Using Seed Moisture as a Harvest Management Tool

EM 9012 • November 2010

Thomas B. Silberstein, Mark E. Mellbye, Thomas G. Chastain, and William C. Young III

Seed moisture content is the most reliable indicator of seed maturity and harvest timing in grass seed crops. There are two significant times during harvest that knowledge of seed moisture is critical: at swathing and at combining. Swathing within the correct range of seed moisture content will maximize seed yield and minimize seed losses during harvest. Taking an accurate measurement of seed moisture content is a key component of economic grass seed crop management.

This publication covers these two topics relating to seed moisture:

1. The Role of Seed Moisture in Grass Seed Harvest Systems.
2. How to Accurately Measure Seed Moisture on the Farm.

Figure 1. Field of tall fescue at swathing.

1. The Role of Seed Moisture in Grass Seed Harvest Systems

Grass seed crops do not pollinate and mature over a uniform time period; thus a wide range of seed maturity within a crop stand is normal. Figure 2 illustrates the various stages of maturity found in a single field. In order to optimize the time to swath grass seed crops, one must find the balance between swathing too early and too late. Swathing too early, at high moisture content, shortens the seed fill period, leading to immature and reduced seed size. Swathing too late, at low moisture content, reduces yield as a result of seed shattering losses (Klein and Harmond, 1971; Andersen and Andersen, 1980). Seed shattering losses can be 20 percent or more when the crop becomes too mature prior to swathing. In subsequent crops for perennial grasses, shattered seed can contribute to excessive levels of volunteer plants and result in a Certified seed field's failure to meet the requirements for producing Certified seed. Extremes and variation in harvest timing can also have a negative impact on seed quality as well as seed yield.

With substantial improvements in swathing and combining equipment that increase overall speed and efficiency, growers are able to swath at a much faster rate and better keep up with the harvest maturation. Knowing the range of seed moisture content for optimum harvest, growers can have a method to prescriptively prioritize which fields need swathing on any particular day (or night). Early investigations into the relationship of seed moisture content and harvest maturity in perennial ryegrass, orchardgrass, and fine fescues as well as other grass and legume species (Klein and Harmond, 1971) provided the

Thomas B. Silberstein, Marion County Extension, Mark E. Mellbye, Linn County Extension, Thomas G. Chastain, Department of Crop and Soil Science, and William C. Young III, Department of Crop and Soil Science, Oregon State University. All figures by Thomas B. Silberstein,

Oregon State University | Extension Service initial seed moisture content–based harvest recommendations in the Willamette Valley of Oregon. Variability in maturity among cultivars of tall fescue was documented by Andrade et al. (1994).

With the knowledge that improvements in grass seed crop genetics and the resultant increases in seed yields over the past 20 years may be affecting the prior recommendations, on-farm and research station trials were conducted from 2004 to 2008 on seed moisture content and harvest timing in annual ryegrass, perennial ryegrass, tall fescue, and fine fescue seed crops. The data from these recent large plot trials have provided new insights into determining the full optimum range of seed moisture contents for harvesting in these species. Additionally, seed moisture–based recommendations were not available for annual ryegrass. To develop seed moisture recommendations for annual ryegrass, research trials were conducted in 2004 and 2005 to determine the range of seed moisture content for maximizing seed yield. This publication brings together the research findings into management guidelines for each crop. Research results of all these trials are reported in the online annual Seed Production Research Reports (2004–2006, 2008). These guidelines along with grower experience are intended to provide helpful information for obtaining optimum yields.

In order to determine the seed moisture content of a particular seed field, a representative sample will need to be taken. Seed will need to be stripped from at least 30 to 50 heads and kept cool in an airtight container or bag until the samples can be weighed and dried. Complete instruction on taking and measuring the seed sample is provided in the second part of this publication. For best results, begin sampling a few days before you expect to swath so you can use the rates of change in moisture content to guide your decision making. Use of plant growth regulators (Apogee and Palisade) can delay maturation a few days so seed moisture testing will be helpful in assessing when the crop is ready to swath.

