

Seed yield components and their potential interaction in grasses - to what extent does seed weight influence yield?

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Abstract

In a first-year seed crop of red fescue (*Festuca rubra* L.) the degree of lodging was controlled by the use of Moddus (Trinexapac-ethyl). Seed weight was found to increase by the decreasing degree of lodging prior to harvest. The higher seed weights were accompanied by higher yields even though the number of reproductive tillers and floret site utilization (FSU) were unaffected by the treatments.

Seed yield is affected by several yield components and reflects the interaction between the seed yield potential (e.g. number of reproductive tillers, number of spikelets and florets/spikelet per reproductive tiller), the utilization of the potential (e.g. seed set, seed weight) and the realization of the seed yield potential, defined as the number of florets forming a saleable seed. The realization of the seed yield potential is affected by seed retention, seed weight and other traits associated with yield loss during the harvest and post-harvest processes.

Introduction

The number of reproductive tillers per unit area is an important component in establishing the seed yield potential; however, its importance varies among grass species. In slow-establishing species or species with a high vernalization requirement tiller number and tiller size in autumn are important factors in maintaining a high yield potential in first-year seed crops. Tiller development influences transition rate from vegetative to reproductive growth with large tillers being more successful than smaller tillers (Boelt 1999; Meijer 1987).

The total number of spikelets and florets per inflorescence depends on the number of primary branches and on the number of florets produced per primary branch. It is believed that the number of primary branches increases with apex size (Colvill and Marshall 1984). Therefore autumn-produced tillers usually have more spikelets per tiller and in addition, they are also found to have more florets per spikelet (Ryle 1964). This is in agreement with a more recent study of Yamada et al. (2004), who found a positive correlation between plant height, tiller size, spike length and the number of spikelets per spike.

The seed set is of major importance for grass seed production. Elgersma (1991) distinguished between the *biological* floret site utilization (FSU), which is the percentage of florets present at anthesis resulting in a viable seed and the *economic* FSU, which is the percentage of florets present at anthesis resulting in a cleaned pure seed. Different studies are reporting large variations in biological FSU, but on average 20-50% of the florets are biologically unproductive with losses occurring during pollination, fertilization and seed development.

Seed development depends on the position of the seed within the inflorescence. Seed weight decreased from the basal to the distal spikelets and with an even steeper gradient within the spikelet (Anslow 1964). From a glasshouse experiment with spaced plants of perennial ryegrass, Warringa et al. (1998) concluded that the amount of carbon assimilates in flowering tillers does not limit seed growth. Reducing light intensity by 75% had only minor effects on seed dry weight.

Information on how seed weight is influenced by seed crop management is very limited, and often it is confounded with variation in other seed yield components such as reproductive tiller number.

Materials and methods

A field experiment was conducted in 2007 and 2008 at Aarhus University, Research Centre Flakkebjerg where the growth regulator Moddus (Trinexapac-ethyl) was evaluated in different doses in a first-year seed crop of red fescue (*Festuca rubra* L.) cv. Maxima. In the seed production year one plant sample per plot was cut within an area of 0.25 m² prior to seed harvest and the number of reproductive tillers was registered. The number of florets per spikelet at flowering and the number of seeds per spikelet prior to harvest were registered in 30 reproductive tillers in selected treatments in each of four replicates. Lodging was assessed at flowering and prior to harvest using a scale where 0 equals 'all reproductive tillers erect' and 100 equals 'all reproductive tillers completely lodged'. Before shedding, 8 m x 2.5 m area per plot was harvested directly with a trial combine harvester, and seeds were air-dried to 12% moisture before determining seed yield. After seed drying and cleaning, one sample from each replicate was analyzed for purity, and seed yield expressed as 100% clean seed was calculated. Thousand seed weight was calculated on basis of eight individual counts of 100 seeds in each plot.

Results

Variation in the degree of lodging at harvest was recorded in response to growing season and the applied dose of Trinexapac-ethyl. In the harvest year 2007 lodging ranged from 71-88; whereas the responses in 2008 were 0-41. Seed weight ranged from 0,94 to 1,08 mg seed⁻¹, the lowest seed weight obtained when lodging at harvest was registered at 71 and highest when lodging was registered at 11 (figure 1).

