BREEDING FOR HEAD SCAB RESISTANCE USING MODERN TOOLS

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OBJECTIVES:

1) To compare conventional scab screening methods with a method based on molecular markers.
2) To estimate the value of scab resistance genes from the Chinese wheat Sumai 3.

INTRODUCTION:

Head scab or Fusarium Head Blight (FHB) caused by *Fusarium graminearum* (Schwabe) causes significant losses in the soft red winter wheat crop in Kentucky and in small grain crops in many regions of North America. FHB epidemics result in significant yield losses and can cause serious reductions in grain quality. Phenotypic screening for FHB resistance is expensive and time consuming. Use of molecular markers linked to FHB resistance genes may increase efficiency of the breeding process.

MATERIALS AND METHODS:

Three populations of 40 lines each were evaluated during 2001 in one location (Lexington, KY) and during 2003 in two locations (Lexington and Princeton, KY). In 2001 we used hill plots planted on a 1 foot grid. In 2003 each plot consisted of two 7" rows 4 ft in length. The previous crop was corn and the seedbed had been chisel-plowed and disked.

Field Inoculation

In early April, wheat plots were inoculated prior to heading by spreading 3.3g/ft^2 of scabby corn. Plots were mist-irrigated daily beginning just prior to heading. The irrigation system was set with an automatic timer programmed to mist-irrigate the plots for 5 minutes every 15 minutes between the hours of 6 to 10 AM and 10 minutes every 20 minutes between the hours of 8 and 10 PM.

Disease evaluations were initiated approximately 21 days after the earliest varieties began to head and scab symptoms were detected on susceptible check varieties. Incidence was recorded as the number of infected heads per row. Ten heads per plot were visually rated for severity of infection.

Scabby Seed Evaluation

A 200 seed sample was randomly taken and sorted into two classes (healthy and non-healthy) based on the visual appearance of the seed. The number of seed in each class was counted and the percentage of scabby seed was estimated.

DON test procedure

A five gram sample of grain from each class was analyzed for the toxin deoxynivalenol (DON) using the EZ-Quant Vomitoxin Test Kit from Diagnostix Company.

RESULTS AND DISCUSSION:

Pedigree information led us to expect that all three populations would have some lines possessing resistance from the Chinese wheat Sumai 3. However, we found that only 19 lines of population 2 had the Sumai 3 resistance genes. We detected these genes by the presence of molecular markers that are linked to the genes. We compared the scab severity in the lines containing the Sumai 3 genes with the severity in the lines that lacked these genes (Table 1). For all of the traits measured, the lines with the Sumai 3 genes showed greater resistance, although the differences were small. The markers will be useful in identifying these genes in other populations, but we can't always expect very high levels of resistance to be associated with them.

Interestingly, Population 1 had the lowest mean FHB severity (29.5%) and Population 3 had the lowest mean FHB incidence (43%) even though both populations lacked the Sumai 3 resistance. In both of these populations, estimates of heritability, a measure of the degree of genetic control, was moderately high. This means that it is probable that resistant lines can be developed from these populations. Evidently the adapted SRW parents in these crosses had some resistance as well. The results are promising in that we have sources of genetic resistance to FHB in addition to Sumai 3 that we can use to develop resistant varieties.

Table 1. Comparison of lines with and without Sumai 3 scab resistance genes, Lexington and Princeton, KY, 2003. Resistant (25R18) and susceptible (2555) check varieties also shown.

Line	Incidence	Severity	Scabby Seed	DON
	(%)	(%)	(%)	(ppm)
Sumai 3 genes	46.9	27.7	9.4	9.7
No Sumai 3 genes	53.0	32.3	11.3	10.6
Average	50.1	30.1	10.4	10.2
25R18	47.1	12.1	4.8	10.3
2555	87.5	51.8	16.3	14.3

Table 2. Average values of three populations for traits related to head scab, Lexington and Princeton, KY 2003. Resistant (25R18) and susceptible (2555) check varieties also shown.

Entry	Incidence	Severity	Scabby Seed	DON
	(%)	(%)	(%)	(ppm)
Pop1	45.5	29.5	12.2	8.0
Pop2	50.1	30.1	10.4	10.2
Pop3	43.3	32.1	13.0	12.2
25R18	47.1	12.1	4.8	10.3