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and

NORTH DAKOTA  
AGRICULTURAL EXPERIMENT STATION  
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**NOTICE OF RELEASE OF HA-BSR2, HA-BSR3, HA-BSR4, AND HA-BSR5,  
OIL SUNFLOWER**

Sclerotinia and downy mildew are two fungal diseases that are major yield limiting factors in global sunflower production. The use of resistant hybrids, where available, is the most efficient means of controlling these diseases. Four sunflower (*Helianthus annuus* L.) germplasms, HA-BSR2, HA-BSR3, HA-BSR4, and HA-BSR5 have been developed to provide diversity for resistance to *Sclerotinia* basal stalk rot (BSR) caused by *Sclerotinia sclerotiorum* (Lib.) de Bary. All germplasms except HA-BSR5 were also resistant to downy mildew caused by *Plasmopara halstedii* (Farl.) Berl. & de Toni. HA-BSR2, HA-BSR3, and HA-BSR4 represent the first germplasms to combine resistance to *Sclerotinia* BSR and downy mildew.

HA-BSR2 is a BC2F5 derived BC2F6 maintainer oilseed sunflower line selected from the cross HA 89/3/HA 458/NMSHA 89/PI 435843. HA 89 (PI 599773) is an inbred maintainer line released by USDA and the Texas Agricultural Experiment Station in 1971. The nuclear male-sterile line NMSHA 89 (PI 559477) was induced by streptomycin treatment of HA 89 that possessed a single recessive nuclear male sterility gene *ms9*, released by the USDA and the North Dakota Agricultural Experiment Station, Fargo, ND in 1990. HA 458 (PI 655009) is a high oleic and downy mildew resistant germplasm (carrying the *Pl17* resistance gene) released by USDA and the North Dakota Agricultural Experiment Station, Fargo, ND in 2010. PI 435843 is an accession of wild annual *Helianthus petiolaris* Nutt. subsp. *fallax* Heiser collected in New Mexico in 1978 and identified as resistant to *Sclerotinia* BSR.

HA-BSR3 to HA-BSR5 are BC2F5 derived BC2F6 maintainer oilseed sunflower lines selected from the cross HA 89/3/HA 458/NMSHA 89/PI 494573. PI 494573 is an accession of wild annual *Helianthus argophyllus* Torrey & Gray collected in Texas in 1985 and identified as resistant to *Sclerotinia* BSR. The remaining parents are described above.

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Sclerotinia BSR screenings for the resistant wild species donor parents, and the early generations of F1, BC1, BC2, and BC2F2 were conducted in the greenhouse under controlled conditions. The selected lines, HA-BSR2, HA-BSR3, HA-BSR4 and HA-BSR5 were tested for resistance to BSR in inoculated field nurseries across seven environments from 2012 to 2015 in North Dakota and Minnesota, and consistently showed high levels of BSR resistance across all environments. Average disease incidence of basal stalk rot for HA-BSR2, HA-BSR3, HA-BSR4 and HA-BSR5 was 4.4, 3.0, 0.8, and 1.9 percent, respectively, compared to an average of 36.1 percent for Cargill 270 (susceptible hybrid check), 31.0 percent for HA 89 (recurrent parent), 19.5 percent for HA 441 (resistant check), and 11.6 percent for Croplan 305 (resistant hybrid check).

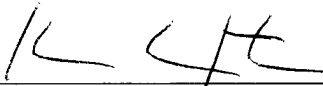
A whole genome scan was performed using a genotyping-by-sequencing approach to detect the presence of *H. petiolaris*, and *H. argophyllus* segments in the highly BSR resistant introgression lines, HA-BSR2, HA-BSR3, HA-BSR4 and HA-BSR5. Polymorphic single nucleotide polymorphism markers revealed the presence of introgressed chromosome segments in HA-BSR2 located on linkage group (LG) 8, HA-BSR3 on LGs 8, 9, 10, and 11, HA-BSR4 on LGs 8 and 10, and HA-BSR5 on LGs 3 and 10. HA-BSR3, HA-BSR4, and HA-BSR5 likely carry different *H. argophyllus* segments associated with BSR resistance.

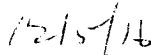
HA-BSR2, HA-BSR3, and HA-BSR4 are also homozygously resistant to downy mildew that was confirmed by greenhouse testing and DNA markers linked to the gene PI17, which was derived from HA 458. However, HA-BSR5 was susceptible to downy mildew. Seed of HA-BSR2 averaged 85.7 percent oleic acid from plants grown in a field nursery at Glyndon, MN during the summer of 2015, while HA-BSR3 averaged 67.1 percent, HA-BSR4 25.0%, and HA-BSR5 23.1 percent.


Plant heights of HA-BSR2, HA-BSR3, HA-BSR4, and HA-BSR5 were 111, 115, 140, and 151cm, respectively compared to 119 and 127 cm, respectively for the parents HA 89 and HA 458. The HA-BSR lines flowered in 74, 77, 74, and 75 days after planting, respectively, compared to 68 days for HA 89 and 72 days for HA 458, all grown in a field nursery at Glyndon, MN during the summer of 2015.

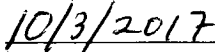
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Signatures:

  
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North Dakota State University

  
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