1988

SEED PRODUCTION RESEARCH

AT OREGON STATE UNIVERSITY
USDA-ARS COOPERATING

Edited by Harold W. Youngberg
Associate Editor Janet Burcham

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SEED CONDITIONING RESEARCH

A. G. Berlage, D. B. Churchill, T. M. Cooper, and D. M. Bilsland

For many problem separations in seed conditioning and research, subtle visual differences in seed size and shape exists that can only be seen under magnification. A machine vision system (MVS) has been adapted to measure the dimensional properties of seeds and their contaminants. A MVS consists of a video camera, video monitor, and computer system. This provides electronic imaging of the seeds for gathering a large number of measurements and shape characteristics.

Indent Cylinder Study. Seeds lots, as they come from the field, are not uniform in their dimensional properties and exhibit normal population distributions with respect to most physical properties. Generally, dimensional separation is the most effective and widely used method for reducing the quantity of foreign material in seed lots. These types of separations are most often accomplished by use of a screening machine for width and thickness separations and by indent cylinder or disc for length separations. The use of an indent cylinder or disc divides the original seed lot into two fractions (lifted and unlifted) based on differences in the length of the particles. The shorter material stays in the disk pocket as the cylinder or disk rotates and then is lifted and discharged onto a catch-pan.

The objectives of the research were to quantify the physical property differences of the fractions obtained by separation with the indent cylinder and determine the effect of different machine operating parameters on the distribution of the two fractions by length. Wheat was chosen for this experiment because of the seed's uniform shape and relatively large size. It was felt that this uniformity might reduce the possible influence of differences in shape, resilience, and other properties of the lot.

An indent cylinder separator was used to divide wheat seed into two fractions. Seed length measurements of the fractions were made using the MVS. The effect of changing various machine operating parameters was evaluated. Twenty-seven combinations of operating parameters and two replications were conducted. Three indent-pocket diameter sizes, three catch-pan positions, and three cylinder-revolution speeds were used. Each test was conducted as a batch until separation was complete. Length measurements of 50 randomly selected seeds from each fraction were made. The average length of the wheat seed for this study was 7.1 mm.

Cylinder pocket size, catch-pan position and cylinder revolution speed all had significant effects on the length of seeds in the lifted fraction but cylinder revolution speed did not have a significant effect on the lengths of seeds in the unlifted fraction. In general, higher catch-pan positions resulted in greater length differences between fractions and less seed in the lifted fraction. Higher revolution speeds of the cylinder resulted in less length difference between the two fractions but greater quantities of material in the lifted fraction. This is the result of centrifugal force which causes seeds to be carried farther and suggests that lower revolution speeds are preferable when making close length separations. The quantity of seed lifted increases with increasing revolution speed.

Ryegrass Identification. Annual ryegrass seed lots moving in market channels must not contain mixtures of seeds with different chromosome numbers. The tetraploid ryegrass varieties have 28 chromosomes while the diploid varieties have 14. Seeds of the two types are difficult to distinguish by visual inspection because of their similarity. Seed analysts germinate the seeds, stain the roots with dye, and count the number of chromosomes in the squashed root tips using a microscope This test is slow and expensive.

In order to reduce the cost of this test, studies using MVS were used to measure hundreds of seeds. These data were used to develop a mathematical model which was then used to calculate a value related to the difference in chromosome count. Seed samples with known mixtures of each type were then analyzed to test the model. This video and computer method of seed testing initiates a new approach to seed quality control. The model did not correctly classify every seed, but the number of seeds requiring the chromosome stain technique was reduced by 31%. When fully developed, use of this procedure will reduce the labor and time intensive part of the ploidy test and reduce the cost to the seed industry.

REDUCTION OF INSECTICIDE ACTIVITY BY CARBON RESIDUE PRODUCED BY POST-HARVEST BURNING OF GRASS SEED FIELDS

J.A. Kamm and M.L. Montgomery

The post-harvest burning of straw and stubble on commercial grass seed fields is an economical way to eliminate crop residue and reduce the incidence of weeds, diseases, and certain insects. The burning process produces carbon residue that is incorporated into the surface layer of soil by winter rains. Because most grasses are perennial and require no yearly tillage, the carbon accumulates in the top layer of soil up to a depth of several cm on old fields. Insecticides are normally applied to grass fields in spring to control cutworms, billbugs, or other insect pests. Adult billbugs come in contact with the insecticide when they exit plant crowns and walk between rows in search of a mate during spring. Control of crown-dwelling cutworms or gelechiids depends on penetration of the insecticide into the crown where larvae feed. Adsorption on organic matter has long been known to reduce activity of many insecticides. We suspected that carbon residue of field burning was a major factor for the relatively poor results that orchardgrass growers obtained with insecticide applied for control of billbugs. Therefore, a study was conducted to investigate the possibility that the carbon residue on the soil surface between the rows of orchardgrass was responsible for the poor control of billbugs with insecticides.

Intact cores of soil from between rows of orchardgrass were removed and treated with chlorpyrifos in the laboratory. Field crickets were used to bioassay the insecticide because billbugs were not available. The percentage of field crickets killed when caged on these cores ranged from 95% for a three-year field to less than 15% for a sixteen-year field.

In another test, chlorpyrifos, diazinon, fonofos, dimethoate, acephate, and fenvalerate were applied to a twelve-year field of orchardgrass. When cores of soil were removed and crickets were caged on these cores, 51 to 96% fewer insects were killed when compared with the number killed when the same insecticides were applied to soil cores without carbon. Chemical analysis of treated cores with and without carbon residue indicated similar amounts of insecticide. The reduced mortality in our tests was attributed to the strong adsorption of the toxicant by the carbon residue that resulted from burning. When the toxicant is tightly adsorbed by the carbon, the insecticide molecules cannot kill insects.

Insecticides applied to fields with heavy carbon in the fall will likely result in poor control. The same insecticide applied to the same field in the spring will probably be more effective because the carbon will have degraded to some degree during the winter. As carbon accumulates on the soil surface over a period of years, the degree of control will decrease over time. The total surface area of the pores in one pound of activated charcoal is equivalent to the surface area of 125 acres. The adsorptive capacity of charcoal obtained from a given amount of straw has a greater capacity to adsorb pesticides than the straw from which it was made. In other words, both the straw and carbon residue from burning will adsorb pesticides but to a different degree. Therefore, any management program that prevents or slows the accumulation of carbon residue or straw should result in better control of insects when use of an insecticide is necessary.

Mechanical removal of straw and stubble is an alternative to field burning for straw removal but is more costly. However, some of this cost could be recovered if the frequency of insecticide applications could be reduced because of improved control in the absence of carbon on the field.

VARIETAL RESPONSE TO FENOXAPROP IN ITALIAN RYEGRASS

G. Mueller-Warrant and G. Hassan

Horizon 1EC (fenoxaprop) was registered in late 1987 for control of wild oats, roughstalk bluegrass, barnyardgrass, and crabgrass in perennial ryegrass, tall fescue, Italian ryegrass, and fine fescue. By late winter, several instances of severe injury to 'Tetrone' Italian ryegrass were reported, which suggests that varieties may differ in their inherent tolerance to fenoxaprop. Most of the injured fields of Tetrone had been treated in mid- to late-winter with 0.25 lb/a of fenoxaprop.

A greenhouse screening trial of 22 varieties of certified Italian ryegrass was conducted to determine the range in tolerance to fenoxaprop. Response to fenoxaprop was measured as reduction in growth (fresh weight), compared to untreated plants of each variety. Plants were treated with five rates of fenoxaprop, ranging from 0.05 to 0.25 lb/a, at a 7-leaf, 2-tiller stage of growth. The amount of fenoxaprop causing a 50% reduction in growth (GR50%) was estimated from response curves derived from the actual reduction in growth at all five rates.

Results from the greenhouse screening trial showed that varieties differed widely in their tolerance to fenoxaprop (Table 1). Among the most tolerant were the commonly grown varieties 'Marshall' and 'Gulf', which occupy most of the uncertified acreage of Italian ryegrass. The variety Tetrone was near the middle of the ranking, implying that many other varieties may also have the potential for injury if treated with similar rates of fenoxaprop. The varieties 'Ace', 'Barmultra', and others are even more sensitive than Tetrone. Since the GR50% rate for Tetrone of 0.15 lb/a is well below the rate actually applied which resulted in severely injured fields, this implies that one is at risk when treating any of these varieties with rates higher than their GR50% doses.

A field test of the response of Tetrone Italian ryegrass to Horizon was conducted at the Hyslop Field Laboratory. Ryegrass was planted on Jan. 27, 1988, into a stale seedbed which had been treated with glyphosate 6 days earlier. Horizon was applied at rates of 0.05 to 0.25 lb/a on March 28, April 15, and May 10. Ryegrass was 3 inches tall with 1-2 tillers on the first date, 5 inches tall with 5 tillers on the second date, and 13 inches tall with 7 tillers and jointed on the last date. Crop injury was rated three separate times (April 20, May 20, and June 10) for all plots which had been treated at least 3 weeks prior to the rating. Visual symptoms of injury began to appear 1 to 2 weeks after treatment, and reached a maximum by 3 to 4 weeks. Ryegrass was harvested July 13, and clean seed yield was determined.

In the field test of Tetrone Italian ryegrass, yield was not affected by rates of 0.05 and 0.10 lb/a, but did drop at 0.15 lb/a and higher (Table 2). This cutoff range, between 0.10 and 0.15 lb/a, corresponded to visual injury ratings of around 50% damage. Injury below this level was not associated with yield loss, while injury above it was too severe for full recovery to occur. Visual injury to ryegrass, relative to untreated checks, was still evident 74 days after the earliest treatment. Date of application had little effect on sensitivity to fenoxaprop, with only a slight trend toward greater injury from the April 15 treatment.

The Horizon registration label was changed in late 1988 to reflect these differences in varietal response to fenoxaprop. Rates for use of this herbicide to control wild oats were dropped to 0.15 lb/a (1.2 pt/a) for all registered grasses. In Italian ryegrass, only the common (uncertified annual) type and the varieties Marshall, Gulf, 'Promenade', and 'Barspectra' can now be treated. All varieties of perennial ryegrass, tall fescue, and fine fescue can still be treated. Higher rates of 0.19 to 0.25 lb/a (1.5 to 2.0 pt/a) are still recommended for control of roughstalk bluegrass in established grasses.

One use of Horizon currently under investigation is application to seedling stands of spring-seeded perennial ryegrass and tall fescue. Treatment in late spring or early summer would be of greatest value where spring seedings, possibly under irrigation, had become infested with susceptible warm-season grasses, such as barnyardgrass and crabgrass. Treatment under such conditions might greatly improve the chances of successful establishment.

