Original Research Article

Correlation analysis for leaf pubescence, leaf micro-macro nutrient content and MYMV disease index in blackgram genotypes (Vigna mungo (L.) Hepper)

ABSTRACT

The present field study was conducted to characterize the blackgram genotypes based on morpho and nutrient content under yellow mosaic virus disease infection. The present investigation was carried out with ten blackgram genotypes (5 known tolerant + 5 known susceptible) in Randomized Block Design (RBD) during summer 2018. Experimental crop was affected by yellow mosaic virus (YMV) naturally at 30 DAS. No management practices were taken for controlling of whitefly population during crop season. Correlation studies were done at 50 DAS which helps to find out the most resistant and most susceptible genotypes among ten backgram genotypes based on leaf pubescence and nutrient content in leaf. Leaf pubescence is one of the most important resistant factors in a number of crops and Minerals, apart from being a vital part of the plant nutrition, may manifest certain maladies in the plants either through disturbing normal metabolism and physiology of the plants or by favouring or by discouraging the plant pathogens, if in excess or otherwise deficient.

Correlation analysis of present field investigation revealed that blackgram genotypes showed strong negative correlation for leaf pubescence, leaf Phosphorous (P) and leaf potassium (K) content with percentage disease index (PDI%) as well as strong positive correlation for leaf Nitrogen (N), leaf Iron (Fe) and leaf Zinc (Zn) content under YMV.

Keywords: Blackgram- YMV- leaf pubescence- Micro and Macro nutrients- Correlation.

Introduction

Blackgram [*Vigna mungo* (L.) Hepper] is an important grain legumes short duration crop and widely cultivated in India. In the developed countries, grain legumes are an important indirect source of protein. It gives us an excellent source of easily digestible good quality protein and ability to restore the fertility of soil through symbiotic nitrogen fixation. The seeds are highly nutritious with protein (24-26%), carbohydrates (60%), fat (1.5%), minerals, amino acids and vitamins. The biological value improves greatly, when wheat or rice is combined with blackgram because of the complementary relationship of the essential amino acids such as arginine, leucine, lysine, isoleucine,valine and phenlalanine etc., (Vadivel *et al*., 2019). In India, the area comes under blackgram is about 4.50 million hectares with the production of 3.23 million tonnes (Annonymous, 2018). Yellow Mosaic Disease (YMD) is a significant biotic stress causing profound yield loss in blackgram. Yellow Mosaic Virus (YMV) belongs to the genus Begomo virus and transmitted by the vector whitefly, *Bemisia tabaci*. Yield loss due to this disease varies from 5 to 100 per cent depending upon disease severity, susceptibility of cultivars and population of whitefly (Nene, 1972). Research on epidemiological aspects indicates that MYMV disease incidence depends upon the host genotypes, growing seasons and prevailing environmental conditions. Certain resistant genotypes are now available to the breeders and farmers (Bashir *et al*., 2005; Ashfaq *et al*., 2007) but no information is available on the mechanism of disease resistance in these germplasms. Being dependent on metabolic system, plant viruses cause disturbances in the physiology and anatomy of infected plants (Ashfaq *et al*., 2010). No generalization appears justified concerning the metabolic effects following infection with plant viruses. Most of the metabolic changes observed are probably indirect effects of viral infection as a result of interference with various physiological processes, besides the transport of water, nutrients, and other substances.

Minerals, apart from being a vital part of the plant nutrition, may manifest certain maladies in the plants either through disturbing normal metabolism and physiology of the plants or by favouring or by discouraging the plant pathogens, if in excess or otherwise deficient. Disturbance in growth regulation results in morphological abnormalities, ranging from a mosaic pattern on leaves and flowers to necrotic spots and streaks to leaf enation and tumours (Luria *et al.*, 1978). However, correlation studies for micro and macro nutrients and leaf pubescence helps to screening the blackgram genotypes for YMV tolerance and moreover needed for further evaluation of nutrients efficacy in improving YMV tolerance through foliar nutrition.

Materials and methods

The present field experiment was conducted at S.V. Agricultural college farm, Tirupati campus of Acharya N.G. Ranga Agricultural University, during summer 2018 which is graphically situated at 13.5^{O}N latitude and 79.5^{O}E longitude, with an altitude of 182.9 m above the mean sea level in the southern Agro- Climatic Zone of Andhra Pradesh. YMV infection was high and uniform during Summer compared to *Rabi* (Rajitha, 2018). Hence the present evaluation was taken up during summer 2018 only where disease pressure is high and reliable data can be generated regarding nutrient interventions in YMV tolerance.

