Forage Res., **52**(2) : pp. 183-190 (2026) **http://forageresearch.in**

SCREENING OF MAIZE GENTOYPES AGAINST FALL ARMYWORM, *SPODOPTERA FRUGIPERDA* AND MANAGEMENT STRATEGIES WITH DIFFERENT DATES OF SOWING

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(Received: 23 July 2026; Accepted: 20 September 2026)

SUMMARY

Studies on screening of maize genotypes and management strategies with different date of sowing against fall army worm, *Spodoptera frugiperda* were undertaken at Department of Entomology and Research Farm Regional Research Station, Uchani, Karnal of CCS Haryana Agricultural University, during *Kharif*, 2020 under natural field infestation. Among the tested genotypes five genotypes were identified as partially resistant, twenty as susceptible and thirty as highly susceptible to *S. frugiperda*. Effect of crop sowing time indicated the minimum plant infestation (37.92%) in crop sown during 39th standard meteorological week (SMW) as compared to others.

Key words: Maize, screening, management and *Spodoptera frugiperda*

Maize is one of the most adaptable crop and can thrive in almost all agro-climatic conditions. It is the second major cereal crop in the world and originated from America (Badhai *et al.*, 2020). In *Kharif* season, maize accounts for approximately 83 per cent of the total area in India, though its productivity is considerably lower than that of *Rabi* maize owing to the higher pressure of biotic and abiotic stresses under rainfed conditions. Maize is grown in India throughout the year on an area of 120.91 lakh hectares with total production and productivity of 434.09 lakh tonnes and 3.59 tonnes ha^{-1}, respectively (Anonymous, 2025). In India, maize cultivation is mainly followed in Karnataka, Bihar, Tamil Nadu, Rajasthan, Uttar Pradesh, Telangana, Maharashtra, Madhya Pradesh, Haryana and Andhra Pradesh. In Haryana it is cultivated during *Kharif* and *Spring* seasons occupying an area of about 0.04 lakh hectares with annual production and productivity of 0.16 lakh tonnes and 3.7 tonnes per hectars, respectively (Anonymous, 2025).

In recent years, *S. frugiperda* (Lepidoptera: Noctuidae) has been evolved as an aggressive problem worldwide. Earlier, it was endemic to the tropical and subtropical regions of USA but for the first time, it was noticed in Nigeria, Sao Tomé, Benin, and Togo on the African continent (Goergen *et al.*, 2016).

Fall armyworm is an economically important insect pest native to tropical and subtropical America and has recently invaded India, causing more damage to maize and sorghum (Chormule *et al.*, 2019). This pest thrives on over 353 host crop spp. but feeds insatiably on every stage of the developing maize (Montezano *et al.*, 2018) making it a significant pest. Early instars of larvae create an extended papery window by scraping the epidermis of leaf (Sharanabasappa *et al.*, 2018). Conversely, 3rd instar onwards, larvae settle in leaf whorl and feed inside. This pest has spread to many countries including its invasion in India from 2018 in states like Karnataka, Tamil Nadu, Andhra Pradesh, Telangana and Maharashtra (Srikanth *et al.*, 2018; Maruthadurai & Ramesh, 2020). This is an invasive pest having gregarious feeding habit at all growth stages of plant with maximum damage to whorl area. So, repeated application of pesticide is required to manage this pest, that may increase the cost of production and residual issues of pesticides in corn. The adjustment of sowing time and seed rate are helpful to reduce pest infestation upto some extent. Therefore, present studies were undertaken to address the prevailing issue raised due to fall army worm.

MATERIALS AND METHODS

The studies were conducted at Research Farm and laboratories, Department of Entomology, CCS

Haryana Agricultural University, Hisar and Regional Research Station, Uchani, Karnal during *Kharif*, 2020. Pest infestation and pest abundance was observed on predetermined and tagged 50 plants per replication at each observation by visual count. Larval count was recorded in morning and evening hours between 6.30 am to 8.30 am and 5.00 pm to 7.00 pm, respectively from the tagged 50 plants. The observations were recorded at weekly interval starting from 5 days after germination till harvest of the crop.

