

SHORT COMMUNICATION

**STATUS OF FALL ARMYWORM *SPODOPTERA FRUGIPERDA*
(J.E. SMITH) IN SUGARCANE IN TAMIL NADU STATE, INDIA,
A YEAR AFTER ITS FIRST OCCURRENCE**

J. Srikanth*, N. Geetha, P. Mahesh, L. Saravanan, B. Singaravelu and K.P. Salin

Abstract

The status of fall armyworm (FAW) *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae) on sugarcane in Tamil Nadu State, India, in the past one year, i.e. since its first occurrence on the crop in November 2018, is presented in this communication with comparative observations in maize. In M/s Bannari Amman Sugars Ltd, Sathyamangalam, attack rates in young sugarcane (cv Co 14061) crop were lower (0.0-7.2%) than in maize (86.4%). In M/s Amaravathi Sugars, Udumalpet, too, sugarcane (cv Co 86032) recorded lower (1.7%) attack rates than maize (33.8%). The incidence level in M/s Sakthi Sugars, Appakudal, was about 20.0%. In experimental plots, the attack rates in diverse germplasm, including commercial hybrids, was less than 2.2%. Selected life-history parameters such as percent of pupation, percent of adult emergence and sex ratio recorded in small field-collected samples were more or less same in sugarcane and maize. Likewise, pupal period and pupal weight of males and females did not differ significantly between the two hosts. The entomopathogenic fungus *Metarrhizium (=Nomuraea) rileyi* (Farl.) Kepler, Rehner & Humber was observed in FAW larvae collected from maize and not sugarcane. The host preference displayed by FAW and *M. rileyi* was discussed in relation to the long-term occurrence of the former and biological control prospects with the latter.

Keywords: Fall armyworm, *Spodoptera frugiperda*, sugarcane, maize, host preference, host suitability, *Metarrhizium (=Nomuraea) rileyi*

The exotic fall armyworm (FAW) *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae) was first reported from India in mid-2018, primarily on maize (Shylesha et al. 2018). The first confirmed report of its occurrence in sugarcane was from Maharashtra State during September-October 2018 (Chormule et al. 2019). The next report of its occurrence in the crop was from Tamil Nadu state in November 2018 (Srikanth et al. 2018). Almost simultaneously (December 2018), FAW attacked sugarcane in Belgaum district, Karnataka state (Matti and Patil 2019). Subsequently, the pest was observed in experimental plots and scattered sugarcane farms in Andhra Pradesh state during February-April 2019 (Bhavani et al. 2019). In

April 2019, the pest was observed in sugarcane in Bagalkot, Belgaum and Dharwad districts of Karnataka (Chouraddi et al. 2019).

In all the above instances, FAW attack in sugarcane varied in intensity but was restricted to tillering phase of the crop. For instance, the level of infestation ranged 2-5% in 45-80 d old crop (cv Co 86032) (Chormule et al. 2019), 1.9-30.9% in 75-120 d old crop (cv Co 86032) (Srikanth et al. 2018), 0-5% in 30-45 d old crop (Matti and Patil 2019), 5-25% in 20-60 d old crop (Bhavani et al. 2019) and 3-5% in 45-60 d old crop (Chouraddi et al. 2019). Subsequent to its first occurrence on the crop in tropical states in quick succession, the

J. Srikanth*, N. Geetha, P. Mahesh, L. Saravanan, B. Singaravelu and K.P. Salin

Section of Entomology, ICAR-Sugarcane Breeding Institute, Coimbatore-641007, Tamil Nadu, India

*Corresponding author: srikanth_jsk@yahoo.co.in

Submitted: 16 January 2020; Accepted: 2 March 2020

pest continues to attack young sugarcane crop sporadically. In this communication, observations of FAW occurrence in growers' farms and sugarcane experimental plots in Tamil Nadu in the past one year, with comparative notes on its presence in maize grown alongside in the crop habitat, are presented and an overview of its status in sugarcane in the country is discussed.

