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Ankush Chormule

6th Grain Corporation, Pune,
Maharashtra, India

Naresh Shejawal

6th Grain Corporation, Pune,
Maharashtra, India

Sharanabasappa

Department of Entomology,
College of Agriculture,
University of Agricultural and
Horticultural Sciences,
Shivamogga, Karnataka, India

CM Kalleshwaraswamy

Department of Entomology,
College of Agriculture,
University of Agricultural and
Horticultural Sciences,
Shivamogga, Karnataka, India

R Asokan

Division of Biotechnology,
Indian Institute of Horticultural
Research (IIHR), Hessaraghatta
Lake (PO), Bangalore,
Karnataka, India

HM Mahadeva Swamy

Division of Biotechnology,
Indian Institute of Horticultural
Research (IIHR), Hessaraghatta
Lake (PO), Bangalore,
Karnataka, India

Correspondence

I. Ankush Chormule

6th Grain Corporation, Pune,
Maharashtra, India
ankushc@6grain.com

First report of the fall Armyworm, *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera, Noctuidae) on sugarcane and other crops from Maharashtra, India

Ankush Chormule, Naresh Shejawal, Sharanabasappa, CM Kalleshwaraswamy, R Asokan and HM Mahadeva Swamy

Abstract

Fall armyworm (FAW), *Spodoptera frugiperda* (J E Smith) is an economically important pest native to tropical and subtropical America has recently invaded India, causing more damage to maize and sorghum. It is a notorious pestiferous pest with high dispersal ability, wide host range, high fecundity makes the fall armyworm one of the most severe economic pests. Recently in the month of September its feeding on two months old sugarcane crop, variety (Co 86032) was noticed at Ghogaon village of Sangli District (Maharashtra). Other than sugarcane, it was also reported on maize, sorghum and sweet corn in different districts of Maharashtra. Infestation on sugarcane was less than 5 per cent in Sangli, Kolhapur and Pune districts. On sweet corn (Bhasagi village of Akkalakot Tq) it was 35 per cent. The natural enemies like *Campoletis chloridae* and *Noumuraea rileyi* activity was meager. This is the first report of fall armyworm incidence on sugarcane and on other crops from Maharashtra. It is evident from the phylogenetic tree that sugarcane fall armyworm is indeed belongs to 'corn' strain.

Keywords: Fall armyworm, *Spodoptera frugiperda*, sugarcane, maize, sorghum and sweetcorn

1. Introduction

Fall Armyworm, *Spodoptera frugiperda* (J E Smith) (Lepidoptera, Noctuidae) is native to the tropical and subtropical region of America. The pest has invaded Africa, with the first detections being reported in Central and Western Africa in early 2016^[1], and in late 2016 and 2017 in parts of Southern, Eastern and Northern Africa^[2]. Being a polyphagous pest known to cause major damage to economically important cultivated grasses such as rice, sorghum, and sugarcane as well as cabbage, beet, peanut, soybean, alfalfa, onion, cotton, pasture grasses, millet, tomato and potato^[3, 4, 5]. A total of 353 *S. frugiperda* larval host plants recorded belonging to 76 plant families, principally Poaceae (106), Asteraceae (31) and Fabaceae (31)^[6]. Within a short span of its introduction in Africa, FAW has been confirmed in over 43 African countries^[7]. In India, in the month of May 2018 pest was reported on maize for the first time from Karnataka, India^[8] and molecular diversity of fall armyworm, *Spodoptera frugiperda* was studied from different states of India indicated prevalence of R strain^[9]. In this paper we discuss the fall armyworm incidence on sugarcane and other crops from Maharashtra.

2. Materials and Methods

2.1. Species identification

Male genitalia was dissected and compared with earlier findings^[3, 10]. Dissection of male genitalia was performed with Zeiss-Stemi 508 stereo binocular microscope and imaged using a Leica M-205C Auto Montage stereomicroscope. Voucher specimen used and dissected genitalia in labeled micro vials with glycerin was housed at the Department of Entomology, College of Agriculture, UAHS, Shivamogga.

2.2. DNA extraction

Total genomic DNA was extracted from *S. frugiperda* larvae using the Cetyl Trimethyl Ammonium Bromide (CTAB) with some modification and was used for PCR analysis.

