Black Point of Irrigated Wheat in Central Washington

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ABSTRACT

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A survey of 42 fields of the spring wheat cultivar Yecora Rojo revealed that black point occurs more frequently in fields irrigated by center-pivot than by rill or wheelline. There was no consistent association of fungi with black point nor was there any apparent detrimental effects of black point on seed germinability. *Helminthosporium* and *Fusarium* species were found in seed from a high proportion of the fields sampled. Surface disinfestation did not eliminate these fungi but, rather, enhanced their development, presumably by eliminating competing organisms.

Black point is a condition of wheat in which the embryo end of the kernel is discolored. A large number of fungi have been associated with black point (8), but species of *Alternaria*, *Helminthosporium*, and *Fusarium* have been noted most frequently (2,3). Black point is generally most severe in areas where rainfall occurs during seed maturation (2,3). It can be serious enough to affect flour quality, but generally does not alter seed viability unless *Helminthosporium* is involved (1,2,5).

The hard red spring wheat cultivar Yecora Rojo is grown on about 45,000 acres in irrigated regions of central Washington and is the principal cultivar exported for seed. Exporters state that purchasers of seed of Yecora Rojo are concerned that parasitic fungi such as *Helminthosporium* spp. or *Fusarium* spp. will be introduced with black point seed and have asked about the extent and possible reduction of black point in Washington seed.

Concerns about the incidence of black point in Yecora Rojo and its impact on the export of this cultivar for seed prompted a survey to obtain the following information: the relative occurrence of black point, the relationship to type of irrigation, the involvement of *Helminthosporium*, the effect of black point on seed viability, and possible means to reduce black point or any effects of black point.

MATERIALS AND METHODS

Forty-two fields in Grant and Yakima counties were sampled just before harvest (21–23 July 1987). In center-pivot

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irrigated fields, five subsamples were taken from each field. The first was taken from within the innermost (center) section of the pivot. The fifth was taken from the outermost (end) section. The other three subsamples were taken equidistant between the first and fifth sample areas. In wheelline and rill irrigated fields, samples were taken from five random locations. Each subsample consisted of 12–15 wheat heads.

Heads were threshed in a single-head thresher and a total seed count was obtained with an electronic seed counter. The number of seeds with black point was determined and all of the black point seeds plus enough additional seeds to total 100 seeds were placed on water agar (1% w/w Difco agar). Each field was represented by 500 seeds. After 7–10 days, the percent germination was recorded. In addition, each seed was examined at 10–30 magnification for the presence of fungi. The number of seeds yielding *Helminthosporium* (in the sense before Shoemaker's revision [6]) and *Fusarium* was recorded. *Alternaria* occurred so frequently that only a visual evaluation was made.

In order to determine whether or not *Helminthosporium* and *Fusarium* were carried in the seed, some field samples were disinfested to eliminate surface organisms. The samples used in this test were several that had 1) a high incidence of black point and 2) a relatively high occurrence of *Helminthosporium*. These seeds were disinfested by soaking them in a solution of 1.3% sodium hypochlorite in 45% ethanol. This solution was prepared by mixing together 1 part liquid bleach, 1 part water, and 2 parts 95% ethanol. Seeds were immersed in this solution for a minimum of 1 min and then were placed directly onto 1% water agar.

The potential of the fungicide imazalil to eliminate seedborne infections was tested by treating two commercial seed lots with 0.05 ml of 31% imazalil flowable formulation (0.02 ml a.i.) per 160 ml (dry volume) wheat seed. One of these seed lots had a high incidence of *Fusarium*, whereas the other had only a trace of either *Fusarium* or *Helminthosporium*. Treated seed was air-dried and then placed in a moist chamber to germinate for 7 days. Seed moistened with tap water and dried was used as a control treatment. Germinated seeds were surface-disinfested in the sodium hypochlorite/ethanol solution for 1 min and placed on water agar. From each seed lot, 1,000 imazalil-treated and 1,000 untreated seeds were tested. After incubating for 4 days, the seeds were observed for the presence of fungi and the occurrence of *Fusarium* was recorded; *Helminthosporium* was not observed in these tests.

The germinated seed in the moist chamber was held in a refrigerator (6 C) for an additional 7 days and then placed on water agar as described above. These plates were observed for fungi after incubation for 4–8 days.

Statistical analyses for comparisons of means were carried out using t tests ($P = 0.05$).

RESULTS

The results of this survey are presented in Table 1. The incidence of black point varied from 0.2 to 32% affected seed. There was a significant difference in the amount of black point between different types of irrigation. Black point had no apparent effect on seed germination under any of the irrigation systems. Germination in samples with high incidence of black point was similar to samples with little or no black point.

Alternaria spp. developed on almost every seed regardless of black point and this fungus most often developed on the brush end of the seed. Somewhat unexpected was the relatively frequent occurrence of *Helminthosporium* spp. from apparently healthy seeds, which was recorded from 21 of the 42 fields sampled. The same was true of *Fusarium* spp., which was present in 34 of the fields sampled. Both of these fungi were present most frequently in center-pivot irrigated, followed by rill and wheelline irrigated fields.