Table 1. Tolerance of Italian ryegrass varieties to Horizon (fenoxaprop).

Variety	Fenoxaprop rate (lb/a)[1]	Tolerance ranking[2]	Label permits use[3]
Sakurawase[4]	0.35	1	N
Marshall	0.32	2	Y
Promenade	0.29	3	Y
Gulf	0.26	4	Y
Barspectra	0.26	5	Y
Torerro	0.25	6	N
Lemtal RVP	0.23	7	N
Florida 80	0.23	8	N
Florida Rust Resistant	0.20	9	N
Ellire	0.20	10	N
Hitachiaoba	0.18	11	N
Aubade	0.17	12	N
Billiken	0.16	13	N
Tetrone	0.15	14	N
TT80	0.14	15	N
Barmultra	0.13	16	N
Waseyutaka	0.12	17	N
Bartolini	0.10	18	N
Yamaaoba	0.08	19	N
Ace	0.07	20	N
Futahara	0.07	21	N
Minamewase	0.05	22	N

[1] Fenoxaprop rate causing 50% reduction in growth in greenhouse

[2] 1 = most tolerant

[3] Horizon label permits use on this variety.

[4] Preliminary samples of Sukarawase from two sources differed in their response to fenoxaprop. Retesting of this variety placed it near Marshall in tolerance.

Table 2. Response of Tetrone Italian ryegrass planted on Jan. 21, 1988, to postemergence applications of Horizon (fenoxaprop).

Treatment main effects	Italian ryegrass visual injury ratings[1] One month after treatment	 Two months after treatment	 Clean seed yield
Horizon rate[2]	(%)	(%)	(lb/A)
0	0	0	1690
0.05	32	45	1690
0.10	44	45	1830
0.15	64	62	1280
0.20	75	59	1360
0.25	80	75	1000
LSD 0.05	12	17	500
Application date			
March 28	57	54	1480
April 15	57	60	1330
May 10	63	--	1490
LSD 0.05	9	11	390

[1] Injury was rated on April 20, May 20, and June 10 for plots treated in March, March and April, and March, April, and May, respectively. Ratings at one month are averaged over all three application dates, and ratings at two months are averaged over only the first two application dates.

[2] Rate in lb/a.

USE OF KERB TO CONTROL CALIFORNIA BROME IN ORCHARDGRASS

G. Mueller-Warrant and M. Mellbye

California brome (*Bromus carinatus*) is a weed causing much concern to grass seed producers in the Willamette Valley. Field problems are likely to intensify with further restrictions on open field burning. Failure of atrazine and diuron to reliably control California brome seedlings has previously been reported, in addition to a shortage of ways to control the established plants. In orchardgrass, the use of Kerb (pronamide) does show promise for control of established California brome. This selectivity only exists in orchardgrass, but is probably worth investigating even for just a single crop because of the lack of any more widely adapted alternatives.

Orchardgrass at six sites in the Willamette Valley was treated with combinations of several herbicides designed to control only the seedlings, along with several rates and dates of application of Kerb to control the established plants. Weed control was evaluated at all sites, and orchardgrass was harvested for seed yield at four of them. Severe leaf diseases developed at all locations, and success of fungicide applications in controlling disease varied from site to site. Yields appeared to be reduced most severely by leaf diseases at sites possessing the most dense orchardgrass leaf canopy. It is possible that a disease by tiller density interaction may have adversely affected the most promising treatments. Winter weather was close to normal, and orchardgrass tolerance to Kerb should be similar in other years with normal or above normal temperatures. Tolerance in years with harsher growing conditions may not be as satisfactory.

Furloe, Nortron, Cinch and Kerb all provided good to excellent control of seedling brome. Karmex failed to consistently control all of the brome seedlings, although it did suppress this weed at some of the sites. Because of regulatory considerations, the manufacture of Furloe has ceased and the development of Cinch has been dropped, thus removing both herbicides for future use on seedling brome. Kerb controlled established brome at all but one of the sites when applied in December at 0.5 to 0.6 lb/a. It also suppressed, but did not fully control, the brome when applied at 0.4 lb/a in December or at any rate in November. Control from November applications looked very good until late in the spring, by which time the surviving brome plants had sufficiently recovered to develop some seed heads. Failure of Kerb to control established bromes at the oldest site may have been due to buildup of charcoal in the soil from repeated field burns or to the advanced age of the individual brome plants. January application of Kerb failed to control established bromes, and a split November plus January treatment did no better than the November treatment by itself. Soil life of Kerb is greatly influenced by temperature, as the herbicide rapidly breaks down above 50 F, resulting in a very short soil life for this herbicide if applied anytime other than late fall through early winter.

Orchardgrass turned yellow in response to application of Kerb, eventually recovering after about two months. Crop tolerance, based on visual symptoms in late winter and early spring, was somewhat better for November than December applications. This may only reflect the greater length of time available for recovery after treatment. Orchardgrass seed yield was either unaffected by Kerb treatment or actually increased because of reduced weed competition. Best control of California brome was achieved by December application of 0.6 lbs a.i./a of pronamide (1.2 lb of Kerb 50 WP). Crop tolerance to this treatment was acceptable in the 1987-88 growing season. Since December application caused greatest injury to both the weed and the crop, it is possible that an alternative application date might be needed for adequate crop safety in years with more severe growing conditions.

Failure to control California brome with January and February applications of Kerb in the present and previous tests suggests that the only timing of interest is the November through December period. Unfortunately, the choice of application date must be made before the arrival of the determining factor, which is the influence of the severity of winter weather on the tolerance of orchardgrass to pronamide. Application of Kerb should be made during December to maximize control of brome during years with normal and milder than normal winters, since adequate crop tolerance exists. Crop tolerance will likely be poorer in colder than normal winters with many freezing events, and earlier application dates and/or use of lower rates of Kerb would help reduce crop injury. Such adjustments would be advisable if a severe winter was forecast and anticipated. Delaying application beyond December is not useful because the weed will probably not be controlled.

DISEASE CONTROL RESEARCH

R. E. Welty

Severe leafspot and rust diseases of grass seed crops in 1988 were attributed to above-normal precipitation (+1.92 inch and +0.63 inch, respectively), and below-normal temperatures (-1.4 F and -0.7 F, respectively) occurring in May and June. From April 28 through May 19, precipitation occurred at Hyslop Field Laboratory 18 of 21 days. These weather conditions were ideal for disease development. For a contact fungicide (e.g., Bravo) to be effective, the fungicide must be applied before a prolonged period of wet cool weather.

Orchardgrass (cv. Potomac). Bravo (2 pt./a) or Tilt (4 oz./a) were applied once [on April 28 at Growth Stage 10 (GS)] or twice (on April 28 and May 21, GS 10 and GS 10.5), or as a tank-mix (same as above). A non-sprayed control was included in the study. Disease scores are the average of six replications; yield results are the average of 12 replications.

Percentage of leaf area damaged by scald (*Rhyncosporium orthosporum*) in the top four leaves (scored on May 24 at GS 10.5 and June 8 at GS 11.1) was significantly lower (P=0.01) in plots treated with one or two sprays of Bravo than in the non-sprayed controls (Table 1). Likewise, seed yields in Bravo-treated plots were significantly higher (P=0.05) than the non-sprayed control. Disease scores and seed yields in plots treated with the tank-mix of Bravo+Tilt were similar to plots treated with Bravo alone. Seed yields in plots treated with Tilt were not significantly different (P=0.05) from the non-treated controls.

Table 1. Severity of scald (*Rhyncosporium orthosporum*) and seed yield for Potomac orchardgrass treated with Bravo or Tilt alone and in tank-mix; Hyslop Field Laboratory, 1988.

Fungicide and rate/a	No. of applications[1]	Leaf area damaged by scald(%)		Seed yield, % of control[2]
		5/24	6/8	6/29
Control	-	29	62	100
Bravo (B) 2 pt.	1	15	30	124
Bravo 2 pt.	2	10	29	114
Tilt (T) 4 oz.	1	19	56	100
Tilt 4 oz.	2	25	57	105
B+T (as above)	1	14	28	123
B+T (as above)	2	11	25	114
LSD 0.10		5.8	6.5	-
0.05		7.0	7.9	12.4
0.01		9.4	10.6	16.4

[1] Fungicides applied: 1=4/28 and 2=5/21/88.

[2] Seed yield is percent of non-sprayed control (213 g/plot), harvested 6/29 and is the average of 12 replications.

Scald (percentage of leaf area damaged) in the top four leaves of each of 10 cultivars of orchardgrass was scored on June 8. Scald damage (average of four replications) among cultivars was significantly different (P=0.01, LSD=10.8%). Cultivars ranked by disease scores (lowest to highest) were Pennlate (42%), Cambria (46%), Frontier (47%), Aonami (53%), Able (54%), Latar (64%), Juno (65%), Potomac (68%), Sterling (68%), and Hallmark (69%). Cultivars with highest levels of susceptibility to scald would benefit the most from fungicide applications.

The results for one or two applications of Bravo (Table 1) indicate a single well-timed application of Bravo was as effective as two applications for disease control and seed yield. Depending on how a cultivar is managed and how closely weather conditions are monitored, a single application of Bravo applied to cultivars of orchardgrass with high levels of resistance to scald may be sufficient for disease control. Before this practice is widely adopted, it should be field tested to determine its effectiveness for individual growers. This could be done by leaving non-sprayed strips in a field.

Perennial ryegrass (cv. Linn). Tilt (4 oz./a) was applied in a series-omission schedule one to six times at 12- to 14-day intervals, beginning April 16, to control stem rust. Rust was scored (July 1) by two methods, percentage of incidence and rust severity (Table 2). Incidence was determined by recording stem rust present in 10 random handfuls (about 30 panicles per handful) for each plot (10/10=100%). Rust severity was the average of 10 random scores of stems and heads within a plot; 1=0% or <1% rust on stems and heads, 5=severe or > 50% rust on stems and heads. Seed was harvested (July 1) and seed yields (g/plot) determined. Each value is the average of five replications. Rust was significantly less (P=0.01) in plots receiving two applications of Tilt (June 9 and June 23) than in non-treated controls (Table 2); rust control in plots receiving three to six late-season applications of Tilt was not significantly different (P=0.01) from plots receiving two late-season applications of Tilt. Rust developed in non-treated plots and in plots receiving one application of Tilt. The observed F value for the effects of Tilt applications on seed yield means was P=0.16. In this experiment when seed yield from the highest-yielding plot within treatment replications was divided by seed yield from the lowest-yielding plot, the difference ranged from 17 to 124% (average 63% for 12 treatments). When data such as these are analyzed for variation, this much variability prevents statistical differences at the 5% level of significance. In other years, this observation has been made with other open-pollinated grass species and with other experimental treatments. Seed yield measurements by themselves do not provide effective criteria for evaluating treatments in small-plot testing. One way to reduce variation in treatment means is to increase replication, but this increases the size of field experiments.

