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POPULATION DYNAMICS OF *MESOMORPHUS VILLIGER* BLANCHARD IN FLUE CURED VIRGINIA TOBACCO

B. SAILAJA JAYASEKHARAN, U.SREEDHAR AND V. VENKATESWARLU

ICAR-Central Tobacco Research Institute, Rajahmundry, A.P.- 533105

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Flue Cured Virginia (FCV) tobacco is infested by various chewing and sucking pests throughout the crop season and ground beetle, *Mesomorphus villiger* (Blanchard) (Tenebrionidae: Coleoptera) is one among them. The newly transplanted seedlings suffer from injury due to ground beetles. Even though it is a minor pest feeding on grasses, weeds and decaying organic matter, it is a menace in tobacco as it causes damage to the freshly transplanted seedlings already subjected to transplantation shock. When the beetles gnaw the stem deeply, seedlings die causing gaps in the field. In severe cases, the damage necessitates replanting. Estimation of *M.villiger* population abundance under climate change scenario is extremely important and can have an impact on their management. The results indicated that maximum and minimum temperatures have a positive correlation with ground beetle population where the latter has a significant effect (r=0.86*). Morning relative humidity and rainfall had negative correlation with *M.villiger* population, where the former has a significant effect (r=-0.37*).

INTRODUCTION

Population dynamics of insect pests provide an insight into their seasonal occurrence, which in turn helps in formulating effective IPM strategies. Kingsolver (1989) substantiated that weather, is not merely involved in population control but has a prominent role in population ecology in directing the interplay of biotic and abiotic factors. FCV tobacco is affected by many insect pests in the field *viz*., tobacco caterpillar *Spodoptera litura* (Fabricius), tobacco whitefly *Bemisia tabaci* (Gennadius), ground beetle *Mesomorphus villiger* Blanchard, tobacco aphid *Myzus nicotianae* (Blackman), budworm *Helicoverpa armigera* (Hubner) and stem borer *Scrobipalpa heliopa* (Lower). Tenebrionid beetles *M. villiger, Seleron latipes, Opatroides frater* are considered in tobacco ecosystem as ground beetles (Gopalachari, 1984). Among them, *M.villiger* is predominant and observed frequently. They are generally referred to as darkling beetles, which feed upon decaying vegetation, animal excrement, fungi, and also on stored products (Rogers *et al.*, 1978). *M.villiger* is a minor and sporadic pest that can cause substantial damage to tobacco yield and quality under favourable conditions (Sreedhar, 2016). It has cosmopolitan distribution and reported from Indian subcontinent, Afghanistan, Siberia, Australia and Africa (Seena and Thomas, 2013). The yield losses in tobacco due to *M.villiger* could be as high as 40 % during drought conditions (Sitaramaiah *et al.*, 1998) and during prolonged hot spells immediately after planting. These beetles inflicts damage by gnawing the tender stems of seedlings immediately after transplanting, resulting in death to an extent of 50-60 % (Sitaramaiah *et al.*, 1999). This necessitates gap filling, leading to increased cost of cultivation and ultimately affects the yield and quality of the leaf (Sreedhar and Raghupathi Rao, 2017). Powdered pongamia cake 5g mixed in handful of fine sand applied at the base of transplanted seedlings (75 kg pongamia cake per ha) prevents crop damage. As a cultural practice, sprinkling water on soil and keeping heaps of grasses in between crop rows at a distance of 6 m attracts the beetles which can be easily killed by spraying insecticides (Sitaramaiah *et al.*, 1998). Spraying seedlings with chlorantraniliprole 18.5 SC @ 0.005 %, one day prior to transplanting offers better protection to the transplanted seedlings (Sreedhar, 2020). However, with change in weather parameters, the beetle population changes over the seasons. Hence,

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studies on population dynamics and abiotic factors can provide valuable information for the management of *M.villiger*.

MATERIALS AND METHODS

The experiment was conducted during 2017-18 and 2018-19 crop seasons. FCV tobacco cv. *Siri* was planted at ICAR-CTRI Black Soil Research (BSR) Farm, Katheru as per recommended agronomic practices. Seedlings were raised as per the recommended package of practices and transplanted in the main field at sixty days after sowing. As most of the feeding by the ground beetle occurs during night time, population estimation in the daytime is not possible. Earlier works were conducted on percent seedling damage, rather than relative population estimation. Hence, ground beetle population was estimated uniquely for the first time using pitfall traps with ethyl acetate as killing agent. Small cotton balls were saturated with ethyl acetate and placed in the pitfall container. The traps were placed in the soil 20 m away from each other, with the brim of the upper funnel of the trap flush with soil surface. Throughout the crop season, ground beetle population was recorded at weekly intervals. Weather data was obtained from the meteorological observatory, BSR Farm, ICAR-CTRI. Weather parameters *viz.*, maximum, minimum temperatures, relative humidity, evaporation and rainfall were recorded and the change in insect pest population was correlated with the abiotic factors. The relationship was estimated using multiple linear regression analysis.

