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A survey on fall armyworm, *Spodoptera frugiperda* (Lepidoptera: Noctuidae, J.E. Smith) in maize crop in northern hill zone of Chhattisgarh

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Abstract

A field survey was conducted on fall armyworm (FAW) to know the presence and infestation by the caterpillar of fall army worm on maize crop during August 2019 in northern zone of Chhattisgarh. The survey was undertaken of this invasive pest in twenty six villages of seven blocks of two Districts Surajpur and Surguja in 202.2 hectares. The caterpillar was observed feeding on mid portion (Leaf whorl) of the maize crop from 4-6 leaves stages with 25-30 and 30-35 per cent infestation, in knee high stage 65-70 per cent and tassal stage respectively. In seven blocks Mainpat (6.2 ha, 03 villages, 30-35 % damage), Batauli block (4.0 ha, 01 village, 30-35 % damage), Lundra (6.0 ha, 01 village 30-35 % damage), Lakhanpur at tasseling stage (20.0 ha, 05 villages 75-80% damage), Udaipur at knee high stage (140.0 ha, 04 villages, 75-80 % damage), Ambikapur at knee high stage (17.0 ha, 08 villages, 60-65 % damage) and Surajpur at knee high stage (9.0 ha, 04 villages, 70-75% damage) respectively.

Keywords: Fall armyworm, *Spodoptera frugiperda*, maize, survey, northern hill zone of Chhattisgarh

Introduction

Maize (*Zea mays* L.) is a cereal crop which is cultivated widely throughout the world and has the highest production among all the cereals. *Zea* is an ancient Greek word which means “sustaining life” and *Mays* is a word from Taino language meaning “life giver.” Because of its high potential yield among the cereals crops globally its, also known as “queen of cereal”. It is an important staple food in many countries and is also used in animal feed and many industrial applications. It plays a significant role in human and livestock nutrition world-wide. Maize is the third most important crop among the cereal crops grown in India. Presently it occupies 8.69 million hectare area and produces around 28.75 MT of maize Sujay Rakshit and Chikkappa G.K., 2018 [17]. In Chhattisgarh it occupies of 1.93 lakh hectare area and production and productivity are 489.48MT and 2.536 MT respectively Anonymous 2019 [3]. Maize grain is gaining popularity in our country due to huge demand, particularly for poultry feed industry. Besides, maize has diversified uses as food and industrial raw materials. Maize acreage and production have an increasing tendency with the introduction of hybrids due to its high yield potential but at the same time these attracts the incidence of so many insect pests.

Maize crop is attacked by several insect pests but a new invasive pest was observed in maize crop in this region *i.e.* Fall armyworm, *Spodoptera frugiperda* (J.E.Smith, 1797) (Lepidoptera-Noctuidae) native of Americas. Besides maize it also feed on soybean, cotton, beans Pogue 2002 [14], Nagoshi *et al.* 2007 [13], Bueno *et al.* 2010 [5] rice other grasses and number of weeds Nabity *et al.* 2011 [12].

The caterpillar is damaging stage of this pest. It has been observed that 1st and 2nd instar of FAW larvae feeding habit is just scarping on leaf surface. After that once the larva enters in 3rd and 4th instar, its feeding causes ragged-edged round to oblong holes on leaves. Extensive leave damage was recorded during its 5th and 6th instars because of its voraciously feeding habit. After that pupation take place inside the soil, 6-7cm depth. Then it completes its life cycle 30-35 days. The caterpillar can be identify with a white inverted “Y” mark on the front of the dark head. The moth is a strong flier can fly over 100 km for search the host plants. The male moth has two characteristics markings *viz.*

fawn colored spot toward the centre and a white patch at the apical margin of forewing while the forewing of female insects is dull with faint markings. The incidence of this pest was first observed in Shivamogga, Karnataka on 18th May 2018. FAW was later reported in different maize growing areas like, Madhya Pradesh, Odisha, Bihar, West Bengal, Chhattisgarh and other different states Anonymous, 2019 [4]. In Chhattisgarh this insect was first reported in farmer field of Bastar region then Raipur. Surveillance of these insect is recorded on Surguja region in different blocks of Ambikapur, Lakhanpur, Udaipur, Lundra, Mainpat, Batauli and Surajpur. Survey for the occurrence of *Spodoptera frugiperda* were undertaken in different maize growing areas. An attempt was made in each place collected and visually observed the caterpillar put it in Entomology laboratory, it reared and identified the pest with the help of scientists working on AICRP on maize at this station and literature. In the infested field feeding injury in the leaf whorl and the presence of fresh frass were used to identify the presence of *S. frugiperda* larvae.

