Seed Physical Characteristics And Germination of Hardinggrass (*Phalaris tuberosa* var *stenoptera* (Hack.) Hitch.)[1]

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Highlight

Commercial samples of hardinggrass contained an appreciable number of immature seeds. These seeds were light green in color, generally lighter in weight, and after storage for some time had low viability. When care was taken to harvest only mature seed there was little relationship between seed weight and viability. Seeds from the lower portions of the panicles matured last and had a lower seed weight than those from the top.

Hardinggrass (*Phalaris tuberosa* var *stenoptera* (Hack.) Hitch.) is an important perennial range species in areas with a Mediterranean climate such as California. An important application of this species is in the conversion of chaparral to grassland. However, hardinggrass is noted for low seedling vigor, and difficulty is often experienced in obtaining satisfactory stands. Part of the difficulties in establishment could result from low seed viability. Accordingly, a study was carried out to examine the physical characteristics of individual seeds in different samples of hardinggrass and their relationship, if any, to germination.

Materials and Methods

A number of hardinggrass seed lots were kindly supplied by the Crop Improvement Association, Agronomy Department, University of California at Davis. Some of these were from samples which had been submitted by commercial growers for germination and purity tests and some were from seed grown on the station.

An additional lot of hardinggrass seed was collected by hand from an established stand at Tule Springs Range, Alpine, California (McKell et al., 1965). Only mature seed was collected for comparison with machine-harvested seed lots. The identification numbers used by the suppliers were used throughout.

Two hundred seeds were selected at random from several of these hardinggrass seed lots and the color of each seed determined according to the Munsell system of color notation (Munsell Book of Color, 1958). This is a three dimensional notation, involving hue (yellow, blue, etc.); value, indicating the degree of lightness or darkness; and chroma or degree of saturation of the color. Thus, any color may be denoted in numerical terms by comparison with a set of standard color chips, and results may be statistically analyzed. The seeds were then weighed individually, and frequency distribution histograms of the seed weights constructed. Correlation coefficients were also calculated for the three components of color and seed weight. Approximately 3 g samples from several seed lots were divided into three or four sub-samples of differing mean seed weight, using a South Dakota seed blower and 50 seeds weighed individually from each sub-sample. Frequency distribution histograms were then constructed to show the degree of separation achieved.

Germination tests were carried out on the sub-samples on moist blotters on top of "Kimpak" in petri dishes in an alternating temperature incubator, to determine the effects of seed weight on germination. Temperatures used were 20 C for 16 hours and 30 C for 8 hours. Tests were carried out in the dark but trays were usually examined twice per day under a fluorescent light. Total exposure to diffuse daylight and this lamp was approximately 0.5 hour each day. An arcsin transformation was applied to the germination percentages followed by an analysis of variance.

To obtain further information about the seed color differences noted in machine-harvested hardinggrass seed, a stand of this species at Tule Springs Range, San Diego County, was studied during the ripening period in 1963. Seed was collected by hand from individual plants and from different parts of the panicles from a number of plants. Mean seed weights were obtained for the seed from the sectioned panicles.

Single seeds were harvested from one plant growing at Riverside over a period of about a week in 1964. The color and moisture percentage of each seed was determined individually. Correlation coefficients were then calculated for the three components of color and seed moisture percentage.

Results

Frequency distribution histograms revealed wide differences

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in the distribution of different weight classes within lots of similar mean seed weight (Fig. 1). Correlation coefficients showed inverse relationship between hue, value, and chroma and seed weight for all lots, but not all r values were significant for each lot (Table 1).

With lot SCS 35-32, all seeds were of one hue. This was a relatively old sample and probably any new seeds which originally were green in color had been bleached to a straw color.

Germination tests showed a significant increase in germination percentage with increasing seed weight (Table 2) in machine-harvested lots of seed. With the hand-harvested lot from Tule Springs where care was taken to only collect mature seed, there was no significant change in germination percentage. Germination of the lighter fractions could not be improved by using KNO_3. The degree of overlapping in seed weight between the sub-samples is shown in Fig. 2.

