Oregon State University

Crop Science Report
RESEARCH/EXTENSION

POTENTIAL FOR GROWTH RETARDANTS in GRASS SEED PRODUCTION

D.O. Chilcote, H.W. Youngberg and D. Albeke (1) (2)

Research results over the past two years indicate a good potential for the use of growth retardants (chemical dwarfing agents) to enhance seed yield of perennial grasses. Perennial ryegrasses, tall fescue and fine fescue have all shown positive yield responses from application of two experimental growth retardants at OSU. Growth retardant application increased the per acre seed production of perennial ryegrasses from 50 to over 100% in 1981. The What, how, and when of the use of growth retardants are questions pertinent to potential use in grass seed production.

What are these materials? After studying a number of chemicals, two experimental compounds with some very special characteristics have been identified for use in the research investigations. These compounds are coded PP333 produced by Imperial Chemical Industries in England and EL500 marketed by Eli Lilly and Company. The compounds produce very similar effects on plants. They reduce stem growth with very little effect on reproductive differentiation and development. The compounds are considered desireable for use in grass seed crops because they do not control inflorescence development while providing good general vegetation growth control. These chemicals are still experimental and have not been registered for use.

What have these experimental compounds been able to accomplish insofar as crop growth is concerned? Basically, the growth retardant compounds have allowed us to create semi-dwarf grass plants similar to what breeders and geneticists have accomplished through their breeding programs in development of semi-dwarf stiff strawed varieties of cereal crops. It should be noted, however, that growth retardants

---

(1) Professor of Crop Physiology, Extension - Research Agronomist and Research Assistant, Oregon State University, respectively.

(2) We would like to acknowledge the valuable assistance of Daryl Ehrensing, Carroll Moon, William Young and Jim Hunter in harvesting, data collection and processing which made completion of this work possible.

EXT/CS 42
2/82

are now used extensively in Europe to dwarf the taller growing wheat varieties to avoid lodging and improve seed yield. Studies with tall fescue in 1980 provided evidence of dramatic reduction in the height of individual culms with little or no effect on numbers of leaves, leaf area or inflorescence size. These compounds through chemical dwarfing have increased yield and, therefore, enhanced efficiency of production.

The use of growth retardants in our forage and turf grasses has an additional rationale for areas of seed production such as the Willamette Valley and other areas of Oregon since we produce seed of crops developed elsewhere for their characteristics of good forage production or good turf quality. Here, we wish to enhance the seed yield of these crops without altering the genetic constitution. There's little opportunity for breeders of forage or turf varieties to examine seed production as a primary objective and the possibility of combining good forage or good turf characteristics with high seed production is remote and would involve extended breeding and testing procedures. There are also excellent forage and turf varieties of our forage and turf species presently available which are not consistently good seed producers. For these reasons, we explored the use of growth retardants to enhance the growth and crop seed yield. A major benefit of reduced stem growth is reduction or elimination of lodging which can seriously reduce seed production.

The important criteria for these compounds is its effect on seed yield. Table 1 shows the seed yield response of tall and fine fescue comparing treated versus untreated experimental plots in 1980.

Table 1

Seed Yield of Tall Fescue and Fine Fescue Comparing Growth Retardant Treated and Untreated Plots in 1980.

		Clean Seed Yield (kg/ha)		
Species	Variety	Treated	Untreated	% Increase
Tall Fescue	Fawn	1299	790	64*
Fine Fescue	Cascade	762	602	27*

Optimum treatment rates (3/4 pound per acre) and stages of differentiation (floret initiation) were selected for comparison. The results show a significant yield response over a good yield for the untreated plots. The crop stand in these tests was about six years of age.

Table 2 shows the results from similar treatments in 1980 and 1981 with three varieties of ryegrass.

Table 2

Seed Yield of Perennial Ryegrass Varieties Comparing Growth Retardant Treated and Untreated Plots in 1980 and 1981.

	Clean Seed Yield (kg/ha)					
	1980		%	1981		%
	Treated	Untreated	Increase	Treated	Untreated	Increase
Pennfine	1382	930	49	2429	1113	118*
Caravelle	-	-	-	1867	1209	54*
Linn	-	-	-	1879	734	156*

In 1980, the growth retardant resulted in a yield increase of 49% in a six year old stand of Pennfine perennial ryegrass. Again untreated plots produced a moderate to good seed yield. In 1981, treatments were applied to new fields of Pennfine, Caravelle, and Linn perennial ryegrass and in this case, very spectacular yield enhancement was observed an average of 109% over the three varieties. It is difficult to assess whether the different results were due to age of stand or to seasonal variation in environment recognizing that lodging in 1981 was more severe than in 1980.

