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Insects and Ergot in Kentucky Bluegrass Seed Production Fields in the Pacific Northwest

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Kentucky bluegrass (*Poa pratensis* L.) seed is produced on nearly 100,000 acres in the Pacific Northwest. Dryland production occurs in Spokane County, Washington, and Kootenai County, Idaho. The major irrigated production areas include the Grande Ronde Valley near La Grande and Elgin, Oregon; the Rathdrum Prairie between Spokane, Washington, and Coeur d'Alene, Idaho; and the Madras and Culver areas in central Oregon. All three irrigated areas are semiarid.

Kentucky bluegrass fields generally are planted in April or May, although planting occurs in August in central Oregon. The grass is grown as a perennial for 3 to 5 years.

Harvest of Kentucky bluegrass seed begins about the first of July in all areas. Postharvest residue management in Oregon generally includes thermal treatment such as open field burning or treatment with large propane burners. Burning is not allowed in Washington, and residue there typically is baled. In Idaho, residue management may include baling, burning, or both.

This paper summarizes previously published work (Butler et al., 2001), in which Kentucky bluegrass fields were surveyed for insects and the fungal disease ergot. The association of insects and ergot also was investigated. The association of ergot and insects in Kentucky bluegrass seed production previously had not been investigated.

Insect pests of Kentucky bluegrass

Several insect pests are found on Kentucky bluegrass in the Pacific Northwest.

- The winter grain mite *(Penthaleus major)* can cause severe damage in Kentucky bluegrass fields by feeding on plants through the winter. It is the primary pest in the Grande Ronde Valley and central Oregon.
- The sod webworm or cranberry girdler *(Chrysoteuchia topiaria)* is a well-known pest of Kentucky bluegrass, as well as other grasses, in the Pacific Northwest (Crawford and Harwood, 1959; Kamm, 1971a). It is considered the most severe pest on bluegrasses and creeping fescue in northeast Washington (Harwood, 1958).
- The cutworm *Protagrotis obscura* is a major pest of grasses grown for seed in the Pacific Northwest, especially in the Grande Ronde Valley (Kamm, 1982). The glassy cutworm *(Crymodes devastator)* was found in large numbers near Spokane in a survey of grass seed

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fields (Crawford and Harwood, 1959). It is considered the primary cutworm pest in that area (Harwood, 1958). Cutworm damage frequently occurs in fall and may continue through winter and into spring. Cutworms can cause significant damage by feeding on the crowns of developing plants (Kamm, 1982).

- Thrips (e.g., *Anaphothrips obscurus)* (Kamm, 1971b) and fly larvae of the genus Chloropidae (Starks and Thurston, 1962) can cause silvertop. Silvertop refers to bleached, whitish, or silver-colored dead panicles, resulting from damage to the panicle stalks. Grass seed fields occasionally are treated to control thrips (*Anaphothrips* spp. and *Aptinothrips* spp.) and other potential pests such as leafhoppers (cicadellids) and the English grain aphid *(Sitobion avenae).*
- A grass bug *(Labops hesperius)* is considered a minor pest but has been reported to cause serious damage to grass leaves in seed fields near Spokane (Harwood, 1958).

Ergot on Kentucky bluegrass

In addition to insect pests, Kentucky bluegrass often is infected with ergot, a disease caused by the fungus *Claviceps purpurea* (Alderman et al., 1998). Host seed is replaced with a hard black body (sclerotium) about one to four times larger than normal seed (Alderman, 1991; Barger, 1931; Bove, 1970). Both the disease and the sclerotium are commonly referred to as ergot.

Most cultivars of Kentucky bluegrass are susceptible to ergot, although some are more susceptible than others. Rainfall or irrigation at the time of flowering promotes the development of ergot. High soil moisture conditions support the development of fruiting bodies and subsequent production and release of spores (ascospores). The tiny, threadlike ascospores move through the air like fine particles of dust, easily carried by the slightest air current. Ascospores that contact flower stigmas germinate and infect the flowers.

During infection of Kentucky bluegrass flowers by *C. purpurea,* plant sap exudes from the infected ovaries (Luttrell, 1980). This exudate is commonly referred to as "honeydew" because of its high sugar content (Barger, 1931; Bove, 1970; Mower and Hancock, 1975). *Claviceps* interferes with the normal wound-healing process that occurs when plant tissues are cut or damaged. The result is continuing seepage of sap through the infection site.

