Introduction

The Central Oregon Agricultural Research Center (COARC) faculty and staff are pleased to present this summary of 2015 research activities for your review. The reports included in this publication focus on grass seed, vegetable seed, potatoes and peppermint, forages and cereals and community projects.

As you have heard in the past, the OSU College of Agricultural Sciences (CAS) challenged local agricultural communities around the state to provide 25% of the current base budget for the branch experimental stations. At the time of this challenge, the CAS indicated that future strategic investment across the state would be guided by industry response to this challenge. Not only did you meet this challenge head on, you did so with resounding success.

As a direct result of your ongoing financial support, the College has made several recent investments in COARC. These include contributions toward equipment purchases, infrastructure upgrades and the hiring of two outstanding researchers within the last two years. These investments are helping to move COARC to the forefront of cutting edge research.

In 2014, the COARC Advisory Council recommended continuing the voluntary local contribution plan for the foreseeable future to ensure the ongoing success of the research center and local research faculty. Your ongoing participation is vital to the continued commitment by the College of Agriculture to investing in COARC.

We would like to thank you for your continued support of COARC. Your contributions allow us to continue to provide important research and education opportunities for central Oregon that are vital to the agricultural community and local economy.

Each year, the COARC Advisory Council meets with individual researchers to review their projects from the previous year and to preview projects for the upcoming year. We will also send a pdf version of this report along with a questionnaire to the local agricultural community by email. Please feel free to provide comments in addition to answering the questionnaire. It is through your input that we are able to adjust what we do in order to best serve your needs. Your feedback and comments are appreciated and will be taken under consideration as we plan for the upcoming year.

Thank you,

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Evaluation of Ergot Resistance and Disease Escape in Kentucky Bluegrass Cultivars

Jeremiah Dung, Cara Boucher, and Stephen Alderman

Introduction

Ergot is an important disease of Kentucky bluegrass seed production in Oregon. The disease is caused by the fungal pathogen *Claviceps purpurea*, which infects flowers prior to fertilization resulting in the production of sclerotia rather than seed. Sclerotia are the overwintering structures of the fungus and produce airborne ascospores that serve as primary inoculum the following growing season. In some years the timing of ascospore release by the fungus may not coincide with grass flowering (anthesis), which is the only period of host susceptibility, and cultivars with short, uniform flowering periods, or those that flower outside of periods of peak spore production, may potentially escape infection. The objective of this study was to evaluate Kentucky bluegrass cultivars for the potential to escape or resist ergot under central Oregon field conditions. It was hypothesized that cultivars which flower before or after peak ergot spore production, or those with shortened periods of anthesis, would have reduced ergot incidence and severity compared to cultivars with prolonged periods of anthesis or those which flower when ergot spores are present in large numbers.

Materials and Methods

A total of 11 Kentucky bluegrass cultivars (‘Blue Ghost’, ‘DB-1013’, ‘Fielder’, ‘Gateway’, ‘Gladstone’, ‘Jumpstart’, ‘Merit’, ‘Midnight II’, ‘PST-K4-7’, ‘Right’, and ‘Shamrock’) were planted in plots at COARC in August 2015. Plots (26 ft long and 5 ft wide consisting of 6 rows of plants) were planted at a seeding rate of 5 lb seed/acre. Each plot was replicated four times and cultivars were arranged in a randomized complete block design. The border of the experiment area was artificially infested in October 2015 with Kentucky bluegrass sclerotia collected from seed lots produced in central Oregon.

Crop phenology was assessed weekly from April until mid-June to determine the timing and duration of anthesis for each Kentucky bluegrass cultivar. Crop phenology was measured using the Feekes scale, whereby the appearance of stigmas and/or anthers was considered the beginning of flowering (stage 10.51). The percentage of tillers with flowers at each Feekes stage were estimated for each plot. Flowering was considered to be completed when 90% of the tillers in a plot reached Feekes stage 11.1. Disease incidence (number of infected seed heads) and severity (number of sclerotia) were determined from a random sample of 100 seed heads collected from each plot at harvest. Data were analyzed using ANOVA and multiple comparisons were made using Tukey’s test.

A Burkard 7-day recording volumetric spore sampler was used to collect airborne ascospores of *C. purpurea*. The spore sampler was placed in the middle of the plots from April 20 to June 21, 2016 with the air intake orifice located approximately 2 ft above the soil. Spore trap tapes were replaced weekly and each tape was cut into daily segments, stained, and the number of *C. purpurea* ascospores were determined for each hour and then totaled to establish daily counts.

Results and Discussion

A total of 3,748 ascospores were trapped between May 1 and June 21, 2016. Honeydew was first observed on May 31 and was present in most plots by June 7. Significant differences in ergot incidence and severity were observed among Kentucky bluegrass cultivars. Similar to 2015, Midnight II exhibited the highest ergot incidence and severity among the cultivars tested (Table 1; Fig. 1). PST-K4-7 and Fielder exhibited the lowest ergot incidence and severity (Table 1; Fig. 1); Fielder also exhibited relatively low ergot incidence and severity ratings in the 2015 trial. Ergot severity ratings in 2015 and 2016 were highly correlated for the 10 cultivars that were evaluated in both years ($r = 0.86$) (Fig. 2); ergot incidence ratings were also highly correlated ($r = 0.84$).

Anthesis was first observed in the earliest flowering cultivars on May 12 and significant differences in anthesis initiation date, anthesis termination date, and anthesis duration were observed among the 12 KBG cultivars ($P \leq 0.03$) (Table 1). However, significant correlations were not observed between anthesis initiation, termination, or duration and ergot incidence or severity. Further research is needed to determine if the differences in ergot levels were due to genetic/physiological resistance to ergot, environmental conditions during anthesis, or other factors.

Acknowledgements

The researchers would like to thank the Oregon Seed Council, Washington Turfgrass Seed Commission, and Oregon Department of Agriculture Alternatives for Field Burning Research Financial Assistance Program for financial support. The authors are grateful for the in-kind support provided by Central Oregon Seeds Inc., CHS Inc., Jacklin Seed, Pure Seed, and Wilbur-Ellis. The authors also thank Hoyt Downing for providing technical assistance. Ms. Boucher’s internship was made possible by the Oregon State University Branch Experiment Station Experiential Learning Internship program.

Tables

Table 1. Ergot incidence and severity, anthesis initiation, termination, and duration, and total number of ergot spores captured during anthesis of 11 Kentucky bluegrass cultivars grown in artificially-infested plots at COARC[1]

Cultivar	**Ergot incidence (%)**	**Ergot severity**	**Anthesis initiation[2]**	**Anthesis termination[2]**	**Anthesis duration (days)**	**Total spores during anthesis**
Blue Ghost	26.8 d	81.8 b	138.5 ab	155.5 ab	17.0 a	1269.0
DB-1013	17.3 c	57.0 ab	133.0 a	157.3 ab	24.3 b	1582.8
Fielder	7.3 ab	15.8 a	133.0 a	157.3 ab	24.3 b	1582.8
Gateway	18.0 c	38.3 ab	144.0 bc	159.0 b	15.0 a	1475.0
Gladstone	14.0 bc	38.8 ab	138.5 ab	157.3 ab	18.8 ab	1442.3
Jumpstart	11.3 abc	25.8 ab	138.5 ab	153.8 ab	15.3 b	1095.8
Merit	10.9 abc	17.1 a	142.6 b	158.1 b	15.5 b	1423.5
Midnight II	31.0 d	153.8 c	141.3 ab	159.0 b	17.8 ab	1545.3
PST-K4-7	3.3 a	6.8 a	144.0 b	159.0 b	15.0 b	1475.0
Right	11.8 abc	37.3 ab	135.8 ab	152.0 a	16.3 b	992.8
Shamrock	11.5 abc	19.3 ab	133.0 a	153.8 ab	20.8 ab	1236.3
***P*-value**	**< 0.0001**	**< 0.0001**	**0.0001**	**0.0032**	**0.0241**	**0.0518**

[1] Means followed by the same letters are not statistically different using Tukey's comparison.
[2] Anthesis initiation and termination dates are presented as perpetual Julian days (133 = May 12; 159 = June 7).

Figures

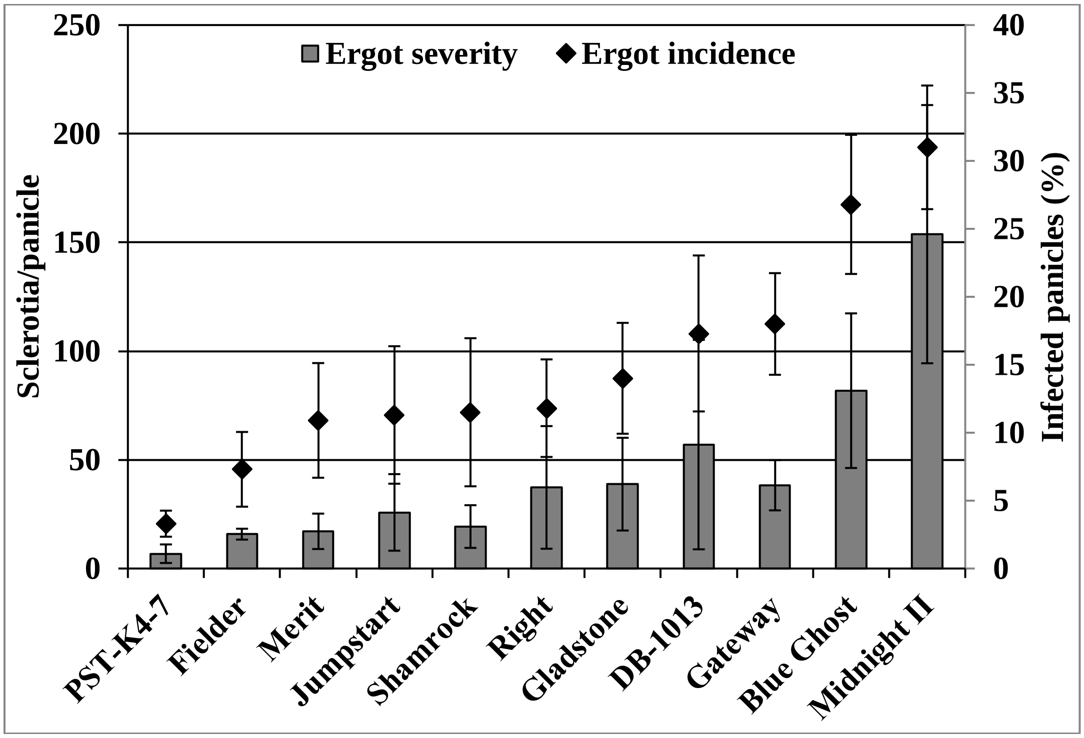

Figure 1. Ergot incidence (% infected panicles out of 100 sampled) and severity (average number of sclerotia per 100 panicles) among 11 Kentucky bluegrass cultivars grown in artificially-infested plots at COARC.

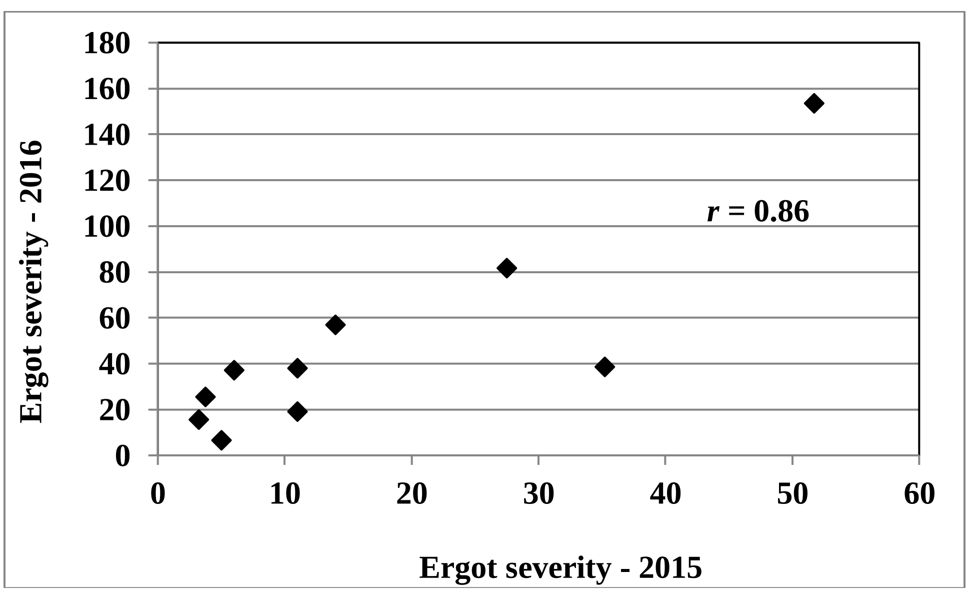

Figure 2. Correlation between ergot severity ratings among 10 Kentucky bluegrass cultivars evaluated in 2015 and 2016. Ergot incidence ratings were also highly correlated between the two years (r = 0.84).

Evaluation of Herbicides for Control of Rough Bluegrass, Cheatgrass, Rattail Fescue and Medusahead in Establishment Year and Second Year Kentucky Bluegrass Grown for Seed

Marvin Butler, Rich Affeldt, Jim Carroll and Kurt Feigner

Abstract

Adequate weed control during the establishment year of Kentucky bluegrass seed production is a challenge, particularly for grassy weeds in a grass crop. This project is a second-year project to evaluate innovative ways to use currently registered products to accomplish this goal, focusing on rough bluegrass, cheatgrass, rattail fescue and medusahead. Treatments and application timings include Callisto pre-emergence between planting and first irrigation, Beacon applied at 0.19 oz/acre, with and without Bronate at 1 pt/acre, at the 2-3 leaf and 4-5 leaf stages, and Beacon at the split application rate of 0.38 oz/acre during a October/November timing. Potential new herbicides, Fierce, Alion and Sharpen were evaluated in a second year stand for control of the same four grassy weeds and for crop safety, compared to two current industry standards. Application timings were pre-emergence and during October/November. Results from establishment year plots indicates significantly less stunting of Kentucky bluegrass when Beacon is applied at 2-3 leaf rather than the 1-2 leaf stage as was done during 2015. Bronate appears to be an effective crop safener when added to Beacon at either 2-3 leaf or 4-5 leaf stages, with similar control of the grassy weeds.