The experiment was laid out in a Randomized Block Design (RBD) with ten genotypes and replicated thrice as per the details given below. Treatments consist of totally ten blackgram genotypes [5 known tolerant (LBG 752, PU 31, GBG 1, LB 792 and TBG 104) + 5 known susceptible (LBG 645, LBG 623, LBG 685, PBG 32 and PBG 1)] obtained from Regional Agricultural Research Station (Lam) and Regional Agricultural Research Station (Tirupati). Need based plant protection measures were taken. Experimental crop was affected by yellow mosaic virus (YMV) naturally at 30 DAS. No management practices were taken for controlling of whitefly population during crop season. Sampling was done at 50 DAS.

1. Scoring of YMV Infection %

It was calculated by counting number of plants infected and total number of plants in a plot.

$$\text{Per cent disease incidence} = \frac{\text{Number of plants infected in a row}}{\text{Total number of plants in a row}} \times 100$$

The readings were recorded at 50 DAS and the data were analysed statistically.

2. Leaf pubescence (No. of trichomes per sq. cm)

Leaf pubescence was measured based on trichome density by using stereomicroscope (40X). The leaflet was cut into bits of 0.25 cm^2 and number of trichomes present on the upper and lower surface was counted under stereo zoom trinocular microscope and expressed as number of trichomes per square centimetre leaf area.

3. Nutrient content in leaf

i. Nitrogen (mg $100mg^{-1}$)

Nitrogen content was determined by using the Microkjeldhal distillation apparatus (AOAC, 1970) and expressed as mg $100mg^{-1}$.

ii. **Phosphorus (mg $100mg^{-1}$)**

Vanadomolybdo phosphoric yellow colour method (Jackson, 1973) was used for estimating Phosphorus content in leaf samples. The intensity of the yellow colour was measured at a wave length of 420 nm in spectrophotometer and expressed as mg $100mg^{-1}$.

iii. **Potassium(mg $100mg^{-1}$)**

Potassium content was determined by using the flame photometer (Jackson, 1973) from the diacid extract and expressed as mg $100mg^{-1}$.

iv. **Micronutrients (Fe and Zn) (ppm)**

Micronutrients *viz.,* Fe and Zn were estimated in diacid extract using an Atomic Absorption Spectrophotometer (Vogel, 1978) and expressed as ppm.

Calculation: The uptake of Nitrogen, Phosphorus, Potassium, Iron and Zinc in plant was calculated as follows.

$$\text{Uptake of nutrients} = \text{Nutrient Concentration} \times \frac{\text{Wt. of drymatter}}{100}$$

STATISTICAL ANALYSIS

The experimental data were analyzed statistically by following standard procedure outlined by Panse and Sukhatme (1985). Significance was tested by comparing 'F' value at 5 per cent level of probability. Correlation studies were undertaken for biochemical parameters according to the method proposed by Fisher and Yates (1963).

Results

Correlation analysis of leaf pubescence and micro- macro nutrient content against percentage disease index (PDI%) for screening of blackgram susceptible and tolerant genotypes under yellow mosaic virus condition (YMV) at 50 DAS was investigated in present field study.

1. Scoring of YMV Infection %

Significant differences were observed in both susceptible and tolerant genotypes during the crop growth. Susceptible genotypes showed higher percent of YMV infection of 12.63 per cent compared to tolerant genotypes 0.77 per cent at 50 DAS during summer 2018. Among all the genotypes, LBG-623 resulted higher YMV infection of 16.56 per cent followed by PBG- 32 and PBG-1. Similarly Devi (2016) also found higher disease severity (PDI) in genotype LBG-623. Among the tolerant genotypes higher PDI was recorded in LBG-792 as well as lower in TBG-104 whereas in susceptible genotypes LBG-623 recorded higher PDI and lower PDI was recorded in LBG-685.

2. Leaf pubescence (No. of trichomes per sq. cm)

Trichomes play a major role by providing a first line defence in reducing whitefly infestation, with a subsequent beneficial effect of reducing the incidence of virus. The variation in trichome density of

YMV susceptible and tolerant blackgram genotypes has been depicted in Plate 1. Among the tolerant and susceptible group of genotypes, tolerant genotypes recorded higher mean leaf pubescence of 23.53 per one sqcm compared to susceptible mean value of 16.20 per one sqcm.

