# Studies on the seasonal occurrence of fall armyworm, *Spodoptera frugiperda* J.E. Smith on maize at different sowing dates

**Abstract**

Fall armyworm is a destructive insect pest in maize farming and has expanded widely throughout various agroecological zones, which threatens food security. An experiment was carried out at the Winter Nursery (ICAR-IIMR, Hyderabad) field to study the occurrence of fall armyworm on maize single cross hybrid DHM 117 across different sowing dates during *kharif* and *rabi* seasons of 2021-22. Among the six sowing dates, crop sown on 2nd August, 2021, had a relatively lower mean percent of infestation range (4.02% - 80.37%), a minimum larval count per plant range (0.01 - 0.24), and the least number of egg masses per plant range (0.00 - 0.11). The findings will be helpful in the construction of forecasting models, facilitating the formulation of eco-friendly management tactics to manage fall armyworm in maize.

**Key words**: FAW, sowings, SMW, infestation, larvae and egg masses

## 1. INTRODUCTION

Maize ~~*Zea mays L.*~~ (*Zea mays* L. ~~Maize~~) is one of the predominant cereal crop globally, cultivating in a wide range of environmental conditions. Maize farming in India spans 9.2 million hectares, with a production of 31.65 million metric tons (DACNET, 2021). This accounts for almost 4% of the maize cultivation area and 2% of worldwide production. Maize serves multiple roles, primarily as poultry feed (47%), fodder (13%), human consumption (13%), in the starch industry (14%), processed foods (7%), for export purposes, and in various other applications (6%). Despite the upward trend in maize production over the past 10 years, productivity remains low. Its growth and development are constrained by several biotic and abiotic factors. Of the biotic stresses, insect pests are responsible for causing a decline of 18–26% in crop yield (Mantzoukas *et al.*, 2020).

Fall armyworm (FAW), *Spodoptera frugiperda* (J.E. Smith) (Lepidoptera: Noctuidae), is an invasive pest native to tropical and subtropical regions of America (Sisay *et al*., 2019). FAW has become a serious concern due to its feeding on most parts of the maize plant, including the leaf whorl, tassel, and cob, leaving shot holes, skeletonized leaves, and heavily windowed whorls with frass. The annual maize losses caused by FAW ranged between 8.3 and 20.6 million tons, as reported by Day *et al*. (2017). Insect populations experience fluctuations as a consequence of shifts in ecological elements such as competition intensity, predator abundance, resource availability, and weather patterns (Prakash *et al*., 2014). As a part of Integrated Pest Management (IPM), an optimum period of sowing is advised to manage the FAW. Hence, the current research was taken up to determine appropriate sowing dates that would result in a lower infestation of FAW.

## 2. MATERIALS AND METHODS

### 2.1. Experiment

The purpose of this study was to analyse the seasonal occurrence of FAW on maize at six different sowing dates from August to December 2021 (late *kharif* and *rabi* seasons) at the Winter Nursery Centre, ICAR-IIMR, Hyderabad. During 2021, the maize single cross hybrid DHM 117 was sown on the following dates: August 2nd, August 17th, October 23rd, November 10th, November 24th, and December 4th. The crop was grown with a spacing of 75 cm by 20 cm in a plot area measuring 7.5 m by 3 m containing three replications. Each replication has three crop rows. The crop was raised according to the recommended agronomic practices. Weekly observations were made on a whole-plot basis to record the number of plants damaged, the number of larvae and egg masses per plant.

Percentage (%) of infested plants = Number of infested plants x 100



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Total number of plants

## 3. RESULTS AND DISCUSSION

### 3.1. Incidence of FAW on DHM 117 sown during- 2nd August 2021 (1st sowing)

At the start of the initial observation, on the 32nd Standard Meteorological Week (SMW), the infestation was 11.82% with 0.13 larvae per plant. In the following 33rd SMW, the infestation and mean larvae per plant were significantly reduced to 4.02% and 0.01, respectively. Again, the FAW infestation and larvae per plant grew gradually until the 42nd SMW and it peaked with 80.37% infestation and 0.24 larvae per plant on the 43rd SMW. Egg masses were first observed during the 34th SMW (0.06) and peaked around the 42nd SMW (0.11).

### 3.2. Incidence of FAW on DHM 117 sown during- 17th August 2021 (2nd sowing)

At the start of the 34th SMW (1st observation), the FAW infestation was 5.95%, with 0.06 mean larvae per plant. A plant infestation of 74% was observed during the 37th SMW, with 0.41 larvae per plant. The 43rd SMW recorded the maximum infestation (100%), with the highest larvae per plant (0.56). The 43rd (0.18) and 44th SMWs (0.17) had a higher number of egg masses per plant.

