Central Oregon Agricultural Research Center
Madars, Oregon

ANNUAL REPORT 2002

Research conducted in 2001

INTRODUCTION

Central Oregon Agricultural Research Center's (COARC) faculty and staff are pleased to present this summary of research activities conducted during 2001. Our research activities are in large part based on mutually identified high priority areas and opportunities facing agriculture. It is with special thanks that we acknowledge the many growers, industry personnel, and others who have assisted and helped focus our efforts.

The agricultural industry in central Oregon faces a changing question of what to grow, as old standby crops leave the area because of decreasing demand, low prices, and crops that are "diseased out". Our goal is to shift more resources devoted to addressing the increasing complex problems associated with potential new crops for the area.

Our ability to be meet the research needs is challenged by the large short fall in state funds in the 2002-03 budget year and proposed cuts to the agricultural research system. Our vacant crop scientist position is on hold until the budget is satisfactorily resolved. This position is critical for us to address issues facing agriculture. Nevertheless, we are pleased that during the last legislative session a funded research assistant position was authorized for cereals and cropping systems. This position has added focus and clarity to portions of our research.

Obtaining funding from Federal and State governments to support our efforts is a continuing problem. As these funds have become limited we have made an increasing effort to seek grants and other outside funding to support research and maintenance and repair of our facilities. Central Oregon's agriculture is a unique mix of specialty crops, many of which are not supported by commodity organizations and often do not meet the guidelines for grants. Obtaining research support for this unique mix of crops and for screening potential new crops requires innovative grant writing and searching for new funding sources.

Our research report acknowledges our cooperators through authorship. We extend special thanks to growers who have been invaluable in collaborating with off-station research. Growers generously supply land and resources and tolerate the inconvenience caused by research. Their efforts are deeply appreciated. In addition, the agricultural industry has been responsive to requests for support and assistance and has freely shared their observations and resources.

Many of our research activities are joint projects with researches at other branch stations, Oregon State University campus, or at other research institutions. It is with this large pool of collaboration and partnerships that we have been able conduct research, which is much greater than just the sum of our resources alone.

For those who have access to the Internet, we invite you to view our home page at http://www.orst.edu/dept/coarc. You will find this publication on the COARC web site along with summaries of past research projects and other information. We welcome any comments you might offer on how we can make the web page more useful.

Finally, I thank all the faculty, staff, including our seasonal employees, for their dedication and efforts. At a time when commitment and productivity of public employees is questioned, government money is declining, and regulations increasing, we can be proud of the dedication from staff for all we have accomplished.

Clint Jacks
Superintendent
Central Oregon Agricultural Research Center

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WEATHER INFORMATION: 2001 WATER YEAR, POWELL BUTTE, OREGON (SOURCE: AGRIMET)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
AIR TEMPERATURE (°F)												
Avg. Maximum	59	41	41	41	42	54	54	71	70	78	82	76
Avg. Minimum	32	23	26	25	23	27	29	36	39	46	47	41
Mean	45	32	33	33	32	41	42	55	56	63	66	59
AIR TEMP (no. of days)												
Max. 90°F or Above	0	0	0	0	0	0	0	0	0	1	6	0
Max. 32°F or Below	0	7	3	4	5	0	0	0	0	0	0	0
Min. 32°F or Below	13	27	29	28	25	24	18	10	7	0	0	3
Min. 0°F or Below	0	0	0	0	0	0	0	0	0	0	0	0
SOIL TEMP (°F at 4 in.)												
Avg. Maximum	52	41	37	36	37	42	47	59	65	68	67	60
Avg. Miniumum	49	39	36	35	35	40	43	53	60	62	63	58
SOIL TEMP (°F at 8 in.)												
Avg. Maximum	51	40	36	35	36	40	44	55	59	65	66	60
Avg. Miniumum	50	39	36	35	35	39	43	52	56	63	64	59
PRECIPITATION (in.)												
Monthly Total	1.06	0.49	0.46	0.34	0.44	0.76	1.05	0.21	0.94	0.68	0.28	0.08
EVAPORATION (in.)												
Daily Avg.	0.10	0.04	0.04	0.03	0.04	0.09	0.12	0.24	.025	0.30	0.26	0.19
WIND SPEED (mph)												
Daily Avg.	3.87	3.69	4.95	4.58	4.04	5.00	4.82	4.64	4.33	4.33	3.81	3.53
SOLAR RADIATION (langley)												
Daily Avg.	259	135	108	125	202	303	395	594	586	613	549	429
HUMIDITY (% relative humidity)												
Daily Avg.	68	79	77	74	76	68	67	49	58	52	54	52

GROWING SEASON	Last Day Before July 15	**First Day After** July 15	Total Number of Days **Between Temp. Mins.**
Air Temp Min.			
32°F or Below	Jun 25	Sep 5	73
28°F or Below	Jun 4	Oct 17	135
24°F or Below	Jun 4	Oct 18	136

WEATHER INFORMATION: 2001 WATER YEAR, MADRAS, OREGON (SOURCE: AGRIMET)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
AIR TEMPERATURE (°F)												
Avg. Maximum	60	41	38	39	42	54	56	73	72	81	86	79
Avg. Minimum	36	26	26	26	26	31	33	41	44	49	51	46
Mean Temp.	48	33	31	32	34	42	44	57	58	66	69	62
AIR TEMP (no. of days)												
Max. 90°F or Above	0	0	0	0	0	0	0	2	0	6	10	0
Max. 32°F or Below	0	6	8	1	4	0	0	0	0	0	0	0
Min. 32°F or Below	11	25	30	31	22	19	14	4	1	0	0	2
Min. 0°F or Below	0	0	0	0	0	0	0	0	0	0	0	0
SOIL TEMP (°F at 4 in.)												
Avg. Maximum	59	47	43	42	43	47	51	63	70	78	71	69
Avg. Miniumum	57	46	42	41	41	45	49	59	66	76	68	63
SOIL TEMP (°F at 8 in.)												
Avg. Maximum	56	46	41	40	41	45	49	59	67	74	----	67
Avg. Miniumum	55	45	41	40	40	44	48	57	65	73	----	65
PRECIPITATION (in.)												
Monthly Total	0.93	0.54	0.55	0.46	0.68	0.33	0.87	0.68	0.71	0.59	0.13	0.31
EVAPORATION (in.)												
Daily Avg.	0.09	0.03	0.01	0.02	0.04	0.09	0.13	0.25	0.26	0.31	0.29	0.20
WIND SPEED (mph)												
Daily Avg.	4.14	3.76	3.86	3.59	4.39	5.77	6.11	5.16	5.17	5.04	4.61	4.31
SOLAR RADIATION (langley)												
Daily Avg.	266	135	87	117	210	308	415	606	588	618	571	443
HUMIDITY (% relative humidity)												
Daily Avg.	68	82	88	86	79	66	64	47	54	48	47	47

GROWING SEASON	Last Day Before July 15	**First Day After** July 15	Total Number of Days **Between Temp. Mins.**
Air Temp Min.			
32°F or Below	Jun 4	Oct 9	127
28°F or Below	May 6	Oct 18	165
24°F or Below	Apr 14	Nov 6	206

EVALUATION OF APOGEE® ON KENTUCKY AND ROUGH BLUEGRASS, 2001

Marvin Butler, Bart Brinkman, Claudia Campbell, Brad Klann, and Kurt Feigner

Abstract

The growth regulator, Apogee® was evaluated on a commercial Kentucky bluegrass seed field (var. 'Merit') and a commercial rough bluegrass seed field (var. 'Laser') near Madras, Oregon. There were no significant differences between treatments for either Kentucky or rough bluegrass. There were no yield increases greater than 8 percent on Kentucky bluegrass or 10 percent on rough bluegrass. On the rough bluegrass, split applications may provide a slight advantage.

Introduction

Research to evaluate Apogee on Kentucky bluegrass was conducted during 1999. Three rates were applied early and late, or as a split application. The greatest reduction in plant height was from split applications at 11 oz/acre or 14.5 oz/acre. Lodging was best controlled with a late application at 22 oz/acre or 29 oz/acre. Yields showed the greatest increase with an early application at 29 oz/acre.

Methods and Materials

Plots 10 ft x 25 ft were replicated four times in a randomized complete block design in commercial fields of 'Merit' Kentucky bluegrass and 'Laser' rough bluegrass near Madras, Oregon. Apogee plots were added to an existing rough bluegrass trial after the first treatment of the growth regulator Palisade® had been applied. To fit existing plot configuration, treatments were replicated only three times. Apogee was applied to the Kentucky bluegrass at 14.5 oz/ acre on May 18 (very few heads visible), May 25 (heads out but not open), or as a split application at 7.3 oz/ acre across both dates. The same treatments were applied to rough bluegrass on May 18 (very few heads visible) and May 29 (heads beginning to open). Treatments were applied both with and without 2 percent ammonium sulfate (AMS). A non-ionic surfactant was added to all treatments at 0.25 percent.

Treatments were applied with a CO_2-pressurized, hand-held boom sprayer at 40 psi and 20 gal/acre water using TeeJet 8002 nozzles. Both Kentucky bluegrass and rough bluegrass plots were evaluated for plant height June 6, June 13, June 20, and June 29. Percent lodging was evaluated June 20 and June 29.

Prior to harvest, a Jari mower was used to cut 3-ft alleyways across the front and back of each row of plots. A research-sized swather was used to harvest a 42-in by 22-ft portion of Kentucky bluegrass plots July 3 and of rough bluegrass plots July 6. Samples were placed in large bags and hung in an equipment shed to dry, and then transported to Corvallis for combining with a Hege 180 at the Hyslop Farm. Tom Silberstein cleaned the seed at the Hyslop Farm. Thousand-seed counts were conducted using the seed-conditioning lab at the National Forage Seed

Production Research Center in Corvallis, and germination testing was done at the Central Oregon Agricultural Research Center.

Results and Discussion

There was no statistical difference between treatments on seed yield for either Kentucky or rough bluegrass (Tables 1-4). However, the trend was for Apogee at 14.5 oz/acre applied May 18, either with or without AMS, to increase yield on Kentucky bluegrass 8-10 percent. On rough bluegrass the split application of Apogee, either with or without AMS, tended to increase yields by 7-10 percent. Plant height on the final evaluation date was significantly reduced on Kentucky bluegrass by a split application of Apogee with AMS. On rough bluegrass the split application, either with or without AMS, significantly reduced lodging on the final evaluation date, while also generating the highest seed yields.

There were no differences between treatments for biomass harvested, percent germination, or 1,000 seed weight as a measure of seed size for either Kentucky bluegrass or rough bluegrass.

Table 1. Effect of Apogee growth regulator on yield, 1,000 seed weight, and percent germination of Kentucky bluegrass, Madras, Oregon, 2001.

Treatment	Application timing May 18	Application timing May 25	Seed yield lb/acre	Seed yield % check	1,000 seed weight	Germination
	--------product/acre-------		lb/acre	% check	--g--	--%--
Apogee	14.5 oz	----	1718[1]	108	0.408	83
Apogee+AMS[2]	14.5 oz +2%	----	1578	100	0.398	89
Apogee	7.3 oz	7.3 oz	1491	95	0.413	95
Apogee+AMS	7.3 oz +2%	7.3 oz +2%	1521	96	0.413	90
Palisade	1.5 pt	----	1446	92	0.413	89
Untreated	----	----	1584	100	0.420	88
			NS	NS	NS	NS

[1]Mean separation with Student-Newman-Kuels (SNK) Test at $P \leq 0.05$.
[2]AMS = ammonium sulfate.

Table 2. Effect of Apogee growth regulator on yield, 1,000-seed weight, and percent germination of rough bluegrass, Madras, Oregon, 2001.

Treatment	Application timing May 18	Application timing May 29	Seed yield lb/acre	Seed yield % check	1,000 seed weight	Germination
	--------product/acre--------		lb/acre	% check	--g--	--%--
Apogee	14.5 oz	----	1160[1]	96	0.271	86
Apogee+AMS[2]	14.5 oz +2%	----	1184	98	0.289	85
Apogee	7.3 oz	7.3 oz	1327	110	0.269	87
Apogee+AMS	7.3 oz +2%	7.3 oz +2%	1294	107	0.286	87
Palisade	1.5 pt	----	1333	110	0.278	91
Untreated	----	----	1211	100	0.264	88
			NS	NS	NS	NS

[1]Mean separation with Student-Newman-Kuels (SNK) Test at $P \leq 0.05$.
[2]AMS = ammonium sulfate.

Table 3. Effect of Apogee growth regulator on biomass, height, and lodging of Kentucky bluegrass, Madras, Oregon, 2001.

Treatment	Application timing: May 18	Application timing: May 25	Biomass	Plant height: June 6	Plant height: June 13	Plant height: June 20	Plant height: June 29	Lodging: June 20	Lodging: June 29
	--------product/acre--------		--t/acre--	-----------------------in-----------------------				-------%-------	
Apogee	14.5 oz	----	6.2	14.9 b[1]	20.9 ab	24.4 bc	28.5 ab	0	15
Apogee+AMS[2]	14.5 oz +2%	----	5.6	14.3 b	19.4 b	25.0 b	28.4 ab	0	5
Apogee	7.3 oz	7.3 oz	5.8	12.8 b	17.6 b	22.5 c	27.0 ab	0	10
Apogee+AMS	7.3 oz +2%	7.3 oz +2%	5.2	12.0 b	17.0 b	19.4 d	25.8 b	0	13
Palisade	1.5 pt	----	5.4	13.2 b	18.1 b	19.9 d	25.1 b	0	8
Untreated	----	----	5.5	19.0 a	23.6 a	28.0 a	30.0 a	0	8
			NS					NS	NS

[1]Mean separation with Student-Newman-Kuels (SNK) Test at $P \leq 0.05$.
[2]AMS = ammonium sulfate.

Table 4. Effect of Apogee growth regulator on biomass, height, and lodging of rough bluegrass, Madras, Oregon, 2001.

Treatment	Application timing: May 18	Application timing: May 29	Biomass	Plant height: June 6	Plant height: June 13	Plant height: June 20	Plant height: June 29	Lodging: June 20	Lodging: June 29
	--------product/acre---------		--t/acre--	-----------------------in-----------------------				-------%-------	
Apogee	14.5 oz	----	5.9	20.4	26.7	30.0	33.2	30	67 ab[1]
Apogee+AMS[2]	14.5 oz +2%	----	5.5	23.0	28.6	30.8	34.4	30	67 ab
Apogee	7.3 oz	7.3 oz	6.2	22.2	25.7	28.6	32.0	30	58 b
Apogee+AMS	7.3 oz +2%	7.3 oz +2%	5.8	22.5	25.2	27.2	31.7	30	50 b
Palisade	1.5 pt	----	5.7	22.3	26.1	29.7	31.1	30	69 ab
Untreated	----	----	5.9	24.7	27.3	32.6	35.5	30	94 a
			NS	NS	NS	NS	NS	NS	

[1]Mean separation with Student-Newman-Kuels (SNK) Test at $P \leq 0.05$.
[2]AMS = ammonium sulfate.

EVALUATION OF MILESTONE® FOR CROP TOLERANCE ON KENTUCKY BLUEGRASS AND ROUGH BLUEGRASS, 2000-2001

Marvin Butler, Claudia Campbell, Les Gilmore, Norm McKinley, and Dennis Wilson

Abstract

Milestone® herbicide was evaluated to determine the potential for use for seedling and weed control in Kentucky and rough bluegrass seed production. Three rates were broadcast over the rows (1 oz/acre to 4 oz/acre), followed by banded applications of 4 oz/acre and 8 oz/acre for Kentucky bluegrass and 5.25 oz/acre and 10.5 oz/acre for rough bluegrass. In general, the rates applied either broadcast or banded produced unacceptable levels of crop injury. Kentucky bluegrass shows more tolerance to Milestone than rough bluegrass.

Introduction

Grass seed growers in central Oregon are using banded spraying between rows to control weeds and seedlings. However, this leaves in-row seedlings and weeds that remain untreated. The objective of this trial was to evaluate Milestone as a banded spray between planted rows of Kentucky bluegrass and rough bluegrass in combination with low rates broadcast over the top to provide potential control of in-row seedlings and weeds.

Methods and Materials

Plots were placed in a commercial Kentucky bluegrass (‘Merit’) field and two commercial rough bluegrass (‘Laser’ and ‘Saber’) fields near Madras, Oregon. Plots were replicated three times in a split-block design, with the broadcast application as the main plots. Broadcast rates of Milestone were 1 oz/acre, 2 oz/acre, and 4 oz/acre. Sub-plots were banded with Milestone at 4 oz/acre, 8 oz/acre, and banded at 5.25 oz/acre and 10.5 oz/acre on the rough bluegrass locations.

Broadcast treatments were applied to 10-ft x 30-ft plots with a CO_2-pressurized, hand-held boom sprayer at 40 psi and 20 gal/acre water. Banded applications were applied with an experimental push-type shielded sprayer to 10-ft x 10-ft plots. Treatments were applied to the Kentucky bluegrass plots October 6 and to the rough bluegrass plots October 13, 2000. Plots were evaluated for percent between row seedling control and percent stand reduction on April 3 for the Kentucky bluegrass, April 5 for the ‘Laser’ rough bluegrass, and April 6 for the ‘Saber’ rough bluegrass.

Results and Discussion

Milestone applied broadcast alone significantly reduced grass stand for all treatments compared to untreated plots (Table 1), except Kentucky bluegrass at 1 oz/acre. Kentucky bluegrass (‘Merit’) shows greater tolerance to Milestone applied broadcast than rough bluegrass (‘Laser’, ‘Saber’), with 3 percent rather than 30 percent stand reduction at 1 oz/acre, 33 percent compared to 67 or 73 percent at 2 oz/acre, and 72 percent rather than 97 or 98 at 4 oz/acre.

Seedling control was greater for rough bluegrass than Kentucky bluegrass. Milestone broadcast at 1 oz/acre reduced Kentucky bluegrass seedlings by 17 percent, without a banded application. All other treatments were unacceptable, with stands of either Kentucky or rough bluegrass reduced between 50 and 100 percent. No seedlings were present in the 'Saber' rough bluegrass plots.

There appeared to be an effect on crop stands by banded application of Milestone alone, as indicated by the reduced stands observed in plots without a broadcast application. The crop stands in these plots were consistently reduced as banded application rates increased. This may have been the result of the product movement into the root zone, or increased Milestone concentrated at the base of the shields near the seed line.

The potential use of Milestone for row spraying appears greater for Kentucky bluegrass than rough bluegrass. However, lower rates will need to be evaluated to determine if adequate crop safety can be achieved.

Table 1. Milestone evaluation for crop tolerance on Kentucky bluegrass ('Merit') and Rough bluegrass ('Laser', 'Saber') in three commercial fields near Madras, Oregon, 2001.

Treatment		Stand reduction						Seedling control			
Broadcast	Banded	'Merit'		'Laser'		'Saber'		'Merit'		'Laser'	
-------Prod/acre-------		--------------------%--------------------						-------------%-------------			
4 oz	8 or 10.5 oz	91	a[1]	100	a	100	a	98	a	100	a
4 oz	4 or 5.25 oz	75	ab	100	a	100	a	95	a	100	a
4 oz	Untreated	2	ab	97	a	98	a	78	a	92	a
2 oz	8 or 10.5 oz	70	ab	99	a	100	a	90	a	100	a
2 oz	4 or 5.25 oz	40	c	94	a	100	a	85	a	99	a
2 oz	Untreated	33	cd	67	b	73	a	50	b	70	b
1 oz	8 or 10.5 oz	47	bc	97	a	100	a	88	a	100	a
1 oz	4 or 5.25 oz	7	d	85	ab	8	a	77	a	98	a
1 oz	Untreated	3	d	30	c	30	b	17	c	53	c
Untreated	8 or 10.5 oz	33	cd	80	ab	100	a	80	a	100	a
Untreated	4 or 5.25 oz	0	d	37	c	88	a	73	a	98	a
Untreated	Untreated	0	d	0	d	0	c	0	c	0	d

[1]Mean separation with Student-Newman-Kuels (SNK) Test at $P \leq 0.05$.

EVALUATION OF FUNGICIDES FOR CONTROL OF POWDERY MILDEW IN KENTUCKY BLUEGRASS SEED PRODUCTION IN CENTRAL OREGON, 2001

Marvin Butler, Claudia Campbell, and Martin Richards

Abstract

Fungicides were evaluated for control of powdery mildew in a commercial Kentucky bluegrass seed field near Madras, Oregon. Fungicide applications were made early in disease development and disease pressure remained low throughout the evaluation period. All fungicides significantly reduced powdery mildew compared to untreated plots, and generally provided similar disease control. However, the trend was for styletoil to provide less control that the other treatments.

Introduction

Fungicides have been evaluated yearly for control of powdery mildew in Kentucky bluegrass seed production fields since 1998. The new fungicides Quadris®, Folicur®, and Laredo® were compared to industry standards and other registered fungicides. During 2001 the objective was to apply fungicides at the first sign of disease infection, and include alternative products that may provide a more cost effective method of control early in the season.

Methods and Materials

Fungicides were evaluated for control of powdery mildew in a commercial field of Kentucky bluegrass ('Crest') grown for seed near Madras, Oregon. The fungicides Laredo, Tilt®, Folicur, Bayleton®, Microthiol®, and styletoil were applied alone. Bayleton was also applied in combination with Microthiol and styletoil. Treatments were made to 10-ft x 25-ft plots replicated four times in a randomized complete block design.

Plots were treated at the first sign of disease on April 16. Fungicides were applied with TeeJet 8002 nozzles on a 9-ft, CO_2-pressurized, hand-held boom sprayer at 40 psi and 20 gal of water/acre. Sylgard 309 was included in all treatments at 1 qt/100 gal except styletoil.

Plots were evaluated using a rating scale from 0 to 5, with 0 being no mildew present and 5 indicating total foliar coverage. Pretreatment evaluations were made on untreated plots. Due to inadequate disease development in the plot area, the only evaluation date was May 23.

Results and Discussion

On May 23 powdery mildew levels were minimal for evaluation. Under this light disease pressure all fungicides significantly reduced powdery mildew compared to untreated plots, and generally provided similar disease control (Table 1). However, the trend was for styletoil to provide less control than the other treatments, and Tilt was somewhat less effective than Folicur, Laredo, Microthiol, or Bayleton alone or in combination with Microthiol or styletoil.

Table 1. Severity of powdery mildew on Kentucky bluegrass near Madras, Oregon following fungicide application on April 16, 2001 and evaluated May 23, 2001.

Treatment[1]	Application rate	Severity of powdery mildew[2]	
	product/acre	0-5 rating scale	
Bayleton + Microthiol	4 oz + 3 lb	0.00	b[3]
Bayleton + Styletoil	4 oz + 1 qt	0.00	b
Bayelton	4 oz	0.02	b
Microthiol	5 lb	0.02	b
Laredo	8 oz	0.03	b
Folicur	4 fl oz	0.04	b
Tilt	4 fl oz	0.15	b
Styletoil	2 qt	0.23	b
Untreated	----	0.50	a

[1]All treatments except Styletoil were applied with Sylgard 309 at 1 qt/100 gal.
[2]Rating scale was 0 (no mildew) to 5 (total leaf coverage).
[3]Mean separation with Student-Newman-Kuels (SNK) Test at $P \leq 0.05$.

EVALUATION OF PALISADE® ON KENTUCKY AND ROUGH BLUEGRASS, 2001

Marvin Butler, Carl Buchholtz, Claudia Campbell, Brad Klann, and Kurt Feigner

Abstract

The growth regulator, Palisade® was evaluated on a commercial Kentucky bluegrass seed field (var. 'Merit') and rough bluegrass seed field (var. 'Laser') near Madras, Oregon. On Kentucky bluegrass there were no significant differences between treatments. However, the trend indicates that Palisade applications increased yields by 7 to 10 percent at rates of 1.0 to 2.5 pint/acre applied pre-anthesis on June 1. Rough bluegrass yields were significantly increased by 29 percent at 2.0 pint/acre applied May 9 compared to untreated plots or most rates applied May 29 when heads were beginning to open. There is no indication that rates above 2.0 pint/acre increase efficacy.

Introduction

Research to evaluate Palisade on Kentucky bluegrass was initiated during 1999. This was followed by a second year of evaluation during 2000 when Palisade was applied at 11 oz/a, 22 oz/a and 33 oz/a at each of the following growth stages: when one to two nodes were detectable (Feekes 7), when the heads were just emerging (Feekes 10.1) and when heads extended just above the flag leaf (Feekes 10.4). Yields were increased by 36 percent by Palisade applied at 22 oz/a from detection of the first and second node (Feekes 7) to when the head just becomes visible (Feekes 10.1) compared to untreated plots. Increasing the rate of Palisade increasingly reduced plant height and lodging. Late application when the heads extended just above the flag leaf (Feekes 10.4) produced the greatest reduction in plant size, while plants tended to out grow the effect of earlier Palisade applications. There were no differences between treatments in weight per 1,000 seed. Percent germination for Palisade treated plots was equal to or better than the untreated plots.

Methods and Materials

Plots 10 ft x 25 ft were replicated four times in a randomized complete block design in commercial fields of 'Merit' Kentucky bluegrass and 'Laser' rough bluegrass near Madras, Oregon. Palisade was applied at 1.5 pint/acre, 2.0 pint/acre and 2.5 pint/acre on the first two application dates, with the addition of a 1.0 pint/acre treatment for the third application. Treatments were applied to rough bluegrass on May 9 (2nd node detectable), May 18 (very few heads visible) and May 29 (heads beginning to open), and to Kentucky bluegrass on May 18 (very few heads visible), May 25 (heads out but not open) and June 1 (pre-anthesis). The Kentucky bluegrass was quite short in the plots and, unfortunately, the first node went undetected near the bottom up the stem. This delayed the first application beyond the targeted developmental stage.

Treatments were applied with a CO_2-pressurized, hand-held boom sprayer at 40 psi and 20 gal/a water using TeeJet 8002 nozzles. Both Kentucky bluegrass and rough bluegrass plots were evaluated for plant height June 6, June 13, June 20 and June 29. Percent lodging was evaluated June 20 and June 29.

Prior to harvest, a Jari mower was used to cut 3-foot alleyways across the front and back of each row of plots. A research-sized swather was use to harvest a 42 inch by 22-foot portion of Kentucky bluegrass plots July 3 and of rough bluegrass plots July 6. Samples were placed in large bags and hung in an equipment shed to dry, and then transported to Corvallis for combining with a Hege 180 at the Hyslop Farm. Tom Silberstein cleaned the seed at the Hyslop Farm. Thousand seed counts were conducted using the seed-conditioning lab at the National Forage Seed Production Research Center, and germination testing was done at the Central Oregon Agricultural Research Center.

Results and Discussion

There were no statistically significant differences between treatments on seed yield for Kentucky bluegrass. However, the trend was for Palisade to increase yields 7 to 10 percent, at rates of 1.0 to 2.5 pint/acre when applied pre-anthesis on June 1 (Table 1). Rough bluegrass yields were significantly increased at 2.0 pint/acre applied May 9, compared to untreated plots or most application rates made May 29 when heads were beginning to open (Table 2). There is no indication that rates above 2.0 pint/acre increases efficacy.

Reduction in plant height for Kentucky bluegrass was the greatest with Palisade applied at 2.5 pint/acre applied May 25. All treatments of Palisade greater than 1.0 pint/acre significantly reduced plant height on the final evaluation date compared to untreated plots. Plants tended to outgrow early applications of Palisade.

With rough bluegrass, the best treatment to control plant height appeared to be with Palisade applied at 2.5 pint/acre on May 9 or May 18, though it was not statistically significant (Tables 3-4). It didn’t appear that rough bluegrass outgrew earlier applications of Palisade. There was good correlation between plant height and percent lodging; however, the amount of biomass didn’t appear to be correlated with either.

There were no differences between treatments for percent germination or 1,000 seed weight as a measure of seed size for either Kentucky bluegrass or rough bluegrass. The only difference between biomass harvested per plot appears to be an anomaly between Palisade applied at 2.0 pint/acre on May 18 and on June 1 for Kentucky bluegrass.

Table 1. Effect of Palisade growth regulator on yield, 1,000 seed weight, and percent germination of Kentucky bluegrass, Madras, Oregon, 2001.

Treatment	Application timing May 18	May 25	June 1	Seed yield		1,000 seed weight	Germination
	--------product/acre--------			lb/acre	% check	--g--	--%--
Palisade	1.5 pt	----	----	1446[1]	92	0.413	89
Palisade	2.0 pt	----	----	1547	98	0.401	90
Palisade	2.5 pt	----	----	1537	97	0.398	86
Palisade	----	1.5 pt	----	1605	102	0.405	78
Palisade	----	2.0 pt	----	1534	98	0.396	89
Palisade	----	2.5 pt	----	1549	98	0.400	91
Palisade	----	----	1.0 pt	1692	107	0.411	87
Palisade	----	----	1.5 pt	1702	108	0.402	83
Palisade	----	----	2.0 pt	1713	109	0.410	90
Palisade	----	----	2.5 pt	1727	110	0.400	85
Untreated	----	----	----	1584	100	0.420	88
				NS	NS	NS	NS

[1]Mean separation with Student-Newman-Kuels (SNK) Test at $P \leq 0.05$.

Table 2. Effect of Palisade growth regulator on yield, 1,000 seed weight, and percent germination of rough bluegrass, Madras, Oregon, 2001.

Treatment	Application timing May 9	May 18	May 29	Seed yield				1,000 seed weight	Germination
	--------product/acre--------			lb/acre		% check		--g--	--%--
Palisade	1.5 pt			1263	ab[1]	104	ab	0.297	85
Palisade	2.0 pt			1560	a	129	a	0.275	89
Palisade	2.5 pt			1490	ab	123	ab	0.279	92
Palisade		1.5 pt		1333	ab	110	ab	0.278	91
Palisade		2.0 pt		1306	ab	108	ab	0.284	84
Palisade		2.5 pt		1294	ab	107	ab	0.296	87
Palisade			1.0 pt	1150	b	95	b	0.281	85
Palisade			1.5 pt	1200	b	100	b	0.281	89
Palisade			2.0 pt	1313	ab	109	ab	0.286	93
Palisade			2.5 pt	1212	b	100	b	0.286	88
Untreated	----	----	----	1211	b	100	b	0.264	88
								NS	NS

[1]Mean separation with Student-Newman-Kuels (SNK) Test at $P \leq 0.05$.

Table 3. Effect of Palisade growth regulator on biomass, height, and lodging of Kentucky bluegrass, Madras, Oregon, 2001.

Treatment	Application timing May 18	May 25	June 1	Biomass		Height June 6		June 13		June 20		June 29		Lodging June 20	June 29
	----product/acre----			--t/acre--		----------------------in----------------------								-------%-------	
Palisade	1.5 pt	----	----	5.4	ab[1]	13.2	cde	18.0	bcd	19.9	cd	25.1	bc	0	8
Palisade	2.0 pt	----	----	5.0	b	11.8	e	15.0	d	19.0	d	23.3	bc	0	0
Palisade	2.5 pt	----	----	5.9	ab	10.8	e	14.7	d	19.4	d	23.5	bc	0	0
Palisade	----	1.5 pt	----	5.7	ab	15.7	bcd	17.3	cd	21.0	bcd	23.7	bc	0	5
Palisade	----	2.0 pt	----	5.5	ab	14.3	cde	15.7	d	18.0	d	21.4	c	0	0
Palisade	----	2.5 pt	----	5.4	ab	12.3	de	13.7	d	14.6	e	17.8	d	0	0
Palisade	----	----	1.0 pt	5.6	ab	19.0	ab	21.8	ab	23.8	bc	27.3	ab	0	0
Palisade	----	----	1.5 pt	6.0	ab	20.1	a	20.8	abc	24.4	b	26.3	b	0	8
Palisade	----	----	2.0 pt	6.2	a	16.7	abc	17.9	bcd	18.8	d	22.1	c	0	0
Palisade	----	----	2.5 pt	6.0	ab	16.6	abc	17.8	bcd	20.6	bcd	21.5	c	0	0
Untreated	----	----	----	5.5	ab	19.0	ab	23.6	a	28.0	a	30.0	a	0	8
														NS	NS

[1]Mean separation with Student-Newman-Kuels (SNK) Test at $P \leq 0.05$.

Table 4. Effect of Palisade growth regulator on biomass, height, and lodging of rough bluegrass, Madras, Oregon, 2001.

Treatment	Application timing May 9	May 18	May 29	Biomass	Height June 6		June 13		June 20		June 29	Lodging June 20	June 29	
	----------product/acre----------			--t/acre--	-----------------------in-----------------------							-------%-------		
Palisade	1.5 pt	----	----	6.2	22.8	ab[1]	27.7	ab	31.5	ab	32.3	30	69	b
Palisade	2.0 pt	----	----	6.9	21.7	ab	26.2	ab	28.7	ab	31.8	30	56	b
Palisade	2.5 pt	----	----	6.4	18.6	b	23.8	b	28.2	b	30.3	30	50	b
Palisade	----	1.5 pt	----	5.7	22.3	ab	26.1	ab	29.7	ab	31.1	30	69	b
Palisade	----	2.0 pt	----	6.0	23.8	a	26.1	ab	29.0	ab	32.5	30	50	b
Palisade	----	2.5 pt	----	5.2	22.3	ab	25.7	ab	29.5	ab	30.5	30	50	b
Palisade	----	----	1.0 pt	5.1	25.3	a	28.9	a	32.8	a	33.6	30	75	b
Palisade	----	----	1.5 pt	5.7	25.3	a	26.4	ab	31.3	ab	32.8	30	50	b
Palisade	----	----	2.0 pt	6.2	22.6	ab	25.3	ab	29.0	ab	31.5	30	50	b
Palisade	----	----	2.5 pt	5.9	22.3	ab	27.1	ab	28.9	ab	31.7	30	63	b
Untreated	----	----	----	5.9	24.7	a	27.3	ab	32.6	ab	35.5	30	94	a
				NS							NS	NS		

[1]Mean separation with Student-Newman-Kuels (SNK) Test at P $\leq$ 0.05.

EVALUATION OF HERBICIDES FOR CONTROL OF CHEATGRASS, PERENNIAL RYEGRASS, AND ROUGH BLUEGRASS IN CENTRAL OREGON GRASS SEED PRODUCTION, 2000-2001

Marvin Butler, Les Gilmore, Ron Burr, Jed Colquhoun, and Claudia Campbell

Abstract

Herbicides were fall applied in combination over two application dates to Kentucky bluegrass, perennial ryegrass, and rough bluegrass to determine efficacy and crop safety. No injury was observed to Kentucky bluegrass or established perennial ryegrass. Treatments that included Axiom® provided 90-100 percent control of established rough bluegrass and 97-98 percent control of volunteer perennial ryegrass. Follow-up treatments of Goal® plus Sinbar® generally provided greater control than Goal plus Diuron®.

Introduction

Cheatgrass (downy brome) control in Kentucky bluegrass is a major concern to the grass seed industry in central Oregon. Contaminated seed lots must either be re-cleaned at a significant cost to the grower or remain largely unmarketable. The objective of this project was to evaluate herbicide treatments on a commercial Kentucky bluegrass field, a perennial ryegrass field, and two rough bluegrass fields. The new product, Axiom, was of particular interest in combination with current products in use.

Methods and Materials

Plots were replicated four times in a randomized complete block design in a commercial Kentucky bluegrass (cultivar 'Geronimo') seed field north of Madras, in a commercial perennial ryegrass (cultivar 'SH-2') field between Metolius and Culver, and two commercial rough bluegrass (cultivars 'Laser' and 'Saber II') fields west and north of Madras. Each plot received two herbicide applications. Treatments were applied to Kentucky bluegrass plots on September 25 and November 16, to the perennial ryegrass and 'Saber II' rough bluegrass plots on September 26 and November 16, and to the 'Laser' rough bluegrass on October 18 and November 16, 2000. A non-ionic surfactant was applied in combination with all treatments at 1 qt/100 gal. Treatments were made to 10-ft x 20-ft plots with a CO_2-pressurized, hand-held boom sprayer at 40 psi and 20 gal/acre water. Plots were evaluated March 9, 2001 for control of cheatgrass, volunteer perennial ryegrass, and established rough bluegrass, as appropriate for each location. Kentucky bluegrass plots were evaluated for crop injury, perennial ryegrass plots were evaluated for injury to established plants and control of seedling volunteers, and rough bluegrass was evaluated for injury to established plants ('Laser') and cheatgrass control ('Saber II').

Results and Discussion

There was no observable injury to either established Kentucky bluegrass or established perennial ryegrass. However, treatments that included Axiom provided 100 percent control of volunteer rough bluegrass (Table 1), between 90 and 100 percent control of established rough bluegrass (Table 2), and 97-98 percent control of volunteer perennial ryegrass. The follow-up treatments applied November 16 that included Goal plus Sinbar generally provided better control than Goal plus Diuron. Treatments that included Axiom in the first application did not gain efficacy by adding Prowl to the follow-up application.

Table 1. Cheatgrass control in 'Saber II' rough bluegrass and volunteers in established perennial ryegrass near Madras, Oregon 2000-2001.

