ENERGY USE AND EFFICIENCY IN GRASS SEED CROP PRODUCTION

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Energy prices are an important consideration in managing the cost of producing grass seed crops. The cost of energy and the cost of farm inputs that are tied to energy have risen faster than the price of crops. Potential public policy changes, an improving economy, and the possibility of unforeseen international instability could individually and collectively, drive energy prices up even more sharply than anticipated by economists.

Since crops capture solar energy and convert that energy into harvested yield products, profitable crop production is aimed at making the best possible solar energy capture system at the lowest possible price. Direct and indirect energy costs in the form of diesel fuel, electricity, fertilizers, pesticides, and others can make economic crop production a challenge. To increase the efficiency of solar energy capture and partitioning to harvested products, grass seed growers use a wide variety of management inputs to optimize the size of the crop's biological solar energy collector. However, there is currently no information available on the energy use and efficiency of grass seed crops grown in the Willamette Valley.

Field trials were conducted in Evening Shade perennial ryegrass and Falcon IV tall fescue in order to measure the energy consumption of seed production management activities. Seed yield, straw, and other production characteristics were determined on the crops and a life-cycle energy budget was constructed for each species.

The field trials were designed to manipulate energy capture and partitioning within the crop and through the following management treatments:

1. Spring applied nitrogen (160 lbs/acre – perennial ryegrass, 120 lbs/acre – tall fescue)
2. Trinexapac-ethyl (Palisade) plant growth regulator (PGR)
3. Control (no spring N, no PGR)

Spring N was applied in March of each year by use of an Orbit Air spreader system and the PGR treatment [Palisade® (trinexapac-ethyl)] was applied in May to control lodging. Seed yield components were collected from each plot near peak anthesis of each seed crop in June. The seed crops were cut with a small-plot swather and threshed by a small-plot combine in July of each year.

The average seed yield harvested over the past two years of the study was increased by spring N in perennial ryegrass and yield was further increased by the use of PGR (Figure 1). However, only the combination of spring N and PGR consistently affected seed yield in tall fescue. Seed yields were not increased by PGR application in either grass seed crop in the absence of spring N.

The difference between straw yield with and without spring N was much greater in perennial ryegrass than in tall fescue over the two years (Figure 1). While the lower spring N rate in tall fescue (120 lbs N/acre) could be partly responsible for the difference between the species, the amount of straw produced by tall fescue without spring N was much larger than observed in perennial ryegrass. The PGR produced small but consistent reductions in straw yield.

Seed yield resulting from the treatments outlined above was used in calculating energy budgets for perennial ryegrass and tall fescue seed production. Energy consumption values were derived from the energy budgets for both crops and are reported in Table 1. The energy consumed in production of perennial ryegrass ranged from 4,080 to 8,760 MJ/acre, depending on the management inputs used. Production energy use values for tall fescue were slightly lower than for perennial ryegrass. The energy consumption for perennial ryegrass and tall fescue falls within the published range for other major field crops such as wheat, soybeans, and barley, and is less than what is required in production of sugar beets for sugar.

Seed energy outputs are tied to seed yield with lower energy output evident with low seed yield and higher energy output with high seed yield (Table 1). Energy efficiency is determined by the ratio of energy produced (output) to energy consumed (input). When energy efficiency ratios are greater than 1, the energy produced exceeds the energy used in producing the crop. The net gain in energy comes from the capture of solar energy and storage of that energy in the seed. The energy efficiency resulting from production of perennial ryegrass and tall fescue for seed is similar to other major grain crops, and is dependent on the production inputs used to grow the crop.

The energy embodied in the straw co-product further increases the amount of energy produced by grass seed production systems (Table 2). In perennial ryegrass and tall fescue, the straw is either harvested from the field for livestock feed or is chopped to decompose in place in the field, and energy is recovered as livestock products or plant nutrients released in the soil. But the straw might have potential value as a source of energy as a feedstock for biofuel or for the thermal generation of electricity. Energy efficiency of grass seed production is much greater with the addition of the straw co-product than was observed with harvested seed alone (Table 2). Efficiency ratios for the combined seed and straw harvest ranged from 4 to nearly 12 in perennial ryegrass and tall fescue seed crops.

The results from the first two years of field trials indicate that perennial ryegrass and tall fescue grown for seed are energy efficient crops, even when the straw co-product is not considered. But the work to date also identifies some potential areas of energy cost savings and opportunities for additional energy output. This will be further illustrated after the harvest of the 3rd crop from the experimental fields is completed next summer and a final report is produced.

