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Identification of the Downy Mildew Resistant Sources in Sunflower

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Short Communication

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ABSTRACT

Four different evaluation trials were conducted in the field between 2017 and 2020, with varied numbers of genotypes, to evaluate the performance of sunflower genotypes for agromorphological features and resistance to Sunflower Downy Mildew (SDM) at Latur, Maharashtra, India. A validation experiment was carried out in 2021–2022, using artificial screening in National Diseased Plot Screening Facility at Latur, to screen a small number of accessions that had previously shown resistance to SDM during 2017-2020. The released variety "Morden," also susceptible check showed at least 60% of the SDM incidence for four years. This suggests that *Plasmopara halstedii* spores could be present in the experimental soils, which increases the variety's susceptibility to SDM disease. Out of the tree genotypes that were reported to be resistant in field screening *viz*., GMU-481 (GP1 909 genotype), Ec-198078, and RHA 1-1 (selection) only two GMU-481 (GP1 909)

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and Ec-198078 were verified to be resistant under artificial screening in 2021–2022 and can be designated as sources of resistance for SDM disease. These two genotypes with resistance to SDM could be used in future breeding attempts and as potential gene donors for SDM.

Keywords: Sunflower; screening; sunflower downy mildew; resistance; donor.

1. INTRODUCTION

The cultivated sunflower (*Helianthus annuus* L.) is one of the most important oilseed crop in the world after soybean, rapeseed-mustard and groundnut [1]. Sunflower Downy Mildew (SDM) was a devastating disease that caused yield losses of up to 100% in the state of Maharashtra, particularly in the Marathwada region, since the introduction of the sunflower crop in India [2]. Researchers discovered in the late 1980s that *Plasmopara halstedii* (Farlow) Berlese and de Toni are the fungus that induces SDM disease [3,4]. Nearly all of the Indian states that grow sunflowers Andhra Pradesh, Karnataka, Maharashtra, Telangana, Tamil Nadu, and Punjab are now reporting cases of the disease spread [5,2], which results in 5–80% yield losses [6,7,3,8,2]. To improve the SDM resistant breeding program in India, a crucial first step is the systematic artificial screening and identification of suitable donor sources. Hence the objectives of the present investigation was to identify the resistant sunflower gernotype with '0' incidence of SDM through filed and artificial screening.

2. MATERIALS AND METHODS

Four distinct evaluation trials with varying numbers of genotypes in the field between 2017 and 2020 were undertaken during *kharif* season to assess the performance of the sunflower genotypes for both agromorphological traits and Sunflower Downy Mildew (SDM) resistance/tolerance at Latur. Maharashtra, India (170 35' to 200 40' N latitude and 740 40' to 780 16' E longitude). The trial site has black cotton soils with an average rainfall of 750–800 mm. Two replications of the field evaluation trial were carried out in RBD every year. The germplasm evaluation trial was planted in 4-meter rows each year, with 12–15 plants per row. In addition to several agromorphological traits, the genotypes' performance was evaluated for resistance to Sunflower Downy Mildew (SDM) under field condition. The observations on SDM incidence were recorded from 30 days to up to 60 days after sowing by counting infected seedlings with SDM incidence. All the plants in each entry were scored for SDM incidence. Finally, mean disease incidence percentage from all the replications was calculated for each test entry according to Shirshikar [9]. In 2021–2022, a validation experiment was conducted under artificial screening to screen a small number of accessions that were already resistant to SDM [10]. The National Diseased Plot Screening Facility in Latur, Maharashtra, India is accessible for screening breeding material for SDM resistance or tolerance [5,2]. Sunflower downy mildew is a soil-borne disease, and spread through seeds, soil, and plant debris [3]. *Plasmopara halstedii* race-100 pathogen is often observed in the center's experiment site; as a result, infected plants can be seen at the Oilseeds Research Station, Latur, during conduction of trials or in sunflower growing plots. In all the years released variety 'Morden' and highly susceptible check for SDM screening was used [2,10] for the SDM incidence under field condition and under artificial screening. Therefore, information gathered at Latur centre from field screening will help to identify genotypes that are resistant or tolerant of SDM.

