EB1929

Performance Quality of Washington's Certified Wheat Seed

Washington Certified Wheat Seed

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Introduction

Various state and federal laws regulating sale and distribution of seeds provide legal protection for buyers and sellers of seeds. These "truth in labeling" laws provide standards for seed purity and viability. In addition, the Federal Seed Act of 1939 authorized certification of seeds to provide the public with high quality seeds. Subsequently, most states established seed certification agencies and developed standards for seed purity and viability. In Washington, the Department of Agriculture assigned the Washington State Crop Improvement Association (WSCIA) responsibility for certification of cereal seeds. WSCIA enjoys a well-deserved reputation for successfully promoting production of high quality certified seed and acceptance of certified seed by growers.

The need for standardized seed testing rules and procedures became apparent soon after passage of seed laws in the early 20th century and resulted in the formation of several seed testing associations including the International Seed Testing Association (ISTA) and the Association of Official Seed Analysts (AOSA). Both organizations developed standardized rules and procedures for testing a wide variety of seeds. AOSA is comprised largely of official seed analysts from North America. ISTA, a worldwide organization, originated in Europe. The rules and procedures developed by AOSA and ISTA have great similarity, although some differences exist. Efforts to reconcile the differences will likely increase as seed trade becomes more international.

Seed Performance Evaluation

Seeds must be viable, germinate and produce "normal" seedlings. While these expectations are straightforward, determining the potential of seeds to achieve them is far more complex. For example, it is impossible to evaluate the potential of seeds to emerge under all of the adverse conditions that might be encountered in the field. Furthermore, "normal" is a subjective term and open to interpretation. Consequently, AOSA and ISTA have developed extensive rules and procedures for estimating seed viability in the laboratory under conditions favorable for germination. Although viability can be determined by other tests, only an "official" germination test meets the labeling requirements established by most seed acts including the Federal Seed Act.

Although seed germination provides important information to the buyer, establishment of normal seedlings under field conditions is generally less than the germination value listed on the tag. Emergence in the field depends upon the magnitude and type of stresses encountered and the vigor of the seed.

Vigor can be defined as the potential of seeds to rapidly emerge under a wide range of conditions. Unlike the germination test for viability, no universal test for estimating seed vigor has been developed. The cold test, which was originally developed to estimate vigor of warm season crop species such as corn and soybean, has proven useful for predicting vigor of wheat seed. As implied by the name, a portion of the cold test is performed at 35°–40°F (2°–5°C). In addition, a small amount of soil taken from a wheat field after harvest is added to the germination medium to provide microbial stresses that may interfere with germination and emergence of a normal seedling in the field.

Certified Wheat Seed

At present, 75 to 80% of Washington's certified wheat seed is produced under irrigation. The shift in recent years from dryland to irrigated production of certified wheat seed has been due in part to the spread of jointed goat grass in the dryland production areas and in part to a desire for more consistent high quality seed. Exposure of seeds to water after physiological maturity and prior to harvest has long been known to adversely affect seed quality and performance. In the dryland region of eastern Washington, preharvest rains tend to be a more serious problem than in the drier irrigated regions. Furthermore, irrigation offers the prospects of higher yields, more rapid seed increase of new cultivars, and the potential for somewhat larger and more vigorous seeds.

In recent years, however, some seed lots produced under irrigation have failed to meet the expectations of high quality and vigor. Although most of the problem seed lots have had good viability (germination), they also have had higher frequencies of seedlings with abnormal coleoptiles leading to reduced vigor and field performance (Table 1). The coleoptile is a cone-like sheath that serves to protect the leaves while emerging through the soil (Figure 1A). A common abnormality in low vigor seed lots has been the split coleoptile (Figures 1B & C). When the coleoptile splits below the soil surface, the exposed leaves are unable to move through the soil (Figure 1D) and the seedling fails to emerge. Seed lots with high split coleoptile frequencies have poor emergence in the field (Table 1).

