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Research Article

Population Dynamics of Pod Borers on Pigeonpea (*Cajanus cajan* (L) Millsp.) in Relation to Abiotic Factors

M. Sreekanth*, M. Ratnam and M. V. Ramana

Regional Agricultural Research Station, Lam, Guntur (522 034), India

Abstract

The experiment conducted at Regional Agricultural Research Station, Lam farm, Guntur, Andhra Pradesh, India during 2015-16 on pigeonpea, *Cajanus cajan* on population buildup and seasonal abundance of gram pod borer, *Helicoverpa armigera* and spotted pod borer, *Maruca vitrata* revealed that peak male moth catches of *H. armigera* (8.0 moths trap^{-1} week^{-1}) were observed during 47th SMW (Nov.19 – 25), which coincides with flower bud initiation stage whereas, peak male moth catches of *S. litura* were observed twice (99.3 and 78.0 moths trap^{-1} week^{-1}, respectively) at 45th SMW (Nov. 5-11) and 50th SMW (Dec. 10-16). The larval population of both *H. armigera* and *M. vitrata* was more during 48th SMW (Nov. 26-Dec.2), which coincides with peak flowering stage of the crop, which recorded 5.2 and 15.6 larvae plant^{-1} week^{-1}, respectively, which coincides with peak flowering stage of the crop. Highly significant correlation was observed between pheromone trap catches of *H. armigera* and rainfall, rainy days, sunshine and wind speed with correlation coefficient (r) being 0.576, 0.649, -0.528 and 0.685, respectively. Similarly, highly significant correlation was observed between RH I and RH II with larval population of *H. armigera* with correlation coefficients (r) being 0.503 and 0.777, respectively. Further, highly significant correlation was observed between RH II and larval population of *M. vitrata* with correlation coefficient (r) being 0.919. The farmers need to be vigilant so as to optimize the application of insecticides in order to check the pest population from reaching the economic threshold level.

Keywords: *Helicoverpa armigera*, *Maruca vitrata*, Pigeonpea, *Spodoptera litura*, Weather

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Corresponding Author

M. Sreekanth
e-mail: meragana.angrau@gmail.com

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Data Availability Statement: Legal restrictions are imposed on the public sharing of raw data. However, authors have full right to transfer or share the data in raw form upon request subject to either meeting the conditions of the original consents and the original research study. Further, access of data needs to meet whether the user complies with the ethical and legal obligations as data controllers to allow for secondary use of the data outside of the original study.

Conflict of interests: The authors have declared that no conflict of interest exists.

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1. Introduction

Pigeonpea (*Cajanus cajan* (L) Millspaugh) is a tropical grain legume mainly grown in India and ranks second in area and production and contribute about 90% in the world's pulse production. In India pigeonpea was grown in 3.96 mha with a production of 2.56 mt and productivity of 646 kg ha^{-1}, whereas, in Andhra Pradesh, India the area, production, productivity of pigeonpea was 0.22 mha, 0.13 mt and 600 kg ha^{-1}, respectively during 2015-16 (Anonymous, 2017). Though the area under redgram is increasing, the yields have remained stagnant (500-700 kg ha^{-1}) for the past 3-4 decades, largely due to insect pest damage (Sharma and Pampapathy, 2004). More than 300 species of insect pests were reported infesting the crop (Lal and Singh, 1998) of which pod borers *viz.*, gram pod borer, *Helicoverpa armigera* and spotted pod borer, *Maruca vitrata*

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are very important. Both the pests prefer to feed on flowers and fruiting bodies, thereby causing heavy yield loss. The yield loss due to *H. armigera* and *M. vitrata* was up to more than 60 and 84% (Vishakantaiah and Jagadeesh Babu, 1980), respectively. The annual monitory loss due to *H. armigera* and *M. vitrata* was estimated globally as US $ 400 million (ICRISAT, 2007) and US $ 30 million (Saxena et al., 2002), respectively. Spotted pod borer, is basically a hidden pest and completes its larval period inside the web formed by rolling and tying together leaves, flowers, buds and pods. This typical concealed feeding protects the larvae from natural enemies, human interventions and other adverse factors including insecticides (Sharma, 1998). *Spodoptera* will not cause any economic loss to farmers as it feeds mainly on leaves and the plant has the capacity to compensate the vegetative loss. Management of pod borers relies heavily on insecticides (Sreekanth, 2018; Sai et al., 2018; Mahalakshmi et al., 2016; Sunita Devi et al., 2014). However, indiscriminate use of insecticides has resulted in the development of resistance and resurgence. In order to optimize the application of insecticides*,* studies on monitoring and influence of various weather parameters on the population build up and seasonal incidence of the pest are very much required for planning an effective pest management strategy that will help farmers benefit financially without the risk of long term problems including resurgence (Rao et al., 2013; Imosanen and Singh, 2005; Sivaramakrishna et al., 2004; Kumar et al., 2003; Srivastava and Vaish, 2000). Hence, an attempt was made to monitor the pod borer population along with studies on influence of weather parameters on the population buildup.

