

Perennial ryegrass (*Lolium perenne* L) seed crop response to spring nitrogen: a comparison of New Zealand and Oregon results

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Abstract

Nitrogen (N) uptake and seed yield from eight site years in Oregon (OR) and nine locations in New Zealand (NZ) are compared. The production systems between the two regions are very different. Despite these differences, a striking similarity exists between the OR and NZ data sets. Using a Cate-Nelson technique for data separation, the N content above which yield was not limited by N was 143 kg/ha.

Introduction

Characterizing N uptake by ryegrass seed crops is necessary to develop prediction models for spring N application. The ability for a prediction model to be useful in differing production regions is dependent on factors including similarities or differences in plant N uptake. Production systems and environments between the main ryegrass seed production regions of New Zealand (NZ) and Oregon (OR) are very different.

In the Canterbury area, NZ, the 600 to 800 mm of rainfall is received uniformly throughout the year. In contrast, the 1000 to 1200 mm of rain falling in the Willamette Valley of OR is primarily received from mid-autumn to mid-spring. To supplement rainfall in Canterbury, NZ, approximately two-thirds of the area producing perennial ryegrass seed is irrigated compared to less than five percent of the area in the Willamette Valley, OR. The first year seed crops in Canterbury, NZ reach spikelet initiation at approximately 520 GDD (Growing Degree Days base 0°C) from July 1 where spikelet initiation in first or second year crops in the Willamette Valley, OR occurs at approximately 370 GDD from January 1. The forage seed varieties grown in Canterbury, NZ are routinely grazed and the predominantly turf varieties grown in the Willamette Valley, OR are rarely grazed.

This paper compares N uptake data and seed yield from N rate trials in NZ and Oregon forage and turf perennial ryegrass and discusses utility of the data for prediction of spring N rate in perennial ryegrass seed production.

Methods

New Zealand. Nine N rate, seed yield response trials in grower fields were undertaken from 2006/07 to 2008/09 in Canterbury and mostly in two districts; Ashburton, coastal (30 m asl); and

Methven (300 m asl). The sites were irrigated and managed by the grower for all inputs except for nitrogen (N). The plant growth regulator trinexapac-ethyl was used at all trial sites usually at 400 g ai/ha. Trials were grazed with sheep during winter and spring and closed for grazing at the beginning of stem elongation (usually late September). Trial plots were 32 m² and with four replicates in a randomized block design.

Applied N as urea was evaluated with rates increasing in 50 kg/ha increments usually covering the range of 0 to 250 kg N/ha. Spring N was applied as a split application with equal amounts at each application, the first application at closing and the second application about two weeks later. At late seed fill (about 7 to 10 days before harvest) a 0.25m² quadrant was sampled from each plot for an assessment of crop mass and components of yield. Straw from this sample and seed after harvest were analyzed for N content at a commercial laboratory. N uptake by the crop (seed and straw) was calculated from this data.

At harvest a 17 m² swath was cut from the centre of all plots with a modified plot windrower, and then harvested with a plot combine. Seed samples were machine dressed on a small-scale air-screen separator to achieve a 1st Generation seed purity standard. Cleaned plot samples were weighed and converted to a yield per ha.

Oregon. Between 1998 and 2009, eight replicated nitrogen rate experiments in perennial ryegrass fields were evaluated in the Willamette Valley or low hills on the valley margin and none were grazed. Plant growth regulator to decrease lodging was used at the discretion of growers, but used at most sites after 2000. All sites had a nil treatment and increments of approximately 50 kg N/ha to a maximum of 200 to 350 kg N/ha. In 2007 and 2009, the plots were located on Oregon State University's Hyslop Crop Science Farm, Corvallis; and the other sites were in grower fields, and except for addition of N, managed by growers.

Either a single or split application of urea was made in grower fields to plots between 400 and 800 GDD with a Gandy Orbit-air spreader. Plots were 6.2 m wide and 75 to 120 m long, allowing for harvest with grower equipment. Growers cut a single swath through the middle of each plot that dried and was then harvested with their combines on the same schedule held for the field. Seed from each plot was transferred from the combine to a Brent Yield cart for weighing. A sub sample of seed from each plot was cleaned and the yield from the combine adjusted with this data.

Plots at Hyslop were 50 m². Treatments were swathed and after drying, a plot combine was used to separate straw from seed. After the seed was weighed, a bulk sample was taken for cleaning using a two-screen cleaner. Clean seed yield for each treatment was determined using the cleanout percentage from the bulk sample.

Biomass, aboveground N accumulation, and yield components were determined from 30 cm sections of row by clipping all plant tissue above the soil surface after anthesis. Two or more samples were collected for each treatment from random locations and combined to create a

single composite sample. Composite samples were analyzed for dry biomass and whole-plant N concentration. Relative seed yield was calculated with the highest treatment value for a trial set at 100%.

Results

Perennial ryegrass seed yield increased with N uptake until the aboveground plant content was 143 kg/ha (Figure 1). The average seed yield response in the linear response phase was 3.7 and 5.6 kg seed/kg N for NZ and ORs respectively, reflecting the higher mineral N level of NZ sites. N uptake beyond need for seed yield is stored in straw. Straw N concentration commonly doubles from 10 to 20 mg/kg while seed N remains constant within range 20 to 24 mg/kg.

The range of mean seed yield for a location was 1700 to 3000 kg/ha in Canterbury, NZ and 1400 to 2300 kg/ha in the Willamette Valley, OR. In the Canterbury area, the average perennial ryegrass seed yield with nil N was approximately 1600 kg/ha compared to only 1200 kg/ha in the Willamette Valley, OR. These differences likely reflect soil N contribution of approximately 100 kg/ha in New Zealand compared to only 60 kg/ha in Oregon (Hart et al 2007).