Leaf pubescence showed strong negative correlation with percentage disease index (R^2 = -0.690) as depicted in Fig.1, which denotes lower trichome density is favourable to whitefly infestation.

3. Nutrient content in leaf

i. Nitrogen (mg 100mg^{-1})

Higher nitrogen content was observed in susceptible genotypes of 2.75mg 100 mg^{-1} compared to tolerant genotypes of 2.77mg 100 mg^{-1}.

Nitrogen content of blackgram genotypes showed strong positive correlation with percentage disease index (R^2= +0.925) as depicted in Fig.2.

ii. **Phosphorus (mg 100mg^{-1})**

At 50 DAS higher phosphorous content was observed in tolerant genotypes of 0.53 mg 100 mg^{-1} compared to susceptible genotypes of 0.27mg 100 mg^{-1}.

The correlation results revealed that strong negative correlation (R^2=-0.808) as depicted in Fig.3 existed between phosphorous content and disease severity.

iii. **Potassium(mg 100mg^{-1})**

Potassium content was decreased from 30 DAS to 50 DAS irrespective of genotypes. But reduction percent was high in susceptible genotypes compared to tolerant genotypes so due to this disease severity was more pronounced in susceptible genotype can be explained by the factor that it is a mobile nutrient and is transported through the phloem from older to younger leaves.

Higher mean potassium content was observed in tolerant genotypes of 1.00mg 100 mg^{-1} compared to susceptible genotypes of 0.69mg 100 mg^{-1}.

Potassium content of blackgram genotypes showed strong negative correlation with percentage disease index (R^2= -0.785) as depicted in Fig.4.

iv. **Micronutrients (Fe and Zn) (ppm)**

The mean iron content was reduced by 42.96 per cent in tolerant genotypes compared to susceptible genotypes. The correlation results revealed that strong positive correlation (R^2=+0.604) as depicted in Fig.5 existed between iron content and disease severity.

The mean zinc content was reduced by 47.50 per cent in tolerant genotypes compared to susceptible genotypes. Zinc content of blackgram genotypes showed positive correlation with percentage disease index (R^2=+0.589) as depicted in Fig.6.

Discussion

Lower trichome density is favourable to whitefly infestation. Lower density attains moe vectors, thus higher YMV infection due to whitefly adults prefer to oviposit near trichomes is because o the selection pressure exerted by the natural enemies or the improved microhabitat on the blackgram leaves. Similar results were reported by Subedi *et al*., 2016 in blackgram. A general increase of the total N in virus infected plants have been reported for a number of host virus combination by Selman and Grant, 2008. The main component of total N was probable insoluble protein, free amino acids, nucleic acids and amides. Alteration in any one of the components may disturb the nitrogen metabolism. Virus protein contributes significantly to the total protein of the plant and as a consequence there is an increase in total N.

The higher percentage seems due to virus multiplication which entails the synthesis of virus specific abnormal protein that accumulates an ultimately raises the percentage over healthy. Increase in protein contents observed in infected blackgram plant leaves may also be correlated with respiration. Increased nitrogen uptake by diseased plants associated with rapid respiration probably helps in the synthesis of more amino acids (Szczepanski and Redolfi, 2008). Strong negative correlation of potassium might be due to elements of phloem in virus affected plants get blocked due to cell multiplication in parenchymatous tissues. Since the transportation of potassium takes place via phloem from aged to new young leaves, therefore, decrease of potassium concentration in leaves of virus-infected conditions (Ashraf *et al*., 1999). The positive correlation of iron against PDI% which is similarly reported by Ashfaq *et al*., 2010 who opined iron as a component of various flavoproteins (Metalloflavproteins) active in biological oxidation, which may increase as result of inoculation with the virus.

Conclusion

From the present findings based on the results and correlation analysis of blackgram genotypes showed strong negative correlation for leaf pubescence, leaf Phosphorous (P) and leaf potassium (K) content with percentage disease index (PDI%) as well as strong positive correlation for leaf Nitrogen (N), leaf Iron (Fe) and leaf Zinc (Zn) content under YMV. The experiment has to be conducted on long term basis to find the standard reasons for fluctuations in micro and macro nutrients as well as to recommend the present findings.