The honeydew contains large numbers of fungal spores (conidia) that are produced on the surface of the ovary during the early stages of infection. Conidia are released and accumulate in the plant sap as it leaks from the wounded ovaries, accumulating in large drops.

Insects are believed to play a role in the spread of ergot (Atanasoff, 1920; Moreno et al., 1971; Ingold and Plunkett, 1979; Lemon, 1992) as they feed on conidia-containing honeydew. The sweet syrup is especially attractive to flies (Atanasoff, 1920; Barger, 1931; Ingold and Plunkett, 1979; Lemon, 1992), wasps (*Polistes* spp.) (Hardy, 1988), and nocturnal moths (Moreno et al., 1971). The presence of conidia in the honeydew makes it no less attractive to insects.

During feeding, conidia are consumed by the insects and pass intact through their digestive tract, with no apparent harm to the insect. Honeydew and conidia also stick to mouthparts, legs, and other body parts. When insects then land on healthy flowers, they can transfer conidia to the flower stigmas or ovary, providing opportunity for new infections and, in turn, new sources of honeydew. This association is of mutual benefit to the insect and the fungus.

Methods and materials

Kentucky bluegrass fields in the Rathdrum Prairie, Idaho; central Oregon; and the Grande Ronde Valley, Oregon, were sampled for insects, ergot

sclerotia, and honeydew from 1996 to 1998. Three Kentucky bluegrass seed fields in each region were sampled during 1996 and 1997. In two of the regions in 1998, only two fields were sampled. Fields were sampled 1 week or less before harvest to coincide with peak occurrence of ergot sclerotia and honeydew.

Varieties sampled each year on the Rathdrum Prairie were 'Shamrock,' 'Midnight,' and 'Plush.' In central Oregon, 'Coventry' and 'Gnome' were sampled in 1996; 'Coventry,' 'Georgetown,' and 'Merit' in 1997; and 'Georgetown' and 'Coventry' in 1998. In the Grande Ronde Valley, the varieties sampled included 'Bristol' and 'Coventry' in 1996; 'Sidekick,' 'Nassau,' and 'Ascot' in 1997; and 'Fairfax' and 'Nassau' in 1998.

Insect collection and identification

Insects were sampled with a sweep net, an aphid sampler (Gray and Schuh, 1941), and universal black light traps. Most of the insects were collected with a 14-inch sweep net. Insects collected by both the sweep net and aphid sampler were taken from each of four quadrants in each field. A representative series of individuals of each insect species collected was pinned and identified with the location and date of collection.

The aphid sampler was used to collect small insects from grass heads and foliage. The aphid sampler consisted of a cylinder (16 inches in diameter x 20 inches tall) with a handle on each side near the lid for shaking. Grass foliage was placed on an 0.25-inch mesh screen inside the shaker and exposed to methyl ethyl ketone to relax the insects and make it easier to separate them from the foliage during shaking.

Insects were collected in a jar at the base of the shaker and transferred to vials containing ethyl alcohol. Insects were identified, and the number of specimens of each species was recorded.

Moths were sampled with a single black light trap placed 100 feet from the edge of each field at dusk. Moths were collected the following morning. A Bio-Strip fumigant strip (2.5 inches x 6.5 inches) impregnated with dichlorvos was placed in the bottom of the traps to kill the moths. Specimens were mounted and identified.

Sampling Kentucky bluegrass for ergot

Grass seed heads were collected during 1997 and 1998 to determine the amount of honeydew and ergot sclerotia present in each field. Using a finger knife, 100 samples of grass panicles were randomly collected by hand from a single area (100 feet x 100 feet) in each field. The total number of sclerotia per sample, the percentage of panicles with honeydew, and the percentage of panicles with sclerotia were recorded.

Detecting ergot on insects

To quantify the association of insects and ergot, a second collection was made at each site using a modified sweep net and aphid sampler. In both cases, sticky cards were used to prevent cross contamination and enable individual insects to be evaluated for the presence of ergot honeydew and conidia.

