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Seasonal activity of spotted pod borer, *Maruca vitrata* (Fabricius) in relation to weather factors infesting cowpea

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Abstract
A field experiment was conducted to study the seasonal incidence of spotted pod borer, *Maruca vitrata* in cowpea variety AVCP-1 at Entomology farm, B. A. College of Agriculture, AAU, Anand during *Kharif*, 2021. The incidence of *M. vitrata* in cowpea was commenced from 6th week after sowing *i.e.* 4th week of August (34th SMW) with 0.60 larva/plant and gradually increased to reached its first peak (3.51 larvae/plant) and the highest peak (6.97 larvae/plant) during the 1st week of September (36th SMW) and 2nd week of October (41st SMW) when crop age was 8th and 13th weeks old, respectively. Thereafter, the population gradually declined towards the crop maturity. Concerned to the damage of *M. vitrata* on pods of cowpea, it was recorded between 8.63 to 59.93% per plant. The maximum pod damage *i.e.* 59.93% per plant was observed in the second week of October (41st SMW) when *M. vitrata* incidence was at its highest peak. The population of *M. vitrata* had highly significant negative correlation with wind speed (-0.882**) whereas, bright sunshine hours (0.586*) and maximum temperature (0.625*) showed significant positive association on cowpea. Furthermore, it was worked out that the bright sunshine hours, maximum temperature and wind speed each contributed 11, 10.9 and 68.2% of the variation in the *M. vitrata* larval population, respectively.

Keywords: Cowpea, *M. vitrata*, pod damage, population, spotted pod borer

Introduction
India is a major pulse growing country sharing 26% in production and 30% in consumption of total pulses in the world (Anonymous, 2017) [2]. India produced about 25.46 million tonnes of pulses from 28.78 million ha of land, where Gujarat produced 1.80 million tonnes of pulses from 1.39 million ha of land (Anonymous, 2021) [3]. The major pulse crops of India are Pigeonpea, Mungbean, urdbean, chickpea, horse gram, cowpea along with some other minor pulse crops. Amongst which, cowpea *Vigna unguiculata* (L.) of *Fabaceae* family is one of the most ancient human food sources in our country providing daily nutrition to majority of our vegetarian population and generally termed as yard long bean in tropical and subtropical countries. Yield of cowpea is affected by several biotic and abiotic factors among which insect-pests are major one. As many as 21 insect pests of different groups are recorded damaging the cowpea crop from germination to maturity (Sardhana and Verma, 1986) [3] and most of the pests appeared simultaneously in the crop especially at the pod bearing stage. *M. vitrata* is the most dangerous and potential pests creating considerable damage to the crops. It was first reported by Dietz (1914) [4] on beans in Indonesia and described by Hubner but the work was published later on by Geyer. Due to its destructiveness at critical stages of crop growth *viz.*, flowering and pod development stages especially to the economic plant parts such as flower buds, flowers and pods, it has become a significant constraint in attaining potential Productivity causing 42 to 80% losses due to pod damage alone (Halder and Srinivasan, 2011) [5].

Keeping this in view, the present study was undertaken to know population fluctuation of *M. vitrata* infesting cowpea in relation to weather parameters during *kharif* season, 2021 in Anand district of Gujarat.

Materials and Methods
The experiment was carried out at Entomology farm, B.A. College of Agriculture, Anand Agricultural University, Anand during *Kharif*, 2021. Cowpea crop variety Anand Vegetable

Cowpea-1 (AVCP-1) was grown in plot size 6×18 meter area at a spacing of 60×45 cm between row to row and plant to plant by adopting all recommended agronomical practices except plant protection measures in 108 m^2. The experimental plot (6×18) was divided into six equal quadrates (3 x 6 m) to study the activity of *M. vitrata*. From each quadrate, five plants were selected randomly and total number of *M. vitrata* larvae as well as damaged and healthy pods were counted. The observations were made at weekly interval starting from initiation of flowering until termination of crop.
Further, the larval population of *M. vitrata* correlated with the different weather parameters to see an instantaneous effect. For that weekly data of different weather parameters is collected from the meteorological observatory of AAU, Anand.

