

OCCURRENCE AND TRENDS OF WEED SEED AND PATHOGEN CONTAMINANTS IN BENTGRASS SEED LOTS IN OREGON¹

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Introduction

Nearly all of the bentgrass seed grown in the United States is produced in Oregon as certified seed. However, little is known about the occurrence of weed seed or pathogen propagule contaminants in bentgrass seed lots. Dade (1996) summarized weed contaminants, as recorded in Oregon State University (OSU) Seed Lab records for the years 1986–1995 in a report to the Oregon Seed Council, but the report included raw data and was not published. A portion of the report, describing weed seed contaminants in fine fescue seed lots from seed production fields in Oregon was recently compiled and published (Alderman et al., 2011).

Purity analyses for certified seed lots are conducted at the OSU Seed Lab, as required by the Oregon Seed Certification Program. Seed samples are collected for testing by certified personnel, using standardized sampling protocols to provide a representative sample of each lot, and are submitted as sealed official samples to the OSU Seed Lab. During purity analyses, the sample is separated into four components: pure seed, weed seed, inert matter, and other crops. Ergot and seed galls are recorded as number of pieces and grouped into the inert matter fraction. Each component is determined as a percentage by weight. Weed seed species are identified by experienced seed analysts at the OSU Seed Lab.

The two most common pathogen contaminants found in bentgrass seed are sclerotia of the fungus *Claviceps purpurea*, commonly known as ergot, and galls of the seed gall nematode, *A. agrostis*. In a survey of seed lot samples from 1986 to 1989, the percentage of seed lots of colonial and creeping bentgrass contaminated with ergot ranged from 9 to 30% and 14 to 21%, respectively (Alderman, 1991). In a field survey in the Willamette Valley during 1988, the seed gall nematode was found in 9 out of 45 bentgrass fields examined (Alderman, 1988). In a survey in the Willamette Valley in 1989, the seed gall nematode was found in 5 out of 38 colonial bentgrass fields and 3 out of 37 creeping bentgrass fields examined (Alderman, 1991). It is not known whether levels of these pathogens or weed seed

contaminants have changed over the past two decades. This study was conducted to assess the diversity and frequency of occurrence of weed seeds, ergot (*Claviceps purpurea*), and seed galls (*Anguina agrostis*) in colonial (*Agrostis capillaris* L.) and creeping [*Agrostis stolonifera* L. var. *palustris* (Huds.) Farw.] bentgrass certified seed lot samples submitted to the OSU Seed Lab for purity analysis during 1986–1995 and 2002–2010.

Materials and Methods

Source of data

Data for 1986–1995 were obtained and compiled from a summary of weed seed occurrence in certified seed sample purity records at the OSU Seed Lab (Dade, 1996). Data for 2002–2010 were obtained from the OSU Seed Lab purity records for certified seed lots of colonial and creeping bentgrass. The percentage seed lots contaminated with ergot and seed gall was also determined for 2011 and 2012. The OSU Seed Lab purity records list weed seed contaminants by common or scientific names, based on the AOSA *Uniform Classification Handbook of Weed and Crop Seeds* (AOSA, 2011a). Duplicate records associated with retesting of a given bentgrass seed lot were excluded from this analysis.

Purity samples were drawn and prepared for testing according to the AOSA *Rules for Testing Seeds* (AOSA, 2011b). The size of purity sample for bentgrass is 0.25 g (approximately 2,500 seeds). In addition, a total of 2.5 g (approximately 25,000 seeds) were inspected using the “all states noxious weed exam” for the presence of prohibited and/or restricted noxious weed seeds. The test is based on Federal and official State lists of noxious weed seeds. Presence of sclerotia of ergot or seed gall nematode is noted on the purity record. Common and scientific names of weed species used in this report are based on the *Uniform Classification of Weed and Crop Seeds* (AOSA, 2011a) or, for entries missing from that publication, the USDA online Plants Database (<http://plants.usda.gov/java/>).

¹This report is a condensed version of a paper of the same title published in *Seed Technology* in 2012, volume 34, pages 203–215. Two additional years of data (2011 and 2012) concerning ergot and seed gall contaminants are included in this report.

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 each year.

