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Developmental and morphometric parameters of *Spodoptera frugiperda* on maize genotypes

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Abstract
The fall army worm, *Spodoptera frugiperda* (J.E. Smith, 1797) is a polyphagous insect pest that damages several field crops including corn, sorghum, cotton and soybean in many parts of the world. In this study, the effect of 8 maize genotypes on biological and morphometric parameters of *S. frugiperda* was studied under laboratory conditions. The results showed that the longest larval and pupal period and adult longevity were observed on genotype JM-218 (14.24, 9.99 and 36.65 days, respectively), while it was shortest on CHH-213 (11.47, 9.01 and 33.28 days, respectively). Significant differences were observed in head capsule width, body length and width of different larval instars. Based on these parameters, JM-218 and CHH-213 were found to be least and highly suitable genotypes for the insect development.

Keywords: Morphometric parameters, *Spodoptera frugiperda*, maize genotypes

Introduction

The fall army worm (FAW), *S. frugiperda* (Lepidoptera: Noctuidae) is a pest of America. Recently, it has also been detected causing damage in the India (Kalleshwaraswami *et al*., 2018 and Montezano *et al*., 2019) [4, 8]. It is reported to attack about 353 plant species belonging to 76 families, but greatest damage occurs in grasses such as maize and sorghum, and in other monoculture crops such as cotton and soybean (Pitre and Hogg, 1983) [12]. FAW has been identified as a notorious polyphagous pest with high migration ability, a wide range of hosts, voracious feeder with high fecundity, resulting in economic damage to the crops (Westbrook *et al*., 2016) [19].

It is well known fact that host plants play an important role in the growth and development of insect pests, ultimately leading to a higher or lower rate in population increase. The indiscriminate and repeated use of particular pesticides by the farmers over the years is one of the factors for the development of resistance in pest population as well as resurgence (Kumar, 2007) [6]. The alternative methods of pest control are therefore more promising and the cultivation of least susceptible genotypes is one, which is hoped that it will halt the resurgence and resistance development in pests (Kurra and Pathipati, 2013) [7].

Maize is one of the most important cereal crops next to wheat and rice in the world (http://iimr.icar.gov.in) [3]. The identification of potential cultivar(s) of maize which are least susceptible to *S. frugiperda,* is of paramount importance and a vital component for efficient pest management strategies (Kurra and Pathipati, 2013) [7].

Therefore, this work was aimed to evaluate the developmental and morphometric parameters of *S. frugiperda* on different maize genotypes.

Material and Methods

The experiment was carried out in the Biocontrol Research and Production Centre, Department of Entomology, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh. Seeds of eight maize genotypes (*viz*. CHH-202, CHH-213, CHH-214, HMM-1018, HMM-1019, JM-216, JM-218 and Pusa Jawahar Hybrid Maize-1) were obtained from All India Coordinated Research Project on Maize, Zonal Agriculture Research Station, Chhindwara, (M.P.).The crop was raised as per the recommended package of practices of the university, except the plant protection measures.

To maintain the culture of *S. frugiperda* in the laboratory, egg masses were collected from the unsprayed maize fields of College of Agriculture, Jabalpur and placed in petri dishes over a moist blotting paper for hatching.

After hatching, neonates were individualized into plastic container (3.5 cm height, 2 cm diameter) and fed with 25 to 40 days old leaves of each genotype until pupation (Santos *et al.*, 2004) [15]. Pupae were sexed and separated (Butt and Cantu, 1962) [2]. Seven pair of male and female moths were placed in ovipositional plastic container and provided with 10% honey-water solution as a food for the adult moths. Five maize plants of 15 days old were placed in a 250 ml conical flask with water and supplied to female moth as an ovipositional substrate. Studies were carried out at 25±1 °C and 65±5% RH, with a photoperiod of 16:8 (L: D), as suggested by Kurra and Pathipati, (2013) [7].
The design of the experiment was completely randomized with eight treatments and replicated thrice. Duration for completion of larval, prepupal and pupal period and adult longevity were recorded on all the tested genotypes. Measurement of head capsule width and body length and width were taken with ocular micrometer. The significance of the treatments were computed by applying DMRT test.