Results and Discussion
The periodical week-wise data on number of *M. vitrata* larval population and % pod damage per plant along with weather parameters are presented in Table 1 and depicted in Figure 1 while, correlation co-efficient between larval activity of *M. vitrata* and different weather parameters are presented in Table 2.

Larval Population of *M. vitrata* and it's damage
The data presented in Table 1 indicated that the activity of spotted pod borer, *M. vitrata* commenced from the 6th week after sowing *i.e.* 4th week of August (34th SMW) and continued till the 1st week of November (44th SMW). The larval population of *M. vitrata* ranged from 0.60 to 6.97 per plant. The incidence of *M. vitrata* gradually increased up to the 1st week of September *i.e.* 8th week after sowing (36th SMW) and reached its first peak (3.51 larvae/plant). Then, it slightly decreased in the next week *i.e.* 2nd week of September (37th SMW). Further, the larval population of *M. vitrata* suddenly increased with crop development up to the 2nd week of October (41st SMW) and reached its second highest peak (6.97 larvae/plant). In the subsequent weeks after the second peak, the larval population of *M. vitrata* declined gradually as the crop matured. Higher activity of *M. vitrata* (5.17 to 6.97 larvae/plant) was noticed during the month of October *i.e.* from 40 to 43 standard meteorological weeks when crop age was 12 to 15 weeks and it was the reproductive phase of the crop.
Patel (2000) [7] reported that the incidence of larval population was higher during the *kharif* season on the cowpea crop with peak activity during September and October. Sonune *et al.* (2010) [9] revealed that the incidence of spotted pod borer in black gram observed between second week of August to first week of October with highest peak of its population *i.e.* 3.84 larvae per plant during the fourth week of August. Zakari *et al.* (2019) [11] observed that the cowpea spotted pod borer appeared in the month of August (0.03 ± 0.03 and 2.48 ± 0.32 larvae per flower and pod, respectively). Thus, present findings are more or less in accordance with above findings.

Pod damage due to *M. vitrata*
The pod damage percentage per plant was observed in accordance with the density of *M. vitrata* larval population (Table 1). The pod damage due to *M. vitrata* began in the cowpea crop from 4th week of August (34th SMW) when the crop age was six weeks old and remained up to the maturity of the crop i.e. 1st week of November (44th SMW) with recorded at between 8.63 and 59.93% pod damage per plant. The pod damage started with 8.63% per plant on the 4th week of August (34th SMW) and subsequently damage was increased up to 23.19% on the 1st week of September, *i.e.* 8th week after sowing (36th SMW) where *M. vitrata* larvae attained their first peak. Then, pod damage slightly decreased (18.13% /plant) in the next week *i.e.* 2nd week of September (37th SMW) due to decreasing trend in larval population of *M. vitrata*. Further, the pod damage gradually increased and recorded the highest pod damage with 59.93% per plant in the 2nd week of October (41st SMW) as the *M. vitrata* larval population reached its second peak. Afterward, pod damage diminished along with a fall in the number of larvae.
Sharma *et al.* (2021) [8] observed the incidence of pod borer from last week of August with 3.33% pod damage and attained its peak with a mean of 39.29% pod damage per plant during last week of September. Further, they noticed that the pod damage reduced gradually with a mean of 12.87% pod damage per plant during last week of October. Thus, above reports are more or less similar with the present findings.

