1984

SEED PRODUCTION RESEARCH

AT OREGON STATE UNIVERSITY
USDA-ARS COOPERATING

Edited by Harold W. Youngberg

Contents

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Introduction

The third edition of Seed Production Research at Oregon State University, USDA-ARS Cooperating includes reports of work from the Agricultural Experiment Stations in central Oregon and eastern Oregon as well as from the central Station at Corvallis.

We acknowledge the financial support of the Oregon Seed Council for the significant grant in support of printing this report.

National Forage Seed Production Research Laboratory

R. E. Welty, USDA-ARS

The United States Department of Agriculture, Agricultural Research Service will construct a research facility on the campus of Oregon State University. The facility will house research programs in plant pathology, weed science, entomology, agricultural engineering, and seed physiology. The facility will include an office-laboratory and a greenhouse-headhouse complex. Planning has reached 50 percent of design, with pre-final and final design to be agreed upon by March 15, 1985. Bidding is expected to last three months, and construction is planned for 18 months. Without unexpected delays, the building is expected to be completed and ready for occupancy by December 31, 1986. The second phase of the program calls for an increase in scientific and technical support by adding five new forage seed projects at Corvallis and five new forage seed projects to be located elsewhere in the Northwest. The new programs planned for Corvallis will be housed in the new laboratory. At the present time, Congress has not appropriated funds for these new positions.

Disease Control in Grasses Grown for Seed

R. E. Welty, M. D. Azevedo, and James T. Hayes, USDA-ARS, U.S. Dept. of Agric., Agric. Res. Service

Orchardgrass

Three experiments were done in 1983-84 at Hyslop Crop Science Field Laboratory to evaluate fungicide control of the leaf and head blight disease in two cultivars. In the first study, a single-rate application of each of three fungicides was applied to cv. Potomac at three stages of plant development (late boot, 100% head emergence, and 100% flowering) in 1, 2, and/or 3 spray combinations. One or more applications of Bravo (3 pt/a) at the late-boot or 100% head-emergence stage resulted in significantly (P = 0.05) higher seed yields and lower disease scores than the non-sprayed checks. Two or three applications of Difolatan (1.5 lb/a) that included the late-boot and 100% head-emergence stages resulted in significantly higher seed yield than the checks. Single applications at the late-boot or 100% head-emergence stage resulted in significantly lower disease scores, but lower disease scores were not reflected in significant increase in seed yield; however, seed yields were slightly higher from fungicide-treated plants. Two or three applications of Tilt (8 oz/a) increased seed yields, but had no significant effect on disease scores. All fungicide applications resulted in larger 1000 seed weights vs. non-sprayed controls with a 15% increase for Bravo and a 10% increase for Difolatan. The most effective single application for all three fungicides was that applied at 100% head emergence.

In the second experiment, the same fungicides and applications were used for cv. Pennlate. Head and leaf blight was not observed on Pennlate on June 29, 1984, or when the plots were harvested on July 19, 1984. Rust was severe, and plants were scored (0-4 scale) on June 29, 1984. Application at 100% head emergence and 100% flowering, or three applications of Tilt resulted in less rust than the check (14%, 10%, and 43%, respectively), but yield and 1000-seed weights were not statistically different (P = 0.05). None of the Bravo or Difolatan treatments resulted in less rust or significant increases in yield compared with the non-sprayed checks.

In a third study, eight cultivars were sprayed three times with Bravo (3 pt/a) on April 13, April 26, and May 16 (early sprays); or on April 26, May 24, and June 11, 1984 (late sprays). Comparing the yields from plots receiving three early or three late sprays vs. the non-sprayed checks (averaged for cultivars), Hallmark and Potomac early sprays increased yield 15%; three late sprays increased yields 49%. Yields of late-maturing cultivars (Able, Latar, Pennlate, and Frontier) indicated early sprays increased yields 47% and late sprays increased yields 12%. Blight was generally more severe on early maturing cultivars. Rust was generally more severe on late-maturing cultivars. When comparing yields of Juno and Aonami, it was shown that late sprays resulted in a 28% increase in yield compared with an 8% increase for early sprays.

These results (three experiments) are based on a one-year study and should be evaluated as such. Plans are to repeat these studies with some modifications.

Endophyte

The seed-stain technique was compared with ELISA for detecting endophyte in seeds of tall fescue and ryegrass and for determining levels of endophyte infection in seed lots. The seed-stain method was found to be reliable and accurate and can be economically performed by trained personnel. The method is currently used for endophyte detection by the Oregon Department of Agriculture for endophyte labeling and in the Oregon State University Seed Laboratory for seed analysis. Others using the seed-stain method include Missouri, Mississippi, and Alabama. Work is proceeding to develop an accurate and rapid grow-out method suitable for detecting viable endophyte in seeds.

A storage study (3 temperatures and 5 moisture contents in all combinations) was established with tall fescue and ryegrass seed with high initial levels of viable endophyte. Seeds are tested monthly. The study has progressed for 8 months, but results are too preliminary to summarize at this stage.

Research done in cooperation with the Oregon Agricultural Experiment Station.

Mention of a commercial or proprietary product does not constitute an endorsement of the product by the USDA.

Seed Pests of Clovers Used in Rotation with Grasses

James A. Kamm

The acreage of white and red clover has increased the past several years in rotation with grass seed crops. If you raise clover seed, you will likely have trouble with insect pests. Some pests produce no observable damage symptoms until harvest, and often low yields are attributed to poor pollination. Studies are now in progress on the clover seed chalcid to identify new ways to reduce seed loss due to this pest. Before discussing this work, a brief review of pests that attack flowers, pods, or seeds will help put in perspective insect damage in different clovers and also aid in diagnosis of the problem (Table 1).

Since it is possible to distinguish damage symptoms of these pests but not until after the damage is done, fields must be monitored with an insect net. Infestations of lygus bugs, nitidulids, and clover seed weevil can be assessed in this way and controlled with an appropriate spray program. No monitoring is necessary for the midges since cutting an early hay crop is essential to avoid damage by these pests. Infestations of clover seed chalcid are particularly difficult to assess. During harvest, significant amounts of larval-infested seed go out the back of the combine since these seeds are often lighter than viable seeds. However, some infested seeds are similar in weight to good seed and cannot be removed during cleaning, which creates problems in the export market because infested lots are rejected.

Presently we are close to identification and synthesis of the clover seed chalcid phermone and expect to conduct initial field tests in 1985. Our first objective is to develop monitoring traps so clean fields can be identified and that seed used for export. Also, fields known to be heavily infested may benefit from light harrowing to bury infested seed and prevent emergence of adults the following year. A second objective is to determine the source of chalcids other than clover fields. Most chalcids are believed to originate in cultivated red clover. In most fields, the first generation is relatively low compared with the number of chalcids in the second generation. If a significant number of males can be removed from the first generation by trapping, unmated females in the first generation will lay eggs destined to become males. Only the second-generation chalcids infest the seed crop to reduce yields. If the population is predominantly male, few eggs are laid and thus fewer seeds are destroyed.

Table 1. Insect pests of specific clover flowers, pods, and seeds.

Host/insect	Damage or symptom	Control
Red Clover		
Clover seed midge (*Dasineura leguminicola*)	Florets fail to open, lopsided heads, no seed	Cut for hay first week in June
Clover seed chalcid (*Bruchophagus gibbus*)	Light hollow seed, some with exit hole made by adult on emergence	None except sanitation
Nitidulid beetle (*Meligethes nigrescens*)	Chewed florets, brown flowers	Timed application of insecticide
White and Alsike Clovers		
Ladino clover seed midge (*Dasyneura gentneri*)	No seed set	Cut for hay first week in June
Clover seed weevil (*Miccotrogus picirostris*)	Seed firm except for feeding holes	Timed application of insecticide
Nitidulid beetle (*Meligethes nigrescens*)	Chewed florets, brown flowers	Timed application of insecticide
Lygus bugs (*Lygus* spp.)	Flowers normal but seed shriveled	Timed application of insecticides

Seed Conditioning Research[1]

A. G. Berlage, P. Krishnan, D. M. Bilsland, and T. M. Cooper, USDA ARS

This project is involved in both basic and applied seed conditioning research. Physical property data are acquired for both crop and contaminant and then applied to seed separation problems.

Experimental Indent Cylinder for Separating Seeds

Earlier research showed that pigweed could be effectively removed from alfalfa with no plugging of the special indent cylinder. Investigations continued on the special indent cylinder to remove Bermudagrass seed not in the hull (groats) from seed in the hull.

A blended Bermudagrass mixture was subdivided with a Boerner divider to obtain a representative 5-kg test lot. The same sample was used for all tests, and two runs were made for each set of test conditions. To insure that lot composition was not changing with use, purity analyses were made during the trials.

Separation results with the Bermudagrass cylinder were obtained at three cylinder speeds, three feed rates, three cylinder slopes, and three collector heights. Cylinder speeds were 15, 20, and 25 r/min. Average feed rates were 0.10, 0.20, and 0.30 t/h. Cylinder slopes were 3, 6, and 9 deg from horizontal. Collector lip heights were 111 mm (4.38 in.), 216 mm (8.50 in.) and 324 mm (12.75 in.) from the bottom of the cylinder.

Test runs were conducted using all combinations of the variables. Eighty-one combinations of machine settings were examined with two runs of each combination. In contrast to the alfalfa trials, the lifted fraction (mainly groats) was the desired component of the Bermudagrass mixture. This fraction was lifted into the collector, weighed, and analyzed for purity. The unlifted fraction (mainly seed in the hull) passed through the machine and was collected. Additional passes were not made since preliminary results indicated a good separation with a single pass. The quality of Bermudagrass separations was evaluated by determining weights and purities of separated fractions. Table 1 shows four examples of test-run data. Contaminant removal and crop loss figures serve to evaluate the machine performance related to cylinder speed, cylinder slope, feed rate, and collector height.

Contaminant removal was influenced significantly by collector height and cylinder slope. The contaminant removal was directly proportional to collector height and cylinder slope. Cylinder speed and feed rate had little effect on removal of contaminant.

Crop loss was influenced significantly by collector height, cylinder slope, cylinder speed, and feed rate. Crop loss was directly proportional to collector height, feed rate, and cylinder slope, and indirectly proportional to cylinder speed.

The best separating performance for the Bermudagrass cylinder is characterized by maximum contaminant removal and minimum crop loss. With Bermudagrass, the contaminant is seed in the hull, and the crop is seed not in the hull (groats). Bermudagrass seed not in the hull is desirable because the groats germinate more readily than seed in the hull. In typical conditioning of Bermudagrass, seed lots are passed through hulling units which remove hulls from some of the seeds. Seeds without hulls then must be separated from those with hulls as illustrated by the Bermudagrass mixture of this investigation. Once separated, seeds with hulls can be passed again through the hulling machine to produce more of the desired groats.

The greatest allowable level of seed in the hull for the final Bermudagrass product is 0.5%. This means that the minimum acceptable purity is 99.5% groats. Approximately one-third of the 81 test combinations produced final purities of 99.5% or more. Within this group, the optimum separating condition would be the one with minimum crop loss. On this basis, the best was test 3 which showed 98.6% contaminant removal and 27.1% crop loss. Cylinder speed was 25 r/min, cylinder slope was 9 deg, feed rate was 0.10 t/h, and collector height was 216 mm.

The purity of the final product from this run was 99.6% groats and 0.4% seed in the hull, by weight. Even though the required purity was readily achieved with one pass through the cylinder, the separation would be improved by reducing crop loss. Three techniques have potential for reducing this loss. The reject fraction (unlifted) can either be rerun one or more times through the cylinder at the indicated best machine settings, or cylinder adjustments can be made that tend to reduce crop loss. These include lower settings of collector height, feed rate, and cylinder slope, and a higher setting of cylinder speed. However, these adjustments also tend to reduce contaminant removal and final purity. A different approach is to rerun the reject fraction through the hulling machine and then the cylinder. This gives the cylinder an opportunity to reduce crop loss by reclaiming groats not lifted earlier, and at the same time, to pick up groats newly produced from otherwise reject material, thereby increasing the total percentage of crop recovered.

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[1]Contribution of the Oregon Agricultural Experiment Station in cooperation with the Agricultural Research Service, U.S. Dept. of Agriculture.

