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June 1999

CENTRAL OREGON
AGRICULTURAL RESEARCH CENTER
1998 ANNUAL REPORT

Agricultural Experiment Station
Oregon State University

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Central Oregon Agricultural Research Center 1998 Annual Report

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Note from the Superintendent

Welcome to the 1998 annual research report for the Central Oregon Agricultural Research Center (COARC). We are pleased to share the results of our various research projects with you. 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 report there in addition to other reports that will be of interest to you. We welcome any comments you might offer on how we can make the page more useful.

The agricultural industry in central Oregon faces a changing mix of crops produced as old standby crops are leaving the area because of decreasing demand, low prices, or being "diseased out". To assist in this shift, it has become important that more resources of the Center are devoted to potential new crops.

Funding from the Federal and State governments to support the Central Oregon Agricultural Research Center increasingly are becoming limited. More effort and time will be devoted seeking grants and outside funding to support operations. Central Oregon's agriculture is a unique mix of specialty crops that do not have commodity organizational support. In addition, many specialty crops do not fit into the traditional guidelines for grants. Obtaining research support for this unique mix of specialty crops and for screening potential new crops will require innovative writing and search out new funding sources.

Our research reports acknowledge some of our cooperators through authorship. We extend special thanks to growers who have been invaluable in partnering with off-station research. Growers generously supply land and resources, another inconvenience caused by research needs; there are deeply appreciated. Also, the agricultural industry has been responsive to requests for support and assistance. Their observations to what is happening across the central Oregon area provides valuable information.

Special thanks goes to the City of Madras for transferring irrigation water to the Madras Research Center site. This allocation of irrigation water will allow more flexibility for research plot work. Also, thanks goes to the support that Crook, Deschutes, and Jefferson Counties provide to the agricultural industry in central Oregon.

Finally, I thank all Research Center 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 accomplishments of our staff.

Clint Jacks
Superintendent
Central Oregon Agricultural Research Center

Station Staff in 1998

Clint Jacks, Superintendent

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

Dr. Peter Sexton, Assistant Professor, Crop and Soil Science

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

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

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

Neysa Farris, Research Assistant

Robin Parks, Research Assistant

Pat Foltz, Bio-Science Research Supervisor

Peter Thomseth, Bio-Science Research Technician

Gerald Baker, Bio-Science Research Technician

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Weather Information: 1998 Water Year, Madras, OR, (source: AgriMet).

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
AIR TEMPERATURE (°F)												
Ave. Max. Temp.	60	49	42	44	48	53	58	61	74	89	88	81
Ave. Min. Temp.	37	35	26	29	33	31	35	41	45	54	50	47
Mean Temp.	48	41	34	37	40	42	46	51	60	71	69	63
AIR TEMP (no. of days)												
Max. 90°F or Above	0	0	0	0	0	0	0	0	0	16	16	9
Max. 32°F or Below	0	0	4	3	0	0	0	0	0	0	0	0
Min. 32°F or Below	5	11	28	16	12	13	14	0	0	0	0	0
Min. 0°F or Below	0	0	0	0	0	0	0	0	0	0	0	0
GROUND TEMP (°F at 4 in)												
Ave. Maximum	52	46	38	39	42	45	48	56	62	69	69	64
Ave. Minimum	50	45	37	38	40	43	46	53	59	66	66	61
GROUND TEMP (°F at 8in)												
Ave. Maximum	52	47	39	39	42	44	47	56	61	68	68	64
Ave. Minimum	51	46	39	39	41	43	46	54	59	66	66	63
PRECIPITATION (in)												
Monthly Total	0.79	0.45	0.18	1.95	0.76	1.06	1.04	5.12	0.88	0.52	0.26	0.36
EVAPORATION (in)												
Ave. Per Day	0.09	0.03	0.02	0.02	0.05	0.08	0.12	0.14	0.25	0.31	0.28	0.19
WINDAGE (mi)												
Ave. Per Day	149	101	102	160	177	124	107	111	107	96	101	97
SOLAR RADIATION (langley)												
Ave. Per Day	264	128	111	119	201	318	429	445	670	627	584	409
HUMIDITY (% relative humidity)												
Ave. Per Day	70	86	86	85	78	76	74	81	69	58	53	58

GROWING SEASON	**Last Day Before July 15**	**First Day After July 15**	**Total Number of Days Between Temp. Min.**
Air Temp. Min.			
32°F or Below	April 26	October 15	170
28°F or Below	April 8	October 16	189
24°F or Below	March 29	October 30	213

Weather Information: 1998 Water Year, Powell Butte, OR, (source: AgriMet).

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
AIR TEMPERATURE (°F)												
Ave. Max. Temp.	59	50	42	45	46	52	56	57	70	84	82	76
Ave. Min. Temp.	35	34	25	30	31	29	31	38	42	50	47	42
Mean Temp.	47	42	33	37	39	41	44	48	57	68	66	59
AIR TEMP (no. of days)												
Max. 90°F or Above	0	0	0	0	0	0	0	0	0	6	5	3
Max. 32°F or Below	0	0	2	1	0	0	0	0	0	0	0	0
Min. 32°F or Below	10	13	26	19	16	20	18	8	0	0	0	0
Min. 0°F or Below	0	0	0	1	0	0	0	0	0	0	0	0
GROUND TEMP (°F at 4 in)												
Ave. Maximum	53	47	38	39	40	43	48	54	63	74	73	64
Ave. Minimum	50	45	37	38	38	41	44	49	57	67	67	61
GROUND TEMP (°F at 8 in)												
Ave. Maximum	52	46	38	38	39	41	44	50	57	64	64	59
Ave. Minimum	51	45	38	37	38	40	42	47	54	60	60	57
PRECIPITATION (in)												
Monthly Total	0.64	0.78	0.56	1.42	0.99	0.66	1.63	4.46	4.61	2.65	0.83	0.48
EVAPORATION (in)												
Ave. Per Day	0.11	0.06	0.04	0.04	0.05	0.08	0.12	0.13	0.25	0.29	0.27	0.18
WINDAGE (mi)												
Ave. Per Day	135	112	115	148	158	107	98	99	105	92	85	78
SOLAR RADIATION (langley)												
Ave. Per Day	275	150	135	130	194	291	415	402	646	630	606	428
HUMIDITY (% relative humidity)												
Ave. Per Day	66	79	78	77	73	73	71	81	69	61	58	63

GROWING SEASON	**Last Day Before July 15**	**First Day After July 15**	**Total Number of Days Between Temp. Min.**
Air Temp. Min.			
32°F or below	May 28	October 3	126
28°F or Below	April 26	October 3	155
24°F or Below	April 8	October 16	189

FIELD PERFORMANCE OF MINT PROPAGATED BY VARIOUS MEANS, 1997-1998

Fred Crowe, Steve Lommel, Cathy and Tom Smith, Jan Lake,
Neysa Farris and Robin Parks

Abstract

Field performance of Black Mitcham peppermint in 1997 and 1998 was similar for test plots planted with virus-infected propagation stock derived from (i) a single plant held *in vitro* [*in vitro* refers to rooting and storage in a test tube in the absence of microorganisms] (ii) a single plant not held *in vitro* from the same mother plant as the previous treatment and (iii) multiple plants held *in vitro*. Materials were from Mint Industry Research Council (MIRC) propagation sources. Among these three treatments, however, there was a consistent trend toward higher hay and oil yield for plots planted with plants derived from the single, virus-infected plant held *in vitro*. There was no obvious adverse or beneficial field performance associated with either *in vitro* or single plant sources. However, so few single plants were used and no conscious selection for different types was conducted in the choice of plants, consequently these data do not discount the possibility that clonal selection might result in treatment differences.

For peppermint, plants in two additional treatments were initially tested to be virus free: In one, plants propagated from a meristem tip cultured plant taken from the same MIRC mother plant as the single sourced treatments above (this is necessarily an *in vitro* process). In the second, Black Mitcham plants had been privately propagated for several years *in vitro*, but the process for developing virus freedom was uncertain. In 1996 to 1998, plants in both putative virus-free treatments were more vigorous in spring through summer, grew longer stems, and lodged later than virus-infected mint. In 1996, but not 1997 or 1998, there was a statistically greater mean hay yield ($P \leq 0.05$) for plots with putative virus free mints than for plots planted with virus-infected mints. Mean oil yields among all treatments could not be separated ($P \leq 0.05$) for any year, nor were there consistent trends.

In a companion spearmint field trial, planted with the same treatments excluding the private virus-free source, no treatment means could be separated ($P \leq 0.05$) for any character in 1997 or 1998, except for reduced stem length in 1998 for the putative virus free material. Some of these findings may be substantially different from those reported elsewhere.

The infection status of the putative virus free MIRC-source of meristem tip cultured peppermint and spearmint, initially tested as virus free in 1996, was reconsidered in 1998, when lab tests suggested virus was present in the field grown plants. However, the peppermint originating from the private source of initially virus free material continued to test free of virus in the field in 1998. That the two sources of putative virus free peppermint tested differently in 1998 suggests that the MIRC-sourced material (either peppermint or spearmint) was never truly virus free, and that virus did not spread in the field either mechanically or via some vector. This further raises the possibility that a failed meristem tip culture process accounted for reappearance of virus after several years in the field in our earlier 1992 to 1995 trial. In both the 1992 to 1995 trial and the

current trial, spring vigor and longer stems continued to occur in plots planted with initially virus free material, even as virus reappeared.

A reliable assay for Trichovirus now is available from North Carolina State University. However, this virus seems to replicate very slowly. Based on both laboratory and field data, it can take a year or more following failed a meristem tip culture process for the titer to rise high enough for positive testing. While the meristem tip culturing process used for generating virus free material for this trial was very standard, it appears that the appropriate variations in laboratory techniques for reliably freeing plant material of Trichovirus (and the time course for subsequent verification of virus freedom) have yet to be specified.

Background

Clonal propagation typically involve mass transfer of plant parts, retaining genetic type of the mother stock, but also usually transferring any systemic infections by viruses or other pathogens. Special techniques such as meristem tip culture can free plants of systemic pathogens, again while retaining the genetic type (Murashige and Skoog, 1962; Wright, 1988). Verification is required to guarantee that meristem tip culture successfully eliminated systemic pathogens (Wright, 1988).

Clonal variants genetically distinct from the original type plant can occur if stable genetic changes have occurred in the plant parts used for propagation. Some plants are more prone to clonal offshoots than others. For example, sweet potatoes so frequently develop off types that the industry must annually reselect for the original varietal type when choosing propagation material (F. Crowe, 1974 to 1977, personal observation; D. Hall, Univ. Calif. Davis, 1974, personal communication). For true potatoes and garlic, noticeable clonal offshoots occur more rarely. Selection of new garlic and potato clones requires close inspection of hundreds of thousands of plants in commercial or seed fields, plus several years of field trials to determine whether the initially perceived differences persist (J. Scudder, Montana seed potato grower, 1989, personal communication; E. Kurtz, Am. Dehydrated Onion and Garlic Assoc., 1978, personal communication). For peppermint, the frequency of clonal formation is not clear, although some private clonal selection efforts exist in the industry. There is some concern, however, that inadvertent selection could occur during routine greenhouse selection of a few plants to redevelop mother bed stock, or when only one or a few plants are held as nuclear stock in test tubes, or when a few plants are selected from which to derive meristem tip cultured plants. Further, there is some concern that simply holding plants for extended periods in test tubes might induce genetic changes from the original type.

From 1992 to 1995, commercially propagated, meristem tip cultured Black Mitcham peppermint was initially found to be free of a Trichovirus that was present in non-meristem tip cultured Black Mitcham (Crowe and Lommel, 1995). The virus free Black Mitcham matured early, was highly vigorous, and produced more hay but less oil when harvested late in the summer compared to virus infected Black Mitcham (Crowe, 1994, 1995). Growth of virus free mint became stunted when the Trichovirus was used to re infect virus free mint (S. Lommel, No. Carolina St. Univ., 1998, personal communication). Preliminary data from Montana suggests that meristem tip cultured spearmint grew more vigorously but also yielded more oil than Trichovirus infected peppermint (L. Welty, Montana St. Univ., and S. Lommel, No. Carolina St. Univ., 1998).

Research Goals & Objectives

Field trials in central Oregon and Montana were established in 1996 with peppermint and spearmint propagated in various ways, primarily by a common propagator, to determine whether field performance might vary.

Methods

Peppermint treatments included all five listed below; Scotch spearmint treatments included only the first four described below. The first four treatments included plants from the MIRC stock sources at Summit Labs, Ft. Collins, Colorado. Plants for the fifth treatment were provided by Late Seed, Ronin, Montana. Peppermint and spearmint were located in separate trials, with randomized block experimental designs. Until October 1997, treatments were handled as a "blind" study, with treatments unknown to field staff.

<u>Virus Free, Single</u>: Meristem tip cultured from a single, virus-infected MIRC Black Mitcham mother plant. The regenerated plant used for propagation was initially tested virus free. Not held *in vitro* after regeneration. Treatment codes: Summit Spearmint = 20112, COARC = S-1. Summit Peppermint = 20111, COARC = P-3.

<u>Not *in vitro*, Single, Virus Infected</u>: Rooted Cuttings from the same single, virus infected mother plant as in the previous treatment. Not held *in vitro*. Treatment Codes: Summit Spearmint = 20103, COARC = S-4. Summit Peppermint = 20102, COARC = P-1.

<u>*In Vitro*, Single, Virus infected</u>. In Vitro nodal propagation taken from the same single mother plant as in the treatments above. Nodes from an aseptically maintained mother plant a few daughters from this plant were rooted briefly in aseptic medium and transferred to greenhouse flats during propagation. Treatment Codes: Summit Spearmint = 20109, COARC = S-2. Summit Peppermint = 20108, COARC = P-2.

<u>*In Vitro*, Multiple, Virus Infected</u>. Recent *in vitro* nodal propagation from many MIRC Black Mitcham plants. Less likely to result in inadvertent selection of a clonal variant. Treatment Codes: Summit Spearmint = 20106, COARC = S-3. Summit Peppermint = 20105, COARC = P-4.

<u>Virus Free, *In Vitro*</u>. *In vitro*, private propagator commercial stock for 4 years, commercially meristem tip cultured Black Mitcham. Prior to that, initially determined to be virus free. Treatment Codes: Lake Seed Peppermint = Lake, COARC = P-5.

In 1996, plants were propagated commercially as above in potting medium in individual plastic flat cells, shipped mid-June from Colorado and Montana, and received in excellent condition the next day in Madras, Oregon. Plants were placed 15 in. apart into 20 ft open furrows and covered with 3 in. soil on June 18. Treatments were randomized within 4 replications. Plants were laid along the furrow for greater rooting area. In 1997 and 1998, plots were grown as per commercial management. Spearmint was sprayed each season with Tilt to prevent mildew development. Plots were harvested on August 7, 1997, and August 12, 1998. Hay was air dried in gunny sacks, and distilled in mini stills.

To reduce risk of virus spread with plant sap, tools, rubber gloves, and cutting surfaces of equipment were disinfected with 5% household bleach when working among plots. Plant tissue samples were collected from all plots in late June of each year, and sent to North Carolina for virus RNA analysis as per methods described in the North Carolina report.

Results

Peppermint. In 1996, P-3 and P-5 (both initially virus free) were higher in vigor, yielded greater hay weights ($P \leq 0.05$). Oil data were not taken in 1996. In 1997, virus free mint (P-3 and P-5) had longer and weightier stems than other treatments, lodged later, but no other statistical differences were observed ($P \leq 0.05$). Treatment data in 1998 was comparable to 1997, except for some variation among treatments ($P \leq 0.05$) for compositional proportions of Menthofuran and Menthol (Tables 1 and 2).

In 1998, treatment P-3 was tested positive for Trichovirus and P-5 tested negative. Testing in 1997 gave mixed results (both positive and negative results, or indeterminate results) for treatment P-3, and negative for P-5. All initially virus infected materials continued to test positive. The tester plants considered virus free in North Carolina, used to compare with our field grown material, were from a different meristemmed plant than the P-3 material, but originating from Summit's MIRC material. These tester plants remained virus free according to various testing methodologies not described here.

Spearmint. Some flower initiation differences were seen in 1996 ($P \leq 0.05$) [data not shown], but these did not persist into 1997 and 1998. These were probably attributable to undetermined temporary cultural handling differences. In general, no statistically significant differences ($P \leq 0.05$) were seen in 1997 or 1998, except for some minor features (Tables 1 and 2).

In 1998, treatment S-1 tested positive for Trichovirus, as did the material from all other treatments. In 1997, S-1 plants gave mixed results in virus analysis. The tester plant considered free of virus in No. Carolina, used to compare with our field grown material, was from the original S-1 material from Summit. According to the virologists in North Carolina, it was possible that their tester material could be virus infected. But if so, the titer remains so low even after several years that it cannot be detected, so it remains useful for comparative purposes. This raises concerns about how one determines true virus freedom for these Trichoviruses, and how long it may take for titer to become enough elevated in the field before true virus freedom is certain.

Discussion

We do not find these data conclusive concerning the choice of single Vs multiple plants as greenhouse propagative material. Similarly, we do not find these data conclusive concerning the choice of *in vitro* Vs non *in vitro* plants. Based on our very limited study, there appeared to be no clear adverse or beneficial field performance associated with these choices. This does not mean that selection of novel growth types cannot result in clonal separation.

Peppermint initially thought to be virus free but which later tested positive (MIRC/Summit) and peppermint which remained virus free (Lake Seed) both grew with the greater vigor and delayed lodging expected based on earlier investigations (Crowe, 1994, 1995). They did not yield greater hay or less oil as found earlier, but this could have been due to statistical "noise" in the trial area resulting from erratic occurrence of verticillium wilt, or perhaps we harvested too early for yield differences to manifest (Crowe, 1994, 1995).

That the Summit meristemmed peppermint and spearmint both tested positive for Trichovirus after being in the field, whereas the Lake material re-tested negative, suggested that no field spread of virus occurred, either mechanically or vectored. Instead, it appears that the initial meristem tip culture process failed to eliminate the virus. The Trichovirus group is notoriously slow growing, and it simply may take an extended period of time for the titer to become elevated enough to detect with available methods (S. Lommel, personal communication, 1998). This complicates verification of virus freedom or infection for meristem tip culture or other virus eradication procedures. Unfortunately, it also complicates determination of virus infection or freedom from material regenerated from tissue culture in the MIRC Biotech Program. It may further complicate Spearmint certification for virus freedom if freedom from Trichovirus proves beneficial in this species. Because the Trichovirus infection appears beneficial to peppermint (Crowe, 1994, 1995), lack of a quick and reliable detection method is less problematic for non tissue cultured peppermint propagative stock.

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Murashige, I., and F. Skoog. 1962. A revised medium for rapid growth and bioassay with tobacco tissue cultures. Physiol. Plant. 15:473-497.

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Table 1. Growth and harvest data in 1997 and 1998 for spearmint and peppermint originally propagated in various ways and planted in 1996 at the OSU-COARC.

Peppermint Propagation Source	**VIGOR** (visual rating) 5/6/97	5/27/98	**STEM HEIGHT** (cm) 6/10/97	6/16/98	**FRESH HAY** (lb/A) 8/5/97	8/12/98	**OIL YIELD** (lb/A) 8/5/97	8/12/98
P-1. Not *In-vitro*, single	3.0 a	2.6 b	33.8 a	35.5 d	26900	18995	85.7	48.3
P-2. *In-vitro*, single	3.0 a	2.9 b	32.9 a	38.4 b	28800	26354	90.1	63.9
P-3. Virus-Free, single, not held *in-vitro* after regeneration	4.2 b	3.9 a	36.6 b	44.6 a	31100	23165	87.9	51.8
P-4. *In-vitro*, multiple	3.2 a	2.7 b	32.5 a	35.9 c	25600	21360	86.9	57.6
P-5. Virus-Free (uncertain method); held *In-vitro*	4.8 a	3.7 a	36.7 b	47.1 a	27800	21516	82.1	49.8
F-value	4.58	4.65	3.66	83.62	0.54	0.30	0.19	1.16
F-test for 5%	3.26	3.26	3.26	3.26	3.26	3.26	3.26	3.26

Spearmint Propagation Source	**VIGOR** (visual rating)[b] 5/6/97	5/27/98	**STEM HEIGHT** (cm) 6/10/97	6/16/98	**FRESH HAY** (lb/A) 8/5/97	8/12/98	**OIL YIELD** (lb/A) 8/5/97	8/12/98
S-1. Virus-Free, single, not *held* in-vitro	4.0	3.1	36.6	39.2 c[c]	30700	25669	84.8	61.0
S-2. *In-vitro*, single	4.0	3.1	36.6	40.4 bc	31800	25965	77.3	63.6
S-3. *In-vitro*, multiple	3.8	3.1	36.6	41.5 ab	34800	27458	82.0	64.7
S-4. Not *In-vitro*, single	3.5	3.0	37.8	42.6 a	35700	27474	86.1	58.5
F-value[a]	0.86	0.20	0.11	8.06	0.60	0.71	0.19	1.60
F-test for 5%	3.49	3.49	3.49	3.49	3.49	3.49	3.49	3.49

[a]Analysis of Variance F-value. F-test is significant if the F-value obtained is greater than the F-test at significance level 0.05 from an F-distribution table.
[b]Visual integration of plant vigor, including height, breadth and abundance of foliage. 0 = lowest; 5 = highest vigor.
[c]Means followed by the same letter are not significantly different at $P \leq 0.05$ according to Fisher's protected least significant difference test.

Table 2. Oil component analysis for spearmint and peppermint in 1998 originally propagated in various ways and planted in 1996 at the OSU-COARC.

	OIL COMPONENT (% Area)						
Peppermint Propagation Source	**Heads**	**Menthone**	**MF**	**Ester**	**Isopulegol**	**Pulegone**	**Menthol**
P-1. Not *In-vitro*, single	10.1	14.4	10.7 A[a]	5.98	0.40	2.60	36.9 B
P-2. *In-vitro*, single	9.35	13.8	9.28 B	5.89	0.41	2.36	39.3 A
P-3. Virus-Free, single, not in-vitro after regeneration	9.60	13.3	9.17 B	6.70	0.45	2.18	39.1 A
P-4. *In-vitro*, multiple	9.79	13.1	8.85 B	6.59	0.44	2.14	39.2 A
P-5. Virus-Free (uncertain method); held *In-vitro*	9.87	13.7	9.14 B	6.14	0.42	2.57	38.6 AB
P-value[b]	0.0515	0.5683	0.0059	0.6005	0.1968	0.4543	0.0895
Propagation Source	0.0768	0.6044	0.0117	0.5457	0.1988	0.4040	0.0551
Block	0.0704	0.4072	0.0131	0.5167	0.2339	0.4397	0.3023

	OIL COMPONENT (% Area)									
Spearmint Propagation Source	**Heads**	**Menthone**	**Menthol**	**Iso-menthol**	**Dihydro-carvone**	**Carvone**	**B-Pinene**	**Limonene**	**Cineole**	**3-Octanol**
S-1. Virus-Free, single, not in-vitro after regeneration	32.3	1.20	0.27	0.05	1.28	57.1	1.46	27.4	1.19	1.28
S-2. *In-Vitro*, single	33.4	1.18	0.27	0.06	1.23	56.5	1.47	28.4	1.22	1.19
S-3. *In-Vitro*, multiple	31.7	1.12	0.34	0.05	1.26	58.0	1.41	26.9	1.18	1.24
S-4. Not In-Vitro, single	30.7	1.13	0.34	0.05	1.20	59.1	1.37	26.1	1.17	1.29
P-value[b]	0.6219	0.7332	0.3563	0.8698	0.3559	0.6148	0.6114	0.5703	0.3690	0.1299
Propagation Source	0.3512	0.7414	0.4348	0.8314	0.9182	0.4185	0.4485	0.3627	0.6177	0.4502
Block	0.8460	0.5473	0.2686	0.7017	0.1363	0.7001	0.6469	0.7091	0.2063	0.0601

[a]Means followed by the same letter are not significantly different at $P \leq 0.05$ according to Fisher's protected least significant difference test.
[b]Probability of obtaining $F \leq_{0.05}$.

PEPPERMINT VARIETY TRIAL, CENTRAL OREGON, 1994-1998

Fred Crowe, Neysa Farris, Robin Parks

Abstract

Six peppermint (*Mentha piperita* L.) varieties and advanced lines were grown in uniformly wilt-infested or wilt-free soil for four full production years, 1995 to 1998. All plots were maintained identically through 1995 and 1996 until the infested plots only were tilled after harvest in 1997 and 1998. For infested plots, wilt levels were moderate for all varieties in infested plots from 1995 through 1998, except that wilt levels increased greatly in Black Mitcham in 1997 and 1998 after the tillage events of 1996 and 1997. Stands were uniformly high until 1998, when Black Mitcham in infested plots developed only 60% spring stand density. Yields were uniformly high among all varieties until 1998, when the combination of poor stand and greater than one wilt strike per square foot of plot area for Black Mitcham resulted in only 70% of the hay average and only 80% of the oil average for other varieties. In 1998, other peppermint mint varieties maintained 91 to 97% spring stand density, developed only 0.1-0.3 wilt strikes per square foot of plot area, and generally suffered no yield losses. Except for Black Mitcham, inoculum densities of *V. dahliae* in 1997 and 1998 in the soil in infested plots of all varieties were similar, and were at levels expected to elicit moderate symptoms but no yield losses. In infested Black Mitcham plots, inoculum levels were 3-5 times higher than found for other varieties, and were at levels expected to elicit wilt abundant enough to cause yield losses. After four years, the Murray variety developed the lowest amount of wilt in infested plots, and the least residual inoculum density of *V. dahliae*. However, these differences were not statistically significant ($P \leq 0.05$) between Murray and other varieties including Todds, Roberts, M83-7 or T84-5, nor were there any other meaningful performance differences among any of these non-Black Mitcham varieties.

For uninfested plots (which were never tilled), M83-7 seemed to lose vigor and yield in this fourth year, whereas M83-7 maintained this vigor in the infested plots, which had been tilled. There was trend in most years that Black Mitcham yielded slightly more oil and slightly less hay than other varieties, but no varieties could be separated statistically with respect to hay and oil yield ($P \leq 0.05$).

The Central Oregon variety trials were maintained with sprinkler irrigation. Over four years, we observed that Black Mitcham required less water than other varieties to maintain vigorous growth, and Black Mitcham always lodged earlier and more extensively than other varieties ($P \leq 0.05$). As a result, other varieties tended to stop growing and began to drop older leaves once stressed for soil moisture, whereas with the same irrigation regime Black Mitcham held its leaves and continued to develop new growth. This difference was noted even in the absence of wilt. If stressed greater than the mint in our trial, this difference could account for much of the difficulty growers have in transitioning from Black Mitcham to other varieties as wilt intensifies in new production regions.

Background

Before 1994, mint generally had not been evaluated in public field trials which provided comparisons among varieties which could be statistically evaluated (randomized, replicated plots in an appropriate experimental design). Such field trials were designed and implemented at the COARC and other locations in 1994 and following years. Primary objectives were to compare varieties for field response to wilt resulting from *Verticillium dahliae* and to compare field performance of mints both with and without the presence *of V. dahliae*. As discussed in this and previous progress reports (Crowe, 1994, 1996, 1997), we believe these objectives were met in 1994 through 1998, although we proposed elsewhere some modifications in plot design and management for future variety testing. A limiting factor was that oil character comparisons were desired in addition to field performance, and many in industry had reservations that the relatively small amounts of hay taken from small field plots and distilled in mini stills would provide a reasonable estimate of commercial oil character. These reservations included two questions: whether commercial character could be derived from scaled down stills at all, and also whether small plots could well represent large fields in which mint character was presumed to be variable. Both questions may have been addressed by modern mini still designs developed by L. McKellip and Newhouse Manufacturing (Redmond, OR) – preliminary reports are that commercial oil character can be achieved, and that the character is similar to large field character (L. McKellip, personal communication, 1997 and 1998) although more experience is required fully accept these preliminary reports. The COARC initiated its first variety field trial in 1994 without the benefit of a reliable mini still system, although a McKellip-Newhouse system was put in place and utilized beginning with the 1998 season.

Objectives

This study had two objectives: compare peppermint variety performance under uniform management and compare variety performance under (initially) uniform infestation of *V. dahliae*, the mint wilt pathogen.

Methods

The trial area and plots were extensively described in previous reports (See Crowe, 1996, for greatest plot detail). Plots were established from rooted cuttings in 1994. The trial area was split into an artificially infested area and an uninfested area, with each variety replicated four times in a randomized block design within each area. The infestation was accomplished by tilling *V. dahliae* (grown in the lab) into the soil in the fall of 1994 at a calculated rate of about 2.5 microsclerotia/gm of soil. This rate of infestation was anticipated to elicit a moderate amount of wilt in presumed wilt-tolerant varieties such as Murray and Todds, but was expected to immediately elicit much higher wilt in the presumed susceptibly variety Black Mitcham.

For the first two seasons, plot management was identical on both areas, allowing for some statistical analysis of infestation by variety interaction. After harvest in 1996, we decided to fall till the infested area (without any post-harvest propane flaming) in an attempt to exacerbate the wilt, which had remained at only moderate levels for all varieties in 1995 and 1996. In contrast, the uninfested area was post-harvest propane flamed, but not fall tilled, in order to suppress wilt development so that varietal performance could continue to be assessed free of wilt. As a result of the non uniform plot management, infestation by variety interactions were precluded for 1997 and 1998, and the two areas were treated as two independent trials. (Propane flaming kills *V. dahliae* in stems, which reduces the MS which might later find their way into the soil. Tillage tends to incorporate any MS from wilted stems directly into the soil, which eventually intensifies wilt (Horner and Dooley, 1996; McIntyre and Horner, 1973).)

Apart from the tillage events in 1996 and 1997, plots and both trial areas were managed identically, although not necessarily optimally for the best performance for each variety. In 1995 and again in 1997, water stress was shown to be more quickly and severely expressed by all varieties except Black Mitcham. After 1995, we attempted to over water to prevent such stress. Because the varieties could not be watered individually, this seemed the best management alternative. With respect to the performance of Black Mitcham, such over watering might accentuate the lodging, could result in some nitrogen leaching, might encourage greater root infection by *V. dahliae* (Cappaert et al, 1992), could suppress some wilt symptoms, and has an unknown affect on yield comparisons with other varieties. Spring stand density was measured as the proportion of plot area covered with mint growth, expressed as a percentage. As demonstrated in previous wilt trials (Crowe, 1994), higher *V. dahliae* infestations can affect the survival of mint rhizomes over the winter, and this effect was measured in 1998.

Individual wilt loci were flagged as symptoms appeared during the season, and where they could be distinguished. While the number of flags remained low (i.e. less than 50 per 200 ft^2 plot area, or $0.25/ft^2$), most flagged locations represented either new systemic invasions from root infections or systemic carryover of rhizome infections from the previous year. Where such strikes developed closer than 1 ft, they could no longer be distinguished, such that the number of strikes becomes increasingly under estimated. The upper limit on the number of strikes for these 200 ft^2 plots is around 200 strikes per plot (i.e., $1.0/ft^2$), but under estimation probably increased rapidly as strikes exceeded 100 per plot ($0.5/ft^2$). Nevertheless, without clear estimates of under estimation, numbers were compared statistically as if no under estimation was present.

Harvest in each year was during the first week of August. Subsamples from each plot were collected, air-dried in gunnysacks, and distilled in mini stills as per Hughes (1952). Oil from each plot sample was provided to oil-buying companies for oil component analysis.

In both 1997 and 1998, soil was collected from plots in the late summer, air-dried for one month to eliminate ephemeral conidial spores and hyphae of *V. dahliae* (Butterfield and DeVay, 1977), then assayed (Harris et al., 1993). Briefly, two 20-soil-core sub samples per plot were collected to 15 cm depth, and then mixed well. Following air drying, sub samples were passed through a grinder to pulverize the soil, and rocks larger than 1 cm were removed. From each subsample, 25 g soil were shaken and dispersed in water (containing a small amount of detergent) for 1 hr, then passed by wet sieving though 60- and 400-mesh screens to reduce soil volume and many competitive organisms. Residue remaining on the 400-mesh screen was re-suspended with continuous agitation in 100 ml H_2O, and 2 ml of this suspension was spread evenly onto a modified pectate agar semi-selective growth medium in a Petri plate, ten plates per subsample. Thus, residue from 2 g of soil was plated per original subsample. Plates were observed after 2 wk growth at room temperature. Colonies distinctive *of V. dahliae* were counted and data was expressed as the number of CFU (colony forming units) per g soil per plot, after averaging of the two subsamples. CFU presumably represent microsclerotia or aggregates of microsclerotia that have not fully disassociated from decaying stem pieces.

Data were analyzed by analysis of variance (ANOVA) using SAS version 6.12, Proc CLM (SAS Inst., Cary, NC). Means were separated by Fisher's protected least significant difference (LSD) test.

Results

Treatment means for spring plant stand, late summer lodging, cumulative seasonal wilt disease incidence, fresh hay weight and oil yield are shown in Table 1 for the infested and uninfested trials in 1998. Data from 1995 through 1997 is available in earlier reports, but in general most data were similar among varieties except for lodging (Black Mitcham was greater) in each year, and for wilt incidence in 1997 where Black Mitcham manifest substantially more wilt than other varieties in uninfested plots. As these differences are again reflected in 1998, the earlier data is not included here. In 1998, wilt continued to be nearly absent from uninfested plots, in spite of the close (30 ft) distance to nearby infested plots. Fall 1997 tillage of infested plots resulted in slight delay (one week) in growth of infested plots in comparison to uninfested plots. This delay is reflected in the lower level of lodging in infested plots than infested plots, and was probably reflected in yield, also. As in other years, Black Mitcham lodged more extensively than other varieties.

Infested Trial: In 1995 and 1996, in-season wilt incidence was moderate and comparable among all varieties, but the plots had not been tilled since the original inoculum was incorporated in the fall of 1994. Following fall tillage in 1996, wilt incidence in 1997 was much greater in Black Mitcham plots than other varieties (Crowe, 1997) and it was worse again in 1998 (Table 1). The mean number of wilt strikes recorded in Black Mitcham in 1998 was 113 per 200 ft^2 (0.56/ft^2), whereas the mean number of wilt strikes for other varieties was roughly 15-60 per 200 ft^2 (0.07-0.29/ft^2).

In fact, the wilt was more severe in Black Mitcham than suggested above: We previously reported (Crowe,1994) that spring plant stand density could be lowered in some years by higher populations of *V. dahliae*, presumably by weakening the vigor of rhizomes infected the previous fall. Following the high incidence of wilt in Black Mitcham in 1997, spring stand was severely reduced for this variety (60% ground cover) in 1998 (Table 1), in contrast to the other varieties in the trial (91-97% ground cover). When number of wilt strikes at harvest was calculated based on spring stand density, Black Mitcham, Murray, Todds, Roberts, M83-5 and T84-5 accumulated 0.16, 0.65, 1.89, 0.57, 0.43, 0.48 strikes/ft^2, respectively. In this sense, Black Mitcham manifest at least 3-10 times as much in-season wilt per unit of spring stand as the other varieties. Because numbers above 1.0 strikes/ft^2 are underestimated, the relative number of independent systemic wilt strikes would be higher yet for Black Mitcham.

Inoculum density as measured by the CFU/g soil in plots increased disproportionately for Black Mitcham in 1997 and 1998 compared to all other varieties (Table 1 shows this data for both 1997 and 1998. Data in 1997 was incomplete at the time of the last report, so is included here). In the discussion section below, we attribute the dramatic increase in wilt in Black Mitcham after tillage primarily to the increase in inoculum density, rather than to any inherent differences in varietal susceptibility to infection.

Based on the very high incidence of wilt in Black Mitcham in the infested area, it was anticipated that hay and oil yields would be much lower in 1998 for this variety than are shown in Table 1 relative to the other varieties. Surprisingly, yield was lower than other varieties but still was 81% of their average, This probably reflects the high compensative growth capacity of mint in general, the high yield capacity for Black Mitcham to compared to other varieties, and Black Mitcham's ability to continue to grow yield right up until the time much of the stand is dead. Yields were slightly higher in the uninfested trial than in the infested trial, but this might reflect maturity rather than disease incidence. Within each trial, no statistically significant differences ($P \leq 0.05$) were measured among any of the six peppermint varieties.

A partial list of oil composition appears in Table 2. In the infested trial, except for Menthone, no differences were noted among components. Menthone levels were statistically lower for Black Mitcham, and higher for Murray, Roberts and T84-5. Menthone for Todds, and M83-7 was intermediate.

Uninfested Trial: Uninfested plots were never tilled since 1994 and were post harvest propane flamed to suppress wilt development (Tables 1 and 2).

Spring stand density was comparable among varieties, but we noticed a decided weakness in growth during the summer with M83-7 compared to the other varieties in this fourth year of the trial. This weakness carried through much of the season and may account for the lower oil yield for M83-7 in the uninfested plots, although hay yield for M83-7 was among the high performers. Such a growth weakness was not apparent in the tilled, non-infested plots of this variety, which yielded as well as other varieties. It may be that M83-7 requires periodic tillage for rejuvenation.

As in past years, Black Mitcham yielded less hay but was the highest oil producer in 1998, followed closely by Roberts, and more distantly by Todds and T84-5, which all were inseparable from Black Mitcham in our statistical analysis ($P \leq 0.05$). Murray and M83-7 yielded less again, and were statistically separable ($P \leq 0.05$). Murray also yielded less hay than all varieties except for Black Mitcham. After several years without tillage, Murray may require tillage as discussed above for M83-7. No oil components were statistically separable among the varieties in the uninfested plots (Table 2).

Discussion

When we originally designed the infested phase of the variety trial for Central Oregon and for the Willamette Valley, it was generally accepted that Black Mitcham was inherently more susceptible to *V. dahliae*, based on many years of experience with this variety in growers' fields. We assumed that Black Mitcham would manifest perhaps 10 or more times as much wilt in the first year or two than the other varieties, based simply on the fact that the rate of infestation was expected to elicit a moderate amount of wilt in Todds and Murray.

In 1995 and 1996 in Central Oregon, and in 1996 in the Willamette Valley, we were surprised to find comparable wilt incidence among all varieties. The tillage conducted in Central Oregon in the fall of 1996 was done with the intent of worsening the wilt pressure for all varieties. Microsclerotia of *V. dahliae* form in the stems of infected plants, and are returned to the soil with tillage. Our 1997 and 1998 data clearly indicate that inoculum increase was favored following tillage in the Black Mitcham plots compared to other varieties. Why this was so we are uncertain. In fact, the steps from ramification of stems to formation of inoculum are not well delineated for *V. dahliae* for any crop.

Our initial uniform infestation of inoculum across all plots, calculated to be about 2.5 MS/g soil, was reasonably close to our recovered CFU in 1997 and 1998 for all varieties except Black Mitcham. While increases in inoculum for Black Mitcham must require formation of new inoculum, it is not clear whether we recovered original or newer inoculum from soil in plots planted with other varieties. Given that we tilled twice, readers may be concerned why some increase in inoculum was not measured for 1997 and 1998 for varieties other than Black Mitcham. In our previous tillage Vs. flaming trial at Powell Butte (Crowe, 1994; Crowe, 1996), both wilt incidence and soil inoculum increased for the Todds variety over several years of annual tillage. Lack of apparent increases in the variety trial, however, may be attributable to insufficient years of tillage, seasonal fluctuations in assay efficiency, variation in laboratory technique (e.g., two different lab assistants) or other effects with which we are not yet experienced enough to understand clearly. We really are only certain that the soil assay is consistent within a given sampling date, and that the general area in which the trials were located was initially free of recoverable *V. dahliae*.

Supporting our conclusions above, Black Mitcham has not shown any greater susceptibility to *V. dahliae* in greenhouse inoculations in central Oregon, using a range of mint isolates (See 1998 updated report on verticillium strain comparisons). On the other hand, Black Mitcham has manifest greater wilt in a companion trial in the Willamette Valley which also was uniformly infested but never tilled. Whether this was due to some regional difference in wilt behavior, or whether inoculum produced in stems is finding its way back into soil in other ways (e.g. earthworm and insect activity?) is not clear. Perhaps both processes occur: Black Mitcham may be a little more susceptible, and inoculum increases also occur if the crop is tilled.

Our data confirm that Black Mitcham should be tilled as little as possible after wilt first is recorded in a field. Further, our data seems to support the concept that if soil populations already are quite high, all varieties initially will suffer comparable amounts of wilt i.e., Todds, Murray, and others will likely wilt out as rapidly as Black Mitcham. On the other hand, some verticillium workers now suggest that microsclerotia may not survive as long as once thought (O. Huisman, Univ. Calif. Berkeley, personal communication). If so, then continued culture of newer mint varieties may allow soil population of *V. dahliae* to drop to less damaging levels, rather than keeping them high as is likely with Black Mitcham.

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TABLE 1. Field performance data, Peppermint Variety Trial, OSU-COARC, 1998.

UNINFESTED

VARIETY	May 27 STAND (% cover)	Aug 5 LODGING (%)	Aug 5 WILT (strikes/200 ft^2)	Aug 11 DRY HAY (lb/A)	Sept 10 OIL (lb/A)	1997 Aug *V. dahliae* (cfu/g soil)[c]	1998 Jul 16 *V. dahliae* (cfu/g soil)[c]
Murray	94	52 C[a]	0.2 B	8643 AB	43.3 C	0 A	0
Todds	96	67 BC	0 B	10514 A	48.8 ABC	0.1 AB	0.02
Black Mitcham	94	96 A	1.7 A	7747 B	58.6 A	0.2 A	0
Roberts	94	80 AB	0 B	8481 AB	55.4 AB	0.1 AB	0.02
M83-7	91	64 BC	0.2 B	10133 A	37.4 C	0.1 AB	0.02
T84-5	97	49 C	0.2 B	10331 A	45.0 ABC	0 B	0
P-value[b]	0.1579	0.0101	0.0055	0.0395	0.0395	0.0548	0.8596
Variety	0.3478	0.0062	0.0046	0.0598	0.0740	0.0368	0.8580
Block	0.0801	0.1391	0.0612	0.0649	0.0494	0.2471	0.6098

***VERTICILLIUM DAHLIAE* INFESTED**

VARIETY	May 27 STAND (% cover)	Aug 5 LODGING (%)	Aug 5 WILT (strikes/200 ft^2)	Aug 11 DRY HAY (lb/A)	Sept 10 OIL (lb/A)	1997 Aug *V. dahliae* (cfu/g soil)	1998 Jul 16 *V. dahliae* (cfu/g soil)
Murray	94 A	6 C	14.7 C	6476	44.0	4.3 B	2.0 B
Todds	91 A	27 BC	59.2 B	6406	46.8	3.5 B	3.2 B
Black Mitcham	60 B	77 A	113 A	4528	38.4	19.6 A	9.5 A
Roberts	88 A	34 B	50.0 B	7016	52.9	5.1 B	3.9 B
M83-7	92 A	12 BC	40.5 BC	6402	46.5	4.3 B	2.4 B
T84-5	92 A	10 BC	43.7 BC	6628	47.2	5.6 B	3.0 B
P-value[b]	0.0001	0.0008	0.0002	0.0514	0.7251	0.0001	0.0013
Variety	0.0001	0.0003	0.0001	0.1227	0.5126	0.0001	0.0114
Block	0.1008	0.2303	0.0205	0.0422	0.8971	0.0107	0.0011

[a]Means followed by the same letter are not significantly different at $P \leq 0.05$ according to Fisher's protected least significant difference test.