2.3 Incidence of fall armyworm in different districts

Roving Survey on the occurrence of *S. frugiperda* was conducted in different sugarcane, maize and sweet corn growing areas of Kolhapur, Pune, Sangli, Satara and Solapur districts of Maharashtra state covering 13 taluks from September – November 2018. In each field, twenty plants at 10 randomly selected spots were selected and observations on the number of plants damaged were recorded. Larvae were collected from different sugarcane fields and were brought to the laboratory, reared to adults and observed for diagnostic characters of *S. frugiperda*. The morphological characters of *S. frugiperda* done at Department of Entomology, College of Agriculture, Shivamogga. The molecular identification and confirmation of the fall armyworm was done at Indian Institute of Horticultural Research, Bangalore. The per cent plant infestation due to fall armyworm and natural enemies was recorded in each of the localities surveyed. We also added points, through remote sensing developed by 6th Grain Corporation, Pune and farmers were asked to give missed call to this number 022 - 4037579. When given missed call to this number, it will ask to take the picture of the field, farmers name, contact number, place and infestation level.

3. Results and Discussion

3.1. It was confirmed based on male genitalia dissection as *Spodoptera frugiperda*

3.2. Sequence analysis

Most fragments amplified from the MtCOI primer pairs aligned with their target reference sequence. All the search analysis results revealed that the analyzed species belong to *S. frugiperda*. Alignment of the *S. frugiperda* mtCOI sequences found no deletions or insertions and no stop codons, consistent with the amplified DNA arising from functional COI genes. By using the mitochondrial COI gene (Folmer region-658 bp consensus sequence) FAW collected from Kolhapur, Maharashtra on sugarcane, was identified molecularly. Sugarcane FAW MtCOI gene was cloned and sequenced. The comparison of the FAW MtCOI sugarcane sequence in triplicates did not show any differences, no sequencing errors, therefore. There was no evidence of nuclear copies in any of the analyzed sequences, supported by the absence of stop codons and with no indels, the base composition was similar. NCBI BLASTn results of sugarcane FAW mtDNA COI partial sequence results showed 99 percent homology to U72974, U72975 and U72976 designated Corn strain sequences with 97 per cent query coverage. Barcode of life (BOLD) database specimen identification results showed that *Spodoptera frugiperda* sp. 2 (100 per cent). The PCR analysis with the LCO/HCO primers detecting FAW sugarcane samples is of the “C” strain. This strategy enables the identification of FAW populations associated with sugarcane. The nucleotide data set for the Sugarcane FAW mtCOI DNA sequences shows no significant variation with respect to the so-called “corn” strain sequences U72974, U72975 and U72976. There was a significant nucleotide (14) variation with the U72977 of the designated “Rice” Strain. Nucleotide variations were found at the positions of 42 (C-A), 43 (T-A), 46 (T-G), 73 (A-G), 117 (A-G), 171 (C-T), 207 (A-T), 258 (T-C), 489 (C-T), 564 (C-T), 570 (T-C), 600 (T-C), 634 (C-T), and 663 (A-T). The Sugarcane FAW mtCOI gene nucleotide frequencies were 29.35% (Adenine), 40.60% (Thymine), 16.26% (Cytosine), and 13.79% (Guanine). The maximum composite likelihood (MCL) estimate of the pattern

of nucleotide substitution with overall transition/transversion bias is $R = 0.68$. There were 30 nucleotide sequences in the analysis. In the final data set, there were a total of 545 positions.

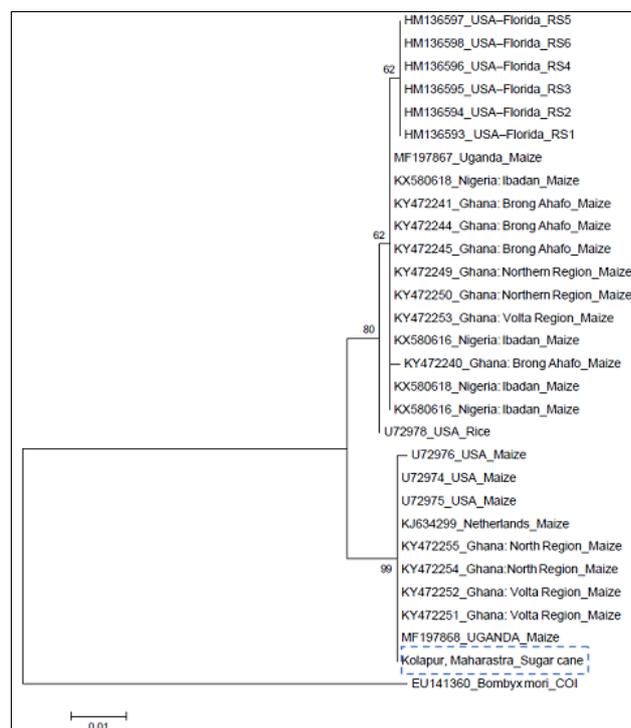


Fig 1: Sugarcane FAW, Kolhapur, Maharashtra, India's phylogenetic relationship was determined by 658 bp Mitochondrial cytochrome oxidase I (COI) sequence using Maximum Likelihood model Tamura-Nei (Tamura and Nei, 1993) Bootstrap values (1,000 replications) have collapsed in < 60 percent replicates and the bootstrap values are displayed at the branch points. For the respective reference sequence, the Gen Bank accession numbers are indicated. The analysis included 30 nucleotide sequences, with a total of 545 positions in the final data set.

