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Reaction of CMS, restorer lines and hybrids of sunflower to *Alternaria helianthi*

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Tolerant reaction for Alternaria leaf blight has been observed in hybrid CMS 17A x RHA-857 and KBSH-44. Among lines, FMS R265A and restorer lines 6-D-1 and RHA-274 shown high degree of susceptibility with grades of 9 and remaining parents shown susceptible reaction with grade of 7 or 8. It indicates that it is possible to synthesize hybrids with reasonable degree of tolerance by involving susceptible parents also. The extent of resistance however, can be enhanced when allelic differences exist between parents and by subjecting above crosses to recurrent selection. The high yielding hybrids CMS 17A x 6-D-1P#2 and CMS 234A x 6-D-1P#2 exhibited some degree of tolerant reaction. Based on disease severity, CMS 17A x RHA-857, CMS 234A x 6-D-1P#2 and CMS 302A x VI-34 were termed as slow blighters, whereas hybrids, CMS 234A x VI-34, CMS 234A x 6-D-1, CMS 234A x VI-66, CMS 302A x R-16 and CMS 302A x V-20 could be termed as intermediate blighters.

Key words : Sunflower, PDI, AUDPC, Slow blighters

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INTRODUCTION

Sunflower has emerged as a competitive oilseed crop on account of its wide adaptabilities, high productivity, short duration, remunerative market price and excellent nutritional properties. Despite the rapid spread of the crop disheartening trend is that, the productivity is going down in recent years. The full potential of the crop is far from being exploited and the yield levels of the country (549 kg/ha) are the lowest in the world due to several biotic and abiotic factors. Among the several biotic limiting factors for sunflower production, susceptibility to diseases is one of the major constraints. Among these, Alternaria leaf blight caused by *Alternaria helianthi* (Hansf.) Tubaki and Nishihara has been considered as a potentially destructive disease in many parts of the sunflower growing countries (Allen *et al.*, 1983, Morris *et al.*, 1983). In India, the disease is particularly severe during the rainy season and is known to cause reduction in flower size, number of seeds per head, seed yield per plant, seed weight and oil content (Balasubrahmanyam and Kolte, 1980). The loss in yield varies from 11.30 to 73.33 per cent depending on the extent of infection (Reddy and Gupta, 1977). In Northern Karnataka, Alternaria leaf blight is known to cause more than 80 per cent of the yield loss under severe epiphytotic conditions (Hiremath *et al.*, 1990). There is no resistant source identified for Alternaria disease so far and no hybrid is released for Alternaria resistance. Breeding for resistance to *Alternaria* leaf spot faces the challenge of a gene pool containing only moderate levels of resistance. There is a strong need to screen the genotypes against *Alternaria* isolates of this geographical region and identify potential hybrid with genes for resistance/ tolerance to *Alternaria helianthi*.

RESEARCH METHODOLOGY

The base material for this investigation consisted of six cytoplasmic male sterile lines (CMS) and ten promising restorer lines. The six CMS *viz.*, CMS 302A, CMS 607A, 852A x NDOL2, CMS 17A, CMS 234A and FMS R265A were used for hybrid development with ten restorer lines *viz.*, RHA-857, RHA-274, 6-D-1, 6-D-1P#2, VI-66, VI-34, V-20, R-16, R-298 (Br) and R-298 (NB) in the L × T mating design. Sixty crosses along with their parents and checks were grown at MARS, Dharwad University Campus in the *Kharif* 2009-2010. Each plot consisted of three rows of 3m length in a randomized complete block design with three replications. The total rainfall of the Research Station was 1140.4 mm in 69 rainy days and an average relative humidity was 81.14 per cent. In July month recorded highest rainfall of about 256.8mm, during September and October about 229 and 141mm rainfall was recorded which is coincide with flowering stage and seed filling stage. The alternaria leaf blight disease intensity was recorded from five plants as per scale of Mayee and Datar (1986) at 50, 60, 70 and 80 days after sowing. The genotypes were classified using average of all scores into six groups given by Nagaraju *et al.* (1992).

