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Monitoring and studying the impact of weather parameters on lepidopteron pests of pigeonpea (*Cajanus cajan* (L) Millsp.)

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Abstract
Field experiment conducted to study the impact of weather parameters on the population buildup of different lepidopteron pests of pigeonpea yielded a good amount of information. The peak population of gram pod borer, *Helicoverpa armigera* was observed during 45th SMW (5-11 Nov.) with 3.8 moths / trap / week. Whereas, the peak population of tobacco caterpillar, *Spodoptera litura* was observed during 40th (1-7 Oct.) and 1st (1-7 Jan, 2019) SMW with 101.0 and 108.0 moths / trap / week, respectively. The fall armyworm, *Spodoptera frugiperda* population was more (10.0 moths/trap/week) during 40 SMW (1-7 October). Peak larval population of *H. armigera*, spotted pod borer, *Maruca vitrata* and *S. litura* was observed during 47th, 49th and 42nd SMW with 4.8, 4.8 and 4.0 larvae/plant, respectively. However, there was no larval population of *S. frugiperda* on redgram. Further, significant correlation was obtained between adult trap catch of *S. litura* and wind speed with correlation coefficient (r) being -0.521; adult trap catch of *S. frugiperda* and max. temp., mean temp. RH II and Evaporation with correlation coefficient (r) being 0.616, 0.512, -0.526 and 0.584, respectively; and adult trap catch of *H. armigera* and RH-II with correlation coefficient (r) being -0.431. Similarly, moderately significant correlation was obtained between larval population of *M. vitrata* and max. temp., RH I, RH-II, Sun shine hours and evaporation with correlation coefficient (r) being -0.527, -0.588, 0.744, -0.709 and -0.553, respectively; larval population of *S. litura* and max temp., mean temp. and evaporation with correlation coefficient (r) being 0.493, 0.447 and 0.406, respectively; and larval population of *H. armigera* and RH-I and wind speed with correlation coefficient (r) being 0.319 and 0.304, respectively.

Keywords: Pigeonpea, lepidopteron pests, population, seasonal incidence, weather parameters

Introduction
Pigeonpea (*Cajanus cajan* (L) Millsp.) is a tropical grain legume mainly grown in India and ranks second in area and production and contributes about 90% in the world's pulse production. In India, during 2019-20, the crop was cultivated in an area of 4.23 million ha with 3.89 million tons and 919 kg ha^{-1} of productivity. In Andhra Pradesh, during 2018-19, it was cultivated in an area of 2.81 lakh ha with 1.58 lakh tons of production and 564 kg ha^{-1} of productivity (Anonymous, 2021). 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 insect pest damage particularly, gram pod borer, *H. armigera*, spotted pod borer, *M. vitrata* and pod fly, *Melanagromyza obtusa* causing heavy yield loss (Sharma *et al.*, 2011) [14]. All these pests prefer to feed on flowers and fruiting bodies, thereby causing yield loss up to 60, 84 and 80%, respectively (Vishakantaiah and Jagadeesh Babu, 1980; Subharani and Singh, 2009) [19, 18] and annual monitory loss was estimated globally as US $ 400 million (ICRISAT, 2007) [5], US $ 30 million (Saxena *et al.*, 2002) [11] and US $ 256 million (ICRISAT, 1992) [4], respectively. The typical concealed feeding habit of spotted pod borer protects the larvae from natural enemies, human interventions and other adverse factors including insecticides (Sharma, 1998) [12]. Though, larval and adult population of *S. litura* and adult population of *S. frugiperda* were observed, they will not cause any economic loss to farmers as they feed 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. Considerable number of insecticides have been tested and few of them found effective against pod borers in pigeonpea (Yadav and Dahiya, 2004) [20]. However, indiscriminate use of insecticides has resulted in the development of resistance, resurgence and adversely affected the crop ecosystem and increased the cost of production.

