

Are Higher Seed Yields Possible in Grass Seed Crops?

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Yield Components

- Several seed yield components make contributions to seed yield, but fundamentally, seed yield is composed of just two components: seed number and seed weight.
- The variation in seed number is typically greater than variation in seed weight, which usually varies in a more narrow range.







- Grass seed crops are biologically inefficient in the production of seed.
- Many flowers are produced by grasses yet relatively few of the flowers become seed.
 - Losses due to inadequate pollination and fertilization, seed abortion, and shattering all contribute to reduced seed number.

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Seed Yield Trends in the Willamette Valley



- Are higher seed yields possible for grass seed crops?
- Seed yield trends show that seed yields are increasing over time.
- Growers have adopted better management practices, implemented more timely pest control strategies, and use equipment that is more efficient than in the past.

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Seed Number



Relationship of seed number to seed yield in tall fescue (Huettig et al, 2013).

- Greatest opportunities to enhance seed yield through management is by increasing seed number.
- Seed number is increased by spring irrigation.



Seed Number

• The biggest increases in seed number can be obtained through PGRs and spring N.



Effect of Palisade (TE) PGR rate on seed number in perennial ryegrass (Chastain et al, 2014).



Seed Weight

• Spring nitrogen increases seed weight in grass seed crops.





Spring N effects on seed weight in perennial ryegrass (Chastain et al, 2014).



Seed Weight

• Fungicide application for rust control can increase seed weight.





Effect of a strobilurin containing fungicide on seed weight in tall fescue (Anderson et al, 2014).

Tall fescue stem rust



- **Pollination** is the process of pollen transfer.
- Grass seed crops are wind pollinated.
- They are also cross-pollinated because of high levels of self-incompatibility.
- Pollination is essential to seed production in grass seed crops, reducing pollination results in lower seed number.



Grass pollen (scanning electron micrograph)





- Spikelets release pollen first in the apical part of the inflorescence and then downward from there to the basal part.
- Pollination on an individual inflorescence can be spread over a 4-10 day period.

Spike - a non-branched inflorescence.



- The **stamen** is the male part of the grass floret.
- The upper portion of the stamen is known as the **anther**. The anther is the site of pollen production.
- The lower portion of the anther is known as the **filament** and is the support structure for the anther.
- Anthers start releasing pollen within 10 minutes after the stamen emerges from the floret.

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- Pollination in a grass seed field can be spread out over a 21-day or longer period.
- The maximum pollination is known as peak anthesis.
- Cloudy cool weather can extend the length of pollination while hot, dry weather will shorten the pollination period.
- High rainfall reduces pollen in the air, and can reduce pollination as a result.



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Pollen Viability

- **Pollen viability** measures the ability of pollen to germinate and produce a pollen tube.
- Most grass species produce pollen that is viable for only a few hours while tall fescue pollen can remain viable for up to 48 hours.
- Grass pollen quickly loses viability in high temperatures.
- Viability is highest in the morning and is low in the afternoon.

Effect of temperature on pollen viability (%).

Temperature (°F)	1 hour	2 hour	8 hour
80	50	45	7
90	28	30	3
100	24	15	0
110	10	8	0

PGRs for Lodging Control in Grass Seed Crops



- Stem elongation results from activity of the intercalary meristem. Each internode elongates independently and is promoted by the hormone GA₁.
- When the tiller cannot support the weight of the inflorescence, the tiller lodges or falls to the ground.
 - Lodging restricts pollination and reduces fertilization. Seed filling is reduced due to self-shading of the lodged crop.
- Seed number is reduced by lodging.

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Acylcyclohexanedione PGRs



Trinexapac-ethyl (Palisade)



Prohexadione-calcium (Apogee)



2-oxoglutaric acid

- 2B-hydroxylase OH OH HO ĆO ćo **GA**₂₀ H COOH COOH GA_{29} 2,3-desaturase 3B-hydroxylase OH CO COOH GA5 COOH **GA**₁
- Trinexapac-ethyl (TE) and prohexadione-calcium (PC) plant PGRs are inhibitors of the 3- β hydroxylation of GA₂₀ to GA₁. GA₁ promotes stem elongation, GA₅ promotes flowering, GA₂₉ is inactive.
- The PGRs are structurally similar to 2-oxoglutaric acid, a cofactor in the hydroxylation reaction.

Acylcyclohexanedione PGRs



- While TE and PC shorten stems and reduce lodging, seed yield may be increased even with low incidence of lodging.
- TE and PC increase the efficiency of carbon partitioning to seed.

Acylcyclohexanedione effects

Increased floret number Increased seed set Increased seed number Increased seed yield Increased harvest index Mixed effects on seed weight Decreased stem length Decreased lodging

Acylcyclohexanedione PGRs

• The efficacy of TE and PC applications is influenced by rate, and other factors.

TE effects on perennial ryegrass seed production in 9 years of trials (Chastain et al., 2014).

TE rate (pt/acre)	Seed yield (Ibs/acre)
0	1305 a
1.4	1635 b
2.8	1868 c
4.2	2056 c



Interaction of PGRs and Nitrogen





Stand Age Losses

- Seed yield declines as the stand ages in perennial ryegrass and tall fescue.
- In New Zealand, this stand age loss is avoided in perennial ryegrass as the crop is mostly treated as an annual.
- Maximum effort is made to produce the greatest seed yield in one year.



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Stand Age Losses

- Several factors contribute to the loss in yield as the stand ages.
- Reductions in the number of florets and seeds account for some of the decline in seed yield.
- Declining vigor of the stand with increasing stand age is evident in less water soluble carbohydrate storage in the crown and diminished regrowth of the crop.

Stand Age Losses

- Can PGRs be used to eliminate yield loss as a crop stand ages?
- While increases in seed yield with use of PGRs are consistent, our work in perennial ryegrass and creeping red fescue suggests that it is not possible to erase stand age losses with PGRs.

Effect of PGR and stand age on seed yield in perennial ryegrass (Chastain et al, 2003).



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Seed Shattering

- Pre-harvest seed losses due to shattering are much lower in the cereals than in grass seed crops.
- Shattering reduces seed number.
- Harvest timing strategies using seed moisture as a guide, have shown the best efficacy.
- Even with the best timing, seed shattering is still too high.
- Breeding is likely the best way to reduce shattering in grass seed crops.



Shattered grass seed on the ground



Seed Yield Factors in Perennial Ryegrass



Are higher seed yields possible in grass seed crops?

- Grass seed crops have low efficiency of seed production. Many flowers fail to pollinate or are not fertilized. As a result, seed yield is lower than the potential.
- Seed yield has been increased but further increases are needed to maintain or improve the profitability of grass seed production.
- Management practices such as PGRs, irrigation, nitrogen management, harvest timing, and others can be fine tuned to increase seed yield/profitability.
- Some problems such as shattering are likely best solved by plant breeding.



Tall fescue seed

