Suppressors of Oat Crown Rust Resistance in Interspecific Oat Crosses

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Introduction

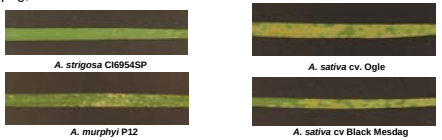
Attempts to transfer disease resistance genes between related species may be hindered by suppression, or lack of expression, of the trait in the interspecific combinations. For example, Singh et al. (1996) found that suppressors of leaf and stem rust resistance in interspecific crosses occur at all ploidy levels and can be accession-specific. Recently, Rines et al. (2007) reported a suppressor factor in the oat crown rust resistant diploid oat *Avena strigosa* accession CI6954SP which apparently is activated in F1 combinations with *A. sativa* lines causing the F1 plants to be rust susceptible. The crown rust resistance could be segregated from the suppressor in backcross derivatives of the interspecific F_1. The resistance gene appeared to be the same as *Pc94*, which Aung et al. (1996) earlier had transferred into *A. sativa* from a different *A. strigosa* accession. Aung et al. (1996) and Chong and Aung (1996) had found that *Pc94* resistance was suppressed in crosses with *A. sativa* lines containing the crown rust resistance gene *Pc38*, which had been transferred from *A. sterilis*. Wilson and McMullen (1997) reported that *Pc38*, or a factor closely linked to it, also suppressed *Pc62*.

Here we describe behavior of the suppressor factor found in *A. strigosa* CI6954SP, compare its specificity to that in the *Pc38* line, and report the occurrence of suppression or lack of it in other crosses made to attempt introgression into hexaploid *A. sativa* (AACCDD) of crown rust resistances from a different diploid *A. strigosa* (AA) accession and from tetraploid *A. murphyi* (AACC) and *A. barbata* (AABB) accessions.

Materials and Methods

The oat crown rust resistant accession CI6954SP of *A. strigosa* (Figure 1) was obtained from the late Dr. Paul Rothman at the USDA Cereal Rust Lab in St. Paul, MN, who had obtained it many years earlier from Dr. Marr Simons at Iowa State University. The susceptible hexaploid cultivars Ogle and Black Mesdag were chosen because Ogle is a well-established cultivar found in pedigrees of many current oat lines while Dr. Rothman had observed that Black Mesdag, an older cultivar, seemed to hybridize more easily in previous wide crossing efforts. The tetraploid *A. murphyi* accessions, including P12, were obtained from researchers at Purdue University and had been maintained at the USDA Cereal Disease Lab. The *A. strigosa* accession PI258731 and the *A. barbata* accessions were identified as crown rust resistant by screening in a buckthorn nursery of materials obtained from the National Oat Germplasm Collection in Aberdeen, ID (see poster by Carson and Rines). The *Pc* lines had been obtained from Dr. James Chong, Winnipeg, Manitoba.

Figure 1



Rust reactions of *A. strigosa* CI6954SP (highly resistant – HR), *A. murphyi* P12 (resistant – R, necrosis but no rust pustules), and *A. sativa* cvs. Ogle and Black Mesdag (susceptible – S).

Embryos, aseptically removed ~15 days after pollination of emasculated florets, were planted on 1/2 –strength MS media. Young interspecific hybrid plants were colchicine treated by procedures described in Rines et al. (2007).

Oat seedling tests were conducted using an inoculum that traced to a bulk composite of crown rust uredinio spores collected in field buckthorn nurseries, as described in Rooney et al.(1994), or as individual isolates maintained at the Cereal Disease Lab.

Results and Discussion

Introgression of crown rust resistance from A. strigosa CI6954SP. (Figure 2)

From >100 pollinations each of Ogle and Black Mesdag (rust susceptible – S) onto *A. strigosa* (highly resistant – HR), only one embryo was recovered that developed to a plant, that from Black Mesdag. The 1x+3x amphiploid and the octaploid C_1 progeny plants produced after colchicine doubling were rust susceptible, as were the BC_1F_1 plants obtained by crossing by Ogle. However, resistant (R) plants were among plants recovered either from selfing of BC_1F_1 or a second backcross by Ogle. This result indicated that the resistance was segregating from a suppressor.

Introgression of resistance from 2x *A. strigosa* PI258731. (Figure 3)

The scheme for introgressing resistance from *A. strigosa* PI258731 was similar to that with *A. strigosa* PI6954SP. However, no suppression was observed with resistance expressed in the F1, the colchicine-derived C_1, and the BC_1F_1 plants. The resistance R* in *A. strigosa* PI258731 is novel in being only MR-MS (moderately resistant to moderately susceptible) in young seedlings, but resistant (R) to highly resistant (HR) in adult plants.