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

An experiment was carried out at Regional Agricultural Research Station, Lam farm, Guntur, Andhra Pradesh during 2018-19 with pigeonpea cv. LRG 52 (Amaravathi) sown in 1.8x 0.2 m spacing by following all the package of practices recommended for the crop in this region and season and was kept completely under unprotected conditions. In order to monitor the population of *H. armigera*, *S. litura and S. frugiperda* pheromone traps @ 10 ha $^{-1}$ were erected 60 cm above the crop canopy (Plate 3). The male moth catches were recorded once in each standard meteorological week (SMW) starting from sowing to pod maturity stage of the crop and expressed as number of months/trap/week. The lures were changed at 30 days interval. Simultaneously, observations on larval population of *H. armigera*, *M. vitrata* and *S. litura* were recorded at weekly intervals from 10 randomly selected plants from three locations in the plot. The trend of population build-up of the borers was determined by working out the mean number of larvae/plant. Different weather parameters collected from meteorological observatory, RARS, Lam were used for correlation studies to know the influence of weather parameters on the population of different pod borers.

Plate 1: Gram pod borer, *H. armigera* and its damage on pigeonpea

Plate 2: Spotted pod borer, *M. vitrata* and its damage on pigeonpea

Plate 3: Monitoring of adult population of different lepidopteron pests

Plate 4: Adult of *Helicoverpa armigera*

Plate 5: Adult of *Spodoptera litura*

Plate 6: Larva of *Spodoptera litura*

Results and Discussion

The larval population of *H. armigera* started appearing from 36th SMW (3-9, Sept.) and fluctuating population was noticed with three peaks during 44, 47 and 50th SMW which coincides with flower bud initiation to peak flowering stage of the crop and thereafter decreased. The adult moth catch of *H. armigera* was started appearing from 35th SMW to 2nd SMW with three peaks during 42 (3.0 moths/trap/week), 45 (3.8 moths/trap/week) and 48 SMW (3.6 moths/trap/week) which coincides with vegetative to flowering stage of the crop (Table 1 & Fig.1). Similarly, the larval population of *S. litura* started appearing in 34th SMW. The population gradually increased with peak at 42 SMW (4.0 larvae/plant). Whereas, the peak adult moth catch of *S. litura* was observed during 40th (1-7 Oct.) and 1st (1-7 Jan, 2019) SMW with 101.0 and 108.0 moths / trap / week, respectively (Table 1 & Fig. 2). The incidence of *M. vitrata* commenced from 44th SMW (0.4 larvae per plant) and remained active up 2nd SMW (Jan. 8-14). The pest reached its peak level (4.8 larvae per plant) during 49th SMW (Dec. 3-9), which coincides with peak flowering stage of the crop (Table 1 & Fig.3). The peak moth catch of *S. frugiperda* (10.0 moths / trap / week) was observed during 40 SMW (Table 1 & Fig. 4). There was no larval population of *S. frugiperda* on redgram.

Table 1: Population of *H. armigera*, *M. vitrata*, *S. litura* & *S. frugiperda* on Pigeonpea

SMW	Date	No. of moths/ trap / week			No. of larvae / plant		
		H. armigera	*S. litura*	*S. frugiperda*	*H. armigera*	*M. vitrata*	*S. litura*
29	16-22 July, 2018		17.8				
30	23-29		6.2				
31	30-5 Aug		2.2				
32	6-12		3.4				
33	13-19		17.2				0
34	20-26		18.2	0			0.4
35	27-2 Sep	0.4	29.6	1.0	0.0		1.2
36	3-9	0	15.8	1.4	0.6		2.0
37	10-16	0.4	8.8	2.0	1.0		2.8
38	17-23	0	7.2	3.2	1.2		3.4
39	24-30	1.8	19.6	4.0	1.4		2.2
40	1-7 Oct.	1.2	101.0	10.0	1.0		1.2
41	8-14	3.0	8.8	7.5	2.4		2.0
42	15-21	3.0	3.2	1.5	2.0		4.0
43	22-28	2.2	1.8	1.5	3.6	0	3.2
44	29-4 Nov	2.4	14.6	4.0	4.2	0.4	2.6
45	5-11	3.8	26.0	5.5	3.0	0.6	2.0
46	12-18	0.4	53.0	1.5	2.4	1.0	1.6
47	19-25	0.2	23.4	0	4.8	2.2	0.8
48	26-2 Dec	3.6	69.8	0.5	2.2	3.0	0.4
49	3-9	0.6	72.0	1.0	1.0	4.8	0.2
50	10-16	0.4	69.8	0	4.0	4.0	0
51	17-23	0.4	10.8	0	2.0	3.2	0
52	24-31	0.8	9.4	0.5	1.2	2.8	0
1	1-7 Jan,2019	1.6	108.0	0	1.0	1.4	0
2	8-14	0	44.8	0	1.2	0.8	0