Results and Discussion

Data on incubation period given in Table 1 revealed that it differed significantly among the genotypes. Shortest embryonic developmental period was observed on CHH-213 (2.43 days) followed by CHH-202 (2.56 days), CHH-214 (2.61 days) and PHM-1 (2.69 days), but all were at par with each other. While it was delayed on JM-218 (2.97 days) and did not differ significantly with JM-12, HMM-1018 and JM-216 (2.86, 2.84 and 2.76 days, respectively).These findings are in conformity with several workers (Santos *et al*. 2004, Murua *et al*. 2008, Sharanabasappa *et al*. 2018, Manjula *et al*. 2019, Bankar 2020, Tiwari 2020 and Rajisha *et al*. 2021) [15, 10, 16, 8, 1, 17, 13], as they also claimed that the average incubation period ranged from 2-3 days on different corn geotypes. In the present study, the shortening of the incubation period in CHH-213 may reflect a shorter generation time, which may result in a larger number of generations and, as a consequence, greater damage.

Duration of larval instars

The data presented in Table 1 revealed that the *S. frugiperda* larvae passed through six instars on different maize genotypes and moulted five times to attain full maturity. The differences in the mean larval duration of first to fifth instar among different genotypes were significant. However, sixth instar was found to be non-significant.
The mean larval duration of first to sixth instar was shortest when larvae were reared on CHH-213 (2.49, 1.35, 1.22, 1.49, 1.95 and 2.92 days, respectively) followed by CHH-202 (2.53, 1.42, 1.29, 1.59, 2.00 and 2.99 days, respectively), but no significant difference were observed between them. While it was significantly prolonged on JM-218 (2.90, 1.86, 1.73, 2.32, 2.33 and 3.06 days, respectively) which exhibited non-significant differences with JM-12 (2.88, 1.75, 1.61, 2.27, 2.29 and 3.02 days, respectively) and HMM-1018 (2.79, 1.80, 1.69, 2.06, 2.11 and 3.04 days, respectively). Similar findings have been reported by Santos *et al*. (2003), and they reported that the average larval duration of first to fifth instars of *S. frugiperda* on different corn genotypes ranged from 2.97-3.12, 1.88-1.90, 1.51-1.78, 1.97-2.12 and 2.27 days, respectively. The present findings contradicts that of Tiwari (2020) [17], who reported that larval period of first to sixth instars varied from 2.00-2.10, 2.95-3.90, 2.05-2.95, 2.15-3.00, 3.05-4.25 and 4.00-4.70 days, respectively. An extended duration of the larval phase is considered as a compensatory strategy when food is not suitable for their development so that they extend their period of feeding to form active pupae and adults (Yu *et al*., 2020) [20].
The duration of the sixth larval instar significantly differed with all the other instars and the larva had spent maximum time during the sixth instar (3.01 days), whereas it was minimum during the third instar (1.48 days) (Table 4).

