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Seasonal incidence of defoliators on black gram and its correlation with abiotic factors

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Abstract
The field experiment was conducted in research farm BAU, Kanke, Ranchi during *Kharif* 2016 and 2017 for assessment of seasonal incidence of defoliators on black gram with relation to weather factors. The population of defoliators recorded namely, tobacco caterpillar (*Spodoptera litura*), Bihar hairy caterpillar (*Spilosoma obliqua*), semilooper (*Trichoplusia ni*) and grasshoppers (*Khaoyaiana nitens, Atractomorpha crenulata and Diabolocatantops pinguis)*. The peak population of defoliators (tobacco caterpillar, Bihar hairy caterpillar and green semilooper) was recorded during the second and third week of August (32nd and 33rd standard meteorological week) while the highest population of grasshopper recorded in the third and fourth week of August (33rd and 34th standard meteorological week). The temperature and relative humidity positively impact on defoliator population, hence the correlation of defoliators positively significant with temperature and relative humidity. The rainfall correlated negatively with defoliators. The multiple linear regressions analysis revealed that per cent abundance population of defoliators were recorded as follows tobacco caterpillar (50.4 and 75.8), Bihar hairy caterpillar (44.6 and 68.9), green semilooper (50.5 and 84.4) and grasshopper (44.4 and 74.7) during the year 2016 and 2017 respectively.

Keywords: black gram, defoliators, abiotic factors

Introduction
Black gram [*Vigna mungo* (L.) Hepper] is one of the important pulse crop grown in India. It is an important short duration grain legume crops with wide adaptability, low input requirement and have the ability to improve soil fertility by fixing atmospheric nitrogen and also benefits the succeeding crops (Singh and Singh, 2011) [3, 4, 9, 10]. It belongs to family leguminosae popularly known as urd bean or mash kalai or black bean is native of India and it ranks fourth important pulse crop with high nutritional significance (Singh, 2004) [3, 4, 9, 10]. It is one of the major *Kharif* pulse crop in India covering 54.39 lakh ha area with the production of 35.62 lakh tonnes and productivity of 655 kg/ha, whereas, in Jharkhand, it is cultivated in 1.48 lakh ha area with the production of 1.32 lakh tonnes and productivity of 982 kg/ha (Anonymous 2017-18) [1]. The average 2.5 to 3.0 million tonnes of pulse production are lost annually due to pest problems (Rabindra *et al.*, 2004) [8]. The vegetative stage is mostly preferred by defoliators which cause noticeable damage. Bihar hairy caterpillar (*Spilosoma obliqua*) is a polyphagous pest and affecting numerous important crops, including vegetables, legumes, oil seeds and medicinal plants. Lal (2008) [6] reported that among sixty four insect-pests there were four pests noticed as major leaf defoliators namely, Bihar hairy caterpillar, tobacco caterpillar, green semilooper and pod borer. Keeping this in view, the present study was undertaken to know the seasonal incidence of insect pests on black gram and their relationship with abiotic factors.

Materials and Methods
The field experiment was conducted on black gram crop during *kharif* season of two consecutive years 2016 and 2017 in the research farm BAU, Kanke, Ranchi, Jharkhand. The black gram variety Pant U 19 was sown in the 9 x 9 m^2 plot with maintaining distance 30 cm (row to row) and 10 cm (plant to plant) respectively. Observation on insect pests was recorded at weekly interval from date of sowing to crop maturity. Crop was grown under insecticides free condition. The observational data of insect pests were correlated with weather parameters which were collected from Department of Agricultural Physics and Environment Science, RAC, Kanke, Ranchi. The defoliator *viz.*, tobacco caterpillar, Bihar hairy caterpillar and green semilooper were counted number of larvae per 10 plants while grasshopper was recorded as number of nymph or adults per 10 plants. The mean of recorded data was subjected statistical analysis to find out the correlation between pest population and various weather parameters

viz; maximum temperature, minimum temperature, maximum relative humidity, minimum relative humidity, wind velocity and rainfall and multiple regression equation also worked out.