Figure 2

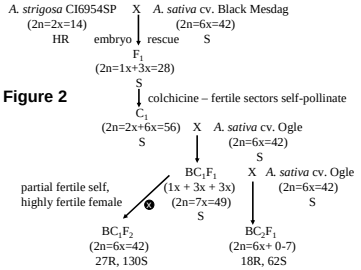
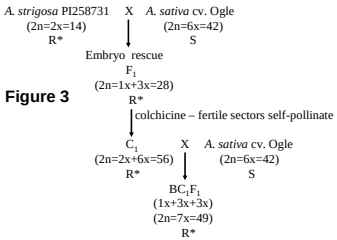


Figure 3



Comparison of *Pc38* and *A. strigosa* CI6954SP suppressors

Table 1. Comparison of the suppressor in line *Pc38* and one derived from *A. strigosa* CI6954SP (As/BM C1). Based on Expected if no suppression vs. Observed reactions in F1 combinations with various *Pc* gene lines (R = resistant, S = susceptible).

Resistant donor line	Donor reaction and rust test isolate	"Suppressor" line tested in F_1 combination			
		Pc38		$ASBMC_1$	
		Expected	Observed	Expected	Observed
Pc94	R[1]	R	S	R	S
BT14-3	R[1]	R	S	R	S
Pc62	R[2]	R	S	R	S
Pc58	R[3]	R	R	R	R
Pc63	R[2]	R	R	R	S
Pc38	R[3]	R	R	R	S

[1]Tested with rust isolate bulk.
[2]Tested with rust isolate 06AUS501.
[3]Tested with rust isolate 06MN110.

The specificity of the F_1 suppression from *A. strigosa* CI6954SP was similar to that of the *Pc38* line in suppressing resistance of *Pc94*, BT14-3 (a resistant backcross derivative of CI6954SP), and *Pc62*, and not suppressing resistance of *Pc58*. However, it differed in suppressing resistance of *Pc63* and *Pc38* while *Pc38* did not. *Pc94* resistance was also suppressed by *Pc58*.

Attempted introgression of resistance from tetraploid *A. murphyi* P12. (Figure 4)

Successful viable seed set requires use of 4x *A. murphyi* as the male parent in crosses with 6x *A. sativa*, though embryo rescue is not needed. In the cross of *A. sativa cv.* Ogle with *A. murphyi* P12, the resistance of P12 was suppressed in the F_1, C_1, and BC_1 and BC_1F_2 plants. No resistant backcross derivative segregating from suppression have been recovered.

Because suppression of resistance had been reported to be line-specific in *Triticeae* in some cases, we tried various susceptible *A. sativa* cultivars including Ogle, Otana, Marvellous, Sun II, and Gopher in F_1 combinations with various *A. murphyi* accessions including P10, P11, P12, P13, and P17; however, all of the interspecific F_1 plants were susceptible. Crosses with *A. sativa* lines Kame, ND020965, and SD030888, each with resistance to many rust isolates, by *A. murphyi* P12 (HR) all gave resistance similar to the *A. sativa* parent; thus, *A. murphyi* does not suppress the resistance from the *A. sativa* parent, but the *A. murphyi* resistance is highly suppressed in the interspecific F_1s.

Introgression of resistance from 4x *A. barbata*. (Figure 5)

Viable seed was easily obtained from crosses of *A. barbata* (R, HR) by *A. sativa cv.* Ogle (S) where *A. barbata* was the female parent. Initial introgression efforts (Carson and Rines, poster) showed no suppression of A. barbata resistance. F_1 plants (2x+3x) exhibited crown rust resistance at levels near or slightly below the *A. barbata* parent.

Figure 4

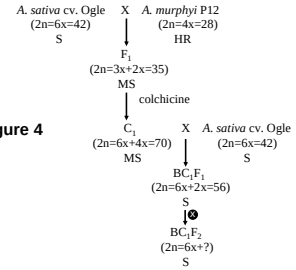
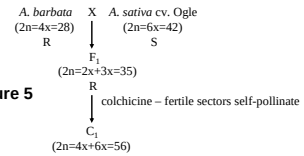


Figure 5



Summary

- Oat crown rust resistance from *A. strigosa* CI6954SP was suppressed in F_1, C_1, and BC_1F_1 plants but segregated free of it in BC_1F_2 and BC_2F_1 plants.
- Suppression specificity of the *A. strigosa* CI6954SP derivative was similar to that of a *Pc38* line in suppressing *Pc94* and *Pc62* and not suppressing *Pc58*; however, it suppressed *Pc63* and *Pc38* resistance and the *Pc38* line did not.
- No suppression was observed in *A. strigosa* PI258731 by *A. sativa* F_1, C_1, and BC_1F_1 plants.
- Suppression of resistance of *A. murphyi* line P12 was encountered in F_1, C_1, BC_1F_1, and BC_1F_2 plants from crosses with *A. sativa cv.* Ogle, and in F_1 plants from crosses of four other *A. murphyi* accessions by five different susceptible *A. sativa* cultivars.
- No suppression of resistance was observed in F_1 plants of several resistant *A. barbata* accessions from crosses to *A. sativa cv*. Ogle.

References

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