18 days after application. Fifteen plants per plot were randomly collected and placed in a Schun Shaker with methyl ethyl ketone. Aphids were collected in a jar at the base of the funnel, and transferred into vials of ethanol for separation and identification.

Results and Discussion

Foliar application of Admire significantly reduced total aphid numbers over the untreated plots 8 days after application, and over both the Lorsban treatment and untreated plots 18 days after application (Table 1). Although not statistically different, the Admire-treated seed and Asana application did not appear to perform as well as the foliar application of Admire. There was no statistical difference between treatments when comparing the relative population of green peach aphids to carrot aphids. However, the percentage of green peach aphids appeared to build slightly across treatments over time.

Table 1. Average total aphid populations, with percent green peach aphid and carrot aphid, per carrot seedling following foliar insecticide applications October 9, 1995 near Madras, Oregon.

		Average number of aphids/plant					
		8 days after treatment			18 days after treatment		
Treatment	Product/acre	Green peach	Carrot	Total	Green peach	Carrot	Total
Admire 2F	seed treatment	1.6	0	1.6 ab	4.3	0.4	4.7 ab
Admire 2F	10 fl oz	0.4	0.2	0.6 b	0.6	0.2	0.8 b
Asana XL	9.6 fl oz	1.2	0.1	1.3 ab	4.7	0	4.7 ab
Lorsban 4E	1 pt	2.8	0.2	3.0 ab	6.6	0.2	6.8 a
Untreated	-----	2.5	1.8	4.3 a	5.4	1.4	6.8 a

Mean separation with the T-method at $P \leq 0.05$

STATE-WIDE CEREAL VARIETY TESTING PROGRAM TRIALS IN CENTRAL OREGON

Russ Karow, Helle Ruddenklau,
Steve James and Mylen Bohle

Abstract

Winter and spring barley, triticale, and wheat trials were conducted at Madras in 1994-95 as part of a state-wide variety testing program. This was the third year of such coordinated trials. These trials are sponsored by the Oregon State University Extension Service, OSU Agricultural Experiment Station, Oregon Wheat Commission and Oregon Grains Commission. As groups, winter wheats and triticales had the highest average yield (6,162 lb/a), followed by spring wheats and triticales (5,184 lb/a), spring barleys (4,409 lb/a) and winter barleys (4,067 lb/a); however, there were significant differences among varieties within each grouping. For example, SDM204 winter barley yielded 6,257 lb/a while Hyak wheat yielded only 4,392 lb/a. 1995 trial results for all grains and a three year summary for winter grains are presented in tabular format. Growers are encouraged to carefully review prospective varieties for both yield and other desirable charcteristics. Trial results from across the state will be summarized in separate winter and spring grain publications. These publications will be available at local county Extension offices in early 1996.

Introduction

New cereal varieties are being released by public and private Pacific Northwest plant breeders each year. In order to provide growers with accurate, up-to-date information on variety performance, a state-wide variety testing program was initiated in 1993 with funding provided by the OSU Extension Service, OSU Agricultural Experiment Station, Oregon Wheat Commission, and Oregon Grains Commission. The program is centrally coordinated by Russ Karow, OSU Extension specialist, Dept. of Crop and Soil Science, and Helle Ruddenklau, Crop and Soil Science research assistant. The central team packages and distributes seed to cooperators across the state. Cooperators, such as Steve James and Mylen Bohle in Central Oregon, plant, manage, and harvest the trials. The central team processes harvested grain, analyzes results, and provides summary data to interested parties across the state and region.

Eleven sites are included in the testing network. More than 50 varieties are tested each year at each site. Height, lodging, yield, test weight, and protein data are determined for all plots. Other information is collected as time and labor allows. Collected data are summarized in Extension publications and county Extension newsletters as well as in *Oregon Wheat Magazine* and other popular press media.

Materials and Methods

Plots (5 x 20 feet) were seeded at a rate of 30 seeds per square foot using an Oyjord plot drill. Winter trials were seeded on October 7, 1994, while spring trials were planted on March 30, 1995. Winter grains were fertilized on March 29, 1995 (116 lb N, 40 lb S) and had a soil reserve nitrogen level of 86 lb/a. Spring trials were also fertilized on March 29 (20 lb N, 40 lb s) and had a soil reserve nitrogen level of 90 lb/a. Herbicide and irrigation programs were typical for central Oregon production. A thunderstorm in mid-July caused severe lodging in all trials, but most continued to mature and grain was normal in test weight. Plots were harvested with a Wintersteiger plot combine then cleaned on a Peltz rub-bar cleaner. Plot yield, test weight, protein, moisture, and seed size were all determined on cleaned grain samples. Wheat and triticale yields are reported on a 10 percent moisture, 60 lb bushel basis. Barleys yields are in pounds per acre at 10 percent moisture. Protein and moisture levels were determined using a whole-grain, near infrared protein analyzer. Proteins are reported on a 12 percent moisture basis.

Results and Discussion

Winter Wheats and Triticales

Winter wheat and triticale data are presented in Table 1. Considering that all plots were lodged at a 47 or greater percent level, average yield (102.7 bu/a), and test weight (56.6 lb/bu) are good. Average test weight is skewed due to inclusion of low test weight triticales and club wheats. The highest yielding, named soft white wheat was Rod at 115 bu/a. Highest yielding entries per se were two experimental soft whites at 122 bu/a. There were few statistical differences among commercially available soft white wheats. Protein levels were above the target level of 10 percent indicating surplus nitrogen fertility.

Spring Wheats and Triticales

Spring wheat and triticale data are presented in Table 2. Spring grains also lodged but to a lesser extent than winter grains. Average yield was 86 bu/a with a 58.3 lb/bu test weight. Alpowa, a recently released Washington State University variety, was the highest yielding released variety. It significantly outyielded commonly grown soft whites such as Penawawa and Centennial. It's test weight was also excellent (61.5 lb/bu) despite the fact that it was 70 percent lodged. The red wheat WPB936R had a yield equivalent to that of Alpowa and a protein level of 14.1 percent. The triticales Juan and Victoria had yields above those of most commonly grown varieties but below that of Alpowa. Proteins were high indicating surplus nitrogen fertility.

Winter and Spring Barleys

Barley data are shown in tables 3 and 4. Spring and winter barley yields were significantly lower than those of the wheats and triticales with two notable exceptions. SDM204, a winter barley bred by Don Sunderman, (retired Univ. of Idaho winter grains breeder), had a yield equivalent to that of the winter wheats (104 bu/a), and Steptoe, the most commonly grown barley in Oregon, had a yield better than that of most spring wheats and triticales (94 bu/a). Low yielding barleys such as Gwen and ORW7 showed little lodging indicating that head weight played a significant role in the mid-July lodging event. The two-row feed barley Baronesse has been an exceptionally high yielding variety in trials elsewhere in the state but has not performed well in the Madras trials.

Three year Summary

Table 5 is a summarization of yield data for winter grains over the period 1993-95. The ability to analyze variety performance over time is one of the real benefits of coordinated, long-term trials. Data is presented in two different formats in table 5. Actual yields for each year are presented in one set of columns. Yields expressed as a percent of the trial average yield are presented in a second set of columns. The percent of average figures are easiest to visually analyze. The data show that from a statistical point of view (5 percent probability level) there are no real differences among the winter wheats and triticales or winter barleys. The range of percent values for wheats and triticales, excluding Yamhill, is 93 to 106 percent - a very tight range for commonly grown varieties. The range for barleys, excluding Kamiak, is 90 to 125 percent, again a narrow range of values. These narrow ranges are not too surprising if you consider that the newest and best varieties are being tested in these trials. What the data suggests is that you not be overly concerned about yield performance when selecting a newer variety to grow, but rather that you consider other desired characteristics.

Data from the Madras site will be combined with that from the other ten locations in the state-wide variety testing network and published in Extension bulletins. Contact your local OSU county Extension office in early 1996 for a copy of the summary bulletins for both winter and spring grains.

Table 1. 1995 state-wide variety testing program winter wheat and triticale trial at Madras

Variety/ line	Market class	Julian heading date	Height (in)	Lodging percent	Yield (bu/a)	Test weight (lb/bu)	Protein percent	Thousand kernel wgt (g)
Basin	SW	162	32	47	110	58.2	10.5	35.4
Cashup	SW	162	40	100	100	57.4	11.8	29.7
Celia	Triticale	158	44	63	99	51.1	12.0	37.3
Daws	SW	160	40	98	114	58.6	11.7	39.0
Flora	Triticale	159	44	100	74	44.3	11.9	32.6
Gene	SW	155	33	100	89	56.1	11.9	35.1
Hill 81	SW	161	42	93	113	59.0	12.2	32.5
Hoff	HR	154	38	98	118	60.0	12.0	33.6
Hyak	Club	159	40	98	73	55.5	12.3	30.0
ID447	SW	158	37	100	105	58.7	12.4	30.5
Kmor	SW	163	40	100	84	54.6	12.3	30.7
LAD349	Triticale	150	51	88	120	54.1	10.8	42.4
Lambert	SW	157	42	67	107	56.3	12.0	33.6
Lewjain	SW	165	40	100	93	55.3	13.0	31.0
Mac1	SW	156	42	100	100	58.2	11.9	42.7
MacVicar	SW	158	39	65	104	58.3	11.2	46.2
Madsen	SW	162	39	77	98	59.5	11.7	37.7
Malcolm	SW	156	40	83	113	57.3	11.5	41.4
OR870082	SW	155	36	100	122	59.7	11.3	36.0
OR889176	HW	157	31	93	108	59.0	11.9	38.5
OR939645	SW	158	36	68	123	56.3	12.0	38.1
Parma	Triticale	163	47	100	89	50.7	12.2	40.8
Rely	Club	160	44	97	93	56.6	12.2	30.0
Rod	SW	162	42	100	115	57.0	12.1	32.5
Rohde	Club	160	41	99	105	58.7	11.7	30.0
Rulo	Club	162	43	98	100	54.9	12.6	28.7
Stephens	SW	156	39	99	105	57.9	11.8	47.5
W301	SW	154	39	100	97	58.6	11.5	44.2
WA7663	SW	163	40	100	119	56.1	11.8	37.9
WA7686	SW	156	36	53	114	59.0	11.8	37.5
WA7690	SW	158	43	86	98	60.1	12.0	45.4
WA7697	Club	160	38	70	117	57.7	11.8	36.9
Whitman	Triticale	151	52	100	100	51.8	11.2	43.6
Yamhill	SW	163	42	98	74	57.7	11.7	42.2
Average		159	40	89	103	56.6	11.8	36.8
PLSD (5%)		3	4	NS	21	2.4	0.7	--
EMS(66)		2.36	5.29	522.10	167.50	2.13	0.18	--
CV(%)		1	6	26	13	3	4	--
P-VALUE		0.00	0.00	0.12	0.00	0.00	0.00	--

Table 2. 1995 state-wide variety testing program spring wheat and triticale trial at Madras

Variety/ line	Market class	Julian heading date	Height (in)	Lodging percent	Yield (bu/a)	Test weight (lb/bu)	Protein percent	Thousand kernel wgt (g)
Alpowa	SW	177	35	70	99	61.5	11.3	40.2
Calorwa	Club	176	34	95	73	56.4	12.7	32.4
Centennial	SW	176	35	93	85	58.0	12.3	33.8
Dirkwin	SW	179	33	58	79	56.4	12.1	37.5
ID377S	HW	177	35	92	90	58.4	13.4	35.3
ID448	SW	181	34	57	86	57.5	12.4	27.4
ID471	SW	175	33	93	86	59.7	11.9	36.6
Klasic	HW	168	29	100	97	59.6	13.4	38.5
Juan	Triticale	177	46	33	91	53.0	11.5	69.8
Owens	SW	179	34	93	78	58.3	12.5	23.9
Penawawa	SW	177	34	65	82	59.7	12.2	32.1
Treasure	SW	180	35	63	86	59.8	11.5	37.8
Victoria-RSI	Triticale	175	41	73	92	52.4	12.1	43.8
Wakanz	SW	178	33	65	94	60.4	11.9	36.0
Wawawai	SW	175	38	98	72	58.9	12.5	40.0
WPB Vanna	SW	180	33	62	86	58.8	12.4	32.6
WPB906R	HR	172	31	37	80	58.8	13.5	40.0
WPB926R	HR	173	32	30	79	59.0	13.9	36.7
WPB936R	HR	174	32	42	99	58.8	14.1	40.7
Yecora Rojo	HR	169	28	64	94	60.3	13.3	42.5
Average		176	34	69	86	58.3	12.5	--
PLSD (5%)		3	3	NS	14	2.2	1.0	--
EMS(38)		2.42	4.32	1331.00	71.84	1.72	0.34	--
CV		1	6	53	10	2	5	--
P-VALUE		0.00	0.00	0.34	0.00	0.00	0.00	--

Table 3. 1995 state-wide variety testing program winter barley trial at Madras

Variety/ line	Market class	Julian heading date	Height (in)	Lodging percent	Yield (lb/a)	Test weight (lb/bu)	Protein percent	Thousand kernel wgt (g)
Gwen	6RF	141	41	22	2889	52.8	10.1	31.1
Hesk	6RF	150	42	73	4078	50.1	9.5	31.8
Hoody	6R hoode	152	46	72	3040	47.8	10.9	35.2
Hundred	6RF	150	38	43	3860	49.9	9.6	27.5
Kamiak	6RF	141	39	77	4077	49.9	11.1	26.5
Kold	6RF	150	39	68	4215	52.4	9.3	32.4
Scio	6RF	150	40	72	3650	50.4	10.1	35.3
Showin	6RF	150	31	73	5258	50.6	9.0	31.4
Steptoe	6RF	150	45	88	3932	50.9	9.6	39.9
ORW6	6RF	146	39	72	4984	52.0	9.0	37.5
ORW7	6RF	151	43	28	1945	50.4	9.9	37.5
SDM204	6RF	154	36	70	6257	48.8	8.4	28.2
SDM208	6RF	150	39	82	4692	50.8	10.3	33.8
Average		149	40	65	4067	50.5	9.7	32.9
PLSD (5%)		2	5	NS	1534	2.0	NS	--
EMS (24)		1.21	8.92	769.10	828500	1.43	0.88	--
CV (%)		1	7	43	22	2	10	--
P-VALUE		0.00	0.00	0.15	0.00	0.00	0.07	--

Table 4. 1995 state-wide variety testing program spring barley trial at Madras

Variety/ line	Market class	Julian heading date	Height (in)	Lodging percent	Yield (lb/a)	Test weight (lb/bu)	Protein percent	Thousand kernel wgt (g)
78Ab10274	2RM/F	172	35	67	4725	52.8	12.7	47
82Ab23222 (Payette)	6RF	176	40	92	4473	48.7	12.8	37
Baronesse	2RF	173	35	75	4002	51.0	13.0	43
Colter	6RF	168	43	57	4733	47.9	11.5	35
Columbia	6RF	177	36	80	4513	46.8	12.8	33
Crest	2RM	171	31	85	4697	51.3	13.0	40
Germains 2319	6RF	165	35	97	4422	49.8	11.6	44
Maranna	6RF	171	38	80	4524	49.7	12.9	32
Russell	6RM	164	39	60	3685	49.8	11.7	35
Steptoe	6RF	171	37	73	5661	47.8	11.9	41
WPB-BZ489	6R hulles	176	38	95	3710	54.5	15.5	40
WPB-Sissy	6RF	176	34	57	3766	49.9	14.0	41
Average		172	37	76	4409	50.0	12.8	39
PLSD (5%)		3	4	NS	1016	2.4	1.0	--
EMS (22)		3.73	6.76	326.50	360100	2.06	0.33	--
CV		1	7	24	14	3	4	--
P-VALUE		0.00	0.00	0.10	0.03	0.00	0.00	--

Table 5. 1993-95 yields for winter wheats, triticales and barleys at Madras

	Market class	1993	1994	1995	Average	1993	1994	1995	Average
		bu/a				Percent of average			
Winter wheats and triticales									
Cashup	SWW	109	123	100	111	1.01	1.10	0.98	1.03
Celia	Triticale	111	117	99	109	1.03	1.04	0.97	1.01
	SWW	107	93	114	105	0.99	0.83	1.11	0.98
Gene	SWW	114	107	89	103	1.06	0.95	0.87	0.96
Hill 81	SWW	98	112	113	108	0.91	1.00	1.10	1.00
Hoff	HRW	108	126	118	117	1.00	1.13	1.16	1.10
Lewjain	SWW	101	106	93	100	0.93	0.95	0.91	0.93
MacVicar	SWW	120	118	104	114	1.11	1.05	1.02	1.06
Madsen	SWW	121	101	98	107	1.12	0.90	0.96	0.99
Malcolm	SWW	99	123	113	111	0.91	1.09	1.10	1.04
Rod	SWW	110	108	115	111	1.02	0.96	1.13	1.04
Rohde	Club	101	112	105	106	0.93	1.00	1.02	0.98
Stephens	SWW	109	120	105	111	1.01	1.07	1.03	1.04
W301	SWW	119	119	97	112	1.10	1.06	0.95	1.04
Whitman	Triticale	106	108	100	105	0.98	0.96	0.98	0.97
Yamhill	SWW	84	107	74	88	0.78	0.95	0.72	0.82
Average		108	112	102	107				1.00
PLSD (5%)		17	13	21	NS				NS
CV		9	7	13	8				8
P-VALUE		0.02	0	0.00	0.12				0.11
		lb/a				Percent of average			
Winter barleys									
Gwen	6RF	6061	4266	2889	4405	1.15	1.07	0.71	0.97
Hesk	6RF	5196	4408	4078	4561	0.98	1.10	1.00	1.03
Hundred	6RF	4972	5044	3860	4625	0.94	1.26	0.95	1.05
Kamiak	6RF	4763	2418	4077	3753	0.90	0.60	1.00	0.84
Kold	6RF	5620	4289	4215	4708	1.06	1.07	1.04	1.06
Showin	6RF	6247	5157	5258	5554	1.18	1.29	1.29	1.25
Steptoe	6RF	4170	3796	3932	3966	0.79	0.95	0.97	0.90
Average		5290	4005	4067	4510				1
PLSD (5%)		NS	622	1534	NS				NS
CV		17	9	22	14				9
P-VALUE		0.12	0.00	0.00	0.09				0.11

NS = non-significant

DORMANT WEED CONTROL ON FIRST-WINTER ALFALFA IN 1992

Mylen Bohle, Randy Dovel, and Larry Burrill

Abstract

Very little work has been done on the effects of herbicides applied to dormant first-winter alfalfa. Three dormant-type herbicides (Velpar, Lexone, and Sinbar) were applied to first winter alfalfa at the Central Oregon Agricultural Research Center (COARC), Powell Butte, Oregon. The check had a significantly higher yield on first cutting than all the herbicide treatments. Sinbar was significantly lower than Velpar, and was close to being significantly lower than Lexone. There was no difference between Velpar and Lexone. There were no significant yield differences on second and third cuttings.

Introduction

Weed control for first-winter alfalfa is usually no herbicides applied, or weed control is applied after establishment. The effect of dormant herbicide applications on spring-planted or early summer-planted, first-year winter alfalfa hay yield was of interest for central Oregon. Very little local research information was available. High rates of three dormant stage herbicides were applied to measure the effect on hay yield and quality.

Materials and Methods

Vernal alfalfa was planted on June 1, 1991 at the COARC, at Powell Butte, Oregon. The herbicides and rates applied were Velpar (1.0 lb a.i./a), Sinbar (1.0 lb a.i./a), and Lexone (1.0 lb a.i./a). Paraquat (0.5 lb a.i./a) was applied with the herbicide treatments, but not to the check. The application was made on January 29, 1992 with a 6-ft boom, CO^2 backpack sprayer. The design was a randomized complete block with two replications. Percent weed control was estimated by visual appraisal. Plots were 20 feet x 40 feet. Two clippings, each 3.5-feet x 15 feet harvests were taken from each treatment plot for yield assessment. Harvest dates were June 17, July 23, and September 9, 1992. One-pound samples were taken for percent moisture content and quality evaluation, and the samples were dried at 149 degrees Fahrenheit until there was no change in weight. Forage quality was measured by near infra-red spectroscopy at the Klamath Experiment Station, Klamath Falls, Oregon. All data are presented on a dry matter basis.

Results and Discussion

Dry matter yield (t/a), percent moisture, and quality data are presented in Tables 1-2. There were no significant differences in hay quality measured on the first cutting. All of the treatments produced dairy quality hay, which means the weeds present had no negative effect on quality, and the growth stage at which the alfalfa was harvested contributed to the high quality of the hay.

The check was the highest yielding treatment in the first cutting, significantly higher than Lexone and Sinbar treatment, but not Velpar. The plots treated with Velpar were significantly higher yielding than those treated with Sinbar, but not Lexone. Sinbar apparently stunted the alfalfa; this was also seen in the third cutting. There were no significant differences in hay yield for the second and third cuttings. There were abundant weeds present, but species and the amount of area infested was not consistent, so weed control was not documented, per se. Clover (mostly white) control by the herbicides appeared to be as follows: Velpar (45 percent), Check (0 percent), Lexone (95 percent), and Sinbar (95 percent). Shepherdspurse was controlled completely by all of the herbicide treatments.

Table 1. Total dry matter hay yield (tons/acre) and harvest moisture response to dormant weed control trial conducted at the COARC, Powell Butte in 1992.

	1st Cut		2nd Cut		3rd Cut		Total
Herbicide	Yield t/a	Moisture %	Yield t/a	Moisture %	Yield t/a	Moisture %	Yield t/a
1. Velpar	1.90	75.7	1.42	80.9	1.58	78.7	4.90
2. Lexone	1.71	75.4	1.43	81.1	1.40	77.6	4.54
3. Check	2.07	75.8	1.31	80.7	1.49	77.6	4.87
4. Sinbar	1.57	75.2	1.27	80.4	1.13	77.2	3.97
Mean	1.81	75.5	1.36	80.8	1.40	77.8	4.57
PLSD (.10)	0.27	NS	NS	NS	NS	NS	---
PLSD (.05)	NS	NS	NS	NS	NS	NS	---
CV%	13.0	1.2*	7.9	1.2*	21.1	1.2*	---

*CV% for all cuttings analyzed together

Table 2. First cutting quality response to dormant weed control at the COARC, Powell Butte, Oregon in 1992.

Herbicide	Protein %	ADF %	NDF %	TDN %	RFV
Velpar	22.1	27.7	35.7	64.5	175.8
Lexone	21.6	27.6	35.7	64.7	175.8
Check	21.5	27.3	34.7	64.9	181.2
Sinbar	22.7	27.4	35.4	64.8	178.1
Mean	22.0	27.5	35.4	64.7	177.7
PLSD (.10)	NS	NS	NS	NS	NS
PLSD (.05)	NS	NS	NS	NS	NS
CV%	5.2	2.9	2.9	1.4	3.8

ON-FARM WINTER WHEAT GRAIN VARIETY DRILL-STRIP TEST[1]

Mylen Bohle and Russ Karow

Abstract

Stephens, Gene, Madsen, MacVicar, and Rod soft white winter wheat, and Rohde winter white club wheat were drill-strip tested for grain yield, protein, and other agronomic traits on the Bill Guthrie Farm, near Prineville, Oregon.