Table 1. Bermudagrass Cylinder Test Data

Test no.	Cylinder speed	Cylinder slope	Feed rate	Collector height	Contaminant removal[1]	Crop loss[2]	Final purity
	(r/min)	(deg)	(t/h)	(mm)	(%)	(%)	(%)
97	15	9	0.30	324	99.8	85.7	99.7
122	20	6	0.20	216	98.3	38.6	99.4
156	25	3	0.10	111	92.0	6.3	98.2
75	25	3	0.10	111	86.7	4.1	97.1

[1]Percentage of total contaminant by weight

[2]Percentage of total crop seed by weight

Separation of Shells from Walnut Meats Using Magnetic Methods

Magnetic separation research was continued. Dried walnuts received in the plant are sized, cracked, and conditioned through air separators, color sorters, and pin machines. Final grading is done on a picking table, and shells are removed by hand. The finished product contains no more than two shell pieces per 2.27 kg (5 lb) of meats, which is within the USDA standard of 0.05% by weight. Shell pieces have the same size and color as meats and pose problems in marketed products like candies, bakery goods, etc.

An alternative to the present conditioning procedure would be to treat whole nuts before cracking so they appear different from meats when cracked. One technique would be to coat the whole nuts with glue and iron powder or magnetic fluid and dry them. Coated nuts could be cracked and passed over a magnetic drum or belt and (if necessary) through a pneumatic separator to separate the meats from shells and membranes. This procedure may help remove small shell pieces from the meats.

The purpose of this research was to study the feasibility of using iron powder and magnetic fluid to remove shells from walnut meats. Privately developed methods and equipment, utilizing non-toxic glue and iron powder, were used to coat whole walnuts with iron powder. Alternately, a 1:1 mixture, consisting of 125 ml of water and 125 ml of magnetic fluid with 10 g non-toxic gelatin powder, was used to coat walnuts for the magnetic fluid treatment. Coated (both iron powder and magnetic fluid) nuts were cracked in a commercial nut cracker. Treatments were replicated five times. Control walnuts were not treated with iron powder or magnetic fluid. Cracked walnuts (including the control) were conditioned over the permanent magnetic drum separator two times. Analyses were done to determine percentage shells and membranes removed along with percentage walnut meats recovered. Iron analyses were carried out on walnut meats. Both iron powder and magnetic fluid removed essentially all shells from walnut meats. However, both require Food and Drug Administration approval as food additives.

Link-Supported Vibrating Deck

The vibrating separator is an important machine for the seed conditioning industry, making separations that are difficult or impossible with other equipment. The need for a machine to better study the process involved in vibratory separation was demonstrated by review of several attempts to increase the capacity of vibrating deck separators and study of an excitable oscillating deck operating near its resonant frequency.

A link-supported oscillating deck was constructed to provide a predictable motion for study of the vibrating separation process. This deck was designed to give a stable relationship in the phase angle between the horizontal and vertical component of deck surface motion independent of frequency or amplitude of vibration. An electrodynamic shaker is used to drive a vibrating deck separator with a sinusoidal signal of variable frequency and amplitude. A tiltable structure was designed, constructed, and tested to support the linked deck and the electrodynamic shaker. Testing indicates that deck motion in the vertical direction is influenced by the support structure.

Seed Recognition Potential of Machine Vision Systems

Many seed-conditioning problems involve removing contaminants that are very similar to the desirable crop seed. A zero tolerance exists for some noxious contaminants. Limitations of 0.05% or less are not unusual. Seed lots not meeting purity requirements must be discarded or sold at discount. A commercial vision system with appropriate image processing software is being used to determine its potential to distinguish slight differences between crop seeds and their contaminants.

A crop/contaminant mixture with slight color, silhouette, and shape differences was used to evaluate the recognition algorithms. A basis for future machine vision research was established. The need for proper illumination was demonstrated as was the need to increase processing speed through simplified algorithms or high-speed hardware. Machine vision systems (MVS) have potential for seed-conditioning research and commercial application in seed testing labs and conditioning plants.

Seed Production Research at the Central Oregon Experiment Station

J. Loren Nelson

Seed production research at the station is conducted almost entirely under one project, "Improving the Efficiency of Kentucky Bluegrass Seed Production in Central Oregon."

Recent and current studies include (1) the assessment of mechanical and chemical methods for the control of volunteer Kentucky bluegrass plants and other grasses in Kentucky bluegrass seed fields, (2) a follow-up on plots from a Parley experiment to determine residual effects, (3) nitrogen rate and timing experiments, (4) foliar fertilization as supplement to soil fertilization, (5) post-harvest residue management, and (6) a fall regrowth management test.

Control of Volunteer Kentucky Bluegrass

An experiment was conducted at Madras in cooperation with Orvid Lee, USDA-ARS, to control volunteer Kentucky bluegrass by mechanical and chemical methods, alone and in combination. This research was reported in Agricultural Experiment Station Special Report 717. If volunteer Kentucky bluegrass prevents certification of seed fields in Central Oregon, the problem can be overcome by spring planting coupled with various herbicide and tillage treatments to control volunteer Kentucky bluegrass that comes from seed in the soil. Future research may be conducted to find more efficient and effective techniques to control volunteer plants.

Residual Effects of Parlay (PP-333) on Mystic, Rugby, and Merit Kentucky Bluegrass

The integrity of plots from an experiment conducted in 1982 to evaluate the effects of Parlay applied at three rates each on two dates was maintained for an additional year to determine residual effects on Mystic, Rugby, and Merit Kentucky bluegrass. The test was conducted on the Madras site of the Central Oregon Experiment Station which has a Madras loam soil. All plots were managed in the conventional manner for bluegrass seed production in Central Oregon following the 1982 seed harvest. On September 8, 1982 ten, 10 cm-deep soil cores were taken at random from each plot with a standard soil sampling probe. Each core was divided in half for bio-assay analysis of each 5 cm depth in Dr. David Chilcote's laboratory. Soybean was used as the assay plant. All soil samples were later sent to ICI Americas laboratory for further analysis.

A slight shortening of the lowest internode on the soybean plant occurred when grown on soil from the top 5 cm depth from plots treated with .3 kg/ha of Parlay compared to no internode shortening on soybean plants grown on the soil from the lowest sampling depth.

The fall regrowth of each bluegrass cultivar appeared to be shorter on the plots in some replications which had been treated with .3 kg/ha, however, these differences were not observed on the spring regrowth. No significant height reduction on July 15, 1983 was found from any cultivar on plots with .150 and .3 kg/ha Parlay (Table 1).

There was no significant difference for seed yield and its components in 1983 or 1982. These observations indicate that small quantities of Parlay may persist in the top 5 cm of soil for 4-6 months.

Table 1. Height of Mystic, Rugby and Merit Kentucky Bluegrass from three rates of Parlay each on two dates at Madras, Oregon

Application		Mystic		Rugby		Merit	
Date	Rate (kg/ha)	1982	1983	1982	1983	1982	1983
		(cm)					
Check		67.4	79.3	79.8	89.3	61.9	68.7
Apr. 15, 1982	.075	66.5	80.3	79.6	89.3	58.0	68.7
May 6, 1982	.075	72.4	79.3	78.6	90.7	55.2	66.7
Apr. 15, 1982	.150	62.1	75.0	75.0	92.7	51.9	69.0
May 6, 1982	.150	60.7	81.3	69.9	92.0	41.1	65.0
Apr. 15, 1982	.300	52.4	72.7	52.4	91.0	34.2	65.3
May 6, 1982	.300	51.6	80.3	56.6	89.3	34.4	65.3
	Mean	61.9	78.3	70.3	90.6	48.1	67.0
	LSD .05	9.2	NS	8.7	NS	8.0	NS
	CV%	8.4	6.4	7.0	2.4	9.4	4.5

Nitrogen Rate and Timing Experiments

An experiment was initiated in the fall of 1983 to determine the effect of N rate and application time on the fourth year seed yield of Baron, Merit and Rugby Kentucky bluegrass. Similar studies in 1981, 1982, and 1983 on Parade Kentucky bluegrass did not show consistent beneficial results when compared to the standard practice of applying 200 lb N/A in the fall or splitting it between fall and spring. Seed yield data from the tests are available in OSU, Agricultural Experiment Station Special Report 717, "Irrigated Crops Research in Central Oregon — 1984."

The rate and time of N application in 1983-84 are shown in table 2. Ammonium Nitrate was the N source. Higher N rates were used than in the previous experiments on Parade bluegrass. Four above-ground bio-mass (tiller) samples, each 21 x 76 cm, were taken November 28, 1983 per plot in each of the three replications. The average tiller dry matter yield was significant at the .01 level of probability among treatments for Baron and Rugby according to the F test. The standard fertilization practices (Treatment no. 17 and 19) give similar tiller yields (Table 2). No other treatment produced more tiller yield than the standards except treatments 2 and 6 for Baron Kentucky bluegrass. These data will be compared with information on seed yield and its components after collection.

Foliar Fertilization as a Supplement to Soil Fertilization

Experiments on Baron Kentucky bluegrass in 1982 and Merit in 1983 showed no beneficial effect on seed yield and its components from applications of foliar nutrient sprays compared to the soil fertilized control (see OSU, AES Special Report 717). Another experiment was conducted in 1984 on Merit Kentucky bluegrass in which two applications of foliar sprays were made, one at early boot and the other at pollination of the bluegrass, for a single treatment. In prior tests all foliar sprays were applied only once when the bluegrass was in the boot stage or at various stages of development. The recommendation for many foliar nutrient sprays is for multiple applications at different growth stages during the same season. Therefore, the treatments in the 1984 test were changed to simulate these recommendations. Data collection and analysis has not been completed.

Table 2. Effect of nitrogen rate and timing on fall tiller dry matter yield for Baron, Merit, and Rugby Kentucky bluegrass at Madras, Oregon.

Trt. No.	Nitrogen Application Date/Rate (lb N/A)		Tiller Dry Matter Yield[1] Baron	Merit	Rugby
			(g)		
1	9-15-83/30	10-19-83/170	2.03	3.37	2.17
2	60	140	3.00	3.03	2.33
3	90	110	2.50	2.63	2.97
4	30	200	2.60	2.67	1.70
5	60	200	2.57	3.20	2.10
6	90	200	3.00	3.37	2.90
7	10-3-83/30	3-2-84/170	2.33	2.50	1.47
8	60	140	2.03	2.47	1.57
9	90	110	2.73	3.00	2.17
10	10-19-83/30	170	1.53	2.43	1.90
11	60	140	2.17	1.80	1.60
12	90	110	2.63	2.53	1.87
13	0	0	1.23	1.70	1.40
14	30	0	1.70	2.40	1.23
15	60	0	1.67	1.67	1.33
16	90	0	2.43	2.03	2.20
17	100	100	1.83	2.57	2.10
18	150	50	1.57	2.50	1.40
19	200	0	2.17	2.60	2.30
		Mean	2.20	2.55	1.93
		LSD .05	.82	1.06	.83
		CV %	22.5	25.0	26.1

[1]Samples for tiller dry matter yield were taken on November 28, 1983.

Post Harvest Residue Management

Conditions prior to or after combining may cause the Kentucky bluegrass plant to remain green, or to initiate regrowth, before the normal post harvest residue removal by open field burning. In addition, if natural drying of the field does not occur, growers must resort to some method of drying the regrowth such as the use of chemical desiccants or propane flaming. Under these conditions seed producers have experienced varying degrees of success in achieving good field burns and subsequently sustaining good seed yields. Therefore, a study was initiated at Madras in 1981 to assess the effect of regrowth drying by different temperatures, desiccants, and clipping on the seed yield of Kentucky bluegrass. The effect of these treatments is being determined on six varieties—Merit, Baron, America, Parade, Rugby, and Mystic.

Preliminary observations indicate that actively growing bluegrass plants with 6-14 inches of leaf growth can be dried and burned without decreasing seed yield the following year if drying and burning occur early enough to allow good fall tiller development. Paraquat at 1 qt/a is a more effective desiccant than Contact (dinitro-) at 2 qt/a. Presently it does not appear that paraquat has decreased the seed yield of the six cultivars tested. This research will continue for another year.

