The Pharma Innovation Journal 2022; 11(12): 786-790

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(12): 786-790

www.thepharmajournal.com
Received: 12-10-2022
Accepted: 16-11-2022

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# Effect of different sowing dates and varieties on the incidence of fall army worm (*Spodoptera frugiperda*) in hybrid maize

**C Parhi, A Khuntia, US Nayak, AKB Mohapatra, BS Rath, A Nanda, AP Acharya and DS Priyadarshi**

**Abstract**
Field investigation was conducted during Rabi seasons of 2021 at Regional Research and Technology Transfer Station (RRTTS), Ranital, Bhadrak of Odisha University of Agriculture and Technology, Bhubaneswar, Odisha to study the Effect of different sowing dates and varieties on the incidence of Fall Army Worm *(Spodoptera frugiperda*) in hybrid maize. The experiment was carried out with the objective of studying the effect of sowing date and variety on the incidence of Fall Army Worm (FAW) in hybrid maize. The experiment laid out in a split plot design replicated thrice with 4 varieties i.e. two normal maize hybrids (DKC9081, 900 M gold) and two sweet corn varieties (Sugar 75 and NSCH130) in the main plot and four dates of planting (9th January, 19th January, 29th January and 8th February) in the sub-plots. Results of this systematic investigation revealed that the FAW (*Spodoptera frugiperda)* (J.E. Smith) larvae infested the sweet corn varieties earlier than the normal maize hybrid under the same date of sowing. The larval population was more in between 22nd February to 19th March, where a sizable crop damage occurred in all the varieties and sowing dates. The sweet corn variety Sugar 75 was more susceptible to the FAW, where the maximum damage to the tune of 64.84% and larva (1.18 /plant) was recorded, followed by the sweet corn variety NSCH130, where a crop damage up to 61.21% and larval intensity (1.05 /plant) was noticed. The hybrid DKC 9081 caused a damage up to 39.09%, whereas, in 900M gold it was 35.45 percent. The maximum insect infestation was observed under the third sowing date in all varieties with a maximum 60.83% in sweet corn variety, Sugar 75. The maximum insect infestation was observed in the third sowing date (up to 60.83%) followed by D4 (up to 54.16%), D1 (up to 49.16%) and D2 (47.50%) as the crop stage coincided with the peak population build up of FAW.

**Keywords:** Fall army worm, SMW, maize, WAS (Week after sowing)

## 1. Introduction
Maize (*Zea mays*) is one of the most important cereal crops in the world agricultural economy both as a food source and raw material for animal feed (Abebe & Feyisa, 2017) [1]. It is grown throughout the year because of its greater flexibility. In America and India, maize is referred to as corn which literally means "that which sustains life" (James 2001) [14]. It is grown with altitude ranges of 0 to 3000 meters above sea level (MSL). It has very high yield prospective, there is no cereal which has so immense potentiality and in this reason it is called "queen of cereals" (Parihar *et al*., 2011) [8]. It is rank third among the cereals next to wheat and rice in the world (FAO 2018) [15]. Maize is also the sources of various industrial raw materials like glucose, starch, ethanol, synthetic rubber, dyes etc. Food and Agriculture Organization (FAO) predicts that an additional 60 million tons of maize grain will be needed from the annual global harvest by 2030 (FAO 2018) [15]. The maize is cultivated to serve various purposes like human consumption, cattle and poultry feed, food processing and in the extraction of starch, dextrose, corn syrup, corn oil. Maize contains approximately 72% starch, 10% protein, and 4% fat, supplying an energy density of 365 Kcal /100 g (kumar *et al*., 2020) [7].
Maize is grown on around 2.8 lakh hectares in Orissa, of that Kharif maize alone accounts for about 2.6 Lakh hectares. South Odisha districts also show similar trend in growing of maize where Kharif maize is having the major contribution. The state has a cultivated area of 61.80 lakh hectares out of which 29.14 lakh ha (47%) is high land, 17.55 lakh ha (28%) medium land and 15.11 lakh ha (25%) low land**.** The state produces 7.79 lakh tones of maize with a productivity of 2785 kg/ha (Odisha Agricultural Statistics, 2018-19). Despite its current productivity is higher than other major cereal crops, the yield productivity is below its potential. This is due to many biotic and abiotic factors that can contribute to its yield potential

