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Perennial Ryegrass Seed Production in Western Canada

Perennial ryegrass (*Lolium perenne* L.), also known as English ryegrass, is one of the most important forage and turf grasses in the world.

It is particularly well suited as a pasture grass because it grows quickly, is high yielding and produces high-quality palatable forage. It can also be harvested for silage and makes good dairy-quality silage when harvested at the early boot stage. The use of perennial ryegrass as a turfgrass has increased worldwide in recent years as more persistent turf types have been developed.

Description

Perennial ryegrass is used throughout the world because of its valuable characteristics including high, excellent quality forage yields, long season production, rapid germination and adaptation to many climatic conditions.

Perennial ryegrass is a bunchgrass and has a shallow fibrous root system; the majority of roots occur in the top 15 cm of soil. Despite the lack of rhizomes, perennial ryegrass tillers freely and forms a dense sod.

The leaves are dark green, dense, glossy and folded when young. The leaf blades are short and narrow. Auricles are short or absent. The stems are 30 to 60 cm tall and end in a slender, stiff spike that can be up to 30 cm long.

Perennial ryegrass is cross-pollinated and self-incompatible, and will readily cross with fescue species such as meadow and tall fescue. There are diploid and tetraploid varieties and a wide range in plant maturity and persistence.

Tetraploid varieties have larger seeds (about 40% larger) than diploid varieties.They also have larger, wider and darker leaves, fewer but more robust tillers and a more open growth habit. The diversity in seed size within and between genetic types (diploid and tetraploid) and cultivars is large. The 1000-seed weight for a single cultivar may have a range of 1 to 4 g.

Adaptation

Perennial ryegrass is considered a short-lived, cool-season perennial under western Canadian conditions and is less tolerant of freezing temperatures than fescues, timothy or orchardgrass. Periods of warm weather in winter often reduce cold tolerance, especially in plants that do not achieve a high level of dormancy.

The main areas of adaptation for perennial ryegrass are the moister parts of the grey-wooded and black soil zones (Figure 1) and the irrigated areas of southern Alberta (Figure 2), Saskatchewan and Manitoba. Perennial ryegrass may winterkill when winter onset is rapid, dry conditions exist, there is no snow-trap or plant dormancy is broken too early.

Figure 1. Perennial ryegrass seed field – Peace River Region

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Figure 2. Irrigated perennial ryegrass seed field in southern Alberta

Although perennial ryegrass has a high moisture requirement it will tolerate ponding only for brief periods. Perennial ryegrass goes dormant in the summer if soil moisture is low. It is not as tolerant of drought or high temperatures as smooth bromegrass, but is more tolerant than timothy. Optimum growth occurs in the temperature range of 20 to 25°C.

Perennial ryegrass is adapted to a wide range of soils, including heavy clay and poorly drained soils, but prefers well-drained soils of medium to high fertility. It tolerates soil pH ranging from 4.5 to 8.4, but the optimum pH for production is in the range of 5.5 to 7.5. Alkalinity tolerance is low, acidity tolerance is high, and salinity tolerance is moderate.

Floral induction and initiation

Most perennial cool-season grasses go through several stages in the initiation and induction of growing points. Initially, after the seed germinates, there is a vegetative or juvenile stage during which the growing points of the grass develop into leaves and stems. These growing points grow vegetatively through spring and summer. In the fall or early winter, there is a response to low temperatures (vernalization) and/or day length (short day). This response induces a tiller to become reproductive and is called primary induction.

Many factors affect the induction of growing points, including plant age, variety, nitrogen fertility, planting date, date of tiller formation, clipping or grazing, stage of plant development, plant spacing and temperature. In perennial ryegrass, heads are larger on tillers formed in the fall than those formed later in the winter or in the following spring.

Secondary induction or floral initiation is the next stage. This stage is affected by timing and environmental requirements. Many cool season grasses such as perennial ryegrass require warm temperatures and long days in the spring for floral initiation and development of the seed head.

Most perennial ryegrass cultivars have an obligatory requirement for a vernalization period (12-16 wks) of cold temperatures (4°C or lower) before long day (>13 h) floral initiation in the spring. Vernalization requirements and critical day lengths for heading are closely related to the geographical origin of cultivars.

The extensive breeding that has been conducted on perennial ryegrass means there is a wide range of heading dates among cultivars. Seed producers should be aware of this factor when selecting a cultivar for seed production. The time between floral initiation and head emergence is 4 to 5 weeks. The growth of the inflorescence and the spikelets is indeterminate, so some florets will be fully developed and others will be empty or sterile.

Anthesis occurs once the flowers have completely developed. Pollen is released from the anthers in the early afternoon and is carried by the wind. The main factors affecting anthesis are temperature and relative humidity. Night temperatures greater than 10°C cause an earlier onset and shorter duration of anthesis. Lower night temperatures decrease both flowering intensity and the number of flowers that open at peak anthesis. High temperatures can cause blasting and poor seed set. Rainfall can have a negative affect on anthesis by causing earlier and shorter duration of anthesis during the day; however, wet weather can extend the total time of anthesis.

Marketing

Contract production

Producers interested in growing perennial ryegrass for seed should be aware of the time and dedication needed to grow a quality product. In western Canada, perennial ryegrass is generally underseeded with a cereal crop and harvested for seed in the second year. The stand is then terminated. There are turf and forage types, with the majority of seed production in North America concentrated in Oregon.

