

Study the Distribution and Damage Potential of *Spodoptera frugiperda* on Maize in Southern Rajasthan

Ankur^{1*}, M.K. Mahla², Vikram¹, Tanmaya Kumar Bhoi³, S. Ramesh Babu⁴, Hemant Swami⁵, Anil Vyas⁵ and Gaurang Chhangani⁶

¹Ph.D. Scholar, Department of Entomology, Rajasthan College of Agriculture, MPUAT, Udaipur 313001, (Rajasthan), India.

²Professor, Department of Entomology, Rajasthan College of Agriculture, MPUAT, Udaipur 313001, (Rajasthan), India.

³Scientist B, ICFRE-Arid Forest Research Institute, Jodhpur, 342005 (Rajasthan), India.

⁴Associate Professor, Department of Entomology, Rajasthan College of Agriculture, MPUAT, Udaipur (Rajasthan), India.

⁵Assistant Professor, Department of Entomology, Rajasthan College of Agriculture, MPUAT, Udaipur (Rajasthan), India.

⁵Assistant Professor, Department of Entomology, Rajasthan College of Agriculture, MPUAT, (Rajasthan), India.

⁶Assistant Professor, Department of Entomology, COA, Jodhpur, AU, Jodhpur (Rajasthan), India.

(Corresponding author: Mrinal Kumar Das*)

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ABSTRACT: FAW was an invasive pest and destructive as reported in Southern Rajasthan having high fecundity and have the ability of long distance travel which was most challenging. The survey on incidence and damage potential of *S. frugiperda* was carried out in maize growing area of Southern Rajasthan during July to October 2021 and 2022. Infested fields by *S. frugiperda* were found 100 per cent in both years. Infestation by *S. frugiperda* was found 8 to 19.33 and 11 to 23 per cent with the mean 15.39 and 16.37 per cent or visual leaf damage rating (Davis scale 0-9) was 3 to 7 with the mean of 5.18 and 5.11, respectively in both years. The maximum infestation by *S. frugiperda* was recorded in Pratapgarh (17.94%) and lowest in Udaipur (12.65%) during 2021 and During 2022, the highest infestation by *S. frugiperda* was recorded in Pratapgarh (19.28%) followed lowest in Banswara (13.67%). The maximum visual leaf damage rating was observed in Rajsamand (6) and lowest in Udaipur (4.43) during 2021 and during 2022, maximum visual leaf damage rating was observed in Pratapgarh (6) and minimum in Rajsamand (4.25). On the basis experimental result infested prone area has been marked from southern Rajasthan for applying control measure.

Keywords: Maize, Survey, Incidence, Per cent infestation, Davis Scale, FAW.

INTRODUCTION

Maize, *Zea mays* L. is a member of the family, Poaceae also known as corn, is one of the most flexible growing crop with greater adaptability to different agro-climatic conditions. Due to higher genetic yield potential amongst the cereals, this crop is globally popular as the "Queen of cereals" (Jeyaraman, 2017). In world, maize is cultivated over an area of 200 million hectares having the production of 1160 million tonnes with productivity of 5815 kg/ha (Anon.,2020a). In Asia, maize is cultivated over an area of 65.74 million hectares having the production of 365 million tonnes with productivity of 5553 kg/ha (Anon.,2020b). In India, maize is cultivated over an area of 9.86 million hectares having the production of 31.65 million tonnes with productivity of 3209 kg/ha (Anon.,2021). While in Rajasthan, it was grown in about 0.85 million hectares with a production of 1.89 million tonnes and productivity of 2240 kg/ha, respectively. (Anon., 2018-

19). Maize is known as "Makka, Makai, Chhali, Bhutta, Cholum, Mokochana and Khaukiri" in different parts of India.

There are many factors responsible for low productivity of maize. Among them, insect pests are the major factor for low productivity of maize and caused appreciable damage which ultimately affect the yield of crop. Maize crop is attacked by nearly 130 species of insect pests in India. The major insect pests infesting the maize are Fall armyworm : *Spodoptera frugiperda* (J. E. Smith), Stem borer: *Chilo partellus* Swinhoe, Aphid: *Rhopalosiphum maidis* Fabricius, Pink stem borer: *Sesamia inferens* Walker, Armyworm: *Mythimna separata* Walker, Bark beetle: *Anthracophora crucifera* Olivier, Blister beetle: *Cylindrothorax audouini* Melo., Grasshopper: *Epacromia dorsalis* Thub., Surface grasshopper: *Chrotogonus* sp., White grub: *Holotrichia consanguinea* Blanchard, Cob borer: *Helicoverpa armigera* Hubner, Leaf eating caterpillar: *Spodoptera*

litura Fabricius and White ants: *Odontotermes* sp. and *Microtermes* sp. (Atwal and Dhaliwal, 2002).