Table 2. Incidence and severity of stem rust and seed yield in Linn perennial ryegrass treated with Tilt (4 oz/a) 1 to 6 times, Hyslop Field Laboratory, 1988.

Application date and no.[1]	Stem rust score Incidence (%)	 Severity 1-5	Seed yield % of control[2]
0	100	4.4	100
1	98	3.4	98
1, 2	100	2.6	104
1, 2, 3	96	2.8	97
1, 2, 3, 4	16	1.4	111
1, 2, 3, 4, 5	0	1.0	97
1, 2, 3, 4, 5, 6	0	1.0	123
2, 3, 4, 5, 6	0	1.0	117
3, 4, 5, 6	0	1.0	111
4, 5, 6	0	1.0	87
5, 6	0	1.0	105
6	72	2.8	91
LSD P=0.05	20.1	1.0	NS
P=0.01	26.9	1.3	NS

[1] Application dates: 1=4/16, 2=4/28, 3=5/12, 4=5/26, 5=6/9, 6=6/23.

[2] Seed yield is % of control (353 g/plot).

In another experiment, seven fungicides were applied alone or in combination (tank-mix) on April 23, May 11, and May 24 to *L. perenne* Linn. The treatments were scored on May 26 and June 6 for damage to leaf area (average percentage of top two leaves) by scald (*Rhyncosporium* spp.) and leafspot (*Drechslera* sp.) and for incidence (June 30) and severity (July 1) of stem rust. Leaf disease scores on May 26 in plots treated with Folicur and a tank-mix of Folicur+Rovral were significantly lower (P=0.05) than non-treated control plots (Table 3). On June 6, disease damage in plots treated with Folicur or tank-mixes of Bravo+Tilt or Folicur+Rovral was less than the non-treated controls (P=0.10). Both rust scores for all fungicide-treated plots, except Rovral, were significantly lower (P=0.05 or P=0.01) than the non-treated controls. Rovral was included in the test to evaluate leafspot control and

Table 3. Disease severity (leafspots and stem rust) and seed yield of Linn perennial ryegrass treated with fungicides, Hyslop Field Laboratory, 1988.

Fungicide[1] and rate/a	Leaf area damaged (%)[2]		Stem rust Severity[3]	 Incidence	Seed yield (%)[4]
	5/26	6/6	6/30	7/1	7/1
Control	24	54	3.6	100	100
Bayleton 4 oz.	27	56	1.0	12	112
Tilt (T) 4 oz.	27	57	1.0	50	129
Sisthane 4 oz.	24	51	1.0	18	110
Rovral 1 lb.	22	54	3.6	100	129
NuStar 10 oz.	21	50	1.0	32	97
Bravo (B) 2 pt.	20	43	1.0	8	103
Folicure (F) 12 oz.	14	42	1.0	4	130
B+T (as above)	19	40	1.0	0	122
R+F (as above)	16	41	1.0	24	121
LSD 0.10	6.5	11.7	-	-	NS
0.05	7.8	NS	0.70	23.7	NS
0.01	NS	NS	0.94	31.8	NS

[1] Fungicides applied: 4/28, 5/11, and 5/24.

[2] Average of top 2 leaves for 10 tillers per lot.

[3] 1=none to few pustules, 5=panicle severely rusted.

[4] Seed yield is percent of control (346 g/plot), harvested 7/1.

does not have activity against rust diseases. Seed yields from fungicide-treated plots were similar to non-treated controls. The observed F value for fungicide treatment means was P=0.28. Variation in seed yield for fungicide treatment within a replication (i.e., 5 observations) ranged from 31 to 110% and averaged 73% for the test. As stated previously, this variation reduces the probability of showing differences in treatment means at the 5% level of significance.

Tall fescue (cv. Fawn). Seven fungicides were applied alone or in combination three times (April 16, April 26, and May 12) and evaluated (May 11 and May 19) for leaf area damaged by leafspot fungi (species of *Rhyncosporium* and *Drechslera* (*Helminthosporium*) and seed yield (harvested June 27).

Leaf disease on May 19 was significantly less (Table 4) in plots treated with Folicur, Tilt, Bravo, Rovral, NuStar, Bayleton, tank-mixes of Bravo+Tilt and Rovral+Folicure than in the non-treated control (LSD 0.05=12.8%). The most effective fungicide treatments with the least leafspot disease were tank-mix Bravo+Tilt and Folicur.

Table 4. Disease severity (leafspots) and seed yield of Fawn tall fescue treated with fungicides; Hyslop Field Laboratory, 1988.

Fungicide[1] and rate/a	Leaf area damaged (%)		Seed yield % of control[2]
	5/11	5/19	
Control	6	76	100
Bravo (B) 2 pt.	8	55	93
Tilt (T) 4 oz.	5	55	105
B+T	4	43	121
Rovral (R) 1 lb.	7	59	105
Folicur (F) 12 oz.	3	49	97
R+F (as above)	3	59	76
Bayleton 2 pt.	4	59	105
NuStar 10 oz.	5	56	76
Sisthane 4 oz.	6	68	100
LSD 0.10	2.7	10.6	19.9
0.05	NS	12.8	23.9
0.01	NS	17.2	NS

[1] Fungicides applied on: 4/16, 4/26, and 5/12/88.
[2] Seed yield is percent of non-sprayed control (406 g/lot), harvested June 27, 1988.

Seed yield means from plots treated with Bravo+Tilt tank-mix were significantly higher (P=0.10, LSD 19.9%) than non-treated controls. When the highest seed yield within the four replications of a specific treatment was divided by the lowest seed yield, the difference ranged from 22 to 67% (average 44%). Less variation in seed yield occurred among plots in this study. However, plots with the greatest variation in yield were NuStar (67%) and tank-mix Rovral+Folicur (64%).

As in other years, stem rust was slow to develop in this field of Fawn tall fescue, and only a trace of rust was observed when plots were harvested near the end of June. A field of Bonanza was planted (fall 1988), and fungicide tests in 1989 will be conducted with this cultivar.

MOISTURE TESTING METHODS FOR SEED CROPS

D.F. Grabe and C. Garbacik

Development of accurate seed moisture testing methods is important for several aspects of the seed industry: seed production and harvesting, quality assurance, marketing, research, gene banks, seed testing laboratories, and in calibration of electric meters and other quick moisture testers. However, there are no standard methods for seed moisture testing in the United States, and different laboratories get different results. Discrepancies in moisture tests go undetected because it is not common for different laboratories to conduct moisture tests on the same seed lot.

The International Rules for Seed Testing (ISTA) contain recommendations for oven moisture testing methods, but these methods produce incorrect results for many crops. Attempts to improve the accuracy of oven methods have been stymied by a lack of a standard reference method for determining the true moisture content.

We have just completed a three-year project to develop a standardized Karl Fischer moisture titration procedure as a basic reference method for seed moisture testing, and to develop accurate oven moisture testing methods by calibration against the basic reference method. During this period, we:

1. Conducted a survey of seed testing laboratories belonging to AOSA and SCST Rules to obtain information on their current moisture testing activities, methods, and equipment.
2. Traced the origins of moisture testing methods of the ISTA and their relationships, if any, to basic reference methods.
3. Collected official moisture testing methods of many national and international organizations involved with seeds and grains.
4. Tabulated oven moisture testing methods for 65 species that have been proven accurate by calibration with basic reference methods.

5. Reviewed the scientific and commercial literature on moisture testing procedures and equipment for possible adaptation to seed moisture testing.
6. Developed a microwave oven procedure for rapid testing of moisture content of grass seed.
7. Adapted the automatic Karl Fischer titration technique for moisture testing of grass seed.
8. Modified oven methods for grass seeds to give results comparable to the Karl Fischer basic reference method.
9. Completed an M.S. thesis. "Development of oven and Karl Fischer techniques for moisture testing of grass seeds."
10. Participated in committee activities in national and international seed testing organizations to promote improved moisture testing methods in the AOSA and ISTA Rules for testing seeds.

The project will be continued for another three-year period to complete the development of rules for seed moisture testing.

RESPONSE OF WINTER WHEAT TO YIELD-ENHANCING AGENTS

D.F. Grabe, F.E. Bolton, C. Garbacik, and J. DeNoma

Several products and processes on the market are advertised to produce substantial yield increases when applied to wheat seed. The scientific basis for some of these claims is not always clear. Trials were conducted to provide Oregon growers with unbiased information for making decisions on whether to invest in these products and processes.

Trials were conducted for the third successive year to determine the effect of these products on seedling growth and grain yield of soft white winter wheat. Trials including seven treatments and three varieties were located at Corvallis (45 inch annual rainfall) in the Willamette Valley, and at Moro (11 inch annual rainfall) in central Oregon. The varieties were Stephens, Hill 81, and Malcolm which together are planted on over 80% of the Oregon commercial wheat acreage. The products tested were YEA!, containing chitosan, a crabshell derivative; Amplify-D, containing adenosine monophosphate (AMP) with sodium phosphate buffers; and Car-Dak, a super absorbent starch graft polymer with graphite. Another treatment consisted of passing the seed through a Bio-Mag seed treater.

Seed moisturizing was included in the trials this year for the first time. Commercial moisturizing equipment has been developed in Canada as a way of increasing crop yields. With this machine, 200 bushels per hour can be moisturized, making it feasible to use on a commercial scale.

The products were applied to Vitavax-treated seed at rates recommended by the suppliers. Seed moisturizing was done with laboratory-model equipment supplied by the manufacturer. Controls consisted of untreated seed and seed treated with Vitavax-200. Standard plot techniques appropriate for each location were employed. Plots were planted in a randomized block design with four replications. Planting dates were September 29, 1987, at Moro and October 9, 1987, at Corvallis. Laboratory studies were also conducted to determine the effects of treatments on germination and early seedling growth.

Seedling Growth. Seedling growth rate in germination towels was measured as milligrams of dry weight per seedling 7 days after germination.

Car-Dak, Bio-Mag and Amplify-D had no effect on seedling growth rate. YEA! had a small, but significant positive effect on seedling growth. Vitavax-200, while normally applied for its fungicidal effects, increased growth rate by 15%.

