Crop Protection 92 (2017) 70–78

Contents lists available at ScienceDirect

Crop Protection

journal homepage: www.elsevier.com/locate/cropro

Sources of resistance to *Alternariaster* leaf blight in sunflower pre-breeding lines derived from interspecific crosses and wild *Helianthus* species

M. Santha Lakshmi Prasad*, M. Sujatha, K. Alivelu, K. Sujatha

ICAR - Indian Institute of Oilseeds Research, Rajendranagar, Hyderabad 500 030, India

ARTICLE INFO

Article history:
Received 7 February 2016
Received in revised form
19 October 2016
Accepted 21 October 2016

Keywords:
Alternariaster helianthi
Leaf blight
Pre-breeding lines
Resistance
Sunflower
Wild *Helianthus* species

ABSTRACT

Leaf blight caused by *Alternariaster helianthi* (Hansf.) Tubaki and Nishihara is one of the important diseases of sunflower that causes considerable yield loss. Resistance against leaf blight in the germplasm, parental lines and released sunflower cultivars is rather limited. Hence, screening of sunflower accessions comprised interspecific derivatives, core germplasm, pre-breeding lines, exotic lines and wild *Helianthus* species was carried out under natural field conditions over five years *viz*., 2003 to 2009. Sunflower lines which showed resistance under field conditions were further confirmed under controlled conditions by artificial inoculation with *A. helianthi*. Among interspecific crosses evaluated, pre-breeding lines derived from crosses of cultivated sunflower with wild *H. annuus* (ANN-SF) followed by trispecific crosses of cultivated sunflower with *H. argophyllus*, wild *H. annuus* (ARG-ANN-SF) and cultivated sunflower with *H. argophyllus* (ARG-SF) showed less leaf blight disease under field conditions. The disease severity was greater during 2004–05, 2006–07, 2007–08 and 2009–10 which was favoured by high rainfall, many rainy days and high relative humidity. Six sunflower accessions showed less leaf blight severity. Of three *A. helianthi* isolates tested, *Ah*-112 was found to be highly aggressive causing more than 30% leaf blight severity on all tested cultivars. Among different wild *Helianthus* species tested against leaf blight by detached leaf and whole plant assay techniques, *H. tuberosus* Acc 03, 1705, 08, 07, 15, 2729, *H. maximiliani* Acc 007 and *H. strumosus* Acc 15 recorded <20% leaf blight severity in the whole plant assay method indicating some resistance. Appropriate strategies are being devised to utilize the interspecific accessions and wild *Helianthus* species identified to be moderately resistant to *Alternariaster* leaf blight in the sunflower breeding programmes.

1. Introduction

Sunflower (*Helianthus annuus* L.) is an important oilseed crop and cultivated mainly in Europe, USA, Argentina, India and China. Although an introduced crop, sunflower is a preferred crop for Indian farmers due to its wide adaptability, high yield potential, short duration and profitability. The major diseases limiting cultivation are leaf blight, sunflower necrosis disease, downy mildew and powdery mildew. Leaf blight caused by *Alternariaster helianthi* (Hansf) Tubaki and Nishihara is one of the economically important diseases and reduces the seed yield by 27–80% and oil yield by 17–33% (Allen et al., 1981; Balasubramanyam and Kolte, 1980). Williamson (1979) reported that a severely affected crop produces only 0.1 t/ha yield, compared to the estimated yield potential of 1.25 t/ha. In India, the disease is particularly severe during the rainy season and Hiremath et al. (1990) reported 95–100% disease severity in Northern Karnataka. The pathogen causes brown spots on the leaves, stem, petals, sepals which lead to premature defoliation, stem breakage and death of the plant under severe infection (Anilkumar et al., 1974; Morris et al., 1983). The most affected components due to disease are the number of seeds per head, seed filling, kernel weight and oil content. Cloudy weather, high humidity and drizzling rains can result in severe outbreak and spread of the disease.

* Corresponding author.
E-mail address: santhalakshmib@gmail.com (M. Santha Lakshmi Prasad).

http://dx.doi.org/10.1016/j.cropro.2016.10.010
0261-2194/

Among the various approaches to manage the disease, host plant resistance is the most reliable and economical. Plant breeding efforts to develop cultivars with tolerance or resistance to the major diseases are constrained by the narrow genetic base of sunflower. Being an introduced crop in India the varieties are selections from these introductions. Most studies on breeding for disease resistance have been confined to screening of the available cultivar germplasm against the diseases under natural conditions and hence, these sources could not be converted into agronomically acceptable cultivars. Interspecific hybrids have contributed to the improvement of agronomic traits, disease resistance and oil quality of sunflower (Liu et al., 2009).