Growers' farms of sugarcane under the aegis of sugar industry were inspected, after receiving reports of suspected occurrence of FAW from factory personnel, to assess incidence levels and recommend control measures. After ensuring that the farms received no prior plant protection measures, FAW incidence levels were estimated from about 50 plants in each of the 10 or more spots selected randomly as per our earlier protocol (Srikanth et al. 2018). A similar sampling procedure was followed for assessing FAW level in sole crop of maize in the neighborhood. In a plot that featured sugarcane as main crop and maize sown intermittently in the border rows and scattered in the main plot, the above protocol was followed for the main crop. In the border maize crop, 10 spots were selected randomly and FAW level was assessed from the plants available (14-40) at each spot. In an experimental plot of ICAR-Sugarcane Breeding Institute, Coimbatore, Tamil Nadu, laid out to investigate sucrose regulating genes in 31 species clones, diverse clones and hybrids, FAW levels were assessed in whole plots of the germplasm planted in 1-3 rows of 6 m length. In a demonstration plot with the short duration sugarcane variety Co 11015 intercropped with coriander and pulses, FAW incidence was assessed in 20 spots (42-150 plants) in the main crop.

Preliminary observations were made to examine if sugarcane and maize cultivated in the same habitat exhibit differential suitability to FAW. Small batches of grown-up larvae of mixed age

were collected from the two crops and reared in the laboratory until pupation. Percent of pupation, percent of adult emergence and sex ratio were recorded; pupal period and pupal weight on the two hosts were compared for males and females separately using two sample *t*-test. Mycosed larvae from both hosts were incubated in Petriplates lined with moist filter paper and infection levels computed; spores were examined and identity of the entomopathogenic fungus (EPF) was established.

In the registered cane area of M/s Bannari Amman Sugars Ltd, Satyamangalam, sugarcane crop (cv. CoVC 14061) of varying age (45-135 d) showed low levels of FAW infestation (0.0-7.2%) in different farms in January 2019 (Table 1). In farm-I, the 45 d old crop with highest level of infestation was preceded by maize which reportedly suffered from FAW attack. While two other plots (Farm-II & III) with older (135-180 d) crop showed no symptoms of attack, another young crop (Farm-IV) showed low level of attack. In farm-V, located adjacent to farm-IV, while the 60 d old sugarcane main crop had low level of attack (0.2%), sparse maize, sown in the border rows and scattered in the sugarcane plot, displayed higher level of attack (86.4%). In two 90 d old maize farms in the neighborhood inspected for comparative purpose, the crop was attacked heavily by FAW with the presence of faecal matter and larvae on leaves, tassels and cobs. In one of these farms, EPF-infected larvae were seen adhering to the leaf surface. In the same month (January), low intensity FAW attack in a 90 d old sugarcane (Co 86032) crop was recorded in M/s Amaravathi Sugars, Udumalpet; in contrast, maize showed higher attack rates (Table 1). However, a few plots of paddy and sorghum examined in the habitat were free from FAW attack. On a mature maize crop at Dharapuram, EPF infected larvae adhering to the plant surface were observed in large numbers. FAW

Table 1. Fall armyworm *Spodoptera frugiperda* incidence in sugarcane in Tamil Nadu, India (2019)

| Location | Month | Crop | Variety | Age of crop (d) | % incidence |
|--|---------|----------------------|----------------------------|-----------------|-------------|
| M/s Bannari Amman Sugars, Sathyamangalam | January | I. Sugarcane | CoVC14061 (P) [#] | 45 | 7.2 |
| | | II. Sugarcane | CoVC14061 (P) | 135 | 0.0 |
| | | III. Sugarcane | CoVC14061 (P) | 180 | 0.0 |
| | | IV. Sugarcane | CoVC14061 (P) | 60 | 1.0 |
| | | V. Sugarcane | CoVC14061 (P) | 60 | 0.2 |
| | | Maize (Main crop) | Local | 60 | 86.4 |
| M/s Amaravathi Sugars, Udumalpet | January | Sugarcane | Co 86032 (P) | 90 | 1.7 |
| | | Maize | | 90 | 33.8 |
| M/s Sakthi Sugars, Appakudal | April | Sugarcane | Co 86032 (P) | 60 | 20.0 |

[#]Plant crop

attacked sugarcane to a moderate level (20.0%) in April in M/s Sakthi Sugars Ltd, Appakudal (Table 1). Subsequent to these observations, independent roving surveys covering entire Tamil Nadu carried out by the authors during March-June 2019 failed to reveal the presence of FAW.