Results and Discussion

There were four defoliators noticed on the black gram crop during *Kharif* season *viz*., tobacco caterpillar (*Spodoptera litura*), Bihar hairy caterpillar (*Spilosoma obliqua*), Green semilooper (*Trichoplusia ni*) and three grasshoppers species (*Khaoyaiana nitens, Atractomorpha crenulata and Diabolocatantops pinguis)*.

Tobacco caterpillar (*Spodoptera litura*)

The initial population of tobacco caterpillar 2.96 larvae/10 plant recorded in (30th SMW) in the year 2016 where it was 1.10 larvae/10 plants in the 2017 year. Its population was noticed maximum (3.50 larvae/10 plants) on 32nd SMW in 2016 whereas it was maximum (4.10 larvae/10 plants) in the year 2017 (Table 1 & 2). The correlation coefficient revealed that the population of tobacco caterpillar influenced by minimum temperature (0.380*) and maximum relative humidity (0.501**) in 2016 while it was maximum temperature (0.429**) and minimum relative humidity (0.454**) in the year 2017 (Table 3). The other abiotic factors showed non-significant and positive correlation whereas rainfall noticed negative and non-significant in both the years. The multiple regression equation presented in table 4 which indicated that increase in one unit of maximum temperature, minimum temperature, maximum relative humidity and minimum relative humidity, wind velocity, rainfall resulted in the increase of tobacco caterpillar population by 0.39, 0.97, 0.30, 0.10, 0.52 and 0.00 respectively during the year 2016. In the second year 2017, the multiple regression equation indicated that increase in one unit of maximum temperature, maximum relative humidity, wind velocity and rainfall resulted in the increase of tobacco caterpillar population by 1.08, 0.57, 0.81, and 0.01 respectively. The other abiotic factors showed that increase in one unit of minimum temperature and minimum relative humidity resulted in the decrease of pest population by 0.61 and 0.03 respectively. The present investigation of tobacco caterpillar is agreed with Yadav *et al.* (2015) [12] and Kumar *et al.* (2007) [4, 5] they reported that this pest incidence occurred after 2 weeks of germination and remained 6-7 weeks. The peak population attainted at 5-6 weeks after germination and non-significant positively correlated with temperature, relative humidity and non-significant negatively correlated with rainfall. Brahman *et al.* (2018) [3], gave information about *Spodoptera litura* that it positively correlated with temperature and negatively correlated with rainfall as similar found in present findings. Present result is in accordance with findings of Suyal *et al.* (2018) [11], reported that the high active period of *S. litura* was noticed after second fortnight of August with larval population of 12.5 larva/mrl, respectively and showed positive correlation to temperature, relative humidity and rainfall.

