First report of fall army worm, *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae) on maize (*Zea mays*) from Madhya Pradesh, India

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Abstract

In recent times, India is witnessing a huge damage in maize crop due to attack of an invasive polyphagous pest i.e. Fall army worm, which has been first reported from Shivamogga district of Karnataka in May 2019. Now, it has expanded and stretched across the different states of the country and has also been observed in few areas / pockets of Jabalpur, Dhar and Indore districts of Madhya Pradesh. The insect samples collected from these places resembled the morphological characters of Fall army worm, *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae), as reported by various scientists, which confirms the presence of the pest in the state, and in the near future it may create a massive havoc for the maize growers of Madhya Pradesh.

Keywords: Fall army worm, *Spodoptera frugiperda*, maize, Madhya Pradesh

Introduction

This communication records Fall army worm, *Spodoptera frugiperda* (J.E. Smith) (Lepidoptera: Noctuidae), as a new invasive pest on maize (*Zea mays* L.) with some preliminary observations. The Fall armyworm (FAW) is a highly voracious polyphagous pest (Murua et al., 2009) [7], native to tropical and subtropical regions of USA, which is mainly reported from primary host maize but it has also been reported from other secondary hosts like rice, sorghum, sugarcane and many vegetables (Abrahams et al., 2017 and Day et al., 2017) [1, 3]. Its infestation in the maize crop can be seen in both the vegetative and reproductive stages, causing yield losses ranging from 15 - 73% (Hruska and Gould, 1997) [5]. During vegetative stage, the first two instars feed gregariously on the underside of young leaves causing the characteristic skeletonizing or ‘windowing effect’ and the later instars feed and move deep inside the whorls, thus killing the growing point, whereas during the reproductive stage of the crop, the larvae are found to bore in the cob which are filled with frass (Luginbill, 1928) [6]. The explosive spread and dispersal of *S. frugiperda* can be attributed to the human aided transport and natural migration as it has the ability to fly hundreds of kilometers in one windy night. Moreover, the short developmental cycle and high fecundity of *S. frugiperda* is also adding to its invasivity (www.iita.org) [12].

In India, FAW was first reported from the maize fields at College of Agriculture (UAHS), Shivamogga, Karnataka on 18th May 2019 (Sharanabasappa et al., 2018b) [11]. Now, it has expanded and stretched across the states of Andhra Pradesh (Venkateswarlu et al., 2018) [14], Bihar (Sarfaraz et al., 2018) [9], Chhattisgarh (Deole and Nandita, 2018) [4], Karnataka (Sharanabasappa et al., 2018b) [11], Tamil Nadu (Srikanth et al., 2018) [12] and Maharashtra (Chromule et al., 2019) [2]. Recently, FAW has also been observed from tank area and engineering fields of JNKVV, Jabalpur (23.16°N and 79.93°E), Badwi and Dhamnod villages of Dhar district (22.82°N and 75.47°E) of Madhya Pradesh.

During field survey the FAW larvae were found feeding on the maize crop. It can be visualized that the FAW may become a serious pest for many other crops of economic importance in due course of time.
Therefore it was thought pertinent to study its life cycle on maize under in vitro conditions, to figure out every detail about the biology and behaviour of FAW.

Materials and Methods
The present study was conducted in the Biocontrol Research & Production Centre, Department of Entomology, Jawaharlal Nehru Agricultural University, Jabalpur (M.P.). Survey for the occurrence of FAW was made in the maize growing areas of Madhya Pradesh. It was carried out on 50 plants randomly selected per spot and ten such spots per field were observed. Estimation of leaf damage was done by counting the damaged leaves per plant. The larvae of FAW were collected from a number of locations in Jabalpur, Indore and Dhar districts of M.P. (Table 1) and reared under laboratory conditions as per the methodology suggested by Santos et al. (2003) [9].

S. frugiperda adults was kept in breeding jars for egg laying. The breeding jars were covered with muslin cloth and wet cotton so as to maintain proper humidity. Maize leaves were kept as food every day for different larval stages of S. frugiperda to keep them alive. The duration of instars of S. frugiperda was recorded by observing exuvium shed after each moult. Observations were recorded on various developmental periods viz., pre oviposition period, oviposition period, adult longevity and fecundity during the course of investigation. The colours of the various stages were also observed.

