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RESEARCH PAPER

Identification of resistant sources and population dynamics of whitefly transmitting yellow mosaic disease in blackgram

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Abstract: Blackgram (*Vigna mungo* (L.) Hepper) is one of India's most important legume crops, cultivated during both *kharif* and summer seasons. Yellow Mosaic Disease (YMD) caused by Mungbean Yellow Mosaic Virus (MYMV), is one of the major biotic constraints to successful production of blackgram. The disease is transmitted by the hemipteran whitefly, *Bemisia tabaci*, in a persistent circulative manner. Among 119 germplasm lines screened for YMD under field condition, two blackgram germplasm lines *i.e*., IC 584696 and IC 614830 were found to be moderately resistant, while nine lines were identified as moderately susceptible, fifty-seven lines were susceptible and fifty-one lines were showed highly susceptible reaction. The whitefly population was highest during the 41st and 42nd Standard Meteorological Weeks (SMWs), with mean values of 69.3 and 64.9, respectively and was lowest during the 36th SMW, with a mean value of 12.9. The whitefly population varied at different crop stages. The population buildup showed a strong significant positive correlation with maximum temperature and a significant negative correlation with rainfall. There was a non-significant positive correlation with minimum temperature and sunshine duration and a non-significant negative correlation with morning relative humidity and evening relative humidity.

Key words: Blackgram, Germplasm lines, Population dynamics, YMD

Introduction

Blackgram (*Vigna mungo* L.), commonly known as urdbean in India, belongs to the *Leguminosae* family. It is a significant short-duration, self-pollinating legume. Renowned for its rich nutritional profile, blackgram contains proteins (25-26%), carbohydrates (60%), fats (1.5%), minerals, amino acids and vitamins. It also aids in the process of atmospheric nitrogen fixation into the soil (Swapna and Prema, 2024). This highly valued pulse crop is cultivated across various regions of India (Archana *et al*., 2018). Blackgram is grown during both *kharif* and summer seasons, particularly in central Indian conditions. Blackgram has been found to be beneficial in reducing elevated cholesterol levels (Marabi *et al*., 2017).

India holds the title of the world's largest producer of blackgram, with cultivation spanning approximately 40.02 lakh hectares, resulting in a production of 26.31 lakh tonnes and a productivity rate of 657 kg/ha. The primary blackgram cultivating states include Andhra Pradesh, Bihar, Karnataka, Maharashtra, Madhya Pradesh, Orissa, Rajasthan, Tamil Nadu, Uttar Pradesh and West Bengal. Andhra Pradesh leads the chart as the top blackgram producing state, with cultivation across approximately 3.45 lakh hectares, with a production of 4.31 lakh tonnes and achieving a productivity of 1249 kg/ha. In Karnataka, it is cultivated across roughly 0.71 lakh hectares, with a production of 0.33 lakh tonnes and productivity rate of 466 kg/ha. Notable blackgram cultivating districts in Karnataka include Kalburgi, Bidar, Mysuru, Belagavi, Dharwad, Bagalkot and Vijayapur (Anon., 2023).

The low yield of blackgram is attributed to various factors, primarily due to attack by numerous insects (such as pod borers and sucking pests) and diseases (including Alternaria leaf spot, Cercospora leaf spot, powdery mildew and viral diseases), as well as other abiotic factors from seedling to maturity stages. Among these constraints, Yellow Mosaic Disease (YMD) caused by Mungbean Yellow Mosaic Virus (MYMV) stands out as the most serious disease and a significant bottle neck for blackgram cultivation and production (Biswas *et al*., 2012).

The initial symptoms of the disease manifest as small yellow flecks in the veinlets of young emerging leaves. Subsequently, developing leaves display more prominent and irregular yellow and green patches, alternating with each other. There is not much impact on leaf size. However, in susceptible genotypes, affected plants produce only a few pods that are smaller in size and deformed (Verma *et al*., 1992; Prema and Rangaswamy, 2018). The degree of yield loss largely depends on the age of the plant at the time of infection and the severity of the disease to a tune of 85-100 per cent during seedling stage (Naimuddin *et al*., 2011). Keeping in view above facts, the present study is undertaken to identify and screen blackgram genotypes for resistance against YMD which is vital for developing resilient cultivars. Additionally, to know the influence of weather parameters on whitefly population which would be useful to develop management strategies in blackgram ecosystem.

Material and methods

An evaluation to assess the resistance of various blackgram genotypes against yellow mosaic disease in field conditions was conducted at College of Agriculture, Vijayapur, during the

kharif season of 2023 (Table 1 and Table 2). A total of 119 germplasm lines of blackgram (100 lines from NBPGR, New Delhi and 19 lines from MULLaRP, MARS, UAS, Dharwad) were screened for Yellow Mosaic Disease (YMD) under field conditions. Each germplasm line was sown in rows of 2 meters length, with a spacing of 30 cm X 10 cm. A local check variety (DBGV-5) was planted after every 10 lines and along all four sides of the field to act as a disease source (infector row technique). Both disease incidence and severity were recorded

