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Field studies on preferential feeding sites of spotted pod borer, *Maruca vitrata* (Lepidoptera: Crambidae) on different legumes

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Abstract
A field study was carried out to know the preferential feeding sites of spotted pod borer, *Maruca vitrata* (Geyer) within its host plant at crop fields of Department of Pulses, TNAU, Coimbatore during 2012-13. Five different host plants *viz*., pigeonpea (var: CO RG 7), greengram (var: CO GG 7), blackgram (var: CO BG 6), cowpea (var: CO 7) and lablab or field bean (var: Rohini) were maintained under pesticide free environment for the study. Among three different plant parts of legumes, the maximum preferential feeding was towards top portions irrespective of host crop. Among different host plants, on lablab, the highest population of 6.3 larvae/ plant was recorded followed by 5.7 larvae/ plant on redgram and 2.1 larvae/ plant on cowpea when compared to 1.1 larva/ plant on black gram (Table 1). However least and non significant difference was recorded with respect to population on middle and bottom portions irrespective of host plants. On bottom portion the population was very meager (less than 0.2 larvae/ plant). Only slight microclimate variation recorded within each host plant and there were no significant variations recorded in maximum and minimum temperatures as well as maximum and minimum relative humidity among top middle and bottom portions.

Keywords: Legumes, pulses, spotted pod borer, legume pod borer, *Maruca vitrata*, preferential feeding sites, microclimate

Introduction
Worldwide, leguminous pulse crops are recognized as the richest source of digestible proteins and occupied important place in the human diet next to cereals. It is widely being attacked by many insect pests and among them, spotted or legume pod borer, *Maruca vitrata* (Geyer) is the devastating pest of pulses [1]. At flowering and pod formation stages, larvae fed on buds, flowers and pods by webbing them [2]. Immediately after invading on the target feeding areas on host plant, it produces webbings on the economic parts which resulted in the lesser penetration of sprayed chemicals on the crops into the target feeding sites. However, in Uganda, it was recorded grain yield loss of up to 80 per cent in cowpea [3]. Similarly in pigeonpea, the infestation level was estimated from 9.0 to 51.0 per cent [4]. It makes webbings of flowers and pods and feeding by remaining inside never known to feed on any other plant parts. Earlier studies showed that the general pattern of diet restriction to one or a few host plant species in many of the herbivores and some polyphagous insects have multiple plants for their feeding and oviposition [5]. This plasticity would be a great evolutionary adaptation and permitting them to adapt to wide range of environments [6-7]. With this knowledge a study was conducted to find out the preferential feeding sites of *M. vitrata* within its host plant and influence of microclimate available on infestation.

Material and methods
A study on preferential feeding site of *M. vitrata* larvae was conducted during 2012-13 on five different host plants *viz*., pigeonpea (var: CO RG 7), greengram (var: CO GG 7), blackgram (var: CO BG 6), cowpea (var: CO 7) and lablab or field bean (var: Rohini). The individual host plant was raised in 40 m^2 plots at monthly intervals at the Department of Pulses, TNAU, Coimbatore under pesticide free environment. Observations were made on the number of larval webbings of *M. vitrata* on 25 randomly selected plants on top, middle and bottom of above host plants separately. The above observation was taken from replications on each host

at weekly interval from flowering to harvest. The mean and standard deviation of individual observations was computed out on each host plant separately. Weather parameters that predominantly influence on the microclimate of crop canopy such as maximum temperature, minimum temperature, maximum relative humidity, and minimum humidity were recorded using Digital thermohygrometer (Make: Preciva, Temperature range: -20 to 80^{O}C & RH range: 0 to 95%) at top, middle and bottom portions of host plants were recorded separately to have an idea about its influence on larval infestation.

Results and discussion

The maximum population was recorded on the top portions of the plants. Among different host plants, on lablab (field bean), the highest population of 6.3 larvae/ plant was recorded followed by 5.7 larvae/ plant on redgram and 2.1 larvae/ plant on cowpea when compared to 1.1 larva/ plant on black gram (Table 1). However least and non-significant difference was recorded with respect to population on middle and bottom portions irrespective of host plants. On bottom portion the population was very meager (less than 0.2 larvae/ plant). The present result of more infestation on the top portions of host plants is mainly due to the higher density of foliage with the presence of reproductive parts such as flowers and pods congregated together. This ensures the availability of feeding parts of the host plants and help them to switch to adjacent portions immediately when the exhausting of food.