We studied the mechanism of the Vacu-Pressure Seed Moisturizer and compared its effects with simply soaking seeds in water. In the commercial apparatus, the treatment is a two-step process. In the first step, seed is soaked in a large tank under vacuum for 6 minutes. In the second step, the machine releases the vacuum and applies 5 pounds pressure for 6 minutes. The seed is then dumped in a truck for about 8 hours, during which time the moisture equilibrates throughout the seed and is surface-dried so it will run through a drill. We duplicated this process with our laboratory model, and compared moisture uptake, germination percentage, and seedling growth rate with seeds that had been merely soaked in water for similar lengths of time.

These early results indicate that moisture uptake may be a little faster under vacuum, but not very much. Total moisture uptake by moisturized seed after standing 8 hours may be a little higher than with an 8-hour soak in an open container, but not much. Germination and seedling growth rate were relatively unaffected by any of the treatments.

Questions have arisen regarding the fate of soaked seeds planted in soil that is too dry to sustain germination and continued seedling growth. We planted soaked seeds (about 25% moisture content) and dug them up at intervals to compare their moisture content with seeds planted dry. The field soil contained 3.5% moisture during this period. We found moisturized seeds quickly lost moisture to the dry soil while dry seeds sbsorbed moisture. Both moisturized and dry seeds equilibrated with the soil moisture at about 20-

21% moisture at 7 days. This moisture content is too low for seeds to germinate.

Yield. None of the treatments positively or negatively affected wheat yields at either location, confirming the results obtained in 1986 and 1987. Because of the dry fall, plantings at Moro were quite small in the spring, but stands were uniform at both locations. The dry conditions should have provided a good test of the treatments under stress since two of the procedures were designed to provide better moisture conditions for seed germination and early growth.

In summary, there were no indications of beneficial effects from treating wheat seed with these purported yield-enhancing agents.

MOISTURE STRESS TEST FOR WHEAT SEED VIGOR

S.P. Currans and D.F. Grabe

Seed vigor tests are conducted to evaluate the relative ability of seed lots to produce stands of seedlings in the field. Vigor tests are generally based on some aspect of seedling growth, biochemical measurements, or environmental stress during germination. Examples of environmental stresses incorporated in vigor tests are high temperatures combined with high humidities, and cold temperatures combined with seed pathogens. We investigated the possibility of differentiating vigor levels of wheat seed lots by germinating seeds under osmotic (moisture) stress.

The objectives of this study were to (1) develop an osmotic stress vigor test for wheat seed, (2) evaluate the effectiveness of this test in ranking seed lots for field emergence, and (3) compare the osmotic stress vigor test with other vigor tests.

A procedure for the vigor test was developed: Forty seeds were placed on top of 100 g of Grade 20 silica sand and covered with 210 g sand in 11 x 11 x 3.5-cm plastic germination boxes. This quantity of sand provided approximately 1 cm of sand above the seed. Fifty ml of polyethylene glycol (PEG 8000) solution giving an osmotic potential of -0.5 megapascals were added to each box. The lid was replaced and the box enclosed in plastic bags to prevent water evaporation. Seedling emergence above sand was recorded after 10 days in a dark germinator at 20 C.

Three field emergence trials were conducted at Hyslop Field Research Laboratory with 16 artificially aged and 19 naturally aged seed lots of soft white winter wheat. Planting dates were 30 September, 20 October, and 5 November, 1987. The 35 seed lots had laboratory germination of 85 to 100%, but field emergence ranged from 43 to 93% for individual lots. The average emergence of artificially aged seed was 59, 83, and 72%, while emergence of naturally aged seed was 60, 78, and 79% for the three planting dates respectively.

Under the relatively cold, wet field conditions of the third planting, the osmotic stress test was significantly correlated with field emergence of artificially aged ($r=0.85$) and naturally aged ($r=0.62$) seed lots. Correlation coefficients were also significant, but lower, for the other planting dates.

The osmotic stress test was compared with six other germination and vigor tests to evaluate their relative ability to rank seed lot emergence in each of the six field experiments. When the vigor tests were ranked according to correlation coefficients, the predictive value of the osmotic stress test was lower than some of the other vigor tests. The four-day sand germination test ranked among the top three tests all six times; accelerated aging, four times; seven-day blotter germination test, four times; glutamic acid decarboxylase activity, two times; and osmotic stress, dehydrogenase activity, and seedling growth rate, one time each.

While the osmotic stress test was successful, it and five other vigor tests were not as efficient as the four-day sand germination test in predicting field emergence of wheat seed lots. Results of the osmotic stress test were encouraging, and research should continue to determine its potential as a practical vigor test for other seed kinds.

RESPIRATION TEST FOR WHEAT SEED VIGOR

H.A. Van de Venter and D.F. Grabe

A positive relationship between oxygen uptake of seeds and subsequent seedling growth has been demonstrated for seeds of various species. Oxygen uptake of imbibing seeds has also been correlated with field emergence of corn and wheat, indicating the usefulness of this measurement as an index of seed vigor.

Intact seeds have normally been used when studying the relationship of respiration rate to seed vigor. Intact seeds have disadvantages, however, in that differences in seed coat permeability may limit imbibition of water and rates of oxygen diffusion. This study was undertaken to determine if these disadvantages can be eliminated by measuring respiration of ground seeds as an index of seed vigor.

Oxygen uptake of intact and ground wheat seeds was determined on six artificially aged wheat seed lots representing different vigor levels. Field emergence of the six lots was determined in trials planted 16 March 1988 when soil conditions were cold and wet, and 12 April 1988 when conditions were more favorable.

Higher rates of oxygen uptake were recorded with ground seeds than with intact seeds. Oxygen uptake of ground seeds appeared to be a better predictor of emergence rate under stress (cold and wet) conditions than oxygen uptake of intact seeds. Under favorable conditions, the predictive value for emergence rate was similar for intact and ground seeds. Oxygen uptake by ground seeds was less related to final stands in both trials than was the case with oxygen uptake by intact seeds, but the correlation was still significant.

The use of ground seeds for determination of oxygen uptake rates eliminates differences in diffusion rates of water and gases which might occur in intact seeds. It also eliminates differences in imbibition due to differences in seed size. It is suggested that the use of ground seed samples, as opposed to intact seeds, may find wider application in seed vigor testing.

SEED DORMANCY IN CUPHEA

D.F. Grabe and C. Garbacik

Seeds of *Cuphea* species are potential sources of medium-chain triglycerides for manufacture of soaps, detergents, and pharmaceutical products. The approximately 260 species of *Cuphea* occur in temperate to tropical climates from the eastern U.S.to southern Argentina. All known species of *Cuphea*, however, have several wild-plant characteristics which must be modified before a suitable plant type can be developed for agronomic purposes. Among the obstacles to domestication are indeterminate flowering, seed shattering, and seed dormancy. This work on seed dormancy is part of a broader project on domestication of *Cuphea*.

A series of experiments were conducted to determine the germination characteristics, optimum germination conditions, and methods of breaking dormancy of several *Cuphea* species. All seeds were harvested in the fall of 1987 and tests were conducted during the first six months of 1988.

After studying the germination responses of six species to six constant and three alternating temperatures in light and dark, the recommended germination procedure for maximum germination is to plant the seeds on top of blotters, at an alternating temperature of 20-30 C, in light, for 14 days. The species varied in degree of dormancy, ranging from nearly complete germination in one line of *C. lanceolata* to nearly no germination in *C. viscosissima*.

Numerous procedures for breaking dormancy were investigated, with varying degrees of success. Prechilling was largely unsuccessful. Continuous light was more effective than shorter durations. Removal of seedcoats and rupturing of seedcoats was successful in some species, but not in others. Acid scarification was unsuccessful.

A seed priming procedure was developed after evaluating various osmotic potentials, temperatures and treatment durations. The best priming procedure was to soak the seeds in a solution of polyethylene glycol 8000 with an osmotic potential of -10.0 bars at 20 C for seven days. Germination of four species increased substantially following priming, while germination of *C. viscosissima* and *C. leptopoda* increased only minimally.

Attempts were made to accelerate the after-ripening of *C. viscosissima* seeds by storing air-dried seeds in sealed tubes at 40, 50, and 60 C for periods up to nine weeks. This, too, was unsuccessful in breaking dormancy.

In general, the methods employed in these experiments were successful in promoting germination of the less-dormant species, but methods of germinating deeply-dormant species are still to be developed. For some species, the best procedure for obtaining germination is to allow the seeds to after-ripen in storage for a year or more.

OREGON FORAGE AND TURF GRASS VARIETY SEED YIELD TRIAL, 1988

H.W. Youngberg, W.C. Young, III, and T.B. Silberstein

A fee-supported seed yield evaluation program has been conducted at Oregon State University since 1981. In the most recent planting, 39 perennial varieties and 6 annual ryegrass varieties were planted in May, 1987, and September, 1987, respectively at the Hyslop Field Laboratory. Seed yield from all varieties was harvested in 1988. Perennial stands will be maintained for harvest in 1989; annual ryegrass varieties were replanted in September, 1988, for harvest in 1989.

Significant differences in yield, plant height and lodging were observed in all species except tall fescue (Table 1). Improvement in seed yield combined with lodging resistance was noted in orchardgrass and fine fescue entries as compared to the standard varieties.

A complete report of results, including management practices, is available on request from the authors.

Table 1. Seed yield of annual ryegrass, perennial ryegrass, bluegrass, orchardgrass, tall fescue, and fine fescue, 1988.

