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Effect of sowing dates and cultivars on the incidence of *Spodoptera frugiperda* (J.E. Smith) on maize (*Zea mays* L.) in Nagaland, India

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ABSTRACT: The Effect of sowing dates and cultivars on the incidence of fall army worm *Spodoptera frugiperda* (J.E. Smith) and yield attributes of maize (*Zea mays* L.) was carried out with five cultivars namely, Zarsi (local), Sipho (local), Ronimi (local), Khoi (local) and HQPM-1 (composite) and three different sowing dates (6th March, 21st March and 5th April). Among the different dates of sowing, 6th March recorded maximum pest incidence, while 5th April recorded the least on maize. The interaction between sowing dates and cultivars showed significant effect on the incidence of army worm at different days after sowing. The maize sown on 21st March, recorded the highest grain yield (4.12 t ha^{-1}). It can be suggested that manipulating the sowing date and growing of tolerant variety of maize such as HQPM1 can be an effective measure to manage exotic army worm infestation. Mid sowing of maize (21st March) and growing of local cultivars such as Sipho observed significantly better yield attributes which will ensure higher economic returns to the farmers.

KEY WORDS: Exotic army worm, months, pest incidence, grain yield

Maize (*Zea mays* L.) is an important cereal crop belonging to the family Gramineae. It is also called as the 'Queen of Cereals' which is the most widely cultivated cereal crop in India. It is a staple and an important source of carbohydrate in human diet and also serves as a source of animal feed (Onasanya *et al*., 2009), an important source of industrial and pharmaceutical production in the country (Olaniyan, 2015). The yield of maize is greatly affected by many insect pests. Out of 140 species of insect pests (army worm, stem borer, thrips, aphids, termites, white grub, seed corn maggots, root worms, Indian meal moth, grain borer and grain weevil during storage), only 12 species are the serious pests of maize causing damage from sowing to the harvesting and also in the storage conditions (Siddiqui and Marwaha, 1993). Exotic army worm *Spodoptera frugiperda* (J.E. Smith) (Lepidoptera, Noctuidae), infests maize crop from emergence to tasseling, silking and cob formation stage. The caterpillars feed on leaves and stems of more than 80 plant species.

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Dates of planting significantly influence the growth, development and yield due to climate changes that occur during the cropping season (Dahmardeh, 2012). Manipulation of sowing dates of crops is an important cultural practice to avoid the peak infestation of insect pests on the crop. In this context, the information pertaining to dates of sowing (DOS) on the incidence of major pest infestation in maize and also in yield has been lacking in the regions of Nagaland.

A field experiment was carried out in the experimental farm of SASRD, Nagaland University, Medziphema campus, Nagaland during March to July, 2019 located at 25° 45′ 45′′N; 93° 53′ 04′′E, at an altitude of 304.8m above mean sea level, in the foot hills of Nagaland. The experimental site falls under sub-tropical with high humidity and moderate annual temperature range (21-32°C), having average annual rainfall (2000 - 3000mm) and RH (70-80%). The soil is sandy loam in texture, acidic in nature with pH ranging from 4.5-6.5. The treatments are three dates of sowing [6th March (D_1), 21st March (D_2) and 5th April (D_3)] and five cultivars [Zarsi (C_1), Sipho (C_2), Ronimi (C_3), Khoi (C_4) and HQPM-1(C_5)]. The experiment was carried out in Split Plot Design with three replications, keeping planting dates in the main plot and cultivar in the sub plots. The main plot was

Table 1. Effect of different sowing dates and cultivars on leaf infestation by *Spodoptera frugiperda* on maize

Treatments	Infestation (%)		
	30 DAS	45 DAS	60 DAS
Sowing dates			
D1: 6th March	16.33(23.65)	21.87(27.73)	26.00(30.55)
D_2: 21st March	13.80(21.43)	18.00(24.82)	22.67(28.21)
D_3: 5th April	10.53(18.58)	14.47(22.07)	18.67(25.37)
SEm±	0.27	0.32	0.36
CD (p=0.05)	1.04	1.26	1.43
Cultivars			
C_1: Zarsi	15.56(23.06)	20.78(27.00)	25.56(30.28)
C_2: Sipho	10.78(18.99)	14.89(22.49)	18.89(25.59)
C_3: Ronimi	20.56(26.93)	25.78(30.47)	30.00(33.18)
C_4: Khoi	13.33(21.34)	17.78(24.90)	22.22(28.09)
C_5: HQPM1	7.56(15.79)	11.33(19.51)	15.56(23.08)
SEm±	0.43	0.50	0.69
CD (p=0.05)	1.25	1.47	2.02

