Yield Components and Crop Yield

Thomas G Chastain

CROP 200 Crop Ecology and Morphology

What is Crop Yield?

- Crop yield has many definitions, but we are most interested in economic yield.
- Crop yield in the context of this course is weight of harvested economic product per unit area.
- Yield depends on the economic product desired by the producer or by the marketplace:

root	grain	pharmaceuticals
tuber	seed	vegetable
oil	forage	novel products
sugar	fiber	energy

Pharmaceutical poppy (*Papaver somniferum*) field in Tasmania, TG Chastain photo

What is Crop Yield?

- **Potential yield** is the absolute capacity of a crop/genotype to produce economic yield under optimum production conditions. Under these conditions, the product of the yield components is expressed at the maximum possible for the genotype and production environment.
- Crop breeding improves genetic yield potential.

Sorghum breeding trials (TG Chastain photo)

Oregon State University

What is Crop Yield?

- **Farm yield (actual yield)** is the economic yield attained at harvest under standard production conditions. Farm yield results from the interaction of the following factors:
  1. Genetic yield potential.
  2. Environment.
  3. Management practices.
  4. Pests.

Wheat harvest in Oregon
(John McManigal photo)

Oregon State UNIVERSITY

What is Crop Yield?

- Crop yield is linked to CO_2 fixation through the photosynthetic process and partitioning of photoassimilates to the harvested part of the plant. The photosynthetic basis for yield depends on:
  1. Light interception by foliage.
  2. Conversion of intercepted light to the products of photosynthesis.
  3. Partitioning of photoassimilates to harvested yield.

Oregon State University

What is Crop Yield?

- Crop yield is the product of the individual **yield components** (morphological characteristics) operating in the crop species in question.
- The yield components and the inherent physiological activities involved in their formation interact with the crop growth environment, management practices, and pests to affect yield.

Canola Yield Components: plant, flower, pods, seed (TG Chastain photos)

Oregon State UNIVERSITY

Wheat grain crop

Yield Components

- Crop yield is the biological and mathematical product of the components of yield.
- For example, yield of a grain crop can be expressed as:

  Grain yield = Nf•Ns•Ws

  where:

  Nf = number of florets.

  Ns = number of seeds.

  Ws = weight per seed.

Yield Components: Wheat Grain

$$\frac{350{,}000 \text{ plants}}{\text{hectare}} \times \frac{14 \text{ tillers}}{\text{plant}}$$

$$\times \frac{0.50 \text{ spikes}}{\text{tiller}} \times \frac{30 \text{ grains}}{\text{spike}}$$

$$\times \frac{3.3 \times 10^{-5} \text{ kg}}{\text{grain}} = 2470 \text{ kg/ha}$$

Wheat spikes and grain

Yield Components: Perennial Ryegrass

$$\frac{12{,}022{,}560\ \text{Spikes}}{\text{Acre}} \times \frac{21\ \text{Spikelets}}{\text{Spike}} \times \frac{9.4\ \text{Florets}}{\text{Spikelet}} \times \frac{0.213\ \text{Seed}}{\text{Floret}} \times \frac{4.19 \times 10^{-6}\ \text{lbs.}}{\text{Seed}} = 2215\ \text{lbs./acre}$$

Perennial ryegrass spikelet (left), and seed (inset)

Yield Components: Forage

$$\text{Yield} = \frac{\text{Plants}}{\text{Area}} \times \frac{\text{Branches}}{\text{Plant}} \times \frac{\text{Weight}}{\text{Branch}}$$

Red clover

Yield Components: Soybean Grain Yield

$$\text{Yield} = \frac{\text{Plants}}{\text{Area}} \times \frac{\text{Branches}}{\text{Plant}} \times \frac{\text{Pods}}{\text{Branch}} \times \frac{\text{Seeds}}{\text{Pod}} \times \frac{\text{Weight}}{\text{Seed}}$$

Soybean pods (left) and seed (right)

Yield Components: Potato Tuber Yield

$$\text{Yield} = \frac{\text{Plants}}{\text{Area}} \times \frac{\text{Tubers}}{\text{Plant}} \times \frac{\text{Weight}}{\text{Tuber}}$$

Tubers (left), potato crop stand (right)

Seed Yield Components

- Seed crops are **biological solar energy collectors**. How big is this collector? For every acre of perennial ryegrass field, there are 3 acres of leaves.
- The number of plants in the stand as well as number of tillers and leaves must be managed so as to optimize the size and efficiency of this biological solar energy collector.