Results

Colonial bentgrass

For colonial bentgrass, 113 weed seed contaminants were detected, with 75 identified to species, 37 to genus, and 1 to family (Table 1). The most common contaminants, occurring in each of the 19 years evaluated, were *Alopecurus* spp. (foxtail), *Cerastium glomeratum* (sticky mouse-ear), *Daucus carota* L. subsp. *carota* (wild carrot), *Epilobium* spp. (willowherb), *Holcus* spp. (velvetgrass), *Juncus bufonius* L. (toad rush), *Poa annua* L. (annual bluegrass), and *Rorippa palustris* (L.) Besser (western yellowcress). Forty-one out of the 113 weed contaminants identified occurred in only a single year. The occurrence of any given species contaminant varied from year to year, and there was no indication of a trend toward increasing or decreasing frequency or level of occurrence for any species.

Ergot occurred in 41–87% of seed lots, and seed gall occurred in 3–29% of seed lots (Table 2). The level of ergot was relatively stable (41–57%) between 2002 and 2008, but in 2010, 2011, and 2012 increased to 77%, 75%, and 87% respectively. Percentage of lots with seed gall during 2002–2009 ranged between 2% and 10%, but levels in 2010, 2011, and 2012 increased to 15%, 21%, and 29%, respectively.

Creeping bentgrass

For creeping bentgrass, 61 weed seed contaminants were identified to species, 26 to genus, and 3 to family (Table 1). The most common contaminants, occurring in each of the 19 years evaluated, were *Capsella bursa-pastoris* (L.) Medik. (shepherd's-purse), *Epilobium* spp. (willowherb), and *Poa annua* (annual bluegrass). Twenty-eight of the 90 weed contaminants identified occurred in only one of the 19 years evaluated. Within any given year, 12 to 41 contaminant species or genera were identified.

Ergot occurred in 16–48% of seed lots, and seed gall was not detected in any of the samples examined (Table 2). Between 2002 and 2011, the percentage of lots with ergot ranged from 16% to 30%, but in 2012 the level increased to 48%.

Discussion

Results from this study indicated a large diversity of weed seed contaminants in bentgrass seed lots, although

most contaminant species or genera occurred at a low level and in few years. This indicates that bentgrass seed growers are, for the most part, utilizing effective weed management practices for seed production. Weed contaminants that occurred annually indicate difficulty both in control within the field and in separating out the weed seeds during cleaning. In colonial bentgrass, these species were *Alopecurus* spp., *C. glomeratum*, *D. carota*, *Epilobium* spp., *Holcus* spp., *J. bufonius*, *P. annua*, and *R. palustris*. In creeping bentgrass, these species were *C. bursa-pastoris*, *Epilobium* spp., and *P. annua*. These species have seeds with physical properties, including size, shape and/or density, that make them difficult to separate from bentgrass seed during seed cleaning.

Of the 113 weed contaminants detected in colonial bentgrass and the 90 contaminants detected in creeping bentgrass, 69 were common to both grass species, 44 unique to colonial bentgrass, and 21 unique to creeping bentgrass (Table 1). The reason for the greater diversity of contaminants in colonial bentgrass, despite its lower acreage relative to creeping bentgrass, is unclear. Spatial and temporal distribution of weeds in grass seed cropping systems often is a consequence of cropping history and soil factors that may play a role in the diversity and frequency of weed seed contaminants found in bentgrass seed lots (Mueller-Warrant et al., 2008). Differences between colonial and creeping bentgrass were also noted in terms of pathogen contaminants, in particular the absence of seed galls and lower level of ergot in creeping bentgrass seed lots.

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 sources of most contaminants were weed populations growing in individual fields (i.e., the soil seed bank), but we cannot exclude the possibility of contaminant sources from outside the production fields, including wind-borne seed or introduction of contaminants during transport, storage, or conditioning of seed lots. Additional studies would be needed to determine the source of specific weed contaminants. Certainly the continual presence of species such as *Alopecurus* spp. and *Holcus* spp. reflect the inability of growers to selectively manage these perennial grass weed species with the currently labeled herbicides available for colonial bentgrass seed production. The annual presence of *P. annua* in seed lots may be the result of selection for diuron-resistant biotypes of this species and subsequent poor control of this species in the field over time.

