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Assessment of damage potential of legume spotted pod borer, *Maruca vitrata* (Fab.) in North Coastal Andhra Pradesh, India

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ABSTRACT

The spotted pod borer (*Maruca vitrata*) is a highly destructive insect pest, causing significant damage to a wide range of pulse crops. It occurs throughout pulse-growing areas in the North Coastal districts of Andhra Pradesh. The pest spreads rapidly and can lead to substantial yield losses if not managed promptly. It damages the leaves, flowers and pods of pulse crops. A roving survey was conducted in pulse-growing areas across three districts (North Coastal region) of Andhra Pradesh: Srikakulam, Vizianagaram and Visakhapatnam, during *rabi*, 2021-22 and 2022-23 to study and assess the damage potential of *M vitrata*. The results revealed that the highest mean per cent leaf webbing (17.81) was recorded in Visakhapatnam district, followed by Vizianagaram district (7.79) and Srikakulam district (6.09). Additionally, the highest mean percentage of flower webbing (31.59) and pod webbing (38.87) were also recorded in Visakhapatnam district, followed by Vizianagaram (25.14 % and 37.24 %) and Srikakulam (15.18 % and 20.12 %) districts, respectively inferring that *Maruca vitrata* caused more damage during reproductive stage than vegetative stage.

Key words: *Flower webbing, Leaf webbing, Pod webbing, Pulses, Roving survey, Spotted pod borer.*

Pulses are crucial for the livelihood of millions of farmers and the dietary needs of India's predominant vegetarian population. They are the major source of protein and supply essential amino acids, vitamins and minerals, significantly contributing to a balanced diet and helping to combat malnutrition and anemia. Moreover, pulses are typically grown in rotation with other crops, which aids in maintaining soil health.

India is one of the largest pulse producing countries in the world with an area, average production and productivity of 310.30 lakh hectares, 27.69 million tonnes and 892 kg ha^{-1}, respectively (Annual report, 2022-23, agriwelfare.gov.in). In India, the most commonly grown pulses include chickpea, pigeonpea, blackgram, greengram, fieldbean, and horsegram. Among the various obstacles responsible for diminishing pulse production in India, the predominant factor is the damage caused by insect pests. Notable pests include the gram pod borer, spotted pod borer, plume moth, leafhopper, whitefly and aphids. These pests inflict significant harm on the crops, leading to substantial reductions in yield and productivity.

Spotted pod borer, *Maruca vitrata* Fab. (Lepidoptera: Pyralidae), is the most devastating pest on food legumes in tropical Asia, sub-Saharan Africa and also occurs in the USA, Australia and the Pacific region. Due to its destructiveness at critical stages of crop growth, particularly during the flowering and pod developmental stages, it poses a significant constraint to achieve maximum productivity in grain legumes. The young larvae (1st, 2nd and 3rd instars) especially injure the terminal shoots and the flower buds whereas the older larvae (4th and 5th larval instars) are highly mobile, feeding continuously on flowers and newly formed pods, and causing severe damage throughout the reproductive cycle of the crop. The larvae feed from inside a webbed mass of leaves, flowers, flower buds and pods. This concealed feeding habit protects the larvae from natural enemies and insecticides. This feeding behavior leads to significant yield loss (up to 72%) in many legumes as the larvae can destroy developing seeds inside the pods (Sharma, 1998) whereas, stems, peduncles, flowers and pods of various pulse crops are voraciously fed by the larva

Plate 1. Map depicting locations (mandals) surveyed for *Maruca vitrata* incidence during *rabi*, 2021-22 and 2022-23.

leading to a destructive damage varying from 20-88% (Jayasinghe *et al*., 2015).

MATERIAL AND METHODS

A roving survey was conducted in selected villages of Srikakulam, Vizianagaram and Visakhapatnam districts where pulses (blackgram and greengram) are grown every year in large area. The survey was performed in 27 villages of 9 mandals in North Costal districts at fortnight intervals during *rabi*, 2021-22 and 2022-23 (Plate 1).

