EVALUATION OF NEW FUNGICIDE CHEMISTRIES AND APPLICATION STRATEGIES TO REDUCE ERGOT IN GRASS SEED PRODUCTION SYSTEMS

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Introduction

Ergot, caused by the fungus *Claviceps purpurea,* infects the unfertilized flowers of grasses and grains and transforms seed into fungal structures called sclerotia. Sclerotia overwinter and germinate in the spring to produce fruiting bodies called capitula, which in turn release millions of airborne ascospores. Ergot can be difficult to control, considering the inoculum load of airborne ascospores that is present during the flowering stage of grass seed crops grown for seed production in Oregon and Washington. Another major challenge in ergot control is the extremely large number of sclerotia that can be left in perennial grass seed fields after harvest; one study found between 16,000 and 480,000 sclerotia/acre that were deposited in perennial ryegrass fields after harvest (Dung et al., 2015).

Only two fungicides are labeled for ergot control in Kentucky bluegrass grown for seed in the Pacific Northwest: azoxystrobin (FRAC 11) and propiconazole (FRAC 3). These active ingredients are applied either separately or as one of two commercial products that combine both active ingredients in varying amounts. These products are protective rather than systemic and must be applied during flowering.

Growers make multiple fungicide applications in an effort to prevent and control the disease, spending $14 to $35/acre/application. Correctly timing fungicide application with flowering and knowing when to make multiple applications during flowering are the two most difficult challenges documented by Kentucky bluegrass seed growers in a recently conducted postharvest ergot survey. Taking into account the repeated applications of similar fungicides for powdery mildew and rust control in grass seed crops, there also is a potential for fungicide resistance development in fungal grass seed pathogens.

A need exists for new active ingredients or application strategies, due to the limited fungicide options that are available and the inadequate control they often provide. Moreover, the rotation of fungicide chemistries or use of fungicides with multiple modes of action could delay the development of fungicide resistance in ergot and other diseases affecting grass seed crops. In addition to applying fungicides during anthesis, when flowers are susceptible to infection, it may be possible to apply fungicides to sclerotia in the field during the fall and/or as they begin to germinate in the spring before they release spores (Dung et al., 2012). This approach could reduce the amount of primary inoculum available in the spring to cause ergot infection and, in the long term, break the ergot disease cycle that occurs in perennial fields.

The first objective of this study was to evaluate the efficacy of newer fungicide active ingredients to protect flowers against ergot infection. The second objective of this research was to assess the efficacy of soil-applied fungicides to reduce sclerotia germination.

Materials and Methods

<u>Evaluation of new fungicides to protect flowers from ergot infection during anthesis</u>

Plots of perennial ryegrass cultivar 'Derby Extreme' were established at the Oregon State University Hermiston Agricultural Research and Extension Center (OSU-HAREC) in September 2014. Four replicated plots (20 feet x 3.5 feet) with 10-foot buffer zones were arranged in a randomized complete block design. Five fungicide treatments (Table 1) and a nontreated water

Table 1. Fungicide treatments, trade name, and application rate used during anthesis.

Chemical	Product[1]	Rate	FRAC group
Pyraclostrobin + fluxapyroxad	Priaxor	6 oz/a	7 + 11
Benzovindiflupyr	Solatenol	4 oz/a	7
Penthiopyrad	Fontelis	24 oz/a	7
Fluopyram + prothioconazole	Propulse	14 oz/a	3 + 7
Azoxystrobin + propiconazole	Quilt Xcel	14 oz/a	3 + 11

[1]Registered trade name

control were used. Three applications were made at weekly intervals, beginning at Feekes stage 10.51 (first appearance of stigmas/anthers). Applications were made on May 27, June 3, and June 10, 2015 using a CO_2 backpack sprayer at 30 PSI in a volume of 60 gal/acre. Several foliar treatments evaluated in this study are not registered for use in grasses grown for seed.

When honeydew appeared, the number of seed heads showing symptoms of infection was determined out of 40 heads collected randomly from each plot. At harvest, 40 seed heads were randomly collected from each plot, and disease incidence and disease severity were calculated, based on the number of seed heads containing ergot sclerotia and the number of sclerotia present in each seed head, respectively. Data were analyzed using ANOVA, and multiple comparisons were made using Tukey's LSD test.