In colonial bentgrass, ergot levels were relatively stable (41–57%) between 2002 and 2008, but a steady increase in contaminated lots from 41% in 2008 to 87% in 2012 is of concern. A large increase in ergot contamination also occurred in creeping bentgrass in 2012. The reason for this increase is not clear.

An increase in seed gall in colonial bentgrass beginning in 2009 was also noted, which is of even greater concern because *Anguina* species are of regulatory concern for export markets. In creeping bentgrass, however, seed gall was not detected. It is not clear why seed gall is occurring in colonial bentgrass but not creeping bentgrass.

Acknowledgments

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Table 1. Frequency of occurrence (years out of 19) and range (percentage of seed lots contaminated within a year) of weed seeds found in Oregon colonial bentgrass (*A. capillaris*) and creeping bentgrass (*A. stolonifera* L. var. *palustris*) seed lots. Data summarized for years 1986–1995 and 2002–2010.

Weed species	Common name	Colonial --- bentgrass ---		Creeping --- bentgrass ---	
		F ¹	Range ²	F ¹	Range ²
			(%)		(%)
<i>Achillea millefolium</i> L.	Common yarrow	1	0–1.6	—	—
<i>Agrostis canina</i> L.	Velvet bentgrass	—	—	1	0–2.2
<i>Agrostis capillaris</i> L.	Colonial bentgrass	—	—	7	0–8.9
<i>Agrostis exarata</i> Trin.	Spike bentgrass	15	0–8.4	8	0–3.4
<i>Agrostis stolonifera</i> L. var. <i>palustris</i> (Huds.) Farw.	Creeping bentgrass	1	0–1.6	—	—
<i>Aira</i> L. spp.	Hairgrass	8	0–4.8	3	0–1.1
<i>Aira caryophylla</i> L.	Silver hairgrass	18	0–29.0	7	0–1.1
<i>Alchemilla arvensis</i> (L.) Scop.	Western ladysmantel	3	0–1.3	—	—
<i>Allium vineale</i> L.	Wild garlic	1	0–0.8	—	—
<i>Alopecurus</i> L. spp.	Foxtail	19	1.6–30.7	7	0–4.8
<i>Alopecurus pratensis</i> L.	Meadow foxtail	1	0–0.8	—	—
<i>Amaranthus</i> L. spp.	Pigweed	1	0–0.8	1	0–2.3
<i>Amaranthus retroflexus</i> L.	Redroot pigweed	3	0–1.1	—	—
<i>Anthemis arvensis</i> L.	Field chamomile	4	0–1.6	2	0–0.7
<i>Amsinckia</i> Lehm. spp.	Fiddleneck	—	—	1	0–0.4

