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Population dynamics of important insect pests of Black gram and their correlation with abiotic factors

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ABSTRACT

Black gram is an important pulse crop, which observes 30-50 % losses in yield due to insect pest damage. It is crucial to understand the spectrum of pest damaging it in field, and their response to the prevailing environmental conditions. Population dynamics of important insect pests and their correlation with abiotic factors was studied at CCS HAU, Hisar during *kharif* 2020. The study was carried out from July, 2020 i.e., 30^{th} standard meteorological week (SMW) to October 2020 (39^{th} standard meteorological week). Insect pests whose infestation was recorded during this period includes *Bemisia tabaci, Empoasca kerri, Clavigralla gibbosa, Riptortus pedestris, Maruca vitrata* and *Trichoplusia ni.* No infestation of *Helicoverpa armigera* and *Spodoptera litura* was recorded. Natural enemies like *Coccinella septumpuctata* and spiders were also observed. Out of these, whitefly was observed as most important insect pest causing significant damage to crop. Whitefly incidence commenced in 30^{th}-SMW (19.70 adult/cage) and continued till 39^{th}-SMW (13.35 adult/cage) with its peak population in 31^{st}-SMW (41.75 adult/cage). Rainfall was recorded to be the major factor affecting the population of whitefly adult as significant and negative correlation was reported between the two (r = -0.682*). Further highly significant and negative correlation was observed between spotted pod borer larvae and wind speed (r = -0.792**). This study provides basic understanding about the range of pests damaging crop, and their behavior towards various abiotic factors.

Key words : *Correlation, Population dynamics, Black gram, Abiotic factors, Whitefly*

Introduction

Black gram (*Vigna mungo* L.) popularly known as urdbean, *mash, mashkalai and black mapte* etc., belongs to the family Leguminosae and sub-family Papilionaceae. Black gram is native to Indian subcontinent (Ali and Kumar, 2000), a staple crop in the Central and South East Asia and now grown in the Southern United States, West Indies, Japan and different tropics and subtropics (Delic *et al.*, 2009) regions in the world. High values of lysine make it an excellent complement to rice in terms of balanced nutrition (Anonymous, 2017). In India, it occupies an area of 4.5 million hectares (*kharif* and *rabi*) with average production and productivity of 2.08 million tonnes and 459 kg/ha, respectively. However, in Haryana it occupies an area of 0.00003 million hectares (*kharif*) with average production and productivity of 0.00001 million tonnes and 391 kg/ha, respectively (Anonymous, 2020).

The average productivity of black gram in India is less compared to world's average. Various biotic and abiotic factors are responsible for limiting the productivity of this crop. Insect-pest damage is one of the most important biotic factor limiting the production of crop. About 40 to 60 insect species have been found attacking this crop during different stages of crop growth (Mohanraj *et al.*, 2012). About

2.5 to 3.0 million tonnes (Rabindra *et al.*, 2004), 2.0 to 2.4 million tonnes of pulses worth Rs. 6000 crores (Reddy, 2009) are lost annually due to insect-pests damage. More over indiscriminate use of insecticides to prevent losses due to pest damage has caused environmental pollution and health hazards.

Thus studies on, insect-pests attack during different stages of crop growth and their correlation with weather parameters provides significant information which could be further utilized for predicting the damage caused by the insects and to develop the forecast models which aids in development of pest management strategy. Therefore, keeping above facts in the view, present study was carried out in *Kharif* season to know the population dynamics of important insect-pests and their natural enemies and their relationship with weather parameters

Materials and Methods

The study area

Two genotypes *viz.* UH 1 and MH 479 were sown on (11th July, 2020: 28th SMW) with four replications of each genotype at Experimental area, Department of Entomology, CCS Haryana Agricultural University, Hisar during *Kharif*, 2020. Geographically Hisar is situated at 29.09° North latitude and 75.43° East longitude at an elevation of 215.2 meters (705 ft) above mean sea level. Meteorological attributes of Hisar are scanty rainfall, utmost temperature, dryness, hot and strong winds (May to July), dew and fog (December and January). Most of rainfall occurs in month of July and August and has mean annual rainfall of around 450 mm. Hisar has continental climate, having very hot summers and relatively cold winters.

