

Original Research Article

Seasonal incidence of gram pod borer, *Helicoverpa armigera* (Hübner) and tur pod fly, *Melanagromyza obtusa* (Malloch) on late maturing pigeonpea in Varanasi region of Indo-Gangetic Plain

ABSTRACT

Aim: To study the seasonal incidence pattern of gram pod borer, *Helicoverpa armigera* (Hübner) and tur pod fly, *Melanagromyza obtusa* (Malloch) in pigeonpea ecosystem.

Study Design: Complete Randomized Block Design

Place and Duration of Study: Field experiments were conducted at Agriculture Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi during *Kharif* seasons of 2015-16 and 2016-17.

Methodology: The pigeonpea crop (cv. Bahar) was grown in plots of 10m X 5m (50 m²) replicated thrice and the crop fields were kept free from pesticide sprays. Five plants were selected randomly from each plot and weekly observations of the respective pests were taken through Plant Inspection Method (PIM) starting from 50 per cent flowering stage to till maturity of the crop and then correlated with the meteorological data.

Results: The results revealed that the infestation and severity of these insect pests were highly influenced by weather parameters. *H. armigera* population reached its peak (4.50 and 4.20 larvae per plant, respectively) in the 9th standard week of both the years. Similarly maximum incidence of *M. obtusa* in terms of maggot population was also recorded in 9th standard week with population of 8.00 and 7.75 maggots per plant. Correlation studies indicated that the population of these insect_ pests exhibited a significant positive correlation with maximum temperature whereas a significant negative correlation **was established** with **average** relative humidity. The multiple regression analysis revealed that variations of

different weather variables caused approximately 89.6 and 86.4 per cent variations in *H. armigera* population and 90.7 and 94.6 per cent variations in *M. obtusa* population during both years, respectively.

Conclusion: Different weather parameters determine seasonal activity and population dynamics of *H. armigera* and *M. obtusa* on pigeonpea and this information would help in developing weather based forecasting models for successful development and implementation of the pest management strategies against these major insect_ pests of pigeonpea.

Key words: Pigeonpea, Population dynamics, Gram pod borer, Tur pod fly, Abiotic factors.

INTRODUCTION

Pigeonpea [*Cajanus cajan* (L.) Millsp.] is an important pulse crop which is globally cultivated on 4.64 million ha, with an annual production of 3.43 million tonnes and a mean productivity of 780 kg ha⁻¹ [1]. It is the second most important pulse crop grown in India after chickpea [2]. In India, pigeonpea is grown on 3.88 million hectares of area with an annual production of 3.29 million tonnes and yield of 849 kg/ha [3]. Though, India is largest producer of pigeonpea, its productivity has always been a concern. The low productivity of pigeonpea in the country may be attributed to many reasons, among which damage by insect _ pests is are of paramount importance. Nearly 250 species of insect_ pests are known to infest pigeonpea crop at its various growth stages in India but of these only a few cause significant and consistent damage to the crop [4].

The key pests of pigeonpea include gram pod borer, *Helicoverpa armigera* (Hübner) and tur pod fly, *Melanagromyza obtusa* (Malloch) [5]. Others such as tur pod bug, *Clavigralla gibbosa* Spinola; blue butterfly, *Lampides boeticus* (L.); plume moth, *Exelastis*

49 *atomosa* (Walsingham) and legume pod borer, *Maruca vitrata* (Geyer) are also potential
50 pests and occasionally cause significant grain yield losses in long duration pigeonpea [6]. Pod
51 borers have been estimated to cause 60 to 90 per cent loss in the grain yield of pigeonpea
52 under favourable conditions [7] and the damage of seeds by pod fly generally ranges between
53 14.3 to 46.6 per cent [8]. *H. armigera* and *M. obtusa* cause adequate economic damage
54 leading to very low yield levels of 500 to 800 kg ha⁻¹ as against the potential yield of 1800 to
55 2000 kg ha⁻¹ [9,10]. In Uttar Pradesh the annual loss in pigeonpea production due to pod fly
56 alone has been estimated to the extent of 25 to 30 per cent [11].