Introduction

New cereal varieties have been tested in research trials at Oregon State University Agricultural Experiment Stations, including Madras. An on-farm drill strip testing program was initiated in 1993 along with the State-Wide Cereal Testing Program. Various seed companies have made seed available for producers to test new variety releases in a side-by-side comparison on their farms. The objective was to test these new varieties, using Stephens as the check variety, for yield, quality, and other agronomic traits in producer fields.

Methods and Materials

Fifty-pound sacks of Stephens, Gene, Madsen, MacVicar, and Rod soft white winter wheat and Rohde winter white club wheat were planted with a 12-foot-wide, double-disk drill with 9-inch row spacing in early October, 1993 on the Bill Guthrie Farm, Prineville, Oregon. The seed was planted until the drill was empty. The demonstration was not replicated. The drill was not calibrated independently for each variety, hence plant populations varied. Irrigation was with a side roll sprinkler, applied as needed, as was weed control. Harvested plot size was 12 feet by 887 feet and yield was converted to bu/a (60 lb = bu). Grain was harvested with a John Deere combine with a 12 foot header. The grain was unloaded into a "weigh wagon," weighed and then augured into a truck. Samples were taken for test weight and protein, and measurements were taken for height and lodging. Protein was determined with a whole-grain, near infra-red analyzer. Yield and protein content are presented on a 10 and 12 percent moisture basis, respectively.

Results and Discussion

No disease or insect problems were encountered with the demonstration. Data are presented

[1]**Acknowledgement:** Cooperation by Bill Guthrie is gratefully appreciated

in Table 1. All of the varieties tested were recent releases, except Stephens. Rod had the best yield and lowest protein content. Rod is a Washington State University release that has performed average or better at most test sites across the state of Oregon. MacVicar had the second best yield and protein content. MacVicar has had lower protein content than most other varieties in university trials. Rohde is a new club white wheat that has excellent yield potential for a club wheat and good lodging resistance under irrigated conditions. Madsen is a high yielding variety that has replaced Stephens as the number one variety in Washington. Gene is a very short, awnletted, early-maturing variety with high yield potential, but has been erratic in yield. Gene is less winter hardy than Stephens. Rod and MacVicar had protein contents lower than 10.5 percent, the level that foreign buyers are requesting. As the plots were not replicated, statistical significance can not be determined.

Table 1. On-farm winter wheat grain variety drill strip results from the Bill Guthrie farm, Prineville Oregon in 1994.

Variety	Yield bu/a	Protein %	Test Weight lb/bu	Height in.	Lodging %	Grain Nitrogen Recovery lb/a
Stephens	121	11.2	58.6	38	0	143
Gene	113	11.9	56.6	36	0	142
Rohde	131	11.0	61.1	41	0	152
Madsen	126	11.3	58.3	39	0	150
MacVicar	141	10.4	58.8	39	0	154
Rod	153	10.1	59.2	40	0	163
Average	131	11.0	58.8	39	0	152

SPRING HAY BARLEY VARIETY TEST

Mylen Bohle

Abstract

A new spring hay barley line, WA 7999-88, produced forage yields equivalent to Belford, but had better lodging resistance and shorter height under irrigated conditions.

Introduction

Washington State University is considering releasing a new spring hay barley line, WA-7999-88. There were no local data available. WA 7999-88 was compared to two commonly grown spring hay barleys.

Materials and Methods

Belford, Westford, and WA 7999-88 spring hay barleys were planted at 30 seeds per square foot (Belford, 113 lb/a; Westford, 109 lb/a; and WA 7999-88, 130 lb/a) on April 13, 1995, with a plot cone-type planter at the Central Oregon Agricultural Research Center, Powell Butte, Oregon. The plots were 5 feet x 20 feet, six rows, with 8 inch row spacing. The experimental design was a randomized complete block with three replications, except for Westford, which was only replicated once. The plots were fertilized with 40 pounds of sulfur (gypsum source) and 120 pounds of nitrogen fertilizer (ammonium nitrate source) on April 20, 1995. Irrigation was as needed by solid set hand lines. Plots were hand weeded. Forage yield was determined by harvesting the two center rows (1.33 feet x 15 feet) with a hand sickle. A 1-pound sample was weighed for moisture and dried at 149 degrees Fahrenheit until there was no change in weight. Yield is presented on a dry matter basis.

Results and Discussion

The hay yield and other agronomic data are presented in Table 1. The new Washington line shows potential, with superior lodging resistance compared to Belford. The experimental line, WA 7999-88, is shorter than either Westford or Belford. There was no yield difference between the varieties tested at the nitrogen fertility level utilized for this trial.

Table 1. Yield and other agronomic data for the spring hay barley variety trial conducted at the COARC, Powell Butte, Oregon in 1995.

Variety	Yield t/a	Dry Matter %	Moisture %	Height in.	Lodging %	Harvest Date 1/1=1
Belford	4.99	36.9	63.1	42	57	206
WA 7999-88	5.36	36.8	63.2	38	12	207
Mean	5.18	36.9	63.1	40	34	206.5
PLSD .10	NS	NS	NS	S	S	S
PLSD .05	NS	NS	NS	NS	NS	S
CV%	11.7	3.6	2.1	5.3	45.1	0
Westford*	4.86	37.0	63.0	39	0	206

* 1 rep only

GRAIN AND FORAGE TRITICALE AND BARLEY LINES SCREENED FOR GRAIN PRODUCTION

Mylen Bohle, Russ Karow, Helle Ruddenklau and Robert Metzger

Abstract

Varieties and experimental lines of winter and spring triticale, and spring barley were planted and screened at the Central Oregon Agricultural Research Center (COARC), at Powell Butte in 1995. The plots were harvested only for grain, but varieties and lines are classified as grain, hay, and dual purpose lines.

Introduction

Cereals offer great potential for both grain and forage production in central Oregon. Robert Metzger and Matt Kolding, retired plant breeders in Oregon, continue to develop lines of winter triticale. A new spring hay barley is being considered for release by Washington State University as is a spring triticale line with an awnletted head from CYMMIT in Mexico. A screening was initiated to look at the adaptability of these lines and varieties, and to document their grain production capabilities and other agronomic traits.

Materials and Methods

The cereals were planted at 30 seeds per square foot (unless otherwise stated in Table 2) at the COARC, Powell Butte, Oregon. The winter cereals were planted on October 6, 1994, and the spring cereals on April 13, 1995, with a plot cone-type planter. Plots were not replicated and were 5 feet x 20 feet. All plots were fertilized with 40 pounds of sulfur in the form of gypsum. The winter triticales were fertilized on March 28, 1995, with 180 pounds of nitrogen fertilizer, while the spring triticale and barleys were fertilized with 120 pounds of nitrogen (ammonium nitrate source) on April 20, 1995. The soft white winter wheat border plot received no fertilizer and one plot was harvested for comparison. Irrigation was as needed with solid-set sprinkler lines. The plots were sprayed with Lorsban insecticide (0.5 lb. a.i./a) on March 29, 1995, and Bronate herbicide (2 pints per acre) on April 26, 1995 using a dual-bicycle tire, 15-foot boom battery operated sprayer. Late boot, heading and flowering dates, lodging, height, head type, and susceptibility to ergot were recorded. An area of 5 feet x 15 feet was harvested with a Wintersteiger grain plot harvester. Four outside rows (four rows out of six rows) of WA 7999-88 barley was harvested (the two inside rows were harvested for forage). Grain was cleaned at the Hyslop Farm, Corvallis, Oregon. All yields are based on 60 pound bushels to allow an easier comparison of the data. Grain protein was measured with a whole grain near infra-red analyzer. Test weight, moisture, and 1,000 kernel weight were determined at Corvallis. Seeds per pound, future seeding rate, grain nitrogen recovery, and grain protein yield were calculated. Grain yield and protein are presented on a 10 and 12 percent moisture basis, respectively.

Results and Discussion

Data for the winter and spring cereal varieties and experimental lines are presented in tables 1-3.

Since there was no replication statistical analyses cannot be made, but gross comparisons can be made. Parma is a line that is being released in Idaho. Producers have used it for forage and have begun using it for grain production as it is high yielding and has a higher lysine content than other triticale varieties. It has excellent lodging resistance. but is very late maturing. Iceberg is a selection that was made from Parma - as the only plants that survived a hard freeze in Canada. Parma has excellent winter hardiness and yet is facultative. Newcale is a midwest variety that is very early maturing. A number of triticale lines had excellent yields and test weights. Some of the winter triticale lines need to be evaluated further in a replicated trial. Severe lodging by some of the lines may have occurred from a bad sprinkler, and a July thunderstorm, though some of the entries did not lodge. The lodging did not seem to shrivel grain as evidenced by the normal to high test weights.

Another interesting entry is M94-4393, an awnletted spring triticale. This line has high test weight (58.1 lb/bu), but even more interesting is it's early maturity. M94-4393 reached late boot stage four to six days earlier than did the three spring barley lines, and was nine days earlier than Grace spring triticale. WA 7999-88, a hooded spring barley line, will be released soon by Washington State University. This line had superior lodging resistance and shorter height than Belford.

Table 1. Grain yield, grain protein content, test weight, height, lodging, and 1,000 kernel weight of winter and spring triticale and barley varieties, and experimental lines tested at the COARC, Powell Butte, Oregon in 1995.

Variety/Line	Grain Yield bu/a	Grain Protein %	Test Weight lb/bu	Height in.	Lodging %	1000 Kernel Weight g
Winter (180 lb/a N)						
FT 87788	118.1	8.5	51.9	46	98	37.1
FT 91064	120.6	9.2	55.5	47	40	42.7
M94-? (Salmon)	103.3	8.9	55.4	56	98	39.6
M94-1025	100.3	8.9	55.8	51	95	33.5
M94-93	118.0	8.5	57.0	57	95	39.1
M94-92	103.5	9.2	57.0	52	95	37.5
M94-1114	85.7	10.6	54.1	56	95	40.9
M94-1115	81.9	10.9	54.6	55	95	40.4
M94-1113	75.8	11.0	55.1	58	85	50.2
(3) 1-62 H1031	119.0	8.3	57.0	51	80	43.2
(14) 1-63 H1037*	81.6	9.0	56.3	55	75	43.9
(6) 1-80 H1031	88.2	9.2	55.8	52	60	35.8
(4) 1-70 H1031	88.9	8.4	56.8	45-56	40	41.8
Newcale	89.4	9.7	57.1	47	50	39.8
Parma	132.1	9.1	57.0	45	0	40.4
Iceberg	121.8	8.8	56.4	44	0	43.4
M94-3163>3165	126.2	8.6	58.0	46	0	40.0
M94-2082	121.4	9.2	56.5	45	0	42.2
M94-2113	117.8	9.5	56.0	42	0	43.5
Winter wheat (0 N)	56.3	7.6	59.2	--	0	40.8
Spring (120 lb/a N)						
Grace	47.8	8.5	53.1	--	0	41.8
M94-4393	71.1	8.7	58.1	44	0	36.0
WA 7999-88 barley	44.2	9.9	45.1	39	12	39.1
Westford barley	---	--	---	39	0	---
Belford barley	---	--	---	42	57	---

*...FT 90462 h1001

Table 2. Seeds per pound, future seeding rate, actual 1994 seeding rate, 30 seeds per ft^2 seeding rate, and head type of winter and spring triticale, and barley varieties, and experimental lines tested at the COARC, Powell Butte, Oregon in 1995.

Varieties/Lines	Seeds Per Pound	Future Seeding Rate lb/a	Actual 1994 Seeding Rate lb/a	30 Seeds per ft^2 Seeding Rate lb/a	Head Type	Ergot
Winter (180 lb/a N)						
FT 87788	12,226	106.9	143.0	143.0	awn	no
FT 91064	10,623	123.0	156.5	156.5	awn	yes
M94-? (Salmon)	11,455	114.1	142.1	142.1	awnlett	no
M94-1025	13,540	96.5	132.5	132.5	awnlett	no
M94-93	11,601	112.6	172.8	172.8	awnlett	no
M94-92	12,096	108.0	158.4	158.4	awn	no
M94-1114	11,090	117.8	94.4	127.7	awn	yes+
M94-1115	11,228	116.4	125.5	141.1	awn	yes
M94-1113	9,036	144.6	111.7	158.4	awn	no
(3) 1-62 H1031	10,500	124.5	168.0	168.0	awn	no
(14) 1-63 H1037*	10,333	126.5	164.2	164.2	awn	no
(6) 1-80 H1031	12,670	103.1	154.6	154.6	awnlett	no
(4) 1-70 H1031	10,852	120.4	148.8	148.8	awnlett	no
Newcale	11,397	114.7	103.7	103.7	awn	no
Parma	11,228	116.4	170.9	170.9	awn	no
Iceberg	10,452	125.0	155.2	158.4	awn	no
M94-3163>3165	11,340	115.2	142.1	142.1	awn	no
M94-2082	10,749	121.6	178.6	178.6	awn	no
M94-2113	10,428	125.3	160.3	160.3	awn	no
Winter wheat (0 N)	11,118	117.5	96.0	96.0	awn	no
Spring (120 lb/a N)						
Grace	10,852	120.4	132.5	132.5	awn	no
M94-4393	12,600	103.7	157.5	157.5	awnlett	no
WA 7999-88 barley	11,061	112.6	129.6	129.6	hooded	no
Westford barley	---	---	109.4	---	hooded	no
Belford barley	---	---	113.3	---	hooded	no

*...FT 90462 h1001

Table 3. Grain nitrogen recovery, grain protein yield, late boot date, heading date, and flower date of winter and spring triticale and barley varieties and experimental lines tested at the COARC, Powell Butte, Oregon in 1995.

Variety/Line	Grain Nitrogen Recovery lb/a	Grain Protein Yield lb/a	Late Boot Date 1/1=1	Full Heading Date 1/1=1	Full Flower Date 1/1=1
Winter (180 lb/a N)					
FT 87788	105.3	600.2	---	172	178
FT 91064	116.6	664.6	---	177	182
M94-? (Salmon)	96.9	552.3	---	166	173
M94-1025	94.0	535.8	---	167	174
M94-93	105.7	602.5	---	166	173
M94-92	100.2	571.1	---	166	173
M94-1114	95.2	542.6	---	168	171
M94-1115	93.9	535.2	---	172	171
M94-1113	88.0	501.6	---	166	174
(3) 1-62 H1031	104.4	595.1	---	171	176
(14) 1-63 H1037*	77.0	438.9	---	---	176
(6) 1-80 H1031	85.6	487.9	---	166	175
(4) 1-70 H1031	78.9	449.7	---	166	175
Newcale	91.3	520.4	---	155	169
Parma	125.8	717.1	---	174	180
Iceberg	112.6	641.8	---	174	180
M94-3163>3165	114.8	654.4	---	160	177
M94-2082	117.8	671.5	---	171	178
M94-2113	117.3	668.6	---	---	178
Winter wheat (0 N)	44.8	255.4	---	---	---
Spring (120 lb/a N)					
Grace	42.8	244.0	179	---	196
M94-4393	65.0	370.5	170	---	196
WA 7999-88 barley	45.9	261.6	176	---	---
Westford barley	---	---	178	---	---
Belford barley	---	---	174	---	---

*...FT 90462 h1001

ON-FARM RESPONSE OF HOODY WINTER HAY BARLEY
TO
NITROGEN FERTILIZER[1]

Mylen Bohle

Abstract

Hoody winter hay barley yield and quality response to nitrogen fertilizer was tested in 1994 on the R.L. Coats farm in Lone Pine, Oregon.

Introduction

Hoody winter barley was developed and released by Matt Kolding at Oregon State University's Hermiston Experiment Station. Hoody has performed well in small plot testing. It was decided to test Hoodys' hay yield and quality response to nitrogen fertilizer in a field situation.

Materials and Methods

A 135 acre field was planted with 120 pounds per acre of Hoody winter barley in the second week of October 1993. The field was irrigated by circle pivot as needed. Mint was the previous crop, and a soil test indicated that about 50 pounds of nitrogen was present in the top foot of soil. The plots were fertilized with a commercial applicator. Nitrogen rates were 0, 60, 100, and 120 pounds per acre. The demonstration was not replicated. The plots were harvested on June 20, 1994 at the soft dough stage. A 2.5 feet x 15 feet area was harvested with a Jari-Mower. Plot forage was weighed wet and recorded. One-pound sub samples were placed in plastic bags to retain harvest moisture, transported to the Central Oregon Agricultural Research Center (COARC), Powell Butte, Oregon, weighed and dried at 149 degrees Fahrenheit until there was no change in weight. The samples were reweighed and moisture determined. The wet weight was converted to yield in dry tons per acre. Quality was determined by a near infra-red analyzer at the Klamath Falls Experiment Station, Klamath Falls, Oregon. All information is presented on a dry matter basis.

Results and Discussion

The field, outside the plots, was fertilized with 120 pounds of nitrogen fertilizer and the cooperator estimated the yield at 7.9 air-dry tons per acre. Eighty percent of the field was

[1] **Acknowledgement:** Quality test funding and cooperation provided by Van Seney and Larry Carpenter, Ranch Managers of the R.L. Coats Ranch, is gratefully appreciated.

not lodged. The cooperator remarked that his swather needed to be in excellent mechanical condition in order to swath the field.

The results of the nitrogen fertilizer rate demonstration are presented in Tables 1-2. The high nitrogen rate yield in the demonstration was approximately the same as the field yield. The top two nitrogen rates had virtually the same plant nitrogen recovery at 190 lb/a. There was a trend for additional nitrogen to increase yield, lodging, and height. Measured quality variables showed mixed results. As nitrogen rates increased, protein increased up to 100 lb/a N and then decreased with the 120 lb/a rate. Acid detergent fiber (ADF), neutral detergent fiber (NDF) and relative feed value (RFV) tended to increase and total digestible nutrients (TDN) tended to decrease with additional nitrogen fertilizer. Hoody winter barley shows great potential as an alternative forage crop. Feeding of this forage mixed with alfalfa hay, in the cooperators feedlot, has all but eliminated the bloat problem they were having when feeding calves only alfalfa hay.

Table 1. Hoody winter barley hay yield, percent dry matter, percent moisture, height, lodging, and plant nitrogen recovery response to nitrogen fertilizer rates at the R.L. Coats Farm in Lone Pine, Oregon, 1994.

Nitrogen Rate lb/a	Yield t/a	Dry Matter %	Moisture %	Height in.	Lodging %	Plant Nitrogen Recovery lb/a
0	5.42	38.4	61.6	45	0	100.6
60	5.61	33.0	67.0	45	20	127.5
100	6.86	35.8	64.2	47	25	188.8
120	8.23	28.4	71.6	50	50	192.3

Table 2. Hoody winter barley hay protein, ADF, NDF, TDN, and RFV response to nitrogen fertilizer rates at the R.L. Coats Farm in Lone Pine, Oregon, 1994.

Nitrogen Rate lb/a	Protein %	ADF %	NDF %	TDN %	RFV
0	5.8	29.2	46.1	62.8	133.6
60	7.1	32.1	49.8	59.4	119.4
100	8.6	30.2	47.1	61.6	129.0
120	7.3	34.4	52.3	56.7	110.4

PLANTING METHOD, WEED CONTROL AND SEEDING RATE EFFECTS ON TWIN SOFT WHITE SPRING WHEAT

Mylen Bohle and Russ Karow

Abstract

A planting method x weed control x seeding rate trial with Twin soft white winter wheat was established at the Central Oregon Agricultural Research Center (COARC), Powell Butte, Oregon. The objective was to test if higher seeding rates and/or different methods of planting could decrease the need for herbicides. Grain yield, test weight, height, lodging, and grain nitrogen uptake were all significantly higher with the drill method of planting compared to broadcast and rotovate. Yield was not affected in any way by either weed control or seeding rate.

Introduction

Lower input agriculture and use of less chemical pesticides are of interest to many producers as society becomes more concerned about our environment and the food we eat. If less pesticides were used without a decrease in production, the producer would benefit economically. This trial was conducted to determine if seeding rate and/or planting method have any affect on weed control, yield, and quality of soft white spring wheat. If by increasing seeding rate and/or narrowing the space between rows, wheat can out-compete the weeds, then producers could obtain good-to-excellent weed control without the application of herbicides.

Materials and Methods

Twin soft white spring wheat was planted on April 13, 1990 at the COARC, Powell Butte, Oregon. The design was a three-factor factorial in a randomized block with four replications, three factors - seeding rates, planting methods, and weed control. Seeding rates were 30, 45, and 60 seeds per square foot (97, 145, and 194 lb/a, respectively), planting methods were planting with a cone-type plot drill with six rows and eight-inch row spacing, and broadcast seeding by hand, followed by rotovating. Weed control was two pints of Bronate and one pint of surfactant per acre applied on June 5 and hand weeding on June 13, or no weed control. The plots were fertilized with 80 lb/a of nitrogen (ammonium nitrate source), and 60 lb/a of sulfur (gypsum source). The first irrigation was on May 5 and the last irrigation occurred on August 4. The plots were 5 feet x 20 feet with an area of 5 feet x 15 feet harvested with a Hege plot combine on September 6. Yield, test weight, height, lodging, and grain N uptake data were collected or calculated. The percent protein was analyzed with near infra-red reflectance spectroscopy (NIRS) by the OSU Crop and Soil Science Department at Corvallis. Data are presented on an air dry moisture basis.

Results and Discussion

Yield, test weight, height, lodging and grain N uptake were increased by 21.8 bu/a, 0.3 lb/bu, 2 inches, 10 percent, and 22 lb/a, respectively, by drilling compared to broadcasting and rotovating (Table 1.).

Table 1. Planting method effect on the yield, test weight, protein, height, lodging, and grain nitrogen uptake on Twin soft white spring wheat planted at the COARC, Powell Butte, Oregon in 1990.

Planting Method	Yield bu/a	Test Weight lb/bu	Protein %	Height In.	Lodging %	Grain N Uptake Lb/a
Drilled	83.7	55.6	10.6	39	14	93.3
Broadcast	61.9	55.3	10.9	37	4	71.3
Mean	72.8	55.5	10.8	38	9	82.3
PLSD .10	S	S	NS	S	S	S
PLSD .05	S	S	NS	S	NS	S
CV%	13.2	0.9	7.4	5.1	219.7	15.5

There was no advantage to higher seeding rates, or weed control, as individual treatments, on yield, height, and grain N uptake (Table 2). Test weight was increased by utilizing weed control (55.6 lb/bu vs. 55.3 lb/bu, Probability = .03), but seeding rate did not affect it.

Protein content and lodging were affected by a seeding rate and weed control interaction (Table 2). Without weed control, the 60 seeds per square foot seeding rate protein content was significantly lower than the 30 and 45 seeds per square foot seeding rate. The high seeding rate, with weed control, had a significantly higher protein content than the same seeding rate, with no weed control.

There was a trend for increased lodging as the seeding rate increased, when weed control was used, the reverse trend was seen when weed control was not used. There was a trend for higher protein content as lodging increased. The CV's for lodging were very high and reveal a lot of variability in the treatment plots.