Correlation between *M. vitrata* and weather parameters in cowpea: The results of correlation worked out between number of larvae of spotted pod borer, *M. vitrata* and weather parameters (Table 2) shows that the larval population of *M. vitrata* had significant positive correlation with BSS (Bright Sunshine Hours) and MaxT (Maximum Temperature) with correlation co-efficient (r) value of 0.586 and 0.625, respectively. Thus, as BSS and MaxT increased; the incidence of *M. vitrata* in cowpea also increased or *vice-versa*. On the other hand, WS (Wind speed) had a highly significant negative correlation with the *M. vitrata* larval population in cowpea with a correlation co-efficient (r) of -0.882. This result indicates that as WS increased, the population of *M. vitrata* decreased or *vice-versa*. While, other weather parameters like EP (Evaporation), RF (Rainfall), MinT (Minimum Temperature), MoRH (Morning Relative Humidity), EvRH (Evening Relative Humidity), MoVP (Morning Vapour Pressure) and EvVP (Evening Vapour Pressure) impart negligible role on larval population of *M. vitrata*, the results were non-significant.
Sreekanth *et al.* (2015) [10] reported that sunshine hours (r = 0.656) had positive relationship with *M. vitrata* on pigeon pea. Patel and Borad (2016) [6] found positive association between bright sunshine as well as maximum temperature with *M. vitrata* population in green gram. Cowpea pod borer, *M. vitrata* had positive correlation with maximum temperature and diurnal temperature range, whereas, pod borer incidence showed a negative correlation with rainfall, number of rainy days and afternoon relative humidity (Ajithkumar *et al.*, 2021) [1]. These findings are in corroboration with the present results.
Further, regression model of significant parameters *viz.*, bright sunshine hours, maximum temperature and wind speed correlated with population fluctuation of *M. vitrata* larvae in cowpea. Based on correlation co-efficient results of significant parameters, regression models of each parameter with *M. vitrata* were drawn and have been graphically depicted in Figure 2.
It is evident from Figure 2 [A] that BSS effected the larval population to an extent of 11%. Similarly, the effect of MaxT and WS on larval population is 10.9 and 68.2%, respectively which are depicted in Figure 2 (B) and Figure 2 (C), respectively.

Table 1: Seasonal incidence of *M. vitrata* on cowpea and its relation with abiotic factors

SMW	Month and Week		WAS	No. of larva(e)/ plant	Pod damage (%)	Abiotic factors									
						EP (mm)	BSS (Hrs.)	RF (mm)	WS (km/h)	Temperature (°C)		Relative humidity (%)		Vapour pressure (mm)	
										Max	Min	Mo	Ev	Mo	Ev
33	August	III	5	0.00	0.00	5.20	6.10	5.60	5.50	33.50	26.10	87.00	64.00	22.90	21.90
34		IV	6	0.60	8.63	2.50	1.70	1.00	4.60	31.20	26.00	90.00	69.00	23.30	22.70
35		V	7	3.23	22.53	4.10	4.20	82.80	4.60	33.20	25.60	92.00	75.00	23.30	24.50
36	September	I	8	3.51	23.19	2.60	4.30	13.40	4.70	32.70	26.30	91.00	78.00	23.90	24.60
37		II	9	2.11	18.13	2.60	2.00	54.50	4.20	30.30	25.80	94.00	84.00	23.80	25.10
38		III	10	2.51	20.24	1.80	0.60	89.20	4.20	29.80	25.70	95.00	85.00	24.00	24.80
39		IV	11	3.65	25.66	3.50	3.10	72.00	4.10	31.70	25.50	94.00	72.00	23.80	23.90
40	October	I	12	6.21	54.13	3.30	6.60	18.00	2.80	33.60	25.90	92.00	63.00	23.80	23.90
41		II	13	6.97	59.93	3.10	6.60	0.40	2.50	35.00	25.80	91.00	58.00	23.50	23.00
42		III	14	6.31	53.66	4.20	8.30	0.00	3.00	34.70	21.60	83.00	38.00	17.70	14.90
43		IV	15	5.17	42.11	3.30	9.30	0.00	2.50	33.10	21.20	83.00	41.00	17.20	14.40
44	November	I	16	4.19	40.93	3.70	9.70	0.00	2.90	33.10	16.70	73.00	23.00	11.80	9.30

WS: Wind Speed EP: Evaporation BSS: Bright Sun Shine SMW: Standard Meteorological Week
WAS: Week after Sowing Max: Maximum Mo: Morning
RF: Rainfall Min: Minimum Ev: Evening