In 1981, experiments were also established in the Willamette Valley and the La Grande area to examine the effects of growth retardants on bluegrass varieties. Table 3 shows the results of some of these experiments.

Table 3

Seed Yield of Bluegrass Comparing Growth Retardant Treated and Untreated Plots in 1981.

		Clean Seed Yield Kg/Ha		
Species	Variety	Treated	Untreated	% Increase
Bluegrass	Bristol	420	446	(6)
	Touchdown	440	406	8
	Victa	560	589	(2)

Yields were not enhanced in these tests. However, the lack of success in bluegrass is felt to be related to excessive application rate and treatment at the wrong stage of development. The sensitivity of bluegrass to retardants is much greater and lower rates need to be evaluated. Since the inflorescence is a panicle, application at later stages of development needs to be examined.

The next question is "how" seed yield is effected. The application of growth retardants at high rates delayed or prevented lodging in ryegrass until near maturity. Delay of lodging, which without treatment occurred quite early in 1981, would be beneficial to seed production. Obviously, light penetration is dramatically reduced in a lodged canopy. Light reception by leaves and inflorescences to provide for seed filling would be greatly reduced. Those panicles beneath the surface layer would receive less light and on only one side. In addition, the process of pollination, the movement of pollen to stigmatic surfaces, would also be more restricted. Preventing lodging would maintain the culms upright so that pollen would be more freely distributed throughout the plant canopy and light interception would certainly favor the processes of seed set and seed filling. The lodging scores for 1980 and 1981 are given in figure 1 and figure 2. As you will note in both years, lodging occurred prior to anthesis with a greater severity of lodging in 1981. The application of growth retardants, particularly at the rates greater than one-half kg/ha gave almost complete control of lodging through the season.

Another "how" factor in seed yield enhancement is the increase in dry matter partitioned to potential yield and to seed set and seed filling activities. Research in 1980, on tall fescue (Table 4) showed an increase in numbers of spikelets per panicle and more seed at harvest in treated plants.

Table 4

Effects of Growth Retardants on Certain Seed Components and Harvest Index in Perennial Ryegrass (Pennfine) and Tall Fescue (Fawn) 1980.

Species	Treatment	Fertile Tiller M^2	Spikelets/ Spike, Panicle	Florets/ Spikelet	Seeds/ Spikelet	Harvest Index %
Ryegrass	Treated	2583*	21	8	1.66	17
	Untreated	1689	20	8	1.35	8
Tall Fescue	Treated	414	41*	8	2.8	-
	Untreated	326	34	8	1.5	-