Introduction

The greatest challenge to weed control in Kentucky bluegrass is during the establishment year. Control of grassy weeds while protecting crop safety is vital to crop establishment and is important to first year production and ongoing profitability. This project is designed to evaluate for a second season the most promising of currently available herbicides in various combinations, application timings and rates to identify a successful strategy. Although there are a variety of grassy weeds, the focus of this project is rough bluegrass, cheatgrass, rattail fescue and medusahead. Secondly, it is important to evaluate potential new herbicides that hold promise for use in Kentucky bluegrass to maintain a strong toolbox of herbicides against these four grassy weeds while providing adequate crop safety.

Methods and Materials

Establishment Year:
Kentucky bluegrass (Shamrock) was planted at 7 lbs/acre on August 22, 2016 with the COARC Great Plains drill into ground rotating out of winter wheat. This was done following open field burning, an initial irrigation and reworking the ground. Rough bluegrass, cheatgrass, rattail fescue and medusahead seeds were planted at a high infestation rate (rough bluegrass at 1 g/40 ft, rattail fescue at 1.5 g/40 ft, cheatgrass and medusahead at 3 g/40 ft) with a 5-foot cone planter at 7-inch spacings across 10 x 45 ft plots, replicated 4 times.

Herbicide treatments included Callisto (mesotrione) applied pre-emergence at 6 oz/acre on

August 22 between planting and first irrigation on August 23. Beacon (primisulfuron) was applied at 0.19 oz/acre (1/4th label rate) on September 24 at the 2-3 leaf stage and on October 6 at the 5-6 leaf stage. At both application timings Beacon was applied with and without Bronate (bromoxynil +MCPA) at 1 pt/acre as a potential crop safener. In addition, Beacon was applied at a split-application rate of 0.38 oz/acre at a October/November timing on October 24. The labeled rate for Beacon is 0.76 oz/acre, so all treatments left some Beacon in reserve for use later in the fall or spring as needed by managers of production fields. All treatments (Table 1) were applied using a CO_2 powered, backpack sprayer and 20 gal/water per acre. A non-ionic surfactant at 1 qt/100 gal was added to treatments applied at the 2-3 leaf stage, while crop oil concentrate at 1 gal/100 gal was used with all other post-emergence treatments.

Herbicide performance and crop stunting were evaluated October 26 for efficacy of Callisto applied pre-irrigation and Beacon applied at the 2-3 leaf stage. Follow-up evaluations will be conducted as appropriate.

Harvest data will be collected from Kentucky bluegrass plots (Shannon) located at K & S Farms that received similar herbicide treatments to those at COARC. The committee overseeing this research project felt that duplicate plots in a commercial field would provide the most reliable yield data information. First irrigation at these plots was on September 1, with treatments applied at the 2-3 leaf stage on October 10, the 4-5 leaf stage on October 28 and the October/November timing on November 4.

2nd YearProduction:

Kentucky bluegrass (Shamrock) plots established at COARC during 2015 are being used for a second year production field to evaluation potential new herbicides for the same four grassy weeds use in the establishment year plots. Plots used during 2016 are staggered from the large 2015 plots to avoid weed species planted in 2015 and treatments that included Beacon applied at 0.15 oz/acre at the 1-2 leaf stage that resulted in significant crop stunting.

Following the initial irrigation, grassy weeds were planted on September 7 following the same procedures used in the establishment year plots. This was followed by pre-emergence application of Fierce at 3 oz/acre, Alion at 1.5 fl oz/acre and Prowl at 1 qt/acre plus Outlook at 21 fl oz/acre. A traditional October/November herbicide application timing was used for post-emergence application of Fierce at 3 oz/acre, Alion at 1.5 fl oz/acre, Sharpen at 2 oz/acre and a combination of Beacon at 0.38 oz/acre plus diuron at 2 lbs/acre plus Goal at 12 fl oz/acre.

Similar to the establishment year plots, harvest data will be collected from Kentucky bluegrass plots (Gaelic) with K & S Farms that received similar herbicide treatments to those at COARC. Pre-emergence treatments at this location were applied September 7 and the October/November timing was applied on November 4. Follow-up evaluation will be conducted as appropriate.

Results and Discussion

Establishment Year:

No crop stunting was observed October 26 from Callisto applied pre-emergence, with an average of 8 percent crop stunting observed following Beacon applied at 0.15 oz/acre at the 2-3 leaf stage (Table 1). This compares with 35 percent stunting from Beacon applied at 0.19 oz/acre at the 1-2 leaf stage during the 2015 season. Beacon applied alone caused 13 percent stunting of young Kentucky bluegrass, while Beacon plus Bronate caused 5 percent stunting. Sharpen, a new product registered on grass seed, was included in establishment year plots to evaluate crop safety and produced 8 percent stunting.

A different collection of stored cheatgrass seed was inadvertently used for planting across herbicide plots this season, resulting in a lack of germination. Based on the October 26 evaluation of Beacon application at the 2-3 leaf stage, Beacon alone provided 53 percent control of rough bluegrass, an average of 27 percent of rattail fescue and 10 percent control of medusahead. The Beacon plus Bronate combination provided similar results, with an average of 54 percent control of rough bluegrass, 27 percent control of rattail fescue and an average of 18 percent control of medusahead.

Plots at K & S Farms will be harvested and yield data collected during the 2017 harvest season to evaluate crop safety. Results will be shared in a subsequent report.

2nd Year Production:

Germination of weed species in second year plots has been spotty at best. This is perhaps due to greater difficulty for weeds to establish in second year grass fields or a lack of moisture for weed germination despite adequate moisture for field green-up. Although no significant crop injury from pre-emergence applications was observed at the COARC plots, there was strong burn-back of vegetation at the K & S plots that were sprayed over the top with a grower application of Prowl plus Outlook. This had largely disappeared by early November, but was still discernable on closer evaluation as narrower rows with less regrowth. These plots will be harvested for yield data similar to the establishment year plots at the same location.

Acknowledgements

The primary author would like to thank Jefferson County Smoke Management and the Jefferson County Seed Growers for their financial support of this project, Rich Affeldt for applying treatments in my absence, Rich and Jim Carroll for their cooperation in the final design and management of the project and co-leadership for the October plot tour, Kurt Feigner for his valued advice and willingness to be grower cooperator for the yield data plots at COARC and Ryan Boyle and Curt Crossman for their insight as cooperators on the project.

Table 1. Herbicide treatments, application rates, timings, crop stunting and percent control of rough bluegrass, rattail fescue and medusahead evaluated October 26 and (December 20), 2016.

Treatment*		Application Rate	Timing	% Crop Injury/Weed Control		
					Oct 26	(Dec 20)
1	Callisto	6 oz/A	Pre-irrigation	Injury	0	
	+ Beacon	0.19 oz/A	4-5 leaf	Poa triv	8	
	+ Beacon	0.38 oz/A	October	Rattail	10	
				Medusa	25	
2	Beacon	0.19 oz/A	2-3 leaf	Injury	13	
	+ Beacon	0.38 oz/A	October	Poa triv	53	
				Rattail	25	
				Medusa	10	
3	Beacon	0.19 oz/A	2-3 leaf	Injury	5	
	w/ Bronate	1 pt/A		Poa triv	45	
	+ Beacon	0.38 oz/A	October	Rattail	13	
				Medusa	20	
4	Beacon	0.19 oz/A	2-3 leaf	Injury	13	
	Beacon	0.19 oz/A	4-5 leaf	Poa triv	53	
				Rattail	28	
				Medusa	10	
5	Beacon	0.19 oz/A	2-3 leaf	Injury	5	
	w/ Bronate	1 pt/A		Poa triv	45	
	+ Beacon	0.19 oz/A	4-5 leaf	Rattail	28	
				Medusa	10	
6	Beacon	0.19 oz/A	2-3 leaf	Injury	5	
	w/ Bronate	1 pt/A		Poa triv	73	
	+ Beacon	0.19 oz/A	4-5 leaf	Rattail	40	
	w/ Bronate	1 pt/A		Medusa	23	
7	Sharpen	2 oz/A	4-5 leaf	Injury	8	
				Poa triv	0	
				Rattail	0	
				Medusa	0	
8	UTC	-----		Injury	0	
				Poa triv	0	
				Rattail	0	
				Medusa	0	

* NIS at 1 qt/100 gal was included with treatments applied at the 2-3 leaf stage, while COC at 1 gal/100 gal was used with all other post-emergence treatments.

Evaluation of ManKocide Alternatives for Bacterial Blight Control in Steckling-to-Seed Carrot Seed Crops

Jeremiah Dung, Jeness Scott, and Mike Weber

Introduction

Management of bacterial blight in carrot seed crops can be difficult and begins with the planting of healthy or treated seed. However, planting healthy or treated seed may not prevent the disease in biennial seed production fields because new plantings are often located adjacent to or in close proximity to the previous years' plantings. The pathogen, *Xanthomonas hortorum* pv. *carotae* (*Xhc*), is readily disseminated by contaminated irrigation water, wind-blown rain, insects, soil or carrot refuse and newly emerged seedlings of the next biennial season can become infected from nearby fields of the previous biennial season that already harbor *Xhc*. The disease has even been observed in isolated plantings, suggesting long distance dissemination of the pathogen on aerosolized seed crop residues or introduction of the pathogen on seedborne inoculum.

In addition to infested seed, infected carrot stecklings may be a source of inoculum for carrot seed producers. A previous study detected *Xhc* in 4 of 12 steckling crops that were sampled directly from shipping crates (du Toit et al. 2005). The use of disease-free stecklings is an important component of an integrated disease management program to reduce the impact of bacterial blight on harvested seed. However, there is a lack of effective control options for infected stecklings.

Carrot seed producers would like to reduce *Xhc* populations on harvested seed in order to minimize the need for hot water treatment and lessen the impact of bacterial blight on subsequent root crops in California, Washington, and other carrot-producing states and countries. Copper-based bactericides such as ManKocide (mancozeb + copper hydroxide) are applied multiple times each season to manage bacterial blight and increase seed quality, and are currently a primary control measure for bacterial blight in carrot seed crops. However, copper-based bactericides are most effective when used as preventative treatments and have limited ability to reduce *Xhc* populations once the pathogen becomes established in a seed crop (du Toit and Derie 2008).

The objective of this research is to evaluate potential post-plant treatments for stecklings harboring *Xhc* and evaluate potential alternatives to ManKocide for in-season control of *Xhc* in the field.

Materials and Methods

Plot establishment. A field trial was established at the Central Oregon Agricultural Research Center consisting of treatment plots 25 ft in length with 30 inch row spacing and 5 ft buffers in between plots. Female carrot stecklings were obtained from commercial steckling production fields and vernalized according to standard industry practices. Subsamples of stecklings were assayed for *Xhc* prior to planting and the pathogen was not detected. Stecklings were hand-planted approximately 6 inches apart in each row on April 12. Stecklings were rolled and watered in using overhead irrigation and then drip-irrigated for the remainder of the season. Standard management practices for steckling-to-seed hybrid carrot seed crops were followed.

In order to promote uniform infection in the plots, stecklings were inoculated on April 28 with a mixture of three *Xhc* isolates that were previously shown to cause bacterial blight on carrots under greenhouse conditions. *Xhc* inoculations were performed in-furrow using a CO_2-pressurized backpack sprayer. Each steckling was inoculated with a total of 10^6 CFU/steckling. The non-inoculated control was mock-inoculated with sterile phosphate buffer.

Treatments. Treatments included labeled and half-rates of KleenGrow (7.5% didecyldimethylammonium chloride; PACE 49 Inc., Canada), OCION PT81 (20.3% copper sulfate pentahydrate; OCION Water Sciences Group, Canada), OCION FT33 (4.16% Cu, 1.64% Zn, and 4.97% S; OCION Water Sciences Group, Canada), Oxycom Calcium (20% K_2O, 14% Ca, 7% S, and 4% P_2O_5; Redox Chemicals, LLC) and tank-mixes of KleenGrow + OCION PT81, KleenGrow + OCION FT33, and Oxycom Calcium + ManKocide (15% mancozeb, 46% copper hydroxide; Certis USA, Columbia, MD) (Table 1). A non-treated/non-inoculated treatment, a non-treated/inoculated treatment, and a ManKocide treatment were included as controls. Bactericide treatments were applied in a 6-inch band after planting using a CO_2-pressurized backpack sprayer calibrated to apply the products in 50 to 100 gallons/acre (Table 1). Initial bactericide treatments were applied on May 3 and 4. Subsequent in-season applications were made approximately every 2 weeks until the month of July, when bees were present for pollination of seed crops.

Disease evaluations. Incidence and severity of bacterial blight was rated at the onset of symptoms (June 1) and every 3 to 4 weeks thereafter. The incidence of bacterial blight was determined by counting the number of plants exhibiting bacterial blight symptoms in each plot. Bacterial blight severity was assessed on 10 randomly selected plants/plot using a scale of 0 to 5 where: 0 = no symptoms, 1 = a few small lesions on one leaf, 2 = 5 to 10 lesions on one or two leaves, 3 = at least two leaves with prevalent symptoms, 4 = three or more leaves with extensive lesions, and 5 = >50% of the leaves with symptoms. A disease index value was calculated by multiplying incidence and severity values for each plot.