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Table 1. Mean data of PDI%, leaf pubescence, leaf N, P, K, Fe and Zn content for YMV tolerant and susceptible blackgram genotypes during summer 2018

	Genotypes	PDI%	leaf	Nutrient content (50 DAS)	
				(mg 100 mg^{-1})	ppm

S. No			pubescence (No. of trichomes per sq.cm)	N	P	K	Fe	Zn
	Tolerant							
1	**LBG-752**	0.88	25.00	2.55	0.60	1.00	620.67	53.14
2	**PU-31**	0.67	23.00	2.58	0.54	0.98	545.80	63.21
3	**GBG-1**	1.33	20.67	2.87	0.51	0.90	809.67	87.33
4	**LBG-792**	0.86	20.00	3.08	0.39	0.93	847.80	52.87
5	**TBG-104**	0.10	29.00	2.65	0.62	1.17	562.80	49.33
	Mean	**0.77**	**23.53**	**2.75**	**0.53**	**1.00**	**677.30**	**61.20**
	Susceptible							
6	**LBG-645**	10.92	18.00	3.69	0.40	0.89	747.13	66.35
7	**LBG-623**	16.56	15.33	4.26	0.20	0.57	848.80	74.87
8	**LBG-685**	7.97	16.00	3.79	0.31	0.73	750.47	71.33
9	**PBG-32**	14.04	16.33	3.98	0.23	0.68	894.47	79.33
10	**PBG-1**	13.67	15.33	4.18	0.24	0.58	980.80	78.79
	Mean	**12.63**	**16.20**	**3.98**	**0.27**	**0.69**	**844.30**	**74.10**
	Grand Mean	**6.70**	**19.87**	**3.36**	**0.40**	**0.84**	**760.84**	**67.66**
	SE m ±	0.385	1.1205	0.0065	0.01	0.0132	2.8872	0.5204
	CD (P=0.05)	1.145	3.3293	0.0193	0.0297	0.0392	8.5786	1.5462

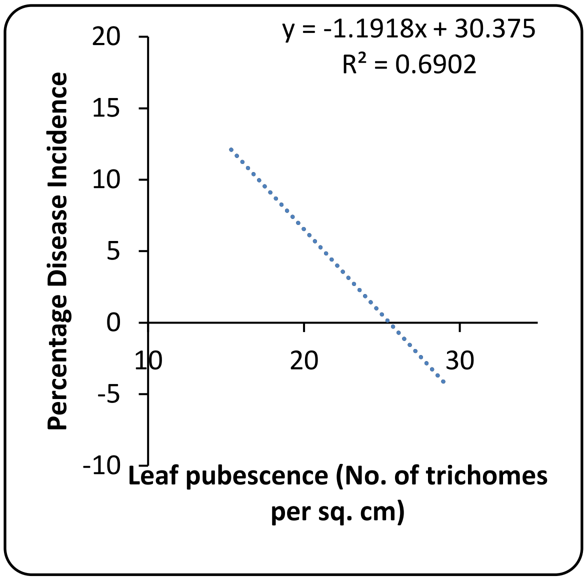


Fig.1. Correlation between leaf pubescence and PDI % in blackgram genotypes during summer 2018 at 50 DAS

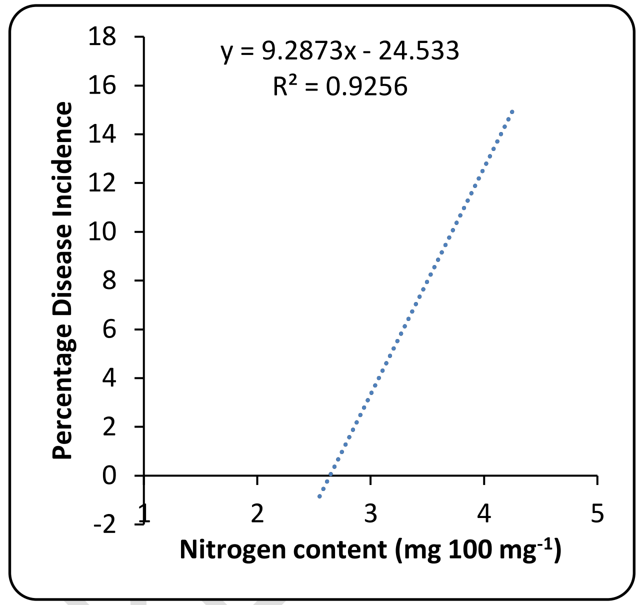


Fig.2. Correlation between Nitrogen content (mg 100 mg^{-1}) and PDI % in blackgram genotypes during summer 2018 at 50 DAS