FIGURE 1

LODGING SCORES - PERENNIAL RYEGRASS 1980

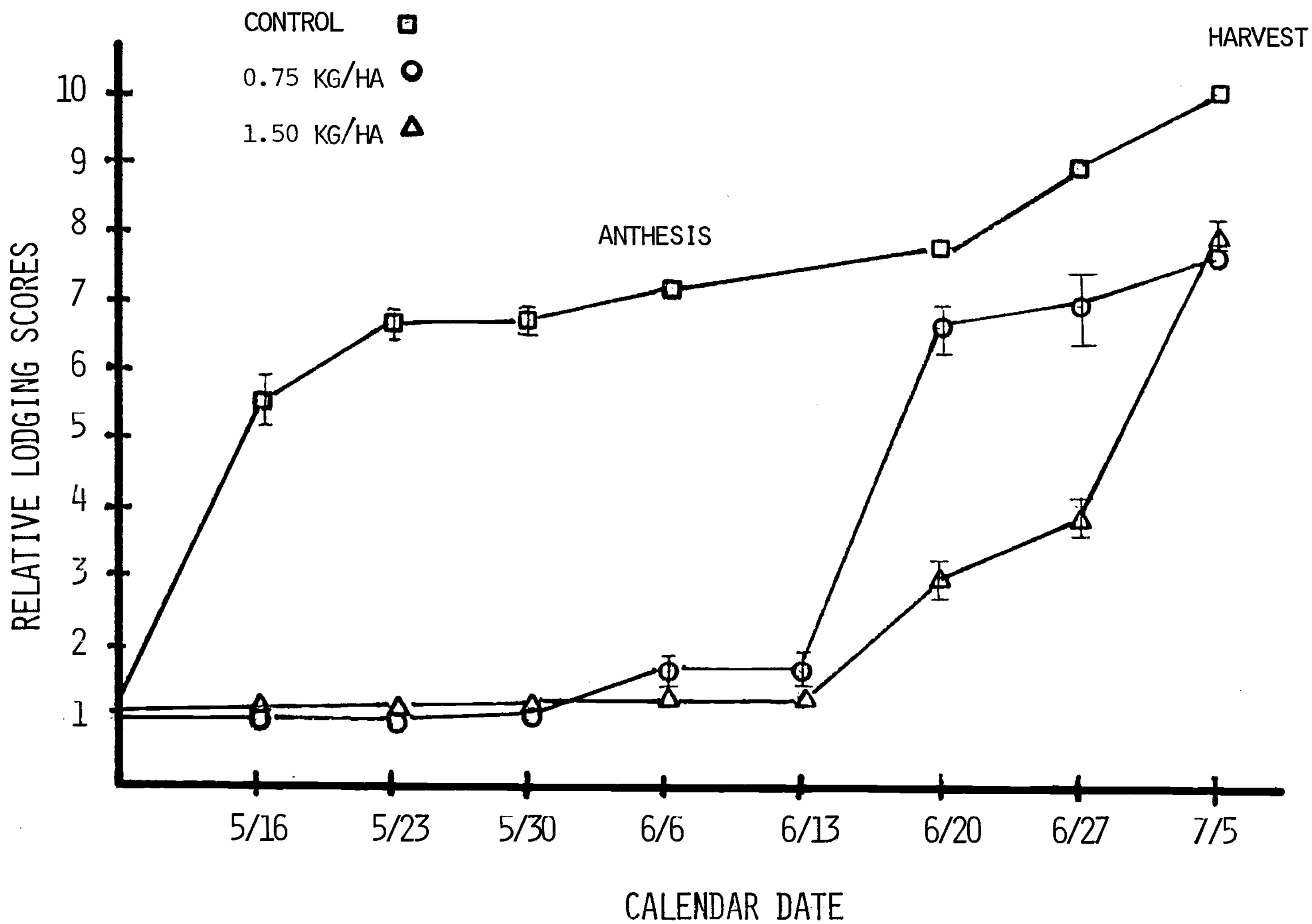
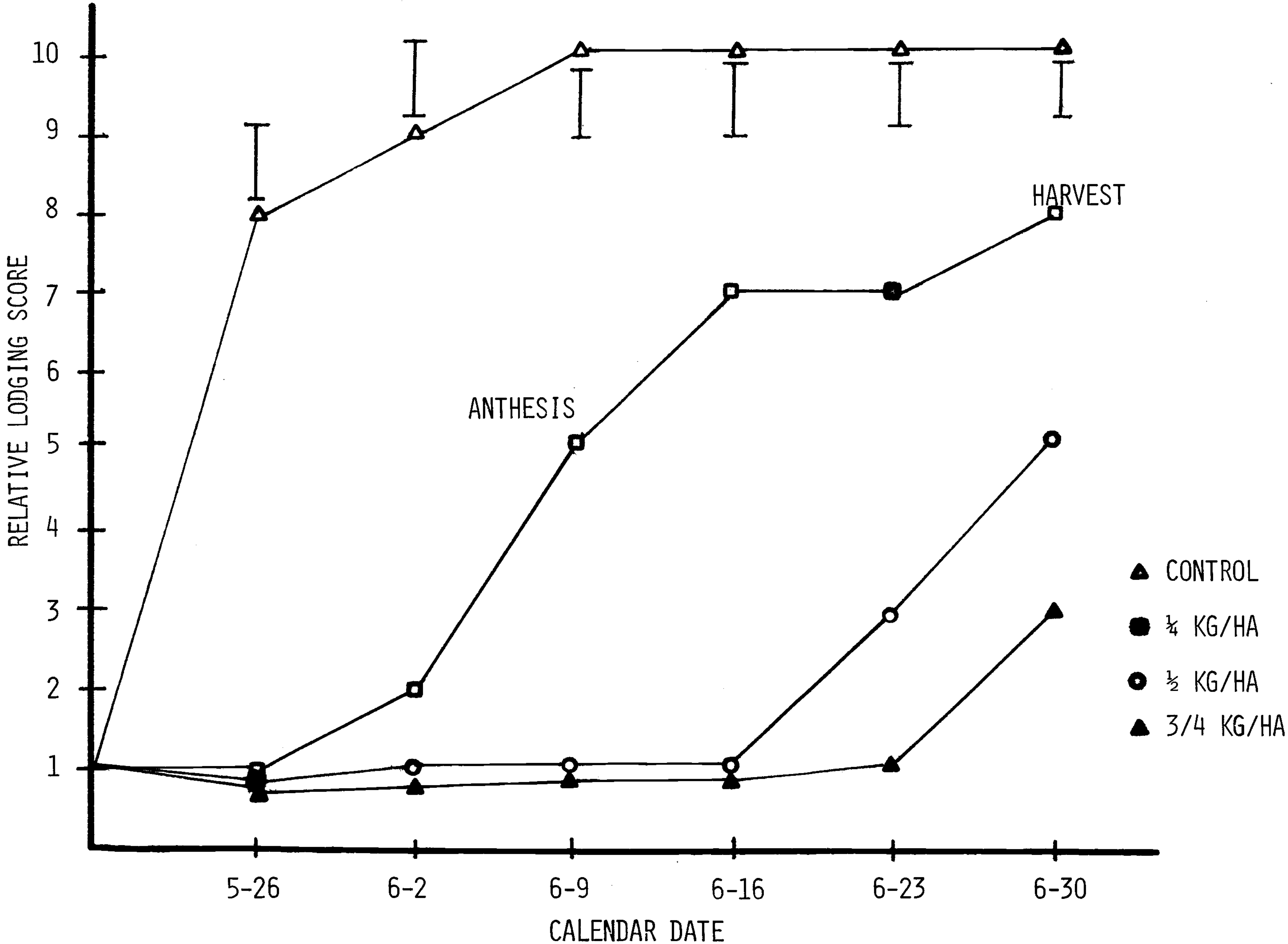