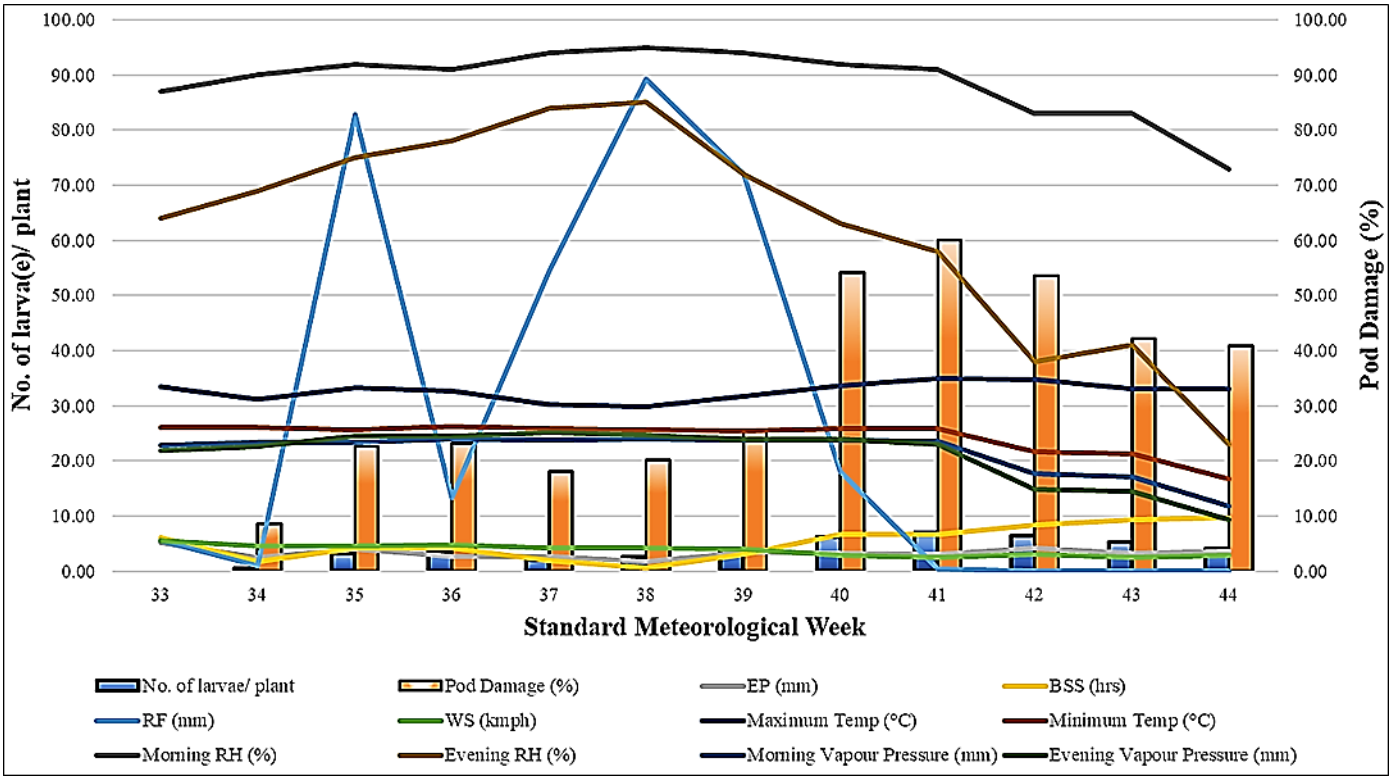
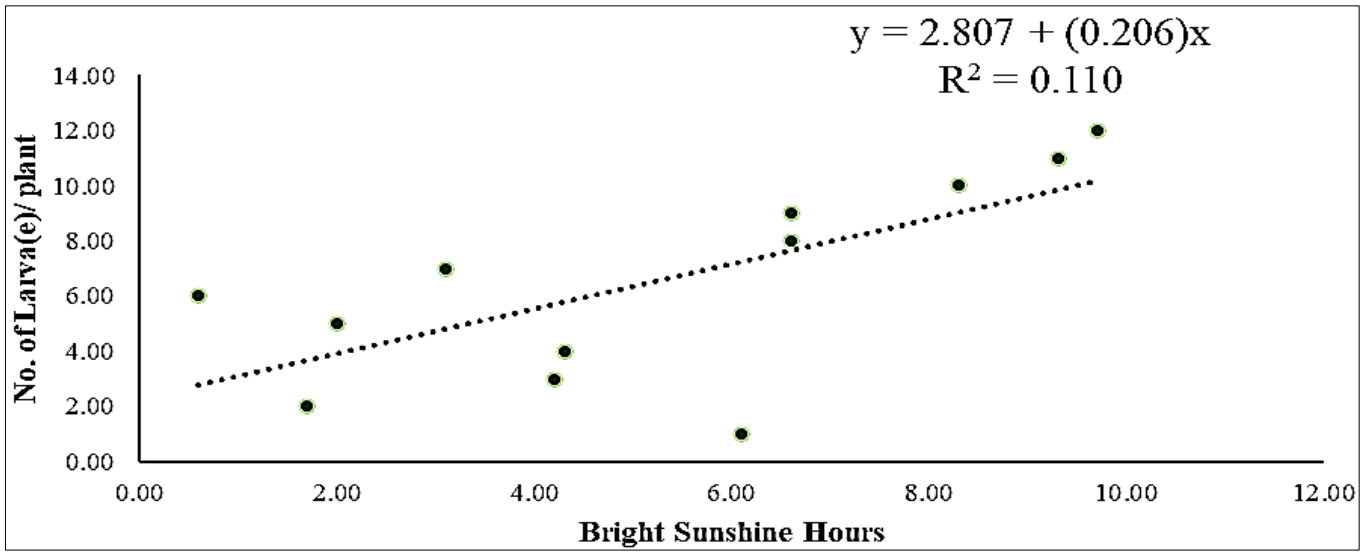