When fully mature seed was harvested from individual plants the color and shape of seed from each plant was remarkably constant (Fig. 3). However, there were large variations in seed size and shape from plant to plant. There was little variation in hue or chroma from plant to plant but there were large variations in value. That is, seeds were all more or less the same brownish-grey, but they varied in degree of darkness. These plant to plant variations were probably the result of genetic differences. Variation in seed size from the same plant was also variable. When harvested at maturity, seed from the top third of the panicles weighed more than seed from the bottom third (Table 3).

When seeds were harvested with moisture contents ranging from 45% to 9%, significant correlations were found between moisture content and hue, mois-

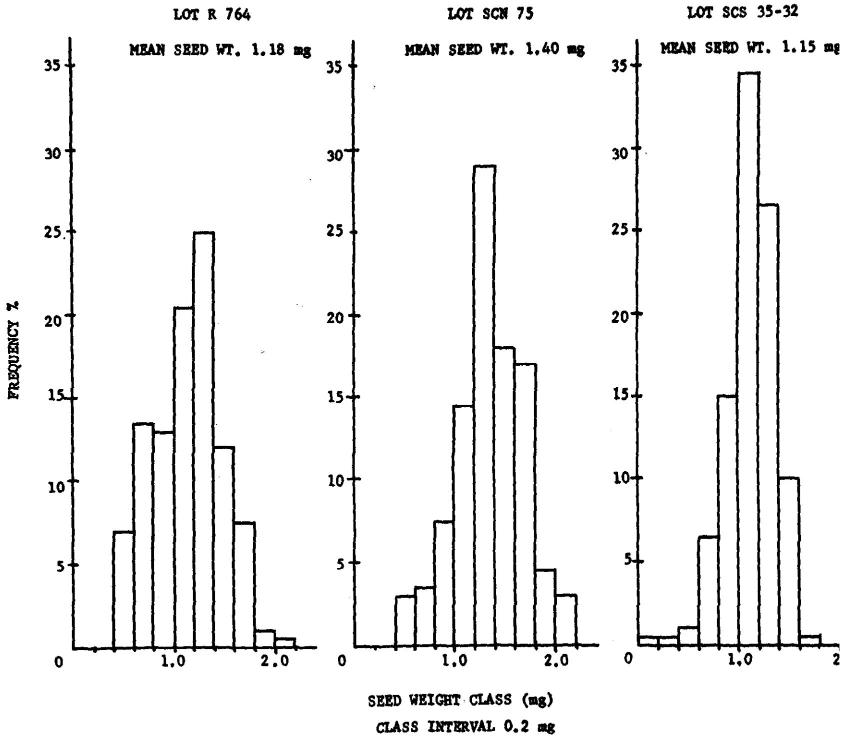

FIGURE 1. Frequency distribution histograms for individual seed weights of three sampl of hardinggrass.

Table 1. Correlation coefficients among the three components of color ar seed weight or seed moisture percentage of hardinggrass seed.

Munsell notation	Corr. coeff. between seed weight and color			Corr. coeff betwee color and moist. o seed from one plar
Sample No	R764	SCN75	SCS 35-32 all seeds	
Hue	−0.383*	−0.361*	one hue	0.693*
Value	−0.715*	−0.615*	−0.613*	0.365
Chroma	−0.087	−0.277*	+0.025	0.911*

* Significant at 1%.

Table 2. Mean seed weight (mg) and germination percentage of sub-sampl separated from five hardinggrass seed lots with a South Dakota see blower.[1]

	R 764		SCN 75		SCS 35-32		0067		Tule Springs 1963	
Sub-sample	Seed wt	Germ %	Seed wt	Germ %	Seed wt	Germ %	Seed wt	Germ %	Seed wt	Germ %
1	0.65	0_a	0.91	25_d	0.64	2_f	0.81	20_h	1.19	72_k
2	1.29	42_b	1.51	78_e	1.21	38_g	1.35	68_i	1.32	77_k
3	1.63	62_c	1.69	78_e	1.76	34_g	1.67	88_j	1.46	71_k

[1] Values differing significantly at the 5% level are indicated by differer letters (Duncan 1955).

