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IDENTIFICATION OF SOURCES OF DISEASE RESISTANCE TO MUNGBEAN YELLOW MOSAIC VIRUS (MYMV) AND CERCOSPORA LEAF SPOT DISEASE (CLS) IN MUNGBEAN (*VIGNA RADIATA* L.)

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A B S T R A C T

One hundred and fifty genotypes of Mungbean were screened against two major diseases of Mungbean prevailed in Pakistan namely, Yellow Mosaic Disease (YMD) and Leaf Spot Disease (CLSD) at two different locations in Faisalabad. Germplasm screening was conducted under inoculum pressure at Faisalabad region during Kharif season 2017-18. Out of these One hundred and fifty genotypes, seventy-six were highly resistant (HR), forty-three were resistant (R), twelve were moderately resistant (MR), fifteen were moderately susceptible (MS), three were susceptible (S) and one was highly susceptible (HS) for Mungbean yellow mosaic virus (MYMV) based on rating scale. Seventy-six genotypes having highly resistant disease reaction can be used for breeding after further screening. No accession was found highly resistant, resistant and moderately resistant for Cercospora Leaf Spot Disease. However, 75 genotypes were found moderately susceptible, 57 genotypes were suspectable and 18 genotypes were highly susceptible against Cercospora leaf spot disease on the basis of rating scale and Percent Diseases Intensity (PDI%). Twelve genotypes were moderately susceptible for both the diseases, thirty-eight genotypes were highly resistant for MYMV and moderately susceptible for CLS. Similarly, fourteen genotypes were resistant to MYMV and moderately susceptible for CLS, seven genotypes were moderately resistant to MYMV and moderately susceptible to CLS. Five genotypes (MPP-15038, MPP-15039, MPP-15024, MPP-15002 and MPP-15003) were higher yielding as compared to other genotypes studied. These five genotypes can be used as a source of higher yield and can be bred with other genotypes having good disease resistance and other desirable characters.

Keywords: Fungicides, Mungbean Yellow Mosaic, Cercospora Leaf Spot, Characterization, Pakistan.

INTRODUCTION

Mungbean (Vigna radiata *L.*) is an economically significant pulse in Pakistan belongs to Fabaceae family and grown in Kharif season. It is a very predominant legume due to its short life cycle, increasing growth rate and practice as numerous food approaches (Singh *et al.,* 2016). Seed of Mungbean is a source of alimentary protein in humans diet counting poor peoples and less fertile areas where vegetarian diet habit prevails. Mungbean leaves and green pods contain high level of vitamins and minerals (Keatinge *et al.,* 2011; Nair *et al.,* 2015).

From the last two years, mungbean area and production has been steadily increasing in Pakistan. The area in Pakistan under Mungbean cultivation was 186,700 ha with yearly production of 132 thousand tons (Anonymous, 2020). While area in 2018-19 was recorded 163,200 ha with yearly production of 117 thousand tons which shows that a 14.39% increase in area and 12.64% increase in annual production was observed (Anonymous, 2019). Estimated crop yield is very low as compared to other countries but a less increase in yield/ha from 477 kg ha^{-1} (2001-02) to 648 kg ha^{-1} (2018-19) shows that a huge gap occurs among

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varietal potential and farmer's yield which needs to be fulfilled. This is due to low inherit yield potential and number of various biotic and abiotic stresses (Saeed *et al.,* 2018).

Amongst biotic stress, diseases remain to be a constraint to many mungbean growers across the country in kharif season where there is high variability in pathogenic races and host resistance in monogenic in nature (Nair *et al.,* 2015). Mungbean Viral diseases have the potential to reduce yield upto 40-60%. (Kaur *et al.,* 2011). Mungbean genotypes are unstable as for as disease resistance is concerned and evolution of new races results in breakdown of their resistance level which is a challenge for Mungbean breeders. Climate change also results in lowering pulses yield at farmers field condition due to variation in climatic factors like temperature, humidity, rainfall etc.

In Pakistan, research related to mungbean is primarily emphasized on the production of high yielding, short duration and bulky seeded varieties. YMD (yellow mosaic disease) is caused by geminivirus (genus Begomovirus, family Geminiviridae), which has binary genomes (DNA A and DNA B) (Parihar *et al.,* 2017). According to Habib *et al.* (2007) in Pakistan low yield in mungbean is due to high attack of diseases and insect pests. In mung bean MYMV resistance is based on a single recessive gene. The disease presently is a key risk to the thriving production of Mungbean in Pakistan, India, Bangladesh, Sri-Lanka, Papua New Guinea, Philippines, Myanmar, Nepal, Indonesia, Malaysia, Taiwan and Thailand (Karthikeyan *et al.,* 2014). Primarily, the symptoms of diseases are slight yellow spots laterally the veins on early leaves and progressively spread on entire leaves. Under extreme disease attack, the distinctive symptoms comprise chlorosis of total leaf surface on whole plant subsequently necrosis, shrinking of internodes, severe inhibiting plants to produce no yield & de-shaped pods with small, immature and shriveled seeds (Akhtar and Haq, 2003; Bashir, 2005; Akhtar *et al.*, 2009). Although, maximum yield loss was observed when disease occurs at early stage of plant development (Kitsanachandee *et al.,* 2013).