Further, these observations were converted to per cent disease incidence (PDI) using following formula given by Wheeler (1969).

$$\text{PDI} = \frac{\text{Sum of disease rating}}{\text{Number of plants rated}} \times \frac{100}{\text{highest rating}}$$

The rate of development of disease (r) at different intervals was also calculated by following formula given by Van der plank (1963).

$$r = \frac{2.3}{t_2 - t_1}\left[\log\frac{X_2}{1 - X_2} - \log\frac{X_2}{1 - X_2}\right]$$

where,

r = Apparent rate of infection or spread

X_1 = Per cent disease index at time t_1

X_2 = Per cent disease index at time t_2

t_2-t_1 = Time interval in days between the two consecutive observations

Using the PDI obtained at ten days for each genotype, the (AUDPC) area under disease progression curve was also calculated using the formula given by Wilcoxson *et al*. (1975).

$$\text{AUDPC} = \sum_{i=1}^{k} 1/2\,(S_i + S_{i-1}) \times (T_i - T_{i-1})$$

where,

S_i = severity at the end of time i,

k = Number of successive evaluation

T_i-T_{i-1} = Constant time interval (10 days)

RESEARCH FINDINGS AND ANALYSIS

The findings of the present as well as relevant discussion have been presented under following heads:

Variability for PDI among hybrids and parents during crop growth :

The mean sums of squares due to genotypes differed significantly for ALB at all stages of crop growth. The variance due to parents was highly significant at 50, 60 and 70 DAS but it was non significant at 80 DAS. The variance due to female parents (lines) and variance due male parents (testers) were highly significant for ALB at all stages except at 80 DAS. The hybrids differed significantly for Alternaria blight at all stages of crop growth.

Disease scoring of parents and hybrids against ALB :

The incidence of Alternaria leaf blight was observed to be severe on parents and some of hybrids recorded 9 grade (Data not shown). All the lines and testers were found to be highly susceptible with grade 9 for the incidence of Alternaria leaf blight. Out of 60 hybrids evaluated, none of the hybrids were found resistant for ALB. While, hybrid CMS 17A x RHA-857 recorded 7 grade which is susceptible. All of hybrids recorded 8 and 9 grade at maturity stage (80 DAS). However, at flowering stage (60 DAS) hybrids CMS 17A x RHA-857 (3 grade), CMS 302A x VI-34 and checks KBSH-53, RSFH-130, KBSH-44 showed tolerance (4 grade) for ALB. Among parents, CMS 607A and R-298(NB) were found to be moderately tolerance with 6 and 5 grades.

Disease severity (PDI) of Alternaria leaf spot at 10 days interval:

In pre flowering stage (50 DAS), disease was noticed in all hybrids, parents and checks (Table 1). The highest PDI was noticed in hybrid FMS R265A x 6-D-1P#2 (34.29). The lowest PDI was recorded by hybrid CMS 17A x RHA-857 (13.06) followed by CMS 17A x R-16 (16.56) and CMS 17A x RHA-274 (16.56). At flowering stage (60 DAS), minimum PDI of 21.33 per cent was noticed in hybrid CMS 17A x RHA-857 followed by 28.67 per cent by hybrids CMS 17A x 6-D-1P#2 and CMS 302A x R-16 whereas high yielding hybrid CMS 17A x R-16 recorded 33.52 per cent. The maximum PDI was noticed in hybrid FMS R265A x 6-D-1 (60%) and FMS R265A x VI-34 (60%). At 70 DAS, the range of PDI in hybrids was from 51.19 per cent (CMS 17A x RHA-857) to 96.30 per cent (FMS R265A x VI-34). At maturity stage (80 DAS), least PDI was recorded by hybrid CMS 17A x RHA-857, CMS 234A x 6-D-1P#2 (85.19%) and highest was 98.51 per cent in CMS 607A x 6-D-1P#2. In majority of hybrids terminal disease severity of Alternaria leaf blight was more than 90.00 per cent. In general the genotypes with a low initial disease incidence invariably ended up with a low terminal disease severity in genotypes CMS 17A x RHA-857, CMS 234A x 6-D-1P#2, CMS 17A x R-16, CMS 17A x 6-D-1P#2 and CMS 302A x R-16.