Recommendations

Annual Ryegrass

Recent swathing studies indicate that maximum seed yields for annual ryegrass are obtained when average seed moisture content is from 40 to 45 percent at the time of swathing, (Table 1). The experimental design of the research plots was a 10 treatment factorial design swathed at five different seed moisture contents and at two daily timings (when the dew was on the crop and later the same day when the dew was gone). Seed yield results with a graphical representation are presented in Chart 1. Harvesting at 40 percent or lower seed moisture content resulted in significant decreases in harvested seed yield. Also, swathing with dew on the stand (night or early morning) increased yield when seed moisture content was 40 percent or lower. Seed shattering was visually evident when the plots were swathed at lower seed moisture content. Though seed size (as measured by 1,000-seed weight) increased as the crop was swathed at lower seed moisture content, the small increase in seed size failed to compensate for the loss in seed yield from shattering. Seed germination was not affected by any of the swath timings and averaged 96.9 to 98.7 percent.

Figure 2. Range of head maturity in perennial ryegrass field.

William C. Young III, © Oregon State University.

Figure 3. Swathing annual ryegrass research plots at Hyslop Research Farm, OSU.

Table 1. Annual ryegrass seed yield comparison between 2004 and 2005, Hyslop Farm.

Main factor	2004 seed yield (lb/a)	2005 seed yield (lb/a)	Average (lb/a)
Seed moisture at swathing:			
50%	2,575[1]	1,220[1]	1,898
45%	2,790	1,241	2,016
40%	2,594	958	1,776
33%	2,386	774	1,580
28%	1,906	664	1,285
Time of day:			
Dew present	2,567[2]	1,064[2]	1,816
No dew present	2,333	879	1,606

[1] Average of dew and no dew at each seed moisture content.
[2] Average of all seed moisture contents with dew or no dew.

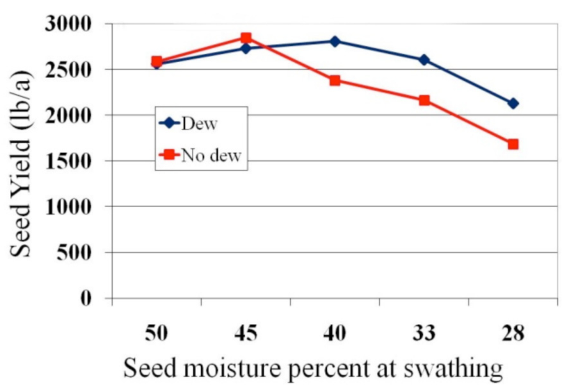

Chart 1. Influence of dew on seed yield of annual ryegrass, Hyslop Farm, 2004.

Perennial Ryegrass

Perennial ryegrass yielded well across a wide range of seed moisture content swath timings during the three years of trials (Tables 2 and 3). Swathing timings ranged from a high of 45 percent seed moisture content down to 23 percent seed moisture content. Research data indicate that swathing a few days early does not impact yield as much as swathing a few days late. All trials in these studies were swathed at night or early morning while dew was present on the crop except for the lowest seed moisture content cutting in 2005. Waiting just a few hours until the crop dried reduced seed yield 148 pounds per acre (from 1,922 lb/a down to 1,774 lb/a). Seed shattering rapidly increased when the crop was swathed at this low seed moisture content (Chart 2 and Figures 4 and 5) without dew present. To reduce shattering at low moisture contents, swathing with the dew on the crop is advised.

Table 2. Perennial ryegrass seed yield comparisons at different swathing seed moisture contents, 2004–2005.

Seed moisture at swathing (date)	Seed moisture at swathing (%)	Seed yield (lb/a)	Seed moisture at swathing (date)	Seed moisture at swathing (%)	Seed yield (lb/a)	Two-year average (lb/a)
Calypso II (2004)			*Fiesta III (2005)*			
July 5	45	1,695	July 8	46	2,075	1,885
July 8	36	1,727	July 11	38	1,963	1,845
July 12	29	1,662	July 16	33	1,955	1,809
			July 20	27	1,922 (dew)	
			July 20	27	1,774 (no dew)	

Table 3. Perennial ryegrass seed yield comparisons at different swathing seed moisture contents, 2008.