The most recent (2003) information available indicates that Oregon had 167,000 perennial ryegrass seed acres, but acres in the state have been as high as 290,000.

With very little production in Canada at present (Table 1), it is desirable to have a marketing plan or a production contract with a seed company before establishing a seed field. In many cases, a local Canadian processor may act as the agent for the contracting seed company.

Table 1. Pedigreed acres of perennial ryegrass seed production in Canada – 1998 to 2003

Year	PEI	Ontario	Manitoba	Sask	Alberta	BC	Total
1998	152	258	1351	565	984	30	3370
1999	130	401	560	650	2023	285	4049
2000	194	595	7572	2409	1570	225	12565
2001	49	233	6049	1389	959	76	8755
2002	0	152	4517	235	90	12	5006
2003	46	67	6780	680	250	0	7823

Most perennial ryegrass in western Canada is grown under a contract. A production contract is an agreement signed between a seed company and grower where the grower agrees to produce seed of a specific variety or from a specific land area. The seed is sold to the company at a specified price (can be the set price at time of delivery) as long as the seed meets the quality standards outlined in the contract. If the seed does not meet the standards as outlined, the price to the producer will be substantially reduced. Seed produced under contract is generally grown for certified production. Production contracts help ensure the producer's profit potential, but it is very important for producers to fully understand the contract before signing.

Growing perennial ryegrass under production contracts reduces the risk of price volatility in the market, as growers know the price they will receive. A rough estimate of yields and costs are also known, so the grower can estimate the amount of revenue that should be generated by the crop. As a primary quality consideration, the market demands seed free of wild oats and quackgrass.

Pedigreed seed requirements

Producers growing pedigreed seed (Breeder, Foundation or Certified) need to consider certain requirements before establishing a seed field. Two important requirements are the previous crops grown on the land and the isolation distance from other perennial ryegrass varieties. Seed producers should refer to the Canadian Seed Growers Association (CSGA) handbook ***Regulations and Procedures for Pedigreed Seed Crop Production*** Circular 6-94 for details on specific requirements for perennial ryegrass seed production. Perennial ryegrass grown for export may require alternative standards and/or inspection guidelines set by the importing country.

Quality

The price received by the grower for perennial ryegrass seed is determined by the quality of the seed produced. Quality is evaluated in terms of weed seed contamination, germination and purity. Specific weed seeds can cause problems depending on the destination and end use of the final product.

Some of the main weed contaminants that reduce the grade of perennial ryegrass seed are quackgrass, wild oats, foxtail barley and cleavers. Growers must be especially aware of weeds that lead to grade reductions and discounts on seed for both domestic and foreign markets. Seed processors cannot clean out all types of weed seed, particularly those similar in size, shape and weight to the ryegrass seed.

Canadian Seed Growers Association

Figure 3. Perennial ryegrass seed

Varieties

Grower choices will be made on the varieties companies are contracting and the winter hardiness and maturity of varieties being offered. There is a wide range in maturity dates for perennial ryegrass varieties, some maturing 3 to 4 weeks earlier than others. Since most perennial ryegrass will be grown under contract and there are wide variations in seed yield, it is important for the producer to obtain seed yield information on any proprietary variety before entering into a contract.

The Western Canadian Grass Seed Testing program, an industry-sponsored testing program, can be a source of yield information for some perennial ryegrass varieties. The latest information can be accessed from the internet at: http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/for7820?opendocument

Field selection

Perennial ryegrass should be established on level to gently sloping land to minimize run-off and water erosion. As well, a flat field will usually result in more uniform crop maturity. Avoid rocky areas and areas contaminated with weed seeds by run-off water. According to the CSGA ***Regulations and Procedures for Pedigreed Seed Production***, crops planted with breeder, foundation or registered seed for certified status must not be grown on land that grew a crop of the same crop kind in any of the preceding two years.

Weeds

Perennial ryegrass must be established in fields free of perennial weeds and other volunteer grass crops. There is zero tolerance for seed of quackgrass and wild oats in perennial ryegrass seed, and producers are encouraged to adopt a zero tolerance program for dealing with all weeds. Seed of other weeds such as foxtail barley, Canada thistle, perennial sow-thistle, Persian darnel, annual bluegrass, rough bluegrass and downy brome are difficult to remove by cleaning. Most perennial weed problems can be managed by applying glyphosate pre-harvest or by fall, spring and/or chemical fallow for several years before seeding perennial ryegrass. Even moderately weed-infested fields should not be used for establishing perennial ryegrass for seed.

Herbicide residues

It is important to know the cropping history and associated cultural practices of the site. Previously applied residual herbicides can seriously affect grass seedlings. Table 2 outlines herbicides that may be of concern when seeding perennial ryegrass. The level of herbicide residue depends on the soil type, moisture, organic matter and pH.

To avoid problems, read the herbicide label for current, detailed information on grass cropping restrictions. Keep detailed field records and plan crops to avoid seeding perennial ryegrass into soils with injurious levels of herbicide residues. Before leasing or purchasing land, obtain a record of the herbicides used during the past five years. The lease should also include a statement regarding liability if a herbicide residue is found.

Establishment

Seedbed preparation, seeding depth and seeding rates

A fine, firm seedbed is the key to successful perennial ryegrass establishment with a zone of 5 to 8 cm free of large lumps and air pockets. When a seedbed is properly packed, tractor tire marks will be barely visible. A firm seedbed allows for a shallow, uniform seeding depth and ensures the seed has close contact with soil moisture resulting in rapid germination and early seedling root growth.

