Sclerotinia Stem and Head Rot Resistant Germplasm Development Utilizing Interspecific Amphiploids

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Abstract

Based on evaluations over two years, interspecific amphiploids are useful sources of resistance genes for both *Sclerotinia* stem rot and head rot. Interspecific amphiploids between wild perennial *Helianthus gracilentus, H. hirsutus, H. strumosus, H. grosseserratus, H. maximiliani*, and *H. nuttallii*, crossed with P21, plus one intercrossed amphiploid involving *H. divaricatus* and *H. grosseserratus* were evaluated. The results indicated that most amphiploids were more resistant to stem rot and head rot than the tolerant checks HA 410 and HA 441, respectively. The good F_1 seed set between the amphiploids and HA 410 or HA 441 provided a sufficient number of plants for further backcrossing and chromosome reduction toward the 2n=34 of the cultivated sunflower.

Introduction

The inability to control *Sclerotinia,* a major fungal disease in cultivated sunflower, is a major concern of sunflower breeders and pathologists (Gulya et al., 1997). A considerable effort has been devoted to the discovery of resistance genes in wild species and their transfer into the present-day hybrids, which possess insufficient resistance to *Sclerotinia*. Interspecific amphiploids of crosses between wild perennial *Helianthus* species and cultivated line P21 have produced germplasm lines with resistance to the newly evolved race F of *Orobanche* in Spain (Jan and Fernandez-Martinez, 2002). Similarly, these amphiploids, with their good backcross seed set, can quickly be utilized for pyramiding of *Sclerotinia* resistance genes, if they prove to be resistant.

In 2005, seven interspecific amphiploids were evaluated at Fargo, ND and all were highly resistant to *Sclerotinia* stem rot, compared to the tolerant check HA 410 (Jan et al., 2006; Miller and Gulya, 1999). Because of the late flowering of most amphiploids, head rot resistance in the field was only observed in amphiploids of *H nuttallii* x P21. Additional evaluations of head rot resistance were conducted in the greenhouse using artificial inoculation.

In 2006, we evaluated the same amphiploids for resistance to *Sclerotinia* stem rot at Mapleton, ND, and head rot at Fargo using artificial inoculation in the field. Meanwhile, resistant amphiploid plants were crossed to stem rot tolerant HA 410 and head rot tolerant HA 441 to facilitate stem and head rot resistance gene pyramiding, respectively (Miller and Gulya, 1999).

Materials and Methods

Six interspecific amphiploids, *H. gracilentus* 1442 × P21, *H. hirsutus*1126 × P21, *H. strumosus* 30-002-1 × P21, *H. grosseserratus* × P21, *H. maximiliani* × P21*, H. nuttallii* 730 × P21, and one intercrossed amphiploid of *H. divaricatus* 830 × P21 and *H. grosseserratus* × P21 were field evaluated for stem and head rot at Fargo, ND, and Mapleton, ND, in 2006 using the method described by Jan et al., 2006. A single-row plot 16 ft long was replicated twice for each entry, with HA 410 and HA 441 as resistant checks for stem rot and head rot, respectively. Resistant amphiploid plants were transplanted from the field and established in the greenhouse for head rot resistance evaluation, as well as for sib-pollination. Seed set was presented as number of seeds divided by the number of pollinated florets. The chromosome numbers of individual F_1 progeny seedlings were examined in mitotic root tips using the standard Feulgen staining method.

Results and Discussion

Based on two years of evaluation, all amphiploids had more resistance to stem and head rot, than HA 410 and HA 441, respectively (Table 1). For example, segregation of 73 resistant and 1 susceptible plants for stem rot, and 10 resistant and 1 susceptible plants for head rot in amphiploid *H. grosseserratus* × P21 was observed, while the tolerant check HA 410 had 38 resistant and 6 susceptible plants for stem rot, and the tolerant check HA 441 had 8 resistant and 18 susceptible plants for head rot.

Because of the cold fall weather at Fargo, head rot resistance was not observed on some amphiploids that flower late. Selected plants resistant to stem rot or to both stem and head rot were transplanted into the greenhouse for further head rot evaluation, and crossing to HA 410 and HA 441, respectively (Fig. 1). In fact, most of the identified head rot resistance shown in Table 1 was from greenhouse evaluations. The expected F_1 chromosome numbers of 2n=68 and 2n=51 were observed for crosses of hexaploid or tetraploid amphiploids with cultivated lines, respectively (Fig. 2 and 3). Good F_1 seed was produced in almost all amphiploid crosses with either HA 410 or HA 441, due to the ploidy of the wild perennial species.