Apparent rate of infection (r) and area under disease progress curve (AUDPC) :

The rate of apparent infection in hybrids revealed a wide variation among the different hybrids and parents at different intervals (Table 2). Among, the hybrids tested, the highest average ‘r’ value was observed in the hybrids CMS 607A x 6-D-1P#2, FMS R265A x RHA-857 and FMS R265A x V-20 (0.17). The least average ‘r’ value was recorded by hybrid CMS 234A

Table 1: Disease severity (PDI) of Alternaria leaf blight at 10 days interval in sunflower hybrids

Sr. No.	Crosses	50 DAS	60DAS	70DAS	80DAS
1.	CMS 302A x RHA-857	22.00	41.05	81.79	96.30
2.	CMS 302A x 6-D-1	22.00	41.05	76.01	96.30
3.	CMS 302A x R 298 (Br)	23.00	36.76	78.48	92.59
4.	CMS 302A x RHA-274	26.00	54.29	92.59	97.77
5.	CMS 302A x VI-66	23.00	38.10	80.86	92.59
6.	CMS 302A x VI-34	24.00	41.62	79.59	85.19
7.	CMS 302A x R-16	20.00	28.67	70.24	88.89
8.	CMS 302A x V-20	20.78	42.95	79.32	88.89
9.	CMS 302A x 6-D-1P#2	21.00	41.43	78.40	92.59
10.	CMS 302A x R-298(NB)	24.00	54.29	90.12	96.30
11.	CMS 607A x RHA-857	24.00	50.48	85.19	96.30
12.	CMS 607A x 6-D-1	21.00	44.29	83.25	92.59
13.	CMS 607A x R 298 (Br)	29.57	42.38	80.78	98.14
14.	CMS 607A x RHA-274	25.00	48.10	79.50	92.59
15.	CMS 607A x VI-66	23.00	46.19	86.73	96.30
16.	CMS 607A x VI-34	26.00	46.19	86.73	96.30
17.	CMS 607A x R-16	20.00	30.00	73.46	92.59
18.	CMS 607A x V-20	24.00	44.29	80.78	97.77
19.	CMS 607A x 6-D-1P#2	25.00	50.00	95.06	98.51
20.	CMS 607A x R-298(NB)	30.00	56.19	92.59	96.30
21.	FMS R265A x RHA-857	25.00	50.00	86.73	98.14
22.	FMS R265A x 6-D-1	30.00	60.00	79.50	92.59
23.	FMS R265A x R 298 (Br)	26.00	56.19	90.12	96.30
24.	FMS R265A x RHA-274	25.00	50.00	89.29	96.30
25.	FMS R265A x VI-66	22.78	48.67	89.29	92.59
26.	FMS R265A x VI-34	30.00	60.00	96.30	96.29
27.	FMS R265A x R-16	25.00	48.10	86.73	92.59
28.	FMS R265A x V-20	22.78	48.67	89.29	98.14
29.	FMS R265A x 6-D-1P#2	34.29	51.30	86.73	97.77
30.	FMS R265A x R-298(NB)	25.00	50.00	85.19	92.59
31.	(852A x NDOL2) x RHA-857	25.00	46.19	86.73	92.59
32.	(852A x NDOL2) x 6-D-1	22.78	42.38	87.65	97.77
33.	(852A x NDOL2) x R 298 (Br)	23.00	48.10	86.73	92.59
34.	(852A x NDOL2) x RHA-274	23.00	44.29	84.26	96.30
35.	(852A x NDOL2) x VI-66	25.00	46.19	87.65	92.59
36.	(852A x NDOL2) x VI-34	23.00	46.19	84.26	92.59
37.	(852A x NDOL2) x R-16	22.78	38.67	78.48	96.30
38.	(852A x NDOL2) x V-20	26.00	46.19	84.26	98.14
39.	(852A x NDOL2) x 6-D-1P#2	22.00	42.38	81.79	96.30
40.	(852A x NDOL2) x R-298(NB)	26.00	52.38	73.63	88.89
41.	CMS 17A x RHA-857	13.06	21.33	51.19	85.19
42.	CMS 17A x 6-D-1	20.00	36.19	84.35	92.59
43.	CMS 17A x R 298 (Br)	23.00	41.43	79.50	88.89
44.	CMS 17A x RHA-274	16.56	41.62	76.10	88.89