Samples of foliage (10 leaves taken from 10 different plants in the center of each plot) were randomly collected and assayed for *Xhc* on May 5, June 2, June 23, and August 1, 2016. Foliage was chopped finely and a subsample was placed in sterilized phosphate buffer. Flasks containing buffer and foliage were incubated for 2 h and the rinsate from each flask diluted serially up to 10^{-5} and plated onto semi-selective XCS medium. Plates were incubated at 28° C for 5 to 7 days and the number of colony forming units (CFUs) of *Xhc* was determined. The chopped and rinsed foliage of each sample was dried at 60° C for at least 4 days and weighed to calculate the mean number of CFUs/g dry foliage.

Data analyses. The experiment was arranged as a randomized complete block design. CFU data was log-transformed and repeated measures data (CFU/g dry foliage and disease index) were converted to area under progress curves. Data were subjected to analyses of variance and multiple comparisons of treatments were made using Tukey's test.

Results and Discussion

Significant differences in pathogen populations (AUCFU) and disease incidence and severity (AUDPC) were observed between the non-treated/non-inoculated control and the non-treated/inoculated control. The ManKocide, Ocion PT81 (40 oz/acre), and KleenGrow (25 oz/acre) + Ocion PT81 (20 oz/acre) treatments all resulted in significantly lower AUDPC values than the non-treated/inoculated control but AUCFU values were not significantly different. AUDPC values were positively correlated with AUCFU values ($r = 0.68$).

Although ManKocide and ManKocide tank-mixed with Oxycom Calcium provided the best overall control, pathogen populations still reached relatively high numbers (> 10^6 CFU/g dry leaf tissue) at the mid-season evaluation date (June 23). It should also be emphasized that the application schedule used in this study (a total of 4 sprays spaced 2 weeks apart) is not representative of what can typically be performed under commercial production settings due to economic, environmental, and/or practical constraints.

The pathogen was not detected at the first sampling date (May 5), but *Xhc* increased in most plots as the season progressed, averaging 4.9×10^4 CFU/g on June 2, 4.5×10^5 CFU/g on June 23, and 2.0×10^8 CFU/g on August 1 (Fig. 1). High levels were observed on the non-treated/inoculated control at all three sampling dates, indicating that the artificial inoculations were successful. In contrast, the pathogen was not detectable on the non-treated/non-inoculated control until the final sampling date (August 1, 2016). Regardless, all treatments harbored *Xhc* at levels greater than 1×10^7 CFU/g dry leaf tissue at the final sampling date suggesting that pathogen populations can increase to large numbers during the pollination period.

Acknowledgements

The authors would like to thank Bejo Seeds, Inc., Central Oregon Seeds, Inc., ICA International Chemicals, Monsanto Vegetable Seeds, Nunhems Netherlands B.V. Vegetable Seeds, OCION, Pace 49 Inc., Redox Chemicals LLC, and Sakata Seed America, Inc. for providing funding and/or in-kind support for this study. The authors also thank Hoyt Downing, Travis Klopp, and Mitchell Alley for providing technical assistance.

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Tables

Table 1. Effect of in-season foliar applications of bactericides, disinfectants, and a nutrient product on bacterial blight area under colony forming unit (AUCFU) and area under disease progress curve (AUDPC) values[1]

Treatment (rate)	Volume	AUCFU[2]	AUDPC[3]
Non-treated/non-inoculated (NA)	**NA**	145.2 a	0.0 a
Oxycom Calcium (2 lb/acre) + ManKocide (2.5 lb/acre)	**20 gal/acre**	214.4 ab	145.8 bc
ManKocide (2.5 lb/acre)	**50 gal/acre**	251.5 ab	106.4 b
KleenGrow (12.5 oz/acre) + Ocion FT33 (10 oz/acre)	**100 gal/acre**	336.0 ab	234.0 bc
Ocion PT81 (40 oz/acre)	**100 gal/acre**	358.9 ab	102.4 b
Ocion FT33 (40 oz/acre)	**100 gal/acre**	384.0 ab	257.3 bc
Ocion PT81 (20 oz/acre)	**100 gal/acre**	400.2 ab	200.8 bc
KleenGrow (25 oz/acre) + Ocion PT81 (20 oz/acre)	**100 gal/acre**	408.3 ab	88.6 b
Ocion FT33 (20 oz/acre)	**100 gal/acre**	415.8 ab	146.4 bc
KleenGrow (12.5 oz/acre)	**100 gal/acre**	438.8 bc	215.6 bc
Oxycom Calcium (2 lb/acre)	**20 gal/acre**	454.9 bc	306.5 bc
Non-treated/inoculated (NA)	**NA**	459.3 bc	562.4 c
KleenGrow (25 oz/acre)	**100 gal/acre**	475.6 bc	223.0 bc
KleenGrow (12.5 oz/acre) + Ocion PT81 (10 oz/acre)	**100 gal/acre**	489.9 bc	363.6 bc
KleenGrow (25 oz/acre) + Ocion FT33 (20 oz/acre)	**100 gal/acre**	480.6 bc	390.5 bc
	***P*-value**	0.0008	0.0063

[1] Treatments were applied approximately every 2 weeks.

[2] Area under colony forming unit (AUCFU) values were calculated from samples taken May 5, June 2, June 23, and August 1, 2016.

[3] Area under disease progress curve (AUDPC) values were calculated from disease index values obtained on June 1, June 24, and July 26, 2016.

Figures

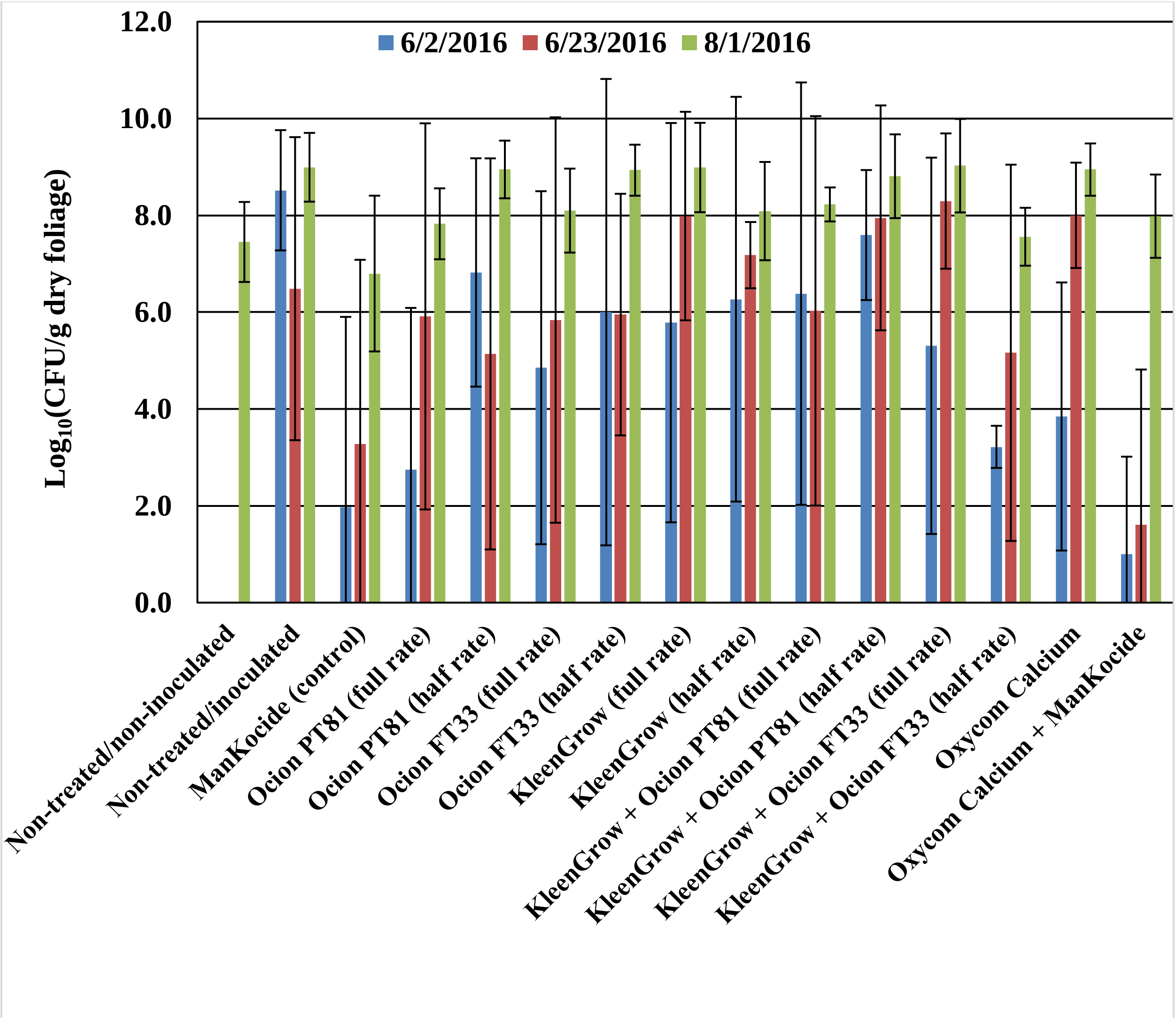

Fig. 1. Effect of bactericides, disinfectants, and a nutrient treatment on colony forming units (CFU) of *Xanthomonas hortorum* pv. *carotae* on carrot foliage at three different sampling dates. CFU values were $\log_{10}$-transformed. Error bars represent standard deviations.

Evaluation of Disinfectant Seed Treatments to Reduce *Xanthomonas hortorum* pv. *carotae* in Carrot Seed Lots

Jeremiah Dung, Mike Weber, and Richard Pollard

Introduction

Bacterial blight of carrot, caused by the plant pathogenic bacterium *Xanthomonas hortorum* pv. *carotae* (*Xhc*), is a common disease of carrot wherever the crop is grown. The disease can affect carrot foliage, stems, umbels, and roots and can be seed-borne. Symptoms of bacterial blight include small, irregular, chlorotic areas on leaves that can manifest into water-soaked, necrotic lesions. Lesions can also occur on stems and petioles. Floral infections can result in blighted umbels, reduced seed yield, and reduced germination rates of harvested seed. Once established, *Xhc* is difficult to control and disease prevention is challenging because *Xhc* is seedborne and seed treatments with hot water or disinfectants may not entirely eradicate the pathogen.

The seed-borne nature of *Xhc* makes it a major concern not only to the hybrid carrot seed industry in the Pacific Northwest but also to regions that import carrot seed for root production. Epiphytic populations can reach high levels on plants in the field, resulting in seed that is infected or infested by the pathogen. Seed lots that are highly infested with *Xhc* (>10^5 CFU/g seed) necessitate seed treatment to reduce the risk of bacterial blight occurring in commercial root crop production. Seed treatments are usually in the form of hot water treatment (52°C for 25 minutes) which can be effective but can reduce germination and/or shelf life of seed lots. Germination can be reduced further if seed lots need to be treated multiple times to reduce infestation levels below the 10^5 CFU/g threshold that was established for carrot seed planted in the Central Valley of California. Chemical seed treatments, which can remove bacterial pathogens that are borne on the seed surface, may provide alternative or additional methods for reducing *Xhc* in carrot seed lots. The objective of this project was to evaluate chemical disinfectants as seed treatments to reduce *Xhc* levels in carrot seed lots.

Materials and Methods

Teabags containing approximately 17 grams of commercially produced, naturally-infested seeds were subjected to one of the following 11 treatments: a non-treated control; hot water treatment (52° C for 25 min followed by a 60 s rinse under running tap water); SporeKill (ICA International Chemicals); PT81 (Ocion Water Sciences, Inc.); FT81 (Ocion Water Sciences, Inc.); KleenGrow (Pace 49 Inc.); Oxidate 2.0 (BioSafe Systems LLC); UpTake (Pace 49 Inc.); and bleach. Seeds were rinsed for 60 seconds under cool, running tap water immediately after treatments were applied with the exception of a non-rinsed, non-treated control and a non-rinsed SporeKill treatment. The non-rinsed SporeKill treatment was included to evaluate the effects of residual disinfectant on *Xhc* recovery and germination (*i.e.* phytotoxicity). Product rates, their active ingredient(s), and treatment times are listed in Table 1.

Treated seeds were air-dried on sterile paper towels in a laminar flow hood. Ten grams of the dried seed were put into 100 mL of phosphate buffer containing Tween and soaked for 2 hours at room temperature. Flasks were agitated on a horizontal shaker at 250 rpm for 5 minutes and the seed wash was serially diluted to 10^{-5}. A total of 100 µl of each dilution was spread-plated onto two replicate plates containing semi-selective XCS medium. Plates were incubated in the dark at 28° C and the number of *Xhc* colonies was counted after 5 and 7 days. Colony counts were $\log_{10}$-transformed prior to analysis of variance (ANOVA) and pairwise comparisons were performed using Tukey's test. The experiment was arranged and analyzed as a randomized complete block design.

The effect of each treatment on seed germination was tested by plating 100 seeds from each treatment on sterile moistened filter papers placed in petri plates. The seeds were incubated for approximately 10 to 14 days at room temperature in the dark and the number of germinated seeds was counted. ANOVA and treatment comparisons were performed as described above.

