



Research Note

Occurrence of fall armyworm, *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae), in Chittoor district of Andhra Pradesh, India with a note on rove beetle as its potential natural enemy

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ABSTRACT: The occurrence of fall armyworm, *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae) in maize fields of Tirupati region, Andhra Pradesh is herewith reported. Field surveys in maize fields revealed that the rove beetle, *Paederus fuscipes* Curtis (Coleoptera: Staphylinidae) was found predated the larvae of fall armyworm and this is the first report of *P. fuscipes* on fall armyworm from India. The species identity of both fall armyworm and the rove beetle was confirmed through molecular studies by amplifying cytochrome oxidase I gene (CO1) and DNA barcoding.

KEY WORDS: Fall armyworm, invasive pest, maize, *Paederus fuscipes*, predator

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Maize (*Zea mays* L.) is the most important cereal crop after wheat and rice, grown virtually in every suitable agricultural region of the world. It has been referred as “Queen of Cereals” due to its highest yield potential among the cereals. Maize is one of the principal food crops of the country and because of its diverse uses in the feed, industry and food sectors, maize is considered as an internationally important commodity driving world agriculture. In India, it is cultivated in an area of 9633.20 thousand ha with a production of 25899.87 thousand tonnes and productivity of 2689 kg ha⁻¹ whereas in Andhra Pradesh, it is cultivated in an area of 250.00 thousand ha with a production of 1653.00 thousand tonnes and productivity of 6612 kg ha⁻¹ during 2016-17 (www.indiastat.com). Maize has wide ecological adaptability and is grown in almost all parts of the country, though Andhra Pradesh, Karnataka, Maharashtra, Bihar, Tamil Nadu, Madhya Pradesh, Rajasthan, Telangana and Uttar Pradesh are the major maize producing states.

Insect pests are posing a major threat to maize crop due to its high susceptibility throughout the crop duration. The recently reported invasive fall armyworm, *Spodoptera frugiperda* (J.E. Smith) in India is emerging as major pest and causing extensive damage to maize crop. Fall armyworm, *S. frugiperda* (Lepidoptera: Noctuidae) originated from the Western hemisphere from United States was reported as an invasive pest in central and western Africa (Goergen and Tam, 2016) during 2016, where it was initially detected in Benin, Nigeria, Sao Tome, Togo and the pest since then has spread to at least 20 other countries in sub-Saharan Africa (Day *et al.*, 2017). In Asia, it was first reported in Karnataka, India during 2018 (Sharanabasappa *et al.*, 2018 and Shylesha *et al.*, 2018).

Regular monitoring of the maize crop at College dryland farm of S. V. Agricultural College, Tirupati in 2018 revealed the occurrence of *S. frugiperda* damaging the maize plants. The occurrence of *S. frugiperda* was first observed during

first week of August, 2018 on sweet corn (cv.Sugar-75). So, a surveillance study has been taken up in and around Tirupati, Chittoor district, Andhra Pradesh to survey the maize growing areas for fall armyworm incidence.

Roving surveys were conducted on the occurrence of *S. frugiperda* and its natural enemies in maize crop at S.V. Agricultural College, Tirupati and Chandragiri mandal of Chittoor district in Andhra Pradesh. The larvae and associated insects were collected from dryland farm, S.V. Agricultural College, Tirupati and Pathasanambatla village, Chandragiri mandal, Chittoor dt, A.P.

The collected larval specimens were brought to the laboratory and reared till adult emergence. Few larvae were preserved in alcohol and sent to ICAR-National Bureau of Agricultural Insect Resources (NBAIR), Bengaluru for morphological and molecular identification. The larvae were identified as *Spodoptera frugiperda* morphologically based on the identification guides available and was also subjected to molecular identification through mitochondrial cox 1 gene sequencing.

Along with the fall armyworm, rove beetles were found in the maize crop, which have been collected and sent to ICAR-NBAIR for identification.

Molecular identification of *Spodoptera frugiperda* and rove beetle

The field collected larvae of *S. frugiperda* were placed in 1.5 ml micro centrifuge tubes separately. Also the rove beetle was placed in 1.5 ml micro centrifuge tube for DNA extraction. Genomic DNA was isolated by using DNA extraction kit (QIAGEN DN easy blood and tissue kit Cat. 69504, Germany).