Published literature, and unconfirmed oral and social media communications from factory personnel in the past one year indicated that FAW occurred intermittently in tropical sugarcane spanning the entire year, though in different geographical locations. Availability of tillering stage of the crop round the year facilitated by staggered planting and harvesting in sugarcane belts can potentially render the crop vulnerable to continuous attack of FAW in the habitat. In such a scenario, the suggestion that maize intercropped in sugarcane could lead to dispersal of FAW to the latter after the former is harvested (Chormule et al. 2019) is untenable as the main crop sugarcane

traverses tillering phase and reaches grand growth phase and, thus, becomes unsuitable for further colonization by FAW. However, the more preferred maize, as observed in earlier studies (Chormule et al. 2019) and indicated by the present survey data (Table 1), sown as intercrop is likely to attract the pest for concurrent colonization of sugarcane through directional selection and adaptation of populations and, hence, may best be avoided as intercrop.

In the experimental plots of ICAR-Sugarcane Breeding Institute, FAW was first noticed in a 60 d old mixed germplasm collection towards the end of March 2019 (Table 2). Incidence was noticed in 12 out of 31 germplasm entries (38.7%) but the attack rates were low ($\bar{x} = 0.9 \pm 1.2$; range: 0.0-3.7). The attacked entries included two *Saccharum officinarum* clones (28 NG-224 & 57 NG-228), two *Saccharum robustum* clones (NG 77-23 & NG 77-24), two *Erianthus arundinaceus* clones (IK

Table 2. Fall armyworm *Spodoptera frugiperda* occurrence in research plots of ICAR-Sugarcane Breeding Institute, Coimbatore, Tamil Nadu, India (2019)

| Experimental plot | Month | Age of crop (days) | % incidence |
|-------------------|----------|--------------------|-------------|
| Mixed germplasm | March | 60 | 0.9 |
| cv Co 11015 | November | 60 | 2.2 |

76-22 & IS 76-162), two diverse clones and four hybrids (Co 13002, Co 16002, Co 11015 and Co 06022). Besides, low level of attack was observed on two sweet sorghum varieties, namely SSV 74 and SSV 84, and one grain sorghum variety SPV 462 grown in the same blocks. In the second experimental plot (Table 2), a 60 d old crop of the short duration variety Co 11015 planted in paired row system with intercrops showed a slightly higher attack rate (2.2%) in November 2019.

In sugarcane crop systems that attracted FAW hitherto, the pest attacked the commercial varieties cultivated locally, including the predominant Co 86032 (Chormule et al. 2019; Srikanth et al. 2018) and a few others such as Co 91010, Co 92005 (Chouraddi et al. 2019), 87 A 298, 2009 A 109, 93 A 145, etc. (Singh 2019), CoVC 14061, Co 13002, Co 16002, Co 11015 and Co 06022 (present study). However, the absence of all these varieties in a single location and low to moderate incidence levels of FAW, including in the germplasm examined in the present study, disallow any meaningful conclusions on varietal preference. Higher levels of incidence in experimental plots

(Bhavani et al. 2019) than in the present study could be related to the experimental material examined, general higher level of FAW activity in the farms and differential climatic conditions.

Selected life-history parameters of FAW collected from sugarcane and maize in Sathyamangalam, namely percent of pupation and percent of adult emergence were similar in both hosts (Table 3). However, proportion of males in the adults emerged appeared slightly higher in maize than in sugarcane. Pupal period and pupal weight of males or females did not differ significantly between the two hosts (Table 4).

The limited life-history data of larvae collected from the two hosts at the same location and in the same month seemed to reflect the identical suitability of the two hosts. However, these observations appear to contradict the higher attack rates and relative field preference for maize by FAW (Chormule et al. 2019; our present data), despite its lower biomass in the sugarcane belts. Moreover, in earlier studies elsewhere too, sugarcane emerged as a non-preferred host (Murúa

Table 3. Selected life-history parameters of fall armyworm *Spodoptera frugiperda* collected from two hosts at Sathyamangalam, Tamil Nadu, India (2019)

| Host | % pupation [@] | % adult emergence | Sex ratio (♂:♀) |
|-----------|-------------------------|-------------------|-----------------|
| Sugarcane | 83.3 | 100.0 | 0.9: 1.0 |
| Maize | 80.0 | 100.0 | 1.4: 1.0 |

[@]n= 18 and 15 larvae from sugarcane and maize, respectively

Table 4. Pupal characteristics of fall armyworm *Spodoptera frugiperda* collected from two hosts at Sathyamangalam, Tamil Nadu, India (2019)

| Host | Pupal period (d) | | Pupal weight (g) | |
|-----------------------------|---------------------|--------------------|----------------------|----------------------|
| | Male | Female | Male | Female |
| Sugarcane | 10.0±0.0 | 8.9±0.4 | 0.2041±0.0179 | 0.1701±0.0269 |
| Maize | 10.0±0.6 | 9.0±0.7 | 0.1997±0.0216 | 0.1664±0.0347 |
| <i>t</i> -test [@] | 0.00 ^{ns} | 0.43 ^{ns} | 0.4146 ^{ns} | 0.2205 ^{ns} |

