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Research Note

Evaluation of sunflower diversified Cytoplasmic Male Sterile lines and their hybrids for resistance to powdery mildew [*Erysiphe cichoracearum* DC.]

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Abstract
Sunflower (*Helianthus annuus* L.) is one of the important oil seed crops both in tropical and subtropical regions. Powdery mildew is a serious problem on the crop. Use of resistant hybrids is the best way for the management of the disease. In the field screening of 90 hybrids along with parents to powdery mildew, it was found that three parental lines *viz.*, CMS E 002-92 (6.67%), R-5 (10.00%) and R-77-2 III (10.00%) as resistant, while other four parents *viz.*, CMS E 002-91 (13.33%), CMS AGR-6 (16.67%), CMS-PRUN 29 (18.33%) and R-393 Br (12.67%) as moderately resistant to the disease. Among the hybrids, none of them were resistant to powdery mildew. However three hybrids CMS DV-10 x R-393Br, CMS DV-10 x R-5 and (77A x 72B) x (R-393Br) were found moderately resistant to disease. Remaining six parental lines and 31 hybrids showed moderate susceptibility.

Key words:
Sunflower, diversified CMS, powdery mildew, resistance

Sunflower (*Helianthus annuus* L.) is one of the important oil seed crops and rapidly gaining importance in the present agricultural scenario. The full potential of the crop is yet to be exploited, which depends largely on the biotic and abiotic factors. The main biotic factors that affect the crop growth are *Alternaria* leaf blight, sunflower necrosis, powdery mildew and rust. Among these, *Alternaria* blight and powdery mildew are serious diseases in many parts of India. Karnataka is the leading state in the country contributing 53 and 35 per cent of total area and production respectively. Sunflower is the second important oil seed crop after groundnut in the state with an area of 1.03 m ha, a production of 0.59 m tones, and productivity of 571 kg/ha (Anon., 2007).
Powdery mildew (*Erysiphe chicoracearum* D C.**)** is the widely distributed pathogen on cultivated sunflower in warmer regions of the world (Zimmer and Hoes, 1978), but is seldom severe enough to warrant the fungicide applications in temperate climates (Gulya *et al*., 1997). Due to powdery mildew caused by *Erysiphae cichoracearam* on sunflower, the seed yield reported to be reduced by as much as 70 per cent with significant reduction in oil quantity (17%) and quality (33%) (Kolte,1990). It can occur on leaves, petiole, and stem and even on flower bracts. An anthesis, the crop is highly susceptible to powdery mildew.

The management of disease through host plant resistance is an ideal choice in all crop improvement programs. Therefore, identification and development of resistant genotypes/ hybrids is essential either to recommend directly for cultivation in endemic areas or to use as the donors of resistant genes. In Karnataka, Raichur is considered as the hot spot for powdery mildew disease especially during late *kharif* and *rabi* seasons favoring initiation and development of disease. Hence, experimental work has been initiated to screen available CMS lines and hybrids identify the resistance/tolerance to powdery mildew disease.

The experimental materials consisted of ten CMS lines, nine inbreds and 90 hybrids along with two checks *viz.,* RSFH-130 and KBSH-1were evaluated in Line x Tester design during *rabi*-summer 2008-09. The experiment was carried out at Main Agricultural Research Station, Raichur and each hybrid was sown with two rows in a plot having 3 m length and checks were sown after every ten hybrids.

Five plants in each entry were randomly selected for observation of powdery mildew disease at fifty per cent seed filling stage by using 0–5 scale and Percent Disease Index (PDI) was calculated by using the

formula given by Wheeler (1969). After calculating PDI, the entries were grouped into different categories.

Scale (0 – 5)	Per cent infection	Grade	Status
1	0	0	Immune
2	1-10 %	I	Resistant
3	11-25 %	II	Moderately resistant
4	26-50 %	III	Moderately susceptible
5	51-75 %	IV	Susceptible
6	>75 %	V	Highly susceptible

The use of fungicides has become an inevitable method of controlling the disease in the absence of resistant cultivars. All the hybrids and parents were included for evaluation against powdery mildew in field under natural epiphytotic conditions. Out of 90 hybrids along with parents, it was found that three parental lines CMS E 002-92 (6.67%), R-5 (10.00%) and R-77-2 III (10.00%) as resistant while other four parental lines CMS E 002-91 (13.33%), CMS ARG-6 (16.67%), CMS-PRUN 29 (18.33%) and R-393 Br (12.67%) as moderately resistant to the disease. However, none of the hybrids was resistant to powdery mildew.