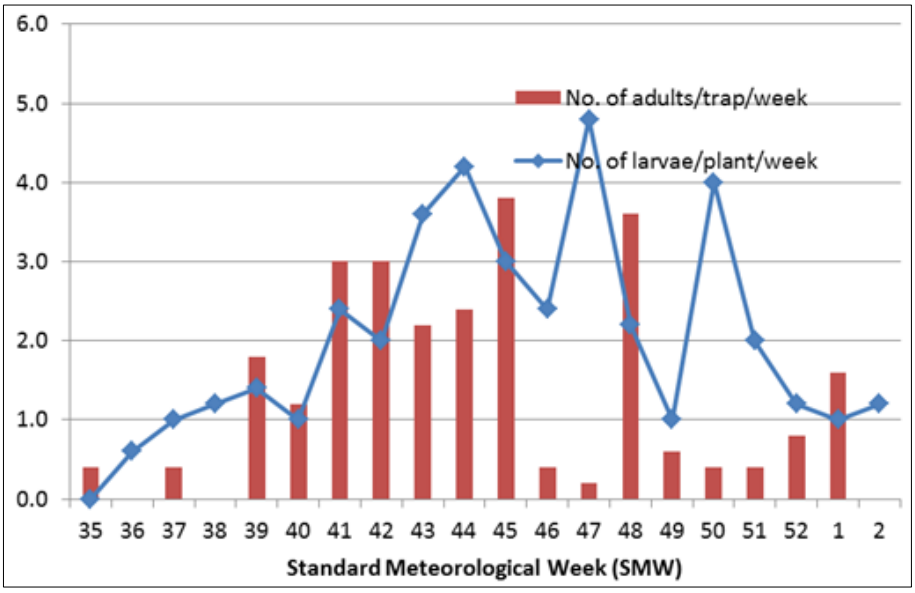

Fig 1: Incidence of *Helicoverpa armigera* on Pigeonpea during 2018-19

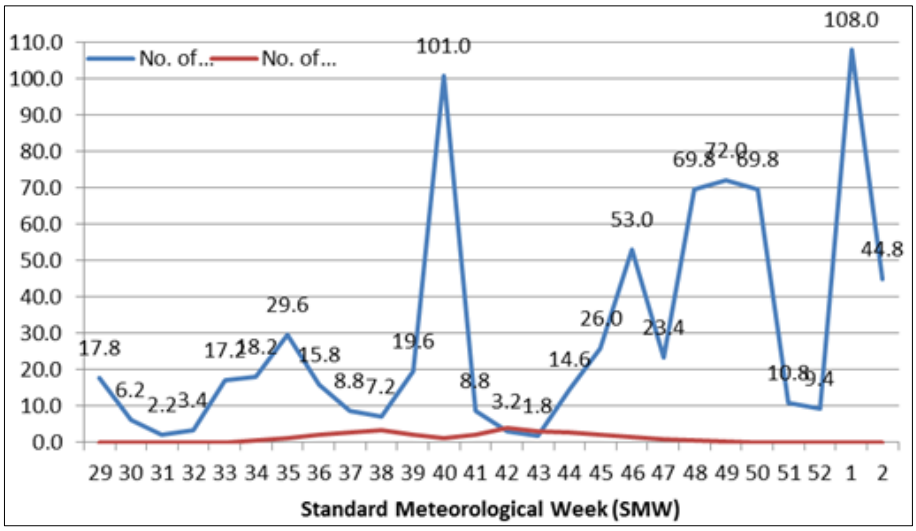

Fig 2: Incidence of *Spodoptera litura* on Pigeonpea during 2018-19

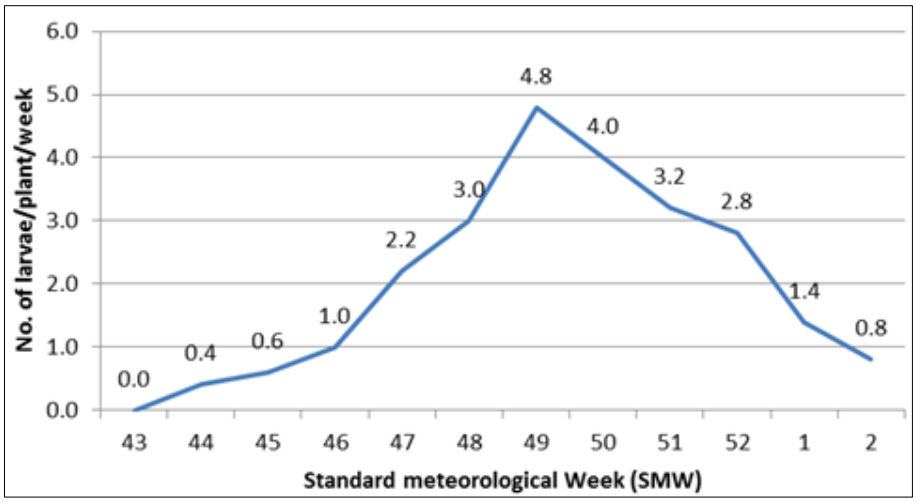

Fig 3: Incidence of *Maruca vitrata* on Pigeonpea during 2018-19

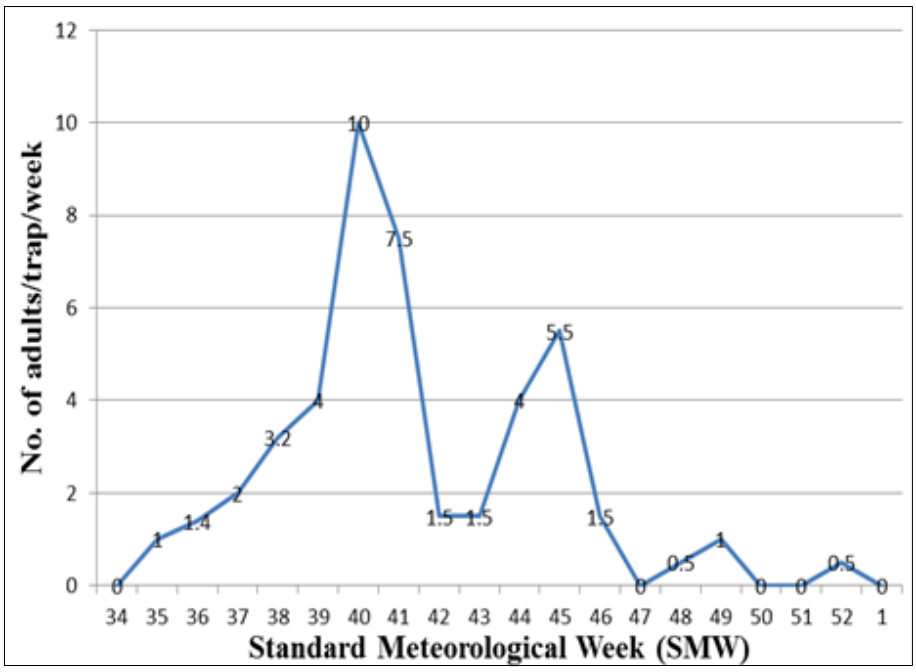

Fig 4: Incidence of *Spodoptera frugiperda* on Pigeonpea during 2018-19

The results were in conformity with the findings of Srivastava and Vaish (2000) [17], who observed peak male moth catches of *H. armigera* from 43 to 45th SMW in pigeonpea at Sriganganagar (Rajasthan). Similarly, with regard to *M. vitrata*, the present finding were in accordance with the findings of Sreekanth *et al.* (2015) [16], who reported that *M. vitrata* larval population gradually increased from third week of November (47th SMW) and reached peak level at the 3rd week of December (51st SMW) and remained active up to last week of January. The results obtained were also in concurrence with the reports of Sharma and Franzamann (2000) [13], 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) [6].