Treatment		Product/acre		Percent control			
Sept 26	Nov 16	Sept 26	Nov 16	Cheatgrass		Volunteer ryegrass	
Axiom + Goal	Goal + Diuron	11 oz 8 oz	1.0 pt 1.0 lb	70	ab[1]	98	a
Axiom + Goal	Goal + Sinbar	11 oz 8 oz	1.0 pt 0.3 lb	70	ab	97	a
Axiom + Goal	Goal + Diuron + Sinbar	11 oz 8 oz	1.0 pt 1.0 lb 0.3 lb	70	ab	98	a
Axiom + Goal + Prowl	Goal + Diuron	11 oz 8 oz 5 pt	1.0 pt 1.0 lb	60	ab	98	a
Axiom + Goal + Prowl	Goal + Sinbar	11 oz 8 oz 5 pt	1.0 pt 0.3 lb	76	a	98	a
Axiom + Goal + Prowl	Goal + Diuron + Sinbar	11 oz 8 oz 5 pt	1.0 pt 1.0 lb 0.3 lb	70	ab	97	a
Goal + Prowl	Goal + Diuron	8 oz 5 pt	1.0 pt 1.0 lb	40	c	73	c
Goal + Prowl	Goal + Sinbar	8 oz 5 pt	1.0 pt 0.3 lb	53	b	85	b
Goal + Prowl	Goal + Diuron + Sinbar	8 oz 5 pt	1.0 pt 1.0 lb 0.3 lb	56	b	88	ab
Beacon	Goal + Diuron	0.75 oz	1.0 pt 1.0 lb	60	ab	53	d
Beacon	Goal + Sinbar	0.75 oz	1.0 pt 0.3 lb	66	ab	53	d
Beacon	Goal + Diuron + Sinbar	0.75 oz	1.0 pt 1.0 lb 0.3 lb	66	ab	78	c
Untreated	----	----	----	0	d	0	e

[1]Mean separation with Student-Newman-Keuls (SNK) Test at $P \leq 0.05$.

Table 2. Control of established 'Laser' rough bluegrass near Madras, Oregon 2000-2001.

Treatment		Product/acre		Percent control
Oct 18	Nov 16	Oct 18	Nov 16	Rough bluegrass
Axiom + Goal	Goal + Diuron	11.0 oz 4.0 oz	1.0 pt 2.0 lb	90 a[1]
Axiom + Goal	Goal + Sinbar	11.0 oz 4.0 oz	1.0 pt 0.75 lb	97 a
Axiom + Goal	Goal + Diuron + Sinbar	11.0 oz 4.0 oz	1.0 pt 2.0 lb 0.75 lb	99 a
Axiom + Goal + Prowl	Goal + Diuron	11.0 oz 4.0 oz 5.0 pt	1.0 pt 2.0 lb	93 a
Axiom + Goal + Prowl	Goal + Sinbar	11.0 oz 4.0 oz 5.0 pt	1.0 pt 0.75 lb	100 a
Axiom + Goal + Prowl	Goal + Diuron + Sinbar	11.0 oz 4.0 oz 5.0 pt	1.0 pt 2.0 lb 0.75 lb	98 a
Goal + Prowl	Goal + Diuron	4.0 oz 5.0 pt	1.0 pt 2.0 lb	60 b
Goal + Prowl	Goal + Sinbar	4.0 oz 5.0 pt	1.0 pt 0.75 lb	86 a
Goal + Prowl	Goal + Diuron + Sinbar	4.0 oz 5.0 pt	1.0 pt 2.0 lb 0.75 lb	96 a
Beacon	Goal + Diuron	0.75 oz	1.0 pt 2.0 lb	91 a
Beacon	Goal + Sinbar	0.75 oz	1.0 pt 0.75 lb	93 a
Beacon	Goal + Diuron + Sinbar	0.75 oz	1.0 pt 2.0 lb 0.75 lb	91 a
Untreated	----	---	----	0 c

[1]Mean separation with Student-Newman-Kuels (SNK) Test at $P \leq 0.05$.

EVALUATION OF RELY® FOR CROP TOLERANCE ON PERENNIAL RYEGRASS, 2000-2001

Marvin Butler, Les Gilmore, and Claudia Campbell

Abstract

Rely® was evaluated for stunting and stand reduction on perennial ryegrass near Madras, Oregon. Treatments were applied November 7, March 8, and March 27. Crop injury following application of Rely at 3 pint/acre increased as the number of applications increased from one to three. Single applications on either March 8 or March 27 did not significantly increase crop injury compared to untreated plots.

Introduction

Grass seed growers in central Oregon are concerned about cheatgrass control in all their grass seed crops, including the recently revived production of perennial ryegrass. The objective of this trial was to evaluate the timing of Rely on crop injury, when applied as single, double, or triple applications to perennial ryegrass.

Methods and Materials

Plots were placed in a commercial perennial ryegrass field (‘Gater II’) near Madras, Oregon. Plots were replicated three times in a randomized complete block design. Rely was applied without surfactant at 3 pint/acre as single, double, or triple applications on November 7, March 8, and March 27. Plots 10 ft x 20 ft were treated with a CO_2-pressurized, hand-held boom sprayer at 40 psi and 20 gal/acre water. Plots were evaluated for combined stunting and stand reduction on April 25.

Results and Discussion

Rely applied as a single application on either March 8 or March 27 did not significantly change stunting and stand reduction (Table 1) compared to untreated plots. The single March 8 application produced 3 percent stunting and stand reduction compared to 12 percent following the March 27 application. Double applications of Rely increased injury to 27 percent (March 8 and March 27 applications) and 30 percent (November 7 and March 8 applications) compared to untreated or single applications. A triple application of Rely (November 7, March 8, and March 27) produced 53 percent injury.

Anything over a single application of Rely at 3 pint/acre caused unacceptable crop injury. Additional evaluations are needed to determine optimal application timing.

Table 1. Effect of Rely herbicide on combined stunting and stand reduction on perennial ryegrass (‘Gater II’) near Madras, Oregon, 2000-2001.

Product	Application timing: November 7	March 8	March 27	Combined stunting and stand reduction
	-------------------product/acre-----------------			----%----
Untreated	----	----	----	0 a[1]
Rely	----	3.0 pt	----	3 a
Rely	----	----	3.0 pt	12 a
Rely	----	3.0 pt	3.0 pt	27 b
Rely	3.0 pt	3.0 pt	----	30 b
Rely	3.0 pt	3.0 pt	3.0 pt	53 c

[1]Mean separation with Student-Newman-Kuels (SNK) Test at $P \leq 0.05$.

EVALUATION OF POSTEMERGENCE HERBICIDES ON EIGHT NATIVE GRASS SPECIES GROWN FOR SEED, 2000-2001

Marvin Butler, Peter Sexton, Claudia Campbell, Rhonda Bafus, and Tom Shibley

Abstract

Herbicide screenings were conducted on eight native grass species: great basin wildrye, bluebunch wheatgrass, streambank wheatgrass, big bluegrass, Idaho fescue, Indian ricegrass, squirreltail, and prairie junegrass. Fall-applied treatments on October 18, 2000. included 1x and 2x rates of Axiom®, Beacon®, Clarity®, Diuron®, Frontier®, Goal®, Kerb®, Maverick®, Sencor®, Sinbar®, and Surflan®. Dormant application of Maverick, Milestone®, Rely®, and Roundup® were made November 3, 2000. Herbicides causing the most damage across grass species were Roundup applied during dormancy, and 2x fall-applied treatments of Sinbar and Kerb. Herbicides applied at a 2x rate that caused the least damage were Frontier, Goal, and Surflan. The greatest reduction on heading across the herbicide treatments was on Idaho fescue, prairie junegrass, and squirreltail. Grass species with the least effect on heading following herbicide treatments were bluebunch wheatgrass, great basin wildrye, and streambank wheatgrass.

Introduction

The demand for seed of native grasses used to reseed burned or otherwise disturbed rangelands continues to increase. Because agricultural production of native grasses is relatively new, management practices are still in the process of being determined. One of the major factors for successful production is adequate weed control. The objective of this project is to evaluate the crop safety of potential herbicides that may be used in native grass seed production.

Materials and Methods

On April 20, 2000 big bluegrass, bluebunch wheatgrass, squirreltail, great basin wildrye, streambank wheatgrass, and Idaho fescue were planted at a rate of 45 seeds/ft. Indian ricegrass was planted at a rate of 90 seeds/ft and prairie junegrass was planted at 135 seeds/ft. A four-row small-plot cone planter (Almaco, Inc.) was used, with a planting depth of 0.25 in. Plots were a single row, 80 ft long, with 2-ft row spacing. Plots were irrigated as needed to keep the seed zone moist for 2 weeks following planting. Weeds were controlled by hoeing and cultivation, with no herbicides applied prior to plot treatment.

Most herbicides were applied at both 1x and 2x rates. Application timing included fall-applied herbicides on October 18 and herbicides applied during dormancy on November 3, 2000. Treatments were applied with a CO_2-pressurized, hand-held, boom sprayer at 40 psi and 20 gal/acre water in 9-ft bands perpendicular to the grass rows. A non-ionic surfactant was added at 0.5 percent v/v to the November 3 application of Maverick only.

Evaluations were conducted using a rating scale from 0 (no negative effect) to 5 (maximum negative effect). Plots were evaluated for stunting, chlorosis, and mortality on March 27 and 28, 2001. Reduced heading was evaluated June 16-19, and stand reduction was evaluated November

2, 2001. Data were analyzed as a randomized complete block design, and no comparisons were made between grasses.

Results

Table 1 is a summary of the results for herbicide treatments across the eight native grass species for both stand reduction and reduced heading. Less than 10 percent damage is indicated by a +, more than 50 percent damage is shown with a –, while 10-50 percent damage received a 0. Separate numerical ratings for the effect of herbicide treatments on reducing heading and stand reduction are provided in tables 2 and 3.

Treatments that caused the most damage across grass species were Roundup at 1.5 pint/acre applied during dormancy, and 2x fall-applied treatments of Sinbar at 1.5 lb/acre and Kerb at 0.8 lb/acre. The safest herbicides at the 2x rate across grass species were Frontier at 64 fl oz/acre, Goal at 20 oz/acre and Surflan at 6 qt/acre. Other 2x herbicide treatments that were relatively safe include Axiom at 22 oz/acre, Beacon at 1.52 oz/acre, Maverick at 1.34 oz/acre and Milestone at 4 oz/acre.

Stand reduction following herbicide treatments was the greatest for Indian ricegrass and great basin wildrye, followed by squirreltail, prairie junegrass, and Idaho fescue. Stands were least affected by herbicide treatments for streambank wheatgrass and big bluegrass.

Grass species where heading was least affected following herbicide treatments were bluebunch wheatgrass, great basin wildrye, and streambank wheatgrass. Grass species with the greatest reduction in heading following herbicide treatments were Idaho fescue, prairie junegrass, and squirreltail. It is interesting to note that herbicide treatments on these three species generally had little effect on stand reduction but did cause a strong reduction in heading.

Table 4 through Table 11 provide results by grass species for stunting, chlorosis, mortality, stand reduction, and reduced heading following each of the herbicide treatments.

Table 1. Summary of herbicide effect on stand reduction (SR) evaluated on November 2 and reduced heading (RH) evaluated on June 16-19 across native grass species, 2001.

			Gr basn wrye		Blbnch whtgr		Strmbk whtgr		Big blgr		Idaho fescue		Indianricegr		Squirreltail		Pr. junegr	
Treatment	Rate/acre	Timing	SR	RH	SR	RH	SR	RH	SR	RH	SR	RH	SR	RH	SR	RH	SR	RH
Axiom	11 oz	fall	0[1]	0	+	+	+	0	+	–	+	0	0	0	+	+	+	–
Axiom	22 oz	fall	+	+	+	0	+	0	+	–	+	–	+	0	0	+	0	–
Beacon	0.76 oz	fall	0	+	+	+	0	0	+	+	+	0	+	0	+	0	+	0
Beacon	1.52 oz	fall	+	0	0	+	+	0	+	+	+	0	+	0	+	–	0	–
Clarity	4 pt	fall	0	0	+	0	0	0	+	0	0	–	0	0	0	–	0	–
Clarity	8 pt	fall	0	–	0	–	+	–	+	0	0	–	0	–	0	–	+	–
Diuron	1.8 lb	fall	+	+	0	+	+	+	+	0	+	0	0	0	+	0	0	–
Diuron	3.6 lb	fall	0	0	0	–	0	0	+	–	0	–	0	0	–	–	0	–
Frontier	32 fl oz	fall	0	0	+	+	+	+	+	0	0	0	–	0	+	+	+	0
Frontier	64 fl oz	fall	+	+	+	+	+	+	+	+	+	–	+	+	+	+	+	0
Goal	10 fl oz	fall	+	+	+	+	+	+	+	+	+	0	0	+	+	0	0	+
Goal	20 fl oz	fall	0	+	+	+	+	+	+	+	+	0	0	0	+	–	+	0
Kerb	0.4 lb	fall	0	–	0	–	+	0	0	–	0	–	0	0	–	–	+	–
Kerb	0.8 lb	fall	–	–	–	–	+	–	–	–	–	–	0	0	–	–	–	–
Maverick	0.67 oz	fall	0	+	+	+	+	+	+	+	0	–	0	0	0	0	+	0
Maverick	1.34 oz	fall	0	0	+	+	+	0	+	0	0	–	0	0	+	+	+	–
Maverick	0.67 oz	dormant	0	0	+	+	+	0	+	0	0	–	0	0	+	–	0	–
Milestone	2 oz	dormant	+	+	0	+	+	+	+	+	+	0	0	0	+	–	+	+
Milestone	4 oz	dormant	0	+	+	+	+	+	+	0	0	0	0	0	+	+	0	0
Rely	3 pt	dormant	+	+	0	0	+	+	+	0	+	0	0	0	+	–	+	0
Roundup	1.5 pt	dormant	0	–	–	–	–	–	–	–	–	–	0	–	–	–	–	–
Sencor	0.4 lb	fall	0	0	+	+	+	+	+	0	+	0	+	0	0	0	0	+
Sencor	0.8 lb	fall	0	+	+	+	0	0	–	–	0	–	0	0	0	0	0	–
Sinbar	0.75 lb	fall	+	0	+	0	+	0	0	0	+	0	+	0	–	–	0	0
Sinbar	1.5 lb	fall	–	–	–	–	–	–	–	–	–	–	+	0	–	–	–	–
Surflan	3 qt	fall	0	+	+	+	+	+	+	+	+	0	0	0	+	+	+	0
Surflan	6 qt	fall	+	+	0	+	+	+	+	+	0	0	0	+	0	+	+	0
Control	---	----	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

[1] Symbol key: + = <10% damage , 0 = 10-50% damage, – = >50% damage.

Table 2. Effect of herbicide treatments on reduced heading of native grass species evaluated on June 16-19, 2001.

Treatment	Rate	Timing	Gr basn wrye	Blbnch whtgr	Strmbk whtgr	Big blgr	Idaho fescue	Indianriceg	Squirreltail	Pr. junegr
Axiom	11 oz	fall	0.5[1] a[2]	0.3 a	0.6 ab	2.7 c	1.7 cdef	1.1	0.0	2.5 bcd
Axiom	22 oz	fall	0.0 a	0.7 a	1.1 ab	4.0 d	2.7 fgh	1.3	0.3	4.0 de
Beacon	0.76 oz	fall	0.0 a	0.2 a	1.0 ab	0.2 a	1.2 bcde	0.8	0.9	1.7 abc
Beacon	1.52 oz	fall	0.8 ab	0.3 a	1.7 bc	0.2 a	2.0 def	1.7	5.0	4.0 de
Clarity	4 pt	fall	1.5 ab	2.0 b	2.4 cd	1.0 a	3.5 ghi	2.2	5.0	2.7 cde
Clarity	8 pt	fall	2.6 ab	3.0 c	2.6 cd	0.7 a	3.5 ghi	2.8	4.1	3.0 cde
Diuron	1.8 lb	fall	0.0 a	0.2 a	0.3 ab	0.5 a	1.0 abcd	0.6	1.9	4.3 e
Diuron	3.6 lb	fall	1.5 ab	3.0 c	1.0 ab	2.5 bc	2.5 efg	2.4	5.0	5.0 e
Frontier	32 fl oz	fall	0.8 ab	0.0 a	0.3 ab	0.5 a	1.7 cdef	1.9	0.0	2.0 abc
Frontier	64 fl oz	fall	0.3 a	0.3 a	0.2 a	0.2 a	3.5 ghi	0.2	0.0	2.0 abc
Goal	10 fl oz	fall	0.0 a	0.2 a	0.0 a	0.0 a	0.7 abcd	0.0	1.9	0.0 a
Goal	20 fl oz	fall	0.4 a	0.0 a	0.4 ab	0.0 a	1.0 abcd	0.6	3.4	0.5 ab
Kerb	0.4 lb	fall	2.7 ab	3.4 c	2.3 cd	4.5 d	3.7 hij	1.1	4.1	4.0 de
Kerb	0.8 lb	fall	4.1 b	4.6 de	3.0 d	5.0 d	5.0 k	1.7	4.1	5.0 e
Maverick	0.67 oz	fall	0.3 a	0.2 a	0.3 ab	0.2 a	2.7 fgh	1.3	0.9	1.0 abc
Maverick	1.34 oz	fall	0.8 ab	0.3 a	0.6 ab	1.0 a	4.2 ijk	2.4	0.3	2.5 bcd
Maverick	0.67 oz	dormant	1.2 ab	0.3 a	0.9 ab	1.5 ab	4.0 ijk	2.2	3.4	3.0 cde
Milestone	2 oz	dormant	0.0 a	0.2 a	0.3 ab	0.2 a	0.5 abc	1.1	2.8	0.0 a
Milestone	4 oz	dormant	0.0 a	0.2 a	0.0 a	0.5 a	2.0 def	1.1	0.0	2.0 abc
Rely	3 pt	dormant	0.3 a	1.3 ab	0.0 a	0.5 a	1.5 bcdef	0.8	3.4	1.3 abc
Roundup	1.5 pt	dormant	4.1 b	5.0 e	4.7 e	5.0 d	4.7 jk	2.8	4.1	5.0 e
Sencor	0.4 lb	fall	0.5 ab	0.4 a	0.0 a	0.5 a	1.0 abcd	1.1	1.3	0.3 abc
Sencor	0.8 lb	fall	0.0 a	0.0 a	0.7 ab	4.5 d	2.5 efg	0.6	0.9	3.0 cde
Sinbar	0.75 lb	fall	1.2 ab	1.3 ab	0.9 ab	2.2 bc	1.5 bcdef	0.6	5.0	1.3 abc
Sinbar	1.5 lb	fall	2.8 ab	4.1 d	5.0 e	5.0 d	4.5 ijk	1.9	3.4	5.0 e
Surflan	3 qt	fall	0.0 a	0.0 a	0.0 a	0.0 a	0.7 abcd	0.6	0.0	1.0 abc
Surflan	6 qt	fall	0.0 a	0.4 a	0.3 ab	0.2 a	0.7 abcd	0.2	0.3	1.3 abc
Control	---	----	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0	0.0	0.0 a
								NS	NS	

[1] Rating scale from 0 (no negative effect) to 5 (maximum negative effect).
[2] Mean separation with Student-Newman-Kuels Test at $P \leq 0.05$.

Table 3. Effect of herbicide treatments on stand reduction of native grass species evaluated on November 2, 2001.

Treatment	Rate	Timing	Gr basn wrye		Blbnch whtgr		Strmbk whtgr	Big blgr		Idaho fescue		Indianriceg	Squirreltail		Pr. junegr
Axiom	11 oz	fall	0.5[1]	ab[2]	0.2	a	0.4	0.0	a	0.1	a	0.6	0.0	ab	0.1
Axiom	22 oz	fall	0.1	a	0.0	a	0.0	0.1	a	0.3	a	0.0	2.1	ab	2.2
Beacon	0.76 oz	fall	1.0	ab	0.0	a	0.6	0.0	a	0.3	a	0.0	0.4	ab	0.4
Beacon	1.52 oz	fall	0.2	a	0.6	a	0.3	0.3	a	0.0	a	0.0	0.0	ab	2.0
Clarity	4 pt	fall	0.5	ab	0.2	a	0.6	0.1	a	0.7	a	1.2	2.1	ab	1.3
Clarity	8 pt	fall	0.9	ab	1.4	a	0.1	0.0	a	1.4	a	1.7	0.8	ab	0.0
Diuron	1.8 lb	fall	0.0	a	0.0	a	0.0	0.0	a	0.1	a	0.9	0.0	ab	1.0
Diuron	3.6 lb	fall	1.3	ab	2.3	ab	0.5	0.1	a	1.7	a	2.1	3.8	ab	2.0
Frontier	32 fl oz	fall	1.8	ab	0.0	a	0.0	0.0	a	1.2	a	2.7	0.0	ab	0.0
Frontier	64 fl oz	fall	0.0	a	0.0	a	0.0	0.0	a	0.0	a	0.0	0.0	ab	0.4
Goal	10 fl oz	fall	0.0	a	0.0	a	0.0	0.0	a	0.3	a	0.9	0.0	ab	0.7
Goal	20 fl oz	fall	0.7	ab	0.2	a	0.0	0.0	a	0.1	a	0.9	0.0	ab	0.1
Kerb	0.4 lb	fall	1.8	ab	1.1	a	0.0	2.2	b	1.7	a	1.5	3.8	ab	0.1
Kerb	0.8 lb	fall	3.0	b	4.6	c	0.2	4.7	c	4.1	c	1.5	4.6	ab	2.9
Maverick	0.67 oz	fall	1.0	ab	0.2	a	0.0	0.3	a	1.2	a	0.9	1.3	ab	0.0
Maverick	1.34 oz	fall	0.9	ab	0.2	a	0.3	0.1	a	1.2	a	1.5	0.0	a	0.0
Maverick	0.67 oz	dormant	1.0	ab	0.0	a	0.0	0.0	a	0.7	a	0.9	0.0	ab	0.7
Milestone	2 oz	dormant	0.0	a	0.8	a	0.2	0.0	a	0.1	a	0.6	0.4	ab	0.1
Milestone	4 oz	dormant	0.5	ab	0.0	a	0.0	0.0	a	1.2	a	1.5	0.4	ab	0.5
Rely	3 pt	dormant	0.0	a	2.3	ab	0.0	0.0	a	0.3	a	0.6	0.0	ab	0.1
Roundup	1.5 pt	dormant	1.9	ab	5.0	c	3.0	4.9	c	3.0	b	1.5	5.0	ab	4.6
Sencor	0.4 lb	fall	1.0	ab	0.0	a	0.2	0.0	a	0.3	a	0.3	1.7	ab	0.7
Sencor	0.8 lb	fall	0.5	ab	0.0	a	0.6	3.9	c	1.2	a	0.6	0.8	ab	1.6
Sinbar	0.75 lb	fall	0.0	a	0.2	a	0.0	2.0	b	0.3	a	0.0	5.0	ab	1.0
Sinbar	1.5 lb	fall	3.0	b	3.5	bc	5.0	5.0	c	5.0	c	0.3	5.0	b	5.0
Surflan	3 qt	fall	0.8	ab	0.2	a	0.0	0.1	a	0.3	a	0.6	0.4	ab	0.0
Surflan	6 qt	fall	0.2	a	0.5	a	0.2	0.1	a	0.9	a	0.6	1.3	ab	0.1
Control	---	----	0.0	a	0.0	a	0.0	0.0	a	0.0	a	0.0	0.0	a	0.0
							NS					NS			NS

[1] Rating scale from 0 (no negative effect) to 5 (maximum negative effect).
[2] Mean separation with Student-Newman-Kuels Test at P≤ 0.05.

Table 4. Effect of herbicide treatments on Idaho fescue, 2001.

Treatment	Rate/acre	Timing	Stunting		Chlorosis		Mortality		Stand reduction		Reduced heading	
Axiom	11 oz	fall	0.6[1]	abc[2]	1.5	abcdefg	0.0	a	0.1	a	1.7	cdef
Axiom	22 oz	fall	0.6	abc	2.4	fgh	0.6	abcd	0.3	a	2.7	fgh
Beacon	0.76 oz	fall	0.0	a	0.9	abcde	0.0	a	0.3	a	1.2	bcde
Beacon	1.52 oz	fall	0.5	abc	1.3	abcdef	0.0	a	0.0	a	2.0	def
Clarity	4 pt	fall	0.9	abc	1.7	bcdefgh	0.0	a	0.7	a	3.5	ghi
Clarity	8 pt	fall	0.3	ab	2.0	defgh	0.4	abc	1.4	a	3.5	ghi
Diuron	1.8 lb	fall	0.1	a	0.3	ab	0.1	a	0.1	a	1.0	abcd
Diuron	3.6 lb	fall	0.9	abc	2.0	defgh	0.4	abc	1.7	a	2.5	efg
Frontier	32 fl oz	fall	0.5	abc	1.5	abcdefg	0.0	a	1.2	a	1.7	cdef
Frontier	64 fl oz	fall	0.0	a	2.3	efgh	0.4	abc	0.0	a	3.5	ghi
Goal	10 fl oz	fall	0.0	a	0.6	abcd	0.1	a	0.3	a	0.7	abcd
Goal	20 fl oz	fall	0.0	a	0.3	ab	0.0	a	0.1	a	1.0	abcd
Kerb	0.4 lb	fall	0.0	a	2.7	fghi	0.8	abcd	1.7	a	3.7	hij
Kerb	0.8 lb	fall	0.5	abc	3.8	i	1.1	cde	4.1	c	5.0	k
Maverick	0.67 oz	fall	0.1	a	1.7	bcdefgh	0.1	a	1.2	a	2.7	fgh
Maverick	1.34 oz	fall	1.6	c	3.8	i	1.2	de	1.2	a	4.2	ijk
Maverick	0.67 oz	dormant	0.1	a	3.2	hi	1.0	bcde	0.7	a	4.0	ijk
Milestone	2 oz	dormant	0.0	a	0.1	a	0.0	a	0.1	a	0.5	abc
Milestone	4 oz	dormant	0.3	ab	1.3	abcdef	0.2	ab	1.2	a	2.0	def
Rely	3 pt	dormant	0.5	abc	1.8	cdefgh	0.7	abcd	0.3	a	1.5	bcdef
Roundup	1.5 pt	dormant	0.3	ab	5.0	j	4.4	f	3.0	b	4.7	jk
Sencor	0.4 lb	fall	0.0	a	0.0	a	0.0	a	0.3	a	1.0	abcd
Sencor	0.8 lb	fall	0.5	abc	1.7	bcdefgh	0.1	a	1.2	a	2.5	efg
Sinbar	0.75 lb	fall	0.0	a	1.5	abcdefg	0.2	ab	0.3	a	1.5	bcdef
Sinbar	1.5 lb	fall	1.5	bc	2.8	ghi	1.6	e	5.0	c	4.5	ijk
Surflan	3 qt	fall	0.0	a	0.5	abc	0.0	a	0.3	a	0.7	abcd
Surflan	6 qt	fall	0.3	ab	1.3	abcdef	0.0	a	0.9	a	0.7	abcd
Control	---	---	0.0	a	0.0	a	0.0	a	0.0	a	0.0	a

[1]Rating scale from 0 (no negative effect) to 5 (maximum negative effect).
[2]Mean separation with Student-Newman-Kuels (SNK) Test at $P \leq 0.05$.

Table 5. Effect of herbicide treatments on great basin wildrye, 2001.

Treatment	Rate/acre	Timing	Stunting	Chlorosis		Mortality		Stand reduction		Reduced heading	
Axiom	11 oz	fall	0.0[1]	0.5	ab[2]	0.0	a	0.5	ab	0.5	a
Axiom	22 oz	fall	0.1	0.0	a	0.0	a	0.1	a	0.0	a
Beacon	0.76 oz	fall	0.1	0.5	ab	0.0	a	1.0	ab	0.0	a
Beacon	1.52 oz	fall	0.7	2.5	cd	0.9	a	0.2	a	0.8	ab
Clarity	4 pt	fall	0.0	0.2	ab	0.0	a	0.5	ab	1.5	ab
Clarity	8 pt	fall	0.1	1.3	abc	0.2	a	0.9	ab	2.6	ab
Diuron	1.8 lb	fall	0.0	0.5	ab	0.0	a	0.0	a	0.0	a
Diuron	3.6 lb	fall	0.0	0.8	ab	0.2	a	1.3	ab	1.5	ab
Frontier	32 fl oz	fall	0.1	0.5	ab	0.0	a	1.8	ab	0.8	ab
Frontier	64 fl oz	fall	0.1	0.0	a	0.0	a	0.0	a	0.3	a
Goal	10 fl oz	fall	0.1	0.0	a	0.0	a	0.0	a	0.0	a
Goal	20 fl oz	fall	0.0	0.3	ab	0.0	a	0.7	ab	0.4	a
Kerb	0.4 lb	fall	0.1	3.3	de	1.9	ab	1.8	ab	2.7	ab
Kerb	0.8 lb	fall	0.5	4.1	ef	2.6	b	3.0	b	4.1	b
Maverick	0.67 oz	fall	0.7	1.9	bcd	0.8	a	1.0	ab	0.3	a
Maverick	1.34 oz	fall	0.3	2.3	cd	0.7	a	0.9	ab	0.8	ab
Maverick	0.67 oz	dormant	0.7	2.4	cd	1.9	ab	1.0	ab	1.2	ab
Milestone	2 oz	dormant	0.5	0.1	ab	0.0	a	0.0	a	0.0	a
Milestone	4 oz	dormant	0.1	0.1	a	0.0	a	0.5	ab	0.0	a
Rely	3 pt	dormant	0.1	0.0	a	0.0	a	0.0	a	0.3	a
Roundup	1.5 pt	dormant	1.0	5.0	f	4.8	c	1.9	ab	4.1	b
Sencor	0.4 lb	fall	0.0	0.0	a	0.0	a	1.0	ab	0.5	ab
Sencor	0.8 lb	fall	0.1	0.1	ab	0.2	a	0.5	ab	0.0	a
Sinbar	0.75 lb	fall	0.0	0.1	a	0.0	a	0.0	a	1.2	ab
Sinbar	1.5 lb	fall	0.5	0.7	ab	0.0	a	3.0	b	2.8	ab
Surflan	3 qt	fall	0.1	0.2	ab	0.0	a	0.8	ab	0.0	a
Surflan	6 qt	fall	0.1	0.1	a	0.0	a	0.2	a	0.0	a
Control	---	---	0.0	0.0	a	0.0	a	0.0	a	0.0	a
			NS								

[1]Rating scale from 0 (no negative effect) to 5 (maximum negative effect).
[2]Mean separation with Student-Newman-Kuels (SNK) Test at $P \leq 0.05$.

Table 6. Effect of herbicide treatments on bluebunch wheatgrass, 2001.

Treatment	Rate/acre	Timing	Stunting		Chlorosis		Mortality		Stand reduction		Reduced heading	
Axiom	11 oz	fall	0.3[1]	abc[2]	0.6	ab	0.0	a	0.2	a	0.3	a
Axiom	22 oz	fall	0.1	abc	0.0	a	0.0	a	0.0	a	0.7	a
Beacon	0.76 oz	fall	0.2	abc	0.3	a	0.0	a	0.0	a	0.2	a
Beacon	1.52 oz	fall	0.9	abc	0.9	ab	0.2	a	0.6	a	0.3	a
Clarity	4 pt	fall	0.7	abc	0.7	ab	0.0	a	0.2	a	2.0	b
Clarity	8 pt	fall	0.6	abc	1.3	abc	0.0	a	1.4	a	3.0	c
Diuron	1.8 lb	fall	0.5	abc	0.0	a	0.0	a	0.0	a	0.2	a
Diuron	3.6 lb	fall	1.3	abcd	2.4	c	0.8	a	2.3	ab	3.0	c
Frontier	32 fl oz	fall	0.0	a	0.0	a	0.0	a	0.0	a	0.0	a
Frontier	64 fl oz	fall	0.0	a	0.1	a	0.0	a	0.0	a	0.3	a
Goal	10 fl oz	fall	0.0	a	0.0	a	0.0	a	0.0	a	0.2	a
Goal	20 fl oz	fall	0.0	a	0.0	a	0.0	a	0.2	a	0.0	a
Kerb	0.4 lb	fall	1.5	cde	3.7	d	1.6	a	1.1	a	3.4	c
Kerb	0.8 lb	fall	2.3	de	4.5	de	2.7	b	4.6	c	4.6	de
Maverick	0.67 oz	fall	0.0	a	0.0	a	0.0	a	0.2	a	0.2	a
Maverick	1.34 oz	fall	0.1	abc	0.0	a	0.0	a	0.2	a	0.3	a
Maverick	0.67 oz	dormant	0.1	abc	0.3	a	0.0	a	0.0	a	0.3	a
Milestone	2 oz	dormant	0.0	ab	0.2	a	0.0	a	0.8	a	0.2	a
Milestone	4 oz	dormant	0.0	a	0.0	a	0.0	a	0.0	a	0.2	a
Rely	3 pt	dormant	1.5	bcde	2.1	bc	0.3	a	2.3	ab	1.3	ab
Roundup	1.5 pt	dormant	2.6	e	5.0	e	5.0	c	5.0	c	5.0	e
Sencor	0.4 lb	fall	0.0	a	0.0	a	0.0	a	0.0	a	0.4	a
Sencor	0.8 lb	fall	0.0	a	0.0	a	0.0	a	0.0	a	0.0	a
Sinbar	0.75 lb	fall	0.3	abc	0.6	ab	0.0	a	0.2	a	1.3	ab
Sinbar	1.5 lb	fall	0.9	abc	1.6	abc	0.6	a	3.5	bc	4.1	d
Surflan	3 qt	fall	0.0	a	0.3	a	0.0	a	0.2	a	0.0	a
Surflan	6 qt	fall	0.0	a	0.0	a	0.0	a	0.5	a	0.4	a
Control	---	---	0.0	a	0.0	a	0.0	a	0.0	a	0.0	a

[1]Rating scale from 0 (no negative effect) to 5 (maximum negative effect).
[2]Mean separation with Student-Newman-Kuels (SNK) Test at $P \leq 0.05$.

Table 7. Effect of herbicide treatments on Indian ricegrass, 2001.

Treatment	Rate/acre	Timing	Stunting	Chlorosis		Mortality	Stand reduction	Reduced heading
Axiom	11 oz	fall	0.0[1]	0.5	ab[2]	0.0	0.6	1.1
Axiom	22 oz	fall	0.0	0.0	a	0.0	0.0	1.3
Beacon	0.76 oz	fall	0.1	0.0	a	0.0	0.0	0.8
Beacon	1.52 oz	fall	0.1	0.3	ab	0.0	0.0	1.7
Clarity	4 pt	fall	0.0	0.9	ab	0.2	1.2	2.2
Clarity	8 pt	fall	0.6	1.1	ab	0.6	1.7	2.8
Diuron	1.8 lb	fall	0.2	0.5	ab	0.1	0.9	0.6
Diuron	3.6 lb	fall	0.1	0.6	ab	0.4	2.1	2.4
Frontier	32 fl oz	fall	0.1	0.5	ab	0.1	2.7	1.9
Frontier	64 fl oz	fall	0.0	0.0	a	0.0	0.0	0.2
Goal	10 fl oz	fall	0.0	0.0	a	0.0	0.9	0.0
Goal	20 fl oz	fall	0.1	0.1	a	0.0	0.9	0.6
Kerb	0.4 lb	fall	0.2	0.5	ab	0.1	1.5	1.1
Kerb	0.8 lb	fall	0.7	1.8	ab	1.2	1.5	1.7
Maverick	0.67 oz	fall	0.1	0.1	a	0.0	0.9	1.3
Maverick	1.34 oz	fall	0.2	1.5	ab	0.4	1.5	2.4
Maverick	0.67 oz	dormant	0.6	0.7	ab	0.2	0.9	2.2
Milestone	2 oz	dormant	0.0	0.0	a	0.0	0.6	1.1
Milestone	4 oz	dormant	0.7	1.1	ab	1.1	1.5	1.1
Rely	3 pt	dormant	0.2	0.3	ab	0.0	0.6	0.8
Roundup	1.5 pt	dormant	0.2	2.4	b	1.2	1.5	2.8
Sencor	0.4 lb	fall	0.0	0.1	a	0.0	0.3	1.1
Sencor	0.8 lb	fall	0.1	0.1	a	0.0	0.6	0.6
Sinbar	0.75 lb	fall	0.0	0.0	a	0.0	0.0	0.6
Sinbar	1.5 lb	fall	0.2	0.5	ab	0.0	0.3	1.9
Surflan	3 qt	fall	0.1	0.0	a	0.0	0.6	0.6
Surflan	6 qt	fall	0.0	0.3	ab	0.0	0.6	0.2
Control	---	---	0.0	0.0	a	0.0	0.0	0.0
			NS			NS	NS	NS

[1]Rating scale from 0 (no negative effect) to 5 (maximum negative effect).
[2]Mean separation with Student-Newman-Kuels (SNK) Test at $P \leq 0.05$.

Table 8. Effect of herbicide treatments on streambank wheatgrass, 2001.