Morphometrics of different larval instars

The data presented in Table 2 indicated that the mean head capsule width, larval body length and width of different instars were significant.
The mean head capsule width (HCW) of first to sixth instar was minimum when larvae were fed on JM-218 (0.329, 0.439, 0.738, 1.084, 1.948 and 2.473 mm, respectively) followed by JM-12 (0.331, 0.441, 0.747, 1.201, 2.017 and 2.491 mm, respectively) and HMM-1018 (0.334, 0.443, 0.751, 1.185, 1.999 and 2.494, respectively), but the latter two were at par with each other. However, maximum HCW of first to sixth instars recorded were 0.340, 0.454, 0.761, 1.430, 2.216 and 2.637 mm, respectively on genotype CHH-213.The present findings corroborates that of Tiwari (2020) [17], who claimed that the HCW of first to fifth instars ranged from 0.34-0.36, 0.46-0.48, 0.71-0.74, 1.26-1.29 and 1.99-2.01 mm, respectively, when reared on different maize genotypes. In the present study FAW reared on genotype CHH-213, resulted in the development of smaller size individuals which led to the formation of smaller sized pupae and the adults emerged had low reproductive capacity and longevity.
The mean body length (BL) of first to sixth instar was minimum when larvae were reared on JM-218 (1.614, 3.417, 6.908, 11.860, 17.830 and 32.463 mm, respectively) followed by HMM-1018 (1.635, 3.527, 7.113, 11.922, 18.032 and 32.792 mm, respectively) and JM-12 (1.637, 3.590, 6.965, 11.940, 18.070 and 32.722 mm, respectively), but non-significant differences were observed among them. Whereas, maximum BL of first to sixth instar was recorded on CHH-213 (1.721, 4.217, 7.990, 13.488, 20.203 and 34.740 mm, respectively) and was at par with CHH-202 (1.684, 4.097, 7.822, 13.442, 19.883 and 33.865 mm, respectively). Similar findings have been reported by Bankar (2020) [1] and he also claimed that maize was highly preferred by *S. frugiperda*, which resulted in the development of maximum larval length of all the six instars (1.68, 4.20, 9.30, 11.90, 22.10 and 35.90 mm, respectively).
The mean body width (BW) of first to sixth instar was minimum in JM-218 fed larvae (*ie*.,0.324, 1.075, 1.427, 2.475, 3.371 and 4.188 mm, respectively) followed by JM-12 (0.326, 1.092, 1.439, 2.486, 3.392 and 4.192 mm, respectively) and HMM-1018 (0.329, 1.096, 1.433, 2.502, 3.386 and 4.208 mm, respectively), but all were at par with each other. Whereas highest BW was observed in genotype CHH-213 (0.338, 1.197, 1.599, 2.635, 3.525 and 4.343 mm, respectively) which exhibited non-significant differences with CHH-202 (0.337, 1.188, 1.583, 2.618, 3.515 and 4.330 mm, respectively). Our study is in disagreement with Bankar (2020) [1], who reported that the mean body width of first to sixth instars was less and it ranged from 0.17-0.19, 0.99-1.02, 1.07-1.55, 1.80-3.05, 2.40-3.30 and 3.30-3.95 mm, respectively, when *S. frugiperda* larvae were reared on different food plants. This variation may be attributed to the difference in the preference of the host plants by the pest.
Data on various morphological traits (HCW, BL and BW) presented in Table 6 revealed that it differed significantly

among all the six instars and was minimum during first instar (0.33, 1.67 and 0.33 mm, respectively), while maximum in the sixth instar (2.56, 33.37 and 4.27 mm, respectively).

Total larval period

The total larval duration varied significantly among the genotypes (Table 1) and was shortest on CHH-213 (11.47 days) followed by CHH-202 (11.87 days), but both were at par with each other. The longest total larval duration was recorded on JM-218 (14.24 days) but was at par with JM-12 (13.87 days). Earlier total larval duration has been reported to be 14-19 days (Sharanabasappa *et al*., 2018) [16] and 11-20 days (Montezano *et al*., 2019) [9] on different food diets.

Prepupal period

Before entering into the prepupal stage, full grown larva stopped feeding and decreased in size, and was greenish and bright brown color.

The data presented in Table 1 showed that the differences in the prepupal period among tested genotypes were significant and was shortest when larvae were reared on CHH-213 (1.11 days) which was followed by CHH-202 (1.17 days) and CHH-214 (1.23 days), but they did not differ significantly with each other. Whereas, the larvae reared on JM-218 showed longest prepupal period (1.38 days), but was statistically at par with HMM-1018, JM-12, JM-216, PHM-1 and CHH-214 (1.33, 1.32, 1.31, 1.26 and 1.23 days, respectively). Similar, results were reported by Montezano *et al*. (2019) [9] and Navasaro and Navasaro (2020) [11], as they also claimed that the prepupal stage of *S. frugiperda* was completed in 1-3 days on different food diets.

Pupal period

It is evident from Table 1 that there was a significant difference in the pupal period among the genotypes and it was shortest on CHH-202 (8.75 days) followed by CHH-213, PHM-1 and CHH-214 (9.01, 9.21 and 9.34 days, respectively), but non-significant differences were observed among them. The pupal period was significantly prolonged on JM-218 (9.99 days) which was at par with HMM-1018, JM-12 and JM-216 (9.86, 9.64 and 9.52 days, respectively), In the present study, female pupae emerged 1–2 days earlier than the male pupae, which might be attributed to the immediate need for the search of food and to locate suitable oviposition sites. Furthermore, migratory female possess a greater migration capacity than the male moths, which ensures the rapid expansion of migratory populations (Wang *et al*., 2020) [18].