The sweep net was modified with a sticky card mounted at the end of a handle and enclosed in an 0.25-inch mesh hardware cloth cylinder 10 inches in diameter. Insects passed through the mesh and were collected on the sticky card, permitting sweeps to be taken without contamination by foliage and associated honeydew.

The modified aphid sampler consisted of a sticky card in the bottom of a straight-sided 5-gallon plastic bucket with a collecting jar at the bottom. This allowed individual insects to fall directly onto the sticky card.

For moth collection, two sticky cards were attached to the outer edge of the collection bucket so that individuals could be collected as they approached the black light trap.

For ergot assessment, a drop of water was placed on the mouthparts of insects attached to the sticky cards to wash off any conidia. The drop was removed, mounted on a

glass slide and examined for ergot conidia. Since species identification on sticky cards was difficult, insect identification to the species level was not attempted.

Results

Insects collected

Of the 30 species of insects collected in sweep nets and the aphid sampler, 4 were pests or potential pests on grass seed, 10 were beneficial, and 15 were classified as casual visitors or pests on other crops (Table 1). Pests or potential pests on Kentucky bluegrass seed included the sod webworm, aphids, thrips, and leafhoppers. The sod webworm was the only serious insect pest on grasses that was collected in sweeps from all three locations.

Beneficial predators included the lady beetle (*Hippodamia* spp.), minute pirate bug *(Orius tristicolor)*, big-eyed bug (*Nysius* spp.), damsel bug (*Nabis* spp.), and common green lacewing *(Chrysoperla plorabunda)*. Parasitic insects included braconid and ichneumon wasps. The most abundant beneficial insects collected in sweep nets across the three regions were big-eyed bugs, damsel bugs, ichneumon wasps, and lady beetles.

The average number of aphids, leafhoppers, and thrips collected from grass foliage samples in the aphid sampler was relatively low across locations and years (Table 2). On the Rathdrum Prairie, leafhoppers and thrips were collected in the greatest numbers; in central Oregon, thrips were most common; and low numbers of aphids and leafhoppers were collected in the Grande Ronde Valley. However, the number of thrips collected in the Grande Ronde Valley in 1998 (184) may raise concerns about silvertop. The number of aphids generally was less than the number of leafhoppers or thrips.

Night-flying moths included grass-feeding cutworms (Table 3). *Protagrotis obscura* was the most common cutworm species of those known to be pests in grasses grown for seed, and it was present in all sampled fields. Significantly different cutworm complexes were collected from the three growing areas. For example, *Agroperina dubitans* was collected from all fields in Idaho, but from only one field in Oregon. The glassy cutworm *(Crymodes devastator)* was common in samples from the Oregon sites, but was found at only one field in Idaho.

Presence of ergot and honeydew on insects and Kentucky bluegrass

The amount of ergot sclerotia and honeydew on grass panicles varied among fields (Table 4). The number of sclerotia per 100 panicles ranged from zero to 565, and ergot was found in all fields except on the variety 'Georgetown' in 1998 (Table 4).

Ergot conidia were found on 40 to 100 percent of moths (Table 4). In 13 of 15 collections, the percentage of moths with conidia exceeded 67, indicating a strong association between moths and ergot. Conidia also were found on flies, leafhoppers, and thrips.

Discussion

Insect–ergot relationships

A relationship between the presence of ergot in a field and the percentage of moths, flies, leafhoppers, or thrips with ergot conidia was not established. Fields with higher levels of ergot did not necessarily have insect populations with high levels of ergot or honeydew.

Insect populations

A rich diversity of insects was collected in grass fields at all three locations (Table 1). The majority of insects were collected using the sweep net. However, aphids, thrips, and leafhoppers were collected more effectively using the aphid sampler, and moths (other than the sod webworm) were collected at night with universal black light traps.

Results from this project and discussions with industry representatives suggest there are significant differences in insect pests among the three growing areas. The winter grain mite, cutworms, and the sod webworm are important pests on grass fields in the Grande Ronde Valley. The

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Table 1.—Number of fields in which each insect type was collected with a sweep net.