Note: Figures in the table are mean values and those in parentheses are angular transformed values

divided into 5 sub-plots to accommodate five cultivars. Recommended agronomic package of practices were followed for the crop cultivation. The seeds were sown with a spacing of 60 X 25cm in a 4.2 X 1m plot size maintaining a population of 24 plants per plot. At random, ten plants were tagged in each plot to observe incidence of *S. frugiperda* at 30, 45, and 60 days after sowing (DAS). The crop was subjected to natural infestation and infestation was calculated (No. of infested plant/ Total no. of plants × 100). The yield attributes were recorded and the cob yield and grain yield were converted in t ha^{-1}. The data obtained were then subjected to analysis of variance (ANOVA). F test was used to determine the significance of difference between the two means and in case F-test was significant, the critical difference (CD) was calculated for comparison.

Effect of sowing dates and cultivars on leaf infestation by exotic army worm on maize:

DOS showed significant effect on infestation by army worm. At 30 DAS, the highest infestation (16.33%) was observed in 1st DOS, while it was the lowest (10.53%) in 3rd DOS. At 45 DAS the infestation was maximum in1st DOS (21.87%), followed by 2nd DOS (18.00%) and 3rd DOS (14.47%). Similar trend was observed at 60 DAS, where the highest infestation (26.00%) was noted at 1st DOS followed by 2nd DOS (22.67%) and the 3rd DOS recorded the lowest infestation (18.67%) (Table 1).

The interaction between sowing dates and cultivars showed significant effect on the incidence of army worm. At 30 DAS, 'Ronimi' sown on the 1st DOS recorded highest infestation (23.00%) and the lowest (6.00%) on the variety HQPM-1 sown on the 2nd DOS. At 45 DAS also Ronimi recorded, the highest percentage (29.33) sown on the 1st DOS and the lowest (9.00) HQPM-1 which was sown on 3rd DOS (Table 1). At 60 DAS the interaction between 1st DOS interacting with Ronimi showed the highest infestation and the lowest infestation was observed on the interaction of D_2C_5 (13.33%) and D_3C_1 (13.33%) with the variety HQPM-1(Table 2).

Table 2. Interaction effect of different sowing dates and cultivars on infestation by *Spodoptera frugiperda* on maize

Dates x Cultivars	Leaf infestation (%)		
	30 DAS	45 DAS	60 DAS
D_1C_1	18.67 (25.60)	25.33 (30.18)	30.00 (33.21)
D_1C_2	14.33 (22.23)	19.67 (26.30)	23.33 (28.88)
D_1C_3	23.00 (28.65)	29.33 (32.79)	33.33 (35.25)
D_1C_4	15.33 (23.04)	19.33 (26.05)	23.33 (28.86)
D_1C_5	10.33 (18.75)	15.67 (23.30)	20.00 (26.57)
D_2C_1	17.67 (24.85)	21.33 (27.51)	26.67 (31.07)
D_2C_2	10.67 (19.06)	15.33 (23.05)	20.00 (26.57)
D_2C_3	20.33 (26.79)	25.67 (30.44)	30.00 (33.21)
D_2C_4	14.00 (21.94)	18.33 (25.34)	23.33 (28.86)
D_2C_5	6.33 (14.53)	9.33 (17.78)	13.33 (21.34)
D_3C_1	10.33 (18.73)	15.67 (23.30)	20.00 (26.57)
D_3C_2	7.33 (15.68)	9.67 (18.11)	13.33 (21.34)
D_3C_3	18.33 (25.34)	22.33 (28.19)	26.67 (31.07)
D_3C_4	10.67 (19.06)	15.67 (23.31)	20.00 (26.57)
D_3C_5	6.00 (14.09)	9.00 (17.44)	13.33 (21.34)
SEm±	0.74	0.87	1.20
CD (p=0.05)	2.17	2.55	3.50

Note: Figures in the table are mean values and those in parentheses are angular transformed values

Table 3. Effect of different sowing dates and cultivars on yield attributes of maize

