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Weather and its impact on population buildup of pod borers in pigeonpea

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Abstract
The experiment conducted at Regional Agricultural Research Station, Lam, Guntur during 2016-17 on pigeonpea (*Cajanus cajan* (L.) Millspaugh) yielded a good amount of information on the trend of population build up and seasonal abundance of gram pod borer, *Helicoverpa armigera*, spotted pod borer, *Maruca vitrata* and tobacco caterpillar, *Spodoptera litura*. Peak populations of *H. armigera* adults were observed during 37 and 45th SMW, whereas peak populations of *S. litura* adults were observed during 37, 42 and 46th SMW. The peak larval population of *H. armigera* and *M. vitrata* were observed during 39th SMW and 48th SMW, respectively which coincides with peak flowering stage. The correlation studies conducted between weather parameters and pest incidence showed that moderately significant correlation was obtained between adults of *H. armigera* and rainy days and sunshine hours with correlation coefficient (r) being 0.578 and -0.583, respectively. Moderately significant correlation was obtained between adults of *S. litura* and RH-II and rainy days with correlation coefficient (r) being 0.510 and 0.518, respectively. Further, moderately significant correlation was obtained between larval population of *H. armigera* and *M. vitrata* with sunshine hours with correlation coefficient (r) being -0.509 and -0.495, respectively. Thus, concluded that as the number of rainy days increase with decrease in sunshine hours the adult population of *H. armigera* and *S. litura* will increase. Similarly, the larval population of *H. armigera* and *M. vitrata* will increase as the number of sunshine hours decrease during the crop growing period. Thus, farmers can predict the pest early and optimize the application of insecticides in order to check the pest population from reaching the economic threshold level.

Keywords: Gram pod borer, *Helicoverpa armigera*, *Maruca vitrata*, pigeonpea, population, *Spodoptera litura*, spotted pod borer, tobacco caterpillar, weather

Introduction
In India, Pigeonpea (*Cajanus cajan* (L) Millsp.) crop was grown in an area of 5.32 million ha, production 4.78 million tons and productivity was 898 kg per ha, whereas, in Andhra Pradesh, the area, production, productivity of pigeonpea was 3.45 lakh ha, 2.24 lakh tons and 669 kg per ha, respectively [1]. Though the area under redgram is increasing, the yields have remained stagnant (500-700 kg per ha) for the past 3-4 decades due to the insect pest damage particularly, gram pod borer, *Helicoverpa armigera* and spotted pod borer, *Maruca vitrata* [2, 3]. 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%, respectively [4]. The annual monitory loss due to *H. armigera* and *M. vitrata* was estimated globally as US $ 400 million [5] and US $ 30 million [6], respectively. The typical concealed feeding habit of spotted pod borer, protects the larvae from natural enemies, human interventions and other adverse factors including insecticides [7]. Though, larval and adult population of *Spodoptera litura* was observed, it 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, often to the exclusion of other methods of management. 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. Hence, an attempt was made to monitor the pod borer population along with studies on influence of weather parameters on the population buildup.

Materials and Methods

The population buildup and seasonal abundance of pod borers on pigeonpea cv. LRG 52 (Amaravathi) was ascertained by raising the crop in 1000 m^2 area during *Kharif*, 2016-17 at Regional Agricultural Research Station, Lam farm, Guntur, Andhra Pradesh 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) up to maturity stage of the crop and expressed as number of months/trap/week. 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. 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.

Results and Discussion

The experimental results showed that peak moth catches of *H. armigera* were observed during 37th SMW (18 adults per trap/week) and 45th SMW (10.0 adults/trap/week), which coincides with flower bud initiation stage of the crop. Similarly, the larval population of *H. armigera* was observed in 37th SMW (Sept. 10-16) and peak incidence (3.0 larvae per plant) was observed during 39th SMW. The larval population of *M. vitrata* was observed during 44th SMW, then gradually increased and reached peak (21.6 larvae per plant) by 48th SMW (26-02 Dec.) which coincides with peak flowering stage of the crop and then gradually decreased and nil population was recorded in 3rd SMW (Jan 15-21). The peak adult trap catches of *S. litura* were observed during 37, 42 and 46th SMW (Table 1 & Fig. 1, 2 & 3).