2. Materials and Methods

2.1. Experimental details

The population buildup and seasonal abundance of pod borers on pigeonpea (cv. ICPL 85063) was ascertained by raising the crop in 1000 m^2 area during *Kharif*, 2015-16 at Regional Agricultural Research Station, Lam farm, Guntur, Andhra Pradesh, India by following all the package of practices recommended for the crop in the region and season except the insecticidal contamination. In order to monitor the population of *Helicoverpa* and *Spodoptera,* pheromone traps @ 10 ha^{-1} were erected 60 cm above the crop canopy. The male moth catches were recorded once in each standard meteorological week (SMW) starting from flower bud initiation to pod maturity stage of the crop and expressed as number of months $trap^{-1}$ $week^{-1}$. The lures were changed at 30 days interval. The larval population of *Helicoverpa*, *Spodoptera* and *Maruca* was also recorded at weekly intervals on 10 randomly selected tagged plants from three locations in the plot and expressed as number of larvae $plant^{-1}$. Abiotic factors such as temperature (maximum, minimum, mean), relative humidity (morning and evening), sunshine hours and rainfall were also recorded from meteorological observatory, RARS, Lam. The meteorological data thus collected was subjected to simple correlation analysis with larval population and male moth catches to know the influence of abiotic factors on the occurrence of pod borers (Gomez and Gomez, 1984).

3. Results and Discussion

The results during 2015-16 showed that male moth catches of *H. armigera* were observed (2.0 moths $trap^{-1}$ $week^{-1}$) in 44th standard meteorological week (SMW) (Oct. 29-Nov.4) and reached peak (8.0 moths $trap^{-1}$ $week^{-1}$) during 47th SMW (Nov. 19–25). Whereas, the male moth catches of *S. litura* were observed in 43rd SMW (Oct. 22-28) with a peak twice at 45th SMW (Nov. 5-11) and 50th SMW (Dec. 10-16), which recorded 99.3 and 78.0 moths $trap^{-1}$ $week^{-1}$, respectively. The larval population of *H. armigera* was observed in 44th SMW and reached peak (5.2 larvae $plant^{-1}$ $week^{-1}$) during 48th SMW (Nov. 26-Dec. 2), which coincides with peak flowering stage of the crop. Similarly, the larval population of *M. vitrata* was observed in 43rd SMW and reached peak (15.6 $larvae^{-1}$ $plant^{-1}$ week) during 48th SMW (Nov. 26-Dec. 2), which coincides with peak flowering stage of the crop (Table 1 and Figure 1, 2 and 3). The results were in conformity with the findings of Sreekanth and Ramana (2017), who found that peak larval population of *M. vitrata* was observed during 50th SMW. Similarly, Sreekanth et al. (2016) reported that larval and moth catches of *H. armigera* were more during 48th SMW during 2012-13. Sreekanth and Ratnam (2016) in their studies

Table 1: Monitoring of Helicoverpa, Maruca and Spodoptera on pigeonpea

SWN	SMW	HATW	HLPP	MLPP	SATW
42	15-21	0.0	0.0	0.0	0.0
43	22-28	0.0	0.0	0.8	1.0
44	29-04 Nov	2.0	0.2	1.2	20.5
45	05-11	7.0	1.4	2.4	99.3
46	12-18	7.3	2.0	4.4	52.8
47	19-25	8.0	2.8	8.2	16.5
48	26-02 DEC, 2014	2.8	5.2	15.6	29.5
49	03-09	1.8	4.6	12.2	30.5
50	10-16	1.0	4.0	6.8	78.0
51	17-23	0.8	3.4	4.8	66.8
52	24-31	0.3	3.0	2.6	11.5
1	01-07 JAN,2015	0.0	2.2	0.8	4.5
2	08-14	0.0	0.4	0.0	1.8
3	15-21	1.8	0.0	0.0	2.3
4	22-28	0.3	0.0	0.0	0.5