In India the fall armyworm, an alien invasive pest on maize was first reported by Sharanabasappa *et al.* (2018). This pest has caused severe damage to maize in southern parts of Karnataka during May and June, 2018 (Ganiger *et al.*, 2018), also reported on bajra and sorghum crop in Andhra Pradesh. ICAR-NBAIR released pest alert on the occurrence of invasive *S. frugiperda* on maize in Southern Rajasthan in February 2019 (CABI, 2019). That's why the knowledge of incidence pattern and damage potential of the exotic armyworm is must to control or monitoring the invasive FAW pest.

The fall armyworm, *Spodoptera frugiperda* (J.E. Smith), is a caterpillar pest native to the western hemisphere, and invasive across Africa (Goergen *et al.* 2016), Asia (Ganiger *et al.* 2018 and Australia (Wu *et al.* 2019). This polyphagous species, with 353 host plants recorded (Piggott *et al.* 2021), is known to cause substantial damage to crops including corn, sorghum, and pasture grasses, with more occasional losses reported in millet, alfalfa, rice, vegetable crops, and cotton (Montezano *et al.* 2018). The fall armyworm species is comprised of two morphologically identical but genetically distinct strains, the C-strain and the R-strain. These strains are host associated (Sparks *et al.* 1979; Pashley *et al.* 1986) or more recently allochronic (Nagoshi and Meagher 2008; Nagoshi, 2022), referring to the two primary behavioural differences that have been observed between strains.

MATERIAL AND METHOD

Description of study area

Present investigation on the bioecology, molecular characterization of fall armyworm, *Spodoptera frugiperda* (J E Smith) and biochemical basis of resistance in maize was carried out in the laboratory of Department of Entomology, Rajasthan College of Agriculture, MPUAT, Udaipur and surveys will be undertaken in maize crops cultivated in districts of southern Rajasthan from August 2021 to October 2022 in *Kharif* season. The study was carried out in farmer's fields and the number of fields samplings based on the maize field availability at the particular time of sampling in districts of southern Rajasthan. The materials used and techniques employed for conducting various experiments are presented here under.

Sampling sites. ICAR-NBAIR released pest alert on the occurrence of invasive *S. frugiperda* in maize in southern Rajasthan in February 2019. Based on this pest alert, surveys were undertaken in maize crops cultivated in districts of southern Rajasthan from August 2021 to October 2022 in *Kharif* season. The study was carried out in farmer's fields and the number of fields samplings based on the maize field availability

at the particular time of sampling in districts of southern Rajasthan.

Damage assessment. The total availability of maize fields was surveyed for the occurrence of fall armyworm in maize during July-September (Navik *et al.*, 2021). In each field randomly selected five spots and in each spot 10 plants were selected to observe for the presence of *S. frugiperda*. The presence of *S. frugiperda* was determined based on the larvae feeding on the leaves and whorl, irregular damage (window) and the presence of egg masses on the leaves. The feeding larvae were identified based on inverted 'Y' shaped in their head and the upper surface with four dots in a square on the last abdominal segment (Prasanna *et al.*, 2018). The per cent infested field and plant by the fall armyworm was calculated. The leaf damage by *S. frugiperda* were subjected to visual observation based on a 0-9 scale (Davis and Williams, 1992). The visual leaf damage rating for the individual plants under the observation from each field were averaged to estimate the leaf damage rating for particular districts surveyed.

Mathematical Analysis. Pest incidence was calculated based on the percentage of the plant infested by *S. frugiperda* and the damage severity score were averaged of the total number of plants observed.

The per cent infested field was estimated by the following equation: -

$$= \frac{\text{Number of } S. frugiperda \text{ infested field}}{\text{Total no of field surveyed}} \times 100$$

The per cent incidence was calculated by the following equation: -

$$= \frac{\text{Number of } S. frugiperda \text{ infested plant}}{\text{Total no of plant surveyed}} \times 100$$

From observed data comparison was made for the *S. frugiperda* incidence and severity between districts.

