Evaluation of Selections of Perennial Cereal Rye for Perennial Grain Production in Manitoba

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Introduction

Perennial cereal rye (*Secale cereale* L. x *S. montanum*) was developed in an attempt to produce a perennial cereal crop (Reimann-Philipp 1995). Perennial cereal rye has been suggested as a potential candidate for perennial grain production for western Canada. Jaikumar et al. (2013) found consistent seed yields in the first two harvest years in Michigan. ACE-1 perennial cereal rye was selected for winter-tolerance to western Canadian conditions (Acharya et al. 2004). High reproductive fertility is associated with the annual plant type (Reimann-Philipp 1995), resulting in ergot development and contamination of the seed (Acharya et al. 2004).

Methods and Materials

- Selections made in 2009 from ACE-1 (Acharya et al. 2004) established in 2007.
- Selection for perennial plants with no or reduced ergot infestations.
- Seed was increased in 2010 (open-pollinated).
- Seeds planted in September of 2010 and 2011.
- 20 hills per row, 2 and 4 seeds hill^{-1} in 2010 and 2011, respectively.
- Reduced to one seedling hill^{-1} within 3 weeks of seeding.
- Three heads plant^{-1} were harvested each year.
- 6th, 15th and 24th spikelets used to count florets spikelet^{-1} and to count seeds and ergot bodies spikelet^{-1}
- Sufficient inoculum of ergot exists and after the first year, ergot bodies were found throughout the nurseries each spring Figure 2.
- Remaining seedheads were hand harvested in 2011, 2012 and 2013.
- All heads per plant were counted, threshed, cleaned and weighed.
- Seed yield consistency was calculated for the 2010 seeding as follows:

$$\left\{ \frac{\text{yield year 1}}{\text{yield year 1 + year 2}} \right\} * 100$$

Data was analyzed with PROC GLIMMIX in SAS 9.3 (SAS 2010).

Figure 1. Perennial cereal rye: a scanned image of a typical ergot infestation level found in seed grown in Manitoba.

Figure 2. Ergot bodies on the soil in spring.

Figure 3. The 2010 seeding (foreground) and 2011 seeding (background) in summer of 2012.

Figure 4. First production year of perennial cereal rye at Carman, MB, June 20, 2012.

Results

- Persistence was extremely poor: for the 2010 planting < 15% surviving to two seed harvests and < 6.5% in 2013; 2011 planting < 26% to second harvest.
- 2010 planting 4% averaged greater than 25 g plant^{-1} year^{-1}
- 2% showed yield consistency of 40-60% of the total yield in the first seed harvest.
- Second harvest (2013) from the 2011 seeding is not yet complete.
- As selection was made for perenniality, no advancement was made for Manitoba.
- All plants produced ergot, some > 50%
- Ergot occurrence was negatively correlated to floret fertility (r = -0.35, P = <.001).
- Floret number was inconsistent on individuals across years
- 2010 planting in 2012, all but one spikelet had two florets
- Seed set plant^{-1} ranged between 34 and 50% in the first year of production
- Seed set plant^{-1} ranged between 6% and 42% for second year of the 2010 seeding
- Seed set plant^{-1} ranged from 31% to 55% second year for the 2011 seeding.
- Production year 2012 produced the highest levels of ergot
- ACE-1 was consistently equal to or better than all lines for ergot occurrence.
- Progress was not made using the breeding methodology employed.
- Individual plants have been found can be used for directed crosses in the future.
- Less than 10 plants are deemed acceptable for further study.

Figure 5. A six year-old perennial cereal rye plant.

Table 1. Comparison of harvest year by seeding year interactions between perennial cereal rye lines for reproductive characteristics.

	2010 seeding		2011 seeding	
	1st Harvest	2nd Harvest	1st Harvest	2nd Harvest
Florets – spikelet 6	2.09 a	2.00 b	2.09 b	2.16 a
Florets – spikelet 15	2.18 a	2.01 b	2.15 b	2.25 a
Florets – spikelet 24	2.10 a	2.00 b	2.10 a	2.08 b
Seeds – spikelet 6	0.79 a	0.55 b	0.89 a	0.87 a
Seeds – spikelet 15	0.77 a	0.52 a	1.02 a	1.06 a
Seeds – spikelet 24	0.85 a	0.64 b	1.00 a	0.92 a
Ergot – spikelet 6	0.24 b	0.50 a	0.35 a	0.13 b
Ergot – spikelet 15	0.22 b	0.46 a	0.34 a	0.08 b
Ergot – spikelet 24	0.23 b	0.47 a	0.31 a	0.08 b
Spikelets head^{-1}	34.4 a	33.5 a	35.4 a	27.6 a
Percent Seed	38.1 a	28.4 b	46.0 a	44.4 a
Percent Ergot	10.8 b	23.8 a	16.3 a	5.4 b
Seed less Ergot	27.4 a	5.0 b	29.7 a	39.0 a
Regrowth - October	4.54 a	4.33 a	3.74 a	3.95 a

Means followed by the same letter within harvest columns are not significantly different by LSMeans (p=0.05).

Figure 5. Third production year of 2010 seeding of perennial cereal rye.

Conclusions

- Perennial cereal rye lacks tolerance to Manitoba's climatic conditions.
- < 10% of plants survived a second harvest and only < 10% persisted into a third year of production.
- No morphological traits were significant between annual and perennial plant types.
- Seed fertility and ergot occurrence similar between annual and perennial plant types.

Perennial cereal rye is not a reliable perennial grain for growth conditions found in Manitoba due to poor winter tolerance and high ergot potential.

Literature cited:

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