Adult longevity

Significant differences were observed in the male and female moth longevity among the genotypes (Table 1).

Minimum longevity of male was recorded on JM-218 (8.64 days) followed by JM-12 (8.76 days), but both were at par with each other. Maximum longevity of male was observed on CHH-202 (10.43 days) but did not differ significantly with CHH-213 (10. 40 days). The present finding is in conformity with that of Santos *et al*. (2004) [15] and Sharanabasappa *et al*. (2018) [16] as they also observed that the male longevity of *S. frugiperda* on maize ranged from 7-10.86 days.

Minimum longevity of female was noticed on JM-12 (10.20 days), but was statistically at par with CHH-214 (10.30 days). Whereas, maximum longevity was observed on HMM-1018 (10.55 days).Similarly Sharanabasappa *et al*. (2018) [16] and Rajisha *et al*. (2020) [13] revealed that the female longevity of *S. frugiperda* on maize lasted for 9-12 days.

Total life span

Perusal of the data in Table 1 revealed that significant differences was observed among the genotypes for total life span of male and female moths, it was shortest when the pest was reared on CHH-213 (33.17 and 33.40 days, respectively) and was followed by CHH-202 (33.58 and 33.63 days, respectively), but both were at par with each other. While, it was longest on JM-218 (36.06 and 37.65 days, respectively) which exhibited non-significant difference with HMM-1018 (35.86 and 36.7 days, respectively).The present finding corroborates the findings of Sharanabasappa *et al*. (2018) [16] and Rajisha *et al*. (2021) [13], as they also recorded an average total life expectancy of 32-46 and 34-47 days of male and female moths, respectively.

The male longevity and total life span (9.55 and 34.70 days, respectively) was significantly shorter than the female moths (10.41 and 35.43 days, respectively) (Table 5).

Morphometrics of *S. frugiperda* pupae

Data on length and width of male and female pupae presented in Table 3 revealed that it differed significantly among the genotypes.

Male pupae

The male pupal length and width were shortest on JM-218 (13.76 and 2.86 mm, respectively), while it was longest on CHH-213 and CHH-202 (both registered 15.25 and 3.38 mm, respectively).

Female pupae

The shortest female pupal length and width were recorded on JM-218 (15.86 and 3.88 mm, respectively) which was followed by JM-12 (16.00 and 3.92 mm, respectively), but both were at par with each other. However, the maximum length and width of female pupae were observed on CHH-213 (17.76 and 4.16 mm, respectively). The present findings are in close proximity with the findings of Navasaro and Navasaro (2020) [11], as they reported that the length and width of male and female pupae to be 15.28 and 16.15 mm; 4.81 and 4.93 mm, respectively, when reared on maize at 27º-29 °C. In the present findings shortest length and width of *S. frugiperda* pupae were obtained from JM-218, indicates a negative influence of secondary metabolite in the leaves of this genotype which might have reduced the food conversion and absorption of essential nutrients by the insect for transformation into a healthy and robust pupae.

From Table 7 it is evident that the length and width of male pupae (14.66 and 3.14 mm, respectively) were significantly shorter than that of female pupae (16.84 and 4.01 mm, respectively).

Morphometric of *S. frugiperda* adult

Significant differences were observed among the genotypes with regard to wing expansion and body length of male and female moths.

Male: Minimum wing expansion and body length of male moths were observed on JM-218 (30.57 and 11.59 mm, respectively), whereas, it was maximum on CHH-214 (33.06 and 13.10, respectively) and was at par with CHH-202 (33.27 and 13.13 mm, respectively) and CHH-213 (33.37 and 13.40 mm, respectively).

Female: Minimum wing expansion and body length of female moths were recorded on JM-218 (31.70 and 13.82 mm, respectively), while, it was maximum on CHH-213 (34.62 and 15.76 mm, respectively), but was at par with CHH-202 (34.54 and 15.62 mm, respectively) and CHH-214 (34.20 and 15.66 mm, respectively). Similarly, Kalyan *et al*. (2020) [5] and Navasaro and Navasaro (2020) [11], have reported that the size of male and female moths of *S. frugiperda* varied from 29.00×12.20 mm to 35×17 mm and 29×13 mm to 34×17 mm, respectively, when reared on maize leaves.

