OCCURRENCE AND TRENDS OF WEED SEED CONTAMINANTS IN FINE FESCUE SEED LOTS IN OREGON[1]

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Introduction

Approximately 60% of fine fescue seed is produced in the foothills of the Cascade Mountains (Silverton Hills) east of Salem, in Marion and northern Linn Counties. An additional 30% of the seed production occurs in the Grand Ronde Valley in the northeastern region of Oregon, near LaGrande, in Union County. The remaining acreage is scattered among counties in the northern half of the state, especially near the eastern end of the Columbia River Gorge.

State and Federal seed laws include lists of prohibited and restricted noxious weed species in order to limit the spread of weeds and the introduction and spread of objectionable weed species. In addition, seed certification programs in each state have their own maximum standards of tolerance for weed seeds in seed lots. Contamination of fine fescue seed with undesirable weed species reduces the value of high quality seed for the end user and increases production costs to control weeds introduced with the seed. However, little is known about the species diversity and frequency of occurrence of weed seed contaminants in fine fescue seed produced in Oregon. An unpublished list of weed contaminants, based on seed lot samples submitted to the Oregon State University Seed Laboratory (OSU Seed Lab) during the period 1986–1995, was prepared for the Oregon Department of Agriculture Field Burning Alternatives Research Program (Dade, 1996). Beyond this, our understanding of the occurrence of weed seeds in fine fescue seed lots is incomplete, and published reports of weed seed occurrence of weed seed contamination in fine fescue seed lots are lacking.

Nearly all fine fescue seed produced in Oregon is certified. Purity analyses for certified seed lots are conducted at the OSU Seed Lab after harvest, as required by OSU's Seed Certification program. During purity analysis, the sample is separated into four components: pure seed, weed seed, inert matter, and other crops. Each component is determined as a percentage by weight. Weed seeds are identified by accredited seed analysts.

The objective of this study was to develop a comprehensive summary of weed seed occurrence in Oregon fine fescue seed lots, based on OSU Seed Lab purity reports between 1986–1995 and 2002–2006.

Materials and Methods

Data for 1986–1995 were obtained and compiled from a summary report of weed seed occurrence in certified seed samples of chewings fescue, red fescue, and hard fescue, prepared by Dade (1996). Data for 2002–2006 were obtained from the purity records of the OSU Seed Lab. The OSU Seed Lab purity records list weed seed contaminants by common and scientific name, based on the Uniform Classification of Weed and Crop Seeds (AOSA, 2010a). Non-certification records and duplicate records associated with retesting of a given fine fescue seed lot were excluded. Purity samples were drawn according to the AOSA Rules for Testing Seeds (AOSA 2010b). The size of purity sample for fine fescues is 3 g (approximately 2,500 seeds). In addition, a total of 30 g (25,000 seeds) are inspected using the 'all states noxious weed exam' for the presence of prohibited noxious weed seeds, based on official lists of noxious weed seeds in the state of Oregon.

Data were summarized to include the number of years in which each contaminant was found (frequency of occurrence) and the percentage of seed lots in which each contaminant was detected in each

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year. Common and scientific names used throughout this report were based on the Uniform Classification of Weed and Crop Seeds (AOSA, 2010a).

Results

Chewings Fescue

In chewings fescue, 68 weed contaminants were identified to species and 23 to genus (Table 1). The most prevalent contaminant was *Vulpia myuros* L. (rattail fescue), occurring annually in 30% to 61% of samples. Other species occurring annually were*Bromus tectorum* L. (downy brome) in 1.0% to 5.9% of samples, and *Poa annua* L. (annual bluegrass) in 2.0% to 17.1% of samples. All three of the grasses are widespread weeds in Oregon. Most of the other weed species detected in samples occurred infrequently, with 37% occurring in two to four years out of 15, and 36% occurring in only a single year. In 2002–2006, 32% to 58 % of seed lots were free of contaminants and less than 7% of samples had three or more different contaminant species. In most cases, only one to several seeds of any given species was detected in the purity test. The occurrence of new species (or genera), relative to 1986, increased at the rate of 2.6 per year. From 1986 and 2006, the percentage of samples with *Anthoxanthum* spp. (vernal grass) or *Rumex acetosella* L. (sheep sorrel) decreased. *Lolium* spp. (ryegrass) seeds, found in 6.8 to 17.5% of samples in 2002–2006, were not reported in 1986-1995, presumably because ryegrass would have been listed as crop rather than weed in the database used by Dade (1996).