Treatment	Rate/acre	Timing	Stunting	Chlorosis		Mortality	Stand reduction		Reduced heading	
Axiom	11 oz	fall	0.1[1]	0.3	ab[2]	0.0	0.4	a	0.6	ab
Axiom	22 oz	fall	0.1	0.3	ab	0.0	0.0	a	1.1	ab
Beacon	0.76 oz	fall	0.6	0.7	ab	0.0	0.6	a	1.0	ab
Beacon	1.52 oz	fall	0.7	1.7	cd	0.3	0.3	a	1.7	bc
Clarity	4 pt	fall	0.8	1.8	cd	0.0	0.6	a	2.4	cd
Clarity	8 pt	fall	1.1	1.7	cd	0.0	0.1	a	2.6	cd
Diuron	1.8 lb	fall	0.0	0.0	a	0.0	0.0	a	0.3	ab
Diuron	3.6 lb	fall	0.1	0.7	ab	0.0	0.5	a	1.0	ab
Frontier	32 fl oz	fall	0.9	0.1	ab	0.0	0.0	a	0.3	ab
Frontier	64 fl oz	fall	0.0	0.0	a	0.0	0.0	a	0.2	a
Goal	10 fl oz	fall	0.0	0.0	a	0.0	0.0	a	0.0	a
Goal	20 fl oz	fall	0.0	0.0	a	0.0	0.0	a	0.4	ab
Kerb	0.4 lb	fall	0.9	3.1	e	0.6	0.0	a	2.3	cd
Kerb	0.8 lb	fall	1.3	3.3	e	1.1	0.2	a	3.0	d
Maverick	0.67 oz	fall	0.3	0.2	ab	0.0	0.0	a	0.3	ab
Maverick	1.34 oz	fall	0.4	0.5	ab	0.0	0.3	a	0.6	ab
Maverick	0.67 oz	dormant	0.7	0.3	ab	0.0	0.0	a	0.9	ab
Milestone	2 oz	dormant	0.2	0.1	ab	0.0	0.2	a	0.3	ab
Milestone	4 oz	dormant	0.0	0.5	ab	0.0	0.0	a	0.0	a
Rely	3 pt	dormant	0.4	1.3	bc	0.0	0.0	a	0.0	a
Roundup	1.5 pt	dormant	1.1	4.7	f	3.6	3.0	b	4.7	e
Sencor	0.4 lb	fall	0.3	0.0	a	0.0	0.2	a	0.0	a
Sencor	0.8 lb	fall	0.2	0.5	ab	0.0	0.6	a	0.7	ab
Sinbar	0.75 lb	fall	0.0	1.3	bc	0.0	0.0	a	0.9	ab
Sinbar	1.5 lb	fall	0.9	2.5	de	0.2	5.0	c	5.0	e
Surflan	3 qt	fall	0.0	0.1	ab	0.0	0.0	a	0.0	a
Surflan	6 qt	fall	0.2	0.1	ab	0.0	0.2	a	0.3	ab
Control	---	---	0.0	0.0	a	0.0	0.0	a	0.0	a
			NS			NS				

[1]Rating scale from 0 (no negative effect) to 5 (maximum negative effect).
[2]Mean separation with Student-Newman-Kuels (SNK) Test at $P \leq 0.05$.

Table 9. Effect of herbicide treatments on prairie junegrass, 2001.

Treatment	Rate/acre	Timing	Stunting	Chlorosis		Mortality		Stand reduction	Reduced heading	
Axiom	11 oz	fall	0.0[1]	1.3	abc[2]	0.0	a	0.1	2.5	bcd
Axiom	22 oz	fall	0.8	2.2	cd	0.8	ab	2.2	4.0	de
Beacon	0.76 oz	fall	0.2	0.8	abc	0.2	a	0.4	1.7	abc
Beacon	1.52 oz	fall	0.1	1.2	abc	0.4	a	2.0	4.0	de
Clarity	4 pt	fall	0.8	0.6	ab	0.1	a	1.3	2.7	cde
Clarity	8 pt	fall	0.0	0.8	abc	0.0	a	00	3.0	cde
Diuron	1.8 lb	fall	1.4	3.8	ef	3.4	c	1.0	4.3	e
Diuron	3.6 lb	fall	0.5	4.3	fg	4.6	d	2.0	5.0	e
Frontier	32 fl oz	fall	0.0	0.9	abc	0.0	a	0.0	2.0	abc
Frontier	64 fl oz	fall	0.4	0.8	abc	0.1	a	0.4	2.0	abc
Goal	10 fl oz	fall	0.1	0.1	ab	0.1	a	0.7	0.0	a
Goal	20 fl oz	fall	0.0	0.3	ab	0.0	a	0.1	0.5	ab
Kerb	0.4 lb	fall	0.5	1.4	abc	0.0	a	0.1	4.0	de
Kerb	0.8 lb	fall	0.2	1.7	bcd	0.0	a	2.9	5.0	e
Maverick	0.67 oz	fall	0.0	1.1	abc	0.0	a	0.0	1.0	abc
Maverick	1.34 oz	fall	0.6	1.3	abc	0.0	a	0.0	2.5	bcd
Maverick	0.67 oz	dormant	0.4	1.6	bc	0.4	a	0.7	3.0	cde
Milestone	2 oz	dormant	0.2	0.6	ab	0.2	a	0.1	0.0	a
Milestone	4 oz	dormant	0.0	1.3	abc	0.0	a	0.5	2.0	abc
Rely	3 pt	dormant	0.7	2.3	cd	1.1	ab	0.1	1.3	abc
Roundup	1.5 pt	dormant	1.2	5.0	g	5.0	d	4.6	5.0	e
Sencor	0.4 lb	fall	0.5	0.8	abc	0.1	a	0.7	0.3	abc
Sencor	0.8 lb	fall	1.1	2.3	cd	1.8	b	1.6	3.0	cde
Sinbar	0.75 lb	fall	0.1	0.8	abc	0.0	a	1.0	1.3	abc
Sinbar	1.5 lb	fall	0.6	3.0	de	1.4	ab	5.0	5.0	e
Surflan	3 qt	fall	0.0	0.2	ab	0.0	a	0.0	1.0	abc
Surflan	6 qt	fall	0.4	0.8	abc	0.0	a	0.1	1.3	abc
Control	---	---	0.0	0.0	a	0.0	a	0.0	0.0	a
			NS					NS		

[1]Rating scale from 0 (no negative effect) to 5 (maximum negative effect).
[2]Mean separation with Student-Newman-Kuels (SNK) Test at $P \leq 0.05$.

Table 10. Effect of herbicide treatments on squirreltail, 2001.

Treatment	Rate/acre	Timing	Stunting	Chlorosis		Mortality		Stand reduction		Reduced heading
Axiom	11 oz	fall	0.0[1]	0.3	abc[2]	0.0	a	0.0	ab	0.0
Axiom	22 oz	fall	0.7	1.6	abcd	1.2	abc	2.1	ab	0.3
Beacon	0.76 oz	fall	0.8	2.0	abcd	1.2	abc	0.4	ab	0.9
Beacon	1.52 oz	fall	0.9	4.0	abcd	3.3	abc	0.0	ab	5.0
Clarity	4 pt	fall	0.7	1.9	abcd	1.7	abc	2.1	ab	5.0
Clarity	8 pt	fall	0.9	3.1	abcd	2.1	abc	0.8	ab	4.1
Diuron	1.8 lb	fall	1.0	2.1	abcd	2.2	abc	0.0	ab	1.9
Diuron	3.6 lb	fall	0.9	4.8	cd	4.7	bc	3.8	ab	5.0
Frontier	32 fl oz	fall	0.0	0.0	a	0.0	a	0.0	ab	0.0
Frontier	64 fl oz	fall	0.3	1.0	abcd	1.2	abc	0.0	ab	0.0
Goal	10 fl oz	fall	0.5	1.9	abcd	2.1	abc	0.0	ab	1.9
Goal	20 fl oz	fall	1.7	2.9	abcd	3.0	abc	0.0	ab	3.4
Kerb	0.4 lb	fall	1.5	4.5	cd	3.8	abc	3.8	ab	4.1
Kerb	0.8 lb	fall	1.0	4.4	cd	4.0	abc	4.6	ab	4.1
Maverick	0.67 oz	fall	0.5	1.8	abcd	1.2	abc	1.3	ab	0.9
Maverick	1.34 oz	fall	0.3	1.6	abcd	1.5	abc	0.0	a	0.3
Maverick	0.67 oz	dormant	0.3	0.9	abcd	0.0	a	0.0	ab	3.4
Milestone	2 oz	dormant	0.3	1.5	abcd	1.2	abc	0.4	ab	2.8
Milestone	4 oz	dormant	0.0	0.1	ab	0.0	a	0.4	ab	0.0
Rely	3 pt	dormant	1.2	4.1	bcd	3.5	abc	0.0	ab	3.4
Roundup	1.5 pt	dormant	2.0	5.0	d	5.0	c	5.0	ab	4.1
Sencor	0.4 lb	fall	0.2	1.4	abcd	0.9	abc	1.7	ab	1.3
Sencor	0.8 lb	fall	1.4	2.4	abcd	1.6	abc	0.8	ab	0.9
Sinbar	0.75 lb	fall	1.3	3.1	abcd	3.0	abc	5.0	ab	5.0
Sinbar	1.5 lb	fall	2.2	4.7	cd	4.7	c	5.0	b	3.4
Surflan	3 qt	fall	0.2	0.5	abc	0.2	ab	0.4	ab	0.0
Surflan	6 qt	fall	0.0	0.9	abcd	1.0	abc	1.3	ab	0.3
Control	---	---	0.0	0.0	a	0.0	a	0.0	ab	0.0
			NS							NS

[1]Rating scale from 0 (no negative effect) to 5 (maximum negative effect).
[2]Mean separation with Student-Newman-Kuels (SNK) Test at P $\leq$ 0.05.

Table 11. Effect of herbicide treatments on big bluegrass, 2001.

Treatment	Rate/acre	Timing	Stunting		Chlorosis		Mortality		Stand reduction		Reduced heading	
Axiom	11 oz	fall	1.1[1]	abc[2]	1.5	abc	0.0	a	0.0	a	2.7	c
Axiom	22 oz	fall	1.8	cd	2.8	d	1.3	a	0.1	a	4.0	d
Beacon	0.76 oz	fall	0.1	a	0.0	a	0.0	a	0.0	a	0.2	a
Beacon	1.52 oz	fall	0.2	ab	0.1	a	0.0	a	0.3	a	0.2	a
Clarity	4 pt	fall	0.6	ab	0.3	a	0.0	a	0.1	a	1.0	a
Clarity	8 pt	fall	0.6	ab	0.1	a	0.0	a	0.0	a	0.7	a
Diuron	1.8 lb	fall	0.2	ab	0.5	a	0.0	a	0.0	a	0.5	a
Diuron	3.6 lb	fall	1.3	bc	2.4	cd	0.4	a	0.1	a	2.5	bc
Frontier	32 fl oz	fall	0.2	ab	0.3	a	0.0	a	0.0	a	0.5	a
Frontier	64 fl oz	fall	0.8	abc	0.3	a	0.0	a	0.0	a	0.2	a
Goal	10 fl oz	fall	0.0	a	0.0	a	0.0	a	0.0	a	0.0	a
Goal	20 fl oz	fall	0.0	a	0.0	a	0.0	a	0.0	a	0.0	a
Kerb	0.4 lb	fall	1.1	abc	2.3	cd	0.1	a	2.2	b	4.5	d
Kerb	0.8 lb	fall	1.8	cd	2.8	d	0.8	a	4.7	c	5.0	d
Maverick	0.67 oz	fall	0.2	ab	0.3	a	0.0	a	0.3	a	0.2	a
Maverick	1.34 oz	fall	1.0	abc	1.0	ab	0.1	a	0.1	a	1.0	a
Maverick	0.67 oz	dormant	1.2	abc	2.0	bcd	0.1	a	0.0	a	1.5	ab
Milestone	2 oz	dormant	0.1	a	0.0	a	0.0	a	0.0	a	0.2	a
Milestone	4 oz	dormant	0.2	ab	0.5	a	0.1	a	0.0	a	0.5	a
Rely	3 pt	dormant	1.0	abc	0.9	ab	0.0	a	0.0	a	0.5	a
Roundup	1.5 pt	dormant	2.4	d	5.0	e	5.0	c	4.9	c	5.0	d
Sencor	0.4 lb	fall	0.1	a	0.3	a	0.0	a	0.0	a	0.5	a
Sencor	0.8 lb	fall	1.2	d	4.1	e	3.3	b	3.9	c	4.5	d
Sinbar	0.75 lb	fall	1.0	abc	1.8	bcd	1.3	a	2.0	b	2.2	bc
Sinbar	1.5 lb	fall	2.4	d	4.4	e	3.9	b	5.0	c	5.0	d
Surflan	3 qt	fall	0.0	a	0.0	a	0.0	a	0.1	a	0.0	a
Surflan	6 qt	fall	0.2	ab	0.0	a	0.0	a	0.1	a	0.2	a
Control	---	---	0.0	a	0.0	a	0.0	a	0.0	a	0.0	a

[1]Rating scale from 0 (no negative effect) to 5 (maximum negative effect).
[2]Mean separation with Student-Newman-Kuels (SNK) Test at P $\leq$ 0.0

EVALUATION OF MESSENGER® ON SEED CARROTS, 2001

Marvin Butler, Brian Tipton, and Claudia Campbell

Introduction

Seed carrots, along with garlic seed, provide a large portion of the agricultural income in the Madras and Culver areas of central Oregon. Diseases such as *Alternaria* and *Xanthomonas* are becoming an increasing problem as the industry tries to maximize production acres and maintain yields. If Messenger® can increase disease resistance, or otherwise increase seed yield, it would generate a large amount of industry and grower interest.

Methods and Materials

Small plots were established to evaluate the effect of Messenger in a commercial seed carrot field north of Madras. A 20 percent concentration applied three times at either a 14- or 21-day interval was compared to untreated plants. Plots one row by 10 ft were replicated three times in a randomized complete block design. Plot size was minimized because of the difficulty associated with hand harvesting and processing a large amount of biomass.

Applications were initiated when the plants began to bolt (May 29) and continued through early bloom (June 26 or July 10, depending on application interval). Treatments were applied with a CO_2-pressurized, hand-held, boom sprayer at 40 psi and 20 gal/acre water. Distilled water and a separate Messenger packet was used for each application date.

Plots were hand harvested on September 10, just prior to commercial harvest of the field. Plants were removed from the soil, placed in canvas bags, and hung to dry in a three-sided shed at the Central Oregon Agricultural Research Center (COARC). Seed was cleaned with equipment at COARC and the seed-conditioning lab at the USDA-Agricultural Research Service Forage Seed Production Research Center in Corvallis. Seed weight and percent germination were determined at COARC.

Results and Discussion

There was inadequate disease pressure to evaluate plots for either *Alternaria* or *Xanthamonas,* common foliar diseases on seed carrots grown in central Oregon (Table 1). This was despite hail damage to the plots May 23 prior to application of Messenger. This early hail damage would not be expected to affect yield, but would provide disease entry points.

Statistical evaluation of the rough clean seed weights, percent germination, and 1,000 seed weight indicate no differences between treated and untreated plots.

Table 1. Effect of Messenger applied at 20 percent concentration to seed carrots near Madras, Oregon, 2001.

Treatment	Application	Yield	Germination	1,000 seed weight
20% product	----------dates----------	----lb/acre----	----%----	----g----
Messenger	May 29, June 12, June 26	1207.3[1]	78	1.07
Messenger	May 29, June 20, July 10	1265.6	86	1.10
Untreated	----------------------------	1359.4	81	1.08
		NS	NS	NS

[1]Mean separation with Student-Newman-Kuels (SNK) Test at $P \leq 0.05$.

EVALUATION OF PREEMERGENCE HERBICIDES IN SEED ONIONS, 2001

Marvin Butler, Brad Holliday, Dean Brooks, and Claudia Campbell

Abstract

Prowl® was applied alone at two rates and in combination with Dacthal® to onions grown for seed near Madras, Oregon, in 2001. All herbicide treatments significantly reduced the number of pigweed, watergrass, nightshade, and lambsquarters plants compared to untreated plots. The trend indicated Dacthal may improve pigweed control, while increasing Prowl from 1 pint/acre to 2 pint/acre may increase the control of buttonweed.

Introduction

With limited weed control tools for use in onion seed production, the search continues for additional herbicides that may be effective. This project focused on the preemergence application of Prowl alone and in combination with Dacthal. Dacthal is currently one of the few herbicides registered for use on seed onions.

Methods and Materials

Herbicide treatments were Prowl at 1 pint/acre, Prowl at 2 pint/acre, and Prowl at 1 pint/acre plus Dacthal at 7 lb/acre. Herbicides were applied July 13 after planting but before the first irrigation. Treatments were applied with a CO_2-powered boom sprayer at 40 psi and 20 gal/acre water. Plots 9 ft x 15 ft were replicated three times in a randomized complete block design. Plots were evaluated August 8 for control of pigweed, watergrass, buttonweed, nightshade, and lambsquarters.

Results and Discussion

Prowl at 1 pint/acre, 2 pint/acre, or 1 pint/acre in combination with Dacthal at 7 lb/acre significantly reduced the number of pigweed, watergrass, nightshade, and lambsquarters plants compared to untreated plots (Table 1). None of the treatments controlled buttonweed. The trend indicated that the addition of Dacthal to Prowl improved pigweed control, while not providing additional control of watergrass, buttonweed, nightshade, or lambsquarters. Prowl at 2 pint/acre compared to 1 pint/acre did not significantly increase weed control in this trial, but the trend was for potentially increasing control of buttonweed. No detectable crop stunting was observed.

Table 1. Effect of herbicides applied to seed onions July 13 and evaluated August 8, 2001, near Madras, Oregon.

Treatment	Rate	Weed control									
		Pigweed		Watergrass		Buttonweed		Nightshade		Lambsquarters	
	Prod/acre	-------------------------Number of plants-------------------------									
Prowl	1.0 pt	21.3	b[1]	1.3	b	8.0		1.0	ab	0	b
Prowl	2.0 pt	19.3	b	0	b	2.7		0	b	0	b
Prowl +Dacthal	1.0 pt +7.0 lb	10.0	b	5.3	b	2.3		0	b	0	b
Untreated	----	82.3	a	32.3	a	9.7	NS	2.7	a	3.0	a

[1]Mean separation with Student-Newman-Kuels (SNK) Test at P $\leq$ 0.05.

TESTING FUNGICIDE AND BIOLOGICAL PRODUCTS FOR CONTROL OF GARLIC AND ONION WHITE ROT DISEASE, 2000-2001

Fred Crowe, Robin Parks, and Rhonda Bafus

Summary

In 2000-2001, a main garlic trial and a smaller border trial were planted and harvested near Madras, Oregon. Only seed treatments were included in the garlic trials in 2000-2001. In retrospect, in-furrow treatments should have been included, as these may be favored over seed treatments. In the 2000 onion trial (previously reported), post-planting seasonal drenches with Folicur® (immediately followed by irrigation) were effective in white rot control, but we did not have the onion efficacy data at the time garlic was planted, so no drenches were included in the fall 2000 garlic planting.

We suspect that product efficacy reported below was slightly less than it might have been, because aggressive seed treatment in rotating drums dislodged many of the wettable clove sheaths, leaving less product on the waxy clove surface (although stem plates were well-treated). Seed treatment may need to be gentler than conducted here.

In 2000-2001, artificial infestation with the white rot fungus was between 4 and 5 sclerotia/liter of soil, which was estimated to be enough to result in about 70-85 percent bulb infection by harvest. Due to a mild winter and longer disease activity, bulb infection averaged about 98 percent. All plant losses were attributable to white rot disease. The untreated check in the main trial yielded 1,016 lb/acre of fresh garlic bulbs $\geq$1 inch in diameter, only 2 percent of the original stand was harvested as symptomless bulbs, and 3.4 percent of the original stand was intact but infected. Thus, only 3.6 percent of the original stand was harvestable bulbs. In the main trial, Folicur at 0.89oz product/100 lb seed cloves was the superior treatment with respect to yield (88 percent symptomless bulbs, 92 percent harvested bulbs, 19,239 lb/acre yield). This was followed closely by the next highest rate of Folicur at 1.78 oz product/100 lb seed (83 percent symptomless bulbs, 87 percent harvested bulbs, and 18,204 lb/acre yield). Dividend®, when applied at rates of the active ingredient difenconazole similar to that of the rate of active ingredient tebuconazole in Folicur, allowed more disease to develop than Folicur, with correspondingly lower yield. The highest rate of Maxim® (0.32 oz product/100 lb seed) performed similarly to Dividend. Nevertheless, fludioxonil (either as the seed treatment Maxim or as an in-furrow spray as Scholar®) remains of high interest as a fungicide that has proven to be effective most of the season, that is likely to be easy to register for this disease, and that may allow lower rates of triazoles to be used (Folicur, Dividend). Dividend combined with Maxim did not perform as well as expected in 2000-2001. The Folicur (0.89 oz/100 lb seed) + Maxim (0.16 oz product/100 lb seed) combination was the superior treatment of all (89 percent symptomless bulbs, 95 percent harvested bulbs, 21,530 lb/acre yield. The 2001-2002 garlic planting, to be reported next year, includes in-furrow, drenches and seed treatments, and various combinations of products.

We remain convinced that Folicur (tebuconazole) moves a short distance in the soil to provide control up to perhaps a few inches away from the treated cloves. This is partly based on observations of root systems at harvest, and partly by the fact that post-plant drenches were effective in the 2000 onion trial. Because of such limited soil movement, it may matter less about how one applies Folicur for white rot control of garlic, as long as sufficient material is applied and it is retained in the upper root zone and near the bulbs. Post-planting drenches may be critical on onions, because high rates of Folicur are phytotoxic to onion seedlings (although dispersing Folicur by coating it onto granular materials at planting, or a revised in-furrow type of treatment may be effective). Our 2001-2001 onion planting has a number of treatment combinations and methods.

Introduction

The entire soil population of sclerotia of *Sclerotium cepivorum* germinates in response to root leakage of germination stimulants. Root infections progress upward on root systems, spreading along the planted row via root contact. Infected plants rapidly die once the fungus reaches the stem plate, a result of both extensive root death and bulb decay. A few bulbs very lightly infected near to harvest may pass into fresh onion or garlic markets or may be passed along through garlic seed lots. A few intact but infected bulbs on which the disease has advanced somewhat further may or may not be retained for processing depending on the degree of rot and the harvesting process. Fungicidal control of white rot is difficult, requiring season-long protection in parts of the world where soil temperatures are conducive to prolonged fungal activity. Due to a lack of available controls and the abundant proliferation of the fungus, fields are commonly abandoned following one or a very few Allium crops infected with white rot.

Prior to 1970, a few very persistent fungicides (e.g. mercury compounds and PCNB) provided partial control of white rot. Since the late 1970’s and previous to 1998-1999, few or no fungicides were screened against Allium white rot in the United States, on either onions or garlic. Products still labeled in the U.S. include Terrachlor® (Uniroyal Chem.; a.i. PCNB; for garlic only as a banded spray at planting); Rovral® (Rhone-Poulenc; a.i. iprodione; for garlic only as an in-furrow spray at planting), and Botran® (Gowan Co.; a.i. DCNA; eastern Oregon and Washington, western Idaho only; for onions, banded pre-seeding; for garlic in-furrow spray at planting). None of these fungicides currently are being used on full-season Allium crops for white rot because of insufficient or inconsistent control. Benlate® (DuPont; a.i. benomyl) is labeled as a garlic seed treatment for control of *penicillium* seed piece decay, and provides partial control of white rot for a limited duration, but is ineffective for season-long control. In other countries, Sumislex® (a.i. procymidone) has provided fair-to-good control of white rot, depending on the disease pressure. More recently, Folicur (Bayer; a.i. tebuconazole) has provided fair-to-excellent control in Mexico, Australia, and New Zealand, depending on disease pressure and rate and method of application. The work reported here was initiated as a result of reported successes in those countries.

An additional incentive to test Folicur was that this product proved effective against garlic rust in California, and an emergency label was granted for this use in 1998. Having a rust tolerance for Folicur should expedite labeling of Folicur for white rot, even though the methods and rates of application might differ. Another fungicide, Quadris®, had full label usage for garlic rust, but this product did not prove highly effective in our earlier white rot studies.

Fumigants have been used to lower soil populations of white rot and reduce the risk of disease spread, but have not provided sufficient control. This includes even methyl bromide, which may lower sclerotial populations by 98-99%. More recently, germination stimulants have achieved 98-99% population reduction when used at appropriate rates and methods of application. Such stimulants may be registered soon in the U.S. (United Agri Products, a.i. diallyl disulfide), and research-in-progress has shown that comparable population reduction of sclerotial populations may be achieved with commercially available dehydrated garlic powder as the source of germination stimulants– and likely at similar cost to the United Agri Products product that is derived from petroleum. Use of stimulants is of interest because of their relatively high efficacy and low cost compared to methyl bromide. As indicated above, fungicides provide less control of white rot when sclerotial populations of the white rot fungus are high. A recent concept has been to pretreat fields with germination stimulants in years prior to planting of Alliums, and then apply the more effective fungicides such as Folicur. Our trials in 1999-2000 tested the efficacy of fungicides against a high and low population of *S. cepivorum* to evaluate this concept.

In addition to direct economic control of white rot with fungicides on a specific crop, sclerotial population reduction is a goal of fungicide use. Temporary control can be misleading and sustained control elusive: if even a few Allium plants are allowed to develop white rot, which might be economically acceptable in the short term, the sclerotial population may increase, making future control more difficult.   On the other hand, season-long control might lead to near-eradication if Alliums are repeatedly protected with a superior fungicide. Thus, full product evaluation must be based not only on control achieved, but also on the increase or decrease on the resultant sclerotial population.

This report addresses the third trial year. In 1998-1999, Folicur and Dividend performed well, but the garlic stand was reduced by an untimely winter freeze. In 1999-2000 we again tested fungicides, this time in two adjacent trials against both a moderately low and a moderately high soil population of *S. cepivorum*. This report is for our third year, 2000-2001, in a moderately infested soil. Our long-term goal was to identify and refine those treatments that provide full control of white rot under low to moderate infestations of *S. cepivorum*, and possibly under high infestation.

In addition, we tested fungicides at Madras, Oregon in 2000 on spring-seeded, fall-harvested onions against a moderate soil population of *S. cepivorum*. The onion trial was considered preliminary for testing methods of Folicur and Dividend application that might circumvent seedling sensitivity to these fungicides but still provide adequate disease control. These approaches included distributing fungicides more widely around the seed by coating them on granular materials planted with the seed, and spraying fungicides believed to be somewhat mobile in water directly over the seedbed prior to irrigation. The former idea was adapted from the Folicur label for onions in Tasmania, and the later idea was suggested by Mary Ruth McDonald with the University of Guelph, Ontario, based on preliminary data in Canada. Results were highly encouraging for both alternative treatment methods, but data were not available by the time the fall 2000 garlic trial was planted, so no such treatments were included. (They are included in the onion trial planted in the summer of 2001 and the garlic trial planted in the fall of 2001.)

Methods

The field was naturally infested only at trace levels that contributed very little to the disease levels experienced. The trial area was uniformly infested as in previous years with very heavily concentrated sclerotia in soil collected from the base of white rotted onion plants in a nearby field. This added inoculum was tilled to 15 cm (6 in), and upon soil assay the inoculum density was about four sclerotia/liter of soil. Based on previous experience, it was expected that 70-85 percent bulb infection or plant death would occur in untreated plots of the low infestation area. Each plot consisted of two, 30-ft bed sections. All treatments were randomized within four blocks. Two trials were created; one border trial included beds adjacent to a road on one side and a grass seed field on the other side. The main trial included rows separated from any edge effects next to the road and grass seed field, bordered only by garlic.

Fungicide products were applied onto seed by rotating seed in a rotary mixer and spraying concentrated product through an atomizer as the seed tumbled. Little product was retained by the sides of the mixer, although this was cleaned between each treatment. We became concerned that using a rotating drum for seed treatment dislodged many clove sheaths. Aqueous seed treatments seemed to wet and attach to these covering leaves better than to the waxy clove surface itself. Thus, some cloves may not have had as much product attached as desired, and a gentler seed treatment system is desired. However, substantial product did attach to the stem plate, which is the most important location for fungicide to adhere, so all cloves received product on stem plates.

In the border trial, a seed dip treatment was included by immersing a seed bag in given concentration of product, then allowing the bag to drain for several minutes, then leaving the bag to dry for several days.

The area was tilled, fertilized with 400 lb/acre 16-16-16 and pre-bedded. Beds were shaped and in the first few days of October were planted at 2.5-3 in deep with a planter provided by Basic Vegetable Products. Virus-free ‘California Early’ garlic cloves, cracked but not hot-water treated, commercially sized (a medium-sized seed lot was used, approx. 2,300 lb/acre) and planted 18 cloves per bed ft on 36-in centers. This is the first trial in which we have not hand planted because we were concerned that hand planting (about 1.5-2 in deep) was a risk for winter freezing injury. Because of machine planting, however, clove size and spacing were less uniform, and stand counts were probably more erratic. To compensate, we made the plots somewhat larger than in past trials.

The garlic crop was grown as per commercial standards for central Oregon, and no special problems were encountered. Rovral was sprayed twice in the spring of 2001 to keep botrytis from complicating white rot disease ratings. Plots were hand weeded in addition to the use of commercial herbicides. Water was cut at the end of June and the garlic undercut and hand lifted after foliage was mostly dried down. Soil was removed from the roots, by harvest, for bulbs which were not rotted or on which rot had not progressed enough to prevent machine harvest, most roots had been pruned by the white rot fungus to within a few inches below the stem plate with Folicur and some Dividend treatments, or near to the stem plate with Maxim and no treatment. Bulbs were rated as symptomless or infected, and machine harvestable or not by the judgement of the Principal Investigator, and only bulbs greater than 1 inch (2.5 cm) in diameter were retained as harvestable. After full drydown of tops, harvestable bulbs were weighed and counted.

Results

Garlic was well-rooted during the late fall of 2000, but no top growth developed until mid-February through mid-March 2000. The winter of 2000-2001 was mild.

Stand

Emergence was determined on March 12, 2001. Apparent differences in stand (Tables 1 and 2) were difficult to trust, given that the trial was machine planted. The specific treatments in which the garlic appeared to stand the best don't seem to follow a logical pattern and are discounted here.

White Rot Progress

White rot progress was rated periodically during the season. Nearly all plant loss following emergence was attributed to white rot. No plants infected with botrytis were found. White rot symptoms were observed on a few plants by the end of March. Irrigation began in mid-April. White rot was present early, probably a result of prolonged activity during the relatively mild winter. By May, white rot symptoms were noticeable in untreated plots. During May, white rot symptoms appeared in plots of all treatments in which yields were low at harvest. A plot tour was held in late June, immediately prior to water cutoff on about July 1. At that time a little white rot appeared in even the best plots. Essentially all postemergence plant loss was attributable to white rot, and some white rot appeared in all treatments.

Treatment Comparisons at Harvest

Main Trial

Means are shown in Table 1 and Figure 1. The untreated check plots yielded a mean of only 2.0 percent symptomless bulbs, 3.7 percent harvestable bulbs, and 1,016-lb bulbs/acre. For Folicur at 0.89 oz product/100 lb seed, a mean of 87.9 percent symptomless bulbs, 91.9 percent harvestable bulbs, and 19,239 lb bulbs/acre exceeded the results of the higher rate of Folicur (82.9 percent symptomless, 86.6 percent harvestable, 18,204 lb/acre), but these means were not statistically separable at 5 percent. Both treatments manifested less white rot than other treatments. Dividend and Maxim treatments were of variable success, depending on rate and combination.

Border Trial

Means are shown in Table 2 and Figure 1. White rot control and yield for the combination of Folicur (0.89 oz product/100 lb seed) + Maxim (0.16 oz product/100 lb seed) were excellent, with a mean of 89.1 percent symptomless bulbs, 95.1 percent harvestable bulbs, and 21,530 lb bulbs/acre. This exceeded the results of the Folicur dip treatment, and exceeded the performance of any treatments in the main trial, although treatments between trials cannot be compared directly. In retrospect, the dip treatment (0.67 oz Folicur/100 lb seed) was probably too low a rate for optimum seed treatment, even though more clove sheaths were retained by this method.

Discussion

Even though the products used prevented much bulb infection, we continue to be impressed with how little of the root system remained by harvest, even with the best treatments. In such uniformly infested trials, the disease pressure is high and products are severely challenged. To prevent the white rot fungus from reaching the bulb is an achievement, especially for a product such as fludioxonil (Maxim, Scholar) that does not move in soil. At least a few inches of root remains with Folicur, evidence of some downward movement in soil, even though this is only a few inches.

The superior treatment used in both trials was Folicur 3.6F applied to seed at 0.25 g a.i./kg seed (0.89 oz Folicur/100 lb seed), as in previous years. In the past, higher rates of Folicur seed treatment may have resulted in decreased bulb infection but also in reduced stand, numbers of harvestable bulbs, and harvest weight, although these differences were not significant statistically and were even less in 2000-2001. Perhaps garlic, like onions, may be sensitive to Folicur. In Tasmania, Jason Dennis (personal communication, Fieldfresh) indicated that in every white rot trial where Folicur was included, onion stands were reduced. Onion roots and foliage may be adversely affected, but Folicur nevertheless provided the best control of all products tested.

Dividend did not perform as well as Folicur, even though we increased the rates of application for Dividend in 2000-2001. The active ingredients in Folicur (tebuconazole) and Dividend (difenconazole) are related but not identical triazole compounds. In the past, Novartis (now Syngenta) was reluctant to use higher rates, so we weren’t sure whether Dividend had the same potential as Folicur at equivalent rates of active ingredient. Because Dividend will only be available as a seed treatment, we chose not to use this product in our 2001-2002 garlic trial.

Maxim 4FS applied as a seed treatment, especially at 0.16 oz/100 lb seed, provided impressive white rot control, especially considering that the active ingredient, fludioxonil, is not mobile in soil. However, white rot control was not quite as good as in 1999-2000. Reduced efficacy could have been due to lack of retention on clove sheaths. As before, Maxim control did not persist through to the end of the season. While perhaps insufficient by itself, Maxim (or Scholar) might greatly extend the level of control when combined with an appropriate rate of Folicur. In fact, in the border trial, the Folicur + Maxim combination was the superior treatment, and outperformed any treatment in the main trial.

Whereas the 2000-2001 results reported here support results from earlier years, the level of white rot was high and led to more disease than preferred even in the best treatments. Somewhat better control was acheived with Folicur alone and Maxim alone in 1999-2000. Even if a few bulbs are rotted, this can lead to increasing soil populations of sclerotia, and lowered control in the future. We suspect the lesser control achieved here may have been due to either reduced material on the seed pieces because of the aggressive handling during treatment, or the more intense disease pressure during a mild winter, or both.

We continue to worry that seed-treatment application based on garlic seed weight might result in high variability in actual applied material per plant and per unit area: garlic seeds (cloves) commonly are sized before planting to create more uniform growth in the crop. Seed lot sizes may vary from less than 1,500 lbs/acre (very small seed) to over 3,500 lbs/acre (very large seed) to achieve the same plant population. Our estimates suggest nearly a 2.5-fold difference in product applied per plant for cloves at the extremes of this range, although most seed lots may fall within a narrower range, perhaps 2,200-2,800 lb/acre. Further discussions with pesticide manufacturers will be needed to resolve the question of the best way to apply the product. This concern could become moot, however, as seed companies have already expressed a preference for in-furrow treatments, which are looked at in greater detail in our 2001-2002 trial.

Most likely, if Folicur becomes the material of choice, it may be applied in several ways (seed, in-furrow, drench from above), as long as equivalent rates per unit volume of soil around the bulb are achieved.

Acknowledgments

This research was supported by the American Dehydrators of Onions and Garlic Association (ADOGA) and the Nevada Onion and Garlic Research Advisory Committee. Field assistance was also provided by Basic Vegetable Products.

Table 1. Main trial data, fungicides for control of white rot (*Sclerotium cepivorum*), Madras Oregon, 2000-2001.

	Spring stand (Mar 12, 2001)	No. bulbs ≥1iInch in diameter per plot at harvest (Aug 15, 2001)			Yield (lbs/acre) of bulbs >1 inch in diameter at harvest (Aug 15, 2001)		
Treatments[1] oz/100 lb seed	Plants/60 bed ft (% of seeded[2])	Symptomless bulbs (% of stand)	White rot infected but intact (% of Stand)	Total (% of stand)	Symptomless bulbs	White rot infected but intact	Total
Folicur 0.89	762 (79.4) b	670.5 (87.9) a	29.5 (3.9) cd	700.0 (91.9) a	18,519 a	720 cd	19,239 a
Folicur 1.78	840 (87.5) ab	696.3 (82.9) a	31.0 (3.7) cd	727.3 (86.6) a	17,448 ab	756 cd	18,204 a
Dividend 3.0	856 (89.1) ab	422.5 (49.4) b	94.0 (11.0) ab	536.5 (62.6) ab	12,530 bc	2,347 ab	14,877 ab
Dividend 1.5	782 (81.5) b	371.5 (47.5) b	65.8 (8.4) abcd	437.3 (55.9) bc	9,734 cd	1,742 abcd	11,477 bc
Maxim 0.32	823 (85.7) ab	313.8 (38.1) bc	92.5 (11.2) ab	406.3 (49.3) bc	9,008 cde	2,414 ab	11,422 bc
Maxim 0.16 + Dividend 0.75	937 (97.6) a	314.8 (33.5) bc	81.3 (8.7) abc	396.0 (42.3) bc	8,942 cde	1,978 abc	10,920 bc
Maxim 0.16 + Dividend 3.0	829 (86.4) ab	290.8 (35.1) bcd	118.0 (14.2) a	408.8 (49.2) bc	7,399 cde	3,049 a	10,448 bc
Maxim 0.16 + Dividend 1.5	779 (81.1) b	249.0 (32.0) bcde	73.8 (9.5) abc	322.8 (41.4) cd	6,643 cde	1,972 abc	8,615 cd
Maxim 0.16	818 (85.2) ab	120.0 (14.7) cdef	43.5 (5.6) bcd	163.5 (20.0) de	4,435 ef	1,300 bcd	5,735 cd
Maxim 0.08	853 (88.8) ab	98.5 (11.5) def	85.0 (10.0) abc	183.5 (21.5) de	3,412 ef	2,323 ab	5,735 cd
Dividend 0.75	838 (87.3) ab	95.0 (11.4) ef	68.3 (8.2) abcd	163.3 (19.5) de	3,557 ef	1,863 abcd	5,421 cd
Untreated	821 (85.5) ab	17.0 (2.0) f	13.5 (1.6) d	30.5 (3.7) e	629 f	387 d	1,016 d

[1]Treatments ranked by order of total yield per acre. Products included Folicur 3.6F; Dividend 3FS, and Maxim 4FS. For seed treatments, cloves were tumbled while a highly concentrated solution of product and water was sprayed over the seed with an atomizer.
[2]Plots were machine planted with commercial seedlots (not sized), at approx. 18 cloves per bed foot.