Significant differences were observed for wing expansion and body length between both the moths of both the sexes (Table 7). It was significantly shorter in male (32.32 and 12.55 mm, respectively) than the female moths (33.23 and 14.78 mm, respectively).

Table 1: Duration and longevity of *S. frugiperda* developmental stages fed on different maize genotypes

Maize genotypes	Mean duration of different life stages of *S. frugiperda* (days)*													
	Incubation period	Larval instars						Total larval duration	Pre pupa	Pupa	Adult longevity		Total life span	
		First	Second	Third	Fourth	Fifth	Sixth				Female	Male	Female	Male
CHH-202	2.56^{cd} (1.89)	2.53^{c} (1.88)	1.42^{cd} (1.55)	1.29^{de} (1.51)	1.59^{de} (1.61)	2.00^{b} (1.73)	2.99^{a} (2.00)	11.87^{fg} (3.59)	1.17^{bc} (1.47)	8.75^{e} (3.12)	10.44^{abc} (3.38)	10.43^{a} (3.38)	33.63^{d} (5.88)	33.58^{cd} (5.88)
CHH-213	2.43^{d} (1.85)	2.49^{c} (1.87)	1.35^{d} (1.53)	1.22^{e} (1.49)	1.49^{e} (1.58)	1.95^{b} (1.72)	2.92^{a} (1.98)	11.47^{g} (3.53)	1.11^{c} (1.45)	9.01^{de} (3.16)	10.48^{ab} (3.39)	10.40^{a} (3.38)	33.40^{d} (5.86)	33.17^{d} (5.85)
CHH-214	2.61^{cd} 1.9b	2.60^{c} 1.9b	1.62^{abc} (1.62)	1.42^{c} (1.56)	1.86^{bc} (1.69)	2.15^{ab} (1.77)	3.02^{a} (2.00)	12.65^{de} (3.69)	1.23^{abc} (1.49)	9.34^{bcde} (3.21)	10.30^{bc} (3.36)	9.90^{b} (3.30)	34.90^{c} (5.99)	34.46^{bc} (5.95)
HMM-1018	2.84^{abc} (1.96)	2.79^{ab} (1.95)	1.80^{a} (1.67)	1.69^{a} (1.64)	2.06^{ab} (1.75)	2.11^{ab} (1.76)	3.04^{a} (2.01)	13.53^{bc} (3.81)	1.33^{a} (1.53)	9.86^{b} 3.3a	10.55^{a} (3.40)	9.20^{d} (3.19)	36.79^{ab} (6.15)	35.86^{a} (6.07)
JM-12	2.86^{ab} (1.97)	2.88^{a} (1.97)	1.75^{ab} (1.66)	1.61^{ab} (1.62)	2.27^{a} (1.81)	2.29^{a} (1.81)	3.02^{a} (2.00)	13.87^{ab} (3.86)	1.32^{ab} (1.52)	9.64^{abc} (3.26)	10.20^{c} (3.35)	8.76^{e} (3.12)	36.57^{b} (6.13)	35.37^{ab} (6.03)
JM-216	2.76^{abc} (1.94)	2.78^{ab} (1.94)	1.64^{abc} (1.62)	1.52^{bc} (1.59)	2.07^{ab} (1.75)	2.15^{ab} (1.78)	3.03^{a} (1.99)	13.15^{cd} (3.76)	1.31^{ab} (1.52)	9.52^{abcd} (3.24)	10.47^{ab} (3.39)	9.46^{cd} (3.23)	35.91^{b} (6.08)	35.09^{ab} (6.01)
JM-218	2.97^{a} (1.99)	2.90^{a} (1.97)	1.86^{a} (1.69)	1.73^{a} (1.65)	2.32^{a} (1.82)	2.33^{a} (1.82)	3.06^{a} (2.01)	14.24^{a} (3.90)	1.38^{a} (1.54)	9.99^{a} (3.31)	10.45^{abc} (3.38)	8.64^{e} (3.10)	37.65^{a} (6.22)	36.06^{a} (6.09)
PHM-1	2.69^{abcd} (1.92)	2.63^{bc} (1.90)	1.49^{bcd} (1.58)	1.41^{cd} (1.55)	1.76^{cd} (1.66)	1.96^{b} (1.72)	3.02^{a} (2.00)	12.35^{ef} (3.65)	1.26^{abc} (1.50)	9.21^{cde} (3.20)	10.39^{abc} (3.37)	9.64^{bc} (3.26)	34.63^{c} (5.97)	33.98^{cd} (5.91)
S.Em±	0.022	0.02	0.03	0.01	0.02	0.02	0.012	0.024	0.02	0.03	0.011	0.019	0.025	0.026
CD at 5%	0.067	0.06	0.08	0.04	0.07	0.06	NS	0.073	0.05	0.089	0.032	0.057	0.075	0.078