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Weed species	Common name	Colonial --- bentgrass ---		Creeping --- bentgrass ---	
		F ¹	Range ² (%)	F ¹	Range ² (%)
<i>Anthemis cotula</i> L.	Dogfennel	11	0–6.6	3	0–1.4
<i>Anthoxanthum</i> L. spp.	Vernalgrass	14	0–11.0	6	0–2.2
<i>Apera spica-venti</i> (L.) P. Beauv.	Windgrass	6	0–3.3	10	0–13
<i>Arabidopsis thaliana</i> (L.) Heynh.	Mouse-ear cress	—	—	1	0–0.7
<i>Barbarea vulgaris</i> W. T. Aiton	Bitter wintercress	1	0–0.8	—	—
Brassicaceae	Brassicaceae	—	—	1	0–0.4
<i>Brassica</i> L. spp.	<i>Brassica</i> spp.	—	—	1	0–0.4
<i>Briza minor</i> L.	Little quackinggrass	2	0–1.6	—	—
<i>Bromus tectorum</i> L.	Downy brome	4	0–2.2	5	0–2.6
<i>Capsella bursa-pastoris</i> (L.) Medik.	Shepherd's-purse	10	0–6.9	19	0.3–8.9
<i>Cardamine</i> L. spp.	Bitter cress	3	0–14.0	—	—
<i>Carex</i> L. spp.	Sedge	11	0–9.3	—	—
<i>Cerastium fontanum</i> Baumg. subsp. <i>vulgare</i> (Hartm.) Greuter & Burdet	Mouse-ear chickweed	12	0–3.7	5	0–1.4
<i>Cerastium glomeratum</i> Thuill.	Sticky mouse-ear	19	1.7–18.8	12	0–8.1
<i>Chenopodium album</i> L.	Common lamb's-quarters	2	0–1.1	3	0–4.4
<i>Cirsium arvense</i> (L.) Scop.	Canada thistle	1	0–0.8	—	—
<i>Crepis</i> L. spp.	Hawksbeard	—	—	1	0–0.5
<i>Crepis capillaris</i> (L.) Wallr.	Smooth hawksbeard	1	0–3.2	2	0–0.7
<i>Crepis setosa</i> Haller f.	Hairy hawksbeard	3	0–1.3	6	0–0.9
<i>Daucus carota</i> L. subsp. <i>carota</i>	Wild carrot	19	1.6–53.0	18	0–6.5
<i>Deschampsia cespitosa</i> (L.) P. Beauv. subsp. <i>cespitosa</i>	Hairgrass, tufted	—	—	1	0–0.4
<i>Descurainia sophia</i> (L.) Webb ex Prantl	Flixweed	3	0–1.7	5	0–1.1
<i>Digitaria</i> Haller spp.	Crabgrass	1	0–0.8	1	0–0.9
<i>Digitaria sanguinalis</i> (L.) Scop.	Large crabgrass	3	0–1.9	3	0–1.5
<i>Downingia</i> Torr. sp.	Downingia	11	0–4.6	4	0–2.2
<i>Eleocharis</i> R. Br. spp.	Spikerush	9	0–6.5	—	—
<i>Eleocharis obtuse</i> (Willd.) Schult.	Blunt spikerush	9	0–7.3	1	1–0.4
<i>Epilobium</i> L. spp.	Willowherb	19	1.1–11.5	19	8.9–28.8
<i>Eragrostis</i> von Wolf spp.	Lovegrass	1	0–2.0	4	0–0.7
Erecaceae	Erecaceae	—	—	1	0–0.9
<i>Erigeron</i> L. spp.	Fleabane	1	0–1.0	—	—
<i>Erysimum</i> L. spp.	Treacle	—	—	1	0–0.5
<i>Festuca</i> L. sp.	Fescue	2	0–1.6	2	0–0.5
<i>Fimbristylis</i> Vahl spp.	Fimbristylis	6	0–4.8	—	—
<i>Galium</i> L. spp.	Bedstraw	5	0–2.3	4	0–0.7
<i>Galium parisiense</i> L.	Bedstraw, wall	17	0–22.0	6	0–1.0
<i>Glyceria</i> R. Br. spp.	Mannagrass	2	0–1.6	—	—
<i>Gratiola neglecta</i> Torr.	Hedge hyssop	2	0–1.3	—	—
<i>Holcus</i> L. spp.	Velvetgrass	19	16.5–44.0	9	0–2.2
<i>Hypericum perforatum</i> L.	Common St. John's-wort	15	0–14.0	10	0–2.2
<i>Hypochaeris radicata</i> L.	Spotted cat's-ear	4	0–1.6	2	0–0.4
<i>Jacobaea vulgaris</i> Gaertn.	Tansy ragwort	3	0–6.8	5	0–0.9
<i>Holosteum umbellatum</i> L.	Jagged chickweed	1	0–2.7	2	0–1.6