Use of soil-applied fungicides to reduce sclerotia germination

Plots of Kentucky bluegrass cultivar 'Midnight' (four replicates per treatment) were established at OSU-HAREC in September 2014. The field was divided into plots 3.3 feet long and spaced 3.3 feet apart, with seven rows per plot. Each plot was infested in October 2014 with 100 sclerotia collected from perennial ryegrass. Treatments consisting of fall, spring, and fall + spring applications of 12 fungicides (Table 2) and a nontreated water control were applied with a CO_2 backpack sprayer at labeled rates in a volume of 400 gal/acre. Fall treatments were applied on October 21, 2014; spring treatments were applied on April 3, 2015. None of the fungicides is registered for soil application.

Treatment efficacy was determined by counting the number of ergot fruiting bodies (capitula) in May and June 2015. Counts were converted to area under capitula production curves (AUCPC). The mean and maximum number of capitula observed for each treatment during the course of the experiment was also calculated. Data were analyzed using analysis of variance (ANOVA), and multiple comparisons were made using Tukey's LSD test.

Results and Discussion

Evaluation of new fungicides to protect flowers from ergot infection during anthesis

Applications of Propulse (fluopyram + prothioconazole), Quilt Xcel (azoxystrobin + propiconazole), and Priaxor (pyraclostrobin + fluxapyroxad) during anthesis significantly reduced ergot honeydew (Figure 1) ($P = 0.002$). Disease severity was significantly reduced in all fungicide treatments compared to the nontreated water control ($P = 0.0079$), indicating that several of these new fungicides were just as effective as the grass seed industry standard (Quilt Xcel) at reducing ergot honeydew during the season and sclerotia after harvest. Additionally, these new fungicides contain succinate dehydrogenase inhibitors and represent a different FRAC group (FRAC 7) that could potentially be used in a fungicide rotation program for ergot management.

Use of soil-applied fungicides to reduce sclerotia germination

Significant reductions in sclerotia germination were not observed compared to the water-treated control plots (Figure 2). Despite the lack of statistical differences, fall applications of Propulse (fluopyram + prothioconazole) reduced AUCPC values by 75%, while spring and fall + spring applications resulted in 40% and 48% reductions, respectively. Fall and fall + spring application of Abound (azoxystrobin) resulted in reduced AUCPC values.

Propulse (fluopyram + prothioconazole; FRAC 3+7), Abound (azoxystrobin; FRAC 11), and Priaxor (pyraclostrobin + fluxapyroxad; FRAC 7 + 11) were the most promising fungicides identified against ergot in multiple field trials conducted between 2012 and 2015 (unpublished data). Soil applications of two fungicides in particular (azoxystrobin and fluopyram + prothioconazole) have reduced sclerotia germination by up to 75% in these trials. We will continue to screen these fungicides in field conditions to generate data that can be used to enter new fungicides/application methods into the IR-4 program. Results are considered preliminary and should not be considered as product endorsement or recommendation for commercial use.

References

Dung, J.K.S., S.C. Alderman, D.L. Walenta, and P.B. Hamm. 2015. Spatial patterns of ergot and quantification of sclerotia in perennial ryegrass seed fields in eastern Oregon. Plant Disease. doi:10.1094/PDIS-08-14-0787-RE

Dung, J.K.S., D.L. Walenta, S.C. Alderman, and P.B. Hamm. 2013. Spatial patterns of *Claviceps purpurea* in Kentucky bluegrass and perennial ryegrass grown for seed and effect of soil-applied fungicides on germination of ergot sclerotia. In A. Hulting, N. Anderson, D. Walenta, and M. Flowers (eds.). *2012 Seed Production Research Report*. Oregon State University, CRS 143.

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Table 2. Fungicide treatments, trade name, application rate, FRAC group, and timing of application in soil-applied fungicide trial.