Normal stand (far left), loss of stand due to anoxia in low portions of field (near left) TG Chastain photos

Oregon State UNIVERSITY

Seed Yield Components

Trinexapac-ethyl treated

- Spike Length = 18.8 cm
- Spikelets per Spike = 22.3
- Seeds per Spike = 48.3

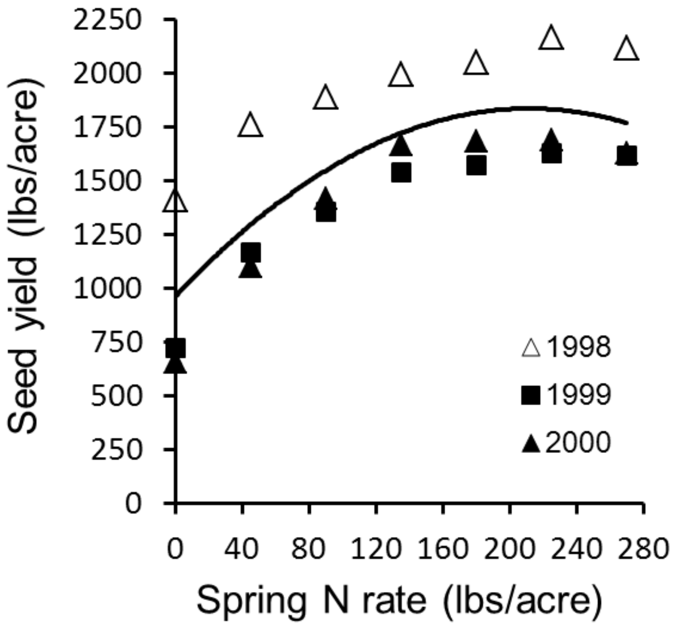
Untreated

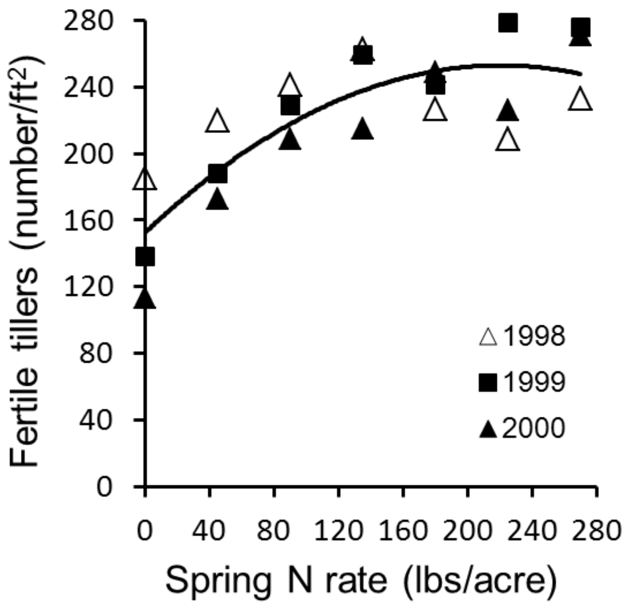
- Spike Length = 21.6 cm
- Spikelets per Spike = 23.0
- Seeds per Spike = 40.8

Effect of TE on perennial ryegrass spike morphology (TG Chastain photos)