RESULT AND DISCUSSION

A roving survey on quantitative incidence of *S. frugiperda* was carried out in maize growing blocks of six districts *viz.*, Udaipur, Chittorgarh, Rajsamand, Pratapgarh, Dungarpur and Banswara of Southern Rajasthan from August 2021 to October 2022 in *Kharif* season as a two-year study.

Incidence of *S. frugiperda* in different maize growing blocks of Southern Rajasthan during *Kharif*, 2021

During the survey we observed 84 villages from 24 blocks in six districts of Southern Rajasthan were studied for the quantitative incidence of *S. frugiperda* during *Kharif*, 2021 (Table 1). Among various blocks surveyed, *S. frugiperda* infested fields were 100 per cent in all blocks of six districts. *S. frugiperda* infestation ranged from 8 to 19.33 per cent in various blocks of Southern Rajasthan. The highest *S. frugiperda* infestation (19.33%) was recorded in Dhariawad block of Pratapgarh district and lowest in Kurabad block of Udaipur district (8%).

Table 1: Incidence of *S. frugiperda* in different maize growing blocks of Southern Rajasthan during *Kharif*, 2021.

Name of district	Name of block	Number of fields surveyed	<i>S. frugiperda</i> infested field (%)	<i>S. frugiperda</i> infestation (%)	Mean of Davias scale
Udaipur	Bhinder	06	100	13.67	05
	Mavli	07	100	11.71	04
	Girwa	05	100	15.20	05
	Badgaon	04	100	11	04
	Kurabad	02	100	08	03
	Salumber	02	100	16	06
	Kherwada	02	100	13	04
	Sub total / Mean	28	100	12.65	4.43
Chittorgarh	Chittorgarh	02	100	16.00	07
	Nimbahera	04	100	16.50	06
	Barisadri	03	100	14.70	05
	Kapasan	04	100	14.00	05
	Dungla	02	100	17.00	06
	Bhadesar	02	100	15.00	05
	Sub total / Mean	17	100	15.50	5.67
Rajsamand	Rajsamand	02	100	16.00	06
	Bhim	02	100	17.00	06
	Railmagra	04	100	12.50	05
	Kumbhalgarh	02	100	17.00	07
	Sub total / Mean	10	100	15.60	06
Pratapgarh	Pratapgarh	02	100	20.00	06
	Chhotisadri	04	100	14.50	05
	Dhariawad	03	100	19.33	04
	Sub total / Mean	09	100	17.94	05
Dungarpur	Dungarpur	04	100	14.00	07
	Aspur	04	100	19.00	06
	Sub total / Mean	08	100	16.50	05
Banswara	Banswara	04	100	12.50	06
	Bagidora	04	100	14.00	04
	Ghatol	04	100	16.00	06
	Sub total / Mean	12	100	14.16	05
	Total /mean	84	100	15.39	05.18

The visual leaf damage rating (Davis scale rating, 0-9) in different blocks ranged from 3 to 7. The maximum visual leaf damage rating (7) was observed in Chittorgarh block of Chittorgarh district and minimum (3) in Kurabad block of Udaipur district.

Within each district, the infestation varied among different blocks (Table 1). In Udaipur district, *S. frugiperda* infested fields were 100 per cent. Highest per cent incidence was observed in Salumber (16.00%) followed by Girwa (15.20%), Bhinder (13.67%), Kherwada (13%), Mavli (11.71%) block, Badgaon (11%) while the lowest was observed in Kurabad (8%). The visual leaf damage rating was observed in Salumber, Bhinder, Girwa, Kherwada, Badgaon, Mavli and Kurabad blocks 6, 5, 5, 4, 4, 4 and 3, respectively. In Chittorgarh district also, infested fields by *S. frugiperda* were found 100 per cent. Highest percent incidence was observed in Dungla (17%) followed by Nimbahera (16.50%), Chittorgarh (16%), Bhadesar (15%) Barisadri (14.70%), while the lowest was

observed in Kapasan (14%) block. The visual leaf damage rating was observed in Chittorgarh, Dungla, Nimbahera, Bhadesar, Barisadri and Kapasan blocks 7, 6, 6, 5, 5 and 5, respectively.

In Rajsamand district, also field infestation by *S. frugiperda* was found 100 per cent. Highest percent incidence was observed in Kumbhalgarh (17.00%), followed by Bhim (17.00%), Rajsamand (16.00%) while the lowest was observed in Railmagra (12.50%) block. The visual leaf damage rating was observed in Kumbhalgarh, Rajsamand, Bhim and Railmagra blocks 7, 6, 6 and 5, respectively.