The means followed by the same letters in each column are non-significant (p<0.05, DMRT)

* = Figures in parentheses are square root transformed values

Table 2: Morphological traits of *S. frugiperda* larvae on different maize genotypes

Maize genotypes	Morphometrical traits of different larval instars of *S. frugiperda* (mm)*																	
	Head capsule width						Larval length						Larval width					
	First	Second	Third	Fourth	Fifth	Sixth	First	Second	Third	Fourth	Fifth	Sixth	First	Second	Third	Fourth	Fifth	Sixth
CHH-202	0.340^{a} (1.158)	0.456^{a} (1.207)	0.762^{a} (1.327)	1.421^{a} (1.556)	2.210^{a} (1.792)	2.642^{a} (1.908)	1.684^{ab} (1.638)	4.097^{a} (2.257)	7.822^{ab} (2.970)	13.442^{a} (3.800)	19.883^{a} (4.570)	33.865^{b} (5.905)	0.337^{ab} (1.156)	1.188^{ab} (1.479)	1.583^{ab} (1.607)	2.618^{ab} (1.902)	3.515^{a} (2.125)	4.330^{ab} (2.309)
CHH-213	0.340^{a} (1.158)	0.454^{ab} (1.206)	0.761^{a} (1.327)	1.430^{a} (1.559)	2.216^{a} (1.793)	2.637^{a} (1.907)	1.721^{a} (1.650)	4.217^{a} (2.284)	7.990^{a} (2.998)	13.488^{a} (3.806)	20.203^{a} (4.605)	34.740^{a} (5.978)	0.338^{a} (1.157)	1.197^{a} (1.482)	1.599^{a} (1.612)	2.635^{a} (1.907)	3.525^{a} (2.127)	4.343^{a} (2.312)
CHH-214	0.337^{ab} (1.156)	0.455^{ab} (1.206)	0.757^{ab} (1.326)	1.404^{a} (1.551)	2.190^{a} (1.786)	2.620^{a} (1.903)	1.706^{a} (1.645)	4.123^{a} (2.263)	7.713^{bc} (2.952)	12.577^{b} (3.685)	19.550^{a} (4.533)	33.990^{b} (5.915)	0.335^{abc} (1.155)	1.186^{ab} (1.479)	1.540^{abc} (1.594)	2.625^{ab} (1.904)	3.460^{bc} (2.112)	4.328^{ab} (2.308)
HMM-1018	0.334^{bc} (1.155)	0.443^{cd} (1.201)	0.751^{bc} (1.323)	1.185^{d} (1.478)	1.999^{c} (1.732)	2.494^{d} (1.869)	1.635^{bc} (1.623)	3.527^{c} (2.127)	7.113^{de} (2.848)	11.922^{d} (3.594)	18.032^{c} (4.362)	32.792^{cd} (5.813)	0.329^{cde} (1.153)	1.096^{c} (1.448)	1.433^{d} (1.560)	2.502^{cd} (1.871)	3.386^{de} (2.094)	4.208^{c} (2.282)
JM-12	0.331^{c} (1.153)	0.441^{de} (1.200)	0.747^{c} (1.322)	1.201^{d} (1.483)	2.017^{c} (1.737)	2.491^{d} (1.869)	1.637^{bc} (1.624)	3.590^{bc} (2.142)	6.965^{e} (2.822)	11.940^{d} (3.597)	18.070^{c} (4.367)	32.722^{cd} (5.807)	0.326^{de} (1.152)	1.092^{c} (1.446)	1.439^{d} (1.562)	2.486^{d} (1.867)	3.392^{de} (2.096)	4.192^{c} (2.279)
JM-216	0.338^{ab} (1.157)	0.444^{c} (1.202)	0.756^{abc} (1.325)	1.275^{c} (1.508)	2.088^{b} (1.757)	2.552^{c} (1.885)	1.673^{abc} (1.635)	3.777^{b} (2.185)	7.263^{d} (2.874)	12.175^{cd} (3.630)	18.147^{c} (4.376)	33.235^{c} (5.851)	0.332^{bcd} (1.154)	1.143^{b} (1.464)	1.494^{cd} (1.579)	2.527^{c} (1.878)	3.422^{cd} (2.103)	4.297^{b} (2.301)
JM-218	0.329^{c} (1.153)	0.439^{e} (1.199)	0.738^{d} (1.318)	1.084^{e} (1.444)	1.948^{d} (1.717)	2.473^{d} (1.864)	1.614^{c} (1.617)	3.417^{c} (2.102)	6.908^{e} (2.812)	11.860^{d} (3.586)	17.830^{c} (4.339)	32.463^{d} (5.785)	0.324^{e} (1.151)	1.075^{c} (1.441)	1.427^{d} (1.558)	2.475^{d} (1.864)	3.371^{e} (2.091)	4.188^{c} (2.278)
PHM-1	0.334^{bc} (1.155)	0.453^{b} (1.205)	0.752^{abc} (1.324)	1.344^{b} (1.531)	2.113^{b} (1.764)	2.595^{b} (1.896)	1.686^{ab} (1.639)	3.763^{b} (2.182)	7.542^{c} (2.923)	12.368^{bc} (3.656)	18.807^{b} (4.450)	33.203^{c} (5.848)	0.332^{bcd} (1.154)	1.161^{ab} (1.470)	1.516^{bc} (1.586)	2.594^{b} (1.896)	3.493^{ab} (2.120)	4.312^{ab} (2.305)
S.Em±	0.001	0.001	0.001	0.005	0.004	0.002	0.006	0.017	0.014	0.033	0.024	0.015	0.001	0.005	0.007	0.003	0.003	0.002
CD at 5%	0.002	0.002	0.003	0.014	0.012	0.006	0.017	0.050	0.042	0.099	0.072	0.046	0.002	0.016	0.021	0.01	0.01	0.007