Individual treatment means and statistical data are presented in Table 3.

Table 2. Weed control (WC) x seeding rate (SR) effect on the percent protein and percent lodging of Twin soft white spring wheat planted at the COARC, Powell Butte, Oregon in 1990.

Treatment WC	Treatment SR	Protein %	Lodging %
+	30	10.8	4
+	45	10.4	0
+	60	11.0	16
-	30	11.2	22
-	45	10.9	10
-	60	10.2	1
Mean		10.7	9
PLSD.10		0.7	16.3
PLSD.05		0.8	19.6
CV%		7.4	219.7

WC: + = weed control, - = no weed control; SR = 30, 45, and 60 seeds per square foot

Table 3. Planting method (PM) x weed control (WC) x seeding rate (SR) effects on the grain yield, test weight, protein, height, lodging and grain N uptake of Twin soft white spring wheat planted at the COARC, Powell Butte, Oregon in 1990.

Treatments PM	WC	SR	Grain Yield bu/a	Test Weight lb/bu	Protein %	Height in.	Lodging %	Grain N Uptake lb/a
D	+	30	88.6	56.0	10.7	39.3	6	99.7
D	+	45	83.5	55.9	10.0	39.0	0	87.7
D	+	60	83.4	55.8	10.8	39.5	19	94.1
D	-	30	77.3	55.1	11.0	38.5	34	89.7
D	-	45	87.4	55.4	10.8	40.3	21	98.6
D	-	60	81.9	55.7	10.4	37.5	1	89.9
B	+	30	58.7	55.4	11.0	36.8	1	68.5
B	+	45	58.3	55.3	10.8	37.8	0	66.2
B	+	60	65.9	55.4	11.2	37.8	13	78.3
B	-	30	60.5	55.1	11.5	37.3	10	73.5
B	-	45	63.9	55.4	11.0	37.0	0	74.1
B	-	60	64.1	55.0	10.0	38.3	0	67.4
Mean			72.8	55.5	10.7	38.3	9	82.3
Probability								
PM			.001	.011	NS	.009	.093	.001
WC			NS	.030	NS	NS	NS	NS
PM x WC			NS	NS	NS	NS	NS	NS
SR			NS	NS	NS	NS	NS	NS
PM x SR			NS	NS	NS	NS	NS	NS
WC x SR			NS	NS	.048	NS	.050	NS
PM x WC x SR			NS	NS	NS	NS	NS	NS
CV%			13.2	0.9	7.4	5.1	219.7	15.5

D= drill, B = broadcast and rotovate; + = weed control applied, - = no weed control; SR = 30, 45, and 60 seeds per square foot. NS = not significant.

CELIA WINTER TRITICALE AND STEPHENS SOFT WHITE WINTER WHEAT RESPONSE TO NITROGEN FERTILIZER

Mylen Bohle, Russ Karow, Helle Ruddenklau and Steve James

Abstract

Celia winter triticale and Stephens soft white winter wheat response to nitrogen fertilizer rates was tested at the Central Oregon Agricultural Research Center (COARC) at Madras, Oregon. The site chosen for the trial had higher nitrogen supplying ability than anticipated. The check had the highest yield, statistically, and there was no advantage to higher nitrogen fertilizer rates. Celia significantly outyielded and had better lodging resistance with 118.2 bu/a and 34 percent lodging, compared to Stephen's yield of 87.6 bu/a and 100 percent lodging. Heavy lodging was caused by a July thunderstorm. Lodging lowered test weights. Protein content was increased with additional nitrogen, which was advantageous for Celia. Stephens protein content, with no nitrogen fertilizer, was already higher than the current market demands.

Introduction

More acreage is devoted to soft white winter wheat in central Oregon than any other cereal grain crop. Winter triticale is a "new" feed grain crop with high yield potential. Interest in triticale is growing for both grain and forage purposes. The grain is excellent for livestock feed, especially in swine and poultry rations. Stephens is a soft white winter wheat that has been grown extensively, and Celia is a recently released OSU winter triticale variety for grain with superior test weight compared to other triticale varieties. A nitrogen fertilizer rate trial was initiated to compare yield, quality, and agronomic response by Celia and Stephens. The information will allow better production practice decision making.

Materials and Methods

Celia winter triticale and Stephens soft white winter wheat were planted on October 7, 1994, at 30 seeds per square foot with a plot cone-type planter. The design was a randomized complete block, two factorial design with three replications. Row spacing was 8 inches and plot size was 5 feet x 20 feet. The soil sample was taken to bedrock in early March of 1995. The soil analysis was performed by Agri-Check, and soil test results are in Table 1. It was assumed that 20 pounds of nitrogen had been taken up by the plants. The plots were individually fertilized by hand with 40 pounds of sulfur (gypsum source), and 0, 40, 80, 120, and 160 pounds of nitrogen per acre (ammonium nitrate nitrogen fertilizer) on March 27, 1995. Irrigation was with solid set sprinkler lines and was applied as needed. Weeds were controlled with an application of Bronate (2 pints/a) and surfactant (1 pint/a) on March 27, 1995. Heading dates (50 percent heading), plant height, and lodging scores were recorded prior to harvest. Seventy-five square feet were harvested in mid-September, 1995. Grain was cleaned, test weights, and 1,000 kernel weights measured, and protein contents determined with a whole grain infra-red analyzer by the state-wide cereal variety testing team in Corvallis. Grain nitrogen recovery, grain protein yield, seeds per pound, and future seeding rates were calculated. The MSTAT statistical program was used to analyze the data. Protected least significant differences (PLSD's) are used in the mean separations. The grain yield, test weight, protein content, grain nitrogen uptake, and grain protein yield data are presented on a 10 percent, 10 percent, 12 percent, 11 percent and 11 percent moisture basis, respectively. Grain yield is presented on a 60 pound bushel basis.

Results and Discussion

Two factors greatly influenced the trial results - the nitrogen supplying power of the soil and the July thunderstorm. All of the measured variables were affected to varying degrees. The results for grain yield, protein content, test weight, height, lodging, and Julian heading date are presented in Table 2. Results for grain nitrogen uptake, grain protein yield, 1,000 kernel weight, seeds per pound, and future seeding rates are presented in Table 3.

Celia winter triticale significantly outyielded Stephens soft white winter wheat 118.2 bu/a to 87.6 bu/a. Nitrogen fertilizer rates had no statistically significant effect on grain yield, height, lodging, Julian heading date, 1,000 kernel weight, seeds per pound, and future seeding rate. There was a definite trend to decrease grain yield and significantly decrease test weight with increasing nitrogen fertilizer rates. Protein content increased significantly with higher nitrogen rates. Stephens protein content was already too high for current soft white wheat market standards with no additional fertilizer. Celia benefitted from the higher fertilizer rates with higher protein content, which would be beneficial for use as a livestock feed.

Stephens lodged at 100 percent (at every nitrogen rate), which was significantly higher than Celia which only lodged at 33 percent. There was a trend for Celia to lodge more as nitrogen rates increased, but with only 53 percent lodging at the highest nitrogen fertilizer rate. Celia straw strength and lodging resistance was superior to Stephens.

Celia had significantly greater grain nitrogen uptake and grain protein yield than did Stephens. Statistically, traits for both Celia and Stephens were at their highest level with no nitrogen fertilizer. Additional nitrogen fertilizer significantly decreased grain nitrogen uptake and grain protein yield. The trends were different, though, for the two varieties. Celia maintained the level, but Stephens decreased with higher rates of nitrogen. Heavy lodging affected the plants.

Though not significant, Celia's 1,000 kernel weight decreased from 42.2 to 33.2 grams, while Stephens only decreased from 38.4 to 37.0 grams with increasing nitrogen fertilizer rates.

The trial will be repeated in the 1995-1996 crop year.

Table 1. Soil test results taken at the COARC, Madras, Oregon in March of 1995.

Soil Depth inches	pH	P_2O_5 ppm	K_2O ppm	NO_3 lb/a	NH_4 lb/a
0 -12	8.0	81	784	35	28
12-24	8.1	136	1070	176	21

Table 2. Celia winter triticale and Stephens soft white winter wheat yield, protein content, test weight, height, lodging, and Julian heading date response to nitrogen fertilizer at COARC, Madras, Oregon in 1995.

Treatment	Yield bu/a	Protein %	Test Weight lb/bu	Height in.	Lodging %	Julian Heading Date 1/1=1
Variety						
Stephens	87.6	12.6	51.5	41.2	100	159.6
Celia	118.2	12.1	52.8	41.0	34	162.1
N Rate lb/a						
0	112.1	12.2	53.5	42.0	58	160.2
40	101.3	12.1	52.3	41.3	67	160.3
80	107.1	12.0	53.9	40.5	67	160.8
120	93.7	12.6	50.7	40.8	67	162.2
160	100.1	12.7	50.2	40.8	76	160.7
Variety x N Rate						
Stephens						
0	103.9	12.6	52.6	42.3	100	158.3
40	84.2	12.6	51.4	40.7	100	158.7
80	88.0	12.3	53.5	41.0	100	159.0
120	76.2	12.7	50.5	41.7	100	161.3
160	85.6	12.8	49.4	40.3	100	160.7
Celia						
0	120.3	11.9	54.3	41.7	17	162.0
40	118.4	11.6	53.3	42.0	33	162.0
80	126.2	11.7	54.3	40.0	33	162.7
120	111.2	12.5	50.9	40.0	33	163.0
160	114.7	12.7	51.0	41.3	53	160.7
Mean	102.9	12.3	52.1	41.1	67	160.8
Variety						
PLSD .10	S	S	S	NS	S	S
PLSD .05	S	S	NS	NS	S	S
N Rate						
PLSD .10	NS	0.5	2.1	NS	NS	NS
PLSD .05	NS	NS	2.6	NS	NS	NS
Variety x N Rate						
PLSD .10	NS	NS	NS	NS	NS	NS
PLSD .05	NS	NS	NS	NS	NS	NS
CV%	11.9	3.8	4.1	4.7	34.1	1.5

Table 3. Celia winter triticale and Stephens soft white winter wheat grain N uptake, grain protein yield, 1,000 kernel weight, seeds per pound, and future seeding rate response to nitrogen fertilizer at COARC, Madras Oregon in 1995.

Treatment	Grain N Uptake lb/a	Grain Protein Yield lb/a	1000 Kernel Weight g	Seeds Per Pound	Future Seeding Rate lb/a
Variety					
Stephens	115.8	660.1	37.3	12,315	107.4
Celia	149.4	851.8	38.4	12,006	110.7
N Rate lb/a					
0	143.9	820.3	40.3	11,297	116.0
40	126.8	722.3	37.7	12,336	108.5
80	134.7	768.0	38.5	11,849	110.8
120	123.9	706.3	37.8	12,226	109.0
160	133.8	762.8	35.1	13,095	101.0
Variety x N Rate					
Stephens					
0	137.4	783.7	38.4	11,836	110.5
40	111.1	633.0	35.0	13,121	100.7
80	114.2	650.7	38.6	11,857	111.1
120	101.8	580.3	37.5	12,287	108.1
160	114.6	653.0	37.0	12,474	106.5
Celia					
0	150.4	857.0	42.2	10,758	121.4
40	142.4	811.7	40.4	11,550	116.3
80	155.3	885.3	38.4	11,842	110.5
120	146.0	832.3	38.1	12,164	109.8
160	153.1	872.7	33.2	13,717	95.5
Mean	132.6	756.0	37.9	12,161	109.0
Variety					
PLSD .10	S	S	NS	NS	NS
PLSD .05	NS	S	NS	NS	NS
N Rate					
PLSD .10	12.9	73.6	NS	NS	NS
PLSD .05	NS	NS	NS	NS	NS
Variety x N Rate					
PLSD .10	NS	NS	NS	NS	NS
PLSD .05	NS	NS	NS	NS	NS
CV%	9.7	9.7	12.9	13.3	12.9

SEEDLING ALFALFA WEED CONTROL TRIALS IN 1991 and 1992[1]

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Abstract

Three seedling alfalfa herbicide trials were conducted in central Oregon in 1991 and 1992. The locations were the Paul Kasberger farm in Lone Pine, the Mike McCabe Farm in Prineville, and the Central Oregon Agricultural Research Center (COARC), in Powell Butte, Oregon. Different herbicides for seedling alfalfa were tested. Six herbicides were evaluated for seedling alfalfa weed control. Herbicides evaluated were 2,4-DB, Buctril, Basagran, Tough, Pursuit, and Sencor. Percent control of selected weeds, as well as some forage yield and quality information was documented.

Introduction

Many acres of alfalfa are planted in central Oregon each year. Weeds can greatly damage alfalfa plant stands, sometimes even causing complete stand establishment failure. Herbicides reduce weed competition and may allow a weed-free first harvest. This may be beneficial for marketing the hay product. Sometimes there may be no difference in quality, depending upon the weed species present. These trials were conducted to evaluate the effect of six herbicides and combinations of herbicides on seedling alfalfa and weeds.

Materials and Methods

Mike McCabe Farm: The alfalfa field was planted the first week of September 1991. The herbicides and rates used were 2,4-DB (1.0 lb a.i./a), Buctril (0.375 lb a.i./a), Basagran (1.0 lb a.i./a), Tough (0.9 lb a.i./a), Pursuit (0.0625 lb a.i./a), Pursuit plus Buctril (same rates as above), Pursuit plus Tough (same rates as above), and 2,4-DB plus Buctril (0.75 lb a.i./a and 0.25 lb a.i./a). Poast (0.28 lb a.i./a) was applied to all plots. X-77 (0.5 percent of carrier) was used as a surfactant. The herbicides were applied on October 18, 1991. Alfalfa was in the two to four trifoliate leaf stage. The experimental design was a randomized complete block with three replications. Plot size was 6 feet x 20 feet. A CO^2 backpack sprayer with a six-foot boom was used to apply the herbicides. Thirty-seven gallons of water per acre was the carrier. Weeds present were volunteer winter wheat (3 to 6 inches in height), and lambsquarters, nightshade, and wild buckwheat (0.5 inch to 1.5 inches in diameter). The trial was resprayed with Poast, at the same rate, in early spring. The plots

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[1]Acknowledgement: Cooperation by Mike McCabe and Paul Kasberger is gratefully appreciated.

were evaluated in outside the sprayed trial and from within the trial area. Percent weed control was visually appraised in May 1992. Samples of 0.25 m^2 were harvested with a hand sickle.

COARC: The field was planted to the alfalfa variety Ultra, on September 9, 1991. The herbicides and rates applied were the same as at the McCabe farm. The herbicides were applied on October 3, 1991, when the alfalfa was in the one to two trifoliate leaf stage. The weeds present were lambsquarters, redroot pigweed, groundsel, and winter rape (0.5 inch to 2 inches in diameter). Poast (0.28 lb a.i./a) was also applied to the trial, including the check. Other methods were the same as utilized at the McCabe Farm. The plots were evaluated in May 1992. The area harvested was 3.5 feet by 15 feet, using a forage plot harvester. One pound samples were taken for moisture determination, weighed, dried at 149 degrees Fahrenheit, and reweighed. Yields are presented on a dry matter basis. Harvest dates were May 28, July 14, and September 9, 1992.

Paul Kasberger Farm: The alfalfa field was planted in early June 1992. Herbicides and rates applied were Sencor (1x) (0.125 lb a.i./a) and (1.5x) (0.187 lb a.i./a), Buctril (1x) (0.125 lb a.i./a) and (2.0x) (0.25 lb a.i./a), Pursuit (1x) (0.63 lb a.i./a) and (1.5x) (0.94 lb a.i./a), 2,4-DB (1.0 lb a.i./a), and Sunit II (1 pt./a). Herbicides were applied on July 10, 1992 with an 8 foot boom, CO^2 backpack sprayer. The plot size was 8 foot x 25 feet. The alfalfa was in the eight to 16 trifoliate leaf stage, up to 1 foot tall. Weeds present were redroot pigweed (6 to 24 inches tall), lambsquarters (6 to 24 inches tall), nightshade, smartweed, wild buckwheat, witchgrass, and common mallow. Other methods were as reported for the other locations. The plots were evaluated in August 1992.

Results and Discussion

McCabe Farm: There was no difference in weed control for broadleaf weeds due to the volunteer winter wheat competition. The second application of Poast controlled the volunteer winter wheat. The total yield, both winter wheat and alfalfa, sampled from an area outside the trial area, was twice the weight as alfalfa (no weeds) in the treated plots. Poast had better effectiveness when spring applied.

COARC: The percent weed control and total dry matter hay yield data are presented in Tables 1-2. None of the herbicides controlled groundsel. 2,4-DB, Pursuit, Pursuit plus Buctril, Pursuit plus Tough, and 2,4-DB plus Buctril all controlled winter rape from 93 to 100 percent. Buctril gave moderate control, while Basagran and Tough were ineffective. For shepherdspurse control, Buctril, Pursuit, Pursuit plus Buctril, Pursuit plus Tough, and 2,4-DB plus Buctril, and 2,4-DB, all had 82 to 98 percent control. Basagran had low to moderate control and Tough had moderate control.

There were significant total dry matter yield differences between treatments on the first and third cuttings. The check had the highest total dry matter yield in the first cutting, which was significantly higher than all the herbicide treatments except for the 2,4-DB plus Buctril treatment. The weed control treatments that reduced yield were Pursuit plus Buctril and

Pursuit plus Tough. Both combinations had excellent weed control, but it appears that the alfalfa was stunted.

There was no difference among the treatments in total dry matter yield on the second cutting.

Interestingly, the two highest yielding treatments on the first cutting, the check and 2,4-DB plus Buctril, were the lowest yielding treatments on the third cutting. 2,4-DB was significantly higher yielding than Buctril, the check, Pursuit plus Buctril, and 2,4-DB plus Buctril. For the year, (for all three cuttings), there was no significant difference in total dry matter yield.

Table 1. Percent weed control by herbicides on selected weeds in seedling alfalfa at the COARC, Powell Butte, Oregon in 1992.

	Shepherdspurse %	Groundsel %	Winter Rape %
Check	0	0	0
2,4-DB	82	0	93
Buctril	96	0	68
Basagran	57	0	48
Tough	70	0	18
Pursuit	88	0	100
Pursuit + Buctril	97	0	97
Pursuit + Tough	98	0	100
2,4-DB + Buctril	93	0	100
Mean	76	0	69
PLSD (.10)	26.6	NS	29.6
PLSD (.05)	36.0	NS	49.6
CV%	14.7	0	29.9

Table 2. First year total dry matter yield response to selected herbicides applied at seedling stage at COARC Powell Butte in 1992.

Herbicide	Cut 1 Yield t/a	Cut 1 Moisture %	Cut 2 Yield t/a	Cut 2 Moisture %	Cut 3 Yield t/a	Cut 3 Moisture %	Total Yield t/a
Check	3.31	75.6	2.16	80.5	1.97	78.8	7.44
2,4-DB	2.93	76.5	2.11	82.1	2.34	77.3	7.38
Buctril	2.82	76.1	2.11	81.5	2.07	78.5	7.00
Basagran	2.99	76.8	2.15	80.7	2.10	79.3	7.24
Tough	2.96	78.9	2.23	80.7	2.31	78.5	7.50
Pursuit	2.87	77.1	2.23	80.8	2.28	78.8	7.38
Pursuit + Buctril	2.62	77.1	2.23	81.0	2.03	78.0	6.88
Pursuit + Tough	2.66	76.0	2.20	82.3	2.25	77.8	7.11
2,4-DB + Buctril	3.07	75.6	2.21	82.0	1.85	78.2	7.13
Mean	2.91	76.6	2.17	81.3	2.13	78.4	7.22
PLSD (.10)	0.29	NS	NS	NS	0.27	NS	NS
PLSD (.05)	0.35	NS	NS	NS	NS	NS	NS
CV%	7.0	2.7	6.6	1.7	8.8	1.2	4.8

Paul Kasberger Farm: The data presented in Table 3 indicates percent stunting with some control, because of the advanced development stage of the weeds. The application of herbicides to this trial was delayed because of weather, and work schedules. The alfalfa and weeds were well beyond the herbicides' labeled growth stage for controlling weeds. Nonetheless, the applications were made to measure the effects of late applications on weeds and alfalfa.

Sencor (1x), Sencor (1.5x), Sencor (1x) + Buctril (1x), and Sencor (1.5x) plus Buctril (1.5x), all stunted alfalfa from 5 to 35 percent. The remaining treatments did not stunt alfalfa. The Sencor with Buctril combinations (highest alfalfa stunting) had the best control (stunting) of lambsquarters and redroot pigweed. The Pursuit plus Sunit II combinations stunted nightshade appreciably. These treatments also stunted lambsquarters and redroot pigweed moderately. None of the treatments had acceptable levels of control. All of these treatments were applied later than the label legally allows.

Table 3. Late herbicide application stunting effect on selected weeds and establishing alfalfa at the Paul Kasberger Farm, Lone Pine, Oregon in 1992.

Herbicide Treatment	Lambsquarters %	Nightshade %	Pigweed %	Alfalfa %
Sencor (1X)	5.0	0.0	26.7	5.0
Sencor (1.5X)	6.7	0.0	8.3	10.0
Sencor (1X) + Buctril (1X)	60.0	3.3	30.0	26.7
Sencor (1.5X) + Buctril (1.5X)	73.3	6.7	46.7	35.0
Buctril (1X)	5.0	6.7	5.0	0.0
Buctril (2X)	36.7	6.7	23.3	0.0
Pursuit (1X) + Sunit II	46.7	25.0	45.0	0.0
Pursuit (1.5X) + Sunit II	53.3	40.0	46.7	0.0
2,4-DB (1X)	5.0	3.3	6.7	0.0
Check	0.0	0.0	0.0	0.0
Mean	29.2	9.2	23.8	7.7
PLSD (.10)	14.1	12.8	23.8	6.2
PLSD (.05)	17.1	15.5	28.8	7.5
PLSD (.01)	23.4	21.2	39.5	10.3
CV%	34.1	98.3	70.6	57.1

A FARM-LEVEL ECONOMIC ANALYSIS PARTICIPATION IN WATER MARKETS BY COMMERCIAL FARMERS IN CENTRAL OREGON

Brenda Turner

Abstract

Low flows due to irrigation diversions in the Deschutes River of central Oregon impact water quality between Bend, Oregon and Lake Billy Chinook. The development of a water market to reallocate water among irrigators and instream uses is one alternative to help alleviate this problem. Important questions include how much water could be supplied, the price irrigators would demand, and how irrigators could change their on-farm operations to free water for transfer. This research addressed these issues in relation to commercial agriculture (usually full-time) operations in the North Unit Irrigation District and Central Oregon Irrigation District. On-farm practices considered included fallowing land, adopting water-conserving irrigation technologies, changing crop rotations, deficit irrigation, and involvement in Oregon's water conservation program. Water supply curves indicating the quantity of water irrigators would be willing to supply to a lease market at various lease prices were generated assuming expected and alternative water availability levels. Results were compared to the cost-effectiveness of lining and piping the district canals that supply these districts. Results indicated that all on-farm alternatives considered were utilized to make water available for lease on the representative, profit maximizing farm in each district. However, the results depended on the market price for water and the annual water availability. Canal lining was generally a more cost-effective means of providing water to enhance flows in the middle Deschutes River than purchasing water directly from irrigators.

