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Title SOME FACTORS INFLUENCING YIELD AND QUALITY OF GRASS SEED

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The seeds of certain grass species have a tendency to shatter easily. The economic loss to the grower due to loss of seed by shattering is an important factor in the selection of certain species for seed production purposes. The yield and quality of grass seed may be influenced by several factors, some of which may be controlled to some degree by the seed producer.

There is disagreement among growers as to the proper time to harvest certain grass species for maximum yield of seed. This study was initiated to investigate some of the factors which must be considered in determining the optimum stage of maturity for harvesting certain grass species to obtain maximum yield and quality of seed. For this purpose, six species extensively grown in Oregon for seed production were chosen.

The influence of varying dates of flowering on seed shattering and germination were studied. Panicles were harvested at the soft, medium and hard dough stages of seed maturity, treated to determine the shattering tendency and cleaned by a uniform method. Replicated samples of each lot of seed were germinated.

The flowering period of certain grass species may extend over a period of several days duration and may be influenced by meteorological factors. Certain grass species have a tendency to shatter seed more readily than other species. Analysis of seed germinations indicated no significant difference between two dates of tagging. The loss of seed due to shattering varied with the species and with the stage of seed maturity at time of cutting. The rate of seed shattering appeared to increase as seed maturity increased. The method and degree of cleaning may influence the germination percentage and the amount of cleaned seed. Germination percentages for all species at the different stages of harvest were relatively high. Harvesting at the most mature stage appears to give the highest quality of seed as measured by their germinating ability.

The seeds of the six species studied may be harvested at an immature stage to reduce the loss of seed due to shattering. These seeds may have a high germinating percentage if properly cleaned, but the loss of weight due to cleaning must be considered.

SOME FACTORS INFLUENCING YIELD AND QUALITY OF GRASS SEED

by

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SOME FACTORS INFLUENCING YIELD AND QUALITY OF GRASS SEED

INTRODUCTION

In the past several years the seed producing industry has become an important part of the agricultural economy of the State of Oregon and of the United States. The production of grass seed, in Oregon, was nearly 90 million pounds of clean seed in 1950. The seeds of the grasses Alta fescue, common, and perennial ryegrass were 85 million pounds of this total (4). Oregon produces the major portion of all seeds of these species that is grown in the United States.

The economic loss to the grower by the loss of seed due to shattering prior to threshing, may often become an important factor in the growing of certain grasses for seed production purposes. The amount of loss due to seed shattering depends upon several factors. Some of these may be, partially at least, under the control of the producer and others due to other causes. Inherited differences, adjustment of machines, and method and time of harvest may play an important part in the amount of seed harvested. The amount of cleaned seed, purity, and germination to some extent, can be materially influenced by the method and thoroughness of the cleaning operation which is often beyond the control of the grower.

The seeds of Alta fescue, common, and perennial ryegrass, and Tualatin tall oatgrass may shatter upon or after reaching a certain stage of maturity. The seeds of these grasses may be dislodged from the spikelet quite easily by mechanical means or by the action of wind or rain while in the field. This loss of seed may occur either before or after the crop has been cut and placed in the windrow prior to threshing.

Some growers of grass seed in Oregon make a practice of cutting part of their seed crop at an immature stage in an attempt to harvest the crop before seed loss by shattering in the field has become excessive. Some controversy has occurred as to the merits of this practice and to what effect it might have on the amount of weight loss due to the cleaning process. These problems have prompted this study, to investigate some of the factors which must be considered in determining the optimum stage of maturity for harvesting certain grass species.

The objectives of this research were to obtain information as to how certain grass species behave in the field, and any factors of importance which may be used as a basis for determining the proper time of harvest to obtain maximum yield and quality of grass seed. It is known that different grass species behave differently as to date of anthesis, time of day which flowering takes place, and other factors relative to seed yield and quality. Therefore, certain species were studied to obtain panicles of approximately the same stage of development and to determine the seed shattering tendency and germination of seeds when harvested at an immature stage of maturity.

REVIEW OF LITERATURE

For many years it was questioned whether the immature seeds in a sample would germinate and produce normal seedlings. As early as 1922, workers (2),(9),(10) found that immature seeds of barley were capable of germinating and producing seedlings themselves capable of producing seeds. Further work on the behavior of prematurely harvested grains of sweet corn, wheat, barley, and rye, (2),(5), (10) show similar results. Small grains harvested as early as five days after fertilization were usually dwarfed but germinated readily and produced normal plants even though the kernel weight was only ten percent that of fully developed kernels. Germination varied greatly with age and maturity but no specific age or moisture content below which all grains ceased to germinate could be found.