[b]Probability of obtaining $F \leq_{0.05}$.

[c]Colony-forming-units per gram of dried soil.

TABLE 2. Oil character data, Peppermint Variety Trial, OSU-COARC 1998.

UNINFESTED

VARIETY	HEADS	MENTHONE	MF	MENTHOL	ESTER	PULEGONE
	OIL COMPONENT (% A)					
Murray	10.4	18.6	4.56	39.5	5.39	1.56
Todds	9.57	18.6	6.02	38.9	5.41	1.93
Black Mitcham	10.2	16.4	7.05	39.7	5.29	1.97
Roberts	10.8	17.8	5.59	38.8	5.30	1.54
M83-7	9.50	17.6	5.62	39.2	6.03	1.84
T84-5	9.47	20.0	5.99	37.5	5.64	1.87
P-value[b]						
Variety	0.1445	0.0846	0.2725	0.4046	0.4170	0.4176
Block	0.0924	0.2191	0.1184	0.6389	0.7485	0.3899
	0.4053	0.0492	0.8978	0.1844	0.1521	0.3998

VERTICILLIUM DAHLIAE **INFESTED**

VARIETY	HEADS	MENTHONE	MF	MENTHOL	ESTER	PULEGONE
	OIL COMPONENT (% A)					
Murray	9.93	18.7 AB[a]	3.17	37.8	6.18	0.39
Todds	8.21	17.7 BC	3.06	38.1	7.89	0.64
Black Mitcham	8.13	16.1 C	3.69	41.1	7.08	0.94
Roberts	8.74	20.6 A	3.39	39.0	5.83	0.85
M83-7	10.7	17.5 BC	3.92	36.8	6.36	0.62
T84-5	10.3	19.9 A	4.15	37.9	6.34	0.73
P-value[b]						
Variety	0.2435	0.0058	0.4166	0.4592	0.3373	0.8967
Block	0.8887	0.0029	0.2173	0.2856	0.4136	0.8012
	0.0607	0.1922	0.9488	0.6814	0.2211	0.8040

[a]Means followed by the same letter are not significantly different at $P \leq 0.05$ according to Fisher's protected least significant difference test.
[b]Probability of obtaining $F \leq_{0.05}$.

WILT INCIDENCE AND SOIL POPULATION OF *VERTICILLIUM DAHLIAE* IN COMMERCIAL PEPPERMINT FIELDS, WITH AND WITHOUT PROPANE FLAMING

Fred Crowe, Neysa Farris, and Robin Parks

Abstract

Annual, commercial, post-harvest propane flaming Vs. no such flaming were compared with respect to control of Verticillium wilt of peppermint. This was the first year in a set of field trials in Central Oregon which will last for several more years. Initially, the fields included replicated and randomized large (roughly 1.5 acre) areas of two commercial farms. In past years, each farm had been cropped with mint which had developed abundant wilt. Farm #2 was planted with the Todds variety, and peppermint on Farm #1 was believed to be the Black Mitcham variety, but this was not known with certainty. The amount of wilt present in 1997, the second year of current production, was uniform and moderate (Farm #2) to moderately severe (Farm #1) according to growers' estimates. On farm #2 in 1997, yield averaged 76 lb oil/acre and wilt averaged 1 strike/m^2. Mint on Farm #1 in 1997 was harvested before the experimental trial was established. Flaming and nonflaming treatments were conducted on each farm after harvest in 1997, but soil samples collected from both farms in 1997 were damaged in storage. Stand density and preharvest wilt estimates were measured in 1998 on both farms. From Farm #2, mint spring ground cover averaged 62%, wilt incidence at harvest averaged 2 strikes/m^2, oil yield averaged 101 lb/acre, and late summer soil population estimates averaged 3.7 colony forming units (CFU) of *V. dahliae*/g soil, but there were no differences ($P \leq 0.05$) between the flamed and nonflamed treatments 1998. Such differences are not expected to develop until after several years. The mint on Farm #1 was discontinued after 1998 harvest by the grower because of high wilt damage field wide (34% spring stand, 5 wilt strikes/m^2 prior to harvest in 1998). *V. dahliae* population was estimated at about 2.1 CFU for Field #1, but this estimate may not reflect higher populations in severely wilt-damaged portions of the field. The trial on Farm #1 was continued. Additional fields may be included beginning in 1999.

CONTINUED INVESTIGATIONS ON STRAIN BEHAVIOR OF *VERTICILLIUM DAHLIAE* ON MINT AND OTHER CROPS

Fred Crowe, Neysa Farris, and Robin Parks

Abstract

In 1997, isolates of *V. dahliae* recovered from mint from the Northwest and Midwest were not variety specific in pathogenicity tests in the greenhouse, when tested on peppermint (Black Mitcham, Todds, Murray and Todds) and spearmint (Scotch and Native). For all varieties except Native Spearmint, roughly 80% of mint isolates elicited severe wilt and foliage death, whereas about 20% elicited milder symptoms and foliage yield reduction. In the greenhouse, Native spearmint generally expressed no or only mild symptoms from *V. dahliae* inoculation, but foliage yield was reduced by about 10%. In the greenhouse, Black Mitcham was no more susceptible to *V. dahliae* inoculation than other mint varieties. In contrast, *V. dahliae* isolates taken from non-mint hosts (potato, echinacea, maple, cauliflower and strawberry) and which may never have encountered mint, generally did not incite wilt of mint. Frequently, the mints grew more robustly (by about 20-200% in leaf size, stem length and foliage dry weight) in their presence. There were rare exceptions in which non-mint isolates incited disease symptoms ranging from mild to severe (e.g., one of six strawberry isolates). In general, our data support other claims that mint isolates of *V. dahliae* are somewhat specialized for mint.

In 1998, greenhouse inoculations of mint were conducted using mint and non-mint isolates of *V. dahliae*, to determine whether low spore concentrations (1×10^4, 1×10^5 and 1×10^6 conidia/ml) of these isolates would induce growth promotion. Mint isolates induced wilt response as expected at concentrations as low as 1×10^5 conidia/ml. Few or no responses were seen with non-mint isolates, and we tentatively concluded that mint growth may not be enhanced by small amounts of non-mint isolates. Field testing of interactions between mint and non-mint strains in the field is planned for 1999.

POSTHARVEST TREATMENTS TO CONTROL SILVER SCURF IN POTATOES: FIRST YEAR PRELIMINARY REPORT

Steven R. James

Abstract

Fungicide treatments were applied to 'Russet Norkotah' (*Solanum tuberosum*) tubers prior to placement in a commercial storage. Samples were stored for eight months and then rated for silver scurf (*Helminthosporium solani*) development. Silver scurf lesions appeared on nearly all of the untreated tubers. All fungicide treatments except Mertect 340-F (thiabendazole) reduced the percentage of tubers on which silver scurf lesions developed as compared with the untreated check. The potassium sorbate treatment produced the largest percentage of scurf-free tubers. The average tuber surface area covered with silver scurf lesions was significantly lower with potassium sorbate treated tubers than any of the other treatments. Of the tubers with silver scurf lesions present, potassium sorbate treated tubers had a lower percentage of surface area infected than any other treatment.

Introduction

Silver scurf is a disease of potatoes caused by the fungus *Helminthosporium solani*. It causes blemishes and lesions on the skin of the tuber that reduces tuber quality and marketability. Packing houses report increased sorting costs, increased inspection time, and rejected lots at destinations. Processors have difficulty peeling the skin off tubers when symptoms become excessive.

Silver scurf infection can occur in the field or in storage. Primary infection occurs in the field while tubers are attached to the stolons from spores that have survived either in the soil or on the surface of seed tubers. Secondary infection occurs during harvest and piling operations or from spores moving about in the storage environment (Frazier et. al., 1998).

Silver scurf spores can remain viable for extended periods of time on structural materials such as wood and polyurethane. There is evidence that the fungus can live for over nine months in the soil of the storage floor, particularly when the soil contains decaying tubers or other organic matter (Shetty et. al., 1997).

Once the tubers are placed in storage, free moisture can increase sporulation and secondary spread of the disease. Free moisture forms inside storages when condensation occurs on ceilings and walls because of to poor insulation or improper management of humidity and ventilating systems. Silver scurf pockets often appear in the warmest areas of the pile and also near the bottom vents where moisture tends to accumulate (Frazier et. al., 1998).

Treating tubers with a fungicide prior to placing them in storage is one strategy to control the development and spread of silver scurf. Postharvest tuber treatments are only one part of an integrated program to control the disease. This study was designed to evaluate several postharvest treatments to control silver scurf in storage.

Materials and Methods

A commercial lot of 'Russet Norkotah' potatoes was identified in a Madras, Oregon, field with the potential for silver scurf infection based on field history. Six hundred tubers (one hundred tubers for each of six treatments) were randomly selected from the conveyor belt moving the potatoes from the truck to the storage. One hundred tubers were immersed in a solution made by combining 1.9 oz. of Dithane ST (mancozeb) in three gallons of water, another set of 100 tubers was dipped in a 0.2 M solution of potassium sorbate ($C_6H_7O_2K$), and a third set of 100 tubers was dipped into a 0.2 M solution of calcium propionate ($C_3H_5O_2 \cdot ½Ca$). Maxim Potato Seed Protectant (fludioxonil) was applied to a fourth set of 100 tubers at a rate of 0.5 lb. product per 100 lb potatoes. The fifth set of 100 tubers was sprayed with Mertect 340-F (thiabendazole) as they tumbled through the piler unit at a labeled rate of 0.42 fl. oz. of product per ton of potatoes. A sixth set of 100 tubers was left untreated. After the fungicide treatments were applied, the tubers were allowed to air dry. The untreated check tubers and the treated tubers for each treatment were placed into mesh bags of twenty tubers each. The mesh bags were placed onto the face of the pile about four feet above the floor of the storage and buried with potatoes. The samples were stored at 42°F until they were removed from the storage on June 2, 1998 after about eight months in storage. Tubers from each mesh bag were placed in plastic bags, moistened, and placed in a dark room to cause the silver scurf lesions to sporulate. After a month, tubers were removed from the plastic bags. Each tuber was scored for the presence of silver scurf, and the tuber area covered by lesions was visually rated.

Results and Discussion

The postharvest fungicide treatments had a significant effect on the number and area of silver scurf lesions that developed during eight months in storage (Table 1). Silver scurf lesions appeared on nearly all of the untreated tubers. All treatments except Mertect reduced the percentage of tubers on which silver scurf lesions developed as compared with the untreated check. The potassium sorbate treatment produced the largest percentage of scurf-free tubers.

Mertect has been commonly applied for a number of years to control Fusarium dry rot in many commercial storages. Apparently, it also controlled silver scurf as well. However, it has been noted that *H. solani* has recently developed resistance to Mertect (Merida and Loria, 1990). This study suggests that local *H. solani* populations have also developed some degree of resistance to Mertect as 93 percent the tubers developed silver scurf lesions.

All fungicide treatments significantly reduced the average tuber surface area covered by silver scurf lesions as compared to the untreated control (Table 1). The average tuber surface area covered with silver scurf lesions was significantly lower with potassium sorbate treated tubers than with any of the other treatments. Of the tubers with silver scurf lesions present, potassium sorbate treated tubers had a lower percentage of surface area infected than any other treatment. Similar results have been observed in *in vitro* and greenhouse experiments (Olivier et. al., 1998).

Calcium propionate and potassium sorbate are fungicides commonly used in food products. Dithane ST was registered in 1997 for post-harvest treatment of seed potatoes only. Mertect is currently registered as a postharvest treatment. Maxim is not currently registered for this type of application.

Table 1. Postharvest fungicide treatments to control silver scurf, Madras, 1997-98.

Treatment	Tubers with silver scurf lesions (%)	Tuber skin surface covered by silver scurf lesions (%)	
		All	Diseased
Potassium Sorbate	47	5	11
Maxim	68	10	14
Dithane ST	78	13	17
Calcium Propionate	79	14	17
Mertect 340-F	93	16	18
Untreated Control	99	23	23
LSD 5%	18	5	5

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Acknowledgments

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A COMPARISON OF TWO WINTER TESTING SCHEMES FOR CERTIFYING SEED POTATO LOTS

Steven R. James

Abstract

Greenhouse and outdoor winter testing schemes for certifying seed potato lots were compared between 1995 and 1998. Samples taken from seed lots produced during the 1995, 1996, and 1997 growing seasons were obtained from central Oregon growers and divided into two size ranges. The 2-3 ounce tubers were planted at Oceanside, California (outdoor site), and the 4-6 ounce tubers were planted at Corvallis, Oregon (greenhouse site) and rated for viral infection by certifying agencies in Idaho and Oregon, respectively. The percentage of plants visually observed to be infected with Potato Virus Y (PVY) or Potato Leafroll Virus (PLRV) was nearly identical at each testing location in 1995-1996 and 1996-1997. In 1997-1998, PVY infection was detected in the same lots at both winter testing sites; however, the percentage of infected plants varied inconsistently. Emergence averaged 73 percent at Oceanside and 96 percent at Corvallis over the three seasons the study was conducted.

Introduction

Seed potato certification agencies require seed lots to be inspected during the growing season for various pathogens, chemical injury, and other varieties. In addition, many agencies require all seed lots passing growing season inspections to be winter tested prior to sale as certified seed potatoes. Some certifying agencies winter test outdoors at southern sites such as Oceanside, California or Homestead, Florida. Other agencies winter test seedlots in greenhouses in more northern climates. Seed growers in Oregon (and perhaps other states) have wondered if the two winter testing methods are equivalent. This study was designed to evaluate samples from the same potato seedlot under two winter testing schemes.

Materials and Methods

1995-1996 Experiment
'Russet Burbank' (*Solanum tuberosum L.*), 'Ranger Russet', and 'Shepody' tubers used for the study were collected from an experiment planted at Madras in 1995 by Mary Powelson and Meghan Arbogast, Oregon State University Plant Pathology Department, to evaluate the effects of cultivar and irrigation rate on *Verticillium* infection. The 'Katahdin' seedlot used for that study was 40-50 percent infected with Potato Virus Y (PVY). The other seedlots used in that study ('Russet Burbank', 'Ranger Russet', 'Shepody', 'Viking', and 'Red Lasoda') were not initially infected with PVY but became infected with PVY during the growing season. Late blight was also present in that study during the later part of the growing season.

Tubers from each lot were collected and sorted into three groups: 1) single drop seed weighing 2-3 ounces, 2) small tubers weighing 4-6 ounces, and 3) tubers weighing over 6 ounces. The single drop seed was packaged and sent to the Idaho Crop Improvement Association for planting and evaluation in Oceanside, California. The 'Russet Burbank', 'Ranger Russet', and 'Shepody' lots were subjected to the same winter testing protocol as seedlots submitted from other seed growers except that the samples arrived too late to receive the normal dormancy breaking treatment. The 4-6 ounce tubers were submitted to the Oregon State University Seed Certification Service, and tubers were subjected to the same winter testing protocol as seedlots submitted from other seed growers. The tubers weighing over 6 ounces were discarded. The seedlots were scored by certification personnel from each respective location for the presence of PVY, potato leafroll virus (PLRV), and any "other varieties" that may have been present in the seedlot.

1996-1997 and 1997-1998 Experiments
Five 'Norkotah' seed lots from the 1996 crop were obtained from local growers and divided into two size ranges. The 2-3 ounce tubers were planted at Oceanside, California (outdoor site), in November and the 4-6 ounce tubers were planted at Corvallis, Oregon (greenhouse site), in November by certifying agencies in Idaho and Oregon, respectively. Submitted seed lots included three lots grown for seed, one commercial lot, and one lot from research trials grown at Central Oregon Agricultural Research Center (COARC). The same procedure was repeated with the 1997 crop. The commercial and COARC lots were expected to contain higher levels of PVY than the lots grown for seed. Seed certification personnel handled the submitted seedlots in the same fashion as lots received from seed growers. Once plants had emerged and grown to sufficient size, they were rated for viral and bacterial diseases by personnel from each certifying agency.

Results and Discussion

1995-1996 Experiment
Table 1 summarizes the winter test results from the 1995-1996 Oceanside and Corvallis plantings. The percent leafroll, PVY, and other varieties observed at each location were nearly identical for each of the varieties tested except 'Shepody'. Fewer PVY infected 'Shepody' plants were reported for Oceanside because the 'Shepody' lot was observed only one time on January 23, 1996. Dr. Richard G. Clarke reported concerning the 'Shepody' lot planted at Oceanside: "I'm sure that I would have scored more visually positive plants if I had read it again on the second inspection. Virtually every plant was probably PVY-infected." ELISA tests performed on 100 'Shepody' leaves at Oceanside showed 99 percent were PVY-positive.

The percentage of plants that emerged and were observed at Corvallis was greater than that observed at Oceanside. The Oceanside samples were not submitted in time to receive the customary dormancy breaking treatment. They were also planted about six weeks earlier than the Corvallis samples, and this likely resulted in a greater number of dormant seed pieces.

1996-1997 Experiment
Results of the 'Norkotah' seedlots planted at Oceanside and Corvallis during the winter of 1996-1997 are shown in Table 2. The percentage of plants visually observed to be infected with PVY was very similar for each testing location, although infection levels varied from zero to over 50 percent infected. No PLRV was observed in any of the submitted samples at either location.

Relatively poor stand counts were recorded at the Oceanside location, possibly because some plants had not broken dormancy and emerged by the first inspection date (January 26-30, 1997) when stand counts were taken.

1997-1998 Experiment
Table 3 summarizes the disease evaluations from the 1997-1998 winter tests. Better emergence was observed at the Corvallis location than at the Oceanside site. Both winter testing sites detected PVY infection in the same lots; however, the percentage of infected plants differed widely. At Oceanside, 100 plants were sampled and ELISA tested for PVY. For 'Norkotah' seed lots one through five, ELISA test results were 63, 11, 0, 80, and 0 percent PVY infected, respectively. Visual PVY symptoms were not apparently discernable in a large percentage of the infected plants.

Observed PVY infection levels may differ because in Idaho, 'Norkotah' certification is based on ELISA tests, so inspectors are less concerned with visual readings. Also, individual 'Norkotah' lots may vary in their expression of PVY symptoms. One PLRV plant (0.66 percent) was detected in 'Norkotah' lot 3 at Corvallis. No PLRV was detected in any of the submitted lots at Oceanside.

Acknowledgments

This study was supported by the Oregon Seed Potato Growers Association and a grant from the Oregon Potato Commission.

We also want to thank the Idaho Crop Improvement Association and the Oregon Seed Certification Service for their willingness to process and evaluate submitted samples without charge.

Table 1. Summary of winter test results for three potato cultivars grown at Oceanside, CA, and Corvallis, OR, 1995-1996.

Cultivar	Plant Count[1]		PLRV (%)[2]		PVY (%)[2]	
	Ocean	Corvallis	Ocean	Corvallis	Ocean	Corvallis
Russet Burbank	305/370	361/400	0.33	0.00	42.30	44.60
Ranger Russet	315/427	430/450	0.00	0.00	41.00	38.37
Shepody	247/400	398/450	0.00	0.00	89.07	98.99

[1] Number of plants observed/number of tubers submitted

[2] Percent of plants observed with visual symptoms

Table 2. Summary of winter test results for five Norkotah seedlots grown at Oceanside, CA, and Corvallis, OR, 1996-1997.

Cultivar	Plant Count[1]		PLRV (%)[2]		PVY (%)[2]	
	Ocean	Corvallis	Ocean	Corvallis	Ocean	Corvallis
Norkotah Lot 1	122/200	198/200	0.00	0.00	0.00	0.00
Norkotah Lot 2	69/200	192/194	0.00	0.00	56.52	47.40
Norkotah Lot 3	138/200	209/209	0.00	0.00	0.00	2.87
Norkotah Lot 4	122/150	203/207	0.00	0.00	0.00	0.00
Norkotah Lot 5	140/200	221/223	0.00	0.00	13.71	12.67

[1] Number of plants observed/number of tubers submitted

[2] Percent of plants observed with visual symptoms

Table 3. 1997-1998 summary of winter test results.

Cultivar	Plant Count[1]		PLRV (%)[2]		PVY (%)[2]	
	Ocean	Corvallis	Ocean	Corvallis	Ocean	Corvallis
Norkotah Lot 1	166/200	204/204	0.00	0.00	28.92	13.24
Norkotah Lot 2	185/200	152/160	0.00	0.66	0.54	6.58
Norkotah Lot 3	132/150	194/200	0.00	0.00	0.00	0.00
Norkotah Lot 4	142/200	195/200	0.00	0.00	2.11	28.21
Norkotah Lot 5	180/200	204/204	0.00	0.00	0.00	0.00

[1] Number of plants observed/number of tubers submitted

[2] Percent of plants observed with visual symptoms

EVALUATION OF SUGAR BEET VARIETIES IN CENTRAL OREGON, 1998

Marvin Butler and Neysa Farris

Abstract

Evaluation of sugar beet varieties (*Beta vulgaris*) in central Oregon was conducted in commercial fields near Culver and Prineville. Subsamples of seed for the thirty varieties were sent to the Beet Sugar Development Foundation to be evaluated for curly top resistance. The 3-row by 22 ft plots were rated for stand establishment prior to plants being hand-thinned to 7 in. apart. A single row per plot was harvested at both locations September 30, and samples evaluated by Spreckles Sugar for weight, percent sugar, and ppm Brie nitrate. The 1998 performance and 3-yr average performances are provided.

Introduction

The seed evaluation committee of the Central Oregon Beet Growers Association determines what varieties may be grown in central Oregon based on yield, sugar, and resistance to beet curly top virus. The objective of this ongoing project is to evaluate performance of sugar beet varieties in both the Prineville and Culver areas.

Methods and Materials

Thirty varieties submitted by five sugar beet seed companies were planted in commercial fields near Prineville on April 30 and near Culver on April 17 with replanting on May 8. An Earthway push planter was used for the 3-row x 22 ft plots, replicated four times in a randomized complete block design. Subsamples of seed from each variety were sent to the Beet Sugar Development Foundation at Kimberly, Idaho, to be evaluated for curly top resistance.

Four rhizomania resistant varieties were included in the evaluations at the request of the Central Oregon Beet Growers Association. The concern of the association was that the disease may have been brought into central Oregon on carrot stecklings or equipment from outside the area.

Plots were evaluated for stand establishment using a rating scale of 1 (poor) to 5 (excellent) on June 3 at Prineville and on June 11 at Culver. Both trials were hand-thinned to 7 in. between plants, with several subsequent passes through the fields to remove any remaining doubles, late germinating seed, and weeds. Varieties at both locations were evaluated September 29 for severity of powdery mildew using a rating scale of 0 (no powdery mildew) to 5 (total leaf coverage). The middle row of the three-row plots was harvested September 30 at both locations. Spreckles Sugar evaluated samples for weight, percent sugar, and ppm Brie nitrate. To determine change in percent sugar following the initial harvest, varieties approved for 1998 were resampled at both locations on October 8 and at the Culver location again on October 14 and 21.

Results and Discussion

Performance of sugar beet varieties at the Prineville location is provided in Table 1. Variety performance at the Culver location is shown in Table 2, and Table 3 provides the average performance across both locations. Varieties are listed in descending order based on total sugar.

Although some varieties were rated low on stand establishment, after thinning to 7 in. between plants, varieties generally had equal, full stands. As a result, germination ratings are not expected to influence yield.

Powdery mildew was more prevalent at Culver than in Prineville, with some statistically significant differences at Culver. However, ratings ranging from 1.8 to 3.3 in Prineville and 2.7 to 4.5 in Culver provide some trends for powdery mildew tolerance between varieties at both locations.

Average percent sugar increased between September 30 to October 8 by 0.6 percent at Culver and 0.8 percent at Prineville. Sugar increased in subsequent samples in Culver by 0.9 percent from October 8 to 14 and by 0.6 percent from October 14 to 21. The total percent sugar increase for the period from September 30 to October 21 was 2.3 percent, averaging approximately 0.1 percent per day.

Yield results for each of the four replications were evaluated for uniformity. There was good uniformity across the replications at Culver but random low yields across the replications at Prineville. As a result, the lowest yield for each variety was dropped at the Prineville location, with yield data based on the three remaining replications. Dropping the low-yielding plots at Prineville and the need to replant at Culver probably contributed to the lower yields reported for Culver.

A 3-yr average of variety performance is provided in Table 4. This information provides the basis for establishing approved varieties by the Seed Committee of the Central Oregon Sugar Beet Growers Association. The standards established by the committee include the following: 1) acceptable varieties will have a 125 percent or less curly top resistance rating compared to the stand variety USH-11, based on a 3-yr trial average, 2) varieties with two years of trial data that rate 125 percent or below could have limited planting, not to collectively exceed 10 percent of total acreage of the previous year's crop, 3) no planting of any seed varieties without the approval of the seed committee, and 4) no sales of seed prior to December 15 for the upcoming season.

Variety performances in this report are best used to compare differences between variety performance under the same conditions, rather than making a direct comparison with other field harvest data. The average performance across the two locations should be helpful in determining performance across different locations and management practices. The 3-yr rolling averages provide an additional time dimension to the evaluations, which can increase confidence in the performance data.

A commercial-sized strip trial with six varieties was conducted at the same Prineville location as the variety evaluations. Those results are available as a separate research report.

Table 1. Performance of sugar beet varieties planted in a commercial field near Prineville, OR, April 30 and harvested September 30, 1998.

Variety	Stand rate (1-5)		Powdery mildew (0-5)	Yield (ton/a)		Sugar Sep 30 (%)	Sugar Oct 8 (%)	Total sugar (lb/a)	Brie nitrate (ppm)	Curly top (% of USH-11)
Beta 8256 (Betaseed)	4.0	abc[1]	2.0	35.3	ab	17.7	18.0	12,493	34	121
Beta 5CG7010 (Betaseed)	2.0	de	2.8	36.7	a	16.6		12,209	58	139
Beta 6KG5925 (Betaseed)	3.5	abcd	2.3	33.9	abc	17.8		12,081	30	109
Oasis (Novartis)	4.5	ab	1.8	34.1	abc	16.8		11,478	31	100
H943226 (Spreckels)	3.0	bcde	2.8	34.6	ab	16.4		11,303	41	124
Beta 8757 (Betaseed)	4.5	ab	2.0	34.0	abc	16.6		11,272	52	112
Beta 8422 (Betaseed)	3.5	abcd	2.5	32.8	abc	17.1	17.4	11,232	41	100
Beta 8348 (Betaseed)	3.0	bcde	2.0	33.1	abc	16.8		11,090	52	136
SX 1404 (Seedex)	3.0	bcde	2.5	34.2	ab	16.2		11,089	31	88
HM2981 (Novartis)[2]	3.5	abcd	2.5	32.0	abc	16.7		10,626	35	100
Crystal 9800 (Crystal)	2.0	de	2.5	31.4	abc	16.9		10,626	36	109
98HX805 (Spreckels)	3.0	bcde	2.3	30.1	abc	17.6		10,586	28	148
Beta 4885 (Betaseed)	1.5	e	2.0	31.1	abc	17.0	17.4	10,581	33	139
96HX405 (Spreckels)	2.0	de	3.0	33.8	abc	15.6		10,572	44	100
PM21 (Novartis)	3.0	bcde	2.3	31.4	abc	16.5		10,371	32	97
Beta 8778 (Betaseed)	3.5	abcd	2.0	30.7	abc	16.9		10,376	39	145
Canyon (Novartis)	3.0	bcde	2.8	32.1	abc	16.2	17.1	10,369	37	94
Ranger (Seedex)	3.0	bcde	2.0	32.1	abc	16.2	16.8	10,353	31	112
97C203-04 (Spreckels)[2]	2.0	de	2.8	32.3	abc	16.0		10,349	67	127
98HX804 (Spreckels)	2.0	de	2.5	32.9	abc	15.5		10,220	42	106
Crystal 203 (Crystal)	4.0	abc	3.3	31.7	abc	16.1	17.4	10,168	55	130
Owyhee (Novartis)	4.0	abc	3.0	30.7	abc	16.9		10,150	42	91
Tomcat (Crystal)	5.0	a	2.8	30.2	abc	16.7		10,072	31	109
97C202-04 (Spreckels)[2]	3.0	bcde	2.8	31.7	abc	15.8		10,019	41	118
Chinook (Seedex)	3.5	abcd	2.8	30.5	abc	15.8	16.9	9,618	49	100
4035R (Betaseed)[2]	2.0	de	2.0	30.0	abc	15.6		9,349	73	118
H943222 (Spreckels)	3.0	bcde	2.0	30.0	abc	15.5		9,296	39	118
98HX816 (Spreckels)	2.5	cde	1.8	29.4	abc	15.7		9,230	44	97
Crystal 211 (Crystal)	3.5	abcd	3.3	26.3	c	17.2	17.5	9,024	27	115
97HX706 (Spreckels)	2.5	cde	2.8	28.4	bc	17.4		9,897	26	127
			n.s.							
Average for 1998 approved varieties						16.7	17.3			

[1] Variety results followed by the same letter(s) are not significantly different from one another

[2] Rhyzomania resistant variety funded by the Central Oregon Beet Growers Association

Table 2. Performance of sugar beet varieties planted in a commercial field near Culver, OR, May 8 and harvested September 30, 1998.

Variety	Stand rating (1-5)	Powdery mildew (0-5)	Yield (ton/a)	Sugar Sep 30 (%)	Sugar Oct 8 (%)	Sugar Oct 14 (%)	Sugar Oct 21 (%)	Total sugar (lb/a)	Brie nitrate (ppm)	Curly top (% of USH-11)
Beta 5CG7010 (Betaseed)	2.0 ab[1]	3.7 ab	33.9 ab	17.1				11,568	40	139
4035R (Betaseed)[2]	1.5 b	4.0 ab	34.5 a	16.8				11,510	34	118
Crystal 9800 (Crystal)	2.5 ab	3.5 ab	32.5 ab	16.9				10,984	27	109
97HX706 (Spreckels)	2.5 ab	3.0 ab	31.1 ab	17.6				10,938	26	127
Beta 8348 (Betaseed)	4.0 a	3.5 ab	31.9 ab	17.1				10,934	41	136
Owyhee (Novartis)	3.0 ab	3.7 ab	31.7 ab	17.2				10,900	27	91
H943226 (Spreckels)	3.0 ab	3.7 ab	32.6 ab	16.6				10,819	38	124
Ranger (Seedex)	1.5 b	3.2 ab	31.5 ab	17.1	17.7	18.8	19.5	10,792	36	112
HM2981 (Novartis)[2]	3.0 ab	2.7 b	31.9 ab	16.7				10,677	33	100
Beta 8422 (Betaseed)	1.5 b	4.0 ab	30.3 ab	17.5	18.1	19.5	20.1	10,591	33	100
98HX805 (Spreckels)	2.5 ab	3.0 ab	29.6 ab	17.5				10,351	32	148
Beta 8256 (Betaseed)	4.0 a	4.2 ab	28.6 ab	18.0	18.9	19.6	20.2	10,303	34	121
Oasis (Novartis)	2.0 ab	3.0 ab	29.4 ab	17.4				10,228	27	100
Canyon (Novartis)	2.5 ab	3.7 ab	29.1 ab	17.4	17.5	18.9	19.3	10,106	35	94
SX 1404 (Seedex)	3.5 ab	3.2 ab	28.6 ab	17.6				10,047	31	88
H943222 (Spreckels)	2.5 ab	3.7 ab	29.5 ab	16.9				9,988	29	118
96HX405 (Spreckels)	2.0 ab	4.2 ab	30.6 ab	15.8				9,792	37	100
Beta 6KG5925 (Betaseed)	3.5 ab	3.5 ab	26.9 ab	17.9				9,668	23	109
97C203-04 (Spreckels)[2]	2.0 ab	4.5 ab	29.6 ab	16.2				9,621	45	127
Crystal 211 (Crystal)	3.0 ab	4.0 ab	26.6 ab	18.0	19.1	19.6	20.2	9,589	26	115
Tomcat (Crystal)	2.5 ab	4.0 ab	27.1 ab	17.7				9,573	29	109
Chinook (Seedex)	3.0 ab	3.7 ab	28.0 ab	17.0	18.8	19.1	20.0	9,507	34	100
PM21 (Novartis)	1.5 b	3.7 ab	27.1 ab	17.5				9,478	24	97
Crystal 203 (Crystal)	3.0 ab	4.7 a	27.1 ab	17.4	18.6	19.7	19.8	9,446	25	130
Beta 8778 (Betaseed)	3.5 ab	4.0 ab	26.4 ab	17.7				9,357	29	145
Beta 8757 (Betaseed)	2.0 ab	4.0 ab	26.6 ab	17.5				9,314	30	112
98HX804 (Spreckels)	2.5 ab	4.0 ab	27.6 ab	16.8				9,307	28	106
98HX816 (Spreckels)	1.5 b	3.5 ab	28.0 ab	16.7				9,287	31	97
Beta 4885 (Betaseed)	3.5 ab	2.7 b	26.4 ab	17.8	18.6	19.2	20.0	9,251	38	139
97C202-04 (Spreckels)[2]	3.0 ab	3.5 ab	24.9 b	16.6				8,265	31	118
				n.s.						
Average for 1998 approved varieties				17.6 a	18.4 b	19.3 c	19.9 c			

[1] Variety results followed by the same letter(s) are not significantly different from one another

[2] Rhyzomania resistant variety funded by the Central Oregon Beet Growers Association

Table 3. Average performance of sugar beet varieties across the Prineville and Culver locations in central Oregon during 1998.

Variety	Stand rating	Powdery mildew	Yield	Sugar 30-Sep	Sugar 8-Oct	Sugar 14-Oct	Sugar 21-Oct	Total sugar	Brie nitrate	Curly top
	(1-5)	(0-5)	(ton/a)	(%)	(%)	(%)	(%)	(lb/a)	(ppm)	(% of USH-11)
Beta 5CG7010 (Betaseed)	2.0	3.2	35.3	16.9				11,889	49	139
Beta 8256 (Betaseed)	4.0	3.1	31.9	17.9	18.5	19.6	20.2	11,398	34	121
H943226 (Spreckels)	3.0	3.2	33.6	16.5				11,061	39	124
Beta 8348 (Betaseed)	3.5	2.8	32.5	17.0				11,012	46	136
Beta 8422 (Betaseed)	2.5	3.3	31.6	17.3	17.8	19.5	20.1	10,916	37	100
Beta 6KG5925 (Betaseed)	3.5	2.9	30.4	17.9				10,875	26	109
Oasis (Novartis)	3.3	2.4	31.7	17.1				10,853	29	100
Crystal 9800 (Crystal)	2.3	3.0	31.9	16.9				10,805	32	109
HM2981 (Novartis) [1]	3.3	2.6	32.0	16.7				10,652	34	100
Ranger (Seedex)	2.3	2.6	31.8	16.7	17.3	18.8	19.5	10,573	33	112
SX 1404 (Seedex)	3.3	2.9	31.4	16.9				10,568	31	88
Owyhee (Novartis)	3.5	3.4	31.2	17.1				10,525	35	91
98HX805 (Spreckels)	2.8	2.6	29.9	17.6				10,469	30	148
4035R (Betaseed) [1]	1.8	3.0	32.3	16.2				10,430	54	118
97HX706 (Spreckels)	2.5	2.9	29.8	17.5				10,418	26	127
Beta 8757 (Betaseed)	3.3	3.0	30.3	17.1				10,293	41	112
Canyon (Novartis)	2.8	3.2	30.6	16.8	17.3	18.9	19.3	10,238	36	94
96HX405 (Spreckels)	2.0	3.6	32.2	15.7				10,182	40	100
97C203-04 (Spreckels) [1]	2.0	3.6	31.0	16.1				9,985	56	127
PM21 (Novartis)	2.3	3.0	29.3	17.0				9,925	28	97
Beta 4885 (Betaseed)	2.5	2.4	28.8	17.4	18.0	19.2	20.0	9,916	36	139
Beta 8778 (Betaseed)	3.5	3.0	28.6	17.3				9,867	34	145
Tomcat (Crystal)	3.8	3.4	28.7	17.2				9,823	30	109
Crystal 203 (Crystal)	3.5	4.0	29.4	16.8	18.0	19.7	19.8	9,807	40	130
98HX804 (Spreckels)	2.3	3.3	30.3	16.2				9,764	35	106
H943222 (Spreckels)	2.8	2.9	29.7	16.2				9,642	34	118
Chinook (Seedex)	3.3	3.2	29.3	16.4	17.9	19.1	20.0	9,563	41	100
Crystal 211 (Crystal)	3.3	3.6	26.5	17.6	18.3	19.6	20.2	9,307	26	115
98HX816 (Spreckels)	2.0	2.6	28.7	16.2				9,259	38	97
97C202-04 (Spreckels) [1]	3.0	3.1	28.3	16.2				9,142	36	118

[1] Rhyzomania resistant variety funded by the Central Oregon Beet Growers Association

Table 4. Three-year rolling average and yearly performance for the 1999 approved varieties of sugar beets planted in central Oregon from 1996 to 1998.

Variety	Seed Company	Year	Yield (ton/a)	Sugar (%)	Total sugar (lb/a)	Curly top resistance (% of USH-11)
Beta 8220	Betaseed	**Aver.**	**36.7**	**17.1**	**12,530**	**123**
		1998	35.3	16.9	11,889	139
		1997	40.1	17.1	13,713	128
		1996	34.7	17.3	11,989	104
Beta 8757	Betaseed	**Aver.**	**33.7**	**17.3**	**11,621**	**115**
		1998	30.3	17.1	10,293	112
		1997	37.0	17.1	12,724	110
		1996	33.7	17.6	11,848	124
Beta 8422	Betaseed	**Aver.**	**32.4**	**17.5**	**11,349**	**105**
		1998	31.6	17.3	10,916	100
		1997	33.9	17.6	11,916	110
		1996	31.7	17.7	11,215	107
Ranger	Seedex	**Aver.**	**33.0**	**17.2**	**11,345**	**111**
		1998	31.8	16.7	10,573	112
		1997	34.1	17.6	11,987	108
		1996	33.2	17.3	11,477	113
Canyon	Novartis	**Aver.**	**32.5**	**17.0**	**11,071**	**93**
		1998	30.6	16.8	10,238	94
		1997	34.1	17.3	11,868	88
		1996	32.7	17.0	11,108	96
Crystal 203	Crystal Beet Seed	**Aver.**	**32.0**	**17.0**	**11,055**	**119**
		1998	29.4	16.8	9,807	130
		1997	34.2	17.4	11,948	98
		1996	33.2	17.2	11,410	130
Chinook	Seedex	**Aver.**	**32.6**	**16.9**	**11,036**	**105**
		1998	29.3	16.4	9,563	100
		1997	35.3	17.4	12,269	100
		1996	33.2	17.0	11,278	117
Crystal 211	Crystal Beet Seed	**Aver.**	**29.7**	**17.6**	**10,449**	**121**
		1998	26.5	17.6	9,307	115
		1997	31.4	17.9	11,249	123
		1996	31.2	17.3	10,792	126

Table 5. The two-year rolling averages and yearly performance for the limit sale varieties of suage beets grown in central Oregon, 1997 and 1998.

Variety	Seed Company	Year	Yield	Sugar	Total sugar	Curly top resistance
			(tons/a)	(%)	(lb/a)	(% of USH-11)
96HX405	Spreckels	**Aver.**	**33.8**	**16.9**	**11,537**	**105**
		1998	32.2	15.7	10,182	100
		1997	35.4	18.1	12,892	110
Oasis	Novartis	**Aver.**	**32.7**	**17.4**	**11,428**	**100**
		1998	31.7	17.1	10,853	100
		1997	33.8	17.7	12,003	100
Tomcat	Crystal Beet Seed	**Aver.**	**32.2**	**17.5**	**11,321**	**106**
		1998	28.7	17.2	9,823	109
		1997	35.7	17.9	12,819	103
PM21	Novartis	**Aver.**	**31.3**	**17.4**	**10,910**	**103**
		1998	29.3	17.0	9,925	97
		1997	33.4	17.8	11,894	108
SX1404	Seedex	**Aver.**	**31.6**	**16.9**	**10,662**	**98**
		1998	31.4	16.9	10,568	88
		1997	31.8	16.9	10,756	108

COMMERCIAL-SIZED SUGAR BEET VARIETY EVALUATIONS IN CENTRAL OREGON, 1998

Marvin Butler and Neysa Farris

Abstract

Replicated small-plot sugar beet (*Beta vulgaris*) variety trials have been conducted in central Oregon since 1995. During 1998, six varieties were evaluated on commercial conditions. Unreplicated plots six rows by one half mile long were commercially planted to a stand and harvested. Emergence counts were taken from May 13 to June 10. A semi-trailer was harvested from each plot October 7, and yields adjusted by the area harvested. Ranger and Beta 8256 produced near 10,300 pounds of sugar per acre.

Introduction

There has been industry interest in evaluating popular varieties under commercial conditions where plots are planted to a stand using a precision air planter. In this situation both the quality of emergence and variety characteristics after emergence are combined to determine varietal performance. The objective of this project was to evaluate the performance of some of the more commonly used varieties when planted to a stand using commercial equipment for planting and harvesting.

Methods and Materials

A commercial-sized variety evaluation was established at Prineville in the same field as the replicated small-plot variety trial. Six commonly used varieties were planted at 6-in. spacing in 6 rows by ½ mile plots with an air planter on April 30. Seed boxes were cleaned out with a shop vacuum before changing varieties.

Emergence counts were taken from 50 ft of the four center rows at each end of the field. To determine emergence over time and total stand establishment, nine counts were taken from May 13 to June 10. Plots were harvested with commercial equipment October 7. A semi-trailer load was harvested from each plot. The area per truckload was determined using a measuring wheel, and the yield adjusted to a per acre amount.