Seed moisture at swathing (date)	Seed moisture at swathing (%)	Seed yield (lb/a)	Seed moisture at swathing (date)	Seed moisture at swathing (%)	Seed yield (lb/a)
Chaparral			*Caddieshack*		
July 11	45	1,875	July 11	44	2,308
July 13	43	1,675	July 12	30	2,203
July 15	25	1,658	July 13	23	2,239

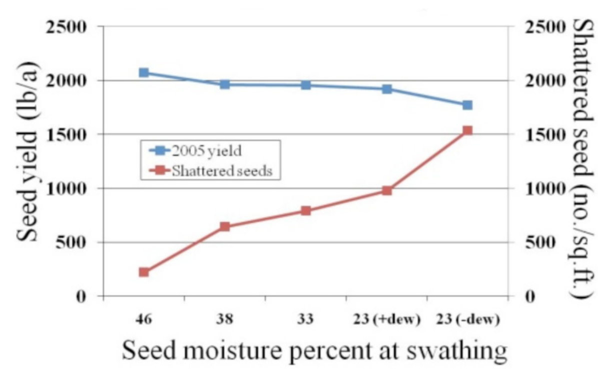

Chart 2. Seed yield and shattered seed as affected by seed moisture content in perennial ryegrass, 2005.

Figure 4. Between rows under swath at early cut timing.

Figure 5. Between rows under swath at late cut timing.

Fine Fescue

The flat response in seed yield over a wide range of seed moisture contents (Tables 4 and 5) indicates that the seeds are mature and can be harvested across a wide range of seed moisture content. There was an increase in seed size (though not very much) in the Aruba creeping red fescue (2006–2007) and Ambrose Chewings fescue as the crop dried down to lower seed moistures. This may be a consideration that would encourage delaying swathing until seed moisture is in the 20s and is not unlike current practices. The Ambrose Chewings fescue (2008) site did have a slightly higher seed yield and a lower 1,000-seed weight at the earliest swath timing (both P values between 0.05 and 0.10). As with the perennial ryegrass, the cause of this variation is not clear. Yields at both sites were good and the yield response to the range of seed moistures measured (39 percent down to 16 percent) was consistent across all years. Though there is a wide range of seed moisture content at swathing, frequently the time frame was only a couple days when the weather was hot. On some of the hot days, seed moisture decreased an average of almost 8 percent per day. Fine fescue is mature and ready for harvest by the time the seed moisture drops into the mid-30s. Both sites were swathed at night/early morning (normal practice) so the effect of swathing later in the day was not measured.

Table 4. Seed yield responses to seed moisture at swathing time in fine fescue, 2006–2007.

Swath date	Seed moisture (%)	Seed yield (lb/a)	1,000-seed weight (g)
	2006 Aruba creeping red fescue		
July 7	35	1,610	1.075 b[1]
July 10	24	1,622	1.094 a
July 12	19	1,616	1.107 a
LSD 0.05		NS	0.017
P value			0.012
	2007 Aruba creeping red fescue		
July 7	38	1,388	1.218 b[1]
July 10	24	1,421	1.255 ab
July 12	20	1,366	1.273 a
LSD 0.05 (0.10)		NS	(0.038)
P value			0.071

[1] Values followed by the same letter are not significantly different by Fisher's protected LSD values.

Table 5. Seed yield responses to seed moisture at swathing time in fine fescue, 2008.

Swath date	Seed moisture (%)	Seed yield (lb/a)	1,000-seed weight (g)
	Wendy Jean creeping red fescue		
July 9	36	2,128	1.13
July 11	31	2,144	1.15
July 12	16	2,105	1.16
LSD 0.05 (0.10)		NS	NS
	Ambrose Chewings fescue		
July 11	39	1,760 a[1]	1.08 b[1]
July 12	30	1,654 b	1.09 ab
July 13	23	1,638 b	1.11 a
LSD 0.05 (0.10)		(95)	(0.02)
P value		0.090	0.091

[1] Values followed by the same letter are not significantly different by Fisher's protected LSD values.

Figure 6. Harvesting fine fescue seed moisture trial plots.

Table 6. Seed yield responses to seed moisture at swathing time in Paraiso tall fescue, 2006–2007.

Seed moisture at swathing (date)	(%)	Seed yield (lb/a)	Seed moisture at swathing (date)	(%)	Seed yield (lb/a)
	2006			*2007*[2]	
June 30	50	1,206 b[1]			
July 3	45	1,559 a	July 4	45	1,318
July 7	42	1,588 a	July 5	42	1,270
			July 7	34	1,294
LSD 0.05		70			NS
P value		0.000			

[1] Values followed by the same letter are not significantly different by Fisher's protected LSD values.
[2] 2007 combine run "dirt yield" only.