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Weed species	Common name	Colonial --- bentgrass ---		Creeping --- bentgrass ---	
		F ¹	Range ² (%)	F ¹	Range ² (%)
<i>Juncus bufonius</i> L.	Toad rush	19	1.9–30.2	14	0–4.3
<i>Juncus</i> L. spp.	Rush	3	0–11.3	—	—
<i>Juncus tenuis</i> Willd.	Path rush	9	0–7.3	—	—
<i>Kickxia spuria</i> (L.) Dumort.	Roundleaf toadflax	1	0–3.7	2	0–0.7
<i>Lamium amplexicaule</i> L.	Henbit	—	—	1	0–0.9
<i>Lapsana communis</i> L.	Nipplewort	1	0–0.9	—	—
<i>Leontodon saxatillis</i> Lam.	Rough hawkbit	1	0–0.8	2	0–0.5
<i>Leucanthemum vulgare</i> Lam.	Ox-eye daisy	4	0–2.4	1	0–0.3
<i>Linaria maroccana</i> Hook. f.	Spurred snapdragon	1	0–0.8	—	—
<i>Lobelia</i> L. spp.	Lobelia	1	0–2.4	—	—
<i>Lolium</i> L. spp.	Ryegrass	4	0–3.9	4	0–0.7
<i>Lotus pedunculatus</i> Cav.	Big trefoil	1	0–0.9	—	—
<i>Lythrum hyssopifolia</i> L.	Loosestrife, hyssop	12	0–27.4	8	0–1.1
<i>Matricaria chamomilla</i> L.	Sweet false chamomile	—	—	1	0–0.9
<i>Matricaria discoidea</i> DC.	Pineappleweed	9	0–3.3	18	0–11
<i>Melissa officinalis</i> L.	Balm	1	0–5.2	—	—
<i>Mentha</i> L. spp.	Mint	1	0–1.7	—	—
<i>Mimulus</i> L. spp.	Monkeyflower	7	0–10	—	—
<i>Misopates orontium</i> (L.) Raf.	Little snapdragon	1	0–0.8	—	—
<i>Myosotis</i> L. spp.	Forget-me-not	1	0–1.7	—	—
<i>Navarretia intertexta</i> (Benth.) Hook.	Needleleaved navarretia	1	0–0.8	—	—
<i>Navarretia squarrosa</i> (Eschsch.) Hook. & Arn.	Skunkweed	3	0–1.6	2	0–0.7
<i>Panicum capillare</i> L.	Witchgrass	4	0–1.6	4	0–0.5
<i>Papaver</i> L. spp.	Poppy	—	—	1	0–0.5
<i>Parentucellia vicosa</i> (L.) Caruel	Parentucellia	6	0–3.4	2	0–1.1
<i>Persicaria maculosa</i> Gray	Ladysthumb	2	0–0.8	—	—
<i>Phacelia</i> Juss. spp.	Scorpionweed	7	0–2.6	1	0–0.4
<i>Plantago lanceolata</i> L.	Buckhorn plantain	2	0–4.1	—	—
<i>Plantago major</i> L.	Common plantain	14	0–5.3	16	0–8.9
<i>Poa</i> L. spp.	Bluegrass	9	0–21.9	9	0–2.2
<i>Poa annua</i> L.	Annual bluegrass	19	3.9–30.7	19	1.6–20.9
<i>Poa compressa</i> L.	Canada bluegrass	3	0–2.0	6	0–2.6
<i>Poa nemoralis</i> L.	Wood bluegrass	—	—	1	0–0.7
<i>Poa palustris</i> L.	Fowl bluegrass	2	0–2.7	7	0–5.4
<i>Poa pratensis</i> L.	Kentucky bluegrass	3	0–1.7	2	0–1.6
<i>Poa trivialis</i> L.	Rough bluegrass	9	0–32.5	8	0–3.3
Poaceae	Poaceae	6	0–4.4	1	0–0.9
<i>Polygonum aviculare</i> L.	Prostrate knotweed	1	0–1.1	—	—
<i>Polygonum</i> L. spp.	Smartweed, knotweed	1	0–0.9	1	0–0.5
<i>Portulaca oleracea</i> L.	Common purslane	—	—	1	0–2.2
<i>Potentilla norvegica</i> L.	Rough cinquefoil	—	—	1	0–0.5
<i>Puccinellia lemmonii</i> (Vasey) Scribn.	Lemmons alkaligrass	—	—	5	0–1.6
<i>Puccinellia</i> Parl. spp.	Alkaligrass	1	0–1.7	6	0–1.6
<i>Rorippa curvisiliqua</i> (Hook.) Besser ex Britton	Curvepod yellowcress	2	0–2.0	—	—
<i>Populus</i> L. spp.	Poplar	1	0–1.6	4	0–1.3