Work done by Hermann and Hermann (11) with crested wheatgrass indicated that some seeds do not germinate well immediately after harvest, but that storage results in an increased and accelerated germination. Seed weight, percent of emergence from different depths of planting, and of heights of seedlings grown in darkness, increased with greater maturity of seed; however, differences were not large after reaching the hard dough stage of development. Immature seeds of timothy and Kentucky bluegrass obtained from heads with a high moisture content (3) gave a low germination percentage during the first 10 to 14 days following collection. These seeds gave a relatively high germination percentage after being thoroughly dried. Results of experiments on crested wheatgrass (11), timothy and Kentucky bluegrass (3), several western range and pasture grasses (13), and certain weedy grasses (7), indicate that seeds of high viability may be obtained by harvesting as soon as the early dough stage of seed development has been reached.

Work with sweet corn (5) indicated that immature harvested kernels germinated better when allowed to dry on the cob attached to the stalk, than when removed from the cob before drying. This effect of seed maturing while attached to the culm was also observed by Harlan and Pope (9) who stated that in small grains, it is thought that no additional material enters the seed from the spike for a period longer than one hour after the culm has been severed from the plant.

Extensive studies have been conducted on the effect of meteorological factors on pollen dispersal and pollination of several grass species. Jones and Newell (12,pp.9-10) found that tall fescue, Festuca elatior (L.) var. arundinacea (Schreb.) Wimm, under average conditions began blooming by 1:00 p.m. each day, with most active blooming occurring between 1:30 and 3:30 p.m. and ceasing about 5:30 p.m. Blooming took place at temperatures of 65 to 85 degrees Fahrenheit with 78 degrees being optimum. Light blooming occurred at temperatures from 58 to 60 degrees, with days of both heavy and moderate pollen shedding in this species. The average pollen dispersal period per inflorescence for tall fescue was 9 days at 1:00 to 6:00 p.m. In the case of tall oatgrass, Arrhenatherum elatius (L.) Presl., this period was 7 days at 3:00 to 7:00 p.m. Wind movement was very important in speeding up anthesis, dehiscence, and pollen dispersal.

Further work with tall oatgrass and timothy (6,pp.109-113) indicates that not only does the weather conditions of a day have a great influence on the time of appearance of the first bloom but the conditions of the day before, also exercise a similar influence. The latter may, by checking the blooming, make available more flowers which are ready to bloom on the following day. Experiments showed that under artificial conditions temperature has by far the most influence on time of flowering. If there is not sufficient warmth available, blooming does not take place at all. Other workers (12,p.41) found that the optimum temperature for pollen dispersal varies with the species and below minimum temperatures may delay blooming for hours or even days. High humidity did not hinder blooming, even if it does delay the opening of the anthers.

A survey made in 1949 (14,pp.239-240) on recent developments in seed technology states that commercial grass seeds often contain heavy mature seeds, empty florets and various intermediate types, such as badly shriveled or immature caryopses and undeveloped ovaries.

Other than a purity test, a uniform air pressure appears to be the most practical method of separating the empty, immature and shriveled florets most of which are non-viable, from the heavy, pure seed. The retention in the pure seed fraction of a small percentage of these light weight and mostly non-viable florets causes a decrease in germination that is disproportionate to the increase in purity when such particles are included as pure seed.

METHODS AND MATERIALS

For this study it was decided that the grasses to be studied should all be species which are commonly grown for seed production in the Willamette Valley. The species Alta fescue, Festuca elatior var. arundinacea (Schreb.) Wimm; red fescue, Festuca rubra L.; Chewings fescue, Festuca rubra commutata Gaud. (F. fallax Thuill); Tualatin tall oatgrass, Arrhenatherum elatius (L.) Presl.; perennial ryegrass, Lolium perenne L.; and common ryegrass, Lolium multiflorum LAM., were selected. All but red fescue were located in the forage class nursery on the College West Farm.

It was realized that there may be differences due to inherent make-up between plants in a row which might influence the amount of variability within the plot. Therefore, another experiment was established. For this experiment an attempt was made to obtain isolated single plants, four each of Alta fescue, perennial ryegrass, and Tualatin tall oatgrass. These plants were cloned, potted in ten inch pots, allowed to grow and planted in the field on October 12, 1950. The planting plan is shown in Appendix Table 1.

To study some of the factors which might influence yield and quality of grass seed it was felt that a knowledge of the flowering habits of each species should be obtained. Therefore, all species were checked daily at approximately 11:00 a.m. beginning May 28 until the beginning of anthesis. After it was noted that anthesis had begun, that particular species was checked twice daily at 10:00 a.m. and 3:00 p.m. To obtain a number of panicles of a uniform degree of development, individual heads were tagged when flowering had progressed to the approximate center of the panicle. Using a different colored disk for each day of tagging, individual panicles were tagged at random as anthesis progressed to the appropriate degree as indicated by exsertion of the anthers. From 50 to 100 panicles of each species were tagged at various dates and allowed to develop in the field.

