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IMPACT OF MAIZE GENOTYPIC VARIABILITY ON MORPHOMETRIC TRAITS OF FALL ARMYWORM (*SPODOPTERA FRUGIPERDA*)

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ABSTRACT

The Fall army worm, *Spodoptera frugiperda* (J.E. Smith) (Lepidoptera: Noctuidae), an important polyphagous insect pest, attacks 350 plant species in dozens of countries. In this study 50 larvae of *S. frugiperda* were measured on JM 218 (Highly susceptible) and CHH 213 (least susceptible genotype) maize genotypes. Results showed that the existence of six larval instars on both genotypes. The progressive growth in head capsule width (HCW) during successive instar follows Dyar's law, whereas the progressive growth in body length (BL) and body width (BW) showed deviation from the theory of Przibram and Megusar. In conclusion, progressive development in the *S. frugiperda* morphometric traits (HCW, BL and BW) were not affected by tested maize genotypes.

Key words : *Spodoptera frugiperda* larvae, Morphometric traits, Maize genotypes, Genotypic susceptibility.

Introduction

Determination of instar distribution can provide important information for pest management (Calvo and Molina, 2009). Spray applications usually are done during a particular stage of larval development to be effective. For example, Neem seed kernel extract a generalized botanicals against lepidopteran pests, generally is applied to coincide with population at the peak frequencies of 1st and 2nd instar larvae, to maximize treatment effects (Wakil *et al.*, 2012). Accurate determination of population age and phenology not only provide a tool for timing spray application, but also for explaining the reasons for treatment failures (Mc clellan and Logan, 1994). Morphometric methods are powerful research tools when used in the context of biological knowledge. According to Dyar (1980), head capsule width measurement provides a reliable estimate of the age of the larvae, because it shows minimal variation during intermolt.

Spodoptera frugiperda (FAW) is the most important noctuid pest in the Americas; recently it has been detected in Asian countries including India. It was first detected in India on 18th May 2018 in maize fields at the College of Agriculture, Shivamogga, Karnataka (Sharanabasappa *et al.*, 2018) and later in Madhya Pradesh in March 2019 (Vishwakarma *et al.*, 2020). Since then, it has rapidly spread across all maize-growing states (Suby *et al.*, 2020). However, information about this invasive insect-pest is scarce in Indian condition. Currently, brief morphometric descriptions of the *S. frugiperda* larvae are available in the literature (Sharanabasappa *et al.* 2018 and Motezano *et al.* 2019), but no detailed morphometric studies have been found on different maize genotypes.

Hence, in the present study the morphometric variation of *S. frugiperda* larval exoskeleton was examined on JM-218 and CHH-213 maize genotypes under laboratory conditions.

Materials and Methods

Insect mass culture : Initially, late larval instars of *S. frugiperda* were collected from unsprayed maize fields of College of Agriculture, Jabalpur. Larvae were individually transferred to transparent plastic containers (3.5×2) and provided fresh maize leaves till pupation. Pupae were sexed and separated. Seven pair of male and female moth were placed in ovipositional plastic container and provided 10% honey-water solution as a food for adult moths. 15 days old five maize plant were placed in a 250 ml conical flask with water and supplied to female moth as a ovipositional substrate. Studies were carried out at 25±2^{0}C and 60-70% RH, with a photo period of 14:10 (L:D), as suggested by Sandhyarani and Usharani (2013).

Biometrical observations : Freshly moulted 30 larvae were killed in hot water (60°C temperature) HCW, BL and BW of each larva instar was measured with the help of ocular micrometer.

Applicability of Dyar's (1890) law was tested for all the larval instars and relationship between instars, and the mean head capsule width of larva was calculated. The observations on the larval body length and width were tested for the applicability of Prazibran and Megusar's (1912) rule and the regression lines were obtained. Further, the following parameters were calculated as suggested by Maghodia (2005).

1). $\text{Growth ratio} = \dfrac{\text{Value of succeeding instar}}{\text{Value of preceeding instar}}$

2). Difference = Observed value of instar- Estimated value of instar.

3). $\text{Difference (\%)} = \dfrac{\text{Difference}}{\text{Estimated value}} \times 100$

Results and Discussion

Least susceptible genotype JM 218

Persual of data (Table 1) on the mean HCW revealed that, when the larvae reared on genotype JM-218 were measured 0.32, 0.43, 0.73, 1.08, 1.94 and 2.40 mm with the estimated width 0.31, 0.47, 0.73, 1.12, 1.72 and 2.63 mm in 1st to 6th instar respectively. The measurement falls into six different groups, each characterized as an instar. Similarly, Capinera (2017), Shranabasappa *et al*. (2018) and Motazano *et al*. (2019), who reported that HCW of *S. frugiperda* first to sixth instar ranged from 0.35 to 2.60 mm, 0.34 to 1.96 mm and 0.35 to 2.72 mm, respectively on various food sources. In the present studies the number of larval instars was 6 less than the findings of Murua *et al*. (2003) as they reported 7 larval instars on artificial diet. According to Esperk *et al*. (2007) number of instars, is related to a compensation scenario, where additional instars are inserted in poor conditions when larvae fail to reach a species- specific threshold - size with the normal instar number.

The growth ratio in successive instar was also computed and the mean observed and estimated progression factors were 1.51 and 1.53, respectively. The

Table 1 : Comparison of the progressive development of *S. frugiperda* HCW on the highly and least susceptible maize genotypes.

