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Screening of Urdbean Germplasm for High Seed Yield Coupled with Resistance to *Mungbean yellow mosaic virus (MYMV)*

Sunita Kumari[1+], Sangita Sahni[2+*] and Bishun Deo Prasad[3]

[1]Krishi Vigyan Kendra, Kishanganj, Bihar Agricultural University, Sabour, Bhagalpur, Bihar, India.
[2]Tirhut College of Agriculture, Dholi, Muzaffarpur, Rajendra Prasad Central Agricultural University (RPCAU), Pusa, Bihar, India.
[3]Bihar Agricultural College, Sabour, Bhagalpur, Bihar, India.

Authors' contributions

This work was carried out in collaboration among all authors. Authors SK and SS designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors SK, SS and BDP managed the analyses of the study. All authors managed the literature searches, read and approved the final manuscript.

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ABSTRACT

Yellow mosaic disease (YMD) caused by *Mungbean yellow mosaic virus* (MYMV) is one of the most destructive biotic production constraints in urdbean. Development and introduction of resistant cultivars with high seed yield are considered as the most economical and eco-friendly option to manage YMD, for which availability of stable sources of resistance with high seed yield is a pre-requisite. A set of one hundred twenty eight genotypes of urdbean including a susceptible check were evaluated against MYMV in the field for two consecutive years during summer and *kharif* 2015-2016 under natural condition of disease incidence. There was considerable variation among the genotypes with respect to disease reaction. Out of 128 genotypes tested, only five genotype namely KU 96-3, NDU 12-1, NIRB 002, NIRB 003 & NIRB 004 were found to be disease free, nineteen genotypes (IPU 10-23, IPU 11-01, KPU 34, KUG 540, KUG 586, Mash-338, NDU 12-2, NDU 12-300, NDUZ 14-21,OBG 35, PU 09-35, Shekhar 3, UH 07-06, Uttara, VBG 10-008, VBG

**Corresponding author: E-mail: sangitampp@gmail.com;*
[+]Co-first author

11-053,VBN (BG) 3, VBN 6 & Vijay) found to be highly resistant and twenty two genotypes (IGKU 02-1, Kopergaon, KPU 12, KPU 13, KPU 14, KPU 16, KPU 33, KPU 7, KPU 8, KU 363, NDU 11-01,Palampur 93, Pant U 19, PU 08-05, PU 20, PU 22, RUG-44, Sekhar 2 , TU 67, UG 218, VBG 09-005 & WBU 108) showed highly resistance or resistance consistently in both the seasons. However, eight genotypes i.e. Uttara, PU-31, KU-363, KUG 540, UH 07-06, KUG 503, WBU 108 & Shekhar 33 were found to be superior for seed yield as well as resistant to MYMV. Among these lines, UH 07-06 and KUG 503 give highest seed yield in *Kharif* and summer.

Keywords: Urdbean; MYMV; resistance; seed yield.

1. INTRODUCTION

India is the largest producer of pulses in the world with 25% percent share in global production. Among pulses, Urdbean (*Vigna mungo* L.) is one of the important pulse crop of India grown on an area of 3.30 million ha with a production of 1.83 million tons [1]. Urdbean (*Vigna mungo* L. Heper), known as urd dal/black gram/mashbean, is an important pulse crop in India as well as in South East Asia. It is cultivated in three different seasons, *viz*., *kharif*, *Rabi* and summer. The average annual yield of urdbean fluctuates between 300 to 500 kg/hafor a decade in India. Yield losses (5-100%) reported due to various biotic and abiotic stresses are responsible for the fluctuation in the average yield. The biotic stresses like yellow mosaic, powdery mildew, cercospora leaf spot and web blight are major limiting factors for high yield. Among several constraints for mungbean production, *Mungbean Yellow Mosaic Virus* (MYMV) disease occupies prime position and has been known in India for more than five decades [2]. It is caused by a group of geminiviruses belonging to the genus, begomovirus of the family, *Geminiviridae* [2,3,4]. They are transmitted through whitefly in a persistent manner and circulative manner [5]. MYMV was first reported in India in 1955 and is spreading rapidly towards newer areas. The virus initially cause yellow patches to develop, then progressively turns the entire leaf yellow. Affected plants flower sparsely and the pods contain shriveled seeds. Yield loss up to 80% was reported in susceptible cultivars [6]. The infection of the viruses reduces not only yield but also severely impairs the grain size and quality. Reduction in number of pods/plant, seeds/pod and seed weight are the main contributing factors for yield reduction. Though there is large area under urdbean cultivation in India, the productivity levels are low because of MYMV infections. The yield loss due to MYMV disease in mungbean ranges between 76 to 100 per cent. Controlling MYMV incidence is only possible by the way of reducing the vector viz., whitefly population using insecticides which is ineffective under severe infestations. Therefore, the hunt for newer sources of disease resistance needs to be intensified. Use of virus resistant variety is the most efficient and cheapest way to alleviate the occurrence of MYMV disease. Screening urdbean germplasm against MYMV for the identification of resistant genotypes is very much essential. A number of resistant lines have been reported by several workers4–7. With this background knowledge, the present investigation was envisaged to screen the urdbean germplasm accessions and identify the resistant MYMV genotypes with higher seed yield through field screening under natural condition