	Rathdrum Prairie, ID			Central Oregon			Grande Ronde Valley, OR		
	1996	1997	1998	1996	1997	1998	1996	1997	1998
	3 fields	3 fields	3 fields	3 fields	3 fields	2 fields	3 fields	3 fields	2 fields
Common pests on grass seed									
Butterflies, moths (*Lepidoptera*)									
Sod webworm (*Pyralidae*)	3	3	3	2	1	0	1	1	3
Beneficial predators and parasites									
Beetles (*Coleoptera*)									
Ground beetle (*Carabidae*)	0	0	1	0	0	0	0	0	0
Lady beetle (*Coccinellidae*)	2	2	2	3	1	2	0	1	1
Rove beetle (*Staphylinidae*)	0	0	0	1	0	0	0	0	1
True bugs (*Heteroptera*)									
Minute pirate bug (*Anthocoridae*)	0	2	0	0	0	0	0	0	0
Big-eyed bug (*Lygaeidae*)	3	1	3	3	2	2	3	3	2
Damsel bug (*Nabidae*)	3	0	2	3	3	2	3	2	2
Wasps, bees, ants (*Hymenoptera*)									
Braconid wasp (*Braconidae*)	2	0	0	1	0	1	2	0	0
Ichneumon wasp (*Ichneumonidae*)	1	3	3	1	3	1	2	3	3
Lacewings (*Neuroptera*)									
Green lacewing (*Chrysopidae*)	0	0	0	1	0	0	0	0	0
Damselflies, dragonflies (*Odonata*)									
Damselfly (*Coenagrionidae*)	0	0	0	1	0	0	0	1	0
Casual visitors/pests on other crops									
Beetles (*Coleoptera*)									
Seed beetle (*Bruchidae*)	0	0	1	0	0	0	0	0	0
Leaf beetle (*Chrysomelidae*)	0	1	0	0	0	0	1	2	1
Flies (*Diptera*)	3	3	3	3	3	2	3	3	2
True bugs (*Heteroptera*)									
Plant bugs (*Miridae*)									
Calocoris	0	0	1	0	0	0	0	0	0
Hoplomachus	2	3	2	0	0	0	0	0	0
Lygus	2	0	0	1	1	0	0	1	0
Megaloceroea	1	3	1	1	0	0	0	1	0
Monosynamma	1	3	3	0	0	0	1	1	0
Stenodema	0	2	0	0	0	0	0	3	1
Stink bug (*Pentatomidae*)	0	2	1	0	0	0	0	0	0
Scentless plant bug (*Rhopalidae*)	0	0	0	2	0	0	1	0	0
Shield-backed bug (*Scutelleridae*)	2	2	3	0	0	0	0	2	1
Planthoppers (*Homoptera*)									
Froghopper (*Cercopidae*)	0	1	3	0	1	0	0	0	1
Delphacid planthopper (*Delphacidae*)	0	0	2	1	2	1	1	1	1
Grasshoppers, katydids (*Orthoptera*)									
Grasshopper, katydid (*Acrididae*)	2	0	0	0	0	1	2	0	1

Table 2.—Average number of insects per sample from Kentucky bluegrass foliage extracted in sampling can.

	Number of individuals collected per sample								
	Rathdrum Prairie, ID			Central Oregon			Grande Ronde Valley, OR		
	1996	1997	1998	1996	1997	1998	1996	1997	1998
	3 fields	3 fields	3 fields	3 fields	3 fields	2 fields	3 fields	3 fields	2 fields
Aphids, leafhoppers (*Homoptera*)									
Aphid (*Aphididae*)	0.8	1.6	1.2	1.1	4.6	1.8	2.5	0.9	2.5
Leafhopper (*Cicadellidae*)	6.7	37.3	15.5	1.1	4.0	1.1	4.7	24.1	5.8
Thrips (*Thysanoptera*)									
Thrips (*Thripidae*)	1.1	25.1	13.8	0.5	40.3	30.1	0.1	48.3	184.1

Table 3.—Number of fields in which each species of grass-feeding cutworm moths was collected in black light traps.