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45.	CMS 17A x VI-66	21.00	36.19	84.26	92.59
46.	CMS 17A x VI-34	21.00	42.38	76.01	92.59
47.	CMS 17A x R-16	16.56	33.52	79.50	92.59
48.	CMS 17A x V-20	18.78	34.86	72.62	92.59
49.	CMS 17A x 6-D-1P#2	20.00	28.67	84.35	92.59
50.	CMS 17A x R-298(NB)	21.00	36.19	76.01	92.59
51.	CMS 234A x RHA-857	26.00	54.29	90.12	96.29
52.	CMS 234A x 6-D-1	21.00	42.38	78.40	92.59
53.	CMS 234A x R 298 (Br)	25.00	45.24	89.20	98.14
54.	CMS 234A x RHA-274	25.00	48.10	84.35	97.77
55.	CMS 234A x VI-66	22.00	42.38	78.40	92.59
56.	CMS 234A x VI-34	20.56	46.76	79.50	92.59
57.	CMS 234A x R-16	22.78	44.29	81.88	96.29
58.	CMS 234A x V-20	26.00	56.19	95.06	97.53
59.	CMS 234A x 6-D-1P#2	21.00	40.48	78.40	85.19
60.	CMS 234A x R-298(NB)	26.00	52.38	87.65	96.29
	S.E.	2.16	5.65	4.81	1.48
	C.D. (P=0.05)	6.02	15.75	13.40	4.12

x 6-D-1P#2 (0.10) followed by CMS 17A x R-298(Br) and CMS 302A x VI-34 (0.11). The crosses involving female parent FMS R265A recorded higher average 'r' value while, the crosses involving line CMS 17A recorded lower 'r' value. Among parents, the highest average 'r' value recorded in 6-D-1 and RHA-274 (0.20) and the lowest was noticed in R-298(NB) (0.13). Among checks, KBSH-53 and KBSH-1 recorded least (0.10) average 'r' value, while, KBSH-44 recorded higher (0.12) average 'r' value.

The AUDPC values differed considerably for different genotypes. In hybrids, the highest AUDPC value was observed in FMS R265A x 6-D-1 (1800.00) followed by FMS R265A x VI-34 (1744.40) and CMS 234A x V-20 (1731.56) and least was observed in hybrid CMS 17A x RHA-857 (1214.47) followed by CMS 17A x 6-D-1P#2 (1383.41), CMS 17A x R-16 (1424.67) and CMS 234A x 6-D-1P#2 (1446.21). Among parents, the highest AUDPC value was recorded by RHA-274 (1806.44) followed by 6-D-1 (1804.59) and FMS R265A (1786.72) and least AUDPC value was observed in R-298(NB) (1619.40) and CMS 607A (1622.80). Under epiphytotic conditions, two genotypes CMS 17A x RHA-857 and KBSH-44 were found resistant, twenty one genotypes were found moderately tolerant, fifty five genotypes were found susceptible and four genotypes highly susceptible to Alternaria leaf blight (Table 3).

The breeding research has failed to address disease loss by ALB effectively. There are reports of limited resistance available in cultivated sunflower determined by polygenes. The *Kharif* sunflower can be made more remunerative and attractive only when resistant varieties/hybrids to ALB disease are bred. This has to be the major thrust area in disease resistance breeding. In the present investigation, it could be seen that among lines, FMS R265A and restorer lines 6-D-1 and RHA-274 showed high degree of susceptibility with grades of 9 and remaining parents showed susceptible reaction with grade of 7 or 8. Among the hybrids, the cross combination of CMS 17A (A line of KBSH-44) and RHA-857 (R line of BSH-1) recorded tolerant reaction (3 grade), although CMS 17A and RHA-857 was found susceptible reaction. This indicates that different alleles are involved in the inheritance of Alternaria (Kong *et al.,* 1996 and Garcia *et al.,* 2003). The rare genes present in the susceptible parents CMS 17A and RHA-857 recombined in desired direction to produce tolerance transgressive segregants.

Slow blighting cultivars are becoming popular now a days in many crops. Slow blighters are characterized by a lower 'r' value and AUDPC when compared to susceptible varieties under the same conditions. This type of tolerance is preferred since these slow blighting varieties allow certain amount of disease to develop, which results in reduced selection pressure (Hooker, 1967). There are various mechanisms such as reduction in penetration, infectability, spot number, spot size, pustule size, pustule expression, sporulation, spore deposition which are responsible for host tolerance that ultimately results in slow blighting. This phenomenon of tolerance is horizontal in nature. Of the 60 hybrids tested for slow blighting by assessing per cent leaf area affected at different intervals hybrids *viz.,* FMS R265A x 6-D-1P#2 and FMS R265A x 6-D-1exhibited early onset of disease with more initial disease incidence and ended up with