Red Fescue

Seventy-five weed contaminants were identified to species and 18 to genus in red fescue (Table 1). The most common contaminant was *V. myuros*, occurring annually in 24.8% to 58.1% of the samples, depending on year. *P. annua* occurred in 13 out of 15 years in up to 24.2% of the samples. Forty percent of the contaminant species occurred in 2 out of 4 years and 32% in only a single year. In 2002–2006, 35% to 54% of seed samples were free of weed seed contaminants and 38–40% had only a single species contaminant. The occurrence of new species, increased at the rate of 2.8 species per year. *Lolium* spp. seeds, common in 2002–2006 (6.3% to 13.8% of samples) were not reported in 1986–1995. From 1986 to 2006, the percentage of samples with *Anthricus caucalis* M. Bieb. (bur chervil) decreased.

Hard Fescue

Data from Dade (1996) did not include hard fescue, so only data for 2002–2006 are included. Thirty-three weed seed contaminants were identified to species and seven to genus (Table 1). The most common contaminants, occurring in four out of the five years, were *V. myuros* and *Lolium* spp. Seventy-nine percent of the species contaminants occurred in only one of the five years. In 2002–2006, 20.0% to 42.68% of seed lots were free of contaminants and less than 7% of samples had three or more different contaminant species. No trends of increasing or decreasing levels of any of the contaminant species, with respect to time, were detected.

Discussion

Results from this study indicate that a great diversity of contaminants can occur in certified fine fescue seed lots, although most contaminants occurred at a low level and in few years. Approximately one third of the contaminant species occurred in only one out of the 15 years included in the study. Few species, such as *V. myuros*, *P. annua*, and *B. tectorum* were prevalent at high levels or in most years.

Predictably, the most commonly occurring contaminants were winter annual grass weeds, including *V. myuros*, *P. annua*, and *B. tectorum*, reflecting the difficulty of selectively managing these species in seedling and established perennial fine fescue crop fields. In perennial grass seed fields in Oregon, *B. tectorum* has been problematic since the 1950's and *V. myuros* since the 1960's (Lee, 1965). A variety of cultural and chemical weed management tactics are employed annually to control these species, but adequate control can be elusive and seed production from weed management escapees often occurs, resulting in contaminated fine fescue seed lots.

Vulpia myuros is an increasing problem in grass grown for seed and cereal-based cropping systems across the Pacific Northwest because of its relative tolerance to many of the commonly-applied herbicides used in grass seed and cereal production and its ability to flourish in conservation tillage

production systems (Ball and Hulting, 2009; Ball et al., 2008; Jemmett et al., 2008; Mueller-Warrant et al., 2008). Past chemical management practices have selected for *P. annua* biotypes that are resistant to diuron, ethofumesate or both. At one time these herbicides were standards for selectively controlling annual grass species in seedling (activated carbon-seeding systems) and established perennial grass seed crop fields. Herbicide resistant *P. annua* biotypes are now geographically widespread and result in serious seed contamination issues on an annual basis.

Generally, weed seeds that are similar in size, shape and weight to the crop being cleaned are difficult to separate using air screen machines or similar cleaning equipment, whereas those that are different in size and terminal velocity from the crop can be removed easily. Therefore, producing seeds that are free from weed seed contaminants should start with a successful management program in the field whenever possible. In addition to testing certified seed lots after harvest and cleaning to ensure meeting minimum quality standards for seed lot certification, certified fields also are inspected during the growing season to assure their cleanness from weeds. This may contribute to the relatively low weed contamination incidents in certified seed lots noted in this study.

The sources or mechanisms of weed seed contamination in seed lot samples were not determined and are beyond the scope of this study. We hypothesize that the source of most contaminants was weed populations growing in individual fields, but cannot exclude the possibility of contaminant sources outside the production fields, including wind borne seed contamination or inadvertent introduction of contaminants during transport, storage, or conditioning of seed lots.

As new weed species continue to invade production areas and are increasingly moved around the environment, the number of weed species detected in fine fescue seed lots is expected to continue to increase. Depending on the weed species, this may or may not represent a production problem from a pest management perspective. Management of the more common and persistent contaminants is the focus of ongoing weed science research in fine fescues grown for seed. Most contaminant species will likely fall into the rare or uncommon occurrence categories and will not represent significant management challenges for fine fescue seed production. However, weed seed contamination will continue to pose a problem for seed shipments to domestic and international markets, depending on which contaminant species are restricted or prohibited from entry.