	Rathdrum Prairie, ID			Central Oregon			Grande Ronde Valley, OR		
	1996	1997	1998	1996	1997	1998	1996	1997	1998
	2 fields	3 fields	3 fields	1 field	3 fields	2 fields	2 fields	3 fields	2 fields
Soil-surface cutworms									
Protagrotis obscura	2	3	3	1	3	2	2	3	2
Agroperina dubitans	2	3	3	0	0	0	1	0	0
Crymodes devastator	0	0	1	1	2	2	1	1	0
Apamea amputatrix	0	0	0	0	0	1	2	1	0
Chortodes rufostrigata	0	0	0	0	0	2	0	0	0
Apamea alia	0	0	0	0	0	0	0	0	1
Agroperina lateritia	0	0	0	0	0	0	1	0	0
Climbing cutworms									
Aletia oxygala	0	0	0	1	0	0	2	2	2
Leucania farcta	0	0	0	1	1	1	1	0	0

Table 4.—Association of ergot conidia with various insects collected from Kentucky bluegrass fields during 1997 and 1998 and level of ergot present in the fields.

	Sclerotia per 100 panicles[1]	Percent panicles		Percentage of insects with ergot conidia							
				Moths		Flies		Leafhoppers		Thrips	
		Sclerotia	Honeydew	%	Total[2]	%	Total	%	Total	%	Total
Rathdrum Prairie, ID											
1997											
'Shamrock'	20	12	7	67	(6)	75	(4)	19	(505)	14	(28)
'Plush'	65	26	32	80	(10)	63	(8)	60	(216)	32	(142)
'Midnight'	151	55	0	81	(16)	35	(23)	13	(15)	6	(66)
1998											
'Shamrock'	27	15	6	100	(16)	74	(19)	20	(329)	10	(99)
'Plush'	18	9	2	91	(11)	57	(37)	25	(188)	16	(108)
'Midnight'	88	33	4	67	(6)	24	(37)	7	(59)	3	(97)
Central Oregon											
1997											
'Coventry'	212	51	4	100	(3)	52	(23)	—	—	17	(6)
'Merit'	122	49	64	100	(16)	69	(70)	42	(12)	34	(29)
'Georgetown'	3	1	0	—	—	11	(9)	0	(15)	3	(96)
1998											
'Coventry'	565	87	0	67	(15)	37	(402)	4	(24)	4	(237)
'Georgetown'	0	0	0	40	(5)	19	(32)	—	—	6	(17)
Grande Ronde Valley, OR											
1997											
'Ascot'	42	21	1	89	(66)	73	(15)	57	(28)	31	(39)
'Nassau'	82	31	22	84	(37)	14	(7)	10	(51)	0	(2)
'Sidekick'	4	2	0	100	(31)	60	(5)	39	(28)	6	(16)
1998											
'Fairfax'	206	73	30	87	(31)	77	(160)	51	(69)	16	(318)
'Nassau'	12	8	1	43	(14)	32	(327)	22	(68)	8	(247)

[1]Number of ergot sclerotia based on single 100-panicle sample per field.
[2]Total number of individuals examined.

winter grain mite is the major pest in central Oregon, with the sod webworm only occasionally reaching treatable levels. On the Rathdrum Prairie, the sod webworm is considered the only major insect pest.

Aphids were not found to be an economically important pest during the course of this study (Table 2), but the English grain aphid *(Sitobion avenae)* was found in fields in all three regions. Although not normally considered a pest of grasses, this aphid can cause economic injury to cereals in some years.

Anaphothrips spp. and *Aptinothrips* spp. seemed to be the most common genera of thrips collected. Both can cause silvertop symptoms when populations feed within the "boot" as the seed head is developing. However, numbers collected generally were low (Table 2) compared to numbers collected in bentgrasses and fine fescue grasses of western Oregon (Kamm, 1971b), and these pests seemed to be of little significance.

Plant bugs (*Stenodema* spp.) also are known to cause silvertop (Arnott and Bergis, 1967). They were collected in low numbers on the Rathdrum Prairie and in the Grande Ronde Valley, but were absent from central Oregon samples.

Silvertop was not a problem in the fields sampled, but has been reported to occur in Kentucky bluegrass in the Northwest (Crawford and Harwood, 1959; Kamm, 1971b).

Flies were the only casual visitor or pest of other crops that were found consistently in any significant number in Kentucky bluegrass fields across the three regions. Other insects considered casual visitors or noncrop pests included grasshoppers, seed and leaf beetles, and a variety of plant bugs.

The diversity of night-flying moths varied substantially between the Rathdrum Prairie, central Oregon, and the Grande Ronde Valley (Table 3). *P. obscura* was collected from every field across the three growing regions. *A. dubitans* was common only on the Rathdrum Prairie and, along with *P. obscura*, was the only moth species collected in that area, with the exception of glassy cutworms (*C. devastator)* found in one field.