Species and variety	Seed yield		Plant height	Lodging Score[1]
	(lb/a)	(%Std.)	(cm)	
Annual ryegrass				
Marshall (Std.)	2712	100	130	4.3
Lunar	1427	53	121	3.5
Bartolini	1155	43	104	4.3
Bartissimo	924	34	97	4.5
BAR LM 4990	914	34	105	4.0
BAR LM 411	881	32	98	4.8
Mean	1335		109	4.2
LSD 0.05	608		15.5	0.7
Perennial ryegrass				
BAR DK 4GEL	1532	104	86	4.0
Linn (Std.)	1473	100	80	5.0
Chief	1450	98	81	5.0
Boston	1297	88	73	4.0
Sheriff	1293	88	78	5.0
Barcolte	1280	87	106	3.0
Bargold	1209	82	76	5.0
Opinion	1106	75	77	4.3
BAR ER 6K	1093	74	73	4.5
Bar LP 82-LO	1038	70	73	4.0
Barcredo	865	59	65	4.3
Mean	1240		79	4.4
LSD 0.05	355		8.8	0.4
Bluegrass				
Caroline	1039	225	69	4.8
BAR VB 534	1017	221	60	5.0
BAR VB 577	971	211	64	5.0
Miranda	556	121	70	3.5
BAR LP 6611	541	117	66	5.0
BAR VB 7251	532	116	69	5.0
BAR VB 7034	473	103	69	5.0
Newport (Std.)	461	100	66	5.0
Lucia	415	90	53	5.0
Mean	667		65	4.8
LSD 0.05	237		6.5	0.4
Orchardgrass				
BAR DGL 71	1295	125	133	2.8
DS-7	1236	119	134	2.5
Syn 8501	1192	115	113	4.0
Hallmark	1133	109	119	3.5
Potomac (Std.)	1036	100	124	4.0
Paiute	987	95	121	4.5
Mean	1144		124	3.5
LSD 0.05	209		10.2	0.9
Tall Fescue				
BAR FA 7851	1541	113	120	5.0
Fawn (Std.)	1363	100	120	4.0
Barcel	1253	92	122	4.8
Trbl	1194	88	107	4.8
Syn W	961	71	125	4.0
Mean	1262		119	4.5
LSD 0.05	NS		11.7	0.6
Fine Fescue				
Hector	2550	168	86	4.3
Victor	2161	142	79	5.0
Flemo	1798	118	86	4.8
Molinda	1775	117	83	5.0
Camaro	1594	105	79	5.0
Pennlawn (Std.)	1522	100	86	5.0
Koket	1483	97	87	5.0
Barnica	1434	94	76	5.0
Barcrown	1222	80	88	4.5
Baruba	861	57	80	5.0
Mean	1640		83	4.9
LSD 0.05	273		7.0	0.4

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[1] Lodging score 1-5; 1 = no lodging and 5 = flat

PERFORMANCE OF SPODNAM^R IN GRASS SEED CROPS

W.C. Young III, T.B. Silberstein, and H.W. Youngberg

Spodnam has recently been promoted as a harvest aid for grass seed crops grown in the Willamette Valley. Promotional information has suggested that seed yield increases may result through the control of shattering losses. The product's active ingredient, a polymer of cyclohexane, reportedly forms a coating over the inflorescence to reduce water from entering the seed while still allowing water vapor to pass through. The product is exempt from EPA registration.

As grass seed crops mature, seed moisture content declines and the individual florets disarticulate (break) from the rachilla of the spikelet resulting in seed loss from shattering. In theory, restricting moisture (dew and rain) from entering the infloresence during the late stages of seed filling will reduce the shrinking and swelling that occurs as seed moisture content drops during maturation. In practice, timely swathing has been used to windrow seed crops just prior to significant shattering losses. However, the ability to delay swathing (with shattering controlled) could allow more seed to attain true physiological maturity and result in higher seed yields.

Spodnam treatments were evaluated in 1988 at the OSU Hyslop Field Laboratory on second year seed crops of "Pennfine" perennial ryegrass, "Bonanza" tall fescue, and "Hallmark" orchardgrass. Each species was uniformly managed for seed production. Spodnam was applied using a high-clearance plot sprayer with an offset boom to avoid treading the plots. Treatments were made just prior to the completion of anthesis (orchardgrass, June 14; perennial ryegrass, June 18; and tall fescue, June 20) at three rates: 1.00, 1.25 and 1.50 pints per acre. A total solution of 20 gallons per acre was applied with Twinjet TJ60-650134 nozzles on 10 inch spacing. The variable height boom was adjusted to provide a double overlap spray at the panicle region of the plant canopy to ensure excellent coverage of the seed bearing component of the plants. A boom pressure of 30 PSI was provided by a CO_2 cylinder and a pressure regulator.

Seed moisture content is the index most commonly used as a guide for the harvest of maximum grass seed yield. Therefore, plots were harvested on three dates, beginning with the optimum seed moisture content for swathing (Klein and Harmond, 1971), and followed with two later dates at significantly lower seed moisture. Untreated check plots were also harvested at each date resulting in a factorial arrangement of treatments. All plots were replicated four times and data were analyzed in a randomized complete block analysis of variance for each date of harvest.

The effects of delayed harvest date and treatment with Spodnam are shown for orchardgrass, tall fescue and perennial ryegrass in Table 1. Seed yield of orchardgrass and tall fescue was reduced by harvesting at later dates. Perennial ryegrass seed yield was not influenced within the range of harvest dates evaluated in this study, although seed moisture content was significantly reduced at later dates.

Table 1. Influence of Spodnam rate on seed moisture and seed yield at three dates of harvest in orchardgrass, tall fescue, and perennial ryegrass, 1988.

Spodnam rate	Seed moisture at harvest D1[1]	D2	D3	Seed yield D1	D2	D3
(pt/a)	-------- (%)	----------		------- (lb/a)	-------	
Orchardgrass						
Control	30.1	23.8	16.2	623	352	212
1.00	37.0	27.9	17.1	658	404	269
1.25	32.0	23.8	16.4	597	374	246
1.50	31.0	28.1	15.7	624	388	284
LSD 0.05	NS	3.5	NS	NS	NS	NS
Tall fescue						
Control	36.6	20.7	17.1	1656	1213	1110
1.00	39.8	21.9	17.3	1703	1388	1264
1.25	37.2	18.5	15.9	1348	1053	888
1.50	40.6	21.2	16.7	1449	1136	984
LSD 0.05	NS	NS	NS	NS	NS	NS
Perennial ryegrass						
Control	23.2	16.3	14.6	551	495	658
1.00	23.4	16.3	13.5	659	722	790
1.25	22.9	15.4	13.6	466	595	723
1.50	23.8	16.4	13.7	738	762	725
LSD 0.05	NS	NS	NS	NS	NS	NS

[1] Date of harvest: D1, D2, and D3 for orchardgrass, July 1, July 7, and July 14; for tall fescue, July 7, July 14, and July 18; and for perennial ryegrass, July 11, July 15, and July 19, respectively.

Treatment with Spodnam had no significant effect on seed yield in the three grass species studied when these crops were harvested at the optimum seed moisture for maximum seed yield. In addition, no benefit was apparent from Spodnam when harvest date was delayed. Thus, control of seed loss due to shattering was not observed in these trials.

Literature Cited

Klein, L.M., and J.E. Harmond. 1971. Seed moisture - a harvest timing index for maximum yields. Trans. ASAE 14:124-126.

A SURVEY OF NUTRIENT UPTAKE AND SOIL TEST VALUES IN PERENNIAL RYEGRASS AND TURF TYPE TALL FESCUE FIELDS IN THE WILLAMETTE VALLEY

D. Horneck and J.M. Hart

Open field burning has been the primary method of straw disposal and field sanitation for grass seed production in western Oregon. Air quality regulations have forced growers to seek alternative methods of post harvest field management. The practice of straw removal after harvest followed by stubble treatment with a propane flamer, vacuum residue removal, or urea sulfuric acid is being widely used.

Research under non-burn conditions where the stubble was left standing has shown lower yields resulting from reduced light incidence to young tillers (Stanwood, 1974; Ensign et al., 1983). When straw is removed from the field, nutrients are not recycled as when the straw is burned in the field. Most grass seed production research, especially soil fertility work, has been conducted under open field burned conditions, where at least some nutrient recycling occurred. The effect of long-term residue removal from grass seed fields on soil nutrients and pH have not been studied.

A survey was conducted as the first step to answer fertility questions in perennial ryegrass and turf-type tall fescue seed production under non-burned conditions. The survey objectives were to: determine the amount of N, P, K, S, Ca, and Mg removed by a grass seed crop that has straw removed rather than burned in the field; investigate the relationship between nutrient uptake and soil test levels at four soil depths; determine the effect of stand age on nutrient uptake and soil test levels; and provide direction for future research.

Seventy-three established perennial ryegrass and tall fescue fields were selected by straw management and stand age from a five county area in the Willamette Valley. Tissue samples from three-foot-lengths of row were harvested from three randomly selected areas at each site. Samples were clipped at a 4-inch height to simulate plant material that would be removed in a baling operation. Samples were oven dried, weighed and analyzed for N, P, K, Ca, Mg, and S. Soil samples were taken from the sample area from four depths: 0 to 1, 1 to 2, 2 to 6, and 0 to 6 inches. Soil samples were air dried and analyzed for pH, P, K, Ca, and Mg.

A questionnaire was completed by growers. Information was obtained regarding fertilizer and straw management, grass species, stand age, and seed yield for each field. Sigstat was used in statistical analysis for regression and SAS was used for testing differences in means.

Results. Tall fescue produced more dry matter than ryegrass. This is consistent with the growth characteristics of these grasses. Straw management or stand age did not produce a significant difference in dry matter production for either grass species. A trend was observed for lower dry matter production in older fields where residue had been harvested (removed). The reason for the decline in dry matter production was not evident. This trend parallels grower observations that seed yield decreases in older stands.

Young (1988) showed that excessive dry matter production is detrimental to seed yield of perennial ryegrass due to increased number of vegetative tillers. Nitrogen is the predominant factor controlling dry matter production. Average nitrogen application rates used by growers in the fields surveyed are 35 lb/a higher than the 120 lb/a recommended by OSU Extension Fertilizer Guides. The high N fertilizer application rates can account for increased dry matter production and possibly lower seed yield. Elevated N rates should not cause the decreased dry matter trends observed in older fields that have been managed by straw removal by baling.

Few significant differences were observed in nutrient uptake values determined by plant analysis. K uptake was higher than N for both grass types. As residue management practices generally change from burn to baling or physical removal, the corresponding nutrient removal will increase in importance.

Soil testing should be a regular part of the management program used to monitor nutrient levels, especially for K. Nitrogen uptake was significantly lower in older ryegrass stands with straw removed by baling. This was a function of reduced dry matter production rather than N concentration. The same trend was observed in baled tall fescue fields.

Mg, Ca and S uptake also showed similar trends toward lower dry matter yield and lower nutrient uptake in older baled grass seed fields. This is probably due to poor stand vigor, excess crown growth, a change in tiller position and increased disease incidence.

Soil pH decreased with stand age and was lowest in the surface inch of soil. This is a result of continued topdressing of ammoniacal fertilizers. The low surface pH could account for growers' comments about finding P fertilizer response beyond OSU Extension Service guidelines because low soil pH can reduce P availability due to fixation or adsorption. Consequently, higher rates of P fertilizer will be needed to elicit a crop response under these conditions.

Soil pH values for the surface inch were 0.2 pH unit lower than the soil pH for a 0 to 6 inch sampling depth. This indicates that acidification of the surface layer is progressing and growers are not liming between crops. Many of the lowest pH values are found in fields that are rented or leased. Landlords are reluctant to share the cost of lime and renters are similarly reluctant to pay the cost of a lime application and risk losing the lease before the cost of the lime application can be recovered.