Results and Discussion

Plant emergence for four representative sampling dates and harvest data are provided in Table 1. Emergence data are based on an average of eight, 50-ft plots. Significantly less plants emerged across all nine sampling dates for Beta 4885 and Canyon, including final stand counts on June 10.

The commercial-sized plots were unreplicated, so the yield data can not be analyzed statistically. However, the trend shows Ranger and Beta 8256 with similar high yields, followed by Crystal 203 then Beta 4885. Yields then step down to Crystal 211, followed by Canyon. Although additional years of data are needed to establish confidence in these performances, these data provide a first look at side-by-side commercial-sized variety evaluations.

In the small-plot variety evaluations in the same field, Beta 8256 yielded 12,493 lb/a sugar, Beta 4885 was 10,581 lb/a, Canyon was 10,369 lb/a, Ranger was 10,353 lb/a, Crystal 203 was 10,168 lb/a, and Crystal 211 was 9,024 lb/a. The small plots are planted heavy and hand-thinned to 7 in. between plants, eliminating the effect of plant emergence. As expected, this moved Beta 4885 and Canyon up in the rankings.

Table 1. Performance of six sugar beet varieties in commercial-sized plots planted April 30 and harvested October 7 near Prineville, OR, during 1998.

Variety	Plant Emergence				Harvest		
	May 13	May 16	May 19	May 24	Yield	Sugar	Total Sugar
	(no.)	(no.)	(no.)	(no.)	(ton/a)	(%)	(lb/a)
Ranger	24 ab[1]	36 a	52 a	67 a	29.3	17.6	10,309
Beta 8256	33 a	41 a	53 a	64 a	27.4	18.8	10,286
Crystal 203	35 a	45 a	63 a	70 a	26.5	18.7	9,930
Beta 4885	12 b	17 b	29 b	39 b	26.2	18.6	9,759
Crystal 211	31 a	44 a	66 a	73 a	25.3	17.9	9,054
Canyon	9 b	15 b	22 b	28 b	23.4	18.5	8,659

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

Table 2. Performance of six sugar beet varieties in the small plot variety evaluations planted April 30 and harvested September 30, near Prineville, OR, 1998.

Variety	Stand rate	Yield	Sugar	Total Sugar
	(1-5)	(ton/a)	(%)	(lb/a)
Ranger	3.0 bcde[1]	32.1 abc	16.2	10,353
Beta 8256	4.0 abc	35.3 ab	17.0	12,493
Crystal 203	4.0 abc	31.7 abc	16.1	10,168
Beta 4885	1.5 e	31.1 abc	17.0	10,581
Crystal 211	3.5 abcd	26.3 c	17.2	9,024
Canyon	3.0 bcde	32.1 abc	16.2	10,369

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

EVALUATION OF PREEMERGENCE AND POSTEMERGENCE HERBICIDE APPLICATIONS ON SUGAR BEETS, 1998

Marvin Butler and Neysa Farris

Abstract

Evaluation of preemergence and postemergence herbicide applications on sugar beets was conducted in two commercial fields near Prineville and Culver, Oregon. The most effective control of spring germinating annual weeds was provided by preemergence application of Nortron (ethofumesate), followed by Betamix (desmedipham + phenmedipham) plus Upbeet (triflusulfron methyl) applied at the cotyledon stage and 2- to 4-leaf stages. Half rates of Nortron applied preemergence provided similar control to the full rate. Microrates of postemergence herbicides provided similar to slightly less control than standard postemergence treatments. Rescue treatments where no herbicides were applied until the 2- to 4-leaf stage provided similar control to the standard postemergence treatments.

Introduction

This is the fourth year of both commercial sugar beet production and herbicide trials conducted in the Prineville and Culver areas of central Oregon. This project focused on comparing standard and half-rates of Nortron and Pyramin (pyrazon) applied preemergence, comparing applications of Betamix plus Upbeet and Betamix Progress (desmedipham + ethofumesate + phenmedipham) plus Upbeet, evaluating two microrate postemergence applications, and two rescue treatments where no herbicides were applied until the 2- to 4-leaf stage.

Methods and Materials

Treatments applied preemergence were made April 22 at Culver and May 1 at Prineville. Treatments applied postemergence were made at the cotyledon stage May 6 at Culver and May 18 in Prineville. The second postemergence treatments were made at the two-leaf stage May 15 at Culver and May 27 at the four-leaf stage at Prineville. A third postemergence application was made at the Prineville location June 5.

Treatments were applied with a CO_2-pressurized, hand-held boom sprayer at 40 psi and 20-gal/a water. Plots 10 ft x 22 ft were replicated four times in a randomized complete block design. Treatments at the Culver location were evaluated for percent control of common lambsquarters, henbit, hairy nightshade and kochia June 24 and for crop injury and overall weed control on July 7. Evaluations of treatments at the Prineville location were made June 19 and July 7 for redroot pigweed, hairy nightshade, kochia, and common lambsquarters.

Results and Discussion

Results from the Prineville location is provided in Table 1 and from the Culver location in Table 2. Nortron at the full rate followed by Betamix plus Upbeet provided 97-98 percent overall weed control, Pyramin gave 87-91 percent overall weed control, and a combination of the two provided 88-95 percent overall weed control. A reduction in Nortron applied preemergence from 3 pt/a to 1.5 pt/a reduced overall weed control 3 percent at each of the two locations. Reducing the rate of Pyramin from 4.6 lb/a to 2 lb/a reduced overall weed control by 6 percent (Culver) and 9 percent (Prineville). All treatments with both preemergence and postemergence applications provided greater weed control than postemergence treatments alone.

Postemergence application of Betamix plus Upbeet and Betamix Progress plus Upbeet provided similar weed control. In previous years Betamix plus Upbeet has out-performed Betamix Progress plus Upbeet. Microrate applications of Betamix at 0.33 oz/a plus Upbeet at 0.25-0.33 oz/a plus Stinger at 1.3 fl oz/a plus methylated seed oil (MSO) at 1.5 % v/v provided similar to slightly less weed control than standard postemergence applications. Rescue treatments not applied until the second postemergence application included Betamix at 2 pt/a plus Upbeet at 0.5 oz/a plus Stinger at 4 oz/a plus MSO at 1.5 % v/v, with and without UN32 at 4 % v/v. The performance was similar to the standard postemergence herbicide treatments.

Since similar weed control was provided by preemergence applications of Nortron and Pyramin at two-thirds rates in 1997 and half rates in 1998, reducing the rate of these applications could be cost effective while still providing adequate weed control. However, eliminating these preemergence treatments altogether could significantly increase the risk of weed problems unless there were no problems associated with replanting or timely application of postemergence herbicides. In general, treatments that included Nortron applied preemergence provided greater kochia control than those without.

Table 1. Effect of herbicide application on sugar beets near Prineville, OR, evaluated June 19, 1998.

		Application (product/a)				Percent Weed Control				
		Preemergence	Cotyledon	Two-leaf	Four-leaf	Nightshade	Pigweed	Kochia	Lambsquarters	Average
1.	Nortron	1.5 pt				98.7 a	99.5 a	89.5 a	93.7 a	95.3
	Betamix		1.5 pt	2.0 pt						
	Upbeet		0.5 pt	0.5 oz						
2.	Nortron	3 pt				98.5 a	100 a	92.5 a	98.3 a	97.3
	Betamix		1.5 pt	2.0 pt						
	Upbeet		0.5 oz	0.5 oz						
3.	Pyramin	2 lb				98.5 a	94 a	55 ab	81.3 a	82.2
	Betamix		1.5 pt	2.0 pt						
	Upbeet		0.5 oz	0.5 oz						
4.	Pyramin	4.6 lb				99.3 a	98.7 a	52 ab	99 a	87.3
	Betamix		1.5 pt	2.0 pt						
	Upbeet		0.5 oz	0.5 oz						
5.	Nortron	1 pt				98.7 a	100 a	57.5 ab	96.3 a	88.1
	Pyramin	0.8 lb								
	Betamix		1.5 pt	2.0 pt						
	Upbeet		0.5 oz	0.5 oz						
6.	Betamix Progress		1.2 pt	1.7 pt		97.7 a	96.7 a	72.5 ab	62 a	82.2
7.	Betamix Progress		1.2 pt	1.7 pt		95.7 a	95.7 a	58.7 ab	81.3 a	82.8
	Upbeet		0.5 oz	0.5 oz						
8.	Betamix		1.5 pt	2.0 pt		93.5 a	52.5 b	42.5 ab	79.5 a	67
9.	Betamix		1.5 pt	2.0 pt		94.3 a	92.5 a	54.5 ab	59.5 a	75.2
	Upbeet		0.5 oz	0.5 oz						
10.	Betamix		0.5 pt	0.5 pt	0.5 pt	94 a	85 ab	37.5 ab	88.5 a	76.3
	Upbeet		0.33 oz	0.33 oz	0.33 oz					
	Stinger		1.33 fl oz	1.33 fl oz	1.33 fl oz					
	MSO		1.5 %	1.5 %	1.5 %					
11.	Betamix		0.5 pt	.5 pt	.5 pt	93 a	79.5 ab	41.3 ab	70.7 a	71.1
	Upbeet		0.25 oz	0.25 oz	0.25 oz					
	Stinger		1.33 fl oz	1.33 fl oz	1.33 fl oz					
	MSO		1.5 %	1.5 %	1.5 %					
12.	Betamix			2.0 pt	2.0 pt	98.3 a	95 a	46.3 ab	86.3 a	81.5
	Upbeet			0.5 oz	0.5 oz					
	Stinger			4 oz						
	MSO			1.5 %	1.5 %					
13.	Betamix			2.0 pt	2.0 pt	97.3 a	55.7 ab	71.3 ab	88.7 a	78.3
	Upbeet			0.5 oz	0.5 oz					
	Stinger			4 oz						
	MSO			1.5 %	1.5 %					
	UN32			4 %	4 %					
14.	Untreated	---	---	---	---	0 b	0 c	0 b	0 b	0

Table 2. Effect of herbicide application on sugar beets near Culver, OR, evaluated June 24, 1998.

	Treatments	Application (product/a)			Percent Weed Control				
		Preemergence	Cotyledon	Two-leaf	Nightshade	Henbit	Kochia	Lambsquarters	Average
1.	Nortron	1.5 pt			94 a	98.3 a	92.5 a	95 a	94.9
	Betamix		1.5 pt	2.0 pt					
	Upbeet		0.5 pt	0.5 oz					
2.	Nortron	3 pt			100 a	99.5 a	91.3 a	100 a	97.7
	Betamix		1.5 pt	2.0 pt					
	Upbeet		0.5 oz	0.5 oz					
3.	Pyramin	2 lb			92.5 a	75 a	67.5 a	97.5 a	83.1
	Betamix		1.5 pt	2.0 pt					
	Upbeet		0.5 oz	0.5 oz					
4.	Pyramin	4.6 lb			99 a	99 a	66.3 a	100 a	91.1
	Betamix		1.5 pt	2.0 pt					
	Upbeet		0.5 oz	0.5 oz					
5.	Nortron	1 pt			95 a	98.7 a	91.3 a	96.3 a	95.3
	Pyramin	0.8 lb							
	Betamix		1.5 pt	2.0 pt					
	Upbeet		0.5 oz	0.5 oz					
6.	Betamix Progress		1.2 pt	1.7 pt	92.5 a	95.7 a	60 a	100 a	87.1
	Upbeet		0.5 oz	0.5 oz					
7.	Betamix		1.5 pt	2.0 pt	81.3 a	97.3 a	81.3 a	100 a	90
	Upbeet		0.5 oz	0.5 oz					
8.	Betamix		0.5 pt	0.5 pt	86.3 a	75 a	82.5 a	91.3 a	83.8
	Upbeet		0.33 oz	0.33 oz					
	Stinger		1.33 fl oz	1.33 fl oz					
	MSO		1.5 %	1.5 %					
9.	Betamix		0.5 pt	0.5 pt	92.5 a	72.5 a	77.5 a	91.3 a	83.4
	Upbeet		0.25 oz	0.25 oz					
	Stinger		1.33 fl oz	1.33 fl oz					
	MSO		1.5 %	1.5 %					
10.	Betamix			2.0 pt	85 a	62.5 a	71.3 a	98.7 a	79.4
	Upbeet			0.5 oz					
	Stinger			4 oz					
	MSO			1.5 %					
11.	Betamix			2.0 pt	90.7 a	80 a	73.7 a	97.5 a	85.5
	Upbeet			0.5 oz					
	Stinger			4 oz					
	MSO			1.5 %					
	UN32			4 %					
12.	Untreated	---	----	----	0 b	0 b	0 b	0 b	0

PRELIMINARY REPORT ON USE OF A SPAD CHLOROPHYLL METER FOR EARLY DETECTION OF PLANT NITROGEN STATUS IN SUGARBEET

Peter Sexton

Abstract

In sugarbeets, petiole nitrate content is assayed through the season as a tool for indicating plant N status. This requires sending the petioles off for laboratory analysis. An in-field assay of plant N status would be more timely and perhaps less expensive than the petiole nitrate assay. The objective of this work is to determine the suitability of a hand held chlorophyll meter (SPAD meter) for determining sugarbeet N status. This is a work in progress, but from initial results it appears that the SPAD meter will not provide an early indication of N deficiency symptoms.

Introduction

This is a work in progress so only preliminary results will be reported herein. Excess N applied to the sugarbeet crop results in excessive top growth, decreased sugar percentage, and increased levels of impurities in the beet (Akeson et al., 1979; Ulrich and Hills, 1990; Winter, 1990). For this reason growers often limit N applied at planting and then monitor petiole nitrate through the season to determine whether their crop would benefit from additional applications of N. Petiole nitrate is a useful criteria for determining N status of sugarbeets (Ulrich and Hills, 1990), but there is a lag time between when samples are taken and when results are reported from commercial laboratories. Use of an in-field analysis providing immediate results would allow growers to make more timely decisions regarding whether to apply extra N or not. The SPAD chlorophyll meters give immediate results and have been used successfully for determining N status of corn (*Zea mays*) (Varvel et al., 1997) and rice (*Oryza sativa*) (Ladha et al., 1998) crops. It has also been tried and found not well correlated with N in mint (Mitchell et al., 1995) and tobacco (MacKown and Sutton, 1998). Near-infrared (NIR) spectrometry has been used for in-field determination of N status in cotton (Saranga et al., 1998). To our knowledge, there are no reports in the literature on the suitability of using a SPAD meter, nor NIR analysis, for determining N status of the sugarbeet crop. The objective of this work was to test these two methods against the standard of petiole nitrate analysis.

Materials and Methods

Three varieties of sugarbeet (Beta 8256, HM Canyon, and Crystal 203) were grown under 6 levels of applied N (0, 60, 120, 180, 240, and 300 lb N per acre) in a split plot design with N treatment being the main plot and variety as the subplot. Initial soil N was 58 lb per acre measured to a 2-ft depth. All plots were replicated four times. Subplots consisted of 6 rows, 6.1 m in length (20'), spaced 0.61 m apart (2'). The trial was planted on 6 June 1998 with a seeding rate of 8.2 plants m^{-2} (5 plants per foot of row). The stand was thinned to 0.18 m (7") plant to plant spacing on 25 June. Weeds and insects were controlled with agrochemicals.

Relative absorbance measurements using a SPAD-502 chlorophyll meter (Minolta Camera Co., Japan) was taken on 10 leaves per plot at 47, 54, 61, 71, 74, 81, 94, 102, and 109 days after planting (DAP) for 'Beta 8256'. The other two cultivars were sampled on 47, 61, 74, and 109 DAP. Measurements were taken by removing the fifth or sixth leaf from 10 plants chosen at random from the plot. The leaves and petioles were placed in a paper bag in the shade immediately and within 15 minutes were placed within a refrigerator at 5°C. SPAD readings were taken on opposite sides of the leaf (two measurements per leaf) approximately one-third of the way down from the tip and about 3 cm in from the edge. The leaf blade was stripped from the petiole and each were dried separately at 70°C and ground for future analysis.

Plots were harvested on 15 October 1998. Bordered two row samples, 4.4 m long (14'6") were dug and topped for each plot. Plants were topped and fresh weight of tops and beets were determined in the field. Five beets were taken at random for sugar analysis complements of Spreckles Sugar Company. Sugar yield was calculated as the product of fresh weight per unit area and sugar percentage. Two beets from each plot were quartered and one-quarter from each were weighed, chopped, and dried at 90°C for future analysis.

If resources permit, we will analyze the petiole samples for nitrate and carbohydrate. Following this the samples will be submitted for NIR (near-infrared) analysis. At that point a comparison of SPAD reading, petiole nitrate, and NIR analysis will be possible.

Results and Discussion

Only preliminary results will be reported as sample analysis is ongoing. At this point, it appears that the SPAD meter will probably not provide an early indication of N deficiency. Over the course of the season SPAD readings declined as N deficiency symptoms began to develop in treatments receiving little N (Fig. 1). Nitrogen deficiency symptoms were discernable with the naked eye by 50 DAP, which was about when the SPAD meter began to show significant differences. So the SPAD meter did not provide advanced indication of N deficiency, although it did give a quantitative estimate of deficiency.

Top growth responded to added N, but beet and sugar yield did not (Fig. 2). Because of the late planting date, this should not be taken to mean that N fertilization of beets is not profitable in central Oregon. This trial was not conducted to answer that question. Earlier planting would have given the plants more time to grow and probably resulted in a greater response to N. What this data does show is that N deficiency occurring late in the season does not affect yield. Ulrich and Hills (1990) recommend that N fertility be managed so that the plants are N deficient during the last 4 to 10 weeks of growth in order to retard top growth and enhance sugar percentage.

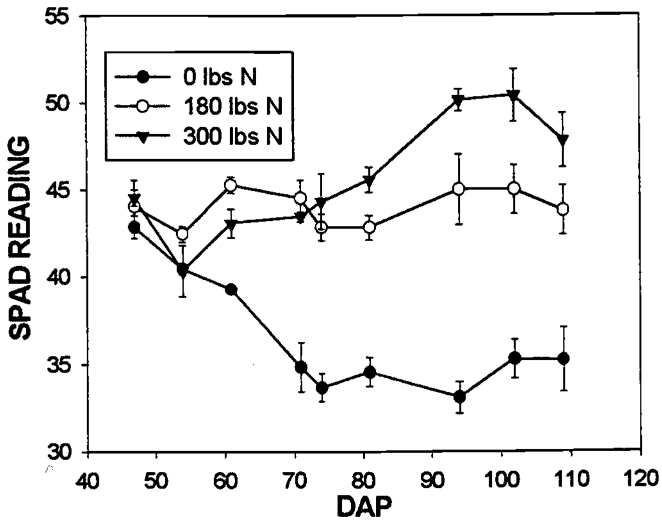

Figure 1. SPAD meter readings taken over the course of the season for 'Beta 8256' sugarbeet. Deficiency symptoms were discernable with the naked eye by 50 DAP in the zero added N treatment.

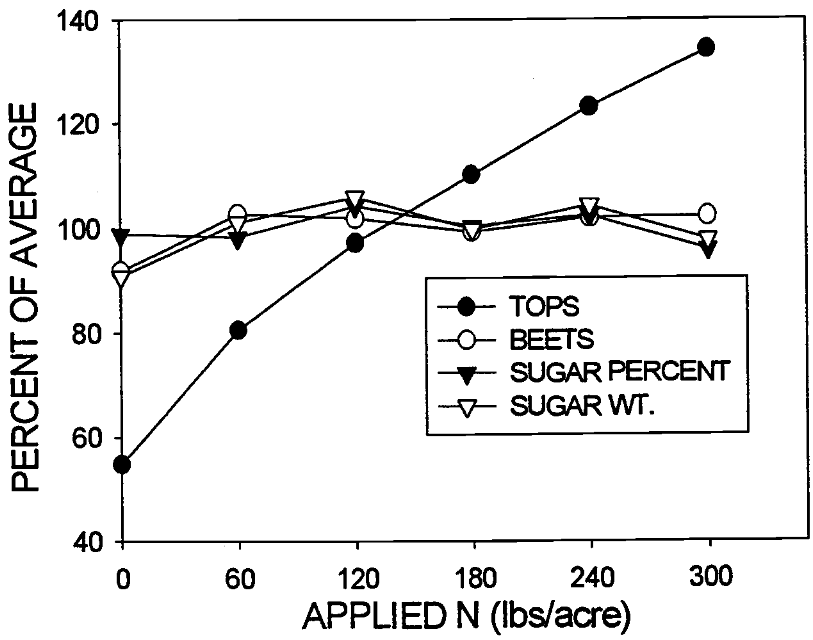

Figure 2. Response of top, beet, and sugar yields, and sugar percentage of beets to applied N in a late-planted N fertility trial conducted at Madras. For each variable, the data presented are means of three cultivars expressed as a percentage of the grand mean. This was done so that all the variables could be plotted in one graph.

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EVALUATION OF HERBICIDES FOR CONTROL OF ROUGH BLUEGRASS AND INJURY TO KENTUCKY BLUEGRASS, 1998

Marvin Butler, Les Gilmore, Al Short, and Neysa Farris

Abstract

This is the fifth year of a multiyear study to evaluate herbicides for control of rough bluegrass (*Poa trivialis*) and injury to Kentucky bluegrass (*Poa pratensis*). Herbicides were applied to two rough bluegrass varieties and one Kentucky bluegrass field. The most effective treatment was fall-applied Sinbar (terbacil) plus Karmex (diuron) followed by a spring application of Beacon (primisulfuron-methyl) in March or April. A single fall application of Sinbar plus Karmex provided better control of rough bluegrass than Beacon plus Karmex. There were no consistent differences between Beacon applied in March or April, or as a slit application in March and April. Milestone does not appear to be an effective tool for control of rough bluegrass in Kentucky bluegrass.

Introduction

Research to evaluate herbicides for control of rough bluegrass in Kentucky bluegrass was begun in 1993. A wide variety of herbicide combinations were screened early in the process. In subsequent years, the objective has been to evaluate treatments with the most promise, and to fine-tune application rates and timings of the most effective herbicide combinations. In addition, several new herbicides have been evaluated as they have become available.

The objectives of the research this year was to determining the best timing and the rate of a spring application of Beacon following a fall application of Sinbar plus Karmex or Beacon plus Karmex. Timings evaluated were a single treatment in March or April, or a split application made in both March and April. A new herbicide, Milestone, was included in the evaluation at two application rates.

Methods and Materials

Plots were placed in three commercial grass seed fields to evaluate control of 'Cypress' and 'Saber II' rough bluegrass and injury to 'Crest' Kentucky bluegrass. Treatments included a November 4 application of Sinbar at 0.5 lb/a plus Karmex at 2 lb/a or Beacon at 0.38 oz/a plus Karmex at 2 lb/a alone, or followed by a spring application of Beacon. Beacon was applied either March 30, April 24, or both at 0.76 oz/a following Sinbar plus Karmex or at 0.38 oz/a following Beacon plus Karmex. New product evaluations included a November 4 application of Milestone at 2 oz/a and 4 oz/a.

Treatments were applied with a CO_2 pressurized, hand-held, boom sprayer at 40 psi and 20 gal/a water. Plots 10 ft x 20 ft were replicated three times in a randomized complete block design. A nonionic surfactant was applied at 1 qt/100 gal in combination with all herbicides.

A visual evaluation for the percentage of reduction in biomass to established plants was conducted March 24 on rough bluegrass. Preharvest evaluations of the percentage of reduction in seed set were conducted on both rough bluegrass and Kentucky bluegrass June 4.

Results and Discussion

Data on the effect of herbicide applications for control of rough bluegrass is provided in Table 1, and data on the reduction in yield to Kentucky bluegrass is shown in Table 2. In comparing fall applications alone, Sinbar plus Karmex provided better control of rough bluegrass than Beacon plus Karmex. Beacon applied in either March or April provided greater control of rough bluegrass following the fall application of Sinbar plus Karmex than following Beacon plus Karmex. However, the least injury to Kentucky bluegrass was with Beacon applied in March following Beacon plus Karmex in November. There were no consistent differences between March and April applications of Beacon. Beacon applied as a split application in March and April did not increase control of rough bluegrass, but may have caused slightly less injury to Kentucky bluegrass.

Milestone at 4 oz/a compared to 2 oz/a provided more control of rough bluegrass but caused more injury to Kentucky bluegrass. Early plant injury to rough bluegrass declined later in the season causing less reduction in seed set.

The most effective treatment for control of rough bluegrass continues to be a fall application of Sinbar at 0.5 lb/a plus Karmex at 2 lb/a followed by a Beacon application in late March or early April.

Table 1. Effect of herbicides applied November 4, 1997 alone or followed by Beacon applied March 30 and/or April 24 to rough bluegrass. Crop reduction was evaluated March 24, 1998 and yield reduction was evaluated June 4, 1998.

	Treatments	Rate	Crop Reduction[1]				Yield Reduction[2]		
			Fuzzy		Saber II		Fuzzy		Saber II
		product/a	--------------------percent----------------						
1.	Sinbar	0.5 lb	83	a[3]	50	ab	60	ab	30
	+Karmex	2.0 lb							
2.	Beacon	0.76 oz	60	a	47	ab	45	b	10
	+Karmex	2.0 lb							
3.	Sinbar	0.5 lb	87	a	47	ab	97	a	60
	+Karmex	2.0 lb							
	Beacon (Mar)	0.76 oz							
4.	Sinbar	0.5 lb	87	a	60	ab	93	a	37
	+Karmex	2.0 lb							
	Beacon (Apr)	0.76 oz							
5.	Sinbar	0.5 lb	82	a	57	ab	98	a	33
	+Karmex	2.0 lb							
	Beacon (Mar)	0.38 oz							
	Beacon (Apr)	0.38 oz							
6.	Beacon	0.38 oz	33	b	32	ab	55	ab	33
	+Karmex	2.0 lb							
	Beacon (Mar)	0.38 oz							
7.	Beacon	0.38 oz	22	bc	15	b	65	ab	3
	+Karmex	2.0 lb							
	Beacon (Apr)	0.38 oz							
8.	Milestone	2.0 oz	15	bc	12	b	35	bc	20
9.	Milestone	4.0 oz	85	a	80	a	35	bc	40
10.	Untreated	---	0	c	0	b	0	c	0
									NS

[1]Data based on visual evaluation of reduction in biomass.

[2]Data based on visual evaluation of reduction in seed set.

[3]Mean separation with Student-Newman-Keuls ($P \leq 0.05$).

Table 2. Effect of herbicides applied November 4, 1997 alone or followed by Beacon applied March 30 and/or April 24 to Kentucky bluegrass. Yield reduction was evaluated June 4, 1998.

	Treatments	Rate	Yield Reduction[1] Crest Kentucky bluegrass
		product/a	-------percent------
1.	Sinbar	0.5 lb	53 a[2]
	+Karmex	2.0 lb	
2.	Beacon	0.76 oz	57 a
	+Karmex	2.0 lb	
3.	Sinbar	0.5 lb	60 a
	+Karmex	2.0 lb	
	Beacon (Mar)	0.76 oz	
4.	Sinbar	0.5 lb	53 a
	+Karmex	2.0 lb	
	Beacon (Apr)	0.76 oz	
5.	Sinbar	0.5 lb	43 a
	+Karmex	2.0 lb	
	Beacon (Mar)	0.38 oz	
	Beacon (Apr)	0.38 oz	
6.	Beacon	0.38 oz	13 b
	+Karmex	2.0 lb	
	Beacon (Mar)	0.38 oz	
7.	Beacon	0.38 oz	50 a
	+Karmex	2.0 lb	
	Beacon (Apr)	0.38 oz	
8.	Milestone	2.0 oz	33 a
9.	Milestone	4.0 oz	40 a
10.	Untreated	---	0 b

[1]Data based on visual evaluation of reduction in seed set.
[2]Mean separation with Student-Newman-Keuls ($P \leq 0.05$).

EVALUATION OF FUNGICIDES FOR POWDERY MILDEW AND STRIPE RUST CONTROL IN KENTUCKY BLUEGRASS IN CENTRAL OREGON, 1998

Marvin Butler, Neysa Farris and Ron Burr

Abstract

Fungicides were evaluated in replicated plots for powdery mildew (*Erysiphe graminis*) and stripe rust (*Puccinia striifarmis*) control in Kentucky bluegrass (*Poa pratensis*) during the spring of 1998. Two trials for powdery mildew control were conducted with different sets up fungicide treatments, and one trial for rust control.
Tilt with Microthiol, or alone, and Bayleton provided the best control of powdery mildew in the early trial, with Rally providing the best control in the late evaluation. BAS 500 and Stratego provided the best stripe rust control.

Introduction

Kentucky bluegrass (*Poa pratensis*) remains a valuable component of the agricultural industry in central Oregon despite acreage declined to 5,400 acres in 1998 as acres of rough bluegrass increased to 5,300. The level of powdery mildew and stripe rust infection is dependent on weather conditions in the spring. Powdery mildew (*Erysiphe graminis*) typically appeared earlier in the spring when temperatures are between 60 and 70°F under humid conditions. The appearance of stripe rust (*Puccinia striiformis*) usually followed powdery mildew during late spring when temperatures had increased and free moisture was available.

Several new fungicides are expected to be available which may have activity on powdery mildew and stripe rust. The objective of this research is to evaluate these new products against those historically used on Kentucky bluegrass in central Oregon.

Methods and Materials

Plots 10 ft x 22 ft were replicated four times in a randomized complete block design. Treatments were applied with a CO_2-pressurized, hand-held boom sprayer at 40 psi and 20 gal/a water. TwinJet 8002 nozzles were used to improve fungicide coverage. Silwet at 1 qt/100 gal was applied with all treatments. Plots were evaluated pre- and post-treatment using a rating scale of 0 (no symptoms) to 5 (total coverage).

Two fungicide evaluations for powdery mildew control in Kentucky bluegrass were conducted in a commercial 'Geronimo' field near Madras, Oregon. Tilt (propiconazole) at 4 fl oz/a, Tilt at 4 fl oz/a plus Microthiol (sulfur) at 2 lb/a, Folicur (tebuconazole) at 4 fl oz/a, Bayleton (triadimefon) at 4 fl oz/a, Quadris (azoxystrobin) at 6 and 12 fl oz/a, and Microthiol at 5 lb/a were applied to the first set of plots April 17, 1998. Plots were evaluated before treatment April 16, and aftertreatments on April 28, May 5, and May 14.

The second set of plots for powder mildew control were conducted in the same commercial field adjacent to the first set of plots. Fungicide applied May 22 were Tilt at 4 fl oz/a, Stratego (combination of Flint and Tilt) at 10 fl oz/a, Folicur at 4 fl oz/a, Quadris at 12 fl oz/a, Flint (experimental) at 2.75 oz/a and BAS 500 00 F (experimental) at 9 fl oz/a. Plots were evaluated before treatment May 21 and after treatments on June 11, June 17, and June 25.

Fungicide evaluations for stripe rust were conducted in a 'Sodnet' Kentucky bluegrass field at the Central Oregon Agricultural Research Center, Madras location. Fungicides were applied on May 28. Treatments were the same as the second powdery mildew trial. Plots were evaluated before treatment May 28 and after treatments on June 9, June 16, and June 25.

Results and Discussion

The effect of fungicides on the level of powdery mildew varied between the early trial (Table 1) and the later trial (Table 2). In the first trial Tilt in combination with Microthiol provided the best control, followed by Tilt alone, Bayleton, Microthiol, and Folicur. Quadris did not reduce powdery mildew at either rate.

In the second powdery mildew trial the best control was provided by Rally, followed by Flint from Norvartis. Treatments of the other fungicides including Stratego (a combination Flint and Tilt) did not significantly reduce the level of disease compared to the untreated plots. At the time of the second trial, disease levels were quite advanced and plant growth was substantial, making good fungicide coverage more difficult.

The effect of fungicides on the level of stripe rust is provided in Table 3. Stripe rust was significantly reduced by the numbered compound BAS 500 00F, Stratego, Tilt, and Flint. Fungicides were applied when disease levels were already high, rather than as a preventive treatment.

Table 1. Severity of powdery mildew on Kentucky bluegrass near Madras, Oregon following fungicide application April 17, 1998.

Treatments[2]	Rate	Powdery Mildew[1]						
		Pre-trt	Post-trt		Post-trt		Post-trt	
	product/a	4-16	4-28		5-5		5-14	
Tilt	4 oz	2.9	1.3	c[3]	0.8	cd	1.1	b
Tilt	4 oz							
+ Microthiol	2 lb	2.6	1.6	c	0.6	d	0.7	c
Folicur	4 oz	2.6	1.7	bc	1.3	bc	1.4	b
Bayleton	4 oz	2.3	1.3	c	0.7	d	1.2	b
Quadris	6 oz	2.6	2.4	ab	2.6	a	2.6	a
Quadris	12 oz	2.7	2.3	ab	2.4	a	2.4	a
Microthiol	5 lb	2.7	1.8	bc	1.6	b	1.3	b
Untreated	---	2.6	2.8	a	2.8	a	2.5	a
		NS						

[1]Rating scale was 0-5, with 0 = no mildew and 5 = the leaves completely covered.
[2]Treatments applied with 1 qt/100 gal Silwet.
[3]Mean separation with Student-Newman-Keuls Test at $P \leq 0.05$.

Table 2. Severity of powdery mildew on Kentucky bluegrass near Madras, Oregon following fungicide application May 22, 1998.

Treatments[2]	Rate	Powdery Mildew[1]					
		Pre-trt	Post-trt	Post-trt		Post-trt	
	product/a	5-21	6-11	6-17		6-25	
Tilt	4 oz	2.5	2.4	1.9	ab[3]	2.3	ab
Stratego	10 oz	2.2	2.2	2.4	a	2.2	ab
Flint	2.75 oz	2.3	2.5	2.5	a	2	b
Folicur	4 oz	2.2	2.1	2.5	a	2.1	ab
Quadris	12 oz	2.3	2.6	2.5	a	2.4	ab
BAS 500 00F	9 oz	2.4	2.6	2.5	a	2.5	a
Rally	6 oz	2.2	2.2	1.7	b	1.6	c
Untreated	---	2.2	2.5	2.5	a	2.5	a
		NS	NS				

[1]Rating scale was 0-5, with 0 = no mildew and 5 = the leaves completely covered.
[2]Treatments applied with 1 qt/100 gal Silwet.
[3]Mean separation with Student-Newman-Keuls Test at $P \leq 0.05$.

Table 3. Severity of stripe rust on Kentucky bluegrass near Madras, Oregon following fungicide application May 28, 1998.

Treatments[2]	Rate	Stripe Rust[1]					
		Pre-trt		Post-trt	Post-trt	Post-trt	
	product/a	5-28		6-9	6-16	6-25	
Tilt	4 oz	2.6	ab[3]	2.7	2.4	1.7	bc
Stratego	10 oz	3.2	a	3.0	2.2	1.5	c
Flint	2.75 oz	2.8	ab	3.0	2.5	1.7	bc
Folicur	4 oz	2.9	ab	3.0	2.7	2.1	ab
Quadris	12 oz	2.6	ab	2.9	2.5	1.8	abc
BAS 500 00F	9 oz	3.0	ab	3.0	2.4	1.5	c
Rally	6 oz	2.9	ab	3.2	2.5	2.1	ab
Untreated	---	2.5	b	3.2	2.7	2.3	a
				NS	NS		

[1]Rating scale was 0-5, with 0 = no rust and 5 = the leaves completely covered.
[2]Treatments applied with 1 qt/100 gal Silwet.
[3]Mean separation with Student-Newman-Keuls Test at $P \leq 0.05$.

EVALUATION OF FUNGICIDES FOR CONTROL OF ERGOT IN KENTUCKY BLUEGRASS, 1997

Marvin Butler, Steve N. Alderman, and Fred Crowe

Abstract

During the 1997 season, fungicides evaluated for control of ergot in Kentucky bluegrass (*Poa pratensis*)included Tilt (propiconazole), Folicur (tebuconazole), Quadris (azoxystrobin), and Orthorix, along with surfactants Penaturf, Sylgard 309, and crop oil concentrate (COC). The Powell Butte location was infested with *Claviceps purpurea* at 1 sclerotia/ft^2 on December 20, 1996. The level of ergot infection at Henderson Flat was very low. At the Powell Butte location, where inoculum was high, a double application of Tilt at 8 oz/a applied at the initiation of anthesis and 10 days later was the most effective. High rates of applied Penaturf and Sylgard 309 appeared to reduce seed weight.

Introduction

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

Previous fungicide evaluations in central Oregon from 1992 to 1996 indicate excellent ergot control with Punch, for which there are no plans for registration in the United States. Suppression of ergot has been provided by Tilt and Folicur. As a result of this research, and similar fungicide evaluations by William Johnston at Washington State University, ergot suppression was added to the Tilt label in 1995 through a Special Local Need 24(c) registration. Folicur was also recently registered for use on grass seed.

Methods and Materials

During the 1997 season, fungicides were evaluated for control of ergot by trialsconducted in a commercial field of 'Georgetown' Kentucky bluegrass at Henderson Flat, Culver, Oregon, and in a 'Coventry' Kentucky bluegrass plot at the Central Oregon Agricultural Research Center, Powell Butte location. The Powell Butte location was infested with ergot at 1 sclerotia/ft^2 on December 20, 1996. Tilt, Folicur, Quadris, and Orthorix were evaluated during the 1997 season. Surfactants Penaturf, Sylgard 309, and crop oil concentration (COC) were also evaluated in combination with fungicide treatments.

Plots 10 ft x 20 ft were replicated four times in a randomized complete block design. Materials were applied using a 9-ft CO_2 pressurized boom sprayer with 8003 TwinJet nozzles at 40 psi and 30 gal/a water. Sylgard 309 at 16 fl oz/100 gal and R-56 at 1 pt/100 gal were applied in combination with all fungicides, but not when Penaturf, Sylgard 309, or Orthorix were applied alone. COC was applied at 1 percent v/v with single and double applications of Quadris, and a double application of Tilt. Treatments were applied at Henderson Flat on June 2 and on June 13, and at Powell Butte on May 30 and on June 9, 1997. The first treatments were applied at the initiation of anthesis at both locations. Plots in the commercial field at Henderson Flat were covered with 4 mil polyethylene to prevent contamination during aerial application of Tilt on June 6 and on June 20, 1997.

One hundred panicle samples were randomly collected from each plot on July 3 at Henderson Flat and on July 11 at Powell Butte. Number of panicles with sclerotia, total sclerotia per sample, panicles with honeydew, seed weight, and percentage of germination were determined per sample for each plot.

Results and Discussion

The level of ergot infection at Henderson Flat was extremely low, with only one sclerotia found in the 400 panicles from the untreated plots. Counting sclerotia in the treated plots was discontinued, but seed cleaning, seed weight, and percentage of germination were determined.

At the Powell Butte location which was infested with ergot sclerotia, disease levels averaged 741 sclerotia per 100 panicle samples in the untreated plots (Table 1). All fungicide treatments significantly reduced sclerotia per sample, with the best treatment being two applications of Tilt at 8 oz/a. Penaturf, Orthorix and COC in combination with the 8 oz/a Tilt treatments did not significantly alter its performance.

Tilt applied as a single 8 oz/a application or as a double 4 oz/a application was not significantly different, but the trend was for slightly better control with the double application. The trend also indicated that Tilt at 8 oz/a followed by a Penaturf treatment provided better control than Tilt followed by Sylgard 309, which was better than Tilt applied alone. The performance of the new fungicide Quadris at 12 oz/a was similar to Folicur at 8 oz/a when applied as a double treatment.

The presence of honeydew followed a similar trend to the number of sclerotia per sample. There was no consistent difference between treatments in weight per sample or 1,000 seed weight across both locations. However, a reduction in sample weight has been observed following application of Penaturf at high rates in evaluations during previous years. Percentage of germination was not affected by treatments at Powell Butte. At Henderson Flat there was a statistical difference between a single application of Tilt at 8 oz/a at 69 percent and a double application of Folicur at 8 oz/a at 87 percent. It would appear that this difference is an artifact rather than a real difference because a double application of Tilt at 8 oz had a germination of 83 percent.

Table 1. Evaluation of fungicides applied for ergot control to 'Coventry' Kentucky bluegrass at the COARC Powell Butte site in central Oregon on May 30 and June 9, 1997.

Fungicide Treatment	Rate May 30	Rate June 9	Panicles with sclerotia	Total sclerotia per sample	Total honeydew per sample	Weight per sample	1000 Seed Weight	Germination
	(fl oz/a)		(%)	(no.)	(no.)	(g)	(g)	(%)
Tilt[1]	8		71 ab	303 bc	99 a	3.65	0.385 ab	82
Folicur	8		73 ab	228 bc	79 a	4.15	0.403 a	91
Quadris (COC[2])	12		78 ab	374 b	96 a	3.78	0.402 a	91
Tilt + Tilt	4	4	68 bc	234 bc	93 a	3.5	0.386 ab	92
Folicur + Folicur	4	4	65 bc	194 bc	92 a	3.38	0.391 ab	93
Tilt + Tilt	8	8	21 e	35 c	6 d	3.45	0.373 b	96
Folicur + Folicur	8	8	46 cd	108 bc	11 d	3.3	0.400 a	91
Tilt (COC) + Tilt (COC)	8	8	33 de	87 c	7 d	3.23	0.392 ab	96
Quadris (COC) + Quadris (COC)	12	12	46 cd	108 bc	23 cd	3.75	0.402 a	95
Tilt + Penaturf	8	48	63 bc	234 bc	38 bc	3.2	0.380 ab	87
Tilt + Sylgard 309	8	32[3]	53 bcd	181 bc	23 cd	3.25	0.394 ab	90
Tilt/Penaturf+Tilt Penaturf	8/48	8/48	33 de	105 bc	4 d	3.6	0.393 ab	85
Tilt/Orthorix +Tilt/Orthorix	8/64	8/64	26 de	76 c	8 d	3.63	0.385 ab	85
Untreated	---	---	92 a	741 a	99 a	4.3	0.391 ab	84
						NS		NS

[1] Sylgard 309 16 fl oz/100 gal and R-56 at 1 pt/100 gal applied with all treatments except when Penaturf, Sylgard 309, or Orthorix were applied alone.

[2] crop oil concentrate (COC) applied at 1% in combination with fungicides

[3] fl oz/100 gals

Mean in the same column with different letters are significantly different at P≤ 0.05

ROLE OF INSECTS IN THE DEVELOPMENT OF ERGOT IN KENTUCKY BLUEGRASS GROWN FOR SEED IN THE PACIFIC NORTHWEST, 1998

Marvin Butler, Steven Alderman, Jennifer Mucha, William Johnston

Abstract

The relationship of insects to the spread of ergot (*Claviceps purpurea)* is of particular concern because ergot is an important pathogen of Kentucky bluegrass (*Poa pratensis*). This is the third year of a survey conducted to evaluate insects active in fields producing Pacific Northwest Kentucky bluegrass seed just before harvest. Locations included the Rathdrum Prairie near Post Falls, Idaho, the Madras and Culver areas of central Oregon, and the La Grande and Imbler areas of the Grande Ronde Valley in northeast Oregon. Sample methods included use of sweep nets, Schun shaker, and black light collectors. A reference collection of insects by field and location was made for identification, along with a second collection on sticky cards using modified equipment to analyze individuals for the presence of ergot conidia.