Table 1: Seasonal incidence of defoliators on black gram during *Kharif* 2016

SMW	Observational week	Weeks after sowing (WAS)	Defoliators				Abiotic Factors					
			Tobacco caterpillar (larvae/10 plants)	Bihar hairy caterpillar (Larvae/ 10 plants)	Green semilooper (Larvae/ 10 plants)	Grass hopper (Nymph or adult/10 plants	Temperature (ºC)		Relative humidity (%)		Wind velocity (Km/hr.)	Rainfall (mm)
							Max.	Min.	7:00 AM (Max.)	2:00 PM (Min.)		
27	(2nd Jul-8th Jul)	0	0.00	0.00	0.00	0.00	30.3	20.3	82.0	57.9	6.6	138.4
28	(9th Jul-15th Jul)	1	0.00	0.00	0.00	0.00	29.5	20.7	82.3	71.7	4.5	203.4
29	(16th Jul-22ndJul)	2	0.00	0.00	1.05	1.00	28.7	20.9	82.0	70.1	5.6	94.8
30	(23rd Jul-29th Jul)	3	2.96	3.00	2.36	2.10	30.6	22.3	83.9	71.6	4.4	9.0
31	(30th Jul-5th Aug)	4	3.35	3.90	2.58	3.00	30.5	22.6	84.1	71.3	4.7	76.8
32	(6th Aug-12th Aug)	5	3.50	4.00	2.60	3.15	29.0	20.9	82.6	67.6	5.0	115.0
33	(13th Aug-19thAug)	6	3.20	2.20	3.90	4.63	29.9	21.5	85.1	70.6	4.9	99.0
34	(20th Aug-26thAug)	7	1.67	2.00	2.50	2.65	30.6	21.1	81.7	70.3	4.1	60.6
35	(27th Aug-2nd Sep)	8	1.40	1.90	2.00	2.15	33.0	23.1	81.9	50.7	3.4	6.0
36	(3rd Sep- 9th Sep)	9	0.77	0.50	1.90	1.80	27.9	21.3	85.1	65.0	5.1	85.2
37	(10th Sep-16th Sep)	10	0.00	0.25	0.50	1.00	29.8	21.3	83.3	70.9	3.7	21.3
38	(17th Sep-23rd Sep)	11	0.00	0.00	0.00	0.50	30.9	22.1	80.0	60.6	3.1	10.4

Table 2: Seasonal incidence of defoliators on black gram during *Kharif* 2017

SMW	Observational week	Weeks after sowing (WAS)	Defoliators				Abiotic factors					
			Tobacco caterpillar (Larva/10 plants)	Bihar hairy caterpillar (Larva/ 10 plants)	Green semilooper (Larva/ 10 plants)	Grass hopper (Nymph or adult/10 plants	Temperature (ºC)		Relative humidity (%)		Wind velocity (Km/hr.)	Rainfall (mm)
							Max.	Min.	7:00 AM (Max.)	2:00 PM (Min.)		
27	(2nd Jul-8th Jul)	0	0.00	0.00	0.00	0.00	26.8	16.6	86.0	70.6	2.8	151.0
28	(9th Jul-15th Jul)	1	0.00	0.00	0.00	0.00	27.8	20.4	87.4	70.9	3.2	49.5
29	(16th Jul-22ndJul)	2	0.00	0.00	1.28	0.97	29.5	21.0	85.6	69.4	3.9	56.1
30	(23rd Jul-29th Jul)	3	1.10	1.30	1.35	1.15	25.9	18.0	85.3	70.9	3.9	524.6
31	(30th Jul-5th Aug)	4	2.45	3.20	3.47	2.00	31.2	18.3	84.6	71.6	2.0	57.7
32	(6th Aug-12th Aug)	5	4.10	3.50	4.26	2.49	31.1	20.4	86.9	71.1	3.6	94.3
33	(13th Aug-19thAug)	6	3.30	2.80	4.00	3.00	29.5	20.7	87.3	69.4	3.5	10.5
34	(20th Aug-26thAug)	7	2.40	1.92	3.52	3.32	31.5	21.6	85.6	70.4	3.8	67.3
35	(27th Aug-2nd Sep)	8	2.00	1.87	2.50	2.10	30.1	21.0	87.7	71.1	3.2	103.8
36	(3rd Sep- 9th Sep)	9	1.10	1.60	0.75	1.70	30.5	21.2	84.4	68.6	2.7	0.0
37	(10th Sep-16th Sep)	10	0.00	1.00	0.00	1.05	30.8	22.6	86.4	65.0	2.0	2.0
38	(17th Sep-23rd Sep)	11	0.00	0.00	0.00	0.80	30.3	21.2	85.4	67.4	1.9	14.2

Table 3: Correlation-coefficient between defoliators and weather parameters on black gram during *Kharif* 2016 and 2017