The second most seriously emerging disease is due to a fungus *Cercospora canesens* which causes Cercospora Leaf Spot (CLS), generally spread by spores of infected leaves. Typical indications of disease comprise brown to greyish spots in center with reddish-brown edges of leaves. In mungbean spread of disease is severe causing high reduction in yield. In humid areas of Pakistan, production loses of mung bean due to CLS is upto 23% to 47% (Ali *et al.,* 2010). Extreme loss of 61% was reported in grain yield. The disease initially appears after 30-40 days of planting. Its rapid spread in suspectable varieties triggers leaf loss, reducing pod size and grain weight, however spread is liable upon temperature and humidity (Iqbal *et al.,* 2004).

Moreover, it is very difficult to control these diseases through difficult chemicals, cultural as well as application of different plant extracts. It becomes more challenging to breed MYMV and CLS resistant mungbean cultivars because of its varied host range, virus distinction and quantitative inheritance. Grouping resistant genotypes is an efficient way to mitigate these diseases. Researchers and breeders should need to develop mungbean genotypes that are highly resistant to the precise viruses that source YMD in them (Saeed *et al.,* 2018). Keeping in view the above facts about these diseases of mungbean, the current study was conducted to find out mungbean accessions having resistance against MYMV and CLSD along-with better yield.

MATERIALS AND METHODS

One hundred and fifty genotypes including three check varieties NM-2006, NM-2011 and NM-2016 are the outcome of hybridization at Pulses Research Institute (PRI), Faisalabad and Nuclear Institute for Agriculture and Biology (NIAB) Faisalabad were screened in present study during year 2017. One hundred genotypes were contributed by NIAB and fifty genotypes were from PRI, Faisalabad. The material was planted during on 25th April 2017. Two sets of the material were planted. All genotypes in 1st set, were planted in a plot with row length of 4 m keeping row to row and plant to plant spacing of 30 × 10 cm, respectively for yield evaluation. The net plot size was 1.2 m x 4 m for yield set, whereas a separate set was sown with a single row of 4 m length. After each 2 rows a spreader row of susceptible check was planted. Conventional agronomic practices were followed to keep the crop in good condition. Data for disease severity was recorded following the rating system described by (Akhtar *et al.,* 2009) to calculate disease percentage and severity index and reaction of genotypes.

For MYMD: MYMV occurrence, data were taken on the basis of total plant stand for each accession and the affected with MYMV after 50 days of sowing. Depending on severity of MYMV prevalence, the categorization of genotypes-based rating scale (0-5) is show below: (Bashir *et al.,* 1988).

Rating scale of Mungbean for Mungbean Yellow Mosaic Disease (MYMD)

Score	Symptom Description	Severity Index	Response
0	Complete absence of symptoms	0	Highly resistant
1	Small yellow spots on few leaves seen after careful observations	0.01-1.4	Resistant
2	Bright yellow spots on leaves, easily observed and coalesced.	1.5-2.4	Moderately Resistant
3	Mostly coalesced bright yellow spots present on leaves, but no reduction in yield	2.5-3.4	Moderately Susceptible
4	Plants having coalesced bright yellow specks on all leaves, with minor stunting and set fewer normal pods	3.5-4.4	Susceptible
5	Yellowing of leaves on whole plant, shortening of internode, severe stunting of plants with no yield or produced with small, immature and shriveled seeds	4.5-5.0	Highly Susceptible

(Sekar and Nalini, 2017)

For CLS: Ten plants from each genotype were selected for data recording. The observations on CLS infection were noted 35 days after sowing by selecting three leaves from top, three from middle and three from bottom portion of the plant. The accessions were grouped on the basis of leaf are affected (0-5 scale).

Disease rating scale for Cercospora Leaf Spot Disease (CLSD)

Score	Symptoms	Disease response
0	No visible symptoms on Plants	Highly resistant
1	1 to 10% foliage or pod area affected	Resistant
2	11 to 20% foliage or pod area affected brown spots	Moderately Resistant
3	21 to 30% foliage or pod area affected large spots	Moderately Susceptible
4	31 to 50% foliage or pod area affected coalescing	Susceptible
5	51 to 100% foliage infected plants	Highly Susceptible

(Abbas *et al.,* 2020)

Yield: The grain yield was recorded from each plot (20 Plants) and converted into kg ha^{-1}.

$$\text{Disease incidence of MYMV and CLS (\%)} = \frac{\text{Sum of ratings of infected leaves observed}}{\text{Total number of plants in each plot}} \times 1000$$

(Singh *et al.,* 2015)

At 60 DAS the disease severity was recorded. Five infected plants were randomly selected in each plot and 5 leaves from each plant were selected for scoring the disease severity. The percentage disease incidence (PDI) of MYMV and CLS were calculated as;

$$\text{PDI (\%)} = \frac{\text{Sum of ratings of infected leaves observed}}{\text{Number of leaves observed} \times \text{Maximum disease score}} \times 100$$

(Sekar and Nalini, 2017)

RESULTS AND DISCUSSION

The data for Mungbean yellow mosaic virus and Cercospora leaf spot showed wide variation. The genotypes categorization and grouping were done on the basis of data recorded under field conditions. As most of commercial cultivars show susceptibility against both diseases in Pakistan, the only cheap and workable solution is development of disease resistant breeding material which is reported to be effective and environment friendly way (Sekar and Nalini, 2017). Success of the breeding program aiming to the development of disease resistant cultivars must have diversity in its germplasm collection.