Soil P and K levels tended to increase with stand age and decrease with soil depth; however, there were few significant differences. P and K levels averaged 200 to 500% and 250 to 400% above OSU recommendations which are 25 ppm and 100 ppm, respectively. High soil test levels were in part responsible for low correlations of soil test levels to plant uptake or concentration. These high soil levels are consistent with the annual fertilizer application rates. P, K, Ca and Mg soil test levels had higher correlations with plant nutrient uptake and concentration for the 0 to 1 inch depth than the 1 to 2, 2 to 6 and 0 to 6 inch depths. Higher correlations with surface P and K levels and plant uptake were an interesting and unforeseen result of this survey and will affect our sampling for future soil test calibration research.

Conclusions. In general, K and P soil test levels were high and soil pH values were low. These high nutrient levels in the soil were in part responsible for poor correlations between soil and plant nutrient levels or nutrient uptake.

Current rates of fertilization for grass seed production in the Willamette Valley are above those recommended by OSU Extension Fertilizer Guides. High nitrogen application rates may be reducing seed yields and increasing dry matter that later is to be removed or burned.

Soil pH, Ca, and Mg levels increased with soil depth while P and K levels decreased. Few significant differences were observed between stand age or straw management treatments for any parameter measured. The 0 to 1 inch soil sample provided the best correlation of soil nutrient level with plant nutrient uptake and concentration. The 1 to 2, 2 to 6, and 0 to 6 inch depths had lower correlations. This has resulted in our inclusion of 0 to 1 inch and 0 to 6 inch samples in current calibration work.

Literature Cited

Ensign, R.D., V.D. Hickey and M.D. Bernardo. 1983. Seed yield of Kentucky bluegrass as affected by post-harvest residue removal. Agron. J. 75:549-551.

Stanwood, P.C. 1974. Influence of post-harvest management practices on plant growth and seed yield of cool season grasses. M.S. thesis. Oregon State Univ., Corvallis, Oregon.

Young, W.C. 1988. Seed yield and yield components of Pennfine perennial ryegrass as influenced by time of spring N and chemical dwarfing. Ph.D thesis, Oregon State Univ., Corvallis, OR.

EFFECTS OF XE-1019 GROWTH RETARDANT ON PENNFINE PERENNIAL RYEGRASS SEED PRODUCTION

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

Research was continued in 1986 with Chevron Chemical Company's experimental growth retardant compound XE-1019. The primary objective of this study was to evaluate three formulations of the compound at several rates. Formulations supplied by the manufacturer were: 50% wettable powder (WP) containing no spreader sticker, 10% WP with a sticker, and 1.0 lb emulsifiable concentrate (EC). Four rates were evaluated for each formulation: 0.125, 0.25, 0.50, and 0.75 lb a.i./a. The experimental design was a 3 x 4 (formulation x rate) factorial with one control treatment outside the factorial combination in randomized blocks. In addition, comparisons were made to Parlay (standard 50% WP formulation) using the 0.50 and 0.75 lb a.i./a rates. Analysis of variance procedures were used to determine differences among all treatment combinations and to test for interaction of formulation x rate of XE-1019. All treatments were applied to a first year seed crop of Pennfine perennial ryegrass on April 4, 1986, at the floret initiation growth stage.

Standard cultural practices were followed for the management of the perennial ryegrass seed crop. Conventional seedbed preparation was followed by planting 5.5 lb/a of seed in 12-inch wide rows on June 14, 1985. Irrigation was scheduled to avoid moisture stress during establishment, and phenoxy herbicides were used to control broadleaf weed competition. The stand was well established by late summer. Fertilizer was applied as 16-20-0 at 185 lb/a on October 8, 1985, and was followed by 1.2 lb a.i./a atrazine on October 28, 1985. Spring nitrogen was supplied as urea at 260 lb/a on March 6, 1986. Applications of Tilt fungicide at 4.0 oz./a were used for rust control on May 8, and May 27,

Table 1. Lodged area and lodging severity at two dates, and plant height as influenced by growth retardant treatment, 1986.

Treatment	Lodging 6-12		Lodging 6-27		Plant
	Area	Severity[1]	Area	Severity[1]	Height
(lb a.i./a)	(%)		(%)		(cm)
50% WP					
0.125	63.3	4.2	65.0	4.7	85.2
0.25	40.0	3.2	51.7	4.2	72.3
0.50	16.7	1.8	45.0	3.2	69.1
0.75	21.7	2.0	40.0	3.2	58.8
10% WP					
0.125	68.3	4.0	56.7	4.7	85.5
0.25	41.7	3.5	65.0	3.8	69.7
0.50	23.3	2.2	38.3	3.2	60.9
0.75	10.0	2.0	38.3	3.0	55.3
1.0 EC					
0.125	66.7	4.0	81.7	4.2	90.8
0.25	63.3	3.3	70.0	4.0	75.6
0.50	15.0	2.2	43.3	3.2	58.4
0.75	10.0	1.8	43.3	3.0	53.1
Parlay					
0.50	65.0	3.7	76.7	4.3	81.4
0.75	48.3	3.2	53.3	4.0	78.4
Control	78.3	5.0	83.3	5.0	109.8
LSD 0.05	15.0	0.5	20.0	0.4	11.7

[1] Lodging score 1 - 5: 1 = no lodging and 5 = flat

Table 2. Seed per tiller and dry matter distribution as influenced by growth retardant treatment, 1986.

Treatment	Seed per tiller	Seed yield	Total dry weight	Straw weight	Harvest index
(lb a.i./a)	(no.)	(lb/a)	----(ton/a)----		(%)
50% WP					
0.125	43.0	1297	4.8	4.2	13.31
0.25	45.9	1430	4.5	3.8	15.98
0.50	46.4	1528	4.3	3.5	18.00
0.75	61.2	1451	3.9	3.2	18.60
10% WP					
0.125	41.3	1234	4.7	4.1	13.12
0.25	47.1	1402	4.5	3.8	15.72
0.50	43.5	1434	3.9	3.2	18.32
0.75	59.7	1333	3.4	2.7	19.93
1.0 EC					
0.125	45.4	1219	4.6	4.0	13.13
0.25	46.9	1210	4.5	3.9	13.41
0.50	70.0	1580	4.2	3.4	18.92
0.75	62.3	1550	4.1	3.3	18.83
Parlay					
0.50	53.7	1327	4.3	3.7	15.35
0.75	42.4	1442	4.6	3.8	15.78
Control	28.3	832	4.7	4.3	8.84
LSD 0.05	19.1	210	0.4	0.4	1.84

1986. All plots were harvested at physiological maturity on July 5, 1986.

Analysis of yield components at peak anthesis found no significant difference in the number of vegetative, late-emerging reproductive tillers, fully emerged fertile tillers, or total tillers. Similarly, the fertile tiller number at maturity did not differ. Furthermore, there was no significant change in the number of spikelets per spike or florets per spikelet, and the difference in calculated potential number of seeds per unit area at anthesis was nonsignificant. Plant height was reduced and the area and severity of lodging was significantly reduced where XE-1019 and Parlay were applied (Table 1). The reduced lodging from the PGR treatment appears to have resulted in improved seed set, which corresponded to an increase in seed yield (Table 2). Total dry weight and straw dry weight were reduced when the growth retardant was applied, suggesting that a favorable repartitioning of assimilates to the seed may have occurred. Further evidenced was the significant increase in harvest index.

Seed yield was increased significantly over the untreated control plot at 0.125 lb a.i./a. Increases in seed yield resulted at higher rates of application due to greater control of lodging. Rates higher than 0.50 lb a.i./a did not result in an additional seed yield increase. Highest yields were at the 0.50 lb a.i./a rates in all formulations. Treatment with Parlay growth retardant resulted in a similar benefit to seed yield due to control of lodging (Table 2). There was no significant difference in seed yield due to formulation of XE-1019, however, the 10% WP formulation was slightly more effective as measured by reduced straw weight and total dry weight (Table 3).

Concern over residual effects of growth retardants on the crop in the following year prompted an evaluation of plant height prior to seed maturity in 1987. Rates of XE-1019 greater than 0.125 lb a.i./a resulted in a significant reduction in plant height. However, no significant reduction in plant height was observed in the Parlay treated plots (Table 4). In addition, plots treated with the 50% WP formulation were significantly shorter than plots treated at equal rate with the EC formulation (Table 5).

Table 3. Seed per tiller and dry matter distribution as influenced by formulation and rate of XE-1019, 1986.

Treatment	Seed per tiller	Seed yield	Total dry weight	Straw weight	Harvest index
	(no.)	(lb/a)	----(ton/a)----		(%)
Material					
50% WP	49.1	1427	4.4	3.7	16.47
10% WP	47.9	1350	4.1	3.4	16.77
1.0 EC	56.1	1390	4.4	3.7	16.07
LSD 0.05	NS	NS	0.2	0.2	NS
Rate (lb a.i./a)					
0.125	43.2	1250	4.7	4.1	13.19
0.25	46.6	1347	7.5	3.8	15.04
0.50	53.3	1514	4.1	3.4	18.41
0.75	61.0	1445	3.8	3.1	19.12
LSD 0.05	11.8	126	0.2	0.2	1.13

Table 4. Plant height of Pennfine perennial ryegrass as influenced by growth retardant treatment in the crop year following treatment, 1987.

Treatment	Plant height
(lb a.i./a)	(cm)
50% WP	
0.125	65.9
0.25	60.7
0.50	54.6
0.75	49.2
10% WP	
0.125	65.1
0.25	60.6
0.50	56.2
0.75	51.4
1.0 EC	
0.125	67.5
0.25	64.0
0.50	57.6
0.75	51.3
Parlay	
0.50	67.8
0.75	65.3
Control	68.6
LSD 0.05	4.6

Table 5. Plant height of Pennfine perennial ryegrass as influenced by formulation and rate of XE-1019 in the crop year following treatment, 1987.

Treatment	Plant height
	(cm)
Material	
50% WP	57.6
10% WP	58.3
1.0 EC	60.1
LSD 0.05	2.2
Rate (lb a.i./a)	
0.125	66.2
0.25	61.8
0.50	56.1
0.75	50.6
LSD 0.05	2.6

MINIMUM TILLAGE SYSTEMS FOR CHANGING VARIETIES IN SEED PRODUCTION

W.C. Young III, H.W. Youngberg and T.B. Silberstein

Many new grass varieties are being released for seed production and certification under the Oregon and international Organization for Economic Cooperation and Development (OECD) certification programs. Seed quality and genetic standards are constantly being tightened. The numerous variety options present problems in locating enough fields with suitable crop history to meet the certification standards for growing new varieties.