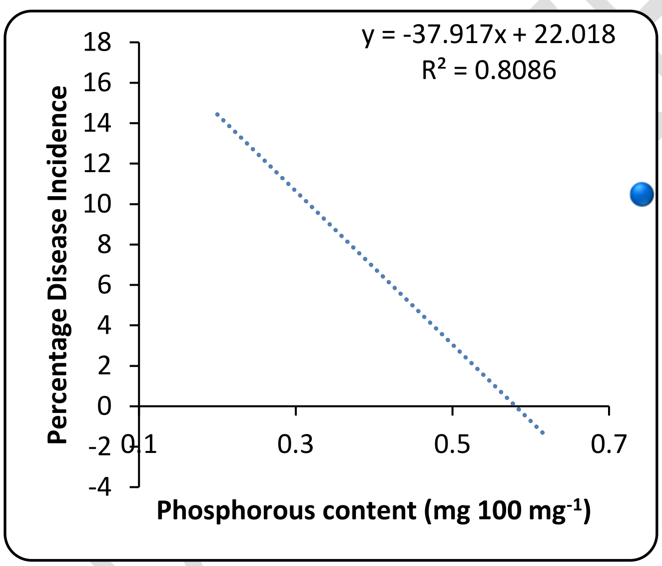


Fig.3. Correlation between Phosphorous content (mg 100 mg^{-1}) and PDI % in blackgram genotypes during summer 2018 at 50 DAS

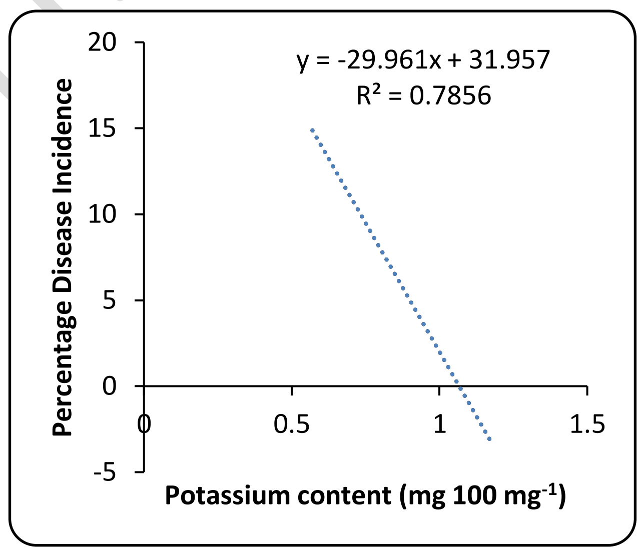


Fig.4.Correlation between Potassium content (mg 100 mg^{-1}) and PDI % in blackgram genotypes during summer 2018 at 50 DAS

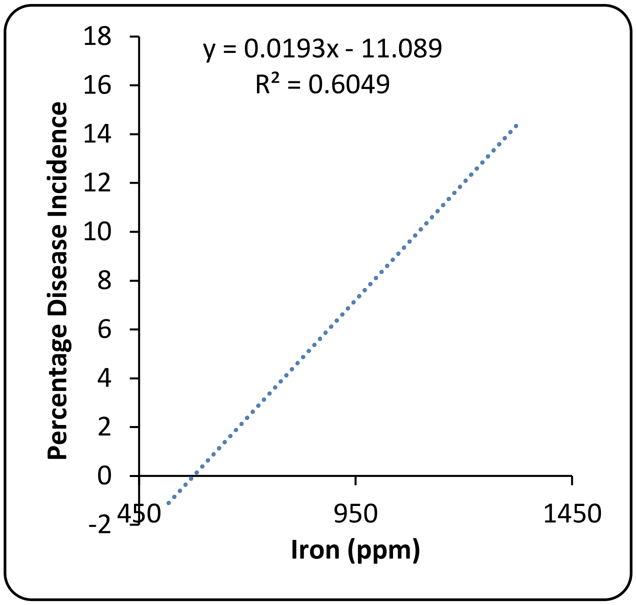
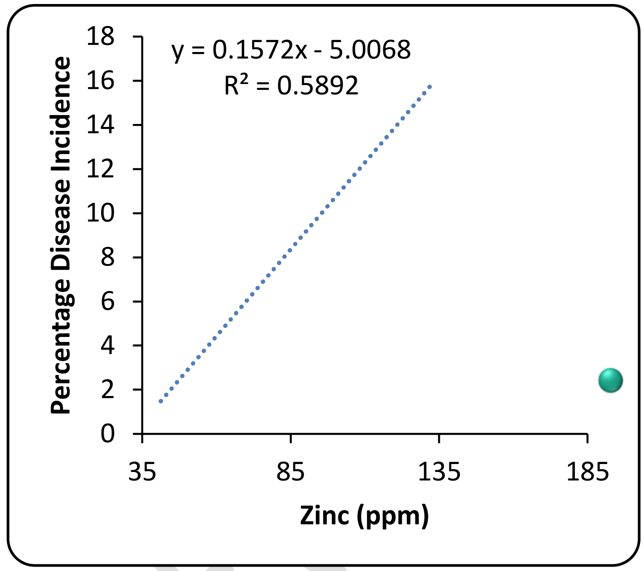
	