Results & Discussion
The insect was identified as per the key characteristics mentioned by Sharanabasappa et al. (2018a) [10] and confirmed as FAW.

Eggs: S. frugiperda laid eggs on the maize leaves, inner walls of the jars and on the cloth that covered the breeding jars. The oviposition period ranged from 2 to 5 days with a mean of 3.5 days. The eggs were laid in mass of 19 to 150 eggs in 1 to 2 rows. The average fecundity per female was 939 eggs which was slightly lower than that reported by Sharanabasappa et al. (2018b) [11]. The incubation period lasted for 2-3 days which corroborates with the findings of Sharanabasappa et al. (2018b) [11]. The eggs were dome shaped, slightly greenish in colour, but prior to hatching they turned shiny cream white or greyish (Table 2 and 3) (Plate 1). The mean post ovipositional period was 3.5 days and it ranged from 3 to 4 days which was slightly lower than that reported by Sharanabasappa et al. (2018b) [11] (mean 4.30 days). The variation in the ovipositional behavior of FAW moth might be attributed to differences in temperature, humidity, photoperiod and light intensity (Luginbill, 1928) [6]. Therefore, the variations reported in present findings from that of previous authors may be attributed to the changed climatic condition, photoperiod duration, nutritional intakes and light intensity.

Larvae: The larvae underwent five moultings resulting into six morphologically distinguishable instars. The first, second, third, fourth, fifth and sixth stadium lasted for 1.5-3, 2-3, 2-4, 2-4 and 4-6 days with an average of 2.25, 2.5, 2.5, 3.0, 3.0 and 5.0 days, respectively. The total larval period varied from 13.5 to 23 days with an average of 18.25 days. The present findings were in conformity with the findings of Luginbill (1928) [6] and Sharanabasappa et al. (2018b) [11]. Immediately after hatching, the neonate larvae aggregated to form a group on or near egg mass to disperse after 1-2 days (Table 2). Initial instars (first to third instar) exhibited orange to reddish colour but as the development progressed, the colour of larvae changed to black with some reddish patches in the abdomen and four dark coloured pinnaculae arranged in a square on dorsal 8th and 9th segment became clearly visible from fourth instar onwards (Table 3) (Plate 2).

Pupae: The pupal period varied from 9 to 11 days with a mean of 10.00 days and is in accordance with the findings of Santos et al. (2003) [6] and Deole and Nandita (2018) [4] (Table 2) (Plate 3). Sexual dimorphism was observed in the pupal stage which was differentiated and identified as per the characters mentioned in Table 3.

Adults: The adults were pale brownish in colour (Plate 4). The male moths were smaller in size as compared to females. Moreover, they can be distinguished on the basis of the spots and patches present on their forewings (Table 3). The longevity of male and female moth ranged from 7-9 days and 8-13 days with an average of 8.0 and 10.5 days, respectively. Similar findings have been reported by Sharanabasappa et al. (2018b) [11] (8.20 and 10.80 days for male and female moths). Whereas, findings of Deole and Nandita (2018) [4] contradicted from the present findings, as they reported shorter longevity of moths i.e. 5 to 7 days. The differences in duration of various life stages of S. frugiperda and a slightly extended life span on whole when compared to the studies done by Sharanabasappa et al. (2018b) [11] might be due to changed climatic condition and nutritional value of different hosts.

Extent of damage: The overall mean plant and leaf damage in western Madhya Pradesh ranged from 0.7 to 49.9% and 25.4 to 65.2% with an average of 9.51% and 33.22%, respectively. Plant and leaf damage was found to be highest in the fields of Dhar district (13.8 and 46.60%, respectively), followed by Jabalpur district (11.65 and 28.75%, respectively) and minimum in Indore district (3.1 and 26.6%, respectively) (Table 1).