Introduction

A recent study of the upper Deschutes River quality revealed that temperature and pH levels were high during summer months. Poor water quality is believed to be the result of low river flows, high ambient air temperatures, lack of riparian vegetation, the existence of agricultural return flow, and excessive growth of aquatic vegetation during summer. Reservoir releases keep flows high for river portions above the city of Bend, which helps alleviate some of the problems on the Deschutes River. But beyond the irrigation district diversions in Bend, the reservoir releases are not enough to meet environmental needs of the middle Deschutes River. It is the area between Bend, Oregon and Lake Billy Chinook that typically experiences critically low flows during the irrigation season.

The development of a water market to reallocate water among irrigators and instream uses is one alternative to help alleviate the water quality problems. To research this water market, we assumed that water would be supplied by irrigators for instream use when it becomes more profitable to lease than retain the water for agricultural production. The 220 cubic feet per second (cfs) needed to raise the middle Deschutes River flow to the Department of Fish and Wildlife recommendation of 250 cfs is equal to about 79,200 acre-feet of water over the irrigation season. Water supplied by commercial agriculture through a water market could potentially meet this requirement. This study focused on water markets for commercial farm and ranch operations in the North Unit Irrigation District (NUID) and Central Oregon Irrigation District (COID), and instream water users.

Methods

Farm budget analysis and mathematical programming were used. Enterprise budgets were generated for major crops based on information from irrigators, local agribusinesses, and existing research. They outline the costs and returns of crop production for traditional and alternate irrigation management practices and technologies (those which demonstrate potential for water conservation and feasibility on major central Oregon crops).

The budgets formed the basis of the mathematical programming models. Several alternative management practices and technologies were considered for leasing water. Water could be freed either by 1) fallowing land with and without involvement in the government wheat program, 2) producing less water intensive crops, 3) conserving water by increasing production and(or) delivery efficiency, 4) deficit irrigation, or 5) complying with Oregon's allocation of the conserved water program. The conserved water program allows up to 75 percent of conserved water, water saved by adopting a conserving irrigation technology or practice, to be leased in addition to water tied to fallowed land. The remaining water permanently reverts to the state for instream flows.

The mathematical programming models were constructed based on the activities of a single hypothetical farm operating in each district. Farm-level leasing results were calculated based on a 300 acre hay producing farm in COID. These results are considered representative of the approximately 10,000 acres of full-time commercial farms located the district. Likewise, NUID results based on a 500 acre specialty seed crop farm are considered representative of the 50,000 acres of Deschutes River water rights in that district. Crops used to represent farm production on the NUID included carrot seed, garlic seed, peppermint, wheat, and bluegrass seed. The crop mix for COID commercial irrigators included alfalfa hay, grass hay, grain hay, pasture, and peppermint.

The models were used to determine the water management practices and crop rotations that would maximize profit, given various assumptions about water allotments. Water production functions were generated to show a direct relationship between irrigation levels and crop yield. Agrimet evapotranspiration estimates for the central Oregon region were used to represent crop water requirements necessary to achieve a maximum crop yield.

Three variations of each district model were constructed. The first assumed that the current irrigation technologies - sprinklers, furrow, flood, and center pivots - were used. This is the Base option. The second option, called Alltech, assumed that either the current or alternate water-conserving practices and technologies could be used. Both of these options required fallowing land to lease water. The last alternative assumed that irrigators could participate in the conserved water program (the Conserve option). This option eliminated the requirement that land must be fallowed to lease water.

The Alltech and Conserve options included six alternate practices selected for their water conservation potential. Employment of these alternatives was assumed to reduce the water application required to meet crop needs by reducing deep percolation and runoff. Though not widely implemented in central Oregon, these alternatives have been shown in previous research to conserve water with minimal yield impacts. The first water-conserving technology is alternate furrow irrigation. This system involves irrigating every other furrow throughout the season, resulting in water never flowing down half the furrows. When irrigating with alternating furrow, every other furrow is irrigated during an irrigation set; those furrows not irrigated in the current set are irrigated in the following set. Surge furrow involves use of an automated valve to apply water intermittently in surges. Center pivots distribute water through a linear overhead sprinkler system that rotates in a large circle. Variations of some of these irrigation schemes were also considered including the use of either gated pipe or syphon tubes and the development of pumpback systems for furrow irrigation techniques.

The last two basic alternatives are not irrigation technologies, but a means of improving the efficiency of existing irrigation systems. The first involves leveling fields to reduce the chance of uneven water distribution and the need to over-water parts of a field to gain a minimum application over the entire field. Gross irrigation applications can also be reduced by monitoring the soil water content and crop evapotranspiration to schedule irrigation sets. One means of monitoring soil water content involves placing soil probes in an irrigated field and using a meter to read the water content of the soil.

The models were solved for a $0 per acre foot lease price (assuming no water market), then re-solved with the water lease price increasing at $5 per acre foot increments. Varying the lease rate illustrated how irrigators might change their crop rotations and irrigation management in response to a range of lease prices if they were to maximize their profit.

Lining and piping irrigation district canals was also considered. Lining and piping would reduce deep percolation losses between the Deschutes River and the farm diversions. The Bureau of Reclamation has estimated the annualized cost of lining district canals and the potential water savings. The Bureau divided the canal systems into sections and estimated the cost-effectiveness of each canal segment. The results of the on-farm analysis were compared to the Bureau's cost and water savings estimates. When comparing these on-farm results to canal lining costs it must be noted that if canals are lined, payment for construction costs must be made regardless of the water availability whereas leasing water can be performed on a year-to-year basis.

Results

Results are presented in the form of water supply curves in Figures 1, 2, and 3, for low, average and above-average water years, respectively. A supply curve was generated for each of the lease options - Base, Alltech, and Conserve - at each level of water availability. The supply curves illustrate the estimated quantity of water that would be leased by commercial farmers in NUID and COID at various lease price levels, assuming that irrigators would intend to maximize their profits. At each $5 lease price increment, a particular profit maximizing crop rotation, irrigation technology, and irrigation water application combination was identified for each district. As the lease price increased, both NUID and COID production practices were altered to free water for the market while still maximizing profit. Garlic and carrot seed were produced in all options and water years while pasture production was never a profit maximizing activity in COID.

Low Water Year

The representative allotment for a low water year was one acre-foot for the North Unit and two acre-feet for COID. In general, Figure 1 illustrates that if irrigators are operating under the Base option, they would be more willing to lease their water than if they were to adopt water-conserving practices under the Alltech and Conserve options. This occurs because the Base technologies are generally more costly and always more water intensive than the alternate water-conserving practices. The results of the Base option show that fallowing land occurred with all lease prices.

NUID-only results with the Base option show that peppermint and wheat did not enter the profit maximizing rotation. Involvement in the government wheat program generated two sources of revenue; one from the program and the other through lease of the water tied to the fallowed program acreage. As water became more valuable in the lease market, bluegrass production ceased leaving only the high valued specialty seed crops in production at lease prices above $125 per acre foot. The results for the Alltech and Conserve options for NUID are identical because the profit maximizing set of activities did not include participation in the conservation program in a low water year. Wheat was produced at low water prices when water-conserving irrigation technologies were introduced but no mint production occurred. The wheat was deficit irrigated and the government wheat program was utilized. The dominant irrigation technology was surge furrow combined with irrigation scheduling.

Alfalfa, pasture, and grass hay never entered the crop mix for the COID-only Base option. Grain hay, peppermint, and fallow land made up the crop rotation. Crops were irrigated to their maximum yield with sprinklers. Most COID land was utilized for crop production at lease prices of $0 to $30 per acre foot. At $30, only 50 of the 300 acres produced crops, and at $90 per acre foot no crops were produced. The water conservation realized by using center pivot irrigation in the Alltech and Conserve options merited alfalfa production but not grass hay or pasture. Alfalfa was the first crop to drop out of production as lease price increased. The water-conserving center pivot system was used to irrigate grain hay and alfalfa. Participation in the conserved water program increased profits slightly for COID irrigators. At $95 per acre foot, all water in COID was leased for farmers to maximize their profits.

A canal-lining supply curve is also shown in Figure 1. This curve would be the cost to instream water buyers for water leased as a result of lining district canals if the water saved was leased at the cost needed to line the canals. In years when the irrigation district allotments are low, results indicate that irrigators were not very willing to give up their water unless canals could be lined. A quantity of only about 15,000 acre-feet (100 percent from COID) could be leased from irrigators operating with the baseline systems at a price slightly higher than the cost to line canals. Quantities greater than 15,000 acre-feet, however, would be obtained least expensively through canal lining.

Average Water Year

The per-acre allotments that were considered average in recent years were two acre-feet for NUID and three acre-feet for COID. The sum of the district supply curves for an average year is shown in Figure 2.

The results of the Base option show all crops entering the profit maximizing crop rotation except peppermint in NUID. Bluegrass, wheat, and garlic were deficit irrigated. With the exception of a mixture of sprinklers and furrow irrigation of carrot seed, every-furrow irrigation was the only irrigation technology utilized at lease prices below $65 per acre foot. Sprinklers were adopted for garlic and carrot seed at higher lease prices. The government wheat program entered the profit maximizing solutions. As lease price increased, deficit irrigation of bluegrass, garlic, and wheat continued. Wheat and bluegrass dropped out of the rotation at $110 per acre foot and $130 per acre foot respectively. The most profitable water-conserving irrigation technology was surge furrow with irrigation scheduling in both Alltech and Conserve. Model results for these options show peppermint production, no deficit irrigation, and no fallowing of land without leasing water.

Crops produced under the COID Base option included mint and grain hay. Pasture, grass hay, and alfalfa did not enter the rotations. Both crops produced were irrigated to reach maximum potential yield. Because only baseline practices were allowed in Base, and because the baseline irrigation systems for the crops produced used sprinklers, sprinkler irrigation was the only technology. When center pivots and irrigation scheduling were included in the irrigator's technology choice set (Alltech), the crop rotations included peppermint, grain hay, alfalfa, and grass hay. Center pivots were used to produce grass hay, alfalfa, and grain hay at low lease prices. Grass hay and alfalfa dropped from the rotation at $5 per acre foot and $40 per acre foot respectively. All water was leased at $85 per acre foot. The conservation program was utilized with an average allotment with center pivots as the conserving system. In an average water year the cost per acre-foot to lease water from commercial irrigators exceeded the cost per acre-foot of water saved by lining canals if greater than 25,000 acre feet of water was supplied to the market. If water availability was similar to that depicted here as an average water year in the long run, canal lining appears to be the most cost effective way to free water for instream use regardless of whether Alltech, Base or Conserve exists.

High Water Year

An above-average water year was depicted with a three acre-foot allotment for the NUID and a four acre-foot allotment for COID. The supply curves in Figure 3 are notably shifted down to the right indicating that more water was supplied to the lease market at lower prices. The 79,000 acre feet needed to meet the recommended minimum flow could be obtained at significantly lower prices in high water years. Generally the profit-maximizing activities in a high water year were similar to those in an average year. In both COID and NUID, all crops were produced at lower lease prices except pasture. The most marginal crops left the rotation first as in the low and average water year scenarios. Less efficient systems were utilized more because of the abundance of water. Fallowing land was not necessary to be able to apply adequate water to achieve maximum crop yields. Also, deficit irrigation was not practiced.

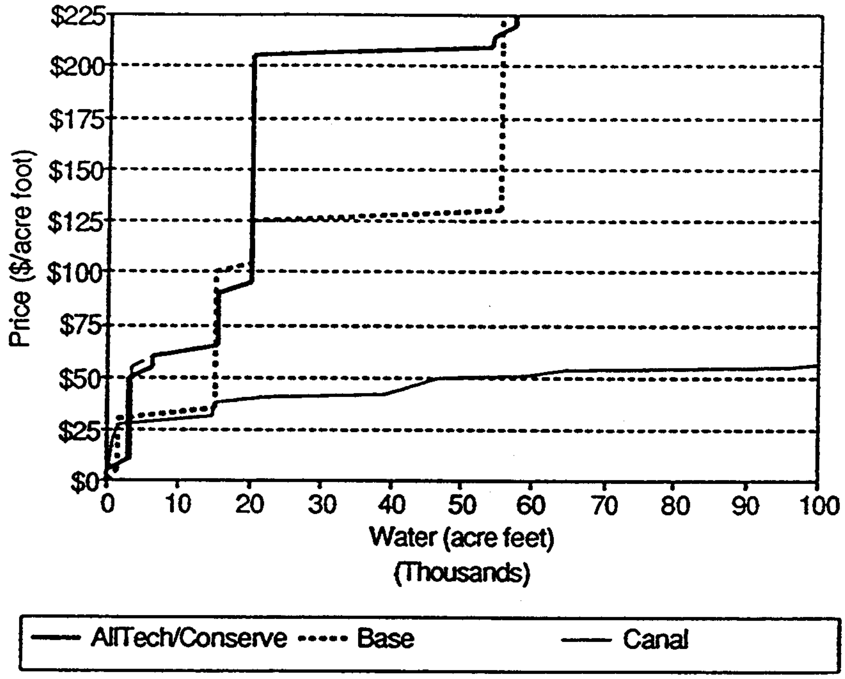

Figure 1. Total Estimated Water Supply in a Low Water Year from Commercial Agriculture in the North Unit Irrigation District and Central Oregon Irrigation District, Central Oregon, 1995.

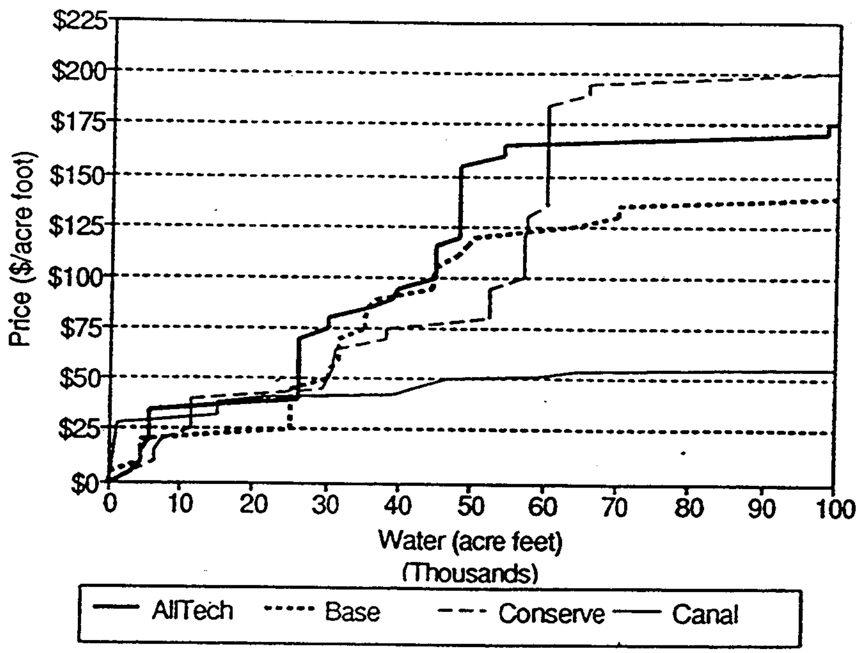

Figure 2. Total Estimated Water Supply in an Average Water Year from Commercial Agriculture in the North Unit Irrigation District and Central Oregon Irrigation District, Central Oregon, 1995.

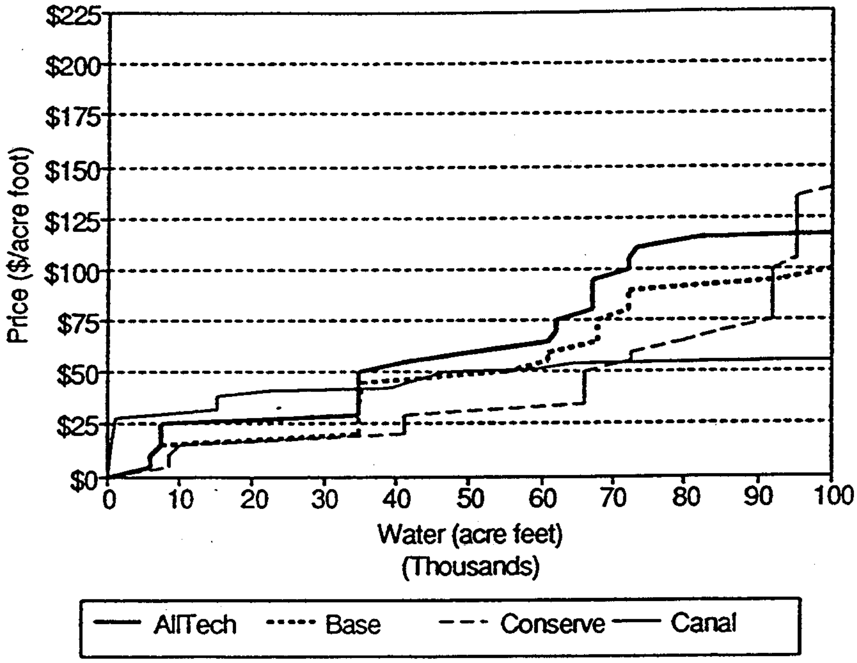

Figure 3. Total Estimated Water Supply in a High Water Year from Commercial Agriculture in the North Unit Irrigation District and Central Oregon Irrigation District, Central Oregon, 1995.

EVALUATION OF POST-HARVEST RESIDUE REMOVAL EQUIPMENT ON KENTUCKY BLUEGRASS GROWN FOR SEED IN CENTRAL OREGON

UPDATE

F. Crowe

Due to the untimely death during 1995 of Dale Coats, who had taken the lead in this long-term project, this report is incomplete and abbreviated. Thanks to Margie Durette, Neysa Farris, Scott Culver, George Mueller-Warrent, Pat Foltz, Peter Tomseth, Bill Durette, and others for assisting in completion of 1995 field work. A more complete report for 1995 may be produced during early 1996. A final report summarizing all 1990-1996 data from growers' fields should be available during 1997.

Post-harvest residue management methods were evaluated in a study initiated in 1991 on two commercial Kentucky bluegrass (*Poa pratensis L.*) fields in central Oregon, which had been planted in the fall of 1990. One field was planted with an aggressive variety and the other field with a non-aggressive variety. Aggressive varieties included those that were highly rhizominous and filled in between a 30 cm row spacing within a year or two. Non-aggressive varieties included those that were less rhizominous. Additional planting locations for both aggressive and non-aggressive types were added to the study each year through 1993 until a total of six locations were included. In each field, residue treatments were organized in a randomized block design with four replications. Because the standard industry practice for residue management of grass seed fields began with baling the straw prior to open-field burning, all residue management treatments in this study included this practice. Data gathered included seed yield, fertile tiller numbers, thousand seed weight, and seed germination. This study will continue through 1996.

On the COARC Madras field, paired plantings of a non-aggressive and an aggressive variety were established in 1992, 1993, and 1994. Randomized and replicated treatments of all residue management options used in the above growers' fields were also established in the on-station trial during 1993, 1994, and 1995, respectively. Treatments will be conducted for three successive seasons for each planting, and will be completed following harvest in 1998. Results from this trial will be merged into a final overall report on residue management in central Oregon in 1998 or 1999.

Water Use of Bluegrass Seed and Its Effect on Yield

Alan Mitchell, Stephen Griffith

Abstract

Bluegrass water stress was studied in a preliminary experiment with six irrigation levels. Biomass and seed yield were very responsive to water stress. Yield continued to increase for the highest irrigation treatment, and was attributed to lesser soil water tension in the final days after irrigation ceased. Bluegrass seed water use for 1995 was 12.6 inches, and was similar to the water use estimates from the Bureau of Reclamation's AgriMet weather network.

Introduction

Water allocation for agricultural use is a matter of increasing concern in the arid Northwest. Because high quality bluegrass seed is produced in arid regions on both irrigated and rain-fed land, it is important to document the crop water use of bluegrass to produce optimal seed yield. It is also important to investigate the relationship between yield and crop water use to better manage irrigation. This study was initiated as part of the USDA-CSREES project "Grass Seed Cropping Systems for a Sustainable Agriculture."

The overall objectives of the three-year study are:

a. Determine the crop water use of bluegrass seed for aggressive and nonaggressive cultivars, and for thermal and nonthermal residue management.

b. Determine the ET/yield relationship for bluegrass seed during the spring for aggressive and non-aggressive cultivars.

c. Measure water stress response in bluegrass for aggressive/non-aggressive cultivars through differences in tillering, plant water potential, dry matter, and seed yield.

d. Measure the soil nutrient status (P, K, C, and S), and the soil N and plant N uptake, and partitioning in the plant/soil system under different irrigation treatments.

To gain preliminary information about the yield response to water, we applied six irrigation treatments to an established stand of the bluegrass variety 'Wildwood' at COARC. This report will cover findings on soil moisture, yield, seed yield, and water use.

Methods

A line-source sprinkler experimental design (Hanks et al., 1976) was used to apply six different irrigation rates on an established stand of 'Wildwood' bluegrass at the COARC. The rates ranged from no irrigation (level 1) to the highest irrigation at level 6. Three replications were located at three corners of the 2-acre field. Fertilizer and herbicide were applied uniformly at standard rates. In April, prior to irrigation, soil samples were taken for water content. At the same time, Watermark soil moisture sensors were installed in each plot at depths of 4-6 inches, 10-12 inches, and 16-18 inches. Readings were taken thrice weekly until harvest. Irrigations were scheduled based on the measured soil water depletion of the fifth irrigation level. Irrigation was measured throughout the season for each plot with catch cans that were raised to the height of the grass canopy.

Harvest consisted of taking above-ground biomass, and seed yield. Biomass was taken on June 29 from three 1-ft^2 areas, and the samples were used to determine the number of fertile and nonfertile tillers. Seed yield was taken from a 1-m^2 area of each plot and thrashed at the USDA-National Forage Seed Production Research Center.