Table 1. List of germplasm lines of blackgram used for screening against MYMV

Germplasm line	Germplasm line	Germplasm line	Germplasm line
IC 519016	IC 296266	IC 283530	IC 616487
IC 530632	IC 330912	IC 570274	IC 611676
IC 436610	IC 250214	IC 600255	IC 589046
IC 519913	IC 10403	IC 530611	IC 530655
IC 530626	IC 250220	IC 557432	IC 600266
IC 519910	IC 297631	IC 565291	IC 471993
IC 530625	IC 393540	IC 530454	IC 565260
IC 449269	IC 398038	IC 584696	IC 570221
IC 530619	IC 296079	IC 614830	IC 611677
IC 525175	IC 10139	IC 587040	IC 570264
IC 436615	IC 396772	IC 598728	DBGV-16
IC 530620	IC 45665	IC 530652	DBGV-18
IC 519906	IC 393543	IC 604265	DBGV-19
IC 472046	IC 330900	IC 616493	DBGV-27
IC 472022	IC 251910	IC 530656	DBGV-31
IC 530628	IC 250206	IC 605329	DBGV-32
IC 426766	IC 324139	IC 20775	DBGV-33
IC 519912	IC 398743	IC 565256	DBGV-34
IC 471975	IC 296265	IC 41718	DBGV-96
IC 530624	IC 296078	IC 570263	TRCRU-134
IC 527176	IC 401376	IC 565272	TRCRU-339
IC 250229	IC 393550	IC 392273	DBGV-5
IC 334237	IC 397928	IC 570273	LBG-752(Shining)
IC 330904	IC 283531	IC 545200	LBG-752 (Dull)
IC 330908	IC 40257	IC 566025	BG Entry
IC 393528	IC 140901	IC 570268	DBGV-5 X LBG-623
IC 393535	IC 305227	IC 600673	BDU-18
IC 296076	IC 399642	IC 565276	DU-1
IC 38984	IC 297665	IC 590132	DBGV-36
IC 253905	IC 337145	IC 545207	

at 15-days interval, starting from 30 days after sowing until maturity.

The disease incidence for individual germplasm line was recorded on the basis of number of plants infected to the total number of plants examined.

$$\text{Percent disease incidence} = \frac{\text{Number of diseased plants}}{\text{Total number of plants examined}} \times 100$$

The genotypes were subsequently classified into various categories using a 0-5 arbitrary scale ranging from immune to highly susceptible, as proposed by Bashir (2005).

The percent disease severity was recorded at 15 days interval starting from 30 days after sowing upto maturity based on modified MULLaRP scale (0-9) (Pavishna *et al*., 2019).

The per cent disease index of each germplasm was calculated using the following formula.

$$\text{Per cent disease index= (PDI)} = \frac{\text{Sum of all the numerical ratings}}{\text{Number of observations x Maximum disease rating}} \times 100$$

Table 2. Disease scoring scale for MYMV infecting blackgram (Bashir, 2005)

Scale	Description	Category
0	No plants showing symptoms	Immune
1	1-5 per cent of plants showing symptoms	Resistant
2	5-15 per cent of plants showing symptoms	Moderately resistant
3	15-25 per cent of plants showing symptoms	Moderately susceptible
4	25-50 per cent of plants showing symptoms	Susceptible
5	>50 per cent of plants showing symptoms	Highly susceptible

The studies on the population dynamics of the whitefly vector, responsible for spreading yellow mosaic disease in blackgram, was conducted at College of Agriculture, Vijayapur, during the *kharif* season of 2023. The study involved monitoring the population dynamics of the vector by installing yellow sticky traps in a 10 m x 10 m area of the blackgram field. Each week, a set of five traps were installed above the crop canopy. After 7 days of installation, these traps were removed from the field, and the whitefly numbers was recorded from each trap on weekly basis (Sonam *et al*., 2024).

Meteorological data, including temperature, humidity, rainfall, and bright sunshine hours during the cropping period was obtained from the Meteorological Observatory at RARS, Vijayapur. A basic correlation analysis was conducted between the whitefly population and various abiotic environmental factors using the following formula.

$$r_{xy} = \frac{\Sigma xy - \frac{\Sigma x \Sigma y}{n}}{\sqrt{\left[\Sigma x^2 - \frac{(\Sigma x^2)}{n}\right]\left[\Sigma x^2 - \frac{(\Sigma y^2)}{n}\right]}}$$

Where,

r_{xy} = Simple correlation coefficient

x= Abiotic components

Y = Mean number of whiteflies

n = Number of observations

Results and discussion

During *kharif* 2023, a total of 119 germplasm lines of blackgram were screened for Yellow Mosaic Disease (YMD) under field conditions using the infector row technique at College of Agriculture, Vijayapur (Plate 1). The per cent disease incidence and severity were recorded from 30 days after sowing (DAS) until the physiological maturity of blackgram at 15-day intervals. The results obtained are tabulated in Table 3 and symptoms observed in screening plot were shown in plate 2 and plate 3.