Results and Discussion

Hot water treatment and SporeKill (rinsed and non-rinsed) significantly reduced the number of *Xhc* recovered compared to both non-treated controls (Table 1). Although the non-rinsed SporeKill treatment reduced *Xhc* levels to undetectable levels (limit of detection = 100 CFU/g seed), the treatment also reduced seed germination by 12 to 16% compared to the non-treated controls (Table 1). Rinsing the seed after treatment with SporeKill resulted in recovery of the pathogen and in increase in germination, suggesting that the product persisted on the seed after drying and influenced pathogen recovery and seed germination (Table 1). These results indicate that residual chemical disinfectants that remain on seed may reduce the recovery of *Xhc* and decrease seed germination. KleenGrow and UpTake, which contained the same active ingredient as SporeKill, did not significantly reduce seed germination but were also not as effective as hot water treatment or SporeKill at reducing *Xhc* in seed. In this study, hot water treatment provided the best control of *Xhc* in seed while still maintaining acceptable germination rates.

Acknowledgements

The authors thank Central Oregon Seeds, Ocion Water Sciences, Inc., Pace 49 Inc., ICA International Chemicals, and Bejo Seeds for providing in-kind support. The authors would like to acknowledge Jeness Scott and Julia Wilson for providing technical assistance.

Tables

Table 1. Effect of chemical disinfectant seed treatments on colony forming units (CFU) of *Xanthomonas hortorum* pv. *carotae* and germination (%) of carrot seed[1]

Treatment (rate)	Active ingredient(s)	Time	CFU/ gram seed	Germination
Non-treated, non-rinsed	**NA**	**NA**	2.96E+07 a	93% ab
Non-treated	**NA**	**25 min**	2.09E+07 a	97% a
Oxidate 2.0 (1%)	**hydrogen dioxide (27.1%); peroxyacetic acid (2.0%)**	**2 min**	1.66E+07 a	98% a
FT33 (1%)	**copper (4.16%); zinc (1.64%); sulfur (4.97%)**	**1 min**	4.99E+06 a	95% ab
PT81 (1%)	**copper sulfate pentahydrate (20.3%)**	**1 min**	4.95E+06 a	98% a
Bleach (1%)	**sodium hypochlorite (8.25%)**	**5 min**	2.11E+06 ab	96% a
UpTake (1%)	**didecyldimethyl ammonium chloride (7.5%); isopropanol (10.0%)**	**1 min**	8.14E+05 ab	92% ab
KleenGrow (1.16%)	**didecyldimethyl ammonium chloride (7.5%)**	**1 min**	1.15E+05 b	92% ab
SporeKill (1%)	**didecyldimethyl ammonium chloride (12%)**	**30 sec**	1.87E+02 c	88% ab
Hot water treatment	**NA**	**25 min**	1.75E+02 c	92% ab
SporeKill, non-rinsed (1%)	**didecyldimethyl ammonium chloride (12%)**	**30 sec**	0.00E+00 c	81% b
		***P*-value**	< 0.0001	0.0015

[1] All treatments were followed by a 60 s rinse under running tap water except where noted.

Characterizing the Incidence and Distribution of Bacterial Blight Infestation in Individual Carrot Seeds: Can One Bad Seed Spoil the Whole Seed Lot?

Jeremiah Dung, Jeness Scott, and Mike Weber

Introduction

Bulk samples of carrot seed are tested for *Xanthomonas hortorum* pv. *carotae* (*Xhc*) using a seed wash dilution-plating protocol (Asma, 2005). In this protocol, three 10 gram samples of carrot seed, equivalent to three subsamples of 10,000 seeds each, are soaked in buffer and serial dilutions are plated onto a semi-selective medium that limits the growth of bacteria other than *Xhc*. Testing protocols for seed-borne pathogens usually assume that infested seeds are fairly uniform (i.e. they follow the normal "bell-shaped curve") with regards to bacterial populations on individual seeds and that the assay will detect the average number of bacteria for infested seed present in the sample. However, several studies have shown that the number of bacteria found on individual seeds may vary widely and follow non-normal distributions (i.e. they do not follow the normal "bell-shaped curve") (Dutta et al., 2013). If the distributions of *Xhc* among infested carrot seeds are non-normal, assay results from bulk samples could result in an inaccurate estimate of the true population number. For example, if a seed lot contains relatively few, highly infested seeds, the bulk seed lot assay will be highly influenced by the number of highly infested seeds that are in a particular sample. On the other hand, a seed wash assay may not detect any infested seeds if only a few seeds in a seed lot are actually infested. The objective of this research is to determine the incidence and level of *Xhc* infestation among individual seeds in infested carrot seed lots. It is anticipated that this information will be important to the Oregon carrot seed industry, since many countries and markets have a zero-tolerance policy for *Xhc* in carrot seed. The incidence and level of infestation on individual seeds could also influence inoculum thresholds that are required for the development of bacterial blight in carrot root production. A better understanding of seed infestation in carrot seed lots will enable carrot seed producers to improve the methods used to prevent, detect, and treat infested seeds prior to market.

Materials and Methods

Carrot seed samples from commercial seed lots grown in central Oregon were subjected to a bulk seed wash dilution plate assay to determine the overall level of *Xhc.* Three 10 gram subsamples from each seed lot were soaked for 2 hours at room temperature in a 250 ml flask containing 100 ml of sterilized phosphate buffer and one drop of Tween 20 (a surfactant). After the soak the flasks were placed on a horizontal shaker set at 250 rpm for 5 minutes. A 10-fold dilution series (10^{-1} to 10^{-5}) was prepared for each subsample and each dilution series was plated onto replicated plates of semi-selective XCS agar medium. The plates were incubated at 82° F in the dark and monitored for the development of colonies typical of *Xhc*. The number of colonies typical of *Xhc* were counted after 5 to 7 days of incubation. Suspect colonies were sub-cultured onto diagnostic agar medium and subjected to a species-specific DNA test using polymerase chain reaction (PCR) to confirm their identities.

Individual seeds were assayed using a modification of the seed wash dilution plating assay described above. Single seeds were placed in wells of 96-well plates filled with phosphate buffer and incubated for 2 hours at room temperature. Plates were shaken vigorously for 5 min on a horizontal shaker and 10-fold dilutions of the rinsate from each well was prepared, plated, and incubated as described above. The process was repeated until a minimum of 30 positive seeds were identified or 100 seeds were assayed.

Results and Discussion

A total of 16 seed lots were tested using bulk seed wash assay, all of which tested at or above the 10^5 CFU/g seed limit for *Xhc* (Fig. 1). However, results from the individual seed wash assays (828 seeds tested) indicate that the incidence of infested seed can vary among lots, ranging from 7.7 to 94.3% infested seed (Fig. 1). Seven of the 16 lots harbored infested seed at levels $\leq 20\%$, while four lots contained infested seed at an incidence of 23 to 39%. Among individual seed, the CFU detected ranged from 2 CFU (the limit of detection of the assay) to 6.4×10^6 CFU; three seed lots contained individual seeds with levels greater than 10^5 CFU (Fig. 2).

Among 11 seed lots and 548 seeds tested, *Xhc* was not detected on 68% of seed (Fig. 3). Among the remaining seed, 18% had low levels of *Xhc* (≤ 10 CFU), 8% of seed was infested at levels between 11 and 100 CFU, 4% of seed contained 101 to 1000 CFU, and 2% harbored >1000 CFU (Fig. 3). The distribution of infested seed in individual seed lots varied among seed lots but mostly reflected the higher distribution of non-infested seed (Fig. 4).

The results from this study to date indicate that seed infestation by *Xhc* is not homogenous in seed lots. In this study, *Xhc* was not detected from the majority (68%) of individual seeds assayed from commercial seed lots produced in central Oregon and 7 of the 16 seed lots tested contained 20% or less infested seed overall. However, the presence of a few, highly infested seeds in a seed lot may result in an unacceptable level of *Xhc* ($\geq 10^5$ CFU/g) in a bulk seed wash test. The epidemiological implications of a relatively few, highly infested seeds in a seed lot are not known, but the incidence of infested seed in a seed lot and infestation levels of individual seed may be important factors influencing seedborne transmission in carrot root crops. Highly infested seeds in seed lots may also be more difficult to disinfest using hot water or other seed treatments, especially when they represent relatively few seeds in a large seed lot.

Acknowledgements

The authors would like to thank the Agricultural Research Foundation Competitive Grants Program and Jefferson County Seed Growers Association for funding this study. The authors also thank Travis Klopp for providing technical assistance.

References

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Dutta, B., C. Block, K. Stevenson, F. H. Sanders, R. Walcott and R. Gitaitis. 2013. Distribution of phytopathogenic bacteria in infested seeds. Seed Science and Technology 41: 383-397.

Figures

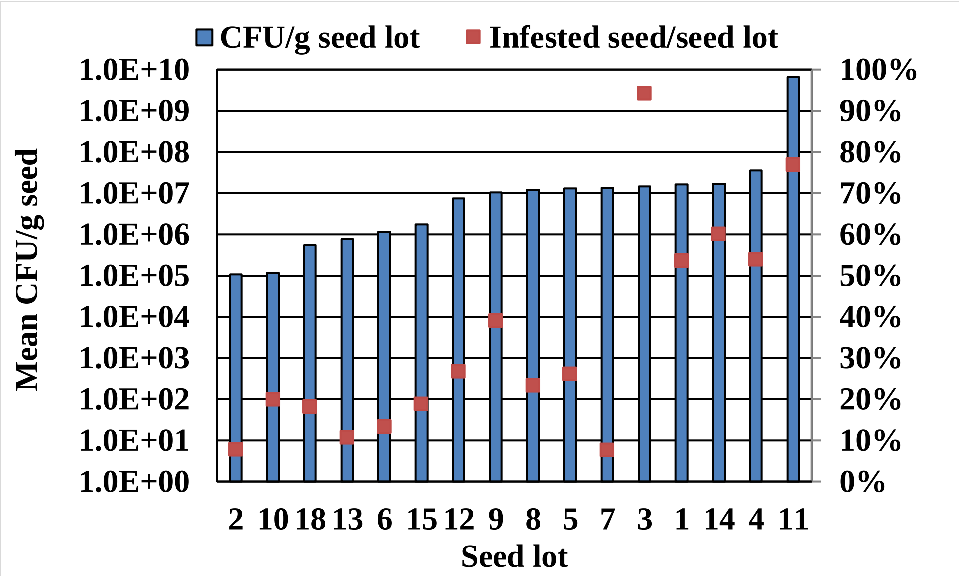

Fig. 1. Mean colony forming units (CFU) of the bacterial blight pathogen *Xanthomonas hortorum* pv. *carotae* in commercial carrot seed lots and percentage of individual carrot seed infested with the pathogen.

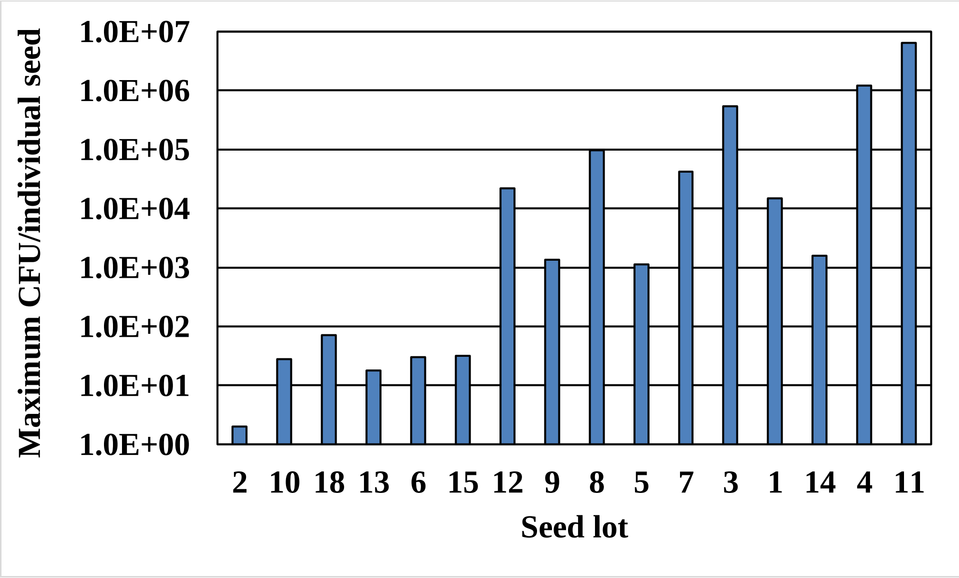

Fig. 2. The maximum colony forming units (CFU) of the bacterial blight pathogen *Xanthomonas hortorum* pv. *carotae* observed on an individual carrot seed from different commercial carrot seed lots.

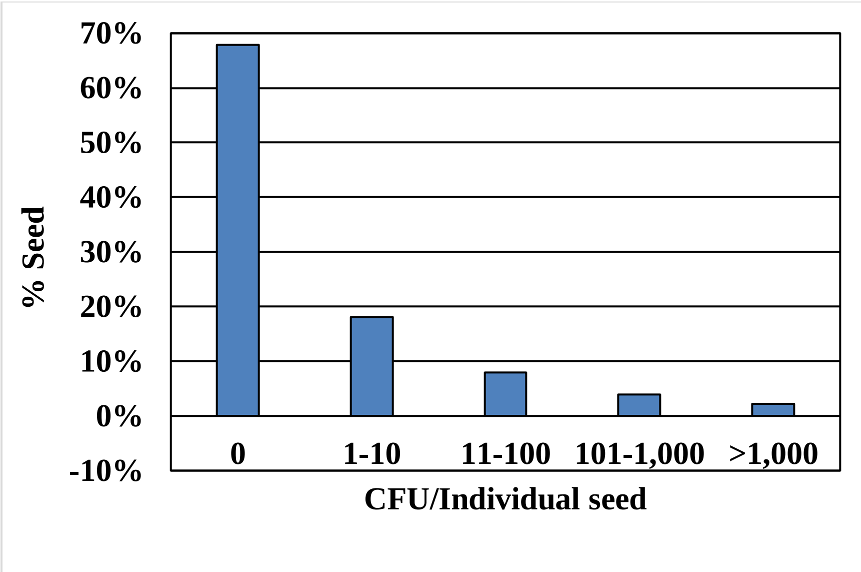

Fig. 3. Histogram showing the mean percentage of individual carrot seed harboring 0, 1 to 10, 11 to 100, 101 to 1,000, and over 1,000 colony forming units (CFU) of the bacterial blight pathogen *Xanthomonas hortorum* pv. *carotae*. A total of 548 seeds from 11 commercial seed lots were tested.