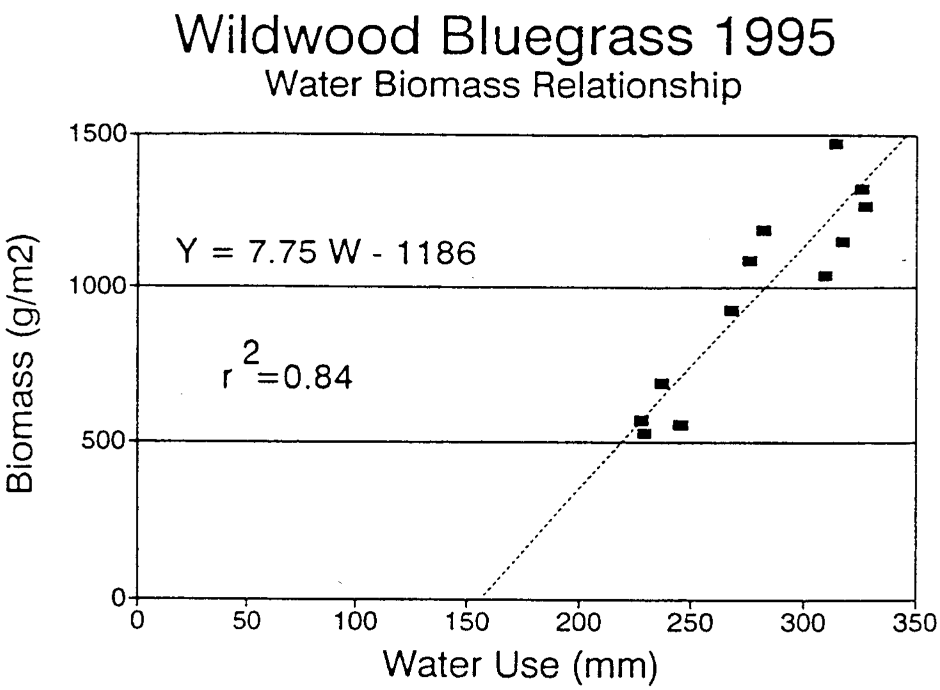

Figure 1. Biomass as a function of water use, Wildwood Bluegrass, Madras, Oregon, 1995.

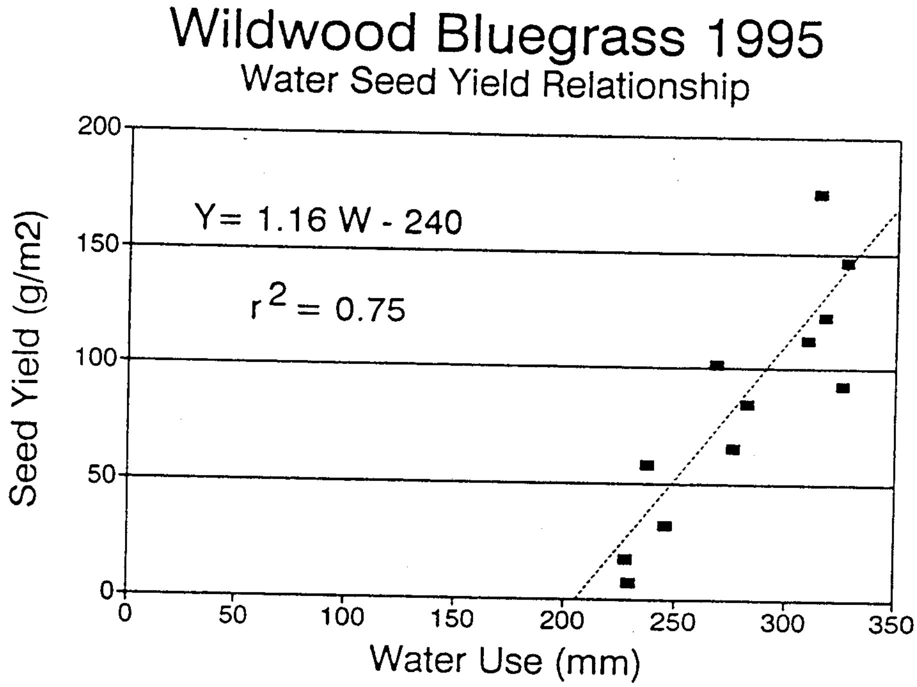

Figure 2. Seed yield as a function of water use, Wildwood Bluegrass, Madras, Oregon, 1995.

Results

One entire replicate was eliminated from the following analyses because it received overland flow of irrigation water from another location that compromised the integrity of the plot. The bluegrass biomass and seed yield responded to irrigation treatment at a highly significant level (Table 1). The harvest index, or ratio of seed yield to biomass, also responded to increasing irrigation treatment. There was no difference in yield components between irrigation treatments 3, 4, and 5 in spite of the differences in calculated water use. However, irrigation treatment 6 was significantly higher in seed yield and harvest index. This will be explained later.

Fertile and non-fertile tiller counts were not significantly different for the irrigation treatments (data not shown), however, the biomass of fertile tillers, when weighed separately, was significantly greater for higher irrigation treatments (Table 1).

The relationships between water use and yield are shown in Figure 1 for biomass and Figure 2 for seed yield. Linear regression was used to produce the equations listed on the graphs. The 1995 data at Madras showed that without irrigation, the 229 mm (9.0 inches) of precipitation plus soil water depletion can produce low levels of biomass, but not significant seed yield. The maximum water use of 321 mm (12.6 inches) produced an average seed yield of 161 g/m2 (1,436 lb/A). Any stress below the maximum resulted in a severe yield reduction. According to the linear relationship, a 1-inch change in water use results in an 195 lb/A change in seed yield!

There was a large yield response between irrigation levels 5 and 6 although there was little difference in water use (Table 1). The difference in soil matric potential can be observed in time in Figure 3, where the greater values indicate drier soil. There was no difference throughout May until after the last irrigation June 12. Rain on June 14 and 15 minimized the differences, but after June 21 there was a marked difference in soil water potential between the two treatments. These data suggest that the improved yield of the highest irrigation treatment may have resulted from less water stress in the final days of development.

Table 1. Water use, yield components, and TKN of Wildwood bluegrass seed by irrigation treatment, Madras, OR, 1995. Column values followed by the same letter are not significantly different at the 0.05 level using LSD tests.

Irrigation Treatment	Water Use[1]	Biomass	Seed Yield	Harvest Index	TKN	Fertile Tiller Biomass
	(mm)	(g/m2)	(g/m2)	(%)	(%)	(g/m2)
1	229	548 a	12 a	2.15	1.68 a	203 a
2	242	623 a	45 ab	7.05	1.16 bc	246 ab
3	272	1010 b	83 bc	8.42	1.14 bc	496 bc
4	300	1171 cb	103 c	8.81	0.99 c	607 c
5	318	1181 cb	102 c	8.84	1.06 c	731 c
6	321	1375 c	161 d	11.72	1.01 c	630 c
Significance		$P<0.01$	$P<0.01$	$P<0.10$	$P<0.01$	$P<0.05$

1. Water use is the sum of irrigation, precipitation, and change in soil water.

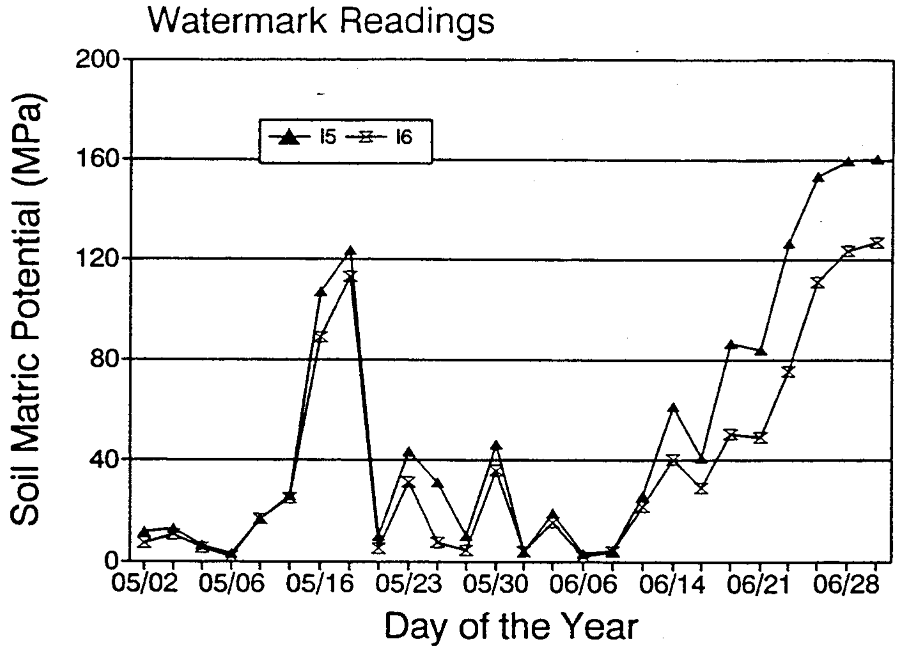

Figure 3. Soil water tension at the six-inch depth for irrigation treatments 5 and 6 of Wildwood Bluegrass, Madras, Oregon, 1995.

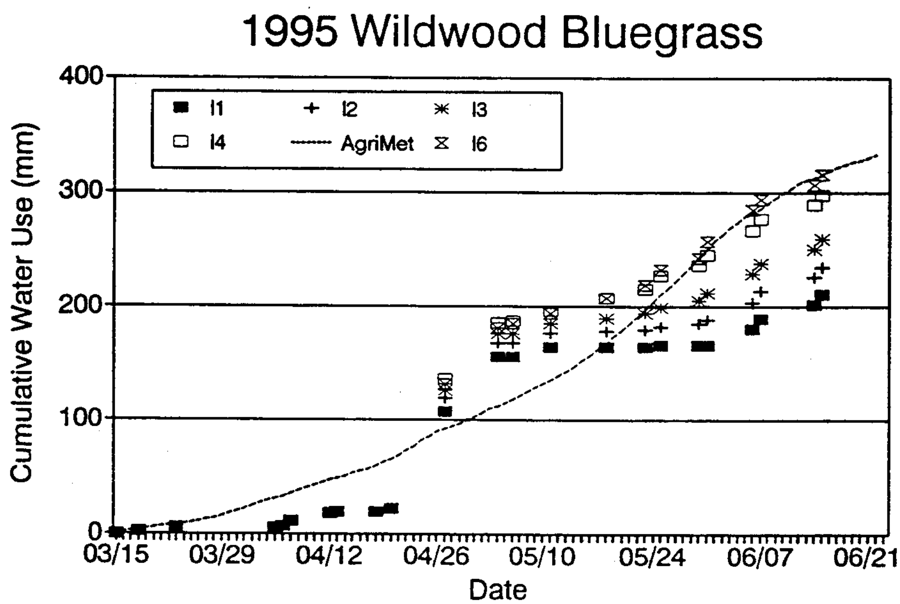

Figure 4. Cumulative water use of Wildwood Bluegrass compared to AgriMet estimates, Madras, Oregon, 1995.

The cumulative water use of 'Wildwood' bluegrass is shown in Figure 4 for all irrigation treatments. Also shown are the AgriMet estimates of bluegrass water use from a weather station within 400 m of the experimental field. The differences between estimates by AgriMet and treatment 6 in April and May are a result of the calculation of water use that included the soil water depletion as occurring during that time period. The virtually identical results at the end of the season show that AgriMet did a good job of estimating bluegrass water use.

Water use, or evapotranspiration (ET), estimates for bluegrass vary widely. Using central Oregon as an example, the most recent OSU publication on water use (Cuenca et al. 1992) listed the yearly median water use for grass seed as 35.9 inches, while the Bureau of Reclamation's AgriMet system (USBOR, 1995) calculated a seven-year average as 15.5 inches, and Watts et al. (1968) listed 5.95 inches (Figure 1). The 1995 AgriMet calculation was 14.9 inches. It appears that the AgriMet calculations was the best estimate of water use available.

Future research will concentrate on the water use and yield of aggressive and non-aggressive bluegrass. With the information from the 1995 experiment, we will be in a position to investigate irrigation in late June that appears to influence yield. We have already established an experimental plot of bluegrass cultivars Abbey and Bristol that are aggressive and non-aggressive, respectively. The experimental design was a double line-source sprinkler (Frenkel, et al., 1990) with room to conduct nested experiments on nitrogen fertility and residue removal. These factors will be tested in 1996, and 1997.

Acknowledgement

We appreciate the efforts of the late D. Dale Coats, our former friend and colleague, who inspired and encouraged this work. We also are grateful to Jessica Jacks and the USDA-NFSPRC staff for care in collecting and processing samples.

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EVALUATION OF HERBICIDES FOR CONTROL OF ROUGHSTALK BLUEGRASS IN KENTUCKY BLUEGRASS, 1994-1995

Marvin Butler, Jim Carroll, Tim Carpenter, Brett Dunn, and Mark Morlan

Abstract

Nine herbicides; terbacil (Sinbar, Dupont), ethofumesate (Nortron, AgrEvo), metribuzin (Lexone, Du Pont), fenoxaprop (Horizon, Hoechst), oxyfluorfen (Goal, Rhom and Haas), diuron, primisulfuron (Beacon, Ciba), dicamba (Banvel, Sandoz), and imazamethabenz (Assert, Cyanamid), were applied at two rates in a grid pattern to plots in three commercial Kentucky bluegrass (Poa pratensis) fields to evaluate crop injury, and three roughstalk bluegrass (Poa trivialis) fields to determine control of established and seedling plants. There were differences in cultivar response to herbicides for both Kentucky bluegrass and roughstalk bluegrass. Across cultivars, crop injury to Kentucky bluegrass was 20 percent for Assert applied at 1½ pt/a, and 18 percent for Sinbar at 1¼ lb/a. Sinbar at 1¼ lb/a provided 89 percent control of established roughstalk bluegrass plants across cultivars, while Sinbar plus Diuron combinations provided 79 to 83 percent control. Ninety-four percent of seedling roughstalk bluegrass, across cultivars, was controlled with Sinbar at 1¼ lb/a, and with Sinbar plus Diuron, control was 92 percent. Application of Horizon reduced seed set in Kentucky bluegrass up to 90 percent for `Merit', 60 percent for `Coventry', and 85 percent for `Unique'.

Introduction

Historically central Oregon has been an important Kentucky bluegrass seed production area. In recent years, however, roughstalk bluegrass production has increased, and currently accounts for over one-third of grass seed in grown in the area. Contamination of Kentucky bluegrass seed with roughstalk bluegrass has become an increasingly serious problem for the central Oregon grass seed industry. Evaluation of herbicides for control of roughstalk bluegrass in Kentucky bluegrass were initiated during the 1993-1994 season, and expanded during 1994-1995.

Methods and Materials

To evaluate herbicides for crop injury three trials were set up in three commercial Kentucky bluegrass fields with varieties `Merit', `Coventry', and `Unique'. To evaluate percent control of established and seedling plants of roughstalk bluegrass, three commercial fields of roughstalk bluegrass (`Saber', `Laser', and `Cypress') were used. Eight herbicides were fall-applied November 3 to the three roughstalk bluegrass fields, November 7 to fields of `Coventry' and `Unique', and November 22, 1995 to the `Merit' field. The ninth herbicide, Horizon, was applied to all locations March 25, 1995. Materials were applied at two rates in a grid pattern of 10 ft x 10 ft plots with 100 plots per location, using a CO2 pressurized, hand-held, boom sprayer at 40 psi and 20 gal/a of water. Spray Booster-S was applied at 1 qt/100 gal in combination with all herbicides. There was rain the evening of November 3, following application to the roughstalk bluegrass fields.

The `Saber' field was removed from production after evaluation March 17, 1995 for control of established and seedling roughstalk bluegrass plants. The other two roughstalk bluegrass fields were evaluated March 28, 1995. Evaluation of percent crop injury, based on reduction in plant biomass, was conducted on the Kentucky bluegrass fields March 29, 1995. Evaluation of the spring-applied Horizon plots was conducted May 10, 1995. Pre-harvest evaluations of percent reduction in seed set were conducted on June 9 and 12, 1995.

Results and Discussion

Crop Injury to Kentucky Bluegrass: The greatest injury to Kentucky bluegrass across cultivars resulted from Assert at 1½ pt/a (20 percent injury) and Sinbar at 1¼ lb/a (18 percent injury). Injury was also produced by Assert at 1½ pt/a (10 to 12 percent) in combination with other materials, and Beacon at 1 oz/a (10 percent). Cultivars `Coventry' and `Unique' appeared to be more sensitive to Beacon, while Merit showed increased injury from Sinbar, Nortron, and Banvel.

Evaluation of phytotoxicity on May 10 following the spring application of Horizon showed up to 30 percent damage to Kentucky bluegrass. Pre-harvest evaluation of seed set indicated reductions from Horizon in all three cultivars, up to 90 percent for `Merit', 60 percent for `Coventry', and 85 percent for `Unique'.

Established Roughstalk Bluegrass Control: The roughstalk bluegrass fields used to evaluate percent control show the greatest control with Sinbar at 1¼ lb/a (89 percent control), and Sinbar plus Diuron combinations (79 to 83 percent control). `Saber' was best controlled with combinations of Sinbar at ¾ lb/a (70-98 percent control), while `Laser' appeared to be more resistant with generally a lesser degree of control from either Sinbar at ¾ lb/a or Diuron at 2 lb/a. The best combination was Diuron plus Sinbar with 85 percent control. `Cypress' showed the greatest promise for control with Sinbar, Diuron, Assert, and Lexone in combination with other materials.

Evaluation of phytotoxicity May 10 following the spring application of Horizon showed some damage to roughstalk bluegrass. Injury up to 10 percent was observed at 1½ pt/a, with 15 to 20 percent injury at 2¼ pt/a for both `Laser' and `Cypress'.

Seedling Roughstalk Bluegrass Control: Across cultivars, seedling plants between the rows were best controlled with Sinbar at 1¼ lb/a (94 percent control) or a Sinbar plus Diuron combination (92 percent control). Sinbar in combination with Beacon or Goal provided 85 percent control, while Sinbar in combination with Lexone gave 80 percent control. As with established roughstalk plants, Sinbar at either rate, and Diuron at 2 lb/a provided the most consistent control across combinations. The only effective material on `Saber' was Sinbar, while Beacon and Diuron provided consistent control above 80 percent on `Laser' (except in combination with Banvel). Some control was also provided by Lexone and Sinbar. As with established plants, `Cypress' was the most sensitive cultivar for seedling control, with Sinbar, Diuron, and Lexone being the most effective materials.

Table 1. Percent control for selected fall-applied herbicides providing the best overall performance on established and seedling roughstalk bluegrass, and crop injury to Kentucky bluegrass, evaluated March, 1995 near Madras and Culver, Oregon.

Material and rate	Roughstalk bluegrass control		Injury to Kentucky bluegrass
	seedlings	established plants	
	------------ percent ------------		
Sinbar 0.5 lb + Sinbar 0.75 lb	94	89	18
Sinbar 0.5 lb + Diuron 2.0 lb	92	83	2
Diuron 1.0 lb + Sinbar 0.75 lb	92	79	3
Sinbar 0.5 lb + Beacon 0.75 oz	85	32	7
Goal 10 oz + Sinbar 0.75 lb	85	68	5
Sinbar 0.5 lb + Lexone 5 oz	80	50	0
Lexone 2 oz + Sinbar 0.75 lb	80	68	7
Assert 0.75 lb + Sinbar 0.75 lb	75	68	3

Table 2. Average percent crop injury to Kentucky bluegrass across 3 locations and varieties for the following herbicides applied alone, and in combination November, 1994 (except Horizon, March 25, 1995) to plots in commercial fields near Madras and Culver, Oregon.

Sinbar ½ lb 2	Sinbar ½ lb Assert 1½ pts 10	Sinbar ½ lb Banvel 5 pts 2	Sinbar ½ lb Beacon ¾ oz 7	Sinbar ½ lb Diuron 2 lbs 2	Sinbar ½ lb Goal 20 oz 0	Sinbar ½ lb Horizon 1½ pts 3	Sinbar ½ lb Lexone 5 oz 0	Sinbar ½ lb Nortron 2 pts 2	Sinbar ½ lb Sinbar ¾ lb 18
Nortron 1 pt 2	Nortron 1 pt Assert 1½ pts 10	Nortron 1 pt Banvel 5 pts 3	Nortron 1 pt Beacon ¾ oz 7	Nortron 1 pt Diuron 2 lbs 2	Nortron 1 pt Goal 20 oz 2	Nortron 1 pt Horizon 1½ pts 3	Nortron 1 pt Lexone 5 oz 0	Nortron 1 pt Nortron 2 pts 3	Nortron 1 pt Sinbar ¾ lb 2
Lexone 2 oz 2	Lexone 2 oz Assert 1½ pts 7	Lexone 2 oz Banvel 5 pts 2	Lexone 2 oz Beacon ¾ oz 3	Lexone 2 oz Diuron 2 lbs 2	Lexone 2 oz Goal 20 oz 0	Lexone 2 oz Horizon 1½ pts 0	Lexone 2 oz Lexone 5 oz 0	Lexone 2 oz Nortron 2 pts 3	Lexone 2 oz Sinbar ¾ lb 7
Horizon ¾ pt 3	Horizon ¾ pt Assert 1½ pts 12	Horizon ¾ pt Banvel 5 pts 7	Horizon ¾ pt Beacon ¾ oz 8	Horizon ¾ pt Diuron 2 lbs 3	Horizon ¾ pt Goal 20 oz 2	Horizon ¾ pt Horizon 1½ pts 5	Horizon ¾ pt Lexone 5 oz 0	Horizon ¾ pt Nortron 2 pts 7	Horizon ¾ pt Sinbar ¾ lb 5
Goal 10 oz 2	Goal 10 oz Assert 1½ pts 8	Goal 10 oz Banvel 5 pts 7	Goal 10 oz Beacon ¾ oz 5	Goal 10 oz Diuron 2 lbs 5	Goal 10 oz Goal 20 oz 2	Goal 10 oz Horizon 1½ pts 3	Goal 10 oz Lexone 5 oz 2	Goal 10 oz Nortron 2 pts 3	Goal 10 oz Sinbar ¾ lb 5
Diuron 1 lb 0	Diuron 1 lb Assert 1½ pts 10	Diuron 1 lb Banvel 5 pts 3	Diuron 1 lb Beacon ¾ oz 5	Diuron 1 lb Diuron 2 lbs 3	Diuron 1 lb Goal 20 oz 0	Diuron 1 lb Horizon 1½ pts 3	Diuron 1 lb Lexone 5 oz 0	Diuron 1 lb Nortron 2 pts 2	Diuron 1 lb Sinbar ¾ lb 3
Beacon oz 5	Beacon oz Assert 1½ pts 12	Beacon oz Banvel 5 pts 7	Beacon oz Beacon ¾ oz 10	Beacon oz Diuron 2 lbs 5	Beacon oz Goal 20 oz 2	Beacon oz Horizon 1½ pts 8	Beacon oz Lexone 5 oz 3	Beacon oz Nortron 2 pts 8	Beacon oz Sinbar ¾ lb 3
Banvel 2½ pts 2	Banvel 2½ pts Assert 1½ pts 5	Banvel 2½ pts Banvel 5 pts 5	Banvel 2½ pts Beacon ¾ oz 7	Banvel 2½ pts Diuron 2 lbs 3	Banvel 2½ pts Goal 20 oz 2	Banvel 2½ pts Horizon 1½ pts 5	Banvel 2½ pts Lexone 5 oz 2	Banvel 2½ pts Nortron 2 pts 5	Banvel 2½ pts Sinbar ¾ lb 3
Assert ¾ pt 0	Assert ¾ pt Assert 1½ pts 20	Assert ¾ pt Banvel 5 pts 3	Assert ¾ pt Beacon ¾ oz 7	Assert ¾ pt Diuron 2 lbs 3	Assert ¾ pt Goal 20 oz 2	Assert ¾ pt Horizon 1½ pts 7	Assert ¾ pt Lexone 5 oz 2	Assert ¾ pt Nortron 2 pts 7	Assert ¾ pt Sinbar ¾ lb 3
Untreated 0	Assert 1½ pts 3	Banvel 5 pts 2	Beacon ¾ oz 7	Diuron 2 lbs 3	Goal 20 oz 2	Horizon 1½ pts 2	Lexone 5 oz 0	Nortron 2 pts 2	Sinbar ¾ lb 2

Table 3. Percent crop injury to 'Merit' Kentucky bluegrass for the following herbicides applied alone, and in combination November 22, 1994 (except Horizon, March 25, 1995) to plots in a commercial field near Madras, Oregon.