Table 2. Border trial data, fungicides for control of white rot (*Sclerotium cepivorum*), Madras Oregon, 2000-2001.

	Spring stand (Mar 12, 2001)	No. bulbs $\geq$1 inch in diameter per plot at harvest (Aug 15, 2001)			Yield (lbs/acre) of bulbs >1 inch in diameter at harvest (Aug 15, 2001)		
Treatments[1]	Plants/60 bed ft (% of seeded[2])	Symptomless bulbs (% of stand)	White rot infected but intact (% of stand)	Total (% of stand)	Symptomless bulbs	White rot infected but intact	Total
Folicur + Maxim Seed Trt [0.89 oz + 0.16 oz per 100 lb seed]	874.3 (91.1)	778.7 (89.1) a	53.0 (6.1) ab	831.7 (95.1) a	20,643 a	968	21,530 a
Folicur Seed Dip (0.67 oz per 100 lb seed)[3]	892.0 (92.9)	534.0 (59.9) a	98.7 (11.1) a	632.7 (70.9) a	16,408 a	2,944	19,352 a
Untreated	933.0 (97.0)	101.3 (10.8) b	32.0 (3.4) b	133.3 (14.3) b	2,388 b	887	3,355 b

[1]Treatments ranked by order of total yield per acre. Products included Folicur 3.6F and Maxim 4FS. For seed treatments, cloves were tumbled while a highly concentrated solution of product and water was sprayed over the seed with an atomizer. For dip treatment, mesh seed bags were dipped into a solution of 2.5 oz Folicur per 4 gal water. Bags were allowed to drip over the suspension for 2-3 min or until draining had stopped. Seed in bags was air-dried for 4 days prior to planting. Rate of application was determined by subtraction, ignoring product retained by loose mesh bags.

[2]Plots were machine planted with commercial seedlots (not sized), at approx. 18 cloves per bed foot.

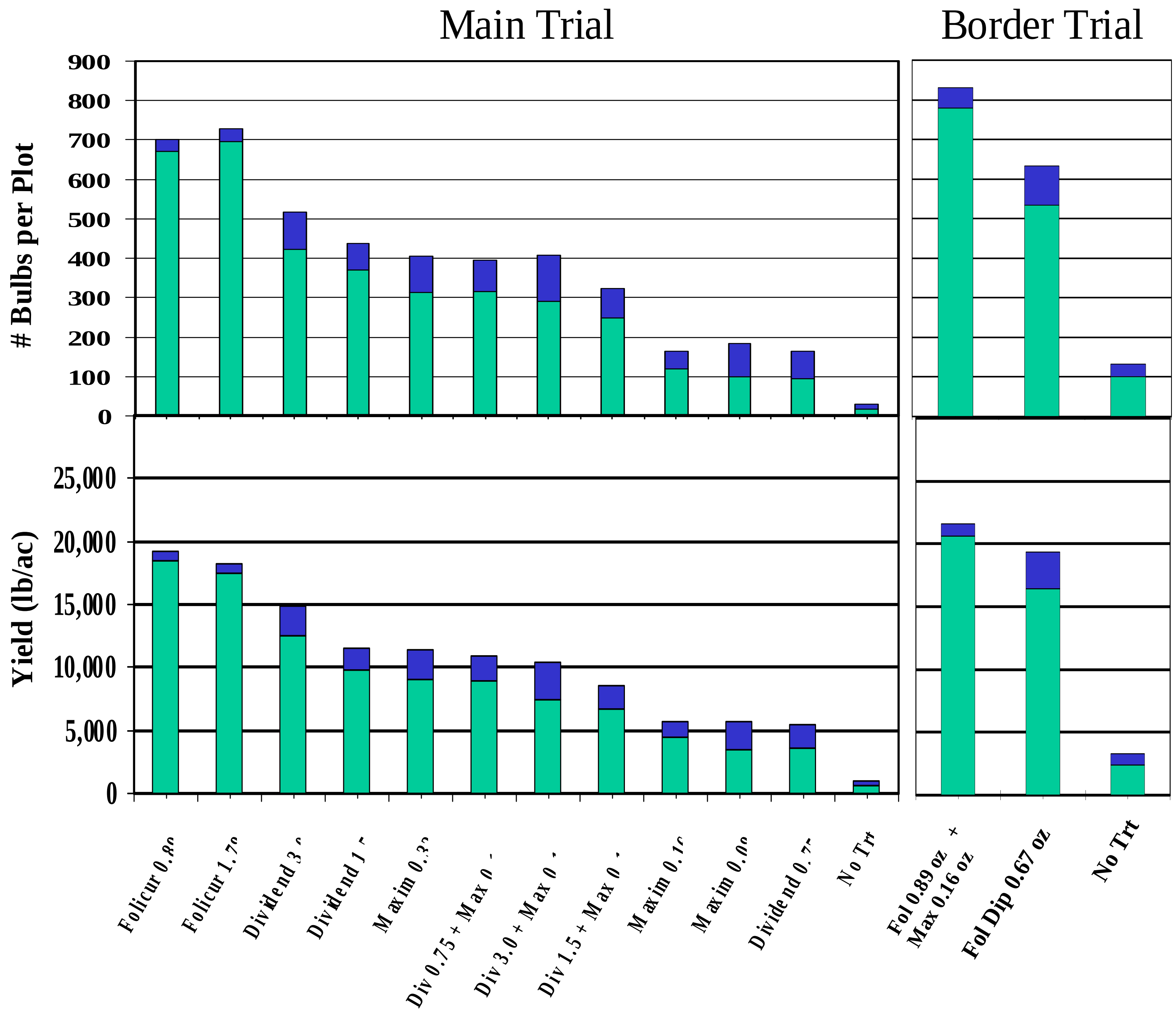


Figure 1. 2000 – 2001 Garlic White Rot Fungicide Trial

NEW POTATO VARIETY DEVELOPMENT
YEARLY PROGRESS REPORT

Steven R. James, Dan Hane, Alvin R. Mosley, Kenneth A. Rykbost, and Clinton C. Shock

Summary

Potato variety trials, seed increases, and screening of potato germplasm were conducted at Central Oregon Agricultural Research Center (COARC) as part of a cooperative program to develop new potato varieties for the Pacific Northwest potato industry. The Oregon Potato Variety Development Program (OPVDP) submitted release materials for ‘Wallowa Russet’ (AO87277-6) in December 2001 and release is imminent. Release documents for ‘Willamette’ (AO91812-1), a chipping variety, have been completed and will be submitted in 2002 pending production of adequate supplies of commercial seed. Another Oregon chipping selection, ‘Ivory Crisp’ (NDO1496-1) was selected in Oregon but will soon be released by Idaho. COARC (1) produced and stored seed of 622 clones at Powell Butte for Oregon, tristate, regional, chip, red-skinned, and other trials to be conducted in 2002; (2) packaged and shipped 33,062 lb of seed to 25 research and 4 industry cooperators in 17 states; (3) preselected, planted, harvested, and evaluated 63,258 single-hill seedling tubers and selected 351 for further evaluation in subsequent years; (4) summarized and published all variety trial information from four Oregon sites; and (5) updated and maintained a fully interactive, dynamic World Wide Web database for all Oregon, tristate, and western regional entries.

Introduction

Potato variety development is an important component of the work of the College of Agricultural Sciences, Oregon State University, in support of the Oregon potato industry. The program now conducts every part of a traditional breeding program, from the selection of parents for crosses through the release of new varieties. Parental lines are screened for disease resistance. Current selection of parents and crosses at Corvallis places emphasis on parental lines with resistance to viruses and market characteristics that will favor future selections of varieties specifically designed to meet growers’ marketing needs. Parents are crossed and the true seed is harvested. True seed is planted to produce seedling tubers for selection at Powell Butte, Klamath Falls, and Hermiston. Oregon continues to grow tubers from true seed produced by the Agricultural Research Service program at Aberdeen, Idaho.

The objectives of the OPVDP are to: (1) develop efficient potato varieties for processing, fresh market, and chipping industries with resistance to environmental stresses, diseases, nematodes, and insects; (2) develop production management guides for selections nearing release; (3) produce and allocate seed of promising Oregon selections to cooperating scientists, growers, processors, and other interested representatives of the potato industry, as well as make provisions for the propagation of disease-free, tissue-cultured plants of advanced selections; and (4) cooperate with other western states and the USDA in evaluating, naming, and releasing superior selections.

The consistent and systematic screening of new lines by the OPVDP team has proven to be an efficient program, providing improved potato varieties for growers. This report details the program's activities at COARC.

Materials and Methods

The Powell Butte field of COARC was the major site producing seed for cooperative regional, tristate, and statewide potato variety trials. In 2001, 22 lines were increased for regional and tristate trials and 110 lines were increased for statewide trials. Prior to planting, 4.5 pints/acre of Eptam 7-E were incorporated into the soil on May 23, 2001. On June 5-7, 2001, 120 tuber units (six seed pieces each) of each regional, tristate, and statewide selection, and 15 tuber units of each preliminary clone were planted. Individual seed pieces were planted 9 in apart within the row and tuber units were separated by 18 in. Two rows were planted 36 in apart and were bordered on either side by a blank row or a 10-ft alley for tractor access. The blank rows/tractor alleys provided space for sprinkler laterals, roguing, and spraying with minimal vine contact. An Iron Age assisted feed potato planter was used to plant the seed pieces and band 1,000 pounds/acre of 16-16-16-7 (NPKS) fertilizer during the planting operation. A systemic insecticide, Admire® (imidacloprid), was applied to the opened furrows at a rate of 0.30 ai/acre. Sencor® (0.48 lb/acre) and Matrix® (1.2 oz/acre) were applied on July 27, 2001 for weed control. The seed increase block was desiccated on September 10 and September 17, 2001, using 1.5 and 1.0 pint/acre of Reglone®, respectively.

First and second field-generation material for which less than five total tubers existed were planted in a combination selection/increase trial. Four hundred and five selections retained from seedling tubers grown in 2000 were planted at Powell Butte on May 30, 2001. Approximately 18 seed pieces (three tuber units of six pieces each) of each selection were planted in the same spatial arrangement as the seed increases. Each selection was separated by 'All Blue' potatoes, which were planted to reduce variety mixing at harvest. Fertilizer and weed control were the same as used for seed increases. The selection trials/increases were harvested on October 2, 2001 by lifting with a level bed potato digger. Selection was based on appearance, shape, malformations, skin color and type, and size and shape uniformity. Approximately 57,700 seedling tubers (small tubers produced in greenhouses from true potato seed) were planted at Madras. Individual tubers were planted 27 in apart in 36-in rows on May 14-17, 2001. Fertility, herbicides, and management practices were similar to the seed increases above.

Two variety trials were grown at Madras in 2001. Twenty varieties/selections were entered in the statewide variety trial and 95 varieties/selections were evaluated in a statewide preliminary variety trial (PYT2). Five and one-half pints/acre of Eptam® 7-E were incorporated into the soil on May 11, 2001. The plots were planted May 21, 2001, and 1,000 lbs/acre of 20.3-13.8-13.5-6.6 (NPKS) fertilizer was banded to the sides and slightly below the seed pieces at planting time. On July 12, 2001, a tank mix of 0.5 lb ai/acre of metribuzin and 1.25 oz/acre of Matrix was applied when plants were 4-5 in high. The field was irrigated with ½in of water after the herbicide application. The variety trials were arranged in randomized block designs; the statewide trial had four replications, the PYT2 trial two replications. Seed pieces were placed 9 in apart in rows spaced 36 in apart and each plot was separated by two hills of 'All Blue' potatoes. The individual plots in the statewide trial were 20.25 ft long (27 seed-pieces) and the

PYT2 plots were 12 ft long (16 seed-pieces). The trials were sprinkler irrigated twice weekly according to demand. Potato vines were desiccated with 2 pints/acre of Reglone on September 13, 2001 and the vines were removed with a flail mower prior to harvest. The trials were harvested on October 8-9, 2001. For each plot, the total number of tubers was recorded and the total weight was recorded for each of six categories: under 4 oz, culls, U.S No. 2's, 4- to 6-oz U.S. No. 1's, 6- to 12-oz U.S. No. 1's, and >12-oz U.S. No. 1's. A 10-lb sample from each plot was taken for french frying, specific gravity determination, and internal defect grading. Specific gravities were determined by weighing approximately 10 lb of tubers in air and water. Ten tubers from each plot were sliced longitudinally and internal defects were recorded as percent of tubers with a given defect. Ten tubers from each plot were stored for 2 months at 50°F for french frying. A single 1-in x ¼-in slab from each of the 10 tubers were fried for 4 min at 375°F. Each strip was evaluated for color and dark ends using a photovolt reflection meter.

Results

The OPVDP team has released six varieties in the last 6 years. These include 'Century Russet', 'Russet Legend', 'Umatilla Russet', 'Klamath Russet', 'Winema' (red-skinned) and 'Mazama' (red-skinned). The 1998 release, 'Umatilla Russet', continues to expand its influence in the northwest. It is now one of the top 10 U.S. varieties. Because of broad adaptability, 'Umatilla Russet' is now grown in more than a dozen countries. 'Umatilla Russet' produces excellent yields of long russet tubers with excellent tuber solids and fry color.

A number of Oregon's advanced selections are showing excellent promise. The OPVDP team submitted release materials for 'Wallowa Russet' (AO87277-6) in December 2001 and release is imminent. Release documents for 'Willamette' (AO91812-1), a chipping variety, have been completed and will be submitted in 2002 pending production of adequate supplies of commercial seed. Another Oregon chipping selection, 'Ivory Crisp' (NDO1496-1) was selected in Oregon but will soon be released by Idaho.

Varieties graduate from the OPVDP to be tested in the Tri-state and Regional Trials, and eventual release to growers. The program continues to generate many promising lines as evidenced by the results of the 2001 statewide trial (Table 1). These results are averages for Hermiston, Klamath Falls, Ontario, and Powell Butte. Selection AO94110-203 was advanced to tristate trials. Table 2 highlights the results for standard varieties and retained selections from the Madras, Oregon PYT2 trial. Some of the weaker performing selections in the Madras trial performed much better at other Oregon locations.

In addition to the variety trials, COARC produced and stored seed of 622 clones at Powell Butte for Oregon, tristate, regional, chip, red-skinned, and other trials to be conducted in 2002; packaged and shipped 33,062 lb of seed to 25 research and 4 industry cooperators in 17 states; pre-selected, planted, harvested, and evaluated 63,258 single-hill seedling tubers and selected 351 for further evaluation in subsequent years; summarized and published all variety trial information from four Oregon sites; and updated and maintained a fully interactive, dynamic World Wide Web database for all Oregon, tristate, and western regional entries.

Table 1. 2001 statewide potato variety trial results averaged over four Oregon locations (Hermiston, Madras, Klamath Falls, and Ontario).

Selection	Yield Total	Yield No. 1	% No. 1	Tuber size	L/W ratio	Spec. grav.	Fry color	Sugar ends	HH/ BC	Black spot	Vine mature
	cwt/a	cwt/a	%	oz			USDA	%	%	%	5 = late
R. Burbank	548	339	62	6.53	1.83	1.084	0.97	14	8	5	3.8
Ranger	569	408	72	8.79	1.93	1.089	0.53	3	0	5	3.7
Shepody	578	398	69	11.02	1.59	1.083	0.86	24	4	4	2.6
Norkotah	493	417	85	7.56	1.82	1.072	1.33	9	4	2	2.5
Umatilla	582	419	72	7.73	1.82	1.089	0.57	1	1	10	3.3
AO92017-6	635	515	81	8.40	1.84	1.091	0.87	3	0	5	3.8
AO94110-203	595	494	83	6.10	1.52	1.096	0.46	0	1	3	3.7
AO92023-3	614	465	76	9.28	1.74	1.077	1.41	4	1	5	3.4
AO92019-4	420	365	87	6.55	1.66	1.078	1.01	18	0	4	2.2
AO94004-3	465	384	83	5.95	1.61	1.090	0.50	0	3	2	3.0
AO96060-1	539	452	84	6.78	1.66	1.086	0.96	0	2	5	3.1
AO96065-7	510	408	80	5.84	1.61	1.096	0.50	1	6	16	3.5
AO96160-3	590	525	89	6.73	1.66	1.094	0.25	8	0	8	3.8
AO96164-1	637	536	84	9.72	1.70	1.087	0.57	0	0	4	3.8
AO96165-2	614	513	83	6.95	1.67	1.090	0.59	2	0	5	3.3
AO96165-9	540	426	79	6.17	1.80	1.087	1.13	14	0	11	3.2
AO96176-3	604	513	85	7.77	1.78	1.085	0.19	0	2	5	3.1
AO96177-6	606	523	86	11.25	1.86	1.094	0.00	6	1	10	4.2
AO96262-1	558	441	79	7.52	1.79	1.088	0.44	3	0	13	3.2
AO96272-1	628	473	75	7.59	1.87	1.090	0.56	0	0	4	3.5

Table 2. PYT2 results for standard and retained selections grown at Madras, Oregon in 2001.

Selection	Yield Total	Yield No. 1	% No. 1	Tuber size	L/W ratio	Spec. grav.	Fry color	Sugar ends	HH/ BC	Black spot	Vine mature
	cwt/a	cwt/a	%	oz			USDA	%	%	%	5 = late
R. Burbank	306	197	64	5.08	1.50	1.090	0.14	0	5	10	3.5
Ranger	415	294	71	7.91	1.67	1.090	0.10	0	0	5	3.0
Shepody	327	212	65	8.48	1.40	1.088	0.00	0	0	5	2.5
Norkotah	288	243	84	8.22	1.58	1.084	0.09	0	0	5	2.5
Umatilla	380	287	76	6.20	1.58	1.099	0.00	0	0	0	3.0
AO96382-3	319	226	71	7.31	1.63	1.094	0.00	0	0	0	2.5
AO97178-1	284	228	80	5.93	1.56	1.103	0.00	0	0	0	3.0
AO97318-2	302	237	78	5.54	1.67	1.099	0.00	0	0	0	3.0
AO97133-2	294	243	83	7.44	1.48	1.092	0.00	0	0	0	2.5
AO97278-3	355	272	77	9.27	1.64	1.092	0.00	0	0	0	3.0
AO97303-2	370	310	84	6.7	1.59	1.096	0.00	0	0	0	3.0
AO97109-3	395	283	72	6.30	1.81	1.093	0.00	0	0	5	3.0
AO97118-3	421	355	84	6.95	1.69	1.075	0.84	0	0	5	3.0
AO97131-3	404	310	77	6.99	1.54	1.084	0.00	0	5	10	3.0
AO97143-1	298	131	44	3.56	1.44	1.100	0.00	0	0	0	3.5
AO97171-4	242	123	51	4.15	1.69	1.089	0.68	0	13	13	3.0
AO97175-13	420	310	74	6.40	1.60	1.094	0.05	5	0	0	3.0

EVALUATION OF VARIETIES OF ORCHARDGRASS, FINE FESCUE, AND BROME IN CENTRAL OREGON, 2001

Marvin Butler, Peter Sexton, Claudia Campbell, Rhonda Bafus,
Les Gilmore, and Tom Shibley

Abstract

Plots were established August 11, 2000 at the Central Oregon Agricultural Research Center (COARC) to evaluate eight varieties of orchardgrass, six varieties of hard fescue, and five varieties of brome. Hard fescue variety 'Warwick' produced significantly higher yields than 'Scallis II' or 'Eureka'. 'SR 3100' hard fescue produced the second-highest yield with the greatest seed yield per biomass. Yields for orchardgrass varieties 'Quantam' and 'Orion' were significantly higher than either 'Mammoth' or 'Justus'. Mountain brome variety 'BCAPN-1' produced an outstanding yield despite significant shatter at harvest.

Introduction

There is a continuing search by the agricultural community in central Oregon to explore new crop opportunities. Since this area is heavily invested in grass and vegetable seed production, evaluating opportunities to expand into additional grass seed crops would be a logical area to pursue. In cooperation with industry representatives, Peter Sexton established plots in 2000 to evaluate varieties of orchardgrass, fine fescue, tall fescue, and bromes at COARC in Madras, Oregon.

Methods and Materials

Plots were established August 11, 2000 at COARC to evaluate eight varieties of orchardgrass, six varieties of hard fescue, five varieties of tall fescue, and three varieties of brome. Eighteen-ft plots by four rows for all varieties except hard fescue (with eight-row plots) were replicated four times in a randomized block design. None of the tall fescue plots were harvested due to a drop in interest in that species.

Plot harvest was determined by varietal maturity. 'Eureka' hard fescue and 'Quatro' sheep fescue were harvested June 23, followed by harvest of 'Scaldis II', 'SR 3100' and 'Warwick' hard fescue and 'CAS-FCS1' chewings fescue on July 2. All orchardgrass varieties were harvested July 12, along with 'CAS-AZ11' and 'BCAPN-1' bromes. There was some shatter in the orchardgrass varieties, but it was slight and appeared to be similar across varieties. 'BCAPN-1' was overmature with significant shatter and should have been harvested a week earlier, while the timing on 'CAS-AZ11' appeared correct. One variety of brome was not harvested due to severe shatter.

Results and Discussion

Seed yields for fine fescue (Table 1), orchardgrass (Table 2), and brome grasses (Table 3) were significantly different between varieties for each of the grass types. Hard fescue variety 'Warwick' produced significantly higher yields (1,249 lb/acre) than 'Scallis II' (778 lb/acre) or 'Eureka' (662 lb/acre). 'SR 3100' hard fescue produced the second highest yield at 1,079 lb/acre, with the greatest seed yield per biomass. Chewings fescue variety 'CAS-FCS1' yielded 945 lb/acre and 'Quatro' sheep fescue produced 892 lb/acre. These yields are competitive with the Willamette Valley production of 775 lb/acre.

Orchardgrass varieties 'Quantam' (621 lb/acre) and 'Orion' (487 lb/acre) yielded significantly higher than either 'Mammoth' (367 lb/acre) or 'Justus' (320 lb/acre). However, all varieties were significantly lower than the 850 lb/acre production in the Willamette Valley.

Mountain brome variety 'BCAPN-1' produced an outstanding yield of 1,683 lb/acre despite significant shatter at harvest, which was estimated to be about a week late. Smooth brome variety 'CAS-AZ11' was harvested in a timely manner and produced 781 lb/acre.

Table 1. Performance of fine fescue varieties planted August 2000 at the Central Oregon Agricultural Research Center and harvested in 2001.

Variety	Harvest	Seed yield		Biomass
	date	----lb/acre----		----ton/acre----
Warwick (hard)	July 2	1,249	a[1]	7.7
SR 3100 (hard)	July 2	1,079	ab	5.8
CAS-FCS1 (chewing)	July 2	945	ab	6.8
Quatro (sheep)	June 23	892	ab	5.9
Scaldis II (hard)	July 2	778	b	5.8
Eureka (hard)	June 23	662	b	6.4
				NS

[1]Mean separation with Student-Newman-Kuels (SNK) Test at $P \leq 0.05$.

Table 2. Performance of orchardgrass varieties planted August 2000 at the Central Oregon Agricultural Research Center and harvested in 2001.

Variety	Harvest date	Seed yield ----lb/acre----		Biomass ----ton/acre----
Quantam	July 12	621	a[1]	4.2
Orion	July 12	487	b	3.9
Frode	July 12	444	bc	4.2
Ambassador	July 12	406	bcd	4.3
Pizza	July 12	388	bcd	3.5
Stampede	July 12	374	bcd	4.0
Mammoth	July 12	367	cd	4.0
Justus	July 12	320	d	3.2
				NS

[1]Mean separation with Student-Newman-Kuels (SNK) Test at $P \leq 0.05$.

Table 3. Performance of brome grass varieties planted August 2000 at the Central Oregon Agricultural Research Center and harvested in 2001.

Variety	Harvest date	Seed yield ----lb/acre----		Biomass ----ton/acre----
BCAPN-1 (mountain)	July 12	1683	a[1]	6.3
CAS-AZ11 (smooth)	July 12	781	b	6.7
				NS

[1]Mean separation with Student-Newman-Kuels (SNK) Test at $P \leq 0.05$.

SEED CARROT ABOVE GROUND BIOMASS AND NUTRIENT ACCUMULATION, 2001

Marvin Butler, John Hart, Bruce Martens, and Claudia Campbell

Abstract

A commercial field of Nantes hybrid carrots grown for seed near Madras, Oregon was sampled for nutrient uptake during the 2000-2001 growing season. Three feet of the outside female row was removed at ground level at four representative locations in the field. Total nitrogen accumulation was approximately 165 lb/acre, total K was 182 lb/acre, and more than 8,500 lb/acre of biomass was generated. The greatest increase in biomass was during mid-June to mid-July, with over two-thirds of the total biomass production. Peak N uptake of over 3 lb/acre/day occurred in late June, at the beginning of flowering. The peak K uptake rate of 2 lb/acre/day occurred a week later than peak N uptake.

Introduction

Central Oregon is the major hybrid carrot seed production area supplying the domestic fresh market carrot industry. Understanding nutrient requirements for carrots grown for seed is an important component in maximizing seed production and quality. The objective of this project is to determine nutrient uptake of carrots grown for seed throughout the growing season.

Before nutrients are applied to a crop, four decisions must be made: how much to apply, when to apply the nutrient(s), what source to use, and how to make the application. Measuring plant growth and nutrient accumulation provides information about time of nutrient application. In addition, an estimation of the amount of nitrogen needed by the crop can be made.

Our hope is to provide growers with information that will aid in making decisions about nutrient application and to accumulate data that can be used in models that will be developed to predict nutrient need/supply.

Methods and Materials

A commercial hybrid Nantes seed carrot field was identified for sampling north of Madras, Oregon. Flags were placed at four representative locations in the field and samples were collected near these flags to control variability. Three feet of the outside female row were removed at ground level at each location; samples were dried and then analyzed for N, P, K, S, Ca, Mg, S, B, Mn, Cu, and Zn. Sampling dates from the fall of 2000 through the summer of 2001 were October 19, March 5, April 23, May 11, June 12, June 26, July 10, July 31, and August 20.

A three-parameter sigmoid equation was used to describe biomass accumulation and nutrient uptake (Fig. 1). The first derivative of the equation was taken to determine a rate function, dN/dt. An estimate of maximum time of biomass or nutrient accumulation can be estimated by plotting the rate function vs. sampling date (Fig. 2).

Results and Discussion

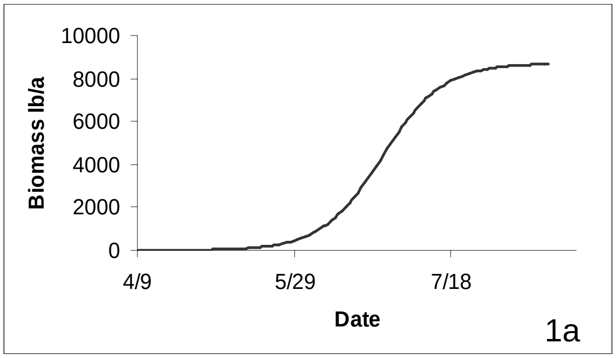
Average biomass and nutrient accumulation for each sampling date is presented in Table 1. The peak nitrogen accumulation, approximately 165 lb/acre, is consistent with the amount found in many other crops grown in the northwest (Sullivan et al. 1999). The peak or largest amount of nitrogen was measured before harvest and is also consistent with measurements made in other crops grown for seed. Lower leaves are shaded, senesce, and are sloughed by the plant. The cumulative effect is a measured loss of aboveground nitrogen accumulation.

Table 1. Average above-ground biomass and nutrient accumulation of Nantes hybrid carrots grown for seed in central Oregon. Carrot seed was planted in 2000 and harvested in 2001.

		Nutrient accumulation							
Sampling date	Biomass accumulation	N	P	K	S	Ca	Mg	B	Zn
		--lb/acre--							
10/19	108	4	0.4	3	0.4	1.5	0.5	0.003	0.003
3/5	244	7	0.9	4	0.6	3.8	1.1	0.006	0.007
4/23	586	24	2.3	17	2.3	13	3.7	0.023	0.024
5/11	657	25	2.1	19	3.3	15	5	0.03	0.02
6/12	1618	51	5.2	48	7.3	28	8	0.07	0.06
6/26	3608	100	11.7	96	15	61	18	0.15	0.09
7/10	6806	149	18.4	172	25	95	31	0.26	0.17
7/31	8974	167	23.4	201	30	135	40	0.35	0.21
8/20	8207	146	21.0	182	25	113	34	0.34	0.18

Carrot seed yield increased with nitrogen application in three N rate/plant spacing trials in India. The seed yield increase was linear with rates to 67 lb/acre (Kumar and Nandpuri, 1976). Higher N rates, 0, 50, and 100 lb/acre, were used by Malik and Kanwar (1969). They reported that maximum carrot seed yield was produced with the application of 50 lb N/acre when soil test N was 90 lb/acre and maximum seed was produced with the application of 100 lb N/acre when soil N was 75 lb/acre. Sharma and Singh (1981) reported little increase in carrot seed yield from the application of 45, 90, or 135 lb N/acre, but found significantly more seed produced with the application of 90 lb N/acre compared to plots receiving no N. Soil N at this site was 200 lb/acre. The amounts of N supplied by soil and fertilizer reported in this literature are consistent with the amount of N measured in the carrot seed crop we sampled.

Potassium accumulation that is greater than nitrogen is routinely reported for crops grown in an environment of sufficient to high levels of soil potassium.



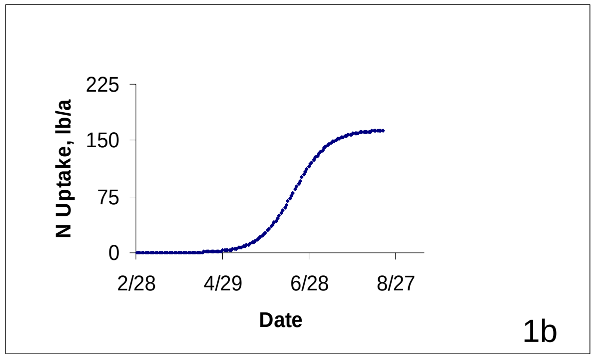


Figure 1. Total biomass and nutrient accumulation for Nantes hybrid carrots grown for seed north of Madras, Oregon, in 2001.

Biomass

Seed carrots grow slowly in the fall and spring, producing only 500 to 600 lb biomass/acre by late April–early May (Fig. 1a). From mid-June to mid-July, the growth is rapid and linear, accounting for two-thirds of the total biomass. Less than 20 percent of the biomass is produced after mid-July. Peak biomass production of more than 200 lb/acre/day occurs in late June.

Nutrients

N uptake is rapid during June and essentially complete by early July, approximately 5-6 weeks before harvest (Fig. 1b). The amount of N taken up by carrots grown for seed is variety dependent, primarily a function of biomass production. Total N uptake was 140 and 175 lb N/acre for a single field of Nantes hybrid carrots in 2001.

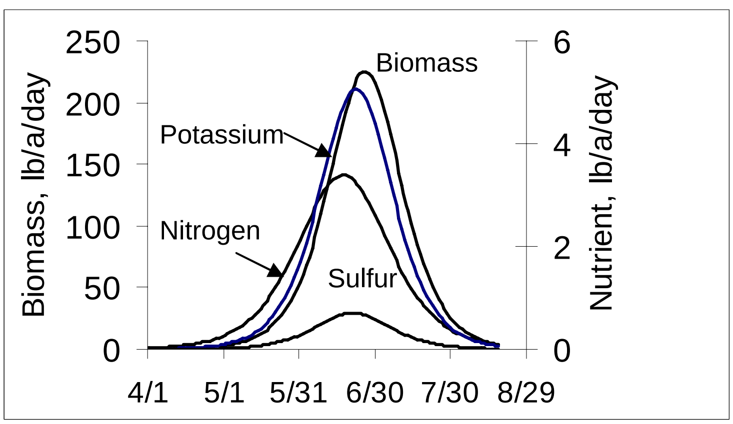


Figure 2. Daily accumulation of biomass, nitrogen, potassium, and sulfur for Nantes hybrid carrots grown for seed north of Madras, Oregon, in 2001.

Peak N uptake of slightly more than 3 lb/acre/day occurred in late June (Fig. 2). The peak N uptake rate occurs as bloom is beginning and before bees are placed in the field. The peak uptake rate of potassium and sulfur coincided with the peak production of biomass and was approximately 1 week later than the peak N rate. Potassium uptake rate was 2 lb/acre/day more than N. The higher K uptake rate resulted in the total K uptake of approximately 40 lb/acre more than N at harvest.

Management

After the beginning of July or after seed set, nutrient uptake decreases rapidly. Nutrients should be supplied well in advance of need, mid-May at the latest. If sufficient nutrients are supplied during the early growing season, late-season applications are not efficient or effective. Some N should be applied in mid- to late-April to support early growth. The bulk of the N is accumulated during June. A combination of available soil and fertilizer N totaling 150 to 200 lb/acre seems a logical rate.

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PEPPERMINT VARIETY TRIAL, CENTRAL OREGON, 2001

Fred Crowe, Rhonda Bafus, and Robin Parks

Summary

Mint varieties and selections were planted in 1999 from rooted cuttings into side-by-side *verticillium* wilt-infested and noninfested trials at the Central Oregon Agricultural Research Center (COARC) in Madras. In 2001 the selection 'B90-9' outyielded other varieties in both infested (59.7 lb/acre) and noninfested (72.3 lb/acre) trials. 'Black Mitcham' and the selections 'M83-14', and 'M90-11' yielded similarly in both infested and noninfested trials. 'Todds' and the selections '84M0107-7', '87M0109-1', and 'McKellip' yielded more in the noninfested than in the infested trial. No wilt was observed in selection '84M0107-7'. Wilt was present but at a relatively low incidence in infested plots for 'Todds' and the selections 'M83-14', '87M0109-1', and 'M90-11'. Wilt incidence in infested 'Black Mitcham' plots was moderate. Wilt incidence in selection 'B90-9' and in the selection 'McKellip' (derived from 'Black Mitcham') was intermediate between that of 'Todds and 'Black Mitcham'. 'Black Mitcham' and 'Todds' were considered to have "Madras-quality" composition. Percentage composition of a number of key oil components for selections 'B90-9', 'M83-14', '92(B-37XM0110)-1', '87M0109-1', and 'McKellip' were not out of range for "Madras quality", although 'Todds' and some selections had reduced menthofuran compared to 'Black Mitcham'.

Introduction

Peppermint variety trials initiated in central Oregon and elsewhere in 1994 and 1995 were the first public, replicated, and randomized such trials under uniform management and in which statistical comparisons could be made. The Oregon State University (OSU)-COARC field at Madras was not cropped with irrigated crops until 1990, and even now has a substantial area that is not infested with measurable levels of any strain of *Verticillium dahliae*. This allowed us in 1994 to artificially infest part of the trial area with a uniform level of only the mint strain of *V. dahliae*. This was an advantage over most fields in which *V. dahliae* populations are non-uniform, and in which mixtures of strains can confuse interpretation of soil assay measurements. This and other trials have proven useful for wilt and yield comparisons, and should become more useful as a new generation of mini stills are developed that may provide near-commercial character for the oil distilled from small plots. A second trial was initiated in 1999, again in a field believed to be noninfested with *V. dahliae* on the OSU-COARC farm at Madras. Half of the trial was infested with mint strains of *V. dahliae* in fall 1999. The growth, yield, oil quality, and *Verticillium* wilt susceptibility of seven entrees and two standard varieties will be evaluated from 2000 to 2003.

Methods

Plots were established from rooted cuttings in the summer of 1999. The trial area is split into an artificially infested area and a noninfested area as per 1994-1998. Plot sizes are 10 ft x 20 ft. All plots have been managed identically. Trials were maintained as per commercial practices with respect to fertility, pest and weed control, and irrigation.

Nine entrees were included. The Mint Industry Research Council (MIRC) submitted six entrees: '84M0107-7', 'M90-11', '87M0109-1', 'M83-14', '92(B37xM0110)-1', and 'B90-9'. A privately developed variety from L. McKellip (labeled 'McKellip 98') was also included. Standard varieties included 'Black Mitcham' and 'Todds'. The field was divided into two randomized complete block design trials: one half of the field was noninfested and the other half was infested with *V. dahliae*. Each variety is replicated four times within each trial.

In 1999, *V. dahliae* inoculum was produced in the laboratory by growing *V. dahliae* on a modified, minimal agar (Puhalla 1979) overlain with sterile, uncoated cellophane. After a 3-week incubation, microsclerotia were harvested by blending the cellophane in sterile water and washed on a 38-µm sieve. The dried concentrated inoculum was ground with sterile sand with a mortar and pestle. The concentration of microsclerotia/g inoculum was estimated and mixed with enough sterile sand to yield about four microsclerotia/g soil, a slightly higher initial rate than in 1994. As in the previous trial, the sand and *V. dahliae* microsclerotia mixture was spread over half of the field on plot surfaces after fall dormancy. At that time, all plots were tilled to both distribute rhizomes and place inoculum within the rooting zone of the mint.