The survey was conducted at the vegetative [7 to 45 Days After Sowing (DAS)] and reproductive stage (46 to 70 DAS) of the crop for studying the per cent leaf, flower and pod webbing by *M. vitrata*. In each field, 10 plants were randomly selected during the vegetative stage to record the per cent leaf webbing and in the reproductive stage to record the per cent flower and pod webbing.

Observations were recorded in the vegetative stage on the number of webbed leaves and the total number of leaves present in 10 randomly selected plants for calculating the per cent leaf webbing and on the total number of buds/flowers/pods and the number of webbed buds/flowers/pods in 10 randomly selected plants during the reproductive stage of the crop. The average of 10 observations recorded from farmer's fields in each village during both vegetative and reproductive stages was expressed as per cent leaf, flower and pod webbing, respectively. The per cent leaf, flower and pod webbings were calculated by using the following formula (Soundararajan and Chitra, 2011).

$$\text{Per cent leaf/flower/pod webbing} = \frac{\text{No. of infested leaves/flowers/pods}}{\text{Total No. of leaves/flowers/pods}} \times 100$$

The data *viz*., per cent leaf webbing, flower webbing and pod webbing were subjected to analysis of variance (ANOVA) and Duncan's Multiple Range Test (DMRT) ($P \leq 0.05$).

RESULTS AND DISCUSSION

At Vegetative stage:

Srikakulam district: The highest leaf webbing of 8.87 % by *Maruca vitrata* was recorded in Burja mandal followed by Srikakulam mandal and Sarubujjili mandal with 4.55 % and 4.17 % leaf webbings, respectively, being at par with each other but statistically different from the earlier observation during *rabi*, 2021-22. But during *rabi*, 2022-23,

the highest percentage of leaf webbing (9.40 %) was recorded in Burja mandal followed by Srikakulam (5.40 %) and Sarubujjili mandals (4.16 %) of Srikakulam district and were statistically different from each other without showing any incidence of being at par.

The overall mean percentage incidence of *Maruca* in Srikakulam district at a par occurrence of 4.98 % and 4.17 % were recorded at Srikakulam mandal and Sarubujjili mandal, which were statistically different from that of Burja mandal (9.13 %) during *rabi* 2021-22 and 2022-23.

Vizianagaram district: Gantyada mandal recorded the highest leaf webbing (8.94 %) followed by Bondapalli mandal (7.99 %) which were significantly at par with each other but, significantly different from S.Kota mandal, which had recorded the lowest leaf webbing (3.10 %) during *rabi*, 2021-22. The prevalence of spotted pod borer in Vizianagaram district during *rabi*, 2022-23 was recorded to be the highest in Gantyada mandal (11.79 %) followed by Bondapalli mandal (10.70 %), in terms of leaf webbing, being at par followed by S.Kota mandal (4.20 %) which was statistically different from others.

During the *rabi* seasons of 2021-2022 and 2022-2023 in Vizianagaram district, an overall mean percentage leaf webbing of 9.35% and 10.37% was observed in the black gram crop in Bondapalli mandal and Gantyada mandal, respectively. These percentages were found to be statistically similar but different from the observed percentage in S.Kota mandal (3.65%).

Visakhapatnam district: During *rabi*, 2021-22 in Visakhapatnam district, K.Kotapadu mandal recorded the highest per cent leaf webbing (22.81) followed by Atchutapuram mandal (17.51) and Anakapalle mandal (8.22) which were statistically different from each other. The per cent leaf webbing during *rabi*, 2022-23 was also recorded the highest in K.Kotapadu mandal followed by Atchuthapuram mandal and Anakapalle mandal (29.13, 19.38 and 9.85, respectively) of Visakhapatnam district and were differing statistically.

During the vegetative stage, the lowest overall mean per cent leaf webbing was observed in Anakapalle mandal (9.03) followed by Atchuthapuram and K.Kotapadu mandals (18.44 and 25.97, respectively) of Visakhapatnam district, in an ascending manner being significantly varying from one another.