Sinbar ½ lb **0**	Sinbar ½ lb Assert 1½ pts **10**	Sinbar ½ lb Banvel 5 pts **5**	Sinbar ½ lb Beacon ¾ oz **5**	Sinbar ½ lb Diuron 2 lbs **0**	Sinbar ½ lb Goal 20 oz **0**	Sinbar ½ lb Horizon 1½ pts **0**	Sinbar ½ lb Lexone 5 oz **0**	Sinbar ½ lb Nortron 2 pts **5**	Sinbar ½ lb Sinbar ¾ lb **5**
Nortron 1 pt **0**	Nortron 1 pt Assert 1½ pts **15**	Nortron 1 pt Banvel 5 pts **5**	Nortron 1 pt Beacon ¾ oz **5**	Nortron 1 pt Diuron 2 lbs **0**	Nortron 1 pt Goal 20 oz **0**	Nortron 1 pt Horizon 1½ pts **5**	Nortron 1 pt Lexone 5 oz **0**	Nortron 1 pt Nortron 2 pts **5**	Nortron 1 pt Sinbar ¾ lb **5**
Lexone 2 oz **0**	Lexone 2 oz Assert 1½ pts **10**	Lexone 2 oz Banvel 5 pts **5**	Lexone 2 oz Beacon ¾ oz **0**	Lexone 2 oz Diuron 2 lbs **0**	Lexone 2 oz Goal 20 oz **0**	Lexone 2 oz Horizon 1½ pts **0**	Lexone 2 oz Lexone 5 oz **0**	Lexone 2 oz Nortron 2 pts **5**	Lexone 2 oz Sinbar ¾ lb **5**
Horizon ¾ pt **0**	Horizon ¾ pt Assert 1½ pts **15**	Horizon ¾ pt Banvel 5 pts **10**	Horizon ¾ pt Beacon ¾ oz **5**	Horizon ¾ pt Diuron 2 lbs **5**	Horizon ¾ pt Goal 20 oz **0**	Horizon ¾ pt Horizon 1½ pts **5**	Horizon ¾ pt Lexone 5 oz **0**	Horizon ¾ pt Nortron 2 pts **10**	Horizon ¾ pt Sinbar ¾ lb **10**
Goal 10 oz **0**	Goal 10 oz Assert 1½ pts **15**	Goal 10 oz Banvel 5 pts **10**	Goal 10 oz Beacon ¾ oz **5**	Goal 10 oz Diuron 2 lbs **5**	Goal 10 oz Goal 20 oz **0**	Goal 10 oz Horizon 1½ pts **5**	Goal 10 oz Lexone 5 oz **0**	Goal 10 oz Nortron 2 pts **5**	Goal 10 oz Sinbar ¾ lb **10**
Diuron 1 lb **0**	Diuron 1 lb Assert 1½ pts **10**	Diuron 1 lb Banvel 5 pts **10**	Diuron 1 lb Beacon ¾ oz **5**	Diuron 1 lb Diuron 2 lbs **5**	Diuron 1 lb Goal 20 oz **0**	Diuron 1 lb Horizon 1½ pts **5**	Diuron 1 lb Lexone 5 oz **0**	Diuron 1 lb Nortron 2 pts **5**	Diuron 1 lb Sinbar ¾ lb **10**
Beacon oz **0**	Beacon oz Assert 1½ pts **15**	Beacon oz Banvel 5 pts **10**	Beacon oz Beacon ¾ oz **5**	Beacon oz Diuron 2 lbs **5**	Beacon oz Goal 20 oz **0**	Beacon oz Horizon 1½ pts **5**	Beacon oz Lexone 5 oz **0**	Beacon oz Nortron 2 pts **10**	Beacon oz Sinbar ¾ lb **10**
Banvel 2½ pts **0**	Banvel 2½ pts Assert 1½ pts **10**	Banvel 2½ pts Banvel 5 pts **5**	Banvel 2½ pts Beacon ¾ oz **5**	Banvel 2½ pts Diuron 2 lbs **5**	Banvel 2½ pts Goal 20 oz **5**	Banvel 2½ pts Horizon 1½ pts **10**	Banvel 2½ pts Lexone 5 oz **0**	Banvel 2½ pts Nortron 2 pts **10**	Banvel 2½ pts Sinbar ¾ lb **10**
Assert ¾ pt **0**	Assert ¾ pt Assert 1½ pts **15**	Assert ¾ pt Banvel 5 pts **5**	Assert ¾ pt Beacon ¾ oz **5**	Assert ¾ pt Diuron 2 lbs **5**	Assert ¾ pt Goal 20 oz **5**	Assert ¾ pt Horizon 1½ pts **10**	Assert ¾ pt Lexone 5 oz **5**	Assert ¾ pt Nortron 2 pts **10**	Assert ¾ pt Sinbar ¾ lb **10**
Untreated **0**	Assert 1½ pts **5**	Banvel 5 pts **0**	Beacon ¾ oz **0**	Diuron 2 lbs **0**	Goal 20 oz **0**	Horizon 1½ pts **5**	Lexone 5 oz **0**	Nortron 2 pts **5**	Sinbar ¾ lb **5**

Table 4. Percent crop injury to 'Coventry' Kentucky bluegrass for the following herbicides applied alone, and in combination November 7, 1994 (except Horizon, March 25, 1995) to plots in a commercial field near Madras, Oregon.

Sinbar ½ lb 5	Sinbar ½ lb Assert 1½ pts 10	Sinbar ½ lb Banvel 5 pts 0	Sinbar ½ lb Beacon ¾ oz 5	Sinbar ½ lb Diuron 2 lbs 5	Sinbar ½ lb Goal 20 oz 0	Sinbar ½ lb Horizon 1½ pts 10	Sinbar ½ lb Lexone 5 oz 0	Sinbar ½ lb Nortron 2 pts 0	Sinbar ½ lb Sinbar ¾ lb 20
Nortron 1 pt 5	Nortron 1 pt Assert 1½ pts 10	Nortron 1 pt Banvel 5 pts 5	Nortron 1 pt Beacon ¾ oz 10	Nortron 1 pt Diuron 2 lbs 5	Nortron 1 pt Goal 20 oz 5	Nortron 1 pt Horizon 1½ pts 5	Nortron 1 pt Lexone 5 oz 0	Nortron 1 pt Nortron 2 pts 5	Nortron 1 pt Sinbar ¾ lb 0
Lexone 2 oz 5	Lexone 2 oz Assert 1½ pts 10	Lexone 2 oz Banvel 5 pts 0	Lexone 2 oz Beacon ¾ oz 5	Lexone 2 oz Diuron 2 lbs 5	Lexone 2 oz Goal 20 oz 0	Lexone 2 oz Horizon 1½ pts 0	Lexone 2 oz Lexone 5 oz 0	Lexone 2 oz Nortron 2 pts 0	Lexone 2 oz Sinbar ¾ lb 10
Horizon ¾ pt 5	Horizon ¾ pt Assert 1½ pts 10	Horizon ¾ pt Banvel 5 pts 5	Horizon ¾ pt Beacon ¾ oz 10	Horizon ¾ pt Diuron 2 lbs 5	Horizon ¾ pt Goal 20 oz 5	Horizon ¾ pt Horizon 1½ pts 5	Horizon ¾ pt Lexone 5 oz 0	Horizon ¾ pt Nortron 2 pts 5	Horizon ¾ pt Sinbar ¾ lb 5
Goal 10 oz 0	Goal 10 oz Assert 1½ pts 0	Goal 10 oz Banvel 5 pts 0	Goal 10 oz Beacon ¾ oz 0	Goal 10 oz Diuron 2 lbs 5	Goal 10 oz Goal 20 oz 0	Goal 10 oz Horizon 1½ pts 0	Goal 10 oz Lexone 5 oz 0	Goal 10 oz Nortron 2 pts 0	Goal 10 oz Sinbar ¾ lb 0
Diuron 1 lb 0	Diuron 1 lb Assert 1½ pts 15	Diuron 1 lb Banvel 5 pts 0	Diuron 1 lb Beacon ¾ oz 5	Diuron 1 lb Diuron 2 lbs 5	Diuron 1 lb Goal 20 oz 0	Diuron 1 lb Horizon 1½ pts 5	Diuron 1 lb Lexone 5 oz 0	Diuron 1 lb Nortron 2 pts 0	Diuron 1 lb Sinbar ¾ lb 0
Beacon oz 5	Beacon oz Assert 1½ pts 5	Beacon oz Banvel 5 pts 5	Beacon oz Beacon ¾ oz 10	Beacon oz Diuron 2 lbs 10	Beacon oz Goal 20 oz 0	Beacon oz Horizon 1½ pts 10	Beacon oz Lexone 5 oz 5	Beacon oz Nortron 2 pts 5	Beacon oz Sinbar ¾ lb 0
Banvel 2½ pts 5	Banvel 2½ pts Assert 1½ pts 0	Banvel 2½ pts Banvel 5 pts 5	Banvel 2½ pts Beacon ¾ oz 10	Banvel 2½ pts Diuron 2 lbs 5	Banvel 2½ pts Goal 20 oz 0	Banvel 2½ pts Horizon 1½ pts 5	Banvel 2½ pts Lexone 5 oz 5	Banvel 2½ pts Nortron 2 pts 0	Banvel 2½ pts Sinbar ¾ lb 0
Assert ¾ pt 0	Assert ¾ pt Assert 1½ pts 30	Assert ¾ pt Banvel 5 pts 0	Assert ¾ pt Beacon ¾ oz 5	Assert ¾ pt Diuron 2 lbs 5	Assert ¾ pt Goal 20 oz 0	Assert ¾ pt Horizon 1½ pts 5	Assert ¾ pt Lexone 5 oz 0	Assert ¾ pt Nortron 2 pts 0	Assert ¾ pt Sinbar ¾ lb 0
Untreated 0	Assert 1½ pts 0	Banvel 5 pts 5	Beacon ¾ oz 10	Diuron 2 lbs 10	Goal 20 oz 5	Horizon 1½ pts 0	Lexone 5 oz 0	Nortron 2 pts 0	Sinbar ¾ lb 0

Table 5. Percent crop injury to 'Unique' Kentucky bluegrass for the following herbicides applied alone, and in combination November 17, 1994 (except Horizon, March 25, 1995) to plots in a commercial field near Culver, Oregon.

Sinbar ½ lb **0**	Sinbar ½ lb Assert 1½ pts **10**	Sinbar ½ lb Banvel 5 pts **0**	Sinbar ½ lb Beacon ¾ oz **10**	Sinbar ½ lb Diuron 2 lbs **0**	Sinbar ½ lb Goal 20 oz **0**	Sinbar ½ lb Horizon 1½ pts **0**	Sinbar ½ lb Lexone 5 oz **0**	Sinbar ½ lb Nortron 2 pts **0**	Sinbar ½ lb Sinbar ¾ lb **30**
Nortron 1 pt **0**	Nortron 1 pt Assert 1½ pts **5**	Nortron 1 pt Banvel 5 pts **0**	Nortron 1 pt Beacon ¾ oz **5**	Nortron 1 pt Diuron 2 lbs **0**	Nortron 1 pt Goal 20 oz **0**	Nortron 1 pt Horizon 1½ pts **0**	Nortron 1 pt Lexone 5 oz **0**	Nortron 1 pt Nortron 2 pts **0**	Nortron 1 pt Sinbar ¾ lb **0**
Lexone 2 oz **0**	Lexone 2 oz Assert 1½ pts **0**	Lexone 2 oz Banvel 5 pts **0**	Lexone 2 oz Beacon ¾ oz **5**	Lexone 2 oz Diuron 2 lbs **0**	Lexone 2 oz Goal 20 oz **0**	Lexone 2 oz Horizon 1½ pts **0**	Lexone 2 oz Lexone 5 oz **0**	Lexone 2 oz Nortron 2 pts **5**	Lexone 2 oz Sinbar ¾ lb **5**
Horizon ¾ pt **5**	Horizon ¾ pt Assert 1½ pts **10**	Horizon ¾ pt Banvel 5 pts **5**	Horizon ¾ pt Beacon ¾ oz **10**	Horizon ¾ pt Diuron 2 lbs **0**	Horizon ¾ pt Goal 20 oz **0**	Horizon ¾ pt Horizon 1½ pts **5**	Horizon ¾ pt Lexone 5 oz **0**	Horizon ¾ pt Nortron 2 pts **5**	Horizon ¾ pt Sinbar ¾ lb **0**
Goal 10 oz **5**	Goal 10 oz Assert 1½ pts **10**	Goal 10 oz Banvel 5 pts **10**	Goal 10 oz Beacon ¾ oz **10**	Goal 10 oz Diuron 2 lbs **5**	Goal 10 oz Goal 20 oz **5**	Goal 10 oz Horizon 1½ pts **5**	Goal 10 oz Lexone 5 oz **5**	Goal 10 oz Nortron 2 pts **5**	Goal 10 oz Sinbar ¾ lb **5**
Diuron 1 lb **0**	Diuron 1 lb Assert 1½ pts **5**	Diuron 1 lb Banvel 5 pts **0**	Diuron 1 lb Beacon ¾ oz **5**	Diuron 1 lb Diuron 2 lbs **0**	Diuron 1 lb Goal 20 oz **0**	Diuron 1 lb Horizon 1½ pts **0**	Diuron 1 lb Lexone 5 oz **0**	Diuron 1 lb Nortron 2 pts **0**	Diuron 1 lb Sinbar ¾ lb **0**
Beacon oz **10**	Beacon oz Assert 1½ pts **15**	Beacon oz Banvel 5 pts **5**	Beacon oz Beacon ¾ oz **15**	Beacon oz Diuron 2 lbs **0**	Beacon oz Goal 20 oz **5**	Beacon oz Horizon 1½ pts **10**	Beacon oz Lexone 5 oz **5**	Beacon oz Nortron 2 pts **10**	Beacon oz Sinbar ¾ lb **0**
Banvel 2½ pts **0**	Banvel 2½ pts Assert 1½ pts **5**	Banvel 2½ pts Banvel 5 pts **5**	Banvel 2½ pts Beacon ¾ oz **5**	Banvel 2½ pts Diuron 2 lbs **0**	Banvel 2½ pts Goal 20 oz **0**	Banvel 2½ pts Horizon 1½ pts **0**	Banvel 2½ pts Lexone 5 oz **0**	Banvel 2½ pts Nortron 2 pts **5**	Banvel 2½ pts Sinbar ¾ lb **0**
Assert ¾ pt **0**	Assert ¾ pt Assert 1½ pts **15**	Assert ¾ pt Banvel 5 pts **5**	Assert ¾ pt Beacon ¾ oz **10**	Assert ¾ pt Diuron 2 lbs **0**	Assert ¾ pt Goal 20 oz **0**	Assert ¾ pt Horizon 1½ pts **5**	Assert ¾ pt Lexone 5 oz **0**	Assert ¾ pt Nortron 2 pts **10**	Assert ¾ pt Sinbar ¾ lb **0**
Untreated **0**	Assert 1½ pts **5**	Banvel 5 pts **0**	Beacon ¾ oz **10**	Diuron 2 lbs **0**	Goal 20 oz **0**	Horizon 1½ pts **0**	Lexone 5 oz **0**	Nortron 2 pts **0**	Sinbar ¾ lb **0**

Table 6. Average percent control of established roughstalk bluegrass across 3 locations and varieties for the following herbicides applied alone, and in combination, November, 1994 (except Horizon, March 25, 1995) to plots in commmercial fields near Madras.

Sinbar ½ lb **17**	Sinbar ½ lb Assert 1½ pts **40**	Sinbar ½ lb Banvel 5 pts **10**	Sinbar ½ lb Beacon ¾ oz **32**	Sinbar ½ lb Diuron 2 lbs **83**	Sinbar ½ lb Goal 20 oz **33**	Sinbar ½ lb Horizon 1½ pts **30**	Sinbar ½ lb Lexone 5 oz **50**	Sinbar ½ lb Nortron 2 pts **38**	Sinbar ½ lb Sinbar ¾ lb **89**
Nortron 1 pt **0**	Nortron 1 pt Assert 1½ pts **13**	Nortron 1 pt Banvel 5 pts **0**	Nortron 1 pt Beacon ¾ oz **12**	Nortron 1 pt Diuron 2 lbs **40**	Nortron 1 pt Goal 20 oz **3**	Nortron 1 pt Horizon 1½ pts **7**	Nortron 1 pt Lexone 5 oz **13**	Nortron 1 pt Nortron 2 pts **12**	Nortron 1 pt Sinbar ¾ lb **60**
Lexone 2 oz **0**	Lexone 2 oz Assert 1½ pts **18**	Lexone 2 oz Banvel 5 pts **0**	Lexone 2 oz Beacon ¾ oz **27**	Lexone 2 oz Diuron 2 lbs **50**	Lexone 2 oz Goal 20 oz **7**	Lexone 2 oz Horizon 1½ pts **7**	Lexone 2 oz Lexone 5 oz **13**	Lexone 2 oz Nortron 2 pts **12**	Lexone 2 oz Sinbar ¾ lb **68**
Horizon ¾ pt **5**	Horizon ¾ pt Assert 1½ pts **17**	Horizon ¾ pt Banvel 5 pts **0**	Horizon ¾ pt Beacon ¾ oz **3**	Horizon ¾ pt Diuron 2 lbs **33**	Horizon ¾ pt Goal 20 oz **0**	Horizon ¾ pt Horizon 1½ pts **0**	Horizon ¾ pt Lexone 5 oz **7**	Horizon ¾ pt Nortron 2 pts **5**	Horizon ¾ pt Sinbar ¾ lb **60**
Goal 10 oz **0**	Goal 10 oz Assert 1½ pts **25**	Goal 10 oz Banvel 5 pts **5**	Goal 10 oz Beacon ¾ oz **10**	Goal 10 oz Diuron 2 lbs **33**	Goal 10 oz Goal 20 oz **3**	Goal 10 oz Horizon 1½ pts **0**	Goal 10 oz Lexone 5 oz **8**	Goal 10 oz Nortron 2 pts **7**	Goal 10 oz Sinbar ¾ lb **68**
Diuron 1 lb **0**	Diuron 1 lb Assert 1½ pts **35**	Diuron 1 lb Banvel 5 pts **7**	Diuron 1 lb Beacon ¾ oz **28**	Diuron 1 lb Diuron 2 lbs **42**	Diuron 1 lb Goal 20 oz **10**	Diuron 1 lb Horizon 1½ pts **12**	Diuron 1 lb Lexone 5 oz **23**	Diuron 1 lb Nortron 2 pts **13**	Diuron 1 lb Sinbar ¾ lb **79**
Beacon oz **0**	Beacon oz Assert 1½ pts **20**	Beacon oz Banvel 5 pts **0**	Beacon oz Beacon ¾ oz **30**	Beacon oz Diuron 2 lbs **43**	Beacon oz Goal 20 oz **0**	Beacon oz Horizon 1½ pts **7**	Beacon oz Lexone 5 oz **13**	Beacon oz Nortron 2 pts **0**	Beacon oz Sinbar ¾ lb **62**
Banvel 2½ pts **0**	Banvel 2½ pts Assert 1½ pts **0**	Banvel 2½ pts Banvel 5 pts **3**	Banvel 2½ pts Beacon ¾ oz **2**	Banvel 2½ pts Diuron 2 lbs **28**	Banvel 2½ pts Goal 20 oz **0**	Banvel 2½ pts Horizon 1½ pts **3**	Banvel 2½ pts Lexone 5 oz **7**	Banvel 2½ pts Nortron 2 pts **0**	Banvel 2½ pts Sinbar ¾ lb **57**
Assert ¾ pt **0**	Assert ¾ pt Assert 1½ pts **8**	Assert ¾ pt Banvel 5 pts **3**	Assert ¾ pt Beacon ¾ oz **18**	Assert ¾ pt Diuron 2 lbs **60**	Assert ¾ pt Goal 20 oz **3**	Assert ¾ pt Horizon 1½ pts **3**	Assert ¾ pt Lexone 5 oz **17**	Assert ¾ pt Nortron 2 pts **0**	Assert ¾ pt Sinbar ¾ lb **68**
Untreated **0**	Assert 1½ pts **7**	Banvel 5 pts **0**	Beacon ¾ oz **8**	Diuron 2 lbs **60**	Goal 20 oz **0**	Horizon 1½ pts **3**	Lexone 5 oz **13**	Nortron 2 pts **0**	Sinbar ¾ lb **62**

Table 7. Percent control of established 'Saber' roughstalk bluegrass for the following herbicides applied alone, and in combination, November 3, 1994 (except Horizon, March 25, 1995) to plots in a commercial field near Madras, Oregon.