Fall Regrowth Management

Applications of Parlay (PP-333) at .125 and .25 lb/a were made on Merit, Baron, Parade, America, Mystic, and Rugby Kentucky bluegrass August 26, 1982 to evaluate its effectiveness in reducing the height of fall regrowth. A fertilizer application of 25-10-0 to give 60 lb N/a was made to insure good regrowth. All plots were sprinkle irrigated with two inches of water. Good soil moisture was maintained by irrigation through October.

About eight inches of regrowth was obtained on all plots. Parlay at the two rates did not reduce the height of regrowth on any of the cultivars. It may be that the ash on the soil surface from the field burn and/or the 3.5 lb/a of Banvel herbicide applied also on August 26, could have interferred with the activity of the Parlay.

Future research on the control of fall regrowth by nitrogen fertilization, irrigation, defoliation, etc. may be conducted if resources are available.

Meadowfoam Studies in the New Crops Research Project

Gary D. Jolliff

Increased seed yield level and stability will be important for the establishment of a profitable (and competitive) meadowfoam crop production industry. Definition of the factors which limit seed yield is an important initial step toward improvement. Interspecific hybridization of *Limnanthes floccosa* × *L. alba* for the purpose of increasing self-pollination in the *L. alba* plant type has not yet resulted in a self-pollinating plant type, however several of the progeny have had seed yields high enough to be of interest.

Currently the focus of research is on the effects of temperature on embryo sac development and seed set. This has been made possible during the past two years through the development of standard methods for growing meadowfoam plants under controlled conditions. A controlled environment growth chamber which was purchased in 1983 was installed recently and is now operational. It will give the added capability to investigate the influence of light intensity and relative humidity on meadowfoam growth, flowering, and seed set.

Small-scale preliminary field trials using honeybees confined in walk-in cages for controlled pollination were successful in producing seed. The use of caged bees for pollination of isolated breeding lines is being investigated for both field and greenhouse conditions.

The Oregon State University Foundation Seed Project reported clean seed yield in commercial acreages of the "Mermaid" cultivar from the growers in 1984, ranging from 523 to 806 pounds per acre. The yield of "Mermaid" from replicated research plots at the Hyslop Crop Science Field Laboratory was 1451 pounds per acre. The reasons for the differences in seed yield are not known.

The 1983 N, P, K fertility study showed no seed yield response to potassium, a small effect of phosphorus on seed size, and no interactions between phosphorus, potassium, and spring-applied nitrogen. Nitrogen at 50 kg/ha increased seed yield, seed size, and lodging above the control, while the 100 kg N/ha was intermediate in performance.

Overcoming Seed Dormancy in Meadowfoam to Facilitate Early Fall Planting

J. F. Aristizabal and D. F. Grabe

Meadowfoam seed is notorious for poor germination at warm temperatures. For this reason, seeding of meadowfoam is usually delayed until mid-October to obtain the cool soil temperatures required for successful stand establishment. If seed dormancy problems related to warm temperatures can be overcome, the crop could be seeded earlier, resulting in more vigorous stands and bigger plants going into the winter season. Earlier seeding would reduce the risk of fall rains and cold weather which delay planting and necessary fall growth and development.

The overall objective of this project is to reduce the temperature-related dormancy problems of meadowfoam to facilitate early fall planting, establishment of optimum stands and maximum crop yields. The first step in accomplishing this is to thoroughly characterize meadowfoam seed dormancy as to its causes, duration, and methods of overcoming.

Three seed lots were selected as being representative of present varieties and of breeding material likely to be utilized in development of future varieties. Those include *Limnanthes floccosa, L. alba* variety 'Mermaid,' and a *L. floccosa* × *L. alba* cross. All seed was harvested in 1983.

Effect of Temperature

Seeds were germinated at constant temperatures of 10, 15, 20, 25, and 30°C (50, 59, 68, 77, and 86°F). Large differences in germinability were evident among seed lots. Germination of *L. alba* and *L. floccosa* × *L. alba* was between 70 and 80% at 10°C and between 50 and 60% at 15°C. Germination of *L. floccosa*, however, was only 17% at 10°C and 11% at 15°C. No germination occurred in any of the lots at 20, 25 or 30°C. Prechilling the seeds at 5 or 10°C for 7 days, however, allowed the seeds to germinate at 20 and 25°C. Prechilling also allowed rather good germination to occur at the relatively warm alternating temperatures of 15-25 and 20-30°C (Table 1).

Table 1. Germination of meadowfoam at warm temperatures after prechilling at 10°C for 7 days.

	Germination temperature			
	20°C	25°C	15-25°C	20-30°C
L. alba	55	64	71	30
L. floccosa	24	18	25	16
L. floccosa × *L. alba*	46	38	67	35

Effect of Growth Regulators

Five chemical growth regulators—potassium nitrate, gibberellic acid, ethephon, kinetin, and thiourea—were evaluated for their ability to overcome seed dormancy. Several concentrations of each chemical were evaluated. Optimum concentrations for promotion of germination without causing damage to the seeds were 0.2% potassium nitrate, 0.1% thiourea, and 400 ppm gibberellic acid. Kinetin and ethephon were not beneficial.

Effect of Light

Exposure to light promotes the germination of many dormant species, particularly grasses. When meadowfoam was exposed to light at 15°C, however, germination was inhibited. Eight hours of light each day reduced the germination of *L. alba* from 33% to 21%, while 24 hours daily exposure almost completely inhibited germination. The reaction of the other seed lots was similar.

The addition of potassium nitrate to the substratum reversed the inhibitory effect of 8 hours of light at 10°C.

Effect of Seedcoat Removal

Removal of the seedcoats increased germination by 30, 14, and 5% in *L. floccosa, L. alba* and *L. floccosa* × *L. alba*, respectively. Seedcoats are thus partially responsible for dormancy, but they are not the only cause.

Conclusions

The need for cool temperatures for germination of meadowfoam has been confirmed, supporting the present recommendation of delaying planting in the fall until soil temperatures are cooler.

The variety Mermaid (*L. alba*) and the cross of *L. floccosa* × *L. alba* were the least dormant seed lots, while *L. floccosa* was extremely dormant. This indicates that selection against the dormancy trait has been, and can be, successfully accomplished in variety development programs.

The growth regulator and prechilling studies indicate there is a potential for developing seed treatment procedures that will improve stand establishment when meadowfoam is planted in warm soils.

This research was partially funded by a grant from the Oregon Department of Environmental Quality.

Soil Fertility Management for Meadowfoam Production

E. H. Gardner, J. L. Hunter, and M. A. Stoltz

A series of field experiments to study the soil fertility requirements of meadowfoam were established in growers' fields in the fall of 1983. A total of 6 experiments were located on 5 different soil series. Seed was harvested from 5 experiments in mid-July, 1984; one experiment was abandoned due to severe stand depletion as a result of low winter temperatures and "heaving" of plants. Seed yields resulting from fertilizer and lime treatments were obtained for the Amity, Dayton, Nekia, Stayton, and Coburg soil series. Soil test values for each of the plant nutrients P, K, B, Zn, Ca, and Mg ranged from very low or low to moderate or moderately high and pH values indicated that the soils ranged from strongly to moderately acid.

A comparison of average yields across all soil series indicates that meadowfoam was not very responsive to fertilizer and lime treatments.

The plots on the Coburg soil series produced the highest average seed yield of 1058 lb/a and the Amity plots gave the lowest yield, 600 lb/a. Plant stand intensity was lower on the Coburg than the Amity, Nekia, and Stayton soils. Stands on some of the plots on the Dayton soil were reduced by surface flooding and run-off. Poor pollination was probably a problem with the denser stands as many flowers were covered by dense foliage and not pollinated.

Nitrogen fertilizer application depressed seed yields on the Amity soil where a dense stand combined with increased vegetative growth resulting from N fertilization resulted in poor exposure of flowers and resulting probably poor pollination (Table 1). N fertilizer increased yields on the comparatively sparse stand on Coburg soil with 50 lb N/a spring applied giving optimum response. Fall applied N was not effective. There was indication of a slight response to spring applied N on Nekia soil where 25 lb/a appeared optimum. A significant response to N was not recorded on the Stayton soil. N fertilizer increased plant growth at all locations.

Table 1. Response of meadowfoam seed yield to spring applied nitrogen.

N Application	Yield of Meadowfoam Seed				
	Soil				
	Amity	Dayton	Nekia	Stayton	Coburg
(lb/a)	(lb/a)				
0	738	836	862	792	705
25	697	915	901	782	951
50	540	811	796	747	1123
100	524	766	830	740	1160
LSD .05	108	NS	NS	NS	199

P, K, S, B, and Zn fertilizers failed to significantly increase seed yields in spite of low soil test values for these nutrients at some locations.

The soils ranged from strongly to moderately acidic but liming failed to significantly increase seed yields. A yield increase resulted from liming on the Coburg soil which was strongly acid. Meadowfoam, therefore, has good tolerance to soil acidity.

Wet soil conditions were experienced at the Dayton and Coburg locations and meadowfoam exhibited good tolerance to these conditions.

Rate and Time of Spring-Applied Nitrogen on Linn and Pennfine Perennial Ryegrass

W. C. Young III, D. O. Chilcote, and H. W. Youngberg

An understanding of the effects of spring nitrogen fertilizer rate and time of application is important to develop management systems to increase efficiency in perennial ryegrass seed production. Research during the last three years has investigated the effect of spring nitrogen rates between 0 and 214 lb/a applied during the vegetative phase, after the transition to reproductive development, or split applications at both stages of crop growth. Two cultivars of perennial ryegrass were used throughout the study: Linn, an early maturing forage cultivar, and Pennfine, a turf-type cultivar which matures several days later.

Total tiller number at anthesis was generally increased as higher rates of early spring nitrogen were applied. However, increased stand density at anthesis usually was due to a greater percentage of vegetative tillers, and did not result in a significant change in fertile tiller number at maturity. Tiller number at anthesis was not influenced as significantly when nitrogen application was delayed until after the transition to reproductive development, although fertile tiller number at maturity was often reduced by high rates of late-spring nitrogen. These effects on fertile tiller number at maturity were probably due to increased inter-tiller competition and more severe lodging, both of which contributed to tiller mortality. Split spring applications totaling 107 to 134 lb/a appeared most likely to insure adequate stand density at anthesis without increasing fertile tiller mortality as the crop matured.

Additional yield component analysis revealed a greater number of spikelets per spike where early-spring nitrogen was applied, and an increased number of florets per spikelet following later-spring nitrogen. Thus, the potential number of seed sites were uniformly increased by applying nitrogen at either morphological stage of crop development. Floret fertility in all treatments was initially about 61%, but by final harvest had decreased to 20-32%. This reduction was likely due to loss of lighter weight seed during harvest and cleaning. Furthermore, the weight per 1000 seeds generally decreased as the actual number of harvested seeds increased.

Seed yield was affected less dramatically than the individual components of yield due to compensation among yield components. Thus, at low fertile tiller densities, a greater number of spikelets per spike, florets per spikelet, or increased seed weight, combined to maintain seed yield. Conversely, higher fertile tiller densities did not necessarily translate into improved seed yield. Furthermore, when the tiller population was greater, individual tillers were frequently smaller and more likely to lodge early, which reduces the efficiency of seed production. Generally, a linear yield increase was associated with increased spring nitrogen rates between 54 and 161 lb/a, regardless of the crop growth stage when applied. However, split spring nitrogen applications totaling 107 to 134 lb/a appeared to provide a better balance between compensating yield components, resulting in improved nitrogen efficiency while maintaining high seed yield.

Fertilizing Bluegrass for Seed Production in the Grande Ronde Valley

F. V. Pumphrey

Increased grass seed yields from improving cultural practices over the last twenty years prompted the resumption of fertilizer research. A series of experiments over a four year period are expected to provide information on how much nitrogen (N) fertilizer is beneficial to increasing seed yield and the need for phosphorus (P_2O_5) or phosphorus plus potassium (K_2O) in addition to nitrogen.

First year results indicate near maximum bluegrass seed yield from 120 pounds per acre N applied in early November. Less than 100 pounds of additional seed was obtained from applying 160 pounds per acre N in early November or dividing the N into 120 pounds fall applied plus 40 pounds in March compared to 120 pounds N applied in early November.

All P_2O_5 and K_2O and 15 pound per acre N were applied post burn and prior to the initial fall irrigation. Forty or 80 pounds per acre of P_2O_5 increased seed yields less than 100 pounds per acre. Forty or 80 pounds K_2O decreased seed yield less than 100 pounds per acre.