Table 2: Apparent rate of infection 'r' and AUDPC of Alternaria leaf blight at different stages of growth

Sr. No.	Genotypes	Rate of spread ' r ' at			Average ' r '	AUDPC value
		50-60 DAS	60-70 DAS	70-80 DAS		
	Crosses					
1.	CMS 302A x RHA-857	0.09	0.19	0.18	0.15	1577.15
2.	CMS 302A x 6-D-1	0.09	0.15	0.21	0.15	1548.27
3.	CMS 302A x R 298 (Br)	0.07	0.18	0.12	0.12	1502.15
4.	CMS 302A x RHA-274	0.12	0.24	0.13	0.16	1712.09
5.	CMS 302A x VI-66	0.07	0.19	0.11	0.12	1520.72
6.	CMS 302A x VI-34	0.09	0.20	0.04	0.11	1531.48
7.	CMS 302A x R-16	0.05	0.18	0.12	0.12	1383.41
8.	CMS 302A x V-20	0.08	0.19	0.07	0.12	1500.26
9.	CMS 302A x 6-D-1P#2	0.08	0.19	0.12	0.13	1525.04
10.	CMS 302A x R-298(NB)	0.13	0.20	0.10	0.15	1685.01
11.	CMS 607A x RHA-857	0.12	0.17	0.15	0.15	1641.27
12.	CMS 607A x 6-D-1	0.11	0.18	0.09	0.13	1563.58
13.	CMS 607A x R 298 (Br)	0.06	0.17	0.25	0.16	1597.18
14.	CMS 607A x RHA-274	0.11	0.16	0.12	0.13	1588.14
15.	CMS 607A x VI-66	0.11	0.20	0.14	0.15	1627.56
16.	CMS 607A x VI-34	0.09	0.20	0.14	0.14	1627.56
17.	CMS 607A x R-16	0.05	0.19	0.15	0.13	1443.21
18.	CMS 607A x V-20	0.09	0.17	0.23	0.16	1603.01
19.	CMS 607A x 6-D-1P#2	0.13	0.25	0.12	0.17	1710.40
20.	CMS 607A x R-298(NB)	0.11	0.23	0.07	0.14	1706.90
21.	FMS R265A x RHA-857	0.11	0.19	0.21	0.17	1665.05
22.	FMS R265A x 6-D-1	0.11	0.14	0.12	0.12	1800.00
23.	FMS R265A x R 298 (Br)	0.13	0.20	0.10	0.14	1694.52
24.	FMS R265A x RHA-274	0.11	0.21	0.11	0.15	1659.41
25.	FMS R265A x VI-66	0.12	0.22	0.04	0.12	1615.69
26.	FMS R265A x VI-34	0.13	0.29	0.00	0.14	1744.40
27.	FMS R265A x R-16	0.10	0.20	0.06	0.12	1600.04
28.	FMS R265A x V-20	0.12	0.22	0.18	0.17	1671.16
29.	FMS R265A x 6-D-1P#2	0.07	0.18	0.19	0.15	1667.83
30.	FMS R265A x R-298(NB)	0.11	0.17	0.08	0.12	1601.88
31.	(852A x NDOL2) x RHA-857	0.09	0.20	0.06	0.12	1590.52
32.	(852A x NDOL2) x 6-D-1	0.11	0.19	0.18	0.16	1559.54
33.	(852A x NDOL2) x R 298 (Br)	0.11	0.20	0.06	0.12	1600.04
34.	(852A x NDOL2) x RHA-274	0.10	0.19	0.16	0.15	1605.69
35.	(852A x NDOL2) x VI-66	0.09	0.21	0.06	0.12	1595.15
36.	(852A x NDOL2) x VI-34	0.11	0.18	0.08	0.12	1578.17
37.	(852A x NDOL2) x R-16	0.08	0.18	0.20	0.15	1548.71
38.	(852A x NDOL2) x V-20	0.09	0.18	0.23	0.17	1633.65
39.	(852A x NDOL2) x 6-D-1P#2	0.10	0.18	0.18	0.15	1583.82
40.	(852A x NDOL2) x R-298(NB)	0.09	0.17	0.11	0.12	1700.18
41.	CMS 17A x RHA-857	0.06	0.14	0.17	0.12	1214.47
42.	CMS 17A x 6-D-1	0.10	0.18	0.08	0.12	1466.45
43.	CMS 17A x R 298 (Br)	0.09	0.17	0.07	0.11	1493.52
44.	CMS 17A x RHA-274	0.13	0.15	0.09	0.12	1477.50