57 Under these circumstances, the scientific investigations for the effective management
58 of *H. armigera* and *M. obtusa* in pigeonpea ecosystem are needed to be further strengthened.
59 Before developing insect- pest management programme for specific agro ecosystem, it is
60 necessary to have basic information on abundance and distribution of pest in relation to
61 weather parameter as it helps in determining appropriate time of action and suitable effective
62 method of control [12]. Hence, an attempt has been made to study the incidence and
63 population density of *H. armigera* and *M. obtusa* on long duration pigeonpea with respect to
64 some abiotic factors in Varanasi region of India.

65 MATERIALS AND METHODS

66 To study the seasonal incidence of *H. armigera* and *M. obtusa* on pigeonpea, field
67 experiments were conducted at Agriculture Research Farm, Institute of Agricultural Sciences,
68 Banaras Hindu University, Varanasi during *Kharif* 2015-16 and 2016-17. The pigeonpea crop
69 (cv. Bahar) was grown in plots of 10m X 5m (50 m²) replicated thrice and the crop fields
70 were kept free from pesticide sprays. Five plants were selected randomly from each plot and
71 weekly observations of the respective pests were taken through Plant Inspection Method
72 (PIM) starting from 50 per cent flowering stage to till maturity of the crop [13]. The

73 observations were recorded as number of larvae per plant in case of *H. armigera* whereas for
74 *M. obtusa*, number of maggots per 10 pods per plant was counted using pod destruction
75 method.

76 Influence of weather parameters on population build up of *H. armigera* and *M. obtusa*
77 were also worked out. For this, the data were subjected to correlation and regression analysis
78 with weather parameters viz., maximum and minimum temperatures, average relative
79 humidity, sunshine hours, wind velocity and evaporation in respect of the corresponding
80 standard week. The meteorological data for the above analysis were obtained from the
81 meteorological observatory of the **university. Significanceuniversity. Significance** of simple
82 correlation was estimated by using *t*-test [14] and the regression equations were derived by
83 using the formula as suggested by Panse and Sukhatme [15].

84 RESULTS AND DISCUSSION

85 The results obtained from the present investigation as well as relevant discussion have
86 been summarized under the following heads:

87 Incidence pattern of gram pod borer, *H. armigera*

88 During *Kharif* 2015-16, the first incidence of pod borer (*H. armigera*) was noticed
89 during 2nd standard week. The population persisted in the field from 2nd to 14th standard week
90 and ranged from 1.25 to 4.50 larvae per plant. The mean larval population of *H. armigera*
91 attained its peak level during 9th standard week (4.50 larvae/ plant) (Table 1 and Figure 1).
92 Similarly, during *Kharif* 2016-17, *H. armigera* incidence was first observed in the 2nd
93 standard week (1.25 larvae/ plant). The mean larval population of *H. armigera* per plant
94 varied from 1.00 to 4.20 during the season and the population reached its peak (4.20 larvae/
95 plant) in the 9th standard week (Table 2 and Figure 2). Similar trend of population build up of

96 *H. armigera* on long duration pigeonpea was also observed by [16], [17] and [18]. Kumar
97 and Nath [19] also studied the population of pod borers on pigeonpea cultivar Bahar. The
98 activity of *H. armigera* started with pod formation and grain filling stage *i.e.*, the 4th standard
99 week and lasted until the 14th standard week.

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100 **Incidence pattern of tur pod fly, *M. obtusa***