Data given in Table 2 clearly indicated that only a slight variation in the maximum and minimum temperatures as well as maximum and minimum relative humidity parameters irrespective of hosts and plant locations and hence there could not be any significant variation existed among top middle and bottom portions. As it was already discussed, top portions of all five host plants harbours maximum number of *M. vitrata* larvae and among different host crops, the maximum and minimum relative humidity were recorded on redgram and lablab. These could be directly correlated to the maximum incidence (6.3 and 5.7 webbings/ plant) of *M. vitrata* larvae on top portions of these host plants. In redgram, Sambathkumar and Durairaj (2015) [8] recorded 61.4 per cent variation in the larval incidence of *M. vitrta* is influenced by weather parameter. About, 62.6 and 89.1 per cent variation in larval damage of *M. vitrata* was influenced by weather parameters on cowpea and lablab respectively [9].

Table 1: Preferential feeding site for *M. vitrata* on different hosts

Crop	Number of webbings/ plant (Mean ± SD)*			
	Top	Middle	Bottom	Mean
Redgram	$5.7^b \pm 0.98$	$0.4^b \pm 0.22$	$0.0^a \pm 0.00$	2.1 ± 3.2
Greengram	$2.0^c \pm 0.34$	$1.0^b \pm 0.59$	$0.2^a \pm 0.11$	1.1 ± 0.9
Blackgram	$1.1^c \pm 0.24$	$0.4^b \pm 0.23$	$0.1^a \pm 0.22$	0.6 ± 0.5
Cowpea	$2.1^c \pm 0.31$	$0.5^b \pm 0.20$	$0.0^a \pm 0.00$	0.9 ± 0.2
Lablab	$6.3^a \pm 1.91$	$1.9^a \pm 0.61$	$0.2^a \pm 0.16$	2.8 ± 3.2

*Mean and standard deviation of five replications and each replication with 25 randomly selected plants

Table 2: Temperature and Relative Humidity of different pulses with respect to feeding sites of *M. vitrata*

Crop	Mean ± SD											
	Top				Middle				Bottom			
	Max T (ºC)	Min T (ºC)	Max RH (%)	Min RH (%)	Max T (ºC)	Min T (ºC)	Max RH (%)	Min RH (%)	Max T (ºC)	Min T (ºC)	Max RH (%)	Min RH (%)
Redgram	28.2 ± 0.46	28.0 ± 0.34	73.4 ± 1.54	71.4 ± 1.20	28.0 ± 0.17	27.8 ± 0.39	73.2 ± 0.99	71.2 ± 1.38	28.1 ± 0.15	27.7 ± 0.87	73.9 ± 2.89	71.5 ± 0.79
Greengram	27.1 ± 0.57	26.9 ± 0.44	54.2 ± 1.03	53.8 ± 1.00	27.3 ± 0.38	26.8 ± 0.52	54.9 ± 0.68	54.1 ± 1.00	27.4 ± 0.40	26.8 ± 0.52	55.4 ± 0.51	54.0 ± 1.00
Blackgram	27.3 ± 0.10	26.8 ± 0.49	54.5 ± 0.77	53.5 ± 0.92	27.2 ± 0.13	27.2 ± 0.17	54.7 ± 0.51	54.0 ± 0.09	27.3 ± 0.21	27.1 ± 0.20	54.6 ± 0.56	54.0 ± 0.09
Cowpea	29.5 ± 0.76	27.7 ± 0.55	34.7 ± 4.80	25.0 ± 1.97	29.6 ± 0.75	27.7 ± 0.57	33.1 ± 6.26	24.1 ± 0.93	29.7 ± 0.65	27.4 ± 0.38	40.1 ± 1.51	24.2 ± 0.95
Lablab	27.6 ± 0.62	26.8 ± 1.28	60.7 ± 5.37	59.3 ± 3.91	27.7 ± 0.79	27.2 ± 0.97	60.1 ± 4.38	59.6 ± 3.93	27.8 ± 1.12	27.0 ± 1.10	61.1 ± 3.42	59.0 ± 4.44