In mid-summer 2000, *V. dahliae* soil populations were estimated. Soil was collected from three random locations within each plot in mid-July and air-dried for 1 month to eliminate ephemeral conidial spores and hyphae of *V. dahliae* (Butterfield and DeVay 1977) prior to analysis (Harris et al. 1993). After drying, subsamples were ground with a mortar and pestle to pulverize the soil and remove rocks larger than 1 cm in diameter. From each subsample, 25 g of soil were shaken and dispersed in water for 1 hour. The soil was wet sieved through 60- and 400-mesh soil screens to reduce soil volumes and many competitive organisms. Residue remaining on the 400-mesh screen was suspended in 100 ml water and 2 ml of this suspension was spread onto a semi-selective modified pectate agar medium in a petri plate. Ten plates were prepared per subsample. A total of 5 g of soil was plated per subsample. After a 2-week incubation in the dark at room temperature, colonies distinctive of *V. dahliae* were counted. The population data were expressed as the number of colony-forming units (CFU) per gram of soil.

Mint performance and oil character were assessed as in 1994-1998. Wilt severity was represented as per the recommended MIRC wilt rating with the proportion of plants in plots allocated to various wilt classes ranging from no wilt through severe wilt. The plots were harvested at about 10 percent bloom in 2000 and 2001. Subsamples from each plot were collected and air-dried in gunnysacks. Oil from these subsamples was distilled using the McKellip-Newhouse mini still located at OSU-Madras. RCB International, Ltd. in Albany, Oregon performed the oil component analysis in 2000, and I.P. Callison did this in 2001. Other evaluations were also made.

All response variables underwent an analysis of variance (ANOVA) using the general linear model, PROC GLM, of SAS version 7.0 (SAS Institute 1988). The noninfested and infested halves of the field were analyzed as separate experiments. Due to an unexpected level of wilt in the noninfested trial, discussed further in the results and discussion sections, four analyses were performed for each response variable. ANOVA was performed on the dataset (1) containing all plots, (2) without plots in the western blocks, and (3) containing all plots but relabeling the western block in the noninfested half of the field as infested. An analysis of covariance, using PROC GLM, was performed on the complete dataset with *V. dahliae* soil population as the covariate. Treatment means were separated by Fisher's protected least significant difference (LSD) test.

Results

As the 2000 growing season progressed, a disproportionate amount of wilt symptoms were evident in the western edge of the trial in both the infested and noninfested halves of the field. The plots most affected were those in the two blocks, one noninfested and one infested, that compose the western edge of the field. Following consultation with Cliff Pereira, statistician at Oregon State University, we performed a series of analyses to determine which approach yielded the most useful and meaningful data, taking into consideration this unbalanced disease incidence.

The *V. dahliae* soil population data were not significant as a covariate for any of the response variables. Therefore, soil populations in the plots could not account for the high proportion of wilt in those plots. We then compared the results from an analysis of the complete dataset with the analysis (1) of a dataset with the western edge blocks removed, and (2) of a dataset with the western edge block in the noninfested half of the field relabeled as infested because all plots displayed high disease severity. Neither the removal of the blocks nor the relabeling of the noninfested block changed the trends in the data with respect to differences in means among the varieties. Therefore, we chose to present results from the more conservative analysis of the dataset with the western blocks removed from both the noninfested and infested trial. This consequently reduced the total number of replications per variety to three in each trial.

The estimated means of net wilt at harvest, spring ground cover, mid-season vigor, mildew, fresh hay yield, and oil yield are shown in Table 1 (infested) and Table 2 (noninfested). Powdery mildew severity, hay yield, and oil yield are displayed in Table 1. The full MIRC wilt ratings are shown in Table 3 (infested) and Table 4 (noninfested). Oil character analyses is not shown in this report, but we hope to include these analyses in the companion MIRC report.

In 2000, the selection 92(B37xM0110)-1 proved to be inferior with respect to nearly all measured parameters, and this trend continued in 2001. The yield of 92(B37xM0110)-1 was only 14.7 lb/acre in the infested trial, and 25.1 lb/acre in the noninfested trial, attributable to poor winter survival and high wilt incidence. Hay weights between 2000 and 2001 varied substantially, with different varieties/selections ranking differently in the 2 years. In 2000, there no few significant yield differences among varieties/selections, but in 2001 the selection 'B90-9' outyielded other varieties in both infested (59.7 lb/acre) and noninfested (72.3 lb/acre) trials. 'Black Mitcham' and the selections 'M83-14', and 'M90-11' yielded similarly in both infested and noninfested trials. 'Todds' and the selections '84M0107-7', '87M0109-1', and 'McKellip' yielded more in the noninfested than in the infested trial.

No wilt was observed in selection '84M0107-7'. Based on the lack of any observed wilt incidence for this selection in the more highly infested western tier of plots, we might expect the apparent tolerance/resistance of selection '84M0107-7' to hold up at higher infestation levels. This is supported by wilt data from the Willamette Valley trials, reported elsewhere. (Note, however, the apparent depressive effect of *verticillium* on yield of this and certain other selections or varieties, even in the absence of wilt symptoms.) Wilt was present but at a relatively low incidence in infested plots for ‘Todds’ and the selections M83-14’, ‘87M0109-1’, and ‘M90-11’. Wilt incidence in infested ‘Black Mitcham’ plots was moderate. Wilt incidence in selection ‘B90-9’ and in the selection ‘McKellip’ (derived from ‘Black Mitcham’) was intermediate between that of ‘Todds’ than ‘Black Mitcham’.

Stand, as measured by percentage groundcover in the spring, was lower in infested than in noninfested trials, for all varieties and selections. In the presence of *V. dahliae*. Stand was particularly depressed in the selection ‘92(B-37XM0110)-1’, and less so for ‘Black Mitcham’. In some plots, the selection ‘92(B-37XM0110)-1’ was particularly poor, and may be classified as nearly wilted out even in the beginning of 2001; none of the individual ‘Black Mitcham’ plots are that severely damaged yet.

Only the variety ‘Black Mitcham’ and the related selection ‘McKellip’ showed any mildew, which has not been severe in central Oregon in either 2000 or 2001.

Partial oil composition is shown in Tables 5 and 6. Oil composition in 2001 was representative of Madras-quality oil for the ‘Black Mitcham’ and ‘Todds’ varieties [8.1-9.1percent total heads, 41.0-41.2 percent menthol, 13.5-21.1 percent total menthone, 3.6-7 percent menthofuran, 1 percent pulegone, and 7.7-8.9 percent total esters], although ‘Black Mitcham’ was slightly high for menthofuran (5.7-7.0 percent) vs ‘Todds’ (3.6-4.5 percent). Percentage composition for both of these standard varieties and for the selections did not vary substantially between infested and noninfested trials. Percentage composition of these components for selections ‘B90-9’, ‘M83-14’, ‘92(B-37XM0110)-1’, ‘87M0109-1’, and ‘McKellip’ did not vary much from that of ‘Black Mitcham’ and ‘Todds’, although (as with ‘Todds’) some had reduced menthofuran compared to ‘Black Mitcham’. Total menthone was high for selections ‘84MO107-7’ (45.3 percent) and ‘87M0109-1’ (27.8 percent). Menthofuran was low for selections ‘84MO107-7’ (1.2-1.5 percent), ‘92(B-37Xmo110)-1’ (2.1-2.8 percent), and ‘87M0109-1’ (2.0-3.2 percent). Pulegone was high for selection ‘M90-11’ (5.1 percent). Total esters were low for selection ‘84M0107-7’ (3-3.2 percent).

Discussion

There are probably several different infestation levels within the entire variety trial. The first level is the artificial inoculum in the infested half of the field. A second level is contamination from a previous trial immediately to the west that was infested with a mint isolate of *V. dahliae*. Infected plant debris and infested soil was likely dragged by machinery into the western portion of what is now the variety trial. This would account for the higher wilt severity in the westernmost block of plots in both the infested and noninfested trials. Once these western plots were removed from the data analysis, there were only low levels of wilt, which did not differ among the varieties.

In 2000, the first full production year of this trial, there were differences in stand among the varieties in both the noninfested and infested trials. In both trials, the lowest stand was observed in ‘92(B37xM0110)-1’. In both trials in 2000, this variety also exhibited the lowest height, dry hay, and oil yield. This trend continued for 2001, and it is likely that selection '92(B37xM0110)-1' will "wilt out" or winter kill (these phenomena can be related) within another year or two.

Selection 'B90-9' appears promising with respect to yield; it performed substantially better than all other selections and the two standard varieties, 'Black Mitcham' and 'Todds'. Selection 'B90-9' seems to show a level of wilt tolerance somewhere between 'Black Mitcham' and 'Todds', although a few more years may make its relative tolerance more clear. (In the Willamette Valley trial, this selection has been intermediate between 'Murray' and 'Black Mitcham', which supports this speculation.)

Selection '84M010707' appears highly promising with respect to wilt tolerance, showing no wilt in central Oregon (and only slight wilt in the Willamette Valley trial). Yield of this selection seems comparable to that of 'Todds' and 'Black Mitcham' in central Oregon. Without oil characterization, we can't say what the oil is like at this time. Other selections have not shown to be either superior or inferior at this time to standard varieties, but several more years' performance may be required to evaluate them.

The private selection 'McKellip', field selected from 'Black Mitcham', yielded well in the noninfested trial (better than 'Black Mitcham', and second ranked overall) but fell down in ranking in the infested trial; its wilt tolerance seemed intermediate between 'Black Mitcham' and 'Todds'. It, too, needs more time to be fully evaluated.

In 2001, percentage composition of a number of key oil components for selections 'B90-9', 'M83-14', '92(B-37XM0110)-1', '87M0109-1', and 'McKellip' did not vary much from that of 'Black Mitcham' and 'Todds', although (as with 'Todds') some had reduced menthofuran compared to 'Black Mitcham'. Of course, the partial oil composition shown in Tables 5 and 6 does not suggest totally equivalent flavor with standard varieties. 'Black Mitcham' and 'Todds' were considered to have Madras-quality composition in 2001, although menthofuran in 'Black Mitcham' was slightly elevated over that of 'Todds' and some of the selections. As in other years, the timing of harvest may have substantially affected oil composition, but this was not investigated–all varieties/selections were cut on the same date.

It is anticipated that this trial would last for four full-season production years, 2000-2003. Depending on initial wilt levels and crop management practices, 'Black Mitcham' and other varieties might "wilt out" within this period of time. This is about how long some varieties take to show whether periodic tillage is beneficial (in the absence of *V. dahliae*).

Acknowledgements

This research was supported by the Oregon Mint Commission and the Mint Industry Research Council.

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Table 1. Second year peppermint production and verticillium wilt disease incidence on infested soil. Central Oregon peppermint variety trial, 2001.

Variety	Verticillium Wilt Infection 8/1/01 (%)	Ground Cover 5/22/01 (1-5)	Vigor Rating 7/31/01 (1-5)	Mildew Rating 7/31/01 (%)	Hay Yield Fresh Wt 8/5/01 (lbs/ac)	Oil Yield 8/5/01 (lbs/ac)
Black Mitcham	18.0	79.9	1.5	1.3	22,775	36.0
Todds	2.3	94.0	1.2	0	25,430	39.1
84MO107-7	0	92.0	1.0	0	39,722	34.1
M83-14	2.7	90.0	1.0	0	28,085	42.3
B90-9	7.7	86.7	1.3	0	23,626	59.7
92(B-37XM0110)-1	24.7	43.3	3.2	0	16,946	14.7
87M0109-1	1.7	96.3	1.0	0	33,935	45.0
M90-11	3.0	94.7	1.0	0	27,210	47.5
McKellip	4.3	87.0	1.2	1.3	23,709	33.9
LSD (.05)	15.6	12.5	0.5	0.5	13,000	26.0

Table 2. Second year peppermint production and verticillium wilt disease incidence on non-infested soil. Willamette Valley peppermint variety trial, 2001.

Variety	Verticillium Wilt Infection 8/1/01 (%)	Ground Cover 5/22/01 (1-5)	Vigor Rating 7/31/01 (1-5)	Mildew Rating 7/31/01 (%)	Hay Yield Fresh Wt 8/5/01 (lbs/ac)	Oil Yield 8/5/01 (lbs/ac)
Black Mitcham	0.3	90.7	1.5	1.3	31,259	38.8
Todds	1.0	96.7	1.2	0	35,574	45.7
84MO107-7	0.7	95.3	1.2	0	45,576	49.4
M83-14	0	91.3	1.0	0	32,836	42.5
B90-9	0.7	88.3	1.2	0	29,164	72.3
92(B-37XM0110)-1	9.7	55.0	2.7	0	28,625	25.1
87M0109-1	0	95.0	1.2	0	40,635	51.0
M90-11	0	93.7	1.0	0	34,018	47.7
McKellip	2.7	86.7	1.0	1.3	31,404	59.6
LSD (.05)	3.4	6.6	0.5	0.5	7,225	21.4

NS = Not statistically significant
Vigor rating: 1 = Excellent / 5 = Poor. Acceptable less than or equal to 2.0
Ground cover: 1=100% / 5 = 20%.

Table 3. Second year peppermint verticillium wilt disease incidence by verticillium class on infested soil. Central Oregon peppermint variety trial. August 1, 2001.

Variety	Verticillium wilt severity scale[1]				
	1 Healthy	2	3	4	5 Severe
	- - - - - - - - - - - - - - - - - - -	(%)	- - - - - - - - - - - - - - -	- - - -	
Black Mitcham	81.9	0	2.6	7.0	8.5
Todds	97.7	0	1.0	0.7	0.7
84MO107-7	100.0	0	0.0	0.0	0.0
M83-14	97.3	0	1.3	1.0	0.3
B90-9	92.3	0	1.0	3.0	3.7
92(B-37XM0110)-1	75.3	0	4.3	10.7	9.7
87M0109-1	98.3	0	0.7	0.3	0.7
M90-11	97.0	0	1.3	1.0	0.7
McKellip	95.7	0	1.3	1.3	1.7
LSD (.05)	14.7	NS	2.1	5.1	6.1

Table 4. Second year peppermint verticillium wilt disease incidence by verticillium class on non-infested soil. Central Oregon peppermint variety trial. August 1, 2001.

Variety	Verticillium wilt severity scale[1]				
	1 Healthy	2	3	4	5 Severe
	- - - - - - - - - - - - - - - - - - -	(%)	- - - - - - - - - - - - - - -	- - - -	
Black Mitcham	99.6	0	0	0.0	0.3
Todds+A3	99.0	0	0	0.3	0.7
84MO107-7	99.3	0	0	0.0	0.0
M83-14	99.7	0	0	0.0	0.3
B90-9	99.3	0	0	0.3	0.3
92(B-37XM0110)-1	90.3	0	1.0	2.0	6.7
87M0109-1	100.0	0	0	0.0	0.0
M90-11	100.0	0	0	0.0	0.0
McKellip	97.3	0	0	0.3	2.3
LSD (.05)	3.4	NS	0.1	0.8	4.5

[1]Verticillium wilt severity scale

1. Healthy
2. Mild chlorosis upper leaves
3. Distinct crescent leaves, mild stunting, chlorosis
4. Severe chlorosis, severe stunting
5. Very severe stunting, 60% or more of foliage necrotic

Table 5. Second year peppermint oil partial compositional analysis from infested soil. Central Oregon peppermint variety trial, 2001.

Variety	Total Heads (%)	Menthol (%)	Total Menthone (%)	Mentho-furan (%)	Pulegone (%)
Black Mitcham	9.2	42.8	13.5	5.7	1.1
Todds	8.9	42.2	18.7	3.6	1.0
84MO107-7	6.0	27.5	45.3	1.2	1.0
M83-14	9.1	39.0	20.7	4.7	2.0
B90-9	10.6	44.6	13.2	5.9	0.9
92(B-37XM0110)-1	7.0	47.7	16.9	2.1	1.0
87M0109-1	7.5	32.6	27.9	2.0	1.6
M90-11	8.7	37.4	21.4	4.2	2.1
McKellip	8.7	43.8	14.3	6.7	1.4
LSD (.05)	3.1	6.4	3.9	1.7	1.2

Table 6. Second year peppermint oil partial compositional analysis from non-infested soil. Central Oregon peppermint variety trial, 2001.

Variety	Total Heads (%)	Menthol (%)	Total Menthone (%)	Mentho-furan (%)	Pulegone (%)
Black Mitcham	9.1	41.0	16.1	7.0	1.0
Todds	8.1	42.2	21.1	4.5	1.0
84MO107-7	6.6	28.9	43.2	1.5	1.0
M83-14	7.5	42.9	20.5	5.3	1.3
B90-9	9.3	44.0	14.9	7.8	1.1
92(B-37XM0110)-1	6.5	46.9	21.4	2.8	0.6
87M0109-1	7.3	33.1	27.8	3.2	1.6
M90-11	10.3	32.1	20.7	6.8	5.1
McKellip	8.7	40.3	16.6	8.8	1.4
LSD (.05)	1.8	3.9	2.1	1.4	0.7

TULIP BULB INCREASE IN CENTRAL OREGON

Rhonda Bafus and Peter Sexton

Abstract

Because of their high value, flowering bulbs present an attractive alternative crop for central Oregon. Tulip bulbs of 'Monte Carlo', 'Apeldourn', 'Apeldourn Elite', 'Golden Apeldour', 'Attilla', 'Orange Emperor', 'Burgundy Lace', 'Abba', and 'Gander' were established in plots at the Central Oregon Agricultural Research Center (COARC), Madras to examine performance under mulch treatments and investigate planting and harvest equipment. Emergence, flowering date, and marketable quality was evaluated in the 2001 trial.

Introduction

Although most tulip (*Tulipa* spp.) production occurs in Holland, the region of origin of these plants is in the mountains of western and central Asia. For this reason, and because of the success of garlic seed production, it was thought that central Oregon might serve as a good location for increasing tulip bulbs. Results from the 1999 and 2000 tulip bulb trial confirmed adequate increase in weight. Nevertheless, there are several hurdles to overcome: (1) greater risk of winterkill; (2) need for an infrastructure for treating and storing bulbs; (3) need to develop market channels. The objectives of this trial were to (1) evaluate the effect of emergence and flowering date on bulbs under different mulch treatments,(2) evaluate percent marketability based on increase bulb diameter size, and (3) experiment with small-scale equipment to identify prospects of farm production and to better familiarize ourselves with bulb cultivation.

Methods

Bulb stock for 'Monte Carlo', 'Apeldourn', 'Apeldourn Elite', 'Golden Apeldourn', and 'Attilla' were purchased from a commercial supplier through a local nursery. The above-mentioned bulbs were purchased at the 10-cm-diameter size. Marketable size is considered 12 cm or larger in diameter. Bulb stock of 'Orange Emperor', 'Burgundy Lace', 'Abba', and 'Gander' were products of the previous year's trial at Madras and Powell Butte. All tulips were dusted in a thiram bulb dust prior to planting. After tilling in 100-200-200-45 pounds /acre of NPKS, 20 lb/acre of potash, and 50 lb/acre of gypsum, the bulbs were planted to a depth of 6 in (surface to the base of the bulb) with a small-plot two-row potato planter. Each variety of tulip was planted in two rows with 3-ft spacings at 120-ft length. Four mulch treatments were randomized within each variety and applied by hand. The treatments included no mulch, wheat straw mulch, Agribon season-extender floating rowcover with 30% light transmittance, and Agribon floating rowcover with 70% light transmittance. Agribon rowcover is placed over the soil and secured with soil around the edges. Straw mulch was weighed for each to ensure even coverage and pitchforked onto the soil surface.

Blossoms were clipped above the first leaf as they approached 50 percent open. Bulbs were harvested using a garlic digger after 60 to 70 percent of the foliage had senesced. Bulbs were hand picked, separated by marketable size (12 cm in diameter or larger), and placed in a warehouse for air-drying at 60ºF. 'Orange Emperor', 'Burgundy Lace', 'Abba', and 'Gander' were not evaluated for size because they were already at marketable size at planting.

Results

All tulip varieties appeared healthy throughout the growing season. Varieties were monitored for signs of damage, but showed no signs of disease or insect injury. Results indicate that emergence dates were later in the untreated (no mulch) and the 30 percent light transmittance row cover. The 50 percent transmittance row cover and straw mulch provided more insulation and warmer soil conditions that were probably the main factor in increasing the speed of emergence. Flowering dates were not consistently later in the same treatments. Some of this can be attributed to different stages of development requiring different optimal temperatures. Increases in bulb size to marketable quality on average were 27 percent (Table 2.). Evaluation of machinery used was very positive and slight modifications could make production more efficient. The most labor-intensive aspect of the harvest is collection of the bulbs. Consumer preferences for unblemished bulbs make this difficult. Bulbs are easily bruised and excessive handling can damage the brown skin covering of the bulb. Although this is not required for growth, the consumer prefers it. Overall, we were pleased with the outcome of this trial; possible small-scale production could be achieved with modifications of present equipment. Unfortunately, production cost is still very high, which makes competing in the international market difficult.

Table 1. Emergence and flowering dates for tulips at COARC, Madras, Oregon , 2001.

	No mulch		**Straw mulch**		**30% transmittance rowcover**		**50% transmittance rowcover**	
Variety	Emergence date	Flowering date	Emergence date	Flowering date	Emergence date	Flowering date	Emergence date	Flowering date
Monte Carlo	8-Apr	23-Apr	26-Mar	29-Apr	26-Mar	25-Apr	28-Mar	27-Apr
Apeldourn Elite	26-Mar	28-Apr	26-Mar	29-Apr	24-Mar	23-Apr	17-Mar	28-Apr
Apeldourn	17-Mar	2-May	15-Mar	27-Apr	18-Mar	27-Apr	15-Mar	25-Apr
Attilla	3-Apr	6-May	27-Mar	4-May	1-Apr	27-Apr	1-Apr	30-Apr
Golden Apeldourn	2-Apr	26-Apr	17-Mar	28-Apr	25-Mar	27-Apr	20-Mar	28-Apr
Burgandy Lace	10-Apr	4-May	-	-	-	-	-	-
Orange Emperor	5-Apr	23-Apr	-	-	-	-	-	-
Gander	2-Apr	26-Apr	-	-	-	-	-	-
Abba	20-Apr	1-May	-	-	-	-	-	-

Table 2. Tulip bulb count, weight, and percent marketable bulbs per variety.

Variety	Number of bulbs planted	Number marketable Bulbs	weight	Marketable size
			(lbs)	(%)
Monte Carlo	1000	410	33.9	41
Apeldourn Elite	1000	286	24.2	29
Apeldourn	1000	253	22.1	25
Attilla	1000	143	9.2	14
Golden Apeldourn	1000	242	19.9	24

STATE-WIDE CEREAL VARIETY TESTING PROGRAM TRIALS IN CENTRAL OREGON, 2001

Rhonda Bafus, John Bassinette, Russ Karow, and Mylen Bohle

Abstract

Grain variety trials were conducted at Madras, Oregon, as part of the eighth year of a state-wide variety testing program. Winter wheat, triticale, and barley trials were established as well as spring wheat and barley trials. Soft spring wheat varieties were planted separately from hard spring wheat varieties to facilitate application of different nitrogen fertilizer rates. In previous years, all varieties received the same rate of nitrogen, a site-specific rate, expected to maximize yield of the soft white cultivars. Consequently, grain protein concentrations in hard wheats have been generally lower than desired. This year, hard spring wheats were fertilized to increase grain protein concentrations. As groups, winter triticale (28 varieties) had the highest average yield (9,300 lb/acre) followed by winter wheat (45 varieties; 7,260 lb/acre), winter barley (8 varieties; 5,547 lb/acre), hard spring wheats (31 varieties; 5,280 lb/acre), soft spring wheats (30 varieties; 4,860 lb/acre), and spring barley (16 varieties; 3,757 lb/acre). Spring wheat yields were lower than in past years, which may have been due to moisture problems in the soil. Lodging was a problem in the winter barley trial, but was limited in all other trials. Within each grain class, several varieties appear to be top performers across years. Growers are encouraged to carefully review prospective varieties for both yield and other desirable characteristics, such as grain quality, plant height, and resistance to disease and lodging.

Introduction

Public and private Pacific Northwest plant breeders release new cereal varieties each year. To provide growers with accurate, up-to-date information on variety performance, a statewide variety testing program was initiated in 1993 with funding provided by the Oregon State University (OSU) Extension Service, OSU Agricultural Experiment Station, Oregon Wheat Commission, and Oregon Grains Commission. Ten sites are included in the testing network. More than 50 varieties are tested each year at each site. Height, lodging, yield, test weight, 1,000-kernal weight, and protein data are determined for all plots in Madras, Oregon. Other information is collected as time and labor allows. Data are summarized in extension publications and county extension newsletters as well as in other popular press media. Data for all trials are on the OSU Cereals Extension web page (http://www.css.orst.edu/cereals). For future reference, use the web page for earliest access to data, as trial results are posted as soon as they are available.

Materials and Methods

Plots (4.5 ft x 20 ft) were planted at a rate of 30 seeds/ft^2 using an Oyjord plot drill. Winter trials were planted on October 17, 2000. Spring trials were planted on April 5, 2001. The nitrogen supply goal for winter wheat and triticale is 200 lb N/acre. The nitrogen supply goal for hard spring wheat is 320 lb N/acre and 220 lb N/acre for soft spring wheats. The nitrogen target for winter and spring barley is 100 lb N/acre.

Table 1. Soil test results from samples taken on March 14, 2001, for the winter wheat, winter triticale, and winter barley, state-wide variety test trial, at COARC, Madras, Oregon.

Soil depth	pH	NO_3	NH_4	P	K	S
		(lb/acre)	(lb/acre)	(ppm)	(ppm)	(ppm)
0-12 in	7.5	21	8	12	321	4.0
12-24 in	8.0	24	-	8	232	4.2
0-24 in total		45	8			

Table 2. Soil test results from samples taken on April 4, 2001, for spring wheat state-wide variety test trial, at COARC, Madras, Oregon.

Soil depth	pH	NO_3	NH_4	P	K	S
		(lb/acre)	(lb/acre)	(ppm)	(ppm)	(ppm)
0-12 in	7.0	122	13	34	353	18.4
12-24 in	7.9	90	18	17	248	14.1
0-24 in total		212	31			

Table 3. Soil test results from samples taken on March 28, 2001, for the spring barley state-wide variety test trial at COARC, Madras, Oregon.

Soil depth	pH	NO_3	NH_4	P	K	S
		(lb/acre)	(lb/acre)	(ppm)	(ppm)	(ppm)
0-12 in	7.1	26	15	26	444	5.2
12-24 in	7.5	16	9	17	346	4.9
0-24 in total		42	24			

The winter wheat and triticale variety trials were fertilized with 450 lb/acre of 30-10-0-7 on April 21, 2001. Total nitrogen (soil + fertilizer N) available to the plants was 180 lb/acre. The hard spring wheat variety trial was fertilized with 350 lb/acre of 30-10-0-7 on April 6, 2001. Total nitrogen (soil + fertilizer N) available to the plants was 317 lb/acre. Soft spring wheat was not fertilized and total nitrogen available to the plants was 212 lb/acre. The spring barley variety trial was fertilized with 150 lb/acre of 30-10-0-7 on April 6, 2001. Total nitrogen (soil + fertilizer N) available to the plants was 87 lb/acre. Only soil NO_3 is used for the nitrogen budget, in addition to the applied nitrogen.

Weed control for the trials included applying 1.3 pints/acre of 2,4-D on April 13, 2001 on the winter wheat, triticale, and barley variety trial, and 1.5 pints/acre of 2,4-D on May 29, 2001 to the spring wheat and spring barley variety trial.

The trials were irrigated as needed with a 30-ft x 40-ft-spacing solid-set irrigation system. Date of first irrigation for the winter wheat, triticale, and barley variety trial occurred on April 17, 2001, for spring wheat variety trials on April 18, 2001, and for the spring barley variety trial on April 17, 2001. The last irrigation for the winter wheat, triticale, and barley variety trial occurred on July 10, 2001 and July 17, 2001 for spring wheat and spring barley variety trials.

Heading dates were recorded when 50 percent heading occurred. Just prior to harvest, lodging scores (percent) and plant height (in) measurements were taken. The trials were harvested with a Hege plot combine. Harvest dates for the winter wheat and triticale variety trial, spring wheat and triticale variety trial, and spring barley variety trial were August 14, August 16, and August 15, 2001. The grain samples were shipped to the OSU Hyslop Farm at Corvallis and the grain was cleaned on a Peltz rub-bar cleaner. Plot yield, test weight, protein, moisture, and 1,000-kernel weight (not reported in tables, but is located on tables on the internet) were all determined on cleaned grain samples. Yields are reported on 10 percent moisture, bu/acre basis (60 lb/bu). Barley yields are reported as lb/acre. 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

Weed control in all trials was excellent. The lowest temperature recorded at the Agri-met weather station was 19.7ºF. Frost events occurred on June 13, and may have affected yield.

Winter Wheat and Winter Triticale Trial

The winter wheat and triticale trial average yield was 121 bu/acre and yields ranged from 96 to 154 bu/acre (Table 4). For the top-yielding 14 entries, 'ID52814A' to 'WA7855' (a range of 148 bu/acre to 130 bu/acre), there were no significant differences between varieties. The top-yielding variety in the trial was 'KFT 31', a triticale variety out of Kansas. Given the similarity in yields for the leading varieties, selections should be made based on traits such as disease and lodging resistance, plant height, grain quality, or other desired characteristics.

Average plant height was 36 in and average lodging was six percent for the trial. The lodging was considerably less that the 38 percent reported in the 2000 trial.

Average grain protein was 9.5 percent. The classes and species protein percentage ranges were oat, 16.6 to 6.7; rye, 7.4; triticale, 9.8 to 11.1; club wheat, 8.4 to -9.8; hard red wheat, 9.7 to 0.5; durum, 10.4; and soft white wheat, 8.3 to 11.2. Only five of the soft white varieties had protein percentages greater than 9.4. Optimum grain yield occurs at approximately 9.5 percent protein for soft white winter wheat and 11.5 percent for hard red wheat and is an indicator of sufficient nitrogen supply for yield. Though the trial averaged 9.5 percent protein, many soft white wheat varieties did not achieve that percentage, which would indicate that some of the varieties did not maximize yield. The lower proteins would indicate that the 180 lb/acre total N available at the beginning of the season was not sufficient to optimize yield for soft white wheat and hard red wheat.

Two additional seeding rates of 20 and 45 seeds/ft^2 were compared to 30 seeds/ft^2 for the variety 'MacVicar'. Significant differences between the seeding rates occurred. There were significant differences between yield, protein, test weight, and heading date. This may have been an anomaly or was it a varietal response? More than 1 year of data is needed to make any conclusions. The plots with 20 and 45 seeds/ft^2 were all in the third rep and were not randomized in each rep.

The winter oat varieties were included to obtain winter hardiness and other agronomic information. The oats were ripe and shattered before the trial could be harvested, which helps explain the low yields for the two oat varieties. The lodging resistance of ‘Crater’ and ‘Kolding’ winter oats was excellent considering the high nitrogen fertility conditions.

Winter Triticale Trial

The winter triticale variety trial average yield was 155 bu/acre and yields ranged from 129 to 179 bu/acre (Table 5). The winter triticale varieties averaged 30 bu/acre more than the winter wheat varieties, comparing trial to trial. There were no statistically significant differences between the top six yielding varieties (‘RSI-MAH 3198’, at 179 bu/acre, to ‘Lamberto’ at 166 bu/acre). ‘Bogo’ and ‘Alzo’, Polish cultivars, are grown locally.

‘Celia’, the check triticale variety, and ‘Weatherford’, the check soft white wheat variety, were the lowest yielding at 129 and 133 bu/acre. ‘Weatherford’, a soft white winter wheat variety, was used as the wheat check variety because it has the best disease resistance package of any wheat variety. Much progress has been made in increasing yield over the years.

Many of these varieties in the trial are from Poland. The RSI lines are entries from Resource Seed in Gilroy, California. Resource Seed has made great strides in improving yields of their lines. As yield has increased in the triticale cultivars, protein contents have decreased. Average protein content (9.5 percent) was the same as for the winter soft white wheat trial.

Test weight average was 56.6 lb/bu, unchanged from the 2000 trial. ‘Celia’ was the last variety to head out. Great strides have been made in breeding earlier heading cultivars.

Spring Hard Wheat Trial

In contrast to the winter trials where soft white varieties dominate, hard white and hard red lines and varieties tend to have higher yields in the spring trials. While yields are high for the hard classes, desired protein levels have never been reached. In previous years, all spring varieties received the same rate of nitrogen; a site-specific rate managed to maximize yield of the soft white cultivars. Consequently, grain protein concentrations in hard wheats have been generally lower than desired. This year, hard spring wheat varieties and lines were planted in a separate trial and fertilized to maximize grain protein concentrations. The trial was compromised by a frost event.

The hard spring wheat trial average yield was 88 bu/acre and yields ranged from 72 to 113 bu/acre (Table 6). However, there was no significant difference (P = 0.10) between the top eight yielding entries. ‘IDO 377S’ was the highest yielding entry but had the lowest grain protein concentration of 9.9 percent. Average protein concentration was 12.3 percent compared to the average of 11.1 percent in the 2000 state-wide trial. ‘Bonus’ was another high-yielding variety. ‘Bonus’ is early maturing and shorter than most hard wheat cultivars, but had lower protein than the trial average. The 317 lb/acre of nitrogen (soil and fertilizer) available at the beginning of the trial was not sufficient for achieving desired protein levels.

‘Yecora Rojo’, hard red wheat cultivar, was planted at seeding rates of 10, 20, 30, and 40 seeds per square foot with in this trial. There were no significant differences between seeding rates for yield, test weight, and protein. Winsome, hard white cultivar, was planted at 20, 30 and 45 seeds/ft^2, and there were no differences in yield, test weight, and protein.

No lodging occurred in the trial.

Spring Soft White Wheat Trial
The soft spring wheat variety trial average yield was 88 bu/acre and ranged from 75 to 115 bu/acre (Table 7), similar to the hard wheat trial. There was no significant difference between the top five yielding entries. Among soft white lines, there has been high yield variability from year to year. ‘IDO 526’ and ‘Whitebird’ have been among the most consistent of the high-yielding varieties. ‘Whitebird’ is later maturing than most other soft white lines and has slightly lower protein. ‘IDO 526’ has good resistance to lodging and excellent stripe rust resistance. ‘Chalis’, Treasure’, and ‘Penawawa’ are other soft white lines that have good yield potential in central Oregon. ‘Challis’ and ‘Treasure’ yield well under irrigation and have good resistance to lodging. Only one plot in the entire trial lodged at around 5 percent.

The average protein content of the cultivars was 12.2 percent, which would suggest that the 212 lb/acre nitrogen available at the beginning of the trial was greater than needed for maximizing yield.

‘Provena’ and ‘Lamont’ naked spring oats were included in the soft white trial to gain some data on agronomic characteristics. Again, as in the winter trial, the oat varieties ripened and shattered before harvest.

The ‘Recora Rojo X’ (hard red wheat) entry yield at 63 bu/acre in the trial really represents yield from only 0.615 acre and actual yield should be 87 bu/acre. The two outside rows were not harvested to check the accuracy of the plot area of 4.5 ft^2, which is presently being used. In this first year test, it suggests that perhaps the yield data presented are under-represented by 9 percent, or that yields shown in the tables should be 9 percent greater. This exercise needs to be repeated for a few more years.

Spring Barley
Spring barley data are presented in Table 8. The average yield for spring barleys was 4,257 lb/acre and ranged from 2,981 to 4,762 lb/acre. Yield was down considerably from last year. There were no significant differences (P = 0.10) between the top eight yielding barley varieties. The 87 lb/acre nitrogen available at the beginning of the season may not have been sufficient for maximum yield.

The varieties were equally lodged, at an average of 15 percent. Average height was slightly higher and test weights were down compared to the 2000 trial data. ‘Garnet’ (2RM) is a feed variety that shows potential as a malt-type barley, but needs further testing. ‘Garnet’ competes favorably in yield with existing two-rowed varieties.

Winter Barley
The data for the winter barley are in Table 9. The winter barley trial was only replicated twice due to land restrictions. The average yield was 5,547 lb/acre and ranged from 3,904 lb/acre to 7,473 lb/acre. Lodging was a major problem in the 2001 trial due to fertilization of the field for

winter wheat and triticale. That was the only available site on station. 'Scio' was the highest yielding variety and normally shows good resistance to lodging.

Table 4. Statewide variety testing program for winter wheat, Madras, Oregon, 2001.