At reproductive stage:

Srikakulam District: During *rabi* 2021-22, per cent flower webbing and pod webbing of 8.22 and 10.54, respectively, were recorded at Srikakulam mandal and were observed to be the lowest followed by Sarubujjili mandal (12.11 and 16.59) and Burja mandal (23.76 and 31.32) in an ascending manner, which were statistically different from each other.

Similarly, the highest percentage of bud/ flower webbing and pod webbing of 24.90 % and 33.60 % were recorded at Burja mandal followed by Sarubujjili mandal (13.02 % and 17.53 %) and Srikakulam mandal (9.08 and 11.16) during *rabi*, 2022-23 being statistically non-significant.

The overall mean per cent bud/flower webbing pertaining to *rabi* 2021-22 and 2022-23 at Srikakulam mandal (8.65) and Sarubujjili mandal (12.56) were at par but statistically different from the per cent bud/flower webbing (24.33) recorded at Burja mandal of Srikakulam district. The overall mean values of per cent pod webbing observed at Srikakulam mandal (10.85), Sarubujjili mandal (17.06) and Burja mandal (32.46) in Srikakulam district were statistically different from one another.

Vizianagarm district: In Vizianagarm district, the per cent bud/flower webbing and pod webbing of 12.09 and 20.12 (S.Kota mandal), 19.98 and 32.98 (Bondapalli mandal) and 32.43 and 47.10 (Gantyada mandal) were recorded during *rabi* 2021-22 and were statistically different. Similarly, the bud/ flower webbing in black gram *rabi* 2022-23 crop recorded during at S. kota manadal (19.37 %), Bondapalli mandal (29.28 %) and Gantyada mandal (37.69 %) of Vizianagaram district were also statistically different. But the highest percentage of pod webbing recorded at Gantyada mandal (47.67 %) followed by Bondapalli mandal (43.75 %) and were at par and significantly different from S.Kota mandal (31.81 %) during *rabi*, 2022-23 in Vizianagaram district.

The highest overall mean per cent bud/flower webbing and pod webbing were observed at Gantyada mandal (35.06 and 47.39) followed by Bondapalli mandal (24.63 and 38.37) and S.Kota mandal (15.73 and 25.97) pertaining to *rabi* 2021-22 and 2022-23 in Vizianagaram were significantly different.

Visakhapatnam district: In Visakhapatnam district, a highest bud/flower webbing of 31.23 % was recorded at Atchutapuram mandal followed by K.Kotapadu mandal (27.42 %) followed by Anakapalle mandal (23.28 %) and were statistically different during *rabi*, 2021-22. But during *rabi*, 2022-23, the highest bud/flower webbing was recorded at K.Kotapadu mandal (43.94 %) followed by Atchutapuram mandal(33.67 %) and Anakapalle mandal (30.03 %) which were statistically different.

The lowest pod webbing of 26.58 % was recorded in black gram crop at Anakapalle mandal preceded by K.Kotapadu (37.83 %) and Atchutapuram mandal (41.47 %) which recorded the highest and statistically different in Visakhapatnam district during *rabi*, 2021-22. Whereas a maximum per cent pod webbing of 50.90 followed by 40.79 and 35.64 were recorded at K.Kotapadu mandal, Atchutapuram mandal and Anakapalle mandal, respectively, during *rabi* 2022-23 in Visakhapatnam district.

On perusal of overall mean data pertaining to two seasons (*rabi*, 2021-22 and *rabi* 2022-23) the highest flower webbing and pod webbing of 35.68 % and 44.36 % were observed in K.Kotapadu mandal followed by Atchutapuram mandal (32.45 % and 41.13 %) and Anakapalle mandal (26.65 % and 31.11 %) of Visakhapatnam district and were statistically different from one another (Table 1).