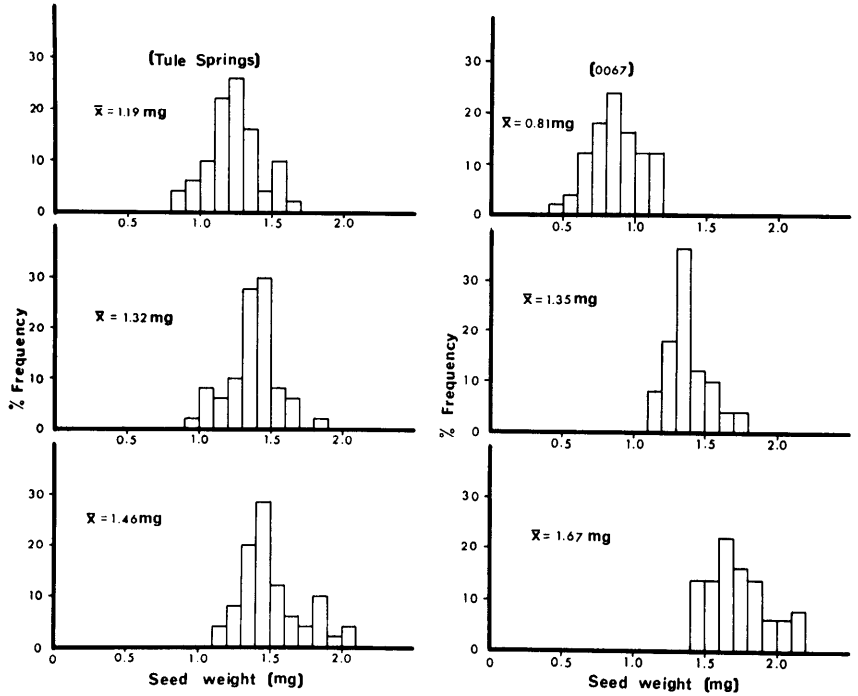

FIGURE 2. Frequency distribution histograms of individual seed weights of hardinggrass from two seed lots separated into three sub-samples with a South Dakota seed blower. The Tule Springs lot was hand-harvested at maturity and the 0067 lot was machine harvested according to usual procedures.

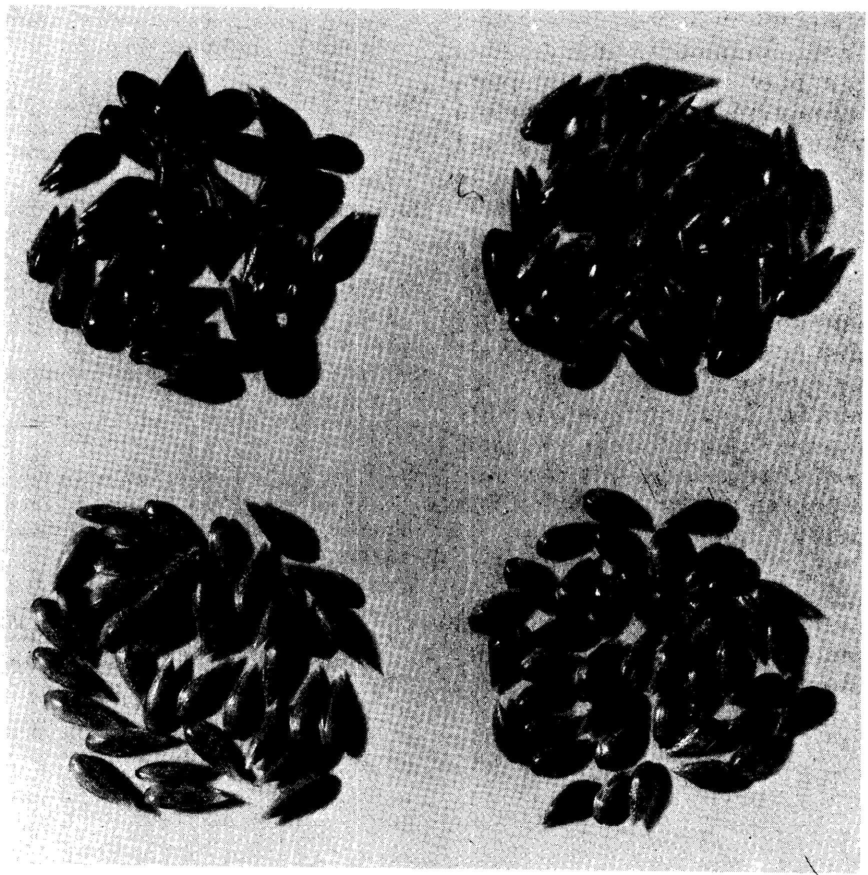

FIGURE 3. Randomly selected seeds harvested from four individual hardinggrass plants.