Evaluation of a Propane Flamer Modification

H. W. Youngberg, C. C. Moon, and D. T. Ehrensing

This study was conducted to evaluate the effectiveness and cost of operation of a modified propane flamer constructed by Mr. Willard Smucker under a contract with the Oregon Department of Environmental Quality. The major changes included the hood design to conserve heat and reduce fuel consumption, the sloping shield to concentate heat on the soil surface, and a 30-foot wide stainless steel hood to increase the width of coverage. A mild steel frame was used to reduce construction cost. Other specifications are shown in Table 1.

Table 1. Specifications of flamers tested.

Flamer	Shield			Fuel consumption	
	width	length	height		
	(ft)	(ft)	(in)	(gph)	(gpa)
Modified	30	8	20	120	8.25
Standard	18	4	4-5	80-85	9.20

The modified flamer was compared with the standard mint flamer in field tests. During field testing, the improved flamer operated efficiently at a ground speed of 4 miles per hour (mph). Fuel consumption was 120 gallons per hour (gph) and the 80 gph for the modified and standard the mint flamer, respectively, when operating at 4 mph and 35 pounds per square inch (psi). Since the modified burner was two-thirds wider, the fuel consumption was reduced from 9.2 gpa for the standard mint flamer to 8.25 gpa for the modified burner when operating at 4 mph. There were no differences in effectiveness of the two units based on measurement of temperature and evaluation of regrowth and weed development.

The comparative cost of the modified propane flamer and the standard mint flamer was estimated to be $7.83 and $9.84 per acre, respectively, resulting in twenty percent reduction in operating costs for the modified flamer. This study demonstrates the opportunity for improvement in flamer design to reduce the cost of grass field sanitation with flamers.

Acknowledgement: This study was supported by the Field Burning Research Committee of the Oregon Department of Environmental Quality.

Electrophoresis for Identification of Varieties and Species of Ryegrass (*Lolium spp.)*

Janet M. Ferguson and Don F. Grabe

The number of varieties of ryegrass (*Lolium spp.*) has increased greatly in recent years. An accurate and rapid laboratory technique to identify these varieties would benefit the consumer as well as protect an organization's Plant Variety Protection rights. There is also a need for a technique to complement the seedling fluorescence test to differentiate annual (*L. multiflorum* Lam.) from perennial (*L. perenne* L.) ryegrass. The purpose of this work was to develop electrophoretic procedures which would identify varieties of perennial ryegrass, differentiate between annual and perennial ryegrass species and detect seed mixtures of these two species.

Water soluble proteins were analyzed using sodium dodecyl sulfate-polyacrylamide gel electrophoresis (SDS-PAGE). Extractions were made on ground seed from bulk samples and from single seeds.

In the perennial ryegrass identification study, 28 varieties were tested. Individual varieties were characterized by presence or absence of specific bands and by band intensity ratios calculated from densitometer scans. Most of the varieties were differentiated by unique banding patterns. The varieties 'Pennant' and 'Premier,' however, were not successfully differentiated from each other nor was 'Omega' found to be different from the variety 'Birdie.'

In a study to determine the feasibility of detecting mixtures of species, SDS-PAGE was conducted on 17 annual, 3 intermediate, and 28 perennial ryegrass varieties. The annual and intermediate varieties possessed two protein bands that were not found in any of the perennial varieties. Two bands were present in the perennial varieties that were absent or very faintly stained in the annual and intermediate varieties. The intermediate species could not be differentiated from the annual species.

Attempts were made to use SDS-PAGE to detect contamination of perennial ryegrass seed lots with small percentages of annual ryegrass seed. Annual and perennial ryegrass seeds were mixed together in different proportions to make concentrations of 0, 1, 3, 5, 10, 25, 50, 75, and 100% annual seed. Visible detection of the annual bands was possible in the mixtures of 25% or more annual seed. Densitometer scans could detect the presence of these annual bands in mixtures of 10%, but not in lower concentrations.

Protein extractions of individual seeds were electrophoresed to determine whether species mixtures can be detected on an individual seed basis. When individual seeds were used, the resulting banding patterns were different than those produced from bulk seed extracts from the same variety. Furthermore, no two seeds within a variety showed the same banding patterns. However, the two characteristic annual bands were still evident in most single seeds of annuals. Likewise, the two characteristic perennial bands were normally present in individual seeds of the perennials.

SDS-PAGE of water soluble seed proteins of ryegrass is a dependable procedure since banding patterns were not affected by year and location grown, class of certification, or viability or vigor of the seed. This one procedure can be used to differentiate varieties as well as species of ryegrass, making this SDS-PAGE system adaptable to seed testing needs.

This research was partially funded by a grant from Agriculture Service Corporation.

Cereal Crop Response to Plant Growth Retardants

D. T. Ehrensing, L. A. Morrison, D. O. Chilcote, and H. W. Youngberg

Experiments using growth retardants for yield enhancement of wheat and barley were continued in 1984 both in the Willamette Valley and in the Hermiston area. Previous work suggests that no significant yield enhancement can be expected from growth retardant treatments unless the crop lodges. In order to assess the potential of growth retardants under conditions that promote lodging these studies were conducted with high levels of nitrogen fertility, increased stand density, or a taller growing variety.

Several chemicals were used in these tests including CCC, Cerone, Parlay (PP-333), and XE1019 (a new experimental compound). XE1019 has a crop response similar to Parlay and was included in our studies for the first time this year. Timing of growth retardant applications were based on the Feekes Scale of cereal plant growth.

Wheat

A single trial was conducted in 1984 on Hyslop Crop Science Field Laboratory, Corvallis to determine the effect of several growth retardants on Yamhill wheat grown under conditions of high nitrogen fertility. A split application of nitrogen fertilizer (90 lb/a fall, 160 lb/a spring) was applied for a total of 250 lb of N/a. Parlay, XE1019, and CCC were all applied as reproductive development began (Feekes 5-6). XE1019 was also applied as the flag leaf emerged (Feekes 8). CCC and Cerone were applied in the early boot stage (Feekes 9-10). One treatment also included the combination of CCC at the early reproductive stage followed by Cerone at early boot stage.

All growth retardant treatments producing significant reductions in plant height ranging from 5-33%. No lodging occurred under any treatment in this trial. Yield ranged from 7521-8150 lb/a with no significant difference between the check and any treatment.

Barley

Three experiments were conducted at the Hermiston Experiment Station with Morex barley, a 6-row, tall-growing variety. Two experiments examined the effect of either Parlay or XE1019 in a high density planting. To achieve high plant density the field was cross-drilled for a total seeding rate of 180 lb/a and fertilized with 50 lb/a of nitrogen preplant followed by a 100 lb/a treatment after seedling emergence. The third experiment studied the interaction of nitrogen fertilization and Parlay treatment. The field was seeded in standard rows at a rate of 100 lb/a and treated with a preplant application of 50 lb/a nitrogen. Nitrogen was applied at 50 and 100 lb/a after seedling emergence in a split plot experimental design.

In each of the three experiments, lodging occurred in both the check and treated plots. The checks lodged shortly after anthesis, while treated plots generally lodged later in the seed filling period. Early lodging of the check plots was reflected in lower yields. The higher yield in the treated plots was attributed to a higher production of seeds per head and improved seed filling. No significant differences in tiller production were observed.

In the high density plantings, Parlay significantly increased yield at all growth retardant application rates (Table 1). Under the same conditions XE1019 did not significantly change plant height or grain yield. Timing and severity of lodging were not greatly affected due to minimal stem shortening from the XE1019 treatment. This lack of response is most likely due to low application rates of XE1019 rather than to effectiveness of the chemical. Yields from the high density planting trials were much lower than those in the normally seeded trial probably due to the extreme intra-plant competition that results from cross-drilling.

Table 1. Effect of Parlay treatment on height and yield of cross-drilled Morex barley, 1984.

Parlay Rate	Plant Height	Yield
(lb ai/a)	(in)	(lb/a)
0.00	50	3168
0.36	46	4310
0.53	41	4420
0.71	39	4493
0.89	39	4763
LSD .01	2	856

There was no significant interaction between post-emergence nitrogen rate and Parlay rate in Morex barley at the normal seeding rate. Plant height was decreased and yield was increased at all rates of Parlay (Table 2).

Table 2. Effect of Parlay treatment on height and yield of normally drilled Morex barley, 1984.

Parlay Rate	Plant Height	Yield
(lb ai/a)	(in)	(lb/a)
0.00	55	3921
0.36	48	5188
0.53	46	5331
0.71	43	6013
0.89	42	6045
LSD .01	2	575

Conclusions

Results obtained in 1984 support previous work with cereals which show that significant yield enhancement can not be expected from growth retardant applications unless lodging occurs. These studies suggest that application of this type of growth retardant on genetically dwarfed wheat will not increase grain yield even with high nitrogen fertility without crop lodging.

Growth retardants can increase grain yield in tall-growing cereal varieties, especially when they are grown under irrigation or fertility conditions that cause lodging. This may be particularly important in spring barley where sources of genetic dwarfism are limited. Barley appears to have a lower sensitivity to soil active growth retardants than wheat, however, and higher rates are needed to effectively control lodging.

The effects of high fertility and plant density require further study to determine their role in an intensive, high-input production system using growth regulators. Future studies should also examine the impact of growth retardant treatments on cereal quality.

We wish to express special thanks to the following: Vance Pumphrey, Matt Kolding, and the field crew at the Hermiston Experiment Station for their help in completing this research; ICI, Chevron, and Union Carbide for supplying growth retardants and financial support.

Italian Grass Seed Yield Cooperative Trial

H. W. Youngberg and W. C. Young III

Italian scientists have developed several Mediterranean types of perennial ryegrass, orchardgrass, and tall fescue which have excellent forage characteristics in their area of adaptation. However, the Italian climate is not favorable for seed production of these species. The Willamette Valley appears to be a suitable region for seed increase because of the mild winter climate. Stock seed from parent material produced in Italy has a low 1000 seed weight. Before large scale commercial production is undertaken, it is important that the seed yield characteristics of these varieties are known. In 1982 a cooperative project was started to study the seed yield potential of several Italian varieties under western Oregon conditions.

All varieties survived the 1982-83 and 1983-84 winter seasons without significant injury. In 1983-84, Vejo perennial ryegrass did not significantly differ from the standard, Linn, in plant height or tendency to lodge. It was two days later reaching harvest maturity, and was significantly lower in seed yield, 1000 seed weight, and harvest index. Marta and Cesarina orchardgrass were significantly shorter than the standard. Both had lower 1000 seed weights and harvest indexes. Sibilla tall fescue was not significantly shorter than the standard variety, Fawn, but lodged less. It reached harvest maturity 11 days later than Fawn. Sibilla had a lower 1000 seed weight. There was no significant difference in seed yield but the harvest index was lower.

The Italian varieties appear to have sufficient winterhardiness to survive the winter conditions in the Willamette Valley. In general, the seed yield and 1000 seed weight are lower than the standard varieties. Other growth characteristics are suitable for seed production in the region.

Oregon Forage and Turf Grass Variety Seed Yield Trial - 1984

H. W. Youngberg, W. C. Young III, and D. O. Chilcote

Fifty-five entries were received for evaluation in the 1984 grass variety seed yield trial. Species included: perennial ryegrass (*Lolium perenne*), Italian ryegrass (*Lolium multiflorum*), fine-leaf fescue (*Festuca rubra*), Kentucky bluegrass (*Poa pratensis*), orchardgrass (*Dactylis glomerata*), and tall fescue (*Festuca arundinacea*).

The trial, designed to follow commercial field practices of Willamette Valley seed growers was at Hyslop Crop Science Field Laboratory, Corvallis, on a Woodburn silt loam soil.

Seeding rates were adjusted for germination percentage to allow planting of equal amounts of pure live seed per length of row. Row spacing was 12 inches (30 cm) for all species except tall fescue and orchardgrass, which were spaced 18 inches (45 cm apart). Four replications of each entry were established. A standard variety was included for each species. Plant height was measured at approximately peak anthesis and estimates of lodging were made at maturity for all entries.