### 3.3. Incidence of FAW on DHM 117 sown during- 23rd October 2021 (3rd sowing)

The infestation (25.49%) and mean larvae per plant (0.07) during the 44th SMW (first week of observation) were found to be significantly greater than those of the first and second sowing dates. The amount of infestation increased steadily over time and the peak infestation of FAW was observed in the fourth SMW (100.00%). The highest mean larvae per plant (0.66) and egg masses per plant (0.12) were recorded in the 49th and 46th standard meteorological weeks, respectively.

### 3.4. Incidence of FAW on DHM 117 sown during- 10th November 2021 (4th sowing)

The infestation started soon after germination (23.74%) during 47th SMW and it made a rapid increase at 48th SMW with 82.33% infestation and 0.17 larvae per plant, which continued throughout the crop growth period. The maximum FAW infestation of 100% was seen during the 7th SMW with 0.05 larvae per plant. The highest larvae per plant (0.33) and egg masses per plant (0.15) were noticed during the 49th SMW.

### 3.5. Incidence of FAW on DHM 117 sown during- 24th November 2021 sown crop (5th sowing)

A moderate infestation of 25.15% was observed on DHM 117 in the first week (49th SMW) of germination, with 0.11 larvae per plant. The FAW infestation increased to 69.71 % in the 50th SMW. The 6th, 7th, 8th and 9th SMW recorded the highest infestation of 96.50%. The fourth SMW (0.34) and sixth SMW (0.09) registered the highest number of larvae and egg masses per plant, respectively.

### 3.6. Incidence of FAW on DHM 117 sown during- 4th December 2021 (6th sowing)

The incidence of FAW declined slightly as compared to the previous three sown crops (2nd fortnight of October, 1st fortnight of November, and 2nd fortnight of November). The infestation begins soon after germination, *i.e.*, at the seedling stage (50th SMW), with 15.07% infestation and 0.03 larvae per plant. During the 51st SMW, there was a rapid increase in the plant infestation of 48.59% and 0.03 larvae per plant. The occurrence of FAW was observed throughout crop growth. The highest plant infestation (89.09%) was

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observed in the 7th SMW. However, the highest number of egg masses (0.11) and larvae per plant (0.31) was observed in the 3rd and 4th SMWs, respectively.

An increased FAW incidence during the third, fourth, and fifth sowing dates might be due to favourable weather conditions, which were conducive to FAW growth and development and an early FAW incidence in preceding sowings contributed to the build-up of the population of this pest for the next subsequent sowings. According to Darshan's findings in 2020, late-planted maize crops exhibited significantly higher rates of FAW incidence in comparison to those planted early. Canico *et al*. (2020) found that the occurrence and density of FAW upsurged during the dry season. These results suggest that sowing maize at the beginning of the cropping season could be more successful in reducing FAW occurrence compared to sowing during the dry season, which is in line with the present study.

Similar kinds of results were reported by Warkad *et al*. (2021), who studied the seasonal fluctuations in FAW on maize during the *rabi* season of 2019–20. The plants exhibited minimal damage at the onset of the season in December, and it increased progressively throughout the season, reached its peak at crop maturity during the 50th SMW. Lavan Kumar (2020) conducted research on the seasonal prevalence of FAW in sweet corn during the *kharif* season of 2019 across three distinct sowing dates: June 15th, July 1st, and July 16th. Across all three sowing periods, the incidence of FAW was observed at 12 days after sowing, with its population peaked between 25 and 45 days after sowing and persisted up to harvest. Niassy *et al*. (2021), found that the abundance of FAW larvae exhibited a notable dependence on crop phenology. Specifically, infestation levels were observed to peak during the vegetative and reproductive phases of the crop, while declining during its mature stages. The current findings align with those of Pitre *et al*. (1983), indicating a preference for egg laying within plants exceeding 32 days of age compared to younger and smaller ones.

