EFFECT OF RED SMUDGE INFECTION ON DURUM WHEAT SEED QUALITY.

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INTRODUCTION

Red smudge of wheat kernels is caused by Pyrenophora tritici-repentis (Died.) Drechs. (anamorph Drechslera tritici-renentis (Died.) Shoemaker). Although there is variation in red smudge susceptibility within durum wheat, all the durum wheat cultivars registered in western Canada are susceptible to this disease (Femandez ***et al.,*** 1994). In southwestern Saskatchewan, red smudge has been found to vary in incidence depending on environmental conditions at the time of seed development. For example, there were higher levels of red smudge under irrigation in 1992 and 1993 than in the drier seasons of 1990,199 1 or 1994 (Femandez ***et al.,*** 1994, and unreported observations). Average levels of red smudge in durum wheat cultivars were 2.5% in 1992 and 4.1% in 1993, with levels of up to 8.5% (Femandez ***et al.,*** 1994a and b).

Red smudge reduces market grade of wheat (Canadian Grain Commission, 1991). In durum wheat, an incidence of 0.27 to 1% of red smudge will reduce grade from #1 to #2 Canadian Western Amber Durum with a 3 to 5% decrease in price. An incidence of 1 to 1.5% will further reduce grade to #3, with a 5 to 20% decrease in price (Canadian Grain Commission, 1991).

This study was initiated to examine the effect of red smudge on seed germination, seedling emergence, plant development, and yield components of durum wheat in the field and under controlled conditions.

MATERIALS AND METHODS

Controlled-environment studies. Percent germination, and rate of germination of healthy and naturally-infected red smudged seed were measured in four durum wheat cultivars: Medora, Sceptre, Wakooma and Plenty. Seeds of each cultivar/treatment combination (25 per replicate) were plated on wet filter paper in petri dishes, and incubated in the dark at constant 8°C. They were arranged in a RCB design, with three replicates each. Number of germinating seeds was determined daily for a period of 12 days. At 12 days, the number of seminal roots, the length of the longest root and of the coleptile were determined in 15 germinated seeds per replicate.

Healthy and naturally-infected red smudged seed of the same cultivars as above were used in a growth chamber study to examine seedling emergence and plant development. Sixteen seeds from each treatment/cultivar combination were sown at a depth of 4 cm, four per pot (7 x 7 x 18 cm). There were three replicates in a RCB design. Emergence counts were made daily. Plants were kept at constant 8°C, 16 h photoperiod, up to the 2-leaf stage. Pots were then thinned to 2 seedlings, and kept at 22°C day and 15°C night until maturity. Average time to heading was recorded for each treatment/cultivar combination.

Field study. Field trials were conducted in 1993 and 1994 near Swift Current, Sask., with the same cultivars used above, and three treatments: 0, 50 and 100% red smudge infected seed, in a RCB design with 4 replicates. Plots consisted of 50 space-planted seed in 3-m single rows. Total number of seedlings emerged, and time to emergence of the first seedling(s), of 50% and 100% of total emerged seedlings were recorded. At maturity, plants were cut at soil level and dried at 35°C.

Spike density, total dry weight of above-ground plant tissue, and grain yield per plot were determined.

Statistical analysis. General Linear Models (Lawes Agricultural Trust, 1993) were used to analyze the data. Probabilities less than 0.05 are considered significant.

RESULTS

Seed germination and early seedling: development. Naturally-infected red smudged seeds had a lower percent germination than healthy seeds (Table 1). There was no difference among treatments in the rate of seed germination. At 12 days, the length of the longest root and of the coleptile was greater in the healthy than in the red smudged treatment. In addition, the number of roots developed by the naturally-infected red smudged seeds was significantly lower than those developed by healthy seeds.

Table 1. Percent germination, and length of seminal roots and coleoptile at 12 days, of naturally-infected red smudged and healthy seeds.