Study method

Plot size of 5 × 5 m^2 was maintained in each replication in each genotype. Row to row and plant to plant spacing was maintained 30 and 10 cm, respectively. All the recommended agronomic package of practices except insecticidal spray was followed to raise good crop stand. For recording the insect-pests, five plants were selected at random and tagged, in each replication of genotypes, UH 1 and MH 479. Whitefly adult population was counted by cage, from the tagged plants, leafhopper nymphs were recorded by observing population on top, middle and bottom of trifoliate leaves of tagged plant. All other important insect pests and natural enemies were recorded visually from tagged plants. Population of the insects-pests were recorded at weekly interval initiating 15 days after sowing till harvesting of crop and further correlated with weather parameters (maximum temperature, minimum temperature, morning relative humidity, evening relative humidity, wind speed, bright sunshine hours and wind speed) of Hisar during the study period (Fig. 1).

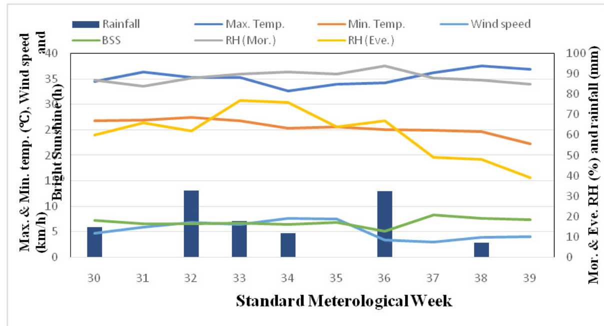

Fig. 1. Weather factors during study period at Hisar in 2020

Statistical Analysis

Data recorded were systematized and subjected to statistical analysis as per prerequisite of the experiments. The computer programme namely, IBM SPSS Statistics for Windows, Version 21.0. and Microsoft Excel ® were used for statistical analysis of the data

Results

Data presented in Table 1 and 2 predicted about the major insect-pests and their natural enemies in black gram varieties MH 479 and UH 1. Whitefly adult, *Bemisia tabaci* population was recorded by cage method initiating from 30th SMW to 39th SMW. Peak population of whitefly in both varieties, i.e., MH 479 (35.9 adults/cage) and UH 1 (47.6 adult/cage) was recorded in 31st SMW and it ranged from 12.9 (MH 479) to 47.6 adult/cage (UH 1). Whitefly infestation started at vegetative stage (30th SMW) and continued till harvesting of crop (39th SMW). Slight decrease (32nd, 33rd, 36th and 39th SMW) and increase (34th , 35th and 37th SMW) in whitefly population was observed in MH 479, while similar trend was observed for UH 1 except increasing trend in 36th SMW (Fig. 2a). Population of leafhopper nymphs, *Empoasca kerri* was almost negligible (0.1 nymph/3 leaves) in both the varieties and found only in 37th

SMW. Population build-up of major insect-pest during different SMW is shown in Fig. 2(a) to 2 (c). Pod bug (*Riptortus pedestris* and *Clavigralla gibbosa*), spotted pod borer, *Maruca vitrata*, tobacco caterpillar, *Spodoptera litura*, gram pod borer, *Helicoverpa armigera* and semilooper, *Trichoplusia ni* population was recorded by visual count method. Pod bugs (*R. pedestris, C. gibbosa*) incidence started during 31st SMW and continued till 37th SMW with an exception of 32nd, 35th SMW (MH 479) and 32nd SMW (UH 1). However, population remained very low and it ranged from 0.05 to 0.15 adult per plant with peak in 33rd and 35th SMW in MH 479 and UH 1, respectively.

Spotted pod borer, *M. vitrata* commenced during 36th SMW (0.10 larvae/plant) in both genotypes and continued till 38th and 39th SMW in MH 479 and UH 1, respectively. However, peak was observed in 36th (0.1 larvae/plant) in MH 479, while in 37th and 38th SMW (0.25 larvae/plant) in UH 1. No infestation of gram pod borer and tobacco caterpillar was found during the period of study. Semilooper larvae population was 0.05 larvae per plant in both varieties and was recorded during 32nd, 37th SMW (MH 479) and 37th SMW (UH 1). Data collected regarding the population dynamics of natural enemies indicated that coccinellids and spiders were the major natural enemies during the period of study (Fig. 2d). Population of coccinellids commenced in 30th SMW and remained till 39th SMW. Peak population of coccinellids (0.25 adult/plant) was recorded during 31st SMW (MH 479), 31st and 33rd SMW (UH 1).