Fifty-five maize genotypes (hybrids and inbreds) developed by CCSHAU were screened against *S. frugiperda* under natural field conditions during *Kharif*, 2020. The recommended agronomic practices were followed to raise the good crop (except application of insecticides). No insecticide was sprayed during the course of study. The crop was sown during 27th SMW at the spacing of 75 cm x 20 cm with four-meter row length. The observations on leaf injury were recorded as per the scale suggested by Davis and Williams (1992) for assessment of foliar damage by *S. frugiperda* in maize germplasm at 40-50 days after germination (Table 1). To study the effect of different date of sowing maize hybrid HQPM 1 was sown on five different dates/ SMWs during months of June and July at weekly interval (24/6/2020, 01/7/2020, 08/7/2020, 15/7/2020 and 22/7/2020). A spacing of 75 cm x 20 cm was followed in plots of 15 m^2 (five rows of 4-meter row length). The experiment was laid in Randomized Block Design (RBD) with four replications. The infestation was recorded at weekly interval by counting the number of larvae and infested plants starting from 5 days after germination to harvesting of the crop.

RESULTS AND DISCUSSION

The results of the evaluation studies of maize inbred and hybrid lines against *S. frugiperda* during field conditions showed that the susceptibility varied significantly across different maize genotypes (Fig.2). Five genotypes *viz.*, HKI 1105, HKI 139, HKI 193-2, HKI 1011 and HM 10 were found partially resistant (LIR 4.00 to 5.99 score) against this pest during *Kharif*, 2020. Twenty genotypes *viz.*, HKI 287, HKI 1105-ER-4-3, HKI 161, HKI 488-T, HKI 164-7-4, HKI 1354-7, HKI 586-3, HKI 536-YN, HKI 193-1, HKI 1344, HKI 327T, HKI 488, HKI 536, HKI 1664, HKI 325-17ANER-3, HKI 1352, HKI 288-2, HKI 1025, HQPM 5 and HQPM 7 were categorized as susceptible having leaf injury score of 6.00 to 7.99. However, thirty genotypes *viz.*, HKI 1651-1, HKI 488T-3, HKI 165, HKI 194-7, HKI 335, HKI 1041-2, HKI 788, HKI 1352-2FLT (3+11+18), HKI 1015-6, HKI 1352YE, HKI 1354-7, HKI 191-2-6, HKI 1348-6-2, HKI 1352-58-9-2, HKI 161ER-7-1, HKI 1354-2, HKI 1657, HKI 1348, HKI 1670, HKI 191-2-5, HKI 325-A, HKI 1558-4, HKI 1659, HKI 488-1RG, HKI 163ER-7, HKI PC-8, HKI 72286-1, HKI 323, HQPM 1 and HQPM 4 were reported to be highly susceptible having a leaf injury score of 8.00 to 9.00 (Table 2).

Differential reactions of germplasms to *S. frugiperda* infestation have been recorded by several researchers, which support the current study.

TABLE 1
Leaf injury Scale for recording leaf damage by *S. frugiperda*

Score	Response/Category	Damage symptoms/description
1	Highly resistant	No visible leaf-feeding damage
2	Resistant	Few pin holes on 1-2 older leaves
3	Resistant	Several shot hole injuries on a few leaves (<5 leaves) and small circular hole damage to leaves
4	Partially resistant	Several shot hole injuries on several leaves (6–8 leaves) or small lesions/pinholes, small circular lesions, and a few small elongated (rectangular-shaped) lesions of up to 1.3 cm in length present on whorl and furl leaves
5	Partially resistant	Elongated lesions (>2.5 cm long) on 8-10 leaves, plus a few small to midsized uniform to irregular shaped holes (basement membrane consumed) eaten from the whorl and/or furl leaves
6	Susceptible	Several large elongated lesions present on several whorl and furl leaves and/or several large uniform to irregular-shaped holes eaten from furl and whorl leaves
7	Susceptible	Many elongated lesions of all sizes present on several whorl and furl leaves plus several large uniform to irregular shaped holes eaten from the whorl and furl leaves
8	Highly susceptible	Many elongated lesions of all sizes present on most whorl and furl leaves plus many mid to large-sized uniform to irregular-shaped holes eaten from the whorl and furl leaves
9	Highly susceptible	Whorl and furl leave almost totally destroyed and plant dying as a result of extensive foliar damage

(Davis and Williams, 1992).