of productivity to be below the previous productivity. The crop is attacked by several pests viz., insects, nematodes, mites, birds, rodents. As many as 141 insect pests cause varying degree of damage to maize from the time of sowing till harvest. The Fall Army Worm (FAW), *Spodoptera frugiperda* (J.E. Smith) (Lepidoptera: Noctuidae), an invasive pest which is highly migratory and economically destructive, is native of tropical and subtropical regions of the Americas. The first infestation of FAW was reported formally in Africa during January 2016 and spread to several parts of African continent. Maize losses have been estimated at 2.5 to 6 million US $ in Africa in 2017. FAW has the potential of causing losses from 8 to 20 million tons of maize every year in the absence of effective control methods in 12 maize producing countries of Africa and has invaded the 44 African nations already a (Goergen *et al*. 2016; Prasanna *et al*. 2018) [6, 9]. The pest has been reported for the first time in India in Karnataka Shivamogga district in July 2018 (Sharanabasappa *et al*., 2018) [11] and subsequently in few other states, such as Andhra Pradesh, Telangana, Tamil Nadu, Maharashtra and Odisha. The production of maize in 2017-18 was 20,118 MT in Kharif and 8,634 MT in Rabi with a total production of 28,753 MT in India. After the entry of Fall Army Worm reduced to 19,410 MT in Kharif and 8300 MT in Rabi with a total of 27,720 MT in 2018-19. FAW displays high migratory ability (over 100 km per night), through which the moths can find a broad range of habitats within its preferred environmental conditions (Tendeng *et al*. 2019) [12]. The damage results from the young larvae feed on the opened leaves by scraping and skeletonizing the upper epidermis leaving a silvery transparent membrane, later on the larvae enters into the whorl and start feeding between the leaves.

## 2. Materials and Methods

### 2.1 Field sites details

The field trial were conducted at Agrometeorological field, Regional Research and Technology Transfer Station (RRTTS), Ranital, Bhadrak located at an elevation of 20 m above mean sea level at $21^0$ 8'58" N latitude and $86^0$ 33 '23" E longitude and North Eastern Coastal Plain Zone of Odisha. The soil of the experimental plot was sandy loam and acidic with a pH of 5.9. RRTTS comes under Tropical wet climate of Odisha.

### 2.2 Meteorological details

The general climatic condition of Ranital is under Tropical wet. The maximum temperature of crop growth period 2021 was 39.2 °C and minimum temperature was 11.8 °C. Summer season (March to May) is hot and humid, with temperatures ranging 18.3-39.2 °C. Winter season (December and January) is cold and dry with temperature ranging 12–28 °C. May is the hottest month, when daily temperatures range from 23.7-36.6 °C. January, the coolest month, has temperatures varying from 13.1–30 °C The highest recorded temperature is 39.2 °C and the lowest is 11.8 °C.

### 2.3 Weather conditions during crop growth season

The weekly mean of maximum temperature, minimum temperature, relative humidity (RH) and bright sunshine hour (BSH) along with total weekly rainfall, number of rainy days during the crop growth season ($9^{th}$ January–May 2021) is presented in Table 1.

The weekly maximum temperature during the crop growth period ranged from 27.5 to 39.2 °C, with a weekly average of 33.35 °C, whereas, the weekly minimum temperature varied from 11.8 to 23.6 °C, with a weekly average of 17.7 °C.

The mean morning relative humidity during the crop growth varied from 78 to 92%, while the mean afternoon relative humidity varied from 29 to 70%.The mean bright sunshine hour received during the crop growth period varied from 2.7 to 9.7 hours, with a weekly average of 6.2 hours. The total rainfall received during the crop growth period was 30.5 mm.

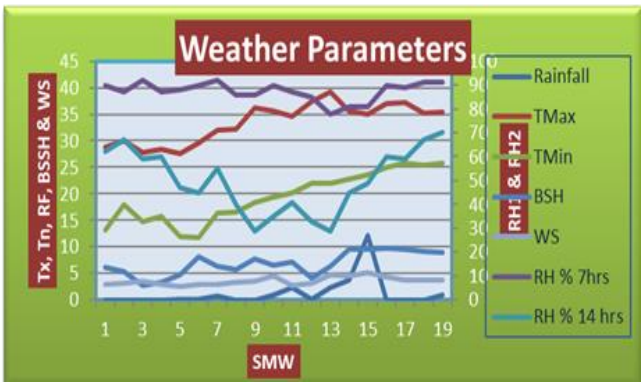


**Fig 1:** Weather parameter

### 2.4 Field experiment details

The field experiment was conducted during Rabi season of 2021, laid out in a split plot design with 4 varieties i.e. two normal maize hybrids (DKC9081, 900 M gold) and two sweet corn varieties (Sugar 75 and NSCH130) in main plots and sowing dates ($9^{th}$ January, $19^{th}$ January, $29^{th}$ January and $8^{th}$ February 2021) in sub plots which were replicated thrice. The dimension of the experimental area 57.5m X 27.5 m (1581.25 $m^2$) with each plot dimension of 6m X 4m (24 $m^2$). The field was laid out into 48 plots. The plots were separated by bonds and irrigation channels were provided to irrigate individual plot. The recommended dose of fertilizer is 150-75-75(N-$P_2O_5$-$K_2O$) kg/ha was applied in the form of Urea, DAP and Muriate of Potash (MOP).