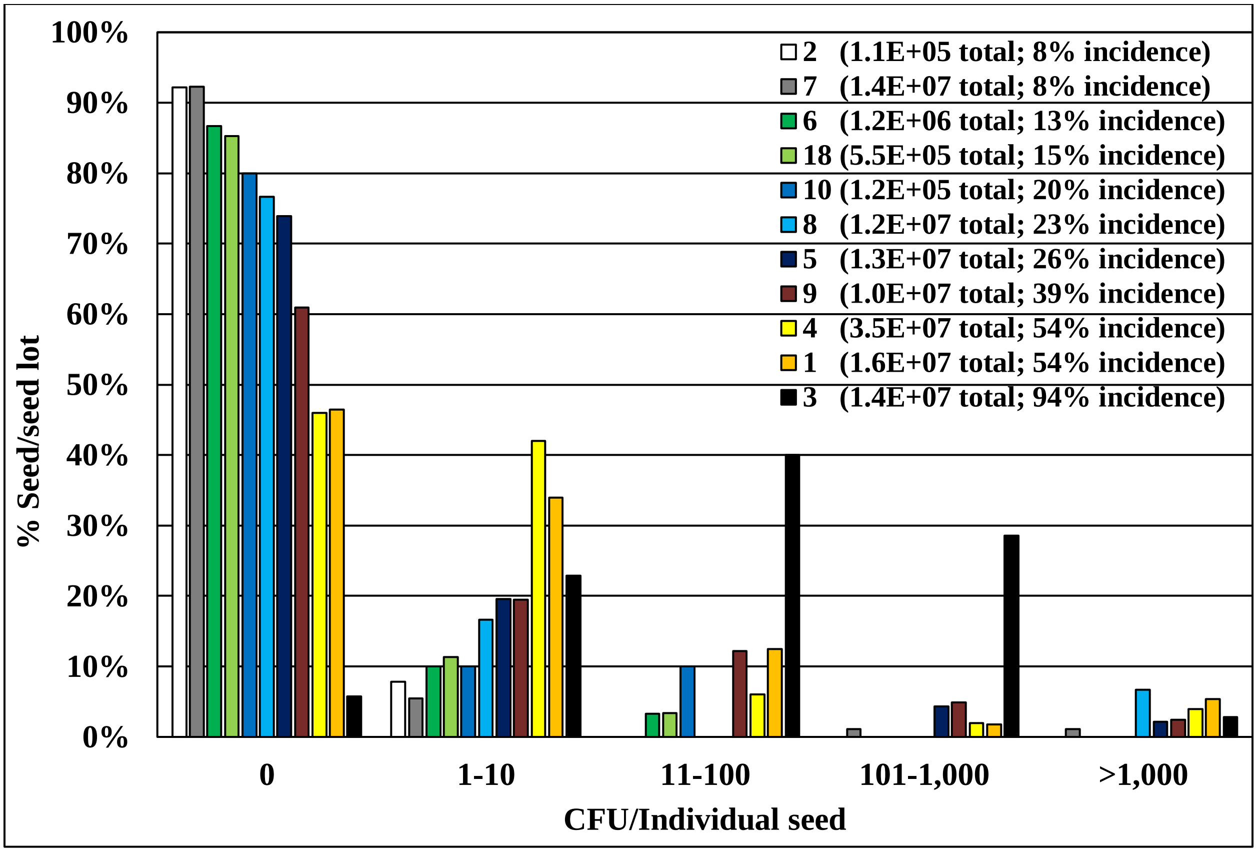

Fig. 4. Histogram showing the percentage of individual seed (*n* = 548) among 11 seed lots harboring 0, 1 to 10, 11 to 100, 101 to 1,000, and over 1,000 colony forming units (CFU) of the bacterial blight pathogen *Xanthomonas hortorum* pv. *carotae*. Legend indicates seed lot number, the total CFU level obtained from bulk seed wash assays, and the incidence of infected seed detected in individual seed assays.

Foliar Boron Fertilizer Application and Timing in Hybrid Carrot Seed Production

Tracy Wilson and Rich Affeldt

Introduction

Hybrid European Nantes carrot seed production can be challenging for growers as yields can be unreliable. Demand for boron (B) in many crops is greatly elevated during flowering and seed set even when B in the plant leaves are in the "adequate" range for that crop. Several studies have found that foliar B applications can increase fruit set and yield (Nyomora et al,. 1999; Perica et al., 2001; Asad et al., 2003). Research conducted on alfalfa seed found that foliar B applications increased seed yield even though B concentrations in the plants and soil were considered adequate for alfalfa forage production (Dordas, 2006). The objective of this research project was to determine what effect foliar B application and application timing had on hybrid carrot seed production.

Materials and Methods

Three hybrid carrot seed fields of the same variety were selected for the trial. Soil tests for the three fields selected had B levels that ranged from "low" (1.1 lb B/ac) to "medium low" (1.5 lb B/acre). Two fields were planted in a 2x4 configuration of two rows of males and four rows of females, the third field was planted in a 4x4 configuration of four rows of males and four rows of females. Four areas near the corners of each field were randomly assigned a treatment: control (no B), pre-bloom B application, during bloom B application, and split (pre- and during bloom) B application. Four plots were replicated in each area in a quasi-randomized complete block in an effort to minimize pollen carryover from other treatments while bees were in the fields. Plots were 50 feet long with two sets of males (4 rows in 2x4, 8 rows in 4x4) and one set of females in each plot. A buffer of one set of females separated the plots. Foliar B applications were made using a CO_2 powered backpack sprayer to apply Tri-Plex B (0-0-0-16, Redox, Burley, Idaho). Pre-bloom and during bloom applications of 0.5 lb B/ac were applied to the males in each plot in all three fields June 13, 2016 and July 8, 2016, respectively. Split applications of 0.25 lb B/ac were applied at pre-bloom (June 13, 2016) and during bloom (July 8, 2016).

Just prior to application and seven days after application, above ground samples were collected from male and female plants in each treatment by clipping the carrot plant at the soil surface. Plant samples were dried at 80° F and then ground. Ground plant samples were sent to the Central Analytical Laboratory at Oregon State University for analysis of B concentrations.

Just prior to each field being swathed, a 5 ft by 5 ft area of each plot was hand harvested to determine seed yield. Seed heads were clipped in the field and placed in a burlap sack to dry down. Once seed heads dried down, they were passed through a thresher and sieved to remove pieces of stem and other flower pieces. Seed will be stored until it can be taken to the Oregon State Seed Laboratory (Corvallis, OR) to be cleaned.

Preliminary Results

Preliminary results from the plant sample analysis indicate that foliar applications of B to the male plants at pre-bloom increased plant B concentrations one week after application (Figures 1-3). The split application of foliar B at the pre-bloom timing did not increase plant B concentrations (Figures 1-3). However, the application at the during bloom timing did increase plant B concentrations one week after application (Figures 1-3).

While the foliar B applications show promise to increase plant B concentrations when applied at certain stages of plant growth, it remains to be seen if these increases in plant B concentrations in the male plants will translate into increased seed set in the females.

Acknowledgements

The authors wish to thank the growers for the use of their fields and for their cooperation. The authors are grateful to Central Oregon Seeds, Inc. for their generous support of this project. Thank you as well to Mitchell Alley and Misty Cottingham for their hard work and invaluable assistance in hand harvesting the field plots.

Figures

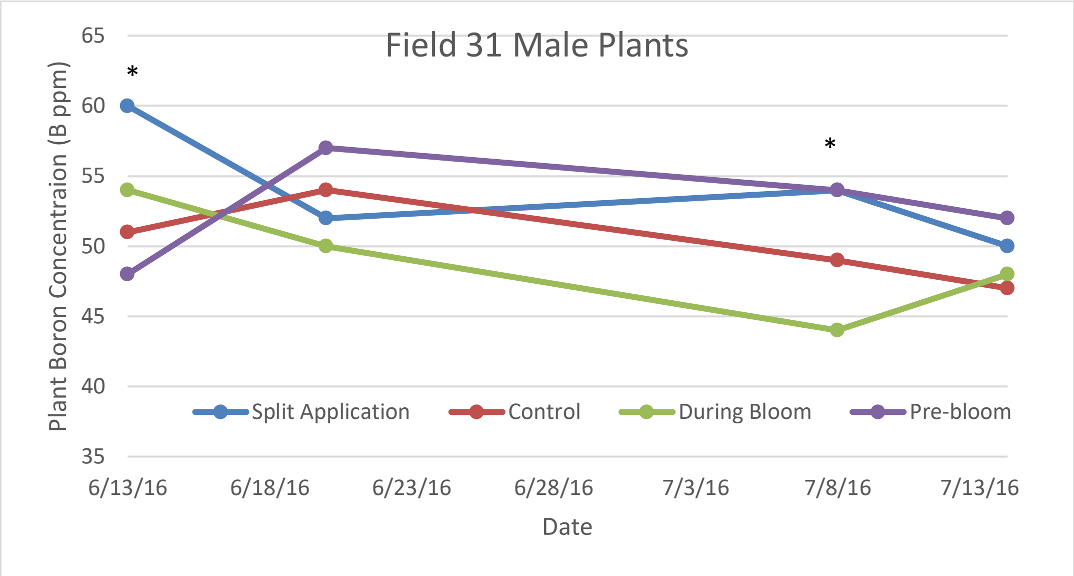

Figure 1. Plant B concentrations (ppm) for male plants collected from field 31 (2x4 planting). Application dates are noted with an *.

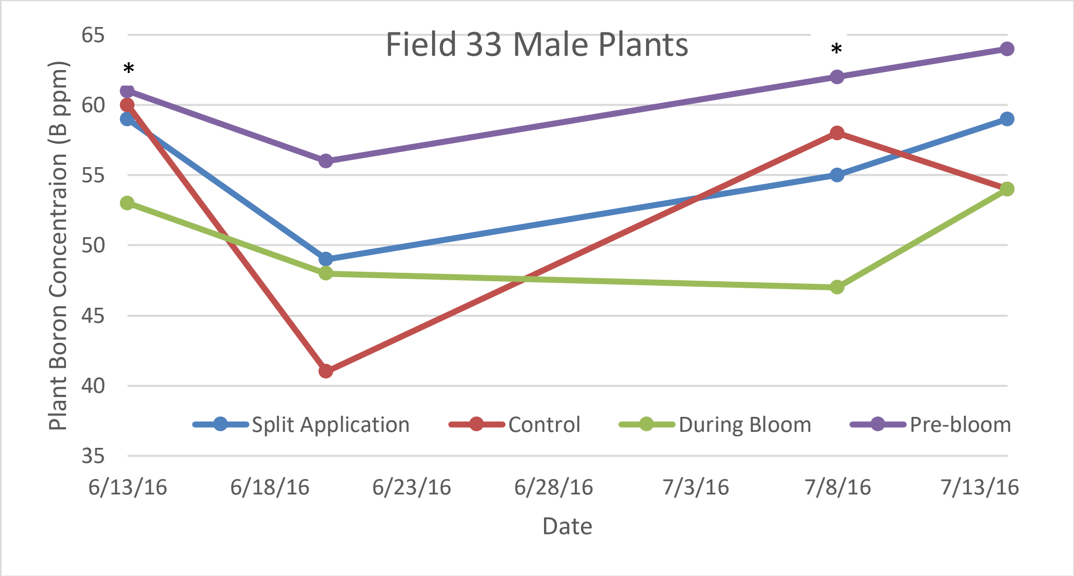

Figure 2. Plant B concentrations (ppm) for male plants collected from field 33 (2x4 planting). Application dates are noted with an *.

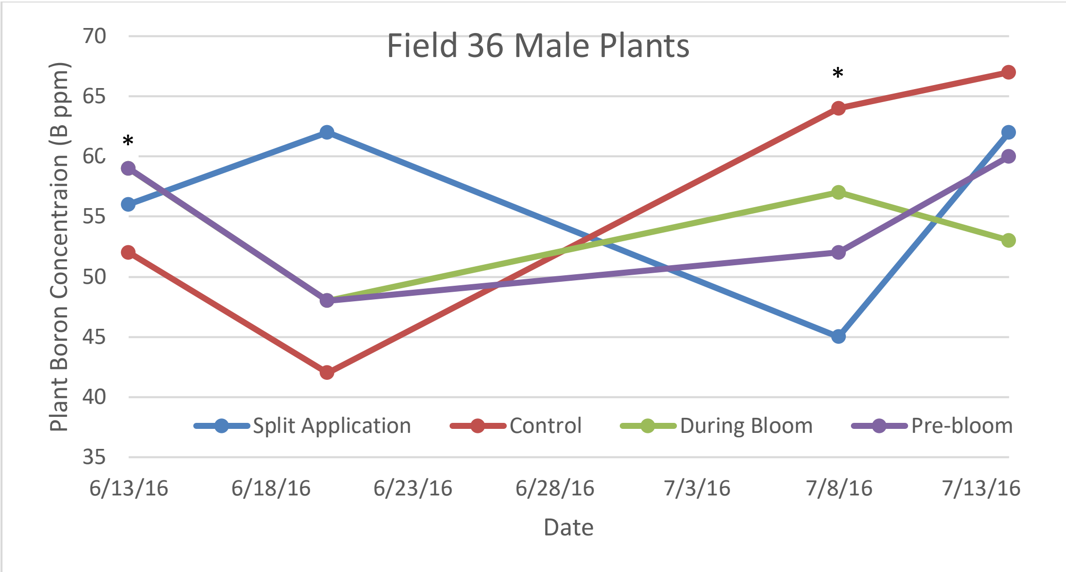

Figure 3. Plant B concentrations (ppm) for male plants collected from field 36 (4x4 planting). Application dates are noted with an *.