There was no statistically significant difference in the occurrence of *Helminthosporium* or *Fusarium* spp. with or without disinfestation (Table 2). This suggests that the fungi are protected in some way by the seed coat, perhaps being internal in the seed. This fact makes seed

Table 1. The occurrence of black point in the spring wheat cultivar Yecora Rojo seed collected from irrigated fields in central Washington in July of 1987

Type of irrigation	No. of fields	Black point[x] (%)	Germination[x] (%)	*Helminthosporium*		*Fusarium*	
				Infested seeds (no.)	Average incidence[x] (%)	Infested seeds (no.)	Average incidence[x] (%)
Rill	19	5.6 a[y]	96 a[y]	7 (4)[z]	0.074 a[y]	27 (10)[z]	0.28 a[y]
Wheelline	3	10.3 b	98 a	1 (1)	0.067 a	7 (1)	0.47 ab
Pivot	20	18.5 c	96 a	74 (16)	0.74 b	152 (14)	1.5 a

[x] Average of all fields, 500 seeds per field.
[y] Means followed by the same letter are not significantly different ($P = 0.05$) as determined by t test comparisons between treatment means.
[z] Figures in parentheses represent the total number of fields in which infested seeds were found.

Table 2. Occurrence of *Helminthosporium* and *Fusarium* on the spring wheat cultivar Yecora Rojo seed with and without surface disinfestation

Field no.	Black point average (%)	Without disinfestation				With disinfestation			
		Seeds in sample (no.)	Germination (%)	Percent with:		Seeds in sample (no.)	Germination (%)	Percent with:	
				Helminthosporium[v]	*Fusarium*[v]			*Helminthosporium*[v]	*Fusarium*[v]
6	30	500	98[w]	2.0	0.0	500	94[w]	1.2	0.4
7	19	500	94	1.0	0.0	275	97	1.1	0.0
9	12	500	97	1.8	0.4	280	95	1.7	0.6
10	31	500	96[w]	3.2	0.6	500	89[w]	3.4	0.4
18	19	500	93	1.4	2.8	280[x]	95	1.4	0.4
21	18	500	95[z]	1.8	0.2	290	91[z]	3.8	0.1
31[y]	15	500	80[z]	0.0	17.2	320	68[z]	0.3	22.2

[v] Samples without disinfestation were not significantly different from samples with disinfestation.
[w] Samples without disinfestation had significantly ($P = 0.05$) greater germination than samples with disinfestation for this field.
[x] Only two of the original five subsamples were available for this test.
[y] Included because of the high incidence of *Fusarium*.
[z] Samples without disinfestation had significantly ($P = 0.10$) greater germination than samples with disinfestation for this field.

Table 3. Occurrence of *Helminthosporium* and *Fusarium* in seeds without disinfestation and seeds with disinfestation from two commercial seed lots of the spring wheat cultivar Yecora Rojo

Test no.	Lot no.	Without disinfestation[z]				With disinfestation			
		Seeds (no.)	Germination (%)	*Helminthosporium* (%)	*Fusarium* (%)	Seeds (no.)	Germination (%)	*Helminthosporium* (%)	*Fusarium* (%)
I	R-1	120	77 *	0.0	16.7	120	45	0.0	19.2
I	R-2	140	96 *	1.4	1.4	120	65	3.3	2.5
II	R-1	500	78 *	0.2	19.8 *	500	56	0.0	32.4
II	R-2	500	99 *	0.6	0.0 *	500	88	1.0	3.2

[z] Values for seed without disinfestation followed by an asterisk (*) are significantly ($P = 0.05$) different from the corresponding values for seed with disinfestation as determined by t tests.

treatment to eliminate these fungi more difficult.

Following the processing of the samples collected from the field, two seed samples were submitted by a seed company. Surface-disinfested and non-disinfested seeds from these samples were placed on water agar. This test was repeated and the results of both tests are presented in Table 3. The results are similar to those of the *Fusarium*-infested sample (field no. 31) in Table 2. Disinfestation did not reduce the incidence of *Fusarium* but actually resulted in a slight increase and greatly enhanced its growth on the agar. In addition, germination was decreased by seed disinfestation.

Imazalil reduced the incidence of *Fusarium* in seed to about 20% that of untreated seed, but did not eliminate it. It is unlikely that this level of reduction is acceptable to the seed industry. More testing is needed, especially for *Helminthosporium* control and for field results.

DISCUSSION

Black point occurs commonly and frequently in the cultivar Yecora Rojo grown under irrigation in central Washington. However, there is no apparent detrimental effect to the seed, which germinates vigorously and normally.

The occurrence of fungi, particularly *Helminthosporium* and *Fusarium*, the primary pathogenic fungi observed, is coincidental with black point. These fungi were found as often on seeds without black point as on seeds with black point. *Fusarium* was observed as having the greatest detrimental effect on seed; the lowest germination was associated with the highest incidence of *Fusarium*. The majority of *Fusarium* isolates were identified as *F. graminearum* Schwabe, which previously has been associated with center-pivot irrigation systems, especially in wheat following corn (7).

The potentially detrimental fungi observed on wheat seed, whether or not associated with black point, are intimately associated with seed, perhaps internally, so that surface disinfestation does not eliminate them. Surface seed treatments would probably be ineffective, although the use of systemic seed fungicides may eventually give a satisfactory reduction in the seed transmission of these fungi.

There appears to be a protective or beneficial microflora on the seed. When seed was surface-disinfested it was observed that *Fusarium* developed much more aggressively on the seed and agar, and seed germination was markedly reduced or retarded. The nature of this beneficial microflora was not determined, but is probably similar to that described by Ledingham et al (4).

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