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Weed species	Common name	Colonial --- bentgrass ---		Creeping --- bentgrass ---	
		F ¹	Range ² (%)	F ¹	Range ² (%)
<i>Rorippa palustris</i> (L.) Besser	Western yellowcress	19	3.8–23.0	17	0–8.8
<i>Rumex acetosella</i> L.	Sheep sorrel	5	0–7.7	—	—
<i>Rumex</i> L. spp.	Dock	1	0–0.7	2	0–0.5
<i>Sairocarpus pusillus</i> (Brandege) D.A. Sutton	Lesser snapdragon	2	0–1.7	5	0–0.9
<i>Senecio vulgaris</i> L.	Common groundsel	15	0–7.6	18	0–2.8
<i>Sherardia arvensis</i> L.	Field madder	1	0–1.4	—	—
<i>Silene armeria</i> L.	Sweet-William catchfly	1	0–0.8	—	—
<i>Silene</i> L. spp.	Catchfly	1	0–1.6	1	0–0.4
<i>Sisymbrium altissimum</i> L.	Tumble mustard	—	—	6	0–1.1
<i>Sisymbrium officinale</i> (L.) Scop.	Hedge mustard	2	0–1.0	1	0–0.4
<i>Solanum</i> L. spp.	Nightshade	1	0–1.9	—	—
<i>Solanum villosum</i> Mill.	Hairy nightshade	—	—	1	0–0.4
<i>Sonchus asper</i> (L.) Hill	Spiny sowthistle	4	0–2.4	3	0–0.8
<i>Sonchus oleraceus</i> L.	Annual sowthistle	1	0–1.6	—	—
<i>Spergula arvensis</i> L.	Corn spurry	—	—	1	0–0.3
<i>Spergularia rubra</i> (L.) J. Presl & C. Presl	Red sandspur	14	0–4.6	3	0–1.8
<i>Sporobolus</i> R. Br. spp.	Dropseed	1	0–5.2	4	0–0.7
<i>Stellaria media</i> (L.) Vill.	Common chickweed	4	0–2.0	1	0–0.9
<i>Thlaspi arvense</i> L.	Field pennycress	1	0–0.8	—	—
<i>Trifolium aureum</i> Pollich	Hop clover	2	0–0.8	—	—
<i>Trifolium</i> L. spp.	Clover	1	0–1.0	—	—
<i>Trifolium pratense</i> L.	Red clover	1	0–0.8	—	—
<i>Trifolium repens</i> L.	White clover	1	0–1.0	1	0–0.3
<i>Triodanis perfoliata</i> (L.) Nieuwl.	Venus lookingglass	2	0–1.5	—	—
<i>Vaccinium</i> L. spp.	Blueberry	1	0–3.9	2	0–2.2
<i>Ventenata dubia</i> (Leers) Coss.	Ventenata	7	0–2.6	—	—
<i>Verbascum thapsus</i> L.	Common mullein	1	0–1.9	6	0–1.8
<i>Veronica</i> L. spp.	Speedwell	15	0–13.3	16	0–6.5
<i>Veronica peregrina</i> L.	Purslane speedwell	—	—	3	0–0.9
<i>Viola cornuta</i> L.	Viola	1	0–0.9	—	—
<i>Vulpia myuros</i> (L.) C. C. Gmel.	Rattail fescue	16	0–11.0	10	0–4.8

¹F = Frequency of occurrence (years out of 19)

²Range = Percentage of seed lots contaminated within a year

Table 2. Percentage of seed lots of colonial bentgrass or creeping bentgrass with ergot (*Claviceps purpurea*) or seed gall nematode galls (*Anguina agrostis*) in 2002–2012.¹

Year	----- Colonial bentgrass -----		----- Creeping bentgrass -----	
	Ergot	Seed gall	Ergot	Seed gall
----- (%) -----				
2002	53.3	3.3	16.8	0
2003	44.2	7.8	23.9	0
2004	42.5	1.6	19.7	0
2005	42.3	7.7	22.2	0
2006	57.0	9.7	20.1	0
2007	54.5	6.9	18.6	0
2008	40.7	1.9	30.0	0
2009	66.7	10.0	25.7	0
2010	77.4	14.5	16.2	0
2011	75.0	20.6	28.3	0
2012	87.3	29.1	47.9	0

¹Percentage of total seed lots within each year.