To classify the heads as to stage of seed development by visual and sensory methods it was necessary to inspect the individual panicles daily to determine the stage of maturity of the caryopses. When the seeds of several of the panicles tagged at a certain date had reached the desired stage of maturity, soft, medium or hard dough, at least 15 of those panicles for that species were cut with stems of 12 to 18 inches in length and tied into bundles. Each bundle was labeled and placed upon a laboratory table to dry and mature. All grass samples were threshed by hand on July 12, weighed, placed in small paper envelopes and labeled.

Part of this study was to obtain some measure of the shattering ability of these grass species which had been cut at various stages of seed development. To obtain some degree of susceptability to shattering, each bundle at date of threshing, was dropped a distance of three feet upon the laboratory table, then turned and dropped an equal distance upon the other side. The seeds which dislodged from the spikelets were weighed, placed in paper envelopes and labeled. All seeds which did not shatter out when the bundle was dropped on the table, were removed from the head by handstripping.

The seed samples were cleaned by a Bates Aspirator, and each sample except tall oatgrass, was recleaned by means of a South Dakota model-B blower to remove any light weight seeds or inert matter that may have remained in the sample. Tall oatgrass was recleaned by means of hand seives. After the seeds were cleaned, all lots were weighed to obtain a measure of weight loss due to cleaning. The weight of one thousand seeds of certain seed samples were obtained at this time.

One of the major factors to be considered in this study was to determine the germinating ability of seeds harvested at an immature stage of development and compare with that of mature seeds. Each seed sample was sub-sampled by placing 100 seeds on filter papers in each of four Petri dishes. All seeds except those of tall oat-grass were pre-chilled. Seeds were germinated using standard methods and equipment recommended by the Association of Official Seed Analysts (1).