Often, neither the seedsman nor the buyer is aware that a seed lot has a potential for emergence problems in the field. In part, this is because most split coleoptile seedlings are considered normal by AOSA rules and are counted as germinated seeds. On the other hand, by ISTA and cold test rules, seedlings with splits below the upper third of the coleoptile are classified as abnormal and are

Table 1. Effect of split coleoptiles on emergence of Alpowa spring wheat seedlings. Seed lots Irr-L and Irr-H were produced under irrigation in the Columbia Basin and were planted in replicated trials the following spring at six locations [Lind (2), Royal Slope, Ritzville, Pomeroy, and Pullman]. Emergence was counted three weeks after planting.

Lot	Seed Size		Germination*	Split Coleoptile**	Emergence†
	seeds/lb	mg/seed	%	%	%
Irr-L	1032	44	96	21	45
Irr-H	1081	42	97	1	68

* AOSA germination test
** ISTA abnormal (AOSA normal)
†Average of three replications at six locations

not counted as germinated seeds. Thus, seed lot Irr-L (Table 1) would have had much lower ISTA viability and cold test vigor values than the 96% estimated by the standard AOSA germination test. In an effort to assess the magnitude of the split coleoptile problem and to evaluate the overall quality of certified wheat seed produced in Washington, viability and vigor of 390 certified seed lots produced in the 1998, 1999 and 2000 growing seasons were determined.

Certified Seed Quality

Viability of certified wheat seed for the 1998, 1999 and 2000 growing seasons was very good (Table 2). Seed quality differed among seasons with the 1999 and 2000 seasons having somewhat better seed viability than the 1998 season. Seed vigor as determined by the cold test was good (Table 2), but was lower than viability due largely to (1) classification of seedlings with split coleoptiles as abnormal and (2) to an increase in the frequency of abnormal seedlings resulting from exposure of germinating seeds to cold and soil microbial stresses. The difference between viability and vigor was greater in 1998 than in 2000, suggesting that seasonal variation in environmental and/or production conditions may impact seed quality.

Small differences in both seed viability and vigor were detected among cultivars (Table 3); however, there was no evidence that these differences were due to genetic factors. The majority of the seed lots of all cultivars had excellent quality. However, a small fraction of the seed lots of all cultivars had reduced seed viability or vigor that lowered cultivar averages to varying degrees. Production conditions and environments appeared to have had greater effects on seed viability and vigor averages than did genotype.

Most seed lots with reduced vigor had been exposed to water after physiological maturity and prior to harvest. Exposure of physiologically mature seeds to water results in swelling of the embryonic axis and expansion of the pericarp and seed coat. Subsequent drying of the seed results in damage to the pericarp overlying the embryonic axis as illustrated in Figure 2, and failure of the embryonic axis to fully contract to its original position. Seeds subjected to one or more hydration/dehydration cycles may suffer reduced viability and vigor, are vulnerable to a variety of biotic stresses, and are predisposed to abiotic stresses. Seeds damaged by hydration (Figures 2C & D) have increased susceptibility to attack by soil microorganisms such as *Pythium* during germination, and are sensitive to mechanical injury. Mild to moderate mechanical abrasion significantly increased the frequency of seedlings with split coleoptiles and reduced seed vigor (Table 4). Viability, as estimated by the AOSA germination test, was not reduced because, by rule, seedlings with split coleoptiles are normal and are counted as germinated

Table 2. Certified wheat seed viability and vigor for the 1998, 1999 and 2000 production years.

Year	No. Lots	% Viability*	% Vigor**
1998	114	96.6	92.8
1999	150	97.7	94.6
2000	126	98.0	96.1
	Total 390	**Ave. 97.5**	**94.6**

* AOSA germination test
** Cold test

A B C D

Figure 1. Wheat seedling coleoptile. (A) Intact coleoptile providing a cone-like sheath to protect seedling leaves. (B & C) Splits in the coleoptile permitting leaves to exit through the side of the coleoptile. (D) Folding of seedling leaves in soil after exiting through a split in the coleoptile.