2. MATERIALS AND METHODS

Studies were undertaken to identify the urdbean germplasms for high seed yield coupled with resistance against *Mungbean yellow mosaic virus* disease. Field experiments were conducted for two consecutive years during summer and *Kharif* 2015-2016 under natural condition of disease incidence. Well levelled plots with satisfactory drainage system were selected for the experiment. A set of total of 128 urdbean genotypes were assessed for yield performances as well as reaction against MYMV under natural field conditions in the augmented design by planting 2 rows of two test entries, each alternated with one row of LBG 623 as susceptible check. Each test entry was planted in a row of 4 meter in length with row to row distance 30 cm and within row plant distance 10 cm. Percent disease incidence at pod formation stage was calculated and the genotypes were later grouped into different categories based on a 1 to 9 scale [1] ranging from highly susceptible to disease free which is described in (Table 1). Ripened pods in the individual row were picked at appropriate marturity, sun dried for 10 days, and grains were separated and weighed to record the yield.

Yield performance of selected top five urdbean lines/varieties exhibiting resistance to MYMV as well as high seed yield per plant was revalidated along with local check varieties like Uttara, PU 31, WBU 108 and Naveen in in Randomized Complete Block Design (RCBD) with three replications in summer and *Kharif* 2017. The size of the individual plot was 6.0 m^2 (4 m × 1.5 m). Seed yield per plot were recorded and subjected to statistical analysis. The per cent disease incidence was also analysed.

3. RESULTS AND DISCUSSION

3.1 Disease Reaction of *Mungbean yellow mosaic virus* on Urdbean during Summer and *Kharif* Season of 2015-2016

The tested mungbean germplasms/varieties showed wide variation in reaction to MYMV disease under field condition at different growth stages. The sensitivity of the tested mungbean germplasms/varieties increased with the increase in age of the plants. The tendency of prevalence of MYMV was as follows: flowering stage > maturity stage. But this tendency was not always a regular pattern to all the germplasms/varieties. Some materials are sensitive at flowering stage. Moreover, the tested germplasms/varieties showed variation in tolerance/resistance over the experimental period. These findings corroborate findings of previous studies [7,8].