DNA extraction was performed on single specimen using Qiagen DNeasy® kit, following the manufacturer's protocols. The remaining individuals of same species were kept as voucher specimens at -70°C in ICAR-NBAIR, Bengaluru. DNA thus obtained was subjected to PCR amplification of a 658 bp region near the 5' terminus of the COX1 gene following standard protocol (Hebert *et al.*, 2003). Primers used for amplification of CO1 gene were: forward primer (LCO 1490 5'-GGTCAACAAATCATAAAGATATTGG-3') and reverse primer (HCO 2198 5'-TAAACTTCA GGGTGACCAAAAATCA-3'). Polymerase Chain Reaction were carried out in flat capped 200 µL volume PCR tubes obtained from M/s Tarsons, Kolkata, India. 50 µL reaction volume contained: 5 µL GeNei™ Taq buffer, 1 µL GeNei™ 10 mM dNTP mix, 1 µL (20 pmol/µL) forward primer, 1 µL (20 pmol/µL) reverse primer, 1 µL GeNei™ Taq DNA polymerase (1 U/µL), 5 µL DNA (50 ng/µL), and

36 µL sterile water. Thermo cycling consisted of an initial denaturation of 94°C for 5 min, followed by 30 cycles of denaturation at 94°C for 1 min, annealing at 45°C for 1 min, extension at 72°C for 1 min. PCR was performed using a BioRad C1000™ Thermal Cycler. The amplified products were analysed on 1.5% agarose gel electrophoresis as standard protocol. The amplified products were sequenced by M/s Chromous, Bengaluru. Each specimen PCR sample was bi-directionally sequenced and checked for homology, insertions and deletions, stop codons, and frame shifts by using NCBI-BLAST and ORF finder. The COI generated consensus sequences have been deposited in NCBI GenBank database (Benson *et al.*, 2005).

Incidence

The incidence of *Spodoptera frugiperda* in maize crop ranged from 20 to 25 per cent at Dryland farm, S. V. Agricultural College, Tirupati and 40 to 50 per cent (Table 1) at Pathasanambatla village, Chandragiri mandal, Chittoor district of Andhra Pradesh. The number of larvae per plant ranged from 1 to 3. In maize, the infestation was found on leaves, tassel, whorls and cobs on which the cream colour frass was visible in the form of pellets. Due to feeding of the larvae on central whorl of the leaves, small holes and window pane feeding was observed (Fig. 1). Only one larva is usually present feeding in the leaf whorl. The larvae were also found feeding on the tassels and tender cobs damaging it with its faecal pellets (Fig. 2). The fall armyworm larvae possessed a white inverted "Y" shaped mark on the dark brown head and had four dark spots arranged in a square on dorsal surface of the 8th abdominal segment (Fig. 3). As they matured, the larvae changed from light green to dark brown. When feeding, larvae excrete big lumps that are visible on leaf surfaces.

The fall armyworm collected from the Tirupati region was identified as *Spodoptera frugiperda* through molecular mitochondrial Cox 1 gene sequencing (Fig. 4). In order to compare our isolated sequence with available database sequences, we referred to BOLD (<http://v4.boldsystems>).



Fig. 1. Larvae of *Spodoptera frugiperda* feeding on maize leaves

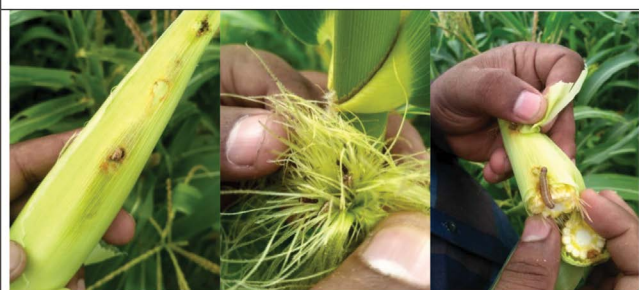


Fig. 2. Larvae of *Spodoptera frugiperda* feeding on maize tassel and cobs



Fig. 3. Late instar larvae of *Spodoptera frugiperda*

Table 1. Collection locality and incidence of *Spodoptera frugiperda* and *Paederus fuscipes*

| Species | Locality | Incidence (%) |
|------------------------------|--|---------------|
| <i>Spodoptera frugiperda</i> | S. V. Agricultural College, Tirupati, Andhra Pradesh 04.viii. 2018 (13°37' N 79°25' E) | 20-25 |
| <i>Spodoptera frugiperda</i> | Chandragiri, Tirupati, Andhra Pradesh 05.viii. 2018 (13°37' N 79°25' E) | 40-50 |
| <i>Paederus fuscipes</i> | Chandragiri, Tirupati, Andhra Pradesh 05.viii.2018 (13°37' N, 79°25' E) | 5-7 |

org/) to download COI sequences of *S. frugiperda* (Accession No.MN26474). The larval population of *S. frugiperda* from Tirupati showed 100% resemblance with the sequences submitted from Kenya (GenBank: MH190445.1) and Uganda (GenBank: MF197867.1). The predatory population of *P. fuscipes* (MH916764) from Tirupati showed 99% resemblance with the sequences submitted from Korea (GenBank: KU188413.1).