Table 3. Per cent disease severity and per cent disease incidence of different germplasm lines of blackgram against YMV at different intervals

Germplasm	30 DAS		45 DAS		60 DAS		75 DAS		Physiological maturity		Reaction
line	DS(%)	DI(%)	DS(%)	DI(%)	DS(%)	DI(%)	DS(%)	DI(%)	DS(%)	DI(%)	
IC 519016	0.00	0.00	11.52	35.00	12.32	42.00	15.42	47.5	28.14	53.5	HS
IC 530632	17.54	30.44	28.33	30.44	34.00	66.67	38.33	68.90	40.00	68.90	HS
IC 436610	19.39	34.54	23.33	35.00	25.55	50.00	33.33	52.45	35.55	52.45	HS
IC 519913	18.34	25.34	24.22	37.06	27.74	47.06	34.22	50.00	37.77	50.00	S
IC 530626	24.39	35.79	32.24	42.50	35.25	62.50	42.22	64.50	45.18	64.50	HS
IC 519910	21.54	35.93	30.22	39.23	32.24	43.73	40.28	47.00	42.22	47.00	S
IC 530625	13.34	27.98	28.46	36.67	40.85	42.67	53.58	46.67	55.55	46.67	S
IC 449269	18.45	51.59	29.43	65.00	52.48	70.00	64.44	80.00	67.40	80.00	HS
IC 530619	12.39	24.59	27.28	32.85	49.23	43.85	55.50	55.60	59.25	55.60	HS
IC 525175	0.00	0.00	21.57	35.71	23.38	35.71	29.27	38.64	30.00	38.64	S
IC 436615	0.00	0.00	23.50	37.85	34.25	49.85	37.58	55.54	38.51	55.54	HS
IC 530620	11.67	28.59	25.23	36.67	49.20	59.67	57.50	66.67	59.25	66.67	HS
IC 519906	0.00	0.00	13.75	30.77	18.50	30.77	21.00	34.90	23.70	34.90	S
IC 472046	27.54	31.58	35.53	40.00	51.80	60.00	65.55	60.00	71.85	60.00	HS
IC 472022	0.00	0.00	23.45	48.33	31.50	59.33	40.40	60.13	44.44	60.13	HS
IC 530628	0.00	0.00	25.00	37.14	34.90	57.14	40.00	57.14	45.92	57.14	HS
IC 426766	19.59	41.59	24.40	58.82	37.30	81.82	43.45	81.82	47.40	81.82	HS
IC 519912	26.98	36.79	39.00	45.33	64.25	83.33	75.00	83.33	85.92	83.33	HS
IC 471975	12.45	27.57	24.34	33.85	43.80	53.85	45.33	55.45	48.88	55.45	HS
IC 530624	0.00	0.00	26.36	31.67	40.68	42.63	43.26	46.50	46.66	46.50	S
IC 527176	0.00	0.00	29.20	30.00	33.79	42.35	34.98	42.35	36.29	42.35	S
IC 250229	22.76	34.79	35.25	43.75	47.98	43.75	50.22	45.54	54.81	47.50	S
IC 334237	0.00	0.00	23.35	33.85	46.92	53.85	50.58	55.50	52.59	55.50	HS
IC 330904	0.00	0.00	25.41	22.57	27.12	22.57	28.00	24.90	29.11	24.90	MS
IC 330908	0.00	0.00	23.25	30.00	28.52	50.00	29.32	53.57	29.59	55.90	HS
IC 393528	0.00	0.00	11.34	21.00	12.13	30.00	13.33	34.50	13.33	34.50	S
IC 393535	0.00	0.00	15.30	23.33	19.50	33.33	21.74	35.44	23.70	35.44	S
IC 296076	10.32	12.54	21.00	29.41	25.45	29.41	27.40	30.10	27.40	30.10	S
IC 38984	40.75	30.32	49.00	43.33	52.34	53.33	55.27	55.50	57.77	55.50	HS
IC 253905	0.00	0.00	20.40	38.46	22.20	38.46	25.92	38.46	25.92	38.46	S
IC 296266	20.34	27.78	24.10	36.67	28.74	46.65	31.05	50.00	34.07	50.00	S
IC 330912	35.67	30.57	40.15	41.54	43.34	52.34	50.00	61.54	53.33	61.54	HS
IC 250214	21.37	37.98	23.98	45.50	25.20	62.50	27.24	62.50	29.29	62.50	HS
IC 10403	27.45	39.56	32.58	47.59	35.81	59.52	37.00	70.59	38.51	70.59	HS
IC 250220	10.32	35.33	13.84	41.67	15.78	41.67	17.77	43.50	17.77	43.50	S
IC 297631	19.45	31.37	27.00	35.00	28.25	40.00	29.50	40.00	29.50	40.00	S
IC 393540	21.22	37.67	38.63	41.00	40.72	47.06	43.23	47.06	45.92	47.06	S
IC 398038	0.00	0.00	11.68	30.05	13.32	40.00	13.87	48.57	14.77	48.57	S
IC 296079	0.00	0.00	21.84	20.29	23.36	23.22	25.40	23.22	26.66	23.22	MS
IC 10139	0.00	0.00	16.82	25.41	18.40	29.41	20.00	35.33	21.48	35.33	S
IC 396772	0.00	0.00	15.00	27.78	18.34	27.78	20.00	29.54	20.00	29.54	S
IC 45665	23.43	37.79	31.63	42.11	35.26	42.11	37.23	48.90	39.25	48.90	S
IC 393543	27.77	39.37	38.64	45.00	41.00	45.00	42.22	49.88	42.22	49.88	S
IC 330900	30.32	43.78	37.65	47.05	42.19	50.00	45.22	54.44	48.14	54.44	HS
IC 251910	34.57	45.77	44.34	53.16	70.83	63.21	75.44	63.21	77.03	70.88	HS
IC 250206	28.37	41.54	34.33	53.64	46.84	63.69	51.39	63.69	53.33	63.69	HS
IC 324139	0.00	0.00	30.61	18.84	34.54	22.44	37.41	24.88	38.51	24.88	MS
IC 398743	25.32	32.56	35.54	37.14	57.35	49.67	69.55	60.33	71.85	63.50	HS
IC 296265	33.78	35.77	46.10	44.00	62.87	57.00	65.00	65.00	66.66	65.00	HS
IC 296078	30.39	31.56	34.68	39.00	47.61	47.32	52.80	50.00	54.81	50.00	S
IC 401376	32.37	41.32	38.76	48.90	45.87	61.90	49.35	64.80	51.85	64.80	HS
IC 393550	29.32	30.79	35.53	38.89	47.94	38.89	52.59	40.54	52.59	40.54	S
IC 397928	31.59	40.45	45.00	43.37	52.63	47.06	55.00	47.06	58.51	47.06	S
IC 283531	25.45	35.78	37.00	45.00	64.87	67.30	71.00	75.00	74.07	75.00	HS
IC 40257	30.13	32.45	35.40	40.71	63.28	65.71	80.00	85.56	85.18	88.50	HS
IC 140901	20.57	34.57	31.36	42.63	49.48	52.79	55.33	59.88	64.44	59.88	HS
IC 305227	0.00	0.00	18.58	18.57	22.67	18.57	25.36	23.84	26.66	23.84	MS
IC 399642	18.32	32.33	24.21	37.06	39.84	45.79	43.17	49.80	45.18	49.80	S
IC 297665	23.57	34.72	33.62	45.35	57.34	55.56	68.22	55.56	70.37	58.70	HS
IC 337145	18.79	32.79	23.38	37.41	27.32	57.14	33.33	60.70	33.33	60.70	HS