**Table 1. Percent plant infestation of FAW on maize DHM 117 during 2021-22**

| Std. Weeks | Mean percent of infested plants (%) | | | | | |
|---|---|---|---|---|---|---|
| (SMW) | 1st sowing (2 Aug 2021, 31 SMW) | 2nd sowing (17 Aug 2021, 33 SMW) | 3rd sowing (23 Oct 2021, 43 SMW) | 4th sowing (10 Nov 2021, 45 SMW) | 5th sowing (24 Nov 2021, 47 SMW) | 6th sowing (4 Dec 2021, 49 SMW) |
| 32 | 11.82 | - | - | - | - | - |
| 33 | 4.02 | - | - | - | - | - |
| 34 | 27.03 | 5.95 | - | - | - | - |
| 35 | 23.16 | 26.47 | - | - | - | - |
| 36 | 14.43 | 14.87 | - | - | - | - |
| 37 | 40.37 | 74.00 | - | - | - | - |
| 38 | 37.57 | 68.50 | - | - | - | - |
| 39 | 26.17 | 53.87 | - | - | - | - |
| 40 | 43.17 | 82.83 | - | - | - | - |
| 41 | 39.87 | 78.37 | - | - | - | - |
| 42 | 58.17 | 98.60 | - | - | - | - |
| 43 | 80.37 | 100.00 | - | - | - | - |
| 44 | 72.07 | 97.20 | 25.49 | - | - | - |
| 45 | - | 95.49 | 63.71 | - | - | - |
| 46 | - | 91.53 | 85.78 | - | - | - |
| 47 | - | - | 78.18 | 23.74 | - | - |
| 48 | - | - | 90.36 | 82.33 | - | - |
| 49 | | - | 96.88 | 89.61 | 25.15 | - |
| 50 | | - | 96.88 | 88.57 | 69.71 | 15.07 |
| 51 | | - | 94.84 | 87.83 | 72.95 | 48.59 |
| 52 | | - | 99.32 | 93.77 | 89.25 | 71.52 |
| 1 | | - | 97.95 | 92.29 | 87.92 | 63.78 |

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| | | | | | | |
|---|---|---|---|---|---|---|
| 2 | | - | 97.27 | 93.77 | 84.17 | 56.10 |
| 3 | | - | 99.32 | 94.51 | 91.46 | 73.54 |
| 4 | | - | 100.00 | 97.17 | 93.98 | 79.26 |
| 5 | | - | - | 97.92 | 95.26 | 82.47 |
| 6 | | - | - | 98.96 | 96.50 | 84.63 |
| 7 | | - | - | 100 | 96.50 | 89.09 |
| 8 | | - | - | - | 96.50 | 84.63 |
| 9 | | - | - | - | 96.50 | 84.63 |
| 10 | | - | - | - | - | 84.63 |
| Range | 4.02-80.37 | 5.95-100.00 | 25.49-100 | 23.74-100 | 25.15-96.50 | 15.07-89.09 |
| Mean±SD | 36.78±22.83 | 68.28±33.02 | 86.61±21.15 | 87.73±19.87 | 84.30±19.87 | 70.61±20.77 |

**Table 2. FAW larval count on DHM117 maize during 2021-22**

| Std. Weeks plant (SMW) | Mean number of larvae per | | | | | |
|---|---|---|---|---|---|---|
| | 1st sowing (2 Aug 2021, 31 SMW) | 2nd sowing (17 Aug 2021, 33 SMW) | 3rd sowing (23 Oct 2021, 43 SMW) | 4th sowing (10 Nov 2021, 45 SMW) | 5th sowing (24 Nov 2021, 47 SMW) | 6th sowing (4 Dec 2021, 49 SMW) |
| 32 | 0.13 | - | - | - | - | - |
| 33 | 0.01 | - | - | - | - | - |
| 34 | 0.14 | 0.06 | - | - | - | - |
| 35 | 0.04 | 0.16 | - | - | - | - |
| 36 | 0.07 | 0.09 | - | - | - | - |
| 37 | 0.21 | 0.41 | - | - | - | - |
| 38 | 0.15 | 0.34 | - | - | - | - |
| 39 | 0.08 | 0.32 | - | - | - | - |
| 40 | 0.15 | 0.39 | - | - | - | - |
| 41 | 0.09 | 0.34 | - | - | - | - |
| 42 | 0.14 | 0.43 | - | - | - | - |
| 43 | 0.24 | 0.56 | - | - | - | - |
| 44 | 0.13 | 0.40 | 0.07 | - | - | - |
| 45 | - | 0.13 | 0.19 | - | - | - |
| 46 | - | 0.02 | 0.23 | - | - | - |
| 47 | - | | 0.05 | 0.02 | - | - |
| 48 | - | | 0.32 | 0.17 | - | - |
| 49 | - | - | 0.66 | 0.33 | 0.11 | - |
| 50 | - | - | 0.55 | 0.08 | 0.06 | 0.03 |
| 51 | - | - | 0.15 | 0.07 | 0.04 | 0.03 |
| 52 | - | - | 0.35 | 0.23 | 0.19 | 0.23 |
| 1 | - | - | 0.09 | 0.11 | 0.08 | 0.07 |
| 2 | - | - | 0.03 | 0.18 | 0.08 | 0.03 |
| 3 | - | - | 0.05 | 0.20 | 0.18 | 0.10 |
| 4 | - | - | 0.01 | 0.24 | 0.34 | 0.31 |
| 5 | - | - | - | 0.23 | 0.29 | 0.25 |
| 6 | - | - | - | 0.06 | 0.28 | 0.17 |
| 7 | - | - | - | 0.05 | 0.14 | 0.15 |
| 8 | - | - | - | - | 0.10 | 0.08 |
| 9 | - | - | - | - | 0.02 | 0.06 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 10 | - | - | - | - | - | 0.05 |
| Range | 0.01-0.24 | 0.02-0.56 | 0.01-0.66 | 0.06-.0.65 | 0.02-0.34 | 0.03-0.31 |
| Mean±SD | 0.12±0.06 | 0.28±0.17 | 0.21±0.19 | 0.25±0.20 | 0.15±0.10 | 0.13±0.09 |