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45.	CMS 17A x VI-66	0.10	0.20	0.08	0.13	1498.85
46.	CMS 17A x VI-34	0.10	0.15	0.14	0.13	1517.90
47.	CMS 17A x R-16	0.08	0.17	0.12	0.12	1424.67
48.	CMS 17A x V-20	0.08	0.16	0.15	0.13	1463.31
49.	CMS 17A x 6-D-1P#2	0.09	0.20	0.08	0.12	1383.41
50.	CMS 17A x R-298(NB)	0.08	0.17	0.14	0.13	1486.95
51.	CMS 234A x RHA-857	0.12	0.20	0.10	0.14	1684.95
52.	CMS 234A x 6-D-1	0.10	0.16	0.12	0.13	1529.81
53.	CMS 234A x R 298 (Br)	0.09	0.23	0.19	0.17	1653.58
54.	CMS 234A x RHA-274	0.10	0.18	0.21	0.16	1639.91
55.	CMS 234A x VI-66	0.10	0.16	0.12	0.13	1529.81
56.	CMS 234A x VI-34	0.12	0.15	0.12	0.13	1557.22
57.	CMS 234A x R-16	0.10	0.17	0.17	0.15	1593.72
58.	CMS 234A x V-20	0.13	0.27	0.07	0.16	1731.56
59.	CMS 234A x 6-D-1P#2	0.09	0.17	0.05	0.10	1446.21
60.	CMS 234A x R-298(NB)	0.11	0.19	0.13	0.14	1663.08
Female parents						
1.	CMS 17A	0.13	0.27	0.03	0.14	1719.22
2.	CMS 302A	0.12	0.33	0.01	0.15	1755.91
3.	CMS 607A	0.10	0.21	0.14	0.15	1622.80
4.	852A x NDOL2	0.13	0.33	0.05	0.17	1772.84
5.	CMS 234A	0.13	0.27	0.10	0.17	1737.74
6.	FMS R265A	0.05	0.32	0.12	0.16	1786.72
Male parents						
1.	RHA-857(Br)	0.13	0.32	0.03	0.16	1775.62
2.	6-D-1(Br)	0.09	0.36	0.14	0.20	1804.59
3.	R-298(Br)	0.13	0.21	0.16	0.17	1696.78
4.	RHA-274(Br)	0.14	0.43	0.03	0.20	1806.44
5.	VI-66(Br)	0.13	0.25	0.07	0.15	1755.86
6.	VI-34(Br)	0.13	0.17	0.13	0.14	1727.47
7.	R-16(Br)	0.13	0.21	0.13	0.15	1747.22
8.	V-20(Br)	0.13	0.32	0.01	0.15	1761.80
9.	6-D-1#2(Br)	0.13	0.25	0.08	0.15	1759.57
10.	R-298(NB)	0.12	0.23	0.03	0.13	1619.40
Checks						
1.	KBSH-53	0.05	0.14	0.10	0.10	1230.45
2.	KBSH-1	0.11	0.18	0.02	0.10	1478.35
3.	RSFH-130	0.08	0.17	0.09	0.11	1462.13
4.	KBSH-44	0.07	0.17	0.13	0.12	1377.05
5.	SB-275	0.08	0.17	0.07	0.11	1493.52
6.	KBSH-41	0.05	0.19	0.09	0.11	1333.99

maximum terminal disease severity. While, CMS 17A x RHA-857, CMS 234A x 6-D-1P#2 and CMS 17A x R-16 showed lower initial diseases through on set of disease was in the same week. Vander Plank (1963) suggested to measure the disease severity by several means from the beginning to the end of epidemic to assess slow blighting tolerance in compound interest disease like Alternaria leaf blight. Based on disease severity, CMS 17A x RHA-857, CMS 234A x 6-D-1P#2 and CMS