We also made a phylogenetic assessment of the maximum likelihood method. ML phylogenetic tree built using all publicly available authenticated NCBI GenBank and BOLD database sequences (BankIt2175715 Seq1 MK295625). The support of the branch was estimated by bootstrap analysis (1000 replicates). The MtCOI nucleotide sequence of *Bombyx Mori* (NCBI Accession number EU141360) was used as a group. For Sugarcane FAW from Kolhapur, Maharashtra, India, two distinct and well supported clades were inferred. First clade consists of all the specimens that have been assigned to the ‘rice’ strain. Sugarcane MtCOI sequence is clustered with the all the specimens assigned as ‘corn’ strain. From our study it showed from the phylogenetic tree that sugarcane FAW is indeed belongs to ‘corn’ strain (Fig 1).

3.3. Incidence of fall armyworm in different Districts

The fall armyworm incidence on sugarcane was first recorded on 22 September 2018 in the Ghogaon Village of Palus Taluka of Sangli District on 60 days old Sugarcane cultivar Co 86032 with an infestation up to 5 per cent. On sugarcane, FAW feeds on leaves, made characteristic irregular windows on leaf and moist sawdust-like frass in the form of lumps. This easily helped the farmers to locate the larvae (Plate 1 and 2) During our roving survey and from remote sensing, 11 taluks from five districts of Maharashtra were studied for the incidence of fall armyworm *S. frugiperda* (Table 1). The

points raised by our team and farmers indicated its distribution in Maharashtra. Among different districts surveyed, the infestation of fall armyworm ranged from 2.00 to 35 per cent in different crops (Fig.2). Among these, maximum cent per cent incidence was observed on sweet corn

than maize, sorghum and sugarcane. However, lowest per cent plant infestation was observed in sugarcane which ranged from 2-5 per cent in Sangli, Pune and Kolhapur districts. Fall armyworm completes its life cycle when it feed on sugarcane leaf bit under laboratory conditions [11].

Table 1: Incidence of *Spodoptera frugiperda* on sugarcane and other crops in Maharashtra

| Districts | Tehsil | Village | Crop | Variety/Hybrid | Month | Stage of the crop | Level of infestation | Natural enemies recorded |
|-----------|-----------|--------------|------------|----------------|----------------|-------------------|----------------------|-----------------------------|
| Solapur | Malshiras | Tandulwadi | Maize | Advanta 751 | 20 August 2018 | 40 days | 20% | <i>Campoletis chloridae</i> |
| | Begampur | Begampur | Maize | local | 29 Sept 2018 | 30 days | 15% | -- |
| | Akkalkot | Bhasagi | Sweet-corn | Bioseed 4043 | 22 Sept 2018 | 30-40 days | 35% | <i>Campoletis chloridae</i> |
| | Mahud | Mahud | Maize | -- | 29 Sept 2018 | 40 days | 10% | -- |
| Sangli | Palus | Ghogaon | Sugarcane | Co-86032 | 22 Sept 2018 | 60 days | 5% | -- |
| | Palus | Hajarwadi | Sugarcane | Co-86032 | 27 Oct 2018 | 70 Days | 2% | -- |
| | Khanapur | Balawadi | Maize | local | 6 Oct 2018 | 50 days | 20% | <i>Nomuraea rileyi</i> |
| | Khanapur | Balawadi | Sugarcane | Co-86032 | 6 Oct 2018 | 70 days | 2-5% | - |
| | Walawa | Walwa | Sugarcane | Co-86032 | 13 Oct 2018 | 75 days | 3% | -- |
| | Walawa | Aitwade Bk. | Sorghum | Maldandi | 28 Nov 2018 | 50 Days | 10% | -- |
| Kolhapur | Karveer | Vasagade | Sugarcane | Co-86032 | 19 Oct 2018 | 80 days | 2% | -- |
| | Kagal | Vannur | Sugarcane | Co-86032 | 10 Oct 2018 | 45 days | 2% | -- |
| | Kagal | Vannur | Sorghum | Maldandi | 26 Oct 2018 | 30 days | 3% | <i>Nomuraea rileyi</i> |
| Pune | Baramati | Khamgalwadi | Sugarcane | Co-86032 | 28 Oct 2018 | 65 days | 3% | -- |
| | Baramati | Morgaon | Maize | African Tall | 28 Oct 2018 | 35 days | 2% | -- |
| | Haveli | Uralikanchan | Maize | African Tall | 30 Oct 2018 | 40 days | 4% | -- |
| Satara | Karad | Antwadi | Sorghum | Local | 18 Nov 2018 | 40 days | 10% | -- |
| | Vaduj | dharuj | Maize | -- | 23 oct 2018 | 30 days | 5% | -- |