					2001 Data				
	Market	Yield (bu/acre)			Test wt.	Protein	Heading	Height	Lodging
Variety or line[1]	class[2]	2001	2000	1999	(lb/bu)	(%)	(doy)[3]	(in)	(% of plot)
KFT31	Trit	154	-	-	58.3	10.5	141	39	3
ID52814A	SW	148	151	-	60.1	8.8	152	36	1
Alzo	Trit	145	179	155	55.7	9.8	150	41	2
Titan	Trit	142	178	186	56.1	11.1	143	36	5
Rod	SW	137	156	165	60.7	8.5	160	35	4
ID-B-96	SW	137	145	-	60.1	8.9	155	33	1
ID517	HR	135	-	-	59.9	10.5	150	32	1
OR 941044	HW	135	-	-	62.4	9.5	151	35	0
Brundage	SW	135	-	-	61.6	8.8	150	29	0
OR 941904	SW	134	-	-	61.1	8.8	159	34	2
Bogo	Trit	132	163	190	53.8	10.2	147	38	3
Hiller	Club	131	138	147	59.6	8.4	158	34	2
Macvicar (45 seeds/ft^2)	SW	131	-	-	60.2	9.6	152	35	0
WA7855	Club	130	-	-	58.9	9.3	161	37	27
Basin	SW	129	149	-	59.5	8.3	161	28	1
Madsen/Stephens	SW	128	162	166	60.0	8.9	152	34	0
OR 939526	SW	128	149	-	60.0	8.8	155	36	2
Malcolm	SW	126	-	-	59.4	9.7	152	35	0
Weatherford	SW	125	150	150	60.5	8.9	159	36	0
Boundry	HR	125	120	-	61.7	9.7	153	34	0
ID17113A	SW	124	-	-	59.6	9.1	161	34	0
MacVicar	SW	123	149	-	59.9	8.5	152	33	1
OR 850513-19	HW	122	127	-	60.6	8.9	158	34	0
OR 939528	SW	122	153	161	59.9	9.1	157	36	2
Rely	Club	121	122	140	59.4	8.4	160	38	31
Rohde	Club	121	124	147	60.8	8.9	151	32	3
OR 941899	SW	121	-	-	61.5	8.9	161	35	0
Coda	Club	121	130	139	60.8	8.8	160	39	3
Madsen	SW	120	141	156	62.3	9.0	159	34	0
WA7853	SW	118	-	-	60.2	9.2	159	37	1
Temple	Club	118	127	143	61.1	8.6	152	36	20
Foote	SW	117	136	145	59.6	9.7	153	36	0
Hubbard (ID10420A)	SW	116	-	-	60.8	9.3	158	40	1
OR 850513-8	HW	116	133	-	60.4	8.7	152	36	0
Rifle	Rye	116	121	119	55.5	7.4	143	36	1
Stephens	SW	113	151	178	59.0	9.6	151	32	0
OR 943560	SW	110	132		60.4	8.8	157	33	0

Table 4. cont.

Bruehl	Club	110	137		61.2	8.7	161	39	3
Yamhill	SW	107	-		58.8	9.1	162	42	5
Connie	Durum	103	137	80	61.9	10.4	150	30	0
Edwin	Club	102	106		60.1	9.8	158	43	40
ID550	HW	102	115		60.7	9.1	152	40	67
MacVicar (20 seeds/ft^2)	SW	96	-	-	57.5	11.2	160	34	2
Kolding oat	Oat	70	-	-	43.3	16.7	162	42	18
Crater Oat	Oat	32	-	-	39.1	16.6	162	47	27
Trial Mean		121	141	153	58.9	9.5	155	36	6
PLSD 0.05		24	17	15	2.5	10.5	avg	avg	avg
PLSD 0.10		20	14	7	2.4	1.6			
CV (%)		12	7	7	2.0	1.3			
P > F		<0.00	0.00	0.00	<0.00	<0.00			

[1]All seed treated with fungicide and Gaucho® (insecticide) prior to planting unless otherwise noted. Seeding rate was 30 seeds/ ft^2 unless otherwise noted.
HR = hard red, HW = hard white, SW =soft white.
[3]Doy = day of year.

Table 5. Statewide variety testing program for winter triticale, Madras, Oregon, 2001.

					2001 Data				
	Market	Yield (bu/acre)			Test wt.	Protein	Heading	Height	Lodging
Variety or line[1]	class[2]	2001	2000	1999	(lb/bu)	(%)	(doy)[3]	(in)	(% of plot)

RSI-MAH 3198	Trit	179	-	-	57.3	8.2	145	37	2
Elan	Trit	177	-	-	57.0	9.0	143	37	0
RSI-17318	Trit	175	-	-	56.6	9.0	143	39	2.7
Magnito	Trit	171	-	-	56.6	8.7	149	40	0.7
RSI-MAL 366	Trit	170	155	-	56.1	9.1	144	38	2.7
Lamberto	Trit	166	178	-	57.1	8.9	147	42	1
RSI-5420	Trit	163	175	-	57.3	9.6	147	39	0
Piano	Trit	163	-	-	55.9	9.8	147	42	1.7
Kitaro	Trit	161	181	-	56.6	9.2	146	39	4.3
Cahar	Trit	161	-	-	53.4	9.7	144	40	5
RSI-8917	Trit	157	-	-	56.1	9.7	149	42	1
Décor	Trit	157	-	-	59.0	9.8	143	36	2
Disko	Trit	156	-	-	55.5	8.7	148	45	0
Dictor	Trit	154	-	-	56.4	10.0	144	40	5
Fidelio	Trit	154	-	-	55.2	8.9	150	40	0
Bogo	Trit	154	164	175	55.5	9.5	149	40	4.3
Sturdy	Trit	153	-	-	57.0	10.3	142	40	1.7
Titan	Trit	152	178	186	56.6	9.4	146	37	1
Enot	Trit	150	-	-	57.1	10.0	143	37	3
RSI-VIC 1439	Trit	150	152	-	57.0	9.5	148	41	0
M99-748	Trit	148	-	-	58.2	9.8	143	42	12.7
RSI-10008	Trit	147	-	-	56.8	10.5	147	46	21.7
Stephens	SW	147	151	178	58.2	9.1	151	32	0
Celia/Presto	Trit	137	-	-	56.5	10.5	148	36	4.3
Alzo	Trit	134	185	155	55.1	9.2	150	43	2.7
Steel	Trit	133	-	-	55.9	11.4	141	39	2.7
Weatherford	SW	133	150	150	57.8	8.9	150	34	0
Celia	Trit	129	157	139	56.8	10.2	151	35	0
Trial Mean		155	149	-	56.6	9.5	146	39	2.9
CV		18	16	-	3.2	6.5	avg	avg	avg
PLSD (0.05)		15	8	-	NS	1.0			
PLSD (0.10)		7.2	19	-	NS	0.8			
Pr > F		<0.00	<0.00	-	0.35	<0.00			

[1]All seed treated with fungicide and Gaucho® (insecticide) prior to planting unless otherwise noted. Seeding rate was 30 seeds/ft^2 unless otherwise noted.

Wtrit = winter triticale, Sptri t= spring triticale, WSWW = soft white winter wheat.
[3]Doy = day of year.

Table 6. Statewide variety testing program for hard spring wheat, Madras, Oregon, 2001.

Variety or line[1]	Market class[2]	Yield (bu/acre) 2001	2000	1999	Test wt. (lb/bu)	2001 Data Protein (%)	Height (in)	Heading (doy)[3]
IDO 377S	HW	113	133	107	64.1	9.9	35	170

Bonus	HR	108	122	-	62.2	11.4	26	165
IDO 560	HW	105	129	-	62.9	10.3	36	171
Yecora Rojo (20 seeds/ft^2)	HR	98	-	-	63.2	12.2	24	165
Alpowa	SW	96	114	109	62.1	10.9	33	172
Brooks	HR	95	119	-	62.3	12.0	27	166
Yecora Rojo	HR	94	114	143	63.2	12.0	27	165
ML 181,A,1-38	HW	94	-	-	61.9	11.6	32	169
Yecora Rojo (10 seeds/ft^2)	HR	92	-	-	63.7	12.2	24	163
Scarlet	HR	91	106	100	62.4	12.2	37	169
Pronto	HR	91	-	-	63.4	13.2	34	165
Hank	HR	90	98	-	61.9	14.2	31	165
WA 7839	HR	89	-	-	62.5	13.1	33	168
WPB 936	HR	89	117	144	61.7	13.4	29	167
Yecora Rojo (40 seeds/ft^2)	HR	87	-	-	63.3	12.4	25	164
IDO 557	HR	87	-	-	63.5	12.8	32	168
WA 7900	HW	87	-	-	61.8	11.6	34	170
Penawawa	SW	86	121	133	61.0	10.9	29	171
OR 4910028	HR	86	-	-	61.0	11.6	31	167
IDO 545	HR	83	-	-	61.4	13.4	36	172
Winsome (45 seeds/ft^2)	HW	83	-	-	60.5	11.5	31	173
WA 7901	HW	82	-	-	61.0	12.5	36	172
Winsome	HW	82	127	-	61.8	11.7	31	173
Winsome (20 seeds/ft^2)	HW	81	-	-	61.6	11.7	32	172
Lolo (IDO 533)	HW	78	122	-	63.1	11.9	33	170
Tara (WA 7824)	HR	77	111	-	62.3	14.2	36	167
Jefferson	HR	76	112	113	61.0	14.1	30	168
Sunco	HW	75	-	-	61.2	12.6	30	174
WA 7899	HW	74	-	-	61.9	12.5	33	170
OR 49120002	HR	74	-	-	61.1	11.9	31	171
Iona	HR	72	-	-	62.0	14.2	34	169
Trial Mean		88			62.1	12.3	31	169
LSD (0.05)		14.1			2.3	7.8	avg	avg
LSD (0.10)		20.0			NS	1.5		
CV (%)		17			1.9	1.3		
P > F		0.00			0.06	<0.00		

[1] All seed treated with fungicide and Gaucho® (insecticide) prior to planting unless otherwise noted. Seeding rate was 30 seeds/ft^2 unless otherwise noted.
HR = hard red, HW = hard white, SW = soft white.
[3]Doy = day of year.

Table 7. Statewide variety testing program for soft spring wheat, Madras, Oregon, 2001.

					2001 Data			
	Market	Yield (bu/acre)			Test wt.	Protein	Height	Heading
Variety or line[1]	class[2]	2001	2000	1999	(lb/bu)	(%)	(in)	(doy)[3]

IDO 526	SW	115	116	124	62.7	10.2	32	169
Jefferson	HR	100	112	113	64.0	12.3	33	166
Whitebird	SW	95	130	105	64.1	10.8	31	171
Challis	SW	94	122	-	61.7	11.3	30	169
Treasure	SW	90	111	-	62.9	10.8	27	173
WA 7902	SW	88	-	-	63.4	10.2	30	170
Penawawa	SW	87	121	133	61.9	9.6	29	168
Zak	SW	85	108	90	62.8	11.4	31	170
Alpowa (no gaucho)	SW	84	126	108	63.0	11.7	29	171
Alpowa (untreated)	SW	84	118	-	63.5	10.0	28	169
Winsome	HW	83	127	-	62.4	10.4	29	171
Jubilee (IDO 525)	SW	81	117	126	63.5	11.9	30	171
Yecora Rojo	HR	79	114	143	63.7	11.4	23	164
Wawawai	SW	78	106	105	63.7	11.0	32	169
WA 7884	SW	77	-	-	63.4	10.5	29	172
Alpowa	SW	75	114	143	63.1	11.1	29	171
Cayuse	Oat	67	-	-	39.2	14.6	34	172
Yecora Rojo X	HR	63	-	-	63.8	12.0	25	162
Provena	N Oat	35	-	-	52.2	22.9	33	177
Lamont	N Oat	34	-	-	48.4	20.0	36	177
Trial Mean		80			60.6	12.2	30	170
LSD (0.05)		26			1.0	1.5	avg	avg
LSD (0.10)		21			0.9	1.2		
CV (%)		19.4			1	7.4		
P > F		<0.00			<0.00	<0.00		

[1] All seed treated with fungicide and Gaucho® (insecticide) prior to planting unless otherwise noted. Seeding rate was 30 seeds/ft^2 unless otherwise noted.
HR = hard red, HW = hard white, SW = soft white, N = naked.
[3]Doy = day of year.

Table 8. Statewide variety testing program for spring barley, Madras, Oregon, 2001.

					2001 Data				
	Market	Yield (lb/acre)[3]			Test wt.	Protein	Height	Heading	Lodge
Variety or line[1]	class[2]	2001	2000	1999	(lb/bu)	(%)	(in)	(doy)[4]	(% plot)
Garnet	2RM	4762	4854	-	53.9	11.1	24	171	13.9
Chinook	2 RM	4458	4309	6101	52.2	9.5	30	171	15.8

Stab-113	2RF/M	4214	-	-	53.8	9.8	28	171	15.6
Othello (BCD-47)	2RF/M	4194	4497	-	53.0	10.2	24	172	13.9
H3860224	2RF	4029	4265	-	53.8	9.7	28	172	13.3
Morex	6RM	3962	-	-	51.5	10.8	34	170	15.6
Stab-47	2RF/M	3887	-	-	53.9	9.4	28	171	13.6
Orca	6RF	3855	3772	4898	52.3	8.9	30	169	16.6
Valier	2RF	3698	4676	-	52.2	9.7	25	168	14.3
Stab-7	2RF/M	3685	-	-	52.1	9.7	26	167	12.9
Steptoe	6RF	3468	4417	6227	53.6	9.2	28	171	16.8
Harrington	2RM	3414	4481	-	51.5	9.6	29	171	14.8
Bancroft	2RM	3229	4097	4946	50.7	9.6	30	169	13.8
Farmington	2RF/M	3186	-	-	50.4	10.2	27	169	14.3
Tango	6RF	3099	4736	5984	51.0	9.9	31	168	15.1
WA 8682-96	6RF/M	2981	-	-	50.6	9.9	31	167	16.5
Mean		3757	4257	5953	52.2	9.8	28	170	14.8
LSD (0.05)		NS	944	1064	NS	NS	avg	avg	avg
LSD (0.10)		909	784	884	NS	NS			
CV (%)		17	13	11	3.4	9.1			
Pr > F		0.10	0.00	0.00	0.23	0.39			

[1] All seed was treated with fungicide and Gaucho® (insecticide) prior to planting unless otherwise noted. Seeding rate was 30 seeds/ft^2 unless otherwise noted.
2R = two row; 6R = six row; F = feed; M = malt; F/M = may be considered for feed and malt.
[3]Adjusted to 10% moisture. [4] Doy = day of year.

Table 9. Statewide variety testing program for winter barley, Madras, Oregon, 2001.

					2001 Data				
	Market	Yield (lb/acre)[3]			Test wt.	Protein	Height	Heading	Lodge
Variety or line[1]	class[2]	2001	2000	1999	(lb/bu)	(%)	(in)	(doy)[4]	(% of plot)
Scio	6RF	7473	-	-	49.9	10.8	31	142	73
Strider	6RF	6410	-	-	49.5	11.7	29	138	95
Kold	6RF	6310	-	-	51.2	12.1	34	145	78
Stab-47	6RF/M	6066	-	-	49.8	12.2	30	137	93
Kab 37	2RF/M	5177	-	-	51.8	12.2	33	143	78
Stab-113	6RF/M	4534	-	-	49.9	13.3	35	145	80
88Ab536	6RM	4498	-	-	48.6	13.8	31	136	95
Stab-7	6RF	3904	-	-	48.5	13.1	31	137	93
Trial Mean		5547	-	-	49.9	12.4	32	140	85
		avg			avg	avg	avg	avg	avg

[1]All seed was treated with fungicide and Gaucho® (insecticide) prior to planting unless otherwise noted. Seeding rate was 30 seeds/ft^2 unless otherwise noted.
RF = row and feed; RM = row and malt; F/M = being evaluated for feed and malt.
[3]Adjusted to 10% moisture. [4]Doy = day of year.

IRRIGATED SOFT WHITE WINTER AND HARD RED SPRING WHEAT VARIETY DRILL STRIP DEMONSTRATION

Mylen Bohle, Scott Simmons, Tom Shibley, John Bassinette, and Russ Karow

Introduction

Soft white winter wheat and hard red spring wheat are important crops for central Oregon. Proximity to the grain market in Portland, Oregon, and their benefits as a rotational crop make both wheat classes a good choice for cultivating in central Oregon. These two wheat classes represent most of the wheat acres grown in central Oregon Drill strip demonstrations were conducted to compare the performance of soft white winter wheat and hard red spring wheat varieties under commercial farm conditions. Some of the varieties have been grown in the area for years, while other varieties have been released more recently. Four on-farm fields in central Oregon were planted for drill strip comparison to determine yield and other agronomic characteristics.

Materials and Methods

H & T Farms

Twelve cultivars of soft white winter wheat were planted in double strips with a 12-ft-wide drill on October 17, 2000 at the H & T Farm east of Culver, Oregon. The field was furrow irrigated on October 17 and irrigated in the same manner as needed throughout the growing season. The previous crop was potatoes. No soil sample was taken. Nitrogen (174 lb/acre) and sulfur (40.6 lb/acre) were applied on May 8 (580 lb/acre of 30-0-0-7), as well as 1.33 pints of Starane/Salvo® and 0.4 oz. of Harmony Extra® was applied on the same day. Plots 20 ft wide x 1,161–1,169 ft long were harvested out of the strips on August 21.

Bonnie Craig Farm

Twelve soft white winter wheat cultivars were planted in double strips with a 12-ft-wide drill on October 27, 2000 at the Bonnie Craig Farm Prineville, Oregon. The field was irrigated by center pivot as needed. The previous crop was garlic. On April 23, 250 lb/acre of 25-5-5-5 fertilizer (63 lb/acre N), and 1.3 pints/acre of Starane/Salvo, and 0.4 oz/ac Harmony Extra + 2 pints/100 gallon Spreader 90® were applied. There was an estimated total of 314 lb/acre of N available to the crop. Harvest occurred on September 4, and the harvest area was 19.75 ft wide by 869-889 ft long, depending on the strip.

Table 1. The soil tests results for the field sampled on March 20, 2001 at the Bonnie Craig Farm, Prineville, Oregon (the soil test was performed by Agri-Check, Inc.).

Soil depth (ft)	pH	P (ppm)	K (ppm)	NO_3 (lb/acre)	NH_4 (lb/acre)	S (ppm)	B (ppm)	Zn (ppm)
0-1	7.2	24	180	119	26	13.7	0.3	0.8
1-2				133	16			
Total				251	42			

Three Fold Farm

Three hard red spring wheat cultivars were planted in April 2001 at the Three Fold Farm north of Madras, Oregon. The field was irrigated by rolling wheel line throughout the season as needed. The previous crop was seed carrots. No soil sample was taken. Nitrogen (197 lb/acre) and sulfur (46 lb/acre) were applied on March 30 (fertilizer applied was 656 lbs/acre of 30-0-0-7). Weeds were controlled with 1.64 pints of Saber® applied on May 22. The strips were swathed with a 12-ft-wide swather, and grain threshed with a combine with a pickup attachment in August. The harvest area was 12 ft wide x 1,127 ft long.

Santucci Farm

Four hard red spring wheat cultivars were planted into double strips with a 12-ft grain drill on April 6, 2001 at the Brad Santucci Farm north of Prineville. The field was irrigated by rolling wheel line throughout the season as needed. The previous crop was alfalfa. On March 22, 555 lb/acre of 29-5-0-4 fertilizer (161 lb/acre N) was applied to the field. An application of 60 lb/acre of N (17 gallons/acre of Solution 32®) was applied through the irrigation system at early boot growth stage. An estimated total of 339 lb/acre of nitrogen was available to the crop (total of 221 lb/acre N was applied to the field in addition to 118 lb/acre nitrate N available in the soil). On May 17, 1.5 pints Starane/Saber, 0.4 oz. Harmony Extra, and 2 pints/100 gallon of Spreader 90 were applied on a per-acre basis for weed control. An area of 16 ft wide by 1,208 ft long was harvested out of the strips on August 30.

Table 2. Soil test results for the field sampled on January 31, 2001 at the Brad Santucci Farm, Prineville, Oregon (the soil test was perfomed by Agri-Check, Inc.).

Soil depth (ft.)	pH	P (ppm)	K (ppm)	NO_3 (lb/acre)	NH_4 (lb/acre)	S (ppm)
0-1	7.2	16	283	83	40	7.6
1-2				35	16	
Total				118	56	

The plots were harvested with the producers' combines, and the grain was weighed in the Oregon State University (OSU) weigh wagon in the field. Samples for protein, moisture, and test weight were sent to OSU Crop and Soil Science Department, Corvallis for processing. Protein was predicted with near-infrared spectroscopy (NIRS). Plant heights were measured and a lodging score was given for the strip. Yield and test weight are reported on a 10-percent moisture basis and protein is reported on a 12-percent moisture basis. The grain nitrogen uptake is reported on a 0-percent moisture basis. The estimated grain N use efficiency was calculated by dividing the grain N uptake by the estimated total N available (soil nitrate nitrogen, 0-2 ft from soil test + fertilizer nitrogen) * 100 = percent. Soil mineralized N available during the growing season and soil ammonium nitrogen are not factored into the formula. The data represent single replications.

Results and Discussion

The yield, test weight, protein, height, lodging, grain N uptake and estimated grain use efficiency data are reported in Tables 3 and 5 for the two white winter wheat variety drill strip comparisons, and Tables 4 and 6 for the hard red wheat variety drill strip comparisons. Each table has been sorted and ranked by highest yielding to lowest yielding cultivar at each site.

Frost affected the data at both Prineville sites. Irrigation management may have further affected the data at the Santucci site. No problems occurred at the drill strip demonstration at the Culver site. It appears that the irrigation was cut off too early at the Madras site (Three Fold Farm) based on the low test weights and high protein contents. There may have been a 10-18 bu/acre yield reduction.

Acknowledgments

The participation by H & T Farms (Wes Hagman), the Bonnie Craig Farm, the Brad Santucci Farm, and Three Fold Farm (Rich Lewis) for providing the land, time, and labor was greatly appreciated. The seed was funded by the Oregon Wheat Commission.

Table 3. Grain yield, test weight, height, lodging, grain N uptake, and estimated grain N use efficiency results for the 2001 white winter wheat variety drill strip demonstration planted on October 27, 2000 at the Bonnie Craig Farm, Prineville, Oregon.

Variety	Yield	Test Weight	Protein	Ht	Lodging	Grain N uptake	Grain N use eff.
	(bu/acre)	(lb/acre)	(%)	(in)	(%)	(lb/acre)	(%)
Rod	148.4	58.3	9.4	36	0	169.1	53.7
Basin (east)	129.8	60.6	9.5	31	0	149.3	47.4
MacVicar	127.1	60.0	9.2	35	0	141.6	45.0
Coda club	126.1	59.3	10.0	40	5	152.6	48.4
Weatherford	125.4	60.5	9.4	36	0	143.3	45.5
Madsen	123.4	59.6	9.1	36	0	135.9	43.1
Edwin club	119.4	57.1	10.1	43	3	146.0	46.3
Basin (west)	118.7	60.6	8.9	30	0	129.2	41.0
Stephens	113.4	59.3	10.4	36	0	142.5	45.2
Rhode/Edwin club	113.1	60.2	10.3	36 + 39	0	141.8	45.0
Basin (center)	106.8	60.3	9.4	32	0	122.1	38.8
Hiller club	102.0	56.6	10.3	35	0	127.2	40.4
Brundage	89.2	59.6	10.7	37	0	115.5	36.7
Temple club	82.5	58.7	11.2	35	0	112.2	35.6
Mean	116.1	59.3	9.9	36	1	137.7	43.7

Table 4. Yield, test weight, protein, height, grain N uptake, and estimated grain N use efficiency results for the 2001 hard red spring wheat variety drill strip demonstration planted on April 6, 2000 on the Brad Santucci Farm at Prineville, Oregon.

Variety	Yield (bu/acre)	Test weight (lb/bu)	Protein (%)	Ht (in)	Lodging (%)	Grain N uptake (lb/acre)	Est. grain N use eff. (%)
Bonus	102.8	58.3	15.4	23	2	192.2	56.7
Brooks	100.7	60.1	15.8	29	3	193.3	57.0
Pronto	99.9	59.3	15.5	32	10	188.2	55.5
Yecora Rojo (east)	98.0	60.5	14.9	23	6	176.8	52.2
Yecora Rojo (west)	97.2	60.0	15.7	23	1	184.8	54.5
Mean	99.7	59.7	15.5	26	4	187.1	55.2

Table 5. Yield, test weight, protein, height, lodging, grain N uptake, and estimated grain N use efficiency results for the 2001 white winter wheat variety drill strip demonstration planted at the H & T Farm on October 17, 2000 at Culver, Oregon.

Variety	Yield	Test weight	Protein	Height	Lodging	Grain N uptake	Est. grain N use eff.
	(bu/acre)	(lb/bu)	(%)	(in)	(%)	(lb/a)	(%)
Brundage	172.5	61.9	9.8	39	0	204.1	--
MacVicar	167.4	61.5	9.1	41	0	185.4	--
Stephens	166.1	60.1	9.2	40.5	0	184.4	--
Rod	161.2	60.3	9.9	41.5	2	193.2	--
Basin	159.6	62.2	8.9	32	0	173.0	--
Weatherford	157.1	61.3	10.3	41.5	0	195.8	--
Hiller club	155.2	57.2	9.8	40	1	184.2	--
Madsen	154.0	61.3	10.5	39	0	196.8	--
Rhode club	143.0	62.3	10.0	40	5	173.1	--
Temple club	135.2	58.8	9.5	43	3	155.6	--
Coda club	130.4	61.6	10.7	45	5	168.4	--
Edwin club	90.2	60.8	11.4	49	90	124.2	--
Mean	149.3	60.8	9.9	41	9	178.2	--

Table 6. Yield, test weight, protein height, and grain N uptake for the 2001 hard red spring wheat drill strip demonstration planted in April 2001 at the at the Three Fold Farm, Madras, Oregon.

Variety	Yield (bu/acre)	Test weight (lb/bu)	Protein (%)	Ht (in)	Lodging (%)	Grain N uptake (lb/acre)	Est. grain N use eff. (%)
Yecora Rojo (2)	143.6	55.5	15.9	--	--	276.7	--
Bonus	128.9	56.1	15.7	--	--	243.4	--
Yecora Rojo (4)	123.1	55.4	16.4	--	--	225.7	--
Yecora Rojo	111.0	56.2	16.6	--	--	245.3	--
Pronto	106.1	55.4	17.6	--	--	222.3	--
Mean	122.3	55.7	16.4	--	--	242.7	--

GRASS-FEEDING MOTHS COLLECTED IN KENTUCKY BLUEGRASS SEED FIELDS TREATED WITH POST-HARVEST BURNING OR BALE-ONLY IN THE GRANDE RONDE VALLEY, 2001

Marvin Butler and Paul Hammond

Abstract

A survey of moths was conducted in a Kentucky bluegrass field in the Grande Ronde Valley to assess the effects of post-harvest burning on their composition and abundance. Just prior to harvest, blacklight traps were operated in the burned portion of a field and the bale-only portion of the same field. Although the survey was conducted only on the night of July 6, it suggests that post-harvest burning the previous season can have a beneficial effect on reducing cutworms compared to bale only.

Introduction

A fifth year of study was conducted in 2001 to assess the composition and population dynamics of grass-feeding moths in commercial Kentucky bluegrass seed fields in the Pacific Northwest. The first studies in 1996-1998 were more qualitative and examined the species composition in three different regions: central Oregon, the Grande Ronde Valley of northeastern Oregon, and the Rathdrum Prairie of northern Idaho (Butler et al. 2001). A more quantitative study was conducted in 2000 to follow the seasonal phenology and actual abundance of different moth species in central and northeast Oregon (Butler and Hammond 2001).

Methods and Materials

The results of 2000 suggested that a follow-up study might be helpful to assess the effects of post-harvest burning on the composition and abundance of the moth fauna. This was conducted on July 6, 2001 in a field near LaGrande in Union County. Part of the field had received the usual post-harvest burn treatment during 2000, while the remainder of the field was not burned and the straw was baled. One blacklight trap was operated in the burned portion of the field, and a second trap was operated in the baled portion. The results of 2001 are shown in Table 1 and are compared with the 2000 results from other fields in the same region.

Results and Discussion

These 5 years of studies have identified a complex community of grass-feeding moths that occupy Kentucky bluegrass fields in the Pacific Northwest, and this community is comprised of three distinct feeding guilds as follows.

1. The sod-webworms belong to the family Pyralidae, subfamily Crambinae. They included two species, *Chrysoteuchia topiaria* and *Pediasia dorsipunctella*. Of these, *C. topiaria* was sporadically common in different fields but was never abundant. During 2001, it was twice as common in the burned treatment compared to the baled treatment, but this may not be significant in view of the low numbers in general. *Pediasia dorsipunctella* was always

present in every field but was always quite rare.

2. The climbing cutworms belong to the family Noctuidae, subfamily Hadeninae. Their larvae feed on leaves, inflorescences, and developing seed-heads. They included two species, *Aletia oxygala* and *Leucania farcta*. During 2000, *A. oxygala* was relatively common in several fields, but it was scarce in 2001. *Leucania farcta* was uncommon during 2000 and rare in 2001. These moths were never abundant enough to be of much economic consequence, and were of virtually no significance in the 2001 field study.

3. The largest group is the soil cutworms that feed at the soil surface or burrow into the soil, feeding on roots, rhizomes, and stems. They belong to the family Noctuidae, subfamily Amphipyrinae. Four species were present, including *Protagrotis obscura, Apamea amputatrix, Agroperina dubitans*, and *Crymodes devastator*. Of these, *A. dubitans* was common on the Rathdrum Prairie in Idaho, but it was always quite rare in Oregon fields. *Apamea amputatrix* was also a rare species, while *C. devastator* was frequent to common. The only species present at epidemic outbreak levels that could have inflicted serious economic damage in the fields during this study was *P. obscura*.

Huge numbers of *Protagrotis obscura* were present in the Kentucky bluegrass fields of Union County during 2000; indeed one trap in the Coventry field yielded close to 10,000 moths on a single night. By contrast, all other species were present only at very low numbers, certainly well below any economic thresholds. It was thought that post-harvest burning practices might be a major factor in keeping most species at low levels. However, *P. obscura* is a burrowing cutworm, so its larvae might be well protected in the soil during burning treatments.

The objective of the 2001 study was to compare the effects of post-harvest burning with bale-only on the moth community. These results are shown in Tables 1 and 2. Aside from *P. obscura*, all of the moth species were present in equally low numbers in both the burn and bale-only treatments. No treatment effects were evident on these species. For example, we counted 30 individuals of *Crymodes devastator* in the burn trap and 32 in the bale-only trap.

The major effect was evident on the epidemic species, *P. obscura*, with 2,007 individuals in the bale-only trap and only 717 in the burn trap. This represents a reduction of 64 percent in the number of moths within the burned treatment compared to the baled treatment.

While this is only a single experiment in a single field, it is suggestive that post-harvest burning can have a beneficial effect in reducing numbers of cutworms in these fields. With these results in mind, it is perhaps difficult to explain the massive numbers of *P. obscura* present in the 2000 study fields, particularly the Coventry field. It is possible that the timing of post-harvest burning may be critical to the success of cutworm control. If burning is done shortly after harvest, the eggs and newly hatched larvae may suffer heavy mortality, but if burning is delayed for a month or more, most larvae may have burrowed into the soil where they would be protected from the fire.

One interesting question concerns the effects of high *P. obscura* numbers on the other species of grass-feeding moths. For example, *Crymodes devastator* might potentially exist at much higher numbers if not for the presence of so many *P. obscura*. Of particular interest is the competitive interaction of high densities of cutworms with sod-webworms. If *P. obscura* was much less common, sod-webworms such as *Chrysoteuchia topiaria* might become more common in these fields. Both the 2000 and 2001 field data tend to suggest this possibility as shown in Table 1.

Table 1. Total numbers for all grass-feeding moths collected near La Grande, Union County, Oregon near July 1, 2000 and 2001, in Kentucky bluegrass seed fields.

	2000			2001	
Species	Abbey (north)	Abbey (south)	Coventry	Burn	Bale- only
	----------------------------number----------------------------				
Protagrotis obscura	4,339	2,205	9,431	717	2,007
Apamea amputatrix	1	1	6	0	0
Agroperina dubitans	1	0	0	1	0
Crymodes devastator	5	6	10	30	32
Aletia oxygala	6	12	31	4	2
Leucania farcta	4	4	4	0	1
Chrysoteuchia topiaria	7	22	1	16	6
Pediasia dorsipunctella	2	4	1	3	3
Totals	4,365	2,254	9,484	771	2,051

Table 2. Identification, feeding type, and number of grass, hardwood, and herb-feeding moths collected in Kentucky bluegrass treated with post-harvest burning or bale-only near La Grande, Union County, Oregon, 2001.

		Black light location	
Species	Feeding type	Open burn	Bale-only
		------------number------------	
Protagrotis obscura	grass	717	2,007
Crymodes devastator	grass	30	32
Chrysoteucia topiaria	grass	16	6
Aletia oxygla	grass	4	2
Pediasia dorsipunctella	grass	3	3
Agroperina dubitans	grass	1	0
Leucania farcta	grass	0	1
Paonias excaecatus	hardwood	1	0
Sericosema juturnaria	hardwood	1	0
Hessperumia sulphuraria	hardwood	1	0
Caenurgina erechtea	herbs	12	6
Anagrapha falcifera	herbs	5	1
Euxoa idahoensis	herbs	1	0
Loxostege cereralis	herbs	1	0
Grammia ornata	herbs	0	2
Platyyerigea montana	herbs	0	1
Spodoptera praefica	herbs	0	1
Totals		793	2,062

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PILOT BALLOON PROJECT TO ASSIST THE JEFFERSON COUNTY SMOKE MANAGEMENT PROGRAM, 2001

Claudia Campbell and Marvin Butler

Abstract

The Pilot Balloon (Piball) Project was conducted for a third year to provide real-time weather data for the Jefferson County Smoke Management Program. The project also provides feedback to Oregon Department of Agriculture meteorologist Jim Little, who makes daily forecasts for the program. A balloon is released daily between 10:30 and 11:30 a.m., followed by a second release between 12:30 and 1:30 p.m. or as requested by the Smoke Management Coordinator. Information on wind direction and speed, and identification of inversion layers is generated by these Piball releases.

Introduction

The Pilot Balloon (Piball) Program continues to focus on incorporating the weather balloon information into the daily routine of the Jefferson County Smoke Management Program. As with the year 2000 program, emphasis was put on burning more acres on the better burn days and not allowing burning on the marginal days.

Materials and Methods

Balloon releases occurred in the morning between 10:30 and 11:30 and, at the request of the smoke management coordinator, in the afternoon generally between 12:30 and 1:30. This year, instead of the Piball data being integrated into the burn forecast provided by the Oregon Department of Agriculture (ODA), the Piball was used to verify the burn forecast for upper level wind direction and speed and provide an indication of real-time mixing height. The wind directions and speeds were faxed to the smoke coordinator, who then used this data in conjunction with the aircraft soundings and the ODA burn forecast to determine the field burning status for the day.

Wind directions and speeds were determined at 1-min intervals for a period of 10 min during each balloon release using an observation Theodolite System and 26-inch-diameter helium-filled balloons. Each minute corresponds with the following above-ground level elevations in feet: 709, 1,358, 2,008, 2,628, 3,248, 3,839, 4,429, 5,020, 5,610, and 6,201. Air temperature, relative humidity, surface wind direction, and speed were documented for each day at the time of the balloon releases using the weather station at the Central Oregon Agricultural Research Center (COARC).

Results

The 2001 weather patterns provided for a good burn season. Using the Piball data as a supplement to the burn forecast worked well. Having the balloon releases later in the morning sometimes delayed a decision regarding the burning status; however, those timings helped to prevent adverse smoke impacts on the local communities. There were 15 days during the smoke management season where the Piball indicated wind direction and speeds at the 5,000-ft level that were contrary to the forecast. Knowing the actual transport wind direction provided the coordinator with the ability to keep the program moving forward in some locations while perhaps shutting it down at other locations throughout the project. Of the 15 days when actual conditions differed from those predicted, the forecast called for winds out of the northwest 80 percent of the time. Forty six percent of the time winds actually came from the northeast to east, and 17 percent of the time they varied from southeast to west. The Piball indicated transport wind speeds slower than the forcasted speeds 27 percent of the time and faster wind speeds than predicted 9 percent of the days.

The Piball was also a valuable tool for determining the mixing height for smoke during the optimal burn times. There was an inversion layer extending from the surface up to an average of 5,000 ft on 87 percent of the mornings, as indicated by the temperature readings provided by the airplane flights. A counter clockwise direction of travel by the Piball also indicates an inversion. The morning (10:30 a.m. to 11:30 a.m.) balloon releases indicated that 71 percent of the time the inversion had lifted to a minimum of 4,500 ft. Of the 15 days that a second Piball was released, only 3 of those days showed an improvement in the mixing height. Six days actually indicated a slight worsening of the inversion layer. The remainder of the days showed no significant change in the upper level conditions. During the period following September 11, when general aviation was grounded, the Piball was the only means by which to determine the mixing height and how high the smoke would go before being trapped by the inversion.

Recommendations

1. Continue to release one Piball for each smoke management day between 10:30 and 11:30 a.m.
2. Continue to use the ODA burn forecast.
3. Extend the smoke management season for open field burning to the end of October.

TOWARDS IMPROVING CONTROL OF *BOTRYTIS* DRY ROT OF GARLIC (*BOTRYTIS PORRI*)

Fred Crowe

Abstract

A review of the limited understanding of this disease is presented. Attempts were made to induce an epidemic of *Botrytis porri* in a 1-acre field of garlic grown in 2000-2001. While some *B. porri* dry rot did occur, the attempt to induce a general epidemic failed; possible reasons why are discussed. A fungicide spray trial was conducted, but too little disease occurred to evaluate relative control by various products included. Cloves from this crop are being grown in the greenhouse in an attempt to find sporulation of *B. porri* on young plants, and to verify that this fungus may be carried in seedlots. Seed from a damaged commercial crop was planted in the fall of 2001, both with and without Rovral fungicide treatments, in a further attempt to discern whether this disease is expressed early from seedlot infection, and whether seed treatment or fall season control efforts may suppress disease development in late winter or early spring.