FIGURE 2

LODGING SCORES - PERENNIAL RYEGRASS 1981



In ryegrass, the primary response was an increased number of inflorescences (spikes) and more seeds per spike at harvest time. (Table 4 and 5).

Seed yield in grasses is a product of number of inflorescences per unit area, seeds per inflorescence and weight per seed. The number of seeds per inflorescence is determined by number of spikelets and florets per spikelet and how many of the potential florets mature into a seed. Differences in seed yield can be accounted for by variation in number of inflorescences, or weight per seed or number of seeds per inflorescence. In these tests, yield enhancement by growth retardants was primarily due to increased numbers of inflorescences per unit area and more harvested seeds per inflorescence. The numbers of spikelets and florets per spikelet are not usually different, at least in ryegrass. Since the weight per individual seed is maintained, it appears that the growth retardant by maintaining an upright canopy facilitates light energy capture and improves the seed filling capacity. Usually increased number of seeds is accompanied by reduced seed size. The fact that the weight per seed was not reduced with the dramatic increase in numbers of seeds per unit area is evidence that the seed filling process is enhanced. In other words, of the total number of potential florets, a greater number of those actually produce a seed and this seed is not reduced in weight (size), thus increasing yield.

Harvest index is a ratio of weight of seed harvested divided by the total weight of above ground dry matter produced. Growth retardant treatment improved the percent of dry matter that was harvested as seed versus straw. The result was much more dramatic in 1980 with an older stand than it was for a younger stand in 1981. (See Tables 4 and 5). An improved harvest index may suggest benefits in terms of reduced clean out in the threshing and cleaning processing.

Table 5

Effects of Growth Retardants on Certain Seed Yield Components and Harvest Index in Perennial Ryegrass Varieties 1981.

Species	Treatment	Fertile Tiller M^2	Spikelets/ Spike, Panicle	Florets/ Spikelet	Seeds/ Spikelet	Harvest Index %
Pennfine	Treated	2757*	23	7	2.03*	7*
	Untreated	2064	23	7	.90	5
Caravelle	Treated	2055	20	7	2.4*	8*
	Untreated	1688	20	6	1.63	7

Germination results showed no effect of treatment on this seed quality characteristic.

The results of this work have been very beneficial to our understanding of the restraints to seed yield in grass seed crops. We now know that lodging has a much greater impact on seed yield than we expected. Results provide evidence that we are losing tillers that could potentially become reproductive if we prevent lodging and allow better light penetration and interception. It also appears that seed filling is of major importance to yield and opportunities exist for realizing a greater portion of the seed yield potential.

More research is needed to describe the detailed use of growth retardants in grass seed production. We also need to look at rates of nitrogen fertilizer in conjunction with growth retardant applications. There is obvious potential for use of growth retardants in other species such as alfalfa, sugarbeets and cereals. The potential for growth retardants in seed production appears great and could provide another very beneficial management tool.

The third question of interest is "when" will such compounds be available. At present, indications are that these products will be developed for potential agricultural use. Much remains to be done to establish a basis for registration. 1984 would be the earliest target date for availability for such compounds and, of course, this would depend upon progress made in the development effort. It is likely that these or compounds like them will soon be available to increase our management ability of crop stands for more efficient economic yield.

Conclusions: The results over the past two years with grass seed crops allow us to make the following conclusions: 1) Growth retardants can be used to reduce delay or eliminate lodging; 2) they reduce primarily stem growth and dry matter with little effect on leaf area or number; 3) at proper rates, they do not reduce reproductive development and, in fact, may increase potential yield; and 4) growth retardant applications enhance seed yield primarily by producing more fertile tillers per unit area and providing conditions for better seed filling.

We wish to recognize the following for their support of this research:
ICI Americas, O.M. Scott and Sons, and US Golf Association through Pickseed West.
We also appreciate contribution of chemical for the experiments by Elanco.