The correlation studies conducted between weather parameters and pest incidence showed that significant correlation was obtained between adult trap catch of *S. litura* and wind speed with correlation coefficient (r) being -0.521; adult trap catch of *S. frugiperda* and max. temp., mean temp. RH II and Evaporation with correlation coefficient (r) being 0.616, 0.512, -0.526 and 0.584, respectively; and adult trap catch of *H. armigera* and RH-II with correlation coefficient (r) being -0.431. Similarly, moderately significant correlation was obtained between larval population of *M. vitrata* and max. temp., RH I, RH-II, Sun shine hours and evaporation with correlation coefficient (r) being -0.527, -0.588, 0.744, -0.709 and -0.553, respectively; larval population of *S. litura* and max temp., mean temp. and evaporation with correlation coefficient (r) being 0.493, 0.447 and 0.406, respectively; and larval population of *H. armigera* and RH-I and wind speed with correlation coefficient (r) being 0.319 and 0.304, respectively (Table 2).

Table 2: Correlation coefficient between weather parameters and pest incidence

Weather parameters	Correlation coefficient (r)					
	Trap catch of			Larvae of		
	H. armigera	*S. litura*	*S. frugiperda*	*H. armigera*	*M. vitrata*	*S. litura*
Max T (ºC)	0.232	-0.291	0.616	0.017	-0.527	0.493
Min T (ºC)	-0.034	-0.466	0.405	-0.133	-0.139	0.324
Mean T (ºC)	0.076	-0.414	0.512	-0.079	-0.340	0.447
RH-I (%)	0.284	0.201	-0.167	0.319	-0.588	0.157