The entire plot area was harvested at maturity using a small plot harvester incorporating a sickle bar cutter and draper designed for efficient bagging of the above ground plant bio-mass. The bagged material was air-dried, threshed, cleaned and weighed. A 3 to 5 gram seed sample of each plot was taken with a seed divider to determine the 1000 seed weight. In addition, harvest index was calculated for each entry:

$$\text{Harvest Index} = \frac{\text{Clean seed weight}}{\text{Total harvested weight}} \times 100$$

Data from each species were subjected to a randomized block analysis of variance and least significant difference test to determine differences among variety means. A complete report of methods is available from the authors.

Two perennial ryegrass varieties, Trani, and to a lesser extent, Sisu, were extremely attractive to mice. They were selectively grazed in each replication and suffered reduced yield because of mouse damage. The Italian ryegrass variety, SB-S, began pollination on April 23, 1984, was severely infected by rust, and set very little seed. SB-S did exert a second flush of seed heads which pollinated around June 15, 1984, and contributed to a very low seed yield.

Harvest dates and other observations are presented in Table 1. Yield expressed as a percent of the standard variety for each species is also reported.

NOTE: Seed yields from these research plots should be compared with known standard varieties rather than use the absolute figures. Plot harvest meth‹ ‹s reduce shattering and combine losses that normally occur in commercial production. Mean plot yield for perennial ryegrass, bluegrass, and annual ryegrass was equal to five-year mean commercial seed yields for Oregon. Plot yield of fine-leaf fescue, orchardgrass, and tall fescue was approximately double the five-year mean yields for the state.

Table 1. Plant height, lodging score, harvest date, harvest index, thousand seed weight, seed yield, and percent of standard variety, 1984.

Variety	Plant Height	Lodging Score[1]	Harvest Date	Harvest Index	1000 Seed Weight	Seed Yield	Seed Standard
	(cm)			(%)	(g)	(lb/a)	(%)
Perennial Ryegrass (*Lolium perenne*)							
Prelude	91.9	4.5	7/13	14.5	1.76	1528	130
Palmer	90.6	4.5	7/13	14.0	1.73	1279	109
LP792	88.8	4.3	7/17	19.1	1.64	1193	102
Linn (Std)	91.3	5.0	7/11	13.6	2.07	1173	100
Agree	85.6	3.3	7/13	14.5	1.77	1126	96
2EE	81.9	5.0	7/6	14.9	1.56	993	85
Pennfine	93.1	4.8	7/13	10.5	1.76	821	70
SB-F	92.5	3.3	7/23	10.5	2.55	799	68
Pronto	92.5	5.0	7/11	10.7	1.70	717	61
Sisu	94.4	3.3	7/19	10.5	1.67	711	61[2]
Vejo	96.9	5.0	7/13	9.1	1.88	638	54
Trani	71.3	3.3	7/27	4.9	1.42	306	26[2]
LSD .05	8.5	0.6	--	4.1	0.11	341	--
Fine-Leaf Fescue (*Festuca rubra*)							
ISI 829	80.5	3.5	7/6	21.0	1.11	1660	165
Eboli	83.1	5.0	6/28	16.2	0.94	1604	160
Tatjana	80.0	5.0	6/28	16.9	0.94	1513	151
Z7492	83.1	5.0	7/6	17.3	0.87	1429	142
Pernilla	80.6	4.3	7/9	20.8	0.95	1298	129
Premiere	83.9	4.5	7/9	16.3	0.95	1248	124
ASHF-82	79.4	5.0	7/2	15.5	0.79	1189	118
ZW42-100	75.6	5.0	7/9	19.7	0.84	1132	113
Cascade	88.8	5.0	7/6	14.9	0.93	1117	111
Pennlawn (Std)	83.1	5.0	7/9	16.1	0.85	1005	100
LSD .05	5.1	0.4	--	3.5	0.06	256	--
Bluegrass (*Poa Pratensis*)							
PP-02	68.1	2.3	7/17	20.8	0.42	1073	149
PP-01	68.8	2.8	7/17	18.8	0.39	1054	146
ZW42-96	71.9	2.8	7/17	16.6	0.43	990	138
Conni	41.9	2.0	7/17	19.9	0.39	781	108
Newport (Std)	81.9	2.8	7/17	18.5	0.38	720	100
Annika	65.0	3.5	7/17	18.9	0.36	643	89
Arnolda	48.8	1.3	7/17	19.0	0.40	583	81
Cynthia	66.3	3.3	7/17	16.4	0.37	578	80
Charlotte	58.8	3.5	7/17	10.4	0.42	361	50
LSD .05	5.9	1.0	--	3.9	0.04	215	--
Orchardgrass (*Dactylis glomerata*)							
Hallmark	141.3	1.5	7/6	18.7	0.99	1947	110
SB-SYN-2	140.6	2.8	7/6	18.3	0.95	1868	106
Paiute	140.0	1.5	7/6	17.7	0.99	1876	106
Sparta	125.0	2.5	7/9	24.0	0.89	1799	102
Potomac (Std)	138.8	1.8	7/6	17.1	0.96	1765	100
Jesper	139.4	2.5	7/9	19.7	0.96	1588	90
DG-04	149.4	1.0	7/11	16.0	0.96	1296	73
DG-02	148.8	1.3	7/11	14.9	1.01	1125	64
Marta	128.8	2.5	7/13	11.5	0.83	869	49
Cesarina	124.4	2.8	7/13	14.4	0.81	811	46
DG-03	124.4	1.3	7/17	13.6	0.91	585[3]	33[3]
DG-01	128.1	1.3	7/17	9.5	0.81	522[3]	30[3]
LSD .05	7.9	0.7	--	3.0	0.05	262	
Tall Fescue (*Festuca arundinacea*)							
ASTF-82SP	140.0	4.0	7/6	17.4	2.06	2118	121
Fawn (Std)	141.3	4.0	6/28	14.2	2.32	1754	100
Rebel	136.3	4.0	7/6	16.0	2.10	1644	94
FA-01	137.5	4.0	7/9	12.7	2.15	1609	92
ASTF-82F	140.5	4.0	7/9	14.3	2.10	1547	88
Sibilla	136.9	3.5	7/9	12.2	1.94	1264	72
LSD .05	NS	0.4	--	2.5	0.09	NS	--
Italian Ryegrass (*Lolium multiflorium*)							
Marshall (Std)	100.8	4.0	7/2	18.1	2.70	1899	100
WSG TB-1A	134.9	3.5	7/9	14.6	3.64	1751	92
SB-A	125.0	3.0	7/9	13.7	3.61	1460	77
Westerwold	123.8	3.0	7/9	11.7	3.53	1290	68
Aubade	125.0	3.8	7/9	12.0	3.31	1180	62
SB-S	98.1	4.0	7/2	5.2	2.43	308[4]	16[4]
LSD .05	NS	0.5	--	3.8	0.34	505	--

[1]Lodging score 1-5, with 1 = no lodging and 5 = flat.

[2]Severely damaged by selective mouse grazing.

[3]Very poor stand due to low seed germination.

[4]Severe rust injury.

Establishing Red Fescue with Cereal Companion Crops

T. G. Chastain and D. F. Grabe

Red fescue is an example of a perennial grass seed crop that does not produce a marketable seed yield during the first summer after establishment. This lack of income in the year of sowing, coupled with the increasing costs of production, requires the identification of a more cost-effective establishment method. Intercropping red fescue with a cereal companion crop during the establishment year may be the solution to this problem. Intercropping in this siutation entails the simultaneous planting of a cereal crop with the grass seed crop. The objective of this study was to identify successful combinations of cereal crops and row spacings that would permit the use of the intercropping method under Oregon conditions.

1982 Experiment

Pennlawn red fescue was established with cereal crops at Hyslop Farm in October 1982. Two barley varieties, Hesk and Scio, and two wheat varieties, Hill 81 and Yamhill, were seeded in north-south oriented rows with 6-, 12-, 18-, and 24-inch row spacings. The red fescue was carbon-seeded in 12-inch rows at right angle to the cereal rows with the cereals drilled first to minimize disturbance of the charcoal brand. Karmex (diuron) was applied at a 2 lb/a rate immediately after seeding. The control of volunteer cereals after grain harvest was obtained by a 0.38 lb/a application of Poast (sethoxydim) in November 1983.

The combined cereal and red fescue yields from the 1982 planting are shown in Table 1. Surprisingly, the cereal companion crops did not reduce the red fescue seed yields significantly below that obtained from planting red fescue alone. Any reduction in red fescue seed yield was more than compensated for by the 60-bushel cereal yields. The row spacing of the cereal companion crop appeared to have no effect on subsequent red fescue seed yields.

Table 1. Grain and seed yields from four companion cropping systems.

Cereal variety	1983 Cereal yield	1984 Fescue yield
	(lbs/a)	
Hesk barley	2879	451
Scio barley	3176	583
Yamhill wheat	3654	458
Hill 81 wheat	3666	437
Fescue alone	none	525
LSD 0.05	585	141

To explain any differences in seed yields caused by the various establishment methods, periodic measurements were made of soil moisture, light penetration through the cereal canopy, and plant growth parameters. Cereal competition did not reduce the amount of soil moisture, but reduced the amount of light reaching the red fescue seedlings. Thus the small, non-significant reductions in seed yield observed in Table 1 seem to be due to competition for light with the cereal crop rather than competition for soil moisture. This in turn caused decreases in the number of vegetative tillers and in etiolation of those tillers, but did not reduce the amount of leaf area per tiller.

1983 Experiment

The experiment was re-established in October 1983 and the cereals were harvested in 1984. The effect of cereal row spacings on grain yield is shown in Table 2. Highest yields were obtained with 6-inch row spacing, with lower yields occurring with each successive increase in row width. Hill 81 wheat attained greater yields than the other varieties, while Yamhill wheat outyielded Scio barley, but not Hesk barley. The best combination of row spacing and variety for high cereal yields was Hill 81 drilled in 6-inch rows, but the close spacing may be detrimental to red fescue stand establishment.

Table 2. 1984 Yields of cereals undersown with red fescue (lbs/a)

Variety	*Row spacing (inch)* 6	12	18	24	Mean
Hesk barley	4883	3856	3265	2935	3735
Scio barley	4242	3151	2556	1857	2949
Yamhill wheat	5290	4439	3909	3073	4177
Hill 81 wheat	5805	5329	4892	4322	5090
Mean	5055	4189	3659	3047	
LSD 0.05	Row spacing = 466		Variety = 552		

It is apparent that red fescue can be established successfully with cereal companion crops. Both experiments will be continued until two seed crops are harvested from both. Economic analyses will then be conducted to help determine the most successful of these establishment systems. The study will be expanded to include spring plantings of red fescue, tall fescue, orchardgrass and Kentucky bluegrass in 1985.

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Growth Retardants for Yield Enhancement in Grass Seed Crops

D. O. Chilcote, H. W. Youngberg, and W. C. Young III

Lodging is a common phenomena in most grass seed crops grown in the Willamette Valley and elsewhere. Depending on its timing and severity, lodging can extract a significant cost in terms of reduced seed yield. Lodging is not easily solved by genetic incorporation of resistance to lodging (dwarfing) since grass seed crops produced in the Willamette Valley are bred and used for turf and forage production, usually in other regions. Therefore, chemical growth retardants, synthetic compounds capable of reducing plant height and strengthening stems, can be beneficial in reducing seed yield losses due to lodging.

Growth retardant chemicals, e.g., Cycocel and Union Carbide's Cerone have been commercially available for lodging control for some time. However, only recently have compounds become available which are effective and predictable in reducing stem height and crop lodging in grass seed crops. Notable among these new compounds is Parlay, a chemical growth retardant from ICI Americas. Most of the work in the following reports will deal with Parlay, since up to this point, it has demonstrated the most promise of being developed as a commercial agricultural chemical for grass seed crops. An experimental use permit from the EPA for Parlay is expected in 1985. The Eli Lilly compound, coded EL-500 (Cutlas), was tested early in this research program, but is not presently being considered for use in lodging control of grass seed crops. An experimental compound from Chevron Chemical Company, XE-1019, was tested for the first time this year and shows promise. Interest in developing growth retardants for use in agriculture is continuing and we expect other compounds will become available in the future.

Much of the research has been with ryegrass, a species quite responsive to chemical lodging control. Studies have continued on fine fescue, tall fescue, orchardgrass, and bluegrass. The objectives are to develop a better understanding of seed yield and yield component response, possible disease control, nitrogen fertility effects and determine the best rate and time of retardant application for the various species and varieties of grasses grown for seed.