Introduction and Literature Review

In central Oregon, neck rot of garlic, caused by *Botrytis porri*, has been an erratic problem in the garlic industry in the western United States since about 1980 (Sommerville et al. 1984). Because this disease is termed "dry rot" elsewhere, dry rot will be used in this discussion. While it also occurs in the central regions of California, it is more frequently a problem in the cooler seed production regions of Oregon, Nevada, and northern California. In Oregon's Willamette Valley, *Botrytis allii* (the common onion neck rot pathogen) may incite a garlic disease similar to that caused by *B. porri*, and both fungal species may be present (P. Koepsell, personal communication, Oregon State University).

B. porri has been widely reported in garlic (Harvey 1981, Kovachevesky 1958, Stoikova 1984) with reported crop losses up to 20 percent, but there is essentially no literature on epidemiology of this pathogen or control of this disease. It also is reported in leeks (Asiedu et al. 1986, Cronshey 1947) and wild garlic (Cronshey 1947). The western United States is the only garlic-raising region that reports a chronic problem with *B. porri* on garlic, but this may be a reporting difficulty rather than a true measure of higher or more frequent incidence.

In Northern Europe, *B. porri* causes a storage rot of leeks following field infection in the summer and fall (Hoftun 1978, Tahvonen 1980). That the fungus may continue to grow in cold storage underscores observations that *B. porri* is a cool and cold weather disease in garlic. Curiously, some leek seed is produced in central Oregon, and no *B. porri* problems have been reported, but perhaps too few observations have been made to recognize its presence.

Field symptoms on garlic start with lesions that form on the neck at or near the soil line. Lesions expand somewhat upward, but especially downward and inward into the neck from leaf to leaf. On smaller and younger plants, necks may be totally killed, leading to death of the plant or stunted, unproductive plants. If bulbs are developing at the time lesions appear, bulb size may be reduced by loss of some or all leaves. If plants are large and if bulbs are already fully formed at the time of lesion appearance, ingress into the neck is delayed and there may be little effect on yield. As the fungus grows downward on lesions, the covering bulb leaf sheaths and cloves may be decayed, bulbs may be small, and surviving cloves may shatter on harvest.

As lesions expand, *B. porri* produces mats of grayish-brown asexual spores (conidia). It also produces large, irregular, convoluted sclerotia on lesions and rotted areas on leaves and bulbs. Such sclerotia initially are somewhat soft and gray, but quickly become black and firm as they mature. Late infected bulbs and covering leaf sheaths may remain intact and may or may not be encrusted with sclerotia. Seed lots may contain late-infected cloves, and may be infested with sclerotia and conidia, which might conceivably contribute to disease occurrence in the next planting. Once plants die and/or the crop is harvested, most sclerotia remain shallowly buried in the soil or on the soil surface, along with rotted garlic tissues.

In the laboratory, sclerotia may give rise to both condial sporulation over the surface of sclerotia, and also to sexual structures (apothecia) from which sexual spores (ascospores) may be forcibly ejected (Van Beyma Thoe Kingma 1927, Kovachevesky 1958, Stoilova 1984, Summerville et al. 1984). Apothecia may have stalks up to several centimeters long. On related fungi, stalked apothecia allow ascospore release into the air from shallowly buried sclerotia, but such production from buried sclerotia in the field has not been confirmed for *B. porri*. I sometimes have observed apothecia in the field in central Oregon in the late winter/early spring that formed on sclerotia lying on the soil surface. I have very commonly observed abundant conidial formation during the winter and spring on sclerotia lying on the soil surface.

The relative contribution to current season epidemics of spores arising from infected or infested seed, from infected volunteer garlic or leeks, from sclerotia on or in soil, or from the previous season's garlic debris is unknown--presumably all may contribute to primary infection. Also unknown is the relative contribution of ascospores and conidia. However, based on what is known about this and related pathogens, it is presumed that most secondary or epidemic infection arises from conidial cycling on the current season's lesions just above the soil line.

Information that may be useful towards designing an efficient disease control program include:

1. Sources of epidemic:

    a. What is the relative occurrence/importance of spore production from dead and decayed garlic, sclerotia on soil surface, volunteer garlic, infected/infested garlic seed in current field, leek field sources, etc.? And when are these spores produced?
    b. How are conidial and ascopore production influenced by temperature, wetness, depth in soil, etc.?
    c. Under what conditions and time of day are ascospores discharged?

2. What are the infection requirements (wetness, temperature, light quality)? Are these different for conidia and ascospores?

3. Are there positional effects that affect epidemics? What distances can spores travel, and is this different for conidia and ascospores? This could be important with respect to volunteer management, soil management to deeply bury garlic residue and sclerotia, etc., and understanding the relative importance of within-field sources of inoculum (e.g., infected/infested seed) vs. outside sources of spores.
4. What is the lag period between infection and symptoms. Is the appearance of noticeable neck lesions a useful tool for timing of spray applications, or do spores spread and infect well in advance of symptom development? Is the lag period shortened as the season warms and daylength increases?
5. Preventative control program:

    a. Is seed treatment or better grading of seed lots beneficial if infected/infested seed is a source of initial infection?
    b. Does fall infection on emerged garlic occur?
    c. When should a spray program be initiated and discontinued?
    d. Can sprays be modeled based on wetness and temperature and cloudiness, etc.?
    e. Should sprays be coordinated with irrigation cycles, soil type,?
    f. Where to direct sprays (probably neck and soil line)? How effective is aerial application?

What are the best products to use, and how should concerns about resistance development, cost, etc.be addressed?

In general, foliar diseases incited by species of *Botrytis* are encouraged by extended periods of leaf wetness, high humidity, cloudiness, poor aeration, etc.--conditions that extend the time that spores are likely to infect leaves. For some *Botrytis* diseases, there can be significant lag times between spore infection and appearance of lesions or other decay. We have found no information concerning these aspects for *B. porri*. Possibly useful observations I made in 1984-2000 include the following, but no such observations except "c" and "f" have been verified by experimentation or formal survey:

a. Conidia may be present throughout the winter on sclerotia (and possibly on decaying garlic tissue) located at the soil surface. Apothecia probably only form in late winter and/or early spring, primarily from sclerotia on or very close to the soil surface, and may not form in some or many years. Apothecia seem to take a long time (weeks) to develop.
b. Dry rot has been observed on volunteer garlic in fields where neck rot occurred the previous year. In those same fields, sclerotia with active conidial sporulation also can usually be found.
c. Dry rot is more chronic on heavier soil types. Seemingly, soil dampness at the soil line encourages neck infection at that location.
d. Infection and epidemic development is greater when cool, damp, cloudy weather persists.
e. Irrigation management strongly influences occurrence of dry rot, especially on heavier soils. It is especially important to keep sprinkler irrigation from extending soil and foliage wetness generated by rainfall and cloudy periods. Dry rot can be abundant even in sandy soil when excessive irrigation aggravates already-conducive weather conditions. Whether furrow or drip irrigation reduces neck infection has not been determined.

f. At least for central Oregon, infection may be abundant well before the irrigation season begins about mid-April, especially if there have been extended periods of wet, cloudy weather. Neck lesions have been seen as early as February in some years, and are common in March and early April.
g. Preventative spray applications commonly are initiated well after early epidemic disease development has begun.
h. Early loss of very small garlic plants may go unrecognized.
i. Epidemics may ebb during extended dry and sunny periods, then re-activate if conducive weather resumes.
j. Preventative spray applications commonly are extended too late in the season, when new neck infections likely will not damage larger plants, and when earlier infections cannot be stopped.
k. Choice of control products and timing of applications usually is determined by convenience, cost of products, cost and difficulty of repeated applications, perceived crop yield, and current disease status. Too often, there is elevated interest in preventative fungicide applications *after* epidemic development is well advanced.
l. Disease severity may be region-wide under highly adverse weather conditions, but may vary greatly from field to field in less conducive periods. This suggests a strong influence of local management.
m. Incidence commonly is worse in fields of the varieties 'Chinese'and 'California Late' than in fields of 'California Early', although it can be severe in the latter, too. We are uncertain whether this a varietal effect or seedlot management.
n. Some in the industry believe that fungicide applications to fall-emerged foliage are beneficial.

In the mid- to late-1980's, P. Koepsell and I conducted fungicide research for control of *B. porri* at Madras, Oregon. While somewhat inconclusive, some things were learned. Several products effective against other *Botrytis* species were applied to foliage in randomized, replicated field trials. During one season, no dry rot occurred from within the trial area, including the untreated check plots, but abundant dry rot occurred in the surrounding garlic field. This suggested that the products worked but that the untreated check plots also became protected. This may have occurred by overspraying the plots or by drift of products onto those plots. Alternatively, infection may have spread in the surrounding field without spores effectively bridging the sprayed plots surrounding the untreated check plots. In a second season, no products worked very well, and it was surmised that the spray program may have begun too late.

Materials and Methods

A 1-acre field of garlic ('California Early') was commercially planted on October 5, 2000 at the Central Oregon Agricultural Research Center (COARC)-Madras station. The crop was commercially managed with respect to fertilizer and weed control. Beginning in 2001, this field was irrigated at about twice the frequency as required, in an attempt to keep the soil line and neck areas damp, toward inducing an epidemic of *B. porri*.

Once in late April, and twice in May, fungicide applications were directed at the neck/soil line area on 3-bed x 30-ft plots, with four replications. Fungicides included Benlate®, Folicur®, Quadris®, and Botran®, all at specific rates useful for control of *Botrytis* diseases on various crops, and several rates and timing combinations of Rovral®, as material commonly used in central Oregon. Specific rates are not listed here.

Garlic seed was obtained from a commercial field of garlic in the Willamette Valley where abundant *B. porri* dry rot occurred during 2001. This seed was planted in the field on October 10, 2001, and in-furrow sprayed with 4.3 lb/acre Rovral as per the white rot (*Sclerotium cepivorum*) label for this product. There were three, 200-ft-long x 2-bed plots of both Rovral-treated and untreated garlic in this small trial, which will be evaluated for disease in the 2002 season.

Seed from the COARC field was planted at various times in the greenhouse during the winter of 2000-2001 to force garlic growth and observe for early signs or symptoms of *B. porri* on small plants.

Results

Symptomatic plants did appear in late April, 2001, and by mid-May, a scattering of infected necks had occurred throughout the field. In mid-May, sporulating cultures of *B. porri* were blended and mixed with water and sprayed over the tops of plots. Nevertheless, no widespread or field-wide damaging development of *B. porri* occurred prior to water cut-off in early July . No fungicide comparisons were made after initial comparisons between untreated checks and selected sprayed plots indicated that there was no difference in garlic performance. In contrast, abundant *B. porri* dry rot occurred in various commercial fields in central Oregon where water management was less conducive than in our 1-acre trial.

At the time of this report, we have no data from the 2001 field planting, nor from greenhouse testing.

Discussion

We suggest that our failure to induce an epidemic of *B. porri* in the 1-acre planting can be explained by lack of suitable humidity and shade within the garlic canopy. The garlic was a thin stand and undoubtedly there were strong drying edge effects in such a small planting. We had hoped to overcome these effects by over-irrigating, but did not succeed. Furthermore, immediately following the application of inoculum of *B. porri*, a major rainfall occurred, which may have washed the inoculum from the foliage rather than allowing it to remain in contact. Finally, we may have under-fertilized (in combination with over-irrigating), as we suspect that *B. porri* incidence may be favored by high fertility rates in combination with neck-wetness, high canopy foliage density, and cloudy, cool weather.

Our experiments in progress will be reported later in 2002.

Acknowledgments

This research was supported by the American Dehydrators of Onions and Garlic Association (ADOGA) and the Nevada Onion and Garlic Research Advisory Committee. Field assistance was also provided by Basic Vegetable Products and Gilroy Foods.

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BACTERIAL BLIGHT OF CARROT SEED CROPS IN THE PACIFIC NORTHWEST: IDENTIFICATION OF SOURCES OF INOCULUM

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Introduction

Carrot seed crops in central Washington (WA) and central Oregon (OR) produce approximately 75 percent of the U.S. carrot seed (Thomas et al., 1997) on 2,000-3,000 acres per state (Pelter 2001). Bacterial blight, caused by *Xanthomonas campestris* pv. *carotae,* is a seed-borne disease of concern to the carrot seed industry in the Pacific Northwest and to carrot growers in many regions of the United States and the world. Infection of carrot seed by *X. campestris* pv. *carotae* may reduce seed germination, resulting in losses to seed growers if germination is <85 percent. Seed companies, in turn, face expenses associated with treating infected seed lots, and seed lots destined for export markets may be rejected. Bacterial blight continues to cause losses to the carrot industry despite the ability to detect seed-borne infection (Kuan et al. 1985, Umesh et al. 1996), the availability of seed treatments to eliminate seed-borne inoculum (Howard et al. 1994, Pscheidt and Ocamb 2001), and development of seed contamination thresholds for specific regions of carrot production (e.g., Umesh et al. 1998).

Empirical evidence suggests bacterial blight is more prevalent in carrot seed crops grown in central OR than in central WA, despite similarities between these two regions of seed production. The greater prevalence of bacterial leaf blight in OR compared to WA was confirmed for the 2000-2001 season when plant pathologists from California, OR, and WA toured carrot seed crops in the two states in June and July 2001. Nonetheless, the relationship between incidence/severity of bacterial leaf blight and contamination of the harvested seed has not been clarified for these semi-arid regions of seed production in the Pacific Northwest.

Objectives for this work included:

1. Identify primary sources of inoculum associated with bacterial blight of carrot seed crops in central OR and central WA.
2. Monitor development of *X. campestris* pv. *carotae* in carrot seed crops in central OR and central WA.
3. Identify environmental and cultural factors associated with the differential prevalence of bacterial blight in central OR and central WA.

Materials and Methods

Survey of Carrot Seed Crops

Ten seed-to-seed crops were selected in central Oregon and 12 seed-to-seed crops in central WA to monitor development of *X. campestris* pv. *carotae* through the 2001-2002 season under the diversity of production practices and in the range of locations/environmental conditions representative of carrot seed production in the Pacific Northwest (Table 1). Fields were sampled twice in the fall and winter (1) between 2 and 10 October in OR, and on 28 September and 5 October in WA (before fall frosts); and (2) from 6 to 8 November in OR, and 30 November or 16

January in WA (after the first fall frosts). For the second collection, snow cover in WA prevented sampling of all fields in November. Twenty plants were collected from each field in a "W"' pattern at each sampling date. People collecting plants disinfected their hands between samples. Whole plants were sampled, placed in individual plastic bags, and stored on ice for transportation to a refrigerated facility (4-8^{o}C).

Additional plant samples will be collected from each field in the spring (March/April) and summer (May/June, and July/August) of 2002. Two steckling-to-seed crops will be added to the survey in both OR and WA. Samples of stecklings shipped into OR and WA will be assayed for *X. campestris* pv. *carotae* to determine whether stecklings may provide inoculum for infection of seed crops.

Leaf Assays

The presence or absence of symptoms of bacterial leaf blight was recorded for each plant sampled. Plant samples (foliage only) were assayed for *X. campestris* pv. *carotae* within 2-14 hours of sampling in OR, and within 24-36 hours of sampling in WA. Plants sampled in OR were assayed at the Oregon State University-Central Oregon Agricultural Research Center (OSU-COARC); plants sampled in WA were assayed at the Washington State University (WSU) - Mount Vernon Research and Extension Unit. Fresh plant weights were measured for plants sampled in WA, and dry weights were determined after leaf extractions for plants sampled in OR (leaves oven-dried overnight at 65-70^{o}C). The entire foliage of each plant was assayed, except for plants collected from Field WG in WA in January 2002, from which a 3-g subsample of the foliage from each plant was assayed.

Carrot leaves were assayed for *X. campestris* pv. *carotae* using the protocol described by Umesh et al. (1998), with slight modifications. In WA, foliage from each plant was cut into 1- to 4-mm pieces, placed in a 250-ml erlenmeyer flask containing 30 ml of sterile buffer (0.01 M potassium phosphate), swirled on a rotary shaker for 60 min, and the suspension concentrated 10-fold by centrifugation. The concentrate was assayed for *X. campestris* pv. *carotae* by (1) plating a dilution series (three replications of a 0.1-ml aliquot per dilution) onto XCS agar, a semi-selective medium for *X. campestris* pv. *carotae* (Williford and Schaad 1984); and (2) the polymerase chain reaction (PCR) assay developed by Umesh et al. (1996). For the PCR assay, DNA was extracted using the CTAB method (Zhang 1996) for the first set of plant samples, and the Dellaporta method (Dellaporta et al. 1983) for the second set of plant samples. In OR, foliage of each sample was cut into pieces, placed in a flask containing filtered/deionized water (50, 100, or 150 ml depending on the amount of foliage), swirled on a rotary shaker for 15 min at 250 rpm, and a dilution series prepared and plated onto XCS agar (three replications of a 0.2-ml aliquot per dilution). After incubation at 28^{o}C for 5-10 days, colonies of *X. campestris* pv. *carotae* were counted. Representative colonies were transferred onto YDC agar (Schaad et al. 2001) for verification of colony morphology, and tested using the PCR assay (Umesh et al. 1996). PCR assays were carried out at WSU-Mount Vernon or at the University of California-Davis (personal communication, R.L. Gilbertson and R.M. Davis).

Seed Assays

Samples of stock seed for each seed crop surveyed were collected from collaborating seed companies, and assayed for *X. campestris* pv. *carotae* using a modified version of the dilution plating protocol described by Kuan et al. (1985) and Umesh et al. (1998). Two 10-g subsamples of each stock seed lot were assayed for the bacterial pathogen. Stock seed lots from WA fields were also assayed twice by PCR. Samples of stock seed of several crops remain to be assayed. A third replication of all seed lots will be assayed. Samples of seed harvested from each field in summer 2002 will be assayed for *X. campestris* pv. *carotae* to determine the relationships between inoculum on stock seed, development of the bacterial population on plants in-season, and infection of the harvested seed.

Cultural Practices and Environmental Conditions

Production practices (irrigation system, cropping history, and pest management programs) associated with each carrot seed crop sampled will be examined in relation to development of bacterial blight and final seed-borne populations of *X. campestris* pv. *carotae*. Data on regional weather conditions (temperature, relative humidity, precipitation, frequency and timing of frosts relative to crop maturity, wind, etc.) collected from local weather stations through the 2001-2002 season will be examined relative to development of bacterial blight in the fields surveyed.

Results

The 10 direct-seeded carrot seed crops surveyed in central OR were planted between 1 August and 19 August 2001, and the 12 seed crops sampled in central WA were planted between 20 August and 5 September 2001. *Xanthomonas campestris* pv. *carotae* was detected in stock seed samples of four carrot seed crops in central WA, i.e., Fields WA (detected by PCR and dilution plating), WF (detected by dilution plating), WG (detected by PCR in one replication), and WK (detected by dilution plating) (Table 1). Populations of the pathogen in these infected seed lots ranged from 4.9×10^4 to 2.6×10^5 CFU/g seed. The pathogen was not detected in any of the stock seed samples assayed in OR (Table 1). However, 5 and 12 additional stock seed lots remain to be assayed for WA and OR, respectively.

Symptoms of bacterial leaf blight were not observed on any of the plants sampled during the first (pre-fall frost) sampling period, and *X. campestris* pv. *carotae* was isolated from only a single plant in one field (Field OE, sprinkler irrigated, at 1×10^5 CFU/g tissue) in OR during this period. During the second sampling period in central WA, *X. campestris* pv. *carotae* was found on only one plant (at 2.4×10^2 CFU/g tissue) in one field (Field WH, under furrow irrigation) (Table 2), and none of the plants sampled in WA displayed symptoms of bacterial leaf blight. In contrast, by November symptoms of bacterial leaf blight were observed in several carrot seed fields in central OR, and *X. campestris* pv. *carotae* was isolated from plants sampled from 7 of the 10 fields (Fields OA, OB, OC, OF, OG, OI, and OJ), including both sprinkler and furrow irrigated fields (Table 2). The incidence of plants in these fields that tested positive for the bacterium ranged from 10 to 45 percent, and populations of the pathogen on individual plants that tested positive ranged from 7.4×10^2 to 6.3×10^9 CFU/g dry leaf tissue.

Daily minimum and maximum temperatures, and occurrence of frosts between 1 August and 31 December 2001 were similar for central OR (measured in Madras, OR) and central WA (measured in Moses Lake, WA) (data not shown). However, 5.01 inches of total precipitation was received in Madras, OR during this 5-month period, compared to 3.36 inches of total precipitation in Moses Lake, WA. Splashed or windblown water is a primary means of spreading *X. campestris* pv. *carotae*.

Discussion

Xanthomonas campestris pv. *carotae* was more prevalent in central OR than in central WA by November 2001, approximately 3 months after planting, even though copper sprays were applied to the OR seed crops in September whereas no copper applications were made to the WA seed crops surveyed. Preliminary results of the stock seed assays suggest infected stock seed was not the primary source of inoculum in OR, as the eight stock seed lots tested were negative for *X. campestris* pv. *carotae*. Furthermore, bacterial leaf blight was not observed in WA fields that were planted with infected stock seed, even under sprinkler irrigation. There was also no evidence of greater incidence/populations of *X. campestris* pv. *carotae* in the OR fields under overhead (sprinkler) irrigation vs. fields under furrow irrigation. These results suggest seedborne inoculum may play a less significant role than other sources of inoculum (such as infested debris) in development of bacterial leaf blight in carrot seed crops in the Pacific Northwest. Additional sampling of these fields through the spring and summer of 2002, completion of the stock seed assays, and assays of the seed harvested in 2002 will provide more detailed information on the relative roles of infected stock seed and types of irrigation on: (1) development of bacterial leaf blight in-season, and (2) infection of the seed harvested from carrot seed crops in the Pacific Northwest.

To prevent pollen contamination and ensure trueness-to-type of harvested seed, carrot seed crops are separated spatially by distances ranging from ¼- to >3 miles, depending on the type or variety of the crops. This spatial separation within seasons may provide some control of bacterial leaf blight by minimizing movement of inoculum among fields. However, carrot seed crops are sometimes seeded in close (<¼ mile) proximity to mature seed crops from the previous season. The availability of fewer irrigated acres in central OR than in central WA results in more carrot seed fields in OR planted in close proximity to mature crops of the previous season than in WA. In addition, direct-seeded carrot seed crops are typically planted 3-5 weeks earlier in OR than in WA. As a result, in OR carrot seedlings are more likely to have emerged at the time nearby crops of the previous season are being harvested, potentially exposing young, susceptible plants to windblown infested debris. Work in 2002 will include atttempts to measure the distance of movement of *X. campestris* pv. *carotae* -infested dust and debris from fields during harvest.

The presence of *X. campestris* pv. *carotae* on carrot seed produced in the Pacific Northwest highlights the need to identify primary sources of inoculum leading to infections under the semi-arid conditions of this region. Identifying these sources of infection and the primary periods of infection through the biennial season will assist in development of more efficacious, regional Integrated Pest Management programs for carrot seed crops.

Acknowledgements

We thank the California Fresh Carrot Advisory Board for funding this project; Gary Pelter (WSU Extension Agent) for assisting with collection of plant samples in WA; Mike Derie and

Rhonda Bafus for technical support; Mike Davis, Bob Gilbertson, Joe Nunez, and Shawn Meng for providing information on the bacterial assays; and the Columbia Basin Vegetable Seed Association and carrot seed companies in WA and OR for information on carrot seed crop production and for access to carrot seed fields.

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Table 1. Carrot seed crops direct-seeded in central Oregon and central Washington in 2001 and surveyed for development of *Xanthomonas campestris* pv. *Carotae.*

Field	Hybrid or OP	Carrot type	Planting date (2001)	Irrigation		Stock seed assayed for *X. campestris* pv. *carotae*[a]			
						PCR assay[b]		Dilution plating (CFU/g seed)[c]	
						Replication 1	Replication 2	Replication 1	Replication 2
	Central Washington								
WA	OP	Kuroda	?	Sprinkler		+[d]	+	8.0×10^4	2.6×10^5
WB	Hybrid	Nantes	20 Aug.	Furrow	Female	-	-	-	-
					Male	-	-	-	-
WC	Hybrid	Nantes	28 Aug.	Sprinkler	Female	NT	NT	NT	NT
					Male	NT	NT	NT	NT
WD	Hybrid	Nantes/Flakkee	4 Sep.	Furrow	Female	-	-	-	-
					Male	-	-	-	-
WE	OP	Amsterdam	21 Aug.	Sprinkler		-	-	-	-
WF	OP	Chantenay	23 Aug.	Furrow		-	-	1.9×10^5	5.6×10^4
WG	OP	Flakkee	24 Aug.	Furrow		+	+	-	-
WH	OP	Chantenay	?	Furrow		-	-	-	-
WI	OP	Nantes	?	Furrow		-	-	-	-
WJ	Hybrid	Imperator	5 Sep.	Sprinkler (to emergence), drip	Female	NT	NT	NT	NT
					Male	NT	NT	NT	NT
WK	Hybrid	?	1 Sep.	Sprinkler	Female	-	-	-	-
					Male	-	-	2.2×10^5	4.9×10^4
WL	OP	Chantenay	1 Sep.	Furrow		NT	NT	NT	NT
	Central Oregon								
OA	Hybrid	Nantes	10 Aug.	Sprinkler (fall), furrow (spring)	Female	NT	NT	-	-
					Male	NT	NT	NT	NT
OB	Hybrid	Nantes	18 Aug.	Furrow	Female	NT	NT	-	-
					Male	NT	NT	NT	NT
OC	Hybrid	Nantes	2 Aug.	Furrow	Female	NT	NT	-	-
		Amsterdam			Male	NT	NT	NT	NT
OD	Hybrid	Nantes	23 Aug.	Furrow	Female	NT	NT	-	-
					Male	NT	NT	NT	NT
OE	Hybrid	Nantes	14 Aug.	Sprinkler	Female	NT	NT	-	-
					Male	NT	NT	NT	NT
OF	Hybrid	Nantes	19 Aug.	Sprinkler	Female	NT	NT	-	-
					Male	NT	NT	NT	NT
OG	Hybrid	Nantes	13 Aug.	Sprinkler	Female	NT	NT	NT	NT
					Male	NT	NT	NT	NT
OH	Hybrid	Nantes	11 Aug.	Sprinkler	Female	NT	NT	-	-

Field	Hybrid or OP	Carrot type	Planting date (2001)	Irrigation		Stock seed assayed for *X. campestris* pv. *carotae*[a]			
						PCR assay[b]		Dilution plating (CFU/g seed)[c]	
						Replication 1	Replication 2	Replication 1	Replication 2
					Male	NT	NT	NT	NT
OI	Hybrid	Nantes	1 Aug.	Sprinkler	Female	NT	NT	-	-
					Male	NT	NT	NT	NT
OJ	Hybrid	Nantes	18 Aug.	Sprinkler (fall), furrow (spring	Female	NT	NT	NT	NT
		Amsterdam			Male	NT	NT	NT	NT

[a] 10-g samples of stock seed assayed for *X. campestris* pv. *carotae* as described by Umesh et al. (1998).
[b] PCR assay = polymerase chain reaction assay developed by Umesh et al. (1996).
[c] Dilution series of seed extract plated onto XCS agar (Williford and Schaad 1984), with three plates per dilution. Representative colonies transferred to YDC agar (Schaad et al. 2001) and tested by PCR assay (Umesh et al. 1996). CFU = colony forming units of *X. campestris* pv. *carotae*/g seed.
[d] +, -, NT = stock seed samples positive, negative, or not tested for *X. campestris* pv. *carotae*.

Table 2. Colony-forming-units (CFUs) of *Xanthomonas campestris* pv. *carotae* isolated from carrot plants sampled from direct-seeded carrot seed fields in central Oregon and central Washington between November 2001 and January 2002[a].

Carrot seed fields and sampling dates (November 2001 and January 2002)

Plant[b]	**Central Oregon (CFU/g dry weight of foliage)**									
	OA 7 November	**OB 7 November**	**OC 7 November**	**OD 7 November**	**OE 6 November**	**OF 6 November**	**OG 6 November**	**OH 7 November**	**OI 8 November**	**OJ 7 November**
1	0	0	0	0	0	0	0	0	7.2×10^{4}	0
2	0	0	1.3×10^{6}	0	0	0	2.2×10^{7}	0	0	0
3	0	0	0	0	0	5.7×10^{4}	0	0	8.1×10^{5}	0
4	0	0	2.7×10^{7}	0	0	0	0	0	0	0
5	1.1×10^{3}	0	4.8×10^{5}	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	4.5×10^{8}	0
7	0	0	0	0	0	0	1.3×10^{8}	0	0	0
8	5.6×10^{3}	0	0	0	0	0	1.6×10^{6}	0	1.0×10^{5}	0
9	0	0	3.9×10^{3}	0	0	0	5.7×10^{6}	0	0	0
10	0	0	5.3×10^{8}	0	0	2.0×10^{5}	6.3×10^{9}	0	9.1×10^{5}	8.0×10^{7}
11	0	5.0×10^{9}	0	0	0	0	0	0	5.1×10^{7}	4.2×10^{6}
12	0	0	0	0	0	0	7.5×10^{8}	0	0	0
13	0	2.0×10^{5}	0	0	0	0	6.3×10^{5}	0	0	0
14	0	5.9×10^{5}	0	0	0	0	0	0	9.4×10^{6}	1.2×10^{8}
15	0	2.7×10^{7}	0	0	0	0	0	0	0	1.3×10^{6}
16	0	0	0	0	0	0	0	0	0	0
17	0	1.1×10^{5}	0	0	0	0	0	0	2.4×10^{4}	1.7×10^{9}
18	1.8×10^{3}	0	1.6×10^{9}	0	0	0	0	0	7.4×10^{5}	1.7×10^{5}
19	0	0	0	0	0	0	0	0	0	0
20	7.4×10^{2}	0	0	0	0	0	0	0	0	0
Mean[c]	2.3×10^{3}	1.0×10^{9}	3.6×10^{8}	0	0	1.3×10^{5}	1.0×10^{9}	0	5.7×10^{7}	3.2×10^{8}

	Central Washington (CFU/g fresh weight of foliage)											
Plant	**WA 16 January**	**WB 30 November**	**WC 30 November**	**WD 30 November**	**WE 16 January**	**WF 16 January**	**WG 16 January**	**WH 30 November**	**WI 30 November**	**WJ Not sampled**	**WK 16 January**	**WL 16 January**
1	0	0	0	0	0	0	0	0	0	-	0	0
2	0	0	0	0	0	0	0	0	0	-	0	0
3	0	0	0	0	0	0	0	0	0	-	0	0
4	0	0	0	0	0	0	0	0	0	-	0	0
5	0	0	0	0	0	0	0	0	0	-	0	0
6	0	0	0	0	0	0	0	0	0	-	0	0
7	0	0	0	0	0	0	0	0	0	-	0	0
8	0	0	0	0	0	0	0	0	0	-	0	0
9	0	0	0	0	0	0	0	0	0	-	0	0
10	0	0	0	0	0	0	0	0	0	-	0	0
11	0	0	0	0	0	0	0	0	0	-	0	0
12	0	0	0	0	0	0	0	0	0	-	0	0
13	0	0	0	0	0	0	0	0	0	-	0	0
14	0	0	0	0	0	0	0	0	0	-	0	0
15	0	0	0	0	0	0	0	0	0	-	0	0
16	0	0	0	0	0	0	0	0	0	-	0	0
17	0	0	0	0	0	0	0	0	0	-	0	0
18	0	0	0	0	0	0	0	0	0	-	0	0
19	0	0	0	0	0	0	0	0	0	-	0	0
20	0	0	0	0	0	0	0	2.4×10^2	0	-	0	0
Mean[c]	0	0	0	0	0	0	0	2.4×10^2	0	-	0	0

[a] Foliage of each plant assayed for *X. campestris* pv. *carotae* using the protocol described by Umesh et al. (1998).
[b] Twenty plants sampled in a "W"pattern from each field.
[c] Mean = average CFU/g foliage for those plants that tested positive for *X. campestris pv. carotae.*

DRIP IRRIGATION OF SEED ONIONS IN CENTRAL OREGON: EFFECT OF TAPE PLACEMENT ON DISEASE AND YIELD

Claudia Campbell, Marvin Butler, Peter Sexton, Fred Crowe, and Clint Shock

Abstract

A 2-year project was conducted from 1999 to 2001 at the Central Oregon Agricultural Research Center to evaluate drip irrigation on seed onions. Tape placement comparisons were between the surface and at 2-in, 4-in, and 8-in depths. These replicated plots were compared to a single large sprinkler irrigated plot. Irrigation scheduling was based on a soil moisture potential of –45 kPa during 2000 and –50 kPa for 2001, using granular matrix sensors placed in the row 6 in deep. There were no differences between drip tape placement for disease incidence of neck rot (*Botrytis allii*), bacterial soft rot, and scape blight (*Botrytis allii*). Although no statistical analysis could be made between the drip and sprinkler-irrigated plots, the trend was for decreased yields and the potential for increased soft rot under sprinkler irrigation. Water application to maintain similar soil moisture potentials was reduced by 26 percent under drip-irrigation.

Introduction

Scape blight and neck rot caused by the fungus *Botrytis allii*, along with bacterial soft rot, can be a serious problem in onion seed production, with the potential to cause a complete stand loss. By providing better control of water delivery, drip irrigation may decrease disease pressure while also decreasing water usage and increasing yields. The objective of this experiment is to observe the effect of tape placement depth on disease incidence and yield of onion grown for seed during 1999-2001.

Methods and Materials

Hybrid seed onions were planted in rows on 2.5-ft centers on July 30, 1999 and July 21, 2000 at the Central Oregon Agricultural Research Center (COARC). Two rows of female plants were alternated with two rows of male plants. Plots consisted of four rows, with the two inner rows being females. Treatments consisted of drip tape (Rainbird) delivering 0.25 gal/min/100 ft shanked in at depths of 2, 4, and 8 in before planting, along with a surface placement after planting. The trial was laid out as a randomized complete block design with four replications per treatment. A solid-set sprinkler system was used for plant establishment. After emergence, the irrigation pipe was removed from the drip-irrigated plots. Treatments were begun in the spring following stand establishment. All plots were irrigated whenever the soil moisture potential within a given replication was within 10 percent of -45 kPa for 2000 and -50 kPa in 2001. Soil moisture potential was tracked using granular matrix sensors (one per plot, placed in the row 6 in deep) measured three times weekly in 2000 and five times weekly in 2001. These readings were averaged across the plots for each replication to guide irrigation. During 2000, the plots were originally irrigated for 8 hours per application. However, in June the time was reduced to 4 hours per application when the plots were showing signs of over-watering. Plots were irrigated for 4 hours per application during the 2001 season. A single, large sprinkler-irrigated plot adjacent to the drip-irrigated plots was used to compare the two application methods. Weeds were controlled using a combination of herbicides and hand weeding. Insect control measures were the same for all plots.

Prior to planting in 1999, 16-16-16 fertilizer at a rate of 290 lb/acre and 40 lb/acre S was broadcast on all plots. A spring application of 450 lb/acre of 30-10-0-7 was made on April 5, 2000. In July 2000, the drip-irrigated plots received an additional 48 lb/acre N and 41 lb/acre P and K through an injection system. Prior to planting the second year crop, 16-15-15-3 fertilizer at the rate of 400 lb/acre was broadcast on all plots in July 2000. The sprinkler-irrigated plot received a spring broadcast application of 30-10 at 300 lb/acre in March 2001, while the drip-irrigated plots received a total of 45 lb/acre N, P and K in three applications in May and June.

Disease evaluations were made on June 23, 2000, June 6, 2001, and August 17, 2001. A representative 3-ft section of female row was selected for the June evaluations. A count of bulbs with neck rot (*Botrytis allii*) and bacterial soft rot was made to determine the number of plants affected. The same 3-ft section was used for the August evaluation for neck rot, while entire female rows of the plots were used for bacterial soft rot and scape blight evaluations.

In 2000, a 20-ft section of female plants from each drip-irrigated plot was hand harvested on August 25. The 2001 harvest on August 21 and 22 included the entire female rows from each plot. Four subsamples taken from the single sprinkler-irrigated plot followed the same harvest procedure used for the drip-irrigated plots. The seed heads were placed in woven burlap sacks, hung to air dry, and then threshed in a stationary thresher. The seed was cleaned at COARC using a Clipper Cleaner M-2B. Germination testing followed Association of Official Seed Analysts (AOSA) protocols.

Since the sprinkler-irrigated treatment was applied to a single large plot from which 4 subsamples were taken a direct statistical comparison could not be made between the sprinkler-irrigated and drip-irrigated plots.

Results and Discussion

There was no statistical difference in disease levels between drip-irrigation treatments for any of the parameters evaluated (Tables 1 and 2). Saturating the bulbs with 8-hour sets of water early in the 2000 season is believed to have been responsible for differences seen in neck rot (*Botrytis allii*). When the length of irrigation was changed to 4-hour sets, the differences between drip- and sprinkler-irrigated plots seemed to disappear based on informal observations. During 2001 there was no difference in the amount of neck rot between the drip-irrigated plots and the sprinkler-irrigated plot.