Fig 1: Population fluctuation of *M. vitrata* infesting cowpea in relation to weather parameters

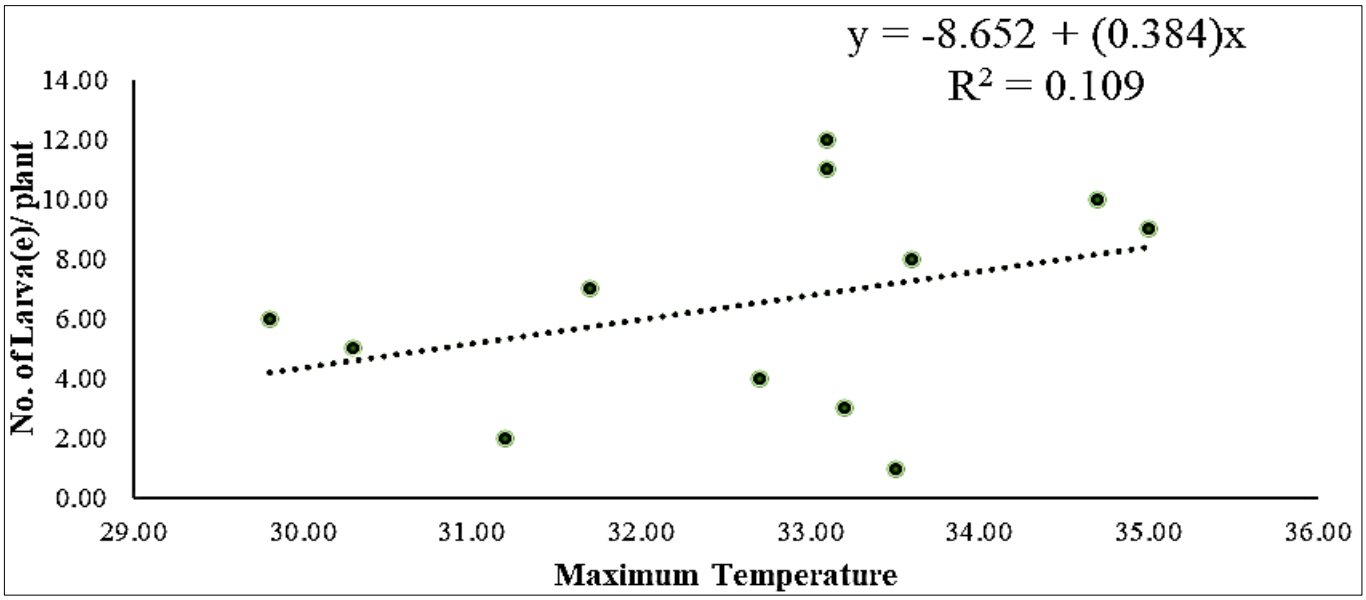
Table 2: Correlation between larval populations of *M. vitrata* in cowpea with weather parameters