Introduction

An understanding of the interactive dynamics of insect populations, and their association with ergot, is essential to develop and evaluate control strategies. This is especially true in development of cropping systems where field ecological relationships may vary among production systems, including nonthermal residue management. This is the third year of a 3-year project to understand host insect interaction and other disease vector relationships.

During 1996, the project focused on conducting a survey of insects active in fields producing Pacific Northwest Kentucky bluegrass seed from anthesis to harvest. This study provided an important baseline from which to compare future studies, both locally and regionally. This information was an essential prerequisite to understand the role of insects in current production systems in the Pacific Northwest. The effect of alternative management approaches, e.g., nonthermal, on insect population and species abundance was unknown. Of particular concern is the effect of nonthermal management on populations of economically important insects that impact the crop directly, or indirectly as vectors of plant pathogens.

During 1997, insects active in Kentucky bluegrass fields of the Pacific Northwest were collected using traditional methods for identification purposes, and a second group of individuals were collected separately on sticky traps using modified equipment to prevent cross-contamination of ergot conidia between insects. Insects on sticky traps were evaluated by Steven Alderman, Plant Pathologist with the National Forage Seed Production Research Center, for the presence of ergot conidia.

The objectives for 1998 were to gather a second year of data in Kentucky bluegrass fields of the Pacific Northwest, following collection and evaluation procedures used during 1997.

Methods and Materials

Seven Pacific Northwest Kentucky bluegrass fields were sampled to identify insects active in grass seed during flowering and to determine which of these carry ergot conidia. Samples were taken just before harvest from two or three Kentucky bluegrass seed fields at each of the three locations: Rathdrum Prairie, Central Oregon and the Grande Ronde Valley. Sampling methods included the use of sweep nets, Schun shakers, black light collectors and collection of panicles. Two collections were made at each site using traditional sweep nets, Schun shakers, and black lights, and a modified set of equipment to collect insect on 6 inch x 6 inch sticky cards. Sticky cards were used to prevent cross contamination, and they enabled individual insects to be evaluated for the presence of ergot conidia by Steven Alderman, plant pathologist with the National Forage Seed Production Research Center.

Samples were collected from three fields (cv. Shamrock, Plush, and Midnight) near Rathdrum Idaho, on June 29-30, 1998, from two fields (cv. Fairfax and Nassau) near Imbler, Oregon, on July 7, 1998, and from two fields (cv. Georgetown and Coventry) in central Oregon on July 10 and 13, 1997.

Insect sweeps were taken with a standard insect net and also with a sticky trap mounted inside a cylinder-shaped, ¼ inch mesh screen. Four replications of 20 sweeps were taken in the four quadrants of each field. Samples were stored in a cooler until being placed in a freezer to kill and preserve the insects. A representative series of each insect type was pinned and identified with the field and date of collection.

Schun shakers with methyl ethyl ketone were used to collect smaller insects from grass heads and foliage. Grass samples, consisting of 2 ft^2 grass, were taken from each of the four quadrants of the fields and placed in a Shun shaker. Insects were collected in a jar at the base of one Shun shaker, then transferred to vials containing ethyl alcohol. A second set of grass samples was placed in a modified Shun shaker with a sticky trap placed at the bottom of the straight-sided shaker. All samples were frozen to kill the insects and preserve them until processing. Insects were identified, and the number of each insect type was recorded.

One hundred panicle samples of grass were collected from each field. After samples were air dried, the number of panicles with honeydew and sclerotia and the total number of sclerotia per sample, were recorded.

A black-light moth trap with a pest strip fumigant was placed near the center of each field at dusk to collect night-flying moths. Two sticky straps were hung around the perimeter of each black-light trap. Moths were taken from the black-light traps in the morning and stored in a freezer until mounting. Moth identification was conducted by Paul Hammond, contract researcher associated with Oregon State University, Department of Entomology.

Results and Discussion

Table 1 lists the order, family, common name and characteristics for insects collected by sweeps across the sampling area. Insects from twenty-five groups were collected during the 1998 season. Insects considered economic pests on crops in collection areas included aphids (Homoptera, Aphididae), leafhoppers (Homoptera, Cicadellidae), thrips (Thysanoptera, Thripidae), cutworm moths (Lepidoptera, Noctuidae), and pyralid moths (Lepidoptera, Pyralidae). None of the insects collected are generally considered an economic threat on Kentucky bluegrass during flowering. Thrips have been an isolated problem during flowering, aphids numbers can build during the spring, and there are some isolated concerns about sod webworm.

Beneficial insects collected were ladybird beetles (Coleoptera, Coccinellidae), big-eyed bugs (Hemiptera, Lygaeidae), damsel bugs (Hemiptera, Nabidae), and parasitic wasps (Hymenoptera, Braconidae and Ichneumonidae). With changes in management practices in Kentucky bluegrass, there is potential for changes in the spectrum of pests and insect ecology found in the Pacific Northwest.

Insects collected from sweeps were identified by location and field cultivar (Table 2). Flies (Diptera) were found at all locations. Beneficial insects found across the three locations were ladybird beetles (Coleoptera, Coccinellidae), big-eyed bugs (Hemiptera, Lygaeidae), damsel bugs (Hemiptera, Lygaeidae), and beneficial parasitic wasps (Hymenoptera, Ichneumonidae). General crop pests found in grass fields were aphids (Homoptera, Aphididae), leafhoppers (Homoptera, Cicadellidae), and pyralid moths (Lepidoptera, Pyralidae).

Insects collected with the Schun shaker were identified by location and field cultivar (Tables 3). Thrips were the dominant insect group, with extremely high numbers found in the 'Fairfax' of the Grande Ronde Valley. Leafhoppers were found in higher numbers on the Rathdrum Prairie. Aphid numbers were relatively low across all areas.

Moths collected by black light are identified by location and field cultivar in Table 4. In general, moth populations in the three growing areas sampled resemble collections from 1996 and 1997. An areas of interest is the presence of *Chortodes rufostrigata*, which appeared in numbers at both the Madras/Culver and Powell Butte locations. This species was previously a very rare species in Oregon, and was only known from wet meadows in the Blue and Wallowa Mountains of northeast Oregon, plus one isolated record from Lake County. Both the central Oregon locations are new county records and significant range extensions for this species within the state. It is not entirely clear what is happening with this species. Quite possibly the irrigation of the bluegrass fields is duplicating the normal wet meadow habitat of this species, allowing a naturally very rare species of montane meadows to invade and successfully occupy an artificial agricultural situation.

Indeed, the irrigation of these bluegrass fields is likely responsible for the presence of this moth fauna. Most are adapted to the moist grasslands of mountain meadows and west of the Cascades under natural conditions. Today, these bluegrass fields occupy areas that were formerly a dessert grassland or sagebrush-bunchgrass steppe. However, the xeric-adapted moths that normally live in native bunchgrass habitats never appeared in these bluegrass fields. Thus, the replacement of native desert grasslands with irrigated bluegrass fields has resulted in a total replacement of xeric-adapted desert moth fauna with mesic-montane moth fauna that has successfully invaded and occupied these agricultural lands.

The number of egot sclerotia and honeydew per 100 panicle samples for each field was provided (Table 5). The highest levels of ergot were found in the 'Coventry' field in central Oregon, followed by those in the 'Fairfax' in the Grand Ronde Valley. No ergot was found in the 'Georgetown' field in central Oregon.

Table 1. Orders, families, common names, and characteristics of insects collected by sweeps, Schun shaker collection, and soil samples in Kentucky bluegrass seed fields on the Rathdrum Prairie, in central Oregon, and in the Grande Ronde Valley, 1998.

Order	Family/Genus	Common Name	Characteristics
Coleoptera	Bruchidae	Seed weevils	Pests attacking beans and peas
	Carabidae	Ground beetles	Predaceous beneficials
	Chrysomelidae	Leaf beetles	Many are serious pests
	Coccinellidae	Ladybird beetles	Adults, larvae are predaceous
	Staphylinidae	Rove beetles	Most predators, some scavengers
Diptera		Flies	Mix of beneficials and pests
Hemiptera	Lygaeidae	Seed bugs (big-eyed bugs)	Both predators and pests
	Miridae	Leaf or plant bugs	Feed on plants, some serious pests
	Calocoris		
	Hoplomachus		
	Megaloceroea		
	Monosynamma		
	Stenodema		
	Nabidae	Damsel bugs	Predators
	Pentatomidae	Stink bugs	Most plant feeders, some predators
	Scutelleridae	Shield bugs	Plant feeders
Homoptera	Aphididae	Aphids	Most serious pests, some vectors
	Cercopidae	Froghoppers, Spittlebugs	Can be pests on some crops
	Cicadellidae	Leafhoppers	Many serious pests, some vectors
	Delphacidae	Delphacid planthoppers	Plant feeders
Hymenoptera	Braconidae	Braconid wasps	Parasitic larvae
	Ichneumonidae	Ichneumon wasps	Parasitic on many noxious insects
Lepidoptera	Pyralidae	Pyralid moths	Many pests of cultivated plants
	Noctuidae	Cutworms	Common foliage feeders on many crops
Orthoptera	Acrididae	Grasshoppers	Many important pests
Thysanoptera	Thripidae	Thrips	Most economic pests

Table 2. Insects collected from sweeps of Kentucky bluegrass seed fields by location and field cultivar, 1998.

Order	Rathdrum Prairie, ID			Central OR		Grande Ronde Valley, OR	
Family Genus	Shamrock 6-29	Plush 6-29	Midnight 6-30	Coventry 7-13	Georgetown 7-10	Fairfax 7-7	Nassau 7-7
Coleoptera							
Bruchidae			x				
Carabidae	x						
Chrysomelidae							x
Coccinellidae	x		x	x	x		x
Staphylinidae						x	
Diptera	x	x	x	x	x	x	x
Hemiptera							
Lygaeidae	x	x	x	x	x	x	x
Miridae							
Calocoris			x				
Hoplomachus		x	x				
Megaloceroea		x					
Monosynamma	x	x	x				
Stenodema							x
Nabidae		x	x	x		x	x
Pentatomidae	x						
Scutelleridae	x	x	x			x	
Homoptera							
Aphididae	x	x	x	x			x
Cercopidae	x	x	x				x
Cicadellidae	x	x	x	x	x	x	x
Delphacidae	x	x		x		x	
Hymenoptera							
Braconidae					x		
Ichneumonidae	x	x	x	x		x	x
Lepidoptera							
Pyralidae	x	x	x			x	x
Orthoptera							
Acrididae				x			x

Table 3. Average number of insects collected from Schun shaker samples in seed fields of Kentucky bluegrass by location and field cultivar, 1998.

	Rathdrum Prairie, ID			Central OR		Grande Ronde Valley, OR	
Order Family	Shamrock 6-29-98	Plush 6-29-98	Midnight 6-30-98	Coventry 7-13-98	Georgetown 7-10-98	Fairfax 7-7-98	Nassau 7-7-98
Diptera	1	0	1	1	0	1	1
Homoptera							
Aphididae	1	1	2	2	2	4	2
Cicadellidae	12	27	9	2	1	7	6
Thysanoptera							
Thripidae	9	18	16	56	5	364	5

Table 4. Moths collected from black light traps in Kentucky bluegrass seed fields by location and field cultivar during the 1998 season.

		Rathdrum Prairie, ID			Central OR		Grande Ronde Valley, OR	
Genus species	Characteristic	Shamrock 6-29	Plush 6-29	Midnight 6-30	Coventry 7-13	Georgetown 7-10	Fairfax 7-7	Nassau 7-7
Agroperina dubitans	grass feeder							
Aletia oxygala	grass feeder							
Apamea amputatrix	grass feeder							
Crymodes devastator	grass feeder							
Leucania farcta	grass feeder							
Protagrotis obscura	grass feeder							
Xestia dolsa	herb feeder							

Table 5. The number of ergot sclerotia and panicles with honeydew per 100 panicle samples from each of the collection sites, 1998.

	Total sclerotia per sample	Total panicles per sample	
	Ergot	Ergot	Honeydew
Rathdrum Prairie, Idaho			
Shamrock	27	15	6
Plush	18	9	2
Midnight	88	33	4
Central Oregon			
Coventry	565	87	0
Georgetown	0	0	0
Grande Ronde Valley, Oregon			
Fairfax	206	73	30
Nassau	12	8	1

ROLE OF INSECTS IN THE DEVELOPMENT OF ERGOT IN KENTUCKY BLUEGRASS GROWN FOR SEED IN THE PACIFIC NORTHWEST, 1997

Marvin Butler, Steven Alderman, Jennifer Mucha, and William Johnston

Abstract

The relationship of insects to the spread of ergot (*Claviceps purpurea)* is of particular concern since ergot is an important pathogen of Kentucky bluegrass. This is the second year of a survey conducted to evaluate insects active in fields producing Pacific Northwest Kentucky bluegrass (*Poa pratensis*) seed before harvest. Locations included the Rathdrum Prairie near Post Falls, Idaho, the Madras and Culver areas of central Oregon, and the La Grande and Imbler areas of the Grande Ronde Valley in northeast Oregon. Sample methods included use of sweep nets, Schun shaker, and black light collectors. A reference collection of insects by field and location was made for identification, along with a second collection on sticky cards using modified equipment to analyze individuals for the presence of ergot conidia.

Introduction

An understanding of the interactive dynamics of insect populations and their association with ergot, is essential to develop and evaluate control strategies. This is especially true in development of cropping systems where field ecological relationships may vary among production systems, including nonthermal residue management. This is the second year of a 3-year project to understand host insect interaction and other disease vector relationships.

During 1996, the project focused on conducting a survey of insects active in fields producing Pacific Northwest Kentucky bluegrass (*Poa pratensis*) seed from anthesis to harvest. This study provided an important baseline from which to compare future studies, both locally and regionally. This information was an essential prerequisite to understand the role of insects in current production systems in the Pacific Northwest. The effect of alternative management approaches, e.g., nonthermal, on insect population and species abundance was unknown. Of particular concern is the effect of nonthermal management on populations of economically important insects which impact the crop directly, or indirectly as vectors of plant pathogens.

The objective for collection and identification of insects during 1997 was to collect individuals active in Kentucky bluegrass fields in the Pacific Northwest using traditional methods for identification purposes, and to collect a second group of individuals separately on sticky traps using modified equipment to prevent cross-contamination of ergot conidia between insects.

Methods and Materials

Nine Pacific Northwest Kentucky bluegrass fields were sampled to identify insects active in grass seed during flowering and to determine which of these carry ergot conidia. Samples were taken just before harvest from three Kentucky bluegrass seed fields at each of the three locations: Rathdrum Prairie, Central Oregon and the Grande Ronde Valley. Sampling methods included the use of sweep nets, Schun shakers, black light collectors and collection of panicles. Two collections were made at each site using traditional sweep nets, Schun shakers, and black lights, and a modified set of equipment to collect insects on 6 inch x 6 inch sticky cards. Sticky cards were used to prevent cross contamination and enabled individual insects to be evaluated for the presence of ergot conidia by Steven Alderman, plant pathologist with the National Forage Seed Production Research Center.

Samples were collected from three fields (cv. Shamrock, Midnight, and Plush) near Rathdrum Idaho on June 26-27, 1997, from three fields (cv. Sidekick, Nassau, and Ascot) near Imbler, Oregon on July 1-2, 1997, and from three fields (cv. Coventry, Georgetown, and Merit) in central Oregon on July 7-11, 1997.

Insect sweeps were taken with a standard insect net and also with a sticky trap mounted inside a cylinder-shaped ¼ inch mesh screen. Four replications of 20 sweeps were taken in the four quadrants of each field. Samples were stored in a cooler until being placed in a freezer to kill and preserve the insects. A representative series of each insect type was pinned and identified with the field and date of collection.

Schun shakers with methyl ethyl ketone were used to collect smaller insects from grass heads and foliage. Grass samples, consisting of 2 ft^2 grass, were taken from each of the four quadrants of the fields and placed in a Shun shaker. Insects were collected in a jar at the base of one Shun shaker, then transferred to vials containing ethyl alcohol. A second set of grass samples was placed in a modified Shun shaker with a sticky trap placed at the bottom of the straight-sided shaker. All samples were frozen to kill the insects and preserve them until processing. Insects were identified, and the number of each insect type was recorded.

One hundred panicle samples of grass were collected from each field. After samples were air dried, the number of panicles with honeydew and sclerotia and the total number of sclerotia per sample were recorded.

A black-light moth trap with a pest strip fumigant was placed near the center of each field at dusk to collect night-flying moths. Two sticky straps were hung around the perimeter of each black-light trap. Moths were taken from the black-light traps in the morning and stored in a freezer until mounting. Moth identification was conducted by Paul Hammond, contract researcher associated with Oregon State University, Department of Entomology.

Results and Discussion

Table 1 lists the order, family, common name and characteristics of insects collected by sweeps across the sampling area. Insects from twenty-one insect groups were collected during the 1997 season, compared to 32 during the 1996 season. In part this may be accounted for by having two sampling dates during 1996 (at the beginning of anthesis and just before harvest), compared to a single sampling date (just before harvest) in 1997. Insects considered economic pests on crops in collection areas included lygus (Hemiptera, Miridae), aphids (Homoptera, Aphididae), leafhoppers (Homoptera, Cicadellidae), thrips (Thysanoptera, Thripidae), cutworm moths (Lepidoptera, Noctuidae), and pyralid moths (Lepidoptera, Pyralidae). None of the collected insects were generally considered to be economically important on Kentucky bluegrass during flowering. Thrips have been an isolated problem during flowering, aphids numbers can build during the spring, and there are some isolated concerns about sod webworm.

Beneficial insects collected were ladybird beetles (Coleoptera, Coccinellidae) minute pirate bugs (Hemiptera, Anthocoridae), big-eyed bugs (Hemiptera, Lygaeidae), damsel bugs (Hemiptera, Nabidae), parisitic wasps (Hymenoptera, Ichneumonidae), and damsel flies (Odonata, Coenagrionidae). With changes in management practices in Kentucky bluegrass, there is potential for changes in the spectrum of pests and insect ecology found in the Pacific Northwest.

Insects collected from sweeps are identified by location and field cultivar (Table 2). Insect found at all locations were flies (Diptera), leafhoppers (Homoptera, Cicadellidae), and beneficial parasitic wasps (Hymenoptera, Ichneumonidae). Predatory big-eyed bugs (Hemiptera, Lygaeidae) were found at six locations across the three areas but more commonly in Oregon than Idaho. Plant bugs (Hemiptera, Miridae, Monosynamma and Stenodema) were found at five of six locations across the Rathdrum Prairie and Grand Ronde Valley, but not in central Oregon. Aphids (Homoptera, Aphididae) were concentrated an the Rathdrum Prairie, but none were collected in the Grande Ronde Valley. The predaceous minute pirate bugs (Hemiptera, Anthocoridae) were found only on the Rathdrum Prairie, while predatory damsel bugs (Hemiptera, Nabidae) were collected only in central Oregon and the Grande Ronde Valley.

Insects collected with the Schun shaker were identified by location and field cultivar (Tables 3). Thrips were the dominant insect group in central Oregon and the Grande Ronde Valley. Leafhoppers were dominant in the Shamrock and Plush fields on the Rathdrum Prairie, with thrips dominant in the Midnight field. Aphid numbers were relatively low across all areas, with the largest number at the Georgetown field in Central Oregon.

Moths collected by black light were identified by location and field cultivar (Table 4). Six of the seven moths captured were functional grass-feeders. The herb-feeders were likely straying from other crops or weedy areas surrounding the grass field. The species *Protagrotis obscura* is a generalized cutworm that feeds on both grasses and herbs; it was present at all locations. *P. obsura* is often extremely abundant in agricultural lands throughout central and eastern Oregon, but it is scarce or absent in natural habitats. Along with *Agroperina dubitans*, these were the only two species found at the three locations on the Rathdrum Prairie. The two Oregon locations had greater diversity in moth species. The species, *Xestia sinigram*, was only found at the Nassau location of the Grande Ronde Valley, while *Leucania farcta* only occurred in the Coventry field of central Oregon.

The number of egot sclerotia and honeydew per 100 panicle samples for each field was provided (Table 5). The highest levels of ergot were found in central Oregon, followed by those in the Rathdrum Prairie and the Grande Ronde Valley.

Table 1. Orders, families, common names, and characteristics of insects collected by sweeps, Schun shaker collection, and black lights in Kentucky bluegrass seed fields on the Rathdrum Prairie, in central Oregon, and in the Grande Ronde Valley, 1997.

Order	Family/Genus	Common Name	Characteristics
Coleoptera	Chrysomelidae	Leaf beetles	Many are serious pests
	Coccinellidae	Ladybird beetles	Adults, larvae are predaceous
Diptera		Flies	Mix of beneficials and pests
Hemiptera	Anthocoridae	Minute pirate bugs	Predaceous beneficials
	Lygaeidae	Seed bugs (big-eyed bugs)	Both predators and pests
	Miridae	Leaf or plant bug	Feed on plants, some serious pests
	Hoplomachus		
	Lygus	Tarnish Plant Bug	Pest on seed crops
	Megaloceroea		
	Monosynamma		
	Stenodema		
	Nabidae	Damsel bugs	Predators
	Scutelleridae	Shield bugs	Plant feeders
Homoptera	Aphididae	Aphids	Most serious pests, some vectors
	Cercopidae	Froghopper, Spittlebug	Can be pest on some crops
	Cicadellidae	Leafhoppers	Many serious pests, some vectors
	Delphacidae	Delphacid Planthoppers	Plant feeders
Hymenoptera	Ichneumonidae	Ichneumon wasps	Parasitic on many noxious insects
Lepidoptera	Pyralidae	Pyralid moths	Many pests of cultivated plants
	Noctuidae	Cutworms	Common pests of many crops
Odonata	Coenagrionidae	Damselflies	Predators
Thysanoptera	Thripidae	Thrips	Most economic pests

Table 2. Insects collected from sweeps of Kentucky bluegrass seed fields by location and field cultivar, 1997.

Order	Rathdrum Prairie, ID			Central OR			Grande Ronde Valley, OR		
Family Genus	Shamrock 6-26	Plush 6-26	Midnight 6-27	Coventry 7-7	Merrit 7-11	Georgetown 7-8	Nassau 7-1	Ascot 7-2	Sidekick 7-2
Coleoptera									
Chrysomelidae			x				x		x
Coccinellidae		x	x	x			x		
Diptera	x	x	x	x	x	x	x	x	x
Hemiptera									
Anthocoridae	x	x							
Lygaeidae			x		x	x	x	x	x
Miridae									
Hoplomachus	x	x	x						
Lygus				x			x		
Megaloceroea	x	x	x						
Monosynamma	x	x	x				x	x	
Stenodema	x		x				x	x	x
Nabidae				x	x	x	x		x
Scutelleridae	x	x					x		x
Homoptera									
Aphididae	x	x	x			x			
Cercopidae			x	x					
Cicadellidae	x	x	x	x	x	x	x	x	x
Delphacidae				x	x				x
Hymenoptera									
Ichneumonidae	x	x	x	x	x	x	x	x	x
Lepidoptera									
Pyralidae	x	x	x			x		x	
Odonata									
Coenagrionidae								x	

Table3. Average number of insects collected from Schun shaker samples in seed fields of Kentucky bluegrass by location and field cultivar, 1997.

Order	Rathdrum Prairie, ID			Central OR			Grande Ronde Valley, OR		
	Shamrock	Plush	Midnight	Coventry	Merrit	Georgetown	Ascot	Nassau	Sidekick
Family	6-26	6-26	6-27	7-7	7-11	7-8	7-1	7-2	7-2
Diptera	1	1	1	2	1	1	1	1	1
Homoptera									
Aphididae	3	2	0	2	2	11	1	1	1
Cicadellidae	71	38	4	3	4	6	39	25	9
Thysanoptera									
Thripidae	17	21	39	23	14	85	62	72	11

Table 4. Noctuid moths collected from black light traps in Kentucky bluegrass seed fields by location and field cultivar during the 1997 season.

Genus species	Characteristic	Rathdrum Prairie, ID			Central OR			Grande Ronde Valley, OR		
		Shamrock 6-26	Plush 6-26	Midnight 6-27	Coventry 7-7	Merrit 7-11	Georgetown 7-8	Ascot 7-1	Nassau 7-2	Sidekick 7-2
Agroperina dubitans	grass feeder	x	x	x						
Aletia oxygala	grass feeder								x	x
Apamea amputatrix	grass feeder									x
Crymodes devastator	grass feeder				x		x		x	
Leucania farcta	grass feeder				x					
Protagrotis obscura	grass feeder	x	x	x	x	x	x	x	x	x
Xestia dolsa	herb feeder								x	

Table 5. The number of ergot sclerotia and panicles with ergot and honeydew per 100 panicle samples from each of the collection sites, 1997.

	Total sclerotia per sample	Total panicles per sample	
	Ergot	Ergot	Honeydew
Rathdrum Prairie, Idaho			
Shamrock	20 a	12 b	7 b
Plush	65 a	26 ab	32 b
Midnight	151 a	55 a	0 b
Central Oregon			
Coventry	212 a	51 a	54 a
Merrit	122 a	49 a	64 a
Georgetown	3 a	1 b	0 b
Grande Ronde Valley, Oregon			
Ascot	42 a	21 ab	1 b
Nassau	82 a	31 ab	22 b
Sidekick	4 a	2 b	0 b

ROLE OF INSECTS IN THE DEVELOPMENT OF ERGOT IN KENTUCKY BLUEGRASS GROWN FOR SEED IN THE PACIFIC NORTHWEST, 1996

Marvin Butler, Steven Alderman, Jennifer Mucha, Glenn Fisher and William Johnston

Abstract

The relationship of insects to the spread of ergot (*Claviceps purpurea*) is of particular concern because ergot is an important pathogen of Kentucky bluegrass (*Poa pratensis*). A survey was conducted to evaluate insects active in seed-production fields of Pacific Northwest Kentucky bluegrass from anthesis to harvest. Locations included the Rathdrum Prairie near Post Falls, Idaho, the Madras and Culver areas of central Oregon, and the La Grande and Imbler areas of the Grande Ronde Valley, Oregon. Sampling methods included the use of sweep nets, Schun shaker, blacklight collectors, and soil samples. A reference collection of insects by field and location was made using individuals collected from sweep nets and blacklight collectors: it is being maintained at the Central Oregon Agricultural Research Center, Madras, Oregon.

Introduction

An understanding of the interactive dynamics of the insect populations, and their association with ergot (*Claviceps purpurea*), is essential to develop and evaluate control strategies. This is especially true in development of cropping systems where field ecological relationships may vary among production systems, including nonthermal residue management. Results of this study may be useful in understanding host insect interaction or other disease-vector relationships.

For the 1996 season, the project focused on conducting a survey of insects active in seed production fields of Pacific Northwest Kentucky bluegrass (*Poa pratensis*) from anthesis to harvest. This study provides an important baseline from which to compare future studies, both locally and regionally. This information was an essential prerequisite to understand the role of insects in current production systems in the Pacific Northwest. The effect of alternative management approaches, e.g., nonthermal, on insect population and species abundance is unknown. Of particular concern was the effect of nonthermal management on populations of economically important insects, which impact the crop directly or indirectly as vectors of plant pathogens.

The relationship of insects to the spread of ergot was of particular concern because it is an important pathogen of Kentucky bluegrass. The current survey information will be instrumental to identify individuals fitting the profile for spore-carriers, which may have a significant impact in the spread of ergot. To be initiated during the 1997 season is the portion of the project involved with collecting and identifying individuals that carry spores of ergot; this portion will include established methods for collecting insects as separate individuals or groups to prevent cross-contamination.

Methods and Materials

During 1996, nine fields of grass seed planted across the Pacific Northwest were sampled at the initiation of anthesis and before harvest to identify insects active in the fields from flowering through harvest. Three Kentucky bluegrass seed fields were sampled at each of three locations: Rathdrum Prairie, Idhao, central Oregon and the Grande Ronde Valley, Oregon. Sampling methods included the use of sweep nets, Schun shakers, black-light collectors and soil samples.

Three sets of samples were collected from three fields (cv. Shamrock, Midnight, and Plush) near Rathdrum, Idaho on June 10-11, June 25 and July 8, 1996. Samples were collected during flowering and before harvest from three locations (cv. Bristol and Coventry) near Imbler, Oregon, on June 12 and July 9-10, 1996. In central Oregon samples were collected near Madras from a 'Coventry' field on June 17 and July 7, 1996 and from a 'Gnome' field June 7 and July 7, 1996. Samples from a 'Coventry' field near Powell Butte, Oregon, were collected on June 21 and July 12, 1996.

Insect sweeps included 10 replications of 10 sweeps in an hour-glass pattern across the field. Samples were stored in a cooler until being placed in a freezer to kill the insects. Insects were manually separated from foreign material, including pollen and seed. A representative series of each insect type was pinned for each field and identified by location and date of collection.

A Schun shaker with methyl ethyl ketone was used to collect smaller insects from grass heads and foliage. Four, 1-ft^2 samples were collected from the four quadrants of each field and placed in the shaker. Insects were collected in a jar at the base of the shaker, then transferred to vials containing ethyl alcohol. Identifications were made, and numbers of each insect type recorded.

Soil samples of 1 ft^2 were also collected from the four quadrants of each field. Samples were placed in zip-lock bags and refrigerated until placement in Berleze funnels. Samples were collected at the base of the funnels in jars containing ethyl alcohol. Insects were manually separated from soil particles and other material using 20, 40, and 60 mesh sieves, then transferred to vials containing ethyl alcohol.

A black-light moth trap with a pest-strip fumigant was set in the center of each field at dusk for collection of night-flying moths, with the exception of the first sample dates at each location. A random sample of moths was retrieved the following morning from the traps. A representative series of individuals from each location was mounted and identified.

Results and Discussion

Table 1 provides the order, family, common name and characteristics of insects collected across the sampling area. Insect groups considered economic pests on crops in collection areas include wireworms (Coleoptera, Elateridae), lygus (Hemiptera, Miridae), aphids (Homoptera, Aphididae), leafhoppers (Homoptera, Cicadellidae), pyralid moths (Lepidoptera, Pyralidae), cutworms and armyworms (Lepidoptera, Noctuidae), grasshoppers (Orthoptera, Acrididae), and thrips (Thysanoptera, Thripidae). None of the insects collected are generally considered pests of economic importance on Kentucky bluegrass during flowering. Thrips have been an isolated problem during flowering, aphids numbers can build during the spring, and there are some isolated concerns about the sod webworm.

Insect groups considered economically beneficial include ladybird beetles (Coleoptera, Coccinellidae), big-eyed bugs (Hemiptera, Lygaeidae), damsel bugs (Hemiptera, Nabidae), parasitic wasps (Hymenoptera), and green lacewings (Neuroptera, Chrysopidae). With changes in management practices in Kentucky bluegrass, there is a potential for changes in the spectrum of pests and insect ecology found in the Pacific Northwest.

Insects collected from sweeps were identified by location and field cultivar (Table 2). All samples contained predatory damsel bugs (Hemiptera, Nabidae) and flies (Diptera). Insect groups found at all locations were leafhoppers (Homoptera, Cicadellidae), preditory big-eyed bugs (Hemiptera, Lygaeidae) and parasitic wasps (Hymentoptera, Ichneumonidae and Braconidae). The predaceous ladybird beetles (Coleoptera, Coccinellidae) was found at all but one location, while pyralid moths (Lepidoptera, Pyralidae) were found at all but two locations. Commonly found in many of the fields were predacious ground beetles (Coleoptera, Carabidae), lygus (Hemiptera, Miridae), and shield bugs (Hemiptera Scutelleridae). Aphids (Homoptera, Aphididae) were not common in northwest grass fields. As indicated, the insect ecology in northwest grass fields included a variety of important beneficial insects in relatively high numbers, along with other beneficial insects whose presence varied by location.

Insects collected with the Schun shaker and soil samples were identified (Tables 3 and 4, respectively). The predominent species in Schun shaker collections across the three growing areas were aphids, leafhoppers, and thrips.

Moths collected using black lights were identified (Table 5). Most of the moths captured in bluegrass fields in all areas were functional grass-feeders. A few moths feeding on herbs or hardwoods were also captured, but these were probably strays from outside the fields. The herb-feeders were likely straying from other crops or weedy areas surrounding the grass field.

Of the grass-feeders, the most common species at all sites was *Protagrotis obscura*. This is a generalized cutworm that feeds on both grasses and herbs. It is often extremely abundant in agricultural lands throughout central and eastern Oregon but is scarce or absent in natural habitats. This species was dominant at the Plush and Shamrock sites on the Rathdrum Prairie and the Bristol site in the Grande Ronde Valley.

In terms of species diversity, the Rathdrum prairie yielded only two species of moths, while the Oregon sites yielded 4-6 species per site. With the exception of *Protagrotis obscura*, all of the grass-feeding moths collected were typical of moist habitats, and were very common in higher elevations of the Blue Mountains and Cascade Range. An interesting feature of this moth fauna in bluegrass fields was the total absence of species found in more desert grasslands such as sagebrush-bunchgrass habitats.

Table 1. Orders, families, common names and characteristics of insects collected by sweeps, Schun shaker, black light and soil samples in Kentucky bluegrass seed fields on the Rathdrum Prairie, in central Oregon, and in the Grande Ronde Valley, 1996.

Order	Family/Genus	Common Name	Characteristics
Coleoptera	Bruchidae	Seed weevils	Pests attacking beans and peas
	Carabidae	Ground beetles	Predaceous beneficials
	Chrysomelidae	Leaf beetles	Many are serious pests
	Coccinellidae	Ladybird beetles	Adults, larvae are predaceous
	Curculionidae	Snout beetles (weevils)	Plant feeders, serious pests
	Elateridae	Click beetles (wireworms)	Mixed group, root-feeding larvae
	Staphylinidae	Rove beetles	Most predators, some scavengers
Collembola	Hypogastruridae	Springtails	Most are harmless to crops
	Isotmidae	Springtails	Most are harmless to crops
Diptera		Flies	Mix of beneficials and pests
Hemiptera	Lygaeidae	Seed bugs (big-eyed bugs)	Both predators and pests
	Miridae	Leaf or plant bugs	Feed on plants, some serious pests
	Hoplomachus		
	Lygus	Tarnished plant bugs	Pest on seed crops
	Megaloceroea		
	Monosynamma		
	Slaterocoris		
	Stenodema		
	Nabidae	Damsel bugs	Predators
	Rhopalidae	Scentless plant bugs	Plant feeders including Boxelder bug
	Scutelleridae	Shield bugs	Plant feeders
Homoptera	Aphididae	Aphids	Most serious pests, some vectors
	Cicadellidae	Leafhoppers	Many serious pests, some vectors
	Delphacidae	Delphacid planthoppers	Plant feeders
Hymenoptera	Braconidae	Braconid wasps	Parasitic larvae
	Ichneumonidae	Ichneumon wasps	Parasitic on many noxious insects
Lepidoptera	Pyralidae	Pyralid moths	Many pests of cultivated plants
	Noctuidae	Cutworms	Important pest across many crops
Neuroptera	Chrysopidae	Green lacewings	Adults, larvae feed mostly on aphids
Odonata	Coenagrionidae	Damselflies	Predators
	Lestidae	Damselflies	Predators
Orthoptera	Acrididae	Grasshoppers	Many important pests
Plecoptera	Perlidae	Stoneflies	No economic importance
Thysanoptera	Thripidae	Thrips	Most economic pests

Table 2. Insects collected from sweeps of seed fields of Kentucky bluegrass by location and field cultivar, 1996 season.

Order	Rathdrum Prairie, ID									Central OR						Grande Ronde Valley, OR					
Family	Shamrock			Plush			Midnight			Coventry		Gnome		Coventry		Bristol		Coventry		Bristol	
Genus	6-10	6-25	7-8	6-11	6-25	7-8	6-10	6-25	7-8	6-17	7-7	6-7	7-7	6-21	7-12	6-12	7-9	6-12	7-10	6-12	7-9
Coleoptera																					
Bruchidae	x			x												x		x		x	
Carabidae		x			x			x		x								x		x	
Chrysomelidae												x				x		x	x	x	
Coccinellidae	x	x			x	x	x	x	x	x	x	x	x	x	x	x		x			
Curculionidae		x			x																
Elateridae	x	x																			
Staphylinidae											x										
Diptera	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Hemiptera																					
Lygaeidae			x		x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x
Miridae																					
Hoplomachus					x	x		x	x												
Lygus			x					x	x	x	x	x		x							
Megaloceroea				x		x		x							x						
Monosynamma		x			x	x		x											x		
Slaterocoris		x			x		x	x						x							
Stenodema								x												x	
Nabidae	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Rhopalidae													x		x	x				x	x
Scutelleridae		x			x	x			x	x		x				x		x		x	
Homoptera																					
Aphididae			x			x					x				x						
Cicadellidae	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x		x	x	x
Delphacidae											x						x			x	
Hymenoptera																					
Braconidae		x				x			x						x	x	x	x		x	x
Ichneumonidae	x	x		x			x	x	x	x		x		x	x			x	x	x	x
Lepidoptera																					
Pyralidae	x	x	x		x	x		x	x		x		x					x	x	x	
Neuroptera																					
Chrysopidae										x	x										
Odonta																					
Coenagrionidae															x	x					
Lestidae								x													
Orthoptera																					
Acrididae	x		x			x	x	x	x								x	x	x	x	
Plecoptera																					
Perlidae																x					

Table 3. Insects collected from Schun shaker samples, in seed fields of Kentucky bluegrass by location and field cultivar, 1996 season.

	Rathdrum Prairie, ID									Central OR						Grande Ronde Valley, OR					
	Shamrock			Plush			Midnight			Coventry		Gnome		Coventry		Bristol		Coventry		Bristol	
Order / Familly	6-10	6-25	7-8	6-11	6-25	7-8	6-10	6-25	7-8	6-17	7-7	6-7	7-7	6-21	7-12	6-12	7-9	6-12	7-10	6-12	7-9
Diptera	x	x													x		x				
Hemoptera																					
Lygaeisae		x																			x
Homoptera																					
Aphididae	x	x	x		x	x		x			x	x	x	x	x		x		x	x	x
Cicadellidae	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x
Thysanoptera																					
Thripidae	x	x	x		x	x	x	x		x	x	x	x	x	x	x		x			x

Table 4. Insects collected from soil samples in Kentucky bluegrass seed fields by location and field cultivar during the 1996 season.

	Rathdrum Prairie, Idaho									Central Oregon						Grande Ronde Valley, Oregon					
	Shamrock			Plush			Midnight			Coventry		Gnome		Coventry		Bristol		Coventry		Bristol	
Order / Family	6-10	6-25	7-8	6-11[1]	6-25[1]	7-8[1]	6-10	6-25[1]	7-8[1]	6-17	7-7	6-7	7-7	6-21[1]	7-12	6-12[1]	7-9[1]	6-12[1]	7-10	6-12	7-9
Coleoptera																					
Elateridae							x														
Staphylinidae																				x	
Collembiola																					
Hypogastruridae										x					x					x	
Isotomidae															x						
Diptera		x								x										x	x
Hemiptera																					x
Lygaeidae																					x
Homoptera												x							x	x	
Aphididae	x		x							x					x				x	x	
Cicadellidae	x		x									x									
Neuroptera																					
Chrysopidae	x																				
Thysanoptera																					
Thripidae	x		x				x				x		x		x				x		x

[1]Collection dates without insect representation indicate samples without any individuals.

Table 5. Noctuid moths collected from black light traps in Kentucky bluegrass seed fields by location and field cultivar during the 1996 season.

		Rathdrum Prairie, ID		Central OR	Grande Ronde Valley, OR	
		Shamrock	Plush	Coventry	Bristol	Coventry
Genus species	Characteristic	7-8	7-8	7-12	7-9	7-10
Agroperina dubitans	grass feeder	x	x			x
Agroperina lateritia	grass feeder					x
Aletia oxygala	grass feeder			x	x	x
Amphipyra tragopoginis	herb feeder			x		
Apamea amputatrix	grass feeder				x	x
Caenurgina erechtea	herb feeder				x	
Crymodes devastator	grass feeder			x		x
Leucania farcta	grass feeder			x	x	
Malacosoma californica	hardwood feeder			x		
Melanchra picta	herb feeder			x		
Oligia violacea	unknown			x		
Paonias excaecatus	hardwood feeder				x	
Protagrotis obscura	grass feeder	x	x	x	x	x
Smerinthus cerisyi	grass feeder					x
Xestia dolsa	herb feeder				x	

NUTRIENT UPTAKE FOR ROUGH BLUEGRASS, 1998

Marvin Butler, John Hart and Neysa Farris

Abstract

This is the second year of a multiyear project to evaluate nutrient uptake of rough bluegrass (*Poa trivialis*). Two feet of two adjacent rows were sampled biweekly from April 13 to June 23, 1998 at three predetermined locations in commercial fields of 'Cypress' and 'Saber II'. Nutrient concentrations decreased as plant biomass increased. Nitrogen uptake at both sites was quite high on the first sampling date, indicating early nitrogen uptake and the need for an early start date for sampling. Potassium accumulation occurred later than the nitrogen, as did phosphorus and sulfur which did not reach near maximum until late May.

Introduction

Rough bluegrass (*Poa trivialis*) was first grown in central Oregon in the mid-1970s. The crop consisted of the single cultivar, 'Saber', with relatively few acres until the mid-1980s. Since then, new varieties, which include 'Laser', 'Cypress', and 'Saber II' were introduced. Plantings steadily increased to approximately 5,300 acres in 1998. Cultural practices for rough bluegrass are substantially different from Kentucky bluegrass (*Poa pratensis*). Rough bluegrass is a shallow-rooted crop with a high water requirement. As harvest nears, growers maintain high moisture levels to cause the crop to lodge and keep the heads moist to reduce shatter and seed loss.

Methods and Materials

This research project was designed to observethe nutrient uptake for rough bluegrass that would be used to assist growers in determining rate and timing of fertilizer applications to maximize their economic return. The 1998 growing season was the second year of a multiyear project conducted on commercial fields at two locations north of Madras, Oregon. Second year fields of the cultivars 'Cypress' and 'Saber II' were chosen for the study. The 'Cypress' location was fairly sandy soil with sprinkler irrigation, while the 'Saber II' location was loamy soil using furrow irrigation. Rows at both locations were spaced 15 in. apart.

