

Screening of cultivated okra, related species and their inter specific hybrid derivatives for resistance to powdery mildew (*Erysiphe cichoracearum* DC)

T. Prabu¹, S.D. Warade², M.A. Jatkar¹ and P.H. Ghante³

¹Department of Horticulture, Mahatma Phule Krishi Vidyapeeth, Rahuri, ²College of Horticulture, Pune -411 005, ³Department of Plant Pathology, Mahatma Phule Krishi Vidyapeeth, Rahuri -413 722. India. E-mail: prabu.hort@gmail.com

Abstract

Okra germplasm, consisting of 85 accessions, which included cultivars, related species and their inter specific hybrids was screened for two seasons, while their amphidiploids, backcrosses and F₃ generations were screened for one season for powdery mildew resistance (*Erysiphe cichoracearum* DC) under severe field epiphytotic conditions. Only the wild species *A. caillei*-2 and *A. moschatus*-1 were found immune while two biotypes of *A. tetraphyllum*, *A. manihot* spp. *manihot*, *A. manihot* spp. *tetraphyllum*, *A. manihot* (L.) Medikus and *A. angulosus* were found highly resistant to powdery mildew in both seasons. *A. tuberculatus*-1, *A. caillei*-1, *A. ficulneus* and cultivars of *A. esculentus* were susceptible. Reaction of inter specific hybrids, backcrosses and amphidiploids revealed that the resistance in *A. caillei*-2, *A. angulosus* and *A. manihot* spp. *tetraphyllum* were partially dominant. Further, it was observed that in F₃ generations, only the lines of *A. caillei* -2 inter specific hybrid derivatives (lines derived from hybrids having *A. caillei*-2 as one parent) were found highly resistant to powdery mildew.

Key words: Okra, powdery mildew resistance, inter-specific hybrids, amphidiploids

Introduction

Powdery mildew (*Erysiphe cichoracearum* DC) is a serious disease of okra in India (Joi and Shende, 1979; Raj *et al.*, 1993 and Neeraja *et al.*, 2004). The literature reveals that there is no source of resistance to powdery mildew in *A. esculentus* and a search for resistance should be invariably shifted to related species. Jambhale and Nerkar (1992) reported *A. manihot*, *A. tetraphyllum*, *A. manihot* spp. *manihot* and *A. moschatus* were immune to powdery mildew. Considering the above facts, an experiment was conducted to screen okra cultivars, related wild species and their inter-specific hybrids, amphidiploids, backcrosses and F₃'s for field resistance to powdery mildew.

Materials and methods

A programme to transfer resistance to yellow vein mosaic virus (YVMV) disease from wild *Abelmoschus* to cultivated okra was undertaken in this department during 2002-2005 (Prabu, 2005). The same experimental material consisting of *A. esculentus* cultivars, related wild species (*viz.*, *A. tetraphyllum*-1 and 2, *A. manihot* spp. *manihot*, *A. moschatus*, *A. manihot* spp. *tetraphyllum*, *A. manihot* (L.) Medikus, *A. angulosus*, *A. tuberculatus*-1, *A. caillei*-1 and 2 and *A. ficulneus*-1) and their inter-specific hybrids were screened for two seasons (Kharif, 2004 and summer, 2005) while their amphidiploids, backcrosses and F₃'s were screened for one season (summer, 2005) for powdery mildew resistance. In summer, humidity in the field was maintained by giving frequent irrigations. A highly susceptible Pusa Sawani was grown around the experimental field for providing uniform powdery mildew inoculum. No control measures were done. However, all the other agronomical practices were carried out as per recommendations. The observations on the disease severity and intensity were

recorded at 30 days interval on ten randomly selected plants of each genotype. The disease reaction was recorded by following 0-4 scale:

Scale for screening okra for powdery mildew resistance

Scale	Symptoms	Disease rating
Grade 0	No infection	Immune (I)
Grade 1	Powdery mildew specks having less than 10 % leaf area affected	Highly Resistant (HR)
Grade 2	Large patches but no coalescing with 11-25 % leaf area affected	Moderately resistant (MR)
Grade 3	Coalescing large patches covering 26-50 % leaf area affected	Moderately susceptible (MS)
Grade 4	More than 51 % leaf area affected, coupled with defoliation of leaves	Highly susceptible (HS)