The results were in conformity with the findings of [8, 9, 10], who reported that peak larval population of *M. vitrata* was observed during 1st fortnight of Dec. The larval and moth catches of *H. armigera* were more during 48th and 2nd SMW, which coincides with flowering and pod development stage of the crop [11, 12, 13]. The larval population of *Helicoverpa* and *Maruca* and adult population of *Helicoverpa* and *Spodoptera* when correlated with different meteorological parameters showed that moderately significant correlation was obtained between adults of *H. armigera* and rainy days and sunshine hours with correlation coefficient (r) being 0.578 and -0.583, respectively. Moderately significant correlation was obtained between adults of *S. litura* and RH-II and rainy days with correlation coefficient (r) being 0.510 and 0.518, respectively. Further, moderately significant correlation was obtained between larval population of *H. armigera* and *M. vitrata* with sunshine hours with correlation coefficient (r) being -0.509 and -0.495, respectively (Table 2). Maximum, minimum and mean temperatures and relative humidity recorded at morning, evening and mean were found to be highly correlated with that of larval population of *M. testulalis* [14]. Highly significant correlation was reported between *M. vitrata* and minimum temperature and wind speed [3, 15, 16]. Population buildup of *H. armigera* and *M. vitrata* varied remarkably in different parts of the country probably due to differences in agro climatic conditions and crop types [2]. Similarly, minimum and maximum temperature and relative humidity greatly influence the moth population of *H. armigera* at Kanpur [17]. 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 [18]. 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. 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 black gram [19]. However, the findings were in contrary to the observations of Kumar *et al.* [14], who reported that larval population of *H. armigera* remained unaffected with weather parameters, whereas strong negative correlation was observed with mean temperature [20].

Further, the incidence of other insect pests like thrips, blister beetles, bud weevils, pod weevils, pod sucking bugs, blue butterflies, plume moths and pod wasps were more during the first fortnight of December. Bruchid infestation was seen during later stages of the crop and increased as the stage increases (Table 3).

Table 1: Monitoring of Pod borers in pigeonpea during *Kharif*, 2016

Std. Meteorological Week	Date	No. of moths/ trap / week		No. of larvae / plant	
		H. armigera	*S. litura*	*H. armigera*	*M. vitrata*
36	03 - 09 Sept.	3.7	54.3		
37	10 – 16	18.7	265.7	0.0	0.0
38	17 – 23	11.3	144.7	1.6	0.0
39	24 - 30 Sept.	0	0.7	3.0	0.0
40	01 - 07 Oct.	5.7	64.0	2.2	0.0
41	08 – 14	3.0	36.7	0.2	0.0
42	15 – 21	8.3	135.0	0.8	0.0
43	22 – 28	2.0	45.7	0.6	0.0
44	29 - 04 Nov.	2.3	68.7	1.0	1.2
45	05 – 11	10.0	1.0	0.6	3.0
46	12 – 18	6.3	145.0	0.4	4.8
47	19 – 25	0.0	24.3	1.4	10.8
48	26 - 02 Dec.	1.3	17.3	1.0	21.6
49	03 – 09	5.0	41.7	0.2	13.2

50	10 – 16	1.7	7.7	0.4	9.0
51	17 – 23	1.3	34.0	1.0	6.0
52	24 - 31 Dec.	3.0	18.3	0.2	3.0
1	01 - 07 Jan.	0.3	62.0	0.2	1.2
2	08 – 14	4.0	16.3	0.4	0.6
3	15 – 21	1.0	71.3	0.0	0.0
4	22 – 28	2.0	15.0		
5	29 - 04 Feb.	1.3	7.3		
6	05 – 11	1.0	6.7		
7	12 -18	0.3	4.0		

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 (ºC)	-0.008	-0.008	-0.012	-0.126
Min T (ºC)	0.492	0.476	0.423	-0.085
RH-I (%)	0.458	0.441	0.281	-0.237
RH-II (%)	0.489	0.510	0.489	-0.063
RF (mm)	0.327	0.257	0.458	0.154
Rainy days	0.578	0.518	0.376	0.153
Sunshine (hrs)	-0.583	-0.484	-0.509	-0.495
Wind speed (km/hr)	0.365	0.305	0.143	-0.290
Evaporation (mm)	0.038	0.141	-0.381	-0.025
Mean Temp. (ºC)	0.436	0.411	0.380	-0.104

