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Incidence of insect pests of black gram [*Vigna mungo* (L.) Hepper] in relation to abiotic factors in the western undulating zone of Odisha

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Abstract
The field experiment on "Incidence of insect pests of black gram [*Vigna mungo* (L.) Hepper] in relation to abiotic factors in the Western undulating zone of Odisha" was conducted at the Research farm, College of Agriculture, OUAT, Bhawanipatna to study the influence of climatic factors on the population growth during *rabi*-2021. It was noticed that maximum temperature exhibited significantly negative correlation with thrips, aphid and spiders population, whereas galerucid beetles showed a significant positive correlation. The bright sun shine hours established significantly positive correlation with aphid, predators like coccinellid beetles and spiders and a significantly negative correlation with galerucid beetles and parasitoids population. The estimated regression equation revealed that with every unit increase of maximum temperature there was increase of 1.22, 0.21, 0.02, 0.04 and 0.97 whitefly, jassid, stem fly, semilooper, galerucid beetle population and decrease of 3.09 and 0.36 aphid and thrips population, whereas the predators, parasitoids, spiders and coccinellid beetles decrease 0.62, 1.03, 0.13 and 0.40 respectively.

Keywords: Black gram, insect pests, abiotic factors

Introduction

Black gram [*Vigna mungo* (L.) Hepper] popularly known as biri in Odisha is grown in about 434.72 thousand ha area with production of about 209.87 thousand tonnes and productivity of 483 kg/ha. The current level of pulse productivity in Odisha is very low and unable to meet the WHO recommended per capita pulse requirement of 80 gms/day. There are numbers of constraints in the low production and productivity of black gram and insect infestation is one of the major factors as they cause damage to three important plant parts *i.e*, leaves, flowers and pods in the field and also seeds during storage. The average yield loss of black gram due to insect pests at various stages of the crop growth accounts 10-15% as reported by Bindra (1968) [1], 17-38% by Odak (1978) [3], and 30 to 54.3% by Dhuri and Singh (1983) [2] in India.

Management of insects in blackgram only by means chemical pesticides leads to development of pest resistance, resurgence, secondary pest outbreak and environmental pollution. So it is the need of the hour to collect the base line information on the insect population and natural enemies build up with relation to abiotic factors and develop a for casting model for the effective management of insect pests. Keeping this point in view the present study was undertaken to evaluate the insect pests and natural enemies populations build up with the prevailing weather factors of the Western undulating zone of Odisha in the blackgram ecosystem, which can be utilized by the entomologist for the development of the IPM package.

Materials and Methods

The field experiment was conducted at College of Agriculture, Bhawanipatna to study the insect pests and natural enemy's population build in blackgram with respect to the prevailing weather factors of the Western Undulating Zone of Odisha during Rabi, 2021. Variety NUL-7 (Vishwas) was shown on 5th October, 2021 at the rate of 15 kg/ha in the plot size of 20 × 15 m^2 with the spacing of 45 cm x 10 cm between the rows. Crops are grown with the recommended fertilizer dose *i.e*, 25:50:25 N_2, P_2O_5 and K_2O/ha respectively under insecticides free condition with an objective to allow insect population builds up.

The population of insect pests and natural enemies were recorded after one month of germination of seeds till harvest of the crop at weekly interval during morning hours (8-9.0 AM) by sweep net (flying insects), yellow sticky trap (white fly and Jassids) and visual observation (Thrips, larval population, natural enemies, beetles etc.) to assess the insect population associated with the crop during different growth stages. The insects collected in the net were immediately killed by placing them in a polythene bag containing ethyl-acetate soaked cotton. The collected dead insects were brought into the laboratory, segregated into various groups *viz*., coleopterans, lepidopterans, dipterans, hemipterans, hymenopterans, orthopterans, parsitoids, predators, spiders etc and their population was counted. Yellow sticky traps were installed in the field at a distance of 10 meters and above the crop canopy to record the white fly and jassids population. In each plot, 20 flowers were collected at random and the number of thrips was counted by shaking of the flowers over a piece of white paper.

Statistical analysis of insect population and natural enemies at various stages of crop growth were done to study the correlation and regressions coefficient of insect population with the abiotic factors *viz*., temperature, relative humidity, rainfall, rainy days and bright sunshine hours.

Results and Discussion

The correlation and regression study of insect and natural enemies' population with the prevailing weather factors were presented below in table 1-6.