Results and discussion

In the present findings (Table 1), it was observed that the wild species *A. moschatus*-1 and *A. caillei*-2 were immune to powdery mildew disease while *A. tetraphyllum* lines (1 and 2), *A. angulosus*, *A. manihot* (L.) Medikus, *A. manihot* spp. *manihot* and *A. manihot* spp. *tetraphyllum* were found highly resistant. Further, it was observed that *A. ficulneus*-1 was found moderately susceptible, while *A. caillei*-1 and *A. tuberculatus* were highly susceptible to powdery mildew disease. Prabhu *et al.* (1971) observed *A. ficulneus*, *A. tetraphyllum* and *A. tuberculatus* to be highly susceptible while *A. manihot* var. *pungens*, *A. moschatus* and *A. manihot* as resistant. Joi and Shende (1979) observed *A. manihot* and *A. tetraphyllum* to be immune to powdery mildew. Jambhale and Nerkar (1992) reported that *A. tetraphyllum*, *A. manihot*, *A. manihot* spp. *manihot* and *A. moschatus* were immune

Table 1. Screening cultivated okra, related species and their inter specific hybrid derivatives for resistance to powdery mildew

Sr No.	Material	Source	Powdery mildew incidence (%)						Disease reaction
			Kharif 2004		Summer 2005		Mean		
			Disease score		Disease Score		Disease score		
Okra cultivars (<i>Abelmoschus esculentus</i> (L.) Moench)									
1	Pusa Sawani	A.I.C.V.I.P, Rahuri	70.63	4	70.00	4	70.32	4	HS
2	Red Bhendi	A.I.C.V.I.P, Rahuri	61.88	4	50.00	3	55.94	4	HS
3	Arka Abhay	A.I.C.V.I.P, Rahuri	48.33	3	60.00	4	54.17	4	HS
4	Phule Utkarsha	A.I.C.V.I.P, Rahuri	50.50	3	75.00	4	62.75	4	HS
5	Arka Anamika	A.I.C.V.I.P, Rahuri	60.00	4	50.00	3	55.00	4	HS
6	Parbhani Kranti	A.I.C.V.I.P, Rahuri	48.00	3	80.00	4	64.00	4	HS
7	Varsha Uphar	A.I.C.V.I.P, Rahuri	59.38	4	70.00	4	64.69	4	HS
8	P7	A.I.C.V.I.P, Rahuri	51.50	4	45.00	3	48.25	3	MS
Wild <i>Abelmoschus</i> spp.									
9	<i>A. tuberculatus</i> - 1	N.B.P.G.R., Akola	51.00	4	55.00	4	53.00	4	HS
10	<i>A. tetraphyllus</i> - 1	I.I.V.R., Varanasi	8.50	1	4.50	1	6.50	1	HR
11	<i>A. tetraphyllus</i> - 2	N.B.P.G.R., Akola	5.25	1	3.00	1	4.13	1	HR
12	<i>A. ficulneus</i> - 1	N.B.P.G.R., Akola	52.50	4	25.00	2	38.75	3	MS
13	<i>A. moschatus</i> - 1	I.I.V.R., Varanasi	0.00	0	0.00	0	0.00	0	I
14	<i>A. caillei</i> - 1	N.B.P.G.R., Thrissur	57.50	4	50.00	3	53.75	4	HS
15	<i>A. caillei</i> - 2	K.A.U., Thrissur	0.00	0	0.00	0	0.00	0	I
16	<i>A. manihot</i> spp. <i>manihot</i>	N.B.P.G.R., Thrissur	6.75	1	5.50	1	6.13	1	HR
17	<i>A. manihot</i> spp. <i>tetraphyllus</i>	N.B.P.G.R., Thrissur	7.50	1	3.50	1	5.50	1	HR
18	<i>A. angulosus</i>	N.B.P.G.R., Thrissur	7.00	1	11.00	2	9.00	1	HR
19	<i>A. manihot</i> (L.) Medikus	N.B.P.G.R., Thrissur	8.50	1	6.50	1	7.50	1	HR