SWN: Standard week no.; SMW: Standard meteorological week; HATW: H. armigera adults $trap^{-1}$ $week^{-1}$; HLPP: *H. armigera* larval population $plant^{-1}$; MLPP: *M. vitrata* larval population $plant^{-1}$; SATW: *S. litura* adults $trap^{-1}$ $week^{-1}$

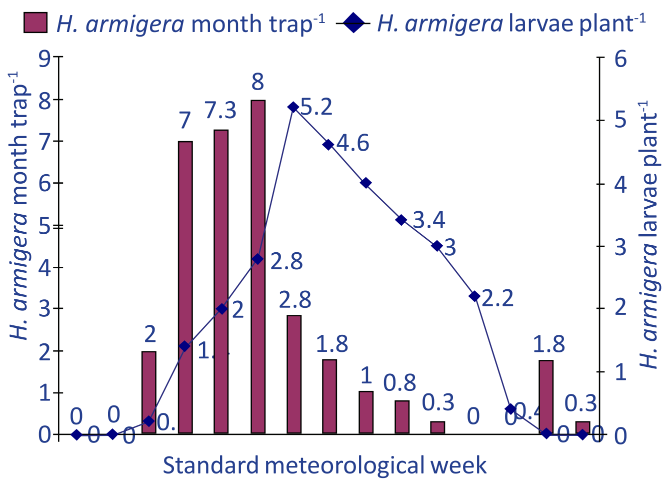

Figure 1: Incidence of *H. armigera* on pigeonpea during *kharif*, 2015 at RARS, Lam, Guntur

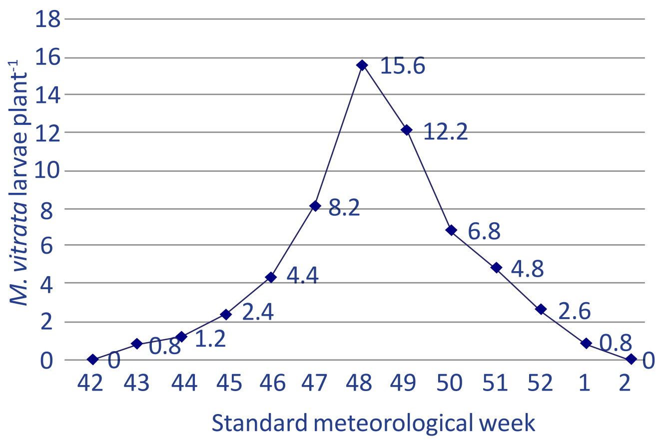

Figure 2: Incidence of *M. vitrata* on pigeonpea during *kharif*, 2015 at RARS, Lam, Guntur

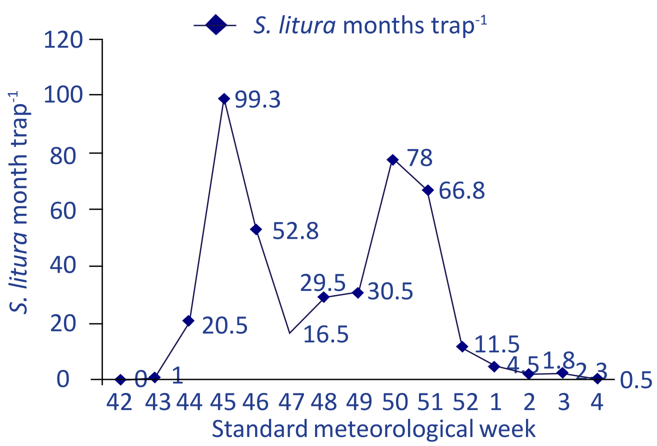

Figure 3: Incidence of *Spodoptera litura* on pigeonpea at RARS, Lam, Guntur

during 2013-14 found that male moth catches of *H. armigera* were more during 48th and 2nd SMW which coincides with 50% flowering and pod development stage, respectively. Similarly, two larval peaks were observed during 51st and 5th SMW which coincides with full bloom to pod initiation stage. Sreekanth et al. (2015) during 2013-14 found that peak larval population of *M. vitrata* was recorded during 51st SMW. Srivastava and Vaish (2000), who observed that peak male moth catches of *H. armigera* were noticed from 43 to 45th SMW in pigeonpea at Sriganganagar (Rajasthan). The results obtained were also in concurrence with the reports of Sharma and Franzamann (2000), who found that incidence of *M. vitrata* on pigeonpea was bimodal where early infestation starts from September reaching its first peak during middle October and second peak during December. The incidence of *M. vitrata* increased with the initiation of flowering, having the highest population at full podding stage of pigeonpea (Imosanen and Singh, 2005).