In Pratapgarh district, field infestation by *S. frugiperda* was found 100 per cent. Highest percent incidence was observed in Pratapgarh (20.00%), followed by Dhariawad (19.33%) while the lowest was observed in Chhoti Sadri (14.50%) block. The visual leaf damage rating was observed in Pratapgarh, Chhoti Sadri and Dhariawad blocks 6, 5 and 4, respectively.

In Dungarpur district, field infestation by *S. frugiperda* was found 100 per cent in both Dungarpur and Aspur blocks. Highest percent incidence was observed in Aspur (19.00%) and least incidence was observed in Dungarpur (14.00%). The visual leaf damage rating was observed 7 and 6 in Dungarpur and Aspur blocks, respectively.

In Banswara district, field infestation by *S. frugiperda* was found 100 per cent. The highest percent incidence was observed in Ghatol (16.00%), Bagidora (14.00%) and least incidence was observed in Banswara (12.50%). The visual leaf damage rating was observed 6, 6 and 4 in Ghatol, Banswara and Bagidora blocks, respectively.

Among districts of Southern Rajasthan, *S. frugiperda* highest infestation (17.94%) was recorded in Pratapgarh district followed by Dungarpur (16.50%), Rajsamand (15.60%), Chittorgarh (15.50%), Banswara (14.16%), and lowest in Udaipur district (12.65%). The visual leaf damage rating was observed between 4.43 to 6. The maximum visual leaf damage rating was observed in Rajsamand (6), followed by Chittorgarh (5.67), Pratapgarh (5), Banswara (5), Dungarpur (5) and minimum in Udaipur (4.43). (Table 1)

Incidence of *S. frugiperda* in different maize growing blocks of Southern Rajasthan during Kharif, 2022

During the survey we observed 84 villages from 24 blocks in six districts of Southern Rajasthan were studied for the quantitative incidence of *S. frugiperda* during Kharif, 2022 (Table 2). Among various blocks surveyed, *S. frugiperda* infested fields are 100 per cent in all blocks of six districts. *S. frugiperda* infestation ranged from 11.00 to 23.00 per cent in various blocks of Southern Rajasthan. The highest *S. frugiperda* infestation (23.00%) was recorded in Dungla block of Chittorgarh district and lowest in Kurabad block of Udaipur district (11.00%). The visual leaf damage rating (Davis scale rating, 0-9) in different blocks ranged from 3 to 7. The maximum visual leaf damage rating (7) was observed in Salumber block (Udaipur district) and Pratapgarh block (Pratapgarh district) and minimum (3) in Kumbhalgarh block of Rajsamand district.

Within each district, the infestation varied among different blocks (Table 2). In Udaipur district, field infestation by *S. frugiperda* was found 100 per cent. The highest per cent incidence was observed in Salumber (18.00%) followed by Girwa (16.80%), Kherwada (15%), Bhinder (14.66%), Badgaon (13.50%), Mavli (12.86%) block while the lowest was observed in Kurabad (11.00%). The visual leaf damage rating was observed in Salumber, Badgaon, Girwa, Bhinder, Kurabad, Mavli and Kherwada blocks 7, 6, 6, 5, 5, 4 and 4, respectively.

In Chittorgarh district also, field infestation by *S. frugiperda* was found 100 per cent. The highest percent incidence was observed in Dungla (23.00%) followed by Chittorgarh (19.00%), Nimbahera (18.00%),

Bhadesar (16.00%) Barisadri (16.00%), while the lowest was observed in Kapasan (14.50%) block. The visual leaf damage rating was observed in Chittorgarh, Kapasan, Nimbahera, Barisadri, Bhadesar and Dungla blocks 6, 6, 5, 5, 5 and 4, respectively.

In Rajsamand district, field infestation by *S. frugiperda* was found 100 per cent. The highest percent incidence was observed in Kumbhalgarh (19.00%), followed by Rajsamand (19.00%), while the lowest was observed in Bhim (13.00%) and Railmagra (13.00%) block. The visual leaf damage rating was observed in Railmagra, Rajsamand, Bhim and Kumbhalgarh blocks 6, 4, 4 and 3, respectively.

In Pratapgarh district, field infestation by *S. frugiperda* was found 100 per cent. The highest percent incidence was observed in Pratapgarh (23.00%), followed by Dhariawad (19.33%) while the lowest was observed in Chhoti Sadri (15.50%) block. The visual leaf damage rating was observed in Pratapgarh, Dhariawad and Chhoti Sadri blocks 7, 6 and 5, respectively.