The means followed by the same letters in each column are non-significant (p<0.05, DMRT)

* = Figures in parentheses are square root transformed values

Table 3: Morphological traits of *S. frugiperda* pupae and adult reared on different maize genotypes

Maize genotypes	Morphometrics of *S. frugiperda* of both sexes (mm)*							
	Pupa				Moths			
	Female		Male		Female		Male	
	Length	Width	Length	Width	Wingspan	Length	Wingspan	Length
CHH-202	17.66^{a} (4.32)	4.12^{ab} (2.26)	15.25^{a} (4.03)	3.38^{a} (2.09)	34.54a (5.96)	15.62a (4.08)	33.27a (5.85)	13.13a (3.76)
CHH-213	17.76^{a} (4.33)	4.16^{a} (2.27)	15.25^{a} (4.03)	3.38^{a} (2.09)	34.62a (5.97)	15.76a (4.09)	33.37a (5.86)	13.40a (3.79)
CHH-214	17.41^{b} (4.29)	4.09^{ab} (2.26)	15.10^{a} (4.01)	3.32^{a} (2.08)	34.20a (5.93)	15.66a (4.08)	33.06a (5.84)	13.10a (3.76)
HMM-1018	16.23^{d} (4.15)	3.93^{cd} (2.22)	14.45^{bc} (3.93)	2.94^{cd} (1.98)	32.36c (5.78)	14.12cd (3.89)	31.32c (5.68)	12.01d (3.61)
JM-12	16.00^{e} (4.12)	3.92^{cd} (2.22)	14.18^{c} (3.90)	3.02^{c} (2.00)	32.35c (5.78)	14.17cd (3.89)	31.87bc (5.73)	11.94d (3.60)