Materials and Methods

The survey was undertaken on fall armyworm in maize crop at different blocks of Northern Hill Zone of Chhattisgarh to study the abundance and damage done by fall armyworm in maize crop. For the survey a committee was formed of agriculture college scientists, scientists of Krishi Vigyan Kendra and officers of agriculture and biotechnology department of Surguja district. The committee members were visited the different blocks of Surguja district i.e. Ambikapur, 8-villages- 17.0 ha, Lundra 01 village, 6.0 ha, Lakhanpur 5 villages, 20.0 ha, Mainpat, 03 villages, 6.2 ha, Batauli 01 village, 4.0ha, Udaipur-04 villages, 140.0 ha and Surajpur -04 villages, 9.0 ha (Total 26 villages and 202.2 ha) respectively. The farmers were advised to use the pheromone trap, deep ploughing in summer, bird perches like conserve the bio agents, utilize the bio agents and chemical control for this invasive pest. Geographically Ambikapur is located at 23°12'N 83°2'E average elevation of 623 meter (2078 feet).

Survey of fall armyworm

Survey can be grouped in two groups first is qualitative and second is quantitative. Quantitative survey provides information on the damaging potential of a species and data can be used to predict future population trends. It provides the decision making for adopting control measure for a pest by the farmers.

Rapid/ Roving survey was undertaken to assessment of pest population or damage from randomly selected spots in a short period of time over a large area. It provides information on pest level which helps in determining the timing of adopting appropriate control measures. It made to monitor the initial development of pests in endemic areas in the beginning of crop season. Based on these surveys the farmers are instructed to monitor the pest incidence in their respective fields by the agriculture extension specialists.

The main aim of survey was to provide the knowledge and awareness about the fall armyworm in maize growing areas how the farmers can manage this pest before reaching the economic injury level what is the role of four stages (egg, larva, pupa and adult) of this pest. Larva/caterpillar was the damaging stage of this pest feeding on the leaf whorl at day and night time, pupa was inactive and adult was responsible for new generation.

Collection and Sampling of FAW (Fall armyworm)

The infested maize plots were randomly selected one square meter area and collected the insect stages in vials, poly bags and damage symptoms were also collected. The egg, caterpillars, pupa and adults were collected from different infested fields and put it in department of Entomology laboratory.

Identification of FAW (Fall armyworm)

The collected samples(larva or adult or damage symptoms) were put in the laboratory of department of Entomology RMD College of Agriculture and Research Station, Ambikapur with the collaboration of department of Genetics & plant Breeding (All India Coordinated Research Project on Maize (C.G.) to study the life cycle and identification of different stages of this pest.

Results and Discussion

The present survey work was undertaken to study the abundance and damage by the fall armyworm (FAW) in maize crop which is depicted in table 1&2 that this invasive pest was recorded in twenty six maize growing villages of seven blocks of two Districts Surajpur and Surguja in 202.2 hectares. The caterpillar was observed feeding on mid portion (Leaf whorl) of the maize crop from 4-6 leaves stages with 25-30 and 30-35 per cent infestation, in knee high stage 65-70 per cent and tassel stage respectively. In seven blocks Mainpat (6.2 ha, 03 villages, 30-35 % damage), Batauli block (4.0 ha, 01 village, 30-35 % damage), Lundra (6.0 ha, 01 village 30-35 % damage), Lakhanpur at tasseling stage (20.0 ha, 05 villages 75-80% damage), Udaipur at knee high stage (140.0 ha, 04 villages, 75-80 % damage), Ambikapur at knee high stage (17.0 ha, 08 villages, 60-65 % damage) and Surajpur at knee high stage(9.0 ha, 04 villages, 70-75% damage) respectively.

The maximum abundance and damage was recorded in block Udaipur (75-80%) followed by Lakhanpur (65-70%) and Ambikapur (60-65%) however the lowest damage was recorded in block Mainpat, Lundra and Batauli (30-35%) respectively. The activities of survey work has been shown in Plate 1 (a to g) and Plate 2 (a to e).