In Dungarpur district, field infestation by *S. frugiperda* was found 100 per cent in both Dungarpur and Aspur blocks. The highest percent incidence was observed in Aspur (20.50%) and least incidence was observed in Dungarpur (13.50%). The visual leaf damage rating was observed 6 and 4 in Aspur and Dungarpur blocks, respectively.

In Banswara district, field infestation by *S. frugiperda* was found 100 per cent. The highest percent incidence was observed in Bagidora (15.50%), Ghatol (14.00%) and least incidence was observed in Banswara (11.50%). The visual leaf damage rating was observed 5, 5 and 4 in, Banswara, Bagidora blocks and Ghatol, respectively.

Among six districts of Southern Rajasthan, maximum infestation by *S. frugiperda* was recorded from Pratapgarh (19.28%) followed by Chittorgarh (17.75%), Dungarpur (17.00%), Rajsamand (16.00%), Udaipur (14.55%) and lowest in Banswara district (13.67%). The visual leaf damage rating was observed between 4.25 to 6. The maximum visual leaf damage rating was observed in Pratapgarh (6), followed by Udaipur (5.29), Chittorgarh (5.17), Dungarpur (5), Banswara (4.67) and minimum from Rajsamand (4.25) (Table 2).

The results of present finding on losses by *S. frugiperda* are in acquiescence with the findings of Tapa-Yotto *et al.* (2022) 8% to 53%, Ahir *et al.* (2021) found 21.87 and 39.22 per cent in 2020 & 2021 both year, Maruthadurai R and R Ramesh (2020) found 16 to 52% on fodder maize, Babu *et al.* (2019) recorded 9.0 to 62.5 per cent, Dhar *et al.* (2019) found maximum damage 27.56%, Shylesha *et al.* (2018) 9.0 to 62.5 per cent and Mallapur *et al.* (2018) recorded infestation of FAW 13.50 to 66.50 per cent. and Navik *et al.* (2021) found average leaf damage rating 4.9 Davies scale (0-9) that was similar with our findings.

Table 2: Incidence of *S. frugiperda* in different maize growing blocks of Southern Rajasthan during Kharif, 2022.

Name of district	Name of block	Number of fields surveyed	<i>S. frugiperda</i> infested field (%)	<i>S. frugiperda</i> infestation (%)	Mean of Davies scale
Udaipur	Bhinder	06	100	14.66	05
	Mavli	07	100	12.86	04
	Girwa	05	100	16.80	06
	Badgaon	04	100	13.50	06
	Kurabad	02	100	11.00	05
	Salumber	02	100	18.00	07
	Kherwada	02	100	15.00	04
	Sub total / Mean	28	100	14.55	5.29
Chittorgarh	Chittorgarh	02	100	19.00	06
	Nimbahera	04	100	18.00	05
	Barisadri	03	100	16.00	05
	Kapasan	04	100	14.50	06
	Dungla	02	100	23.00	04
	Bhadesar	02	100	16.00	05
	Sub total / Mean	17	100	17.75	5.17
Rajsamand	Rajsamand	02	100	19.00	04
	Bhim	02	100	13.00	04
	Railmagra	04	100	13.00	06
	Kumbhalgarh	02	100	19.00	03
	Sub total / Mean	10	100	16.00	4.25
Pratapgarh	Pratapgarh	02	100	23.00	07
	Chhotisadri	04	100	15.50	05
	Dhariawad	03	100	19.33	06
	Sub total / Mean	09	100	19.28	06
Dungarpur	Dungarpur	04	100	13.50	04
	Aspur	04	100	20.50	06
	Sub total / Mean	08	100	17.00	05
Banswara	Banswara	04	100	11.50	05
	Bagidora	04	100	15.50	05
	Ghatol	04	100	14.00	04
	Sub total / Mean	12	100	13.67	4.67
	Total / mean	84	100	16.37	5.11

CONCLUSIONS

Highest per cent infestation was recorded in Pratapgarh and lowest in Udaipur both 2021 and 2022, respectively so on basis of both year damage per cent is less than previous years due to establish their natural enemy and heavy rain or late sowing.

FUTURE SCOPE

This is the new invasive pest in Southern Rajasthan and this study would be helpful for the farmers as they get know about its damage pattern and damage potential of FAW.

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