Seedbed preparation in the previous fall or very early in the spring promotes the germination of some weed seeds and reduces soil moisture losses from excessive cultivation. Perennial ryegrass and the companion crop can be seeded one to two weeks after the last spring cultivation and sprayed with a glyphosate product before seedling emergence. Direct seeding into crop stubble also works well.

Table 2. Grass cropping restrictions for currently used herbicides

Herbicides	Grass cropping restrictions
Absolute Ally Assert Escort Muster Muster Gold Odyssey Prism Pursuit Pursuit Ultra Unity	Seedling grasses may be affected for one or more years after application. Conduct a field bioassay (a test strip grown to maturity) the year before planting grass. The yield from the test strip should be compared to the yield from an adjacent untreated area.
Atrazine/Laddok Primextra II Magnum Princep Nine-T	May cause severe injury to grass one or more years after application.
Banvel II	Grasses may be affected if high rates were used for perennial weed control the previous year.
Edge Fortress Treflan/Rival/ Bonanza/Advance/ Heritage	Grasses should not be grown in the year following a treated crop. High application rate caused by overlapping improper calibration or non-uniform application may reduce grass stands the following year. Drought conditions in the year of treatment may result in higher levels of carryover into the next year.
Sencor	Grasses should not be grown for 24 months following application on irrigated alfalfa.
Sundance Everest K2	Do not plant for at least 22 months following application. A field bioassay must be conducted the year prior to planting grasses to confirm crop safety.
Tordon 22K	When applied as a spot treatment on crop land, Tordon 22K may persist in the soil for up to five years and prevent the establishment of grasses in these spots. Manure from vegetation treated with Tordon 22K should not be applied to sensitive crops such as grasses.
Velpar	Seeding is not recommended less than 24 months after the last Velpar application.

(Refer to the latest Alberta Agriculture, Food and Rural Development publication *Crop Protection*, Agdex 606-1, Saskatchewan Agriculture, Food and Rural Revitalization *Guide to Crop Protection*, Manitoba Agriculture, Food and Rural Initiatives *Guide to Crop Protection* or the herbicide label for specific recommendations).

Soil tests should be conducted to determine nutrient requirements for fertilizers that can be applied before final seedbed preparation. Producers should fertilize for the companion crop in the spring of the establishment year, but ensure that adequate amounts of phosphorus, potassium and sulfur are available for the subsequent perennial ryegrass seed crop.

Perennial ryegrass can be seeded using conventional seeding equipment such as air seeders, air drills, press drills and hoe drills. Use equipment that will provide good seeding accuracy and depth control. Packer wheels increase seed-to-soil contact to enhance moisture availability.

Perennial ryegrass should be seeded no deeper than 1.3 to 2.5 cm (0.5-1 in), with the deeper depths used on light textured sandy soils. Seeding rates used in Alberta range from 4-6 kg ha^{-1} (50 seeds/m row). In Saskatchewan, a seeding rate of 8 kg ha^{-1} produced higher seed yields than either 4 or 12 kg ha^{-1} under irrigation.

Companion cropping, row spacing and seeding date

Perennial ryegrass requires the equivalent of one season's growth before producing seed and generally establishes better when seeded early in the growing season. The time of seeding depends on factors such as the availability of soil moisture for germination and early seedling growth, when soil temperatures reach 4 to 7°C and pre-seeding weed control has been completed.

Under western Canadian conditions, perennial ryegrass is treated as a biennial, and spring establishment with a companion crop is a recommended practice. Seedlings established under a companion crop are physiologically younger than those in straight-seeded stands, resulting in less vegetative matter to serve as a home for disease and insects in the stand going into winter.

Row seeding generally results in higher seed yields than solid seeding, and optimum row spacing varies, depending on moisture availability and machinery capabilities. Row spacings less than 20 cm (8 in) can be used, as only one seed crop is being harvested.

Research in southern Alberta indicates that higher grass seed yields are generally obtained using a cereal companion crop, harvested either for silage or grain, under irrigation than from a straight-seeded stand (Table 3). Winter survival of perennial ryegrass seeded with a companion crop was better than a straight-seeded stand because the seedlings enter winter better protected by the snow trapped in stubble than the exposed straight-seeded stands.

Perennial ryegrass can be established in standing or worked stubble after a silage or grain harvest provided sufficient moisture is available for seedlings to grow into the fall. The stand should be seeded around mid-August and no later than September 1. Generally, this approach will ensure adequate seedling development (3-5 leaves) before fall dormancy occurs, to allow successful overwintering. The effect of late seeding dates on seed yield is shown in Table 4.

Table 4. Effect of seeding dates on the mean seed yield (kg ha^{-1}) of irrigated perennial ryegrass grown at two locations in southern Alberta, 1998-1999.

		Seed yield	
Tillage	**Seeding date**	**Bow Island**	**Brooks**
No-till	August 15	1630	1640
	September 1	1300	1290
	September 15	240	280
Tilled	August 15	1510	1200
	September 1	1260	1310
	September 15	80	320

Seed yields of three diploid perennial ryegrass varieties tested in the Peace River region were 340, 640 and 780 kg ha^{-1} following establishment with a barley companion crop harvested for grain. There is great variation among varieties for seed yield, and it is important to use local performance information to select appropriate varieties.

