Screening of okra genotypes against powdery mildew under natural epiphytotic conditions

ABSTRACT

Okra (*Abelmoschus esculentus* (L.) Moench) is a globally crucialannual vegetable belonging to family malvaceae, it is the most broadly distributed vegetable all over the world. Among the fungal diseases affecting okra crops, powdery mildew caused by *Erysiphecichoracearum* DC. is the most crucial disease-causing considerable yield losses. Host plant resistance is one of the most practical, economical and feasible methods of management of plant diseases. An attempt was made to identify sources of resistance which could be used in developing resistant variety to mitigate loss in farmer's field.Fifty okra genotypes were screened for their response to powdery mildew under natural epiphytotic conditions during *Rabi*, 2020-21Results revealed that, out of fifty genotypes screened, none of them showed immune and resistant reactions to powdery mildew. However, one genotype *i.e*., EC329404 showed a moderately resistance reaction. Twenty genotypes showed a moderately susceptible reaction. While twenty-two genotypes showed susceptible reaction, and one genotype *viz*., IC42531 showed a highly susceptible reaction. The average 'r' value ranged from 0.070 to 0.123. The highest average 'r-value (0.123) was observed in genotypes IC42524 and EC329405, with the least average 'r' value in genotype EC329415 (0.070). For yield, It was found that most of the genotypes screened were potential yielders and recorded good yield despite the pathogen attack. Thus these high-yielding genotypes can be utilised in back cross-breeding along with disease resistant parent (EC 329404) to obtain resistant variety with high-yielding potential.

KEY WORDS:*Powdery mildew, Natural epiphytotic condition, EC329404, Back cross breeding*

1. INTRODUCTION

Okra (*Abelmoschus esculentus* (L.) Moench) is a globally important annual vegetable belonging to family malvaceae, it is the most broadly distributed vegetable all over the world. In the world, it is cultivated in tropical, sub-tropical and warm temperate regions. The crop is usually grown both under irrigated and rainfed conditions. In India, okra occupies a prominent position because of its easy cultivation, dependable yield and adaptability to varying weather conditions, and it is one of the home garden vegetables. The native of okra is considered to be African, and India is considered the secondary centre of diversity.

Among the fungal diseases affecting okra crops, powdery mildew caused by *Erysiphecichoracearum* DC. is the most critical disease causing considerable yield losses. The disease initiates as white minute powdery patches first on the upper surface of leaf and lower older leaves and then spreads to younger ones. The greyish-white powdery coating is visible on severely affected leaves. Leaves finally show necrosis resulting in withering, drying and defoliation. Powdery mildew affects plants at all the growth stages and may result in yield losses of up to 17 to 86.6 per cent (Sridhar and Sinha, 1989)(1).

Host plant resistance is one of the most realistic, economical and feasible methods of management of plant diseases. The use of resistant varieties is more inexpensive and reliable than other methods. Therefore, it is vital to carry out screening of genotypes to become aware of resistant lines, which play an essential role in managing diseases.To identify the resistant source, screening of the okra genotypes against the powdery mildew disease under natural epiphytotic conditions would be of great help. In all the crop improvement programmes, managing the disease through host plant resistance has been the best choice. Utilisation of resistant varieties in farming systems is asimple, effective and economical method in managing disease and keeping powdery mildew below the economic threshold level. Besides this, these resistant genotypes not only conserve natural resources but also reduce the cost, time and energy compared to the other methods of disease management (Badwal, 1975)(2). Therefore, an attempt was made to identify sources of resistance which could be used in developing resistant variety to mitigate loss in farmer's field.Fifty okra genotypes were screened for their response to powdery mildew under natural epiphytotic conditions during *Rabi*, 2020-21.