TABLE 2
Screening of maize inbreds and hybrids against *S. frugiperda* under natural infestation

S. No.	Genotypes	Leaf injury score based on Plant infestation	Relative Rating*
1.	HKI 1651-1	8.30	HS
2.	HKI 488T-3	8.50	HS
3.	HKI 165	8.65	HS
4.	HKI 287	6.45	S
5.	HKI 194-7	8.80	HS
6.	HKI 1105-ER-4-3	6.90	S
7.	HKI 161	6.80	S
8.	HKI 488-T	6.75	S
9.	HKI 164-7-4	6.60	S
10.	HKI 335	8.40	HS
11.	HKI 1041-2	8.45	HS
12.	HKI 788	8.60	HS
13.	HKI 1352-2FLT (3+11+18)	8.50	HS
14.	HKI 1015-6	8.80	HS
15.	HKI 1352YE	8.55	HS
16.	HKI 1354-7	8.40	HS
17.	HKI 191-2-6	8.65	HS
18.	HKI 1348-6-2	8.85	HS
19.	HKI 1105	4.60	PR
20.	HKI 1354-7	6.50	S
21.	HKI 1352-58-9-2	8.50	HS
22.	HKI 586-3	6.55	S
23.	HKI 161ER-7-1	8.55	HS
24.	HKI 1354-2	8.45	HS
25.	HKI 1657	8.25	HS
26.	HKI 1348	8.45	HS
27.	HKI 1670	8.35	HS
28.	HKI 191-2-5	8.80	HS
29.	HKI 536-YN	6.45	S
30.	HKI 193-1	6.55	S
31.	HKI 325-A	8.30	HS
32.	HKI 1558-4	8.75	HS
33.	HKI 1659	8.65	HS
34.	HKI 1344	6.75	S
35.	HKI 327T	6.55	S
36.	HKI 488-1RG	8.35	HS
37.	HKI 488	6.85	S
38.	HKI 536	6.70	S
39.	HKI 1664	6.75	S
40.	HKI 139	4.70	PR
41.	HKI 163ER-7	8.40	HS
42.	HKI 325-17ANER-3	6.55	S
43.	HKI 1352	6.60	S
44.	HKI PC-8	8.65	HS
45.	HKI 288-2	6.50	S
46.	HKI 193-2	4.80	PR
47.	HKI 1025	6.95	S
48.	HKI 1011	4.95	PR
49.	HKI 72286-1	8.80	HS
50.	HKI 323	8.50	HS
51.	HQPM 1	8.80	HS
52.	HQPM 4	8.70	HS
53.	HQPM 5	6.65	S
54.	HQPM 7	6.55	S
55.	HM 10	4.45	PR
	C.D. at 5%	0.823	-
	SE(m)	0.29	-

* S - Susceptible, PR - Partially Resistant, HS - Highly Susceptible, LIR - Leaf Injury Rating.

