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Screening of genotypes and economic assessment of yield loss caused by powdery mildew in blackgram

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Abstract
Forty eight genotypes were evaluated during kharif- 2021 using Pant U-30 and Kopergaon as resistant and susceptible checks respectively. Out of the 48 genotypes, 3 genotypes Pusa B-43, RVSTU 21-1 and Pant U-30 were found immune, two genotypes DKU 87 and PU 31 were resistant. Three varieties having different reactions against powdery mildew i.e., resistant, moderately resistant, and susceptible, were tested to see how recommended disease management practices (DMP) might affect the disease severity and yield. Our present investigation indicated that the powdery mildew disease can be effectively managed using resistant cultivar along with recommended management practices. The yield performance of the resistant/ moderately resistant cultivar will decide the cost benefit ratio.

Keywords: Powdery mildew, blackgram, *Erysiphe polygoni*, screening, economic analysis, yield loss

Introduction
Blackgram (*Vigna mungo* (L.) Hepper) is one of the most important pulse crops belonging to the family Fabaceae. Blackgram contains 24% protein in its seed and is the richest source of phosphoric acid among pulses. It also contains carbohydrate (67%), fiber (3.5%), fat (1.74%) and other valuable nutrients like calcium, potassium, niacin, vitamin B. For the majority of Indians who are vegetarian, blackgram serves as a staple source of protein therefore, it is rightly called as poor man's meat. It can be grown on a range of soil and climatic conditions and play important role in crop rotation, mixed and inter-cropping, maintaining soil fertility through nitrogen fixation, release of soil-bound phosphorus, and thus contribute significantly to sustainability of the farming systems. Blackgram crop is a minifertilizer factory producing nitrogen equivalent to around 22 kg per hectare (Rachie and Roberts, 1974) [6].

India is the largest producer and consumer of blackgram followed by Myanmar and Thailand. The production of blackgram globally is around 8.5 million tonnes, 70% of which comes from India. India produces 20.8 lakh tones of blackgram annually from about 4.5 million hectares of area, with an average productivity of 459.0 kg per hectare in 2019-20. In India, major blackgram growing areas are Andhra Pradesh, Maharashtra, Odisha, Rajasthan, Tamil Nadu and Telangana. In Chhattisgarh, it occupies 0.75 lakh ha, producing 0.25 lakh tones with a productivity of 331 kg per hectare in 2019-20 (Department of Agriculture and Farmers Welfare, Government of India).

The lower productivity of blackgram is attributed to various biotic and abiotic stresses. Biotic stress due to fungal and viral diseases results in heavy yield losses (Nene, 1972) [5]. The major diseases contributing to biotic stresses are Powdery Mildew, Cercospora leaf spot, Anthracnose and Mungbean yellow Mosaic Virus (MYMV). Powdery mildew is one of the major constraints in production of blackgram, causing serious problem in all areas of rice based cropping systems of the country (Abbaiah, 1993) [1]. It occurs in epidemic proportions during the winter/spring season in Chhattisgarh region resulting in varying degree of yield loss (Singh *et al*., 1991) [7]. It causes considerable reduction in yield (20-40 percent) depending on stage and time at which the disease appears, due to the reduction in photosynthetic activity and physiological changes (Legapsi *et al*., 1978) [4].

Powdery mildew is caused by *Erysiphe polygoni* DC, an obligate parasite having a wide host range and pathogen is disseminated by spores carried away by wind. White powdery patches appear on leaves, petioles, stem and even on pods, later become dull in colour. These patches gradually increase in size and become circular covering the lower leaf surface also thereby reducing photosynthetic activity. In severe infections, foliage becomes yellow causing premature defoliation.

The symptoms of the disease are usually observed on 35-40 days old crop during flowering and pod development stage. The disease also creates forced maturity of the infected plants which results in heavy yield losses

Materials and Methods

The present investigation was carried out during kharif 2021-22. The field studies were conducted at the college farm and Department of Plant Pathology, College of Agriculture, Indira Gandhi Krishi Vishwavidayalaya, Raipur, Chhattisgarh. Geographically the College of Agriculture is situated at 81.71˚ E longitude and 21.22˚ N latitude.