Table 3: Incidence of other insect pests on pigeonpea

Std. Week	Date	No. of Thrips /flower	No. of Blister beetles / plant	No. of Bud weevils / plant	No. of Pod weevils / plant	No. of pod sucking bugs / plant	No. of blue butterflies / plant	No. of Plume moths / plant	No. of Pod wasps / plant	No. of bruchids/ plant
42	15 – 21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
43	22 – 28	1.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
44	29 - 04 Nov.	2.6	0.8	0.4	0.0	0.8	0.2	0.0	0.0	0.0
45	05 – 11	4.2	1.0	1.2	0.6	1.2	0.6	0.0	0.0	0.0
46	12 – 18	8.4	1.4	2.8	1.0	2.0	1.0	0.6	0.0	0.0
47	19 – 25	10.2	1.8	3.6	1.6	2.6	1.4	1.0	0.6	0.0
48	26 - 02 Dec.	12.6	2.4	3.0	2.0	3.2	1.6	1.4	1.0	0.0
49	03 – 09	11.0	2.0	2.4	2.8	4.8	1.0	1.8	2.0	0.0
50	10 – 16	10.4	1.4	2.0	5.0	5.4	0.8	2.2	2.4	0.0
51	17 – 23	7.8	1.0	1.6	3.8	4.0	0.6	1.6	3.0	0.0
52	24 - 31 Dec.	5.4	0.8	1.0	3.0	3.0	0.4	1.2	2.6	2.0
1	01 - 07 Jan.	4.4	0.2	0.6	2.4	2.0	0.2	0.8	2.0	3.2
2	08 – 14	3.6	0.0	0.4	1.4	1.4	0.1	0.4	1.4	4.0
3	15 – 21	3.0	0.0	0.2	0.6	1.0	0.0	0.0	1.0	4.4
4	22 – 28	3.2	0.0	0.0	0.2	0.4	0.0	0.0	0.6	5.2
5	29 - 04 Feb.	4.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.8
6	05 – 11	6.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.0
7	12 -18	8.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.6

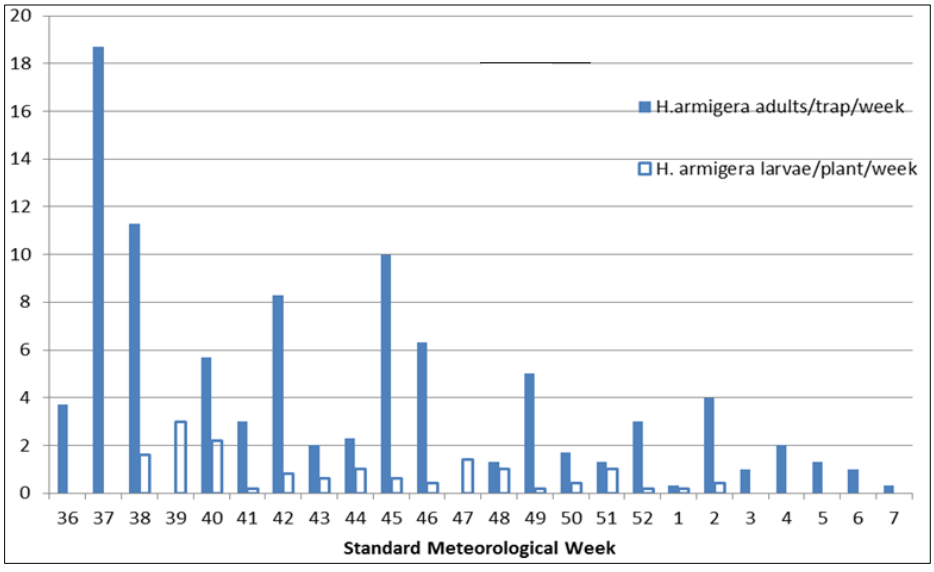

Fig l: Incidence of //, *armigera* in Pigeonpea during 2016-17 at RARS, Lam, Guntur