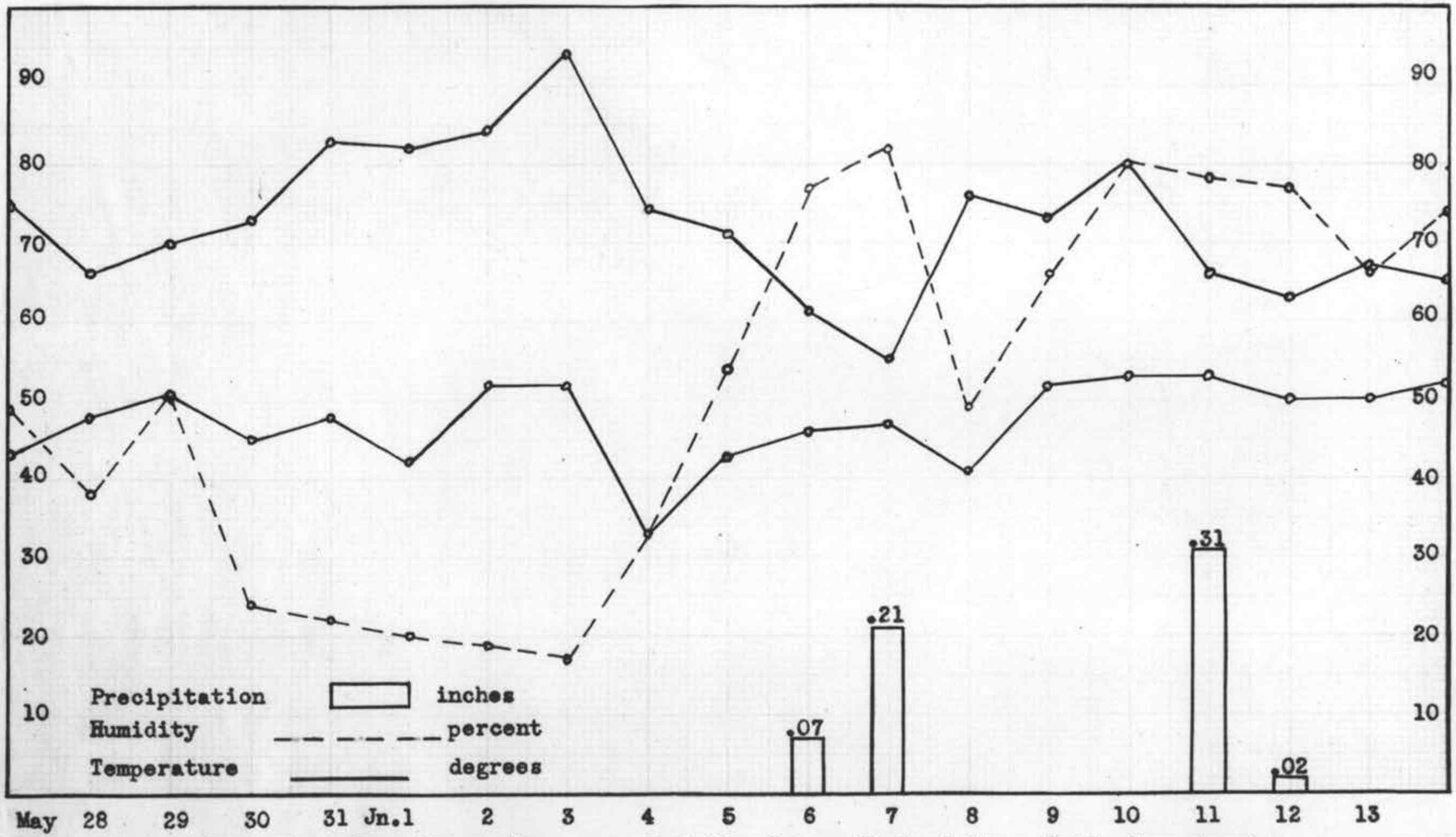
EXPERIMENTAL RESULTS

Field observations of the six species studied indicated that flowering of these species began at the uppermost part of the panicle or spike and advanced downward to the base. Those spikelets attached to the outer ends of branched panicles flower first and progress toward the base of the branch. In the case of individual spikelets, flowering begins at the base and progresses to the tip.

The time of flowering as indicated by exsertion of the anthers may vary between plants and between species. Meteorological conditions may also cause the flowering to be spread over a period of several days. It is thought that the high temperature and relatively low humidity from May 28 to June 6, as indicated in Table 1, caused the grass florets to mature rapidly. Few florets were noted as being in bloom prior to June 2, with all species except Alta fescue and perennial ryegrass. Flowering was very intensive until June 6, then ceased, to begin again on June 8. The cool period with some rain on June 6 and 7, was not conducive to flowering and tended to delay anther exsertion until June 8 and 9. This was noted as being especially heavy on Alta fescue, Tualatin tall oatgrass and common ryegrass.

Observations showed that Alta fescue and perennial ryegrass began flowering May 31 and some seed heads were tagged on that day. Blooming continued until June 5 when it became cooler. One June 8 the weather became warm and it was noted that some panicles of Alta fescue tagged on May 31 showed extruded anthers at the base of the panicle. During the warmer days between May 31 and June 5, Alta

Table 1 Maximum and minimum temperatures, relative humidity and precipitation from May 28 to June 14, 1950 at Corvallis, Oregon. *



* Data taken from the weather record of the Oregon State College Soils Department.

fescue flowered from 4:30 to 8:00 p.m. but on June 8, following a few days of cooler partially cloudy weather, flowering was intense at 2:00 p.m. Similar results occurred in common ryegrass which was first noted in bloom on June 3 and continued blooming till after June 10. This factor was very marked in the case of Tualatin tall oatgrass. On June 3 the oatgrass began blooming with a high percent of panicles extended. When the weather cooled on June 6, flowering ceased temporarily. Oatgrass again flowered profusely on June 11. It was noted on June 12 that some panicles which had been tagged on June 3 still showed some evidence of bloom on a few spikelets, the panicle being open and extended much as on June 3 with some anthers exserted.

Examination of individual panicles suggested that it is possible for part of the panicle to flower, to cease due to unfavorable weather, and then to continue flowering again as the weather becomes favorable. This was evidenced both by observation and by the presence of a caryopsis filled with milky, watery fluid in the upper part of the panicle while the spikelets on the lower half still had anthers exserted.

It is well known among research workers that many of the common grass species include many variable types as to plant characteristics. This variation may have some influence upon the length of the seed setting period and the amount of seed shattering which may occur in the field. It is known that in certain plants of tall oatgrass the caryopsis is held quite firmly within the spikelet while other plants may shatter their seed readily upon reaching a certain stage of maturity.

Field observations on June 23 indicated that some seed shattering had occurred in tall oatgrass prior to this time possibly due to action of wind and panicle movement. Many caryopses were lying on the ground on either side of the row although seed contained in panicles tagged on June 3 at flowering time, were in a soft to medium dough stage of maturity. Panicles tagged on June 3 and harvested June 28 threshed easily; those harvested July 3 were badly shattered in the field resulting in little shattering loss with laboratory treatments. Panicles tagged June 11 and harvested June 28 showed very little shattering in the field and laboratory, but those harvested July 3 were shattering excessively in the field. Early shattering of seed in the field undoubtedly reduced the amount of seed shattering which occurred when the bundles were dropped on the laboratory tables.

The handling of Chewings and red fescue in the field on July 3 while in the hard dough stage, caused very little loss of seed by shattering. Alta fescue shattered quite readily at this time and some seed had fallen to the ground. Slight handling of the panicles caused seed to shatter easily. Perennial ryegrass also showed evidence that many seeds had shattered in the field prior to harvest and shattered easily upon being handled. This was also the case of common ryegrass but to a lesser degree.

