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Screening of blackgram genotypes against mung bean yellow mosaic virus disease

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Abstract
Mung bean yellow mosaic is a major destructive disease affecting blackgram productivity in India. It is transmitted by whitefly *Bemisia tabaci*. The present investigation was to identify resistant blackgram genotypes against MYMV at natural condition through field screening. Infector row method was followed to screen the genotypes. Screening was done with 120 blackgram genotypes during summer 2018. Genotypes which were found to be resistant (28) and moderately resistant (28) at summer 2018 were further screened during summer 2019. Genotypes viz., KKB 14034, KKB 14003, KKB 14004, KKB 14045, KKB 14051, KKB 14014, KKB 14009, KKB 14020, KKB 14038, KKB 14015, KKB 14001, KKB 14043, KKB 14042, KKB 14041, KKB 14053, KKB 14048, VBG 10010, VBG 10053, RU 1511, RU 1513, VBN 6 and VBN 4 exhibited resistance in both the years. These genotypes would be utilized as donors to develop MYMV resistant lines and can also be used for further artificial screening studies like agroinoculation, forced feeding method.

Keywords: Screening, blackgram, resistant, mung bean yellow mosaic virus

Introduction
Blackgram is an important legume crop of the family leguminaceae and it is grown mainly in Indian subcontinent. On comparison with other pulse crop, blackgram is highly priced. It is considered as rich source of protein, potassium, iron, calcium, thymine (B1), niacin (B3), riboflavin (B2) and it is nutritious for human diet**.** It also helps in fixing atmospheric nitrogen to the soil. In India, blackgram cultivation is followed not only in kharif season, it can also be grown in *Rabi* and summer seasons. Among various diseases infecting and reducing yield of black gram, yellow mosaic disease caused by mung bean yellow mosaic virus is the crucial one. MYMV belonging to Geminiviridae family and begomovirus group can affect crop yield upto 100 percent under higher incidence [1]. MYMV in India cannot be transmitted by mechanical means and it can easily be transmitted by whitefly *Bemisia tabaci* [2]. MYMV is highly infectious to legume crops such as black gram, mung bean, pigeon pea, French bean, soya bean causing symptoms like yellow flecks on leaves alternating with green patches. Upon severe infection, leaves become completely yellow and produce lesser flowers and pods. Due to non-availability of resistant varieties, cultivation of black gram crop land is diverted to other cereal crops cultivation [3] and for MYMV management in urdbean production, breeding with the resistant cultivars is effective which is alsoecofriendly [4]. It is essential to find more number of resistant varieties which performs well at all growing seasons and hence to identify MYMV resistant urdbean cultivars several attempts have been made by researchers [5-8]. In view of the above facts, the present study was targeted to screen the MYMV resistant blackgram varieties under natural condition.

Materials and Methods
Field trail was conducted at AC & RI, Killikulam in the allotted experimental plot. One hundred and twenty genotypes along with related varieties were taken for screening against MYMV. Infector row method was followed for providing MYMV infection to all the test genotypes. CO 5 urdbean was used as a susceptible check and VBN 4 urdbean was used as a resistant check. Spacing between the rows was 45 cm and plant to plant spacing was 15 cm. Two replications were assigned for each genotype and after every test genotypes CO 5 (susceptible check) was planted to ensure more MYMV incidence. Agronomic practices like hand weeding, proper irrigation, fertilizer application, herbicide application were provided for successful growth of the plants. No insecticide was sprayed to ensure natural white fly population.

Scoring was done after 80% of the plant showed incidence based on 1-9 modified scale All India Coordinated Research Project on MULLARP proposed by Alice and Nadarajan [8].

Progressive screening was also done at summer 2019 with blackgram genotypes which were resistant and moderately resistant at summer 2018.