Chemical	Product[1]	Rate	FRAC group	Timing
Nontreated control	NA	NA	NA	Fall + Spring
Pyraclostrobin + fluxapyroxad	Priaxor	6 oz/a	7 + 11	Spring
Cyproconazole	Alto	5.5 oz/a	3	Spring
Propiconazole	Tilt	8 oz/a	3	Spring
Prothioconazole	Proline	5.7 oz/a	3	Spring
Fluopyram	Luna	5.5 oz/a	7	Spring
Benzovindiflupyr	Solatenol	4 oz /a	7	Spring
Penthiopyrad	Fontelis	24 oz/a	7	Spring
Penthiopyrad	Fontelis	24 oz/a	7	Fall
Fluopyram + prothioconazole	Propulse	14 oz/a	3 + 7	Fall
Fluopyram + prothioconazole	Propulse	14 oz/a	3 + 7	Spring
Fluopyram + prothioconazole	Propulse	14 oz/a	3 + 7	Fall + Spring
Azoxystrobin + propiconazole	Quilt Xcel	14 oz/a	3 + 11	Fall
Azoxystrobin + propiconazole	Quilt Xcel	14 oz/a	3 + 11	Spring
Azoxystrobin + propiconazole	Quilt Xcel	14 oz/a	3 + 11	Fall + Spring
Pyraclostrobin	Headline	12 oz/a	11	Fall
Pyraclostrobin	Headline	12 oz/a	11	Spring
Pyraclostrobin	Headline	12 oz/a	11	Fall + Spring
Picoxystrobin	Aproach	18 oz/a	11	Fall
Picoxystrobin	Aproach	18 oz/a	11	Spring
Picoxystrobin	Aproach	18 oz/a	11	Fall + Spring
Azoxystrobin	Abound	15.5 oz/a	11	Fall
Azoxystrobin	Abound	15.5 oz/a	11	Spring
Azoxystrobin	Abound	15.5 oz/a	11	Fall + Spring

[1]Registered trade name

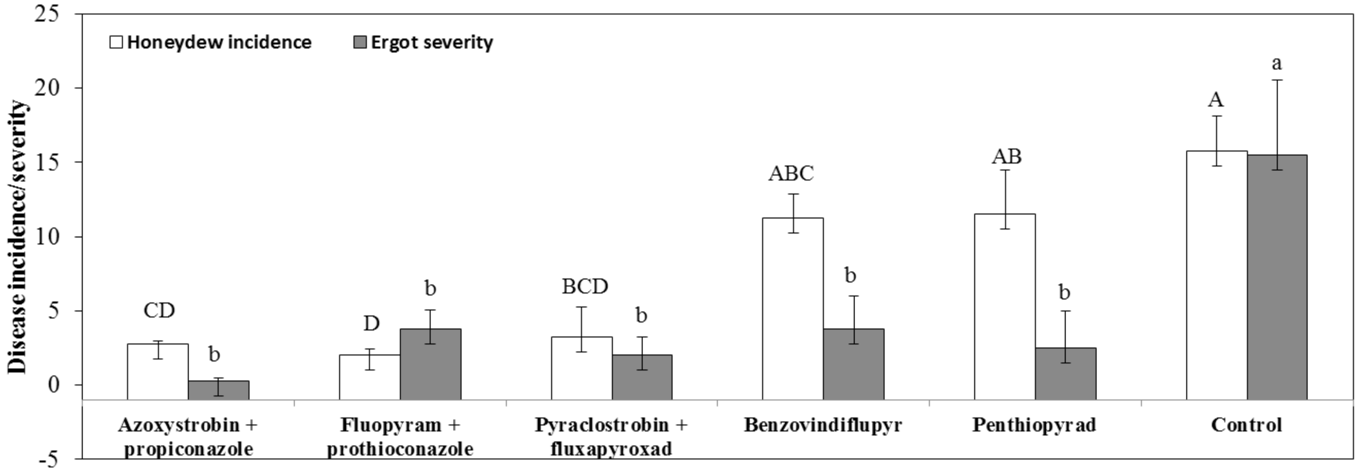

Figure 1. Effect of fungicides on the number of perennial ryegrass seed heads with honeydew (white bars) and disease severity based on the number of sclerotia in seed heads (gray bars). Treatments with the same letters are not significantly different from each other.