The percent of seed loss due to shattering in red fescue as noted in Appendix Table 2, was low. However, loss of seed due to shattering in the other species varied with the species and with the stage of seed maturity at time of cutting. Observations of Chewings fescue indicated that little shattering had occurred in the field but shattered considerably with the laboratory treatment. Alta fescue, perennial and common ryegrass, and Tualatin tall oatgrass shattered in the field at the medium to hard dough stage and excessively with the laboratory treatment.

No analysis of seed shattering was made, but with the laboratory treatment the rate of seed shattering increased as seed maturity increased. Due to the lack of replication and loss of seed in the field it was felt that the data available was not reliable enough to warrant further testing.

The germination percentages for all species at the different stages of harvest were high. An examination of individual species indicated a significant difference between treatments for Alta, red and Chewings fescue, but not for perennial and common ryegrass as given in Table 2.

Table 2 Summary of analysis of variances for all species

species	date tagged	F	L. S. D.
Alta fescue	June 8, 1950	8.469	2.873 **
red fescue	June 3, 1950	4.959	5.417 *
Chewing fescue	June 3, 1950	4.267	3.381 *
per. ryegrass	May 31, 1950	not significant	
com. ryegrass	June 8, 1950	not significant	
tall oatgrass	June 3, 1950	not significant	

* exceeds the value necessary for significance at 5 percent
** exceeds the value necessary for significance at 1 percent

When considering all stages of maturity for all species, in general each species seemed to behave independent of the other. As is shown in Table 3, only four of the fifteen comparisons gave a significant correlation coefficient.

Table 3 Two-way table of correlation coefficients between species for all stages of maturity

species	R. fescue	C. fescue	P. rye	C. rye	T. oat
A. fescue	.4545	.3467	.4944	.7051 *	.4788
R. fescue		.5797	.1331	.5187	.2267
C. fescue			.1356	.5389	.5089
P. rye				.8683 **	.9750 **
C. rye					.6424 *
T. oat					

Harvesting at the most mature stage appears to give the highest quality of seed relative to germinating ability. There is a significant difference between any comparison of the different stages of maturity under consideration as given in Table 4. All "t" values are significant. The hard stage of maturity gave the highest germination percent. Although there was a significant difference between the different stages, each stage for all species varied in the same ratio as indicated by the significant correlation coefficients for all three comparisons.

Table 4 The relationship of three stages of maturity for six grass species

stages of maturity correlated	correlation coefficient	t value	mean germ. stage	mean germ. percent
soft and medium	.6315 **	3.688 *	soft	92.4
soft and hard	.5621 **	3.315 *	med.	94.6
medium and hard	.5816 **	3.333 *	hard	96.9

Two different dates of tagging were used. An analysis of variance, Appendix Table 6, indicated no significant difference between dates of tagging.

The analysis of variance of treatments and species for all six species on one tagging date is presented in Table 5. A significant interaction was shown to exist between species and treatments. Therefore this interaction would be used to test any differences between species or treatments. This analysis also bears out the fact as previously stated in this particular study that all species do not behave the same when considered collectively.

Table 5 Analysis of variance between treatment and species

source of variation	degrees of freedom	mean square	F
Species	5	61.856	7.058 **
Treatment	2	104.515	11.925 **
Replication	3	13.297	4.945
Treatment x species	10	8.764	3.259 **
Replication x species	15	4.219	1.567
Replication x treatment	6	3.422	1.273
Error	36	2.689	
Total	71		

The mean germinations of all species are presented on a frequency basis in Table 6. The check for each species is a sample taken at random on July 3. The standard error of a mean difference for each species was then computed and the average germination for each stage of maturity compared with the average germination of the check. These differences were entered in the correct frequency distribution with class centers plus or minus 1, plus or minus 2, etc. standard deviations away from the check. In each case, the "0" class is the check and takes in one-half of the standard deviation on either side of zero. For example, if the check was 96 and the average germination for the soft dough stage of maturity was 92, medium dough 94, and hard dough stage 97, with a standard error of a mean difference for that species of 2.6, the soft dough stage would be entered in column -2, medium dough stage in column -1, and hard dough stage in column 0.

In general, the distribution of the mean germinations for the different stages of maturity flucuate equally plus or minus the check. Therefore it would appear that much more time should be given to determining how different stages of maturity can be measured. The check, as mentioned above, was taken entirely as a sample at random with special criteria being used in its selection.