Food quality plays a vital role for herbivore insects because their foraging strategies are ultimately aimed at up taking of balanced nutrients. Carbohydrate and protein content are important for the successful development of any insects and can vary depending on the host plant during its phenological cycle. Compared with other leaf components, older leaves generally have higher concentrations of proteins as well as carbohydrates, while younger leaves generally only have higher protein concentrations irrespective of any plants [10-11] and they are mainly influenced by various soil and environmental conditions. Since, matured older leaves contain much of crude protein and much of fibrous materials will make insects to spend more energy on digestion and assimilation. Specifically, reproductive parts feeding insects like *M. vitrata* are mainly prefer carbohydrate and easily digestible protein sources (on flowers and pods) for effective assimilation and to achieve food to nutrition conversion rate.

Therefore, understanding the diversity of insect responses to different host species is a key challenge for the development of sustainable pest management [12-14]. In these contexts, the present study clearly showed the ideal or preferential feeding site on their host plants with greater adaptation within the variation of micro climate. Similarly, earlier studies postulated that that many polyphagous insects have contributed to their rapid adaptation to different agroecosystems [15-16]. The identification of insect feeding preferences, biology and behavior are very important and give way to find economically and ecologically sustainable solutions to the problems caused by these herbivores [17]. Also, the availability of nearby alternate crops as food sources plays important role in population dynamics and outbreaks of polyphagous herbivores. Ability of a phytophagy to detect hosts, its larval physiology, natural enemies, and reproductive behaviors are mainly considered as deciding factors in an herbivore's host range finding process [18-19]. With insects of the order Lepidoptera, host plant selection for larvae is commonly associated with adult female choice of the site of oviposition **[20-21]**. These phenomena are highly supported by mother knows best principle optimal oviposition theory **[22-24]**. These theories explained the concept as juvenile life stages have more limitation in moving greater distance among plants, and therefore female insects should choose the best possible host plant and site their offspring development. Female insect select the ideal developmental site based on factors influencing its survival, such as nutritional quality **[25]** predation, proximity to other resources on the plant **[24 & 26]**, allelochemicals, and physical characteristics such as hardness, size, shape, and texture [27-28].

Most of the herbivorous insects have the ability to attract towards yellow or yellowish green during the host-seeking process than dark green or other colors [29-30]. This is concomitant with the studies of Sambathkumar (2013) [31] who recorded flowers of lablab or field bean followed by pigeonpea and cowpea were found to be most preferred by *M. vitrata* larvae when multicolored of food sources is available. Since, mostly lower portions of many plants are dark green in nature without any flowers and pods, this could be one of the possible reasons for *M. vitrata* to feed predominantly on upper portions of its host plant and especially on reproductive parts. Even though, some flowers and pods are located at middle and bottom portions, the harborage of only few numbers of larvae in those locations might be due to insufficient supply of essential nutrients and micro climatic variations. Also, the wide host range on different pulses of *M. vitrata* might be contributed to their rapid adaptation to different agro-ecosystems and microclimate within the host plant.

The present study also helps us to find a new approach of spraying plant protection chemicals in such a way that the application should be concentrated towards the top one third portions or half of the plant top portions. This aids in reducing the total volume of spray fluid used since many legumes are raised in dry land and rain fed conditions where the availability of water is very less. This finding may also help to reduce the time of application and effective management of larvae by concentrating only on the most preferential portion.

Conclusion

In conclusion, based on the present study, the preferable feeding and development sites of *M. vitrata* was identified as top followed by middle and bottom portions irrespective of their host plants. Thus, the present study illustrated that top portions of host plants are ideal feeding locations for optimum development and survival of *M. vitrata* larvae. Also, it is very clear that slight variation in microclimate within the host plant environment along with other host plant characters had significant influence on the larval preference of *M. vitrata* irrespective of hosts. Results of present study contribute to understanding the feeding ecology of this pest and assist in their control, particularly on pigeonpea. Among five host plants of the present study, pigeonpea is the tall stature crop and having their most of the floral parts on their top portion and superficially across the periphery. Hence, more attention could be paid while spraying of plant protection chemicals on these locations would help in increasing the efficiency of pesticides in managing of this insect pest.

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