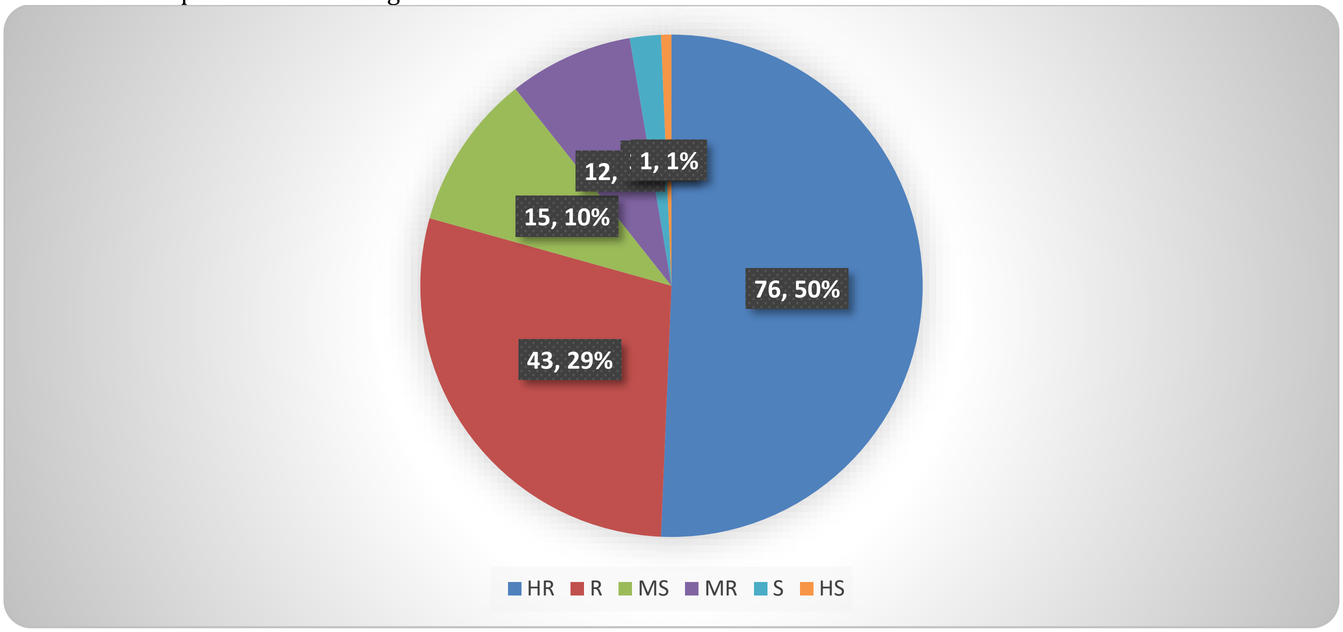
Screening for Mungbean Yellow Mosaic Virus (MYMV) resistance: In this study, leading to identification MYMV resistant genotypes several accessions were identified with varying levels of resistance against the disease. Out of one hundred and fifty tested genotypes the MYMV incidence ranged from 0 to 68.3 percent, seventy-six accessions have shown high resistance level, forty-three accessions were found resistant, twelve accessions were at the level of moderate resistance, fifteen accessions were reported with moderate susceptibility, three were susceptible and only1 genotype was found highly susceptible against MYMV (Table-1) pie chart 1. Significantly maximum incidence of MYMY was recorded in genotype MPP-15001 68.3% and found highly susceptible followed by MPP-15018 (50.0%), MPP-15015 (46%) and MPP-15004 (45.1%) were found susceptible against MYMV incidence. Similarly, MYMY incidence for resistant genotypes ranged from 5.7 to 10.0%, for moderately resistant genotypes ranged 15.2 to 20% and for moderately susceptible genotypes ranged from 23.4 to 29.8% as shown in Table-1 and Table-3.

Pie chart No.1 indicated that 50% of the accessions were highly resistant, 43% resistant, 10% moderately susceptible, 8% moderately resistant, 2% susceptible and 1% highly susceptible against mungbean yellow mosaic virus (MYMV).

Table 1. Reaction of Mungbean germplasm and breeding material against MYMV disease at Pluses Research Institute, Faisalabad during year 2017.