In the present investigation, a total of 128 urdbean genotypes were assessed to identify the resistant genotypes against MYMV under natural field conditions during four consecutive seasons, summer and *Kharif,* 2015 & 2016. Germination was completed within a week and the first appearance of yellow mosaic was recorded in several genotypes two weeks after planting. The results revealed great variation among genotypes. Results of disease reaction of genotypes during summer and *kharif*, 2015 & 2016 are presented in (Table 2). Out of 128 genotypes evaluated, only five genotypes viz., KU 96-3, NDU 12-1, NIRB 002, NIRB 003 & NIRB 004 showed disease free reaction in all the seasons whereas, nineteen genotypes (IPU 10-23, IPU 11-01, KPU 34, KUG 540, KUG 586, Mash-338, NDU 12-2, NDU 12-300, NDUZ 14-21,OBG 35, PU 09-35, Shekhar 3, UH 07-06, Uttara, VBG 10-008, VBG 11-053,VBN (BG) 3, VBN 6 & Vijay) were found to be highly resistant and eight genotypes (IPU 2-43, KPU 1-10, KUG 503, NDUZ 14-24, PU 31, RUG 55, VBG 10-0024, & VBN (BG) 7) showed disease free reaction in one season and highly resistant reaction in another season or high resistance in one of season and resistance in another season. Although, twenty two genotypes i.e. IGKU 02-1, Kopergaon, KPU 12, KPU 13, KPU 14, KPU 16, KPU 33, KPU 7, KPU 8, KU 363, NDU 11-01,Palampur 93, Pant U 19, PU 08-05, PU 20, PU 22, RUG-44, Sekhar 2 , TU 67, UG 218, VBG 09-005 & WBU 108 exhibited a level of resistance consistently in both seasons over two year. Ten genotypes (IPU 13-01, KU 1106, KUG 391, KUG 479, KUG 662, KUG 719, MU 44, Naveen, VBG 12-062 & WBG 109) showed moderately resistance reactions in one of the seasons and high resistance or resistance in another season. Forty three genotypes were found to be moderately susceptible, susceptible and highly susceptible in one season, whereas, twenty one genotypes, i.e. AAU 34, AKU 10-4, AKU 11-15, AKU 15, AKU 7-4, AKU-7-1, CO 5,COBG 10-06, COBG 11-02, COBG 11-03, LBG 623, LBG-645, MU 46, NUL 2-5, NUL-138, PDU 1,TAU-1, TAU-4, TU 17-4, TU-26 & VBN (BG) 4 were found to be highly susceptible against MYMV in both the seasons over two years, showing severe yellow discoloration of leaves covering 50-75% of foliage, stunting of plants and reduction in pod size. The present study showed that some genotypes differ in reaction against MYMV during summer and *Kharif*. In general, overall disease incidence was higher and the majority of genotypes tested recorded susceptible and highly susceptible reactions against MYMV. These findings support previous findings [9] Singh and Awasthi 2004; [8,10]. Another screening experiment reported that none of the test entries were immune [11]. This study indicates the potentiality of these genotypes as resistance donors. Similarly, several mungbean genotypes were screened previously [12,13] and only two Meha and ML-1477 were found resistant in the Jharkhand region.

3.2 Performance of Selected 44 Urdbean Germplasm/ Varieties Showing Resistance to MYMV in Improved Seed Yield during Summer and *Kharif* Season of 2015-2016

Seed yield and disease incidence of urdbean genotypes showing disease free, HR, R, MR reaction against MYMV in both the season over two year are shown in (Table 3). Seed yield of urdbean genotypes showing disease free, HR, R, MR reaction against MYMV ranged from 8.14 g to 0.04 g per plant. KU 363 produced the highest

seed yield of 8.14 g per plant, with 1.88% disease incidence followed by UH 07-06 (7.40 g per plant), KUG 586 (7.12 g per plant) and KUG 503 (6.76 g per plant) and exhibited highly resistance re-action with rating scale "2" showing yellow specks with restricted spread covering 0.1-5% leaf area. Five MYMV resistant genotypes i.e. UH 07-06 (7.40 g/plant), KU 363 (8.14 g/plant), KUG 586 (7.12 g/plant), KUG 503 (6.76 g/plant) & KUG 540 (6.46 g/plant) were found to be superior for seed yield coupled with having high MYMV disease resistance over local checks like Uttara (4.42 g/plant), PU 31 (3.91 g/plant), WBU 108 (5.62 g/plant) and Naveen (2.18 g/plant).

Table 1. Disease rating scale (1-9) for MYMV

Disease Score	Description	Disease Reaction
1	No visible symptoms on leaves or very minute yellow specks on leaves	Free
2	Small yellow specks with restricted spread covering 0.1-5% leaf area	HR
3	Mottling of leaves covering 6-10% leaf area	R
4	Yellow mottling covering 11-15% leaf area	MR
5	Yellow mottling and discolouration of 15-20% leaf area	MS
6	Yellow coloration of 21-30% leaves and yellow pods	S
7	Pronounced yellow mottling and discoloration of leaves and pods, reduction in leaf size and stunting of plants covering 30-50% 0f foliage	S
8	Severe yellow discoloration of leaves covering 50-75% of foliage, stunting of plants and reduction in pod size	HS
9	Severe yellowing of leaves covering above of foliage, stunting of plants and no pod formation	HS