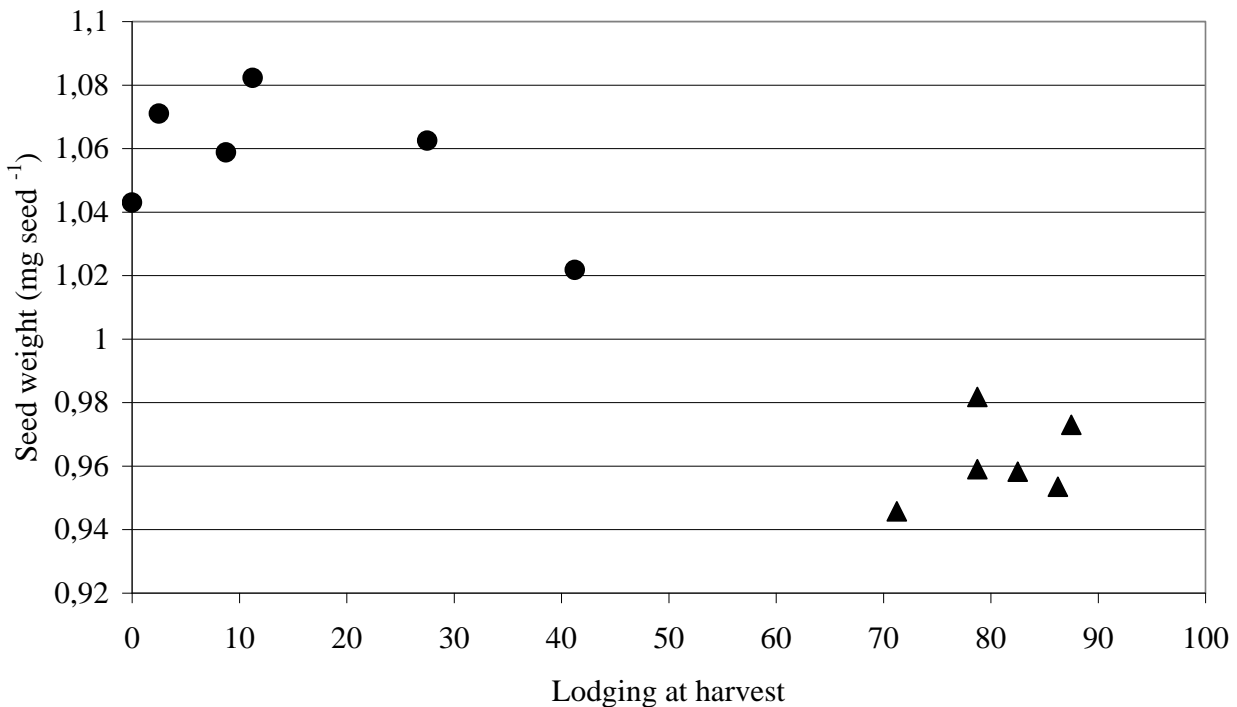


Figure 1. The effect of lodging at harvest on seed weight in red fescue 2007 (▲) and 2008 (●).

The number of reproductive tillers and FSU were not influenced by treatments and varied only slightly between years. The average number of reproductive tillers was 3830 and 3644 m⁻² in 2007 and 2008 respectively. FSU was high in both years with 79,3% and 78,2% in 2007 and 2008 respectively.

Seed yield was 1743 kg ha⁻¹ in 2007 in average of all treatments whereas yield was significantly higher in 2008 with 2642 kg ha⁻¹. In both years application of Trinexapac-ethyl influenced seed yield positively.

Discussion

It is generally recognized that variance in seed yield are best explained by the number of seed per unit area (Hampton & Hebblethwaite, 1983). Often yield components are negatively correlated and a high number of reproductive tillers leads to less and/or smaller seeds on each individual tiller. This assumption is however often based on limited registrations of weight and number of seeds per reproductive tiller or based on glasshouse experiments. Our experiment shows that seed weight is increased by 14,9% when lodging at harvest is reduced from 71 to 11 in red fescue without having any concomitant effect on other yield components such as reproductive tiller number density and FSU. The increase in seed weight was followed by a higher seed yield.

In grass species with poor seed retention, major losses may occur if the crop does not lodge at maturity to an extent where it prevents seed shattering from wind or rain. Further seed loss in the harvesting process may be substantial and in some cases, the harvested seed may even fail to meet certification standards in terms of physical purity and germination ability. The variation of seed size and maturity level both within and among the inflorescences is considered a key factor determining seed loss before and during harvest as well as in the post-harvest management processes of drying and cleaning. During seed cleaning, the saleable seed is separated from impurities, weed seeds, empty seeds etc. on the basis of seed size, shape and gravity. Variation in seed size leads to losses in the separation process where physical impurities and weed seeds are separated from the saleable seed. Therefore a seed crop more uniform in seed maturity level and seed weight will realize a higher proportion of the potential seed yield and in addition it often has a higher seed quality.

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