3. RESULTS AND DUSCUSSION

It is routine practice to systematically assess the germpalsm accessions for agromorphological and other commercially important traits. In all the four years four separate evaluation trials with various numbers of genotypes were conducted (Table 1). The greatest number of genotypes (70) were used for the evaluation in 2019, with the next most used years being 2018 (65), and 2017 (40). Out of the genotypes evaluated under field conditions, nine genotypes with zero incidence during the year 2017 and 2020 were recorded, respectively. On the other hand, in all, 8 genotypes of the evaluated sunflower were shown to have 0 incidence of SDM over 2018 and 2019. Results of the SDM screening and evaluation conducted between years 2017 to 2020 are not disclosed/unpublished. The results of a validation experiment conducted in 2021–2022 to screen SDM resistant accessions under artificial screening were validated by our group [10].

Table 1. Assessment of the genotypes of sunflowers in the field and artificial screening and results for *Plasmopara halstedii* race 100

Sr. No.	Year of evaluation	No. of genotypes evaluated under field condition	Field evaluation location/s	Range of the SDM incidence under field evaluation (%)	Artificial screening results	Total number and list of the few genotypes with '0' incidence of SDM	Incidence of SDM in the Susceptible check "Morden" (%)	Published/ Unpublished data
1	2017	40	Latur	0-95	Not available	(9) RHA-1-1 (selection), EC-601951, LTRR-341, **EC-198078,** GMU 494, GMU-78, **GMU-481**	62	Unpublished
2	2018	65	Latur	0-90	Not available	(8) EC-601951 RHA-1-1 (selection), LTRR-341, **EC-198078,** GMU 494, **GMU-481**	60	Unpublished
3	2019	70	Latur	0-85	Not available	(8) RHA-1-1 (selection), LTRR-341, **EC-198078**, **GMU-481**	71	Unpublished
4	2020	34	Latur	0-90	Not available	(9) RHA-1-1 (selection), GMU-770, EC-399512, **EC-198078**, **GMU-481**	68	Unpublished
5	2021-22	28	Latur, Akola, Solapur IIOR, Hyderabad	0-100	National Screening Facility (diseased plot) at Latur	RHA-1-1 EC-399512 EC-178168-2 EC-601901 **EC-198078** GMU-770 **GMU-481** LTRR-341 GMU-841 GMU-494	100 (Artificial screening)	Published Dudhe et al., [10]

Range of the SDM incidence per cent under the validation experiment conducted during 2021-22 was 0-100 % while under the field condition 0-85% during 2019. In the released variety "Morden," which is extremely susceptible to SDM screening indicates the presence of *Plasmopara halstedii* in the experimental soils, as minimum of 60% of the SDM incidence is reported in all the years (Table 1). It is important to notice that in every year with zero incidence of SDM, among GMU-481 (GP1 909), Ec-198078 and RHA 1-1 (selection) were recorded. RHA 1-1 (selection) is the parental line/ male line (RHA 1-1) of the LSFH 171 released hybrid from Latur centre for all India cultivation. In terms of height, maturity, seed size, and leaf color variation, it deviates from the parental line. The Latur center received both genotypes *viz*., GMU-481 (GP1 909) and Ec-198078 from the Indian Institute of Oilseeds Research (ICAR-IIOR) Rajendranagar, Hyderabad, Telangana, India.

RHA 1-1 (selection) was not used as test genotype under artificial screening during 2021–2022 but under all the four years it was recorded '0' incidence (complete absence of the disease) under field conditions. Of the 28 genotypes screened for SDM resistance, these two lines (GMU-481 and Ec-198078) demonstrated '0' incidence (complete absence of the disease) for the SDM during the validation experiment conducted under the artificial screening [10]. Because of this, these two genotypes namely GMU-481 and Ec-198078 possess genes that are resistant to SDM and the innate ability to tolerate the high pressure of disease that is imposed by artificial screening. Our findings corroborate those from the SDM screening conducted at ORS, Latur, Maharashtra [5,2,10]. These two genotypes that exhibit resistance to SDM may serve as prospective gene donors for SDM and may be employed in further sunflower SDM resistance breeding.

4. CONCLUSION

In conclusion two genotypes *viz.,* GMU-481 and Ec-198078 have been found as resistant to SDM with '0' incidence based on results from a multiyear field screening and through artificial screening. These two resistant accessions identified for SDM could be utilized for the development of resistant genotypes as well as for the development of the resistant inbred lines for further utilization in sunflower breeding under semi-arid conditions.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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