Table 3. Seed yield (kg ha^{-1}) of perennial ryegrass seeded using different establishment methods at two irrigated locations in southern Alberta, 1998-2000

	Bow Island				Brooks			
Seeding method	**1998**	**1999**	**2000**	**Mean**	**1998**	**1999**	**2000**	**Mean**
Spring/straight-seeded	1430	1720	2210	1790	690	1960	1170	1270
Spring/barley for grain	1610	2530	2240	2130	1000	1310	1540	1280
Spring/barley for silage	1570	2380	2720	2220	1170	1910	1690	1590
Mid-summer/straight-no till	1170	1920	2230	1780	600	1460	1460	1180
Mid-summer/straight-tilled	1150	2080	2570	1930	840	1440	1450	1240

Figure 4. Perennial ryegrass established with wheat

Figure 5. Spring emergence of perennial ryegrass established the year before with a barley crop

In Saskatchewan, spring seedings of straight-seeded perennial ryegrass were not reliably winter hardy, and seed yields of surviving stands were only marginally economic (Table 5). Establishing perennial ryegrass in the spring with a companion crop improved both winter hardiness and subsequent seed yields. August seedings under irrigation overwintered better and produced higher seed yields than spring straight-seeded stands.

Table 5. The effect of seeding time and companion crop on the seed yields (kg ha^{-1}) of Norlea perennial ryegrass at Outlook, Saskatchewan under irrigation.

Companion crop	Seeding time - 1996	Seed yield - 1997
None	May	380
Flax	May	450
Wheat	May	420
None	August	570
Mean		**410**

Under dryland conditions in Saskatchewan, August seedings of perennial ryegrass usually failed to establish due to insufficient moisture. At Melfort, Saskatchewan, spring seedings under a barley companion crop produced thicker stands and considerably higher seed yields than spring straight-seedings.

Establishment trials conducted by the University of Manitoba at Carmen compared perennial ryegrass fall-seeded into wheat stubble to a spring straight-seeded stand or with a wheat companion crop. Yields were highest for the fall-seeded crop, and yields for both the straight-seeded and companion crop treatments were relatively the same.

In summary, the optimal establishment method for perennial ryegrass in western Canada is spring seeding with a companion crop. A cereal companion crop harvested for silage rather than grain will usually result in higher perennial ryegrass seed yields the following year. The next best option for producers is to straight-seed perennial ryegrass into standing or worked stubble of a harvested annual crop no later than September 1.

Weed control in year of establishment

Weed control is essential to the successful establishment of a perennial ryegrass stand. Methods of control include cultivation, mowing, herbicides and roguing. A shallow cultivation before seeding will control some weeds. Maintaining a clean, tilled or mowed field border will assist in preventing weed seeds, rhizomes and roots from moving into the seeded field. Mowing perennial grasses and weeds around sloughs, shelterbelts, fencerows, drainage areas and roadsides will also help prevent seeds from contaminating the grass stand. Off-type plants and weeds within rows can be removed to reduce contamination and maintain seed quality.

Several herbicides are available as an alternative to cultivation before or just after seeding. Glyphosate will control the early emerging weeds to give a competitive advantage to the crop. If applied after seeding, glyphosate needs to be sprayed before perennial ryegrass seedling emergence (no later than 5 days after seeding).

There are very few products registered for use on seedling (plants within 3 months of emergence) perennial ryegrass, but trials conducted in western Canada have shown that there are a number of potential herbicides (Tables 6 and 7). Some herbicides should not be used on seedling perennial ryegrass. Herbicides are usually applied on seedling grasses at the 2 to 4 leaf stage, which is crucial for crop safety and for preventing reductions in future seed yields.

Herbicide selection is based on several criteria:

- weeds present
- effectiveness of the herbicide on these weeds
- tolerance of seedling perennial ryegrass to the herbicide
- companion crop tolerance
- cost of the herbicide

Only herbicides that are registered can be recommended for use. Refer to the latest Alberta Agriculture, Food and Rural Development publication *Crop Protection*, Agdex 606-1, Saskatchewan Agriculture, Food and Rural Revitalization *Guide to Crop Protection*, Manitoba Agriculture, Food and Rural Iniatives *Guide to Crop Protection* or the herbicide label for specific recommendations.

Table 7. The effect of herbicides on seedling perennial ryegrass

Currently registered	Potential for a minor use registration	May cause severe injury
2,4-D	Assert*	Accent
MCPA	Attain	Achieve
	Banvel II	Ally
	Buctril M	Assure
	Curtail M	Edge
	Frontline	Everest
	Lontrel	Horizon
	Prestige	Poast Ultra
	Puma Super	Prism
	Spectrum	Refine Extra
		Select
		Sundance
		Treflan/Rival
		Venture

* Minor use registration application submitted

Table 6. Grass seed yields after spraying seedling perennial ryegrass with various herbicides

Herbicide	Average % yield of the untreated check seed yield	
	1 x recommended rate of herbicide	2 x recommended rate of herbicide
Puma Super	102 (7)*	86 (7)
Puma Super + 2,4-D ester	111 (6)	120 (6)
Puma Super + Buctril M	103 (6)	106 (6)
Assert	102 (7)	106 (7)
Assert + 2,4-D ester	116 (6)	116 (6)
2,4-D ester	100 (4)	113 (5)
Buctril M	103 (6)	114 (6)
Banvel II	110 (3)	99 (3)
Banvel II + 2,4-D amine	99 (5)	
Attain	126 (5)	122 (5)
Prestige	117 (7)	142 (2)
Spectrum	111 (1)	91 (1)
Ally	67 (4)	
Everest	0 (1)	

* Number of trial sites included in the average % yield. Trials conducted at Beaverlodge, Edmonton and Brooks, AB, Melfort and Outlook, SK, and Arborg, MB, from 1997 to 2002.