Sinbar ½ lb 10	Sinbar ½ lb Assert 1½ pts 30	Sinbar ½ lb Banvel 5 pts 10	Sinbar ½ lb Beacon ¾ oz 0	Sinbar ½ lb Diuron 2 lbs 70	Sinbar ½ lb Goal 20 oz 20	Sinbar ½ lb Horizon 1½ pts 20	Sinbar ½ lb Lexone 5 oz 40	Sinbar ½ lb Nortron 2 pts 10	Sinbar ½ lb Sinbar ¾ lb 100
Nortron 1 pt 0	Nortron 1 pt Assert 1½ pts 0	Nortron 1 pt Banvel 5 pts 0	Nortron 1 pt Beacon ¾ oz 0	Nortron 1 pt Diuron 2 lbs 10	Nortron 1 pt Goal 20 oz 0	Nortron 1 pt Horizon 1½ pts 0	Nortron 1 pt Lexone 5 oz 0	Nortron 1 pt Nortron 2 pts 0	Nortron 1 pt Sinbar ¾ lb 90
Lexone 2 oz 0	Lexone 2 oz Assert 1½ pts 0	Lexone 2 oz Banvel 5 pts 0	Lexone 2 oz Beacon ¾ oz 0	Lexone 2 oz Diuron 2 lbs 10	Lexone 2 oz Goal 20 oz 0	Lexone 2 oz Horizon 1½ pts 0	Lexone 2 oz Lexone 5 oz 0	Lexone 2 oz Nortron 2 pts 0	Lexone 2 oz Sinbar ¾ lb 98
Horizon ¾ pt 0	Horizon ¾ pt Assert 1½ pts 0	Horizon ¾ pt Banvel 5 pts 0	Horizon ¾ pt Beacon ¾ oz 0	Horizon ¾ pt Diuron 2 lbs 10	Horizon ¾ pt Goal 20 oz 0	Horizon ¾ pt Horizon 1½ pts 0	Horizon ¾ pt Lexone 5 oz 0	Horizon ¾ pt Nortron 2 pts 0	Horizon ¾ pt Sinbar ¾ lb 80
Goal 10 oz 0	Goal 10 oz Assert 1½ pts 0	Goal 10 oz Banvel 5 pts 0	Goal 10 oz Beacon ¾ oz 0	Goal 10 oz Diuron 2 lbs 10	Goal 10 oz Goal 20 oz 0	Goal 10 oz Horizon 1½ pts 0	Goal 10 oz Lexone 5 oz 0	Goal 10 oz Nortron 2 pts 0	Goal 10 oz Sinbar ¾ lb 90
Diuron 1 lb 0	Diuron 1 lb Assert 1½ pts 0	Diuron 1 lb Banvel 5 pts 0	Diuron 1 lb Beacon ¾ oz 0	Diuron 1 lb Diuron 2 lbs 10	Diuron 1 lb Goal 20 oz 0	Diuron 1 lb Horizon 1½ pts 0	Diuron 1 lb Lexone 5 oz 0	Diuron 1 lb Nortron 2 pts 0	Diuron 1 lb Sinbar ¾ lb 98
Beacon oz 0	Beacon oz Assert 1½ pts 0	Beacon oz Banvel 5 pts 0	Beacon oz Beacon ¾ oz 0	Beacon oz Diuron 2 lbs 20	Beacon oz Goal 20 oz 0	Beacon oz Horizon 1½ pts 0	Beacon oz Lexone 5 oz 0	Beacon oz Nortron 2 pts 0	Beacon oz Sinbar ¾ lb 80
Banvel 2½ pts 0	Banvel 2½ pts Assert 1½ pts 0	Banvel 2½ pts Banvel 5 pts 0	Banvel 2½ pts Beacon ¾ oz 0	Banvel 2½ pts Diuron 2 lbs 10	Banvel 2½ pts Goal 20 oz 0	Banvel 2½ pts Horizon 1½ pts 0	Banvel 2½ pts Lexone 5 oz 0	Banvel 2½ pts Nortron 2 pts 0	Banvel 2½ pts Sinbar ¾ lb 70
Assert ¾ pt 0	Assert ¾ pt Assert 1½ pts 0	Assert ¾ pt Banvel 5 pts 0	Assert ¾ pt Beacon ¾ oz 0	Assert ¾ pt Diuron 2 lbs 30	Assert ¾ pt Goal 20 oz 0	Assert ¾ pt Horizon 1½ pts 0	Assert ¾ pt Lexone 5 oz 0	Assert ¾ pt Nortron 2 pts 0	Assert ¾ pt Sinbar ¾ lb 80
Untreated 0	Assert 1½ pts 0	Banvel 5 pts 0	Beacon ¾ oz 0	Diuron 2 lbs 30	Goal 20 oz 0	Horizon 1½ pts 0	Lexone 5 oz 0	Nortron 2 pts 0	Sinbar ¾ lb 70

Table 8. Percent control of established 'Laser' roughstalk bluegrass for the following herbicides applied alone, and in combination, November 3, 1994 (except Horizon, March 25, 1995) to plots in a commercial field near Madras, Oregon.

Sinbar ½ lb 20	Sinbar ½ lb Assert 1½ pts 5	Sinbar ½ lb Banvel 5 pts 0	Sinbar ½ lb Beacon ¾ oz 20	Sinbar ½ lb Diuron 2 lbs 85	Sinbar ½ lb Goal 20 oz 5	Sinbar ½ lb Horizon 1½ pts 0	Sinbar ½ lb Lexone 5 oz 15	Sinbar ½ lb Nortron 2 pts 20	Sinbar ½ lb Sinbar ¾ lb 70
Nortron 1 pt 0	Nortron 1 pt Assert 1½ pts 0	Nortron 1 pt Banvel 5 pts 0	Nortron 1 pt Beacon ¾ oz 25	Nortron 1 pt Diuron 2 lbs 30	Nortron 1 pt Goal 20 oz 0	Nortron 1 pt Horizon 1½ pts 0	Nortron 1 pt Lexone 5 oz 0	Nortron 1 pt Nortron 2 pts 0	Nortron 1 pt Sinbar ¾ lb 5
Lexone 2 oz 0	Lexone 2 oz Assert 1½ pts 5	Lexone 2 oz Banvel 5 pts 0	Lexone 2 oz Beacon ¾ oz 30	Lexone 2 oz Diuron 2 lbs 60	Lexone 2 oz Goal 20 oz 0	Lexone 2 oz Horizon 1½ pts 0	Lexone 2 oz Lexone 5 oz 0	Lexone 2 oz Nortron 2 pts 0	Lexone 2 oz Sinbar ¾ lb 15
Horizon ¾ pt 0	Horizon ¾ pt Assert 1½ pts 0	Horizon ¾ pt Banvel 5 pts 0	Horizon ¾ pt Beacon ¾ oz 10	Horizon ¾ pt Diuron 2 lbs 15	Horizon ¾ pt Goal 20 oz 0	Horizon ¾ pt Horizon 1½ pts 0	Horizon ¾ pt Lexone 5 oz 0	Horizon ¾ pt Nortron 2 pts 0	Horizon ¾ pt Sinbar ¾ lb 5
Goal 10 oz 0	Goal 10 oz Assert 1½ pts 5	Goal 10 oz Banvel 5 pts 0	Goal 10 oz Beacon ¾ oz 10	Goal 10 oz Diuron 2 lbs 15	Goal 10 oz Goal 20 oz 0	Goal 10 oz Horizon 1½ pts 0	Goal 10 oz Lexone 5 oz 0	Goal 10 oz Nortron 2 pts 0	Goal 10 oz Sinbar ¾ lb 20
Diuron 1 lb 0	Diuron 1 lb Assert 1½ pts 10	Diuron 1 lb Banvel 5 pts 0	Diuron 1 lb Beacon ¾ oz 10	Diuron 1 lb Diuron 2 lbs 30	Diuron 1 lb Goal 20 oz 0	Diuron 1 lb Horizon 1½ pts 0	Diuron 1 lb Lexone 5 oz 5	Diuron 1 lb Nortron 2 pts 0	Diuron 1 lb Sinbar ¾ lb 40
Beacon oz 0	Beacon oz Assert 1½ pts 20	Beacon oz Banvel 5 pts 0	Beacon oz Beacon ¾ oz 40	Beacon oz Diuron 2 lbs 20	Beacon oz Goal 20 oz 0	Beacon oz Horizon 1½ pts 0	Beacon oz Lexone 5 oz 0	Beacon oz Nortron 2 pts 0	Beacon oz Sinbar ¾ lb 10
Banvel 2½ pts 0	Banvel 2½ pts Assert 1½ pts 0	Banvel 2½ pts Banvel 5 pts 0	Banvel 2½ pts Beacon ¾ oz 0	Banvel 2½ pts Diuron 2 lbs 5	Banvel 2½ pts Goal 20 oz 0	Banvel 2½ pts Horizon 1½ pts 0	Banvel 2½ pts Lexone 5 oz 0	Banvel 2½ pts Nortron 2 pts 0	Banvel 2½ pts Sinbar ¾ lb 10
Assert ¾ pt 0	Assert ¾ pt Assert 1½ pts 15	Assert ¾ pt Banvel 5 pts 0	Assert ¾ pt Beacon ¾ oz 25	Assert ¾ pt Diuron 2 lbs 60	Assert ¾ pt Goal 20 oz 0	Assert ¾ pt Horizon 1½ pts 0	Assert ¾ pt Lexone 5 oz 0	Assert ¾ pt Nortron 2 pts 0	Assert ¾ pt Sinbar ¾ lb 30
Untreated 0	Assert 1½ pts 0	Banvel 5 pts 0	Beacon ¾ oz 15	Diuron 2 lbs 70	Goal 20 oz 0	Horizon 1½ pts 0	Lexone 5 oz 0	Nortron 2 pts 0	Sinbar ¾ lb 20

Table 9. Percent control of established 'Cypress' roughstalk bluegrass for the following herbicides applied alone, and in combination, November 3, 1994 (except Horizon, March 25, 1995) to plots in a commercial field near Madras, Oregon.

Sinbar ½ lb **20**	Sinbar ½ lb Assert 1½ pts **85**	Sinbar ½ lb Banvel 5 pts **20**	Sinbar ½ lb Beacon ¾ oz **75**	Sinbar ½ lb Diuron 2 lbs **95**	Sinbar ½ lb Goal 20 oz **75**	Sinbar ½ lb Horizon 1½ pts **70**	Sinbar ½ lb Lexone 5 oz **95**	Sinbar ½ lb Nortron 2 pts **85**	Sinbar ½ lb Sinbar ¾ lb **98**
Nortron 1 pt **0**	Nortron 1 pt Assert 1½ pts **40**	Nortron 1 pt Banvel 5 pts **0**	Nortron 1 pt Beacon ¾ oz **10**	Nortron 1 pt Diuron 2 lbs **80**	Nortron 1 pt Goal 20 oz **10**	Nortron 1 pt Horizon 1½ pts **20**	Nortron 1 pt Lexone 5 oz **40**	Nortron 1 pt Nortron 2 pts **35**	Nortron 1 pt Sinbar ¾ lb **85**
Lexone 2 oz **0**	Lexone 2 oz Assert 1½ pts **50**	Lexone 2 oz Banvel 5 pts **0**	Lexone 2 oz Beacon ¾ oz **50**	Lexone 2 oz Diuron 2 lbs **80**	Lexone 2 oz Goal 20 oz **20**	Lexone 2 oz Horizon 1½ pts **20**	Lexone 2 oz Lexone 5 oz **40**	Lexone 2 oz Nortron 2 pts **35**	Lexone 2 oz Sinbar ¾ lb **90**
Horizon ¾ pt **0**	Horizon ¾ pt Assert 1½ pts **50**	Horizon ¾ pt Banvel 5 pts **0**	Horizon ¾ pt Beacon ¾ oz **10**	Horizon ¾ pt Diuron 2 lbs **75**	Horizon ¾ pt Goal 20 oz **0**	Horizon ¾ pt Horizon 1½ pts **0**	Horizon ¾ pt Lexone 5 oz **20**	Horizon ¾ pt Nortron 2 pts **15**	Horizon ¾ pt Sinbar ¾ lb **95**
Goal 10 oz **0**	Goal 10 oz Assert 1½ pts **70**	Goal 10 oz Banvel 5 pts **15**	Goal 10 oz Beacon ¾ oz **20**	Goal 10 oz Diuron 2 lbs **75**	Goal 10 oz Goal 20 oz **10**	Goal 10 oz Horizon 1½ pts **0**	Goal 10 oz Lexone 5 oz **25**	Goal 10 oz Nortron 2 pts **20**	Goal 10 oz Sinbar ¾ lb **95**
Diuron 1 lb **0**	Diuron 1 lb Assert 1½ pts **95**	Diuron 1 lb Banvel 5 pts **20**	Diuron 1 lb Beacon ¾ oz **75**	Diuron 1 lb Diuron 2 lbs **85**	Diuron 1 lb Goal 20 oz **30**	Diuron 1 lb Horizon 1½ pts **35**	Diuron 1 lb Lexone 5 oz **65**	Diuron 1 lb Nortron 2 pts **40**	Diuron 1 lb Sinbar ¾ lb **100**
Beacon oz **0**	Beacon oz Assert 1½ pts **40**	Beacon oz Banvel 5 pts **0**	Beacon oz Beacon ¾ oz **50**	Beacon oz Diuron 2 lbs **90**	Beacon oz Goal 20 oz **0**	Beacon oz Horizon 1½ pts **20**	Beacon oz Lexone 5 oz **40**	Beacon oz Nortron 2 pts **0**	Beacon oz Sinbar ¾ lb **95**
Banvel 2½ pts **0**	Banvel 2½ pts Assert 1½ pts **0**	Banvel 2½ pts Banvel 5 pts **10**	Banvel 2½ pts Beacon ¾ oz **5**	Banvel 2½ pts Diuron 2 lbs **70**	Banvel 2½ pts Goal 20 oz **0**	Banvel 2½ pts Horizon 1½ pts **10**	Banvel 2½ pts Lexone 5 oz **20**	Banvel 2½ pts Nortron 2 pts **0**	Banvel 2½ pts Sinbar ¾ lb **90**
Assert ¾ pt **0**	Assert ¾ pt Assert 1½ pts **10**	Assert ¾ pt Banvel 5 pts **10**	Assert ¾ pt Beacon ¾ oz **30**	Assert ¾ pt Diuron 2 lbs **90**	Assert ¾ pt Goal 20 oz **10**	Assert ¾ pt Horizon 1½ pts **10**	Assert ¾ pt Lexone 5 oz **40**	Assert ¾ pt Nortron 2 pts **0**	Assert ¾ pt Sinbar ¾ lb **95**
Untreated **0**	Assert 1½ pts **20**	Banvel 5 pts **10**	Beacon ¾ oz **10**	Diuron 2 lbs **80**	Goal 20 oz **0**	Horizon 1½ pts **10**	Lexone 5 oz **40**	Nortron 2 pts **0**	Sinbar ¾ lb **95**

Table 10. Average percent control of seedling roughstalk bluegrass across 3 locations and varieties for the following herbicides applied alone, and in combination, November 1994 (except Horizon, March 1995) to plots in commercial fields near Madras, Oregon.

Sinbar ½ lb **73**	Sinbar ½ lb Assert 1½ pts **65**	Sinbar ½ lb Banvel 5 pts **38**	Sinbar ½ lb Beacon ¾ oz **85**	Sinbar ½ lb Diuron 2 lbs **92**	Sinbar ½ lb Goal 20 oz **72**	Sinbar ½ lb Horizon 1½ pts **58**	Sinbar ½ lb Lexone 5 oz **80**	Sinbar ½ lb Nortron 2 pts **55**	Sinbar ½ lb Sinbar ¾ lb **94**
Nortron 1 pt **0**	Nortron 1 pt Assert 1½ pts **15**	Nortron 1 pt Banvel 5 pts **5**	Nortron 1 pt Beacon ¾ oz **40**	Nortron 1 pt Diuron 2 lbs **53**	Nortron 1 pt Goal 20 oz **13**	Nortron 1 pt Horizon 1½ pts **5**	Nortron 1 pt Lexone 5 oz **43**	Nortron 1 pt Nortron 2 pts **13**	Nortron 1 pt Sinbar ¾ lb **77**
Lexone 2 oz **3**	Lexone 2 oz Assert 1½ pts **18**	Lexone 2 oz Banvel 5 pts **3**	Lexone 2 oz Beacon ¾ oz **52**	Lexone 2 oz Diuron 2 lbs **63**	Lexone 2 oz Goal 20 oz **38**	Lexone 2 oz Horizon 1½ pts **8**	Lexone 2 oz Lexone 5 oz **58**	Lexone 2 oz Nortron 2 pts **28**	Lexone 2 oz Sinbar ¾ lb **80**
Horizon ¾ pt **2**	Horizon ¾ pt Assert 1½ pts **5**	Horizon ¾ pt Banvel 5 pts **3**	Horizon ¾ pt Beacon ¾ oz **48**	Horizon ¾ pt Diuron 2 lbs **45**	Horizon ¾ pt Goal 20 oz **12**	Horizon ¾ pt Horizon 1½ pts **0**	Horizon ¾ pt Lexone 5 oz **25**	Horizon ¾ pt Nortron 2 pts **5**	Horizon ¾ pt Sinbar ¾ lb **57**
Goal 10 oz **0**	Goal 10 oz Assert 1½ pts **35**	Goal 10 oz Banvel 5 pts **3**	Goal 10 oz Beacon ¾ oz **55**	Goal 10 oz Diuron 2 lbs **50**	Goal 10 oz Goal 20 oz **18**	Goal 10 oz Horizon 1½ pts **10**	Goal 10 oz Lexone 5 oz **47**	Goal 10 oz Nortron 2 pts **12**	Goal 10 oz Sinbar ¾ lb **85**
Diuron 1 lb **13**	Diuron 1 lb Assert 1½ pts **60**	Diuron 1 lb Banvel 5 pts **5**	Diuron 1 lb Beacon ¾ oz **48**	Diuron 1 lb Diuron 2 lbs **60**	Diuron 1 lb Goal 20 oz **35**	Diuron 1 lb Horizon 1½ pts **22**	Diuron 1 lb Lexone 5 oz **50**	Diuron 1 lb Nortron 2 pts **22**	Diuron 1 lb Sinbar ¾ lb **92**
Beacon oz **2**	Beacon oz Assert 1½ pts **33**	Beacon oz Banvel 5 pts **3**	Beacon oz Beacon ¾ oz **60**	Beacon oz Diuron 2 lbs **58**	Beacon oz Goal 20 oz **23**	Beacon oz Horizon 1½ pts **23**	Beacon oz Lexone 5 oz **33**	Beacon oz Nortron 2 pts **8**	Beacon oz Sinbar ¾ lb **70**
Banvel 2½ pts **0**	Banvel 2½ pts Assert 1½ pts **7**	Banvel 2½ pts Banvel 5 pts **3**	Banvel 2½ pts Beacon ¾ oz **30**	Banvel 2½ pts Diuron 2 lbs **43**	Banvel 2½ pts Goal 20 oz **23**	Banvel 2½ pts Horizon 1½ pts **5**	Banvel 2½ pts Lexone 5 oz **33**	Banvel 2½ pts Nortron 2 pts **3**	Banvel 2½ pts Sinbar ¾ lb **60**
Assert ¾ pt **3**	Assert ¾ pt Assert 1½ pts **25**	Assert ¾ pt Banvel 5 pts **5**	Assert ¾ pt Beacon ¾ oz **53**	Assert ¾ pt Diuron 2 lbs **63**	Assert ¾ pt Goal 20 oz **40**	Assert ¾ pt Horizon 1½ pts **5**	Assert ¾ pt Lexone 5 oz **45**	Assert ¾ pt Nortron 2 pts **5**	Assert ¾ pt Sinbar ¾ lb **75**
Untreated **0**	Assert 1½ pts **17**	Banvel 5 pts **2**	Beacon ¾ oz **43**	Diuron 2 lbs **53**	Goal 20 oz **13**	Horizon 1½ pts **2**	Lexone 5 oz **38**	Nortron 2 pts **8**	Sinbar ¾ lb **68**

Table 11. Percent control of 'Saber' seedling roughstalk bluegrass for the following herbicides applied alone, and in combination, November 3,1994 (except Horizon, March 25, 1995) to plots in a commercial field near Madras, Oregon.

Sinbar ½ lb **80**	Sinbar ½ lb Assert 1½ pts **80**	Sinbar ½ lb Banvel 5 pts **80**	Sinbar ½ lb Beacon ¾ oz **80**	Sinbar ½ lb Diuron 2 lbs **80**	Sinbar ½ lb Goal 20 oz **70**	Sinbar ½ lb Horizon 1½ pts **70**	Sinbar ½ lb Lexone 5 oz **80**	Sinbar ½ lb Nortron 2 pts **50**	Sinbar ½ lb Sinbar ¾ lb **100**
Nortron 1 pt **0**	Nortron 1 pt Assert 1½ pts **20**	Nortron 1 pt Banvel 5 pts **0**	Nortron 1 pt Beacon ¾ oz **0**	Nortron 1 pt Diuron 2 lbs **0**	Nortron 1 pt Goal 20 oz **0**	Nortron 1 pt Horizon 1½ pts **0**	Nortron 1 pt Lexone 5 oz **0**	Nortron 1 pt Nortron 2 pts **20**	Nortron 1 pt Sinbar ¾ lb **100**
Lexone 2 oz **0**	Lexone 2 oz Assert 1½ pts **20**	Lexone 2 oz Banvel 5 pts **0**	Lexone 2 oz Beacon ¾ oz **0**	Lexone 2 oz Diuron 2 lbs **20**	Lexone 2 oz Goal 20 oz **60**	Lexone 2 oz Horizon 1½ pts **0**	Lexone 2 oz Lexone 5 oz **30**	Lexone 2 oz Nortron 2 pts **0**	Lexone 2 oz Sinbar ¾ lb **100**
Horizon ¾ pt **0**	Horizon ¾ pt Assert 1½ pts **0**	Horizon ¾ pt Banvel 5 pts **0**	Horizon ¾ pt Beacon ¾ oz **20**	Horizon ¾ pt Diuron 2 lbs **0**	Horizon ¾ pt Goal 20 oz **0**	Horizon ¾ pt Horizon 1½ pts **0**	Horizon ¾ pt Lexone 5 oz **0**	Horizon ¾ pt Nortron 2 pts **10**	Horizon ¾ pt Sinbar ¾ lb **80**
Goal 10 oz **0**	Goal 10 oz Assert 1½ pts **20**	Goal 10 oz Banvel 5 pts **0**	Goal 10 oz Beacon ¾ oz **20**	Goal 10 oz Diuron 2 lbs **0**	Goal 10 oz Goal 20 oz **0**	Goal 10 oz Horizon 1½ pts **0**	Goal 10 oz Lexone 5 oz **0**	Goal 10 oz Nortron 2 pts **0**	Goal 10 oz Sinbar ¾ lb **90**
Diuron 1 lb **0**	Diuron 1 lb Assert 1½ pts **30**	Diuron 1 lb Banvel 5 pts **0**	Diuron 1 lb Beacon ¾ oz **0**	Diuron 1 lb Diuron 2 lbs **0**	Diuron 1 lb Goal 20 oz **0**	Diuron 1 lb Horizon 1½ pts **0**	Diuron 1 lb Lexone 5 oz **0**	Diuron 1 lb Nortron 2 pts **0**	Diuron 1 lb Sinbar ¾ lb **95**
Beacon oz **0**	Beacon oz Assert 1½ pts **30**	Beacon oz Banvel 5 pts **0**	Beacon oz Beacon ¾ oz **40**	Beacon oz Diuron 2 lbs **0**	Beacon oz Goal 20 oz **0**	Beacon oz Horizon 1½ pts **0**	Beacon oz Lexone 5 oz **0**	Beacon oz Nortron 2 pts **0**	Beacon oz Sinbar ¾ lb **90**
Banvel 2½ pts **0**	Banvel 2½ pts Assert 1½ pts **0**	Banvel 2½ pts Banvel 5 pts **0**	Banvel 2½ pts Beacon ¾ oz **0**	Banvel 2½ pts Diuron 2 lbs **30**	Banvel 2½ pts Goal 20 oz **0**	Banvel 2½ pts Horizon 1½ pts **0**	Banvel 2½ pts Lexone 5 oz **0**	Banvel 2½ pts Nortron 2 pts **0**	Banvel 2½ pts Sinbar ¾ lb **80**
Assert ¾ pt **0**	Assert ¾ pt Assert 1½ pts **30**	Assert ¾ pt Banvel 5 pts **0**	Assert ¾ pt Beacon ¾ oz **40**	Assert ¾ pt Diuron 2 lbs **20**	Assert ¾ pt Goal 20 oz **0**	Assert ¾ pt Horizon 1½ pts **0**	Assert ¾ pt Lexone 5 oz **0**	Assert ¾ pt Nortron 2 pts **0**	Assert ¾ pt Sinbar ¾ lb **70**
Untreated **0**	Assert 1½ pts **0**	Banvel 5 pts **0**	Beacon ¾ oz **20**	Diuron 2 lbs **0**	Goal 20 oz **0**	Horizon 1½ pts **0**	Lexone 5 oz **0**	Nortron 2 pts **10**	Sinbar ¾ lb **80**

Table 12. Percent control of 'Laser' seedling roughstalk bluegrass for the following herbicides applied alone, and in combination, November 3, 1994 (except Horizon, March 25, 1995) to plots in a commercial field near Madras, Oregon.