Currently 46 F_1 plants are in the greenhouse for additional backcrossing to further reduce the chromosome number to 2n=34 before field evaluation of progeny families in replicated tests (Fig. 4). Based on our earlier success of transferring resistance genes from amphiploids for *Orobanche* resistance (Jan and Fernandez-Martinez, 2002), we believe similar results can be achieved by using these amphiploids to develop sunflower germplasms superior to HA 410 and HA 441 for stem rot and head rot resistance, respectively.

Table1. Two-year evaluation of *Sclerotinia* resistance of amphiploids, seed set of amphiploids crossed with HA 410 or HA 441, and the F_1 progeny chromosome numbers.

Parentage	2005-2006	× HA 410		× HA 441			F_1 2n chromosome
	Stem rot R / S	Head rot R / S	Seeds	No. florets	Seeds	No. florets	
H. gracilentus 1442 × P21, 2n=68	15 / 0	-- / --	--	--	--	--	--
H. hirsutus 1126 × P21, 2n=102	48 / 3	-- / --	193	2210	41	860	68, 84
H. strumosus 30-002-1 × P21, 2n=102	49 / 2	0 / 1	755	3800	543	2230	68
H. grosseserratus × P21, 2n=68	73 / 1	10 / 1	165	1818	13	1020	51
H. maximiliani × P21, 2n=68	69 / 1	7 / 0	711	5190	135	2190	51
H. nuttallii 730 × P21, 2n=68	79 / 4	15 / 31	32	2800	11	2140	51
H. divaricatus 830 × P21)× (*H. grosseserratus* × P21), 2n=68	36 / 0	-- / --	835	4620	335	2830	51
Inbred HA 410, 2n=34	38 / 6	4 / 27	--	--	--	--	--
Inbred HA 441, 2n=34	11 / 55	8 / 18	--	--	--	--	--

References

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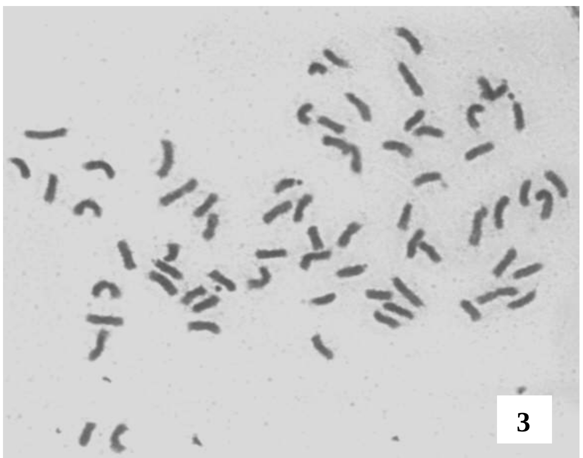

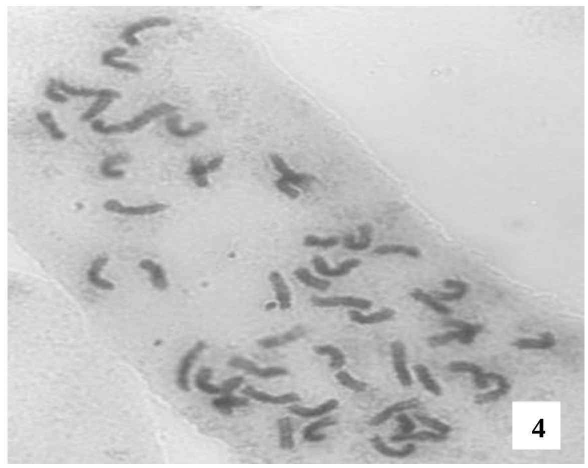

Figure 1. Interspecific amphiploids transplanted from the field grown in the greenhouse

Figure 2. F_1 plants of interspecific amphiploids with HA 410 or HA 441in the greenhouse for backcrossing

Figure 3. Chromosomes of 2n=68 from an F_1 of hexaploid amphiploids with HA 441 (G06/1055)

Figure 4. Chromosomes of 2n=51 from an F_1 of tetraploid amphiploids with HA 441 (G06/1085)