Table 3. Mean seed weight (mg) of hardinggrass from different parts of the panicle.[1]

Portion of panicle	Weight of seeds
Top third	1.45_a
Middle third	1.44_a
Lower third	1.38_b

[1] Values differing significantly at the 5% level are indicated by different letters (Duncan 1955).

ture content and chroma, but not moisture content and value (Table 1).

Examination of an established stand at Tule Springs during the ripening period revealed that the seed of hardinggrass is borne in a contracted spike-like panicle and ripening commences about two-thirds of the way up the head. Ripening then proceeds both up and down, and seed at the base is the last to mature. At maturity, the rachilla disarticulates above the glumes, with the caryopses tightly enclosed within the lemma and palea. So long as the head remains upright, the caryopses remain inside the glumes, but any shaking, such as from a strong wind, tends to dislodge them.

Discussion

The inverse correlations between hue and seed weight and between value and seed weight (Table 1) indicate that the seeds which were lighter in weight were less mature and lighter in color. The positive correlations between moisture content at harvest and hue and chroma (Table 1) indicated that as the individual seeds matured, their color changed from green to a brownish-grey color and from more saturated to less saturated colors. Thus, the light weight fractions contained a high proportion of immature seeds which could be identified by their green color. These green-colored seeds had a low viability and accounted for the minimum germination of the sub-samples which were least in mean seed weight (Table 2). Since the Tule Springs seed lot contained only mature seed, there were no differences in viability among sub-samples. When the seed lots were fractionated using the seed blower the differences in color among the sub-samples were quite striking.

Although there was an inverse correlation between value and seed weight in commercial samples, the correlation between value and seed moisture content of singly-harvested seeds was not significant. This would suggest that whether the seed is light or dark in color is genetically determined and is not related to maturity at harvest (see Fig. 3). However, there may be some genetic association between large seeds and dark seed color.

Except for the hand-harvested lot from Tule Springs, all the seed lots tested were two or more years old. Myers (1963) stated that the green colored seeds of hardinggrass could be induced to germinate with KNO_3 but with the older seed used in the present study, the germination of the light weight sub-samples was not improved. McAlister (1943) has also referred to the short storage life of seed harvested before full maturity.

Myers (1963) also pointed out the usefulness of seed color for identifying immature seeds in hardinggrass seed lots, but Stoddart (1964) was suspicious of the value of this approach for perennial ryegrass, cocksfoot and timothy. He reasoned that the green color could fade following harvest, depending on the conditions of storage. Nevertheless, the presence of an appreciable number of green colored seeds in a lot is a sure indication that the seed was harvested before maturity.

In several of the lots examined, a high proportion of the seed population weighed less than 1.0 mg (Fig. 1). In later studies (Whalley et al., 1966), where individual seeds were weighed and germinated, very few hardinggrass seeds of less than 1.0 mg germinated.

When seed is harvested before full maturity, knowing that the seed at the bottom of the panicles matures last, the differences in seed weight between the top and bottom of the panicles would be accentuated. The light weight seeds recorded in some lots probably come from the lower parts of green panicles.

Sumner (1963) recommended that, for the highest yield per acre, hardinggrass seed should be harvested when 11% of the heads are mature. Excessive losses by shattering will then be avoided. This recommendation is generally applied as shown by the presence of seeds harvested before maturity in all commercial seed lots examined. However, a high proportion of the seeds will then be low in weight, light green in color, and with low viability after storage for some time. There is a distinct need for strains with a high degree of seed retention which may be harvested when the seed is fully mature without loss of seed. Some progress in this direction has been made by McWilliam (1963).

Summary

Commercial samples of hardinggrass seed were found to contain an appreciable number of immature seeds. These seeds were light green in color, low in weight, and after storage for some time had low viability. The immature seeds result from the practice of harvesting seed before all seed heads are fully mature to avoid seed losses by shattering.

When care was taken to only harvest mature seed there was little relationship between seed weight and viability. Seeds from the lower portions of the panicles matured last and had a lower seed weight than those from the top, even when harvested at full maturity.

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