JM-216	16.88^{c} (4.23)	3.97^{c} (2.23)	14.70^{b} (3.96)	3.11^{b} (2.03)	32.83bc (5.82)	14.60b (3.95)	32.14b (5.76)	12.45c (3.67)
JM-218	15.86^{e} (4.11)	3.88^{d} (2.21)	13.76^{d} (3.84)	2.86^{d} (1.96)	31.70d (5.72)	13.82d (3.85)	30.57d (5.62)	11.59e (3.55)
PHM-1	16.94^{c} (4.23)	4.05^{b} (2.25)	14.63^{b} (3.95)	3.19^{b} (2.05)	33.22b (5.85)	14.52bc (3.94)	32.95a (5.83)	12.79b (3.71)
S.Em±	0.01	0.005	0.01	0.007	0.02	0.017	0.02	0.012
CD at 5%	0.029	0.015	0.031	0.021	0.05	0.05	0.05	0.037

The means followed by the same letters in each column are non-significant (p<0.05, DMRT)
* = Figures in parentheses are square root transformed values

Table 4: Comparative studies on duration of different larval instars of FAW reared on different maize genotypes

Larval instars	Mean duration (days)	Paired 't' test of mean duration of different larval instars (days) #					
		First	Second	Third	Fourth	Fifth	Sixth
First	2.70	-	**	**	**	**	**
Second	1.62	**	-	**	**	**	**
Third	1.48	**	**	-	**	**	**
Fourth	1.93	**	**	**	-	**	**
Fifth	2.12	**	**	**	**	-	**
Sixth	3.01	**	**	**	**	**	-

n
** 't' test was significant at 1% level of significance

Table 5: Comparative studies on adult longevity and life span of FAW reared on different maize genotypes

Adults	Longevity (days)	Total life span (days)
♀	10.41	35.43
♂	9.55	34.70
Paired 't' test	**	**

n = 8
** 't' test was significant at 1% level of significance

Table 6: Comparative studies on morphometrics of different larval instars of FAW reared on different maize genotypes

Larval instars	Mean head capsule width (mm)	Paired 't' test of mean head capsule width between different larval instars						Mean body length (mm)	Paired 't' test of mean body length between different larval instars						Mean body width (mm)	Paired 't' test of mean body length between different larval instars					
		1st	2nd	3rd	4th	5th	6th		1st	2nd	3rd	4th	5th	6th		1st	2nd	3rd	4th	5th	6th
1st	2.70	-	**	**	**	**	**	1.67	-	**	**	**	**	**	0.33	-	**	**	**	**	**
2nd	1.62	**	-	**	**	**	**	3.81	**	-	**	**	**	**	1.14	**	-	**	**	**	**
3rd	1.48	**	**	-	**	**	**	7.41	**	**	-	**	**	**	1.50	**	**	-	**	**	**
4th	1.93	**	**	**	-	**	**	12.47	**	**	**	-	**	**	2.56	**	**	**	-	**	**
5th	2.12	**	**	**	**	-	**	18.81	**	**	**	**	-	**	3.45	**	**	**	**	-	**
6th	3.01	**	**	**	**	**	-	33.37	**	**	**	**	**	-	4.27	**	**	**	**	**	-

n = 8
** 't' test was significant at 1% level of significance

Table 7: Comparative studies on pupal and adult morphometrics of FAW reared on different maize genotypes

Sex	Morphometrics (mm)			
	Pupa		Adult moth	
	Length	Width	Body length	Wing expansion
♀	16.84	4.01	14.78	33.23
♂	14.66	3.14	12.55	32.32
Paired 't' test	**	**	**	**

n = 8
** 't' test was significant at 1% level of significance

Conclusions

Among the eight maize genotypes, CHH-213 genotype was found to be highly preferred by *S. frugiperda* as is evident by high mean values of all the developmental and morphometric parameters. Whereas, genotype JM-218 was least preferred as it registered minimum values of all the developmental and morphometric parameters and had negative influence on the growth of fall armyworm.

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