Irrigation

When perennial ryegrass is seeded with a companion crop, producers need to irrigate for the companion crop and ensure surface soil moisture is maintained. After the grain or silage is harvested, continue to apply adequate water to the perennial ryegrass to promote strong seedling growth throughout the fall period.

In perennial ryegrass fields that are straight-seeded after a grain or silage crop, frequent light sprinkler irrigations during establishment will ensure that adequate moisture is available for germination and seedling growth, and will reduce soil crusting. During periods of high evaporation, irrigation intervals of 3 to 4 days may be needed until the grass is 10 cm (4 in) high, after which, intervals can be longer.

Fall stand maintenance

After the cover crop has been harvested, spread the chaff and remove the straw from the field. Burning straw is not advised as this practice could severely damage the seedlings. The final fall irrigations should provide adequate water to maintain soil moisture at the highest field capacity possible going into winter.

Winter survival of perennial ryegrass established with a cereal crop is generally higher than a straight-seeded stand. The standing stubble (10-15 cm, 4-6 in) traps snow providing protection for the young seedlings.

Dr. Nigel Fairey, Agriculture and Agri-Food Canada, Beaverlodge, AB

Figure 6. Perennial ryegrass research plots in early summer the year after establishment with a barley crop.

Fertilization

Soil tests should be taken to determine the nutrient status of the field after the companion crop has been harvested. As floral initiation takes place in spring, fertilizer nutrients are more effective if they are available to the crop soon after spring thaw. Late fall applications (late October to early November) have been successful, as this method ensures nutrients are available to the plant in early spring, while spring weather conditions can sometimes delay spring fertilizer applications. Also, fertilizer is generally cheaper in fall than in spring.

At Brooks, the effect of various rates of nitrogen applied as ammonium nitrate (34-0-0) on perennial ryegrass seed yield was assessed under irrigation (Table 8). There were no significant differences in seed yields for the different rates, but 100-125 kg ha^{-1} of nitrogen are suggested to be applied in the late fall. This approach would ensure adequate nitrogen availability to offset any possible leaching during spring thaw or from heavy spring rains. In the Peace River region, a general recommendation would be to apply 70 to 100 kg ha^{-1} of nitrogen in October.

Form of nitrogen application

Care must be taken in choosing what form of nitrogen to use because most of the fertilizer applied to perennial ryegrass stands is broadcast. Ammonium nitrate (34-0-0) is the preferred choice over urea (46-0-0) for broadcast applications because urea has a greater potential for losses through gassing off (volatilization). Slow-release urea fertilizers may reduce these losses.

The risk of nitrogen losses when using urea is greatest for soils that are sandy with high pH. High urea losses can also occur when there are high winds, high levels of surface residue, wet soil surfaces and soil temperatures above 10°C.

Conditions favorable for using urea fertilizer are a dry, unfrozen soil surface with rainfall or snow occurring shortly after application to move the urea into the soil and prevent losses to the air. Some producers apply urea on top of several inches of snow when the ground is not frozen and the snow is expected to melt.

Fertilizer should not be applied on top of frozen ground covered with several inches of snow, as these conditions would prevent the fertilizer from moving into the soil, making it susceptible to run-off in the spring.

Table 8. Effect of fall-applied nitrogen fertilizer rates on seed yield (kg ha-1) of irrigated perennial ryegrass at two sites in southern Alberta, 1998-2000

	Bow Island			Brooks			
N rate (kg ha^{-1})	1998	1999	2000	1998	1999	2000	Mean
75	940	1840	2490	960	1750	1950	1650
100	980	1760	2300	900	1770	1840	1600
125	1220	2090	2110	1050	1770	1640	1640
150	1240	1940	2130	1030	1470	1880	1620
175	1220	2070	2340	950	1650	1770	1660

Stand management during the seed production year

The major factors affecting seed yields of perennial ryegrass are the timing and amount of irrigation water, timing and method of weed control, soil fertility levels and weather. Extremes of high or low temperature during flowering may reduce seed yields irrespective of stand management.

Irrigation

Early spring moisture is necessary for early vigorous stand growth, and producers should begin irrigating as early as possible to ensure high field moisture capacity. Another critical time for adequate irrigation is from just before flowering until pollination is completed. Inadequate moisture at this time will result in reduced seed yields. Producers should irrigate at or before the boot stage and until after flowering.

Irrigation frequency will depend on the soil type, temperature, rainfall and wind. Irrigate early to avoid excess irrigation later when lodging can be a problem and mold could occur under the lodged canopy, especially on heavy soils. Total moisture consumption, (including precipitation) until the end of August will range from 55 to 65 cm (22-26 in).

Water penetration to 60 cm (24 in) indicates that an adequate amount of water has been applied. Uniform irrigation will promote uniform seed ripening, but too much soil moisture could delay seed maturity. As soil moisture declines, seed matures rapidly, and seed maturity should be monitored to avoid losses due to shattering. Late season drydown facilitates harvest and minimizes regrowth into the swaths.