Table 1. Population dynamics of insect pest and natural enemies on black gram var. MH 479 during *kharif*, 2020

SMW	Number of insect pests and natural enemies/plant								
	B. tabaci adult/ plant	*E. kerri* nymphs/ leaf	*R. pedestris-* and *C. gibbosa*	*M. vitrata*	*S. litura*	*H. armigera*	*T. ni*	Natural enemies /plant	
								Coccinellids	Spiders
30	14.70	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.10
31	35.90	0.00	0.05	0.00	0.00	0.00	0.00	0.25	0.15
32	29.10	0.00	0.00	0.00	0.00	0.00	0.05	0.10	0.00
33	12.90	0.00	0.15	0.00	0.00	0.00	0.00	0.15	0.10
34	26.50	0.00	0.05	0.00	0.00	0.00	0.00	0.10	0.10
35	34.40	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.20
36	24.70	0.00	0.05	0.10	0.00	0.00	0.00	0.05	0.10
37	29.90	0.10	0.10	0.05	0.00	0.00	0.05	0.15	0.05
38	25.90	0.00	0.00	0.05	0.00	0.00	0.00	0.05	0.10
39	13.30	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00

Table 2. Population dynamics of insect pest and natural enemies on black gram var. UH 1 during *kharif*, 2020

SMW	Number of insect pests and natural enemies/plant								
	B. tabaci adult/ plant	*E. kerri* nymphs/ leaf	*R. pedestris* and *C. gibbosa*	*M. vitrata*	*S. litura*	*H. armigera*	*T. ni* larvae	Natural enemies /plant	
								Coccinellids	Spiders
30	24.70	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.05
31	47.60	0.00	0.10	0.00	0.00	0.00	0.00	0.25	0.10
32	27.20	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00
33	15.70	0.00	0.10	0.00	0.00	0.00	0.00	0.25	0.10
34	26.80	0.00	0.05	0.00	0.00	0.00	0.00	0.15	0.15
35	26.70	0.00	0.15	0.00	0.00	0.00	0.00	0.15	0.15
36	26.80	0.00	0.05	0.10	0.00	0.00	0.00	0.05	0.10
37	27.50	0.10	0.10	0.25	0.00	0.00	0.05	0.10	0.00
38	26.20	0.00	0.00	0.25	0.00	0.00	0.00	0.10	0.05
39	13.40	0.00	0.00	0.05	0.00	0.00	0.00	0.10	0.05

However, population ranged between 0.05 to 0.25 adults per plant in both varieties. Spiders were observed during 30th SMW and their presence was recorded till 39th SMW except in 32nd, 39th SMW (MH 479), 32nd and 37th SMW (UH1). Spider population ranged between 0.05 to 0.20 per plant in MH 479, while 0.05 to 0.15 per plant in UH 1, with peaks in 34th SMW (UH 1) and 35th SMW (MH479 and UH 1), respectively.

Influence of weather parameters on insect-pests of black gram

Data presented in Table 3 predicted about the correlation of insect-pests and natural enemies with weather parameters. Significant and negative correlation of *B. tabaci* adult population was found with rainfall (r = -0.682*). The regression equation being as Y = 30.58-0.44x (R^2 = 0.46). From this equation it may be expressed with every unit increase in rainfall there was a decrease of 0.44 adult population of whitefly. Whereas it showed non-significant and negative correlation with minimum temperature, relative humidity (morning and evening) and wind speed, while positive and non-significant correlation was observed with maximum temperature and sunshine hours.