Screening

Forty eight entries of blackgram including susceptible and resistant check were screened against *Erysiphe Polygoni* under field conditions at College of Agriculture, IGKV, Raipur. The experiment was laid out with two replications. Two lines of a test entry were alternated by susceptible check. The entries were planted with a row spacing of 30 cm and plant spacing of 10 cm. Powdery mildew was assessed using 0-5 disease rating scale by AICRP, MULLaRP, 2021. Disease score was recorded twice, first at 30 DAS and second before maturity. Location severity index (LSI) was calculated by taking average of disease score in test entries including resistant and susceptible check.

$$LSI = \frac{\text{Sum of disease scores}}{\text{Total number of entries}}$$

Table 1: Disease rating scale (0-5) for powdery mildew

Grade	Description	Reaction
0	Plants free from infection.	Free (F)
1	Plants showing traces to 10% infection on leaves, stems free from the disease.	Resistant (R)
2	Slight infection with thin coating of powdery growth on leaves covering 10.1-25% leaf area, slight infection on the stem and pods usually free.	Moderately resistant (MR)
3	Dense powdery coating on leaves covering 25.1-50% leaf area, moderate infection on pods.	Moderately susceptible (MS)
4	Dense powdery coating covering 50.1 -75% leaf area, stems heavily and pods moderately infected. Infected portion turns grayish.	Susceptible (S)
5	Sever infection with dense powdery growth covering 75% area of the whole plant including pods, stems etc. resulting in premature defoliation and drying.	Highly Susceptible (HS)

Economic analysis

Field experiment was carried out during kharif 2021-22 at the farm of college of Agriculture, IGKV, Raipur, C.G. The experiment was laid out in randomized block design (RBD) with six treatments and four replication in an area of 10 sq. m. To assess the loss in seed yield of blackgram due to powdery mildew infection, an experiment was conducted with three blackgram varieties of different reactions against powdery mildew i.e., resistant, moderately resistant and susceptible. Each variety was subjected to recommended disease management practices (DMP) in one treatment and without recommended DMP in another. Spray of Sulfex 0.3 percent was applied immediately after appearance of disease and repeated at 15 days interval.

Powdery mildew disease severity was recorded in each treatment plot at 60 DAS and percent disease index was calculated. The yield (kg/ha) from each treatment was recorded. The increased yield was calculated by the difference in yield between treatment with recommended disease management practices (DMP) and without DMP for the resistant, moderately resistant and susceptible variety.

Percent disease index (PDI) for powdery mildew disease was calculated using 0-5 scale by through the following formula (Wheeler, 1969) [8].

$$PDI = \frac{\text{Sum of individual disease ratings}}{\text{No. of leaves observed x Max. Disease grade}} \times 100$$

Increased return was calculated by considering the prevailing minimum support price of blackgram seed. Net profit was computed by taking the difference of increased return and cost of disease management practices. Benefit cost ratio was worked out by dividing net profit and cost of disease management practices.

$$\text{Benefit cost ratio} = \frac{\text{Net profit}}{\text{Cost of DMP}}$$

Table 2: Treatment details

S. No.	Treatment	Disease management practices (DMP)
1	Resistant variety	With recommended DMP
2	Moderately Resistant variety	With recommended DMP
3	Susceptible variety	With recommended DMP
4	Resistant variety	Without DMP
5	Moderately Resistant variety	Without DMP
6	Susceptible variety	Without DMP

Results and Discussion

In all crop improvement efforts, managing the disease through host plant resistance has proven to be the best option. The most straightforward, efficient, and cost-effective approach to disease management is the use of resistant cultivars in farming systems. Even though the germplasm lines are sources of resistance for the breeders, they must be used in breeding programmes to create blackgram germplasm that is resistant to powdery mildew.

The result from Table 3 revealed that, out of 48 genotypes screened, three genotypes Pusa B- 43, RVSTU 21-1 and Pant U-30 (resistant check) were found immune to powdery mildew disease, two genotypes DKU 87 and PU 31 were found resistant(R), eight genotypes DKU 116, IU 92-14, JAUG 2, KUG 888, KUG 921, LBG 787, PU 1706 and Pusa B-34 were

moderately resistant (MR), nine genotypes Daftri 471, IPU 11-02, IPU 18-7, IPU 19-9, IPU 2-43, IPU 94-1, LBG 941, RUG 59 and VBG 17-021 were moderately susceptible (MS), thirteen genotypes BCU 20-10, DBGV 90, KPU 20-28, KU 96-3, KUG 479, KUG 878, LBG