[@] Comparisons based on 7 & 8 and 7 & 5 male and female pupae from sugarcane and maize, respectively

et al. 2009) with least fitness index (Boregas et al. 2013) among several hosts tested. It is possible that as the comparative observations were made on the larvae as soon as the pest was reported on sugarcane, the first generation larvae perhaps did not show any differences in the biological parameters. While continuous rearing of larvae on the two hosts for a few generations might reveal the true picture of relative suitability, comparative morphological, physiological and phytochemical analysis of the two hosts would unravel the underlying causes.

Restriction of FAW to the tillering phase of sugarcane, observed in almost all surveys conducted hitherto, was suggested to be due to the general hardy nature of the crop and absence of a cob-like fruiting body (Srikanth et al. 2018). Besides, the availability of more succulent leaves in maize than in sugarcane even at maturity stage probably enables the former support FAW activity round the crop growth period. Hardy nature of sugarcane could be defined in terms of differential morphological and phytochemical profiles of leaves in different phenological stages serving as defense mechanisms. For example, the general decrease in leaf chlorophyll a and b, total chlorophyll, N, P, N/P ratio and acid soluble

iron, and slight increase in crude silica content from early (4 months age) to ripening (14 months) stage of two hybrid varieties (Jain et al. 1999) and increase in some phenolics such as orcinol and coumarin from 4th to 10th month in the popular variety Co 86032 (K.P. Salin, unpubl. data) could be among several such factors whose role in maintaining the later stages of sugarcane FAW-free would make interesting investigation.

Grown-up larvae collected from sugarcane and maize in Sathyamangalam, and maize in Dharapuram in January 2019, and incubated in the laboratory showed variable levels of entomopathogen activity (Table 5). FAW collected from sugarcane in Sathyamangalam showed moderate level of apparent bacterial infection (16.7%) but no EPF infection. However, larvae from maize in the same area showed moderate level of EPF infection (20.0%). Larvae collected from maize in Dharapuram, including a few mycosed ones adhering to the plant surface, showed a very high level (76.5%) of EPF infection; while 5.9% larvae died due to apparent bacterial infection, the rest (17.6%) pupated.

The EPF observed on FAW in maize (Fig. 1) was identified as *Metarrhizium* (= *Nomuraea*) *rileyi* (Farl.) Kepler, Rehner & Humber based on culture

Table 5. Entomopathogenic fungal infection rates in fall armyworm *Spodoptera frugiperda* collected from two locations and hosts in Tamil Nadu, India (2019)

| Location | Month | Crop | % infection [@] |
|---|---------|-----------|--------------------------|
| M/s Bannari Amman Sugars, Sathyamangalam | January | Sugarcane | 0.0 |
| | | Maize | 20.0 |
| M/s Amaravathi Sugars, Dharapuram | January | Maize | 76.5 |

[@]n= 18, 15 and 17 larvae, respectively

morphology and spore characters (Samson et al. 1988). In the first report of FAW occurrence on maize, considerable incidence of the fungus was observed on larvae collected from the crop (Shylesha et al. 2018). However, in the first report of FAW occurrence on sugarcane, no fungal incidence was observed in larvae colonizing sugarcane but meagre activity of the fungus was noticed in larvae attacking maize and sorghum



Fig. 1. *Metarrhizium* (= *Nomuraea*) *rileyi* infected larva of fall armyworm *Spodoptera frugiperda* from maize in Dharapuram, Tamil Nadu, India (2019)

(Chormule et al. 2019). These limited observations seem to indicate a stronger association of *M. rileyi* with FAW in maize than in sugarcane, possibly mediated by the higher level of pest incidence in maize. More systematic comparative studies of the fungus on FAW in maize and sugarcane are needed to unravel the tri-trophic interactions which are

likely to impact the efficacy of the fungus (Cory and Ericsson 2010) if ever used against the pest in sugarcane.