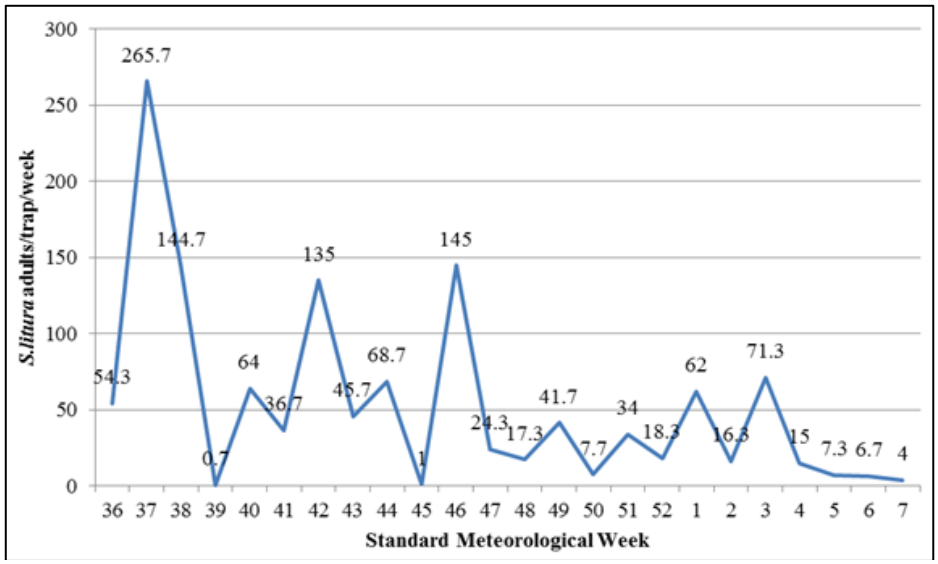

Fig 2: Incidence of *S. litura* on Pigeonpea during 2016-17 at RARS, Lam, Guntur

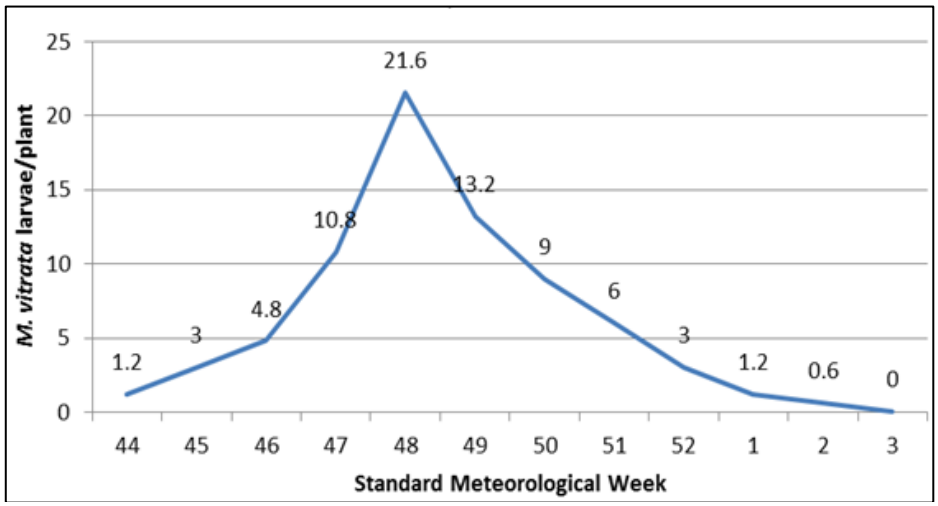

Fig 3: Incidence of M *vitrata* on Pigeonpea at Lam, Guntur (2016-17)

Conclusion

From the present findings it could be inferred that as the number of rainy days increase with decrease in sunshine hours the adult population of *H. armigera* and *S. litura* will increase. Similarly, the larval population of *H. armigera* and *M. vitrata* will increase as the number of sunshine hours decrease during the crop growing period. Farmers should be vigilant on stage of the crop and weather parameters so that they can predict the pest population early and optimize the application of insecticides in order to check the pest population from reaching the economic threshold level.

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