### 2.5 Observation on tagged plant

Fall Army Worm larvae were counted from 10 randomly selected plant of each plot at the weakly interval (7 DAS) from the month of January (2021) to May (2021). The percentage of damaged plants per field (PD) was determined by dividing the number of plants with visual symptoms of FAW attack (Pd) by 10 randomly selected plant (Pt) and converted to percent values.

The average number of FAW larvae per field (LD) was determined by the number of larvae recorded per plant (Lr) divided by 10 randomly selected plant (Pt).

$$PD = Pd/ Pt* 100\% \quad (1)$$

$$LD = Lr/Pt \quad (2)$$

### 2.6 Statistical analysis

The weekly total count of Fall Army Worm in maize was taken. Analysis of variance for all the treatment in split plot design was carried out for testing the hypothesis the ANOVA table was used. The significance and non-significance treatment effect was judged with the help of "F" value was compared with the table value of "F" at 5% levels of significance.

## 3. Results and Discussion

### 3.1 Effect of variety and sowing dates on damage by Fall Army Worm

The data on the crop damage in different varieties study under various sowing dates are presented in the Table 1. It revealed that plant damage is more in between 5 WAS to 8 WAS i.e. 22nd February to 19th March, where a sizable crop damage occurred in all the varieties and sowing dates. The sweet corn variety, Sugar 75 ($V_3$) was more susceptible to the FAW, where the maximum damage to the tune of 63.33% was recorded, followed by the sweet corn variety, NSCH130 (V4) in which a crop damage up to 59.16% was noticed. However, the extent of damaged in both sweet corn varieties were found to be statistically similar. The FAW damage in the normal maize hybrids was significantly lower in comparison to the sweet corn varieties. While, in the hybrid DKC9081 ($V_1$), FAW caused a maximum damage up to 38.50%, in 900M gold ($V_2$) it was 36.00 percent.

Effect of sowing dates had significant influence on the FAW damage as the maximum insect infestation was observed in the sowing date D3 (up to 60.83%). The percentage of plant damage was up to 60% in D3 followed by D4 (up to 54.16%), D1 (up to 49.16%) and D2 (47.50%). Hence, the extent of crop loss by FAW was minimum in the second date sown crop. On the effect of sowing dates on FAW damage, Ayala *et al*., (2012) [4] had observed that 29th January sowing was more susceptible than 3rd February sowing. Naganna *et al*., (2020) [10] also found same that maximum cent percent incidence was observed on sweet corn varieties than normal maize hybrids.

**Table 1:** Effect of variety and sowing dates on Fall Army Worm damage

| Treatment | Week after sowing | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Effect of variety** | **WK 1** | **WK 2** | **WK 3** | **WK 4** | **WK 5** | **WK 6** | **WK 7** | **WK 8** | **WK 9** | **WK 10** | **WK 11** | **WK 12** |
| $V_1$ | 0.00 | 25.83 | 30.00 | 33.33 | 36.66 | 38.50 | 38.33 | 37.50 | 35.83 | 29.16 | 25.00 | 21.67 |
| $V_2$ | 0.00 | 23.33 | 28.33 | 31.67 | 35.00 | 36.00 | 35.83 | 35.00 | 33.33 | 29.06 | 24.83 | 21.00 |
| $V_3$ | 0.00 | 46.67 | 52.50 | 57.50 | 61.66 | 63.33 | 63.00 | 60.00 | 57.50 | 53.33 | 50.00 | 45.83 |
| $V_4$ | 0.00 | 43.33 | 48.33 | 52.50 | 56.66 | 59.16 | 56.67 | 55.00 | 53.33 | 50.00 | 45.83 | 41.66 |
| SEm | 0.00 | 1.50 | 2.05 | 2.25 | 2.65 | 3.01 | 3.03 | 2.88 | 2.49 | 1.36 | 0.96 | 0.83 |
| CD 5% | 0.00 | 5.19 | 7.12 | 7.48 | 8.00 | 8.79 | 8.84 | 7.78 | 6.98 | 4.70 | 3.32 | 2.98 |
| **Effect of sowing dates** | | | | | | | | | | | | |
| $D_1$ | 0.00 | 22.50 | 29.16 | 33.33 | 37.50 | 40.83 | 44.16 | 46.66 | 49.16 | 44.16 | 40.00 | 36.67 |
| $D_2$ | 0.00 | 30.00 | 34.16 | 37.50 | 40.83 | 44.16 | 47.50 | 44.16 | 40.83 | 36.66 | 33.33 | 30.00 |
| $D_3$ | 0.00 | 45.00 | 50.00 | 54.16 | 57.50 | 60.83 | 57.50 | 52.50 | 49.16 | 45.00 | 40.83 | 37.50 |
| $D_4$ | 0.00 | 41.67 | 45.83 | 50.00 | 54.16 | 50.00 | 47.50 | 44.16 | 40.83 | 35.83 | 32.50 | 26.66 |
| SEm | 0.00 | 1.33 | 1.43 | 1.73 | 1.98 | 2.06 | 2.08 | 1.99 | 1.46 | 1.10 | 0.98 | 0.76 |
| CD 5% | 0.00 | 3.90 | 4.15 | 5.06 | 5.76 | 6.01 | 6.35 | 6.01 | 4.27 | 3.21 | 3.00 | 2.35 |