Few studies have been done to evaluate certified grass seed crop establishment under minimum tillage systems. Establishment methods and available herbicides need to be evaluated to develop successful systems to provide better control of weeds and volunteer seedlings. A minimum tillage system in a grass seed production program will take advantage of the weed control practices that have reduced weed seed contamination in an established field. Lack of tillage will keep recently-formed weed and shattered crop seed on the soil surface where they can be readily destroyed before causing crop contamination problems. Other advantages of the minimum tillage system are lower production costs, greater flexibility in crop selection and cropping sequences, and better erosion control than provided by conventional tillage cropping systems.

Field trials were initiated at the Hyslop Crop Science Field Laboratory during late summer of 1985. Objectives were to investigate the effectiveness of minimum tillage systems during the crop rotation period between seed production of two perennial ryegrass crops and the impact of non-burning in this process. An acceptable system would meet the crop purity standards of the Oregon Seed Certification Service and the OECD Certification Scheme.

Crop rotation sequences for both studies began following harvest of a third year seed crop from a diploid (2n) variety of perennial ryegrass. The rotational crops were established in burned and non-burned ryegrass stubble. The method of establishment for each study, and crop growth and yield data for the rotation crops has been reported (Young and Youngberg, 1987).

The first study evaluated the effectiveness of a rotation to one- and two-year red clover crop established by a no-till system in perennial ryegrass sod in preparing for production of a perennial ryegrass seed crop of another variety (R1 and R2, Table 1). The second study compared the effectiveness of a one-year rotation to meadowfoam, and a meadowfoam/spring pea rotation (two-year) before changing to a perennial ryegrass seed crop (R3 and R4, Table 1).

Table 1. Crop rotation sequence between two perennial ryegrass seed crops using minimum tillage establishment.

	Rotation system[1]			
Year	R1	R2	R3	R4
82-85	PR_2	PR_2	PR_2	PR_2
85-86	RC	RC	Mf	Mf
86-87	PR_4	RC	PR_4	SP
87-88	PR_4	PR_4	PR_4	PR_4

[1] PR_2 = perennial ryegrass (diploid); PR_4 = perennial ryegrass (tetraploid); RC = red clover; Mf = meadowfoam; and SP = spring pea.

Following harvest of the rotation crop (red clover or meadowfoam) in the summer of 1986, a tetraploid (4n) variety of perennial ryegrass was fall-seeded into half of both rotation crops (R1 and R3, Table 1). Meadowfoam stubble not seeded to tetraploid perennial ryegrass was seeded to a high-protein spring pea in the following spring (R4, Table 1). In the summer of 1987, second year red clover (R2, Table 1), spring pea, and tetraploid perennial ryegrass seed crops following both rotations were harvested. These data have been reported (Young and Youngberg, 1988). The rotation crops were successfully established in the perennial ryegrass sod using minimum tillage techniques. The percentage of diploid seeds produced in the tetraploid variety harvested after a one-year rotation was in excess of certification tolerances.

In order to test the acceptability of a two-year rotation, a fall-seeding (1987) of the same tetraploid perennial ryegrass variety (planted after a one-year rotation in the fall of 1986) was established into the second year red clover stubble and the spring seeded pea stubble (R2 and R4, Table 1). In addition, post-harvest management of the tetraploid perennial ryegrass seeded in the fall of 1986 was either flail chopped or burned in early-August 1987. Thus, this report summarizes data collected during the 1987-88 crop year from both an established stand of perennial ryegrass entering the second seed crop year, and a seedling crop of perennial ryegrass, which has followed a two-year rotation to either red clover or meadowfoam/spring pea crops.

Second year perennial ryegrass seed crops did not differ significantly in their total dry weight, seed yield or number of fertile tillers in either rotation sequence. Thus, burning crop residue of the previous perennial ryegrass variety (diploid) prior to establishment of the rotation species, or post-harvest burning of the current (tetraploid) variety after the first seed crop had no effect.

The first year perennial ryegrass seed crop, following two years of red clover, did not differ significantly in regard to the post-harvest treatment prior to establishment of the rotation crop. However in the meadowfoam/spring pea rotation, first year perennial ryegrass seed yield was significantly greater where the burning had preceded establishment of the rotation crops. Reduced sanitation with flail chopping and less aggressive herbicide options during the meadowfoam rotation (compared with herbicide use in the red clover rotation) most likely contributed to this situation. In addition, when comparing the rotational sequences, a 60% greater seed yield resulted where perennial ryegrass followed two years of red clover. This may be the result of slightly higher soil nitrogen level when rotating to a system following two years in rotation with a legume (red clover, 1986 and 1987) with only a one year rotation to a legume crop (spring peas, 1987) .

Managing both rotation sequences through the second crop year before returning to another variety of perennial ryegrass was designed to test the level of diploid contamination in the tetraploid crop which followed. However, high seedling counts of ryegrass plants outside the drill row and an excessive percentage of diploid seeds in the harvested crop will not support the recommended use of minimum tillage establishment for crop rotation systems attempting to produce Certified seed. In addition, no difference in the seedling counts or the ploidy test results was observed due to residue management prior to establishment of the rotation species (Table 2).

Table 2. Inter-row spring seedlings counts and ploidy test results in the tetraploid perennial ryegrass crop established following either a two-year rotation to red clover or a two-year rotation to meadowfoam and spring peas, 1988.

Treatment	Seedlings	4n[1]	2n
	(m^2)	------- (%)	--------
Two-years of red clover			
Burn	14	94	7
Flail-chop	9	94	7
LSD 0.05	NS	NS	NS
Meadowfoam/spring peas			
Burn	30	92	9
Flail-chop	34	96	5
LSD 0.05	NS	NS	NS

[1] 4n= tetraploid ryegrass; 2n= diploid ryegrass

Literature cited

Young, W.C., and H.W. Youngberg. 1987. Minimum tillage systems for changing varieties in seed production. pp 38-39. In: 1986 Seed Production Research at Oregon State University, USDA-ARS Cooperating. Ext/Crs 68

Young, W.C., and H.W. Youngberg. 1988. Minimum tillage systems for changing varieties in seed production. pp 9-12. In: 1987 Seed Production Research at Oregon State University, USDA-ARS Cooperating. Ext/Crs 70.

AGRONOMIC STUDIES ON TURF-TYPE TALL FESCUE VARIETIES

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

The introduction of turf-type tall fescue varieties in the late 1970's significantly changed the character of tall fescue seed production in western Oregon. Where formerly tall fescue was grown on relatively infertile soils subject to winter flooding, the crop is now being grown on soils with excellent fertility and better drainage. Generally the management of the turf-type varieties has followed practices formerly used for the forage type varieties.

Tall fescue has long been recognized as a hardy and persistent forage plant, and it is a good seed producer over a long stand life if proper management practices are followed. However, when compared with the forage varieties, many growers have reported declining seed yield in turf-type tall fescue fields during the third and fourth year of production. Several hypotheses have been put forward to explain the condition, but the cause is not clear.

Preliminary observations point to a stronger tillering pattern and more prostrate growth habit in the turf type varieties. These characteristics result in greater vegetative dry matter production, possibly greater straw yields and possibly other differences in growth habit. More information on the plant growth and development pattern of the turf-type varieties was needed to formulate management practices to maintain seed yield throughout the life of the stand or production contract. Therefore, recommended row spacing, seeding density, fertilizer rate and timing and residue disposal methods for turf-type tall fescue varieties are being reviewed.

Research was initiated in August 1985, when four varieties of tall fescue ("Falcon", "Rebel", "Bonanza" turf-types and "Fawn" forage type) were seeded for a long-term study extending over four years. Each variety was seeded separately in 200-foot x 150-foot blocks planted in alternating strips 24- x 150-foot at either 12- or 24-inch inter-row spacing. Intra-row density was held constant in both 12-inch and 24-inch plantings by using a seeding rate of 7.0 and 3.5 lb/a, respectively. Plots were fertilized in the spring at vegetative development, reproductive development or split equally between the two stages with urea applied at rates equivalent to 90, 130 or 170 lb N/a. Since harvest of the first year seed crop, half of the plots have been burned two times with a propane flamer to simulate open field burning. Straw was removed from unburned plots with a flail chopper, leaving 3 to 4 inches of stubble, to simulate baling of post-harvest residue. Seed yield is determined by using a small plot harvester.

Three seed crops have been harvested from these trials to date. This report briefly summarizes the treatment effects observed through the third harvest in the summer of 1988.

Crop management studies. In the first seed crop (1986), Falcon was the only variety where a significant effect due to row spacing was observed; narrow row planting resulted in a higher seed yield (Table 1). There was no difference in the other varieties. Time of nitrogen application was not significant, however, the later maturing varieties, Bonanza and Rebel, had a

Table 1. Seed yield (lb/a) of four tall fescue varieties from three seed harvests, 1986-88 in response to various treatment effects.

Treatment	1986				1987				1988			
	Bonanza	Rebel	Falcon	Fawn	Bonanza	Rebel	Falcon	Fawn	Bonanza	Rebel	Falcon	Fawn
Residue management												
Burn	--	--	--	--	2065	1541	1820	1725	1580	1024	1728	1411
Flail Chop	--	--	--	--	1976	1086	1591	1482	1398	950	1436	1304
LSD 0.05					*	*	(P<0.1)	*	*	*	*	*
Row spacing (inch)												
12	1441	1330	1320	1144	2058	1300	1871	1621	1458	933	1611	1314
24	1340	1318	1118	1152	1984	1327	1541	1586	1520	1041	1553	1401
LSD 0.05	NS	NS	83	NS	*	*	142	NS	*	*	*	*
Nitrogen application time												
Vegetative	1426	1349	1236	1090	2009	1322	1719	1698	1502	1019	1656	1311
Split (50/50)	1437	1381	1161	1185	2001	1321	1745	1608	1557	1071	1588	1372
Reproductive	1309	1243	1261	1169	2052	1297	1653	1505	1408	871	1501	1390
LSD 0.05	NS	NS	NS	NS	NS	NS	NS	118	*	*	NS	NS
Nitrogen rate (lb N/a)												
90	1249	1505	1336	1338	2102	1379	1828	1861	1467	998	1527	1554
130	1431	1267	1158	1072	2066	1345	1701	1557	1603	1019	1517	1383
170	1491	1200	1163	1034	1894	1217	1587	1393	1398	944	1702	1136
LSD 0.05	140	149	NS	97	108	*	146	*	*	*	102	*
Grand mean	1390	1324	1219	1148	2021	1314	1706	1604	1489	987	1582	1358

* Interaction with other treatments significant at the $P<0.05$ level.

slight yield advantage following early and split applications. Fawn, an early maturing forage variety, had the best yield where split and late applications were used. Varieties responded differently to the rate of spring-applied nitrogen. Bonanza produced the best seed yield when at least 130 lb/a or more of N were applied, whereas Rebel, Falcon, and Fawn did not respond significantly to rates greater than 90 lb/a. There were no residue management treatments in the first harvest.