These findings are in agreement with Abrahams *et al.* 2017 [1] who reported that the fall armyworm late instars larvae damage the growing points of the plants furthermore, older larvae burrow into maize tassels and ears, causing extensive damage. Alam *et al.* 2014 [2] who conducted the survey work on insect pests of maize, six major pests were recorded in the maize field among the bird pests (pigeon, Dove and Crow) and insect pests aphid, cutworm, maize cob borer, stem borer and corn ear worm. Deole and Paul 2018 [6] observed the larvae at vegetative stage was 25 in 200 Sq. m area indicating their preference on soft leaves of maize. The nature of damage of caterpillar indicating that there was moist sawdust-like frass near the funnel and upper leaves. Further observed reproductive stage of crop the infestation level of fall army worm, *Spodoptera frugiperda* was 49.20 per cent and the life cycle of fall army worm was completed in about 28-35 days in Raipur (C.G.), Dew 1913 [7] and Sparks 1979 [16] who observed the eggs of fall armyworm laid in masses ranging from just a few to hundreds and will usually hatch within 4 days under optimal conditions. Ganiger *et al.* 2018 [9] observed the occurrence of fall armyworm, in Bangalore Rural and Chikkaballapur districts were devastated by caterpillars during May and June, 2018. Severe damage by

Spodoptera spp. was recorded in several villages of Gouribidanur, Chikkaballapura and Doddaballapura taluks. Maize plants damaged by the early instar larvae showed characteristic pin holes symptoms on the leaves. Grown up larvae were confined to the deep whorls and fed extensively on inner whorl. Goergen *et al.* 2016 [10] observed that, farmers were able to recognize the fall armyworm based on different indicators, and the majority of them observed larvae attacking maize plants. The caterpillars caused severe damage at all maize crop growth stages; however, the damage was more serious at early growth stages of the plants. Hardke *et al.* 2015

[11] observed the *S. frugiperda* late instar showing inverted “Y” on head capsule and four black dots in a square pattern on eighth abdominal segment. Rajin *et al.* 2000 [15] who recorded that maize stem borer was the most predominant species in June to September (60.0%) and October to January (48.43%). They also found that the lower abundant in March. They found that the Infestation of stem borer was predominant from early seedling stages to maximum seedling stage and decreased gradually with increasing the growth of plants.



a. Egg mass

b. Young larvae

c. Full grown larva

d. Pupa



e. Adult Male



f. damage symptom



g. Larva damaging on leaf whorl

Plate 1: View of life cycle of fall armyworm (FAW) and damage symptoms.



A. Pheromone trap installation



B. & C. survey work at farmers maize field



D & E. Interaction with farmers and Agriculture officers

Plate 2: view of pheromone trap installation, survey work and training to officers.

Table 1: Survey conducted in different villages for fall army worm (FAW) during 2019-20.

S. No.	Villages	Blocks	District	Survey areas (ha)	Crop stage	Infestation (%)
1	Amgaon	Mainpat	Surguja	1.0	4-5 leaves	30-35
2	Nagadand	Mainpat	Surguja	1.2	4-5 leaves	30-35
3	Kamleshwarpur	Mainpat	Surguja	4.0	4-5 leaves	30-35
4	Lakda	Batauli	Surguja	4.0	4-5 leaves	30-35
5	Lamgaon	Lundra	Surguja	6.0	4-5 leaves	30-35
6	Amdala	Lakhanpur	Surguja	5.0	Knee high stage	65-70
7	Taparkela	Lakhanpur	Surguja	6.0	Taselling stage	65-70
8	Kewra	Lakhanpur	Surguja	3.5	Tasselling stage	65-70
9	Rajpuri	Lakhanpur	Surguja	4.5	Knee high stage	65-70
10	Lahpatra	Lakhanpur	Surguja	1.0	Knee high stage	65-70
11	Shankarpur	Udaypur	Surguja	35.5	Knee high stage	75-80
12	Tolga	Udaypur	Surguja	34.5	Knee high stage	75-80
13	Kalyan	Udaypur	Surguja	36.0	Knee high stage	75-80
14	Bhadwahi	Udaypur	Surguja	34.0	Teaseling stage	75-80
15	Thakurpur	Ambikapur	Surguja	2.0	Knee high stage	60-65
16	Koldiha	Ambikapur	Surguja	5.0	Knee high stage	60-65
17	Amgaon	Ambikapur	Surguja	1.0	Knee high stage	60-65
18	Labji	Ambikapur	Surguja	3.5	Teaseling stage	60-65
19	Sonpur khurd	Ambikapur	Surguja	1.5	Teaseling stage	60-65
20	Sukhri	Ambikapur	Surguja	1.0	Teaseling stage	60-65
21	Sapna	Ambikapur	Surguja	1.0	Teaseling stage	60-65
22	Bakirma	Ambikapur	Surguja	2.0	Knee high stage	60-65
23	Mahavirpur	Surajpur	Surajpur	5.0	Knee high stage	65-70
24	Silphili	Surajpur	Surajpur	1.0	Knee high stage	
25	Sambalpur	Surajpur	Surajpur	2.0	Knee high stage	65-70
26	Ajabnagar	Surajpur	Surajpur	1.0	Knee high stage	65-70
Total Area				202.2 Ha		