TABLE 3
Infestation of *S. frugiperda* on hybrid maize, HQPM 1 at different dates of sowing

Treatment	Date of sowing	Per cent plant infestation in maize hybrid, HQPM 1								
		02.07.2020 (27SMW)	09.07.2020 (28SMW)	16.07.2020 (29SMW)	23.07.2020 (30SMW)	30.07.2020 (31SMW)	06.08.2020 (32SMW)	13.08.2020 (33SMW)	20.08.2020 (34SMW)	27.08.2020 (35SMW)
T1	24/6/2020	0.00(0.00)	7.50(15.89)	9.25(17.71)	13.25(21.35)	19.50(26.21)	29.50(32.90)	48.50(44.14)	52.50(46.29)	55.00(47.87)
T2	1/07/2020	-	0.00(0.00)	8.75(17.21)	11.5(19.82)	16.25(23.77)	24.75(29.83)	30.75(33.68)	51.50(45.86)	55.75(48.30)
T3	8/07/2020	-	-	0.00(0.00)	10.25(18.67)	15.50(23.18)	20.75(27.10)	27.25(31.47)	35.50(36.57)	56.25(48.59)
T4	15/7/2020	-	-	-	5.50(13.56)	12.25(20.49)	17.25(24.54)	25.75(30.49)	31.50(34.14)	37.25(37.61)
T5	22/7/2020	-	-	-	2.50(9.10)	18.75(25.66)	22.50(28.32)	29.75(33.05)	35.50(41.27)	40.25(39.38)
C.D. at 5%	-	-	-	-	-	-	-	-	-	-
S.E.m (±)	-	-	-	-	-	-	-	-	-	-

Contd...

	03.09.2020 (36SMW)	10.09.2020 (37SMW)	17.09.2020 (38SMW)	24.09.2020 (39SMW)	01.10.2020 (40SMW)	Mean infestation (%)	C.D. at 5%	S.Em (±)
T1	59.25(50.33)	62.50(53.43)	66.25(56.01)	70.25(56.95)	-	37.92(38.01)	7.02	2.44
T2	57.75(49.46)	62.5(52.24)	66.25(54.48)	69.25(56.32)	75.5(60.33)	40.81(39.70)	6.89	2.39
T3	58.50(49.89)	61.75(51.80)	65.50(54.03)	76.25(60.63)	81.75(64.71)	42.44(40.65)	10.59	3.67
T4	61.50(51.65)	63.25(52.68)	67.75(55.40)	73.50(59.02)	86.75(68.65)	43.84(41.46)	9.99	3.46
T5	63.75(52.98)	68.25(55.70)	74.50(59.67)	82.25(65.08)	91.25(72.29)	48.50(44.14)	9.19	3.18
C.D. at 5%	-	-	-	-	(2.31)	-	-	
S. Em (±)	-	-	-	-	(0.74)	-	-	

SMW* (Standard meteorological week).

TABLE 4
Larval population of *S. frugiperda* on maize hybrid, HQPM 1 at different dates of sowing

Treatment	Date of sowing	Larval population/plant in HQPM 1								
		02.07.2020 (27SMW)	09.07.2020 (28SMW)	16.07.2020 (29SMW)	23.07.2020 (30SMW)	30.07.2020 (31SMW)	06.08.2020 (32SMW)	13.08.2020 (33SMW)	20.08.2020 (34SMW)	27.08.2020 (35SMW)
T1	24/6/2020	0.00 (0.00)	0.50 (0.71)	0.75 (0.87)	1.50 (1.22)	1.75 (1.32)	2.25 (1.50)	3.75 (1.94)	3.25 (1.80)	3.00 (1.73)
T2	1/07/2020	—	0.00 (0.00)	1.25 (1.12)	1.50 (1.22)	2.00 (1.41)	2.25 (1.50)	3.00 (1.73)	4.25 (2.06)	3.75 (1.94)
T3	8/07/2020	—	—	0.00 (0.00)	1.75 (1.32)	2.25 (1.50)	2.75 (1.66)	3.25 (1.80)	3.75 (1.94)	5.00 (2.24)
T4	15/7/2020	—	—	—	0.25 (0.50)	1.75 (1.22)	2.50 (1.58)	3.50 (1.87)	4.25 (2.06)	4.50 (2.12)
T5	22/7/2020	—	—	—	0.5 (0.71)	2.00 (1.41)	2.50 (1.58)	3.25 (1.80)	4.00 (2.00)	4.50 (2.12)
C.D. at 5%	-	-	-	-	-	-	-	-	-	-
S.E.m (±)	-	-	-	-	-	-	-	-	-	-

Contd...