During the vegetative stage, the highest pooled mean per cent leaf webbing was recorded in Visakhapatnam district (17.81), which was statistically different followed by Vizianagaram (7.79) and Srikakulam (6.09) districts, which were at par with each other. Whereas during reproductive stage, the pooled mean per cent bud/flower webbing and pod webbing recorded in Visakhapatnam district (31.59 and 38.87, respectively) were the highest followed by Vizianagaram district (25.14 and 37.14, respectively). Though the bud/flower webbing in Visakhapatnam and Vizianagaram districts was statistically different, the pod webbing was at par with each other. The lowest pooled mean per cent bud/flower webbing (15.18) and pod webbing (20.12) were recorded in Srikakulam district which were statistically differing from Visakhapatnam and Vizianagaram districts (Table 2). The results of the survey are in confirmation with the studies conducted by Naresh *et al*. (2020) who conducted a survey to know the intensity of incidence by *M. vitrata* in major blackgram growing areas of Andhra Pradesh and reported that incidence of *M. vitrata* varied from 29.09 to 71.52 per cent during *rabi* 2019-20. Similar results were also recorded by Reddy and Hari Prasad (2018), who conducted a survey during late *kharif*, 2014 in three districts of the Southern zone (Nellore, Kadapa and Chittoor districts) of Andhra Pradesh and reported more per cent infestation of spotted pod borer in Kadapa district (41.99 ± 6.84), followed by Nellore (39.77 ± 5.97) and Chittoor (38.50 ± 5.54) in blackgram.

Incidence of pulse spotted pod borer with significantly higher per cent flower and pod webbing might be due to delayed pulse cropping in rice fallows as a result of late *kharif* paddy cultivation leading to raising of blackgram utilizing the residual moisture after the paddy harvest. These findings corroborate with Patil *et al*. (2009), who found late sowing of black gram and mungbean crops, coupled with dry weather conditions, led to a significant increase in *M. vitrata* infestation and noted that flower and pod webbing could exceed 85%, particularly in years with prolonged dry spells. The present studies are also in concordance with studies made by Giraddi *et al*. (2000) and Sharma *et al.* (2005), who reported that late sowing combined with a dry spell leads to outbreak of *Maruca* resulting in almost 100 % pigeon pea flower buds and podloss in Karnataka and significant increase of *Maruca* population in Central and Southern regions of India, respectively. Similarly, Singh *et al*. (2010) also reported that late sowing during dry conditions exacerbated the *Maruca* problem up to 95 % in cowpea.

The maximum damage was recorded during the reproductive stage (from bud initiation to flowering and from pod formation to pod harvesting) compared to the vegetative stage of the crop in the present study is in agreement with the observations of Rani *et al*. (2013), who reported that the maximum damage occurs during the reproductive stage, with flower infestation ranging from 11.5% to 29% and pod damage ranging from 18% to 27.5% in greengram-growing mandals of Khammam district. Similarly, Bharathi and Balasubramanian (2011) documented the flower damage levels ranging from 12% to 30% and pod damage from 18% to 32% by *Maruca* in blackgram. Whereas, Srinivasan (2009) observed the predominance of *Maruca* during flowering stage lead

Table 1.: Per cent leaf, flower and pod webbing by *Maruca vitrata* in North Coastal Districts of Andhra Pradesh during *rabi*, 2021-22 and 2022-23