101 During *Kharif* 2015-16, the incidence of tur pod fly (*M. obtusa*) commenced in the 2nd
102 standard week and continued till 14th standard week (Table 1 and Figure 1). After attaining its
103 peak (8.00 maggots/ plant) in the 9th standard week, the population declined sharply.
104 Similarly, during *Kharif* 2016-17, *M. obtusa* incidence was first observed in the 2nd standard
105 week (1.26 maggots/ plant). The mean population of *M. obtusa* varied from 1.26 to 7.75
106 maggots/ plant during the season and the population reached its peak (7.75 maggots/ plant) in
107 the 9th standard week (Table 2 and Figure 2). The present findings are in accordance with the
108 findings of Meena *et al.* [20] who examined the seasonal incidence of *M. obtusa* on long
109 duration pigeonpea in Varanasi region and revealed that maximum incidence of *M. obtusa* in
110 terms of maggot population was recorded in 9th standard week with population of 35.6 and
111 2.6/plant. During 2008-2009, pupal activity of *M. obtusa* was maximum (39.2 pupae) in 12th
112 standard week and in 2009-2010 it was 9 pupae in the 11th standard week. Similar trend of
113 population build up of *M. obtusa* on long duration pigeonpea was also observed by [19] and
114 [21].

115 **Impact of abiotic factors on *H. armigera* population**

116 Simple correlation was worked out between the weather parameters and *H. armigera*
117 population in order to study the impact of different abiotic factors on population build up of
118 this pest **insect**. The analytical data on correlation coefficient during 2015-16 indicated that
119 population of *H. armigera* exhibited a significant positive correlation with maximum

120 temperature ($r = 0.753^{**}$), minimum temperature ($r = 0.583^*$) and sunshine hours ($r =$
121 0.644^*) whereas a significant negative relationship was found with average relative humidity
122 ($r = -0.683^*$). The other abiotic factors did not show any significant impact on incidence of
123 the pest (Table 3). Similarly during 2016-17, the results showed that there was a positive
124 significant association of the pest population with maximum temperature ($r = 0.887^{**}$) while
125 a significant negative relationship was exhibited with average relative humidity ($r = -$
126 0.694^{**}). Correlation coefficient with other abiotic factors was found to be non significant
127 (Table 3).

128 The regression coefficient revealed that the various abiotic factors were found to be
129 most influencing factor, which contributed ($R^2 = 0.896$ and 0.864) 89.6 and 86.4 per cent
130 variations in *H. armigera* population during both the years, respectively. Similarly, Bajja *et*
131 *al.* [18] correlated population fluctuations of *H. armigera* with weather parameters and found
132 that among different weather parameters, temperature had greater role in the incidence on
133 pigeonpea. Ali *et al.* [22] who reported that mean temperature was positively correlated with
134 infestation of *H. armigera* on tomato further supports the present findings. Rathore *et al.* [1]
135 also reported that the larval population of *H. armigera* on pigeonpea had significant positive
136 correlation with mean temperature and negative non-significant correlation with relative
137 humidity.

138 **Impact of abiotic factors on *M. obtusa* population**

139 It is evident from the Table 3 that population of *M. obtusa* exhibited a significant
140 positive correlation with maximum temperature ($r = 0.796^{**}$), minimum temperature ($r =$
141 0.659^*) and sunshine hours ($r = 0.690^{**}$) whereas a significant negative relationship was
142 found with average relative humidity ($r = -0.785^{**}$). The other abiotic factors did not show
143 any significant impact on incidence of the pest (Table 3). Similarly during 2016-17, the

results showed that there was a positive significant association of the pest population with maximum temperature ($r = 0.883^{**}$) and sunshine hours ($r = 0.587^*$) while a significant negative relationship was exhibited with average relative humidity ($r = -0.710^{**}$). Correlation coefficient with other abiotic factors was found to be non significant (Table 3).

The regression coefficient revealed that the various abiotic factors were found to be most influencing factor, which contributed ($R^2 = 0.907$ and 0.946) 90.7 and 94.6 per cent variations in *M. obtusa* population during both the years, respectively. The results are in conformity with Meena *et al.* [20] who reported that the maggot population of *M. obtusa* showed significant positive correlation with maximum and minimum temperatures but significant negative correlation with maximum and minimum relative humidity on pigeonpea. Keval and Srivastava [21] also reported that the larval population of *M. obtusa* on pigeonpea had a significant and positive correlation with temperature and sunshine hours whereas, a significant negative correlation was found with relative humidity.