Weed control for established perennial ryegrass

Weed control is essential to produce high quality perennial ryegrass seed. This control will depend on how clean the field was before seeding, stand establishment, row spacing, fertility and the choice of in-crop herbicides. Wild oat and quackgrass are the main weeds of concern for export markets; however, Canada thistle, narrow-leaved hawk's-beard, cleavers and foxtail barley are also common problem weeds found in established perennial ryegrass crops. Hand rouging and/or spot spraying of grassy weeds may be required.

Herbicide selection will depend on the weeds present, tolerance of the perennial ryegrass, stage of the crop, cost and rotation of herbicide groups. Some damage from a herbicide application may be acceptable to a producer if the application controls troublesome weeds that could result in a loss of grade.

Table 9 provides an indication of the tolerance of established perennial ryegrass to a number of grassy weed and broad-leaved weed herbicides. The higher the number of trial sites, the more confidence that can be put in the seed yield information provided.

Table 10 lists the herbicides currently registered for use on established perennial ryegrass, the herbicides causing slight to moderate injury and the herbicides causing severe injury to established perennial ryegrass in research trials, usually applied in the spring before the shot blade stage. **Only herbicides that are registered can be recommended for use**.

Table 9. Seed yields after spraying established perennial ryegrass with various herbicides

Herbicide	Average % yield of the untreated check seed yield	
	1 x recommended rate of herbicide	2 x recommended rate of herbicide
Puma Super	102 (5)*	91 (5)
Puma Super + 2,4-D ester	103 (4)	97 (4)
Puma Super + Buctril M	90 (4)	90 (4)
Assert	93 (5)	80 (5)
Assert + 2,4-D ester	95 (4)	76 (4)
2,4-D ester	108 (2)	111 (4)
Buctril M	100 (2)	101 (4)
Banvel II	116 (2)	109 (2)
Attain	115 (5)	107 (5)
Prestige	105 (4)	107 (3)
Spectrum	121 (1)	102 (1)
Refine Extra	20 (1)	12 (1)
Everest	8 (1)	

* Number of trial sites included in the average % yield. Trials conducted at Edmonton and Brooks, AB, Outlook, SK and Arborg, MB from 1997 to 2002.

Table 10. The effect of herbicides on established perennial ryegrass

Currently registered	Potential for a minor use registration	May cause moderate injury	May cause severe injury
2-4 D	Attain	Assert	Achieve
MCPA	Banvel II	Avenge	Ally
	Buctril M		Assure
	Curtail M		Everest
	Frontline		Horizon
	Lontrel		Poast Ultra
	Prestige		Refine Extra
	Puma Super		Select
	Spectrum		Sundance
			Venture

Diseases

Stem rust (*Puccinia graminis* Pers.) can reduce seed yield of perennial ryegrass in some years. The fungicide Headline (pyraclostrobin) provides control of stem rust and powdery mildew (*Erysiphe graminis* DC.). A second application may be required about 6 weeks after the initial application. Fortunately, the pathogen that causes stem rust rarely (if ever) overwinters in Canada, so a field that has a stem rust epidemic in one year is not a source of inoculum for subsequent crops.

Ergot (*Calviceps purpurea*) infects a wide range of grass species when cool wet conditions occur during flowering. The disease can spread rapidly from inflorescence to inflorescence. Dark ergot bodies are produced in infected florets, which contaminate seed lots and can be very difficult to remove. The only effective control is to mow grasses in headlands and ditches adjacent to the seed field before heading to remove the heads from grassy weeds, which can be a source of inoculum for the seed crop.

Snow molds can cause problems in perennial ryegrass if fall growth is excessive and not removed or when snow accumulates before the soil has frozen. Crop rotations in which there are at least 3 years of annual crops prior to the grass crop will minimize disease risk.

Insects

There are no specific insect pests of perennial ryegrass in Canada, but the crop is susceptible to most of the insects that feed on cool season perennial grasses. Insect problems arise occasionally when conditions are ideal for outbreaks. The same insects that can cause damage in turf and pasture will cause damage in grass seed crops.

Grasshoppers are a chronic pest of grass seed crops, consuming leaves, stems and seed heads. Damage to the grass crop in the establishment year can result in total destruction, and the crop may require reseeding. Even a well-established grass seed field can be severely damaged by grasshoppers if feeding pressure is high. Provincial governments issue annual grasshopper forecast maps predicting grasshopper infestations for the following year.

Warm, dry weather in spring and early summer enhances the survival of grasshopper nymphs, increasing the likelihood of crop damage. Planting non-preferred crops such as oats in wide strips around the edge of a field may deter grasshoppers from moving into that field. Alternatively, leaving a 5 m (16 ft) fallow strip around the field may delay migration into the field. If the source of grasshoppers is known, controlling them in the areas where they hatch may be an option if the hatch sites are not ecologically sensitive. An insecticide application should be made at about the time that the nymphs reach their third instar, when they are 12 mm (0.5 in) long, as the hatch is usually completed.

Use of bran bait rather than a foliar insecticide will decrease contact of the insecticide with non-target species. However, under extreme feeding pressure, bran bait may not keep damage below threshold levels. Economic thresholds depend on the expected price of seed, the projected cost of control and the amount of crop damage a given population of grasshoppers can cause; 10 to 20 grasshoppers/m^2 are a rough estimate of economic threshold in forage grasses. Under extreme outbreaks, repeat applications of insecticide may be necessary.