Diseases	Reaction Group	Name of genotypes	Number	MYMV incidence
Mungbean yellow mosaic virus	Highly Resistant (HR)	MPP-15031, MPP-15033, MPP-15034, MPP-15037, MPP-15038, MPP-15040, MPP-15043, MPP-15047, MPP-15048, MPP-15049, MPP-15050, MPP-15051, MPP-15052, MPP-15053, MPP-15054, MPP-15056, MPP-15057, MPP-15058, MPP-15060, MPP-15063, MPP-15067, MPP-15071, MPP-15072, MPP-15074, MPP-15075, MPP-15076, MPP-15077, MPP-15078, MPP-15080, MPP-15086, MPP-15087, MPP-15088, MPP-15090, MPP-15091, MPP-15092, MPP-15093, MPP-15094, MPP-15095, MPP-15096, MPP-15097, MPP-15098, MPP-15101, MPP-15102, MPP-15103, MPP-15104, MPP-15108, MPP-15109, MPP-15110, MPP-15111, MPP-15112, MPP-15114, MPP-15115, MPP-15116, MPP-15119, MPP-15120, MPP-15121, MPP-15122, MPP-15125, MPP-15126, MPP-15127, MPP-15128, MPP-15132, MPP-15133, MPP-15134, MPP-15135, MPP-15136, MPP-15139, MPP-15140, MPP-15141, MPP-15142, MPP-15143, MPP-15144, MPP-15145, MPP-15146, MPP-15149, MPP-15150.	76	
	Resistant (R)	MPP-15002, MPP-15007, MPP-15009, MPP-15024, MPP-15025, MPP-15029, MPP-15030, MPP-15032, MPP-15035, MPP-15036, MPP-15039, MPP-15041, MPP-15042, MPP-15044, MPP-15045, MPP-15046, MPP-15055, MPP-15059, MPP-15062, MPP-15068, MPP-15069, MPP-15070, MPP-15073, MPP-15079, MPP-15081, MPP-15082, MPP-15083, MPP-15084, MPP-15085, MPP-15089, MPP-15099, MPP-15100, MPP-15105, MPP-15106, MPP-15107, MPP-15113, MPP-15123, MPP-15124, MPP-15131, MPP-15137, MPP-15138, MPP-15147, MPP-15148	43	5.7-10.0
	Moderately Resistant (MR)	MPP-15010, MPP-15011, MPP-15013, MPP-15021, MPP-15027, MPP-15028, MPP-15061, MPP-15064, MPP-15065, MPP-15117, MPP-15118, MPP-15130.	12	15.2-20.0
	Moderately Susceptible (MS)	MPP-15003, MPP-15005, MPP-15006, MPP-15008, MPP-15012, MPP-15014, MPP-15016, MPP-15017, MPP-15019, MPP-15020, MPP-15022, MPP-15023, MPP-15026, MPP-15066, MPP-15129.	15	23.4-29.8
	Susceptible (S)	MPP-15004, MPP-15018, MPP-15015.	3	45.1-50.0
	Highly Susceptible (HS)	MPP-15001	1	68.3

Pie Chart-1:Response of Entries Against MYMD



Screening of Mungbean against *Cercospora* leaf Spot: Mungbean germplasm studied exhibited narrow range of variability ranging from moderately susceptible to highly susceptible disease reaction. Out of one hundred and fifty genotypes screened under natural conditions at Pulses field area of Pulses Research Institute, Faisalabad, none of the variety was resistant against Cercospora leaf spot disease (CLSD). A very low frequency of genotypes comprising 75 genotypes out of 150 were moderately susceptible with ranged incidence between 20.8 to 39.7%, 57 genotypes were susceptible with ranged incidence between 40.4 to 59.2% and 18 genotypes were highly susceptible with ranged incidence between 60.9 to 76.1% against Cercospora leaf spot (Table-2) pie chart 2.

The highest disease incidence against CLSD was found in genotype MPP-15018 (76.1%) followed by MPP-15028 (75.0%) and MPP-15031 (73.8%) categorized as highly susceptible. Similarly, lowest disease incidence against CLSD was found in genotype MPP-15004 (20.8%) followed by MPP-15057 (21.9%) and MPP-15005 (22.1%), respectively categorized as moderately susceptible (Table-3).

Pie Chart-2:Response of Entries Against CLSD:

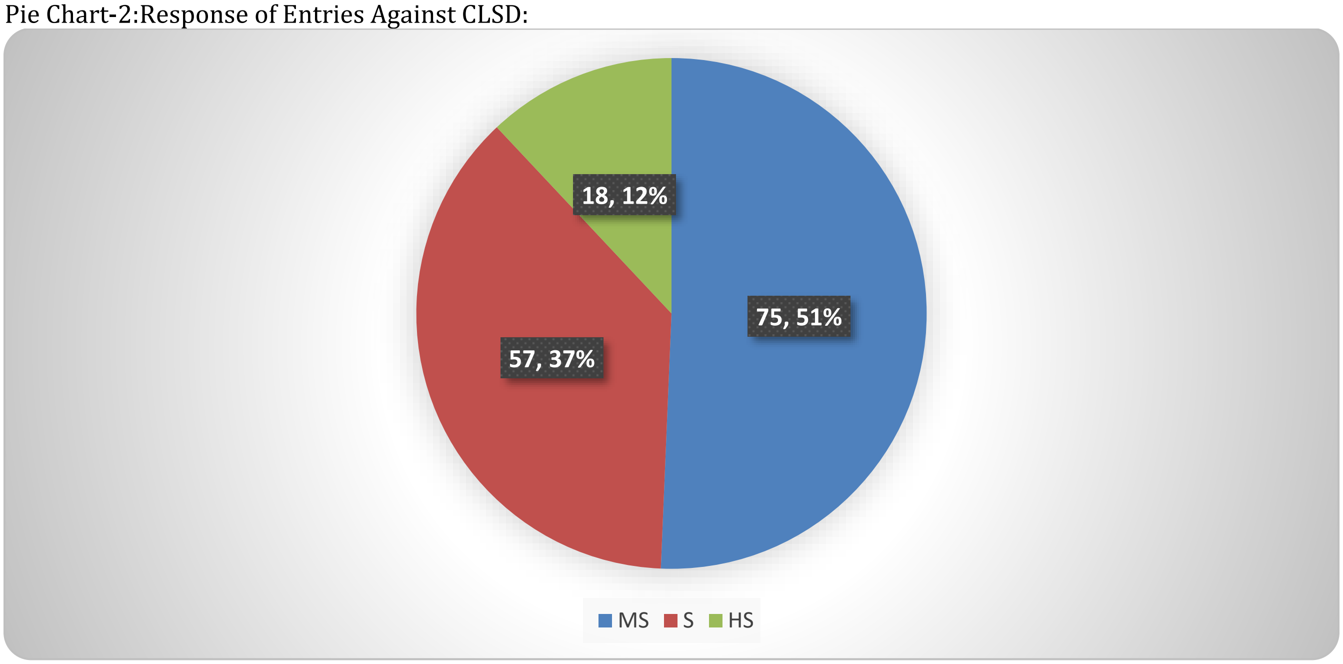


Table-2. Reaction of Mungbean germplasm and breeding material against Cercospora leaf spot (CLS) disease at Pluses Research Institute, Faisalabad during the year, 2017.

Diseases	Reaction Group	Name of genotypes	Number	PDI %
Cercospora leaf spot disease	Moderately Susceptible (MS)	MPP-15003, MPP-15004, MPP-15005, MPP-15006, MPP-15007, MPP-15008, MPP-15009, MPP-15010, MPP-15011, MPP-15012, MPP-15013, MPP-15014, MPP-15015, MPP-15016, MPP-15019, MPP-15020, MPP-15022, MPP-15023, MPP-15024, MPP-15025, MPP-15026, MPP-15027, MPP-15037, MPP-15039, MPP-15051, MPP-15052, MPP-15054, MPP-15055, MPP-15056, MPP-15057, MPP-15061, MPP-15064, MPP-15065, MPP-15066, MPP-15067, MPP-15072, MPP-15074, MPP-15077, MPP-15079, MPP-15087, MPP-15088, MPP-15092, MPP-15095, MPP-15096, MPP-15097, MPP-15098, MPP-15099, MPP-15103, MPP-15108, MPP-15109, MPP-15114, MPP-15115, MPP-15116, MPP-15113, MPP-15117, MPP-15118, MPP-15123, MPP-15124, MPP-15127, MPP-15128, MPP-15131, MPP-15132, MPP-15133, MPP-15134, MPP-15137, MPP-15141, MPP-15142, MPP-15143, MPP-15144, MPP-15145, MPP-15146, MPP-15147, MPP-15148, MPP-15149, MPP-15150.	75	20.8-39.7
	Susceptible (S)	MPP-15001, MPP-15002, MPP-15017, MPP-15021, MPP-15029, MPP-15030, MPP-15032, MPP-15033, MPP-15035, MPP-15038, MPP-15040, MPP-15042, MPP-15043, MPP-15045, MPP-15049, MPP-15050, MPP-15053, MPP-15058, MPP-15060, MPP-15062, MPP-15063, MPP-15068, MPP-15069, MPP-15071, MPP-15073, MPP-15075, MPP-15078, MPP-15080, MPP-15081, MPP-15082, MPP-15085, MPP-15086, MPP-15089, MPP-15090, MPP-15093, MPP-15094, MPP-15100, MPP-15101, MPP-15102, MPP-15104, MPP-15105, MPP-15106, MPP-15107, MPP-15110, MPP-15119, MPP-15120, MPP-15121, MPP-15122, MPP-15125, MPP-15126, MPP-15129, MPP-15130, MPP-15135, MPP-15136, MPP-15138, MPP-15139, MPP-15140.	57	40.4-59.2
	Highly Susceptible (HS)	MPP-15018, MPP-15028, MPP-15031, MPP-15034, MPP-15036, MPP-15041, MPP-15044, MPP-15046, MPP-15048, MPP-15047, MPP-15059, MPP-15070, MPP-15076, MPP-15083, MPP-15084, MPP-15106, MPP-15112, MPP-15111,	18	60.9-76.1

Genetic resistance is the best and most popular option for disease management in mungbean and other crops. In present study, 72 genotypes with multiple disease resistance were identified (Table-4).

Out of these seventy-two genotypes, thirty-eight (38) genotypes were highly resistant for MYMV and moderately susceptible for CLS, fourteen (14) genotypes were resistant for MYMV and moderately susceptible for CLS, eight (8) genotypes were moderately resistant for MYMV and moderately susceptible for CLS and twelve (12) genotypes were moderately susceptible for both (MYMV and CLS) diseases.