All the weather parameters showed non-significant correlation with *E. kerri* nymphs, pod bugs (*R. pedestris* and *C. gibbosa*), semilooper and natural enemies. Leafhopper nymph showed positive and non-significant correlation with maximum temperature and sunshine hours, while negative and non-significant with minimum temperature, relative humidity (morning and evening), wind speed and

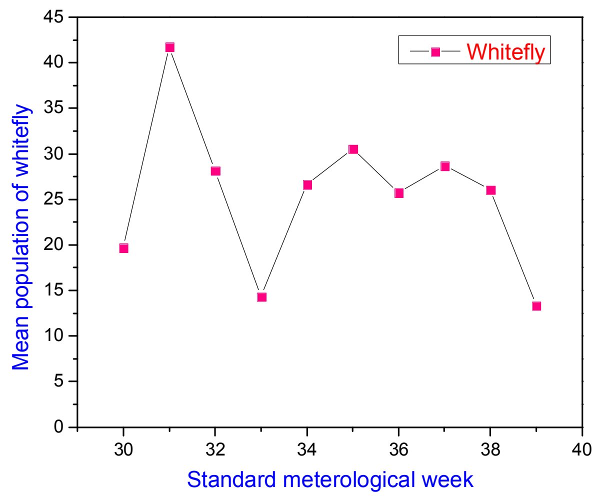

Fig. 2(a). Whitefly

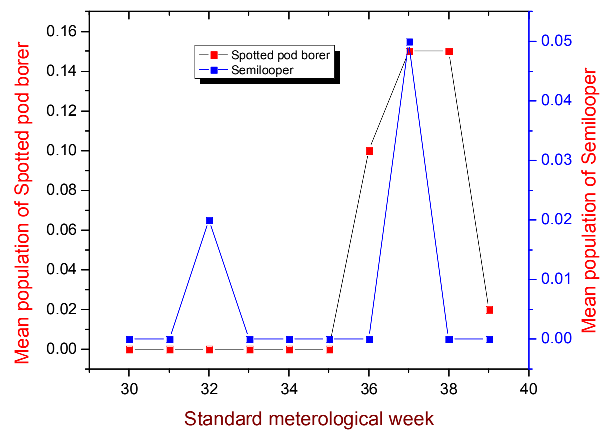

Fig. 2(c). Spotted pod borer and Semilooper

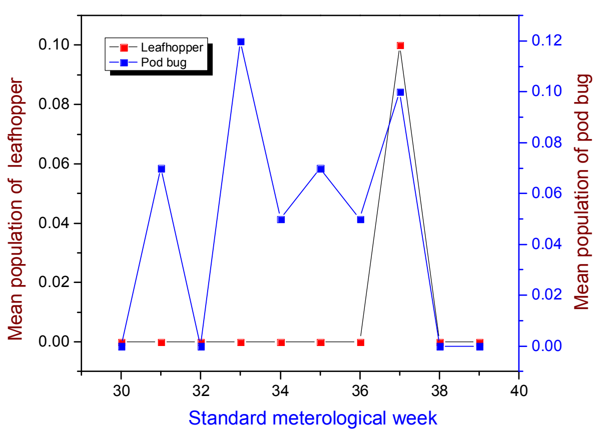

Fig 2(b). Leafhopper and Pod bug

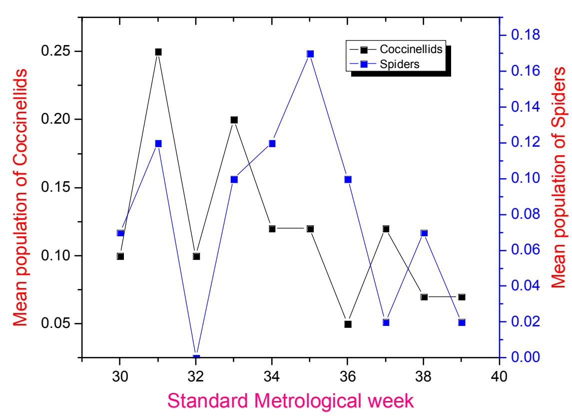

Fig. 2(d). Coccinellids and Spiders

Fig. 2. Population of insect pests (whitefly, leafhopper, pod bug, spotted pod borer and semilooper) and natural enemies (coccinellids and spiders) on black gram during *kharif*, 2020 (Mean of var. UH 1 and MH 479)

Table 3. Correlation of weather parameters with insect pests of black gram varieties ,MH 479 and UH-1