CONCLUSION

From the present study, it can be concluded that *H. armigera* and *M. obtusa* are the two major insect-pests infesting long duration pigeonpea in Varanasi region of Uttar Pradesh, India. Different weather parameters determine seasonal activity and population dynamics of these insect-pests on pigeonpea. The information generated in present study gives an indication about the importance of the different weather parameters in developing weather based forecasting models for successful development and implementation of the pest management strategies against insect-pests of pigeonpea for increasing production efficiency, profit, besides safety to the environment.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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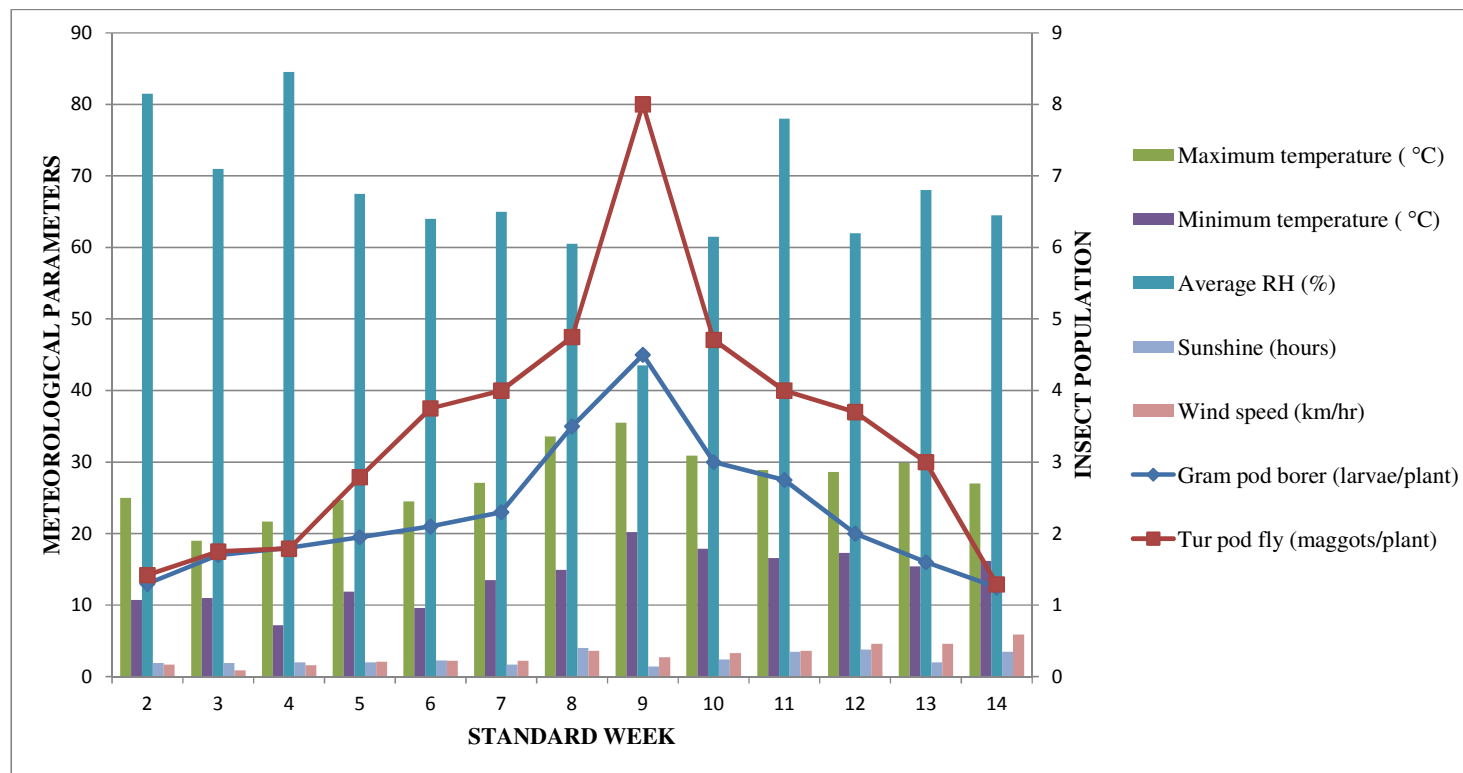
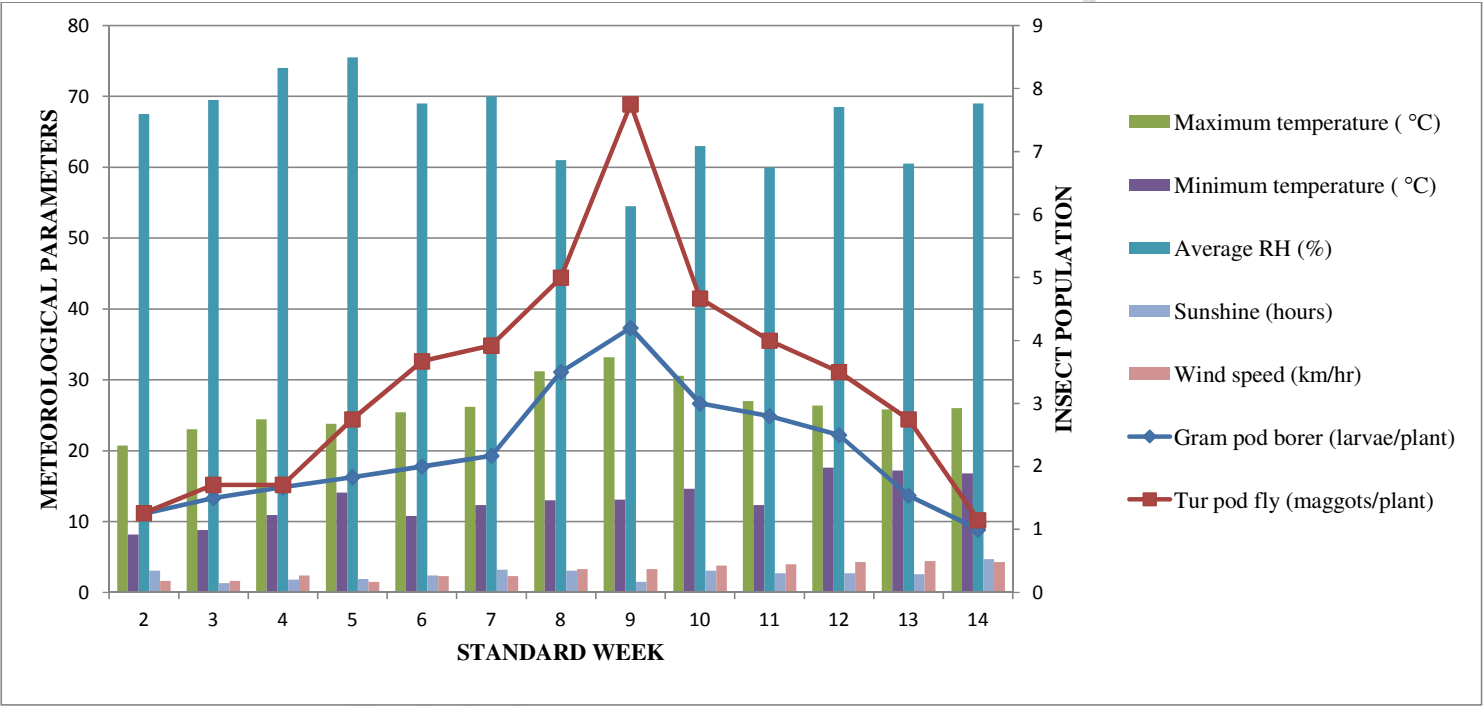