Table 1: Status of FAW on Maize in three districts of Madhya Pradesh

| Districts | Latitude & Longitude (Ft above mean sea level) | Date of observation | Plant damage (%) | Leaf damage (%) |
|-----------|-----------------------------------------------|---------------------|------------------|-----------------|
| Jabalpur  | 23.16°N 79.93°E                              | 30-03-2019          | 11.65            | 0.0 – 26.7      |
| Indore    | 22.80°N 75.73°E                              | 02-04-2019          | 3.10             | 0.7 – 7.4       |
| Dhar      | 22.22°N 75.47°E                              | 26-03-2019          | 13.80            | 10.8 – 49.9     |

http://www.entomoljournal.com
Table 2: Biological parameters of *S. frugiperda* reared on maize

| Parameters                      | Duration (in days) |   |
|--------------------------------|--------------------|--|
| Pre oviposition                | Range: 3-4         | Mean: 3.5 |
| Oviposition                    | Range: 2-5         | Mean: 5.5 |
| Post oviposition               | Range: 3-4         | Mean: 3.5 |
| Incubation                     | Range: 2-3         | Mean: 2.5 |
| 1st instar larva               | Range: 2.5-3.5     | Mean: 3.5 |
| 2nd instar larva               | Range: 3-4         | Mean: 3.5 |
| 3rd instar larva               | Range: 4-6         | Mean: 5.0 |
| 4th instar larva               | Range: 2-3         | Mean: 2.5 |
| 5th instar larva               | Range: 2-3         | Mean: 2.5 |
| 6th instar larva               | Range: 2-3         | Mean: 3.5 |
| Total larval period            | Range: 13.5-23     | Mean: 18.25 |
| Pupa                           | Range: 9-11        | Mean: 10.0 |
| Male longevity                 | Range: 7-9         | Mean: 8.00 |
| Female longevity               | Range: 8-13        | Mean: 10.5 |
| Total life cycle (Male)        | Range: 33-46       | Mean: 39.5 |
| Total life cycle (Female)      | Range: 34-50       | Mean: 42.0 |

Temp. 25 ± 5 °C and RH 70 ± 10%

Table 3: Morphological characters of different immature and adult stages of *S. frugiperda*

| Stage                  | Morphological characters                                                                 |
|------------------------|------------------------------------------------------------------------------------------|
| Egg                    | Slightly greenish in colour, prior to hatching turned shiny cream white or greyish        |
| First instar Larva     | Light yellow in colour with two black colored setae per segment                           |
| Second instar Larva    | Light gray in color and no. of setae per segment varied between 2-4                       |
| Third instar Larva     | Brownish in colour on dorsal surface and dark grey on the ventral side with 4 setae per segment |
| Fourth instar Larva    | Same as third instar but larger in size, inverted Y-shape yellow colour mark on head and four dark coloured pinnaculæ arranged in square on dorsal 8th and 9th segment becomes clearly visible |
| Fifth instar Larva     | Same as fourth instar but with more vigour                                              |
| Sixth instar Larva     | Same as fifth instar but larger in size                                                |
| Pupa                   |                                                                                         |
| Male                   | Distance between genital opening and anal slot is less                                   |
| Female                 | Distance between genital opening and anal slot is more                                   |
| Adult moth             |                                                                                         |
| Male                   | Forewings light brown and straw in color White blotch mark near the tip of each forewing is more pronounced. |
| Female                 | Forewings dark brown with light and dark markings White blotch mark is not very much clear in appearance. |

Plate 1: Egg stage of *S. frugiperda*
Conclusion
The insect samples collected from Jabalpur, Indore and Dhar districts in Madhya Pradesh resembled the morphological characters of Fall army worm, *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae), as being reported by various scientists, which confirms the presence of the pest in the state, which may emerge as a metastasizing nuisance for the maize growers of Madhya Pradesh. Moreover, due to its polyphagous and sturdy nature, it may become a potential threat for other crops too, thus, putting the whole agriculture production and food security of the state at stake. So, more and more concern must be drawn towards efficient management and control of this pest by developing suitable IPM module and identifying the efficient chemical control measures.

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