Contd…

IC 283530	24.55	31.34	31.84	38.33	46.72	58.57	50.83	63.33	53.33	63.33	HS
IC 570274	0.00	0.00	28.62	20.00	37.29	20.00	40.32	23.50	42.22	23.50	MS
IC 600255	0.00	0.00	26.89	32.64	31.70	43.59	34.45	49.74	36.29	49.74	S
IC 530611	0.00	0.00	22.37	36.15	27.71	36.15	30.00	50.00	30.00	50.00	S
IC 557432	0.00	0.00	19.78	31.18	22.28	31.18	25.57	41.57	28.88	41.57	S
IC 565291	0.00	0.00	13.33	35.45	13.79	35.45	14.03	45.77	14.03	45.77	S
IC 530454	0.00	0.00	23.00	31.63	26.85	31.63	31.00	42.74	34.81	42.74	S
IC 584696	0.00	0.00	12.35	12.02	13.50	12.02	15.55	14.40	15.55	14.40	MR
IC 614830	0.00	0.00	10.90	11.32	11.50	11.32	12.59	14.50	12.59	14.50	MR
IC 587040	0.00	0.00	13.38	21.57	15.37	21.57	17.77	23.33	17.77	23.33	MS
IC 598728	0.00	0.00	28.50	28.10	31.35	28.10	35.45	39.17	39.25	39.17	S
IC 530652	0.00	0.00	33.75	35.00	37.87	45.00	40.90	48.77	43.70	48.77	S
IC 604265	0.00	0.00	31.38	37.05	35.54	37.05	40.98	45.00	43.70	45.00	S
IC 616493	27.78	32.59	34.57	45.56	51.43	53.78	55.50	58.80	60.74	58.80	HS
IC 530656	0.00	0.00	26.64	35.37	31.28	47.37	34.98	49.33	36.29	49.33	S
IC 605329	20.22	20.22	35.50	33.67	62.28	56.67	75.50	70.80	82.22	75.80	HS
IC 20775	24.75	34.76	30.27	42.14	47.39	48.42	51.37	48.42	54.07	48.42	S
IC 565256	24.77	40.07	35.38	53.00	52.34	65.00	55.33	75.00	58.51	75.00	HS
IC 41718	0.00	0.00	25.00	38.89	32.25	38.89	40.00	38.89	42.22	38.89	S
IC 570263	0.00	0.00	20.32	35.00	25.57	45.35	27.39	47.88	29.37	47.88	S
IC 565272	12.39	35.66	18.91	47.62	23.48	47.62	25.18	50.00	25.18	50.00	S
IC 392273	15.00	25.00	25.50	31.43	54.39	59.74	65.50	75.60	84.44	75.60	HS
IC 570273	21.57	31.38	30.68	40.70	51.74	42.11	60.00	42.11	71.85	42.11	S
IC 545200	23.79	34.89	32.38	47.30	48.80	58.33	55.33	77.78	63.70	77.78	HS
IC 566025	0.00	0.00	25.29	38.12	34.37	49.57	40.38	58.82	44.44	58.82	HS
IC 570268	25.37	37.89	30.38	42.11	52.16	42.11	60.33	42.11	65.18	42.11	S
IC 600673	0.00	0.00	26.68	22.44	47.28	22.44	50.33	24.34	57.03	24.34	MS
IC 565276	0.00	0.00	13.74	32.42	23.21	45.77	27.18	49.38	29.11	49.38	S
IC 590132	0.00	0.00	12.59	30.00	15.27	35.94	19.25	53.88	19.25	53.88	HS
IC 545207	0.00	0.00	32.70	80.00	54.39	85.00	65.50	85.00	78.51	85.00	HS
IC 616487	0.00	0.00	31.34	40.00	47.63	40.00	53.44	43.70	63.70	43.70	S
IC 611676	10.34	19.78	11.37	21.12	12.94	24.33	13.33	24.33	13.33	24.33	MS
IC 589046	12.87	34.45	22.69	41.00	31.54	57.32	37.88	68.22	41.48	77.78	HS