Biomass samples were collected biweekly from April 16 to June 23, 1998. Two feet of two adjacent rows from three predetermined locations per field were clipped, dried, and weighed. A subsample was taken for analyses of nutrient content.

Results and Discussion

The concentrations of N, P, K, and S are listed in Table 1. Nutrient concentration decreased as plant biomass increased. Concentrations of N, P, K, and S were similar for both sites early in the growing season and at harvest. Biomass was similar for both sites at the initial sampling date, but the site planted with 'Saber II' produced approximately 25 percent more biomass than the site planted with 'Cypress'. A biomass of 4 to 6 tons at harvest is comparable to many other species of grass grown for seed.

Nitrogen uptake at both sites was surprisingly high at the first sampling date (Table 2). More than two-thirds of the N was in the aboveground biomass when less than 25 percent of the biomass was accumulated. The early accumulation of N is important to growers. They should consider having most, if not all, fertilizer N applied by early April if the growth in 1998 was typical of most years. Later applications in May and June are likely not an effective influence on yield.

Nitrogen accumulation in the aboveground biomass was between 150 and 200 lb/a. Last year's report contained an error reported an amount of 300 lb/a. When the error was corrected, N accumulation for both years was between 100 and 200 lb N/a.

Potassium accumulation was similar in amount to N, 150 to 225 lb/a, but occurred later than N accumulation. Accumulation of P and S were similar, between 15 and 25 lb/a. In contrast to the early accumulation of N, accumulation of P, K, and S did not reach near maximum until late May.

Table 1. Biomass accumulation and nutrient concentration for Saber II and Cypress rough bluegrass, Madras, OR, 1998.

Sampling date	Biomass	N	P	K	S
	lb/a	%			
Saber II					
April 16	2715	4.67	0.44	2.97	0.33
April 29	2642	4.63	0.52	3.39	0.39
May 13	4491	2.77	0.41	3.12	0.29
May 26	7709	1.97	0.34	2.52	0.21
June 9	8700	1.51	0.27	2.21	0.19
June 23	12024	1.61	0.26	1.78	0.21
Cypress					
April 16	2706	4.63	0.47	2.95	0.37
April 29	3190	3.83	0.48	3.42	0.35
May 13	4387	2.49	0.41	2.74	0.24
May 26	7394	2.28	0.35	2.39	0.23
June 9	7946	1.82	0.31	1.78	0.19
June 23	7999	1.87	0.29	1.46	0.18

Table 2. Nutrient uptake for Saber II and Cypress rough bluegrass, Madras, OR,1998.

Sampling date	N	P	K	S
	lb/a			
Saber II				
April 16	125	12	80	9
April 29	118	13	86	9
May 13	150	19	141	14
May 26	164	27	204	17
June 9	147	27	208	17
June 23	187	30	222	22
Cypress				
April 16	123	12	76	10
April 29	126	15	104	11
May 13	120	19	127	12
May 26	181	28	188	18
June 9	146	24	153	15
June 23	163	25	128	16

NUTRIENT UPTAKE FOR ROUGH BLUEGRASS, 1997

Marvin Butler and John Hart

Abstract

This is the first year of a multiyear evaluation of the timing of nutrient uptake by rough bluegrass (*Poa pratensis*). Vegetative growth was sampled biweekly from April 1 to June 18, 1997 at two commercial fields. There was significantly more biomass at the 'Saber II' location compared to the 'Cypress' location. Nitrogen, phosphorus and sulfur concentrations decreased over time, while potassium concentrations were adequate throughout the season. Nutrient uptake was similar for the two cultivars, with a rapid increase in nutrient uptake and biomass accumulation in May.

Introduction

Rough bluegrass (*Poa trivialis*) was first grown in central Oregon in the mid-1970s. The crop consisted of the single variety, 'Saber', with relatively few acres until the mid-1980s. Since then, new varieties, which include 'Laser', 'Cypress', and 'Saber II' were introduced. Plantings steadily increased to approximately 4,400 acres in 1997. Cultural practices for rough bluegrass are substantially different from Kentucky bluegrass (*Poa pratensis*). This research project was designed to determine the nutrient uptake for rough bluegrass that would be used to assist growers in determining rate and timing of fertilizer applications to maximize their economic return.

Methods and Materials

The research was conducted on commercial fields at two locations north of Madras, Oregon. First-year fields of the cultivars 'Cypress' and 'Saber II' were chosen for the study. The 'Cypress' location was fairly sandy soil with sprinkler irrigation, while the 'Saber II' location was loamy soil using furrow irrigation. Rows at both locations were spaced 15 in. apart.

First-foot soil samples and biomass samples were collected biweekly from April 17 to June 18. Two feet of two adjacent rows from three predetermined locations per field were clipped, dried, and weighed. Sampling locations in the 'Saber II' field were in an area of lush growth.

Rough bluegrass is a shallow-rooted crop with a high water requirement. As harvest nears, growers maintain high moisture levels to cause the crop to lodge and keep the heads moist to reduce shatter and seed loss. Commercial production on the 'Cypress' field was quite low and thought to be the result of sprinkler-irrigated, sandy soil where adequate moisture levels were not maintained. Biomass production and yield at the 'Saber II' field were considered very high.

Results and Discussion

Aboveground plant material or biomass and concentrations of N, P, K, and S are presented in Table 1. The June 18 sampling was not made at the 'Cypress' site. Even so, the difference in biomass is evident for the two cultivars and locations. These two sites probably represent extremes in production of biomass. Early to mid-May is a time of rapid biomass accumulation.

Table 1. Biomass accumulation and nutrient concentration for 'Cypress' and 'Saber II' rough bluegrass, Madras, OR, 1997.

Sampling Date	Biomass	N	P	K	S
	lb/a	-------	------- %	-------	-------
Cypress					
4/1	556	4.66	0.40	2.44	0.29
4/17	798	4.37	0.37	2.59	0.28
5/6	1052	4.88	0.51	3.95	0.29
5/22	4403	3.10	0.39	3.40	0.22
6/6	5539	2.89	0.34	2.59	0.17
Saber II					
4/1	1458	3.86	0.35	3.45	0.53
4/17	1713	4.12	0.37	3.19	0.37
5/22	6892	2.97	0.38	3.29	0.26
6/6	9032	2.16	0.34	2.31	0.21
6/18	16349	1.86	0.30	2.30	0.20

Nitrogen concentration in the tissue was high, about 4 percent, early in the season and decreased with growth. The decrease was expected and at a normal rate compared to other grass species. Horneck (1995) reported N concentration at harvest of 1 to 3percent for tall fescue, perennial ryegrass, orchardgrass, fine fescue, and Kentucky bluegrass. The lower final N concentration in the 'Saber II' field is probably caused by dilution of the N in the extremely high amount of biomass produced at this site.

Phosphorus concentration also decreased as the crop matured and was above the harvest concentrations reported by Horneck (1995) except for fine fescue. The P concentration at the two sites was well above expected critical concentrations for other grasses.

Potassium concentration is a function of potassium supply and biomass as plants will take up K in excess of needs for growth and reproduction. The K concentrations at both sites were not excessive, or above 4 percent as reported in grass forage fields on many dairies. Potassium was adequate and similar to that reported in other grass species by Horneck (1995).

Sulfur concentration decreased with plant growth or maturity and reached approximately the same level in both cultivars. Sulfur loss through leaching is a concern in central Oregon, especially on shallow sandy soils. The concentration in both cultivars was adequate even in the conditions of high water application used to produce rough bluegrass.

Comparisons of nutrient uptake between the two cultivars (Table 2) were difficult to make because the final sampling was not made in the 'Cypress' field. The nutrient uptake data show that N and K uptake were similar to each other at both sites, as were P and S uptake. Nutrient uptake from these two sites was similar to the amounts reported by Horneck (1995).

Table 2. Nutrient uptake for 'Cypress' and 'Saber II' rough bluegrass, Madras, OR, 1997.

Sampling Date	N	P	K	S
	----------	lb/a	----------	
Cypress				
4/1	26	2	14	2
4/17	35	3	21	2
5/6	52	5	42	3
5/22	136	17	150	10
6/6	160	19	144	10
Saber II				
4/1	56	5	51	7
4/17	69	6	56	6
5/22	205	26	226	18
6/6	195	30	208	19
6/18	302	49	371	32

The most telling data from this study were not the amount of nutrient taken up, but the marked increase in uptake in early May. Biomass increased rapidly in early to mid-May. At the site where 'Cypress' was planted, N, P, K, and S uptake approximately tripled between the May 6 to the May 22nd sampling. A similar increase was seen at the 'Saber II' site between the April 17 and May 22 sampling dates.

Comparison of biomass and nutrient accumulation can be made by dividing the amount at a sampling date by the amount at the final harvest. This calculation provides a percentage of the total accumulation for any sampling date. At both sites, when 10 to 12 percent of the biomass accumulated, more than twice or 25 percent of the N was already in the plant tissue. By the time 50 to 60 percent of the biomass accumulated, over 70 percent of the N were found in the plant. A similar pattern is found for the other nutrients. Accumulation of 60 to 70 percent of the N, P, K, and S occured by June 1.

Nutrient uptake was in advance of biomass accumulation, and nutrient supply to rough bluegrass before the rapid growth and uptake of early May was essential. Rough bluegrass will take up 150 to 200 lb N/a , 20 to 40 lb P/a, and 150 to 350 lb K/a in 4 to 8 t/a of straw plus seed.

Uptake or accumulation by the crop did not mean that all the nutrients in the crop must or should have been supplied by fertilizer. For N, the rate of fertilizer applied should be less than found in the crop. Soil in other areas of Oregon routinely supplies crops with 100 to 150 lb N/a.

Literature Cited

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EVALUATION OF FUNGICIDES FOR CONTROL OF ERGOT IN KENTUCKY BLUEGRASS, 1998

Marvin Butler, Neysa Farris, Steve N. Alderman, and Fred Crowe

Abstract

Fungicides have been evaluated for ergot control in Kentucky bluegrass (*Poa pratensis*) in central Oregon since 1992. During 1998 a single trial was conducted at the Powell Butte location of the Central Oregon Agricultural Research Center. Although there were no significant differences between treatments, two applications of Quadris were associated with the lowest number of sclerotia of *Claviceps purpurea* per sample. Double fungicide applications generally out-performed single applications at the initiation of anthesis.

Introduction

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

Previous fungicide evaluations in central Oregon during 1992 to 1997 indicate excellent ergot control with Punch, for which there are no plans for registration in the United States. Tilt and Folicur have provided suppression of ergot. As a result of this research, and similar fungicide evaluations by William Johnston at Washington State University, ergot suppression was added to the Tilt label in 1995 through a Special Local Need 24(c) registration. Folicur was recently registered for use on grass seed.

Methods and Materials

During the 1998 season, fungicides were evaluated for control of ergot by trials conducted on 'Coventry' Kentucky bluegrass at the Central Oregon Agricultural Research Center, Powell Butte location. The plot area was infested with ergot at 1 sclerotia/ft^2 on March 12. Sclerotia were place in a freezer for 2 weeks to break dormancy prior to distribution. Single and double applications of Tilt (propiconazole), Folicur (tebuconazole), Quadris (azoxystrobin), Stratego, Flint, BAS 500 00F, and Rally (myclobutanil) were evaluated during the 1998 season. Fungicides were applied at the following rates, Tilt at 6 oz/a, Folicur at 6 oz/a, Quadris at 12 oz/a, Stratego at 10 oz/a, Flint at 2.75 oz/a, BAS 500 00F at 9 oz/a and Rally at 6 oz/a.

Plots 10 ft x 20 ft were replicated four times in a randomized complete block design. Materials were applied using a 9-ft CO_2 pressurized boom sprayer with TwinJet 8002 nozzles at 40 psi and 20 gal/a water. Silwet at 1 qt/100 gal was applied in combination with all fungicides. Treatments were applied on June 12 and June 23, 1998. The first treatments were applied at the initiation of anthesis, followed by the second treatment 11 days later.

One hundred panicle samples were randomly collected from each plot on July 15. Number of panicles with sclerotia, total sclerotia per sample, panicles with honeydew, seed weight, and percentage of germination was determined for each plot.

Results and Discussion

Disease levels were moderate, with an average of 3 sclerotia per panicle in the untreated plots (Table 1). There were no significant differences between treatments at the 95 percent confidence level. The trend, however, indicates that fungicides applied twice generally provided greater disease control than single treatments. This is supported by earlier studies. Quadris applied twice at 12 oz/a was associated with the lowest number of infected panicles and total number of sclerotia. Seed germination appeared to be reduced following two applications of Folicur. This is supported by earlier studies where germination has been significantly reduced following Folicur treatments. Although sample weight was lowest for the double Quadris treatments, a reduction in seed weight following application of Quadris is not supported by 1997 data.

Table 1. Evaluation of fungicide applied for ergot control to 'Coventry' Kentucky bluegrass at the Central Oregon Agricultural Research Center, Powell Butte, OR, 1998.

Fungicide treatments	Rate of Product June 6	June 23	Infected panicles	Total sclerotia	Sample weight	1000 seed weight	Seed germination
	-----fl oz/a-----		no./100 panicles	no./100 panicles	(g)	(g)	(%)
Tilt[1]	6 oz		50	193	6.2	0.40	77
Tilt	6 oz	6 oz	40	94	6.8	0.38	84
Folicur	6 oz		50	223	6.2	0.37	73
Folicur	6 oz	6 oz	37	122	6.6	0.37	61
Quadris	12 oz		57	174	6.4	0.40	84
Quadris	12 oz	12 oz	33	58	6.0	0.37	80
Stratego	10 oz		53	199	6.7	0.38	72
Stratego	10 oz	10 oz	55	199	6.7	0.40	75
Flint	2.75 oz		56	193	6.4	0.38	73
Flint	2.75 oz	2.75 oz	54	181	6.4	0.39	82
BAS 500 00F	9oz		48	148	6.8	0.38	73
BAS 500 00F	9 oz	9 oz	46	114	6.4	0.39	68
Rally	6oz		69	336	6.3	0.41	85
Rally	6 oz	6 oz	48	137	6.4	0.38	85
Untreated	---		56	299	7.2	0.40	82
			n.s.[2]	n.s.	n.s.	n.s.	n.s.

[1] Silwet at 1 qt/100 gal applied with all fungicides.

[2] There were no significant differences between treatments with Student-Newman-Keuls at $P \leq 0.05$.

SENSITIVITY OF *XANTHOMONAS CAMPESTRIS* PV. *CAROTAE* TO COPPER PESTICIDES IN CENTRAL OREGON CARROT SEED FIELDS

Robin Parks and Fred Crowe

Abstract

Bacterial leaf blight of carrot (*Daucus carota* subsp. *sativus*), caused by *Xanthomonas campestris* pv. *carotae*, is a common problem in central Oregon carrot seed fields. Infection by this seedborne pathogen is difficult to prevent and disease management is difficult once established. Because copper-containing products are regularly applied to central Oregon carrot seed fields, the development of copper resistant populations of *X. campestris* pv. *carotae* is a possibility. A survey of carrot seed fields was performed in summer 1998. Isolates of the bacterial pathogen were recovered from symptomatic leaf and umbel tissue. Copper resistance of each isolate was tested using a copper amended media technique. No *X. campestris* isolates collected in 1998 were resistant to copper. In 1999, we will obtain a larger collection, isolating bacteria from a larger number of fields in central Oregon to broaden the scope of inference of this study.

Introduction

Bacterial leaf blight of carrot (*Daucus carota* subsp. *sativus*), caused by *Xanthomonas campestris* pv. *carotae*, is a common problem wherever carrots are grown, including central Oregon. Symptoms include necrotic leaf spots with irregular yellow halos, brown stem and petiole lesions, blighted umbels, and gummy bacterial exudates on stems and umbels. Infection reduces both carrot yield and seed quality. Once established, this disease is difficult to manage. Yet, disease prevention also is difficult because *X. campestris* pv. *carotae* is seedborne and hot water seed treatments may not entirely eradicate the pathogen (Umesh et al, 1998).

Carrot seed has been produced in central Oregon since the 1970s and is regularly the most profitable crop per acre for this region. Planting treated seed to prevent disease may not be effective in seed production fields because new plantings are often adjacent to or very near older plantings. As the pathogen can be disseminated by irrigation water splashes, insects, and carrot refuse, initially healthy seedlings can become infected from nearby fields. The disease has even been observed in isolated plantings suggesting long distance transmission or seedborne inoculum. Copper-containing products are regularly applied each year to reduce disease and increase seed quality. Yet, there is no clear evidence that copper-containing products significantly reduce disease incidence or severity.

A variety of reasons may account for this lack of substantial control of bacterial blight in central Oregon. *X. campestris* pv. *carotae* may systemically infect carrot early in the growing season and therefore cannot be eradicated from the field. Chemical protection is difficult because carrot is susceptible to the bacteria throughout its growth and infection can be continuous throughout the growing season. Lastly, the traditional copper-containing products may not be effective.

The ineffectiveness of these products could be due to the development of resistance in strains of the pathogen. Because copper products have traditionally been used in attempts to manage this disease and may be applied many times during the year, copper resistance is a possibility. Copper resistance has been reported in a variety of plant pathogenic bacteria, including *X. campestris* pathovars pathogenic to other crops including pepper, tomato and walnut (Adaskaveg, 1985; Ritchie, 1991 Lee, 1993). Therefore, we investigated whether copper resistant strains of *X. campestris* pv. *carotae* exist in central Oregon carrot seed fields.

Materials and Methods

Symptomatic carrot plants were collected from eight fields located near Madras, OR between June and July 1998. Bacteria were isolated from leaf and stem lesions and blighted umbel tissue. Symptomatic tissue was macerated and soaked in sterile distilled water to allow bacteria to be released from the tissue. The water was then streaked onto nutrient agar to encourage bacterial growth. Bacteria resembling *Xanthomonas* colonies were selected for copper resistance screening and stored in distilled water at 4 C. Isolates were identified to genus and species using media based physiological tests. For comparison, a known *X. campestris* pv. *carotae* isolate was obtained from Donald Cooksey of the University of California at Riverside.

Copper resistance screening was performed using techniques and agar media designed by Scheck et al (1996) and Anderson et al (1991). Jay Pscheidt of Oregon State University provided *Pseudomonas syringae* pv. *syringae* isolates with known copper sensitivity and resistance levels for the screening media. A known copper resistant strain of *X. campestris* pv. *vesicatoria* was also obtained from D. Cooksey. These three strains were used as copper sensitive and resistant controls in the carrot isolate screening tests.

Bacterial isolates were recovered from frozen storage, suspended in sterile distilled water, and plated onto a media containing CuSO4*H2O at concentrations of 0, 0.16, 0.32, 0.48, 0.64, 0.80, and 0.96 mM. This gradient of copper concentrations was used because bacterial copper resistance is quantitative. Cultures were incubated at 23 C for 72 h. The minimum copper concentration that prevented colony growth was recorded. Isolates that could grow at or above 0.32 mM $CuSO_4{*}H_2O$ were considered resistant. Three replicates per isolate were used and each test was performed three times.

Results and Discussion

Of the eight fields from which carrots were collected, *Xanthomonas*-like bacteria was isolated from six locations. Twenty-two isolates were recovered from symptomatic tissue and 10 were characterized as *X. campestris*. No isolate grew on media containing more than 0.16 mM $CuSO_4{*}H_2O$. Therefore, all *X. campestris* isolates were sensitive to copper.

This was a limited field survey and resulted in a small number of *X. campestris* isolates. The results from this limited collection and screening of bacteria from central Oregon carrot fields do not suggest that copper resistant strains exist in the region. But with approximately 3000 acres of carrot seed in central Oregon, more fields should be surveyed to broaden the inference of this study.

In 1999, we will collect symptomatic plants from a larger number of fields. As a copper screening method has now been developed, a large number of isolates can be tested. In addition, laboratory techniques will be modified to increase the recovery of bacteria from plant tissue. By determining whether copper resistant *X. campestris* pv. *carotae* populations exist in central Oregon, the most effective disease management strategies, chemical or cultural, can be developed for bacterial leaf blight.

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EVALUATION OF SIMULATED HAIL DAMAGE TO SEED CARROTS AND ONIONS IN CENTRAL OREGON, 1998

Marvin Butler and Neysa Farris

Abstract

This is the third year of a multiyear study to determine the effect of simulated hail damage on yield of seed carrots (*Daucus carota*) and onions (*Allium cepa*),. Timing and severity of damage were evaluated at the time of bee introduction with 33 and 67 percent damage, and at bee removal with 33 and 67 percent damage. Late season damage caused greater yield reductions than early season damage for both carrots and onions. For carrots 16 percent of the seed came from primary umbels, 60 percent from secondary umbels, and 24 percent from tertiary umbels. There were no differences in seed germination between treatments for either carrots or onions.

Introduction

Vegetable seed production is an integral part of agriculture in central Oregon. Crops for the 1998 season included 2,600 acres of garlic, 3,000 acres of carrots, 200 acres of onions, 35 acres of radishes, 860 acres of coriander, and 250 acres of Chinese brassicas for a total acreage over 7,000. These high value crops are the backbone of profitable agricultural production in the area.

Carrots are predominantly hybrid varieties grown in a single row per bed, with typically 4 rows of females and 2 rows of males with blank rows between. The primary (king) umbel is the first to develop, followed by the secondary umbels, and then the tertiary umbels. The primary umbel typically has the largest, most vigorous seed, and itis expected to account for 8-12 percent of production. Many carrot varieties continue to produce additional heads throughout the growing season.

All onions grown during 1998 were hybrid varieties grown in double rows per bed, generally in a 6-row female, 2-row male configuration with blank rows between. Seed heads are generally 2-3 in. in diameter, and the plant has no way of producing additional heads to compensate for ones that are damaged or destroyed.

Methods and Materials

This is the third year of a multiple year evaluation on the effect of simulated hail damage to seed carrots and onions. The study has been conducted in commercial fields, and for the first time plots were placed in the female rows. In the past the male rows have been used so seed yield and grower income would not be reduced. Plots were a single row x 10 ft for carrots and a single row x 5 ft for onion. Plots were reduced in length from previous year, but were chosen from uniform portions of the row to reduce variability. Treatments were replicated 3 times in a randomized complete block design.

Variables evaluated in this study included timing and extent of damage. Treatments were applied with a weed eater held on edge to simulated hail damage from above. This was done June 25 and August 11, 1998 just before then after the introduction and removal of bees for crop pollination. The five treatments included an untreated check, early light damage (33 percent), early heavy damage (67 percent), late light damage (33 percent), and late heavy damage (67 percent).

Onions plots were harvested August 19, and carrots were harvest August 20. Mature heads in each plot were harvested by hand and allowed to dry in open containers. In the untreated carrot plots, umbels were separated by position to determine the percentage of seed from primary, secondary, and tertiary umbels. Samples were thrashed and cleaned at the seed-conditioning lab of the USDA-ARS National Forage Seed Production Research Center in Corvallis, Oregon.

Results and Discussion

The effect of the simulated hail damage on seed yields for carrots is provided in Table 1. Significantly higher yields were observed following early light (672 g) and early heavy (621 g) damage compared to untreated (533 g) plots. In 1997 early light damage produced 774 g of cleaned seed compared to 678 g for the untreated, while yields were reduced to 596 g for early heavy damage. This increase in seed yields from light damage at the time of bee introduction was not supported by the 1996 data. Umbel damage following bee removal significantly reduced seed yield to 341 g for light damage and resulted in another significant drop to 167 g for heavy damage.

For 1998 there were no statistically significant differences between simulated hail damage treatments on seed onions. However, there was a strong trend with untreated plots producing 860 mg of seed per head compared to 730 mg for early light damage and 520 mg for early heavy damage. Late light damage (700 mg) was similar to early light damage (730 mg), while late heavy damage (320 mg) yielded only about a third of the seed from untreated plots (860 mg).

The amount of carrot seed from primary, secondary, and tertiary umbels is provided in Table 3. Primary umbels produced 16 percent of the seed, secondary umbels produced 60 percent, and tertiary umbels produced 24 percent. If the stage of development is known when hail damage occurs, having determined the percentage of total yield contributed by each order of umbel could be an important indicator of yield loss.

Seed germination percentages were unaffected by simulated hail treatments for both carrots and onions. This is supported by data from the previous two seasons.

Table 1. Effect of 33 and 67 percent simulated hail damage applied with a weed eater to seed carrots June 25 and August 11 near Madras, Oregon, 1998.

Treatment	Clean seed weight	Germination
	(g)	(%)
Untreated	533 b	87
Early Light	672 a	90
Early Heavy	621 a	78
Late Light	341 c	89
Late Heavy	167 d	69
		n.s.

Table 2. Effect of 33 and 67 percent simulated hail damage applied by hand to seed onions June 25 and August 11, near Madras, Oregon, 1998.

Treatment	Seed weight per head	Germination
	(mg)	(%)
Untreated	860	91
Early Light	730	93
Early Heavy	520	92
Late Light	700	90
Late Heavy	320	89
	n.s.	n.s.

Table 3. Portion of seed yield in untreated plots attributable to primary, secondary, and tertiary umbels, near Madras, Oregon, 1998.

Umbel	Seed weight	% of Total
	(g)	
Primary	84 c	15.8
Secondary	318 a	59.7
Tertiary	131 b	24.6

EVALUATION OF HERBICIDES FOR WEED CONTROL IN SEED ONIONS, 1998

Marvin Butler, Brad Holliday and Neysa Farris

Abstract

Prowl (pendimethalin) alone and in combination with Ramrod (propachlor) was applied to onions (*Allium cepa*) grown for seed in Madras, OR, in 1998. The best control across weed species was Prowl plus Ramrod with 99 percent control of redroot pigweed (*Amaranthus retroflexus*) and common mallow (*Malva neglecta*), 97 percent control of common purslane (*Portulaca oleracea*) and volunteer carrots (*Daucus carota*), 93 percent control of hairy nightshade (*Solanum sarrachoides*), and 88 percent control of shepherdspurse (*Capsella bursa-pastoris*).

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 preemergence application of Prowl alone and in combination with Ramrod. Ramrod is currently one of the few herbicides registered for use on seed onions.

Methods and Materials

Herbicide treatments were Prowl at 1 pt/a, Prowl at 2 pt/a, and Prowl at 1 pt/a plus Ramrod at 5 qt/a. Herbicides were applied after planting before the first irrigation July 22. Treatments were applied with a CO_2-powered boom sprayer at 40 psi and 20 gal/a water. Plots 10 ft x 20 ft were replicated two times in a randomized complete block design. Plots were evaluated August 19 for control of redroot pigweed (*Amaranthus retroflexus*), hairy nightshade (*Solanum sarrachoides*), volunteer carrots (*Daucus carota*), shepherdspurse (*Capsella bursa-pastoris*), common purslane (*Portulaca oleracea*), and common mallow (*Malva neglecta*).

Results and Discussion

Results from herbicide applications are provided in Table 1. The best control across weed species was Prowl at 1 pt/a plus Ramrod at 5 qt/a with 99 percent control of redroot pigweed and common mallow, 97 percent control of common purslane and volunteer carrots, 93 percent control of hairy nightshade, and 88 percent control of shepherdspurse. Prowl alone at 2 pt/a provided 95 percent control of common mallow, 93 percent control of hairy nightshade, but inadequate control of the other weed species. Prowl at 1 pt/a provided inadequate control of all weeds evaluated.

Table 1. Effect of preemergence treatment of herbicide applied to seed onions July 22 and evaluated on August 19, 1998, Madras, OR.

Treatment	Rate	Redroot pigweed	Hairy nightshade	Volunteer carrots	Shepherdspurse	Common purslane	Common mallow
		(% control)					
Prowl	1 pt	10	18	30	20	15	8
Prowl	2 pt	63	93	0	63	70	95
Prowl +Ramrod	1 pt 5 qts	99	93	97	88	97	99

EVALUATION OF SIMULATED HAIL DAMAGE TO SEED CARROTS AND ONIONS IN CENTRAL OREGON, 1997

Marvin Butler

Abstract

This is the second year of a multiyear study to determine the effect of simulated hail damage on yield of seed carrots and onions. Timing and severity of damage were evaluated at early pollination with 33 and 66 percent damage and at post-pollination with 33 and 66 percent damage. Late season damage appeared to reduce yields compared to early season damage for both carrots and onions. The lowest yields were from plots with heavy damage (66 percent) compared to light (33 percent) damage. No differences in seed germination were observed.

Introduction

Vegetable seed production is an integral part of agriculture in central Oregon. Crops for the 1997 season included 2,500 acres of both carrots and garlic, 400 acres of onions, 200 acres of radishes, 450 acres of coriander, and 200 acres of both Chinese kale and flowers for a total acreage near 6,000. These high value crops are the backbone of profitable production in the area.

Carrots are predominantly hybrid varieties grown in a single row per bed, with typically 4 rows of females and 2 rows of males with blank rows between. The primary (king) umbel is the first to develop, followed by the secondary umbels, and then the tertiary umbels. The primary umbel typically has the largest, most vigorous seed and accounts for 8-12 percent of production. Many carrot varieties continue to produce additional heads throughout the growing season.

Onions are largely hybrid varieties grown in double rows per bed, generally in a 6-row female, 2 row male configuration with blank rows between. Seed heads are generally 2-3 inches in diameter, and the plant has no way of producing additional heads to compensate for ones that are damaged or destroyed.

Methods and Materials

This is the second year of a multiple year evaluation on the effect of simulated hail damage to seed carrots and onions. The study has been conducted in commercial fields using the male rows of hybrid seed production, so as not to reduce seed yield and grower income. Plots were a single bed (1 row of carrots, 2 rows of onions), replicated 3 times in a randomized complete block design. Plant were hand-thinned to 10 carrot plants per plot, and 30 onion plants per plot during late spring to reduce stand variability in the plots.

Variables evaluated in this study included timing and extent of damage. Treatments were applied with a weed eater held on edge to simulated hail damage from above. This was done July 9 and August 14, 1997 just before and after the introduction and removal of bees for crop pollination. The five treatments included an untreated check, early light damage (33 percent), early heavy damage (67 percent), late light damage (33 percent), and late heavy damage (67 percent).

Onions plots were harvested August 25, and carrots were harvest August 27. In the untreated carrot plots, umbels were to be harvested separately by position to determine the percentage of each. Inadvertently, the primary and secondary umbels were grouped together, and the tertiary umbels were kept separate. Mature heads in each plot were harvested by hand and allowed to dry in open containers. Samples were thrashed and cleaned at the seed-conditioning lab of the USDA-ARS National Forage Seed Production Research Center in Corvallis, Oregon.

Results and Discussion

The effect of the treatments on seed set for both carrots and onions is provided in Table 1 and 2. Carrot seed yields were not reduced with one third of the heads damaged at the beginning of pollination, but were reduced by 12 percent when two thirds of the heads were destroyed. One-third and two-thirds damage following pollination reduced seed yield by 14 and 42 percent, respectively. The early damage had less influence on yield than later damage, as the plant was able to recover from early damage by producing additional umbels.

The amount of carrot seed from primary, secondary, and tertiary umbels is shown in Table 3. Thirty-eight percent of seed yield is set by the primary and secondary umbels, while 62 percent came from the tertiary umbels. If the stage of development is known when hail damage occurs, knowing the percentage of total yield contributed by each umbel level can provide an additional indicator of the amount of yield loss one would expect.

Onion seed production was reduced by 14 and 32 percent with one-third and two-thirds of the heads destroyed at the beginning of pollination. At the end of pollination one-third and two-thirds damage reduced seed yield by 42 and 50 percent compared to the undamaged plots. Although the onion has no way of producing additional heads, it would appear that they are able to compensate for early damage, perhaps through increasing the size of remaining seed to increase weight.

Seed germination percentages were unaffected by simulated hail treatments for both carrots and onions.

Table 1. Effect of 33 and 67 percent simulated hail damage applied with a weed eater July 9 and August 14 on seed carrots near Madras, Oregon, 1997.

Treatment	Clean seed weight	Germination
	(g)	(%)
Untreated	678	80
Early light	774	82
Early heavy	596	77
Late light	581	79
Late heavy	397	82
	NS[1]	NS

[1]NS = no statistical difference between treatments with Student-Newman-Keuls ($P \leq 0.05$).

Table 2. Effect of 33 and 67 percent simulated hail damage applied with a weed eater July 9 and August 15 on seed onions near Madras, Oregon, 1997.

Treatment	Seed weight	Germination
	(g)	(%)
Untreated	105 a[1]	86
Early light	90 a	87
Early heavy	71 b	82
Late light	60 b	80
Late heavy	52 b	89
		NS

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

Table 3. Portion of seed yield in untreated plots attributable to primary and secondary umbels compared to tertiary umbels near Madras, Oregon, 1997.

Umbel	Seed weight	% of Total
	(g)	
Primary/Secondary	895 a[1]	38
Tertiary	82 b	62

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

Observation Trial of Some Late-Planted Seed Vegetables

Peter Sexton and Marvin Butler

Introduction

Production of vegetable seeds is one of the mainstays of the farming economy in central Oregon. In response to a request from a local seed business, some lines of mustard (*Brassica juncea*), radish (*Raphanus sativus*), and Swiss Chard (*Beta vulgaris*) were planted to see how well they would set seed under central Oregon conditions. The seed was received in May and so was late-planted.

Methods

Seed were hand planted in 2 row plots, 4.5 m (15') long, laid out in a randomized complete block design with four replications at Madras. At Powell Butte the trial was laid out with single-row plots, 3.0 m long, with two replications. Fertilizer was applied prior to planting at the rate of 80 lbs N and 30 lbs S per acre. A topdress of 45 lbs N per acre was applied to both plots on 19 June. Carbaryl (Sevin) powder was applied at both sites on 9 June for control of flea beetle. Chlorpyrifos (Lorsban) was applied on 8 July at Madras and 22 July at Powell Butte for control of cabbage maggot. Because the purpose of the trial was mainly to look at flowering and initial seed set, the trial was not carried to maturity. The trial at Powell Butte was tilled in on 14 August. The trial at Madras was tilled in on 9 September. As some of the mustards had matured by then at Madras, the whole plots were harvested by hand, allowed to dry in the field, and threshed in a stationary thresher.

Results

Flowering and maturity dates, and where available, seed-yield data are presented in Table 1. The main insect problems encountered were flea beetles soon after emergence, and later cabbage maggots when the roots became fleshy. The mustard varieties showed large differences in susceptibility to flea beetles. The Powell Butte environment was a little more stressful (coarser soils) for the plants, and some of the mustard appeared to flower better there, suggesting that water stress (and perhaps N deficiency) might promote flowering of some of these varieties. Circumstances did not permit early planting in 1998, but if this or similar trials are repeated next year then early planting, or better yet a range of planting dates, should be planned for.

Table 1. Seed production of certain vegetables at Madras and Powell Butte under late planting (May 13, and 14, at Madras, and Powell Butte, respectively). The plots were tilled under on August 14, and September 9, at Powell Butte, and Madras, respectively.

Variety	Flowering	Maturity	Seed Yield	Problems
Madras:	(DAP)	(DAP)	(lbs/acre)	
Red Mustard	65	112	1000	watering, wilts easily
Mustard '98003'	---	---	---	didn't flower; some crown rot
Red Swiss Chard	80	---	---	uneven bolting
OP Radish '98034'	94	---	---	bolted late; maggots; soft rot
Mustard '98002'	68	118	320	
Mustard '98001'	62	120	710	flea beetle early
Hyb. Radish '98035'	49	115	180	maggots
Powell Butte:				
Red Mustard	67	---	---	
Mustard '98003'	69	---	---	uneven bolting
Red Swiss Chard		---	---	
OP Radish '98034'	---	---	---	didn't bolt; maggots; soft rot
Mustard '98002'	69	---	---	
Mustard '98001'	62	---	---	flea beetle early
Hyb. Radish '98035'	49	---	---	maggots

EVALUATION OF PREEMERGENCE HERBICIDES ON DRY BEANS, 1998

Marvin Butler, Ed Clark, and Neysa Farris

Abstract

Eight herbicide treatments were evaluated in a commercial pinto bean field near Prineville, OR. Most treatments were applied preemergence, however Eptam plus Frontier was applied postplant, preemergence, and a treatment of Frontier was applied postemergence following a commercial preemergence application of Sonalan (ethalfuralin) plus Eptam (EPTC). The two treatments providing the best control of field bindweed, redroot pigweed and lambsquarters were Micro-Tech (alachlor) plus Sonalan and Frontier (dimethenamid) following Sonalan plus Eptam.

Introduction

Dry beans were grown commercially in central Oregon in 1998 for the first time in recent years. Pintos, reds, and pinks were grown on over 1,000 acres, with an average yield near 2,300 pounds per acre. The objective of this project was to evaluate several herbicide combinations applied preemergence to develop an effective weed control strategy for central Oregon in dry bean crops.

Methods and Materials

Eight herbicide treatments were evaluated in a commercial field of Agassiz pinto beans near Prineville with Ed Clark of UAP Pacific and Brian Barney, grower cooperator. Most preemergence herbicide applications were made June 17. However, Eptam plus Frontier was applied postplant, preemergence on June 22, and Frontier was applied postemergence July 7, following the commercial preemergence application of Sonalan plus Eptam on June 17. Treatments were applied with a CO_2 pressurized, hand-held boom sprayer at 40 psi and 20 gal/a water. Plots 20 ft x 30 ft were replicated three times in a randomized complete block design. Treatments applied June 17 were incorporated with a commercial disking operation shortly after application. Later applications were incorporated by sprinkler irrigation.

Plots were evaluated for stunting July 7 and July 22 and for weed control July 22 and August 18. Weeds evaluated July 22 were field bindweed, redroot pigweed and common lambsquarters. Overall weed control was evaluated August 18 for weeds that were able to push through the crop canopy.

Results and Discussion

Results of the herbicide applications are provided in Table 1. Micro-Tech plus Sonalan and Frontier applied postemergence over the top of Eptam plus Sonalan provided the best control across all evaluations, and these combinations were the only herbicides to provide adequate control (97 percent) against field bindweed. All treatments were effective (98-100 percent) against redroot pigweed and common lambsquarters except Micro-Tech alone (80, 78 percent) or in combination with Eptam (93, 83 percent). Overall control evaluated August 18 was excellent for all treatments (98-100 percent) except Micro-Tech alone (85 percent), and in combination with Eptam (94 percent) or Treflan (96 percent). No stunting was observed due to treatments on any of the evaluation dates.

Table 1. Effect of herbicide applications on dry beans near Prineville, OR, 1998.

		Weed control[1]			
Treatment[2]	Rate	Field bindweed	Redroot pigweed	Common lambsquarters	Overall control[3]
	product/a	percent			
1. Micro-Tech	3.0 qt	38 ab[4]	80 b	78 b	85 b
2. Micro-Tech	2.5 qt	72 a	93 a	83 b	94 a
+Eptam	1.0 qt				
3. Micro-Tech	2.5 qt	97 a	100 a	99 a	99 a
+Sonalan	1.5 qt				
4. Micro-Tech	2.5 qt	74 a	98 a	99 a	96 a
+Treflan	1.0 qt				
5. Eptam	2.5 pt	73 a	100 a	100 a	99 a
+Sonalan	4.0 pt				
6. Eptam	3.5 pt	88 a	100 a	100 a	99 a
+Sonalan	4.5 pt				
7. Eptam	1.5 pt	62 a	100 a	98 a	98 a
+Frontier[5]	4.0 pt				
8. Frontier[6]	1.5 pt	97 a	100 a	100 a	98 a
+Sonalan	2.5 pt				
+Eptam	4.0 pt				
9. Untreated	---	0 b	0 c	0 c	0 c

[1]Visual evaluation was conducted on July 22, 1998.
[2]Treatments were applied on June 17, 1998 except for treatment 8.
[3]Visual evaluation was conducted on August 18, 1998.
[4]Mean separation with Student-Newman-Keuls ($P \leq 0.05$).
[5]Treament 7 was applied post plant/preemergence on June 22, 1998.
[6]Frontier was applied postemergence on July 7, 1998 following preemergence herbicides, Sonalan and Eptam, applied commercially.

MODELING DRY BEAN AND SOYBEAN YIELDS IN CENTRAL OREGON

Peter Sexton and Neysa Farris

Abstract

Farmers experimented with both soybean and dry bean as new crops for central Oregon in the 1998 season. While both performed well in 1998, the summer was warmer than most and there is some doubt as to how they would perform in a more typical year. In order to estimate how these crops would produce over time, yields were predicted from 1979 to 1998 by running weather data from Prineville and Madras areas through the CROPGRO simulation model. The CROPGRO model predicted that soybean yields would be variable due to cool temperatures. The maturity group 00 soybeans were predicted to have the best performance over time with a predicted average yield of 43 bushels per acre across the 20 year period. The model predicted that dry beans would give more consistent yields than soybeans, but that frost at the end of the season will be a hazard that will need to be considered (depending on location and variety grown).

Introduction

There is increasing interest in growing soybean (*Glycine max*) and dry bean (*Phaseolus vulgaris*) as alternative crops in central Oregon. Soybean is known to have poor tolerance for cool temperatures (less than 55°F) during pod set (Hume and Jackson, 1981). Dry bean is susceptible to frost damage throughout its life-cycle. Crop modeling provides one way to obtain an initial estimate of how well these crops may do with the relatively cool temperatures of central Oregon. The CROPGRO model predicts daily growth, days to flower and maturity, and seed yield for soybean and dry bean (Boote et al., 1997). Rate of development of the crop is estimated each day based on temperature and photoperiod. The model requires inputs of genetic coefficients for each variety, daily weather data, and soil type. Genetic coefficients for each variety have to be developed or calibrated for the model. Weather data was obtained from the Oregon Climate Service for Madras and Prineville locations, where available, from 1979 through 1998 and used to simulate dry bean and soybean yields at the two locations.