Table 2: Summary for survey of villages for Fall Armyworm (FAW)

Block	Village	Area ha	% infestation
Mainpat	3	6.2	30-35
Batauli	1	4.0	30-35
Lundra	1	6.0	30-35
Lakhanpur	5	20.0	65-70
Udaipur	4	140.0	75-80
Ambikapur	8	17.0	60-65
Surajpur	4	9.0	65-70
Total	26	202.2	

Recommendations for farmers by Government of India

The farmers were strictly advised for management strategies of fall armyworm to save their crop and get the good yield are important the following.

Cultural practices

1. Deep ploughing in summer season this will expose FAW pupae to predators.
2. Timely sowing is recommended.
3. Intercropping of maize with pulse crops of particular region (maize +pigeon pea/ black gram/green gram).
4. Erection of bird purchase @ 10/acre during early stage of the crop (up to 30 days).
5. Clean cultivation and recommended dose of fertilizers.
6. Cultivation of maize hybrid varieties with tight husk cover will reduce ear damage.
7. Sowing the trap crop (Napier) 3-4 rows around maize field and spray with 5% NSKE or azadirachtin 1500ppm as soon as the trap crop shows symptoms.

Mechanical control

1. Hand picking and destruction of egg masses and newly hatched larvae in mass crushing them in carosine water.
2. Application of dry sand in to the whorl of affected maize

plants soon after observation of FAW incidence in the field.

3. Mass trapping of male moths using pheromone traps @ 15/acre.

Biological control

1. Protection of natural enemies by habitat management – increase the plant diversity by intercropping with pulses and ornamental flowering plants which help in build up of natural enemies.
2. Release of *Trichogramma pretosum* or *Telonomus remus* @ 50,000/acre at weekly intervals.
3. Biopesticides: suitable at 5% damage in seedling to early whorl stage and 10% ear damage with entomopathogenic fungi and bacteria.
 - a. *Bacillus thuringiensis* v. *kurstaki* formulations @ 2g/l or 400g /acre is recommended.
 - b. Entomopathogenic fungal formulation- application of *Metarhizium anisopliae* @ 5g/liter whorl application at 15-25 days after sowing. Another 1-2 sprays may also be given at an interval of 10 days depending on pest damage.

Chemical control

1. Seed treatment with Cyantraniliprole 19.8%+ Thiamethoxam 19.8% @ 4ml /kg seed protected up to 2-3 weeks after germination.
2. First window- seedling to early whorl stage- to control this pest at 5% damage to reduce hatchability of freshly laid eggs, spray 5% NSKE or azadirachtin 1500ppm @ 5ml/liter of water.
3. Second window- mid whorl to late whorl stage- to manage the 2nd and 3rd instar larvae at 10-20 % damage spray Emaectin benzoate @0.4g / liter of water or Spinosad @0.3ml/liter of water or Thiamethoxam

12.6%+lamdacyhalothrinn9.5% @ 0.5ml/ liter of water or Chlorantraniliprole 18.5% SC @ 0.3ml/ liter of water.

Poison bait- it is recommended for late instar larvae – 10kg rice bran+2kg jiggery with 2-3 liter of water for 24 hour to ferment then add 100gm thiodicarb just half an hour before application in the field. The bait should be applied in the whorl of the plants.

4. Third window- 8 weeks after emergence to teaseling and post tasseling-insecticides management is not cost effective at this stage. Hand picking of the larvae is advisable.

Conclusion

It is concludes that the fall armyworm, *Spodoptera frugiperda* was found maximum damaging on maize crop at knee high stage in Udaipur block 75-80 per cent means maximum damage can be observed during the knee high stage and farmers can make the control measure during this stage. This stage is found congenial condition for fall armyworm attack.

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