RH-II (%)	-0.431	-0.048	-0.526	-0.168	0.744	-0.110
RF (mm)	-0.239	-0.372	-0.228	-0.193	0.256	-0.087
Rainy days	-0.130	-0.383	-0.125	-0.279	0.241	-0.010
Sun shine (hrs)	0.102	0.191	0.221	-0.264	-0.709	0.279
Wind speed (km/hr)	0.137	-0.521	0.062	0.304	-0.185	-0.104
Evaporation (mm)	0.188	-0.129	0.584	0.026	-0.553	0.406

The present findings were in conformity with findings of Kumar *et al*. (2003) [7] who reported that 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*. However, Arulmozhi (1990) [3], Lakshmi (2001) [8] and Sivaramakrishna *et al.* (2004) [15] reported that highly significant correlation was obtained between *M. vitrata* and minimum temperature and wind speed. Positive correlation (r=0.86) between rainfall and incidence of *M. vitrata* has been reported by Sharma *et al.* (2000) [13]. The larval population of *M. vitrata* was significantly influenced by average temperature and relative humidity at Hisar (Naresh and Singh, 1984) [9]. Akhauri (1992) [2] 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. Rao *et al.* (2013) [10] reported that morning and evening relative humidities showed significant positive correlation and minimum temperature showed significant negative correlation on the larval population of *M. vitrata* in rice fallow blackgram.

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