Materials and Methods

The model used for the simulation analysis was the CROPGRO series of models found in DSSAT version 3.5 (IBSNAT, University of Hawaii, Honolulu, HI). Weather data for 1979 through 1998 at Prineville and Madras were obtained from the Oregon Climate Service web site (www.ocs.orst.edu). Years where there were substantial gaps in the weather data were dropped from the simulation analysis. Missing values were estimated by using the average of the adjacent data points. Soil type used was a standard one given in the model for a "shallow sandy loam" with a depth of 60 cm. For soybean simulation, standard genetic coefficients given for generic maturity group 000, 00, 0, 1, 2, and 3 varieties already in the model were used. For dry bean, three contrasting genotypes already in the model were used with modification to make their predicted time to maturity for 1998 match that observed in the variety trial at Madras (also in this report). The three genotypes were: 'Canadian Wonder', 'UI 114 Pinto', and 'Seafarer'. Each line was calibrated to have a predicted flowering date of 42 to 43 days after planting (DAP) in 1998. Physiological maturity for each line was then calibrated to both 93 and 87 DAP (so there was a set of 6 hypothetical dry bean varieties) by modifying time from seed set to physiological maturity. The 93 DAP maturity date came directly from the variety trial data gathered in 1998. The 87 DAP value was added because it appeared that cutting off irrigation earlier might have brought about more rapid maturity - so to give a broader base to the analysis, the 87 DAP maturity date was also calibrated for. Other than these two phenological traits, no other genetic coefficients were changed in the model. All model runs were made with a 1 June planting date. All results for dry bean are presented as the mean of the 6 hypothetical varieties. Soybean data are presented by maturity group. All yield data is set at 12 percent moisture. The model was set to irrigate 40 mm (1.6") of water every 4 days from the end of June through the first week of September at Madras. For this same period at Prineville the model was set to irrigate 20 mm of water (0.8") every four days, except in 1981 when it was set to 40 mm (the model didn't predict drought stress for the other years at Prineville, so the irrigation amount was left at 20 mm).

Results and Discussion

Soybean. Model results should only be taken as estimates to get a general idea of how soybeans may perform in central Oregon. The mean and range of predicted soybean yields and time to maturity for each maturity group are given in Table 1. The model predicted that varieties with maturity group 00 (adapted to northern Minnesota and North Dakota in the Midwest) would give the greatest average yield over the 20-year period with yield being near 50 bushels per acre in good years and less than 20 bushels per acre in poor years. Looking at variation across the period (Fig. 1), the model predicts that 1993 would have been a particularly poor year with yields less than 20 bushels per acre. The last season, 1998, was better than most. In terms of season duration, frost was predicted 1 year out of 5 at the end of the season; however, the frosts came late enough that they probably wouldn't be a limitation for soybeans.

These model predictions suggest that central Oregon may be too cool to get consistent yields from soybeans. Cold tolerance will be an important trait for any variety to do well here. Also, if higher-value soybeans, such as varieties used for tofu or tempe could be grown here, it would increase the margins in better years and might justify the risk of periodically having a poor year. Future research with soybean in central Oregon should probably focus on identifying cold-tolerant, food (or some other high-value) soybean varieties.

Table 1. Range and mean of soybean yields and time to maturity predicted by the CROPGRO model for 6 maturity groups of soybean grown at Madras over a 20 year period (1979-1998). The model predicted that maturity group 2 would not reach maturity in most years, and that group 3 would not in any year, therefore their times to maturity are indicated on the table as "n/a".

Maturity	Seed yield			Time to maturity		
Group	Least	Average	Greatest	Least	Average	Greatest
	(bu/acre)			(DAP)		
000	22.2	41.6	51.6	97	104	111
00	18.9	43.3	54.0	101	108	115
0	10.3	40.6	57.0	108	116	125
1	6.9	34.5	55.7	116	124	131
2	0.8	19.1	52.5	127	n/a	n/a
3	0.0	5.4	26.0	n/a	n/a	n/a

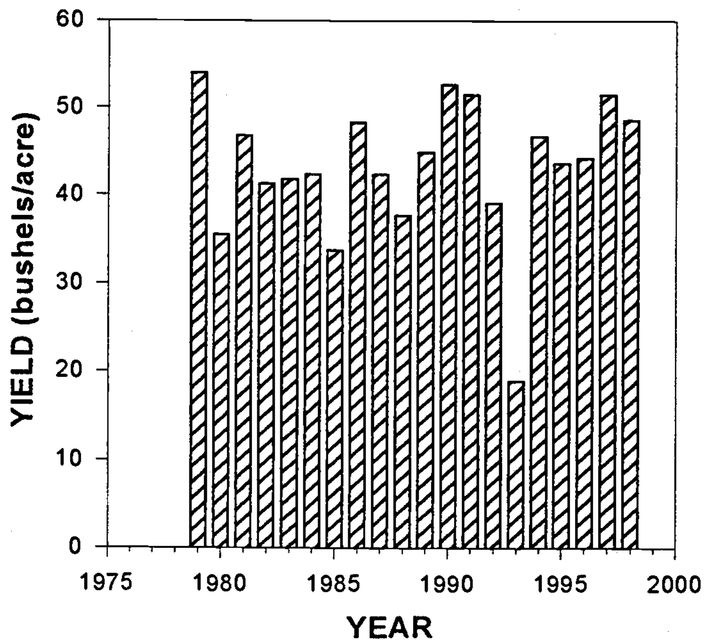

Figure 1. Predicted yield of a standard maturity group 00 variety simulated over a 20 year period with the CROPGRO computer model. The model predicted low yields for 1993 because of cool night temperatures during pod set that season. The average predicted yield across the 20 year period was about 43 bushels per acre. Note that 1998 was a better year than most.

Dry Beans. The dry bean model is not as well tested as the soybean one, so results should only be taken as general estimates of dry bean performance in central Oregon. Comparing predicted yield to actual for the dry bean variety trial at the Madras experiment station, the model was within 10 percent of actual values (4500 lbs per acre predicted, versus 4230 lbs per acre actual average yield for the 10 best lines in the trial). However, yields on commercial fields in the area were typically closer to 2600 lbs per acre, so the dry bean model over-predicted yield relative to what might be expected in a production environment. The model doesn't predict yield losses due to disease or shattering at harvest. Because of the uncertainty of the model predictions, 1998 will be used as a benchmark for evaluating results.

The model predicted that 1998 was a typical season for yield at Madras (about 90 percent of the 20-year predicted average; Fig. 2), and a better year than most at Prineville (Fig. 3). In terms of season length, 1998 was the shortest predicted season in the 20-year period at both sites, about 5 days shorter than predicted average at Madras, and about 7 days shorter than predicted average at Prineville. This was because July and August had higher temperatures than normal in 1998. The model predicted occurrence of frost at the end of the season one year out of five at Madras. Given that this occurred at the end of the season, it is not clear what effect this would have on the value of the crop. The frosts occurred late enough that seed yield would probably not be greatly affected, but whether it would affect the pigmentation of the seed or not is uncertain. The model predicted frost 8 years out of 15 at Prineville with 6 of these frosts occurring at the end of the season and 2 occurring early in the season. The two frosts which occurred early in the season (second and third week of June) resulted in zero predicted yield in 1991 and 1996. Again it is unclear what effect, if any, the frosts at the end of the season might have on the value of the crop. The weather data for Prineville was collected at the KRCO station, which is reported to be a relatively cooler part of the Prineville area. Areas with a warmer microclimate than the KRCO radio station would stand less risk than the model indicates.

In conclusion, results of the dry bean simulation indicated that farmers may expect fairly similar yields to what they obtained in 1998 in the future, as long as the crop is not subject to frost. According to the model, the average growing season for dry bean in central Oregon will be 5 to 7 days longer than that observed in 1998. Obviously, short duration will be an important trait for varieties to do well in this area.

Literature Cited

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Hume, D. J., and K. H. Jackson. 1981. Pod formation in soybeans at low temperatures. Crop Sci. 21: 933-937.

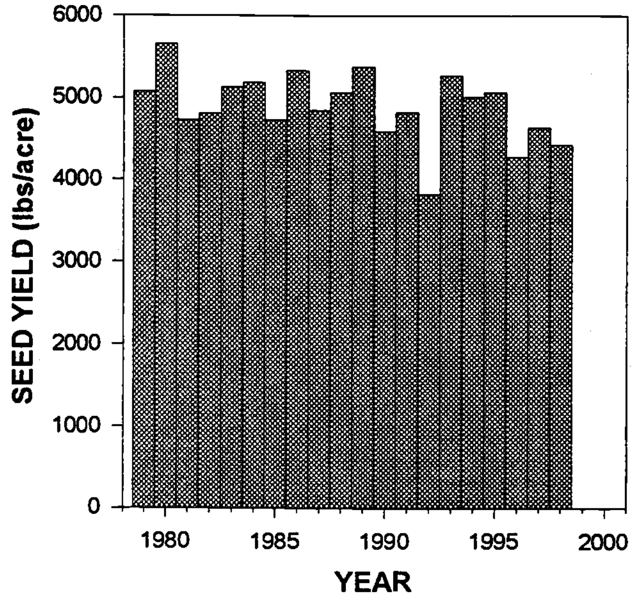

Figure 2. Predicted dry bean yields at Madras, 1979-1998, as simulated by the CROPGRO model.

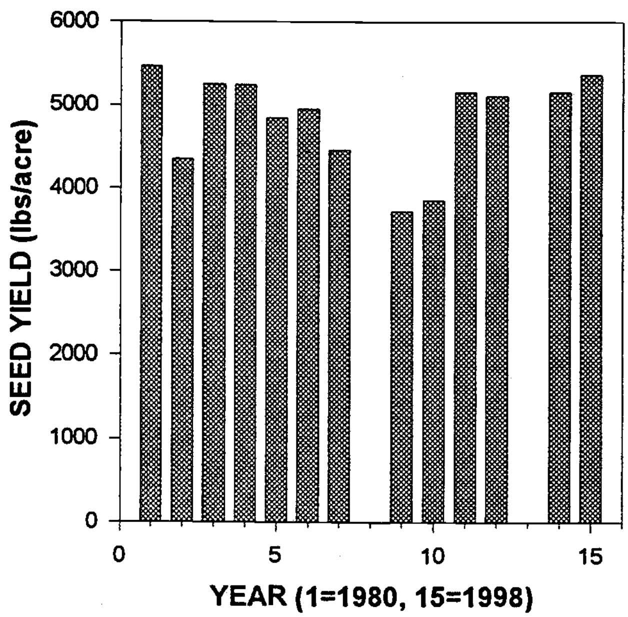

Figure 3. Predicted dry bean yields at Prineville, 1980-1998 (with skips) as simulated by the CROPGRO model. In two years (1991 and 1996), the model predicted no yield due to frost damage early in the season. The years 1983, 1984, 1987, and 1988 were not simulated due to lack of weather data.

1998 MADRAS DRY BEAN VARIETY TRIAL

Peter Sexton

Abstract

Twenty varieties of dry bean were evaluated for yield and time to maturity at the Madras experiment station. Yields were high averaging 3680 lb per acre across all twenty lines. The time from planting to maturity averaged 93 days. Data on days to flower, maturity, seed-size and yield are presented for the 20 varieties in the trial.

Introduction

Dry bean (*Phaseolus vulgaris*) is a new crop for central Oregon with several hundred acres (mostly pintos and small red market classes) being planted in the region in 1998. To support this effort it was decided to evaluate different varieties for their adaptation to central Oregon.

Materials and Methods

Twenty varieties of dry bean were assembled with the goodwill of Ken Grafton (North Dakota State Univ.), Phil Miklas (USDA-ARS, Prosser, WA), Kathy Stewart-Williams (University of Idaho), and Ed Lamens (KBC Trading, Othello, WA):

1) USRM-11	7) AGASSIZ	13) USPT-73	19) UI911
2) R93-365	8) UI537	14) GLACIER	20) UI320
3) EMBER	9) OTHELLO	15) USWA-12	
4) NW63	10) CAMINO	16) USWA-33	
5) FLAMINGO	11) BURKE	17) CELRK	
6) ROZA	12) BILLZ	18) KARDINAL	

Plots consisted of four rows 6.1 m (20') long with a 0.61 m (24") row spacing. Plots were arranged in a randomized complete block design with four replicates. The herbicides S-ethyl dipropylthiocarbamate (Eptam) and ethalfluralin (Sonalan) were preplant incorporated for weed control. Plots were planted on 16 June 1998 at a population of 215,000 seeds ha^{-1} (4 seeds per foot of row). Sulfur and N were broadcast at the rates of 55 and 52 kg ha^{-1}, respectively, and tilled into the soil before planting. Aldicarb was applied in the seed furrow at planting at a rate of 8 kg ha^{-1}. Chlorpyrifos (Lorsban) was applied on 9 July 1998 due to problems with insects feeding on the roots of the seedlings. An additional top-dressing of 47 kg N ha^{-1} was broadcast at flowering as urea. The trial was irrigated to avoid drought stress, and all plots were hand-weeded as necessary.

When plants were fully mature (90 percent or more of the pods turned color), the center 3.05 m (10') of the center two rows were uprooted by hand and, if dry, were bagged immediately or else left in the field to dry and be bagged later. Some plots had gaps due to damage from maggots prior to emergence. In these plots, damaged areas were avoided, and so smaller areas were harvested while trying to maintain some border around sample areas. Samples were allowed to air dry and then threshed in a stationary thresher (Stevens Equipment Co., Salem, Oregon). Seed samples were screened and stored in paper bags for weighing. Seed moisture content was determined from single samples bulked across replicates for each variety.

Results and Discussion

The weather was relatively cool immediately following planting, and we did not get 50 percent emergence until 10 days after planting. Initially there were severe stand reductions in some plots due to seed maggots that burrowed into germinating cotyledons and young roots. Other than this initial problem the trial went well. Yield data for all the lines, sorted according to market class, are presented in Table 1. The varieties Ember and Agassiz which were produced by area farmers performed well in the trial. Yields obtained on farmers fields were typically around 2600 pounds per acre, whereas the average in this trial was about 40 percent greater than that. Central Oregon is cooler than some other dry bean growing areas. A cooler growing period suggests that beans may provide greater yields and greater seed-size than in warmer areas (Sexton et al., 1994); however, the extended growing period associated with cool weather also implies greater risk of frost.

Literature Cited

Sexton, P.J., J.W. White, and K.J. Boote. 1994. Yield-determining processes in relation to cultivar seed size of common bean. Crop Sci. 34: 84-91.

Table 1. Days to flower and to physiological maturity, plants per acre, seeds per pound, seed yield and lodging score for 20 varieties of dry bean grown in a variety trial at the COARC, Madras, 1998. Lines are sorted according to market class and yield. Lodging was scored on a 1 to 5 basis with 1 being 0-20 % lodged and 5 being 80-100 percent lodged. Plants were considered as "lodged" if they were leaning over 45° or more.

Variety	Class	Flower	Maturity	Plants per acre	Seeds per Pound	Yield	Lodging
		(DAP)	(DAP)			(lbs/acre)	
EMBER	RM	42	91	44230	1200	4940	4.0
USRM-11	RM	42	89	52820	1220	4350	3.5
R93-365	RM	44	92	41440	1254	4220	2.5
NW63	RM	39	93	47370	1391	3580	5.0
OTHELLO	PINTO	39	91	51460	1146	4880	4.8
AGASSIZ	PINTO	44	88	57950	1117	3930	2.0
BURKE	PINTO	44	97	41430	1098	3700	4.8
CAMINO	PINTO	44	90	53670	1198	3680	2.5
USPT-73	PINTO	42	92	47250	1043	3490	3.8
UI320	PINTO	42	89	57620	993	3370	4.0
BILLZ	PINTO	44	94	44650	1298	3350	4.5
UI537	PINK	42	94	55050	1278	4430	4.8
FLAMINGO	PINK	42	92	47000	1214	3940	5.0
ROZA	PINK	46	97	49010	1423	2660	5.0
CELRK	LRK	41	94	40950	757	4240	1.3
USWA-33	LRK	44	93	49310	790	2840	1.0
KARDINAL	LRK	44	95	54990	777	2590	1.3
GLACIER	GN	46	94	44240	1280	3340	3.0
USWA-12	GN	44	99	43150	1092	2960	4.0
UI911	BLACK	44	95	43830	2370	3080	3.0
Mean		43	93	48370	1197	3680	3.5
LSD (0.05)						916	1.1
CV (%)						17.5	21.6

STATE-WIDE CEREAL VARIETY TESTING PROGRAM TRIALS IN CENTRAL OREGON

Ernie Marx, Russ Karow, Mylen Bohle, and Steven R. James

ABSTRACT

Grain variety trials were conducted at Madras, Oregon, as part of the sixth year of the state-wide variety testing program. Winter and spring barley, triticale, and wheat were grown. As groups, winter wheats and triticales (30 varieties) had the highest average yield (6960 lb/acre) followed by spring wheats and triticales (23 varieties) (6240 lb/acre), spring barleys (14 varieties) (4411 lb/acre) and winter barleys (7 varieties) (2499 lb/acre). Spring wheat yields were the highest they have been in six years of testing. Lodging was a problem in all trials, though there were differences among varieties within 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 and resistance to disease and lodging. Trial results for 1998 are shown. Results from trials throughout Oregon are on the Oregon State University Cereals Extension web page (http://www.css.orst.edu/cereals).

Introduction

New cereal varieties are released by public and private Pacific Northwest plant breeders each year. To provide growers with accurate, up-to-date information on variety performance, a state-wide variety testing program was initiated in 1993 with funding provided by the 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, 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 Oregon State University 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 (5 ft × 20 ft) were seeded at a rate of 30 seeds/ft^2 using an Oyjord plot drill. Winter trials were planted on October 10, 1997. The nitrogen supply goal for winter wheat and triticale is 200 lb N/acre. A soil test for inorganic N indicated 60 lb N/acre in the soil. The nitrogen target for winter barley is 100 lb N/acre. On March 30, 1998, 70 lb N/acre was applied as 16-20-0-14, bringing the nitrogen supply to 130 lb N/acre (exceeding the target of 100 lb N/acre).

Spring trials were planted on April 2, 1998. The nitrogen supply goal for spring wheat and triticale is 160 lb N/acre. A soil test for inorganic N indicated 80 lb N/acre in the soil. A preplant application of 37 lb N/acre as 16-20-0-14 was made on March 30. On April 2 an additional 38 lb N/acre as 34-0-0 was applied, bringing the N supply to 155 lb N/acre. The nitrogen target for spring barley is 100 lb N/acre. A preplant application of 38 lb N/acre was made as 16-20-0-14 on March 30, bringing the N supply to 118 lb N/acre.

Herbicide and irrigation programs were typical for central Oregon production. Plots were harvested with a Hege plot combine then the grain was cleaned on a Peltz rub-bar cleaner. Plot yield, test weight, protein, moisture, and seed size were all determined on cleaned grain samples. Wheat and triticale yields are reported on a 10 percent moisture 60 lb/bu basis. Barley yields are reported as lb/acre at 10 percent moisture. Protein and moisture levels were determined using a whole-grain, near infrared protein analyzer. Proteins are reported on a 12 percent moisture basis.

Results and Discussion

Winter Wheat, Triticale, and Rye.

The winter wheat, triticale, and rye trial average yield was 116 bu/acre and ranged from 55 to 151 bu/acre (Table 1). Madsen, MacVicar, Stephens, and Gene continue to be among the highest yielding varieties in the Madras trials. OR939515 is a Madsen/MacVicar cross that yielded well in 1998 and is being considered for release. Additional data for OR939515 will be available from the 1999 trials. Given the similarity in yields for the leading varieties, selections should be made based on traits such as disease and lodging resistance, grain quality, or other desired characteristics.

Bogo, a Polish triticale introduced to Oregon by Dr. Robert Metzger, yielded well for the second consecutive year. Bogo heads about one week earlier than Celia and has slightly lower test weight. Bogo can grow to a height of four feet, which may be a concern for growers with low irrigation wheel lines. Straw strength is good, so lodging risk is low in spite of the tall plants. Dr. Metzger introduced several other promising Polish triticales as well, and they are currently being grown in the 1999 trials. Bogo is awned and would most likely be grown for grain as opposed to forage. Seed will be sold by Resource Seeds, Inc. of California.

Hancock and Spooner are winter ryes from Wisconsin. They are short-statured, lodging resistant varieties in the midwest. In Madras, however, they grew extremely tall, lodged, and yielded poorly. We concluded they are poorly adapted for Oregon grain production.

Lodging returned as a problem in the 1998 winter grain trials. Lodging had been a problem from 1993–1995 but had lessened with more careful nitrogen management in 1996 and 1997. Average plant height was 45 in. in 1998 compared to 33 in. in 1997. Average protein, an indication of nitrogen supply, was 10.5 percent in 1998 compared to 9.4 percent in 1997. The tall plants and high protein may indicate excess N supply. Another possibility is that seeding rates are too high. The seeding rate-lodging relationship is being investigated further by Mylen Bohle and will be addressed in the 1999 variety trials, as well.

Spring Wheats and Triticales.
The spring wheat and triticale trial average yield was 104 bu/acre and ranged from 81 to 115 bu/acre (Table 2). 1998 was the second consecutive year of high spring grain yields.

In contrast to the winter trials where soft white varieties dominate, hard white and hard red lines tend to have higher yields in the spring trials. While yields are high for the hard classes, protein levels have been marginal which will make marketing difficult if not economically unviable. Alternate fertilization strategies need to be investigated for hard spring wheats.

Among soft white lines there has been high yield variability from year to year. Pomerelle has been among the most consistent of the high yielding varieties. Pomerelle is later than most other soft white lines and has slightly lower test weight and protein. Pomerelle has also shown some susceptibility to lodging. Penawawa and Alpowa are other soft white lines that have good yield potential in central Oregon.

A number of new hard white and soft white lines from Idaho and Oregon yielded well in 1998. We will be watching these lines closely in the 1999 trials to see if performance is consistent.

Winter and Spring Barleys.

Spring barleys yielded better than winter barleys for the sixth consecutive year. Barley data is shown in Tables 3 and 4. The average yield for spring barleys was 4411 lb/acre and ranged from 2571 to 6799 lb/acre. The average yield for winter barleys was 2499 lb/acre and ranged from 768 to 4073 lb/acre.

Kold, the highest yielding winter barley, yielded 40 percent below the winter wheat average. If winter barley is grown, Kold and Scio are the highest yielding varieties. Kold has barley stripe rust resistance, while Scio does not. While barley stripe rust has not been a problem in the Madras area, it has caused severe damage in other locations.

Among spring barleys, Idagold (2RF) and Galena (2RM) have had significantly higher yields than other varieties over the past three years. Idagold and Galena have above average test weight and good lodging resistance. Neither variety has stripe rust resistance. Yields for both varieties have been similar to spring wheat yields over the past three years. Both lines are from the Coors Brewing Company. Seed for Idagold is handled by Western Seeds in Burley, Idaho. Local seed dealers may be able to contract with Coors for seed production of these varieties. Contact your county extension office for more information.

Other high yielding varieties in the 1998 trials include C-32 (2RM) and UC958 (2RF). C-32 is a Coors variety. UC958 is a UC-Davis line with strip rust resistance. All of the high yielding spring varieties have good lodging resistance, which probably contributes to their yield potential.

Table 1. Statewide variety testing program winter wheat, triticale and rye, Madras, OR, 1998.

Variety or line[†]	Market class	Yield (bu/acre)			1998 data					
					Test weight	Protein	Heading date	Height	Lodging	1000K
		1998	1997	1996	(lb/bu)	(%)	(DOY)	(in)	(%)	(g)
Bogo	Triticale	151	123	--	55.6	9.4	150	49	13	41.2
OR939515	SW	151	--	--	61.7	10.2	160	44	7	38.5
Madsen	SW	147	104	121	62.0	10.3	164	43	0	41.2
MacVicar	SW	147	123	129	59.7	9.5	159	43	3	45.7
Binova	Triticale	145	--	--	54.9	9.4	147	45	57	36.2
Stephens--Raxil+Gaucho	SW	143	--	--	60.7	11.0	158	42	13	53.5
Weatherford (OR898120)	SW	140	108	--	62.1	10.7	164	46	10	45.1
Gene	SW	139	102	137	60.1	11.5	159	37	0	44.2
Madsen+Stephens	SW	136	120	132	61.1	10.7	158	43	3	49.5
Ivory (OR850513)	HW	133	--	--	62.4	10.7	158	44	7	43.9
Stephens--Vitavax+Gaucho	SW	132	119	144	60.1	10.8	158	40	67	51.6
Celia	Triticale	130	--	114	56.1	9.7	159	43	0	41.2
Stephens--Vitavax, no Gaucho	SW	129	119	143	59.8	10.9	159	42	43	49.3
Stephens--Dividend+Gaucho	SW	128	123	--	60.3	10.8	158	41	20	52.2
Rod	SW	126	116	124	60.5	9.8	163	45	27	44.0
Hybritech 1017	SW	122	130	--	60.6	10.6	159	47	23	44.6
Lambert	SW	119	--	--	60.9	10.4	157	45	60	51.2
Rohde	Club	118	116	111	61.2	10.8	162	44	50	39.7
ID86-10420A	SW	117	111	--	61.4	10.2	162	50	3	37.7
Hiller	Club	113	--	90	58.3	10.7	162	44	70	35.9
Hybritech 1019	SW	104	119	--	59.3	11.0	157	45	10	39.0
Eltan	SW	103	--	--	59.8	10.5	163	44	80	36.7
Rely	Club	99	116	112	59.5	10.7	161	47	67	35.0
Temple (ORCL0054)	Club	98	109	--	61.0	10.8	159	45	70	39.9
ID467	HR	97	120	97	61.9	11.8	159	44	97	43.6
Coda (WA7752)	Club	96	109	--	61.0	11.4	164	49	73	37.0
PureSeed Durum	Durum	95	--	--	58.9	11.3	161	42	3	47.6
Brundage (ID14502B)	SW	92	124	.142	57.0	10.5	155	39	7	32.3
Foote (OR880172)	SW	81	103	--	60.3	11.3	158	47	7	38.6
WA7834	Club	67	--	--	58.8	10.9	163	51	63	37.4
Hancock	rye	61	--	--	56.3	9.0	132	59	78	33.9
Spooner	rye	55	--	--	55.3	9.6	132	62	73	35.1
Trial average		116	112	121	59.6	10.5	158	45	35	39.0
PLSD (5%)		20	17	26	1.8	0.7	3	2	28	--
PLSD (10%)		13	14	22	1.5	0.6	2	2	24	--
CV		10	9	13	2	4	1	3	50	--
P--value		0.00	0.00	0	0.00	0.00	0.00	0.00	0.00	--

[†] All seed was treated with fungicide and Gaucho (imidacloprid) insecticide unless otherwise noted.

Table 2. Statewide variety testing program spring wheat and triticale, Madras, OR, 1998.

Variety or line[†]	Market class	Yield (bu/acre)			1998 data: Test weight	Protein	Heading date	Height	Lodging	1000K
		1998	1997	1996	(lb/bu)	(%)	(DOY)	(in)	(%)	(g)
IDO523	HW	115	--	--	61.8	11.1	179	37	23	34.7
IDO506	SW	115	--	--	60.6	10.8	177	41	63	31.9
IDO533	HW	113	--	--	61.8	11.3	178	37	53	34.0
OR4870453	HW	112	111	--	62.2	11.3	178	37	57	36.6
OR4920307	HW	112	--	--	62.4	11.4	178	39	33	39.7
OR3900362	HR	111	--	--	61.5	12.3	177	37	70	36.1
WPB 936	HR	111	120	--	61.9	12.1	174	36	17	42.6
IDO505	SW	109	--	--	61.6	10.4	178	40	80	40.6
Whitebird	SW	107	110	59	61.6	10.5	178	42	23	32.2
OR942845	SW	106	--	--	62.2	11.1	179	40	50	36.8
WPB BZ 987-331	HR	105	--	--	60.9	11.8	172	41	33	43.0
Pomerelle	SW	105	123	103	59.5	10.1	179	37	73	30.0
WPB BZ 992-108	SW	104	--	--	59.9	10.2	175	40	83	33.8
Alpowa (no Gaucho)	SW	103	88	90	61.9	10.3	177	43	30	31.3
M94-4393	Triticale	103	--	--	58.0	10.7	171	50	0	40.4
OR4870255	HW	102	--	--	62.1	12.0	172	40	73	35.9
Yecora Rojo	HR	101	118	69	61.4	12.2	172	31	10	38.3
IDO377S	HW	101	96	86	62.0	12.4	177	38	83	34.8
WA7850	SW	100	--	--	60.5	10.4	179	39	90	38.3
Penawawa	SW	97	105	93	60.8	10.0	176	40	70	33.4
IDO462	HR	97	97	--	62.0	12.8	176	39	77	35.3
WA7802	HR	95	93	--	61.3	13.4	175	43	73	39.2
Wawawai	SW	86	81	94	61.0	11.3	176	44	87	40.1
Alpowa	SW	81	102	101	62.1	10.3	177	40	53	32.5
Trial average		104	99	85	61.3	11.3	176	40	54	36.3
PLSD (5%)		16	23	17	1.2	0.9	2	2	34	--
PLSD (10%)		13	19	14	1.0	0.7	1	2	28	--
CV		9	14	12	1	5	1	4	38	--
P-value		0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	--

[†] All seed was treated with fungicide and Gaucho (imidacloprid) insecticide unless otherwise noted.

Table 3. Statewide variety testing program winter barley, 1998, at Madras, OR.

Variety or line[†]	Market class	Yield (bu/acre) 1998	1997	1996	1998 data: Test weight (lb/bu)	Protein (%)	Heading date (DOY)	Height (in)	Lodging (%)	1000K (g)
Kold	6RF	4073	3941	4686	45.1	10.1	145	39	23	28.9
Scio	6RF	3691	3943	4308	42.7	10.2	141	41	80	28.4
OR1957369	6RF	2951	--	--	45.5	10.5	142	42	33	30.2
Strider	6RF	2638	3880	4020	41.7	10.2	140	41	87	32.7
Steptoe	6RF	1689	--	2242	41.0	10.6	142	53	100	34.3
ORW10	6RF/	1682	2940	--	48.8	10.8	132	44	40	32.9
ORW11	6RF/	768	3421	--	41.3	11.3	145	45	50	29.5
Trial average		2499	3630	4167	43.7	10.5	141	44	59	31.0
PLSD (5%)		1582	NS	1496	2.6	NS	1	4	NS	--
PLSD (10%)		1294	NS	1232	2.1	NS	1	3	47	--
CV		36	20	21	3	6	0	5	55	--
P-value		0.01	0.53	0.01	0.00	0.38	0.00	0.00	0.08	--

[†] All seed was treated with fungicide and Gaucho (imidacloprid) insecticide.

Table 4. Statewide variety testing program spring barley, 1998, at Madras, OR.

Variety or line[†]	Market class	Yield (bu/acre) 1998	1997	1996	1998 data: Test weight (lb/bu)	Protein (%)	Heading date (DOY)	Height (in)	Lodging (%)	1000K (g)
C32	2RM	6799	--	--	52.5	9.3	175	30	0	41.5
Idagold	2RF	6760	5432	5508	51.3	9.0	176	31	33	39.4
UC958	2RF	6576	--	--	47.6	9.5	166	30	3	42.2
Galena	2RM	6231	5628	5026	51.8	9.8	175	35	3	40.0
Baronesse	2RF	4083	5133	4773	50.2	10.7	176	36	87	36.1
Tango	6RF	4022	--	--	48.7	10.1	167	41	100	37.5
Steptoe	6RF	3922	5104	3941	46.3	9.1	171	40	93	37.7
Gallatin	2RF	3904	4548	--	52.6	10.7	175	38	73	38.6
MT920073	2RF	3804	--	--	50.5	12.1	174	33	80	42.4
78Ab10274	2RM	3787	4612	--	51.8	11.4	177	39	77	40.8
H3860224	2RF	3319	--	--	52.6	11.4	175	39	53	37.7
Chinook	2RM	3319	4389	--	51.0	12.1	173	40	60	37.7
Orca	2RF/	2663	3835	--	50.1	11.3	166	42	60	44.0
BZ 594-19	2RF	2571	--	--	50.8	10.4	175	40	30	37.3
Trial average		4411	4727	4256	50.5	10.5	173	37	54	39.5
PLSD (5%)		982	813	927	1.2	0.7	3	3	34	--
PLSD (10%)		815	676	769	1.0	0.6	3	3	28	--
CV		13	10	13	1	4	1	6	37	--
P-value		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	--

† All seed was treated with fungicide and Gaucho (imidacloprid) insecticide.

SEEDING RATE EFFECT ON WINTER TRITICALE AND SOFT WHITE WINTER WHEAT IN 1998

Mylen Bohle, Russ Karow, Ernie Marx, and Steve James

Abstract

Response of 'Celia' winter triticale and 'Stephens' soft white winter wheat to seeding rates, was tested at the Central Oregon Agricultural Research Center (COARC), at Madras, Oregon, in the crop year 1997-1998. Highest yield (136.3 bu/acre) achieved by Celia, was at 30 seeds ft^2, but there was no statistical difference between 16 to 40 seeds per ft^2. Highest yield (155.0 bu/acre) achieved by Stephens, was at the seeding rate of 16 seeds per ft^2, though there were no statistical differences between 8 and 20 seeds per ft^2. With increased seeding rates, there was a trend for protein content to decrease for Celia up to 30 seeds per ft^2, though only significantly to 16 seeds per ft^2; and increase for Stephens up to 20 seeds per ft^2. Celia experienced no lodging, while as seeding rates increased, the lodging of Stephens increased. Lodging may have caused the yield decreases at the higher seeding rates. There was no significant difference for grain nitrogen uptake, protein yield, and 1000 kernel weight for the response of Celia to seeding rates. Grain nitrogen uptake and protein yield of Stephens increased up to 16 seeds per ft^2; there were no differences for 1000 kernel weight. Increasing seeding rates, increased heads per meter row or heads per ft^2 for both Stephens and Celia. Conversely, heads per seed planted and florets per spike were decreased. Stephens had significantly greater ability to tiller, while Celia had greater ability to produce significantly great numbers of fertile florets per spike. Seeding rates had no effect on seeds per pound or future seeding rates. The trial is the first year results of a two year study.

Introduction

Most cereal acreage is devoted to soft white winter wheat in Central Oregon. Winter triticale is a "new" cereal crop with high yield potential. Interest in triticale is growing for both grain and forage purposes. The grain is excellent for livestock feed, especially in swine and poultry rations. Triticale is also being utilized for human food. Celia winter triticale has the ability to outyield barley and is less prone to lodging and disease. Celia also has superior test weight in comparison to other triticale varieties. There is less cultural information available for triticale. A seeding rate trial was initiated in October 1997, to compare yield, quality, and other agronomic responses of Celia winter triticale and Stephens soft white winter wheat. Information generated will allow better production practice decision making

Materials and Methods

Celia winter triticale and Stephens soft white winter wheat were planted on October 10, 1997, at 4, 8, 16, 20, 30, and 40 seeds per square foot with a plot cone-type planter. The pounds per acre seeding rates are given in Table 1. The design was randomized complete block, two factorial design, with four replications. Row spacing was eight inches and plot size was 5 ft x 20 ft, with approximately 5 ft x 15 ft feet harvested. The trial was irrigated as needed with solid-set lines.

A soil sample was taken to bedrock (two feet deep) in early March of 1998. Soil analyses were performed by Agri-Check Laboratory, Hermiston, Oregon, and soil test results are listed in Table 2. The previous crop was "fallow", preceded by Kentucky bluegrass for multiple years. It was assumed that approximately 20 lb/acre nitrogen was taken up by the plants at the time of sampling. The trial was fertilized with 159 lb./a N, 78 lb/a P_2O_5, and 54 lb/a S (387 lb/a of 16-20-0-14 and 285 lb/a of 34-0-0) on April 16, 1998.

Table 1. Seeding rate in pounds per acre based on seeds per square foot for Celia winter triticale and Stephens soft white winter wheat planted for the seeding rate trial at COARC Madras, OR, on October 10, 1997.

Variety	4 Seeds	8 Seeds	16 Seeds	20 Seeds	30 Seeds	40 Seeds
Celia	20	40	80	100	149	199
Stephens	21	41	83	104	155	207

Table 2. Soil test results from February 22, 1998, COARC, Madras, OR.

Soil Depth (inches)	pH	P (ppm)	K (ppm)	NO_3 (lb/a)	NH_4 (lb/a)
0-12	7.3	35	484	54	11
12-24	7.4	13	320	77	8

Results and Discussion

The results for grain yield, protein content, test weight, height, lodging, and heading date are presented in Table 3. The results for grain N uptake, grain protein yield, 1000 kernel weight, heads per meter row, heads per square foot, heads per seed planted, and fertile florets per spike are presented in Table 4. The results for seeds per pound, and future seeding rate in pounds per acre for 4, 8, 16, 20, 30, and 40 seeds per square foot are presented in Table 5.

Stephens soft white winter wheat was significantly higher yielding than Celia winter triticale, at seeding rates of 4 to 20 seeds per ft^2, while Celia was significantly higher yielding at the 30 and 40 seeds per square foot seeding rate. This significant yield decrease by Stephens was probably caused by the lodging problems that Stephens had at the higher seeding rates.

The low seeding rate (4 seeds ft^2) produced the highest protein content for Celia (10.8 percent). There was a trend for decreasing levels, but not significantly so beyond 16 seeds per square foot. Stephens produced its' highest protein content with the 20 seeds per square foot seeding rate. The protein content of Stephens (10.8%) was the same for 4, 8, and 16 seeds per square foot, significantly increased at the 20 seeds per square foot seeding rate, and then there was no significant difference at higher seeding rates.

The overall difference in plant height was approximately one inch, significantly taller for Stephens. There were no statistical differences among seeding rates or varieties x seeding rates.

There were significant differences between the two varieties for lodging. 'Celia' had absolutely no lodging across all seeding rates. With increased seeding rates, 'Stephens' lodging increased from 0 percent, up to 60 percent with the highest seeding rate. This lodging probably affected grain yield, and may have affected other agronomic factors such as grain protein content, test weight, and 1000 kernel weight.

The only significant difference for heading date was between the varieties. Seeding rate did not affect heading date.

There was no difference in grain N uptake between seeding rates for Celia. Stephens had highest the grain N Uptake at seeding rates of 16 and 20 seeds ft^2, lowest at 30 and 40 seeds ft^2, and intermediate levels at 4 and 8 seeds ft^2. Grain N uptakes were significantly different, Stephens had greater ability to take up grain N than Celia.

Stephens had significantly heavier kernel weights. Seeding rates did not significantly affect 1000 kernel weight.

Heads per meter row, or heads per ft^2, were significantly higher for Stephens than Celia. There was a definite trend among varieties to have higher head counts with increased seeding rates. Differences within varieties were not significant.

For heads per seed planted, at every seeding rate, Stephens was significantly higher than Celia. Within the variety, as seeding rate increased, there were not always significant increases in heads per seed planted, but there was a positive trend. There was an inverse relationship between heads per seed planted, versus to heads per meter row or heads per square foot. Stephens ability to tiller, and produce more heads than Celia, is at the rate of 199, 151, 160, 170, 188, and 172 percent at the respective seeding rates of 4, 8, 16, 20, 30, and 40 seeds per square foot. The ability to tiller was probably even greater as the number of plants were not counted. Comparison was made to the seeds planted, not actual plants.

Though 'Celia' has less ability to tiller than Stephens, Celia makes up for this difference, with its ability to produce a larger number of fertile spikelets per spike. The two varieties responded the same in that with increasing seeding rates, there was decreasing numbers of spikelets per spike. But, Celia had 234, 242, 249, 251, 241, and 253 percent greater spikelets per spike, compared to Stephens, at equal seeding rates. The average was 245 percent greater spikelets per spike, over all seeding rates.

There were only significant varietal differences for seeds per pound. Seeding rates had no statistical effect on seeds per pound. The calculated future seeding rate based on seeds per pound, is presented as a comparison to the original seed rate and as reference information. The seeding rates (pounds per acre) used for planting the trial were heavier than those generated by the harvested seed for future seeding rates.

This is the first year of a two year trial comparing Celia winter triticale to Stephens soft white winter wheat. The purpose of the trial was to generate more cultural production information for winter triticale. In the process, other previous unknown information on 'Stephens' has been generated. Though intriguing, it is not wise to base changes in production practice on only one year of data. The trial will be repeated in 1999.

Acknowledgements

The Oregon Grains Commission is gratefully acknowledged for partially funding this trial.

Table 3. The effect of seeding rate on the yield, protein, test weight, height, lodging, and heading date of Celia winter triticale and Stephens soft white winter wheat planted at the CORAC, Madras on October 10, 1997.

	Yield (bu/a)	Protein (%)	Test wt. (lb/bu)	Height (in.)	Lodging (%)	Heading date (1/1 = 1)
Variety						
Celia	130.0	10.0	56.2	42.8	0	160
Stephens	140.2	11.0	60.3	41.6	23	159
Seed Rate (Seeds/ft^2)						
4	130.6	10.8	58.1	42.6	0	159
8	135.7	10.6	58.3	42.8	5	159
16	142.0	10.3	58.6	42.3	5	159
20	141.2	10.5	58.4	42.0	9	159
30	131.5	10.4	58.0	41.9	20	159
40	129.6	10.4	58.1	41.8	30	159
Variety x Seed Rate						
Celia						
4	119.3	10.8	55.9	42.5	0	160
8	124.9	10.4	55.9	43.0	0	160
16	129.0	9.9	56.3	42.8	0	160
20	134.6	9.8	56.5	42.8	0	160
30	136.3	9.7	56.2	43.0	0	160
40	135.9	9.7	56.5	43.0	0	160
Stephens						
4	141.9	10.8	60.3	42.8	0	158
8	146.6	10.8	60.6	42.5	10	158
16	155.0	10.8	60.9	41.8	10	158
20	147.8	11.3	60.4	41.3	18	158
30	126.7	11.1	59.8	40.8	40	158
40	123.4	11.0	59.7	40.5	60	158
Mean	135.1	10.5	58.2	42.2	11	159
Variety						
PLSD .10	S	S	S	S	S	S
PLSD .05	S	S	S	S	S	S
Seed Rate						
PLSD .10	7.1	NS	0.3	NS	10	NS
PLSD .05	8.6	NS	NS	NS	12	NS
Variety x Seed Rate						
PLSD .10	10.1	0.4	0.5	NS	15	NS
PLSD .05	12.1	0.5	0.6	NS	18	NS
CV%	6	3	1	3	107	0

Heading date = days from January 1.

Table 4. The effect of seeding rate on Celia winter triticale and Stephens soft white winter wheat grain N uptake, grain protein yield, 1000 kernel weight, heads per meter row, heads per ft^2, heads per seed planted, and florets per spike, planted at COARC, Madras on October 10, 1997.