MN26474 *Spodoptera frugiperda* strain, Tirupati, Andhra Pradesh

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CCACCTCCTGAAGGGTCTGAAGAATGAAGTATT
TAAATTTTCGATCTGTTAATAATATTGTAATTGCTCCA
GCTAAAACTGGTAATGAAAGAAGTAACAATAAAGC
AGTAATTGCAACTGATCAAACAAATA ATGGTATTT
GTTTCGTATGATATGTTTCTTGCTCGTATATTTAAAGC
TGTAGTAATAAAATTAATTGCACCTAAAATTGATGA
AATACCAGCTAAATGAAGTCTAAAATAGCAAGATC
AACAGAAGATCCGTTATGGAATGCATTTGATGACAG
AGGAGGGTACACTGTTTCATCCTGTTCCAGCACCATT
TTCTACTATTCTTCTTATCAATAAAAGTGTTAAAGCT
GGGGGTAACAATCAAATCTTATGTTGTTTATTTCGA
GGGAAAGCTATATCAGGGGCTCCAAGTATTAAGG
GACTAATCAATTACCAAATCCCCCAATTATAATAGG
TATAACTATGAAAAAATCATAATGAATGCATGAGC
TGTTACAATAACATTATATATTTGGTCATCCCCAATT
AATGAACCTGGGGTTGCTAATTCAGCTCGAATTAG
TAAACTTAATGATGTTCTACTATTCTGATCATGCT
CCAAAATAAAGTATAATGTTCCAATATCTTATGTG
TGGGTTGAATTAT
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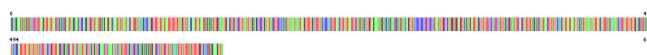


Fig. 4. Barcode image of *Spodoptera frugiperda*

Natural enemy of *Spodoptera frugiperda*

The rove beetles were found predated on the larvae of fall armyworm in the maize fields. The beetle sent to ICAR-NBAIR for identification has been identified as *Paederus fuscipes* (Fig. 5) belonging to Staphylinidae of Coleoptera. This is the first report of rove beetle, *Paederus fuscipes* identified as a predator on larvae of *S. frugiperda*. Clark (1993) reported that carabid beetles, rove beetles along with spiders and ants as important predators of fall armyworm in reduced-tillage maize fields in Florida, USA.

>MH916764 *Paederus fuscipes* strain Tirupati, Andhra Pradesh

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CCACCTCCTGAAGGGTCTGAAGAATGAAGTATTT
AAAT TTCGATCTGTTAATAATATTGTAATTGCT CCAG
CTAAAACTGGTAATGAAAGAAGTAACAATAAAGCA
GTAATTGCAACTGATCAAACAAATA ATGGTATTTGT
TCGTATGATATGTTTCTTGCTCGTATATTTAAAGCTG
TAGTAATAAAATTAATTGC ATGGTATTTGTTTCGTATG
ATATGTTTCTTGCTCGTATATTTAAAGCTGTAGTAATA
AAATTAATTGCACCTAAAATTGATGAAATACCAGCTA
AATGAAGTCTAAAATAGCAAGATCAACAGAAGATC
CGTTATGGAATGCATTTGATGACAGAGGAGGGTACA
CTGTTTCATCCTGTTCCAGCACCATTTTCTACTATTCT
TCTTATCAATAAAAGTGTTAAAGCTGGGGGTAACAA
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TCAAAATCTTATGTTGTTTATTCGAGGGAAAGCTATA
 TCAGGGGCTCCAAGTATTAAGGGACTAATCAATTA
 CCAAATCCCCCAATTATAATAGGTATAACTATGAAAA
 AAATCATAATGAATGCATGAGCTGTTACAATAACATT
 ATATATTTGGTCATCCCCAATTAATGAACCTGGGGTT
 GCTAATTCAGCTCGAATTAGTAACTTAATGATGTTCT
 TACTATTCCTGATCATGCTCCAAAAATAAAGTATAA
 TGTTCCAATATCTTATGTGTGGGTTGAATTAT



Fig. 5. Barcode image of *Paederus fuscipes*

The predatory potential of rove beetle, *P. fuscipes* on fall armyworm needs to be ascertained further and measures to be taken to conserve the same in maize ecosystem. Shylesha *et al.* (2018) reported a wide range of natural enemies viz., egg, larval parasitoids and earwig, *Forficula* sp. occurring naturally along with *S. frugiperda* in Karnataka. So, regular surveillance and monitoring of this invasive pest, *S. frugiperda* in different areas for record of natural enemies is warranted to check the pest at its initial stage through all compatible agro-ecological management strategies.

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