2. MATERIALS AND METHODS

Screening of okra genotypes to powdery mildew disease

A field experiment was conducted to find out the resistance source to okra powdery mildew. Totally 50 genotypes were procured from NBPGR, IARI, New Delhi and screened against powdery mildew under natural epiphytotic conditions during *Rabi* 2020-21 at the research plot, Main Agricultural Research Station, University of Agricultural Sciences, Raichur (Plate 10a). The disease severity was recorded using 0-5 scale (Som Prakash and Saharan, 1999)(3) at an interval of ten days starting from the onset of the disease till the end of the crop and per cent disease index was calculated by using the formula given by Wheeler (1969) (4). Further, based on their disease reaction, the genotypes were scategorised as immune, resistant, moderately resistant, moderately susceptible, susceptible and highly susceptible (Som Prakash and Saharan, 1999). The apparent infection rate was calculated using PDI of 10 days interval. The yield of respective genotypes was recorded, and yield per plot was calculated for every harvesting and was later expressed in q ha^{-1}.

Table 1. List of okra genotypes screened for powdery mildew under natural epiphytotic conditions

Sl. No.	Genotype	Sl. No.	Genotype
1	IC42524	26	IC44529
2	IC42531	27	IC44896
3	IC42535	28	IC45132
4	IC43538	29	IC45723
5	IC43539	30	IC45727
6	IC43587	31	EC329383
7	IC43720	32	EC329384
8	IC43722	33	EC329386
9	IC43732	34	EC329395
10	IC43733	35	EC329396
11	IC43735	36	EC329397
12	IC43736	37	EC329398

13	IC43737	38	EC329399
14	IC43738	39	EC329400
15	IC43741	40	EC329401
16	IC43742	41	EC329402
17	IC43743	42	EC329403
18	IC43744	43	EC329404
19	IC43745	44	EC329405
20	IC43746B	45	EC329406
21	IC43748	46	EC329407
22	IC43749	47	EC329409
23	IC43750	48	EC329411
24	IC43751	49	EC329412
25	IC44526	50	EC329415

3. RESULTS AND DISCUSSION

Results revealed that, out of fifty genotypes screened, none of them showed immune and resistant reactions to powdery mildew. However, one genotype *i.e*., EC329404 showed a moderate resistance reaction (Plate 10b). Twenty genotypes *viz*., IC43735, IC43737, IC43738, IC43745, IC45723, IC45727, EC329384, EC329395, EC329396, EC329398, EC329399, EC329401, EC329402, EC329403, EC329405, EC329406, EC329407, EC329409, EC329411 and EC329415 showed moderately susceptible reaction. While twenty-two genotypes *viz*., IC42524, IC42535, IC43538, IC43539, IC43587, IC43720, IC43722, IC43733, IC43741, IC43742, IC43743, IC43744, IC43746B, IC43748, IC43749, IC43750, IC43751, IC44526, IC44529, IC44896, IC45132 and EC329383 showed susceptible reaction and one genotype *viz*., IC42531 showed highly susceptible reaction (Table 2).

At 55 days after sowing (DAS), maximum PDI was observed in genotype IC42531 (8.64), followed by IC42535 (7.96), IC43539 (7.30) and IC43538 (7.28) genotype. The least PDI was recorded by the genotype EC329404 (2.64), followed by EC329399, EC329401, EC329405 and EC329411 genotypes with PDI of 3.96.

At 65 DAS, maximum PDI was noticed in the genotype IC45132 (33.30) followed by IC44896 (30.64), IC43587 (29.98) and IC45727 (24.64). The minimum PDI was observed in genotypes EC329401 (6.62) and EC329415 (7.96) (Table 2).

Maximum PDI was noticed in genotype IC43539 (52.64), followed by IC42531 (50.52), IC43538 (50.12), IC43749 (49.44) and IC45132 (49.28). In contrast, the lowest PDI was observed in genotypes EC329401 (17.96) and EC329415 (19.30) at 75 DAS.

Maximum PDI was observed in genotype IC42531 (75.28) followed by IC42524 (73.96), IC43539 (69.96) and IC42535 (69.28). While the lowest PDI was observed in genotypes EC329404 (23.24), EC329399 (27.30) and EC329401 (27.96) at 85 DAS.