District	Mandal	Per cent *M. vitrata* infestation								
		Per cent Leaf Webbing		Mean per cent leaf webbing	Per cent Flower Webbing		Mean per cent flower webbing	Per cent Pod Webbing		Mean per cent pod webbing
		rabi 2021-22	*rabi* 2022-23		*rabi* 2021-22	*rabi* 2022-23		*rabi* 2021-22	*rabi* 2022-23	
Srikakulam	Srikakulam	4.55 (12.31)^{b}	5.40 (13.44)^{b}	4.98 (12.89)^{b}	8.22 (16.66)^{c}	9.08 (17.54)^{c}	8.65 (17.11)^{b}	10.54 (18.94)^{c}	11.16 (19.52)^{c}	10.85 (19.23)^{c}
	Sarubujjili	4.17 (11.79)^{b}	4.16 (11.77)^{c}	4.17 (11.78)^{b}	12.11 (20.36)^{b}	13.02 (21.15)^{b}	12.56 (20.76)^{b}	16.59 (24.04)^{b}	17.53 (24.75)^{b}	17.06 (24.40)^{b}
	Burja	8.87 (17.32)^{a}	9.40 (17.85)^{a}	9.13 (17.59)^{a}	23.76 (29.17)^{a}	24.90 (29.94)^{a}	24.33 (29.56)^{a}	31.32 (34.03)^{a}	33.60 (35.43)^{a}	32.46 (34.73)^{a}
	S.Em.±	0.37	0.61	0.49	0.50	0.57	0.56	0.60	0.43	0.54
	CD (P=0.05)	1.09	1.81	1.45	1.49	1.70	1.75	1.77	1.27	1.62
	CV %	11.13	14.56	8.96	8.05	8.38	8.24	8.06	7.54	11.46
Vizianagaram	S.Kota	3.10 (10.15)^{b}	4.20 (11.82)^{b}	3.65 (11.01)^{b}	12.09 (20.35)^{c}	19.37 (26.11)^{c}	15.73 (23.37)^{c}	20.12 (26.65)^{c}	31.81 (34.34)^{b}	25.97 (30.64)^{c}
	Bondapalli	7.99 (16.42)^{a}	10.70 (19.09)^{a}	9.35 (17.80)^{a}	19.98 (26.55)^{b}	29.28 (32.76)^{b}	24.63 (29.76)^{b}	32.98 (35.05)^{b}	43.75 (41.41)^{a}	38.37 (38.27)^{b}
	Gantyada	8.94 (17.40)^{a}	11.79 (20.09)^{a}	10.37 (18.78)^{a}	32.43 (34.71)^{a}	37.69 (37.87)^{a}	35.06 (36.31)^{a}	47.10 (43.34)^{a}	47.67 (43.67)^{a}	47.39 (43.50)^{a}
	S.Em.±	0.7	0.46	0.54	0.48	0.43	0.45	0.59	1.13	0.92
	CD (P=0.05)	2.07	1.37	1.46	1.44	1.27	1.32	1.76	3.35	2.73
	CV %	15.84	8.45	9.67	6.06	8.83	8.76	6.47	7.77	11.19
Visakhapatnam	Atchutapuram	17.51 (24.73)^{b}	19.38 (26.12)^{b}	18.44 (25.43)^{b}	31.23 (33.98)^{a}	33.67 (35.47)^{b}	32.45 (34.73)^{b}	41.47 (40.09)^{a}	40.79 (39.69)^{b}	41.13 (39.89)^{b}
	Anakapalli	8.22 (15.95)^{c}	9.85 (18.36)^{c}	9.03 (17.19)^{c}	23.28 (25.35)^{c}	30.03 (31.85)^{c}	26.65 (28.72)^{c}	26.58 (28.98)^{c}	35.64 (35.29)^{c}	31.11 (32.22)^{c}
	K.Kotapadu	22.81 (28.53)^{a}	29.13 (32.66)^{a}	25.97 (30.64)^{a}	27.42 (31.57)^{b}	43.94 (41.52)^{a}	35.68 (36.68)^{a}	37.83 (37.96)^{b}	50.90 (45.51)^{a}	44.36 (41.76)^{a}
	S.Em.±	0.72	0.37	0.54	0.50	0.48	0.45	0.65	1.15	1.09
	CD (P=0.05)	2.14	1.10	1.58	1.43	1.41	1.38	1.92	3.42	3.15
	CV %	11.12	8.39	7.45	8.18	9.35	6.53	6.74	7.84	9.46

Values in parentheses are arcsine transformed values.