The following reports provide a brief summary of work conducted this past year on grass seed crops.

The work reported in the following section was supported by grants from the Department of Environmental Quality, ICI Americas, and Chevron Chemical Company.

Response of Linn Perennial Ryegrass to Application of Three Plant Growth Retardants

W. C. Young III, D. O. Chilcote, and H. W. Youngberg

Three separate studies were conducted on a third-year crop of Linn perennial ryegrass grown for seed production at Hyslop Crop Science Field Laboratory, Corvallis, to compare the effects of growth retardant chemicals. Three compounds, Parlay, XE-1019, and CCC (cycocel), were tested at two stages of crop development and at two rates of application in a factorial arrangement replicated four times.

Parlay

Table 1. Seed yield and total dry matter distribution of Linn perennial ryegrass in response to Parlay treatment, 1984.

Parlay rate	Total dry weight	Straw weight	Seed yield	Harvest index
(lb ai/a)	(ton/a)	(ton/a)	(lb/a)	(%)
0.00	2.9	2.4	939	16.5
0.45	3.4	2.7	1381	20.4
0.67	3.3	2.8	1635	24.8
LSD .05	NS	NS	235	3.3

Parlay was applied at 0.45 and 0.67 lb ai/a in the spring at either spikelet initiation (SI) or floret initiation (FI) growth stages. Seed yield and harvest index were significantly increased at both rates while total dry weight and straw weight remained constant (Table 1). There was no difference in total tiller number at peak anthesis or in the number of fertile tillers at harvest. However, plots treated at spikelet initiation had a greater number of fully emerged spikes and a reduced number of later maturing tillers at peak anthesis. There was no difference in vegetative tiller number. Florets per spikelet in the upper portion of the inflorescence was the only additional yield component positively affected by Parlay.

Potential seed sites (inflorescences at maturity × florets per inflorescence) were not significantly increased by the treatments under study. However, the actual number of seeds per unit area at harvest was significantly increased by Parlay due to an increased number of seeds recovered per tiller (Table 2). This gain in efficiency is probably due to improved seed set and prolonged seed filling, due to shorter and more upright tillers in the treated plots. Lodging in the treated plots occurred after the control plots and was less severe.

Table 2. Effect of Parlay treatment on the potential seed site, actual number of seeds recovered, harvested seeds per tiller, and floret site utilization (F.S.U.) on Linn perennial ryegrass, 1984.

Parlay rate	Potential seed sites	Actual seeds recovered	Seeds per tiller	F.S.U.
(lb ai/a)	-------- (per ft²)	--------		(%)
0.00	26,680	4,420	25.9	16.4
0.45	33,569	6,932	34.0	21.3
0.67	32.351	8.377	40.6	26.7
LSD .05	NS	1,246	9.4	5.6

XE-1019

Similar results were attained using XE-1019 applied at 0.125 and 0.25 lb ai/a at either floret initiation (FI) or two weeks after floret initiation (FI + 2). Seed yield was increased at both rates, and harvest index increased by the floret initiation stage of application, primarily due to greater reduction in straw weight (Table 3). Total tiller number was not affected at anthesis or maturity, but a reduced percentage of the stand was comprised of vegetative tillers when treated with the 0.25 lb ai/a rate. Additionally, a significantly greater mean number of florets per spikelet resulted at higher rates.

There was no significant effect on the number of potential seed sites. However, a significant increase in the actual number of seeds harvested and an increase in the seed number per tiller resulted at both rates of XE-1019 (Table 4).

CCC

Application of CCC was made at the same stages of development as XE-1019. Rates used were 2.0 and 4.0 lb ai/a. In contrast to Parlay and XE-1019, no significant effects were observed for these treatments. Only a slight reduction in lodging at spike emergence was signficant, but by anthesis no treatment differences were present.

Table 3. Seed yield and harvest index of Linn perennial ryegrass as influenced by time and rate of XE-1019 application, 1984.

Treatment	Seed yield	Harvest index
	(lb/a)	(%)
XE-1019 application stage		
FI[1]	1253	20.5
FI + 2[2]	1295	18.6
LSD .05	NS	1.7
XE-1019 rate (lb ai/a)		
0.00	749	12.3
0.125	1461	20.6
0.25	1611	25.8
LSD .05	196	2.1

[1]FI = floret initiation development stage.
[2]FI + 2 = 2 weeks after floret initiation development stage.

Table 4. Effect of XE-1019 treatment on the potential seed sites, actual number of seeds recovered, harvested seeds per tiller, and floret site utilization (F.S.U.) on Linn perennial ryegrass, 1984.

XE-1019 rate	Potential seed sites	Actual seeds recovered	Seeds per tiller	F.S.U.
(lb ai/a)	-------- (per ft²)	--------		(%)
0.00	27,006	3,723	22.7	14.0
0.125	31,667	7,594	39.0	24.5
0.25	31,825	8,353	46.7	26.5
LSD .05	NS	1,044	9.9	5.2

Summary

Yield response from Parlay and XE-1019 appears due to an improved utilization of predetermined components of seed yield at the time of growth retardant application. Shortening and strengthening of stems delay lodging and improve light penetration into the canopy benefiting both seed set and seed filling. Stage of application had little effect on factors studied. CCC apparently did not provide sufficient lodging control, or duration of control, at the tested rates to benefit seed yield.

Interaction of Tilt Fungicide and Parlay Plant Growth Retardant in Pennfine Perennial Ryegrass Seed Production

W. C. Young III, D. O. Chilcote, and H. W. Youngberg

Data were collected for a second year to evaluate the use of Parlay, both with and without supplementary disease control via Tilt. Tilt is a broad spectrum fungicide commonly used for the control of rusts (*Puccinia* spp.) and powdery mildew (*Ersiphe* spp.) in grass grown for seed in Oregon. This study was a factorial arrangement of two rates of Parlay (0.45 and 0.67 lb ai/a) applied at floret initiation, with two levels of fungicide treatment (0.0 and 0.4 fl oz/a Tilt). Four applications of Tilt were applied between May 16 and June 25, 1984, on approximately 10-day intervals.

Analysis of total dry matter found no significant interaction between growth retardant and fungicide treatment. Total dry weight, seed yield, and harvest index, were significantly increased by both rates of Parlay (Table 1). Only harvest index and 1000 seed weight were increased by Tilt application. This suggests that fungicide treatment provides, through disease control, better seed filling conditions.

Table 1. Total dry matter distribution, harvest index, and weight per 1000 seeds of Pennfine perennial ryegrass as influenced by Parlay growth retardant when summed across fungicide treatments, and Tilt fungicide when summed across growth retardant treatments, 1984.

Treatment	Total dry weight	Straw weight	Seed yield	Harvest index	1000 seed weight
	-------(ton/a)------		(lb/a)	(%)	(g)
Parlay rate (lb ai/a)					
0.0	2.31	2.21	665	14.6	1.63
0.45	2.75	2.41	1202	21.9	1.55
0.67	2.78	2.34	1385	15.3	1.58
LSD .05	0.38	NS	119	2.2	0.06
Tilt rate (fl oz/a)					
0.0	2.70	2.42	1082	19.7	1.55
4.0[1]	2.52	2.22	1086	21.5	1.62
LSD .05	NS	NS	NS	1.8	0.05

[1]Tilt was applied on 5/16/84, 5/29/84, 6/11/84, and 6/25/84.

A visual rating of rust severity (0 to 10, where 0 = no rust and 10 = severe rust) was made on July 5, 1984. A significant reduction in disease was found only for Tilt with no significant interaction with Parlay. Thus, the more upright crop, the result of Parlay application, did not appear to reduce the presence of rust pustules when unprotected by a fungicide.

Tilt is a registered trademark of Ciba-Geigy. The use of a trade name does not imply recommendation of the product.

Effects of Parlay Growth Retardant on Different Grass Species Grown for Seed Production

W. C. Young III, D. O. Chilcote, and H. W. Youngberg

More information is needed to develop a better understanding of correct rates and crop developmental stages for plant growth retardant application in grass seed crops. Several studies were conducted on different grass species at Hyslop Crop Science Field Laboratory, Corvallis, to further evaluate the use of Parlay growth retardant.

Orchardgrass

A third-year crop of Hallmark orchardgrass was treated at 0.22 and 0.45 lb ai/a Parlay in the spring at either floret initiation (FI) or two weeks after floret initiation (FI + 2) stage of development. Total dry weight and straw weight were significantly reduced by Parlay applied at FI. This effect was greatest at the higher rate (Table 1). However, seed yield was increased when application was made at FI + 2, with no significant effect between Parlay rates. Harvest index was greater at the higher rate due to reduced

Table 1. Seed yield and total dry matter distribution of Hallmark orchardgrass as influenced by time (growth stage) and rate of Parlay application, 1984.

Treatment	Total dry weight	Straw weight	Seed yield	Harvest index
	-------(ton/a)-------		(lb/a)	(%)
Parlay application stage				
FI[1]	2.29	1.76	1048	23.8
FI + 2[2]	2.69	2.10	1180	22.8
LSD .05	0.36	0.32	120	NS
Parlay rate (lb ai/a)				
0.00	2.88	2.40	960	16.7
0.22	2.46	1.86	1190	24.5
0.45	2.12	1.53	1193	28.7
LSD .05	0.44	0.39	147	2.8

[1]FI = floret initiation development stage.
[2]FI + 2 = 2 weeks after floret initiation development stage.

total dry weight. Stage of application or Parlay rate had no influence on 1000 seed weight, panicle number at maturity, or seeds recovered per tiller.

Annual Ryegrass

Parlay was applied to Marshall annual ryegrass at 0.45 and 0.67 lb ai/a in the spring at either spikelet initiation (SI) or floret initiation (FI). Total dry weight at harvest was actually increased by Parlay treatment; however, straw weight was not significantly affected (Table 2). Thus, seed yield and harvest index showed a highly significant increase at both rates. No significant effect on dry matter distribution due to stage of application was observed.

Yield component analysis showed a greater number of fertile tillers at maturity in Parlay treated plots (Table 3). Although there was no significant difference in total tiller number at anthesis, treated plots had fewer vegetative tillers and more fully emerged and late emerging spikes. Furthermore, there was no effect on the number of spikelets per spike or florets per spikelet. Increased number of potential seed sites and actual number of seed harvested was due to an increased number of fertile tillers at maturity and not a greater number of seeds recovered per tiller or floret site utilization (Table 4). Delayed lodging, a result of reduced plant height, probably allowed for greater fertile tiller density.

Table 2. Seed yield and total dry matter distribution of Marshall annual ryegrass in response to Parlay treatment, 1984.

Parlay rate	Total dry weight	Straw weight	Seed yield	Harvest index
(lb ai/a)	------- (ton/a) -------		(lb/a)	(%)
0.00	4.49	3.84	1301	14.4
0.45	5.06	4.03	2060	20.5
0.67	5.22	4.21	2029	19.4
LSD .05	0.56	NS	274	2.3

Table 3. Effect of Parlay treatment on tiller population at peak anthesis and maturity in Marshall annual ryegrass, 1984.

	Peak anthesis				
Parlay rate	Total tillers	Fully emerged spikes	Late reproductive spikes	Vegetative tillers	Maturity total spikes
(lb ai/a)	------------------- (per ft²) -------------------				
0.00	81	29	21	31	74
0.45	93	41	27	15	94
0.67	90	38	33	20	92
LSD .05	NS	10	9	10	18

Table 4. Effect of Parlay treatment on the potential seed sites, actual number of seeds recovered, harvested seeds per tiller, and floret site utilization (F.S.U.) on Marshall annual ryegrass, 1984.

Parlay rate	Potential seed sites	Actual seeds recovered	Seeds per tiller	F.S.U.
(lb ai/a)	------- (per ft²) -------			(%)
0.00	24,168	5267	76.7	22.9
0.45	31,402	8953	105.5	32.1
0.67	30,599	9323	112.7	33.8
LSD .05	6,321	1270	NS	NS

Perennial Ryegrass

Two varieties of perennial ryegrass, Pennfine and Caravelle (an early- and mid-season maturing variety, respectively) were used to evaluate the effect of Parlay on perennial ryegrass. Both were third-year stands. Growth stages and rates of application were as described for annual ryegrass.

a. Pennfine

Total dry weight and straw weight at harvest were not significantly affected by the treatments. However, seed yield was increased when Parlay was applied at SI and this response was greatest at the higher rate (Table 5). The number of vegetative tillers in the stand at peak anthesis was significantly reduced at the 0.67 lb ai/a rate, and the mean number of florets per spikelet was increased by application at the earlier growth stage. There was no significant

Table 5. Seed yield and total dry matter distribution of Pennfine perennial ryegrass as influenced by growth stage and rate of Parlay application, 1984.