IC 530655	0.00	0.00	12.23	35.05	17.82	43.39	20.37	48.56	22.22	48.56	S
IC 600266	0.00	0.00	16.45	32.17	20.38	40.32	23.80	50.00	27.40	50.00	S
IC 471993	18.65	34.78	24.67	40.00	39.32	40.00	50.87	43.37	54.81	43.37	S
IC 565260	0.00	0.00	12.84	30.32	16.32	39.79	21.46	49.34	24.44	49.34	S
IC 570221	0.00	0.00	11.59	35.12	16.48	35.12	18.51	45.45	18.51	45.45	S
IC 611677	22.37	35.30	38.39	40.75	54.72	65.32	68.33	85.71	74.81	85.71	HS
IC 570264	0.00	0.00	13.37	32.17	19.84	47.32	20.74	47.32	20.74	47.32	S
DBGV-16	0.00	0.00	11.73	34.43	15.52	34.43	17.03	38.89	17.03	38.89	S
DBGV-18	24.56	37.34	37.30	45.12	51.38	60.00	60.00	60.00	65.18	60.00	HS
DBGV-19	22.78	35.79	31.37	48.32	42.58	68.42	51.30	68.42	60.00	68.42	HS
DBGV-27	16.33	26.33	29.00	46.82	41.78	57.67	60.00	69.84	81.48	69.84	HS
DBGV-31	24.76	37.32	31.28	45.46	53.73	58.79	61.22	78.95	73.33	78.95	HS
DBGV-32	18.72	30.39	21.63	36.82	32.98	42.67	47.39	42.67	52.59	42.67	S
DBGV-33	21.78	35.29	36.37	48.72	53.45	60.50	66.33	80.00	75.55	80.00	HS
DBGV-34	25.78	33.62	38.64	44.27	57.33	49.16	63.44	49.16	77.03	49.16	S
DBGV-96	28.12	39.74	35.44	45.00	48.25	57.32	59.74	75.00	76.29	75.00	HS
TRCRU-134	20.39	33.17	28.95	35.72	39.74	45.56	44.42	49.67	49.62	49.67	S
TRCRU-339	17.45	35.32	22.87	42.37	31.42	47.89	39.83	47.89	41.48	47.89	S
DBGV-5	21.55	30.45	32.85	41.55	43.39	70.12	59.88	85.88	72.59	85.88	HS
LBG-752 (Shining)	23.78	31.79	39.57	44.32	58.73	64.59	70.33	84.21	78.51	84.21	HS
LBG-752 (Dull)	18.43	30.37	24.75	41.72	32.57	50.00	39.83	50.00	48.88	50.00	S
BG Entry	22.75	31.32	31.27	38.10	45.32	38.10	52.57	40.88	59.25	40.88	S
DBGV-5 X LBG-623	25.79	36.83	30.56	40.28	53.74	45.56	60.11	45.56	63.70	45.56	S
BDU-18	30.32	35.72	41.00	41.38	56.69	63.65	70.00	71.43	85.18	71.43	HS
DU-1	0.00	0.00	24.67	33.42	30.81	46.89	34.59	46.89	40.74	48.16	S
DBGV-36	0.00	0.00	22.47	20.00	34.58	23.68	41.74	23.68	44.44	23.68	MS
Susceptible check											
DBGV-5	25.37	33.45	34.70	45.50	53.55	67.80	70.00	86.77	83.95	86.77	HS

Note:DAS: Days after sowing, DS: Disease severity, DI: Disease incidence, MR: Moderately resistant, MS: Moderately susceptible, S: Susceptible, HS: Highly susceptible

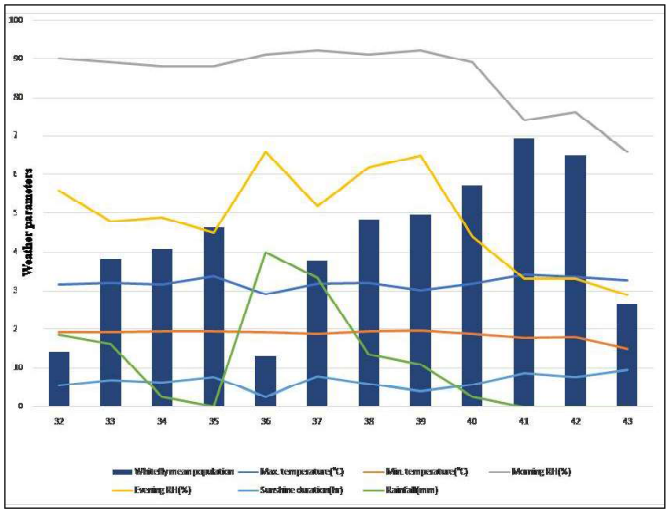

Fig. 1. Relation between weather parameters and mean population of whitefly (*Bemisia tabaci*) transmitting YMD of blackgram at different SMWs