Head capsule width for *S.frugiperda*											
JM-218 (Least susceptible)						**CHH-213 (Highly susceptible)**					
Instar	**Observed**	**Growth ratio**	**Estimated**	**Difference**	**Difference %**	**Instar**	**Observed**	**Growth ratio**	**Estimated**	**Difference**	**Difference %**
I	0.329	-	0.311	0.018	5.79	I	0.34	-	0.325	0.015	4.62
II	0.439	1.33	0.478	-0.039	-8.16	II	0.454	1.34	0.508	-0.054	-10.63
III	0.738	1.68	0.732	0.006	0.82	III	0.761	1.68	0.792	-0.031	-3.91
IV	1.084	1.47	1.122	-0.038	-3.39	IV	1.43	1.88	1.235	0.195	15.79
V	1.948	1.80	1.720	0.228	13.26	V	2.216	1.55	1.927	0.289	15.00
VI	2.473	1.27	2.636	-0.163	-6.18	VI	2.637	1.19	3.006	-0.369	-12.28
Progression factor	-	1.51	1.537	-	-	**Progression factor**	-	1.53	1.563	-	-

Table 2 : Comparison of the progressive development of *S. frugiperda* BL on the most and least susceptible maize genotypes.

Body length for *S. frugiperda*											
JM-218 (Least susceptible)						CHH-213 (Highly susceptible)					
Instar	**Observed**	**Growth ratio**	**Estimated**	**Difference**	**Difference %**	**Instar**	**Observed**	**Growth ratio**	**Estimated**	**Difference**	**Difference %**
I	1.614	-	1.744	-0.130	-7.45	I	1.721	-	1.492	0.229	15.35
II	3.42	2.12	3.134	0.286	9.13	II	4.22	2.45	2.660	1.560	58.65
III	6.91	2.02	5.629	1.281	22.76	III	7.99	1.89	4.742	3.248	68.49
IV	11.86	1.72	10.113	1.747	17.27	IV	13.49	1.69	8.452	5.038	59.61
V	17.83	1.50	18.167	-0.337	-1.86	V	20.2	1.50	15.060	5.140	34.13
VI	32.46	1.82	32.636	-0.176	-0.54	VI	34.74	1.72	26.850	7.890	29.39
Progression factor	-	1.84	1.797	-	-	**Progression factor**	-	1.85	1.783	-	-

Table 3 : Comparison of the progressive development *of S. frugiperda* BW on the highly and least susceptible maize genotypes.

Width for *S. frugiperda*											
JM-218 (Least susceptible)						CHH-213 (Highly susceptible)					
Instar	**Observed**	**Growth ratio**	**Estimated**	**Difference**	**Difference %**	**Instar**	**Observed**	**Growth ratio**	**Estimated**	**Difference**	**Difference %**
I	0.325	-	0.486	-0.161	-33.13	I	0.338	-	0.529	-0.191	-36.11
II	1.075	3.31	0.785	0.290	36.94	II	1.197	3.54	0.847	0.350	41.32
III	1.427	1.33	1.267	0.160	12.63	III	1.599	1.34	1.355	0.244	18.01
IV	2.475	1.73	2.046	0.429	20.97	IV	2.635	1.65	2.167	0.468	21.60
V	3.371	1.36	3.303	0.068	2.06	V	3.525	1.34	3.467	0.058	1.67
VI	4.188	1.24	5.333	-1.145	-21.47	VI	4.343	1.23	5.546	-1.203	-21.69
Progression factor	-	1.79	1.615	-	-	**Progression factor**	-	1.82	1.601	-	-

estimated and observed value of progression factors were very close to each other indicating that growth of larvae was in a definite progression factor. When log HCW plotted against number of instars, almost straight regression line was obtained, and the following regression equation was fitted:

$\log_{10} Y= 0.185x-0.691$

It is evident from the data Table 2 that the BL increased from 1.61 to 32.46 mm in six instars. The observed and estimated progression factors were 1.84 and 1.79, respectively. The regression equation was:

$\log_{10} Y= 0.254x+0.012$

The data presented in Table 3 showed that the mean BW for the first instar was 0.32 mm and it increased to 4.18 mm in the sixth instar. The geometrical progression factor was estimated 1.61 and regression equation obtained was:

$\log_{10} Y=0.208x-0.521$

The mean progression factor of observed and estimated BL and BW had shown a deviation from the value of 1.26 as required by Przibram's rule. Thus, the data obtained in the present investigation did not support Przibram and Megussar theory (Tables 2 and 3).

Highly susceptible genotype CHH-213

Data in Table 1 indicated that the average observed and estimated progression factor which was computed by taking the mean growth ratio which were observed to be 1.63 and 1.56, respectively. The observed head capsule width of 1^{st} to 6^{th} instar was 0.34, 0.45, 0.76, 1,43, 2.21 and 2,63 mm, respectively. The approximation of the data on observed and estimated head width as well as progression factors is evidence that no moult has been accidentally missed through the life cycle of this pest. The following regression equation was fitted:

$\log_{10} Y=0.193x-0.680$

Data depicted in Table 2 exhibited that the average body length for first to sixth instar larvae ranged from 1.72 to 34.74 mm, respectively. The mean observed and estimated progression factor obtained from the mean growth ratio for different instars was 1.85 and 1.78, respectively. The regression equation was fitted:

$\log_{10} Y=0.251x+0.077$

The observed and estimated geometrical progression factors were 1.82 and 1.60, respectively. Data on mean body width ranged from 0.33 to 4.34 mm with the calculated value 0.52 to 5.54 mm, respectively (Table 3). The regression equation for the six larval instars was:

$\log10\ Y= 0.204x-0.480$

Conclusion

In the present study, six larval instar of *S. frugiperda* noticed on tested genotypes. The sequential increase in HCW across instars exhibited a consistent geometric progression, in accordance with Dyar's Law. In contrast, the growth patterns of BL and BW did not align with Przibram's and Megusar rule, suggesting non-isometric development in these parameters. These findings indicate that the morphometric progression of *S. frugiperda* larvae was not influenced by the maize genotypes.

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