Treatment	Total dry weight	Straw weight	Seed yield	Harvest index
	------- (ton/a) -------		(lb/a)	(%)
Parlay application stage				
SI[1]	2.87	2.26	1215	21.1
FI[2]	2.77	2.22	1097	19.8
LSD .05	NS	NS	108	NS
Parlay rate (lb ai/a)				
0.00	2.62	2.22	805	15.5
0.45	2.93	2.30	1256	21.5
0.67	2.91	2.20	1407	24.3
LSD .05	NS	NS	133	1.7

[1]SI = spikelet initiation stage of development.
[2]FI = floret initiation stage of development.

difference in the total tiller number at anthesis, the number of potential seed sites, or the number of spikes at maturity. However, a greater number of seeds per tiller were recovered at harvest from the Parlay treated plots; thus, the actual seed number and floret site utilization were also improved (Table 6).

Table 6. Effect of Parlay treatment on the potential seed sites, actual number of seeds recovered, harvested seeds per tiller and floret site utilization (F.S.U.) on Pennfine perennial ryegrass, 1984.

Parlay rate	Potential seed sites	Actual seeds recovered	Seeds per tiller	F.S.U.
(lb ai/a)	-------(per ft²)-------			(%)
0.00	35,897	4,855	27.1	14.5
0.45	36,025	8,083	45.2	23.7
0.67	40,615	9,220	44.8	23.5
LSD .05	NS	921	8.5	4.5

b. Caravelle

Growth stage and rate of Parlay application significantly interacted in their effect on total dry weight and straw weight at harvest (Table 7). Although the 0.45 lb ai/a rate at SI did not reduce straw weight, seed yield was increased with this treatment combination (Table 8). Actual number of seeds recovered at harvest was similarly improved. There were no other significant effects on yield components observed. Thus, shorter, later-maturing ryegrass may benefit most from lower rates which delay the onset and severity of lodging. Higher rates, which reduce total dry matter production, may be deleterious to seed yield.

Table 7. Effect of stage and rate of Parlay application on total dry weight and straw weight at harvest on Caravelle perennial ryegrass, 1984.

Treatment time and Parlay rate	Total dry weight	Straw weight
(lb ai/a)	----------(ton/a)----------	
SI[1]		
0.00	4.00	3.55
0.45	3.87	3.27
0.67	2.96	2.40
FI[2]		
0.00	3.85	3.43
0.45	2.96	2.46
0.67	2.20	1.75
LSD .05	0.34	0.31

[1]SI = spikelet initiation development stage.
[2]FI = floret initiation development stage.

Table 8. Seed yield, actual number of seeds harvested, and floret site utilization (F.S.U.) on Caravelle perennial ryegrass as influenced by time (growth stage) and rate of Parlay application, 1984.

Treatment	Seed yield	Actual seeds recovered	F.S.U.
	(lb/a)	(per ft²)	(%)
Parlay application stage			
SI[1]	1065	6519	19.3
FI[2]	912	5614	15.7
LSD .05	76	481	3.0
Parlay rate (lb ai/a)			
0.00	869	5199	16.3
0.45	1098	6826	19.1
0.67	1000	6173	17.2
LSD .05	93	589	NS

[1]SI = spikelet initiation development stage.
[2]FI = floret initiation development stage.

Effect of Parlay Growth Retardant When Combined with Varying Spring Nitrogen Management on Pennfine Perennial Ryegrass

W. C. Young III, D. O. Chilcote, and H. W. Youngberg

Investigation continued in 1984 to determine how rate and time of spring applied nitrogen interacts with Parlay growth retardant. Treatments were a factorial arrangement of nitrogen at two growth stages and three rates, and three rates of Parlay growth retardant. Nitrogen was applied either during the vegetative growth stage (VEGN) or after the onset of reproductive growth (SPIN) at 54, 107, and 160 lb N/a as 34-0-0 in a single application. Parlay was applied at 0.45 and 0.67 lb ai/a at the floret initiation development stage.

Nitrogen and Parlay rate interacted significantly on seed yield. Seed yield was increased by Parlay regardless of nitrogen rate; however, the 0.67 lb ai/a rate resulted in a significant increase over the 0.45 lb ai/a rate at higher nitrogen levels (Table 1). Seed yield was not affected by time of spring nitrogen application studied. Higher nitrogen levels and Parlay increased fertile tiller number at maturity and resulted in a greater number of seeds recovered at harvest

(Table 1). There was a significant interaction between stage of nitrogen application and nitrogen rate for number of potential seed sites and harvested seeds per tiller (Table 2). There was nearly equal fertile tiller number at higher nitrogen levels, regardless of application date. However, the number of potential seed sites was greater at higher nitrogen rates applied after spikelet initiation due to an increased number of florets per spikelet. Conversely, the number of seeds per tiller at harvest was reduced by higher nitrogen rates applied after spikelet initiation, probably due to yield component compensation.

Table 1. Interaction of spring nitrogen rate and Parlay growth retardant on seed yield, number of fertile tillers at maturity, and number of actual seeds recovered on Pennfine perennial ryegrass, 1984.

Treatment		Seed yield	Fertile tillers at maturity	Actual seeds recovered
N	Parlay			
(lb/a)	(lb ai/a)	(lb/a)	(per ft²)	
54	0.00	730	175	4,660
	0.45	1455	180	9,721
	0.67	1347	173	8,928
107	0.00	835	185	5,562
	0.45	1490	217	9,968
	0.67	1818	229	12,529
160	0.00	912	181	6,033
	0.45	1444	234	9,888
	0.67	1786	237	12,162
LSD .05 for intermeans		245	27	1,472

Table 2. Interaction of stage and rate of application of spring nitrogen on number of fertile tillers at maturity, number of potential seed sites, and seeds harvested per tiller on Pennfine perennial ryegrass, 1984.

Growth stage at N application and rate		Fertile tillers at maturity	Potential seed sites	Seeds per tiller
	(lb/a)	(per ft²)		
VEGN[1]	54	198	34,155	39
	107	201	37,115	46
	160	223	45,367	44
SPIN[2]	54	153	26,850	53
	107	220	42,943	43
	160	211	42,793	43
LSD .05 for intermeans		23	5,776	9

[1]VEGN = during vegetative growth stage.
[2]SPIN = after transition to reproductive growth.

Table 3. Number of potential seed sites, florets per spikelet, and harvested seeds per tiller as influenced by rate of Parlay growth retardant on Pennfine perennial ryegrass, 1984.

Parlay rate	Potential seed sites	Florets per spikelet	Seeds per tiller
(lb ai/a)	(per ft²)		
0.00	33,724	7.1	31
0.45	40,265	7.9	49
0.67	40,673	8.5	54
LSD .05	3,761	0.3	6

Treatment with Parlay also increased the number of potential seed sites, due to a greater number of florets per spikelet, and increased the number of seeds per tiller at harvest (Table 3). Delayed or reduced severity of lodging following treatment with Parlay probably resulted in the greater seed recovery rates. These effects were significantly greater at the 0.67 lb ai/a Parlay rate.

Response of Fawn Tall Fescue to Two Levels of Spring Nitrogen and Two Plant Growth Retardants

W. C. Young III, D. O. Chilcote, and H. W. Youngberg

Two studies investigating the use of plant growth retardants and spring nitrogen management were conducted on a third-year crop of Fawn tall fescue grown for seed production at Hyslop Crop Science Field Laboratory, Corvallis. Parlay growth retardant was used in split-split plot design at two stages of crop development at two rates of application. Two levels of spring nitrogen were randomized within replicates as main plots. In a separate study, the effect of XE-1019 was investigated at two stages of crop development at three rates, under uniform spring nitrogen management. Both studies were replicated four times.

Nitrogen x Parlay

All plots received 27 lb N/a as 16-20-0 on October 3, 1983; however, on March 8, 1984, either 80 or 134 lb N/a as 46-0-0 was applied as main plot treatments during vegetative development. Subsequently, Parlay was applied at either the double ridge (DR) or floret initiation (FI) stage of crop development at rates of 0.45 or 0.67 lb ai/a.

The only significant effect of increased spring applied nitrogen was a slight reduction in harvest index. All other responses were attributed to Parlay use. Total dry weight and straw weight were significantly reduced at both rates of Parlay, regardless of stage of application; however, seed yield was not affected. As expected, harvest index was significantly improved (Table 1).

Plant height was also reduced at both rates. There was a significant interaction between stage of application and rate of Parlay for panicle number at maturity and weight per 1000 seeds (Table 2). Panicle numbers were increased when Parlay was applied at the double ridge stage; however, reduced seed weight appears to compensate for this gain. There was no significant change in the number of seeds recovered per tiller.

Table 1. Seed yield and total dry matter distribution of Fawn tall fescue in response to Parlay treatment, 1984

Parlay rate	Total dry weight	Straw weight	Seed yield	Harvest index
(lb ai/a)	----- (ton/a) -----		(lb/a)	(%)
0.00	5.3	4.7	1339	12.6
0.45	3.3	2.6	1421	22.1
0.67	2.6	1.9	1308	25.4
LSD .05	0.4	0.2	NS	1.14

Table 2. Effect of stage and rate of Parlay application on panicle number and weight per 1000 seeds on Fawn tall fescue, 1984.

Treatment time and Parlay rate	Panicle number	1000 seed weight
(lb ai/a)	(per ft^2)	(g)
DR[1]		
0.00	60	2.28
0.45	76	2.13
0.67	71	2.10
FI[2]		
0.00	77	2.22
0.45	62	2.23
0.67	59	2.25
LSD .05	14	0.08

[1]DR = double ridge development stage.
[2]FI = floret initiation development stage.

XE-1019

XE-1019 growth retardant was applied at 0.125, 0.25, and 0.375 lb ai/a at either floret initiation (FI) or two weeks after floret initiation (FI + 2). Application at the earlier stage and higher rates reduced total dry weights and straw weights. Seed yield was increased only at 0.125 and 0.25 lb ai/a (Table 3). Harvest index was significantly increased to a greater extent when the above rates were applied at floret initiation.

A significant reduction in plant height was associated with each increase in rate of XE-1019 (Table 4). Panicle number and number of seeds recovered per tiller tend to increase with growth retardant application. Although these differences are not statistically significant, they must contribute to the 24 to 27% increase in seed yield observed in Table 3.

Table 3. Seed yield and total dry matter distribution of Fawn tall fescue as influenced by time and rate of XE-1019 application, 1984.

Treatment	Total dry weight	Straw weight	Seed yield
	------ (ton/a) ------		(lb/a)
XE-1019 application stage			
FI[1]	3.0	2.2	1439
FI + 2[2]	3.4	2.7	1485
LSD .05	0.3	0.2	NS
XE-1019 rate (lb ai/a)			
0.0	4.5	3.8	1271
0.125	3.2	2.4	1577
0.25	2.7	1.9	1611
0.375	2.3	1.6	1389
LSD .05	0.4	0.3	161

[1]FI = floret initiation development stage.
[2]FI + 2 = 2 weeks after floret initiation development stage.

Table 4. Effect of XE-1019 on plant height, panicle number and harvested seeds per tiller on Fawn tall fescue, 1984.

XE-1019	Plant height	Panicle number	Seeds per tiller
(lb ai/a)	(in)	(per ft^2)	
0.00	53	63	97
0.125	47	75	107
0.25	40	65	129
0.375	36	58	127
LSD .05	2	NS	NS

Summary

Increased spring nitrogen did not positively influence seed yield of Fawn tall fescue. Furthermore, there were no significant nitrogen x Parlay growth retardant interactions, or direct Parlay effects on seed yield. XE-1019 did increase seed yield significantly, although the yield component analysis did not provide direct evidence of its primary effect.