Oregon State UNIVERSITY

Seed Yield Components

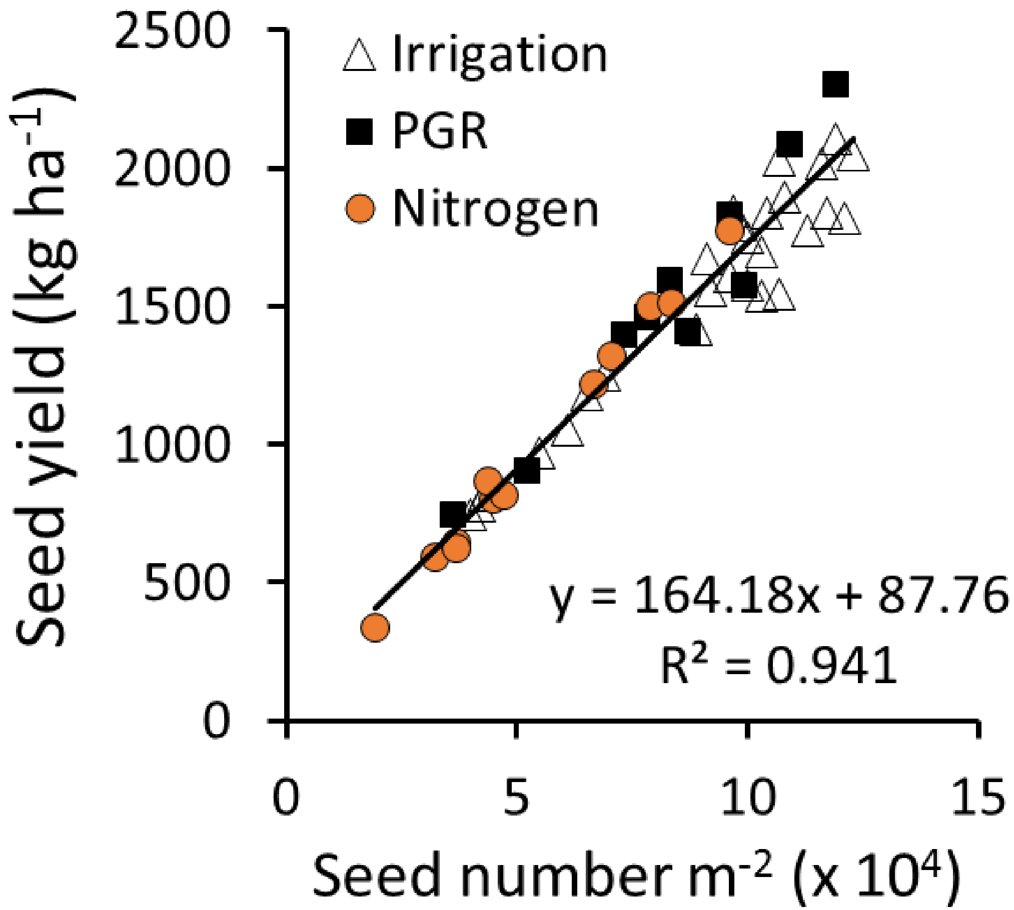




- Optimum spring N application for perennial ryegrass ranged from 120-160 lbs N/acre. Values are averaged over 12 site years.
- Stimulation of spike production accounted for most of the variation in seed yield due to spring N application. Floret production, but not spikelet production were affected by spring N application.
- Seed weight was increased by spring N.

Seed Yield Components

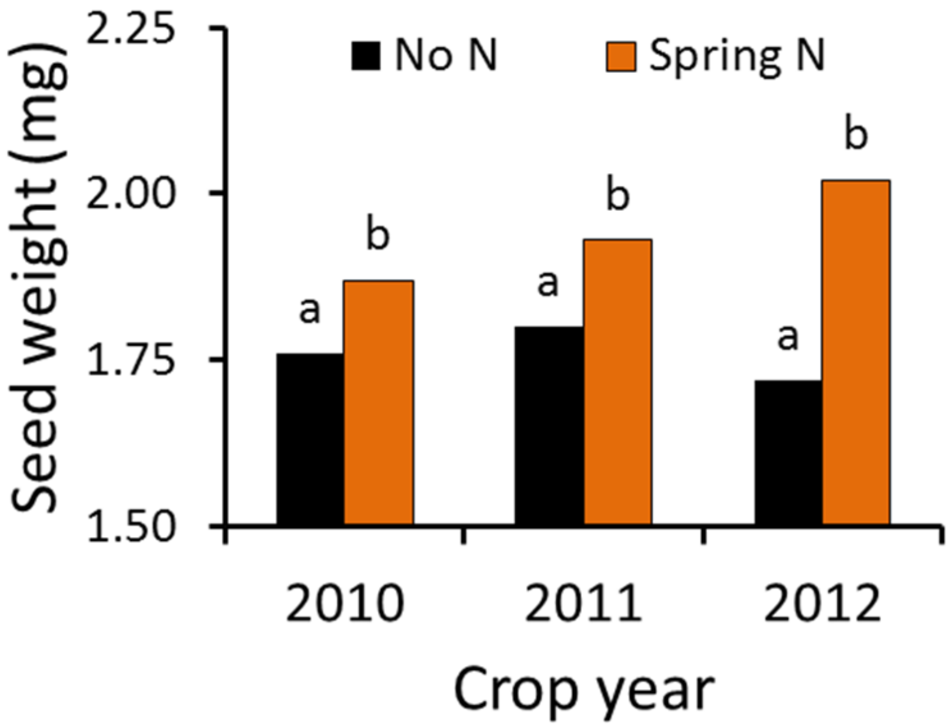
- **Seed number m^{-2}** is related to seed yield in cool-season grasses (Young et al., 1998; Rolston et al., 2010; Chastain et al., 2014a; Zapiola et al., 2014, etc.).
- The number of inflorescences m^{-2}, florets $inflorescence^{-1}$, and seed set can collectively or individually influence seeds m^{-2} (Chastain et al., 1997; Young et al., 1998).
- The greatest opportunities to advance seed yield through management is by increasing seed number.



Seed number and seed yield relationships in perennial ryegrass across agronomic practices in Oregon. Data from Chastain et al., 2014a; 2014b; Chastain et al., 2015b; Young et al, 1996.

Seed Yield Components

- **Seed weight** also affects seed yield (Boelt and Gislum, 2010; Zapiola et al., 2014)
- Contribution of seed weight to seed yield is not as great as seeds m^{-2} (Chastain et al., 2011; Huettig et al, 2013; Chastain et al., 2014a; Chastain et al. 2014b).
- Variation in seeds m^{-2} attributable to environment, management and pests is greater than variation in seed weight, which usually varies in a more narrow range.



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

Seed Yield Components

- Changes in one or more of the yield components can be compensated for by changes in other components.
- For example, lowered production of one yield component can be offset by an increase in production of another component without a loss in yield.
- This process is known as **yield component compensation**. This is a form of phenotypic plasticity.

Relationship of tall fescue yield components with seed yield (Chastain and Grabe, 1988).

Yield Component	Correlation with Seed Yield
Panicles/m^2	0.99**
Vegetative tillers/m^2	0.37
Spikelets/panicle	-0.31
Florets/spikelet	-0.93**

Tall fescue seed

Oregon State University