Weather parameter	Insect pests					Natural enemies	
	B. tabaci	*E. kerri*	*R. pedestris and C. gibbosa*	*M. vitrata*	*T. ni*	Coccinellid	Spider
Max.Temp. (°C)	0.173^{NS}	0.229^{NS}	-0.176^{NS}	0.477^{NS}	0.215^{NS}	0.054^{NS}	-0.506^{NS}
Min. Temp. (°C)	-0.293^{NS}	-0.165^{NS}	0.239^{NS}	-0.427^{NS}	0.047^{NS}	0.529^{NS}	0.182^{NS}
R.H. (M) (%)	-0.337^{NS}	-0.048^{NS}	0.293^{NS}	0.119^{NS}	-0.067^{NS}	-0.351^{NS}	0.327^{NS}
R.H. (E) (%)	-0.185^{NS}	-0.339^{NS}	0.499^{NS}	-0.508^{NS}	-0.301^{NS}	0.467^{NS}	0.586^{NS}
Wind speed (km/h)	-0.126^{NS}	-0.477^{NS}	0.167^{NS}	-0.792**	-0.303^{NS}	0.432^{NS}	0.473^{NS}
Sunshine (h)	0.043^{NS}	0.584^{NS}	-0.058^{NS}	0.314^{NS}	0.493^{NS}	0.042^{NS}	-0.411^{NS}
Rainfall (mm)	-0.682*	-0.317^{NS}	-0.209^{NS}	-0.085^{NS}	-0.026^{NS}	-0.338^{NS}	-0.239^{NS}

rainfall. Contrary to this pod bug population showed non-significant and positive correlation with minimum temperature, relative humidity (morning and evening) and wind speed, whereas correlation was negative and non-significant with maximum temperature, sunshine hours and rainfall.

Larval population of *M. vitrata* showed highly significant and negative correlation with wind speed (r = -0.792**), the regression equation being as: Y = 0.2-0.03x (R^2 = 0.63). From this equation it may be estimated that with every unit increase in wind speed there was a decrease of 0.03 *M. vitrata* larvae/ plant. Further correlation was non-significant positive (maximum temperature, morning relative humidity and sunshine) and negative (minimum temperature, evening relative humidity and rainfall) for other factors. Similarly *T. ni* larvae showed negative and non-significant correlation with relative humidity (morning and evening), wind speed and rainfall, while positive and non-significant association with temperature (Max. and Min.) and sunshine hours.

Coccinellid population showed positive and non-significant correlation with temperature (minimum and maximum), evening relative humidity, wind speed and sunshine, while positive and non-significant with morning relative humidity and rainfall. Spiders population showed positive and non-significant correlation with minimum temperature, relative humidity (morning and evening) and wind speed, while it was negative and non-significant with maximum temperature, sunshine and rainfall.

Discussion

Outcomes about whitefly incidence were found to be in corroboration with Marabi *et al.* (2017) and Garg and Patel (2018) who observed whitefly population from 28th to 38th SMW and 29th SMW to 38th SMW, respectively. Findings are more or less in accordance with other workers who reported whitefly peaks during 36th SMW (Marabi *et al.*, 2017 and Garg and Patel, 2018), 37th SMW (Singh *et al.*, 2017; Kumar and Singh, 2016 and Duraimurugan and Tyagi, 2014) and 39th SMW (Mohapatra *et al.*, 2018 and Yadav *et al.*, 2015). Range of whitefly adult population findings were supported by the finding of Mohapatra *et al.*, 2018: 4.80-36.80 adults/cage/plant and Marabi *et al.*, 2017 (12.62-67.83 whiteflies/sticky trap). Leafhopper nymphs were commenced during 37th SMW and more or less same was supported by Yadav *et al.*, 2015 who reported commencement in 36th SMW. Leafhopper peak as well initiation was 0.1 nymph/ 3 leaves, which is validated by findings of Kumar and Singh (2016) who observed a peak of 1.43 leafhopper/cage during 37th SMW.