The spread of FAW to new geographical areas and reappearance in already reported locations as a pest of sugarcane over the past one year have been rather infrequent and restricted to tropical India (Singh 2019). However, the pest expanded its geographical range more extensively in maize than in sugarcane covering both subtropical and tropical India in the same one year period (EPPO 2019). Despite the presence of huge biomass of sugarcane created in crop zones under the patronage of sugar industry, the inherent defense mechanisms, particularly in the grand growth phase, may have allowed occasional adaptation of FAW to sugarcane through directional selection of its population. FAW is likely to face less selection pressure to adapt to sugarcane in habitats with mixed cropping than monocropping of sugarcane. Pending investigation and confirmation of all such hypotheses, it is prudent to monitor its pattern of occurrence in sugarcane in both types of habitats to plan management measures, should the pest assume serious proportions in the crop.

Acknowledgements

We thank the personnel of sugar factories and growers of sugarcane and maize for their cooperation during the surveys. We also thank our colleagues for their graceful consent to inspect

their experimental plots and providing details. We thank our Director for academic encouragement and logistic support.

References

- Bhavani B, Chandra Sekhar V, Kishore Varma P, Bharatha Lakshmi M, Jamuna P, Swapna B (2019) Morphological and molecular identification of an invasive insect pest, fall army worm, *Spodoptera frugiperda* occurring on sugarcane in Andhra Pradesh, India. Journal of Entomology and Zoology Studies 7(4):12-18.
- Boregas, KGB, Mendes SM, Waquil JM, Fernandes GW (2013) [Fitness stage of *Spodoptera frugiperda* (J.E. Smith) (Lepidoptera: Noctuidae) on alternative hosts] Estádio de adaptação de *Spodoptera frugiperda* (J.E. Smith) (Lepidoptera: Noctuidae) em hospedeiros alternativos [Pt.]. Bragantia 72(1):61-70.
- Chormule A, Shejawal N, Sharanabasappa, Kalleshwaraswamy CM, Asokan R, Mahadeva Swamy HM (2019) First report of the fall armyworm, *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera, Noctuidae) on sugarcane and other crops from Maharashtra, India. Journal of entomology and zoology studies. 7(1): 114-117.
- Chouraddi M, Sutagundi RB, Yekkeli NR, Khandagave RB (2019) Fall armyworm (FAW) *Spodoptera frugiperda*: first record of occurrence on sugarcane in Karnataka, India. Proceedings of Deccan Sugar Technologists Association. 65:152-160.
- Cory JS, Ericsson JD (2010) Fungal entomopathogens in a tritrophic context. BioControl 55:75-88.
- EPPO (2019) EPPO Global Database: *Spodoptera frugiperda* (LAPHFR). <https://gd.eppo.int/LAPHFR/distribution> [Accessed on 17 December 2019].
- Jain R, Shukla SP, Shrivastava AK (1999) Leaf composition during early growth and ripening in sugarcane (*Saccharum* spp. hybrids). Indian Journal of Plant Physiology 4(1):52-54.
- Matti PV, Patil SB (2019) Life cycle of an invasive fall armyworm, *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae) on sugarcane. Journal of Experimental Zoology 22(2):1185-1187.
- Murúa MG, Juárez ML, Prieto S, Gastaminza G, Willink E (2009) [Spatial and temporal distribution of *Spodoptera frugiperda* (Smith) (Lep.: Noctuidae) larval populations on different host plants in northern Argentina provinces] Distribución temporal y espacial de poblaciones larvarias de *Spodoptera frugiperda* (Smith) (Lep.: Noctuidae) en diferentes hospederos en provincias del norte de la Argentina [Spanish]. Rev ind agric Tucumán (Argentina) 86(1): 25-36.
- Samson RA, Evans HC, Latgé JP (1988) Atlas of Entomopathogenic Fungi. Berlin: Springer, pp. 1–187.
- Shylesha AN, Jalali SK, Ankita Gupta, Varshney R, Venkatesan T, Shetty P, Ojha R, Ganiger PC, Navik O, Subaharan K, Bakthavatsalam N, Ballal CR (2018) Studies on new invasive pest *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae) and its natural enemies. Journal of Biological Control 32(3):1-7.
- Singh MR (2019) All India Coordinated Research Project on Sugarcane, Technical Report

2018-2019: Entomology. ICAR-Indian Institute of Sugarcane Research, Lucknow, 84 p.

Srikanth J, Geetha N, Singaravelu B, Ramasubramanian T, Mahesh P, Saravanan

L, Salin KP, Chitra N, Muthukumar M (2018) First report of occurrence of fall armyworm *Spodoptera frugiperda* in sugarcane from Tamil Nadu, India. *Journal of Sugarcane Research* 8(2):195-202.