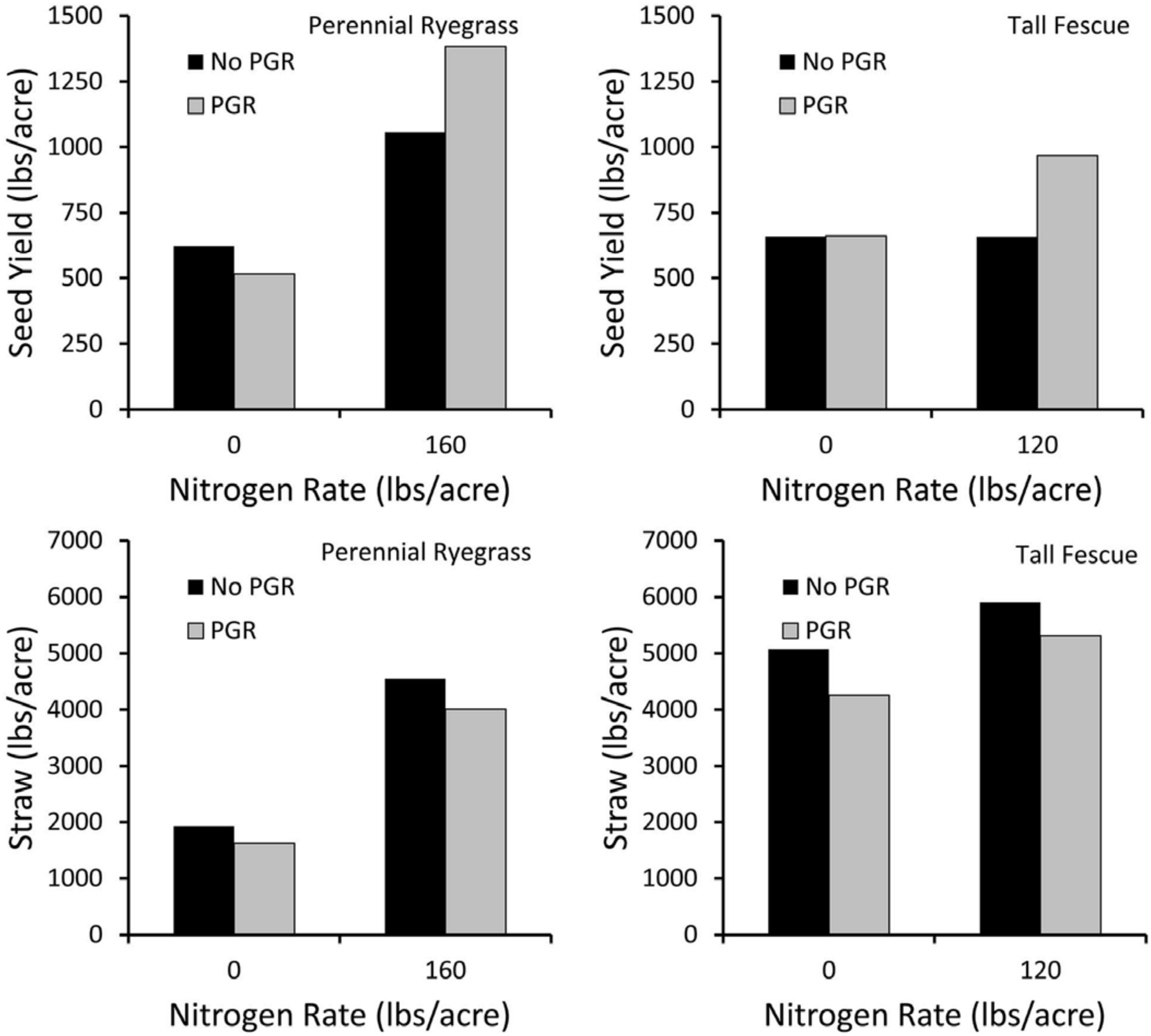

Figure 1. Effect of spring nitrogen and plant growth regulator (PGR) on seed and straw yield in perennial ryegrass and tall fescue.

Table 1. Effect of spring N and PGR on energy use and efficiency of grass seed crops in 2010 and 2011.

Treatment	Energy Consumed (EC)	Seed Energy Output (SEO)	Energy Efficiency
	(MJ/acre)	(MJ/acre)	(SEO/EC)
Perennial Ryegrass			
Spring N + PGR	8,760	11,659	1.33
Spring N	8,485	8,898	1.05
PGR	4,355	4,338	0.99
Control	4,080	5,252	1.29
Tall Fescue			
Spring N + PGR	7,589	8,151	1.07
Spring N	7,314	5,546	0.76
PGR	4,277	5,570	1.30
Control	4,001	5,567	1.39

Table 2. Effect of spring N and PGR on energy use and efficiency for seed and straw co-products produced by grass seed crops in 2010 and 2011.

Treatment	Seed and Straw Energy Output (SEO)	Energy Efficiency
	(MJ/acre)	(SEO/EC)
Perennial Ryegrass		
Spring N + PGR	44,138	5.04
Spring N	45,777	5.39
PGR	17,458	4.01
Control	20,867	5.11
Tall Fescue		
Spring N + PGR	51,198	6.75
Spring N	53,370	7.30
PGR	40,052	9.36
Control	46,700	11.67