Crops in the Willamette Valley, OR produced more aboveground harvest biomass, 11,000 to 16,000 kg/ha compared to 9,000 to 15,000 kg/ha in Canterbury Area, NZ. The aboveground biomass mean of all nil N treatments was similar in both areas, between 8 and 9,000 kg/ha.

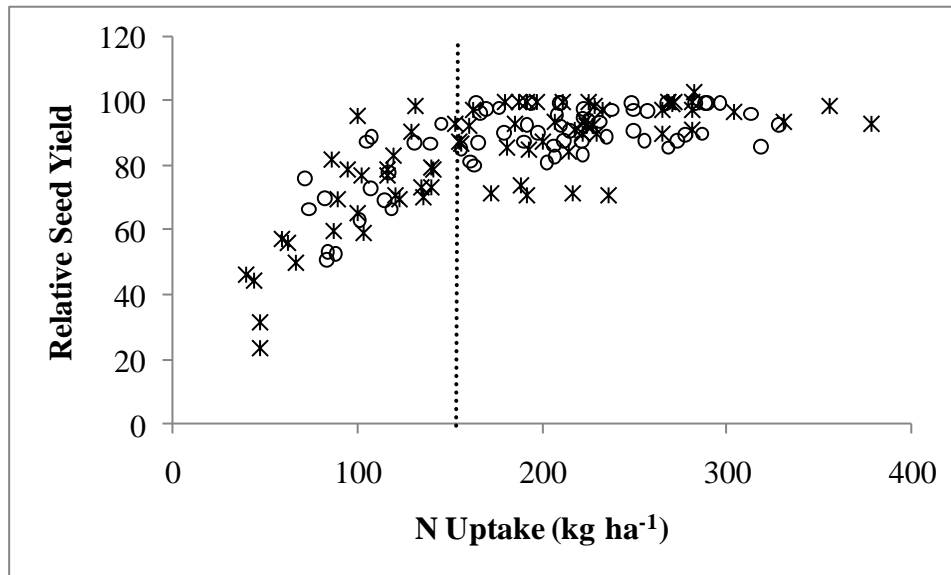


Figure 1. Relative seed yield and ryegrass N uptake from nine New Zealand (o) and eight Oregon trials (*). Critical N uptake (--) calculated at 143 kg N ha⁻¹ (Cate-Nelson 1971).

Discussion

Seed yield change from N rate application is site specific and commonly does not translate to another year or site. For many years, N rate trials have been conducted in both production areas with the same result. No combination of soil N measurements adequately predicted spring N rate.

Rather than attempting to use soil parameters to predict spring N requirement, an alternative approach is to measure N concentration to determine a critical level (Rowarth et al. 1998). N concentration was measured in early reproductive growth with available time to add N and influence seed yield. Sampling perennial ryegrass seed production fields to assess N concentration has limitations: (i) is the time and effort needed to collect samples; (ii) is the time from sampling and tissue analysis to fertilizer application, and (iii) is the rapid dilution of N with stem elongation as N concentration is sensitive to the rapid change in plant growth and can change quickly after N application. A dilution curve approach (Gislum et al. 2009) overcomes dilution effects but not delays in laboratory analysis of N.

To adequately capture changes in biomass and tissue N concentration, N uptake estimation using remote sensing is currently pursued (Flowers et al, 2009). Data used in this paper shows that perennial ryegrass grown for seed assimilates N in a similar amount in two production region despite differences in the environment and crop management. This fact allows data combination into a single model for remote sensing and other predictive research.

The N uptake required for maximum relative seed yield is not an absolute number as it will change with data provided. Even so, it is a reasonable estimate that can initially be used for comparison of early season N uptake estimates from remote sensing.

Conclusion

Perennial ryegrass grown for either turf or forage seed, requires the same amount of total N, approximately 150 kg/ha before N limits seed yield in both Canterbury, NZ and the Willamette Valley, OR. The consistent amount of N in the crop provides opportunity for a universal model of N use by the crop.

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References

Cate, RB. & Nelson, LA. 1971. A simple statistical procedure for portioning soil test correlation data into two classes. *Soil Science Society America Proceedings* 35: 658-660.

Flowers, M.D.; Hart, J.M.; Young III, W.C.; Christensen, N.W.; Garbacik, C.J.; Mellbye, M.E.; Silberstein; T.B. & Gingrich G.A. 2009. Yield estimation and the assessment of in-season nitrogen status of perennial ryegrass for seed production using remote sensing. In: W.C. Young III (ed). *2008 Seed Production Research at Oregon State University USDA-ARS Cooperating*, Department of Crop and Soil Science Ext/Crs 128, 3/09, Corvallis, Oregon.

Gislum, R. & Boelt, B. 2009. Validity of accessible critical nitrogen dilution curves in perennial ryegrass for seed. *Field Crop Research* 111: 152-156.

Hart, J.M.; Rolston, M.P.; Mellbye, M.E.; Silberstein; T.B.; Young III, W.C. McCloy B.L., Gingrich G.A.; Christensen, N.W.; Gislum, R. 2007. Comparison of soil N tests for prediction of spring N rate in perennial ryegrass seed production. *6th International Herbage Seed Conference*, Norway: 239-243.

Rowarth, J.S.; Boelt, B.; Hampton, J.G.; Marshall, A.H.; Rolston, M.P.; Sicard, G.; Silberstein, T.; Sedcole, J.R.; Young, W.C. 1998. The relationship between applied nitrogen, seed yield, and nitrogen concentration in herbage in perennial ryegrass (*Lolium perenne* L.) 1. cv Grasslands Nui at five sites around the globe. *Journal of Applied Seed Production* 16: 105-114.