Tall Fescue

The data suggests that a range of seed moisture contents from 35 to 45 percent are best for tall fescue harvest (Tables 6 and 7), but it is not known how much lower than 35 percent the crop can be swathed without having a significant loss in seed yield due to shatter. Increased seed shatter began once seed moisture dropped to below 40 percent, so it is recommended that when seed moisture is low, swathing be done at night or early morning while there is dew on the crop. Swathing above 45 percent is not recommended as seed yield is limited and seed germination may be affected. Although there is about a 10 to 15 percent range of seed moisture contents for best yields, it is important to monitor crop conditions carefully as seed moisture can decrease 5 percent or more per day on hot, windy days. There can also be differences in how uniformly seed moisture drops in tall fescue with irrigated crop management, so waiting until seed moisture is in the mid range of guidelines is recommended under these circumstances.

Guidelines for Estimating Swathing Time

Table 8 summarizes the OSU guidelines for determining optimum swathing times for various seed crops grown in the Willamette Valley.

Table 7. Seed yield responses to seed moisture at swathing time in tall fescue, 2008.

Seed moisture at swathing (date)	(%)	Seed yield (lb/a)	Seed moisture at swathing (date)	(%)	Seed yield (lb/a)
	Avenger tall fescue (non-irrigated)			*Tarheel II tall fescue (irrigated)*	
July 9	46	2,994	July 10	48	3,376 b[1]
July 12	38	2,853	July 13	35	3,779 a
July 14	31	3,075	July 14	31	3,791 a

[1] Values followed by the same letter are not significantly different by Fisher's protected LSD values.

Figure 7. Swathing tall fescue seed moisture trial plots.

Table 8. Seed moisture guidelines for estimating swathing time in Willamette Valley seed crops.

Crop	Recommended seed moisture	Moisture loss per day
Tall fescue (forage)	40–43	2.5–3
Tall fescue (turf-type)	35–45	2.5–3
Perennial ryegrass	35–43	3.0
Annual ryegrass	43–48	2.0–3.0
Chewings fescue	30	5.0
Creeping red fescue	25–35	4.0
Orchard grass	42–46	1.0
Kentucky bluegrass	24–28	3.0–4.0
Crimson clover	35	3.0
Meadowfoam	42	2.0

Figure 8. Stripping tall fescue seed heads.

Figure 9. Example of tall fescue seed ready to check for seed moisture.

2. How to Accurately Measure Seed Moisture on the Farm

Take an accurate sample.

In order to determine the moisture content of a particular seed field, a representative sample will need to be taken. Strip seed from a minimum of 30 to 50 heads into an airtight container or bag and keep it cool until you are able to process for drying. Sample a few days before you expect to cut, and use the change in moisture content to guide you. Use of plant growth regulators (PGRs) can delay maturation a day or two, so you need to make your harvest decision on the basis of seed moisture rather than by the appearance of the crop.

Sample early.

Taking moisture samples three to five days before the field is ready to swath will provide valuable information as to which fields will be ready first. Typical seed moisture content loss per day values as listed in Table 8 can be used to help estimate how long it will be before swathing time. Weather conditions can cause moisture loss to vary.

Sample effectively.

Prior to taking a field sample, assess the uniformity of the field. Take a sample that best represents the crop maturity over most of the field. If some areas in the field are greener or more mature, take samples from those areas separately. Sample the field once the dew is off the field and the plants have air-dried (usually by mid to late morning) to prevent external moisture from affecting the sample taken. It is important to sample at about the same time each day to help determine daily seed moisture loss.

We recommend taking a minimum sample of 30 to 50 seed heads from representative areas of the field. Randomly select the seed heads within the stand to minimize biasing based on location or appearances. Strip the seeds from the samples and place them into a site-labeled airtight container or reclosable plastic bag. Stripping the seed can be done by using a sturdy comb or by holding the stem at one end and, with the free hand, pinching the seed head between your fingers then sliding your pinched fingers along the stem length. Make sure to remove all the seed from each head to ensure a good sample. Keep the samples cool and out of the sun to minimize moisture loss before the samples are processed for drying. Some drying methods (like the Koster tester) require larger samples, so follow any instructions that come with your tester.

Three Methods for Measuring Moisture Content

Oven drying method. A 10- to 15-gram subsample is sufficient if the primary sample was well mixed prior to weighing out the subsamples. It is advisable to do more than one subsample out of each field sampling to provide better seed moisture averages. Dry with a convection oven if available. Using an oven has the advantage of drying several samples at once, so it is the quickest if you have a lot of samples to do. Dry for 24 hours at 212°F (100°C) or for 1½ to 2 hours at 265°F (130°C). Metal sample containers with tight fitting lids are recommended. Make sure to have the container open (lids off) in the oven so the moisture will move out of the sample. Put the covers on after the drying cycle while the samples cool to room temperature. This will minimize moisture absorption from the air prior to weighing. Metal containers can be purchased through many lab and science supply businesses.