Table 6 Frequency distributions of the results of germinating seeds harvested at three different stages of maturity

Class centers of plus or minus 1 to 10 times the standard error of a mean difference

	-10	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2
Alta fescue						1				1	1	
red fescue							1		1	1		
Chewing fescue									2			1
perennial ryegrass							1				1	1
common ryegrass	1	1					1					
T. tall oatgrass									1	1	1	

DISCUSSION

It was found that the time of flowering as indicated by exsertion of the anthers varied between plants and between species. Meteorological conditions may also cause the flowering to be spread over a period of several days. It was noted that the species studied do not mature all of the flowers of an individual spikelet simultaneously. These facts have been confirmed by others (5), (11), (14,p.29). This causes some variation in the rate of maturity of the individual seeds within a spike or panicle and between seed heads. Therefore, it is difficult to obtain an accurate measure of seed maturity by visual and sensory methods. A more accurate measure of seed maturity is desired for best results.

Meteorological factors definitely influenced the results obtained from this research, but to what extent could not be determined. Alta fescue was noted to begin flowering on May 31, followed by a period of a few days in which no plants were tagged. During this period, as indicated in Table 1, the temperature remained high and humidity low. Flowering began late in the afternoon but was not noted until June 7. A breeze began blowing each afternoon about 3:00 p.m. and disturbed the panicles considerably, causing the anthers to fall from the panicle and making it more difficult to determine when anthesis had occurred.

The first panicles of Tualatin tall oatgrass were tagged on June 3 with small round tags. The next day it was noted that several of these tags had worked up over the panicle and had fallen to the ground. More plants were tagged on June 11 following a period of cool temperatures. At this time it was noted that several panicles with anthers exserted on the lower spikelets had immature caryopses formed in the upper half of the panicle. These seeds were of a fluid watery nature and evidently had been formed several days previously. It was also noted that some panicles which were tagged June 3 still showed some evidence of bloom on a few spikelets, the panicle being open and extended much as it was on June 3.

It is believed that the variation in flowering dates between and within spikelets influenced the time of and rate of seed loss due to shattering in the field. Tall oatgrass showed some evidence of shattering prior to June 23 as indicated by naked seeds lying on the ground near the row. This loss of seed may have been aided by the action of the wind whipping the panicles about and dislodging the seeds from the spikelets.

When seeds of tall oatgrass reached the medium dough stage of maturity some seeds will begin to shatter in the field. The degree of early shattering may be influenced by the meterological conditions occurring at time of anthesis. If flowering is extended over a period of 5 to 10 days, those flowers which are pollinated and have formed seeds during the first few days of the flowering period will have become sufficiently mature as to shatter in the field by the time the latter formed seeds have reached the medium dough stage of maturity. This may help explain the fact that no shattering was indicated by laboratory treatments tagged on June 11 although many shattered seeds were found on the ground and empty glumes on the panicles harvested June 28 and July 3, 1950. Little loss of seed due to shattering in the field occurred in the other species prior to July 3. This seems to indicate that the seeds of Alta fescue, perennial and common ryegrass, and Tualatin tall oatgrass will shatter quite easily upon reaching the medium to hard dough stage of maturity. It is thought that if the seed of these grasses is cut at the medium dough stage of maturity that the amount of seed shattering can be materially reduced and still have a high germinative capacity. Many growers recommend that if a few seeds can be easily removed from the seed head by moderate rubbing between the hands, the proper stage of seed maturity for cutting prior to threshing has been reached.

The results of the different treatments on the seed of the six grass species reported in this paper are brought together in Appendix Table 2. This table affords an opportunity to compare the average germination, percent of seed shattering and the percent of weight loss due to cleaning. As indicated in this table, the average germination for each date of harvest is relatively high. It is felt that the average germination of the seeds of red and Chewings fescue, and common ryegrass would have been raised slightly if a purity test had been made of the seed after cleaning. This was indicated by the presence of non-viable florets remaining in the pure seed sample.

The seeds of those species which were harvested at an immature state were difficult to clean with the materials available. Due to the nature of the seed being awned and light in weight it was necessary to reduce the air in the cleaning process so as not to blow out a large number of the viable seed. As shown in Appendix Table 2 the percent of clean out in the immature samples was relatively lower than might have been expected for these three species. As stated by Porter (13,p.239) the retention in the pure seed fraction of a small percentage of light weight and mostly non-viable florets causes a decrease in germination that is disproportionate to the increase in purity when such particles are not included as pure seed.

Based on the results of this study, all species did not react the same as to harvesting at an immature stage of maturity. This may have been complicated by meteorological conditions at time of anthesis which spread the flowering period over several days. Although the period of anthesis was lengthened, analysis of variance of all species for two different dates of tagging showed no significant difference to exist between seed harvested at the two dates. This seems to indicate that seed of a given species will reach full maturity at approximately the same date. Some differences may have been reduced by the loss due to shattering of mature seed and the cleaning out of the immature seed portions.

It is realized that part of this study was to determine some of the factors which must be considered in determining the optimum stage of maturity for harvesting certain grass species; but it is difficult to make a definite statement from one year's results. It is felt that from this study certain recommendations and suggestions can be made for setting up a further study of this problem. Therefore, an experiment has been planned, material made available and planted in the field as shown in Appendix Table 1, and a few suggestions assembled as to how a problem of this nature might be treated.