Three hybrids CMS DV-10 x R-393Br, CMS DV-10 x R-5 and (77A x 72B) x (R-393Br) showed moderately resistant reaction to this disease. Remaining six parents and 31 hybrids showed moderate susceptibility and six parents and 45 hybrids exhibited susceptible reaction and eleven hybrids showed highly susceptible reaction to powdery mildew disease.

In the results and discussion, the results of this study might be justified or discussed by quoting some supporting inferences.

In the evaluation of 90 hybrids, obtained by crossing ten CMS lines and nine inbred lines, only three hybrids found to be moderately resistant to powdery mildew and none was found to be resistant. Hence it is necessary to use more number of diverse CMS lines and other inbred lines in the crossing programme to obtain more number of resistant hybrids. The identified resistant lines needs further confirmation of their resistance in the subsequent seasons before using in the breeding programme.

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Table 1. Diversified CMS lines and inbred lines used in crossing programme

Sl.No	CMS line	Origin	Inbreds/ Restorers
1.	CMS E 002-91 (A-1)	*Helianthus annuus*	R-393 Br (R-1)
2.	CMS E 002-92 (A-2)	*Helianthus annuus*	R-8297 (R-2)
3.	CMS- ARG-2 (A-3)	*Helianthus argophyllus*	R3-Br (R-3)
4.	CMS-X (A-4)	*Helianthus annuus*	R-127 (R-4)
5.	CMS- ARG-6 (A-5)	*Helianthus argophyllus*	R-27Br (R-5)
6.	CMS DV-10 (A-6)	*Helianthus debilis spp. vertitus*	R-5 (R-6)
7.	CMS-PRUN 29 (A-7)	*Helianthus praecox spp. runyonii*	R-272 (R-7)
8.	CMS PKUZ (A-8)	*Helianthus annuus*	R-77-2III (R-8)
9.	CMS PHIR-27 (A-9)	*Helianthus praecox spp. hirsutus*	275Br (R-9)
10.	77A x 72B (A-10)	*Helianthus annuus*	

Table 2. Categorization of sunflower germplasm lines based on the reaction against *Erysiphe Cichoracearum*

Reaction	Grade	Parents, hybrids and checks
Immune (0)	0	Nil
Resistant (1-10%)	I	Lines:- A-2 Testers:- R-6, R-8 Checks:- - Hybrids:- -
Moderately Resistant (11-25%)	II	Lines:- A-1, A-5, A-7 Testers:- R-1 Checks:- - Hybrids:- A-6 x R-1, A-6 x R-6, A-10 x R-1. **Total : 3 hybrids**
Moderately Susceptible (26-50%)	III	Lines:- A-3, A-6, A-8, A-9 Testers:- R-2, R-9 Checks:- RSFH-130 Hybrids:- A-1 x R-5, A-1 x R-6, A-1 x R-9, A-2 x R-1, A-2 x R-4, A-2 x R-5, A-2 x R-7, A-2 x R-8, A-2 x R-9, A-3 x R-1, A-3 x R-5, A-4 x R-4, A-5 x R-1, A-5 x R-5, A-5 x R-6, A-5 x R-8, A-5 x R-9, A-6 x R-3, A-6 x R-4, A-6 x R-5, A-6 x R-9, A-7 x R-1, A-7 x R-5, A-7 x R-9, A-8 x R-5, A-8 x R-8, A-10 x R-5, A-10 x R-6, A-10 x R-7, A-10 x R-8, A-10 x R-9. **Total : 31 hybrids**
Susceptible (51-75%)	IV	Lines:- A-4, A-10 Testers:- R-3, R-4, R-5, R-7 Checks:- KBSH-1 Hybrids:- A-1 x R-1, A-1 x R-2, A-1 x R-3, A-1 x R-4, A-1 x R-7, A-1 x R-8, A-2 x R-2, A-2 x R-3, A-2 x R-6, A-3 x R-2, A-3 x R-3, A-3 x R-4, A-3 x R-6, A-3 x R-7, A-3 x R-8, A-3 x R-9, A-4 x R-3, A-4 x R-5, A-4 x R-7, A-4 x R-9, A-5 x R-2, A-5 x R-7, A-6 x R-2, A-6 x R-7, A-6 x R-8, A-7 x R-2, A-7 x R-3, A-7 x R-4, A-7 x R-6, A-7 x R-7, A-7 x R-8, A-8 x R-1, A-8 x R-3, A-8 x R-4, A-8 x R-6, A-8 x R-7, A-8 x R-9, A-9 x R-1, A-9 x R-2, A-9 x R-5, A-9 x R-6, A-9 x R-8, A-10 x R-2, A-10 x R-3, A-10 x R-4. **Total : 45 hybrids**