Many researchers have reported reduction in yield losses by developing disease resistant genotypes (kaur *et al.,* 2011 reported 40 to 50 % yield losses in mungbean due to suspectable cultivars while Nair *et al.*(2007) reported that in Mungbean grown during kharif season there is lesser level of disease resistance which basic cause of lower yield.

Habib *et al.* (2007) also reported high attack of diseases as a major factor of low yield in Pakistan. Therefore, use of resistant genotypes in breeding program for introgression of disease resistance genes is urgently needed. Availability of MYMV resistance genes is reported by Karthikeyan *et al.* (2014) in Asian germplasm.

Table-3. Screening of Mungbean genotypes for yield, resistance against mungbean yellow mosaic virus and leaf spot disease during the year 2017.

Sr. No	Entry Name	MYMD (PDI%)	Disease Reaction	CLSD (PDI%)	Disease Reaction	Yield kg ha-1
1	MPP -15001	68.3	HS	50.2	S	472
2	MPP -15002	9.9	R	50.8	S	1082
3	MPP -15003	28.4	MS	29.1	MS	1120
4	MPP -15004	45.1	S	20.8	MS	666
5	MPP -15005	25.7	MS	22.1	MS	726
6	MPP -15006	30.0	MS	30.1	MS	590
7	MPP -15007	5.7	R	32.1	MS	480
8	MPP -15008	28.3	MS	37.1	MS	668
9	MPP -15009	7.8	R	39.2	MS	226
10	MPP -15010	16.1	MR	37.1	MS	336
11	MPP -15011	17.3	MR	26.1	MS	620
12	MPP -15012	27.7	MS	37.0	MS	706
13	MPP -15013	17.8	MR	38.3	MS	928
14	MPP -15014	29.1	MS	30.9	MS	752
15	MPP -15015	46.0	S	29.3	MS	676
16	MPP -15016	29.4	MS	30.5	MS	720
17	MPP -15017	24.5	MS	48.1	S	590
18	MPP -15018	50.0	S	76.1	HS	924
19	MPP -15019	25.9	MS	22.0	MS	722
20	MPP -15020	23.4	MS	23.8	MS	628
21	MPP -15021	18.3	MR	50.3	S	446
22	MPP -15022	28.7	MS	35.9	MS	558
23	MPP -15023	29.8	MS	33.9	MS	642
24	MPP -15024	7.9	R	26.1	MS	1140
25	MPP -15025	7.4	R	29.3	MS	990
26	MPP -15026	26.9	MS	33.9	MS	974
27	MPP -15027	15.2	MR	35.8	MS	854
28	MPP -15028	20.0	MR	75.0	HS	650
29	MPP -15029	8.4	R	48.7	S	402
30	MPP -15030	8.1	R	45.7	S	740
31	MPP -15031	0	HR	73.8	HS	360
32	MPP -15032	9.0	R	56.9	S	924
33	MPP -15033	0	HR	58.2	S	414
34	MPP -15034	0	HR	67.3	HS	680
35	MPP -15035	6.1	R	40.4	S	762
36	MPP -15036	9.7	R	62.0	HS	572
37	MPP -15037	0	HR	23.2	MS	632
38	MPP-15038	0	HR	45.1	S	1222
39	MPP -15039	6.5	R	27.0	MS	1212
40	MPP -15040	0	HR	50.2	S	872

41	MPP -15041	9.6	R	60.9	HS	992
42	MPP -15042	8.1	R	45.0	S	988
43	MPP -15043	0	HR	46.9	S	894
44	MPP -15044	10.0	R	64.0	HS	564
45	MPP -15045	7.7	R	47.9	S	692
46	MPP -15046	8.5	R	65.9	HS	444
47	MPP -15047	0	HR	62.0	HS	660
48	MPP -15048	0	HR	64.8	HS	706
49	MPP -15049	0	HR	49.0	S	728
50	MPP -15050	0	HR	45.9	S	602
51	MPP -15051	0	HR	34.2	MS	700
52	MPP -15052	0	HR	34.9	MS	846
53	MPP -15053	0	HR	44.9	S	972
54	MPP -15054	0	HR	34.8	MS	750
55	MPP -15055	5.9	R	30.9	MS	798
56	MPP -15056	0	HR	25.9	MS	896
57	MPP -15057	0	HR	21.9	MS	930
58	MPP -15058	0	HR	44.1	S	870
59	MPP -15059	9.9	R	65.0	HS	712
60	MPP -15060	0	HR	45.1	S	602
61	MPP -15061	18.0	MR	23.7	MS	598
62	MPP -15062	7.1	R	45.0	S	928
63	MPP -15063	0	HR	45.9	S	718
64	MPP -15064	18.8	MR	37.8	MS	642
65	MPP -15065	17.9	MR	35.9	MS	425
66	MPP -15066	27.4	MS	29.8	MS	325
67	MPP -15067	0	HR	27.9	MS	742
68	MPP -15068	9.2	R	44.1	S	200
69	MPP -15069	8.4	R	40.9	S	660
70	MPP -15070	9.7	R	60.9	HS	708
71	MPP -15071	0	HR	45.9	S	446
72	MPP -15072	0	HR	38.6	MS	456
73	MPP -15073	9.0	R	40.7	S	473
74	MPP -15074	0	HR	24.8	MS	524
75	MPP -15075	0	HR	50.8	S	618
76	MPP -15076	0	HR	69.8	HS	342
77	MPP -15077	0	HR	34.7	MS	304
78	MPP -15078	0	HR	58.9	S	220
79	MPP -15079	7.5	R	34.9	MS	712
80	MPP -15080	0	HR	45.9	S	716
81	MPP -15081	8.0	R	49.9	S	632
82	MPP -15082	8.9	R	58.9	S	812
83	MPP -15083	9.1	R	65.0	HS	660