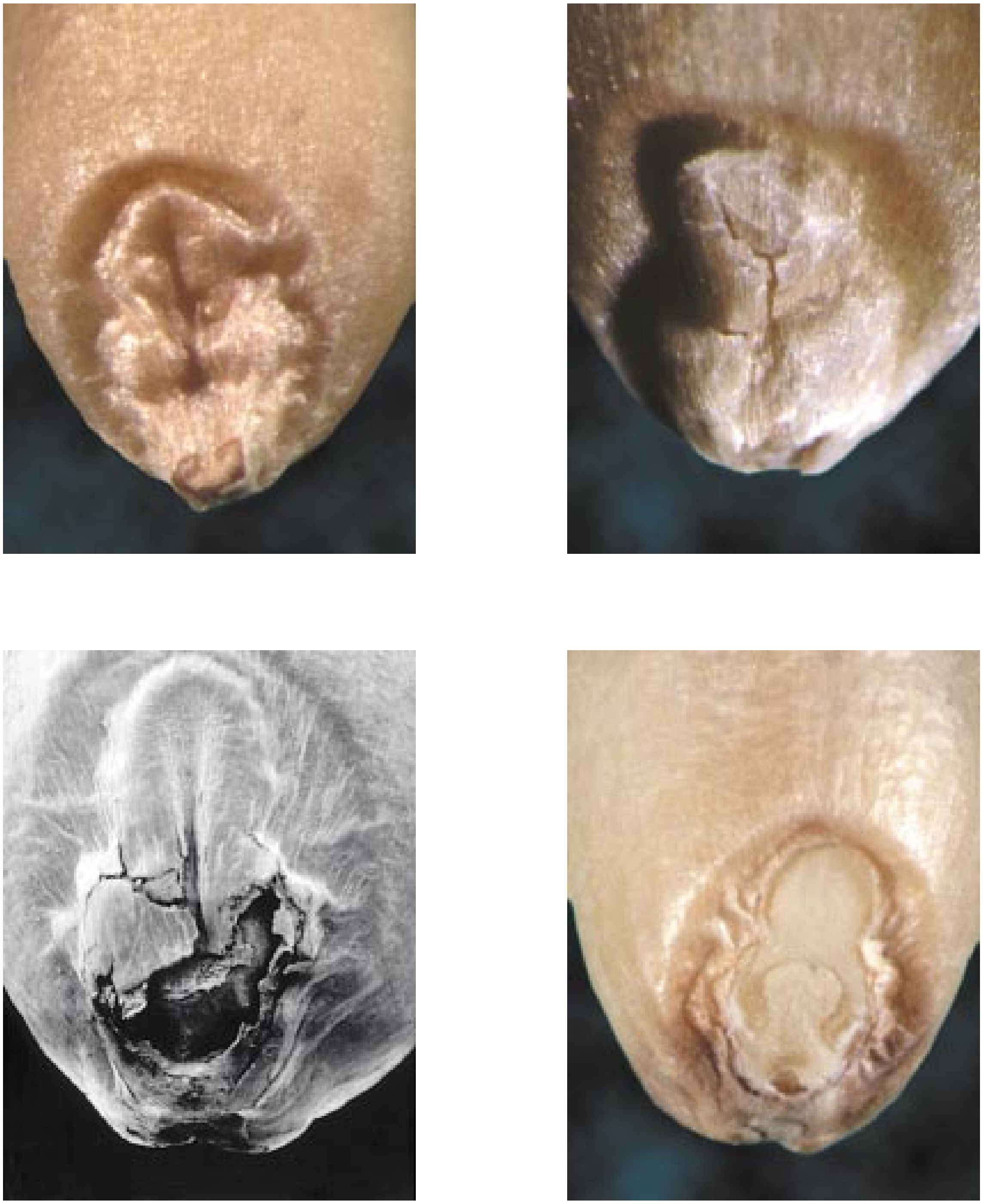

Figure 2. Hydration damage to pericarp covering embryonic axis of wheat seed. (A) Seed not previously hydrated where the pericarp closely follows the contours of the axis. Note: *the slight damage at the point of attachment is caused by mechanical harvesting and conditioning processes and not by hydration.* (B–D) Damage to the pericarp overlying the embryonic axis resulting from hydration induced swelling of the pericarp and the axis. Pericarp "bubbled up" and split (B), unsupported "bubbled up" pericarp partially broken away (C), and pericarp completely removed exposing the entire axis (D).

seeds. Seed lot Irr-L (Table 1), which had good viability and low vigor, had been exposed to water after physiological maturity and may have been subjected to subtle mechanical forces during the harvesting, cleaning, conditioning or handling operations that injured the coleoptile causing the high incidence of split coleoptiles and the reduction in seed vigor.

