Oat Crown Rust vs. Biodiversity

Crown rust of oats is a plague that has been around as long as oats have been raised in the Midwest. It's often invisible, but crown rust sometimes devastates the crop, as in 1996 in northeast Iowa. PFI is partnering with ISU and with farmers and scientists in Minnesota to try a different approach to this disease.

For the better part of a century, plant breeding has developed varieties resistant to strains of crown rust of oat (Puccinia coronata). But crown rust is a sneaky fungus. It keeps evolving, bypassing the resistance bred into the crop. Scientists would respond by breeding in a new resistance gene from wild oat and its relatives. And rust would then develop "virulence" to that new gene as well. Now breeders are running out of resistance genes in the wild. Is this the end of the road for oats on Midwest farms? Let's hope not! Oat is too useful as a nurse crop for forages, a clean-up crop for nutrients and weeds, and a high-fiber feed for baby pigs.

Back in the 1950s, Iowa scientists like Dr. Artie Browning tried a different approach to managing oat rust. They created varieties that were biodiverse. In this "multiline" approach, some oat plants in the field were resistant to one strain of rust, and other plants were resistant to other strains. The crop could compensate for losses to any particular strain of rust that might be prevalent in a given year, much as wild plant populations do in natural systems. In addition, the oat diversity reduced the pressure on the rust to develop new infective strains. The multiline approach definitely worked.

Table 15. Oat Yields of Variety Blend † Compared to Average of Varieties.

State	Farm	Year	Blend Yield	Variety Avg	Blend Benefit
			—— bushels per acre ——		
LA	Natvig	2006	61.0	58.3	2.6
LA	Lansing	2006	95.7	92.1	3.6
LA	Wilson	2006	125.0	112.8	12.2
LA	Ames	2006	111.2	111.5	-0.3
MN	Yokiel	2006	71.3	66.5	4.7
MN	Tews	2006	99.7	86.7	12.9
MN	Fernholz	2006	98.1	88.1	10.0
MN	U of M	2006	102.3	93.4	8.8
LA	Natvig	2007	69.5	66.4	3.1
LA	Grice ‡	2007	67.5	67.7	-0.2
LA	Wilson §	2007		116.6	
LA	Ames	2007	111.2	111.5	-0.3
MN	Yokiel	2007	70.0	61.6	8.5
MN	Tews	2007	106.7	105.3	1.4
MN	Fernholz	2007	79.4	79.9	-0.5
MN	U of M	2007	82.8	81.4	1.4
		Average:	90.1	85.5	4.5

† The experimental variety blend is Blaze-Kame-Spurs.
‡ High in-field variability. § Blend yield not available.

However, it took more time and resources to develop oat varieties that were a mix of different genetics.
Small grains breeding has even fewer resources today than half a century ago when multilines were popular. But if producers knew how to combine different commercially available oat varieties, they might be able to create their own biodiverse, multi-variety seeding. The key piece of information would be how to combine those commercial varieties.

Oat variety differences are visible at heading-out time.

And to do that, we have to know what strains of rust each variety is resistant to. The project is generating just this information by inoculating oat varieties with different rust strains and by comparing the performance of a varietal mixture to that of its components. The work, with producers in Iowa and Minnesota, began in 2006 and will continue through 2008.

What have we learned so far?

- Although infestation levels were low, the variety blend really did reduce rust infestations in 2006; 2007 data are not competely analyzed.
- Although the difference was not statistically significant, the variety blend out-yielded the average of the separate varieties in 2006 on seven out of eight farms and in 2007 on four of seven farms (Table 15). That could be both from less rust and because variety mixes simply use resources ore efficiently.

- Table 16 provides combinations of oat varieties that are "complementary," meaning that together they provide greater resistance to crown rust than either variety separately. In other words, complementarity is relative to the solo performance of the varieties that make it. A good variety blend should combine three things: 1) complementary varieties; 2) varieties whose individual rust resistance is good (CR in the table); and 3) varieties whose yield ptential is good.
- Three-variety combinations will give more diversity than two-variety combos, hence more of the protection that diversity provides. But three also makes it more difficult to maximize some of the other attributes, such as finding three very high yielding varieties or three varieties that all mature at about the same time. In terms of disease resistance, there is probably also diminishing returns to adding more varieties.

The high yielding oat varieties Baker, and Woodburn do not appear in Table 16 because they did not prove to be complementary with other varieties. Also not appearing are blends whose complementarity was not as strong and/or whose individual varieties are not high yielding. If you really like a variety that doesn't appear, PFI can likely provide you with information about the varieties that it combines with best.

Table 16. Oat variety combinations for resistance to crown rust.

Very Highly Complementary Combinations				
	Blaze	Kame	Spurs	Avg
Yld†	145	143	148	145
CR‡	1.8	2.0	1.9	1.9
		Blaze	Esker	Avg
	Yld	145	150	148
	CR	1.8	2.0	1.9
		Blaze	Spurs	Avg
	Yld	145	148	147
	CR	1.8	1.9	1.9
		Blaze	Wabasha	Avg
	Yld	145	140	143
	CR	1.8	1.4	1.6
Highly Complementary Combinations				
	Hifi	Jay	Kildeer	Avg
Yld	143	142	127	137
CR	—	1.2	3.3	2.3
		Blaze	Drumlin	Avg
	Yld	145	143	144
	CR	1.8	2.2	2.0
		Blaze	Jay	Avg
	Yld	145	142	144
	CR	1.8	1.2	1.5
		Jay	Kame	Avg
	Yld	142	143	143
	CR	1.2	2.0	1.6
		Kame	Spurs	Avg
	Yld	143	148	146
	CR	2.0	1.9	2.0
Complementary Combinations				
	Blaze	Esker	Kame	Avg
Yld	145	150	143	146
CR	1.8	2.0	2.0	1.9
		Drumlin	Kame	Avg
	Yld	143	143	143
	CR	2.2	2.0	2.1

† Oat yield in bushels per acre.
‡ CR is crown rust resistance; smaller = better.