The apparent infection rate (r) was calculated for these prominent genotypes from PDI using the formula given by Van der Plank (1963a). The 'r' value has been used to evaluate data on the effectiveness of cultivar resistance. The results are presented in Table 2. At 55-65 DAS highest 'r' value was observed in the genotype IC43587 (0.218) followed by IC45132 (0.207). However, the least average 'r' value was recorded in genotypes EC329415 (0.044) followed by IC43742 (0.048) and EC329401 (0.054).

At 65-75 DAS highest 'r' value was observed in the genotypes IC43751 (0.198) followed by IC44526 (0.188) and IC43743 (0.184). However, least 'r' value was recorded by the genotypes EC329399 (0.052) and EC329404 (0.057).

At 75-85 DAS highest 'r' value was observed by the genotype IC42524 (0.186). However, least 'r' value was recorded by the genotypes EC329411 (0.003), EC329404 (0.011), IC45132 (0.011), EC329406 (0.011) and EC329403 (0.012).

The average 'r' value ranged from 0.070 to 0.123. The highest average 'r' value (0.123) was observed in genotypes IC42524 and EC329405, with the least average 'r' value in genotype EC329415 (0.070) followed by EC329396 (0.071) and EC329395 (0.072).

Concerning yield, a total of seven pickings were done (Table 3), and the average yield (kg) was calculated and converted to q ha^{-1}. The average yield varied from 3.25 q ha^{-1} to 11.30 q ha^{-1}. In the moderately resistant genotype *i.e.,* EC329404 yield obtained was 10.95 q ha^{-1}while in the highly susceptible genotype *i.e.,* IC42531 yield obtained was 7.20 q ha^{-1}. It was found that most of the genotypes screened were potential yielders and recorded good yields despite the pathogen attack. Thus these high-yielding genotypes can be utilised in back cross-breeding along with disease resistant parent (EC 329404) in order to obtain resistant variety with high-yielding potential.

In the present study, out of fifty genotypes screened, none were found immune/resistant only one genotype *i.e*., EC329404 was found moderately resistant to powdery mildew disease. The resistance in this genotype was attributed to variousbiochemical parameters viz., more phenols and higher defence enzyme (PAL, POX and PPO) activity.

Table 2. The reaction of okra genotypes against powdery mildew and apparent rate of infection at the different growth stages of the crop during *Rabi* 2020-21 under natural epiphytotic conditions

Sl. No.	Genotypes	Per cent disease index (%)				Reaction	Apparent rate of infection 'r'			Average 'r'
		55 DAS	65 DAS	75 DAS	85 DAS		55-65 DAS	65-75 DAS	75-85 DAS	
1	IC42524	6.60	16.66	30.62	73.96	S	0.104	0.079	0.186	0.123
2	IC42531	8.64	16.62	50.52	75.28	HS	0.074	0.163	0.109	0.115
3	IC42535	7.96	19.32	37.96	69.28	S	0.102	0.094	0.130	0.108
4	IC43538	7.28	17.96	50.12	62.60	S	0.102	0.152	0.051	0.101
5	IC43539	7.30	21.98	52.64	69.96	S	0.127	0.137	0.074	0.112
6	IC43587	4.62	29.98	45.96	54.56	S	0.218	0.069	0.034	0.107
7	IC43720	5.94	15.98	42.60	62.56	S	0.110	0.136	0.081	0.109
8	IC43722	7.28	20.64	44.32	62.60	S	0.120	0.112	0.074	0.102
9	IC43732	-	-	-	-	-	-	-	-	-
10	IC43733	5.28	11.98	37.80	59.24	S	0.089	0.149	0.087	0.108
11	IC43735	4.62	17.30	37.96	41.32	MS	0.146	0.107	0.014	0.089
12	IC43736	-	-	-	-	-	-	-	-	-
13	IC43737	5.28	17.30	29.24	39.28	MS	0.132	0.068	0.045	0.081
14	IC43738	4.62	16.00	44.36	47.92	MS	0.137	0.143	0.014	0.098
15	IC43741	5.94	16.64	43.96	58.62	S	0.115	0.137	0.059	0.103

Contd...