	Grain N Uptake (lb/ac)	Grain protein yield (lb/ac)	1000 kernel wt. (g)	Heads per meter row	Heads Per ft^2	Heads per seed planted	Spikelets Per spike
Variety							
Celia	136.9	781	42.4	104	47.3	3.9	29.9
Stephens	161.3	919	48.4	179	81.6	6.9	12.2
Seed Rate (Seeds/ft^2)							
4	148.2	845	44.7	120	54.4	13.6	23.2
8	151.5	863	46.0	132	59.8	7.5	22.4
16	155.0	883	46.4	137	62.1	3.9	22.0
20	156.8	894	46.3	144	65.6	3.3	20.3
30	142.8	814	44.8	154	70.0	2.3	19.7
40	140.4	800	44.4	165	74.8	1.9	18.7
Variety x Seed Rate							
Celia							
4	135.0	770	43.5	80	36.5	9.1	32.7
8	136.6	778	42.7	105	47.5	5.9	31.7
16	134.9	769	42.5	105	47.7	3.0	31.4
20	138.4	789	43.7	107	48.5	2.4	29.1
30	138.5	790	41.1	107	48.8	1.6	27.9
40	138.3	788	40.9	121	55.1	1.4	26.8
Stephens							
4	161.5	921	45.8	159	72.3	18.0	13.8
8	166.4	949	49.3	159	72.2	9.0	13.1
16	175.1	998	50.2	168	76.5	4.8	12.6
20	175.2	999	48.9	182	82.6	4.1	11.6
30	147.2	839	48.5	201	91.3	3.1	11.6
40	142.4	812	47.9	208	94.6	2.4	10.6
Mean	149.1	850	45.4	142	64.5	5.4	21.1
Variety							
PLSD .10	S	S	S	S	S	S	S
PLSD .05	S	S	S	S	S	S	S
Seed Rate							
PLSD .10	8.0	45	NS	14	6.5	0.7	1.1
PLSD .05	9.6	55	NS	17	7.8	0.9	1.4
Variety x Seed Rate							
PLSD .10	11.3	64	NS	NS	NS	1.0	NS
PLSD .05	13.6	78	NS	NS	NS	1.2	NS
CV%	6	6	6	12	12	16	6

Table 5. The effect of seeding rate on Celia winter triticale and Stephens soft white winter wheat seeds per pound, and future seeding rates of 4, 8, 16, 20, 30, and 40 seeds per ft^2, in pounds per acre, planted at COARC, Madras, Oregon on October 10, 1997.

	Seeds per Pound	Seed Rate 4/ft^2	Seed Rate 8/ft^2	Seed Rate 16/ft^2	Seed Rate 20/ft^2	Seed Rate 30/ft^2	Seed Rate 40/ft^2
Variety				--lb/acre--			
Celia	10,719	16.3	32.6	65.2	81.4	122.1	162.9
Stephens	9,405	18.6	37.2	74.4	93.0	139.5	186.0
Seed Rate (Seeds/ft^2)							
4	10,187	17.2	34.3	68.6	85.7	128.7	171.5
8	9,924	17.7	35.3	70.7	88.3	132.5	176.6
16	9,857	17.8	35.6	71.3	89.1	133.6	178.1
20	9,877	17.8	35.5	71.0	88.8	133.2	177.6
30	10,217	17.2	34.4	68.9	86.1	129.1	172.2
40	10,310	17.1	34.1	68.2	85.3	127.9	170.5
Variety x Seed Rate							
Celia							
4	10,452	16.7	33.4	66.8	83.5	125.3	167.0
8	10,638	16.4	32.8	65.6	82.0	123.0	164.0
16	10,671	16.3	32.7	65.4	81.7	122.5	163.4
20	10,400	16.8	33.6	67.1	83.8	125.7	167.6
30	11,046	15.8	31.6	63.2	79.0	118.5	158.0
40	11,106	15.7	31.5	62.9	78.6	118.0	157.3
Stephens							
4	9,922	17.6	35.2	70.4	88.1	132.1	176.1
8	9,209	18.9	37.9	75.8	94.7	142.0	189.3
16	9,042	19.3	38.6	77.2	96.5	144.7	192.9
20	9,354	18.8	37.5	75.0	93.8	140.7	187.6
30	9,388	18.6	37.3	74.6	93.2	139.8	186.4
40	9,515	18.4	36.8	73.5	91.9	137.8	183.8
Mean	10,062	17.4	34.9	69.8	87.2	130.8	174.4
Variety							
PLSD .10	S	S	S	S	S	S	S
PLSD .05	S	S	S	S	S	S	S
Seed Rate							
PLSD .10	NS	NS	NS	NS	NS	NS	NS
PLSD .05	NS	NS	NS	NS	NS	NS	NS
Variety x Seed Rate							
PLSD .10	NS	NS	NS	NS	NS	NS	NS
PLSD .05	NS	NS	NS	NS	NS	NS	NS
CV%	5	6	6	6	6	6	6

Seed Rate = Future seeding rate in pounds per acre

THE EFFECT OF SMALL AND LARGE SEEDED ANNUAL LEGUMES ON SUBSEQUENT OAT HAY CROPS IN 1993 AND 1994

Mylen Bohle

Abstract

There is interest in the annual legumes for forage, human food, and subsequent crop rotation benefit. Oats were planted over harvested plots of numerous species and varieties of small and large seeded annual legumes. Oat hay yield was measured. Many of the annual legumes had a positive effect on the following oat-hay crop. There is benefit in using annual legumes in a crop rotation. The benefit of varieties and species of annual legumes varied from year to year.

Introduction

Producers are interested in annual legumes for forage and human food production, as well as in determining what benefit annual legumes would have on a subsequent crop. The benefit of having annual legumes in rotation could be multifold. The intitial growth or regrowth after harvesting for forage or human food can used for green manure crops. There is also the potential of the harvest aftermath and decaying roots and nodules that benefit the soil fertility, which will hopefully increase yields of the subsequently planted crops. Variety trials of large and small seeded annual legumes were grown, harvested for hay, then the following year, an oat crop was planted over the trials to assess the benefit of the previously planted annual legumes on hay yield. The original intent of the annual legume trial was to determine the forage yielding ability and adaptation to central Oregon. The idea of testing the effect of previously grown annual legumes on a subsequent oat hay crop was an afterthought effort to take a look at that benefit.

Materials and Methods

Annual legume crops were grown in 1992 and 1993, harvested for hay, then cultivated with a rototiller in the late summer or early fall, and allowed to lay "fallow" until the spring of 1993 and of 1994. 'Kanota' (1993) and 'Monida' (1994) spring oat varieties were planted on April 22, 1993, and April 22, 1994. The oat crop was planted with a 10 ft. wide, 9 in. row spacing drill. MCPA was applied as weed control. There was no additional fertilizer intentionally added, though the large-seeded and possibly the small-seeded legume area in 1994 may have been inadvertently fertilized. Plant height was measured in 1993. The oat hay crops were irrigated as needed with a solid set sprinkler system. The oat hay was harvested at the soft dough stage on July 21, 1993, and July 20, 1994. Approximately a 3.5 feet x 15 feet area was harvested with a sickle bar, forage plot harvester. The forage harvested from each plot was weighed in the field, and a 0.5 lb.subsample was taken for determining moisture content. The subsamples were dried at 145 degrees Fahrenheit until no change in weight. The wet weight was converted to dry weight (pounds per acre) and is presented on an oven-dried, dry matter basis. Other pertinent information on the previous crop is located in the materials and methods section of the article "Small and Large Seeded Annual Legumes Adaptation for Central Oregon in 1992 and 1993" in the 1998 COARC Annual Report.

Results and Discussion

Yields and other agronomic data are presented in Tables 1-4. No funding was available to test for differences in nitrogen uptake or forage quality of the plants.

1993 Large Seeded Annual Legume Effects on Oat Hay Yield. In the large seeded annual legumes, hairy vetch was responsible for the highest yield of oat hay (7,066 lb/a) in 1993 and was the only significantly different legume than the control (4,527 lb/a) (PLSD .10 = 1,060 lb/a). There was some regrowth before tilling. This higher yield, no doubt, was due to the regrowth of the hairy vetch compared to the other species, for which there was little, if any regrowth, prior to tilling.

The second tier of large seeded legumes were maple pea, 'green' mung bean, 'Timeless Aladdin' faba bean, 'Ackerperle' faba bean, 'Chickling' vetch, and 'Miranda' yellow pea. All of these plots produced from 5173 to 5515 pounds per acre of oat hay, but were not significantly different from the check. See Table 1.

1993 Small Seeded Annual Legume Effects on Oat Hay Yield. Twelve of the 20 small seeded annual legumes had an affect on the oat hay yield compared to the check (4,835 lb/a) (PLSD .10 = 991 lb/a). See Table 2.

1994 Large Seeded Annual Legume Effects on Oat Hay Yield. There were no significant differences for the large seeded annual legumes and the oat hay that was produced in 1994 (Table 3). Because of the high yields obtained for all of the treatments, it appeared that perhaps the area had been inadvertently fertilized, thereby masking any benefit due to previously planted legume. There was no control (no legumes - weeds) to compare to this year.

1994 Small Seeded Annual Legume Effects on Oat Hay Yield. The area appeared to have been inadvertently fertilized with nitrogen fertilizer based on the yields and visual appearance of the plots, compared to 1993 plots. The lowest yielding plot was the Pioneer '5364' alfalfa variety (7,353 lb./a), which was the border area. 'Ascot' barrel medic (8,710 lb./a) had the second lowest yielding effect, which just missed being significantly higher than 5364 alfalfa. All of the other treatments produced significantly higher oat hay yields than did 5364 alfalfa (PLSD .10 = 1,383 lb/a). None of the ten legumes were significantly different from each other (Table 4). There was no control (no legumes - weeds) to compare to this year.

Conclusion

There appears to be fair benefit from using annual legumes in the crop rotation, though the economics of doing so would vary from farm to farm. Some of the annual legume species have greater benefit to affect following crops. The trial was managed more as a preliminary trial than properly a managed study. Notes were not kept on the measured amount, nor visual estimates recorded, of the regrowth of the legumes before plow down. The trial was a first effort to determine if any benefit of the annual legumes in a rotation and what effect they might have on the yield of the next crop. Better-designed trials need to be carried out to determine the true ability of the legumes to increase subsequent crop yields.

Table 1. The effect of previous crop, 1992 planted, large-seeded annual legume on 1993 Kanota spring oat hay harvest, COARC, Powell Butte, OR.

Effect of previous crop Variety/species	Yield (lb/a)	Dry Matter (%)	Moisture (%)	Height (in.)
Hairy vetch	7,066	34.6	65.4	44
Miranda yellow pea	5,515	35.8	64.2	40
Timeless Aladdin faba bean	5,464	36.4	63.6	39
Chickling vetch	5,417	35.4	64.6	38
Green mung bean	5,391	36.4	63.2	36
Ackerperle faba bean	5,185	35.9	64.2	37
Maple pea	5,173	36.1	64.0	38
Hertz Freya faba bean	4,786	36.2	63.8	38
Austrian winter pea	4,750	34.8	65.3	41
Dianna faba bean	4,737	36.6	63.4	37
UI 114 pinto bean	4,687	35.5	64.5	39
Tingata tangier flatpea	4,608	35.8	64.3	38
Sirius field pea	4,603	37.3	62.8	37
Victor cowpea	4,588	34.7	65.3	39
Control (no legumes – weeds)	4,527	36.2	63.8	40
Mississippi pinkeye cowpea	4,435	35.9	64.1	37
Trapper pea	4,238	35.7	64.3	37
Cahaba white vetch	4,075	35.4	64.6	38
Sacramento lt. red kidney bean	4,000	35.7	64.3	37
Mississippi cream cowpea	3,930	35.7	64.4	35
Mean	4,859	35.8	64.2	38
PLSD .10	1,060	1.1	1.1	NS
PLSD .05	1,269	1.3	1.3	NS
CV%	18	1	3	10

Table 2. The effect of previous crop, 1992 planted, small-seeded annual legumes on 1993 Kanota spring oat hay agronomic data, COARC, Powell Butte, OR.

Effect of previous crop Variety/species	Yield (lb/a)	Dry Matter (%)	Moisture (%)	Height (in.)
Maral shaftal clover	7,535	35.2	64.8	41
Youchi arrowleaf clover	7,085	35.6	64.4	44
Mt. Barker sub clover	7,050	35.2	64.8	46
Moapa alfalfa	6,996	36.1	64.0	43
Nitro alfalfa	6,960	36.0	64.0	44
Multicut berseem clover	6,753	35.0	65.0	42
Bigbee berseem clover	6,604	35.7	64.4	42
George black medic	6,285	35.3	64.7	43
MTBMB black medic (Dr. B)	6,219	35.5	64.5	40
Selection 1 berseem clover	6,217	35.1	64.9	44
Santiago polymorpha medic	6,182	36.1	63.9	40
Parabinga barrel medic	6,075	35.4	64.6	39
Borung barrel medic	5,649	35.5	64.5	40
Parragio barrel medic	5,488	35.4	64.6	40
Jemalong barrel medic	5,438	36.0	64.0	39
Ascot barrel medic	5,317	34.7	65.3	41
Control (no legume – weeds)	4,835	35.8	64.2	38
Timeless T-2000 green lentil	4,791	36.2	63.9	38
Sava snail medic	4,648	35.4	64.6	39
Indianhead lentil	4,220	35.6	65.5	36
Mean	6,017	35.5	64.5	41
PLSD .10	991	1.0	1.0	3.7
PLSD .05	1,187	1.2	1.2	4.4
CV%	14	1	2	8

Table 3. The effect of previous crop, 1993 planted, large-seeded annual legumes on 1994 Monida spring oat hay agronomic data, COARC, Powell Butte, OR.

Effect of previous crop Variety/species	Yield (lb/a)	Dry Matter (%)	Moisture (%)
Latah pea	12,131	31.1	68.9
Trapper pea	11,941	33.5	66.5
Procon field pea	11,680	34.4	65.6
Maple pea	11,219	32.7	67.3
Desi chickpea	11,148	31.8	68.2
Tinga tangier flatpea	11,006	34.6	65.4
Chickling vetch	10,908	34.2	65.8
Austrian winter pea	10,784	34.6	65.4
WWII pea	10,744	34.7	65.3
Miranda yellow pea	10,742	35.7	64.3
Kabuli chickpea	10,714	35.5	64.4
Magnus pea	10,144	36.0	64.0
Mean	11,097	34.1	65.9
PLSD .10	NS	NS	NS
PLSD .05	NS	NS	NS
CV %	9	14	7

Table 4. The effect of previous crop, 1993 planted, small-seeded annual legumes on 1994 Monida spring oat hay agronomic data, COARC, Powell Butte, OR

Effect of previous crop Variety/species	Yield (lb/a)	Dry Matter (%)	Moisture (%)
MTBM-5 black medic	10,791	32.1	67.9
Parragio barrel medic	10,285	30.9	69.1
Sava snail medic	10,162	30.9	69.1
Multicut berseem clover	10,124	31.3	68.7
George black medic	10,123	31.9	68.1
Hairy vetch	9,839	28.9	71.1
Nitro alfalfa	9,744	33.0	70.0
Indianhead lentil	9,405	34.4	67.1
Sel. 1 berseem clover	9,331	33.4	66.6
Ascot barrel medic	8,710	31.5	68.5
Pioneer 5364 alfalfa (Border)	7,353	34.6	65.4
Mean	9,624	31.9	68.1
PLSD .10	1383	NS	NS
PLSD .05	1664	NS	NS
CV%	12	9	4

IRRIGATED ANNUAL LEGUME ADAPTATION IN 1992 AND 1993

Mylen Bohle, Randy Dovel, and David Hannaway

Abstract

Little research has been done comparing forage production performance of annual legumes in Oregon. Small- and large-seeded annual legume trials were planted at the Central Oregon Agricultural Research Center (COARC), Powell Butte site; Klamath Experiment Station (KES), Klamath Falls; and at the Hyslop Crop Science Field Research Laboratory, Corvallis, Oregon, in 1992 and 1993. Several small-seeded and large-seeded annual legumes offer productive forage alternatives.

Introduction

There is increasing interest in the use of annual legumes for forage production as a rotation crop, cover crop, and green manure crop. Annual legumes often are planted in mixtures with small grains for hay, silage, and grazing. Austrian winter pea is the most commonly planted annual legume in Oregon. Little research has been done to compare relative performance of species and varieties for the various regions of Oregon. In view of that state-wide interest, adaptation research trials were initiated at Corvallis, Klamath Falls, and Powell Butte, Oregon, in 1992 and completed in 1993.

The objectives of the trials were to evaluate yield and nitrogen-supplying capability of selected annual legumes for their potential use in cropping systems and to identify annual legumes to combine with cereal forages for future evaluation trials.

All of the data from the COARC Powell Butte site will be presented. Only the total yield data from KES will be presented.

Materials and Methods

Small-seeded and large-seeded annual legume field trials were established at the COARC, Powell Butte, and KES, Klamath Falls in 1992 and 1993. Before planting, the seed of different legume species was inoculated with the appropriate rhizobium (Table 1). The annual legume species and varieties, and seeding rates are listed in Table 1.

Planting dates for COARC were May 26, 1992 and May 19, 1993. Planting dates for KES were June 5, 1992 and May 28, 1993. Planting was done with a small-plot cone planter. Plots were established with six, eight-inch rows at COARC and nine, six-inch rows at KES. A randomized complete block experimental design was used with four replications. Plots were 5 ft x 20 ft. The trials were irrigated with solid set lines.

At establishment, 16 lb/a of N, 20 lb/a of P_2O_5, and 60 lb/a of S were spread with a field scale

Gandy-type fertilizer spreader. The fertilizer was worked into the field, before planting. Soil tests revealed that all other nutrients were not limiting. The pH was lower than desired, at 6.0 (1992) and 5.8 (1993) in the trial location at COARC.

Balan and Eptam were used as preplant weed control at both sites, except KES did not use any weed control in 1992. Both years, there was a severe weed infestation at COARC and the plots were hand-weeded.

At COARC, plots were harvested with a small forage plot harvester in 1992. In 1993, the large-seeded legume plots were harvested by hand, using Japanese rice knives. At KES, the harvest was done with a Carter, small-plot forage harvester. Harvest area was 75 ft^2. At COARC, samples were taken for moisture and dried at 140 °F. Yields were calculated and are presented on the oven-dry weight basis.

Harvest dates at COARC were July 7 and September 9, 1992. There were multiple harvest dates in 1993, which are listed in Tables 8 and 9. The harvest dates at KES, were July 17, 1992 and August 23, 1993.

The third cutting regrowth in 1992, and second cutting regrowth in 1993, was rototilled into the soil at COARC. A spring oat hay crop planted the following year to test the nitrogen-supplying effect of the previous grown legume.

Results and Discussion

Total harvest yields for the small-seeded legume species and varieties planted in 1992 and 1993 at KES and COARC are summarized in Table 2. Total yields for the annual legumes at the KES site are offered as a comparison because of the similarity in climates at the two sites. Complete results for the KES annual legume trials for 1992 and 1993 are published in Dovel, et al. (1992, 1993).

The average yield in 1992 and 1993 for all large-seeded entries at KES was about 30 percent and 26 percent higher yielding compared to COARC (Table 3). For the most part, the relative ranking of legume species was similar at both locations, with peas the most productive, faba beans and vetches intermediate, and cowpea and beans the least productive. Because of the similar climatic conditions, this is not unexpected.

Small-seeded annual legumes at KES did not establish in 1992, except 'Sava' Snail medic.

Small Seeded Annual Legumes at COARC. In 1992, the highest yielding (total of two cuttings) small-seeded annual legumes were 'Selection 1' and 'Multicut'Berseem clover and 'Maral' Shaftal clover (Table 2). Results of the 1992 first and second cutting, dry-matter yield, dry-matter percent, moisture content, plant canopy height, and plant stand percent data, are listed in Tables 4 and 5. The three Berseem clover cultivars and Maral Shaftal clover had the best regrowth potential, yielding more on the second cutting than on first cutting.

In 1993, the highest yielding small-seeded annual legumes, were Indianhead lentil, hairy vetch, and 'Paraggio' Barrel medic. They were significantly higher yielding than Sava Snail medic, Selection 1 Berseem clover, and Multicut Berseem clover (Table 2). Also in 1993, a hail storm occurred just after emergence and damaged the young seedlings and affected the stand.

Results of the first cutting, dry-matter yield, dry-matter percentage, moisture percentage, plant canopy height, plant stand percentage, and harvest date for 1993, are listed in Table 6.

Large Seeded Annual Legumes at COARC. In 1992, the highest yielding large-seeded annual legumes were hairy vetch and Miranda Yellow field pea (Tables 3 and 7). Faba beans were at a disadvantage because of the early harvest date, and would have yielded more if the harvest were delayed.

Results from 1992 first and second cutting, dry-matter yield, dry-matter percent, moisture percent, plant canopy height, and percent plant stand on June 20, data are listed in Tables 7 and 8, respectively. The only large-seeded annual legumes to regrow were Common Hairy vetch, 'Cahaba' White vetch, and Chickling vetch. Common hairy vetch regrew the best. The regrowth of the third cutting was rototilled into the soil for a spring planting of an oat hay crop in 1993.

In 1993, a hail storm occurred just after emergence and affected the plant stand. The highest yielding large-seeded annual legumes were 'Latah', Maple, and 'Magnus' field pea, and Chickling vetch. Results on first cutting dry-matter yield, dry-matter percent, moisture percent, plant canopy height, percent plant stand on July 20, and harvest date, are listed in Table 9. The second cutting was not harvested. The regrowth was rototilled into the soil for planting a spring oat hay crop in 1994.

Plant Stand and Emergence Over Time. The rate of emergence over time and percentage plant stand rating for the 1992 (replicate II) and 1993 (replicate I) small-seeded annual legumes are listed in Tables 10 and 11. The rate of emergence over time and plant stand rating for the 1992 (replicate II) and 1993 (replicate I) large-seeded annual legume entries are listed in Tables 12 and 13. Only one replicate was scored each year, but there were large differences in the rate of emergence for the different varieties and species. The data may be useful for a snapshot look at differences to make better decisions on what species and varieties to plant under different conditions, depending upon the end result desired. (A hail storm occurred in 1993, just after seedling emergence.)

Some of the differences may also be due to the different seeding rates used for varieties within a species, which would also account for some stand ratings being greater.

Future Plans. These initial annual legume trials have identified small- and large-seeded annual legumes well suited to three regions. The next logical steps would be to conduct variety trials that concentrate on the species that showed promise at each site. Other trials would include testing the different promising legumes in combination with different cereal species for hay; and interseeding some of the legumes into thinning alfalfa stands to increase yield and extend stand life.

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Table 1. Seeding rates (lb/a) and inoculant used for the small- and large-seeded annual legume trials, 1992 and 1993, COARC, Powell Butte, OR.

Variety	Common Name Species	1992 (lb/a)	1993 (lb/a)	Inoculum Rhizobium
Common	Austrian winter pea	71.4	74.4	C
Cahaba	White vetch	35.7		Vic. Sp 2
Trapper	Field pea	71.4		C
Miranda	Yellow field pea	282.0		C
Sirius	Field pea	89.3		C
Mississippi Pinkeye	Cowpea	130.4		EL
Mississippi Cream	Cowpea	88.4		EL
Victor	Cowpea	80.0		EL
Tingata	Tangier flatpea	71.4	74.4	Lath. Sp.3
Chickling	Vetch	107.2	111.7	Lath. Sp. 3
UI 114	Pinto bean	252.2		D
Sacramento Lt.	Red kidney bean	116.1		D
Dianna	Faba bean	175.9		Q
Ackerperle	Faba bean	151.7		Q
Hertz Freya	Faba bean	256.9		Q
Timeless Aladin	Faba bean	232.9		Q
Green	Mung bean	42.3		EL
Common	Hairy vetch	16.4	17.1	C
Maple	Field pea	222.0		C
Jemalong	Barrel medic	13.4		N
Parabinga	Barrel medic	11.6		N
Ascot	Barrel medic	15.5	15.5	N
Borung	Barrel medic	11.6		N
Paraggio	Barrel medic	15.5	15.5	N
Santiago	Polymorpha medic	12.8		N

Sava	Snail medic	54.4	54.4	N
George	Black medic	8.9	8.9	N
MTMB-5	Black medic (Dr. B)	8.9	8.9	N
Bigbee	Berseem clover	8.9		R
Multicut	Berseem clover	8.9	8.9	R
Selection 1	Berseem clover	8.9	8.9	R
Mt. Barker	Subterranean clover	17.9		WR
Maral	Shaftal clover	4.5		R
Youchi	Arrowleaf clover	8.9		O
Nitro	Alfalfa	8.9	10.6	A
Moapa	Alfalfa	8.9		A
Indianhead	Lentil	28.0	28.0	C
Timeless T-2000	Green lentil	62.5		C
Latah	Field pea		192.0	C
Maple	Field pea		192.0	C
Magnus	Field pea		192.0	C
WW II	Field pea		192.0	C
Miranda	Yellow field pea		282.0	C
Kabuli	Chickpea		278.0	
Procon	Field pea		185.0	C
Trapper	Field pea		71.0	C
Desi	Chickpea		97.0	

Table 2. Total yields for the small-seeded annual legume trials, 1992 and 1993, COARC, Powell Butte, and KES, Klamath Falls, OR

Variety / Species Common Name	1992 COARC (lb/a)	1993 KES (lb/a)	1993 COARC (lb/a)
Selection 1 Berseem clover	6,438	5,621	1,615
Multicut Berseem clover	6,201	5,621	1,503
Maral Shaftal clover	5,841		
Bigbee Berseem clover	5,390		
Paraggio Barrel medic	5,202	8,401	2,625
Santiago Polymorpha medic	4,721		
Ascot Barrel medic	4,636	6,292	900
Moapa Alfalfa	4,073		
Jemalong Barrel medic	4,012		
Nitro Alfalfa	3,659	6,486	792
Sava Snail medic	3,609	7,733	1,624
Borung Barrel medic	3,578		
Mt. Barker Subterranean clover	3,526		
Timeless T-2000 Green lentil	3,507		
Indianhead Lentil	3,349	5,024	3,285
Youchi Arrowleaf clover	2,916		
Parabinga Barrel medic	2,852		
George Black medic	2,367	5,305	1,372
MTBM-5 Black medic (Dr. B)	2,134	3,739	1,189
Control (Weeds)	1,583		
Hairy Vetch		4,475	3,011
Mean	3,980	5,918	1,792
PLSD 0.10	733	1,208	713
PLSD 0.05	878	1,455	859
CV %	15.5	16.9	33.0

Table 3. Total dry-matter yields for the large-seeded annual legume trials, 1992 and 1993, COARC, Powell Butte and KES, Klamath Falls, OR.

Variety / Species Common Name	1992 KES (lb/a)	1992 COARC (lb/a)	1993 KES (lb/a)	1993 COARC (lb/a)
Maple pea	6,600	4,130	6,390	5,934
Sirius field pea	5.560	4,150		
Austrian winter pea	5,080	3,290	5,351	5,298
Trapper pea	4,800	3,420	7,264	3,244
Chickling vetch	4,580	3,266	5,978	5,719
Ackerperle faba bean	4,460	3,230		
Tingata tangier flatpea	4,380	2,690	6,040	4,630
Miranda yellow field pea	4,020	4,150	7,534	4,412
Hertz Freya faba bean	4,020	3,600		
Common hairy vetch	3,860	4,566		
UI 114 pinto bean	3,720	1,770		
Timeless T-2000 faba bean	3,660	4,040		
Sacramento lt. Red kidney bean	3,380	1,440		
Dianna faba bean	3,210	3,690		
Cahaba white vetch	3,020	3,566		
Green mung bean	2,970	1,080		
Mississippi Cream cowpea	2,690	1,170		
Victor cowpea	2,440	1,440		
Mississippi Pinkeye cowpea	1,930	1,150		
Latah pea			6,511	6,406
Magnus pea			9,005	5,883
WW II pea			6,028	4,830
Kabuli chickpea			4,785	4,127
Procon field pea			6,895	3,621
Desi chickpea			4,412	2,432
Mean	3,910	2,852	6,349	4,712
PLSD 0.10	1,094	477	1,789	905
PLSD 0.05	1,312	571	2,149	1,087
CV %	23.6	14.1	11.8	14.4

Table 4. First cutting results of the small-seeded annual legume trial, May 1992 planting, COARC, Powell Butte, OR.

Variety	Species Common name	Yield (lb/a)	Dry Matter (%)	Moisture (%)	Plant Height (in.)	Plant Stand on 6/20 (%)
Sava	Snail medic	3,278	15.3	84.7	18.8	97
Parragio	Barrel medic	3,077	15.6	84.4	17.0	91
Santiago	Polymorpha medic	2,818	14.5	85.6	17.5	93
Ascot	Barrel medic	2,723	13.9	86.2	18.3	90
Indianhead	Lentil	2,645	17.3	82.7	16.5	96
Timeless T-2000	Green lentil	2,645	17.4	82.6	16.3	97
Section 1	Berseem clover	2,596	13.8	86.2	22.3	94
Borung	Barrel medic	2,550	16.0	84.0	18.3	80
Multicut	Berseem clover	2,439	17.0	83.0	23.3	93
Maral	Shaftal clover	2,435	12.7	87.4	21.5	73
Parabinga	Barrel medic	2,299	15.7	84.3	15.3	87
Bigbee	Berseem clover	2,089	14.3	85.7	20.5	86
Jemalong	Barrel medic	2,046	13.5	86.5	14.8	96
Moapa	Alfalfa	1,826	20.3	79.7	20.8	71
Nitro	Alfalfa	1,730	20.2	79.9	20.5	68
George	Black medic	1,493	18.2	81.8	14.0	39
MTBM-5	Black medic (Dr. B)	1,318	20.2	79.9	8.5	13
Mt. Barker	Sub clover	1,296	14.6	85.5	10.8	91
Control	(Weeds)	1,266	20.2	79.8	17.0	0 (100)
Youchi	Arrowleaf clover	1,048	18.6	81.4	11.3	35
Mean		2,191	16.5	83.5	17.1	74
PLSD .10		613	1.1	1.1	2.2	8.7
PLSD .05		734	1.3	1.3	2.7	10.4
CV %		23.7	5.6	1.1	11.1	9.9

Table 5. Second cutting results of the small-seeded annual legume trial, 1992 planting, COARC, Powell Butte, OR.

Variety	Species Common Name	Yield (lb/a)	Dry Matter (%)	Moisture (%)	Plant Canopy Height (in.)
Selection 1	Berseem clover	3,843	14.7	85.3	21.8
Multicut	Berseem clover	3,763	17.1	82.9	23.8
Maral	Shaftal clover	3,407	12.9	87.1	18.5
Bigbee	Berseem clover	3,302	14.7	85.3	21.8
Moapa	Alfalfa	2,247	21.0	79.0	19.5
Mt. Barker	Sub clover	2,231	15.0	85.0	12.0
Parragio	Barrel medic	2,126	17.5	82.5	11.3
Jemalong	Barrel medic	1,967	16.0	84.0	14.3
Nitro	Alfalfa	1,930	21.4	78.6	14.8
Ascot	Barrel medic	1,913	18.9	81.1	11.8
Santiago	Polymorpha medic	1,904	18.6	81.4	11.0
Youchi	Arrowleaf clover	1,868	15.0	85.0	16.8
Borung	Barrel medic	1,029	21.0	79.0	13.0
George	Black medic	874	22.2	77.8	5.3
MTBM-5	Black medic (Dr. B)	816	22.5	77.5	10.5
Indianhead	Lentil	704	27.0	73.0	10.8
Timeless T-2000	Green lentil	657	24.8	75.2	14.3
Parabinga	Barrel medic	553	20.8	79.2	7.3
Sava	Snail medic	331	24.3	75.7	4.3
Control	(Weeds)	317	22.1	77.6	4.0
Mean		1,789	19.4	80.6	13.3
PLSD .10		495	1.9	1.9	5.4
PLSD .05		593	2.3	2.3	6.4
CV %		23.4	8.3	2.0	34.1

Table 6. First cutting results for the small-seeded annual legume trial, 1993 planting, COARC, Powell Butte, OR.

Variety / Species Common Name	Yield (lb/a)	Dry Matter (%)	Moist. (%)	Plant Canopy Height (in.)	Plant Stand on 7/20 (%)	Harvest Date (1/1 = 1)
Indianhead Lentil	3,285	25.0	75.0	15.5	64	237
Common Hairy vetch	3,011	17.0	83.0	15.8	36	237
Paraggio Barrel medic	2,665	21.9	78.1	11.2	44	237
Sava Snail medic	1,624	20.3	79.7	11.5	50	237
Selection 1 Berseem clover	1,615	18.3	81.7	17.2	68	237
Multicut Berseem clover	1,503	19.7	80.3	18.5	70	237
George Black medic	1,372	20.4	79.6	10.0	23	237
MTBM-5 Black medic	1,189	20.4	79.6	12.2	51	237
Ascot Barrel medic	900	21.1	78.9	5.5	9	237
Nitro Alfalfa	792	21.8	78.2	21.5	30	237
Mean	1,792	20.6	79.4	13.9	44	237
PLSD .10	713	2.1	2.1	3.9	17	NS
PLSD .05	859	2.5	2.5	4.7	20	NS
CV %	33.0	8.4	2.2	23.5	31.4	0.0

Table 7. First cutting results of the large-seeded annual legume trial, 1992 planting, COARC, Powell Butte, OR.

Variety / Species Common Name	Yield (lb/a)	Dry Matter (%)	Moisture (%)	Plant Canopy Height (in.)	Plant Stand on 6/20 (%)
Miranda Yellow field pea	4,080	13.8	86.2	21.3	90
Sirius Field pea	4,047	16.7	83.3	36.5	83
Maple Field pea	4,042	14.5	85.5	31.0	89
Timeless Aladin Faba bean	3,995	12.3	87.7	38.0	95
Trapper Field pea	3,927	15.1	84.9	34.3	66
Dianna Faba bean	3,621	11.6	88.4	36.8	93
Hertz Freya Faba bean	3,523	12.9	87.1	37.0	89
Austrian Winter pea	3,241	13.2	86.8	27.0	92
Ackerperle Faba bean	3,210	11.7	88.3	34.5	89
Tingata Tangier flatpea	2,642	13.0	87.0	33.8	73
Chickling Vetch	2,615	15.2	84.8	25.5	92
Cahaba White vetch	2,096	16.9	83.1	23.8	75
Common Hairy vetch	1,881	14.0	86.0	19.0	74
UI 114 Pinto bean	1,726	17.3	82.7	15.0	90
Sacramento Lt Red kidney bean	1,438	17.3	82.7	15.0	51
Victor Cowpea	1,432	17.6	82.4	14.0	57
Control (Weeds)	1,358	18.9	81.1	16.8	0 (100)
Mississippi Pinkeye cowpea	1,162	18.3	81.7	6.8	33
Mississippi Cream cowpea	1,124	17.5	82.5	9.0	44
Green Mung bean	1,076	17.2	82.8	8.5	85
Mean	2,612	15.2	84.8	24.2	73
PLSD 0.10	419	1.3	1.3	4.4	15
PLSD 0.05	502	1.5	1.5	5.2	18
CV%	13.6	7.0	1.3	15.3	17.6

Table 8. Second cutting data for the large seeded annual legume trial in 1992 at the COARC, Powell Butte, OR

Variety / Species Common Name	Yield (lb/a)	Dry Matter (%)	Moisture (%)	Plant Canopy Height (in.)
Common Hairy vetch	2,686	16.8	83.2	16.0
Cahaba White vetch	1,470	21.8	78.2	15.0
Chickling Vetch	651	20.6	79.4	13.8
Mean	1,602	19.7	80.3	14.9
PLSD 0.10	590	2.1	2.1	NS
PLSD 0.05	744	2.6	2.6	NS
CV%	26.8	7.6	1.9	11.1

Table 9. First cutting results for the large-seeded annual legume trial, 1993 planting, COARC, Powell Butte, OR.

Variety / Species Common Name	Yield (lb/a)	Dry Matter (%)	Moisture (%)	Plant Canopy Height (in.)	Plant Stand on 7/20 (%)	Julian Harvest Date (1/1 = 1)
Latah Field pea	6,406	23.1	76.9	31.3	71	236
Maple Field pea	5,934	18.5	81.5	21.3	78	223
Magnus Field pea	5,883	20.1	79.9	31.0	81	223
Chickling Vetch	5,714	21.2	78.8	26.5	68	246
Austrian Winter pea	5,298	17.7	82.3	33.8	61	236
WW II Field pea	4,830	15.2	84.8	31.3	68	223
Tingata Tangier flatpea	4,643	18.3	81.7	37.0	43	246
Miranda Yellow field pea	4,412	16.2	83.9	21.0	78	223
Kabuli Chickpea	4,127	23.2	76.8	24.8	73	246
Procon Field pea	3,621	17.4	82.6	26.5	39	223
Trapper Field pea	3,244	16.2	83.8	28.8	39	236
Desi Chickpea	2,432	23.1	76.9	19.0	48	246
Mean	4,712	19.2	80.8	27.7	62	233
PLSD 0.10	811	2.3	2.3	4.8	21	---
PLSD 0.05	974	2.7	2.7	5.7	25	---
CV%	14.4	9.9	2.4	14.4	28.0	---

Table 10. Emergence over time and percent stand rating for the small-seeded annual legume trial (replicate II only), May 26, 1992 planting, COARC, Powell Butte, OR.

Variety/Species Common Name	Date 6/3	6/5	6/8	6/10	6/13	6/17	6/20
Jemalong Barrel medic	10	60	75	90	95	95	99
Parabinga Barrel medic	10	50	65	75	80	92	92
Ascot Barrel medic	40	65	85	85	90	90	90
Borung Barrel medic	10	35	75	85	85	85	85
Paraggio Barrel medic	35	70	80	85	90	90	90
Santiago Polymopha medic	20	60	90	90	95	95	98
Sava Snail medic	90	99	99	99	99	99	99
George Black medic	10	15	20	35	35	35	35
MTMB-5 Black medic (Dr. B)	0	10	15	15	15	15	15
Bigbee Berseem clover	5	55	75	85	90	90	90
Multicut Berseem clover	60	85	95	99	99	99	99
Selection 1 Berseem clover	20	50	75	85	95	99	99
Mt. Barker Subterranean clover	60	80	95	95	95	95	95
Maral Shaftal clover	15	30	75	85	90	90	90
Youchi Arrowleaf clover	0	10	15	20	20	30	30
Nitro Alfalfa	40	65	80	80	85	85	85
Moapa Alfalfa	10	50	70	70	70	70	70
Indianhead lentil	65	85	95	95	97	99	99
Timeless T-2000 Green lentil	90	99	99	99	99	99	99
Control (Weeds – no legumes)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.

Table 11. Emergence over time and percent of stand (%) (replicate 1 only) for the small-seeded annual legume trial, May 19, 1993 planting, COARC, Powell Butte. OR.

Variety	Species Common Name	5/25	5/28	Date 6/1	6/3	7/20
MTMB-5	Black medic	0	2	15	20	55
Nitro	Alfalfa	20	20	25	25	35
Sava	Snail medic	20	25	50	60	60
Paraggio	Barrel medic	10	10	25	25	25
Common	Hairy vetch	0	1	10	10	30
Multicut	Berseem clover	20	20	40	40	60
Ascot	Barrel medic	5	5	10	10	5
Indianhead	Lentil	0	10	60	80	70
Selection 1	Berseem clover	20	20	20	20	45
George	Black medic	2	2	20	10	15
5364	Alfalfa (Border)	40	40	60	20	---

Table 12. Emergence over time and percent stand rating for the large-seeded annual legumes Trial (replicate II only), May 26, 1992 planting, COARC, Powell Butte, OR.

Variety/Species Common Name	Date 6/3	6/5	6/8	6/10	6/13	6/17	6/20
Austrian Winter pea	35	55	90	95	95	95	95
Cahaba White vetch	0	0	50	55	60	60	70
Trapper Field pea	20	60	85	85	85	85	90
Miranda Yellow field pea	20	40	75	75	80	82	85
Sirius Field pea	5	35	70	80	85	85	85
Mississippi Pinkeye cowpea	2	30	40	40	40	40	40
Mississippi Cream cowpea	5	15	25	25	25	25	25
Victor Cowpea	15	45	75	75	75	75	75
Tingata Tangier flatpea	5	30	75	75	75	75	75
Chickling vetch	10	35	80	80	80	80	80
UI 114 pinto bean	15	65	85	90	90	92	92
Sacramento lt. red kidney bean	1	10	45	50	50	50	50
Dianna faba bean	0	10	80	85	90	92	95
Ackerperle faba bean	0	40	80	90	90	90	90
Hertz Freya faba bean	1	10	80	80	80	80	80
Timeless Aladin faba bean	15	45	70	75	75	75	75
Green mung bean	1	30	90	90	95	95	95
Hairy vetch	15	80	95	95	95	95	95
Maple field pea	0	10	25	25	25	50	60
Control (no legumes – weeds)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.

Table 13. Emergence over time and percent of stand (%) (replicate 1 only) for the large-seeded annual legume trial, May 19, 1993 planting, COARC, Powell Butte. OR.

Variety	Species Common Name	5/25	5/28	Date 6/1	6/3	7/20
Latah	Pea (Border)	0	5	60	65	80
Kabuli	Chickpea	0	1	25	40	90
Chickling	Vetch	0	7	45	65	75
Austrian	Winter pea	0	15	60	65	80
WW II	Pea	0	5	55	65	75
Procon	Field pea	0	3	40	50	50
Latah	Pea	0	15	55	60	65
Desi	Chickpea	0	1	3	15	10
Tinga	Tangier flatpea	0	0	10	60	30
Trapper	Pea	0	2	25	35	30
Magnus	Pea	0	15	60	80	90
Miranda	Pea	0	15	65	75	90
Maple	Pea	0	25	60	75	80

PRELIMINARY WORK WITH MEDICINAL HERBS

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Introduction

Sales of medicinal herbs in the USA are reported to have doubled from 1997 to 1998, and it is anticipated the market will keep expanding (Landes, 1998). The purpose of this trial was to investigate environmental influences on the potency of several medicinal herbs by growing them at several location. This interest overlapped with an interest to see how some of these herbs might perform in central Oregon. Accordingly the following herbs were established at the Madras site in 1997: valerian (*Valeriana officinalis*), feverfew (*Tanacetum parthenium*), clary sage (*Salvia sclarea*), and catnip (*Nepeta cataria*). In addition a plot of *Echinacea purpurea* was established at the Powell Butte site.

Methods

The herbs grown at Madras (valerian, feverfew, clary sage, and catnip) were laid out in 6 row plots with a row spacing of 1.2 m (4') and each row being 7.6 m (25') long. For each herb, about 3.05 m (10') from the middle of the middle four rows were harvested (so all samples were bordered. Feverfew was harvest 22 June. Catnip and clary sage were harvested 14 August. Valerian was topped 31 July and roots were dug from part of the plot (3.5 m^2) on 4 August, and again (7.5 m^2) on 22 October. All samples were air dried in cloth bags. An area of 7.81 m^2 was harvested from the *Echinacea purpurea* plot on 2 October. The plants were cut about 0.3 m (1') from the ground -- about one-third of the plant height. Analysis of samples taken the previous year was conducted by Dr. Barl of the University of Saskatchewan as reported in Tanino and Barl (1998).