Modified MULLARP scale (0-9)

Scale	Description
0	No visible symptoms on leaves
1	Very minute yellow specks on leaves
2	Small yellow specks with restricted spread covering 0.1-5% leaf area of plant
3	Yellow mottling of leaves covering 5.1-10% leaf area of plant
4	Yellow mottling of leaves covering 10.1-15% leaf area of plant
5	Yellow mottling and discolouration of 15.1-30% leaf area of plant
6	Yellow discolouration of 30.1-50% leaf area of plant
7	Pronounced yellow mottling and discolouration of leaves and pods, reduction in leaf size and stunting of plants covering 50.1-75% foliage of plant
8	Severe yellow discolouration of leaves covering 75.1-90% of foliage, stunting of plants and reduction in pod size
9	Severe yellow discolouration of leaves covering above 90.1% of foliage of plants, stunting of plants and no pod formation

The categories used for assessing the resistant genotypes against yellow mosaic virus was given in the following table [9]

Percent Disease Severity	Rating	Reaction
0.1-5	1 to 2	Resistant
5.1-15	2.1 to 4	Moderately Resistant
15.1-30	4.1 to 5	Moderately Susceptible
30.1-75	5.1 to 7	Susceptible
75.1-100	7.1 to 9	Highly Susceptible

Percentage disease index was calculated by using the formula given by Wheeler [10]

$$\text{Percent Disease Index} = \frac{\text{Sum of all the numerical ratings}}{\text{Number of observations} \times \text{Maximum disease rating}} \times 100$$

Table 1: Screening of blackgram genotypes against MYMV during summer 2018

S. no	Genotypes	Percentage of disease incidence	Disease scale	Disease reaction	S. no	Genotypes	Percentage of disease incidence	Disease scale	Disease reaction
1	IC 343812	25.25	5	MS	61	KKB 14022	3.30	2	R
2	IC 343856	10.80	4	MR	62	KKM 1	14.56	4	MR
3	IC 343885	9.39	3	MR	63	KKB 14001	2.40	2	R
4	IC 343936	35.70	6	S	64	KKB 14043	3.30	2	R
5	IC 343939	43.33	6	S	65	KKB 14044	8.98	3	MR
6	IC 343942	56.98	7	S	66	KKB 14046	3.05	2	R
7	IC 343943	38.40	6	S	67	KKB 14042	3.87	2	R
8	IC 343947	28.57	5	MS	68	KKB 14045	1.05	1	R
9	IC 343962	47.95	6	S	69	KKB 14041	4.45	2	R
10	IC 343967	33.33	6	S	70	KKB 14047	5.60	3	MR
11	IC 436808	14.28	4	MR	71	KKB 14048	4.25	2	R
12	IC 436512	81.81	9	HS	72	KKB 14053	2.69	2	R
13	IC 436517	66.66	7	S	73	KKB 14049	4.56	2	R
14	IC 436518	27.27	5	MS	74	KKB 14051	1.35	1	R
15	IC 436524	75.50	8	HS	75	KKB 14052	14.20	4	MR
16	IC 436535	61.53	7	S	76	KKB 14019	13.58	4	MR
17	IC 436536	21.11	5	MS	77	KU 12668	27.60	5	MS
18	IC 436545	54.50	6	S	78	ADT 6	14.29	4	MR
19	IC 436547	22.20	5	MS	79	ADT 5	13.60	4	MR
20	IC 436560	50.77	6	S	80	KKB 14054	9.20	3	MR
21	IC 436565	45.45	6	S	81	VBG 12042	8.50	3	MR
22	IC 436597	91.66	9	HS	82	VBG 11018	15.00	4	MR
23	IC 436604	66.60	7	S	83	VBG 12034	4.44	2	R
24	IC 436606	30.76	6	S	84	VBG 10010	3.14	2	R
25	IC 436609	55.50	6	S	85	KU 11680	12.50	4	MR
26	IC 436610	7.69	3	MR	86	ABG 11032	13.60	4	MR
27	IC 436612	83.30	9	HS	87	VBG 12039	68.76	7	S
28	IC 436621	77.78	8	HS	88	IC 36724	51.18	6	S
29	IC 436626	61.53	7	S	89	VBG 14003	71.40	7	S
30	IC 436627	66.60	7	S	90	IC 281992	68.89	7	S