16	IC43742	7.28	11.30	37.92	61.98	S	0.048	0.157	0.098	0.101
17	IC43743	7.30	12.64	47.68	56.60	S	0.061	0.184	0.036	0.093
18	IC43744	4.62	13.30	40.60	50.64	S	0.115	0.149	0.041	0.101
19	IC43745	5.94	10.53	33.24	41.94	MS	0.062	0.144	0.037	0.081
20	IC43746B	6.60	12.62	46.36	53.92	S	0.071	0.179	0.030	0.093
21	IC43748	5.28	15.30	39.24	51.26	S	0.117	0.127	0.049	0.097
22	IC43749	5.28	16.00	36.60	51.92	S	0.123	0.111	0.063	0.099
23	IC43750	5.94	12.62	40.56	57.28	S	0.083	0.155	0.067	0.101
24	IC43751	6.60	12.62	51.28	54.56	S	0.071	0.198	0.013	0.094
25	IC44526	5.28	13.85	38.56	51.28	S	0.106	0.188	0.052	0.115
26	IC44529	6.60	13.30	25.68	55.96	S	0.077	0.081	0.130	0.096
27	IC44896	5.94	30.64	45.28	51.94	S	0.194	0.063	0.027	0.094
28	IC45132	5.94	33.30	49.28	51.92	S	0.207	0.067	0.011	0.095
29	IC45723	5.28	19.30	41.92	48.64	MS	0.145	0.110	0.027	0.094
30	IC45727	5.94	24.64	45.28	49.24	MS	0.164	0.093	0.016	0.091
31	EC329383	5.28	19.68	25.30	54.56	S	0.180	0.032	0.126	0.112
32	EC329384	5.94	12.62	35.92	49.28	MS	0.083	0.135	0.055	0.091
33	EC329386	-	-	-	-	-	-	-	-	-

Contd...

34	EC329395	5.30	13.98	28.60	33.28	MS	0.106	0.090	0.022	0.072
35	EC329396	5.28	13.28	23.28	31.96	MS	0.101	0.068	0.044	0.071
36	EC329397	-	-	-	-	-	-	-	-	-
37	EC329398	4.62	16.62	26.64	33.94	MS	0.141	0.060	0.035	0.078
38	EC329399	3.96	15.30	23.28	27.30	MS	0.148	0.052	0.021	0.073
39	EC329400	-	-	-	-	-	-	-	-	-
40	EC329401	3.96	6.62	17.96	27.96	MS	0.054	0.113	0.057	0.075
41	EC329402	4.62	11.96	41.92	47.96	MS	0.103	0.167	0.024	0.107
42	EC329403	4.64	17.75	32.60	35.24	MS	0.149	0.092	0.012	0.084
43	EC329404	2.64	13.28	21.32	23.24	MR	0.173	0.057	0.011	0.080
44	EC329405	3.96	13.32	29.28	45.28	MS	0.131	0.099	0.069	0.123
45	EC329406	5.28	15.30	35.32	37.96	MS	0.117	0.111	0.011	0.079
46	EC329407	5.94	16.64	24.64	37.96	MS	0.115	0.049	0.063	0.075
47	EC329409	5.28	13.94	27.24	34.62	MS	0.107	0.084	0.035	0.075
48	EC329411	3.96	12.62	28.72	29.24	MS	0.125	0.102	0.003	0.077
49	EC329412	-	-	-	-	-	-	-	-	-
50	EC329415	5.28	7.96	19.30	31.28	MS	0.044	0.102	0.064	0.070

*- = Seeds not germinated DAS = Days after sowing MR = Moderately Resistant MS = Moderately Susceptible S = Susceptible HS = Highly Susceptible

Table 3. The yield of okra genotypes screened under natural epiphytotic conditions against powdery mildew during *Rabi* 2020-21