Sinbar ½ lb 80	Sinbar ½ lb Assert 1½ pts 30	Sinbar ½ lb Banvel 5 pts 10	Sinbar ½ lb Beacon ¾ oz 90	Sinbar ½ lb Diuron 2 lbs 98	Sinbar ½ lb Goal 20 oz 60	Sinbar ½ lb Horizon 1½ pts 25	Sinbar ½ lb Lexone 5 oz 70	Sinbar ½ lb Nortron 2 pts 35	Sinbar ½ lb Sinbar ¾ lb 85
Nortron 1 pt 0	Nortron 1 pt Assert 1½ pts 15	Nortron 1 pt Banvel 5 pts 5	Nortron 1 pt Beacon ¾ oz 90	Nortron 1 pt Diuron 2 lbs 85	Nortron 1 pt Goal 20 oz 30	Nortron 1 pt Horizon 1½ pts 10	Nortron 1 pt Lexone 5 oz 60	Nortron 1 pt Nortron 2 pts 10	Nortron 1 pt Sinbar ¾ lb 40
Lexone 2 oz 0	Lexone 2 oz Assert 1½ pts 10	Lexone 2 oz Banvel 5 pts 0	Lexone 2 oz Beacon ¾ oz 85	Lexone 2 oz Diuron 2 lbs 90	Lexone 2 oz Goal 20 oz 30	Lexone 2 oz Horizon 1½ pts 10	Lexone 2 oz Lexone 5 oz 70	Lexone 2 oz Nortron 2 pts 15	Lexone 2 oz Sinbar ¾ lb 50
Horizon ¾ pt 0	Horizon ¾ pt Assert 1½ pts 5	Horizon ¾ pt Banvel 5 pts 0	Horizon ¾ pt Beacon ¾ oz 85	Horizon ¾ pt Diuron 2 lbs 85	Horizon ¾ pt Goal 20 oz 30	Horizon ¾ pt Horizon 1½ pts 0	Horizon ¾ pt Lexone 5 oz 35	Horizon ¾ pt Nortron 2 pts 0	Horizon ¾ pt Sinbar ¾ lb 5
Goal 10 oz 0	Goal 10 oz Assert 1½ pts 60	Goal 10 oz Banvel 5 pts 0	Goal 10 oz Beacon ¾ oz 95	Goal 10 oz Diuron 2 lbs 90	Goal 10 oz Goal 20 oz 40	Goal 10 oz Horizon 1½ pts 30	Goal 10 oz Lexone 5 oz 80	Goal 10 oz Nortron 2 pts 30	Goal 10 oz Sinbar ¾ lb 70
Diuron 1 lb 0	Diuron 1 lb Assert 1½ pts 70	Diuron 1 lb Banvel 5 pts 5	Diuron 1 lb Beacon ¾ oz 85	Diuron 1 lb Diuron 2 lbs 95	Diuron 1 lb Goal 20 oz 40	Diuron 1 lb Horizon 1½ pts 40	Diuron 1 lb Lexone 5 oz 75	Diuron 1 lb Nortron 2 pts 30	Diuron 1 lb Sinbar ¾ lb 80
Beacon oz 0	Beacon oz Assert 1½ pts 30	Beacon oz Banvel 5 pts 0	Beacon oz Beacon ¾ oz 90	Beacon oz Diuron 2 lbs 90	Beacon oz Goal 20 oz 40	Beacon oz Horizon 1½ pts 60	Beacon oz Lexone 5 oz 30	Beacon oz Nortron 2 pts 10	Beacon oz Sinbar ¾ lb 30
Banvel 2½ pts 0	Banvel 2½ pts Assert 1½ pts 5	Banvel 2½ pts Banvel 5 pts 0	Banvel 2½ pts Beacon ¾ oz 65	Banvel 2½ pts Diuron 2 lbs 60	Banvel 2½ pts Goal 20 oz 40	Banvel 2½ pts Horizon 1½ pts 5	Banvel 2½ pts Lexone 5 oz 50	Banvel 2½ pts Nortron 2 pts 5	Banvel 2½ pts Sinbar ¾ lb 20
Assert ¾ pt 0	Assert ¾ pt Assert 1½ pts 15	Assert ¾ pt Banvel 5 pts 10	Assert ¾ pt Beacon ¾ oz 80	Assert ¾ pt Diuron 2 lbs 85	Assert ¾ pt Goal 20 oz 70	Assert ¾ pt Horizon 1½ pts 5	Assert ¾ pt Lexone 5 oz 60	Assert ¾ pt Nortron 2 pts 10	Assert ¾ pt Sinbar ¾ lb 60
Untreated 0	Assert 1½ pts 0	Banvel 5 pts 0	Beacon ¾ oz 85	Diuron 2 lbs 85	Goal 20 oz 40	Horizon 1½ pts 0	Lexone 5 oz 40	Nortron 2 pts 10	Sinbar ¾ lb 30

Table 13. Percent control of seedling 'Cypress' roughstalk bluegrass for the following herbicides applied alone, and in combination, November 3, 1994 (except Horizon, March 25, 1995) to plots in a commercial field near Madras, Oregon.

Sinbar ½ lb **60**	Sinbar ½ lb Assert 1½ pts **85**	Sinbar ½ lb Banvel 5 pts **25**	Sinbar ½ lb Beacon ¾ oz **85**	Sinbar ½ lb Diuron 2 lbs **98**	Sinbar ½ lb Goal 20 oz **85**	Sinbar ½ lb Horizon 1½ pts **80**	Sinbar ½ lb Lexone 5 oz **90**	Sinbar ½ lb Nortron 2 pts **80**	Sinbar ½ lb Sinbar ¾ lb **98**
Nortron 1 pt **0**	Nortron 1 pt Assert 1½ pts **10**	Nortron 1 pt Banvel 5 pts **10**	Nortron 1 pt Beacon ¾ oz **30**	Nortron 1 pt Diuron 2 lbs **75**	Nortron 1 pt Goal 20 oz **10**	Nortron 1 pt Horizon 1½ pts **5**	Nortron 1 pt Lexone 5 oz **70**	Nortron 1 pt Nortron 2 pts **10**	Nortron 1 pt Sinbar ¾ lb **90**
Lexone 2 oz **10**	Lexone 2 oz Assert 1½ pts **25**	Lexone 2 oz Banvel 5 pts **10**	Lexone 2 oz Beacon ¾ oz **70**	Lexone 2 oz Diuron 2 lbs **80**	Lexone 2 oz Goal 20 oz **25**	Lexone 2 oz Horizon 1½ pts **15**	Lexone 2 oz Lexone 5 oz **75**	Lexone 2 oz Nortron 2 pts **70**	Lexone 2 oz Sinbar ¾ lb **90**
Horizon ¾ pt **5**	Horizon ¾ pt Assert 1½ pts **10**	Horizon ¾ pt Banvel 5 pts **10**	Horizon ¾ pt Beacon ¾ oz **40**	Horizon ¾ pt Diuron 2 lbs **50**	Horizon ¾ pt Goal 20 oz **5**	Horizon ¾ pt Horizon 1½ pts **0**	Horizon ¾ pt Lexone 5 oz **40**	Horizon ¾ pt Nortron 2 pts **5**	Horizon ¾ pt Sinbar ¾ lb **85**
Goal 10 oz **0**	Goal 10 oz Assert 1½ pts **25**	Goal 10 oz Banvel 5 pts **10**	Goal 10 oz Beacon ¾ oz **50**	Goal 10 oz Diuron 2 lbs **60**	Goal 10 oz Goal 20 oz **15**	Goal 10 oz Horizon 1½ pts **0**	Goal 10 oz Lexone 5 oz **60**	Goal 10 oz Nortron 2 pts **5**	Goal 10 oz Sinbar ¾ lb **95**
Diuron 1 lb **40**	Diuron 1 lb Assert 1½ pts **80**	Diuron 1 lb Banvel 5 pts **10**	Diuron 1 lb Beacon ¾ oz **60**	Diuron 1 lb Diuron 2 lbs **85**	Diuron 1 lb Goal 20 oz **65**	Diuron 1 lb Horizon 1½ pts **25**	Diuron 1 lb Lexone 5 oz **75**	Diuron 1 lb Nortron 2 pts **35**	Diuron 1 lb Sinbar ¾ lb **100**
Beacon oz **5**	Beacon oz Assert 1½ pts **40**	Beacon oz Banvel 5 pts **10**	Beacon oz Beacon ¾ oz **50**	Beacon oz Diuron 2 lbs **85**	Beacon oz Goal 20 oz **30**	Beacon oz Horizon 1½ pts **10**	Beacon oz Lexone 5 oz **70**	Beacon oz Nortron 2 pts **15**	Beacon oz Sinbar ¾ lb **90**
Banvel 2½ pts **0**	Banvel 2½ pts Assert 1½ pts **15**	Banvel 2½ pts Banvel 5 pts **10**	Banvel 2½ pts Beacon ¾ oz **25**	Banvel 2½ pts Diuron 2 lbs **40**	Banvel 2½ pts Goal 20 oz **30**	Banvel 2½ pts Horizon 1½ pts **10**	Banvel 2½ pts Lexone 5 oz **50**	Banvel 2½ pts Nortron 2 pts **5**	Banvel 2½ pts Sinbar ¾ lb **80**
Assert ¾ pt **10**	Assert ¾ pt Assert 1½ pts **30**	Assert ¾ pt Banvel 5 pts **5**	Assert ¾ pt Beacon ¾ oz **40**	Assert ¾ pt Diuron 2 lbs **85**	Assert ¾ pt Goal 20 oz **50**	Assert ¾ pt Horizon 1½ pts **10**	Assert ¾ pt Lexone 5 oz **75**	Assert ¾ pt Nortron 2 pts **5**	Assert ¾ pt Sinbar ¾ lb **95**
Untreated **0**	Assert 1½ pts **50**	Banvel 5 pts **5**	Beacon ¾ oz **25**	Diuron 2 lbs **75**	Goal 20 oz **0**	Horizon 1½ pts **5**	Lexone 5 oz **75**	Nortron 2 pts **5**	Sinbar ¾ lb **95**

EFFECT OF THE LEVEL OF ERGOT INFESTED SEED ON DISEASE INCIDENCE

Marvin Butler, Fred Crowe, Dale Coats, and Steve Alderman

Abstract

Ergot sclerotia are the primary means of survival and source of inoculum for infection of grass flowers. To determine if there is a direct correlation between the number of sclerotia present in seed at planting and incidence of the disease in following years, `Coventry' Kentucky bluegrass seed was infested with 0, 0.1, 1, 4, 7, and 10 percent ergot sclerotia by weight. One hundred panicle samples were harvested from each plot and evaluated for panicles with sclerotia, average sclerotia per panicle, and total sclerotia per sample. There were no significant differences in the number of sclerotia present at harvest for the various levels of infestation.

Introduction

Ergot, *Calvicpes purpurea,* is an important flower-infecting pathogen that is particularly damaging to Kentucky bluegrass seed production. The pathogen produces an elongated, black sclerotia that replaces seed in infected florets and causes a reduction in yield. These sclerotia are the primary means of survival and source of inoculum. In the spring, during flowering, spores from the sclerotia infect the grass flower and produce secondary spores within an exudate (honeydew), which can make harvest difficult. Secondary spores may also be splashed or carried to new florets to infect. The objective of this study is to determine if there is a direct correlation between the number of sclerotia present in seed at planting and incidence of the disease in following years.

Methods and Materials

`Coventry' Kentucky bluegrass seed was infested with 0, 0.1, 1, 4, 7, and 10 percent ergot sclerotia by weight. This seed was planted September 21, 1994 in 10 ft x 10 ft plots replicated four times at the Central Oregon Agricultural Research Center, Powell Butte location. Plots were separated by 10 foot borders planted with `Stevens' wheat to provide isolation and prevent movement of secondary spores by wind and insects between plots.

One hundred panicle samples were harvested from each plot on July 1, 1995. Samples were evaluated for percent of panicles with sclerotia, average sclerotia per panicle, and total sclerotia per 100 panicle sample.

Results and Discussion

There were no differences in the number of sclerotia present at harvest between the different levels of ergot-infested seed at planting (Table 1). Possible explanations would include that much of the inoculum came from outside the plots as either ascospores or as secondary spores associated with insect movement. The 10 foot borders of wheat may not have been sufficient to prevent cross contamination between plots, or alternately, spores could have come from well outside the trial area. With the plots being sprinkler-irrigated twice a week prior to harvest, it appeared that a moist, high-humidity microclimate developed in the protected pockets of grass surrounded by the three-foot high wheat. This would have provided near optimum conditions for ergot infection during flowering. Further, secondary infection may have been highly favored under these conditions, which could have been initiated by relatively few ascospores. This might account for the relatively low percentage of panicles that were highly infected.

Compared to the untreated plots in related fungicide evaluations for ergot control at the same location, the number of panicles infected with sclerotia were nearly double the average of those in this study. In 1993 the number of panicles with sclerotia in untreated fungicide plots were 70 with a total of 466 sclerotia per 100 panicle sample. The number of panicles with sclerotia in 1994 were 92 with a total of 858 sclerotia per 100 panicle sample. The range of panicles with sclerotia for this study were 38 to 52, with total sclerotia per sample of 801 to 1125.

Because there appeared to be a high level of ergot sclerotia throughout the plots at harvest, a second planting was established at the Central Oregon Agricultural Research Center, Madras location, with an upper infestation rate of 3 percent, rather than the10 percent in the current study. Both sets of plots will be evaluated during the 1996 harvest.

Table 1. Evaluation of the effect of various levels of ergot-infested seed on incidence of the disease at the Central Oregon Agricultural Research Center, Powell Butte location, during 1994-1995.

Level of Infestation	Panicles with Sclerotia	Sclerotia per panicle	Sclerotia per sample
(percent)	---------------(number per 100 panicles)----------------		
0	40	7.8	801
0.1	38	8.8	931
1	46	10.7	1125
4	44	9.8	1030
7	52	10.6	1110
10	38	8.4	876
	n.s.[1]	n.s.	n.s.

[1] Non-significant separation of means with the T-method at $P \leq 0.05$

DEVELOPMENT OF CONTROL PROGRAM FOR *CLAVICEPS PURPUREA* IN KENTUCKY BLUEGRASS SEED PRODUCTION, 1994

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Abstract

Ergot, an important flower-infecting pathogen affecting grass production, is particularly damaging to Kentucky bluegrass (*Poa pratensis* L). To determine control measures for this disease, fungicides were evaluated at two locations in central Oregon. Plots at the Central Oregon Agricultural Research Center (COARC), Powell Butte location, were infested with ergot a 1 sclerotia/ft^2 in January to encourage presence of the disease. Incidence of ergot was extremely high at Powell Butte, but quite low at the Trail Crossing near Culver. A single application of Punch or double application of Tilt at 8 oz/a statistically out-performed a single application of Tilt at 4 oz/a with standard surfactants, weekly chlorine treatments, and the nontreated plots. A double Orthorix application provided similar control to a single application of Tilt at 4 oz/a. Differences in seed weight and percent germination between treatments were not significant.

Introduction

Ergot, caused by the fungus *Claviceps purpurea*, is an important flower-infecting pathogen in grass seed production regions of the Pacific Northwest. Of the grass species grown for seed in Oregon, Kentucky bluegrass is particularly affected by ergot. Traditional control has been through open field burning, which has partially suppressed the disease.

Fungicide evaluations in central Oregon during the 1992-93 seasons indicated excellent ergot control with Punch, while Tilt and Folicur provided moderate to good control. Ergot suppression was added to the Tilt label in 1995 through a 24(c) special local need registration as a result of this research project. Tilt was previously registered for powdery mildew and rust control on grass seed crops. Registration of Punch in the United States is not being pursued, and Folicur has been under evaluation at EPA for several years.

Methods and Materials

During the 1994 season fungicides were evaluated for control of ergot in a `Coventry' Kentucky bluegrass seed field at Trail Crossing near Culver, Oregon. A second field of `Coventry' located at the COARC, Powell Butte, was infested with ergot at 1 sclerotia/ft^2 on January 28, 1994. Fusilazole (Punch, Dupont), propiconazole (Tilt, Ciba), tebuconazole (Folicur, Bayer), and Orthorix (Best Sulfur Products) were evaluated during the 1994 season, with an emphasis on Tilt since it is currently registered for grass seed. Surfactants Silwet-77 and Penaturf were evaluated as the second of two applications following Tilt. Orthorix and chlorine were included in the trial as multiple applications, with chlorine applied weekly to simulate application during irrigation.

Materials were applied to 10 ft x 20 ft plots, replicated four times in a randomized complete block design, with 8003 TwinJet nozzles on a 9-foot CO_2 pressurized boom sprayer at 40 psi and 30 gal/a water. Silwet-77 at 8 oz/100 gal and R-56 at 1 pt/100 gal were applied in combination with all fungicides except Orthorix, chlorine, and one 4 fl oz Tilt treatment.

Treatments were applied at the Trail Crossing location on May 30 and June 10, and at the Powell Butte site on May 31 and June 10, plus weekly chlorine applications. The first treatments were applied at the initiation of anthesis at the Trail Crossing location, and early anthesis at the Powell Butte site.

One hundred panicles were collected from each plot on June 30 at the Trail Crossing location, and July 6 at the Powell Butte site. Number of panicles with sclerotia, sclerotia per panicle, and total sclerotia per sample were determined for each plot. Seed weight per sample and weight per 1,000 seed was determined following standard separation procedures. Seed germination followed the Association of Official Seed Analysts (AOSA) rules for testing seed.

Results and Discussion

Incidence of ergot at the Powell Butte site was extremely high, with the infection level at Trail Crossing location relatively low. At the Trail Crossing location, there were no significant differences between treatments (Table 1) when comparing either panicles with sclerotia, sclerotia per panicle, or total sclerotia per sample. Comparison of the number of sclerotia per sample at the Powell Butte site (Table 2) indicates a single application of Punch providing the most effective control of ergot. A single Punch application or a double application of Tilt at 8 oz/a statistically out-performed a single application of Tilt at 4 oz/a with standard surfactants, weekly chlorine treatments, and the nontreated plots. A double Orthorix application provided similar control to a single application of Tilt at 4 oz/a.

Seed weight per sample or weight per 1,000 seed were not significantly different at either location, but seed weight per sample was substantially lower at Powell Butte due to the severe level of ergot infection and/or possibly cultural practices during the growing season. Differences in seed germination were not significant between treatments at either locations.

Table 1. Evaluation of fungicides applied for ergot control to` Coventry Kentucky' bluegrass in the Trail Crossing area near Culver, Oregon on May 30 and June 10, 1994.

Fungicide Treatments	Rate May 30	Rate June 10	Panicles with sclerotia	Total sclerotia per sample	Weight per sample	1000 seed weight	Seed Germination
	(fl oz/a)		(%)	(no.)	(g)	(g)	(%)
Punch 25E	28		0.3	0.3	5.61	0.34	89
Tilt 3.6E	4[1]		0.3	0.3	5.57	0.35	90
Tilt 3.6E + Tilt 3.6E	4[1]	4[1]	1.3	2.5	6.20	0.35	87
Tilt 3.6E	4		1.0	1.5	5.48	0.34	89
Tilt 3.6E	4[2]		1.5	4.5	5.40	0.33	90
Tilt 3.6E + Tilt 3.6E	4	4	0.3	0.5	5.84	0.34	88
Tilt 3.6E + Orthorix	4	64	0.3	0.3	5.68	0.33	87
Tilt 3.6E + Silwet-77	4	8[3]	1.0	1.3	6.03	0.35	91
Tilt 3.6E + Penaturf	4	42	1.3	2.0	5.24	0.36	91
Tilt 3.6E	8		0.5	1.0	5.34	0.36	82
Tilt 3.6E + Tilt 3.6E	8	8	0	0	5.63	0.33	92
Folicur 3.6F	4		0.5	0.8	6.38	0.35	94
Folicur 3.6F	8		3.0	9.0	5.45	0.34	93
Orthorix	64	64	1.0	1.8	4.92	0.35	93
Chlorine (applied weekly)	4[4]		4.0	9.5	5.15	0.35	92
Untreated			1.5	4.5	5.80	0.35	92
			n.s.	n.s.	n.s.	n.s.	n.s.

[1] Aerial application
[2] Application with Penaturf at 42 fl oz rather than standard surfactants
[3] Silwet-77 applied at 8 oz per 100 gals
[4] Applied weekly from May 30 to June 17
Mean separation with T-method at $P \leq 0.05$

Table 2. Evaluation of fungicides applied for ergot control to `Coventry' Kentucky bluegrass at the COARC Powell Butte site, Oregon on May 31 and June 10, 1994.

Fungicide Treatments	Rate May 31	Rate June 10	Panicles with sclerotia	Total sclerotia per sample	Weight per sample	1000 seed weight	Seed Germination
	(fl oz/a)		(%)	(no.)	(g)	(g)	(%)
Punch 25E	28		53 c	148 d	1.80	0.38	93
Tilt 3.6E	4[1]		88 ab	665 abc	1.65	0.40	88
Tilt 3.6E	4		90 a	800 ab	1.67	0.39	89
Tilt 3.6E	4[2]		76 ab	348 bcd	1.53	0.38	94
Tilt 3.6E + Tilt 3.6E	4	4	87 ab	412 abcd	1.83	0.38	93
Tilt 3.6E + Orthorix	4	64	80 ab	596 abcd	1.90	0.41	93
Tilt 3.6E + Silwet-77	4	8[3]	88 ab	655 abc	1.86	0.40	94
Tilt 3.6E + Penaturf	4	42	89 ab	595 abcd	1.64	0.38	93
Tilt 3.6E	8		74 abc	381 abcd	2.03	0.38	94
Tilt 3.6E + Tilt 3.6E	8	8	66 bc	250 cd	2.06	0.38	92
Folicur 3.6F	4		80 ab	628 abcd	1.59	0.39	88
Folicur 3.6F	8		87 ab	584 abcd	1.81	0.39	90
Orthorix	64	64	88 ab	633 abcd	1.78	0.39	93
Chlorine (applied weekly)	4[4]		92 a	813 ab	1.54	0.40	86
Untreated			92 a	858 a	1.59	0.38	91
					n.s.	n.s.	n.s.

[1] Application at 20 gals/a with TeeJet nozzles rather than 30 gals/a with TwinJet nozzles
[2] Application with Penaturf at 42 fl oz rather than standard surfactants
[3] Silwet-77 applied at 8 oz per 100 gals
[4] Applied weekly from May 30 to June 17
Mean separation with T-method at $P \leq 0.05$