### 3.2 Effect of variety and sowing dates on larval intensity of Fall Army Worm

The data on the larval intensity in different varieties study under various sowing dates are presented in the Table 2. It revealed that larval intensity is more in between 5WAS to 8 WAS i.e. 22nd February to 19th March, where maximum larvae occurred in all the varieties and sowing dates. The sweet corn variety, Sugar 75 ($V_3$) was more susceptible to the FAW, where the maximum larval intensity to the tune of 1.13 per plant was recorded, followed by the sweet corn variety, NSCH130 ($V_4$) in which up to 1.00 per plant was noticed. However, the extent of larvae in both these sweet corn varieties were found to be statistically similar. The FAW larvae in the normal maize hybrids was significantly lower in comparison to the sweet corn varieties. While, in the hybrid DKC9081 ($V_1$), FAW caused a maximum larvae up to 0.59 /plant, in 900 M gold ($V_2$) it was 0.58 /plant.

Effect of sowing dates had significant influence on the FAW larvae as the maximum insect larvae were observed in the sowing date D3 (up to 1.18 /plant) followed by D4 (up to 0.93 /plant), D1 (up to 0.85 /plant) and D2 (0.75 /plant). Hence, FAW larvae were minimum in the second date sown crop. Chormule *et al*., (2018) [16] who opined that the infestation percent of maize and sweet corn was 10% and 35%, respectively and sweet corn is regularly damaged by Fall Army Worm, whereas, others are attacked occasionally.

**Table 2:** Effect of variety and sowing dates with Fall Army Worm larval intensity per plant

| Treatment | Week after sowing | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Effect of variety** | **WK 1** | **WK 2** | **WK 3** | **WK 4** | **WK 5** | **WK 6** | **WK 7** | **WK 8** | **WK 9** | **WK 10** | **WK 11** | **WK 12** |
| $V_1$ | 0.00 | 0.37 | 0.45 | 0.51 | 0.55 | 0.59 | 0.58 | 0.57 | 0.55 | 0.48 | 0.40 | 0.30 |
| $V_2$ | 0.00 | 0.36 | 0.43 | 0.46 | 0.52 | 0.58 | 0.57 | 0.56 | 0.54 | 0.50 | 0.44 | 0.36 |
| $V_3$ | 0.00 | 0.71 | 0.84 | 0.92 | 1.05 | 1.13 | 1.06 | 1.03 | 0.99 | 0.89 | 0.77 | 0.62 |
| $V_4$ | 0.00 | 0.60 | 0.75 | 0.82 | 0.96 | 1.00 | 0.99 | 0.95 | 0.89 | 0.76 | 0.67 | 0.56 |
| SEm | 0.00 | 0.01 | 0.018 | 0.019 | 0.21 | 0.43 | 0.38 | 0.34 | 0.28 | 0.19 | 0.15 | 0.09 |
| CD 5% | 0.00 | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |
| **Effect of sowing dates** | | | | | | | | | | | | |
| $D_1$ | 0.00 | 0.26 | 0.32 | 0.36 | 0.53 | 0.61 | 0.68 | 0.75 | 0.85 | 0.76 | 0.65 | 0.52 |
| $D_2$ | 0.00 | 0.37 | 0.42 | 0.47 | 0.59 | 0.66 | 0.75 | 0.70 | 0.65 | 0.57 | 0.50 | 0.41 |
| $D_3$ | 0.00 | 0.76 | 0.89 | 1.0 | 1.05 | 1.18 | 1.06 | 0.97 | 0.85 | 0.75 | 0.64 | 0.53 |
| $D_4$ | 0.00 | 0.65 | 0.84 | 0.89 | 0.93 | 0.84 | 0.75 | 0.70 | 0.65 | 0.55 | 0.50 | 0.39 |
| SEm | 0.00 | 0.02 | 0.021 | 0.023 | 0.03 | 0.07 | 0.08 | 0.07 | 0.05 | 0.04 | 0.03 | 0.02 |
| CD 5% | 0.00 | 0.05 | 0.06 | 0.06 | 0.09 | 0.24 | 0.34 | 0.29 | 0.23 | 0.18 | 0.13 | 0.08 |