Results

The plants survived the winter well and put on a fair amount of top growth (Table 1). Samples were not analyzed this year for active ingredient, but we recently obtained the analysis of samples taken the previous year (1997). Feverfew from Madras was reported to contain 0.29 percent parthenolide. Valerian contained 0.117 percent valerenic acid and 0.36 percent essential oil on a dry weight basis. Components of the valerian essential oil were: 9.95 percent bornyl acetate; 1.88percent caryophyllene; 0.75 percent spathulenol; 0.17 percent camphene; 1.18 percent agarospirol; 0.60 percent caryophyllene oxide; 0.39 percent borneol (note that analytical results were quite variable). Analysis of flavonol glucosides from Calendula sampled in 1997 had 0.413 percent isorhamnetin-3-rutinoside and 0.036 percent isorhamnetin-3-glucoside. Essential oil from calendula flowers contained: 50.6 percent cadinol; 26.0 percent cadinene; 2.23 percent ledol; 2.62 percent hexafarnesyl acetone; 0.40 percent copaene; and 0.24 percent caryophyllene. Milk thistle seed extract (ether followed by methanol) contained the following oils: fixed oil 24.5 percent; silibinin A 0.393 percent; silibinin B 0.546 percent; DH-silibinin 0.249 percent; silychristine 0.63 percent; silydianine 0.482 percent; taxifolin 0.364 percent; and silymarin 2.66 percent. Tanino and Barl (1998) report that valerian and catnip had greater amounts of active ingredient when grown in Saskatchewan than in Madras. Feverfew grown in Madras compares favorably with other sites in terms of dry matter produced and percent active ingredient.

Table 1. Yield of medicinal plants grown at COARC facilities in 1998. All values are for air-dry samples (none were oven-dried).

Herb	Air-dry Weight
	(lbs/acre)
Echinacea purpurea	5870
Feverfew	6310
Clary Sage	7170
Catnip	5760
Valerian Root (Aug. 4)	1790
Valerian Root (Oct. 22)	607

Literature Cited

Landes, P. 1998. Market report. Herbalgram 43: 60-61.

Tanino, K., and B. Barl. 1998. Final Report: Northern vigor potential in medicinal and aromatic plants. Department of Plant Sciences, Univ. of Saskatchewan, Saskatoon.

SURVEY OF CENTRAL OREGON FARMERS

Peter Sexton and Jerry Roetcisoender

Abstract

A survey was taken of central Oregon farmers in order to better identify research needs for the area. Twenty four farmers were asked a set of six questions regarding their farming operation and what problems they thought needed research. Main research problems farmers mentioned were: identification of new crops, verticillium wilt control in mint, cover or green manure crops, winter-kill in carrots and mint, contamination of seed (especially in bluegrasses), and residue management in cereals and grasses.

Introduction

Accurate identification and ranking of research problems is essential for applied agricultural research to be productive. Towards this end, a survey of central Oregon farmers was taken to better understand cropping systems in the area and to poll the farmers on what problems merit research.

Materials and Methods

A random sample of farmers was drawn from the mailing list of the "Central Oregon Agriculture" newsletter. Six farmers each were interviewed from Madras, Culver, and Prineville, and three each from the Powell Butte and Terrebonne areas (24 farmers total). Farmers were asked the following questions in face to face interviews:

1.) Is your operation a part-time or a full-time one? What kind of irrigation system do you use?
2.) What crops are you growing and what rotations do you follow with them? (a table was included with this question to fill out planting dates, harvest, fertilizer use, weed, insect, disease problems, and main problems/limitations for each crop).
3.) What crops would you expand if you could and which would you drop first if a new crop became available? Why?
4.) How would you rank the problems listed earlier (in question 2)?
5.) What direction do you think future research at the COARC should take?
6.) What role do you think the experiment station should play in agricultural production in Central Oregon?

The first two questions more or less sought to characterize the farmer's situation and the latter four questions sought to list and prioritize researchable production problems. Answers were recorded by the interviewer. Putting all the surveys together, crops grown and problems faced were ranked according to how many farmers listed them as being important.

Results

Crops. Crops grown were listed as follows (with number of farmers growing given in parenthesis): wheat (20); mint (16); carrot (12); blue grasses (12); alfalfa (11); garlic (8); sugarbeets (8); cereal/pea mix (6); potatoes (4); dry beans (2); onion (1); timothy (1); orchard grass (1); coriander (1); peas (1); popcorn (1).

Crops that farmers considered meriting expanded production included: mint (6); garlic (5); carrots (5); bluegrass (3); sugarbeets (3); coriander (2); and dry bean (1).

Crops that farmers mentioned as being less desirable included: wheat (5); mint (3); alfalfa (3); carrots (2); dry bean (1); and sugarbeets (1).

Several crops that were put in the "expansion" category by some farmers were also put in the "drop" category by other farmers (mint, carrots, sugarbeets, dry bean). Part of this may be a function of environment, where some growers are in a favorable environment for a particular crop (e.g. dry bean) and would like to grow more, while others may be in a marginal position to grow the crop and so consider it a risky venture. Also some farmers may have more experience with a given crop and have worked out the production problems and would be comfortable expanding it, while others may have difficulty with the same crop and so would shy away from it.

It seems that the crops grown may be split into several groups. Mint, carrot seed, bluegrass seed, and garlic are crops of high economic importance and probably pay the bills on many farms. Crops such as alfalfa and other forages, sugarbeets, peas, and dry bean are crops with lower economic value but grown on many farms. Crops such as potatoes and onions appear to be important for a few farmers. Wheat is grown by almost all, if not all, farmers but is basically grown as a rotational crop because it is relatively easy to grow and has an open market.

Production Problems. Farmers were asked to list the main problems encountered for each crop. The three most important problems for mint were considered to be: verticillium wilt, low market price, and insect problems. For carrot seed the three most important problems were: high production costs, getting good seed set; and stand losses over winter. For bluegrass the main problems listed were keeping seed free of contaminants (esp. Roughstalk bluegrass in Kentucky bluegrass), and low prices / late payment. For garlic the main problems were white rot and cost of harvest. For sugarbeets the main problems were costs of harvest and freight, frost damage, and weed control. For alfalfa the main problems were high water requirement, poor weather at curing, and marketing problems. For potatoes the problems listed were mostly a combination of low price and high costs. Lastly for wheat the problems given were poor market and dealing with straw and tillage after harvest. A complete listing of production problems is given in Table 1.

Farmers ranked research problems as follows (number of farmers follows in parenthesis):
1. Identification of new crops (5)
2. Verticillium wilt control in mint (5)
3. Work with green manure and cover crops (4)

4. Winter-kill in carrots and mint (2)
5. Contamination of seed (esp. Bluegrass) (2)
6. Residue management in grasses and cereals (2)

Role of COARC. Farmers said that besides conducting applied research, COARC should work to educate the public about farming. Also the point was made to keep the research work practical, and to include local farmers, extensionists, and researchers at other locations in the Pacific Northwest in the research process.

Table 1. Listing of weed, disease, insect, and overall problems for several crops as given by central Oregon farmers in a survey taken in the fall of 1998. Under each heading, problems are listed according to the frequency they were mentioned by farmers (those at the top of the list were mentioned most often, and those at the bottom were mentioned by only one or a few farmers).

Mint			
Weeds	Diseases	Insects	Main Problems
Groundsel	Verticillium Wilt	Spider Mites	Verticillium Wilt
Lambsquarter	Stem Rot	Cutworms	Insects
Pigweed		Mint Flea Beetle	Low Market
Kochia		Nematodes	Cost of Chemicals
Nightshade		Strawberry Root-Weevil	Cost of Fertilizers
Canadian Thistle		Mint Root Borer	Cost of Irrigation
Bluegrasses		Wire Worms	Cost of Distilling
Wild Oats		Leaf Hoppers	Groundsel
Morning Glory			Lambs Quarter
Chinese Lettuce			Winter Kill
Shepherdspurse			Labor
			Over-Production

Carrot			
Weeds	Diseases	Insects	Main Problems
Groundsel	Blight	Lygus Bug	Winter Kill
Nightshade	Fungus	Mites	Excessive Chemicals
Lettuces	Mildew	Cutworms	High Production-Cost
Mustard	Xanthomonas	Aphids	Pollination
Thistles		Thrips	Blight
Volunteer Grasses			Groundsel
Pigweed			Fungus
Water Grasses			Acres-vs-Equipment
Rattail			

Garlic			
Weeds	**Diseases**	**Insects**	**Main Problems**
Groundsel Yellow Mustard Rattail Cheat Grass Lettuces Mustard Thistle Nightshade	White Rot Rust Mildew	Winter Mites	Harvest Cost Weather Bad Soil (white rot)

Alfalfa			
Weeds	**Diseases**	**Insects**	**Main Problems**
Mustard Grasses Groundsel Pigweed Lambsquarter Wild Oats Shepherdspurse Tansy Dandelions	Fusarium Wilt	Alfalfa Weevil Aphids Loopers Leaf Hoppers Stem Nematodes	Weather Marketing Problems Excessive Water Excessive Labor Cost Of Chemicals Fertility Annuals Wildlife

Sugarbeets			
Weeds	**Diseases**	**Insects**	**Main Problems**
Pigweed Lambsquarter Nightshade Kochia Wild Oats Groundsel Purslane Quackgrass	Mildew Curlytop Powdery Mildew	Cutworm Leaf Hopper	Harvest Cost Frost Weed Control Limited Acres

Wheat			
Weeds	Diseases	Insects	Main Problems
Wild Oats Russian Thistle Lambsquarter Pigweed Kochia Morning Glory	Rust Fungal	Russian Wheat Aphid Stem Maggot Winter Grain Mites	Poor Market Wild Oats Controlling Straw - after Harvest

Potatoes			
Weeds	Diseases	Insects	Main Problems
Pigweed Lambsquarter Nightshade	Blight	Potato Beetle Aphids Green Peach Aphid	High Production Cost Low Profit Cost of Chemicals Proper Tillage Weather Keeping Disease Free

Grass Seed			
Weeds	Diseases	Insects	Main Problems
Off Type Bluegrass Cheat Grass Rattail Fescue Groundsel Puncture Vine Quack Grass Carrot Seed	Powdery Mildew Rust Ergot	Winter Grain Mites Aphids	High Production Cost Low Market Price Contamination of other Grasses Getting Clean Seed Timely Payments Timing of Planting 3rd Year yield Drops Ergot

SOME HISTORICAL WEATHER DATA FROM MADRAS, PRINEVILLE, AND POWELL BUTTE: AIR AND SOIL TEMPERATURES, RAINFALL, AND EVAPOTRANSPIRATION

Peter Sexton and Neysa Farris

Abstract

Weather data from Madras, Prineville, and Powell Butte over a varying time period (5 to 20 years depending on availability) are presented. Average air temperatures are given for each day of the year for all three sites. Minimum soil temperature (4 inch depth), rainfall, and potential evapotranspiration data are given for Madras. Estimates of frost frequency for each day of the year are also presented for areas near Madras (experiment station) and Prineville (KRCO radio station).

Introduction

This article presents average maximum and minimum daily temperatures for Madras, Prineville, and Powell Butte, and soil temperatures (4" depth), potential evapotranspiration, and rainfall data from Madras. The Prineville data was collected at the KRCO station over a 22 year span (1975-1997). The Madras and Powell Butte data were collected at the respective experiment stations (Madras from 1988-1998, and Powell Butte from 1994-1998). Daily averages are graphed out for each day of the year. For the temperature data, the range of extreme temperatures are also shown for both maximum and minimum temperature. Response to temperature varies tremendously among different crops and also between varieties, so one needs to know what the critical temperatures are for a crop at a particular stage before interpreting data. Also one needs to think about how close they are to the place where the weather data was recorded and how the microclimate might be different. Hopefully these graphs will serve as a useful reference for helping to see what is possible in terms of daily temperature over the course of the year.

Methods

Weather data from Prineville were obtained from the Oregon Climate Service (www.ocs.orst.edu). Weather data from Powell Butte and Madras were obtained from AgriMet weather stations maintained by the Bureau of Land Management. All data were sorted for each day of the year (e.g., January 1 = day 1 and December 31 = day 365), and average values for each variable were calculated. Extra days at leap years (Feb. 29) were excluded from analysis. For temperature data, the range of maximum and minimum temperatures, along with the average, were determined for each day of the year. For the 20 years of rainfall data at Madras, precipitation was summed over the first and second halves of each month (approximately two week periods) and then averaged over the course of 20 years. The frequency of frost (temperature of 32°F or less) at Prineville (1975-1997) and Madras (1988-1997) was determined for each day of the year, as was the frequency for frost within the next five days for each day of the year. All data were plotted using Sigma Plot software, and trend lines where shown are the result of fitting polynomial regressions to the data.

Results

Figure 1 shows daily maximum temperature at the KRCO station near Prineville. For example, for the date of January 1 at Prineville (Fig. 1) from 1975 to 1997 the average high temperature on New Year's Day at KRCO was about 40°F. The warmest high temperature recorded on New Year's Day during this period was a little over 50°F, and on the coldest New Year's Day the high was only 7°F. The lines drawn through the points are "trend lines" which give a kind of running average for each measurement. NOTE THAT TREND LINES DON'T INDICATE EXTREMES. Some points, particularly cold temperatures, are well below the trend line. So it is better to look at individual points rather than trend lines to get an idea of extreme temperatures. Figure 2 shows daily minimum temperatures at the KRCO station. Note that the "lowest low" temperatures at the KRCO station do not go much above freezing even during the summer months.

Figures 3 and 4 show daily maximum and minimum temperatures for the Madras experiment station from 1988 to 1997. Figure 5 shows soil temperature data for Madras. Note the potential for soil temperature to drop well below freezing in October and November. Given that the cold soil temperatures were not prolonged, a mulch may be an effective way to limit freezing damage for sensitive plants here during the winter.

Figures 6 and 7 show maximum and minimum temperatures at Powell Butte over a 5 year period (1994-1998). This data should be interpreted with caution as it doesn't represent a long period of time.

Figures 8 and 9 show average potential evapotranspiration (ET), and precipitation, respectively, at Madras.

Figure 10 and 11 show trend lines for occurrence of frost over the course of the year at the KRCO station, and at Madras, respectively. These lines are based on the historical data mentioned earlier (1975-1997 at KRCO and 1988-1998 at Madras). The lines show trends for how frequently the temperature dropped to 32 F or less for each day of the year. Note that this is not necessarily a "killing frost". The lower line shows the percentage of the times frost occurred on each date, and the upper line shows how often a frost occurred within the next five days for each day of the year. The average last date of frost at KRCO from 1975 to 1997 was June 27 and the average first date of frost was Sept. 1. The average last date of frost at Madras from 1988 to 1997 was May 15 and the average first date of frost was Sept. 27.

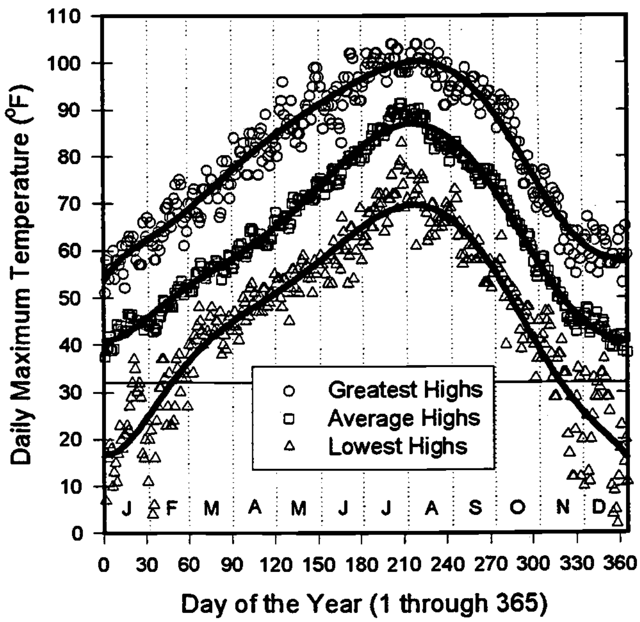

Figure 1. Daily maximum temperatures for Prineville (KRCO Radio Station), 1975-1997. The upper set of points show the highest of the high temperatures, the middle set of points shows the average high temperature for each day of the year, and the lower set of points shows the lowest high temperatures for each day of the year.

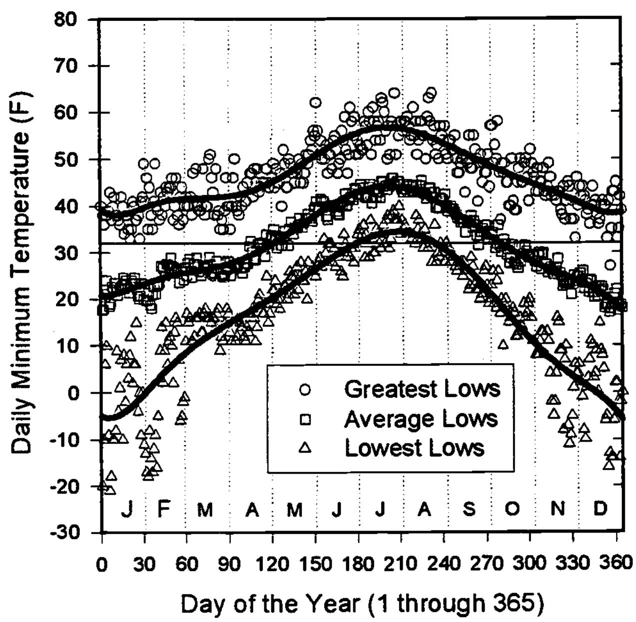

Figure 2. Daily minimum temperatures for Prineville (KRCO Radio Station), 1975-1997. The upper set of points show the highest of the low temperatures, the middle set of points shows the average low temperature for each day of the year, and the lower set of points shows the lowest low temperature for each day of the year.

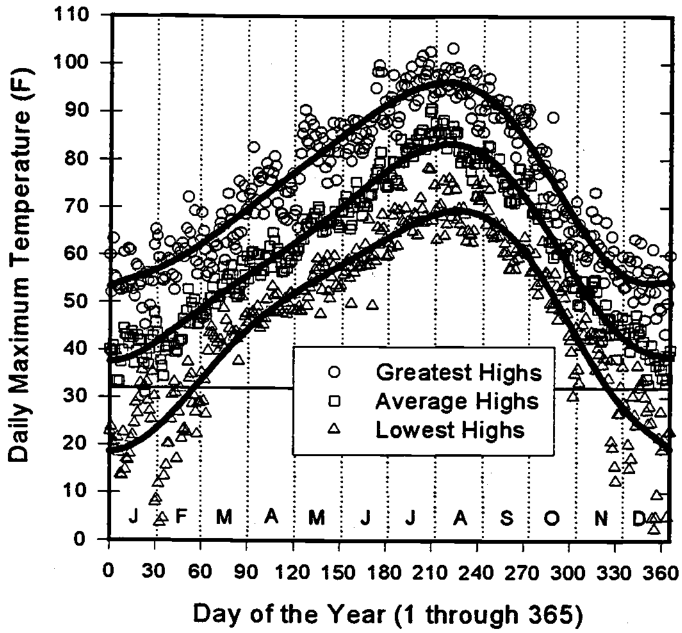

Figure 3. Daily maximum temperatures for the Madras experiment station, 1988-1997. Points and lines are as shown in Fig. 1.

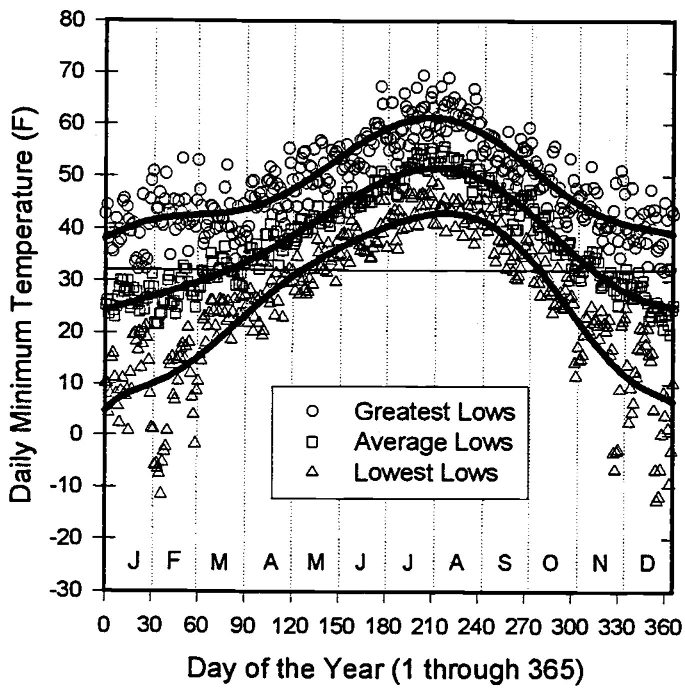

Figure 4. Daily minimum temperatures for the Madras experiment station, 1988-1997. Points and lines are as shown in Fig. 2.

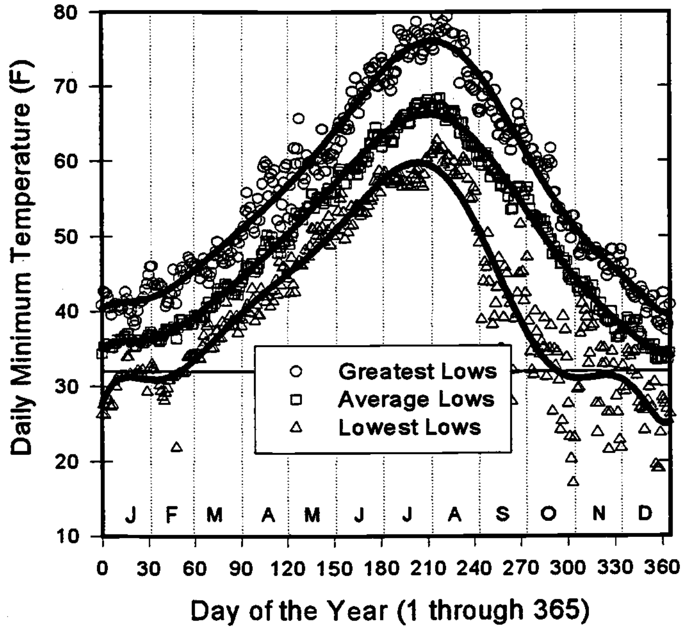

Figure 5. Daily minimum soil temperatures (4" depth) for the Madras experiment station, 1988-1997. Points and lines are as shown in Fig. 2.

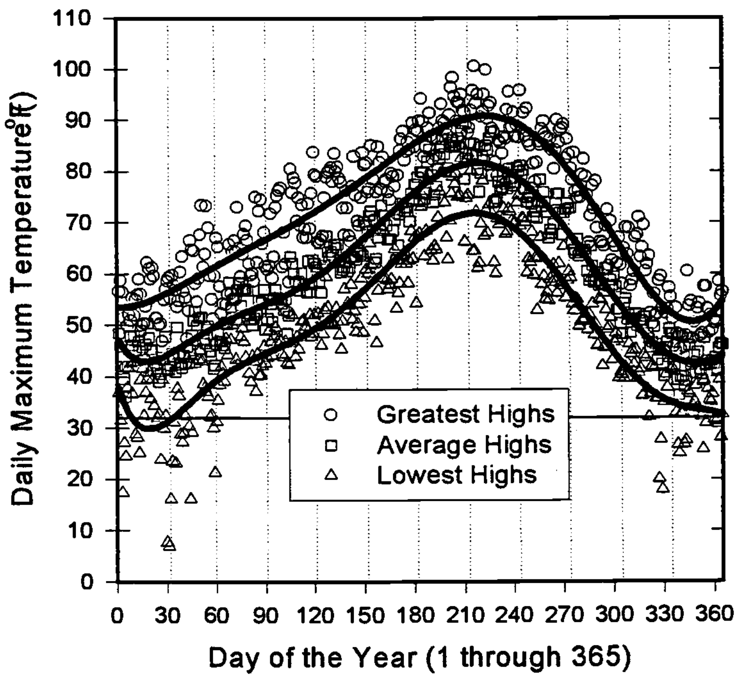

Figure 6. Daily maximum temperatures for Powell Butte experiment station, 1994-1998. Data should be interpreted with extra caution because of the limited time span of the data set. Points and lines are as shown in Fig. 1.

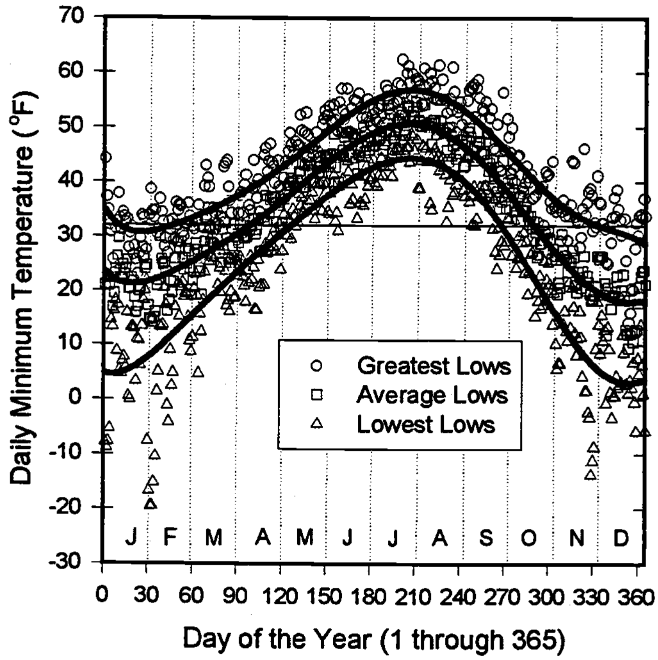

Figure 7. Daily minimum temperatures for Powell Butte experiment station, 1994-1998. Data should be interpreted with extra caution because of the limited time span of the data set. Points and lines are as shown in Fig. 2.

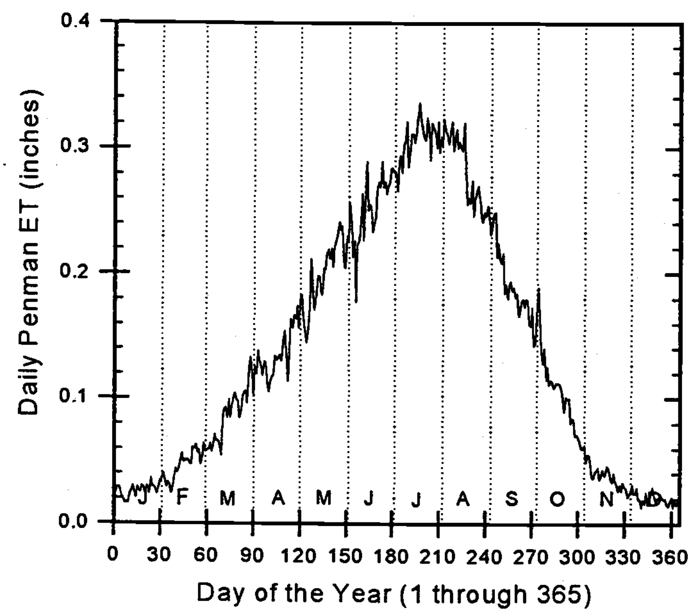

Figure 8. Average daily Penman evapotranspiration (ET) for Madras experiment station, 1991-1998.

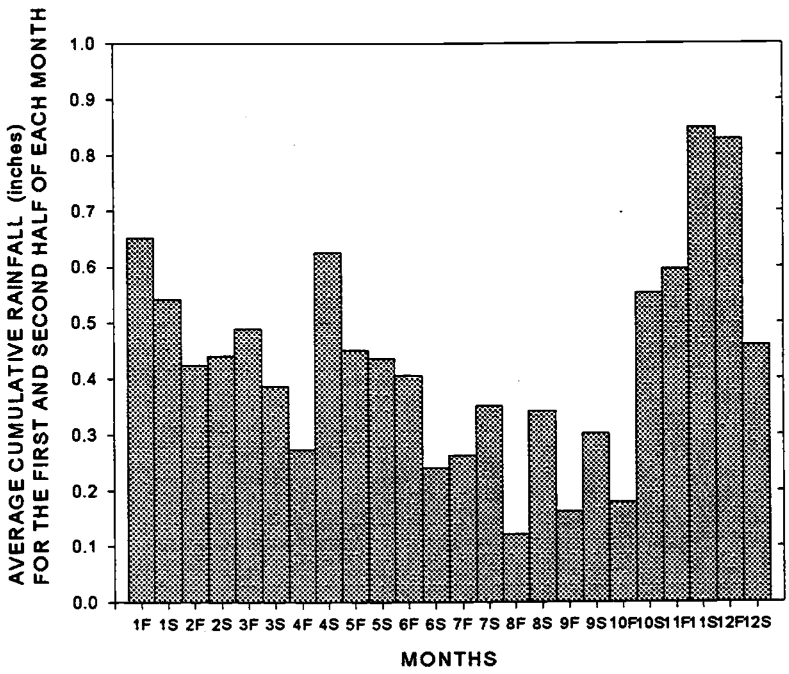

Figure 9. Average cumulative biweekly precipitation at Madras experiment station for each month of the year, 1977-1997. Labels on the x-axis indicate month (1 through 12) and first (f) or second (s) half of each month. Average annual rainfall over the 20 year period was 264 mm (10.4").

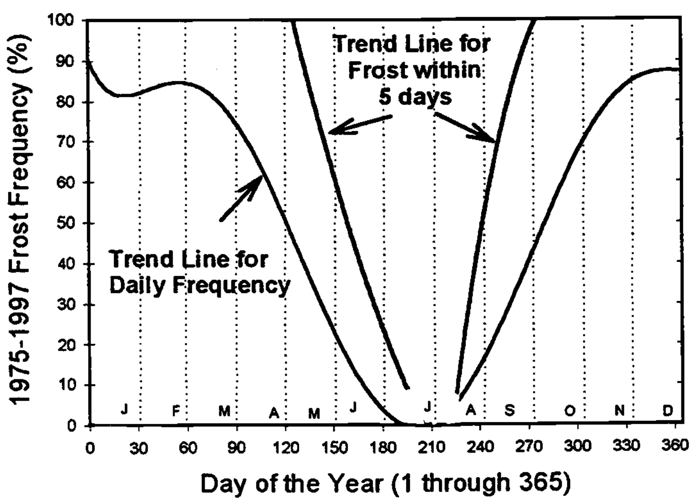

Figure 10. Trend lines for frequency of frost (1975-1997) for each day of the year at the KRCO radio station near Prineville. Frost was defined as low temperatures of 32°F or less. Note this is not necessarily a "killing frost". The average last date of frost at KRCO from 1975 to 1997 was June 27, and the average first date of frost was Sept. 1.

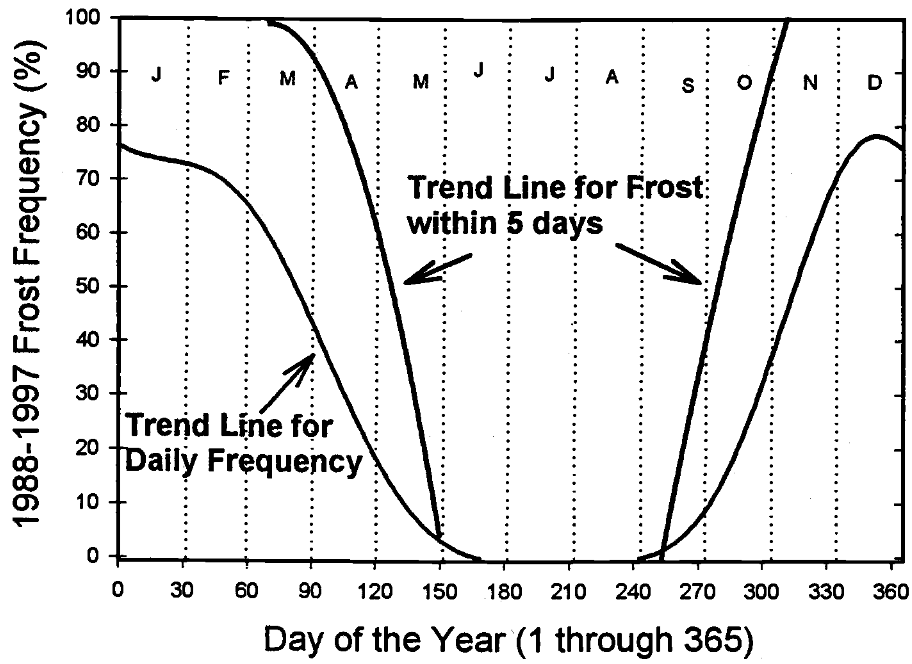

Figure 11. Trend lines for frequency of frost (1988-1997) for each day of the year at Madras (COARC Experiment station). Frost was defined as low temperatures of 32°F or less. Note this is not necessarily a "killing frost". The average last date of frost at Madras from 1988 to 1997 was May 15, and the average first date of frost was Sept. 27.

EVALUATION OF HERBICIDES FOR GRASS CONTROL IN SUGAR BEETS, 1998

Marvin Butler and Neysa Farris

Abstract

Three herbicides, Assure II (quizalofop p-ethyl), Prism, and Poast (sethoxydim) were evaluated for control of two grasses in sugar beets (*Beta vulgaris*) at two locations in central Oregon. All herbicide treatments provided significant control of watergrass (*Echinochlora colona*) compared to untreated plots. Although there were no statistical differences between treatments for quackgrass (*Agropyron repens*) control, the trend was for Assure II to provide the best control, followed by a similar reduced level of control by Prism and Poast.

Introduction

Although evaluation of herbicides for broadleaf control in sugar beets (*Beta vulgaris*) have been conducted for four years, this is the first year that grass control herbicide have been evaluated. The objective of this project was to do a comparative evaluation of grass control herbicides registered for use on sugar beets.

Methods and Materials

Grass control herbicides Assure II, Prism, and Poast were evaluated in commercial sugar beet fields near Prineville and Madras. A single application of Assure at 10 oz/a, Prism at 34 oz/a and Poast at 2.5 pt/a was made at the Prineville location June 3 and at the Culver location June 16. Herbicides were applied with a CO_2-powered, boom sprayer at 40 psi and 20 gal/a water. Plots 10 ft x 20 ft were replicated three times in a randomized complete block design. Crop oil concentrate (COC) was applied at 1 percent v/v in combination with all herbicide treatments. Plots were evaluated for watergrass control at the Culver location July 7 and for quackgrass control at the Prineville location July 14.

Results and Discussion

Results from herbicide applications are provided in Table 1. Although there were no statistical differences between treatments, the trend was for Assure II to provide the best control of quackgrass, followed by similar results from Prism and Poast. Although one commercial application was adequate for quackgrass control in the field, two applications were need for adequate control in the plots. All herbicide treatments provided significant control of watergrass compared to untreated plots.

Table 1. Effect of herbicide treatments applied to sugar beets at Culver, OR, on June 16 and at Prineville, OR, on June 3, 1998. The Culver site was evaluated for watergrass control July 7 and the Prineville site was evaluated for quackgrass control July 14.

		Grass Control		
Treatment[1]	Rate	Watergrass		Quackgrass
	(product/a)	(# of plants)		
Assure II	10 oz	13	b	90
Prism	34 oz	1	b	109
Poast	2.5 pts	5	b	102
Untreated	---	143	a	194
				n.s.

[1]Treatments were applied with 1% COC.

EVALUATION OF HERBICIDES FOR ROADSIDE WEED CONTROL, 1997-1999

Marvin Butler, Brett Dunn, Floyd Paye, and Neysa Farris

Abstract

Fall- and spring-applied residual herbicides were evaluated at the Jefferson County landfill in an area to simulate roadside weed control. Milestone alone at two rates and in combination with Oust and Karmex were compared to traditional roadside weed control programs. Herbicides applied March 6, 1998 provided better control than those applied November 6, 1997. Milestone at 20 oz/a provided the best control of little bur (*Ranunculus testiculatus*) and kochia (*Kochia scoparia*) through February 19, 1999. This peformance was followed Milestone at 10 oz/a and Milestone in combination with Oust (sulfometuron methyl) and Karmex (diuron). These treatments provided greater control than traditional treatments with Oust plus Karmex, Oust plus Krovar (bromacil +diuron), Oust plus Velpar (hexazinone), and Krovar alone. All treatments provided excellent control of grass species.

Introduction

Milestone is a residual herbicide that is expected to be registered in the near future. Because it is from a different chemical family than other residual herbicides currently used for roadside weed control, it could be a valuable tool in resistant management programs. This project was established at the Jefferson County landfill to evaluate Milestone alone and in combination with several other herbicides. These treatments were compared to standard herbicide programs. Both fall- and spring-application timings were evaluated.

Methods and Materials

Herbicides evaluated included Milestone alone at 10 oz/a and 20 oz/a and in combination with Oust at 3 oz/a and Karmex at 8 lb/a. These treatments were compared with Oust at 3 oz/a plus Karmex at 8 lb/a, Oust at 3 oz/a plus Krovar at 6 lb/a, Oust at 3 oz/a plus Velpar at 2 lb/a, and Krovar alone at 8 lb/a. Herbicides were applied November 6, 1997, and March 6, 1998, to separate sets of plots using a 9-ft CO_2 pressurized boom sprayer with 8003 nozzles at 40 psi and 30 gal/a water. Roundup at 1.5 qt/a was applied in combination with treatments of Milestone alone for control of emerged seedling on the March 6 treatment date. Plots 10 ft x 20 ft plots were replicated 3 times in a randomized complete block design.

Plots were evaluated with the assistance of Brett Dunn on June 30, 1998, and February 19, 1999. Plots will continue to be monitored to determine longevity of herbicide treatments and to document when the different weed species begin to appear.

Results and Discussion

The only weed emerged for the June 30 evaluation in the plots treated November 6 was kochia (Table 1). Treatments that were not rated as providing adequate kochia control nevertheless were eventually effective, as no carcasses were visible during later observations. Plots treated March 6, 1998, had only a scattering of perennial weeds present (Table 2) at the June 30 evaluation. Treatments continued to hold without additional weed germination until winter rains.

Plots were again evaluated February 19, 1999, for control of little bur, kochia, and grass species. Treatments applied March 6, 1998, (Table 3) provided better control across herbicides than those applied November 6, 1997 (Table 4). All treatments provided essentially 100 percent control of the grass species.

For the November application, Milestone at 20 oz/a provided 98 percent control of little bur and 100 percent control of kochia, followed by Milestone at 10 oz/a with 84 percent control of little bur and 99 percent control of kochia. Milestone plus Oust and Milestone plus Karmex both provided 82 percent control of little bur and 95 percent control of kochia.

Plots treated in March with Milestone at 20 oz/a provided 100 percent control of both little bur and kochia. Milestone plus Oust provided 100 percent control of little bur and 99 percent control of kochia, while Milestone plus Karmex provided 100 percent control of both species. Milestone at 10 oz/a gave 98 percent control of little bur and 99 percent control of kochia.

Across the two application dates and species evaluated, Milestone alone and in combination with Oust or Karmex provided better control than the standard treatments of Oust plus Karmex, Oust plus Krovar, Oust plus Velpar, or Krovar alone. Evaluation of these plots will continue, but it appears at this time that Milestone could play an important role in roadside weed control programs in the future.

Table 1. Herbicides applied to the Jefferson County, OR, landfill on November 6, 1997, and evaluated for control of roadside weeds on June 30, 1998.

Treatment	Rate	Weed Control Kochia
	product/a	------%-----
Milestone	10 oz	67 a
Milestone	20 oz	100 a
Milestone	10 oz	100 a
+ Oust	3 oz	
Milestone	10 oz	100 a
+ Karmex	8 lb	
Oust	3 oz	100 a
+ Karmex	8 lb	
Oust	3 oz	99 a
+ Krovar I	6 lb	
Oust	3 oz	55 a
+ Velpar	2 lb	
Krovar I	8 lb	100 a
Untreated	---	0 b

Table 2. Herbicides applied to the Jefferson County, OR, landfill on March 6, 1998, and evaluated for control of roadside weeds on June 30, 1998.

		Weed Species			
Treatment	Rate	Alfalfa	Rabbit brush	Diffuse knapweed	Crested wheat
	product/a	------------------number of plants per plot------------------			
Milestone	10 oz	0.3	0.7	0 b	0 b
Milestone	20 oz	0.7	1.3		
Milestone	10 oz	1.3	0	0.3 b	0.7 b
+ Oust	3 oz				
Milestone	10 oz	1.3	1.7	0 b	0 b
+ Karmex	8 lb				
Oust	3 oz	2	0	0 b	0 b
+ Karmex	8 lb				
Oust	3 oz	0	0	0 b	0 b
+ Krovar I	6 lb				
Oust	3 oz	3.3	0	0 b	0 b
+ Velpar	2 lb				
Krovar I	8 lb	0	0	0 b	0 b
Untreated	---	8.7	1	1.3 a	10 a
		n.s.	n.s.		

Table 3. Herbicides applied to Jefferson County, OR, landfill on November 6, 1997, and evaluated for control of roadside weeds on February 19, 1999.

Treatment	Rate	Little bur	Kochia
	product/a	% control	% control
Milestone	10 oz	84 a	99 a
Milestone	20 oz	98 a	100 a
Milestone	10 oz	82 a	95 a
+ Oust	3 oz		
Milestone	10 oz	82 a	95 a
+ Karmex	8 lb		
Oust	3 oz	65 a	99 a
+ Karmex	8 lb		
Oust	3 oz	63 a	93 a
+ Krovar I	6 lb		
Oust	3 oz	58 a	43 b
+ Velpar	2 lb		
Krovar I	8 lb	53 a	100 a
Untreated	---	0 b	0 c

Table 4. Herbicides applied to the Jefferson County, OR, landfill on March 6, 1998, and evaluated for control of roadside weeds on February 19, 1999.

Treatment	Rate	Little bur	Kochia
	product/a	% control	% control
Milestone	10 oz	98 a	99 a
Milestone	20 oz	100 a	100 a
Milestone	10 oz	100 a	99 a
+ Oust	3 oz		
Milestone	10 oz	100 a	100 a
+ Karmex	8 lb		
Oust	3 oz	74 a	97 a
+ Karmex	8 lb		
Oust	3 oz	82 a	100 a
+ Krovar I	6 lb		
Oust	3 oz	77 a	99 a
+ Velpar	2 lb		
Krovar I	8 lb	81 a	99 a
Untreated	---	0 b	0 b