Weather parameters	Correlation co-efficient (r) of Larval population of *M. vitrata* (n=12 week)
Evaporation (EP), mm	-0.010
Bright Sunshine Hours (BSS), hrday^{-1}	0.586*
Rainfall (RF), mm	-0.250
Wind Speed (WS), kmhr^{-1}	-0.882**
Maximum Temperature (MaxT), °C	0.625*
Minimum Temperature (MinT), °C	-0.325
Morning Relative Humidity (MoRH), %	-0.201
Evening Relative Humidity (EvRH), %	-0.476
Morning Vapour Pressure (MoVP), mm of Hg	-0.290
Evening Vapour Pressure (EvVP), mm of Hg	-0.313

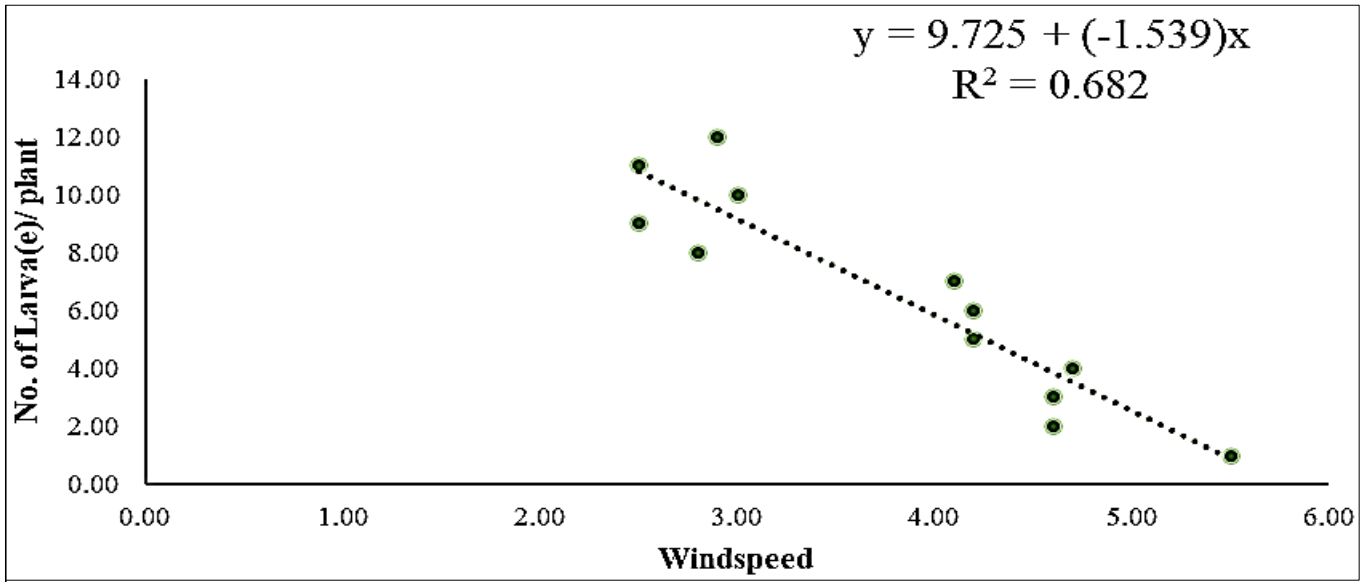
Note: *Significant at 5% level (r = >0.576 and <-0.576)
** Significant at 1% level, (r = >0.708 and <-0.708)



(A)



(B)



(C)

Fig 2: Regression model between *M. vitrata* and weather parameters

Conclusion

The activity of spotted pod borer, *M. vitrata* commenced from the 4th week of August (34th SMW) *i.e*. 6th week after sowing and remained in the field till crop maturity (1st week of November) in a range of 0.60 to 6.97 larvae per plant which was the highest during the 2nd week of October (41st SMW) *i.e*. 13th WAS with 6.97 larvae/plant.

Studies on correlation coefficient between *M. vitrata* larval population and abiotic factors revealed that, significant positive correlation was exhibited between *M. vitrata* and maximum temperature and bright sun shine hours, while highly significant negative correlation exhibited by *M. vitrata* with wind speed. The weather parameters *viz*., MaxT, BSS and WS had contributed 10.9, 11 and 68.2% in fluctuation of *M. vitrata* larval population, respectively.

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