Sl. No.	Accession number	1st Picking	2nd Picking	3rd Picking	4th Picking	5th Picking	6th Picking	7th Picking	Avg yield (kg plot^{-1})	Avg yield (kg plant^{-1})	Avg yield (q ha^{-1})
		12/10/2020	15/10/2020	18/10/2020	20/10/2020	24/10/2020	27/10/2020	7/11/2020			
1	IC42524	250 g	150 g	250 g	260 g	150 g	750 g	1200 g	3.01	0.20	7.52
2	IC42531	250g	150 g	400 g	400 g	200 g	480 g	1000 g	2.88	0.19	7.20
3	IC42535	260 g	150 g	150 g	220 g	200 g	550 g	1000 g	2.53	0.16	6.32
4	IC43538	250g	150 g	250 g	240 g	200 g	750 g	750 g	2.59	0.17	6.47
5	IC43539	250 g	140 g	200 g	250 g	500 g	650 g	2000 g	3.99	0.26	9.97
6	IC43587	240 g	50 g	500 g	250 g	500 g	500 g	1000 g	3.04	0.20	7.60
7	IC43720	250 g	50 g	300 g	600 g	600 g	800 g	750 g	3.35	0.22	8.37
8	IC43722	100 g	30 g	400 g	480 g	600 g	850 g	1250 g	3.71	0.24	9.27
9	IC43732	-	-	-	-	-	-	-	-	-	-
10	IC43733	50 g	10 g	200 g	230 g	400 g	480 g	750 g	2.12	0.14	5.30
11	IC43735	260 g	150	200	500 g	500 g	500 g	700 g	2.81	0.18	7.02
12	IC43736	-	-	-	-	-	-	-	-	-	-
13	IC43737	40 g	50 g	200 g	250 g	200 g	500 g	600 g	1.84	0.12	4.60
14	IC43738	40 g	20 g	200 g	100 g	200 g	250 g	750 g	1.56	0.10	3.90

Contd...

15	IC43741	270 g	100 g	500 g	280 g	500 g	650 g	1500 g	3.80	0.25	9.50
16	IC43742	280 g	100 g	500 g	270 g	500 g	550 g	1500 g	3.70	0.24	9.25
17	IC43743	100 g	20 g	300 g	490 g	500 g	500 g	1200 g	3.11	0.20	7.77
18	IC43744	300 g	100 g	400 g	300 g	500 g	650 g	1750 g	4.00	0.26	1.00
19	IC43745	300 g	100 g	300 g	290 g	700 g	500 g	1000 g	3.19	0.21	7.97
20	IC43746B	40 g	120 g	250 g	250 g	500 g	600 g	1000 g	2.76	0.18	6.90
21	IC43748	40 g	60 g	250 g	230 g	500 g	750 g	750 g	2.58	0.17	6.45
22	IC43749	80 g	40 g	300 g	480 g	500 g	600 g	1000 g	3.00	0.20	7.50
23	IC43750	180 g	60 g	250 g	280 g	400 g	850 g	1000 g	3.02	0.20	7.55
24	IC43751	180 g	40 g	100 g	200 g	200 g	450 g	450 g	1.62	0.10	4.05
25	IC44526	400 g	40 g	300 g	480 g	600 g	1000 g	1250 g	4.07	0.27	10.17
26	IC44529	250 g	20 g	250 g	500 g	500 g	500 g	2500 g	4.52	0.30	11.30
27	IC44896	200 g	30 g	550 g	400 g	600 g	480 g	2000 g	4.26	0.28	10.65
28	IC45132	200 g	40 g	250 g	250 g	500 g	480 g	1250 g	2.97	0.19	7.42
29	IC45723	100 g	50 g	500 g	400 g	750 g	270 g	2000 g	4.07	0.27	10.17
30	IC45727	240 g	40 g	250 g	400 g	500 g	472 g	1400 g	3.30	0.22	8.25
31	EC329383	240 g	40 g	300 g	750 g	500 g	1000 g	1000 g	3.83	0.25	9.57
32	EC329384	250 g	90 g	250 g	400 g	600 g	500 g	1000 g	3.09	0.20	7.72

Contd...