Variable	Maximum temperature (ºC)		Minimum temperature (ºC)		Maximum relative humidity (%)		Minimum relative humidity (%)		Wind velocity (km/hr)		Rainfall (mm)	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Tobacco caterpillar	0.106	0.429**	0.380*	0.023	0.501**	0.207	0.279	0.454**	0.007	0.326	-0.116	-0.018
Bihar hairy caterpillar	0.194	0.490**	0.431**	0.015	0.362*	0.048	0.215	0.340*	-0.064	0.114	-0.171	-0.023
Green semilooper	0.034	0.454**	0.344*	0.029	0.608**	0.161	0.250	0.495**	0.004	0.401*	-0.176	-0.027
Grasshopper	0.029	0.617**	0.320	0.335*	0.565**	0.052	0.269	0.180	-0.048	0.308	-0.168	-0.151

*Significant at 5% level, **Significant at 1% level

Table 4: Multiple regression equation of defoliators with weather parameters on black gram during *Kharif* 2016 and 2017

Variable (Y)	Year (*Kharif*)	Multiple regression equation	R^2 value
Tobacco caterpillar	2016	$Y = - 64.011 + 0.39 (X_1) + 0.97 (X_2) + 0.30 (X_3) + 0.10 (X_4) + 0.52 (X_5) + 0.00 (X_6)$	0.504
	2017	$Y = - 68.378 + 1.08 (X_1) - 0.61 (X_2) + 0.57 (X_3) – 0.03 (X_4) + 0.81 (X_5) + 0.01 (X_6)$	0.758
Bihar hairy caterpillar	2016	$Y = -56.355 + 0.38 (X_1) + 1.19 (X_2) + 0.13 (X_3) + 0.11 (X_4) + 0.60 (X_5) + 0.00 (X_6)$	0.446
	2017	$Y = - 53.420 + 1.00 (X_1) – 0.51 (X_2) + 0.43 (X_3) – 0.04 (X_4) + 0.32 (X_5) + 0.01 (X_6)$	0.689
Green semilooper	2016	$Y = - 57.807 + 0.29 (X_1) + 0.33 (X_2) + 0.48 (X_3) + 0.05 (X_4) + 0.22 (X_5) - 0.00 (X_6)$	0.505
	2017	$Y = - 68.252 + 1.27 (X_1) – 0.74 (X_2) + 0.53 (X_3) – 0.04 (X_4) + 1.26 (X_5) + 0.01 (X_6)$	0.844
Grasshopper	2016	$Y = -58.702 + 0.31 (X_1) + 0.23 (X_2) + 0.52 (X_3) + 0.05 (X_4) + 0.07 (X_5) - 0.00 (X_6)$	0.444
	2017	$Y = - 27.009 + 0.75 (X_1) – 0.24 (X_2) + 0.17 (X_3) – 0.08 (X_4) + 0.77 (X_5) + 0.00 (X_6)$	0.747

Note: X_1 = Maximum Temperature (ºC), X_2 = Minimum Temperature (ºC), X_3 = Maximum Relative Humidity (%), X_4 = Minimum Relative Humidity (%), X_5 = Wind velocity (km/hr), X_6 = Rainfall (mm)

Bihar hairy caterpillar (*Spilosoma obliqua*)