Maximum and minimum temperature

Present study revealed a significant positive correlation of maximum temperature with the insects belongs to order coleoptera. However, hymenoptera and lepidoptera insect order and the parasitoids, predators, coccinellid beetles as well as spiders showed a significant negative correlation with maximum temperature respectively. Correlation study of thrips (r= -0.814) and aphid (r= -0.723) population had exhibited significantly negative correlation with maximum temperature. Thrips are negatively correlated with maximum temperature was reported earlier by Nitharwal and Kumawat (2009) [4].

Minimum temperature exhibited positive correlation with coleopteran insect order and also with jassids, semi-looper, galerucid beetles, pod bugs, whereas lepidoptera, diptera, hemiptera, hymenoptera, odonata, orthoptera insect order as well as aphids, white fly, thrips, pod fly, pod wasp, stemfly , parasitoids, predators and with spiders minimum temperature established a non-significantly negative correlation. The maximum relative humidity showed a significant negative correlation against insect pests of diptera (r= -0.660) and hemiptera (r=-0.718) and the insects jassids, semilooper, galerucid beetles and pod bug. However positive correlation was found with insects belong to order coleoptera and lepidoptera as well as aphids, stem fly, whitefly, thrips , pod fly and pod wasp and a non-significantly negative correlation with diptera, hemiptera, hymenoptera, odonata and orthoptera.

Maximum and minimum relative humidity

All the insect orders and the insects like aphids, stem fly, semiloopers, galerucid beetles, pod bug, pod fly and pod wasp exhibited negative correlation with minimum humidity, where as positive correlation against jassids, white fly and thrips. Maximum humidity exhibited negative correlation with spiders and predators population, whereas coccinellids beetles were negatively correlated with minimum humidity, but statistically found to be non-significant

Rainfall

The rainfall data computed against the insect order *i.e*, lepidoptera, diptera,hemiptera, hymenoptera and orthoptera and insects like aphids, stem fly, whitefly, pod bug, pod fly and pod wasp showed negative correlation, whereas coleoptera and odonata as well as insects jassids, semilooper, galerucid beetle and thrips established positive correlation, but statistically found to be non-significant. Aphid population had exhibited negative correlation with rain fall and was in consonance with the Gehlot and Prajapat (2021) [6]. Rainfall had a non-significant negative correlation with whitefly and was agreement with Bashir et al., (2001) [7] and Bairwa and Singh (2017) [8]. The parasitoids, predators, coccinellid beetles and spiders population exhibited negatively correlation with rainfall, but statistically found to be non-significant.

Rainy day

Rainy day was negatively correlated with all the insect pests and orders and all the parasitoids, predators and spiders except coleoptera, the insect jassid, semilooper and galerucid beetle.

Bright sunshine hours (BSH)

BSH had computed significant negative correlation against coleopteran insects (r= -0.955) and significant positive correlation with insects of lepidoptera (r= 0.728) and hymenoptera (r= 0.909). It showed positive correlation with the insects population belongs to order diptera, hemiptera, odonata and orthoptera. BSH had significant positive correlation with aphids (r= 0.737) and exhibited significant negative correlation against galerucid beetle (r= -0.933). All other insect pests during study period reported positive correlation against BSH, but statistically found to be non-significant.

Significant negative correlation (r=-0.887) were established between parasitoids population and BSH, whereas it showed significant positive correlation with predators (r= 0.757), coccinellids beetles (r= 0.876) and spiders (r=0.970) population. Bright sunshine hours showed positively significant correlation with coccinellid beetles population on cowpea has been earlier reported by Patel *et al*. 2010 [9].

Regression equation of maximum temperature with different insect population

Present simple regression study revealed that with every unit increase of maximum temperature there was increase of 0.98 insects belongs to coleopteran and decrease of 0.27, 0.34, 0.60, 0.95 and 0.03 insects belongs to order lepidoptera, diptera, hemiptera, hymenoptera and orthoptera respectively.

Simple linear regression equation estimated reveals that with every unit increase in maximum temperature there was increase of 1.22, 0.21, 0.02, 0.04 and 0.97 whitefly, jassid, stem fly, semilooper, galerucid beetle population respectively and there was decrease of 3.09 and 0.36 aphid and thrips population respectively. Significantly positive correlation between the maximum temperature and whitefly population in black gram crop had earlier been reported by Bairwa and Singh (2017) [8]. Significant positive correlation between maximum temperature and jassid population was reported earlier by Nitharwal et al. (2013) [5] which was in accordance with our result.