84	MPP -15084	9.9	R	66.7	HS	734
85	MPP -15085	8.7	R	55.8	S	740
86	MPP -15086	0	HR	50.9	S	772
87	MPP -15087	0	HR	34.7	MS	784
88	MPP -15088	0	HR	33.9	MS	666
89	MPP -15089	8.9	R	55.0	S	660
90	MPP -15090	0	HR	54.0	S	600
91	MPP -15091	0	HR	34.0	MS	652
92	MPP -15092	0	HR	29.0	MS	560
93	MPP -15093	0	HR	55.0	S	784
94	MPP -15094	0	HR	51.9	S	874
95	MPP -15095	0	HR	30.7	MS	866
96	MPP -15096	0	HR	35.5	MS	846
97	MPP -15097	0	HR	30.6	MS	802
98	MPP -15098	0	HR	34.5	MS	754
99	MPP -15099	7.8	R	39.3	MS	918
100	MPP -15100	10.0	R	56.8	S	902
101	MPP -15101	0	HR	57.2	S	718
102	MPP -15102	0	HR	59.2	S	835
103	MPP -15103	0	HR	35.9	MS	920
104	MPP -15104	0	HR	55.1	S	914
105	MPP -15105	8.4	R	50.9	S	942
106	MPP -15106	9.5	R	65.0	HS	778
107	MPP -15107	9.2	R	54.8	S	716
108	MPP -15108	0	HR	38.9	MS	820
109	MPP -15109	0	HR	35.8	MS	916
110	MPP -15110	0	HR	49.9	S	702
111	MPP -15111	0	HR	62.9	HS	836
112	MPP -15112	0	HR	69.9	HS	816
113	MPP -15113	7.7	R	38.1	MS	712
114	MPP -15114	0	HR	29.4	MS	654
115	MPP -15115	0	HR	38.9	MS	618
116	MPP -15116	0	HR	39.6	MS	714
117	MPP -15117	17.4	MR	37.2	MS	712
118	MPP -15118	16.8	MR	30.9	MS	820
119	MPP -15119	0	HR	45.1	S	910
120	MPP -15120	0	HR	40.4	S	622
121	MPP -15121	0	HR	46.4	S	734
122	MPP -15122	0	HR	44.8	S	710
123	MPP -15123	6.9	R	34.9	MS	810
124	MPP -15124	7.3	R	35.8	MS	914
125	MPP -15125	0	HR	49.9	S	742
126	MPP -15126	0	HR	47.7	S	704

127	MPP -15127	0	HR	39.8	MS	505
128	MPP -15128	0	HR	39.1	MS	910
129	MPP -15129	28.1	MS	45.8	S	617
130	MPP -15130	19.8	MR	45.8	S	524
131	MPP -15131	6.4	R	34.1	MS	602
132	MPP -15132	0	HR	38.9	MS	618
133	MPP -15133	0	HR	39.9	MS	604
134	MPP -15134	0	HR	29.8	MS	630
135	MPP -15135	0	HR	45.7	S	618
136	MPP -15136	0	HR	49.2	S	714
137	MPP -15137	6.8	R	37.9	MS	704
138	MPP -15138	7.3	R	45.8	S	842
139	MPP -15139	0	HR	45.0	S	628
140	MPP -15140	0	HR	40.9	S	544
141	MPP -15141	0	HR	23.0	MS	648
142	MPP -15142	0	HR	29.9	MS	716
143	MPP -15143	0	HR	29.8	MS	836
144	MPP -15144	0	HR	28.5	MS	702
145	MPP -15145	0	HR	37.9	MS	614
146	MPP -15146	0	HR	37.9	MS	714
147	MPP -15147	6.7	R	35.7	MS	660
148	MPP -15148	6.3	R	35.4	MS	615
149	MPP -15149	0	HR	34.7	MS	714
150	MPP -15150	0	HR	33.9	MS	652