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Table 1. Weed seeds occurring in Oregon chewings fescue (*Festuca rubra* L. subsp. *commutata* Gaudin) red fescue [*Festuca rubra* L. subsp. *rubra*], and hard fescue [*Festuca trachyphylla* (Hack.) Krajina] seed lots, frequency of occurrence, and range of percentage of seed lots contaminated per year. Data summarized for years 1986–1995 and 2002–2006.

Weed species	Common name	Chewings fescue		Red fescue		Hard fescue	
		f[†]	range[‡]	f[†]	range	f[§]	range
Agrostis L. spp.	bentgrass	2	0-1.2	1	0-1.4	2	0-2.5
Aira L. spp.	hairgrass	-	-	4	0-1.1	-	-
Aira caryophyllea L.	silver hairgrass	1	0-1.0	1	0-1.6	-	-
Allium vineale L.	wild garlic	4	0-2.1	3	0-6.7	-	-
Alnus Mill spp.	alder	1	0-0.7	-	-	-	-
Alopecurus L. spp.	foxtail	1	0-0.6	-	-	-	-
Alopecurus pratensis L.	meadow foxtail	3	0-1.1	-	-	-	-
Amaranthus retroflexus L.	redroot pigweed	3	0-2.0	3	0-1.6	1	0-2.1
Amsinckia Lehm. spp.	fiddleneck	2	0-0.8	5	0-3.1	-	-
Amsinckia intermedia Fisch. & C. A. Mey	coast fiddleneck	-	-	2	0-1.0	-	-
Anthemis arvensis L.	field chamomile	13	0-11.7	12	0-10.3	3	0-2.6
Anthemis cotula L.	dogfennel	4	0-1.3	6	0-4.6	-	-
Anthoxanthum L. spp.	vernalgrass	10	0-7.6	4	0-4.8	-	-
Anthriscus caucalis M. Bieb.	bur chervil	11	0-3.6	9	0-4.6	2	0-7.5
Apera spica-venti (L.) P. Beauv.	windgrass	1	0-1.0	8	0-4.0	-	-
Avena fatua L.	wild oat	3	0-5.0	3	0-4.8	-	-
Brassica L. spp.	*Brassica* spp.	3	0-3.0	3	0-3.0	-	-
Bromus arvensis L.	field brome	1	0-0.6	2	0-2.0	-	-
Bromus commutatus Schrad.	hairy chess	4	0-1.0	6	0-1.1	2	0-2.6
Bromus hordeaceus L.	soft chess	4	0-0.9	7	0-4.8	1	0-1.1
Bromus japonicus Thunb.	Japanese brome	-	-	1	0-1.9	-	-
Bromus sterilis L.	barren chess	-	-	2	0-1.1	-	-
Bromus tectorum L.	downy brome	14	1.0-5.9	8	0-15.1	3	0-10.0
Capsella bursa-pastoris (L.) Medik.	Shepherd's-purse	5	0-0.8	1	0-1.0	2	0-2.9
Carex L. spp.	sedge	13	0-2.4	11	0-5.6	1	0-4.3
Centaurea cyanus L.	cornflower, ragged robin	7	0-1.2	1	0-1.6	-	-
Cerastium L. spp.	mouse-ear chickweed	1	0-0.7	1	0-0.8	-	-
Cerastium glomeratum Thuill.	sticky mouse-ear	2	0-0.8	-	-	-	-
Chenopodium album L.	common lamb's-quarters	1	0-1.0	4	0-1.1	1	0-2.5
Chorispora tenella (Pall.) DC.	blue mustard	-	-	-	-	1	0-1.1
Cirsium arvense (L.) Scop.	Canada thistle	5	0-2.5	4	0-1.5	-	-
Cirsium vulgare (Savi) Ten.	bull thistle	-	-	3	0-1.1	-	-
Crepis capillaris (L.) Wallr.	smooth hawksbeard	1	0-0.4	-	-	-	-
Cynodon dactylon (L.) Pers. var. *dactylon*	bermudagrass	-	-	1	0-1.1	-	-
Dactylis glomerata L.	orchardgrass	-	-	1	0-0.7	-	-
Daucus carota L. subsp. *carota*	wild carrot	1	0-0.7	4	0-4.0	-	-
Descurainia sophia (L.) Webb ex Prantl	flixweed	-	-	2	0-5.2	-	-
Digitalis purpurea L.	common foxglove	1	0-0.6	-	-	-	-
Digitaria sanguinalis (L.) Scop.	large crabgrass	3	0-1.0	2	0-2.0	-	-
Echinochloa crus-galli (L.) P. Beauv.	barnyardgrass	-	-	3	0-4.2	1	0-2.5
Eleocharis obtusa (Willd.) Schult.	blunt spikerush	1	0-1.0	-	-	-	-
Elymus L. spp.	wildrye	1	0-0.6	-	-	-	-
Elymus repens (L.) Gould	quackgrass	7	0-7.9	5	0-2.9	-	-
Erodium cicutarium (L.) L'Hér.	redstem filaree	4	0-1.4	4	0-1.6	1	0-1.1
Fallopia convolvulus (L.) Á. Löve	wild buckwheat	2	0-1.6	3	0-1.1	-	-
Festuca arundinacea Schreb.	tall fescue	4	0-1.0	2	0-1.1	1	0-2.1