Table 2. Reaction of urdbean genotypes against *MYMV* during summer and *Kharif*, 2015 & 2016

Genotypes	Total no. of entries	Reaction group/ summer 2015 and *Kharif* 2016
KU 96-3, NDU 12-1, NIRB 002, NIRB 003 & NIRB 004	5	Free-Free
IPU 10-23, IPU 11-01, KPU 34, KUG 540, KUG 586, Mash-338, NDU 12-2, NDU 12-300, NDUZ 14-21,OBG 35, PU 09-35, Shekhar 3, UH 07-06, Uttara, VBG 10-008, VBG 11-053,VBN (BG) 3, VBN 6 & Vijay	19	HR-HR
IPU 2-43, KPU 1-10, KUG 503, NDUZ 14-24, PU 31, RUG 55, VBG 10-0024, & VBN (BG) 7	8	Free-HR, HR-Free
IGKU 02-1, Kopergaon, KPU 12, KPU 13, KPU 14, KPU 16, KPU 33, KPU 7, KPU 8, KU 363, NDU 11-01,Palampur 93, Pant U 19, PU 08-05, PU 20, PU 22, RUG-44, Sekhar 2 , TU 67, UG 218, VBG 09-005 & WBU 108	22	HR-R, R-HR , R-R
IPU 13-01, KU 1106, KUG 391, KUG 479, KUG 662, KUG 719, MU 44, Naveen , VBG 12-062 & WBG 109	10	HR/R-MR, MR-HR/R
AKU 10-1, AKU 9804, AKU 9904, B-3-8-8, Barabanki Local, BDU-1,Birsa Urd-1, CBG 703, CBG-757, CO 6, COBG 10-5,COBG 653, COBG 761, DBG 11, KPU 129-104,KPU 26-10, KPU 405, KPU 406, KPU-07-06, KPU-07-08, KUG 752, Kullu 4, LBG 17, LBG 752, LBG 792, LBG-20,LBG-685, Mash 391,NUL 7, P 726, Phule U-0014, Pragya, RBU-38, RUG-10, RVSU 11-8, RVSU 60, T9, TAU-9, TJ 41, TU 22, TU 631, TU-94-2 & VBN (BG) 5	43	HS/ MS/S in one of season
AAU 34, AKU 10-4, AKU 11-15, AKU 15, AKU 7-4, AKU-7-1, CO 5,COBG 10-06, COBG 11-02, COBG 11-03, LBG 623, LBG-645, MU 46, NUL 2-5, NUL-138, PDU 1,TAU-1, TAU-4, TU 17-4, TU-26 & VBN (BG) 4	21	HS-HS
Total	**128**	

Table 3. Seed yield and disease incidence of urdbean genotypes showing disease free, HR, R, MR reaction against *MYMV* during summer and *Kharif*, 2015& 2016

S. No.	Entries	Percent disease incidence *	Yield/Plant* (g)
1.	IGKU 02-1	95.35	2.73
2.	IPU 10-23	2.6 0	3.45
3.	IPU 11-01	1.25	3.33
4.	IPU 13-01	1.25	3.54
5.	IPU 2-43	1.98	5.64
6.	Kopergaon	96.16	0.04
7.	KPU 1-10	5.34	3.82
8.	KPU 12	41.53	2.76
9.	KPU 13	63.74	2.05
10.	KPU 14	3.17	3.93
11.	KPU 16	7.96	2.73
12.	KPU 33	83.6	3.59
13.	KPU 34	1.34	3.52
14.	KPU 7	4.35	3.28
15.	KPU 8	4.26	4.91
16.	KU 1106	8.55	3.01
17.	KU 363	1.88	8.14
18.	KU 96-3	0.00	3.25
19.	KUG 391	12.5	3.39
20.	KUG 479	25.00	3.58
21.	KUG 503	5.5	6.76
22.	KUG 540	1.45	6.46
23.	KUG 586	8.55	7.12
24.	KUG 662	5.00	3.47
25.	KUG 719	1.34	3.25
26.	Mash-338	9.64	3.19
27.	MU 44	3.75	3.43
28.	Naveen	7.25	2.18
29.	NDU 11-201	10.05	4.49
30.	NDU 12-1	0.00	3.72
31.	NDU 12-2	3.81	4.1 5
32.	NDU 12-300	6.43	2.23
33.	NDUZ 14-21	8.65	3.33
34.	NDUZ 14-24	8.99	3.42
35.	NIRB 002	0.00	3.31
36.	NIRB 003	0.00	3.63
37.	NIRB 004	0.00	3.42
38.	OBG 35	3.23	2.86
39.	Palampur 93	4.26	2.24
40.	Pant U 19	3.24	2.57
41.	PU 08-05	91.6	2.11
42.	PU 09-35	4.85	2.93
43.	PU 31	2.67	3.91
44.	PU20	10.05	1.21
45.	PU22	8.99	2.53
46.	RUG 55	15.34	3.10
47.	RUG-44	12.52	3.44
48.	Sekhar 2	2.34	3.43
49.	Shekhar 3	1.25	3.62
50.	TU 67	2.50	2.24
51.	UG-218	4.26	3.12
52.	UH 07-06	4.08	7.40
53.	Uttara	4.53	4.42