Cutworms are another general pest of grass crops. Some, such as the army cutworm, feed on foliage above ground, while others, such as the red-backed cutworm and glassy cutworm, sever plants at or below the soil surface. Most cutworm species in western Canada have one generation/year. Wilted, severed, missing or heavily defoliated plants are characteristic of cutworm injury.

Weather or natural enemies, including predators, parasites and diseases, usually control cutworms. In an establishment year, cultivation of the field in early spring and then delaying seeding for several weeks may help to decrease cutworm damage. If extensive damage occurs, application of an insecticide in the evening when these insects are most active may be warranted. Special care should be taken to treat the interface between damaged and undamaged areas of the field.

Sod webworms are small moths, the larvae of which overwinter in soil. Young larvae feed only on leaves and stems, while older larvae construct tubular webs or tunnels several cm long in the thatch, emerging at night to feed on grass leaves and shoots. Webworm moths fly erratically low to the ground, generally in late afternoon or evening, from June-August. Parasitism rates can be high following outbreak years.

White grubs, the larvae of several species of scarabaeid beetles, feed on the roots of all commonly grown turfgrasses and can occasionally infest forage grasses. They are considered the most important insect pests of cool season grasses in the United States. Larvae are variable in size, with cream-coloured bodies and dark heads; they typically curl into a C shape when disturbed. Heavily infested grass crops develop irregular patches that can be lifted and rolled back like a carpet. Root pruning that does not kill plants outright may make the plants more susceptible to stress from drought.

White grubs are difficult to control with insecticides because the chemical must penetrate the thatch and soil to be effective. Irrigation, use of high water volumes when spraying or rain after insecticide application will wash the insecticide into the soil and may increase efficacy of the treatment.

Some cultivars of perennial ryegrass contain symbiotic fungal endophytes (*Neotyphodium lolii*) that improve the tolerance of the grass to insects and other stresses. Foliar feeding by sod webworms, bill bugs, chinch bugs, fall armyworm and several species of aphids has been dramatically reduced in turf-type perennial ryegrass with enhanced levels of endophytic fungi. Endophyte-induced compounds are also harmful to livestock, so their presence in forage ryegrasses should be monitored.

Perennial ryegrass may infrequently show symptoms of silvertop, whereupon the plant appears healthy, but the seed head is bleached and sterile. Once silvertopped heads appear, there is nothing that can be done to alleviate the condition in that season. Silvertop has been associated with many insect species, but the condition may be a generalized response by the plant to stress.

Harvesting

Generally, grasses require about 30 days from flowering to seed maturity (Figure 7). This period varies because flowering and seed development can last from several days to 2 weeks resulting in seed heads emerging at different times and not ripening uniformly. Hot, dry weather reduces ripening time, and cool, moist conditions delay seed maturity.

Figure 7. Perennial ryegrass seed heads

There is a wide range of maturities in perennial ryegrass varieties, and the crop will be ready to swath anywhere from mid-July to mid-August. The crop should be green to slightly green, and seed heads should have a brownish tinge to them. Seeds will be in the hard-dough stage.

Perennial ryegrass is generally swathed as the risk of shattering is quite high. At swathing, seed head moisture content should be between 40 to 45 per cent. Perennial ryegrass does not ripen evenly, and the producer must constantly monitor fields near swathing time, as the crop can lose 2 to 3 per cent moisture per day under good weather conditions. Cutting too early will prevent proper seed development and increase dockage, while swathing too late will significantly increase seed shattering. In either case, yield losses will occur.

Moisture testing can help the producer determine when to swath. To conduct a moisture test, collect a representative sample of seed heads from the field, usually in mid-afternoon. The sample must be weighed and dried down until all the moisture is removed.

Dry the sample by using a conventional home oven set at 82°C (180°F) for 4 or more hours. If using a microwave oven, place the sample in the oven along with a cup of water. This approach will prevent the sample from burning and causing damage to the oven. Dry the sample for 5 minutes, weigh it and then dry the sample for an additional 2 to 3 minutes. Weigh the sample again and continue with this process until the weight remains constant. Use the following formula to calculate percent moisture: 100 x (wet weight - dry weight)/wet weight. An accurate scale must be used when weighing samples.

Producers also use other methods to determine when to swath:

1. when a handful of seed heads are gently tapped on the palm of the hand and the seed shatters, then swathing should begin immediately
2. when seed heads are roughly struck against the palm of the hand and the seed shatters
3. if a seed head is pulled between the thumb and finger and there is 5 to 10 per cent loose seed
4. when 75 per cent of the seed heads have matured

Stands can become lodged, so a pickup reel, sharp knife and snub-nosed guards are useful when swathing. Some producers use a disc-bine to cut their crop. To ensure the air gap between the rollers is the same, adjust the stop bolt to push the conditioner arm open, which allows the rollers to widen to about 4 to 5 cm (1.5-2 in) apart. With sharp knives, the crop can be cut at a speed of 6 to 7 mph. Windrow shields should be set to form a swath about 1.2 m (4 ft) wide. Regardless of the machine used, the best time to swath is either in the morning or at night, as dew will minimize shattering.

Swaths can generally be combined 7 to 10 days after cutting, depending on weather conditions. Harvesting at a seed moisture content of 16 to17 per cent will reduce seed loss from shattering, but the seed must then be dried immediately to 12 per cent.