Treatments	No. of cobs plant^{-1}	Cob length (cm)	Cob diameter (cm)	Fresh cob weight (g cob^{-1})	Cob yieldt ha^{-1}	Grain yieldt ha^{-1}
Sowing dates						
D_1: 6th March	1.48	12.00	4.41	176.49	4.17	3.13
D_2: 21st March	1.61	14.20	4.64	214.39	5.49	4.12
D_3: 5th April	1.55	13.53	4.49	194.84	4.79	3.59
Sem±	0.001	0.12	0.01	1.51	0.04	0.03
CD (p=0.05)	0.004	0.48	0.03	5.94	0.15	0.11
Cultivars						
C_1: Zarsi	1.45	13.44	4.52	194.45	4.49	3.37
C_2: Sipho	1.62	14.44	4.74	214.04	5.50	4.13
C_3: Ronimi	1.38	12.56	4.32	188.29	4.15	3.11
C_4: Khoi	1.55	12.00	4.26	180.00	4.45	3.34
C_5: HQPM1	1.73	13.78	4.72	199.42	5.49	4.12
SEm±	0.002	0.13	0.01	1.73	0.04	0.03
CD (p=0.05)	0.005	0.37	0.04	5.05	0.11	0.09

The present finding indicates that late sowing performed better in regards to infestation by exotic army worm than early sowing. HQPM-1 was the most tolerant among the cultivars which might be due to the difference in morphological character like compactness of leaf tissue, hard and tough stem and genetic variability which render the variety 'HQPM - 1' cultivar to escape the attack.

Effect of sowing dates and cultivars on yield attributes of maize:

The results obtained revealed that maize sown on D_2 (21st March) significantly recorded the highest number of cob per plant (1.61), cob length (14.20 cm), cob diameter (4.64 cm), fresh cob weight (214.39g cob^{-1}), cob yield (5.49 t ha^{-1}) and grain yield (4.12 t ha^{-1}). Early sowing D_1 (6th March) recorded lesser yield. Among the different cultivars, HQPM1 (C_5) recorded the highest number of cob per plant (1.73) while the least was observed in Ronimi (1.38). The cultivar Sipho (C_2) recorded significantly higher cob length (14.44cm), cob diameter (4.74cm), fresh cob weight (214.04g cob^{-1}), cob yield (5.50 t ha^{-1}) and grain yield (4.13 t ha^{-1}) as compared to other cultivars (Table 3). The results showed significant interaction effect between sowing dates and cultivars on yield attributes (Table 4). The interaction between D_2C_5 (DOS 21st March and cultivar HQPM-1) recorded the highest number of cobs per plant (1.80) and cob diameter (4.90cm). The highest cob length (15.33cm), fresh cob weight (234.40 g cob^{-1}), cob yield (6.23 t ha^{-1}) and grain yield (4.67 t ha^{-1}) was obtained from the interaction between DOS 21st March and cultivar Sipho. It was observed that the late sown 2nd DOS crop (21st march) proved the best one as it gave the highest grain yield of 4.12 t ha-1 than that sown early on 1st DOS (March). The findings of Chaudhary and Sharma (1992) are also in accordance with the present studies.

From the results obtained in the present study, it can be concluded that late sowing of maize (5th

Table 4. Interaction effect of different sowing dates and cultivars on yield attributes of maize

DOS x Culti vars	Cobs plant^{-1}	Cob length (cm)	Cob diam eter (cm)	Fresh cob weight (g cob^{-1})	Cob yield t ha^{-1}	Grain yield t ha^{-1}
D_1C_1	1.38	12.33	4.40	176.27	3.87	2.90
D_1C_2	1.56	13.67	4.63	200.38	4.95	3.71
D_1C_3	1.32	11.00	4.23	167.22	3.51	2.63
D_1C_4	1.48	10.33	4.20	158.47	3.75	2.81
D_1C_5	1.66	12.67	4.57	180.10	4.75	3.57
D_2C_1	1.52	14.33	4.67	212.88	5.12	3.84
D_2C_2	1.67	15.33	4.85	234.40	6.23	4.67
D_2C_3	1.45	13.67	4.43	204.72	4.71	3.53
D_2C_4	1.62	13.00	4.37	204.53	5.25	3.94
D_2C_5	1.80	14.67	4.90	215.40	6.15	4.62
D_3C_1	1.45	13.67	4.50	194.20	4.47	3.35
D_3C_2	1.62	14.33	4.75	207.35	5.33	4.00
D_3C_3	1.38	13.00	4.30	192.92	4.23	3.17
D_3C_4	1.55	12.67	4.20	177.00	4.35	3.27
D_3C_5	1.73	14.00	4.70	202.75	5.57	4.18
CD (p= 0.05)	0.009	0.63	0.07	8.75	0.20	0.15

April) and HQPM1 variety recorded significantly lower incidence of fall army worm at all stages of crop growth compared to early sowing. Therefore, it can be suggested that manipulating the sowing date and growing of tolerant variety of maize as HQPM1 can be an effective measure to manage exotic army worm infestation. Mid sowing of maize (21st March) and growing of local cultivars such as Sipho observed significantly better yield attributes which will ensure higher economic returns to the farmers.

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