Highly significant correlation was obtained between pheromone trap catches of *H. armigera* and rainfall, rainy days, sunshine and wind speed with correlation coefficient (r) being 0.576, 0.649, -0.528 and 0.685, respectively. Similarly, moderately significant correlation was observed between pheromone trap catches of *S. litura* and wind speed with correlation coefficient (r) being 0.475. Further, highly significant correlation was observed between RH I and RH II with larval population of *H. armigera* with correlation coefficients (r) being 0.503 and 0.777, respectively. Similarly, highly significant correlation was observed between RH II and larval population of *M. vitrata* with correlation coefficient (r) being 0.919 (Table 2). The present findings were in conformity with findings of Sreekanth et al. (2015) and Kumar et al. (2003) who reported that maximum, minimum and mean temperatures and relative humidity recorded at morning, evening and mean were found to be highly correlated with

Table 2: Correlation coefficient between weather parameters and pest incidence

Weather parameters	Correlation coefficient (r)			
	Moths of *H. armigera*	Moths of *S. litura*	Larvae of *H. armigera*	Larvae of *M. vitrata*
Max T (°C)	-0.244	-0.029	-0.427	-0.361
Min T (oC)	0.252	0.108	-0.383	-0.159
RH-I (%)	-0.153	-0.172	0.503	0.344
RH-II (%)	0.314	0.231	0.777	0.919
RF (mm)	0.576	0.255	-0.028	0.007
Rainy days	0.649	0.198	-0.215	-0.087
Sunshine (hrs)	-0.528	-0.073	-0.381	-0.332
Wind speed (km hr^{-1})	0.685	0.475	-0.127	-0.045
Evaporation (mm)	0.156	0.343	-0.130	0.017
Mean Temp. (°C)	0.053	0.054	-0.421	-0.251

that of larval population of *M. testulalis*. However, Arulmozhi (1990), Lakshmi (2001) and Sivaramakrishna et al. (2004) reported that highly significant correlation was obtained between *M. vitrata* and minimum temperature and wind speed. The larval population of *M. vitrata* was significantly influenced by average temperature and relative humidity at Hisar (Naresh and Singh, 1984). Akhauri (1992) reported that population buildup of *M. vitrata* varied remarkably in different parts of the country probably due to differences in agro climatic conditions and crop types. Similarly, Vishwa Dhar et al. (2008) reported that minimum and maximum temperature and relative humidity greatly influence the moth population of *H. armigera* at Kanpur. Yadav et al. (2009) also found that relatively cooler pre-monsoon period, lower amount of monsoon rainfall, rain free post monsoon period with high evening relative humidity have been found to be congenial for build-up of higher population and subsequently resulting higher moth catches of *H. armigera* in pheromone traps during rainy season on pigeonpea. The population buildup of *H. armigera* varied remarkably in different parts of the country probably due to difference in agro climatic conditions and crop types (Akhauri, 1992). The rain free weeks after rainy weeks were found to be congenial for population buildup. Similarly, during post monsoon period, host plants including cotton and pigeonpea were available in abundance resulting build up of population. However, the gaps in knowledge remain to be filled by concentrating on migration, survival and carryover of this dreaded pest in different agro-eco-regions of the country. Rao et al. (2013) reported that morning and evening relative humidity showed significant positive correlation and minimum temperature showed significant negative correlation with the larval population of *M. vitrata* in rice fallow blackgram. However, the findings were in contrary to the observations of Kumar et al. (2003), who reported that larval population of *H. armigera* remained unaffected with weather parameters. Similarly, Sreekanth and Ratnam (2016) in their studies during 2013-14 found that a strong negative correlation was observed between *H. armigera* larvae and mean temperature.

4. Conclusion

There was only single peak without any multiple peaks or overlapping broods of *H. armigera* and *M. vitrata,* whereas *S. litura* has two peaks. Highly significant correlation was observed between pheromone trap catch of *H. armigera* and rainfall, rainy days, sunshine and wind speed**.** Similarly, highly significant correlation was observed between RH I and RH II with larval population of *H. armigera* and *M. vitrata*. Thus, farmers can optimize the application of insecticides.

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