Galium L. spp.	bedstraw	4	0-2.7	10	0-6.7	3	0-10.0
Galium aparine L.	cleavers	-	-	-	-	1	0-2.9
Geranium L. spp.	cranesbill	1	0-0.5	-	-	-	-
Glyceria R. Br. spp.	mannagrass	1	0-0.9	-	-	-	-
Holcus L. spp.	velvetgrass	2	0-1.8	8	0-6.2	-	-
Holcus lanatus L.	velvetgrass	-	-	1	0-1.1	-	-
Holcus mollis L.	German velvetgrass	2	0-0.5	-	-	-	-
Hordeum L. spp.	wild barley	-	-	3	0-1.9	-	-
Hypericum perforatum L.	common St. John's-wort	1	0-0.5	-	-	-	-
Hypochaeris radicata L.	spotted cat's-ear	12	0-5.6	10	0-6.3	1	0-6.4
Juncus bufonius L.	toad rush	10	0-5.9	8	0-1.6	2	0-2.6
Juncus tenuis Willd.	path rush	2	0-0.6	3	0-1.6	-	-
Lactuca L. spp.	wild lettuce	-	-	1	0-0.8	-	-
Lactuca serriola L.	prickly lettuce	-	-	1	0-1.1	-	-
Lamium amplexicaule L.	henbit	8	0-1.0	10	0-1.8	2	0-2.6
Lapsana communis L.	nipplewort	6	0-0.6	5	0-2.1	1	0-2.9
Leontodon saxatilis Lam.	rough hawkbit	6	0-1.7	4	0-3.2	1	0-2.6
Lepidium heterophyllum Benth.	Smith pepperweed	1	0-0.6	-	-	-	-
Leucanthemum vulgare Lam.	ox-eye daisy	3	0-1.6	1	0-1.6	1	0-2.6
Lolium L. spp.	ryegrass	4	0-17.5	4	0-13.8	4	7.5-14.7
Lotus L. spp.	trefoil	3	0-1.0	-	-	-	-
Lotus micranthus Benth.	slender trefoil	2	0-0.8	1	0-1.9	-	-
Matricaria chamomilla L.	sweet false chamomile	1	0-0.9	1	0-1.6	-	-
Matricaria discoidea DC.	pineappleweed	1	0-0.7	1	0-1.6	1	0-2.6
Medicago lupulina L.	black medic	-	-	1	0-2.0	-	-
Onopordum acanthium L.	scotch thistle	-	-	1	0-2.0	-	-
Panicum capillare L.	witchweed	4	0-1.0	3	0-1.4	-	-
Parentucellia viscosa (L.) Caruel	parentucellia	-	-	1	0-1.0	-	-
Persicaria lapathifolia (L.) Delarbre	pale smartweed	-	-	-	-	1	0-2.5
Persicaria maculosa Gray	ladysthumb	8	0-3.6	9	0-3.0	-	-
Persicaria pensylvanica (L.) M. Gómez	Pennsylvania smartweed	1	0-0.4	-	-	-	-
Phacelia Juss. spp.	scorpionweed	3	0-0.8	2	0-1.1	-	-
Phalaris arundinacea L.	reed canarygrass	-	-	2	0-1.1	-	-
Plantago lanceolata L.	buckhorn plantain	3	0-2.5	3	0-1.4	-	-
Poa L. spp.	bluegrass	1	0-1.0	2	0-2.0	-	-
Poa annua L.	annual bluegrass	14	2.0- 17.1	13	0-24.2	3	0-10.0
Poa bulbosa L.	bulbous bluegrass	-	-	8	0-4.4	-	-
Poa compressa L.	Canada bluegrass	-	-	-	-	1	0-1.1
Poa pratensis L.	Kentucky bluegrass	4	0-5.1	4	0-9.8	3	0-7.5
Poa secunda J. Presl.	big bluegrass	-		1	0-1.1	-	-
Poa trivialis L.	rough bluegrass	3	0-2.0	2	0-1.1	2	0-2.9
Polygonum aviculare L.	prostrate knotweed	4	0-1.0	5	0-2.0	-	-
Populus L. spp.	poplar	-	-	-	-	1	0-2.6
Prunella vulgaris L.	heal all	-	-	3	0-1.4	-	-
Puccinellia lemmonii (Vasey) Scribn.	Lemmons alkaligrass	1	0-1.2	-	-	-	-
Puccinellia nuttalliana (Schult.) Hitchc.	Nuttail alkaligrass	-	-	1	0-1.0	-	-
Ranunculus L. spp.	buttercup	1	0-0.6	-	-	-	-
Rorippa palustris (L.) Besser	western yellowcress	6	0-1.1	5	0-1.4	1	0-5.0
Rubus L. spp.	blackberry; raspberry	-	-	1	0-0.8	1	0-2.9
Rumex L. spp.	dock	1	0-0.5	-	-	-	-
Rumex acetosella L.	sheep sorrel	12	0-14.7	11	0-14.5	-	-
Rumex crispus L.	curly dock	6	0-1.8	7	0-1.6	-	-
Rumex maritimus L. var. *persicarioides* (L.) R. S. Mitch.	golden dock	1	0-0.7	1	0-1.1	-	-
Rumex obtusifolius L.	broad dock	-	-	1	0-1.0	-	-