Evaluation of Potential New Herbicides in Carrots Applied as a Directed Spray at Layby

Marvin Butler, Rich Affeldt and Bruce Martens

Abstract

Weed resistance to ongoing use of Lorox in carrots grown for seed is a concern to industry representatives and growers. This project was established to evaluate two new products compared to current industry standard treatments. Spartan (sulfentrazone) is used in peppermint production and there is local knowledge about the spectrum of weed that it is effective on. Results from a directed spray application at layby indicate that it may provide a good fit in carrot seed production.

Introduction

There have been ongoing concerns by growers and fieldmen about the long term use of Lorox in seed carrots without adequate rotation of herbicides to prevent weed resistance. This project focuses on evaluation of potential new herbicide candidates applied as a directed spray at layby. Spartan is known to be ineffective in removing volunteer carrots from peppermint production and is therefore a candidate for this evaluation and there is local interest in a new product, Sharpen. These products applied at both the labeled rate and 2x rate were compared to current industry standard treatments.

Methods and Materials

Plots were established in the male rows of a commercial hybrid carrot seed field near Culver, Oregon. Plots 10 ft x 5 ft were replicated 3 times in a randomized complete block design that included two male rows on 30 inch center with blank rows on each side. Herbicides were applied as a directed spray at the bottom 4 to 6 inches of the plants on June 10, 2016 using a CO_2 powered backpack sprayer, hand-held boom, two 8002 Teejet nozzles 18 inches apart, 40 psi and a carrier rate of 20 gal/acre.

Plots were visually evaluated on June 16 and June 30 with written notes and on July 5 by rating plots for percent weed control of redroot pigweed and a description of crop injury. Statistical analysis was provided by Jeremiah Dung using Tukey's comparisons.

Results and Discussion

Spartan provided 92 percent control of 6 inch redroot pigweed at the label rate of 6 oz/acre, with light to very light crop injury at both the 1x and 2x rates (Table 1). Sharpen provided 100 percent control at the 2 fl oz/acre rate, but caused unacceptable moderate to heavy crop injury at both the 1x and 2x rates. The industry standard Lorox at 16 fl oz/acre plus Caparol at 16 oz/acre provided 68 percent control of the sizeable redroot pigweed in the plots. The addition of Sencor at 4 oz/acre increased control to 80 percent and the addition of Spartan increased control to 88 percent. Additional evaluation of Spartan is needed, but it appears this herbicide could have a fit for carrot seed production in central Oregon.

Table 1. Percent control of redroot pigweed for herbicides applied as a directed spray to seed carrots June 30 and evaluated July 5, 2016.

Treatment	Rate/Acre		Percent Control	
Spartan	6	fl oz	92	cef
Spartan	12	fl oz	95	f
Sharpen	2	fl oz	100	f
Sharpen	4	fl oz	100	f
Lorox	16	oz	68	b
+ Caprol	16	fl oz		
Lorox	16	oz	80	bcde
+ Caprol	16	fl oz		
+ Sencor	4	oz		
Spartan	6	fl oz	88	def
+ Lorox	16	oz		
+ Caprol	16	fl oz		
Untreated	-----		0	a

*COC at 1 gal/100 gal

Acknowledgements

The primary author would like to thank Central Oregon Seed, Inc. for their support of this project, Rich Affeldt and Bruce Martens for their cooperation in designing and managing the project, Jeremiah Dung for doing the statistical analysis and Macy Farms for allowing us to conduct this research in their commercial carrot seed field.

Evaluation of Potential New Insecticides and Fungicides for Honey Bee Repellency in Seed Carrots

Marvin Butler, Rich Affeldt and Bruce Martens

Abstract

To insure honey bee safety during crop pollination, potential new products were screened for bee repellency. This research was conducted in a carrot steckling field at the Central Oregon Agricultural Research Center (COARC). Bee visits were counted beginning one day after bees were brought into the field and continued for a total of four counts. There was no statistical difference between treated and untreated plots, indicating no detrimental effect on bee activity from these products.

Introduction

Honey bee activity and pollination of carrots grown for seed is critical to both yield and quality. It is imperative that potential new products that would be applied shortly before or during bee activity in carrot seed fields be screened for bee repellency. Products of current interest include penthiopyrad (Fontelis), abamectin (Agri-Mek) and sulfoxaflor (Transform).

Methods and Materials

Carrot stecklings were used to establish a carrot field at COARC for the honey bee repellency research. Stecklings were planted on April 27, 2016 using hand labor on a commercial sled designed for that purpose. The plot area used for this research was reduced from the original size due to an inadequate carrot stand in the western portion of the field that created more stand variability than desired. To fit the project into a smaller area plots were reduced from 300 ft rows to 150 ft and the replications reduced from four to three.

Treatments were applied on July 5, 2016 using a CO_2 powered backpack sprayer, hand-held boom, 8002 Teejet nozzles 18 inches apart, 40 psi and a carrier rate of 20 gal/acre. Cool weather delayed bloom following the July 5 application. Therefore treatments were re-applied July 11 to ensure there was adequate product residue present when bees were brought in on July 18. Plots were evaluated for honey bee activity by counting how many bees were making flower visits in the two nearest rows while walking down one side of the 4 row plots and back up the other side. Counts began one day after bees arrived on July 19 and continued on July 21, July 22 and July 25, 2016. Counts were made early afternoon each day for consistency. Statistical analysis of these data was provided by Jeremiah Dung using Tukey's comparisons.

Results and Discussion

There were no statistical differences between treated and untreated plots (Table 1). This lack of positive data is a good thing in this situation, and indicates that these products should be safe and not cause bee repellency issues in carrots grown for seed in central Oregon.

Table 1. Evaluation of potential product bee repellency following application on July 5 and 11 by counting honey bee visitation on carrots during flowering at COARC, Madras, OR.

		Honey Bee Visits/Plot			
Treatment	Rate/A	July 19	July 21	July 22	July 25
Fontelis	30 fl oz	477	707	763	904
Agri-Mek	3.5 fl oz	517	748	789	974
Transform	2.75 oz	502	889	830	959
Untreated	---	493	539	707	788

*NIS at 1 qt/100 gal

Acknowledgements

The primary author would like to thank Central Oregon Seed, Inc. for their support of this project, Rich Affeldt and Bruce Martens for their cooperation in designing and managing the project, Jeremiah Dung for doing the statistical analysis of the data, Hoyt Downing for his cooperation as COARC Farm Manager and Michell Alley for assisting in transplanting stecklings.

Evaluation of Potential New Insecticide in Carrots for Lygus Control

Marvin Butler, Rich Affeldt and Bruce Martens

Abstract

Lygus bugs feeding on carrots grown for seed during flowering and seed maturation reduce seed viability. Potential new insecticides for control of lygus in carrots were evaluated in alfalfa and carrots plots at the Central Oregon Agricultural Research Center (COARC). Sulfoxaflor (Transform) and flupyradifurone (Sivanto) were compared to the industry standard, naled (Dibrom 8) plus lambda-cyhalothrin (Warrior II) and an untreated check. Although Transform was effective one week after application, Dibrom 8 plus Warrior II was the only effective treatment compared to the untreated check in subsequent evaluations and across the three sampling dates.

Introduction

Lygus bugs (*Lygus* spp.) that feed on carrots during flowering and seed maturation pose a risk to carrot seed viability. Dibrom 8 and Warrior II applied pre-bloom is the standard insecticide used to control and repel lygus bugs on carrots for seed. However, new product choices are needed to prevent insecticide resistance. In addition a product that is less harmful to predator mites would open the door for use of this biological control method to control two-spotted spider mites.

Methods and Materials

An existing alfalfa plot at COARC was used to evaluate product efficacy on lygus, as alfalfa is known to have relatively high populations of lygus. New products chosen for evaluation were Transform and Sivanto. These products were compared to the industry standard Dibrom 8 plus Warrior II and an untreated check. Plots 10 ft x 20 ft were replicated 4 times in a randomized complete block design. Treatments were applied on July 3, 2016 using a CO_2 powered backpack sprayer, hand-held boom, 8002 Teejet nozzles 18 inches apart, 40 psi and a carrier rate of 20 gal/acre.

Plots were evaluated weekly for lygus nymphs and adults using a sweep net on July 11, July 18 and July 25 following insecticide application on July 3, 2016. Ten sweeps were taken on each side of the plots and the number of lygus recorded. Due to crop lodging and trampling from foot traffic in the alfalfa plots, additional sweeps were taken July 26 and August 1 in carrot plots at COARC where Transform had been applied July 11 to evaluate bee repellency. Statistical analysis of the data was provided by Jeremiah Dung using Tukey's comparisons.

Results and Discussion

Results provided in this report are focused on lygus nymphs and do not include lygus adults, as they are much more mobile with the ability to move between plots. One week following insecticide application, Transform provided significantly greater lygus nymph control than

Sivanto compared to the untreated check, but not on subsequent sampling dates (Table 1). Two and three weeks after application, Dibrom 8 plus Warrior II was the only treatment significantly different than the untreated check, and the only treatment significantly different when averaging across the three sampling dates. There were no significant differences from lygus counts between Sivanto and the untreated plots in subsequent counts in the carrot plots.

Table 1. Lygus nymphs per plot based on 10 sweeps from each side of the plot for a total of 20 sweeps in alfalfa and carrot plantings at COARC, Madras, OR.

		Lygus Nymphs/Plot									
		Alfalfa Plots						Carrots Plots			
Treatment*	Rate/A	July 11		July 18		July 25		July 26		Aug 1	
Transform	2.75 oz	0.9	b	9.5	a	45.8	a	3.1		4.3	
Sivanto	14 fl oz	4.9	a	9.1	a	21.3	ab	---		---	
Dibrom 8	24 fl oz	1.9	ab	2.6	b	15.0	b	---		---	
+ WarriorII	1.92 fl oz										
Untreated	---	4.8	a	13.5	a	36.9	a	4.8	NS	4.3	NS

*Applied July 3, 2016. All treatments included NIS at 1 qt/100 gal

Acknowledgements

The primary author would like to thank Central Oregon Seed, Inc. for their support of this project, Rich Affeldt and Bruce Martens for their cooperation in designing and managing the project, Curt Crossman as a project design cooperator, Armando Gil-Garibay for doing the sweeps, Jeremiah Dung for doing the statistical analysis of the data and Hoyt Downing for his cooperation as COARC Farm Manager.

Management of Verticillium Wilt Using Green Manure Biofumigants

Jeremiah Dung and Jeness Scott

Introduction

Verticillium wilt caused by the fungus *Verticillium dahliae* is the most important disease of commercial mint production. Rotation to non-hosts is difficult since inoculum of *V. dahliae* can survive in field soils for ten years or more and the pathogen has a wide host range. Green manure crops with biofumigant properties, specifically those which produce glucosinolate-derived compounds such as allyl isothiocyanate, can suppress the growth of a broad range of weeds, bacteria, nematodes, and fungi, including *Verticillium dahliae*. Fast-growing, short-term cover crops could be beneficial in central Oregon since a window of opportunity exists for a green manure cover crop during a 2 to 3-month period in late summer and early fall. The objective of this project was to evaluate potential late summer-planted green manure crops for biomass production potential, their effects on *V. dahliae* inoculum levels, and their impact on Verticillium wilt symptoms of mint in a microplot study under central Oregon growing conditions.

Materials and Methods

A microplot experiment was established at COARC to determine if selected green manure crops can produce sufficient biomass if planted in late summer in central Oregon. Round (24” diameter x 18” tall), bottomless nursery pots were placed in the ground so that the tops were approximately 2” above soil level. Each microplot was infested with a VCG 2B isolate of *V. dahliae* obtained from mint (approximately 3 CFU/cm^3 soil). Green manure crops were broadcast planted at recommended rates (Table 2) on August 11, 2015 and grown using overhead irrigation. Other treatments consisted of allyl isothiocyanate at 10- and 40 gal/acre, a non-treated/non-infested control, and a non-treated/infested control. A non-infested allyl isothiocyanate treatment (40 gal/acre) was also included to determine if allyl isothiocyanate can cause phytotoxicity in peppermint. Green manure biomass was measured on October 8, 2015, after which green manures were chopped and incorporated by hand into each microplot. Microplots were planted with greenhouse-grown rhizomes of Black Mitcham peppermint on November 5, 2015.

Soils from each microplot were sampled in March 2016 and assayed for *V. dahliae* using NP-10 semi-selective medium. Verticillium wilt incidence (the number of infected stems) and severity (based on a scale of 0=no symptoms to 6=dead plant) were recorded at the onset of symptoms (June 24, 2016) and prior to harvest (July 29, 2016). Disease severity index (DSI) values were calculated (incidence x severity) and area under disease progress curves (AUDPC) were calculated using DSI values from both disease readings. Mint hay was harvested from each microplot on July 29, 2016, dried for one week, and weighed. Hay yields were converted to yield ratios by dividing the dry hay yield of each microplot by the mean dry hay yield of the non-inoculated control treatment. A yield ratio > 1 indicated an increased yield compared with the mean yield of the non-inoculated control.