Table 4. Mungbean genotypes having resistance against potential viral diseases

Disease Reaction	Name of Genotypes	Number
Highly Resistant for MYMV and Moderately Susceptible for CLS	MPP-15037, MPP-15051, MPP-15052, MPP-15054, MPP-15056, MPP-15057, MPP-15064, MPP-15067, MPP-15072, MPP-15074, MPP-15077, MPP-15087, MPP-15088, MPP-15091, MPP-15092, MPP-15095, MPP-15096, MPP-15098, MPP-15097, MPP-15103, MPP-15108, MPP-15109, MPP-15114, MPP-15115, MPP-15116, MPP-15127, MPP-15128, MPP-15132, MPP-15133, MPP-15134, MPP-15141, MPP-15142, MPP-15143, MPP-15144, MPP-15145, MPP-15146, MPP-15149, MPP-15150,	38
Resistant for MYMV and Moderately susceptible for CLS	MPP-15007, MPP-15009, MPP-15025, MPP-15024, MPP-15055, MPP-15079, MPP-15099, MPP-15113, MPP-15123, MPP-15124, MPP-15131, MPP-15137, MPP-15147, MPP-15148,	14
Moderately Resistant for MYMV and Moderately susceptible for CLS	MPP-15010, MPP-15011, MPP-15013, MPP-15027, MPP-15061, MPP-15065, MPP-15128, MPP-15117,	8
Moderately susceptible for MYMV and CLS	MPP-15003, MPP-15005, MPP-15006, MPP-15012, MPP-15014, MPP-15016, MPP-15019, MPP-15020, MPP-15022, MPP-15023, MPP-15026, MPP-15066	12

Yield: There was a wide range for yield performance variation between the genotypes/accessions tested in this experiment. The yield ranged from 200 to 1222 $kgha^{-1}$. Maximum yield was observed by accession MPP-15038 (1222 $kgha^{-1}$), followed by MPP-15039 (1212 $kgha^{-1}$) and minimum yield was observed by MPP-15068 (200 kg ha^{-1}) and MPP-1078 (220 $kgha^{-1}$). The accessions MPP-15024 and MPP-15003 were ranked 3rd and 4th on the basis yield

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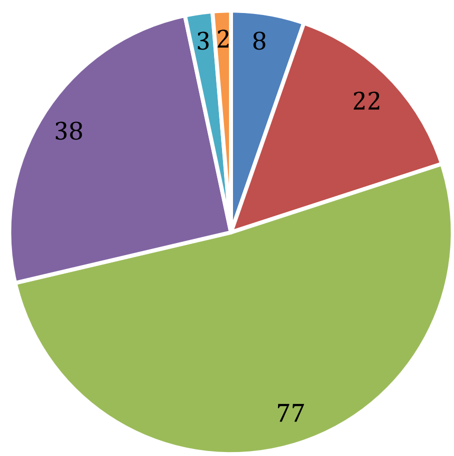
performance. The accession MPP-15002 was on 5th position for yield performance as shown in Table-3 and pie chart No. 3.

Seventy-seven entries were ranged between 601 to 800 yield kgha^{-1}. Thirty-eight raged between 801 to 1000 kg ha^{-1} yield and twenty-two were ranged between 401 to 600 kg ha^{-1} and three were ranged between 1000-1200 kg ha^{-1} and two were ranged between 1201 to 1400 kg ha^{-1}.

The yield potential above 1000 kgha^{-1} was reported under good experimental conditions to be used as higher yield selection criteria for use in breeding by Kumar and Reena, (2007) Panduranga *et al.* (2011).

Pie Chart 3: Diagram Showing Frequency of Mung bea accessions for Yield



Mungbean genotypes MPP-15038 recorded significantly highest yield (222 kg ha-1) with highly resistant reaction to MYMV and susceptible to CLSD, followed by MPP-15039 recorded yield (212 kg ha-1) with resistant reaction to MYMV and moderately susceptible to CLSD, MPP-15051 recorded yield (200 kg ha-1) with highly resistant reaction to MYMV and moderately susceptible to CLSD and MPP-15042 obtained yield (188 kg ha-1) with resistant reaction to MYMV and susceptible to CLSD (Table-3).

Similarly, lowest yield was recorded in genotype MPP-15100, MPP-15127, MPP-15131 and MPP-15144 (2 kg ha-1) with resistant reaction to MYMV and moderately susceptible to susceptible reaction for CLSD (Table-3)

CONCLUSION

It can be concluded from the present study that it is very difficult to identify mungbean genotypes with higher yield and best resistance level for both diseases. The genotypes evolved the study showed good resistance against MYMV as compared to CLS. Seventy-six (76) genotypes found to be highly resistant for MYMV while none of the accession was resistant in case of Cercospora leaf spot disease. These genotypes are the best source of MYMV resistance in mungbean breeding programs. There is an urgent need to study a large number of germplasm accessions collected from different geographical areas for finding the resources of CLS resistance. In the available germplasm there is very narrow range of disease reactions ranging from moderately resistance to highly resistance.

There was good variation for yield performance of the genotypes. Five genotypes were found better yielding (≥1000 kgha^{-1}). These genotypes also showed good disease reactions in general. Therefore, these genotypes are recommended for use in the breeding.

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Muhammad E. Khan	: Data Collection/recording and write up of the manuscript
Khalid P. Akhtar	: Planning and Evaluation of the Experiment
Sadia Kaukab	: Write up the of manuscript
Sajjad Saeed	: Technically evaluated the data
Muhammad J. Asghar	; Supervised the NIAB research work
Jafer Salim	; Data Analysis of the manuscript