Salsola L. spp.	Russian-thistle	1	0-1.0		-	-	-
Scleranthus annuus L.	knawel	5	0-1.9	5	0-3.0	-	-
Senecio L. spp.	groundsel	1	0-0.6	-	-	-	-
Senecio vulgaris L.	common groundsel	2	0-0.6	3	0-1.8	1	0-2.1
Sherardia arvensis L.	field madder	5	0-0.6	1	0-1.0	-	-
Silene vulgaris (Moench) Garcke subsp. *vulgaris*	bladder campion	3	0-1.5	-	-	-	-
Sisymbrium altissimum L.	tumble mustard	-	-	4	0-3.1	-	-
Sisymbrium officinale (L.) Scop.	hedge mustard	-	-	2	0-3.1	-	-
Solanum nigrum L.	black nightshade	-	-	1	0-1.4	-	-
Solanum villosum Mill.	hairy nightshade	-	-	1	0-1.1	1	0-2.5
Sonchus L. spp.	sowthistle	-	-	1	0-1.1	-	-
Sonchus asper (L.) Hill	spiny sow-thistle	5	0-1.9	1	0-1.1	1	0-1.1
Spergula arvensis L.	corn spurry	8	0-6.7	9	0-6.4	-	-
Spergularia rubra (L.) J. Presl & C. Presl	red sandspurry	1	0-0.4	1	0-1.6	1	0-1.1
Stellaria media (L.) Vill.	common chickweed	3	0-0.6	6	0-3.1	-	-
Taraxacum officinale F. H. Wigg. aggr.	dandelion	2	0-0.5	-	-	1	0-2.6
Thlaspi arvense L.	field pennycress	2	0-1.1	10	0-4.7	1	0-2.6
Torilis Adans. spp.	hedge-parsley	1	0-1.7	-	-	-	-
Trifolium aureum Pollich	hop clover	1	0-1.1	3	0-2.9	-	-
Ventenata dubia (Leers) Cross.	ventenata	1	0-0.5	2	0-1.1	-	-
Veronica L. spp.	speedwell	-	-	1	0-1.4	-	-
Vicia sativa L. subsp. *nigra* (L.) Ehrh.	narrowleaf vetch	1	0-0.4	-	-	-	-
Viola L. spp.	violet	1	0-1.7	2	0-1.4	1	0-2.5
Viola tricolor L.	pansy	1	0-0.6	-	-	-	-
Vulpia myuros (L.) C.C. Gmel.	rattail fescue	14	30.1-61.1	14	24.8-58.1	4	41.0-45.0

[†]Frequency of occurrence, years out of 15.

[‡]Frequency of occurrence, years out of 5.

[§]Range of percentage of samples per year in which weed seeds of the given species were identified.