Interaction of Increased Rate of Early Spring Nitrogen and Parlay Plant Growth Retardant in Pennfine Perennial Ryegrass Seed Production

W. C. Young III, D. O. Chilcote, and H. W. Youngberg

Pennfine perennial ryegrass has responded to higher rates of nitrogen, applied in the spring during vegetative development, by increased tiller density and more potential seed sites per unit area. However, this potential seed yield increase frequently does not materialize because the number of harvested seeds per tiller declines as tiller density increases. In addition, severe lodging associated with high rates of early nitrogen cause increased tiller mortality which result in no increse in seed yields. Data collected during the last three years, studying the effects of Parlay growth retardant on Pennfine perennial ryegrass, indicated the potential for increasing seed yield by delaying lodging and increasing the number of seeds per tiller harvested under uniform spring nitrogen management. This study was initiated to examine the potential for capitalizing on increased yield potential, developed by high rates of nitrogen applied at the vegetative growth stage, when combined with a later spring application of Parlay growth retardant.

Treatments were a factorial arrangement of nitrogen applied during the vegetative growth stage (VEGN) at 54, 107, and 160 lb N/a as 34-0-0, and Parlay at 0.0 or 0.67 lb ai/a applied at floret initiation stage. All plots received an additional 54 lb N/a at spikelet initiation; thus, total spring nitrogen rates were 107, 161, and 214 lb N/a applied as a split application.

Increased rate of VEGN and Parlay significantly interacted upon the total number of tillers at spike emergence. A greater number of tillers was associated with Parlay treatment at the two higher levels of nitrogen (Table 1). Furthermore, Parlay treated plots had a greater percentage of larger (3mm stem base diameter) size tillers and a lower percentage of the 2 mm size class. Parlay did not change the 1 mm size tiller size class.

Tiller number at peak anthesis was not significantly affected by Parlay; however, there were fewer vegetative tillers and more fully emerged spikes which resulted in more fertile tillers per unit area at maturity (Table 2). The increased VEGN caused a slight increase in total tiller number at anthesis and at maturity due to a greater number of late reproductive tillers (Table 2). Furthermore, the number of florets per spikelet was increased by higher levels of VEGN; however, no treatment effect on the number of spikelets per spike was observed. These improvements

Table 1. Interaction of nitrogen applied at vegetative growth stage and Parlay growth regulator on the number of total tillers at spike emergence in Pennfine perennial ryegrass, 1984.

	Vegetative nitrogen (lb/a)		
Parlay rate	54	107	160
(lb ai/a)	(per ft²)		
0.00	669	471	554
0.67	611	767	867
LSD .05 for intermeans		163	

Table 2. Effect of nitrogen applied at vegetative growth stage (VEGN) and Parlay growth retardant on tiller population at peak anthesis and at maturity in Pennfine perennial ryegrass, 1984.

	Peak anthesis				
Treatment	Total tillers	Fully emerged spikes	Late reproductive spikes	Vegetative tillers	Maturity total spikes
VEGN (lb/a)					
54	270	96	136	38	180
107	269	103	146	20	207
160	304	105	165	34	219
LSD .05	NS[1]	NS	22	NS	NS[1]
Parlay rate (lb ai/a)					
0.00	277	91	141	45	177
0.67	285	112	157	16	227
LSD .05	NS	15	NS[1]	15	29

[1]Significant at the 0.10 probability level.

Table 3. Effect of nitrogen applied at vegetative growth stage (VEGN) and Parlay growth retardant on the potential seed sites, number of seeds recovered, harvested seeds per tiller, and floret site utilization (F.S.U.), and seed yield in Pennfine perennial ryegrass, 1984.

Treatment	Potential seed sites	Actual seeds recovered	Seeds per tiller	F.S.U.	Seed yield
	(per ft²)			(%)	(lb/a)
VEGN (lb/a)					
54	33,537	8,324	46	24.6	1,322
107	40,948	8,456	40	20.2	1,353
160	46,613	7,591	36	16.9	1,257
LSD .05	7,309	NS	8	4.3	NS
Parlay rate (lb ai/a)					
0.00	35,947	5,301	31	15.8	906
0.67	44,785	10,946	50	25.3	1,715
LSD .05	5,968	770	6	3.5	136

in yield components resulted in a significantly greater number of potential seed sites for both nitrogen and Parlay main effects (Table 3). However, the actual number of seed recovered at harvest was not increased by higher levels of VEGN. Thus, number of seeds per tiller at harvest and floret site utilization were reduced. Conversely, Parlay significantly increased the actual number of seed recovered at harvest, number of seeds per tiller, and floret site utilization. Thus, the increased seed yield was due to Parlay treatment (Table 3).

There was no significant interaction of VEGN and Parlay for seed yield, nor was seed yield significantly changed due to nitrogen rate. Thus, increased yield potential resulting from higher nitrogen rate was not recovered by using Parlay. Loding scores between spike emergence and maturity show that at higher nitrogen levels, Parlay at 0.67 lb ai/a was not able to reduce lodging to the extent necessary to insure maximum seed filling.

Effects of Parlay on Seed Yield and Crop Residue Characteristics in Willamette Valley Grass Seed Production

W. C. Young III, D. O. Chilcote and H. W. Youngberg

This research continued the evaluation of the effect of Parlay growth retardant on seed yield and crop residue (straw and stubble) remaining after standard swathing and combining of several grass species under field conditions. Parlay treated plots were compared with untreated seed fields of Derby perennial ryegrass, Banner fine fescue, and Bristol bluegrass, while all other cultural practices were held constant. Standard swathing and combining methods were used to determine seed yield. Residue samples were collected at three dates following harvest to measure straw and stubble moisture and dry weights.

Seed yield was significantly increased by Parlay in fine fescue and significantly decreased in bluegrass (Table 1). Perennial ryegrass was not significantly affected by Parlay treatment. Parlay was applied at 0.45 lb ai/a for perennial ryegrass and fine fescue, and 0.27 lb ai/a for bluegrass. These rates appear to have been too high for Bristol bluegrass, as an extreme reduction in plant growth was observed, and possibly too low for Derby perennial ryegrass. Furthermore, lodging was not effectively controlled in Derby perennial ryegrass, and in other perennial ryegrass tests, 0.67 lb ai/a was superior in seed yield response.

Straw residue dry weight was determined by raking, weighing, and adjusting for moisture content all loose material from a 120-ft^2 area. Stubble dry weight was determined in the same manner, following a close clipping of the same 120-ft^2 area. Straw or stubble dry weight was not affected in perennial ryegrass or fine fescue. However, bluegrass residue was significantly reduced by Parlay treatment and stubble moisture, probably due to reduced straw cover which improved drying conditions.

Table 1. Effect of Parlay on seed yield of three perennial grasses shown at both lb/a and percent change as compared with untreated plots, 1985.

Treatment	Perennial ryegrass		Fine fescue		Bluegrass	
	(lb/a)	(%)	(lb/a)	(%)	(lb/a)	(%)
Check	1225	--	1192	--	492	--
Parlay[1]	1357	+11	1446	+21	281	-43
LSD .05	NS	--	134	--	34	--

[1]Parlay rate was 0.45 lf ai/a for perennial ryegrass and fine fescue, and 0.27 lb ai/a for bluegrass.

Continuing observations will follow the treatment response to open field burning, i.e., burning effectiveness, stand injury and rate of regrowth.

Summary Growth Retardants in Grass Seed Crops

D. O. Chilcote, H. W. Youngberg, and W. C. Young III

The work summarized in the above section for 1984 is a continuation of research initiated in 1980. During this period, much has been learned about growth retardants, crop response, and our understanding of the plant and environmental limitations on seed yield has been broadened. At this stage, some general comments and conclusions may be in order.

Growth Retardant Compounds

Some of the older growth retardant chemicals, Cycocel and Cerone, were tested again this year but little benefit was observed in lodging control or seed yield enhancement. Parlay has emerged as a leading candidate for commercial use in grass seed crops because of its effectiveness and predictability. A new compound tested this year, XE-1019, from Chevron Chemical Company is very similar to Parlay in terms of response. It may be effective at a lower dosage rate.

At this time, we have no information on the cost of the compounds; therefore, it is not yet possible to develop cost/benefit ratios.

Residue Carryover

The effective growth retardant compounds presently being tested (Parlay, XE-1019, etc.) have soil persistence. This was particularly evident for

Parlay in 1984. Although effects on following crops were transitory, soil residual could be a serious problem if rotations include a sensitive species. Further tests are needed to determine the extent of the residue carryover and possible buildup in the soil with successive annual applications.

Maturity Effects

A 2- to 3-day delay in crop maturation has been observed from Parlay application and this may affect yield comparison betwen treated and untreated plots. However, in many instances, the darker green color in the seedhead imparted by the growth retardant may suggest a delay in maturity while seed moisture content is the same. In an upright stand, crop drying is faster and may minimize delayed maturation.

Plant Density

Growth retardants reduce plant height and improve light penetration. It is important that enough tillers are present to use the better light environment. Growth retardants applied to stands with low tiller numbers may not improve yields because of reduced light-capturing ability of the canopy.

Indirect Benefits of Growth Retardant Application

There may be some other benefits of reducing plant height and straw production in seed fields. Swathing and combining may be more efficient. However, reduced straw may reduce efficiency of seed recovery in the swath should rain shatter occur.

Rates and Dates of Application

Application time for growth retardant compounds, specifically Parlay, must be related to the crop developmental growth stage. The correct stage is the beginning of floral initiation or later, so that the effect of the compound is confined to restricting internode elongation. At this time, examination of the growing point is needed to determine treatment timing.

Rates of application have also been studied extensively, and for ryegrass, .45 to .67 lb ai/a seem to be the proper dosage range. However, the lower rate may be insufficient to prevent lodging and increase seed yield under higher rainfall and heavy plant growth conditions. Lodging severity, which is dependent on weather and variety, needs to be considered in developing the proper rate of application. In fine fescue and tall fescue, the .45 lb ai/a rate seems to be the proper dosage. However, for orchardgrass and bluegrass, even lower rates may realize a significant beneficial yield response.

Species and Varieties

Unfortunately, there is a difference among grass species and varieties for optimum dosage and date of application. This means that more specific recommendations will need to be developed, depending on whether the crop is a turf-type or forage-type, tall versus short stature, or early versus late maturing. The taller growing, earlier varieties do seem to be more responsive to growth retardant application, perhaps because of the greater amount of foliage, and therefore the more harmful effect of lodging on light energy penetration and seed filling. Bluegrass is extremely sensitive and little yield enhancement has been noted. This is partly because lodging problems are limited and usually not extreme. Orchardgrass is another species which has shown a better response to lower Parlay rates applied at later dates.

A factor to be considered in determining the use of a growth retardant on a specific grass variety is the expected severity and time of lodging. If lodging takes place prior to anthesis, substantial yield losses can occur. In contrast, if lodging occurs later and/or is less severe, response to growth retardant chemicals is smaller. In the absence of lodging, little improvement in seed yield can be expected.

Basis for Yield Increases from Growth Retardant Applications

Work with ryegrass showed that the primary benefit and the basis for the seed yield response is an increase in the number of reproductive tillers that are produced per unit area. This is because tiller mortality is reduced and later developing tillers can continue their development and contribute to seed yield in the absence of lodging. Increased numbers of seed are thus produced, and in an upright, unlodged canopy, seed filling is favored, all contributing to a higher seed yield. In short, we harvest more of the potential seeds per unit areas as a result of more tillers and better seed filling.

Nitrogen Effects

Studies indicate that increasing nitrogen fertilization is beneficial in our grass seed crops, primarily when the growth retardant is used. High nitrogen applications in the absence of a growth retardant lead to more vegetative growth, more severe lodging problems, and less realization of the increased seed yield potential created. With growth retardant treatment, there is apparently an optimum level of nitrogen above which increases in seed recovery do not occur. However, high nitrogen rates to obtain proper tiller density is a requisite for realizing a yield increase where the growth retardant is applied. If the tiller densities are low due to lack of nitrogen or poor stand establishment, then quite likely responses to the growth retardant will also be reduced. If there is insufficient density, then an upright unlodged canopy will not use the better light environment.

Obviously, more work needs to be done before we can conclude more precisely variety and species response to growth retardant application. More work on nutrient and crop density aspects is needed to provide the framework for the most efficient use of growth retardants.

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