	03.09.2020 (36SMW)	10.09.2020 (37SMW)	17.09.2020 (38SMW)	24.09.2020 (39SMW)	01.10.2020 (40SMW)	Mean larvae/ plant	C.D. at 5%	S.Em (±)
T1	2.75 (1.66)	2.50 (1.58)	1.25 (1.12)	0.50 (0.71)	—	1.83 (1.35)	NS	0.33
T2	3.50 (1.87)	3.25 (1.80)	2.75 (1.66)	1.75 (1.32)	0.75 (0.87)	2.50 (1.58)	NS	0.31
T3	4.50 (2.12)	4.00 (2.00)	3.50 (1.87)	2.00 (1.41)	0.75 (0.87)	2.79 (1.67)	NS	0.30
T4	5.25 (2.29)	4.25 (2.06)	3.50 (1.87)	2.25 (1.50)	1.25 (1.12)	3.02 (1.73)	NS	0.34
T5	5.00 (2.24)	4.50 (2.18)	3.75 (1.87)	3.00 (1.73)	2.00 (1.41)	3.18 (1.78)	NS	0.31
C.D. at 5%	-	-	-	-	-	(0.21)	-	-
S.E.m (±)	-	-	-	-	-	(0.07)	-	-

SMW* (Standard meteorological week).

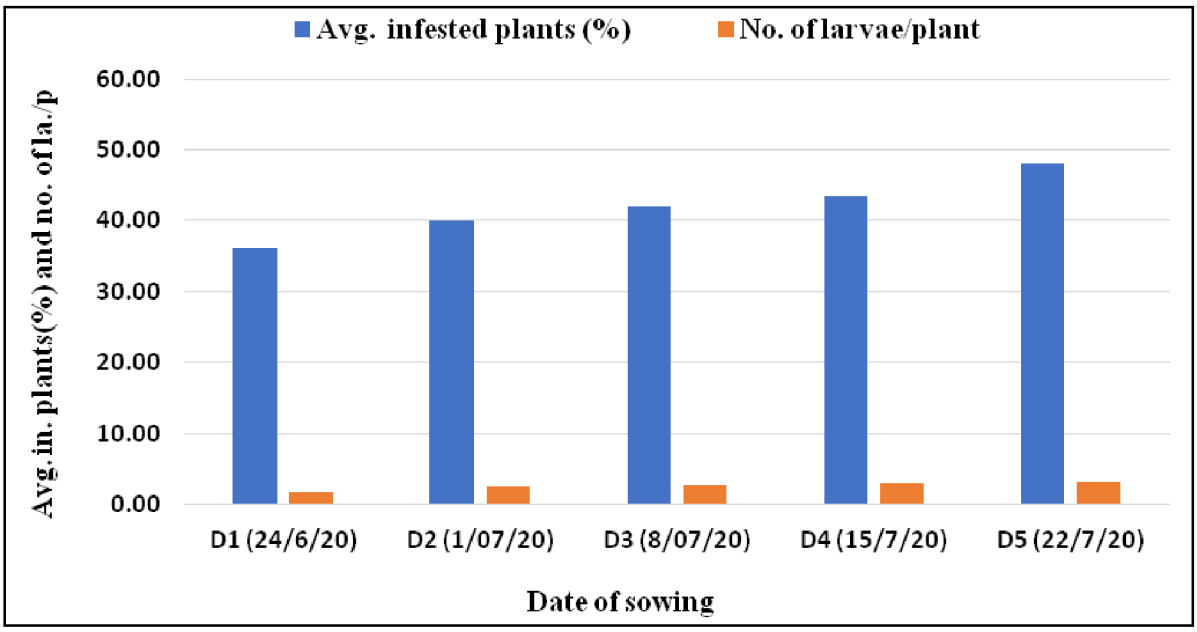

Fig. 1. Plant infestation and larval population of *S. frugiperda* on maize at different dates of sowing.