20	Pusa Sawani x <i>A. tetraphyllus</i> - 2	F ₁	32.00	3	35.00	3	33.50	3	MS
21	Pusa Sawani x <i>A. caillei</i> - 2	F ₁	10.00	1	10.00	1	10.00	1	HR
22	<i>A. caillei</i> - 2 x Pusa Sawani	F ₁	10.50	2	7.00	1	8.75	1	HR
23	Pusa Sawani x <i>A. manihot</i> spp. <i>manihot</i>	F ₁	35.00	3	25.00	2	30.00	3	MS
24	Pusa Sawani x <i>A. manihot</i> spp. <i>tetraphyllus</i>	F ₁	30.00	3	20.00	2	25.00	2	MR
25	Pusa Sawani x <i>A. manihot</i> (L.) Medikus	F ₁	30.00	3	15.00	2	22.50	2	MR
26	Red Bhendi x <i>A. tetraphyllus</i> -2	F ₁	40.00	3	25.00	2	32.50	3	MS
27	Red Bhendi x <i>A. caillei</i> -2	F ₁	9.00	1	6.00	1	7.50	1	HR
28	<i>A. caillei</i> - 2 x Red Bhendi	F ₁	5.00	1	10.00	1	7.50	1	HR
29	Red Bhendi x <i>A. manihot</i> spp. <i>manihot</i>	F ₁	26.25	3	25.00	2	25.63	3	MS
30	Red Bhendi x <i>A. manihot</i> spp. <i>tetraphyllus</i>	F ₁	11.00	2	20.00	2	15.50	2	MR
31	Arka Abhay x <i>A. tetraphyllus</i> -2	F ₁	27.50	3	25.00	2	26.25	3	MS
32	Phule Utkarsha x <i>A. tuberculatus</i> - 1	F ₁	36.00	3	70.00	4	53.00	4	HS
33	Phule Utkarsha x <i>A. tetraphyllus</i> - 1	F ₁	37.50	3	34.00	3	35.75	3	MS
34	Phule Utkarsha x <i>A. tetraphyllus</i> -2	F ₁	46.00	3	29.00	3	37.50	3	MS
35	Phule Utkarsha x <i>A. caillei</i> -1	F ₁	49.00	3	37.50	3	43.25	3	MS
36	Phule Utkarsha x <i>A. caillei</i> -2	F ₁	8.00	1	12.00	2	10.00	1	HR
37	<i>A. caillei</i> -2 x Phule Utkarsha	F ₁	7.00	1	12.00	2	9.50	1	HR
38	Phule Utkarsha x <i>A. manihot</i> spp. <i>manihot</i>	F ₁	25.00	2	17.50	2	21.25	2	MR
39	Phule Utkarsha x <i>A. manihot</i> spp. <i>tetraphyllus</i>	F ₁	20.00	2	10.00	1	15.00	2	MR
40	Phule Utkarsha x <i>A. angulosus</i>	F ₁	26.50	3	15.00	2	20.75	2	MR
41	Phule Utkarsha x <i>A. manihot</i> (L.) Medikus	F ₁	30.00	3	15.00	2	22.50	2	MR
42	Arka Anamika x <i>A. tetraphyllus</i> - 1	F ₁	30.00	3	25.00	2	27.50	3	MS
43	Arka Anamika x <i>A. tetraphyllus</i> -2	F ₁	23.00	3	20.00	2	21.50	2	MR
44	Arka Anamika x <i>A. caillei</i> -2	F ₁	11.00	2	7.50	1	9.25	1	HR
45	<i>A. caillei</i> -2 x Arka Anamika	F ₁	9.50	1	8.50	1	9.00	1	HR
46	Arka Anamika x <i>A. manihot</i> spp. <i>manihot</i>	F ₁	25.00	2	25.00	2	25.00	2	MR
47	Arka Anamika x <i>A. manihot</i> spp. <i>tetraphyllus</i>	F ₁	13.00	2	25.00	2	19.00	2	MR
48	Arka Anamika x <i>A. manihot</i> (L.) Medikus	F ₁	32.00	3	21.50	3	26.75	3	MS
49	Parbhani Kranti x <i>A. tuberculatus</i> -1	F ₁	28.75	3	62.50	4	45.63	3	MS
50	Parbhani Kranti x <i>A. tetraphyllus</i> -1	F ₁	25.50	3	50.00	3	37.75	3	MS
51	Parbhani Kranti x <i>A. tetraphyllus</i> -2	F ₁	24.50	2	35.00	3	29.75	3	MS
52	Parbhani Kranti x <i>A. caillei</i> - 1	F ₁	26.50	3	50.00	3	38.25	3	MS
53	Parbhani Kranti x <i>A. caillei</i> - 2	F ₁	9.50	1	10.00	1	9.75	1	HR
54	<i>A. caillei</i> -2 x Parbhani Kranti	F ₁	9.00	1	10.00	1	9.50	1	HR