Wild *Helianthus* species, interspecific derivatives and exotic germplasm serve as potential sources of novel genetic variability and several desirable characteristics such as resistance to biotic and abiotic stresses; cytoplasmic male sterility, fertility restorer genes and oil quality have been successfully introgressed into cultivated sunflower (Thompson et al., 1981; Seiler, 1992; Skoric, 1992, 1994). Nine perennial species *viz*., *H. maximiliani*, *H. mollis*, *H. divaricatus*, *H. simulans* and *H. occidentalis* (diploids), *H. pauciflorus*, *H. decapetalus* (tetraploids) and *H. resinosus*,*H. tuberosus* (hexaploids) were found to be highly resistant to Alternariaster leaf blight while the annuals were susceptible (Sujatha et al., 1997). Among these, the perennial diploids and hexaploids were selected for the breeding program aimed at introgression of resistance to *A. helianthi*. Seiler (1993) released 12 interspecific germplasm lines derived from perennial accessions of *H. hirsutus*, *H. resinosus* and *H. tuberosus* with reasonably good fertility. Many of these introgressions were aimed at transferring resistance to diseases such as rust, downy mildew, brown stem canker, etc., mostly controlled by single genes. Resistance to leaf blight disease is a quantitative trait and has not received much breeding attention as there were not many major outbreaks of this disease in other major sunflower growing countries. However, this disease is a serious threat to sunflower in India occurring during the rainy season. Among the three moderately resistant and 12 susceptible *Helianthus* taxa, only *H. debilis* sub sp. *silvestris* Heiser and *H. hirsutus* are cross-compatible with *H. annuus* (Rogers et al., 1982). Sources identified include diploid perennials, tetraploids and hexaploids which are cross incompatible with cultivated sunflower. Attempts to exploit hexaploid species (*H. tuberosus*, *H. resinosus*) and diploid perennials (*H. simulans*) through ploidy manipulation met with limited success (Sujatha and Prabakaran, 2006). Efforts to identify new and diverse sources of resistance are important in relation to disease management and resistance breeding. In this study, screening of interspecific derivatives, core germplasm accessions and pre-breeding lines of sunflower for resistance to leaf blight under field conditions for five years and evaluation of promising lines under glass house conditions are presented and discussed. Since levels of resistance to leaf blight in the cultivated sunflower are low to moderate, it is important to identify wild *Helianthus* species with high levels of resistance for utilization in crop improvement and hence, wild *Helianthus* species were evaluated against leaf blight under *in vitro* and *in vivo* conditions.

2. Materials and methods

2.1. Evaluation of interspecific crosses under field conditions

To study the variability and levels of resistance available in interspecific crosses of cultivated sunflower against leaf blight, field screening was carried out at the research farm of the ICAR-Indian Institute of Oilseeds Research (IIOR), Rajendranagar, Hyderabad (17° 25′ 27″ N & 78° 35′ 4″ E) during the rainy seasons of five years *viz*., 2003–04, 2004–05, 2006–07, 2007–08 and 2009–10. Diverse pre-breeding sunflower lines from different interspecific cross combinations *viz*., *Helianthus argophyllus* × cultivated sunflower designated as ARG-SF, *H. petiolaris* × cultivated sunflower as PET-SF; *H. annuus* (wild) × cultivated sunflower as ANN-SF, *H. argophyllus* × *H. annuus* (wild) × cultivated sunflower as ARG-ANN-SF; cultivated sunflower × *H. occidentalis* as SF-OCC and cultivated sunflower × *H. debilis* as SF-DEB were used in the study. Along with these, a few physiologically superior lines (designated as PS) and exotic lines (EC) were also tested (Table 1). Pre-breeding lines that included 213 lines in 2003–04; 245 lines in 2004–05; 221 lines during 2006–07 and 74 lines during 2007-08 were evaluated against leaf blight under natural field conditions. During 2003–04, little infection of leaf blight occurred on most of pre-breeding accessions as compared to the other years with low rainfall and fewer rainy days/week during end of September to October which was not conducive for natural development of leaf blight. During 2009–10, 240 accessions were evaluated against leaf blight at IIOR,

Table 1
Number of pre-breeding lines screened against *Alternariaster* leaf blight under field conditions and artificial inoculation conditions over the years (2003–04 to 2010–11).

Pre- breeding lines	Field conditions(Hyderabad, Andhra Pradesh)				Field conditions (2009–10)	
	2003–04	2004–05	2006–07	2007–08	Hyderabad	Dharwad, Karnataka
ARG-SF[a]	76[b]	67	65	8		
PET-SF	49	46	39	9		
ANN-SF	14	22	13	11		
ARG-ANN-SF	43	74	49	6		
SF-DEB	16	17	19	16		
SF-OCC	0	0	17	17		
PS lines	15	15	15	3		
Ec lines	0	4	4	4		
Interspecific crosses	–	–	–	–	240	284

	Detached leaf technique[c]		Whole plant assay technique			
	2005–06	2008–09	2006–07	2007–08	2009–10	2010–11
Interspecific crosses	93	35	21	56	65	24
Wild *Helianthus* species	41		41			

[a] ANN-SF: *H. annuus* (wild) × cultivated sunflower; ARG-ANN-SF: *H. argophyllus* × *H. annuus* (wild) × cultivated sunflower; ARG-SF: *H. argophyllus* × cultivated sunflower; PET-SF: *H. petiolaris* × cultivated sunflower; SF-OCC: cultivated sunflower × H. *occidentalis*; SF-DEB: cultivated sunflower × *H. debilis*; PS lines: Physiologically superior lines; EC lines: Exotic lines.
[b] Number of lines in each cross combination tested during that year.
[c] Artificial screening techniques used for evaluation under green house conditions.