33	EC329386	-	-	-	-	-	-	-	-	-	-
34	EC329395	240	50 g	250 g	250 g	500 g	500 g	1000 g	2.79	0.18	6.97
35	EC329396	200	50 g	100 g	240 g	200 g	270 g	750 g	1.81	0.12	4.52
36	EC329397	-	-	-	-	-	-	-	-	-	-
37	EC329398	250	70 g	150 g	380 g	750 g	950 g	1750 g	4.3	0.28	10.75
38	EC329399	200	100 g	300 g	230 g	500 g	250 g	750 g	2.33	0.15	5.82
39	EC329400	-	-	-	-	-	-	-	-	-	-
40	EC329401	250	40 g	200 g	200 g	500 g	450 g	1200 g	2.84	0.18	7.10
41	EC329402	270 g	40 g	300 g	450 g	750 g	1250 g	1300 g	4.36	0.29	10.90
42	EC329403	300 g	50 g	250 g	290 g	500 g	600 g	1300 g	3.29	0.21	8.22
43	EC329404	200 g	40 g	540 g	410 g	600 g	490 g	2100 g	4.38	0.29	10.95
44	EC329405	250 g	70 g	400 g	300 g	500 g	800 g	1200 g	3.52	0.23	8.80
45	EC329406	250 g	70 g	550 g	520 g	300 g	500 g	1200 g	3.39	0.22	8.47
46	EC329407	270 g	90 g	300 g	250 g	500 g	750 g	750 g	2.91	0.19	7.27
47	EC329409	250 g	80 g	100 g	100 g	100 g	300 g	700 g	1.63	0.10	4.07
48	EC329411	240 g	70 g	150 g	230 g	100 g	260 g	550 g	1.60	0.10	4.00
49	EC329412	-	-	-	-	-	-	-	-	-	-
50	EC329415	100 g	100 g	100 g	150 g	100 g	250 g	500 g	1.30	0.08	3.25

* - = Seeds not germinated

Plate 10a: Field view of screening of okra genotypes against powdery mildew disease

b) Moderately resistant variety (EC329404)

c) Highly susceptible variety (IC42531)

Plate 10b: Reaction of okra genotypes against powdery mildew disease

Attempts to screen for resistance against okra powdery mildew were made by various workers Jagtap and Dey (2013) (5) screened twenty-eight okra varieties with two checks against powdery mildew (*E. cichoracearum*). Among these, eight varieties (PBN OK 4, PBN OK 5, PBN OK 6, PBN OK 8, PBN OK 9, AOH 23, Surya and NOH 100) were found to be moderately resistant whereas twenty-two were found moderately susceptible to powdery mildew. Pathania and Gupta (2015) (6)evaluated the available 45 okra cultivars/lines/hybrids against powdery mildew during the 2014 cropping season. They observed that three lines *viz*., Shakti, MH-73, VRO-5 were resistant, fifteen cultivars/lines were found moderately susceptible, and the rest of the cultivars exhibited susceptibility to highly susceptible reactions to the powdery mildew disease. Similarly, Kaur *et al*. (2019) (7) screened thirty okra genotypes against powdery mildew disease under natural field conditions at Palampur. Based on the mean performance of the genotypes, Kashi Vibhuti, DPO-5, Palam Komal and Punjab Suhawani were resistant and top yielders. All the genotypes taken for the study were found to be resistant and moderately resistant to powdery mildew disease except genotypes *viz*., Kashi Pragati, Shitla Jyoti, Kashi Satdhari, DPO-6, DPO-8, DPO-13, DPO-19 and Punjab-8 which showed moderately susceptible reaction and genotypes *viz*., Shitla Uphar and DPO-9whichshowed a susceptible reaction.

4. CONCLUSION

Out of fifty genotypes screened under natural epiphytotic conditions during *Rabi* 2020-21, none showed an immune or resistant reaction. However, one genotype *i.e*., EC329404 showed a moderate resistance reaction, and thus it can serve as a source of resistance for further breeding programmes.

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