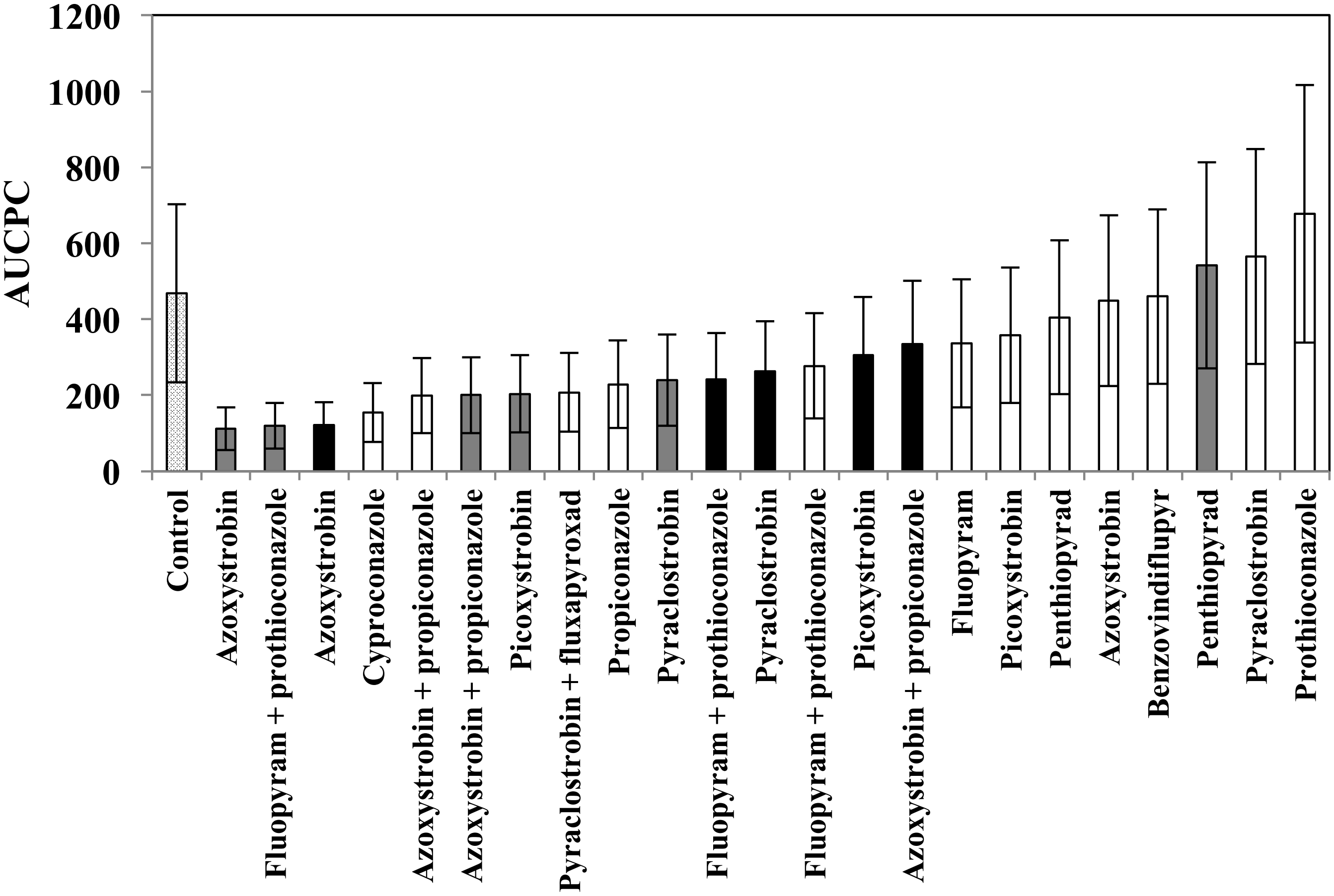

Figure 2. Mean area under capitula production curve (AUCPC) values in experimental plots infested with ergot sclerotia from perennial ryegrass in October 2014 and treated with soil-applied fungicides in fall 2014 (gray bars), spring 2015 (white bars), or in both fall 2014 and spring 2015 (black bars). The bar with dotted diamond pattern represents the water-treated control.