Results and Discussion

Significant differences in aboveground biomass were not observed among the five green manure treatments, but aboveground biomass of the four mustard treatments (Ida Gold, Pacific Gold, Kodiak, and Caliente 199) were greater than expected, ranging between 13.0 and 19.7 tons/acre; Nemat arugula produced 6.8 tons/acre of biomass (Table 1). The broccoli green manure failed to grow in the microplots and did not produce any biomass during the trial period.

Significant effects of allyl isothiocyanate (AITC) treatment on Verticillium wilt AUDPC were not observed (P=0.059); however, all four mustard treatments and arugula significantly reduced *V. dahliae* CFUs compared to the infested/non-treated control (Table 1). Both AITC treatments (10 and 40 gal/acre) reduced *V. dahliae* CFU levels but the reduction was not significant. A small number of *V. dahliae* CFUs were recovered from the non-infested/AITC treatment and mild wilt symptoms were observed, indicating the presence of a background level of inoculum at the trial site. Mint hay yields were not significantly different, but it was notable that hay yields were 1.25 to 1.45 times greater in some green manure treatments (Table 1).

Acknowledgements

The authors would like to thank the Oregon Mint Commission and Mint Industry Research Council for funding this study. The authors also thank Cara Boucher and Julia Wilson for providing technical assistance. Ms. Boucher’s and Ms. Wilson’s internships were made possible by the Oregon State University Branch Experiment Station Experiential Learning Internship program.

Tables

Table 1. Effect of green manure and allyl isothiocyanate (AITC) treatments on *Verticillium dahliae* colony forming units (CFU), Verticillium wilt area under disease progress curves (AUDPC), and yield ratios of mint dry hay yields in microplots grown under central Oregon conditions[a]

Treatment	Green manure yield (tons/acre)	CFU/ g soil	AUDPC	Yield ratio[b]
Non-infested/non-treated	N/A[c]	0.0 a	0.0	1.00
Infested/non-treated	N/A	12.6 c	43.1	1.01

***Brassica juncea* 'Pacific Gold'**	15.0	2.4 ab	32.5	1.01
***B. juncea* 'Kodiak'**	19.7	2.4 ab	15.0	1.45
***Sinapis alba* 'Ida Gold'**	13.0	1.1 a	42.5	1.38
Caliente 199 mustard blend	14.9	1.8 ab	52.5	1.37
Caliente Nemat arugula	6.8	2.3 ab	4.4	1.25
95% AITC (10 gal/acre)	N/A	9.5 bc	0.8	1.12
95% AITC (40 gal/acre)	N/A	5.1 bc	1.9	1.05
Non-infested/95% AITC (40 gal/acre)	N/A	1.1 a	3.8	0.96
***P*-value**	0.1396	< 0.0001	0.0591	0.1425

[a] Values followed by different letters are significantly different at $P \leq 0.05$

[b] Yield ratio values were calculated by dividing the dry hay yield of each microplot by the mean dry hay yield of the non-inoculated control treatment. A yield ratio > 1 indicates an increased yield compared with the mean yield of the non-inoculated control.

[c] N/A = not applicable

Prevalence of Race 2 Strains of *Verticillium dahliae* Causing Verticillium Wilt of Mint in Oregon

Cara Boucher, Kelly Vining, and Jeremiah Dung

Introduction

Verticillium dahliae is a plant pathogenic fungus that causes Verticillium wilt, which is the most detrimental disease of commercially grown peppermint (*Mentha piperita*) in Oregon. Symptoms in peppermint include asymmetrical growth, reddening, chlorosis, necrosis, stunted growth, wilt, and premature plant death. Two pathogenic races of *V. dahliae* have been identified. Race 1 isolates contain the *Ave1*gene. Several plants that are resistant to race 1 have been identified, including lettuce and tomato. These resistant plants contain a gene which encodes for plant immune-receptors that can recognize the avirulence gene in race 1 strains of *V. dahliae* (de Jonge et al. 2012). Race 2 isolates of *V. dahliae* do not possess the avirulence gene and therefore do not trigger an immune response in plants containing the resistance gene. Several studies have reported an increased prevalence of race 2 relative to race 1, likely owing to its success in colonizing a greater variety of plants in crop rotations (Short et al. 2014).

Despite being the top mint producing area in the country, there has been relatively little work done to investigate the races of *V. dahliae* infecting mint in the Pacific Northwest. One study tested 16 *V. dahliae* isolates collected from Washington mint and all 16 isolates were determined to be race 2. However, it is not known which race(s) of *V. dahliae* cause Verticillium wilt in commercial peppermint production fields of Oregon. We hypothesize that race 2 *V. dahliae* strains are responsible for Verticillium wilt in peppermint grown in Oregon. The objectives of this study were to: (i) determine which race of *V. dahliae* is infecting Oregon peppermint; and (ii) determine which race is predominately responsible for causing Verticillium wilt in important crop plants other than peppermint.

Methods and Materials

A total of 65 isolates of *V. dahliae* collected from symptomatic peppermint grown in commercial peppermint fields in Oregon over the last two years were used in this study. The 65 isolates collected from peppermint in Oregon included 25 isolates from central Oregon, 2 isolates from the Grande Ronde Valley, and 38 isolates from the Willamette Valley. An additional 96 isolates from mint and other hosts/sources collected from commercial fields across the United States were also included. The hosts/sources of the additional isolates are listed in Table 2.

All isolates were grown on potato dextrose agar for 5-10 days at room temperature in the dark. Mycelia of each isolate were grown in Czapek Dox broth, retrieved, rinsed with sterile water, and lyophilized. DNA from approximately 20 mg of lyophilized tissue from each sample was obtained using the glass bead breakage method with phenol and chloroform extraction. The concentration of DNA was diluted to 2 ng/µl prior to PCR.

Identification of *V. dahliae* races was performed using two previously developed race-specific primer pairs as previously described (Short et al. 2014). PCR mixtures consisted of 12 µl GoTaq

2X Master Mix (Promega Corporation, Madison, WI), 1µl of each primer from an original concentration of 10 µM, 10 µl of water, and 1 µl of genomic DNA for a total reaction volume of 25 µl. The amplicons were subjected to gel electrophoresis in 1.5% (wt/vol) agarose gels at 90V for 90 min. The three controls were water (negative control), isolate Ls16 (race 1 control), and isolate Ls17 (race 2 control). The race 1 control is expected to generate a band approximately 900-bp in size and the race 2 control is expected to produce a band approximately 256-bp in size (Short et al. 2014). Both PCR reactions (race 1 and race 2) were repeated for 24 isolates to confirm reproducibility and validate the results.

Results and Discussion

Of the total 161 isolates included in this study, 98% were found to be race 2. All 65 isolates of *V. dahliae* collected from Oregon peppermint in 2014 and 2015 were classified as race 2 based on PCR using race-specific primers (Fig. 1; Table 1). Additionally, all 35 isolates of *V. dahliae* isolated from mint in various production areas also were classified as race 2. This is consistent with a previous study which only observed race 2 strains among 16 isolates from mint grown in Washington (Short et al. 2014). A total of 58 out of 61 isolates from other hosts were classified as race 2. One isolate from pistachio and two isolates from tomato were classified as race 1 (Table 2). These results, along with the prevalence of *V. dahliae* race 2 strains observed in association with other crop hosts of the Pacific Northwest, implies the importance of developing peppermint cultivars that are resistant to race 2 strains of *V. dahliae*.

Acknowledgements

The authors would like to thank the Oregon Mint Commission and the Mint Industry Research Council for funding this study. The authors also thank Paul Camuso and Darrin Walenta for collecting *V. dahliae* isolates from mint in Oregon and Dr. Dennis Johnson for providing additional isolates. The technical support provided by Dr. Jeness Scott was greatly appreciated. Ms. Boucher's internship was made possible by the Oregon State University Branch Experiment Station Experiential Learning Internship program.

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Tables

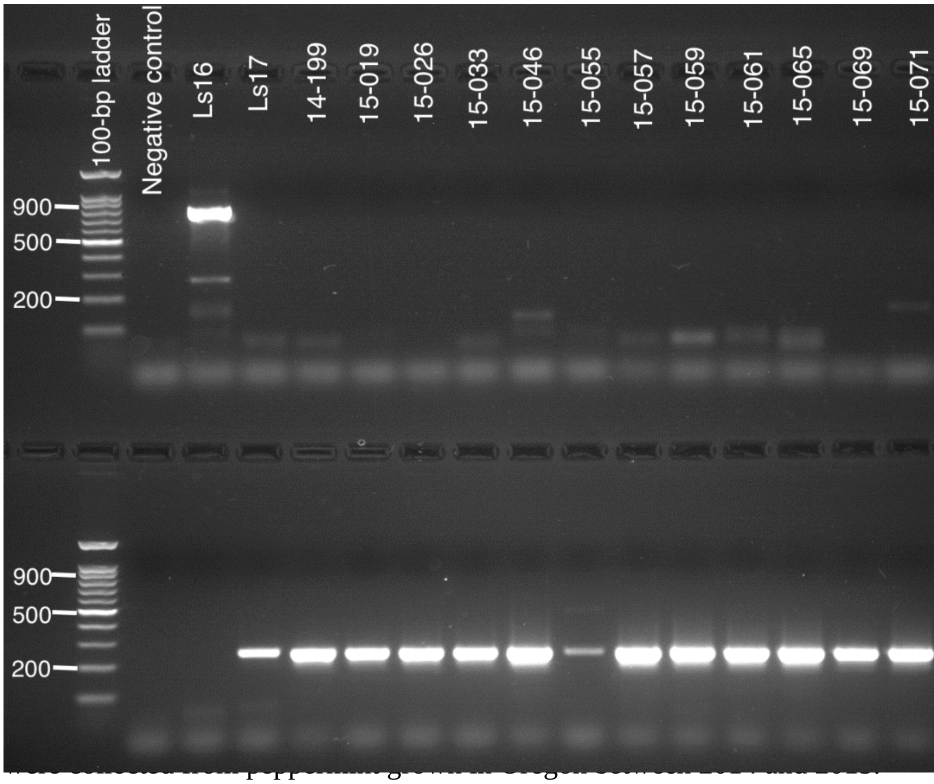
Table 1. Number of *Verticillium dahliae* race 1 and race 2 isolates recovered from infected peppermint samples collected from three locations in Oregon during 2014 and 2015

Location	Number of isolates	
	Race 1	Race 2
Central Oregon	0	25
Grande Ronde Valley	0	2
Willamette Valley	0	38
Total	0	65

Table 2. Number of *Verticillium dahliae* race 1 and race 2 isolates recovered from various hosts and states in the U.S.

Host	State	Number of isolates	
		Race 1	Race 2
Peppermint	**CA, ID, IN, MI, MT, OR, WA**	0	25
Native spearmint	**WA**	0	5
Scotch spearmint	**IN, WA**	0	5
	Subtotal	0	35
Ash	**ID**	0	1
Black Raspberry	**WA**	0	1
Blackberry	**ND, WA**	0	2
Cherry	**ID**	0	1
Cotton	**CA, ID**	0	2
Hyssop	**WA**	0	1
Maple	**ME, OR, WA**	0	3
Pepper	**AZ, CA**	0	2
Pistachio	**CA**	1	0
Potato plant	**NY, OH, OR, WA, WI**	0	12
Potato Seed Tuber	**ID, ME, MI, MT, OR, PA, WA, WI**	0	18
Potato Seed Tuber Tare Soil	**OR, PA, WA**	0	4
Red Raspberry	**ID**	0	1
Skullcap	**WA**	0	2
Spinach	**WA**	0	3
Strawberry	**ID**	0	1
Sugarbeet	**ID**	0	2
Tomato	**ID, NY**	2	0
Watermelon	**WA**	0	2
	Subtotal	3	58
	Total	3	93

Figures



icillium dahliae race-
race 1 and race 2 positive
mately 900-bp in size and
The remaining isolates

Electronic Mint Pest Alert Newsletter Regarding Control of Mint Root Borer, Cutworm Complex and Loopers (Year 3)

Clare Sullivan, Darrin L. Walenta, Marvin Butler, and Ralph Berry

Abstract

An electronic newsletter was developed for the peppermint production regions in Oregon to assist growers and fieldmen consider control of mint root borers, cutworms, armyworms and loopers during the growing season prior to crop damage. Recommendations of optimal insecticide application timing were based on the insect development models, and were provided through weekly e-Newsletters in each region from mid-June until the end of July. Extension Agents from the Willamette Valley, Central Oregon, and Union County provided scouting services to confirm insect development model accuracy. A formal survey of those receiving the newsletter indicates that the newsletter was well received, provided information valuable to growers and crop consultants, and respondents would all like to see the newsletter continue.

Introduction

Mint root borer is one of the more serious insect pests of commercial peppermint in the Pacific Northwest based on discussions with OSU entomologists, Ralph Berry and Glenn Fisher. In some regions, cutworms are considered an equally important pest, with the variegated cutworm being the most common and damaging species of the cutworm complex. Additional pests include loopers and armyworms.

Coragen® provides a new approach to control these insect pests prior to crop damage in an environmentally friendly manner. The traditional approach for mint root borer has been to apply Lorsban Advance® in the fall, which requires irrigation to move the product into the soil for larval control. In contrast, Coragen® provides control of eggs and first instar larvae feeding on foliage prior to dropping to the ground to enter the rhizomes. The life cycles of these larval pests, based on insect development models, offer a window of opportunity to provide control of more than one target pest with a single application of the new insecticide. This in-season and strategic insecticide application provides an opportunity to control mint root borers, cutworms and loopers before the pests cause damage during the growing season.