For convenience, a problem of this type could be broken down into three separate parts, field shattering of seed, cleaning, and germinating the seed. A study of seed shattering may be made on both the panicle and plot basis. Panicles may be tagged at anthesis, 50 percent of them bagged prior to the medium dough stage of maturity, and then harvested at the soft, medium, and hard dough stages. The amount of seed loss by shattering might be checked by counting the number of empty glumes, not due to blasting, on each panicle and compare with the number of seeds on the same panicle. It may be checked on the bagged panicles by comparing the weight of shattered seed caught by the bag against that of non-shattered seeds.

A study of seed shattering on the plot basis might be conducted by establishing plots 5 ft. by 18 ft. and mowing a 30 inch strip down the center at the soft, medium, and hard dough stages of maturity. The cut material could be cured in the windrow, collected on canvases and threshed. Loss of seed due to shattering in the field could be determined by counting the number of seeds per square foot of ground surface in the harvested row and calculate the seed loss row per treatment. By this method the amount of seed lost due to field shattering, lost by handling and saved by canvases, and amount of seed threshed could be determined for each stage of maturity.

The cleaning process has a great influence upon the amount of clean seed obtained and its germinating capacity. In the plot method it would be desirable to use methods similar to that used in commercial practice. The seed may be cleaned by a cleaner similar to the Office Cleaner, size 10 inches by 15 inches as manufactured by the A. T. Ferrell Co. of Saginaw, Michigan or one of a similar type which would adapt itself to cleaning small quantities of seed. All seeds may be blown with a standard seed blower similar to a Bates Aspirator.

Before the seeds are germinated they should be either stored or treated to eliminate any possibility of dormancy and a purity analysis made of the clean seed. Standard techniques and equipment recommended by the Association of Official Seed Analysts should be used for all germinations. Before conclusions can be made it is necessary that the experiment be well designed, both in the field and in the cleaning and germinating processes.

The uniform determination of a certain stage of maturity by sensory and visual methods is very difficult. It is suggested that the possibilities of a moisture meter be studied to determine the moisture content of panicles containing seed and of seeds alone at various stages of maturity as determined by visual and sensory methods. It may be possible to correlate a certain moisture percentage with a certain stage of seed development which should be more accurate than by visual and sensory methods alone.

SUMMARY

1. Field observations indicated that the flowering period of a grass species may extend over a period of several days duration. The meteorological factors of temperature and humidity apparently have an influence upon the length of the flowering period.
2. Certain grass species have a tendency to shatter seed more readily than others. The shattering of seed of Alta fescue, perennial and common ryegrass, and Tualatin tall oatgrass may occur under certain conditions while many of the seeds are still in the medium to hard dough stage of maturity. Even though shattering is difficult to measure, seed loss due to shattering is low at the soft dough stage of maturity, increases with maturity and varies with the species.
3. Based on results of seed germinating ability, all species do not react the same as to harvesting at an immature stage of maturity. Seeds of panicles which flower a few days apart will reach maturity at approximately the same time.
4. The seeds of the six species studied may be harvested when in the soft to medium dough stage of maturity to reduce the loss of seed due to shattering. These seeds will have a high germinating capacity if properly cleaned. The loss of weight due to cleaning may become excessive and should be considered in harvesting seeds at an immature stage of maturity.
5. The results obtained in this study are only indications and

should not be used as the final answer. Further work needs to be done in a more comprehensive manner before definite conclusions can be made.

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APPENDIX

Appendix Table 1. A planting plan of Tualatin tall oatgrass, Alta fescue, and perennial ryegrass to be used for further study of some factors influencing yield and quality of grass seed.

Planting Plan

Culture	Plot Numbers			
	Rep. I.	Rep. II.	Rep. III.	Rep. IV.
1	4	5	9	15
2	1	7	10	14
3	3	6	11	16
4	2	8	12	13

Field Plan

Range Number	25	26	27	28	29	30
	Rep. 1 Rep. 2	Rep. 3 Rep. 4	Rep. 1 Rep. 2	Rep. 3 Rep. 4	Rep. 1 Rep. 2	Rep. 3 Rep. 4
	Tualatin tall oatgrass		Alta fescue		Perennial ryegrass	

Location - Field 8, section 3, ranges 25 to 31, Hyslop Agronomy Farm at Granger, Oregon.

Planted - October 12, 1950.

Appendix Table 2. Effect of stage of maturity on germination, seed shattering and percent of clean seed harvested at various stages of maturity.