Table 2. Contd..

Reaction	Grade	Parents, hybrids and checks
Highly Susceptible (>75%)	V	Lines:- - Testers:- - Checks:- - Hybrids:- A-4 x R-1, A-4 x R-2, A-4 x R-6, A-4 x R-8, A-5 x R-3, A-5 x R-4, A-8 x R-2, A-9 x R-3, A-9 x R-4, A-9 xR-7, A-9 x R-9. **Total : 11 hybrids**

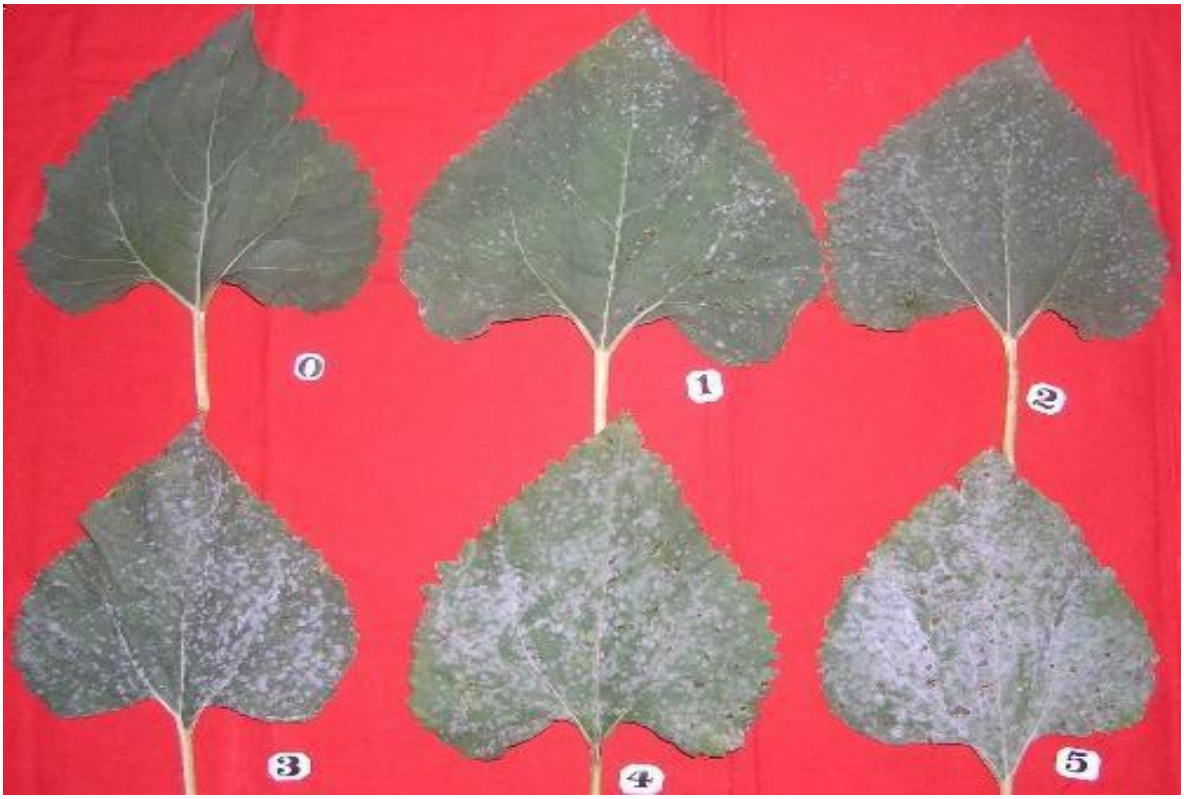

Fig. 1. Photograph showing the scale used for grading powdery mildew