Fig. 2. Experimental field for screening of maize genotypes against *S. frugiperda* during *Kharif*, 2020.



Fig. 3. Experimental field for effect of date of sowing on incidence of *S. frugiperda* during *Kharif*, 2020.

According to Williams *et al.* (1990), the genotype Mp 708 (PI536520) was introduced as a source of resistance to *S. frugiperda* infestation and was developed by crossing Mp 704 with Tx 601 for eight generations. The average resistance scores for Mp 708, Mp704, Tx601, and Ab24E (sensitive standard) were 3.9, 4.4, 8.0, and 8.2, respectively. Wiseman *et al*. (1996) studied the resistance of a maize germplasm 'GT- FAWCC (C5)' to *S. frugiperda* infestation and found that for all resistance traits, this genotype was resistant to whorl damage than the susceptible test 'Ab24E × SC229'. Paiva *et al*. (2016) found that the transgenic genotypes, HX20A55, 30A91PW, LG6036PRO, 20A78HX, and BR 904 PRO were moderately resistant to *S. frugiperda* infestation, whereas two traditional genotypes, AG 1051 and AL Bandeirante, and a transgenic genotype BX1293 YG were found to be highly susceptible.

Data presented in Table 4, 5 and Fig.3, demonstrates the effect of different date sowing on the incidence of *S. frugiperda***.** Minimum infestation (37.92 %) of *S. frugiperda* was recorded on the crop sown on first date i.e. 24/6/2020 (26th SMW) which did not differ significantly with second date of sowing. Maximum plant infestation (48.50 %) by *S. frugiperda* was recorded on crop sown during 27th SMW (22.07.2020) and it differed significantly with other date of sowing. Minimum no. of *S. frugiperda* larvae (1.83 larvae/plant) was recorded on first date of sown crop which differed significantly with other treatments. Maximum population (3.18 larvae/plant) of *S. frugiperda* larvae were recorded on crop sown during 27th SMW (22.07.2020). The result revealed that minimum plant infestation as well as lowest larval population of *S. frugiperda* was observed on first date sown crop (24.06.2020) whereas larval population and infestation gradually increased as date of sowing is delayed (Fig.1). The present investigations were consistent with those of Ayala *et al.* (2013) who reported the damage caused by *S. frugiperda* on corn in northeast Argentina and found less prevalence of insect during optimum sowing date in spring i.e. September 28th (1.16 larvae/plant) compared to late sowing date in summer i.e. during January 29th (1.65 larvae/plant). Nyabanga *et al.* (2021) reported that the late planting resulted in a 40 per cent increase in the incidence of *S. frugiperda* attack as compared to early and medium planted maize crops. Variation in results of present findings and early workers may be attributed to the environmental conditions prevailing at the time of experimentation and genotypes used for studies.

CONCLUSION

Studies on screening of maize hybrid and inbred lines against *S. frugiperda* infestation under natural field conditions revealed that out of total 55 genotypes screened, five genotypes *viz.*, HKI 1105, HKI 139, HKI 193-2, HKI 1011 and HM 10 were found to be partially resistant (leaf injury score: 4.0 to 5.99). Twenty genotypes were categorized as susceptible (leaf injury score: 6.00 to 7.99) whereas 30 genotypes were reported to be highly susceptible (leaf injury score: 8.00 to 9.00) against *S. frugiperda* infestation. Fall armyworm lowest larval population (1.83 larvae/plant) and minimum plant infestation (37.92 %) was observed on crop sown during (26th SMW) while larval population and infestation gradually increased as date of sowing is delayed. Therefore, crop can escape from *S. frugiperda* infestation up to some extent if crop is sown early and by adjusting the sowing time.

ACKNOWLEDGEMENT

Authors are grateful to CCSHAU, Hisar (India) for providing all the necessary facilities to conduct this experiment during the study period.

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