S. No.	Entries	Percent disease incidence *	Yield/Plant* (g)
54.	VBG 09-005	84.66	2.32
55.	VBG 10-0024	2.88	4.31
56.	VBG 10-008	2.50	3.48
57.	VBG 11-053	1.25	3.31
58.	VBG 12-062	1.56	3.47
59.	VBN (BG) 7	3.17	5.32
60.	VBN (BG)3	3.95	4.22
61.	VBN 6	1.92	4.5
62.	Vijay	3.95	5.2
63.	WBG 109	2.34	3.34
64.	WBU 108	1.25	5.62

**Data are mean value of 4 seasons*

Table 4. Validation of MYMV resistant entries for grain yield

Sl. No.	Entries	Summer, 2017	*Kharif*, 2017
		Grain yield (Kg/ha)	Grain yield (Kg/ha)
1.	Uttara	944.44	1093.33
2.	PU-31	1027.78	1053.33
3.	KU-363	1125.00	1206.67
4.	KUG 540	1027.78	1200.00
5.	UH 07-06	982.11	1240.00
6.	KUG 503	1194.44	1066.67
7.	WBU 108	1082.00	1153.00
8.	Shekhar 3	902.00	1004.00

**Data are mean value of 3 replications*

Yield performance of selected top five urdbean lines/varieties exhibiting resistance to MYMV as well as high seed yield per plant is revalidated along with local check varieties like Uttara, PU 31, WBU 108 and Naveen as shown in Table 4. It was found that the maximum yield (1240 kg/ha) was recorded in UH 07-06 followed by KUG 540 (1200 kg/ha) in *Kharif* season, whereas, KUG 503 (1194.44 kg/ha**)** followed by KU 363 (1125 kg/ha) recorded maximum yield in summer season. Minimum yield (902 and 1004.00 kg/ha respectively) was recorded in Shekhar 3 in both summer and *Kharif* season respectively. An experiment using fourteen MYMV susceptible F_3 progenies from a cross NM 92 X VC 1560D showed significant differences for MYMV disease infection, yield and yield components [14].

Since viruses such as the single-stranded (ss) DNA begomoviruses are emergent problems worldwide [15,16]. They have higher mutation rates than other pathogens, and distinct evolutionary dynamics compared to bacterial and fungal phytopathogens. Therefore, breeding and screening of mungbean for resistance against MYMV should be carried out regularly and regionally for identification of suitable cultivars. The outcome of the current experiment gives information for adoption of resistant cultivars for cultivation and also use of resistance sources in improving the released cultivars for disease resistance and yield potential; this will certainly boost the mungbean production and productivity in Bihar.

4. CONCLUSION

With the findings of the present study it may be concluded that the lines UH 07-06 (1240 kg/ha) followed by KUG 540 (1200 kg/ha) gave higher yield coupled with MYMV disease resistance in *Kharif* season whereas, KUG 503 (1194.44 kg/ha) followed by KU 363 (1125 kg/ha) recorded maximum yield with MYMV disease resistance in summer season in comparison to the best local check varieties PU-31 and Uttara in Bihar during both *Kharif* and summer season. Thus, these lines may be released as a variety of mungbean after further investigation for Bihar.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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