Date Tagged	Date of harvest	Stage of Maturity	Germinations R. 1	R. 2	R. 3	R. 4	Av. Germ.	Percent shattering	Percent clean-out	1000 seed weight in grams
Alta fescue										
5-31-50	6-23	med.	97	96	97	95	96.2	13.0	34.8	
	6-28	hard	96	90	100	96	95.5	14.1	15.5	
6-8-50	6-23	soft	93	92	92	93	92.5	2.9	44.3	2.807
	6-28	med.	95	97	96	95	95.7	13.9	19.4	
	7-3	hard	97	97	95	97	96.5	28.1	11.6	2.821
check	7-3		99	96	94	95	96.0	29.3	26.0	
Red fescue										
6-3-50	6-23	soft	91	87	84	90	88.0	---	21.2	
	6-28	med.	97	92	93	86	92.0	---	---	
	7-3	hard	98	95	98	94	96.2	2.1	9.9	
6-5-50	6-28	med.	88	85	87	87	86.7	---	12.9	
	7-3	hard	95	94	98	98	96.2	3.1	11.5	
check	7-3		94	92	98	98	95.5	1.2	18.0	
Chewings fescue										
6-3-50	6-23	soft	93	92	93	92	92.5	8.2	8.7	0.971
	6-28	med.	93	90	91	93	91.7	21.6	5.8	
	7-3	hard	99	96	98	94	96.7	32.2	5.1	2.338
6-5-50	6-23	soft	85	82	84	82	83.2	11.6	12.7	
	7-3	hard	97	92	98	97	96.0	36.8	2.7	
check	7-3		91	91	95	97	93.5	38.0	4.0	
Perennial ryegrass										
5-31-50	6-23	soft	99	98	98	96	95.7	16.7	14.6	2.211
	6-28	med.	100	98	100	100	99.5	30.0	20.9	
	7-8	hard	99	98	99	99	98.7	30.2	9.3	3.114
6-5-50	6-23	fluid	98	99	98	99	98.7	17.4	17.6	
	6-28	soft	100	97	100	98	98.7	13.2	12.9	
	7-3	med.	99	99	99	99	99.0	47.9	4.2	
	7-8	hard	100	100	99	98	99.2	45.6	4.0	
check	7-3		99	99	98	96	98.0	45.1	8.0	
Common ryegrass										
6-5-50	6-23	soft	92	92	89	97	92.2	5.9	40.5	
6-8-50	6-23	soft	94	89	90	93	91.5	5.1	51.9	1.626
	6-28	med.	94	95	90	93	93.0	24.6	18.4	
	7-3	hard	97	95	95	97	96.0	39.0	5.2	2.492
6-10-50	6-23	fluid	76	88	88	88	82.0	7.5	55.6	
	6-28	soft	93	89	96	91	92.2	16.4	32.7	
	7-3	med.	97	97	97	98	97.2	31.2	7.1	
	7-8	hard	99	98	98	98	98.2	40.9	4.4	
check	7-3		98	97	95	99	98.2	28.2	7.2	
Tualatin tall oatgrass										
6-3-50	6-23	soft	95	91	92	98	94.0	1.9	32.1	
	6-28	med.	95	94	95	98	95.5	30.6	20.1	
	7-3	hard	98	96	98	96	97.0	1.7	4.9	
6-11-50	6-23	fluid	91	88	92	90	92.7	---	45.6	
	6-28	soft	93	95	92	91	92.7	---	23.6	
	7-3	hard	96	92	95	98	95.2	---	13.1	
check	7-3		95	96	94	96	95.2	4.6	2.1	

Appendix Table 3. Analysis of variance for alta fescue tagged June 8, 1950 and harvested at various stages of maturity.

Source of variation	degrees of freedom	mean square	F
Treatments	3	13.23	8.4699
Replications	3	2.23	1.4276
Error	9	1.56	
Total	15		

Appendix Table 4. Analysis of variance for red fescue tagged June 3, 1950 and harvested at various stages of maturity.

Source of variation	degrees of freedom	mean square	F
Treatments	3	57.063	4.959
Replications	3	9.730	.846
Error	9	11.507	
Total	15		

Appendix Table 5. Analysis of variance for Chewings fescue tagged June 3, 1950 and harvested at various stages of maturity.

Source of variation	degrees of freedom	mean square	F
Treatments	3	19.083	4.267
Replications	3	3.417	.839
Error	9	4.472	
Total	15		

Appendix Table 6. Analysis of variance for treatments and species at two dates of tagging.

Source of variation	degrees of freedom	mean square
Species	2	218.635
Treatments	3	94.750
Species x treatments	6	35.137
Dates	1	32.670
Species x dates	2	9.700
Treatments x dates	3	13.193
Species x treatments x dates	6	8.141
Replications	3	4.057
Replications x species	6	3.859
Replications x treatments	9	3.067
Replications x dates	3	5.887
Replications x species x treatments	18	3.209
Replications x species x dates	6	4.337
Replications x treatments x dates	9	5.417
Error	18	4.893
Total	95	