There was much more diversity in Oregon, where nine species of grass-feeding moths were collected; six of these were found in central Oregon and eight in the Grande Ronde Valley (Table 3). Of the species collected, seven were soil-surface feeding cutworms, while two were climbing cutworms, which often feed on flowers and seed heads (Crumb, 1956; Kamm, 1982). Only soil-surface feeding cutworms were found at the Idaho site, and they were the most abundant cutworm at the Oregon sites (Table 3).

P. obscura, a generalized cutworm that often is extremely abundant in agricultural areas throughout the Northwest, was collected at every site in this study. However, it is scarce or absent in surrounding natural habitats. In a subsequent quantitative study of grass-feeding cutworms in Kentucky bluegrass seed fields in central Oregon and the Grande Ronde Valley, *P. obscura* made up 99.4 percent of the 30,000 moths collected (Butler and Hammond, 2001). The remaining 0.6 percent included 11 different species.

A preliminary comparison of burning and nonburning residue management conducted in the Grande Ronde Valley indicated a 64 percent reduction in *P. obscura* populations the year following open field burning (Butler and Hammond, 2002).

This study indicates that bluegrass seed production occurs in an environment friendly to beneficial predaceous and parasitic insects. Relatively few insect pests are associated with bluegrass seed production. Most routine insecticide applications are made in late fall, with applications possible through early spring, a time when beneficial insects are less active. Populations of beneficials increase in the absence of insecticides during late spring through early summer, negating the need for insecticide applications during development and maturity of Kentucky bluegrass seed. The avoidance of pesticides during late spring to summer not only

increases populations of beneficials but provides a habitat that facilitates an ecologically desirable increase in insect diversity overall.

The moth *Chortodes rufostrigata*, a casual visitor collected in fields at both central Oregon locations during 1998, previously had been collected only in wet meadows in the Blue and Wallowa mountains of northeast Oregon and in one isolated case in Lake County in south-central Oregon. These first-time collections in central Oregon indicate a significant range extension for this species within Oregon. Quite possibly, the irrigation of bluegrass seed fields duplicates the normal wet meadow habitat of this species, allowing a naturally very rare species, which normally inhabits mountain meadows, to invade and successfully establish in irrigated grass seed fields at much lower elevations.

Central Oregon bluegrass fields occupy areas that formerly were a sagebrush-bunchgrass habitat, but moths that normally live in this native habitat were not found in the grass fields. The replacement of native desert with irrigated bluegrass fields has resulted in a total replacement of native cutworm moths. With the exception of *P. obscura*, all of the grass-feeding moths collected are typical of moist habitats and are common at higher elevations of the Blue Mountains and Cascade Range.

It is interesting to note the similarities between Kentucky bluegrass seed production and a mountain meadow habitat. Common elements generally include adequate water through seed set, with moist conditions and a large amount of vegetative production. In both situations, the grass is allowed to produce seed and then dry down during mid- to late summer, followed by fall rains (or late-summer irrigation) and cold winters.

Conclusions

Key findings from this project include the following.

- A large diversity of insects is present in Kentucky bluegrass fields in the Pacific Northwest, most of which are casual visitors or beneficial insects.
- Pests or potential pests vary among growing areas. Pests include the sod webworm, cutworms, and winter grain mites. Aphids, thrips, and leafhoppers are potential pests.
- *Protagrotis obscura* was by far the dominant cutworm species collected.
- Ergot sclerotia and honeydew were found in nearly all the fields sampled, and ergot conidia were collected from moths, flies, leafhoppers, and thrips. However, a relationship between the level of ergot infection in the field and the number of insects carrying ergot conidia was not established.
- Silvertop was not a factor in the fields sampled, and generally low levels of the thrips that cause the symptoms were collected.
- The moth *Chortodes rufostrigata*, collected in central Oregon fields, previously had been collected only from mountain meadows in the Blue and Wallowa mountains of northeast Oregon and from Lake County in south-central Oregon. It is not considered a potential pest.

References cited

Alderman, S.C. 1991. Aerobiology of *Claviceps purpurea* in Kentucky bluegrass. Plant Dis. 75:1038–1041.