Sources of Water

Late summer and early fall rains are known to occasionally cause serious damage to both seed and grain quality in the PNW, and are generally a more serious problem in eastern Washington than in the irrigated region of the state. A number of the certified wheat seed lots produced in 1998, 1999 and 2000 had been exposed to water. Although a few certified wheat seed fields were exposed to brief summer showers during these years, there were no major storm systems that brought widespread preharvest precipitation to the certified wheat seed production areas. For these years, a greater proportion of the seed lots produced under irrigation had been in contact with water and had lower than

Table 3. Certified seed viability and vigor of major wheat cultivars. Data are averages for the 1998, 1999 and 2000 production years.

Cultivar	No. Lots	% Viability*	% Vigor**
Eltan	35	98.8	97.2
Lambert	21	97.9	95.9
Madsen	121	97.8	94.6
Stephens	55	97.7	94.9
Rod	36	97.2	94.8
Alpowa	60	97.1	93.3
Misc.	62	96.4	93.5

* AOSA germination test
** Cold test

Table 4. Sensitivity of wheat seeds to injury by mechanical abrasion after hydration/dehydration. A laboratory device was used to subject seeds to varying levels of force and movement to simulate mechanical abrasion.

Mechanical Abrasion	Germination		Cold Test	
	Split Coleoptile*	Germination	Split Coleoptile*	Germination
	%			
None	0	99	1	97
Mild	1	98	1	96
Intermediate	2	98	6	90
Moderate	7	99	9	85

* ISTA abnormal (AOSA normal)

Table 5. Viability and vigor of certified wheat seed produced under dryland and irrigation. Data are averages for the 1998, 1999, and 2000 production years.

Production	% Viability*	% Vigor**
Dryland	98.0	96.1
Irrigation	97.4	94.1

* AOSA germination test
** Cold test

desired viability and/or vigor than seed lots produced under dryland conditions (Table 5), indicating that natural precipitation may not have been the only source of water. While direct contact of physiologically mature seed with sprinkler irrigation water can be expected to result in reductions in seed quality, direct contact with irrigation water may not be the only source of water. Some seed lots produced under rill irrigation, including lot Irr-L (Table 1), also showed evidence of exposure to water and had reduced vigor. In these cases, dew and possibly root pressure may have been sufficient to hydrate embryonic axes of physiologically mature seeds after plants begin to turn (senesce), especially during periods of large diurnal temperature fluctuations when the soil profile is at or near field capacity.

Recommendations

Although the overall quality of certified seed produced in Washington is very good, a small proportion (5–10%) of the seed lots produced in 1998, 1999 and 2000 were lower quality than desired. Many of these seed lots had been produced under irrigation, and had been exposed to water after physiological maturity and prior to harvest. While nothing can be done to prevent untimely precipitation, better water management may have prevented some of these seed quality problems.

Seed producers:

- Avoid application of irrigation water to fields with mature or lodged plants. Irrigating entire fields for the benefit of late maturing tillers and plants may adversely affect quality of seeds having reached physiological maturity (hard dough stage). This recommendation applies to all types of irrigation as direct contact with the irrigation water does not appear to be necessary to obtain sufficient hydration of mature seeds to result in injury to the embryonic axis.
- Minimize mechanical injury to the axis during harvest and handling.

Seed processors:

- Minimize the potential for injury to the embryonic axis during cleaning and conditioning. Mechanical forces can readily increase split coleoptiles and other seedling abnormalities in hydrated/dehydrated seeds without causing obvious mechanical damage to the seed.
- Examine all seed lots for evidence that seeds may have been exposed to water prior to harvest. The injury illustrated in Figure 2 can be detected with a small hand lens.
- Perform a cold test for vigor after cleaning and conditioning on all seed lots showing evidence of exposure to water.

Acknowledgments

We thank the Washington State Crop Improvement Association and the Washington Department of Agriculture Seed Program for their collaboration and assistance with this research. Funding was provided by grants from O.A. Vogel Research Fund and the Washington State Crop Improvement Association.

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Published May 2002. A. Subject code 244. EB1929