**Table 3. FAW egg masses count on D H M 1 1 7 maize during 2021-22**

| Std. Weeks | Mean number of egg masses/ plant | | | | | |
|---|---|---|---|---|---|---|
| (SMW) | 1st sowing (2 Aug 2021, 31 SMW) | 2nd sowing (17 Aug 2021, 33 SMW) | 3rd sowing (23 Oct 2021, 43 SMW) | 4th sowing (10 Nov 2021, 45 SMW) | 5th sowing (24 Nov 47 SMW) | 6th sowing (4 Dec 2021, 49 SMW) |
| 32 | 0.00 | - | - | - | - | - |
| 33 | 0.00 | - | - | - | - | - |
| 34 | 0.06 | 0.01 | - | - | - | - |
| 35 | 0.05 | 0.01 | - | - | - | - |
| 36 | 0.03 | 0.00 | - | - | - | - |
| 37 | 0.06 | 0.02 | - | - | - | - |
| 38 | 0.03 | 0.01 | - | - | - | - |
| 39 | 0.02 | 0.00 | - | - | - | - |
| 40 | 0.03 | 0.09 | - | - | - | - |
| 41 | 0.02 | 0.01 | - | - | - | - |
| 42 | 0.11 | 0.12 | - | - | - | - |
| 43 | 0.07 | 0.18 | - | - | - | - |
| 44 | 0.04 | 0.17 | 0.01 | - | - | - |
| 45 | - | 0.13 | 0.06 | - | - | - |
| 46 | - | 0.05 | 0.12 | - | - | - |
| 47 | - | - | 0.02 | 0.01 | - | - |
| 48 | - | - | 0.08 | 0.09 | - | - |
| 49 | - | - | 0.07 | 0.15 | 0.01 | - |
| 50 | - | - | 0.07 | 0.08 | 0.05 | 0.02 |
| 51 | - | - | 0.11 | 0.02 | 0.08 | 0.04 |
| 52 | - | - | 0.06 | 0.06 | 0.08 | 0.03 |
| 1 | - | - | 0.05 | 0.07 | 0.03 | 0.07 |
| 2 | - | - | 0.03 | 0.02 | 0.01 | 0.02 |
| 3 | - | - | 0.05 | 0.04 | 0.03 | 0.11 |
| 4 | - | - | 0.04 | 0.05 | 0.04 | 0.07 |
| 5 | - | - | - | 0.02 | 0.02 | 0.09 |
| 6 | - | - | - | 0.03 | 0.09 | 0.05 |
| 7 | - | - | - | 0.01 | 0.06 | 0.07 |
| 8 | - | - | - | - | 0.02 | 0.03 |
| 9 | - | - | - | - | 0.01 | 0.02 |
| 10 | - | - | - | - | - | 0.02 |
| Range | 0.00-0.11 | 0.00-0.18 | 0.01-0.12 | 0.01-0.15 | 0.01-0.09 | 0.02-0.11 |
| Mean±SD | 0.04±0.03 | 0.06±0.07 | 0.06±0.03 | 0.05±0.04 | 0.05±0.03 | 0.05±0.03 |

## 4. CONCLUSION

The timing of maize sowing significantly influences the occurrence of FAW on maize. We observed variations in pest population dynamics throughout the growing season, with certain sowing dates experiencing higher and lower levels of incidence. The crop sown on August 2, 2021, was proven to be the best sowing time

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out of all six sowing dates. These findings highlight the importance of timely sowing dates as a potential management strategy to mitigate FAW damage to the maize. This data could prove valuable in designing pest monitoring systems and modules aimed at promoting sustainable management of FAW.

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