Although bacterial soft rot in 2000 was low, the sprinkler-irrigated plot had three times the incidence of soft rot compared to the drip-irrigated plots. In 2001, there was a higher incidence of disease, some of which might be accounted for by plant damage from a hail storm on May 23, 2001. The amount of soft rot in the sprinkler-irrigated plot during 2001 was three times higher than in the drip plots. On August 17, 2001 a second visual rating for disease incidence was taken and there were 4.5 times as many plants with soft rot symptoms in the sprinkler-irrigated plot than in the drip plots. Although not significantly different, the trend was for reduced soft rot under drip irrigation.

There was inadequate scape blight (*Botrytis allii*) for evaluation during 2000. In 2001 there was no difference in the number of plants affected with scape blight between the drip-irrigated plots and the sprinkler-irrigated plot. However, when the lower portion of the scape was evaluated separately, the trend indicated that incidence of scape blight was greater in the sprinkler-irrigated plot compared to the drip-irrigated plots.

Yield trends across the 2 years indicate greater yields (188-225 percent of sprinkled plot) with drip irrigation (Table 3). Statistical analysis of the effect of drip tape depth on yield showed no difference, but the trend was for the seed yield to be greatest at a tape depth of 4 in.

When keeping the soil moisture level within the same range, water usage decreased when using drip irrigation compared to sprinkler irrigation (Table 4). The drip-irrigated plots used 74 percent of the water used in the sprinkler-irrigated plot. Observations made by industry representatives suggest that the amount of water applied could be reduced further.

Table 1. Effect of drip irrigation on the incidence of bacterial soft rot, and neck rot (*Botrytis allii)* on onion seed evaluated on June 23, 2000, June 6, and August 17, 2001, at COARC near Madras, Oregon.

	Neck rot			Soft rot		
	2000	2001		2000	2001	
Tape depth	June 23	June 6	August 17	June 23	June 6	August 17
inches	---------plants/3 ft of row---------			---------plants/3 ft of row---------		
0	9	20	1.9	0.25	0.9	0.37
2	15	15	5.6	0.0	1.1	0.37
4	14	17	5.4	0.0	1.1	0.29
8	26	17	6.0	0.0	1.0	0.40
	NS[1]	NS	NS	NS	NS	NS
sprinkle	2	16	5.0	0.75	3.5	1.88

[1]Mean separation with Student-Newman-Kuels Test at P = 0.05; NS = not significant.

Table 2. Effect of drip irrigation on the incidence of scape blight evaluated visually August 17, 2001, at COARC near Madras, Oregon.

Tape depth	Lower scape affected	Upper scape affected	Entire scape affected	Total scapes affected
inches	plants/plot	plants/plot	plants/plot	plants/plot
0	9.5	10.0	9.7	29.3
2	9.7	11.8	6.1	27.6
4	7.4	12.3	11.2	30.9
8	8.3	6.6	12.6	27.5
	NS[1]	NS	NS	NS
sprinkled	18.5	7.4	11.0	36.9

[1]Mean separation with Student-Newman-Kuels Test at P = 0.05; NS = not significant.

Table 3. Effect of drip irrigation on yield,100-seed weight, and germination on onion seed at COARC near Madras, Oregon, 2000-2001.

Tape depth	Yield 2000	Yield 2001	Yield Average	Yield % sprinkled	100-seed weight 2000	100-seed weight 2001	Germination 2000	Germination 2001
inches	----------lb/acre----------			--%--	---------g---------		-------%-----	
0	593	497	545	197	0.478	0.502	87	82
2	648	408	528	191	0.496	0.522	89	88
4	1094	485	789	285	0.499	0.502	91	84
8	610	454	521	188	0.492	0.509	88	90
	NS[1]	NS	NS	NS	NS	NS	NS	NS
sprinkled	274	279	277	100	0.478	0.527	90	75

[1]Mean separation with Student-Newman-Kuels Test at P = 0.05; NS = not significant.

Table 4. Amount of water applied to drip-irrigated and sprinkler-irrigated plots on seed onions, at COARC near Madras, Oregon, 2000-2001.

Treatment	Water applied 2000	Water applied 2001	Water applied Average	Water applied % of sprinkled
	-----------------acre-ft/acre------------------			--%--
Drip irrigated	0.96	0.87	0.92	74
Sprinkler irrigated	1.27	1.21	1.24	100

DRIP IRRIGATION OF SEED CARROTS IN CENTRAL OREGON: EFFECT OF IRRIGATION THRESHOLD ON YIELD

Claudia Campbell, Marvin Butler, Peter Sexton, Fred Crowe, and Clint Shock

Abstract

A 2-year project was conducted from 1999 to 2001 at the Central Oregon Agricultural Research Center to evaluate drip irrigation on seed carrots. Soil moisture in drip-irrigated plots was maintained at -15, -30, -60, -90 and -120 kPa. These replicated plots were compared to a single large sprinkler irrigated plot maintained at -60 kPa. Irrigation scheduling was based on the specific soil moisture potential for each treatment measured by granular matrix sensors placed in the row 8 in deep. Each plot was irrigated for 4 hours when the average soil moisture potential was within 10 percent of treatment threshold. Although no statistical analysis could be made between drip and sprinkler irrigated plots, the trend indicated a 25 percent yield increase for -15, -30, and -60 kPa maintained plots compared to the sprinkler-irrigated plot. The level of *Xanthomonas* in the drip plots was half of that in the sprinkler-irrigated plot.

Introduction

Carrot seed production is a vital component of the seed industry of central Oregon. By providing better control of water delivery, drip irrigation may increase yields while decreasing water usage and foliar disease. The objective of this experiment was to maintain different soil moisture levels (irrigation threshold) and evaluate the effect on yield, water usage and development of *Xanthomonas*.

Methods and Materials

Hybrid seed carrots were planted in rows on 2.5-ft centers August 17, 1999 and August 21, 2000 at the Central Oregon Agricultural Research Center (COARC). Four rows of female plants were alternated with two rows of male plants with a blank row on each side. Plots consisted of eight rows, with the four inner rows being females. Drip tape (Rainbird) delivering 0.25 gal/min/100 ft was shanked in at a depth of 4 in prior to planting. The treatments consisted of five irrigation thresholds, -15, -30, -60, -90, and -120 kPa. The trial was laid out in a randomized complete block design with four replications per treatment. All plots were established with the drip-irrigation system, and treatments were imposed the following spring. Soil moisture potential was tracked using granular matrix sensors (three per plot, placed in the row, 8 in deep) measured three times weekly in 2000 and five times weekly in 2001. The readings from each plot were averaged and individual plots were irrigated whenever the average soil moisture potential was within 10 percent of the treatment threshold. Plots were irrigated for 8 hours per application in 2000 and 4 hours per application in 2001.

A single, large sprinkler irrigated plot adjacent to the drip-irrigated plots was used to compare the two application methods. The irrigation threshold for the sprinkler irrigated plot was -60 kPa. The plot was sprinkled for 4 hours whenever the average of the four granular matrix sensors read within 10 percent of the threshold. Weeds were controlled using a combination of herbicides and hand weeding. Insect control measures were the same for all plots.

Before planting in 1999, 290 lb/acre of 16-16-16 fertilizer and 40 lb/acre S were broadcast on all plots. A spring application of 450 lb/acre of 30-10-0-7 was made April 5, 2000. On June 27, 2000 the drip-irrigated plots received an additional 25 lb/acre N, P, and K through an injection system. Prior to planting the second year crop, 16-15-15-3 fertilizer was broadcast on all plots at a rate of 400 lb/acre in July 2000. The sprinkler-irrigated plot received a spring broadcast application of 300 lb/acre of 30-10 in March 2001, while the drip-irrigated plots received a total of 45 lb/acre N, P, and K in three increments during May and June.

In 2000, a 20-ft section of female plants from each drip-irrigated plot was hand harvested on August 28. The plants were threshed using a stationary thresher at COARC. Four subsamples taken from the single sprinkler-irrigated plot followed the same procedure used for the drip-irrigated plots. The 2001 harvest in September included the entire female rows of each drip-irrigated plot and all the females from the sprinkler-irrigated plot. Each plot was threshed using an IH 403 combine. A preliminary cleaning was conducted at COARC using a Clipper Cleaner M-2B. Final cleaning was done at the National Forage Seed Production Research Center, Corvallis, Oregon. Germination testing followed Association of Official Seed Analysts (AOSA) protocols.

An evaluation of the percentage of *Xanthomonas* infection in each plot was made on August 24, 2001. The entire plot was evaluated for symptoms of *Xanthomonas* and the percentage of foliage and umbels affected was determined by visual examination.

Because the sprinkler-irrigated treatment was applied to a single large plot from which four subsamples were taken, a direct statistical comparison could not be made between the sprinkler-irrigated and drip-irrigated plots.

Results and Discussion

Statistical analysis of the five irrigation thresholds in the drip irrigated plots showed no differences, but the trend across the 2 years was for similar yield increases of about 25 percent at -15, -30, and -60 kPa compared to the sprinkler irrigated plot (Table 1). At -90 kPa, yields were similar to the sprinkler irrigated plot, while at -120 kPa yields decreased by 11 percent.

During the 2000 season there was no discernable disease in any of the plots. However, visible symptoms of *Xanthomonas* appeared in the plots during the 2001 season. Although there was no difference in percentage of *Xanthomonas* in the drip-irrigated plots, the trend was for half the amount of *Xanthomonas* in the drip-irrigated plots compared to sprinkler irrigation.

Water usage tended to decrease for all drip-irrigation treatments when compared to the sprinkler irrigated plot (Table 2). The drip-irrigated plots used 92 percent (-15 kPa) to 26 percent (-120 kPa) of the water used in the sprinkler-irrigated plot. There were significant differences between the water applied between the drip-irrigated plots. The wettest plot (-15 kPa) used 1.87 acre-ft/acre while the driest plot (-120 kPa) used only 0.53 acre-ft/acre. The soil moisture reading for the sprinkler-irrigated plot averaged -64 kPa while the target was -60 kPa. The actual average soil moisture readings for the drip-irrigated plots tended to be slightly higher for the two wettest treatments, 10 percent lower for the -60 kPa, 31 and 36 percent wetter than the target threshold of -90 and -120 kPa, respectively.

Industry observations indicate that drip irrigation provides better water availablity by maintaining near constant soil moisture. This prevents over-irrigation and associated nutrient leaching while avoiding periods of plant stress between irrigations.

Table 1. Effect of drip irrigation on yield, 100-seed weight, germination, and *Xanthomonas* levels on carrots grown for seed at COARC near Madras, Oregon, 1999-2001.

Treatment	Yield 2000	Yield 2001	Yield Average	Yield % of sprinkled	100 seed weight 2000	100 seed weight 2001	Germination 2000	Germination 2001	*Xanthomonas* 2001	*Xanthomonas* % of sprinkled
-kPa	lb/acre			--%--	g		%		%	
15	1506	768 ab[1]	1137	126	0.106	0.010	91	94 a	8.3	42
30	1500	721 ab	1127	125	0.109	0.101	86	93 a	11.8	59
60	1432	822 a	1111	123	0.114	0.092	84	92 ab	8.8	44
90	1306	505 bc	905	100	0.113	0.097	88	90 ab	9.5	48
120	1192	402 c	797	89	0.122	0.095	90	84 b	6.0	30
	NS		NS		NS	NS	NS		NS	
Sprinkled (60)	1284	517	900	100	0.108	0.110	77	88	20.0	100

[1]Mean separation with Student-Newman-Kuels Test at P = 0.05; NS = not significant.

Table 2. Water usage and actual soil moisture level by treatment threshold on seed carrots produced under a drip-irrigation system at COARC, near Madras, Oregon, 1999-2001.

Treatment	Actual soil moisture readings 2000	2001	Average	% of sprinkled	Total water usage 2000	2001	Average	% of sprinkled
-kPa	kPa			--%--	acre-ft/acre			--%--
15	20.2 e[1]	24.4 c	22.3 e	165	1.95 a	1.79 a	1.87 a	92
30	32.7 d	38.1 c	35.4 d	145	1.55 b	1.43 b	1.49 b	73
60	48.9 c	58.1 b	53.5 c	117	1.04 c	1.07 c	1.05 c	52
90	62.2 b	62.5 b	62.3 b	103	0.90 c	0.49 d	0.70 d	34
120	70.8 a	82.2 a	76.5 a	81	0.67 c	0.38 d	0.53 d	26
Sprinkled (60)	75.0	53.4	64.2	100	1.73	2.34	2.03	100

[1]Mean separation with Student-Newman-Kuels Test at P = 0.05; ; NS = not significant.

WINTER GREENHOUSE SEROLOGICAL TESTING OF POTATO CULTIVARS NOT READILY EXPRESSING VISUAL PVY SYMPTOMS

Steven R. James and Robert L. Henderson

Summary

Forty-seven seedlots of potato cultivars not readily expressing visual Potato Virus Y (PVY) symptoms were selected from those submitted for winter greenhouse testing from the 2000 Oregon seed crop. The seedlots were visually inspected for the presence of mosaic viruses and, in addition, 100 leaflet samples were randomly collected from each seedlot and ELISA tested for PVY. Both evaluation methods, visual observation or ELISA, detected the presence of PVY infection equally well. There were no measurable differences (P = 5 percent) between the two detection methods for any of the individual samples, seed classes, or cultivars.

Introduction

Many of the tolerances established for certifying potato seed are based on the ability to detect mosaic viruses visually. In addition, these standards are customarily based on a single cultivar, ‘Russet Burbank’, in which symptoms are readily discernable by visual inspection. In recent years, new cultivars have been released that express mosaic symptoms somewhat differently than ‘Russet Burbank’ or, in some cases, poorly or not at all. As these cultivars have been widely grown across the United States and Canada, mosaic levels in seedlots have increased and seed growers have faced downgrades in certification classes or even the failure to certify some seedlots at all. The economic impact has been severe at times.

Some states have responded to the mosaic epidemic by raising the mosaic tolerances for each seed class. Although more seedlots may meet tolerances for mosaic infection, this action does nothing to address the real causes of infection and may even contribute to the spread of the viruses. Some certification agencies have advocated serological, PCR, or other testing to positively quantify mosaic levels in seed lots, particularly the cultivars not readily expressing visual Potato Virus Y (PVY) symptoms. Since seed classification disease tolerances have traditionally been based on visual inspections, seed growers have been reluctant to adopt mosaic testing programs. In addition, the ability to detect mosaic viruses has increased as more technologically advanced tests have been developed. So, the desire and ability to produce virus-free seedlots has been influenced by these new cultivars and how mosaic tolerances should be established.

Oregon seed growers have recognized the issues detailed above and their economic impacts and wish to base any revisions in mosaic tolerances on scientifically based research. This study was designed to aid in the setting of early seed generation classification tolerances for mosaic viruses in cultivars not readily expressing visual mosaic symptoms.

Materials and Methods

Each winter, Oregon seed growers submit tuber samples from a number of seedlots for pathogen screening in the greenhouses at Oregon State University. Visual inspections are normally performed on each seedlot to quantify virus infection levels, off-types, chemical injury, and other diseases. ELISA tests may occasionally be performed on plants that exhibit indistinct symptoms to aid in diagnosis.

A total of 47 seedlots were selected from those submitted for greenhouse testing as part of the traditional Oregon potato seed certification process. The selected seedlots included 30 ‘Norkotah’, 11 ‘Gem’, 5 ‘Shepody’, and 1 ‘Winema’ seedlot. Seed classification generations included ‘Prenuclear’, ‘Nuclear’, ‘G1’, ‘G2’, and ‘G3’.

In this study, each ‘Norkotah’, ‘Shepody’, ‘Gem’, and ‘Winema’ seedlot was subjected to a dormancy-breaking treatment, after which an eye was extracted from each tuber and planted in the floor of the greenhouse. Plants were allowed to grow for about 6 weeks. Visual PVY readings were made on submitted seedlots. In addition, 100 leaves were randomly collected from each seedlot and ELISA tested for PVY. ELISA tests were initially performed on groups of five leaves. If PVY was detected in the bulked sample, each of the five leaves was individually tested. Comparisons were made between visual and ELISA readings and also among seed generations.

Results

PVY infection levels ranged from 0 to 31.2 percent in the visually read lots and from 0 to 59 percent in the ELISA-tested samples. Results are shown in Tables 1 and 2. Both evaluation methods, visual observation or ELISA, could detect the presence of PVY infection equally well. There were no measurable differences (P =5%) between the two detection methods for any of the individual samples, seed classes, or cultivars. Occasionally, mosaic was observed visually but not detected in any of the samples submitted for ELISA testing (Table 2). Many of the seedlots that were read visually contained several hundred plants. Only 100 leaflets were randomly selected for ELISA testing, so differences are likely due to sampling error.

Table 1. Average of PVY infection levels detected visually and by ELISA for each seed generation and cultivar tested from the 2000 seed crop in Oregon.

Planted seed generation	Cultivar	Average PVY detected visually	Average PVY detected by ELISA
		%	%
Prenuclear	All	0.00	0.00
Nuclear	All	0.16	0.00
G1	All	0.60	1.17
G2	All	1.85	3.41
G3	All	0.00	0.00
All	Gem	0.07	0.09
All	Norkotah	2.06	2.10
All	Shepody	1.02	12.00
All	Winema	0.00	0.00

All comparisons did not differ statistically .

Table 2. PVY infection levels detected visually and by ELISA for all seed generations and cultivars tested from the 2000 Oregon seed crop.

Planted seed generation	Cultivar	Plants observed	PVY detected visually	Leaves tested	PVY detected by ELISA
		no.	%	no.	%
Prenuclear	Gem	165	0.00	100	0
Prenuclear	Gem	37	0.00	36	0
Nuclear	Gem	40	0.00	33	0
Nuclear	Gem	134	0.00	100	0
Nuclear	Gem	259	0.00	100	0
Nuclear	Winema	319	0.63	100	0
G1	Gem	209	0.00	100	0
G1	Gem	277	0.00	100	0
G1	Gem	695	0.00	100	0
G1	Gem	503	0.20	100	0
G1	Gem	324	0.00	100	0
G1	Norkotah	912	3.40	100	7
G2	Gem	323	0.62	100	1
G2	Norkotah	1317	0.46	100	0
G2	Norkotah	522	31.23	100	21
G2	Norkotah	1054	0.00	100	0
G2	Norkotah	642	0.47	100	1
G2	Norkotah	673	0.15	100	0
G2	Norkotah	669	0.15	95	0
G2	Norkotah	540	0.37	100	1
G2	Norkotah	616	3.73	100	4

Table 2

(Continued)					
Planted seed generation	Cultivar	Plants observed	PVY detected visually	Leaves tested	PVY detected by ELISA
G2	Norkotah	696	3.59	100	6
G2	Norkotah	1587	0.25	100	0
G2	Norkotah	1603	0.12	100	0
G2	Norkotah	768	0.00	100	0
G2	Norkotah	967	0.00	100	0
G2	Norkotah	1730	0.00	100	0
G2	Norkotah	1311	0.00	100	0
G2	Norkotah	863	0.00	100	0
G2	Norkotah	924	0.00	100	0
G2	Norkotah	873	0.00	100	0
G2	Norkotah	858	0.00	100	0
G2	Norkotah	510	0.00	100	0
G2	Norkotah	987	0.00	100	0
G2	Norkotah	1004	0.10	100	0
G2	Norkotah	669	0.00	100	0
G2	Norkotah	634	0.00	97	0
G2	Norkotah	687	0.00	100	0
G2	Norkotah	1149	1.39	100	1
G2	Norkotah	802	0.00	100	1
G2	Norkotah	397	9.82	100	13
G2	Norkotah	389	6.43	100	8
G2	Shepody	859	3.96	100	59
G2	Shepody	847	0.00	100	0
G2	Shepody	414	0.00	100	0
G2	Shepody	617	0.00	100	0
G3	Shepody	1917	1.15	100	1
All Generations	All Cultivars		1.45		2.64

COMPARISON OF *VERTICILLIUM* SOIL DETECTION METHODS USING GENETICALLY TRANSFORMED GREEN FLUORESCING ISOLATES, 2001

Robin Parks and Fred Crowe

Abstract

Traditional methods to quantify *Verticillium* species in soil rely on the growth of the fungus in semi-selective agar media. Estimates of soil populations from these plating assays are known to vary between methods and researchers. Yet, until recently, traditional assays could only be compared with each other in order to assess their accuracy. Recently, a mint isolate of *Verticillium dahliae* was genetically transformed with a green fluorescent protein (*gfp*). This novel research tool may be used to quantify *Verticillium* in soil. We developed a technique to estimate *Verticillium* soil populations by visualizing the fluorescence of these *gfp* isolates. Subsequently, we compared the accuracy of the traditional soil assay methods for *Verticillium* with that of fluorescent isolate visualization.

Introduction

Detection and quantification of the causal pathogen of *Verticillium* wilt, *Verticillium dahliae* Kleb., in soil has traditionally depended on plating soil on semi-selective media and counting colonies after incubation. These methods require *Verticillium* to grow in the media and produce microsclerotia, melanized survival structures, for identification. Yet these soil assay methods may not consistently or accurately estimate a soil population. Recovery differs between soil assay types and between researchers (Termorshuizen 2000). Soil assays for *Verticillium* are categorized by whether dry soil is plated (dry-plating) or the soil is suspended in water prior to plating (wet-plating). Although comparisons between the two assays have been performed previously, results are conflicting between studies. In one study, no significant differences in recovery were found between the two techniques but less variation was obtained with wet-plating (Smith and Rowe 1984). In another study, wet-plating gave the lowest recovery from field soil (Nicot and Rouse 1987). In the most recent study, higher populations tended to be recovered using the dry-plating technique (Termorshuizen 2000). In this same study, *Verticillium* recovery differed widely between the 13 research groups in 7 countries that participated. Although estimating soil inoculum density is often part of disease management, the traditional soil assays for *Verticillium* may not be accurate. Aside from variability between researchers, pathogen recovery from soil is inherently difficult. A variety of factors can influence recovery including soil particle size, type of agar medium, amount of soil plated, and length of incubation time (Harris et al, 1993). Soil characteristics, gravel content, and pH in particular have also been linked to recovery efficiency of soil assays (Wheeler and Rowe, 1995). The long incubation (10-14 days) required for microsclerotia production on the semi-selective media can allow other fungi that can grow more rapidly in culture to compete with the growth and microsclerotia formation of *Verticillium* (Platt and Mahuku 2000). This too may lead to inaccurate estimates of soil populations. For example, in our research, we use a wet-plating assay developed by Harris et al. (1993) because the dry-plating assay using Sorensen's NP-10 medium (Sorensen et al. 1991) allowed a *Fusarium* sp. fungus to overgrow the petri dishes. This competing organism obscured recovery of *V. dahliae* from soil collected from a mint trial located at Central Oregon

Agricultural Research Center (COARC), Powell Butte, from 1990 to 1993 (Crowe 1994, Crowe 1996).

The recent development of fluorescing *V. dahliae* isolates provides a novel method of investigating the accuracy of traditional soil assays. In 1999, a mint isolate of *V. dahliae* was transformed with a green fluorescent protein (*gfp*) gene from the jellyfish *Aequorea victoria* using methods developed at the Oregon State University (OSU) Department of Botany and Plant Pathology (Ciuffetti et al. 1997). Two transformants that grow normally and are equal to wild-type (untransformed *V. dahliae*) with respect to pathogenicity on mint were obtained. When illuminated with blue light, the gene product (protein) generates a green fluorescence. This gene product has been used previously as an *in situ* tag to visualize infection biology of fungi. It is a very attractive system because it is stable, very sensitive, and can be monitored by noninvasive methods in living tissue.

It is possible that these fluorescing isolates may be used to estimate pathogen populations in soil (Sawyer et al. 1998). The isolates have been examined in soil and can be positively identified (T. Sawyer, personal communication). The fluorescence can be visualized after only minimal fungal growth and may not require the production of new microsclerotia for identification. Although minimal fungal growth may be required, this system still has an advantage over traditional agar media used in soil assays. The transformants are resistant to the antibiotic hygromycin. Therefore, this antibiotic can be added to traditional semi-selective media to reduce competition between *V. dahliae* and other soil organisms. A high level of resolution has been demonstrated in viewing crude hand-cut sections of plant parts as even single spores can be observed amidst non-fluorescing plant tissue and other non-fluorescing microorganisms. Therefore, it is likely that fluorescence will be evident amidst a small amount of soil.

Prior to the development of these fluorescent transformants, the accuracy of the traditional soil assay methods for *Verticillium* could only be compared with each other. By developing a technique that does not rely on fungal growth and microsclerotia formation, but on visualization of the fluorescing *V. dahliae* isolates in soil, we propose to investigate the accuracy of the wet and dry plating methods. We also propose to perform the experiment using two different soil types in order to broaden the scope of the study.

It is understood that both traditional techniques are biased, as they do not recover the true population in soil (Nicot and Rouse 1987). This is often evident in artificial infestations. For example, in the central Oregon mint variety trial, up to 93 percent fewer microsclerotia than the amount infested were recovered using the wet-plating technique (F. Crowe, Mint Industry Research Council [MIRC] research report, 2000). Why the number of microsclerotia in the soil is often not recovered is not wholly understood. Because soil assays are not accurate, the relation of pathogen populations to disease severity is rarely straightforward. For example, soil populations of *V. dahliae* could not explain the differences in disease severity recently observed in the central Oregon mint variety trial (F. Crowe, MIRC research report, 2000). If an estimate of the accuracy of soil assays was obtained, we may better interpret such research results. Whether microsclerotia do not survive soil infestation, are not placed on the agar medium by the method used, or do not grow in the media is not known. These questions may be addressed in future studies using a soil quantification technique based on fluorescent isolates of *V. dahliae*.

Determining the accuracy of traditional soil assays by comparing them with a wholly different and unique method of counting *V. dahliae* in soil may allow researchers to better understand the limitations of the traditional soil assays and interpret results obtained from them with higher confidence.

We attempted to (1) develop a technique to quantify *Verticillium dahliae* in soil by visualizing green fluorescent protein (*gfp*)-transformed isolates, and (2) compare the accuracy of traditional wet- and dry-plating *Verticillium* soil quantification methods with visualization of *gfp*-transformed isolates in two soil types.

Materials and Methods

All work with genetically transformed isolates was performed in a laboratory according to federal regulatory guidelines. A *gfp*-transformed *V. dahliae* isolate that grows naturally and is as equally pathogenic to mint as the wild-type (non-transformed) was used in this study.

Inoculum was produced in the laboratory by growing the *V. dahliae gfp* transformants on a modified, minimal agar overlain with sterile, uncoated cellophane (Puhalla 1979). After a 3-week incubation, microsclerotia was harvested by blending the cellophane in sterile water and washed on a 38-μm sieve. The dried concentrated inoculum was ground with sterile sand with a mortar and pestle. The concentration of microsclerotia/g inoculum was estimated by plating specific proportions of inoculum and sterile sand on semi-selective agar media.

Field soil from non-infested portions of COARC Madras was collected and steam sterilized in an autoclave to eliminate any *Verticillium* microsclerotia that might have been present. The soil was infested with the *V. dahliae* isolates at a rate of approximately 500 microsclerotia/g soil. The soil and inoculum was mixed in an enclosed cement mixer inside a closed building. This infested soil was used to develop a technique to estimate soil populations based on fluorescence expression. Two hundred-g aliquots of infested soil were placed in wide-mouth plastic nalgene bottles and treated as plots. Samples were taken from the bottles and air dried at room temperature for 3 weeks to eliminate ephemeral conidial spores and hyphae of *V. dahliae* (Butterfield and DeVay 1977). The soil was ground with a ceramic mortar and pestle prior to plating to homogenize the soil particle size. Using both the wet- and dry-plating methods, small known amounts of soil were plated onto agar that is semi-selective for *V. dahliae*.

Wet-plating

From the original sample, 25 g of soil was shaken and dispersed in deionized water for 1 hour (Harris et al. 1993). The soil was wet sieved through 60- and 400-mesh soil screens and residue remaining on the 400-mesh screen was suspended in 100 ml of deionized water. Two ml of this suspension was spread onto a semi-selective modified pectate agar medium in a petri plate. The remaining soil and the soil that passed through the sieves was collected and autoclaved to kill any genetically transformed organisms.

Dry-plating

From the original dried and ground soil samples, 0.20-g subsamples were plated on Sorensen's modified NP-10 medium (Sorensen et al. 1991) using an Andersen air sampler (Andersen Samplers Inc., Atlanta, GA) (Butterfield and DeVay 1977).

Unsure as to whether the microsclerotia would fluoresce and be visible within 24 hours, we tested different incubation times. The plates were examined for microsclerotia fluorescence after 24, 48, and 72 hours. The expression of the *gfp* was visualized by irradiating with blue light (470 nm) using a Leica microscope with an Endow GFP filter cube (exciter HQ470/40, emitter HQ525/50 with beamsplitter Q495LP) located in the Department of Botany and Plant Pathology at OSU.

The *gfp* transformant and the mint isolate from which the transformant was produced were used in this study. The inoculum was produced as in objective 1. Field soil from non-infested portions of COARC Madras was collected and sterilized. Field soil from the Willamette Valley (OSU Botany Farm, Corvallis), which contains a different organic matter content, also was collected and sterilized. The field soil was infested as previously described. The soil was again placed in wide-mouth plastic nalgene bottles, five bottles per treatment, for a total of 40 bottles. Approximately 200-g samples from each bottle were collected and dried at room temperature for 3 weeks. Dried, ground soil samples were dry-plated as per the traditional method to estimate *V. dahliae* soil populations. Verticillium colonies were visualized either using the traditional or fluorescence microscope. The technique developed under objective 1 in this proposal was used to quantify individual fluorescent *V. dahliae*. The experiment was conducted twice.

The experimental design was a factorial with soil type and assay method as the main effects. Soil population data underwent an analysis of variance (ANOVA) using the general linear model, PROC GLM, of SAS version 7.0 (SAS Institute 1988). Treatment means were separated by Fisher's protected least significant difference (LSD) test.

Results

Although we had hoped that the microsclerotia would fluoresce and be visible when plated on media, the fungal structures were not distinguishable using a compound microscope less than 24 hours after plating. Soil particles were indistinguishable from known microsclerotia (known because fluorescent hyphae were seen growing from them) because the soil autofluoresced. Therefore, in order to distinguish and count microsclerotia, we incubated the plates to allow minimal hyphal growth so that fluorescence could be observed. Soil had to be removed from the plates to clearly see the fluorescent colonies. The soil was gently washed off with water, therefore leaving only adhering colonies on the surface of the agar. An incubation time of 30 hours was needed to visualize fluorescent colonies with confidence. The ease of visualization of the *gfp* isolates was noticeably different between the two media types. Although both MSEA and NP-10 allowed the fluorescent *Verticillium* to be distinguished, colonies were brighter and easier to see on NP-10. Therefore, for the second objective, dry soil was plated on NP-10 and the plates were incubated for 30 hours before visualization.

Compared to the fluorescence visualization, the traditional media-dependent soil assay yielded a higher number of counted *V. dahliae* colonies. Although just one of the two experiments yielded significantly different *V. dahliae* populations, 20 and 58 percent fewer colonies were visualized under the fluorescence microscope compared to the traditional soil assay method (P = 0.1199 and P = 0.0001, respectively) (Table 1). There was no difference in recovered colonies between the two soil types (P > 0.5). Similarly, there was no interaction between soil type and assay method (P > 0.6).

Discussion

Unfortunately, microsclerotia, either wild-type or *gfp*-transformed, are indistinguishable from soil particles when on a plate of media under a compound microscope. Trying to identify microsclerotia prior to germination would be tedious, time-consuming, and perhaps unreliable, making it unsuited for a soil assay. Therefore, we had to rely on growth of hyphae into media to distinguish fluorescence and count *V. dahliae* colonies. Because colonies were distinguishable within 30 hours of plating, the long incubation time of the traditional assay could be avoided with this procedure. It was evident that although the medias are similar, fluorescent colonies on NP-10 were much brighter and easier to distinguish than those on MSEA. Therefore, only NP-10 was used in the second objective to enhance the accuracy of the colony counting. Unexpectedly, more *V. dahliae* colonies were counted using the traditional soil assay compared with the fluorescence assay.

This difference may have been due to non-uniform germination times for microsclerotia. Because the fluorescence assay plates were read 30 hours after plating, perhaps not all microsclerotia had germinated by that time so that they were indistinguishable from soil particles or were washed off the media surface and were not counted. Yet, by 10 days after plating, it is assumed that most if not all microsclerotia have germinated and the colonies have produced distinguishable microsclerotial colonies.

From this study, it is evident that comparing traditional soil assays with fluorescent assays will be difficult as the two procedures must be reconciled to equally compare results. Perhaps lengthening the incubation time for the fluorescent assay could allow most if not all microsclerotia to germinate and colonies to be counted. Yet then the assay is perhaps just as media based as the traditional soil assay. The only difference would be if some colonies in the traditional assay fail to produce microsclerotia. Although more difficulties have arisen from this study rather than elucidated which assay is more accurate, it has helped to reveal the limitations of using the *gfp* isolates and comparing them directly to wild-type *V. dahliae*.

Acknowledgements

This research was supported by the Oregon Mint Commission and the Mint Industry Research Council.

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Table 1. Comparison of *Verticillium dahliae* recovery in two soil types and fluorescence or non-fluorescence visualization using a *gfp*-transformed mint isolate.

Treatment	CFU/g soil Experiment 1	 Experiment 2
Soil		
Central OR	386	336
Willamette Valley	370	312
Visualization		
Fluorescence	224 B[1]	286
Non-Fluorescence	532 A	361
Interaction		
Central OR*Fluorescence	229	310
Central OR*Nonfluorescence	543	362
Willamette Valley*Fluorescence	219	263
Willamette Valley*Nonfluorescence	520	361
P-value	0.0001	0.3879
Soil	0.5331	0.6024
Visualization	0.0001	0.1199
Soil*Visualization	0.7945	0.6302

[1]Means followed by different letters are significantly different at $P \leq 0.05$ according to Fisher's protected least significant difference test.

EVALUATION OF SIMULATED HAIL DAMAGE TO PEPPERMINT IN CENTRAL OREGON, 2001

Marvin Butler, Mark Zarnstorff, Claudia Campbell, and Jim Puckett

Abstract

This is the first year of a multi-year study to determine the effect of simulated hail damage on oil yield of peppermint. Timing and severity of damage were evaluated at 6 weeks, 4 weeks, and 2 weeks prior to the projected harvest date with untreated plots and 33 percent, 67 percent, 100 percent damage.

Introduction

Peppermint oil production has historically been an integral part of agriculture in central Oregon. In recent years there has been a decline in acreage due to reduction in price caused by an over supply of peppermint oil, and increasing amounts of verticillium wilt that persists in the soil and reduce yields. The objective of this project was to determine the impact of hail damage timing and severity on peppermint grown for oil. This information will assist the National Crop Insurance Service develop methodology for evaluating hail damage on peppermint.

Methods and Materials

This is the first year of a multiple year evaluation on the effect of simulated hail damage to peppermint grown for oil. The study was conducted in commercial fields under a center pivot in an area known as the grasslands between Madras and Prineville. Plots were 5 ft x 10 ft replicated three times in a randomized complete block design.

Variables evaluated in this study included three timings and four levels of damage. Timing of damage was 6 weeks, 4 weeks, and 2 weeks before the projected harvest date. Actual timing was 37 days, 23 days, and 9 days prior to harvest. Severity of damage included 33 percent damage, 67 percent damage, and 100 percent damage, all of which were compared to undamaged plots.

A Jari mower was used to cut 3-ft alleyways across the front and back of each row of plots on July 18 and August 15. Treatments were made July 18, August 1, and August 15 using a battery-powered hedger to remove either one-third of the growth, two-thirds of the growth, or all the growth except the bottom 4 in. A portable seed stripper (multiple headed weed eater) was used to damage the remaining foliage at the same rate as the growth reduction applied to each plot. A 40-in x 10-ft portion from the center of each plot was harvested with a plot-sized swather August 24, just prior to commercial harvest of the field.

Results and Discussion

The closer to harvest hail damage occurs, the less time there is for peppermint to recover. Plots treated 9 days before the trial was harvested (2 weeks prior to projected harvest) did not have adequate regrowth to be harvested. Yields were severely reduced in plots with 66 and 100 percent damage 23 days before actual harvest. Although other yield reductions were not statistically significant, the trend was for a reduction in yield as the amount of hail damage was increased for both application dates. Later damage reduced yields a greater amount than early damage for plots with 66 and 100 percent damage, but was similar for 33 percent damage for both application dates. Evaluating the amount of oil recovered per biomass harvested does not appear to provide any additional insights.

The yield in untreated plots was 41 lb/acre compared to an average of 87 lb/acre on the rest of the field harvested and distilled commercially. These results, and those of other researchers whose samples were distilled at the Central Oregon Agricultural Research Center, indicate that the distillation process provided substantially less oil than expected or recovered commercially adjacent to research plots. It also makes one less confident that the distillation process was consistent between the samples.

Table 1. Simulated hail damage on peppermint grown for oil with damage inflicted 37 and 23 days prior to harvest on August 24, 2001.

Hail damage		Oil		Biomass		Oil / biomass
--%--	days to harvest	---lb/acre---		---t/a---		---lb/ton---
0	---	41.2	a[1]	15.1	a	2.7
33	37	32.5	ab	12.3	b	2.6
66	37	29.5	ab	9.8	bc	3.0
100	37	16.5	ab	8.8	c	1.9
33	23	30.4	ab	10.2	bc	3.0
66	23	10.2	b	4.7	d	2.2
100	23	2.5	b	1.6	e	1.6
						NS

[1]Mean separation with Student-Newman-Kuels (SNK) Test at $P \leq 0.05$.