Figure 10. Convection oven with seed samples.

Microwave drying method. A 10- to 15-gram sample is sufficient if the sample was well mixed prior to weighing out the subsamples. It is advised to do more than one subsample out of each field sampling to provide better seed moisture averages. Samples can be placed in folded paper towels to allow several to be done at a time. Dry in short cycles (1- to 2-minute cycles) until there is no weight change between cycles. Stirring the sample after each cycle and reducing cycle cooking time as the sample dries out will help prevent scorching. Be careful not to overheat (scorch) the sample as more than free moisture can be cooked off, causing inaccurate readings.

Figure 11. Microwave oven with seed samples ready to dry.

Koster moisture tester. This tester typically uses a 100-gram sample that is dried until there is no weight change between cycles (takes 30 to 45 minutes total). Follow instructions that come with equipment. This is an easy-to-use tester but only does one sample at a time and requires a larger sample of seed.

Figure 12. Koster moisture tester.

Other testers. Conductivity-type grain/seed moisture testers are typically not accurate at the higher seed moisture contents that are typical for grass seed swathing times but are very useful for checking harvested seed to ensure the moisture level is safe for storage.

How to calculate moisture content

Seed moisture is based on wet weight.

Percent seed moisture content =
[(Wet weight – Dry weight)/Wet weight] × 100%

Remember to subtract tare (container) weight.

Basic equipment needed:

- Oven or microwave
- Scale (0.1 g accuracy)
- Containers for seed
- Calculator

Moisture content for harvest and safe storing:

- Grasses, cereals: 12%
- Legumes: 10%

Acknowledgements

Special thanks to the Oregon Seed Council and Ag Research Foundation for grant support, Agri-Seed Testing for germination tests, and grower cooperators for supporting on-farm research trials to make this research possible.

References

Andersen, S., and K. Andersen. 1980. The relationship between seed maturation and seed yield in grasses. In *Seed production*, Chapter 11. Butterworth Publishers.

Andrade, R. P., D. F. Grabe, and D. Ehrensing. 1994. Seed maturation and harvest timing in turf type tall fescue. *Journal of Applied Seed Production*, 12:34–46.

Elias, S., R. Baalbaki, and M. McDonald. 2007. Seed moisture determination: Principles and procedures. *Handbook on seed testing*, Contribution no. 40. Ithaca, NY: Association of Official Seed Analysts.

Grabe, D. F. 1981. Evaluation of moisture testers for high-moisture grass seed. Presented at Oregon Seed Industry Conference, Eugene, Oregon.

Hides, D. H., C. A. Kute, and A. H. Marshall. 1993. Seed development and seed yield potential of Italian ryegrass (*Lolium multiflorum* Lam.) populations. *Grass and Forage Science*, 48:181–188.

Klein, M. K., and J. E. Harmond. 1971. Seed moisture: A harvest timing index for maximum yields. *Trans. ASAE*, 14:124–126.

Silberstein, T. B., M. E. Mellbye, T. G. Chastain, and W. C. Young III. 2005. Response of seed yield to swathing time in annual and perennial ryegrass. In *2004 Seed Production Research Report*, Ext/CrS 124, 27–30. Oregon State University.

Silberstein, T. B., M. E. Mellbye, T. G. Chastain, and W. C. Young III. 2006. Response of seed yield to swathing time in annual and perennial ryegrass. In *2005 Seed Production Research Report*, Ext/CrS 125, 20–23. Oregon State University.

Silberstein, T. B., and S. Aldrich-Markham. 2008. Response of seed yield to swathing time in tall fescue and creeping red fescue. In *2007 Seed Production Research Report*, Ext/CrS 127, 9–11. Oregon State University.

Silberstein, T. B. 2009. Using seed moisture content as a harvest management tool to determine swathing time in grass seed crops. In *2008 Seed Production Research Report*, Ext/CrS 128, 39–42. Oregon State University.

For More Information

Seed Production Research Reports can be viewed and downloaded at http://cropandsoil.oregonstate.edu/seed-ext/publications/research-reports

Published November 2010.