Sr No.	Material	Source	Powdery mildew incidence (%)					Disease reaction	
			Kharif 2004		Summer 2005		Mean		
			Disease score	Disease score	Disease Score	Disease score	Disease score		
55	Parbhani Kranti x <i>A. manihot</i> spp. <i>manihot</i>	F ₁	19.25	2	30.00	3	24.63	2	MR
56	Parbhani Kranti x <i>A. manihot</i> spp. <i>tetraphyllus</i>	F ₁	19.00	2	15.00	2	17.00	2	MR
57	Parbhani Kranti x <i>A. angulosus</i>	F ₁	28.00	3	12.50	2	20.25	2	MR
58	Parbhani Kranti x <i>A. manihot</i> (L.) Medikus	F ₁	40.00	3	30.00	3	35.00	3	MS
59	Varsha Uphar x <i>A. tuberculatus</i> - 1	F ₁	26.50	3	55.00	4	40.75	3	MS
60	Varsha Uphar x <i>A. tetraphyllus</i> - 1	F ₁	27.00	3	37.50	3	32.25	3	MS
61	Varsha Uphar x <i>A. tetraphyllus</i> - 2	F ₁	24.00	2	35.00	3	29.50	3	MS
62	Varsha Uphar x <i>A. caillei</i> - 1	F ₁	35.00	3	60.00	4	47.50	3	MS
63	Varsha Uphar x <i>A. caillei</i> - 2	F ₁	8.00	1	11.00	2	9.50	1	HR
64	<i>A. caillei</i> -2 x Varsha Uphar	F ₁	11.00	2	7.50	1	9.25	1	HR
65	Varsha Uphar x <i>A. manihot</i> spp. <i>manihot</i>	F ₁	27.00	3	37.50	3	32.25	3	MS
66	Varsha Uphar x <i>A. manihot</i> spp. <i>tetraphyllus</i>	F ₁	17.25	2	18.75	2	18.00	2	MR
67	Varsha Uphar x <i>A. angulosus</i>	F ₁	25.00	2	16.50	2	20.75	2	MR
68	Varsha Uphar x <i>A. manihot</i> (L.) Medikus	F ₁	30.00	3	20.00	2	25.00	2	MR
69	P7 x <i>A. tetraphyllus</i> - 1	F ₁	26.00	3	30.00	3	28.00	3	MS
70	P7 x <i>A. tetraphyllus</i> - 2	F ₁	31.50	3	45.00	3	38.25	3	MS
Amphidiploids									
71	Phule utkarsha x <i>A. tetraphyllus</i> -1	Amphidiploids	-	-	25.50	2	25.50	3	MS
72	Phule utkarsha x <i>A. tetraphyllus</i> -2	Amphidiploids	-	-	27.00	2	27.00	2	MS
73	Phule utkarsha x <i>A. manihot</i> spp. <i>tetraphyllus</i>	Amphidiploids	-	-	13.50	2	13.50	2	MR
74	Phule utkarsha x <i>A. manihot</i> spp. <i>manihot</i>	Amphidiploids	-	-	12.00	2	12.00	2	MR
Backcrosses									
75	Varsha Uphar x (Varsha Uphar x <i>A. manihot</i> spp. <i>tetraphyllus</i>)	Backcrosses	-	-	15.00	2	15.00	2	MR
76	Parbhani Kranti x (Parbhani ranti x <i>A. manihot</i> spp. <i>tetraphyllus</i>)	Backcrosses	-	-	19.50	2	19.50	2	MR
77	Varsha Uphar x (<i>A. caillei</i> -2 x Varsha Uphar)	Backcrosses	-	-	7.50	1	7.50	1	HR
78	(<i>A. caillei</i> -2 x Arka Anamika) x Arka Anamika	Backcrosses	-	-	6.50	1	6.50	1	HR
79	(<i>A. caillei</i> -2 x Varsha Uphar) x Varsha Uphar	Backcrosses	-	-	7.25	1	7.25	1	HR
F ₃ generations									
80	Phule Utkarsha x <i>A. tetraphyllus</i> - 2	F ₂ -37	-	-	24.5	2	14.5	2	MR
81	<i>A. caillei</i> -2 x Varsha Uphar	F ₂ - 71	-	-	5.5	1	5.5	1	HR
82	<i>A. caillei</i> -2 x Varsha Uphar	F ₂ - 52	-	-	6.5	1	6.5	1	HR
83	<i>A. caillei</i> -2 x Varsha Uphar	F ₂ - 15	-	-	3.5	1	3.5	1	HR
84	<i>A. caillei</i> -2 x Arka Anamika	F ₂ -5	-	-	9.0	1	9.0	1	HR
85	<i>A. caillei</i> -2 x Arka Anamika	F ₂ -18	-	-	7.0	1	7.0	1	HR