Alderman, S.C., D.D. Coats, F.J. Crowe, and M.D. Butler. 1998. Occurrence and distribution of ergot and estimates of seed loss in Kentucky bluegrass grown for seed in central Oregon. Plant Dis. 82:89–93.

Arnott, D.A. and I. Bergis. 1967. Causal agents of silver top and other types of damage in grass seed crops. Can. Entomol. 99:660–670.

Atanasoff, D. 1920. Ergot of grains and grasses. Stenciled and distributed by USDA Bureau of Plant Industry, Office of Cereal Investigations. 127 pp.

Barger, G. 1931. Ergot and ergotism. Gurney and Jackson, London, United Kingdom. 279 pp.

Bove, F.J. 1970. The story of ergot. S. Karger, Basel, Switzerland. 297 pp.

Butler, M.D., S.C. Alderman, P.C., Hammond, and R.E. Berry. 2001. Association of insects and ergot (*Claviceps purpurea*) in Kentucky bluegrass seed production fields. J. Econ. Entomol. 94:1471–1476.

Butler, M.D. and P.C. Hammond. 2001. Grass-feeding moths collected in commercial Kentucky bluegrass fields of central and eastern Oregon, 2000. In: 2000 Seed Production Research at Oregon State University, USDA-ARS Cooperating, Ext/CrS 115. pp. 45–48.

Butler, M.D. and P.C. Hammond. 2002. Grass-feeding moths collected in Kentucky bluegrass seed fields treated with post-harvest burning or bale only in the Grande Ronde Valley, 2001. In: 2001 Seed Production Research at Oregon State University, USDA-ARS Cooperating, Ext/CrS 121. pp. 86–87.

Crawford, C.S. and R.F. Harwood. 1959. Lepidoptera associated with grass grown for seed in eastern Washington. J. Econ. Entomol. 52:966–969.

Crumb, S.E. 1956. The larvae of the Phalaenidae. USDA Tech. Bull. No. 1135, 356 pp.

Gray, K.W. and J. Schuh. 1941. A method and contrivance for sampling pea aphid populations. J. Econ. Entomol. 34:411–415.

Hardy, T.D. 1988. Gathering of fungal honeydew by *Polistes* spp. (Hymenoptera: Vespidae) and potential transmission of the causal ergot fungus. Florida Entomol. 71:374–376.

Harwood, R.F. 1958. Suggestions for controlling insects affecting grasses grown for seed. Extension Bulletin EM 1918. Washington Cooperative Extension Service, Pullman.

Ingold, C.T. and B.E. Plunkett. 1979. An epidemic of *Entomopthora* on flies and its relationship with the sphacelia stage of *Claviceps*. Bull. Brit. Mycological Soc. 13:35–37.

Kamm, J.A. 1971a. Environmental biology of a cranberry girdler *Crambus tutillus* (Lepidoptera: Crambidae). Entomol. Exp. and Appl. 14:30–38.

Kamm, J.A. 1971b. Silvertop of bluegrass and bentgrass produced by *Anaphothrips obscurus*. J. Econ. Entomol. 64:1385–1387.

Kamm, J.A. 1982. *Protogrotis obscura* Barnes and McDunnough (Lepidoptera: Noctuidae): A pest of grasses grown for seed in the Pacific Northwest. Pan-Pacific Entomol. 58:73–8.

Lemon, K.M. 1992. Dispersal of the ergot fungus *Claviceps purpurea* by the lauxaniid fly *Minettia lupulina*. J. New York State Entomol. Soc. 100:182–184.

Luttrell, E.S. 1980. Host–parasite relationship and development of the ergot sclerotium in *Claviceps purpurea*. Can. J. Bot. 58:942–958.

Moreno, R., V.D. Pederson, and J.T. Schultz. 1971. Transmission of *Claviceps purpurea* (Fr.) conidia by the cabbage looper moth *Trichoplusia ni* (Hubner). Proc. of the North Dakota Acad. Sci. 24:11–14.

Mower, R.L. and J.G. Hancock. 1975. Sugar composition of ergot honeydews. Can. J. Bot. 53:2813–2825.

Starks, K.J. and R. Thurston. 1962. Silver top in bluegrass. J. Econ. Entomol. 55:865–867.

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