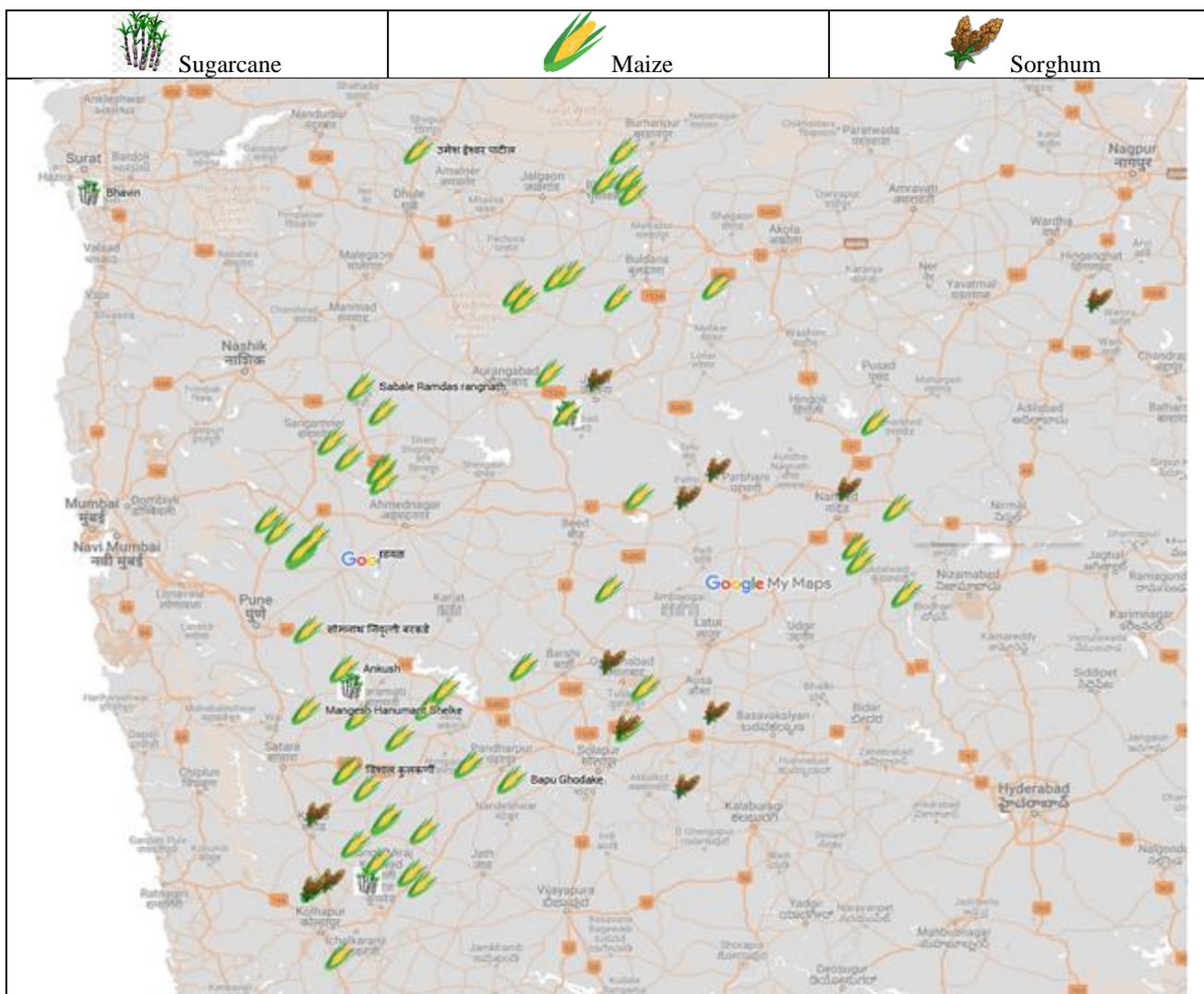


Fig 2: Distribution of fall armyworm on different crops from Maharashtra



Plate 2: Feeding of fall armyworm larva on leaf



Plate 3: General view of infested plant

4. Conclusion

During the survey, we observed maize intercropping in sugarcane. This may act as a predisposing factor for the FAW incidence on sugarcane as the larva shift from maize to sugarcane after 40 to 50 days. FAW incidence on maize was noticed up to 60 days and there after it gets reduced. The intercropping of maize with sugarcane should be avoided thereby blocking the multiplication for further generations. In the early stage of cane regular watching is necessary for its incidence and management. The further investigations on biochemical analysis leaf and its effect on biology of FAW need to be studied.

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