31	IC 436638	77.70	8	HS	91	ABG 11004	46.13	6	S
32	IC 436652	31.25	6	S	92	VBG 10053	3.80	2	R
33	IC 436656	76.70	8	HS	93	IC 282002	3.30	2	R
34	IC 436659	27.27	5	MS	94	IC 282004	73.30	7	S
35	IC 436676	85.71	9	HS	95	VBG 10024	40.20	6	S
36	IC 436720	78.75	8	HS	96	VBG 11027	30.77	6	S
37	IC 436753	88.80	9	HS	97	VBG 11042	27.20	5	MS
38	IC 436758	83.30	8	HS	98	IC 335331	29.20	5	MS
39	IC436765	2.29	2	R	99	ABG 11015	72.70	7	S
40	IC 436772	64.20	7	S	100	ABG 11036	70.15	7	S
41	IC 436774	77.70	8	HS	101	IC 346784	72.30	7	S
42	IC 436780	79.78	8	HS	102	VBG 11040	72.70	7	S
43	IC 436789	86.47	9	HS	103	RU 0151	14.20	4	MR
44	IC 436792	83.30	9	HS	104	RU 152	13.65	4	MR
45	IC 436811	91.60	9	HS	105	RU 153	9.09	4	MR
46	IC 426852	77.70	8	HS	106	RU 154	18.75	5	MS
47	IC 436869	88.80	9	HS	107	RU 155	15.65	5	MS
48	IC 436882	44.40	6	S	108	RU 158	13.50	4	MR
49	IC 436910	87.50	9	HS	109	RU 159	20.44	5	MS
50	IC 436922	70.53	7	S	110	RU 15009	14.29	4	MR
51	KKB 14014	4.17	2	R	111	RU 1510	15.00	4	MR
52	KKB 14034	1.59	1	R	112	RU 1511	3.10	2	R
53	KKB 14002	6.50	3	MR	113	RU 1512	10.80	4	MR
54	KKB 14003	1.99	1	R	114	RU 1513	3.30	2	R
55	KKB 14004	1.79	1	R	115	RU 1515	13.58	4	MR
56	KKB 14009	4.10	2	R	116	RU 1516	9.50	3	MR
57	KKB 14020	2.70	2	R	117	VBN 6	3.05	2	R
58	KKB 14038	4.50	2	R	118	CO 6	7.10	3	MR
59	KKB 14015	2.69	2	R	119	ADT 3	72.30	7	S
60	KKB 14033	13.58	4	MR	120	VBN 4	0.98	1	R

Table 2: Grouping of blackgram genotypes based on their disease reaction to MYMV during summer 2019

Grade	Genotypes	Rating	Reaction	Number of genotypes
0	-	1 to 2	Resistant	28
1	KKB 14034, KKB 14003, KKB 14004, KKB 14045, KKB 14051, VBN 4			
2	IC 436765, KKB 14014, KKB 14009, KKB 14020, KKB 14038, KKB 14015, KKB 14022, KKB 14001, KKB 14043, KKB 14046, KKB 14042, KKB 14041, KKB 14048, KKB 14053, KKB 14049, VBG 12034, VBG 10010, VBG 10053, IC 282002, RU 1511, RU 1513, VBN 6			
3	IC 343885, IC 436610, KKB 14002, KKB 14044, KKB 14047, KKB 14054, VBG 12042, RU 1516, CO 6	2.1 to 4	Moderately Resistant	28
4	IC 343856, IC 436808, KKB 14033, KKM 1, KKB 14052, KKB 14019, ADT 6, ADT 5, VBG 11018, KU 11680, ABG 11032, RU 0151, RU 152, RU 153, RU 158, RU 15009, RU 1510, RU 1512, RU 1515			
5	IC 343812, IC 343947, IC 436518, IC 436536, IC 436547, IC 436659, KU 12668, VBG 11042, IC 335331, RU 154, RU 155, RU 159	4.1 to 5	Moderately Susceptible	12
6	IC 343936, IC 343939, IC 343943, IC 343962, IC 343967, IC 436545, IC 436560, IC 436565, IC 436606, IC 436609, IC 436652, IC 436882, IC 36724, ABG 11004, VBG 10024, VBG 11027	5.1 to 7	Susceptible	33
7	IC 343942, IC 436517, IC 436535, IC 436604, IC 436626, IC 436627, IC 436772, IC 436922, VBG 12039, VBG 14003, IC 281992, IC 282004, ABG 11015, ABG 11036, IC 346784, VBG 11040, ADT 3			
8	IC 436524, IC 436621, IC 436638, IC 436656, IC 436720, IC 436758, IC 436774, IC 436780, IC 426852	7.1 to 9	Highly Susceptible	19
9	IC 436512, IC 436597, IC 436612, IC 436676, IC 437653, IC 436789, IC 436792, IC 436811, IC 436869, IC 436910			