while *A. ficulneus*, *A. tuberculatus* and *A. esculentus* cultivars were found susceptible to powdery mildew. The present results are in agreement with the earlier workers only for *A. moschatus*, *A. tuberculatus* and *A. esculentus*. The present study however revealed that *A. manihot* (L.) Medikus, *A. tetraphyllus* and *A. manihot* spp. *manihot* are highly resistant to the disease. This is in line with Dhankar (1998) and Fageria *et al.* (2001). Prabhu *et al.* (1971) and Jambhale and Nerkar (1992) reported *A. ficulneus* to be susceptible to powdery mildew. In the present study, *A. ficulneus*-1 was found highly susceptible during kharif season but expressed moderate resistance to the disease during summer season, while *A. angulosus* was found highly resistant during kharif season but showed only moderate resistance during summer season. This might be due to the different seed material and environmental conditions under which the material was grown. None of the *A. esculentus* cultivars, screened for two seasons, were found resistant to powdery mildew. These findings are in consonance with those of Premnath (1975), Joi and Shende (1979), Jambhale and Nerkar (1992) and Neeraja *et al.* (2004).

Among the inter-specific hybrids, hybrids having *A. caillei*-2 as one of its parents were found highly resistant to powdery mildew incidence in both the seasons. Nerkar (1990) reported *A. caillei* to be highly resistant to powdery mildew. None of the other inter-specific hybrids screened were found highly resistant to powdery mildew. However, sixteen inter-specific hybrids showed moderate resistance to powdery mildew either in one or in both the seasons. The hybrids between *A. esculentus* and *A. manihot* spp. *tetraphyllus* and *A. esculentus* and *A. angulosus* were found to be moderately resistant to powdery mildew. Thus in above inter-specific hybrids, resistance seems to be partially dominant. Among the amphidiploids, only Phule Utkarsha x *A. manihot* spp. *tetraphyllus* and Phule Utkarsha x *A. manihot* spp. *manihot* showed moderate resistance to powdery mildew. From the present study it was observed that the backcrosses and F₃ of *A. caillei*-2 hybrids (hybrids having *A. caillei*-2 as one of its parents) were found highly resistant to powdery mildew. These hybrids can be exploited in the future breeding programme by backcrossing them continuously to their respective *A. esculentus*

cultivars followed by selection in segregating generations in order to develop a new okra cultivar having desirable recombination of both powdery mildew resistance and *A. esculentus* with consumer preference characters.

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