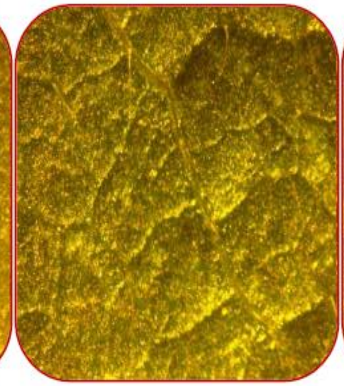
Fig.5.Correlation between Iron content (ppm) and PDI % in blackgram genotypes during summer 2018 at 50 DAS	**Fig.6.Correlation between Zinc content (ppm) and PDI % in blackgram genotypes during summer 2018 at 50 DAS**

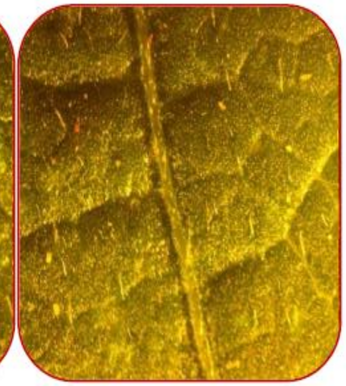
Plate 1. Trichome density of YMV tolerant and susceptible blackgram genotypes at 50 DAS during summer 2018


LBG-752

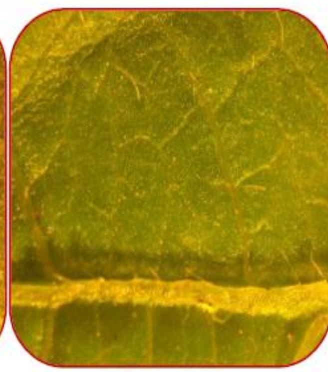

PU-31

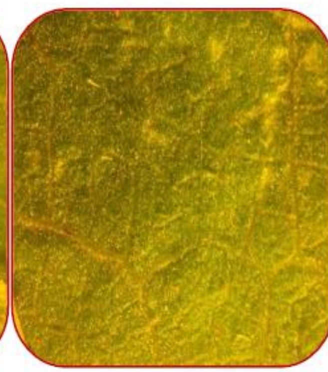

GBG-1

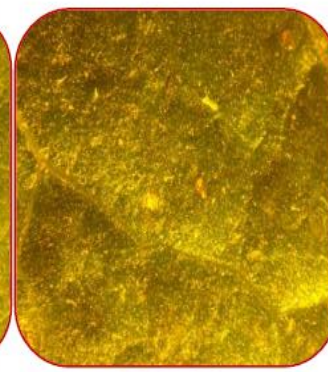

LBG-792

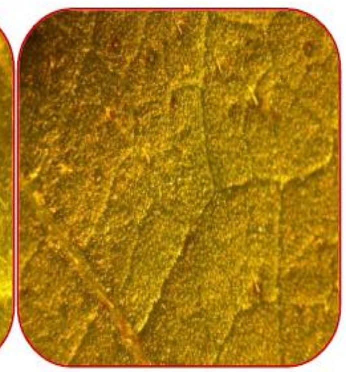

TBG-104


LBG-645


LBG-623


LBG-685


PBG-32


PBG-1