Table 3: Progressive screening of blackgram genotypes during summer 2019 which were resistant and moderately resistant at summer 2018

S. no	Genotypes	Percentage of disease incidence	Disease scale	Disease reaction	S. no	Genotypes	Percentage of disease incidence	Disease scale	Disease reaction
1	KKB 14034	1.92	1	R	29	IC 436610	12.78	4	MR
2	KKB 14003	1.58	1	R	30	KKB 14002	14.95	4	MR
3	KKB 14004	1.64	1	R	31	KKB 14033	2.12	2	R
4	KKB 14045	2.10	1	R	32	KKB 14044	6.76	3	MR
5	IC 436765	6.14	3	MR	33	KKB 14047	2.78	2	R
6	KKB 14014	3.78	2	R	34	IC 343885	19.45	5	MS
7	KKB 14009	3.96	2	R	35	RU 158	11.76	4	MR
8	KKB 14020	4.16	2	R	36	RU 15009	12.40	4	MR
9	KKB 14038	3.88	2	R	37	RU 1515	8.22	3	MR
10	KKB 14015	2.50	2	R	38	RU 1516	18.06	5	MS
11	KKB 14022	7.02	3	MR	39	CO 6	8.54	3	MR
12	KKB 14001	2.90	2	R	40	IC 436808	13.17	4	MR
13	KKB 14043	3.17	2	R	41	KKM 1	14.93	4	MR
14	KKB 14046	10.54	4	MR	42	KKB 14052	1.97	2	R
15	KKB 14042	3.04	2	R	43	KKB 14019	7.52	3	MR
16	KKB 14041	1.52	1	R	44	ADT 6	8.68	3	MR
17	KKB 14048	0.98	1	R	45	ADT 5	14.52	4	MR
18	KKB 14053	2.47	2	R	46	KKB 14054	8.19	3	MR
19	KKB 14049	8.73	3	MR	47	VBG 11018	3.47	2	R
20	KKB 14051	1.55	1	R	48	KU 11680	3.15	2	R
21	VBG 12034	8.40	3	MR	49	ABG 11032	20.54	5	MS
22	VBG 10010	2.56	2	R	50	RU 0151	2.50	2	R
23	VBG 10053	3.14	2	R	51	RU 152	3.76	2	R
24	IC 282002	7.59	3	MR	52	RU 153	7.74	3	MR
25	RU 1511	2.16	2	R	53	VBG 12042	10.56	4	MR
26	RU 1513	1.58	1	R	54	RU 1510	2.17	2	R
27	VBN 6	2.51	2	R	55	RU 1512	3.11	2	R
28	IC 343856	13.44	4	MR	56	VBN 4	0.85	1	R

Table 4: Grouping of blackgram genotypes based on their disease reaction to MYMV during summer 2019