922, PBU 18-1, PU 1814, SKAU-UB-3, SKNU 1809, TBG 141 and TPU 4 were susceptible (S), and thirteen genotypes IU 05-2, JLPU 819-18, KPU 20-13, KPU 405, KU 19-10, LBG 752, NUL 7, PU 10, PU 1804, RVSU 21-2, Shekhar 3, SVU 6 and Kopergaon (susceptible check) were highly susceptible (HS) to powdery mildew disease. Hadimani *et al.* (2015) [3] screened 64 blackgram genotypes against powdery

mildew under natural epiphytotic condition and they found that none of the genotypes showed immune or resistant, 15 were showed moderately resistant. Bhaskar (2017) [2] evaluated genotypes of green gram and blackgram to identify the sources of resistance to leaf spot, powdery mildew and myvy diseases under natural field conditions.

Table 3: Field evaluation of blackgram genotypes for resistance against powdery mildew disease

S. No.	Entry	Disease Score (0-5)	S. No.	Entry	Disease Score (0-5)
1	BCU 20-10	4	25	LBG 787	2
2	Daftri 471	3	26	LBG 922	4
3	DBGV 90	4	27	LBG 941	3
4	DKU 116	2	28	NUL 7	5
5	DKU 87	1	29	PBU 18-1	4
6	IPU 11-02	3	30	PU 1706	2
7	IPU 18-7	3	31	PU 10	5
8	IPU 19-9	3	32	PU 1804	5
9	IPU 2-43	3	33	PU 1814	4
10	IPU 94-1	3	34	PU 31	1
11	IU 05-2	5	35	Pusa B-43	0
12	IU 92-14	2	36	Pusa B-34	2
13	JAUG 2	2	37	RUG 59	3
14	JLPU 819-18	5	38	RVSTU 21-1	0
15	KPU 20-13	5	39	RVSU 21-2	5
16	KPU 20-28	4	40	Shekhar 3	5
17	KPU 405	5	41	SKAU-UB-3	4
18	KU 19-10	5	42	SKNU 1809	4
19	KU 96-3	4	43	SVU 6	5
20	KUG 479	4	44	TBG 141	4
21	KUG 878	4	45	TPU 4	4
22	KUG 888	2	46	VBG 17-021	3
23	KUG 921	2	47	Kopergaon	5
24	LBG 752	5	48	Pant U-30	0
	LSI (Location severity index)				3.375

Table 4: Genotypes screened against powdery mildew disease in blackgram

Grade	Percent infection (%)	Reaction	Genotypes	No. of genotypes
0	0	Free	Pusa B-43, RVSTU 21-1, Pant U-30	3
1	<10	R	DKU 87, PU 31	2
2	10.1- 25	MR	DKU 116, IU 92-14, JAUG 2, KUG 888, KUG 921, LBG 787, PU 1706, Pusa B-34	8
3	25.1- 50	MS	Daftri 471, IPU 11-02, IPU 18-7, IPU 19-9, IPU 2-43, IPU 94-1, LBG 941, RUG 59, VBG 17-021	9
4	50.1- 75	S	BCU 20-10, DBGV 90, KPU 20-28, KU 96-3, KUG 479, KUG 878, LBG 922, PBU 18-1, PU 1814, SKAU-UB-3, SKNU 1809, TBG 141, TPU 4	13
5	>75	HS	IU 05-2, JLPU 819-18, KPU 20- 13, KPU 405, KU 19-10, LBG 752, NUL 7, PU 10, PU 1804, RVSU 21-2, Shekhar 3, SVU 6, Kopergaon	13