Plate 1. Field view of screening of blackgram germplasm lines against YMD

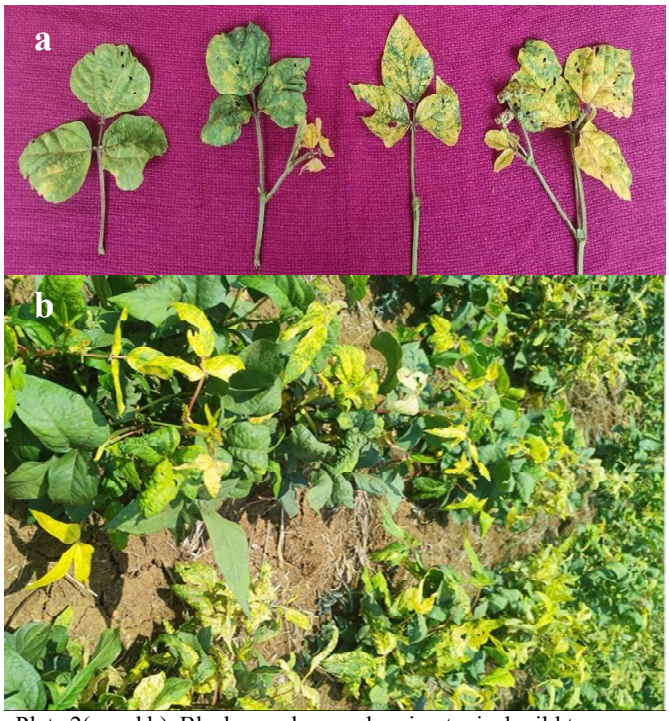

Plate 2(a and b). Blackgram leaves showing typical mild to severe yellow mosaic symptoms

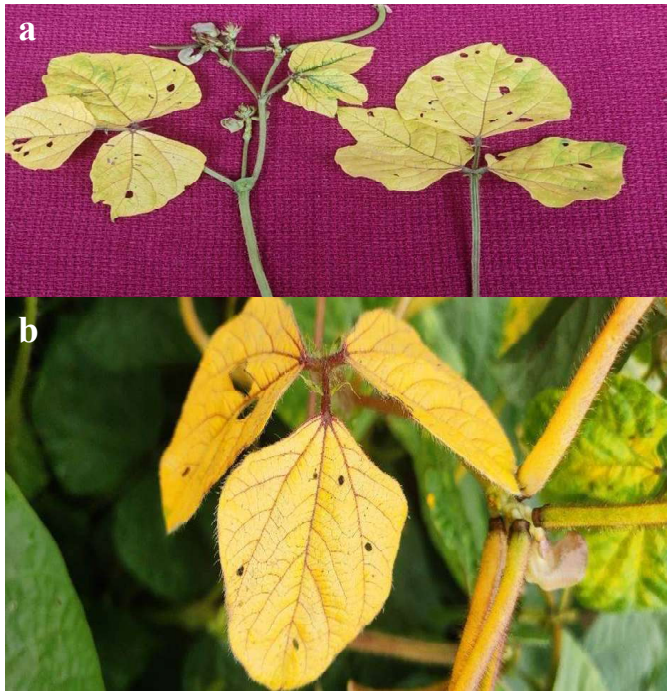

Plate 3 (a andb). Complete yellowing of blackgram leaves caused by MYMV

Among the 119 germplasm lines screened, two lines *i.e.*, IC 584696 and IC 614830, showed moderately resistant reaction (scale 2) with >5-15 per cent infection. Nine lines *i.e.*, IC 330904, IC 296079, IC 324139, IC 305227, IC 570274, IC 587040, IC 600673, IC 611676 and DBGV-36, showed a moderately susceptible reaction (scale 3) with >15-25 per cent infection.

Fifty-seven germplasm lines showed a susceptible reaction (scale 4) with >25-50 per cent infection *i.e.*, IC 519913, IC 519910, IC 530625, IC 525175, IC 519906, IC 530624, IC 527176, IC 250229, IC 393528, IC 393535, IC 296076, IC 253905, IC 296266, IC 250220, IC 297631, IC 393540, IC 398038, IC 10139, IC 396772, IC45665, I C 393543, IC 296078, IC 393550, IC 397928, IC 399642, IC 600255, IC 530611, IC 557432, IC 565291, IC 530454, IC 598728, IC 530652, IC 604265, IC 530656, IC 20775, IC 41718, IC 570263, IC 565272, IC 570273, IC 570268, IC 565276, IC 616487, I C 530655, IC 600266, IC 471993, IC 565260, IC 570221, IC 570264, DBGV-16, DBGV-32, DBGV-34, TRCRU-134, TRCRU-339, LBG-752 (Dull), BG Entry, DBGV-5 X LBG-623 and DU-1.