The regression equation estimated for natural enemies implies that with every unit increase in maximum temperature there was a decrease of 0.62, 1.03, 0.13 and 0.40 predators, parasitoids, spiders and coccinellid beetles respectively.

Multiple regression equation of insect pests and natural enemies with meteorological parameters

The influence of seven weather parameter *viz*; minimum and maximum temperature, minimum and maximum relative humidity, rain fall, rainy day and bright sun shine hours on population of the insects belongs to order coleopteran, lepidoptera, diptera, hemiptera, hymenoptera and orthoptera clearly indicated that 79.4%, 95.1%, 90.7%, 90.2%, 71.4% and 95.7% change in their population was affected by above mentioned weather parameters respectively.

Present study expressed 99.2%, 66.90%, 52.3%, 52.3% and 95.8% change in aphid, jassid, white fly, thrips and stem fly population respectively was due to the seven weather parameters. The influence of weather parameters on whitefly population in black gram has also been reported earlier to the extent of 64% and 59% by Srinivasaraghavan (2014) [10] respectively.

The influence of meteorological parameters on natural enemies population revealed that the percentage change in the population of parasitoids, predators, coccinellid beetles and spiders was 94.1, 95.0, 97.9 and 76.7 respectively due the seven weather parameters. The remaining percentage variation of insect pests and natural enemies may be affected due to other factors.

Table 1: Correlation coefficient between order of insects and weather parameters in black gram during *Rabi*-2021

Sl. No.	Insect Order	Temperature (°C)		Humidity (%)		Rainfall (mm)	Rainy day	BSH/ Day
		Min.	Max.	Min.	Max.			
1	Coleoptera	0.612	0.833*	− 0.306	− 0.106	0.313	0.373	− 0.955*
2	Lepidoptera	− 0.594	− 0.692*	0.227	− 0.193	− 0.108	− 0.107	0.728*
3	Diptera	− 0.333	− 0.258	− 0.344	− 0.398	− 0.241	− 0.225	0.294
4	Hemiptera	− 0.385	− 0.281	− 0.276	− 0.355	− 0.254	− 0.229	0.304
5	Hymenoptera	− 0.477	− 0.648*	0.317	0.232	− 0.301	− 0.380	0.909*
6	Odonata	− 0.486	− 0.532	0.448	0.225	0.032	0.049	0.555
7	Orthoptera	− 0.318	− 0.180	0.229	0.349	− 0.158	− 0.130	0.196

Table 2: Correlation coefficient of insect pests with weather parameters in black gram during *Rabi*-2021

Sl. No.	Insect	Temperature (°C)		Humidity (%)		Rainfall (mm)	Rainy day	BSH/ Day
		Min.	Max.	Min.	Max.			
1	Jassid	0.140	0.185	− 0.027	0.197	0.094	0.107	0.200
2	Aphid	− 0.540	− 0.723*	0.235	− 0.149	− 0.221	− 0.261	0.737*
3	Stem fly	− 0.193	− 0.075	0.264	−0.394	− 0.168	− 0.132	0.045
4	Semi looper	0.260	0.414	− 0.406	− 0.496	0.139	0.191	0.037
5	Galerucid beetle	0.661	0.747*	-0.233	-0.084	0.260	0.294	− 0.933*
6	Whitefly	−0.150	0.085	0.039	0.135	−0.153	−0.108	0.382
7	Thrips	−0.520	−0.814*	0.538	0.422	0.225	−0.318	0.646
8	Pod bug	0.198	0.243	−0.183	−0.009	−0.133	−0.156	0.452
9	Pod fly	−0.395	−0.377	0.049	−0.371	−0.163	−0.125	0.361
10	Pod wasp	−0.395	−0.377	0.049	−0.371	−0.163	−0.125	0.361

Table 3: Correlation coefficient of natural enemies with weather parameters in black gram during *Rabi*-2021

Sl. No.	Natural enemies	Temperature (°C)		Humidity (%)		Rainfall (mm)	Rainy day	BSH/Day
		Min.	Max.	Min.	Max.			
1	Parasitoid	− 0.611	− 0.828*	0.299	0.004	− 0.284	− 0.345	− 0.887*
2	Predators	− 0.621	− 0.699*	0.172	− 0.231	− 0.255	− 0.266	0.757*
3	Coccinellid beetle	− 0.673*	− 0.826*	0.237	− 0.096	− 0.289	− 0.328	0.876*
4	Spider	− 0.611	− 0.753*	− 0.225	0.095	− 0.221	− 0.275	0.970*