Fig 1: Powdery mildew disease severity in different entries of blackgram

Fig 2: Resistant and susceptible reaction in blackgram entries

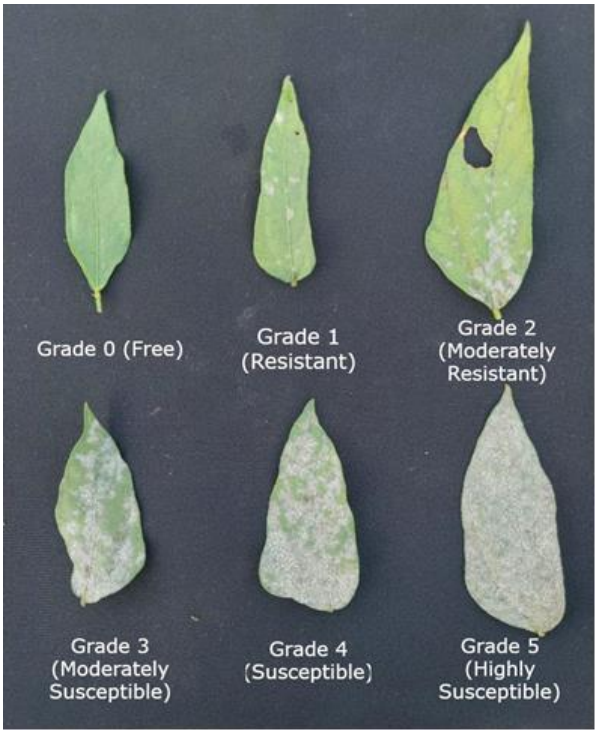

Fig 3: Foliar symptom of powdery mildew showing 0-5 disease grade

Economic analysis

Effect on disease severity

The data recorded revealed significant difference between the percent disease index of a variety with recommended DMP and without recommended DMP. Minimum percent disease index was observed in the treatment of resistant variety with recommended DMP (9.46%) as compared to resistant variety without recommended DMP (12.03%) which was followed by moderately resistant variety with recommended DMP (13.12%), susceptible variety with recommended DMP (18.27%), moderately resistant variety without recommended DMP (22.56) and it was maximum in susceptible variety without recommended DMP (31.21%).

Effect on yield

The maximum yield was obtained from the treatment of resistant variety with recommended DMP (1132 kg/ha) which was followed by moderately resistant variety with recommended DMP (1092 kg/ha), resistant variety without recommended DMP (1050 kg/ha), susceptible variety with recommended DMP (1010 kg/ha), moderately resistant variety without recommended DMP (977 kg/ha) and minimum yield was obtained from susceptible variety without recommended DMP (907 kg/ha).

The maximum effect of application of recommended DMP was observed in moderately resistant variety with an increased yield of 115 kg/ha as compared to that without recommended DMP, followed by susceptible variety with an increased yield of 103 kg/ha while minimum in resistant variety with an increased yield of 82 kg/ha.

Effect on economic loss

The economic analysis for powdery mildew of blackgram given in Table 4.3 revealed significant yield loss when crop was not protected by recommended disease management practices. The net profit from all the treatments with recommended DMP was higher than those without recommended DMP. The increased return caused by application of recommended DMP resulted in increased net profit which was maximum in moderately resistant variety (Rs.5345), followed by susceptible variety (Rs.4589) and minimum in resistant variety (Rs.3266). The application of recommended DMP on moderately resistant variety gave the highest benefit cost ratio of 2.81:1, followed by susceptible variety with 2.41:1 and resistant variety with 1.72:1.

Therefore it can be concluded that use of recommended disease management practices were most effective and economical in moderately resistant and susceptible variety where the yield loss is more than resistant variety.

Table 5: Assessment of yield losses due to powdery mildew disease in blackgram

S.No.	Treatment	Mean PDI at 60 DAS	Yield/ha (kg)	Increased yield/ha (kg)	Increased return (Rs. 6300/qt)	Cost of Disease Manageme nt Practices (DMP) (Rs.)	Net profit (Rs.)	B:C Ratio	Yield losses (%)
1	Resistant variety with recommended DMP	9.46 (17.87)	1132.00	82.00	5166.00	1900.00	3266.00	1.72:1	-
2	Moderately resistant variety with recommended DMP	13.12 (21.20)	1092.00	115.00	7245.00	1900.00	5345.00	2.81:1	-
3	Susceptible variety with recommended DMP	18.27 (25.27)	1010.00	103.00	6489.00	1900.00	4589.00	2.41:1	-
4	Resistant variety without recommended DMP	12.03 (20.25)	1050.00	-	-	-	-	-	7.24
5	Moderately resistant variety without recommended DMP	22.56 (28.33)	977.00	-	-	-	-	-	10.53
6	Susceptible variety without recommended DMP	31.21 (33.93)	907.00	-	-	-	-	-	10.20
	SE(m)	0.744							
	CD@5%	2.262							

Values in parenthesis are angular transformed

Fig 4: Symptom produced by resistant, moderately and susceptible cultivar of blackgram

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