This was the third year of distributing an electronic Mint Pest Alert Newsletter that included information on larval insect development and control recommendations. The e-Newsletter was created and distributed with three objectives in mind:

1. To deliver region-specific, insect development information as an IPM-decision support tool for larval pest control throughout mint production areas in Oregon.

2. To assist growers, fieldmen and industry representatives in maximizing the effectiveness of Coragen® to control eggs and larvae of mint root borer (MRB), cutworms, armyworms and loopers.

3. In addition, to provide degree-day information that will benefit those using traditional products like Orthene® and Lorsban Advance®.

Methods and Materials

Regional cooperators on the project were Clare Sullivan (S. Willamette Valley), Darrin Walenta (Union Co.), and Marvin Butler (COARC). For this third year of the project, electronic templates and contact lists for the newsletter were updated for the three regions: Willamette Valley, northeastern Oregon and central Oregon. Insect pest degree-day development models (source: Integrated Pest Management on Peppermint Program) were generated using temperature data from AgriMet stations in each region: Corvallis (Willamette Valley), Imbler and Baker Valley (N.E. OR), Madras and Powell Butte (central Oregon). Links to AgriMet weather station data is available at: http://www.usbr.gov/pn/agrimet/.

Degree-day development models for mint root borer and variegated cutworm were run weekly using the models in IPMP from mid-June through late July and again in early September, with results provided through the weekly electronic Mint Pest Alert Newsletter. OSU faculty cooperators provided onsite confirmation of model accuracy for each region. Four commercial fields were used for field scouting in each region and were scouted weekly. Pheromone traps were used for mint root borer adults and sweeps were used for cutworms. Soil samples were taken for mint root borer larvae assessment in early September.

A survey was developed to evaluate the newsletter value and impact to Oregon mint growers and industry representatives. Regional OSU cooperators sent out an email with the survey in September. This information will be helpful for OSU faculty to assess the impact of their Extension program, determine whether the newsletter has accomplished its goal, and if there is ongoing value to the Oregon mint industry of continuing the newsletter.

Results and Discussion

Average MRB moth numbers were highest in the Willamette Valley. The MRB moth population first peaked during the June 29-July 6 trapping period, which lined up with the peak moth catch predicted by the model (July 2nd). The population then dropped, as the model predicted, but peaked again from July 20-28. Mint root borer moth numbers in Central Oregon were moderate. Culver trap numbers for MRB moths peaked July 7-14, and Prineville July 14-21; both of these times lined up with the peak moth catch predicted by the models. The MRB moth counts remained very low all season in Baker Valley. Moth catch peaked July 16-22 in Baker Valley, which was in line with the model’s predicted peak moth catch of July 17th.

Cutworm moth and larvae numbers remained fairly low in all regions throughout the 2016 growing season. There were also no MRB larvae found in any of the soil samples taken in early September.

In 2016 the newsletter was sent to 115, of which ~60% are growers, ~35% are crop consultants/fieldmen, and ~5% are involved in other aspects of the mint industry. As of mid-November only 12 people had responded to the survey (5 growers and 7 fieldmen), the majority of which were from the Willamette Valley.

Based on these 12 respondents, the relative importance of the following insect pests across the regions was rated 1) mint root borer, 2) cutworm, 3) symphylan, 4) armyworm, and 5) looper. This was a positive result since the newsletter focuses on MRB and cutworm by providing specific insect development information for these two pests.

Level of knowledge about degree-day insect development models from reading the newsletter increased from 2.7 to 3.8 on a scale of 1 (uninformed) to 5 (fully informed). The degree to which the newsletter influenced insecticide application timing decisions was rated a 3.25, on a scale of 1 (no influence) to 5 (high influence). This was an increase from 2015 when the influence for application timing was rated at 2.9. Level of knowledge about the use of Coragen from reading the newsletter increased from 2.7 to 3.6

on a scale of 1 (uninformed) to 5 (fully informed). The degree to which the newsletter influenced decisions about insecticide product of choice was rated 3.2 on a scale of 1 (no influence) to 5 (high influence). This year an equal number (41%) of respondents used traditional insecticides (Orthene, Lorsban, etc.) to control larval pests as Coragen pre-harvest – last year ~70% of respondents used traditional insecticides. The other method of control was Mocap in the fall.

When asked whether future plans include the use of Coragen, 7 people said "Yes", 1 said "No" and 4 said "Maybe". If respondents did not plan to use Coragen in the future, the major reason given was the higher cost of Coragen (57%), as it was in 2015.

Respondents rated the newsletter effectiveness in assisting grower/crop consultants in using degree-day models and specifically targeting use of Coragen for mint root borer control of eggs and first instar as 3.5 on a scale of 1 (not effective) to 5 (very effective). This was the exact same rating as in 2015. When asked if the Mint Pest Alert Newsletter should continue as an ongoing project all 12 respondents unanimously "Yes".

We also asked respondents how they planned to manage mint larval pests without chlorpyrifos if the EPA proposal to revoke all chlorpyrifos tolerances is enacted. The majority of respondents (53%) said they would use Coragen (Figure 3).

In answering how the Mint Pest Alert Newsletter could be improved in the future, the suggestions were more focus on life cycles, degree day models, and identifying characteristics of the different larval pests.

Acknowledgements

The primary author would like to thank the Oregon Mint Commission for their support of this project, Darrin L. Walenta, and Marvin Butler for their cooperation and active participation, and Ralph Berry for his expertise and ongoing interest in the project.

Pilot Balloon Observations, 2016
Jefferson County Smoke Management

Linda Samsel and Carol Tollefson

Abstract

Pilot Balloon (PIBAL) observations are a major component of the daily decision-making process used in managing open field burning of grass seed and wheat fields in Jefferson County. PIBALs are used to track upper level wind direction and speed. They are released daily from the Central Oregon Agricultural Research Center between 10:30 am and 3:30 pm. Releases at potential burn sites allow for more accurate decision-making under marginal conditions. The PIBAL is essential in minimizing adverse smoke impacts on local communities.

Introduction

The PIBAL program began in 1998, and incorporates the weather balloon data into information the Jefferson County Smoke Management Coordinator receives from the Oregon Department of Agriculture (ODA) Weather Center. PIBAL data compiled with Real-Time Weather Data, courtesy of the US Bureau of Reclamation AgriMet Network, can be found on the Jefferson County Smoke Management website. The objective is to provide real time wind patterns, wind speed and wind direction information for the Smoke Management Coordinator to determine whether burning will be allowed.

Materials and Methods

Daily balloon releases occurred on demand throughout the day. The release times and locations were requested by the Smoke Management Coordinator. Air temperature, relative humidity, and surface wind direction and speed are documented at the time of the PIBAL release using the AgriMet weather station at the Central Oregon Agricultural Research Center. Wind directions and speeds are determined at one-minute intervals for a period of ten minutes using an observation Theodolite System and a twenty-six inch diameter helium filled balloon (PIBAL). The PIBAL is used to verify the forecast for the upper level wind direction, speed and mixing height. The software program, PIBAL Analyzer, developed by the Oregon Department of Agriculture (ODA) analyzes PIBAL information, which includes three components. The first is the PIBAL Sounding, a spreadsheet translating the azimuth (azimuth are angles used to define the apparent position of an object in the sky, relative to a specific observation point) and elevation readings from the wind direction and average wind speed. The second is the Hodograph, which charts the wind direction. The Profile page, the third component, graphs the wind speed. The PIBAL soundings are entered into the PIBAL Analyzer and transmitted to the Jefferson County Smoke Management website for the Smoke Management Program Coordinator. The Coordinator then uses this data in conjunction with the daily aircraft soundings and the ODA Weather Center forecast as well as the ODA's Air Quality Monitor to determine the field burning status for the day.

Results and Discussion

During the open field-burning season, which began Monday, July 25th and ran through Friday, September 23rd. Farmers burned a total of 6,900 acres, which included 5,490 acres of grass and 1,410 acres of wheat. This was 780 acres less than the previous year. There were 355 more acres of grass burned this year. There was 1,135 less acreage of wheat burned than the year before. The 2016 burn season winds were unlike most years we had prevailing transport and surface winds that consistently came from the Northeast, which made it difficult for burning this year.

Daily balloon releases in the late morning and throughout the day were used to refine the weather forecast; it was a valuable tool for determining the mixing height for smoke during the optimal burn times. The PIBAL provided the only method to detect the stable air layers. The PIBAL is particularly helpful on marginal burn days to assist the Smoke Management Coordinator in making the decision whether to allow burning when conditions were either changing or hard to discern. It is on these marginal days, when the conditions are unclear, that the most risk for smoke intrusion into populated areas exists. Using the PIBAL at the site of the potential burn prior to making the final decision has proved to be a valuable tool again during the 2016 season.

COARC Research Garden & Learning Center and Agricultural Education Outreach, 2015

Carol Tollefson, Linda Samsel, Katie Ralls

Abstract

The Central Oregon Agricultural Research and Learning Center is an ongoing project in its 9th year of activity. The garden provides a hands-on teaching location for local outreach, community programs, and K-12 science field trips. In addition to local programming, the garden provides an opportunity for local OSU Master Gardeners to work and provide services to the local community.

Introduction

The Central Oregon Agricultural Research Garden and Learning Center was established in 2008 on a half-acre parcel of land located at the entrance to the Central Oregon Agricultural Research Center (COARC). The garden provides an opportunity for COARC and Central Oregon Extension programming to extend services and opportunities to the local community in addition to the agricultural community. The garden includes woody ornamental, herbaceous perennials, ornamental grasses, fruit trees and raised garden beds. Garden signs throughout the garden display specific plant species and other information, including: common name, botanical name, plant height, width, water usage and sun/shade needs.

Events and Activities

Seeds of Science
As part of an ongoing partnership with the Jefferson County School District and Oregon Open Campus, COARC hosted over 400 fifth-grade students from the Jefferson County 509J and Culver School Districts, as well as a large Central Oregon Homeschool Group. Students were provided opportunities to learn about Honey Bees and the importance of pollinators in agriculture, Soil and Nutrients, Plant Pathology, Animal Science and Forests and Ecosystems, at individual teaching stations located in the garden. In addition, students participated in planting a vegetable garden. Staff at COARC maintained and harvested the vegetable garden, donating over 400 pounds of vegetables grown to local charities.

Pruning Class
During spring of 2015, COARC hosted a two and a half hour pruning class. The class consisted of one hour of classroom instruction and one and a half hours of hands instruction in the garden. In the classroom section, participants learned why and when they should prune along with basic pruning principles. During the hands on section, participants split into small groups and actively pruned and observed pruning techniques for ornamental trees and fruit trees along with berries, shrubs and low growing plants under the guidance of Master Gardeners and COARC staff.

Corn & Pumpkin Patch

COARC staff planted a half-acre pumpkin and corn patch to enhance community learning and outreach opportunities. In the fall of 2015, Jefferson County 4-H held their first annual kick-off party at COARC in the learning garden and all youth attending had the opportunity to choose a Halloween pumpkin to take home. In addition to 4-H, multiple groups of youth, including the Little Red Schoolhouse Preschool, had the opportunity to visit COARC for learning opportunities and to pick a pumpkin. Leftover pumpkins were donated to local food bank groups.

Kids Club

COARC hosted Jefferson County Kids Club summer agricultural camp participants for a field trip. During the fieldtrip, COARC staff presented information about the research center, agriculture equipment, worms and composting, the on-site weather station and honeybees. In addition to the summer camp, COARC faculty offered a garden club on-site at Kids Club to present children hand-on learning opportunities with an agricultural basis.

COARC Summer Science Academy

In 2015, COARC hosted their first annual Summer Science Academy. The academy was open to youth entering grades 6-8 from across central Oregon. Youth applied to the academy by completing an application and essay. Faculty from OSU Extension and the Research Center lead daily activities each day covering different topic areas including: plant pathology, soil science, local farms and bees, animals and rangeland and local agribusinesses. The 2015 academy hosted six students.

Master Gardeners

The Central Oregon Master Gardener program serves Crook, Deschutes and Jefferson Counties. This gives Jefferson County the benefits associated with a tri-county Master Gardener Program, including increased participation from Master Gardeners from outside Jefferson County. The Master Gardener Program is a voluntary, educational program which trains volunteers in the basics of designed botany and entomology; integrated pest management and pesticide safety; soils, fertilizers and composting; ornamental, herbaceous plants and woody plants; vegetable, indoor and container gardening; sustainable landscaping; and plant pathology.

Master Gardeners are available at the Central Oregon Agricultural Research Center weekly throughout the spring and summer months. Volunteers are available to provide informational and technical assistance and to answer questions from the local community in gardening and horticulture. Additionally, volunteers identify insects and diseases based upon sample submissions from the community. For those interested in volunteering or for more information about the Master Gardener program, more information is available at: http://extension.oregonstate.edu/deschutes/horticulture/mg

Future Plans

Goals

During 2016, COARC will continue to develop the Central Oregon Agricultural Research Garden and Learning Center as an outdoor laboratory to engage in teaching, research and conservation. COARC plans to offer two gardening classes and will host two field trips during 2016, including the Seeds of Science field trip which is planned for expansion to Metolius and Warm Springs schools and to additional home-school groups. In addition, during 2016 COARC will continue to partner with the Jefferson County Kids Club to continue educational offerings on-site and at the Jefferson County Fairgrounds Garden. This will allow youth to learn about local and regional agriculture along with gardening and the inputs that go into both. The garden will continue to provide educational opportunities for the public through hands on learning, exhibits and classes in addition to other agriculture and gardening experiences.