Table 4: Multiple regressions of different insect orders with weather parameters in blackgram during *Rabi*-2022

Variable (Y)	Multiple Regression equation	R^2 value
Coleoptera	$Y=1.517228+1.608357(x_1)-1.02244(x_2)-0.64578(x_3)+0.53296(x_4)-1.27645(x_5)+38.39899(x_6)-1.59261(x_7)$	0.794
Lepidoptera	$Y=-1.34421-0.86732(x_1)+0.779054(x_2)+0.433169(x_3)-0.37144(x_4)+0.456894(x_5)-14.4518(x_6)+0.958827(x_7)$	0.951
Diptera	$Y=-63.8069+0.144766(x_1)-0.58673(x_2)+0.752763(x_3)+0.058027(x_4)+0.198268(x_5)-10.1508(x_6)+2.397932(x_7)$	0.907
Hemiptera	$Y=-56.4913-1.12558(x_1)-0.20057(x_2)+0.857947(x_3)+0.238928(x_4)-0.9333(x_5)+16.23497(x_6)+3.989207(x_7)$	0.902
Hymenoptera	$Y=-54.9961+1.176741(x_1)-1.13001(x_2)+0.85923(x_3)-0.4807(x_4)+3.72041(x_5)-99.0521(x_6)+1.250333(x_7)$	0.714
Orthoptera	$Y=-14.7107+0.062133(x_1)-0.09049(x_2)+0.189597(x_3)-0.03819(x_4)+0.273167(x_5)-7.79483(x_6)+0.593903(x_7)$	0.957

Table 5: Multiple regression of insect pests with weather parameters in black gram during *Rabi*-2021

Variable (Y)	Multiple Regression equation	R^2 value
Jassid	$Y=-8.13409-1.99406(x_1)+2.044092(x_2)+0.669275(x_3)-0.57826(x_4)+2.097693(x_5)-57.2457(x_6)+3.71516(x_7)$	0.669
Aphid	$Y=-64.0068-4.46203(x_1)+4.566749(x_2)+4.066837(x_3)-3.49139(x_4)+7.17565(x_5)-210.479(x_6)+6.181319(x_7)$	0.992
Stem fly	$Y=-21.6993-0.3233(x_1)-0.14257(x_2)+0.141103(x_3)+0.296247(x_4)-1.10369(x_5)+26.32673(x_6)+1.26684(x_7)$	0.958
Whitefly	$Y=-914.583-8.98388(x_1)+14.5386(x_2)+17.71195(x_3)-10.7572(x_4)+41.25861(x_5)-1148.73(x_6)+60.9909(x_7)$	0.523
Thrips	$Y=-11.5573+0.547495(x_1)- 0.7113(x_2)+0.547495+0.64254(x_3)+0.07315(x_4)+0.372781(x_5)-9.48383(x_6)-0.27138(x_7)$	0.993

Table 6: Multiple regressions of natural enemies with weather parameters in black gram during *Rabi*-2022

Variable(Y)	Multiple Regression equation	R^2 value
Parasitoids	$Y=-16.1283-1.08651(x_1)+0.897553(x_2)+1.038283(x_3)-0.84661(x_4)+2.314185(x_5)-66.1681(x_6)+1.772492(x_7)$	0.941
Predators	$Y=-11.58886-1.12796(x_1)+1.076142(x_2)+0.88019(x_3)-0.7398(x_4)+1.166196(x_5)-35.886(x_6)+1.45264(x_7)$	0.970
Coccinellid beetle	$Y=-1.12518+0.174233(x_1)-0.24059(x_2)+0.116863(x_3)-0.10272(x_4)+0.015795(x_5)-0.81648(x_6)-0.32454(x_7)$	0.979
Spider	$Y=-4.35683+0.08942(x_1)-0.15317(x_2)+0.082667(x_3)-0.03074(x_4)+0.236824(x_5)-5.93307(x_6)+0.086503(x_7)$	0.767

Note: X_1=Minimum Temperature (ºC), X_2=Maximum Temperature (ºC), X_3 = Minimum Relative Humidity (%), X_4 = Maximum Relative Humidity (%), X_5 = Rain fall (mm), X_6 = Rainy day (No), X_7=BSH

Conclusion
The data generated from the present study on the seasonal fluctuation of insect pests and natural enemies in relation with the prevailing climatic factors can be utilized by the entomologists for development of weather forecasting model against insect pests of black gram and forewarning the farmers about timely decision making for use of chemical pesticides.

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