### 3.3 Response of variety towards larval intensity per plant and damage plant percentage

The data on the larval intensity and damage plant in different varieties study under different sowing dates presented in the Table 3. It revealed that the sweet corn variety sugar 75 variety was most susceptible to FAW where the maximum larval intensity to the tune of (1.18 /plant) and plant damage up to (64.84%), followed by the sweet corn variety, NSCH130 (V4) in which up to larval intensity (1.05 /plant) and extent of damage (61.21%). The FAW larvae and plant damage in the normal maize hybrids was significantly lower in comparison to the sweet corn varieties. In hybrid DKC9081 larval intensity up to (0.64 /plant), and plant damage (39.09%). The lowest larval intensity and plant damage occurred in hybrid 900Mgold (0.60 /plant) and (35.45%) respectively.

Effect of sowing dates had significant influence on the FAW larvae as the maximum insect larvae and plant damage were observed in the sowing date D3 (up to 1.18 /plant) and (64.84%) followed by sowing date D4 (up to 0.98 /plant and 56.66%), D1 (up to0.77 /plant and 50.90%), D2 (up to 0.77 /plant and 49.70%). However, the larval intensity and extent of damage on D1, D2 were found to be statistically similar. Ibrahim *et al*., (2019) [3] and Wahba *et al*., (2015) [13], whom reported that sweet corn varieties were more susceptible to pest then normal hybrid maize due to more TSS and total sugar content. Shahbaz Ahmad and Muhammad Arslan Ibrahim (2021) [2] who found that sweet corn variety were more susceptible to the normal hybrid variety.

**Table 3:** Response of variety towards larval intensity per plant and damage plant percentage

| MPT | SPT | Larval intensity per plant | Percentage of plant damage |
|---|---|---|---|
| $V_1$ (DKC9081) | $D_1$ | 0.41 | 28.48 |
| | $D_2$ | 0.39 | 28.19 |
| | $D_3$ | 0.64 | 39.09 |
| | $D_4$ | 0.45 | 32.11 |
| $V_2$ (900 M gold) | $D_1$ | 0.43 | 30.00 |
| | $D_2$ | 0.37 | 27.27 |
| | $D_3$ | 0.60 | 35.45 |
| | $D_4$ | 0.43 | 29.09 |
| $V_3$ (Sugar 75) | $D_1$ | 0.77 | 50.90 |
| | $D_2$ | 0.77 | 49.70 |
| | $D_3$ | 1.18 | 64.84 |
| | $D_4$ | 0.98 | 56.66 |
| $V_4$ (NSCH130) | $D_1$ | 0.70 | 46.06 |
| | $D_2$ | 0.68 | 46.06 |
| | $D_3$ | 1.05 | 61.21 |
| | $D_4$ | 0.88 | 52.42 |

## 4. Conclusion

From the findings of the present investigation, it can be concluded that varieties and sowing dates had significant influence on the feeding, population build up and damage of Fall Army Worm in maize. Among the different maize varieties Fall Army Worm larvae preferred the sweet corn varieties, with higher larval intensity and greater crop damage in comparison to the normal maize hybrids. Hence, in sweet corn cultivation adequate attention is required to protect the crop from FAW. Similarly, among the different sowing dates, the third date sown crop was very much vulnerable to FAW infestation, where the larvae started damaging the crop very early and thereby substantially reduced the early plant growth and vigour, which ultimately adversely affect the reproductive stage of the crop and finally on crop yield. Extent of damage by fall army and larval intensity was more in between 22nd February to 19th March, where sizable crop damage occurred in all the varieties and sowing dates.

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