Fifty-one germplasm lines showed highly susceptible reaction (scale 5) with >50 per cent infection *i.e.*, IC 519016, IC 530632, IC 436610, IC 530626, IC 449269, IC 530619, IC 436615, IC 530620, IC 472046, IC 472022, IC 530628, IC 426766, IC 519912, IC 471975, IC 334237, IC 330908, IC 38984, IC 330912, IC 250214, IC 10403, IC 330900, IC 251910, IC 250206, IC 398743, IC 296265, IC 401376, IC 283531, IC 40257, IC 140901, IC 297665, IC 337145, IC 283530, IC 616493, IC 605329, IC 565256, IC 392273, IC 545200, IC 566025, IC 590132, IC 545207, IC 589046, IC 611677, DBGV-18, DBGV-19, DBGV-27, DBGV-31, DBGV-33, DBGV-96, DBGV-5, LBG-752 (Shining) and BDU-18. None of the germplasm lines were found to be immune (scale 0) or resistant (scale 1) to the disease. The detailed results are presented in Table 4.

Table 4. Grouping of blackgram germplasm lines based on their reaction against YMD incidence

Reaction	Number of genotypes	Description	Genotypes
Immune (I)	0	0%	-
Resistant (R)	0	1-5%	-
Moderately resistant (MR)	02	>5-15%	IC 584696 and IC 614830
Moderately susceptible (MS)	09	>15-25%	IC 330904, IC 296079, IC 324139, IC 305227, IC 570274, IC 587040, IC 600673, IC 611676 and DBGV-36
Susceptible (S)	57	>25-50%	IC 519913, IC 519910, IC 530625, IC 525175, IC 519906, IC 530624, IC 527176, IC 250229, IC 393528, IC 393535, IC 296076, IC 253905, IC 296266, IC 250220, IC 297631, IC 393540, IC 398038, IC 10139, IC 396772, IC 45665, IC 393543, IC 296078, IC 393550, IC 397928, IC 399642, IC 600255, IC 530611, IC 557432, IC 565291, IC 530454, IC 598728, IC 530652, IC 604265, IC 530656, IC 20775, IC 41718, IC 570263, IC 565272, IC 570273, IC 570268, IC 565276, IC 616487, IC 530655, IC 600266, IC 471993, IC 565260, IC 570221, IC 570264, DBGV-16, DBGV-32, DBGV-34, TRCRU-134, TRCRU-339, LBG-752 (Dull), BG Entry, DBGV-5 X LBG-623 and DU-1
Highly susceptible (HS)	51	>50%	IC 519016, IC 530632, IC 436610, IC 530626, IC 449269, IC 530619, IC 436615, IC 530620, IC 472046, IC 472022, IC 530628, IC 426766, IC 519912, IC 471975, IC 334237, IC 330908, IC 38984, IC 330912, IC250214, IC 10403, IC 330900, IC 251910, IC 250206, IC 398743, IC 296265, IC 401376, IC 283531, IC 40257, IC 140901, IC 297665, IC 337145, IC 283530, IC 616493, IC 605329, IC 565256, IC 392273, IC 545200, IC 566025, IC 590132, IC 545207, IC 589046, IC 611677, DBGV-18, DBGV-19, DBGV-27, DBGV-31, DBGV-33, DBGV-96, DBGV-5, LBG-752 (Shining) and BDU-18

These results were in accordance with Kumar *et al*. (2022) who screened twelve commercial blackgram varieties for YMD under natural conditions. It was noted that four cultivars *viz*., Pratap urd-1, Uttara, PU-31 and IPU-2-43 exhibited resistance to YMD with disease severity ranging from 4.20 per cent to 5.0 per cent. Conversely, varieties T 9 (54.35%) and PU-40 (56.25%) were highly susceptible to the disease, displaying the highest susceptibility reaction.

Singh *et al*. (2023) concluded that among the genotypes studied, NDU 1 and Co 5 were notably susceptible to MYMV, exhibiting a disease incidence exceeding 40 per cent, while the remaining genotypes showed resistance with a disease incidence of up to 10 per cent. Generally, genotypes with higher disease incidence (>40%) showed a lower number of pods per plant (NPP), and conversely Mash 338, R3/12, R3/28 and PU 31 emerged as promising blackgram genotypes.

Studies on the population dynamics of whitefly transmitting Yellow Mosaic Disease (YMD) on blackgram was conducted at College of Agriculture, Vijayapur, during 2023-24 under field conditions. Observations were recorded using yellow sticky traps during different standard meteorological weeks (Plate 4a).The whitefly species observed during the research period was *Bemisia tabaci* (Plate 4b). The mean population of whitefly varied from 12.9 to 69.3 individuals. A simple correlation was calculated between the whitefly population and weather parameters, such as maximum and minimum air temperature, morning and evening relative humidity, sunshine hours and rainfall during the study period. The results related to the population dynamics of whitefly were tabulated and presented in Table 5 and Fig. 1.

The mean population of whitefly (*Bemisia tabaci*) was calculated during different Standard Meteorological Weeks (SMWs). The population of whitefly (*Bemisia tabaci*) was highest during 41st and 42nd SMWs, with mean values of 69.3 and 64.9, respectively. During this period, corresponding weather parameters including maximum temperature, minimum temperature, morning relative humidity, evening relative