Grade	Genotypes	Rating	Reaction	Number of genotypes
0		1 to 2	Resistant	31
1	KKB 14034, KKB 14003, KKB 14004, KKB 14045, KKB 14041, KKB 14048, KKB 14051, RU 1513, VBN 4			
2	KKB 14014, KKB 14009, KKB 14020, KKB 14038, KKB 14015, KKB 14001, KKB 14043, KKB 14042, KKB 14053, VBG 10010, VBG 10053, RU 1511, VBN 6, KKB 14033, KKB 14047, KKB 14052, VBG 11018, KU 11680, RU 0151, RU 152, RU 1510, RU 1512			
3	IC 436765, KKB 14022, KKB 14049, VBG 12034, IC 282002, KKB 14044, RU 1515, CO 6, KKB 14019, ADT 6, KKB 14054, RU 153	2.1 to 4	Moderately Resistant	22
4	KKB 14046, IC 343856, IC 436610, KKB 14002, RU 158, RU 15009, IC 436808, KKM 1, ADT 5, RU 155			
5	IC 343885, RU 1516, ABG 11032	4.1 to 5	Moderately Susceptible	3
6	-	5.1 to 7	Susceptible	-
7	-			
8	-	7.1 to 9	Highly Susceptible	-
9	-			

Results & Discussion

MYMV disease infecting leguminous crops can effectively be controlled by using the resistant varieties. To identify the resistant varieties, the foremost step is screening germplasm against MYMV at field condition with natural infection by *Bemisia tabaci*. Even though several genotypes showing resistance to MYMV have already been screened, lack of durable resistance is observed. Hence continuous screening over year is required for identifying resistance source against MYMV.

Evaluation of 120 urdbean genotypes under field conditions against MYMV was carried out at natural condition on the basis of 0-9 arbitrary scale and percent disease incidence was worked out. After every test entry, presence of most susceptible check Co 5 and good population of white fly in summer minimizes the chance of disease escape and there were good chance of disease spread. The PDI varied from 1.05 percent in KKB 14045 to 91.66 percent in IC 436597 with disease reaction of resistant and highly susceptible at summer 2018 for 120 genotypes. Among these 120 genotypes, 28 genotypes exhibited resistant reaction with 1 to

2 rating scale. 28 fall in the category of moderately resistant with 2.1 to 4 rating scale, 12 were moderately susceptible with 4.1 to 5 rating scale, 33 were susceptible with 5.1 to 7 rating scale, 19 were highly susceptible with 7.1 to 9 rating scale (Table 2). The results of the present study was in close relation with previous findings [11-13]. 56 genotypes which showed resistant and moderately resistant reaction at summer 2018 were again screened at summer 2019. Among these 56 genotypes, 31 were found to be resistant and 22 were found to be moderately resistant (Table 4). Screening urdbean genotypes consecutively for two years showed differential response to MYMV severity. The variation may be due to climatic factor, vector load or genetic characters of varieties. Inspite of variable response to MYMV, genotypes like KKB 14034, KKB 14003, KKB 14004, KKB 14045, KKB 14051, KKB 14014, KKB 14009, KKB 14020, KKB 14038, KKB 14015, KKB 14001, KKB 14043, KKB 14042, KKB 14041, KKB 14053, KKB 14048, VBG 10010, VBG 10053, RU 1511, RU 1513, VBN 6 and VBN 4 exhibited resistance in both the years.

Conclusion

However blackgram genotypes shows various response to MYMV ranges from resistant to susceptible among the genotypes, in which the resistant response may be due to plant morphology or may be due to presence of resistance genes. Genotypes like KKB 14034, KKB 14003, KKB 14004, KKB 14045, KKB 14051, KKB 14014, KKB 14009, KKB 14020, KKB 14038, KKB 14015, KKB 14001, KKB 14043, KKB 14042, KKB 14041, KKB 14053, KKB 14048, VBG 10010, VBG 10053, RU 1511, RU 1513, VBN 6 and VBN 4 showed resistant reaction against MYMV, suggests that utilization of these genotypes as donors for YMV resistance, leads to development of high yielding MYMV resistant varieties through backcross or marker assisted backcross selection by introgression of the genes to agronomically potential genotypes which were susceptible to MYMV.

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