Figure 1: Population fluctuation of *H. armigera* and *M. obtusa* on pigeonpea (cv. Bahar) in relation to meteorological observations during Kharif 2015-16.

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235 **Figure 2:** Population fluctuation of *H. armigera* and *M. obtusa* on pigeonpea (cv. Bahar) in relation to meteorological observations during
236 Kharif 2016-17.

238 **Table 1:** Population dynamics of gram pod borer, *H. armigera* and tur pod fly, *M. obtusa* on late maturing pigeonpea (cv. Bahar) in relation to
239 different weather parameters during *Kharif* 2015-16.

Standard week	<i>H. armigera</i> (larvae/plant)	<i>M. obtusa</i> (maggots/10 pods/plant)	WEATHER PARAMETERS				
			Temperature (° C)		Average Relative Humidity (%)	Sunshine (hours)	Wind speed (km/hr)
			Maximum	Minimum			
2	1.30	1.42	25.0	10.7	81.5	5.9	1.9
3	1.70	1.75	19.0	11.0	71.0	0.6	1.9
4	1.80	1.79	21.7	7.2	84.5	5.2	2.0
5	1.95	2.79	24.7	11.9	67.5	6.5	2.0
6	2.10	3.75	24.5	9.6	64.0	6.3	2.3
7	2.30	4.00	27.1	13.5	65.0	6.3	1.7
8	3.50	4.75	33.6	14.9	60.5	8.5	4.0
9	4.50	8.00	35.5	20.2	43.5	9.4	1.4
10	3.00	4.71	30.9	17.9	61.5	7.6	2.4
11	2.75	4.00	28.9	16.6	78.0	6.4	3.5
12	2.00	3.70	28.6	17.3	62.0	6.6	3.8
13	1.60	3.00	29.9	15.4	68.0	6.0	2.0
14	1.25	1.29	27.0	16.2	64.5	6.4	3.5

241 **Table 2:** Population dynamics of gram pod borer, *H. armigera* and tur pod fly, *M. obtusa* on late maturing pigeonpea (cv. Bahar) in relation to
 242 different weather parameters during *Kharif* 2016-17.

Standard week	<i>H. armigera</i> (larvae/plant)	<i>M. obtusa</i> (maggots/10 pods/plant)	WEATHER PARAMETERS				
			Temperature (° C)		Average Relative Humidity (%)	Sunshine (hours)	Wind speed (km/hr)
			Maximum	Minimum			
2	1.25	1.26	20.7	8.2	67.5	3.2	3.1
3	1.50	1.71	23.0	8.8	69.5	1.0	1.3
4	1.67	1.71	24.4	10.9	74.0	1.8	1.8
5	1.83	2.75	23.8	14.1	75.5	4.1	1.9
6	2.00	3.67	25.4	10.8	69.0	7.1	2.4
7	2.17	3.92	26.2	12.3	70.0	4.6	3.2
8	3.50	5.00	31.2	13.0	61.0	6.4	3.1
9	4.20	7.75	33.2	13.1	54.5	7.4	1.5
10	3.00	4.67	30.6	14.6	63.0	5.7	3.1
11	2.80	4.00	27.0	12.3	60.0	7.6	2.7
12	2.50	3.50	26.4	17.6	68.5	6.2	2.7
13	1.54	2.75	25.8	17.2	60.5	6.8	2.6
14	1.00	1.15	26.0	16.8	69.0	6.5	4.7

244 **Table 3:** Correlation and regression coefficients between weather parameters and population
 245 of *H. armigera* and *M. obtusa* on pigeonpea during *Kharif* 2015-16 and 2016-17

Weather Parameters	<i>H. armigera</i> population		<i>M. obtusa</i> population	
	2015-16	2016-17	2015-16	2016-17
Maximum temperature (°C)	0.753**	0.887**	0.796**	0.883**
Minimum temperature (°C)	0.583*	0.112 ns	0.659*	0.160ns
Average relative humidity (%)	- 0.683*	- 0.694**	- 0.785**	- 0.710**
Sunshine (hours)	0.644*	0.502 ns	0.690**	0.587*
Wind velocity (km/hr)	0.010 ns	0.401 ns	- 0.070ns	- 0.245ns
Regression coefficient (R²)	0.896	0.864	0.907	0.946

246 *Correlation is significant at the 0.05 level (Two-tailed), **Correlation is significant at 0.01
 247 level (Two-tailed), ns = non significant