Values followed by same letter in each column are not significantly different (DMRT)

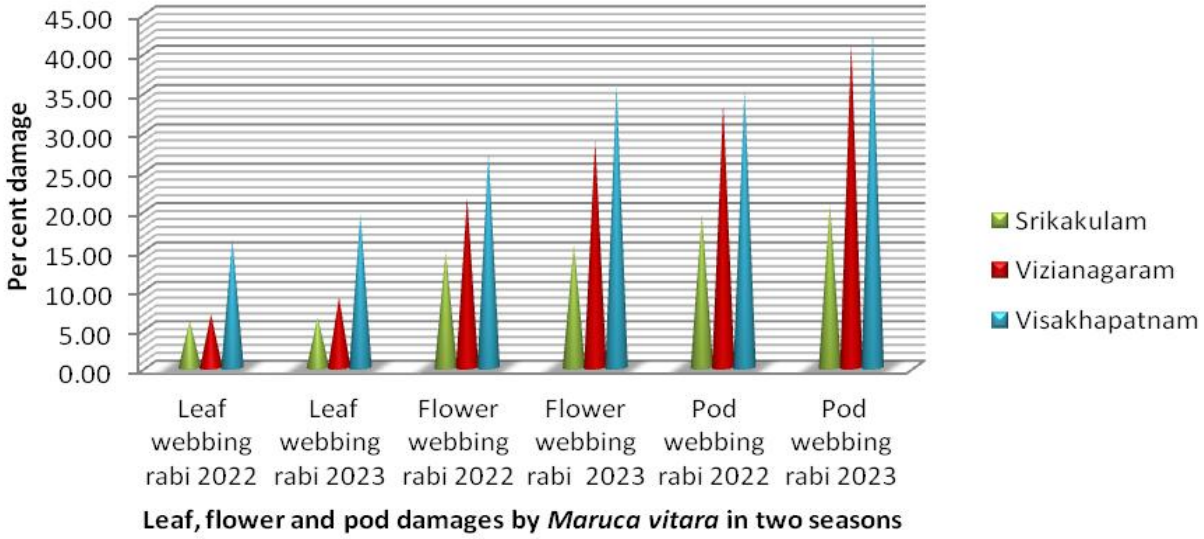

Plate 1. Per cent leaf webbing, flower webbing and pod webbing by spotted pod borer, *Maruca vitrata* during *rabi*, 2021-22 and *rabi*, 2022-23 in North Coastal Districts of Andhra Pradesh

Table 2. Pooled mean per cent infestation of *Maruca* at different stages of crop growth in North Coastal districts of Andhra Pradesh

District	Vegetative stage	Reproductive stage	
	Pooled Mean per cent leaf webbing	Pooled Mean per cent flower webbing	Pooled Mean per cent pod webbing
Srikakulam	6.09 (14.29)[b]	15.18 (22.93)[c]	20.12 (26.65)[b]
Vizianagaram	7.79 (16.20)[b]	25.14 (30.09)[b]	37.24 (37.61)[a]
Visakhapatnam	17.81 (24.97)[a]	31.59 (34.20)[a]	38.87 (38.57)[a]
S.Em.±	0.48	0.45	1.09
CD (P=0.05)	1.44	1.53	3.15
CV%	6.06	6.29	9.46

Values in parentheses are arcsine transformed values.
Values followed by same letter in each column are not significantly different (DMRT)

to significant pod damage ranging from 20 to 35 per cent on mungbean in South East Asia.

The studies made by Taggar *et al.* (2019) in Punjab and Ganapathy (1996) in Tamil Nadu inferred that *Maruca* caused damage during reproductive stage in pigeonpea ranging between 9.40% to 24.50%. Whereas Togola *et al.* (2018) reported that *Maruca vitrata* caused substantial damage to flowers and pods on cowpea up to 40 % in West Africa and Kumar *et al.* (2014) reported infestation levels up to 25% on cowpea in Uttar Pradesh.

The floral parts and pods are highly nutritious and the larvae prefer concealed feeding and thus they are much suitable for the growth and survival of spotted pod borer, which is evident from the findings of the present study.

CONCLUSION

During the survey conducted in *rabi*, 2021-22 and 2022-23, the highest percentage of leaf, flower and pod webbings in pulse crops were recorded in Visakhapatnam and Vizianagaram districts. Conversely, the lowest percentage of flower and pod webbings was observed in the Srikakulam district. The peak incidence of larvae was noted during the flowering and pod development stages, rather than in the leaf stage, across various pulse growing areas. The present study collectively underscores the vulnerability of pulse crops to pest webbing during the reproductive stage, necessitating targeted timely pest management strategies.

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