Contrary to our findings about pod bug, Duraimurugan and Tyagi, (2014) recorded pod bug incidence from 37th to 39th SMW and recorded peak population during 39th SMW with average range of 0.24-0.72 adult/plant. Findings regarding spotted pod borer larval population validated by Kumar and Singh (2016) and Duraimurugan and Tyagi (2014) who reported commencement during 36th SMW and 37th SMW, while peaks during 38th and 37th SMW, respectively. Duraimurugan and Tyagi, (2014) further reported range of 0.04 to 0.28 larvae per plant, contrary to this Kumar and Singh (2016) reported 0.47 to 2.13 larvae per plant.

In contrast to our findings, Sain *et al.* (2020) and Yadav *et al.* (2020) observed gram pod borer incidence from flowering to pod maturity. Further its commencement and peak during 10th SMW and 18th SMW is reported by Kapoor and Shankar, 2019. However, Yadav and Patel (2015) and Yadav *et al.*, (2015) reported tobacco caterpillar larvae incidence during 36th SMW with peaks in 40th SMW. Present

Findings regarding semilooper are in accordance with findings of Yadav *et al.* (2015) who reported commencement in 36th SMW.

Contrary to our findings of coccinellids population Mohapatra *et al.* (2018) and Yadav *et al.* (2015) observed coccinellids incidence during 39th SMW and 36th SMW, respectively with peaks during 41st and 39th SMW, respectively. Findings on spider population are in accordance with those of Rajawat *et al.* (2019) who reported incidence from 30th July to 15th October. Swathi *et al.* (2018) reported peak population of spider as 2.04 spider per plant as compared to 0.20 spider per plant in present study.

Influence of weather parameters on insect-pests of black gram

Garg and Patel (2018) supported our findings more or less partially and reported significant and negative correlation of whitefly adult population with rainfall, while non significant and negative correlation with wind speed and relative humidity and non-significant positive correlation with maximum temperature. Similarly, Singh *et al.* (2017) and Marabi *et al.* (2017) reported negative and non-significant correlation of whitefly with relative humidity. Contrary to present findings Yadav *et al.* (2015) observed a non-significant and positive correlation with rainfall.

Findings are more or less in accordance with Mohapatra *et al.* (2018) who reported non significant positive and non-significant negative correlation of leafhopper with maximum temperature and relative humidity, respectively. Contrary to present findings Yadav *et al.* (2015) observed non-significant and positive correlation of leafhopper with rainfall and relative humidity.

Findings are in contradiction with those of Duraimurugan and Tyagi (2014) who reported non-significant positive and significant positive effect of weather parameters *viz.* (maximum temperature, rainfall and sunshine) with pod bug population. While Khamoriya *et al.* (2017) supported the findings, showing significant and positive effect of maximum temperature, however contradiction was also observed as finding indicateda significant and negative correlation with relative humidity. However, finding was endorsed partially by Kar (2017) who reported negative effect of maximum temperature on pod bug population.

Similar to our finding, Biswas and Banerjee (2019) also reported negative and non-significant correlation of spotted pod borer population with rainfall and minimum temperature. It is in accordance of Duraimurugan and Tyagi (2014), who reported negative and non-significant correlation with wind, while in contradiction with those of Kapoor and Shankar (2019), who observed a non-significant and positive correlation with wind speed. Findings related to semilooper are supported by Matti and Deotale (2017) who observed a negative correlation with morning relative humidity and rainfall. On contrary to this, Yadav *et al.* (2015) observed non-significant and positive correlation with rainfall, wind speed and morning relative humidity, significant and positive with relative humidity and non-significant and negative with sunshine hours.

Findings related to coccinellids are validated by Yadav *et al.* (2015) who reported negative and non-significant correlation with rainfall and positive and non-significant correlation with temperature (maximum and minimum) and evening relative humidity. Findings are also in accordance with those of Mohapatra *et al.* (2018) and Kumar and Singh (2021) who reported non-significant and negative correlation with rainfall, contrarily Borkakati and Saikia (2020) reported non-significant and positive correlation of coccinellid with rainfall. In case of spiders, our findings were endorsed by Patel *et al.* (2013) who reported negative and significant correlation of spiders with rainfall. Similarly, Kumar and Singh (2021) and Borkakati and Saikia (2020) also supported the present findings and reported positive and non-significant correlation of spiders with minimum temperature and negative and non-significant correlation with rainfall.

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