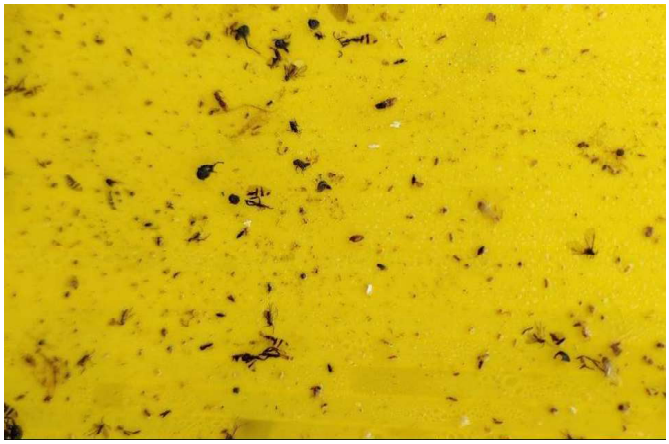

Plate 4a. Yellow sticky trap used for trapping of whiteflies

Table 5. Population of whitefly (*Bemisia tabaci*) transmitting YMD of blackgram during different Standard Meteorological Weeks (SMWs) along with weather parameters during *kharif*- 2023

Standard Meteorological Week No	Date	Air Temperature		Relative Humidity		Sunshine Duration(hr)	Rainfall (mm)	Mean population of *Bemisia tabaci*
		Max. (°C)	Min.(°C)	I(%)	II(%)			
32	August 6, 2023	31.5	19.2	90	56	5.5	18.6	14.3
33	August 13, 2023	32.0	19.2	89	48	6.8	16.2	38.2
34	August 20, 2023	31.6	19.4	88	49	6.3	2.6	40.7
35	August 27, 2023	33.6	19.5	88	45	7.6	0.2	46.3
36	September 3, 2023	29.1	19.3	91	66	2.6	40.0	12.9
37	September 10, 2023	31.9	18.9	92	52	7.8	33.4	37.8
38	September 17, 2023	32.0	19.5	91	62	5.8	13.6	48.2
39	September 24, 2023	30.2	19.7	92	65	4.1	11.0	49.5
40	October 1, 2023	31.8	18.8	89	44	5.7	2.6	57.3
41	October 8, 2023	34.1	17.8	74	33	8.7	0.0	69.3
42	October 15, 2023	33.5	18.1	76	33	7.6	0.0	64.9
43	October 22, 2023	32.6	14.9	66	29	9.5	0.0	26.3

Plate 4b. Whitefly (*Bemisia tabaci*) observed in population dynamics studies

humidity, sunshine hours and rainfall recorded were 34.1°C, 17.8°C, 74 per cent, 33 per cent, 8.7 hr and 0.0 mm, and 33.5°C, 18.1°C, 76 per cent, 33 per cent, 7.6 hr and 0.0 mm, respectively. The population of whitefly was lowest during 36th SMW, with mean value of 12.9 and the corresponding weather parameters including maximum temperature, minimum temperature, morning relative humidity, evening relative humidity, sunshine hours and rainfall were 29.1°C, 19.3°C, 91 per cent, 66 per cent, 2.6 hr and 40.0 mm, respectively.

The whitefly population varied from month to month at different crop stages. It was lower during the vegetative stage but gradually increased during the flowering and podding stages. There was a sudden decline in the whitefly population during the 36th and 37th SMWs because of rainfall received which was of about 40.0 and 33.4 mm, respectively. A strong significant positive correlation was observed between whitefly population buildup and maximum temperature (r = +0.622*). There was a significant negative correlation with rainfall (r = -0.632*). Additionally, there was a non-significant positive correlation with minimum temperature (r = +0.015^{NS}) and sunshine duration (r= +0.376^{NS}), and a non-significant negative correlation with morning relative humidity (r = -0.242^{NS}) and evening relative humidity (r = -0.439^{NS}), as shown in Table 6.

These results were corroborated with Srinivasaraghavan (2014) who recorded a positive correlation between maximum temperature and whitefly population and a negative correlation between whitefly population and morning relative humidity. Similar studies were carried out by Marabi *et al*. (2017) who reported that the whitefly population peaked during the 36th SMW. Their correlation studies indicated a significantly positive association with maximum temperature (r = 0.659) and a highly negative significant association with rainfall (r = -0.809).

Conclusion

Two blackgram germplasm lines *i.e*., IC 584696 and IC 614830 were found to be moderately resistant, while nine lines were identified as moderately susceptible. Identifying genotypes with moderate resistance to YMV offers valuable resources for breeding programs. Additionally, recognizing the susceptibility of certain genotypes underscores the need to avoid using them in breeding efforts to prevent introducing vulnerabilities into future blackgram cultivars.While the application of insecticides helps to prevent the spread of YMV, but it does not provide effective management of the disease in blackgram. Therefore, identifying and utilizing YMV-resistant genotypes is crucial for developing resistant cultivars. The whitefly population was highest during the 41st and 42nd Standard Meteorological Weeks (SMWs), with mean values of 69.3 and 64.9, respectively. The whitefly population buildup showed significant positive correlation with maximum temperature and negative correlation with rainfall. The whitefly population increased with the rise of maximum temperature and decline of rainfall.

Table 6. Correlation of *Bemisia tabaci* population with major environmental factors during *kharif*- 2023

Bemisia tabaci population	Air Temperature		Relative Humidity		Sunshine(hr)	Rainfall(mm)
	Max.(°C)	Min.(°C)	I(%)	II(%)		
r	0.622 ^{S*}	0.015 ^{NS}	-0.242 ^{NS}	-0.439 ^{NS}	0.376 ^{NS}	-0.632 ^{S*}

r - Correlation co- efficient, NS- Non significant, S- Significant * : @ 5% level of significance

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