Bihar hairy caterpillar is an important pest of this crop and its population was noticed first during 30th SMW with population 3.0 larvae/ 10 plants in the year 2016 while it was 1.30 larvae/ 10 plants in the year 2017 (Table 1 & 2). The peak number of 4.0 and 3.5 larvae/10 plants population reached on 32nd SMW during second week of August in the year 2016 and 2017 respectively. The correlation between population of Bihar hairy caterpillar and weather variable revealed that there was significant positive correlation with minimum temperature (0.431**) and maximum relative humidity (0.362*) in 2016 while it was showed with maximum temperature (0.490**) and minimum relative humidity (0.340*) in the year 2017 (Table 3). Rainfall and wind velocity showed non-significant and negative correlation with this pest in both years except wind velocity (r= 0.114) in the year 2017. All the weather parameters collectively influenced the Bihar hairy caterpillar population to extent of 44.6 and 68.9 per cent (R^2=0.446, 0.689) in the year 2016 and 2017 respectively (Table 4). Present finding are supported by Berani *et al*. (2017) [2], noticed that Bihar hairy caterpillar was occurred more potential population with respect to increasing the temperature and lost their account on decreasing the temperature and rainfall. The present result more or less similar to findings of Patidhar (2015) [7], reported that Bihar hairy caterpillar activity was noted from the fourth week of August 2014 to fourth week of October 2014. A maximum (10.44 larvae/mrl) population was recorded in the month of October 2014. A positive correlation with maximum temperature was observed in this case.

Green semilooper (*Trichoplusia ni*)

The pest marked its first appearance in 29th SMW with number of 1.05 and 1.28 larvae/10 plants in the year 2016 and 2017 respectively (Table 1 & 2). The peak population was noticed (3.90 larvae/10 plants) on 33rd SMW in 2016 whereas it was maximum (4.26 larvae/10 plants) on 32nd SMW in the year 2017. In the first experimental year 2016 minimum temperature and maximum relative humidity exhibited significant and positive correlation (0.344** & 0.608**) with green semilooper (Table 3). The correlation between green semilooper and weather parameter showed that it was positive and significant by recording maximum temperature (0.454**), minimum relative humidity (0.495**) and wind velocity (0.401*) in the second experimental year 2017. The pooled co-efficient of determination (R^2) between weather parameters and population of green semilooper was 50.5 and 84.4 per cent showing the importance of these parameters influencing the abundance of this pest in the year 2016 and 2017 respectively (Table 4). The present findings are in accordance with result of Yadav *et al*. (2015) [12], reported that semilooper had significant positive correlation with minimum temperature and evening relative humidity. Brahman *et al*. (2018) [3], found that semilooper was significantly positive correlation with relative humidity (0.568*) and negative correlation to rainfall (-0.012) which are same as present findings.

Grasshoppers

The occurrence of grasshopper was varied from 0.50 (38th SMW) to 4.63 (33rd SMW) numbers in black gram during 2016 whereas it was ranged 0.80 to 3.32 nymph or adult/ 10 plants in the next year (Table 1 & 2). The grasshopper population was noticed high (4.63 nymph or adult/10 plants) on 6th week after sowing (33rd SMW) in first experimental year when attained 29.9ºC maximum temperature, minimum temperature (21.5ºC), maximum relative humidity (85.1%), minimum relative humidity (70.6%), wind velocity (4.9 km/hrs) and rainfall 99.0 mm. It was maximum (3.32 nymph or adult/10 plants) on 7th week of sowing (34th SMW) in the year 2017 with recorded 31.5ºC, 21.6ºC, 85.6%, 70.4%, 3.8 km/hrs and 67.3mm (maximum temperature, minimum temperature, maximum relative humidity, minimum relative humidity, wind velocity and rainfall respectively). The correlation coefficient data revealed that the population of grasshopper influenced by maximum relative humidity

(0.565**) in 2016 while it was maximum temperature (0.617**) and minimum temperature (0.335**) in the year 2017 (Table 3). Wind velocity showed non-significant negative correlation in first year while it was non-significant positive correlation in second year. Rainfall obtained negative and non-significant correlation in both years. The joint impact of weather parameters influenced the population of grasshopper abundantly up to 44.4 and 74.7 per cent (R^2=0.444, 0.747) in the year 2016 and 2017 respectively. Present finding are similar with reports of Chandra *et al.* (2010) [4, 5], which indicated that incidence of grass hopper population was peak at 7th weeks after sowing (40th SMW). They also reported that the grasshopper population was significant negatively correlated with minimum temperature (-0.924), relative humidity (-0.874) which was contrast study with present findings.

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