	Seed	Length of	
Treatment	germination	roots	coleoptile
	--%--	____ cm ____	
Red smudge	90.6(.04) [1]	2.2(0.1)	1.5(<0.1)
Healthy	97.6(0.8)	3.4(0.1)	2.0(<0.1)

1 Standard error.

Seedling: emergence and development of growth chamber-grown plants. Percent emergence of seedlings was significantly lower in the red smudge treatment than in the control (Table 2). Time to emergence of the first seedling(s) (T_E1), and of half of the emerged seedlings (T_E50) was greater for the red smudge than for the healthy treatment. Time to heading was also greater for plants derived from red smudged seeds than for those derived from healthy ones.

Table 2. Percent emergence, time to emergence of first (T_E1) and 50% (T_E50) of seedlings, and time to heading of growth chamber-grown plants derived from red smudged and healthy seed.

	Seedling			Time to
Treatment	emergence	T_E1	T_E50	heading
	--- % ---	---- days ----		
Red smudge	83.6(<0.1) [1]	16.8(0.2)	17.8(0.1)	7 1.9(0.2)
Healthy	92.7(<0.1)	16.1(0.2)	16.9(0.1)	70.7(0.2)

1 Standard error.

Seedling emergence and plant growth in the field. Red smudge infection also reduced percent emergence of seedlings in the field. The control (0%) had significantly greater emergence than the 50% red smudge, and the 100% red smudge treatment had the lowest emergence (Table 3). In addition, red smudge affected time to emergence of all seedlings ($T_{FE}100$). It took longer for all seedlings in a plot to emerge in the 50% and 100% red smudge treatments than in the control.

Table 3. Percent emergence, and time to emergence ($T_{FE}100$) of seedlings derived from healthy (0%) and red smudged seed (50% or 100%) in the field.

Treatment	Seedling Emergence	$T_{FE}100$
	— % —	-- days --
0% red smudge	85.4(0.9) [1]	19.2(0.5)
50% red smudge	73.4(1.1)	21.9(0.6)
100% red smudge	66.8(1.2)	21.3(0.6)

1 Standard error.

Spike density, above-ground dry weight and grain yield per plot were negatively affected by the red smudge infection. The control (0% red smudge) had the highest values for all three variables, the 50% was intermediate, and the 100% red smudge treatment was lowest (Table 4).

Table 4. Spike density, above-ground plant dry weight, and grain yield per plot derived from healthy (0%) and red smudged seed (50% or 100%).

Treatment	Spike density	Dry weight	Grain yield
	spikes/3 m	---------- g ----------	
0% red smudge 342.0 (7.3)	267.3(5.1) [1]	796.1(14.9)	
50% red smudge 3 19.7 (6.9)	241.8(4.8)	728.6(13.8)	
100% red smudge 284.4 (6.1)	2 12.7(4.5)	654.4(12.4)	

1 Standard error.

DISCUSSION

Red smudge infection of durum wheat seed was found to affect seed quality and seedling vigour, and caused poorer plant stands and reduced grain yield per unit area in the field.

The reduction in percent emergence and rate of emergence of seedlings, and slower development of plants derived from naturally-infected red smudged seeds, could not be attributed to any differences in the rate of seed germination, but seems to be related to the lower vigour of the developing seedlings and lower percent germination.

Acknowledgement

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REFERENCES

Canadian Grain Commission, 1991. Official Grain Grading Guide.

Fernandez, M.R., J.M. Clarke, R.M. DePauw, R.B. Irvine and R.E. Knox, 1994a. Black point and red smudge in irrigated durum wheat in southern Saskatchewan in 1990-1992. Can. J. Plant Pathol. (in press).

Fernandez, M.R., J.M. Clarke, R.M. DePauw and R.B. Irvine, 1994b. Black point and red smudge in durum and common wheat cultivars in southern Saskatchewan in 1993. Annual Wheat Newsletter 40:86.

Lawes Agricultural Trust, 1993. Genstat 5, release 3.1 Reference Manual, University Press, Oxford.