Comparison of the grand means for each variety in 1986 and 1987 showed that, with the exception of Rebel, the second year seed crop averaged 40% greater than the first year harvest. Thus, when using fall-establishment, maximum yield potential may not be achieved in the first crop year.

Specific to the 1987 data, burning residue after harvest resulted in greater seed yield for all varieties, and seed yield was slightly greater for 12-inch row spacing for all varieties except Rebel. Time of spring N had no influence on seed yield of the turf-type varieties. High rates of spring N did not significantly increase seed yield, indicating that rates from 90 to 130 lb N/a may be adequate for maximum yield. Caution is urged in the direct interpretation of these data due to several significant interactions between main effects in 1987 and 1988.

Seed yield in 1988, when averaged across all treatments and varieties, was about 82% of the previous year's crop. Both Bonanza and Rebel were down about 25%, while Falcon and Fawn fell by only 7 and 15%, respectively. As in 1987, burning residue after harvest resulted in greater seed yield for all varieties. However, in this third crop year, the 24-inch row spacing resulted in greater seed yield for all varieties except Falcon. A slight advantage for early or split application of spring N was observed; however, these differences were small. As seen in 1986 and 1987, spring N rates between 90-130 lb/a resulted in our top seed yield for all varieties with the exception of Falcon, which in 1988 had a significantly greater seed yield at 170 lb N/a.

As previously noted, many significant interactions have made the interpretation of these data less straightforward than the simple single-factor approach used above. Interaction is the concept that not all factors act independently of each other; thus, changing the level of one factor does not produce the same effect at all levels of another factor. The discovery of interaction broadens the range of validity and conclusions of an experiment. In this experiment, there are four main factors being studied simultaneously: residue management, row spacing, time of spring N, and rate of spring N. It is, therefore, the significance of the interactions between these treatments that is of interest. In addition, we must be aware that not all varieties respond the same to every treatment, and, being perennial crops, it is likely that growth may be influenced over time by the various treatments they have received; thus, older crops may respond differently to the same treatment when measured over time.

The interaction of residue management and row spacing was significant for seed yield of Bonanza and Rebel in 1987, and for Bonanza, Rebel and Falcon in 1988 (Table 2). These data suggest that row spacing may be a more important factor in determining seed yield when crop residue is flail chopped rather than burned. There was no significant difference between 12-inch and 24-inch row spacing for Rebel (1987 and 1988) and Bonanza (1988) when crop residue was burned. However, these same varieties had significantly higher seed yield if grown in 24-inch rows when post-harvest residue was flail chopped and removed. In addition, no difference between 12-inch and 24-inch row spacing was observed for Bonanza (1987) and Falcon (1988) when unburned, although 12-inch row spacing was superior when burned.

Table 2. Interaction of residue management and row spacings on seed yield (lb/a) of several turf type tall fescue varieties in the second and third harvest year.

	1987		1988		
Treatment	Bonanza	Rebel	Bonanza	Rebel	Falcon
Burn					
12-inch	2145	1596	1608	1070	1810
24-inch	1985	1486	1553	978	1646
Flail chop					
12-inch	1971	1004	1308	796	1412
24-inch	1982	1168	1488	1105	1460
LSD 0.05	40	112	157	218	71

It is also of interest to examine the interactions between the rate of spring N and residue management, row spacing, and time of spring N application. Although not significant for all varieties in every year, these relationships are presented in order to define a strategy for maximum economic yield under several crop management regimes. Seed yield of Rebel in 1987 and 1988 was generally higher when crop residue was burned at several levels of spring N; however, no significant advantage resulted from using rates greater than 90 lb/a, regardless of the post-harvest residue management treatment (Table 3). Wider row spacing resulted in greater seed yield for Rebel (1987) and Bonanza (1988), and again, low to moderate spring N rates appear to be sufficient (Table 4). Also, 90 lb N/a results in the maximum seed yield when a split spring N is used; higher rates may be necessary to achieve maximum yield when all spring N is applied during vegetative development (Table 5). Delaying all spring N until after reproductive development has begun may result in lower seed yield.

Table 3. Interaction of residue management and rate of spring N on seed yield (lb/a) of Rebel tall fescue in the second and third harvest years.

Spring N (lb/a)	1987		1988	
	Burn	Flail	Burn	Flail
90	1542	1215	1115	881
130	1597	1093	1029	1010
170	1483	950	928	960
LSD 0.05	104	104	130	130

Table 4. Interaction of row spacing and rate of spring N on seed yield (lb/a) of Rebel (1987) and Bonanza (1988) tall fescue.

Spring N (lb/a)	Rebel (1987)		Bonanza (1988)	
	12-inch	24-inch	12-inch	24-inch
90	1287	1470	1337	1596
130	1326	1326	1531	1675
170	1185	1185	1506	1290
LSD 0.05	104	104	174	174

Table 5. Interaction of time of spring N application and rate of spring N (lb/a) on seed yield of Bonanza and Rebel tall fescue, 1988.

Spring N (lb/a)	Bonanza			Rebel		
	Veg.	Split	Rep.	Veg.	Split	Rep
90	1297	1703	1400	912	1143	939
130	1680	1634	1495	1058	1119	880
170	1530	1335	1330	1088	952	793
LSD 0.05	213	213	213	159	159	159

Conclusions. This study confirms observations of lower seed yields in the first harvest from a fall planting of tall fescue with declining seed yield in the third harvest. Seed yield from unburned plots is lower than from burned treatments. Significant differences between the forage variety (Fawn) and the turf-type varieties for this characteristic were not observed.

A 24-inch row spacing is preferable to a 12-inch spacing when tall fescue seed fields are managed without burning. Turf-type varieties produced higher seed yields with the wider row spacing.

Spring nitrogen rates greater than 130 lb/a generally reduce seed yield in tall fescue. Applying N early (vegetative stage) or split N 50-50 (vegetative and reproductive stages) produced highest seed yields.

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RESPONSE OF TETRAPLOID PERENNIAL RYEGRASS TO THE PLANT GROWTH RETARDANT CCC

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CCC (Clormequat Chloride) is a foliar-applied synthetic plant growth retardant known to inhibit gibberellin biosynthesis and thereby reduce growth of some plants. CCC has been most widely used in cereal production to control lodging by reducing plant height. Research conducted in Oregon during 1984 showed "Linn" perennial ryegrass seed yield was not affected by CCC applied during floret initiation growth stage, or two weeks later, at rates of 2.0 or 4.0 lb a.i./a (Young, et al., 1984). However, a more recent study in New Zealand reported 20 to 30% increase in seed yield of perennial ryegrass when CCC was applied at 2.7 lb a.i./a during spikelet initiation growth stage (Hampton, 1986). The purpose of this trial was to test the effect of an application at an earlier growth stage under Oregon conditions.

CCC was applied to fall-seeded (1987) "Bastion" tetraploid perennial ryegrass on March 31, 1988, after microscopic dissection of tiller apices determined crop growth to be at spikelet initiation stage. Four rates of CCC (1.0, 2.0, 3.0 and 4.0 lb a.i./a) and an untreated control plot were arranged in a randomized complete block. Treatments were replicated four times. Tilt was applied (4 oz a.i./a) on June 16 and June 29, 1988, for rust control. All fertilizer and herbicides were applied according to standard production practices. One-foot row samples were taken just after peak anthesis to evaluate CCC effects on tiller growth and yield components. Plots were harvested July 14, 1988, using a small plot harvester and were later threshed and cleaned for seed yield.

Yield component data showed that lower rates of CCC resulted in significantly more spikelets per spike; however, this advantage was offset by a reduction in the mean number of florets per spikelet (Table 1). Fertile tiller number at peak anthesis was not significantly affected by treatment. On a unit area basis, there was no difference in the potential number of seeds at peak anthesis or the actual number of seeds at harvest. In addition, no significance was observed for the length of individual internodes, spike length, or the combined total.

The results from this study suggest that application of CCC at the spikelet initiation growth stage of perennial ryegrass has very little benefit to Oregon seed growers.

Table 1. Response of fertile tillers, spikelets per spike, and florets per spikelet to varying CCC application rates.

CCC application rate	Fertile tillers	Spikelets per spike	Florets per spikelet
(lb a.i./a)	(per ft^2)		
0	134	19.8	5.9
1.0	114	21.2	4.4
2.0	99	20.2	5.0
3.0	114	18.9	5.7
4.0	120	19.1	4.7
LSD 0.1	NS	1.3	1.0

Total dry weight at harvest was significantly reduced at the highest rate of CCC; however, there was no difference in the seed yield or average seed weight (Table 2).

Table 2. Response of dry weight, seed yield, and 1000 seed weight to varying CCC application rates.

CCC application rate	Plot dry weight	Seed yield	1000 seed weight
(lb a.i./a)	(ton/a)	(lb/a)	(g)
0	3.7	1554	3.39
1.0	3.3	1684	3.43
2.0	3.6	1886	3.36
3.0	3.0	1553	3.41
4.0	2.8	1468	3.40
LSD 0.05	0.7	NS	NS

Literature Cited

Hampton, J.G. 1986. The effect of chlormequat chloride application on seed yield of perennial ryegrass (*Lolium perenne* L.). J. of Appl. Seed Prod. 4:8-13.

Young III, W.C., D.O. Chilcote, and H.W. Youngberg. 1984. Response of Linn perennial ryegrass to application of three growth retardants. pp. 17-18. In: 1984 Seed Production Research at Oregon State University, USDA-ARS Cooperating. Department of Crop Science. Ext/CrS 54.

RECENT PUBLICATIONS

Chastain, T.G., and D.F. Grabe. 1988. Establishment of red fescue seed crops with cereal companion crops. I. Morphological responses. Crop Sci. 28:308-312.

Chastain, T.G., and D.F. Grabe. 1988. Establishment of red fescue seed crops with cereal companion crops. II. Seed production and economic implications. Crop Sci. 28:313-316.

Benjamin, E., and D.F. Grabe. 1988. Development of oven and Karl Fischer techniques for moisture testing of grass seeds. J. Seed Technol. 12:76-89.

Kaliangile, I., and D.F. Grabe. 1988. Seed maturation in *Cuphea*. J. Seed Technol. 12:107- (Accepted for pub. Feb.).

Noland, T.L., J.D. Maquire, R.N. Oliva, K.J. Bradford, J.L. Nelson, D.F. Grabe, and S.P. Currans. 1988. Effect of plant density on carrot seed yield and quality at three locations. J. Applied Seed Prod. 6:(Accepted for pub.).

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