Table 3: Reaction of sunflower genotypes against Alternaria leaf blight

Rating	Reaction	Genotypes responded
0	Immune	Nil
1-2	Highly resistant	Nil
2-5	Resistant	CMS 17A x RHA-857, KBSH-44
5-7	Moderately resistant	CMS 302A x RHA-298(Br), CMS 302A x VI-66, CMS 302A x VI-34, CMS 302A x R-16, CMS 302A x V-20, CMS 607A x 6-D-1, CMS 607A x RHA-274, (852A x NDOL2) x VI-66, (852A x NDOL2) x R-298(NB), CMS 17A x R-298(Br), CMS 17A x RHA-274, CMS 17A x VI-66, CMS 17A x VI-34, CMS 17A x V-20, CMS 17A x 6-D-1P#2, CMS 234A x VI-34, CMS 234A x 6-D-1P#2, KBSH-53, KBSH-1, KBSH-41, KBSH-44, RSFH-130, SB-275
7-8	Susceptible	CMS 302A x RHA-857, CMS 302A x 6-D-1, CMS 302A x RHA-274, CMS 302A x 6-D-1P#2, CMS 302A x R-298(NB), CMS 607A x RHA-857, CMS 607A x R-298(Br), CMS 607A x VI-66, CMS 607A x VI-34, CMS 607A x R-16, CMS 607A x V-20, CMS 607A x 6-D-1P#2, CMS 607A x R-298(NB), FMS R265A x RHA-857, FMS R265A x 6-D-1, FMS R265A x RHA-274, FMS R265A x 6-D-1P#2, FMS R265A x R-298(NB), FMS R265A x RHA-298(Br), FMS R265A x VI-66, FMS R265A x VI-34, FMS R265A x R-16, FMS R265A x V-20, (852A x NDOL2) x RHA-857, (852A x NDOL2) x 6-D-1, (852A x NDOL2) x RHA-274, (852A x NDOL2) x 6-D-1P#2, (852A x NDOL2) x RHA-298(Br), (852A x NDOL2) x VI-34, (852A x NDOL2) x R-16, (852A x NDOL2) x V-20, CMS 17A x 6-D-1, CMS 17A x R-16, CMS 17A x R-298(NB),), CMS 234A x RHA-857, CMS 234A x 6-D-1, CMS 234A x RHA-274, CMS 234A x R-298(NB), CMS 234A x RHA-298(Br), CMS 234A x VI-66, CMS 234A x R-16, CMS 234A x V-20, CMS 302A, CMS 607A, 852A x NDOL2, CMS 234A, RHA-857, VI-66, VI-34, R-16, V-20, 6-D-1P#2, R-298(NB)
9	Highly susceptible	CMS 17A, FMS R265A, 6-D-1, RHA-274

302A x VI-34 were termed as slow blighters. Among parents, CMS 607A and R-298(NB) showed less initial disease severity ended up with low incidence while, FMS R265A, 6-D-1 and RHA-274 showed high initial and terminal disease severity. All checks recorded low disease severity could be considered as slow blighters. The ‘r’ values varied and at times they did not remain consistent for given genotype and also did not show a particular trend in general. This observation is in agreement with that of Wilcoxson *et al.* (1975) and Nargund (1989), who have pointed out that ‘r’ values are not useful criteria as AUDPC values in studying the disease development. It was suggested that, computed ‘r’ values influenced to the extent of new foliage growth that occurred during the epidemic for all the genotypes, but, it was more prevailing in the tolerant genotypes, hence, the present investigation revealed that ‘r’ values are of less reliability in indentifying slow blighting tolerance.

On the other hand area under disease progress curve (AUDPC) values which are summation of values calculated at several intervals during disease progress is probably a better epidemiological concept. The lowest AUDPC values for Alternaria leaf blight were recorded in hybrids like CMS 17A x RHA-857, CMS 17A x 6-D-1P#2 and CMS 17A x R-16 can be considered as slow blighters.

The present study clearly indicates that it is possible to synthesize hybrids with reasonable degree of tolerance by involving susceptible parents also. The extent of resistance however, can be enhanced when allelic differences exist between parents and by subjecting above crosses to recurrent selection (Ravikumar *et al.,* 1995 and Shobarani, 2003). The works in detection of Alternaria resistance is quite meagre in sunflower in view of lack of resistance in the entire world collections. Further, resistance to Alternaria is reported to exhibit differential reaction with the environment (Nagaraju *et al.,* 1992). Therefore, in absence of high level of resistance to Alternaria, there is no option but to involve susceptible parents in hybrid combinations as has been evidential in some of tolerant hybrids to maintain moderate level resistance.

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