A properly adjusted combine is essential to produce maximum yields and high seed quality. Combine settings can also be used to help improve the chances of removing unwanted weed seeds such as wild oats, quackgrass and cleavers at the seed cleaning plant. Proper combine settings will vary from day to day, as well as during the day, depending on weather and moisture conditions of the swaths and seed.

When combining perennial ryegrass, set the combine as you would for barley, but with a very low air fan speed and adjust from this starting point. The clearance between the cylinder and concave should be adjusted to the point where hard rubbing action occurs, but not to the point of peeling the seed coat. Minimum air should be applied to keep the material flowing over the sieves without coming off the back in bunches. Combining is a slow process as it takes time for the seed to settle out from the straw on the walkers.

A flashlight with a 7.5 to 10 cm (3-4 in) flat lens can be used to check to see if good seed is coming out of the back of the combine. A sample is taken from behind the combine and placed on the lens; the light from the flashlight will show good seed as having a dark spot at the germ end of the kernel. The combine can be adjusted accordingly.

Dockage is generally around 20 per cent. Lower dockage may be a sign of over-threshing.

Seed drying and storage

Drying the crop in the field is best, but for safe storage and delivery, the seed should be air dried to 12 per cent as quickly as possible. Germination can be damaged very quickly if the seed is not dried down; tetraploid varieties are especially vulnerable. Seed in the bin should be turned to improve air movement and drying effectiveness. Seed can be stored safely in bulk at 10 to 12 per cent moisture or in bags at 12 to 15 per cent moisture. To maintain high germination, store seed under cool, dry conditions.

Post harvest management

Feed value of straw

A subsequent benefit of growing perennial ryegrass seed crops is that seed producers can make use of the straw for livestock feed and possibly fall regrowth for grazing. However, producers must be aware that endophytes may be present in perennial ryegrass turf varieties, so they must understand the effects that endophytes can have on livestock when utilizing straw, fall regrowth or especially seed screenings.

Endophytes are fungi that live within the perennial ryegrass plant. These fungi generally increase the vigor of infected plants by making them more tolerant to drought, insects, diseases, grazing and physical impacts. Turf grass breeders want high levels of endophyte present in the varieties that they develop, as the fungi are very beneficial in a turf stand. On the other hand, breeders developing grasses for forage and livestock production select for low levels or the absence of endophytes.

The endophytes in perennial ryegrass produce a toxin called lolitrem B that is harmful to livestock at high levels. The toxin causes a condition called ryegrass staggers. Symptoms, which include tremors, loss of coordination and eventually falling down, are initially evident only when animals become excited.

Endophyte can only be transmitted in infected seed. A plant without the endophyte cannot become infected even though the plant right beside it may have the endophyte present. Seed can be tested for per cent endophyte before seeding, and seed companies should be able to provide this information.

Knowing endophyte levels in the seed will only provide a guideline as to whether a producer should be concerned or not about the level of endophyte toxin that could show up in straw, regrowth or seed screenings. Endophyte levels in the seed do not always predict what concentrations of lolitrem B will be present in the forage material. However, a seed lot that tests free of endophyte will produce forage that is also free of this fungus.

Feed can be tested for lolitrem B for a fee by sending samples to:

Oregon State University
Veterinary Diagnostic Lab
30th and Washington Way
Magruder Hall
Corvallis, Oregon 97331
Phone: (541) 737-3261

Research conducted at Oregon State University has determined threshold levels of lolitrem B in the diet that can produce clinical disease (Table 11). Keep in mind that threshold levels will vary depending on environmental conditions and the stress levels the animals are under.

Table 11. Threshold levels of lolitrem B in the diet that can produce clinical disease

	Lolitrem B parts per billion (ppb)
Horses	not determined
Cattle	1,800 - 2,000
Sheep	1,800 - 2,000

Seed and seed screenings can contain very high concentrations of lolitrem B. Straw and fall regrowth may contain the toxin, but usually in comparatively minor quantities. Levels of lolitrem B can vary from year to year on the same field or from one field to another even though the same seed source was used, so management and environmental conditions will have an effect on the levels of toxin present.

Generally, higher rates of nitrogen and stress conditions such as drought on the crop will increase the levels of toxin. Feed should be tested if there are any safety concerns regarding endophyte level. Once levels are known, the ryegrass can be mixed with other feed sources to reduce risk.

Taking out the grass stand

Following harvest, the stand has to be prepared for removal. Volunteer perennial ryegrass seed can be a problem in subsequent crops, and some effort may be required to clean the field.

Under irrigation, some producers lightly harrow their fields following harvest and then water well to stimulate growth. The regrowth is sprayed with a glyphosate or other suitable product and either disced late in the fall or the following spring. Some producers spray the perennial ryegrass and direct seed an annual crop in the spring. The use of broadleaf crops provides producers with more herbicide options.

Some preliminary research findings indicate that Horizon will control volunteer perennial ryegrass in wheat and Assure II and Poast Ultra will control volunteer perennial ryegrass in canola, peas and other broad-leaved crops. Volunteer seedlings in subsequent years can be managed through crop rotations and the use of glyphosate, ethalfluralin and other suitable herbicides.

As there is concern with perennial ryegrass developing resistance to herbicides, rotating herbicides and tillage can delay or prevent herbicide resistant perennial ryegrass. The seed viability of perennial ryegrass in the soil declines rapidly, and 2 years out of the rotation should provide adequate time for a producer to consider growing perennial ryegrass in that field again.

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