RESULTS AND DISCUSSION

Population dynamics

During the season 2017-18, ground beetle initial incidence was observed in the 44th standard week (SW) of 2017, with 9 individuals. The beetles had a peak population during 46th SW with 14 individuals. Thereafter the population declined gradually with 2 individuals observed during 3 SW of the next year, 2018. As there was no rainfall in this period, it was not considered for the analysis (Table 1). During the season 2018-19, *M.villiger* initial incidence was recorded during 39th SW of 2018, and highest population was recorded during the 41st SW. From the 4th SW of 2019, there was negligible catch of the ground beetles.

Weather correlation

Correlation analysis was conducted for the beetle population with the corresponding weather data (Table 2). The two season data with correlation coefficients were recorded at 5 percent level of significance (Table 3). *M.villiger* had a positive correlation with maximum temperature (T_{Max}), minimum temperature (T_{Min}) and evening relative humidity (RH_{II}). Similarly, de los Santos *et al.* (2002) reported that minimum temperature is positively correlated to population size of the darkling beetle *Pimelia radula ascendens*. Cepeda-Pizarro (1989) reported that soil temperature and moisture regime regulated the life cycles of most of the tenebrionid species living in the area and not vegetation of that area. In the present study,

Table 1: Correlation of *M.villiger* population with weather factors in 2017-18

	M.villiger	T_{Max}	T_{Min}	RH_{I}	RH_{II}	**Evaporation**
M.villiger	1					
T_{Max}	0.210774	1				
T_{Min}	0.55828	0.552957	1			
RH_{I}	-0.38713	-0.30549	-0.0281	1		
RH_{II}	0.613657	0.246002	0.835633	0.139348	1	
Evaporation	-0.0012	0.590584	0.225371	-0.44288	-0.00914	1

Table 2: Correlation of *M.villiger* population with weather factors in 2018-19

	M.villiger	T_{Max}	T_{Min}	RH_{I}	RH_{II}	Evaporation	Rainfall
M.villiger	1						
T_{Max}	0.774737	1					
T_{Min}	0.862852	0.826892	1				
RH_{I}	-0.0697	-0.1233	0.184875	1			
RH_{II}	-0.46082	-0.64037	-0.3686	0.2346	1		
Evaporation	0.717887	0.729314	0.761054	-0.1272	-0.59335	1	
Rainfall	-0.2022	-0.46497	-0.16912	0.356619	0.388882	-0.17684	1

Table 3: Correlation coefficients of *M.villiger* population during 2017-18 and 2018-19

Ground beetle	T_{Max}	T_{Min}	RH_{I}	RH_{II}	Evaporation	Rainfall
Season I	0.210	0.558	-0.387*	0.613	-0.001	-
Season II	0.774	0.862*	-0.069	-0.460	0.717	-0.202

* Significant @ 5 % LOS

morning relative humidity (RH_{I}) and evaporation had negative influence on the beetles. During the period of observation there was no rainfall. *M.villiger* was also observed to have a significant negative correlation (r= -0.387*) with morning relative humidity (RH_{I}) during 2017-18.

During 2018-19, *M.villiger* had positive correlation with maximum temperature (T_{Max}), minimum temperature (T_{Min}) and evaporation. Morning and evening relative humidities (RH_{I} and RH_{II}) and rainfall had negative effect on ground beetle population. Ground beetles were observed to have a significant positive correlation with minimum temperature T_{Min} (r= 0.862*). Rainfall during the period of observation might have brought a variation in the correlation of *M.villiger* population to weather factors. Gowda *et al.* (2020) analyzed pitfall trap catches of several tenebrionid beetles and reported that maximum temperature had positive correlation (r= 0.05), whereas minimum temperature and rainfall had correlation of -0.30 and 0.50, respectively, probably due to the degree of habitat disturbance and interplay of biotic factors.

Regression analysis

Multiple regression analysis during the two succeeding seasons yielded two regression models as follows:-

$Y1 = 59.52 + 0.21\, T_{Max} + 0.558\, T_{Min} – 0.387\, RH_{I} + 0.613\, RH_{II} – 0.001\, Evap$

$Y2 = 45.71 + 0.774\, T_{Max} + 0.862\, T_{Min} – 0.069\, RH_{I} + 0.460\, RH_{II} – 0.717\, Evap – 0.202\, Rainfall$

Y1 is the regression model pertaining to 2017-18 season where morning relative humidity RH_{I} has a significant negative effect on *M.villiger* population. Y2 is the model based on 2018-19 population data, where minimum temperature T_{Min} has a significant positive correlation with *M.villiger* population. To estimate ground beetle population, the weather data can be incorporated into any of the models, depending on the relative importance of morning relative humidity RH_{I} and minimum temperature T_{Min}.

Weather factors play an important role in determining pest population dynamics among other crop production factors. *M. villiger* beetles are little studied and the aspects of weather correlation to their population explosion were almost negligible. From the study, it is evident that minimum temperature and morning relative humidity have exerted significant influence on their population at least, their movement. Further regression data on weather correlation studies are necessary for a long time incorporation of other edaphic and weather parameters, tritrophic interactions and crop production aspects, to forecast the beetle population and to expand insights into their population ecology.

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