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MORPHOMETRICS OF *SPODOPTERA FRUGIPERDA* (J E SMITH) AS INFLUENCED BY CEREAL HOSTS

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ABSTRACT

This laboratory study evaluate the morphometrics of fall army worm *Spodoptera frugiperda* (J E Smith) influenced by four cereal host plants. In maize, larval head capsule width was 0.22, 0.42, 0.71, 1.13, 1.29 and 2.94 mm for I to VI instars, respectively in sorghum was 0.20, 0.41, 0.67, 1.06, 1.24 and 3.05 mm for I to VI instars, respectively. In pearl millet, larval head capsule width was 0.19, 0.29, 0.52, 0.83, 1.23 and 2.80 mm, for I to VI instars, respectively. In sugarcane, head capsule width was 0.22, 0.43, 0.67, 0.94, 1.22 and 2.70 mm for I to VI instars, respectively. The mean pupal length varied significantly when reared on different cereal host plants, it was significantly maximum on maize (15.10 mm) followed by sorghum (14.20 mm), sugarcane (13.10) and lowest on pearl millet (12.30 mm). The significantly maximum pupal weight was noticed on maize (185.90 mg) followed by sorghum (144.40 mg), sugarcane (124.80 mg) and lowest on pearl millet (104.70 mg).

Key words: *Spodoptera frugiperda*, maize, bajra, sorghum, sugarcane, morphometrics, head capsule, wing span, instars, body length, body weight, cereal hosts, Dyar's law

The fall armyworm, *Spodoptera frugiperda* (J E Smith) (Lepidoptera: Noctuidae) is a polyphagous, gregarious, destructive, and dreaded insect-pest infesting 353 plant species from 76 families principally Poaceae (106), Asteraceae (31) and Fabaceae (31) (Montezano et al., 2018). Native to tropical and subtropical America (Luginbill, 1928 and Sparks, 1979) spread all over the globe and assumed the position of level A1 threat. It has short development cycle (Sharanabasappa et al., 2018), wide host range, high prolificacy and high dispersal ability (Westbrook et al., 2016) make it a potentially dangerous insect-pest of subsistence and cash crops in large parts of the world. Dyar's law states that the head capsule width in caterpillars increases by a constant ratio at each moult that varies from species to species, usually about 1.2 to 1.4 which applies to almost all insect larvae (Dyar, 1890). Morphometric studies would help in construction of lifetables and to know the effect of different rearing conditions on the physical fitness of the predator and in selecting the preferred stage for its release. This study evaluates the growth and morphometrics of fall army worm on four cereal hosts.

MATERIALS AND METHODS

The morphometrics of *S. frugiperda* were analysed in a completely randomized design with five replications under laboratory conditions. These studies were conducted on four cereal host plants viz., maize (*Zea mays* L.) variety Narendra (M909); sorghum (*Sorghum bicolor* (L.) Moench) variety Parbhani Shakti (ICSR 14001); pearl millet (*Pennisetum glaucum* (L.) R. Br. (1810)) variety ABPC-4-3 and sugarcane (*Saccharum officinarum* L.) variety Nira (Co 86032). These plants were grown by adopting recommended package of practices as per VNMKV Parbhani (Anonymous, 2016), except plant protection on the research farm of Department of Agricultural Entomology, College of Agriculture, Latur, during Kharif 2019.

Immediately after hatching larvae (n-30) of *S. frugiperda* were transferred into separate plastic vials. They were reared individually on leaves and slices of tender stem of respective host plants. Every day fresh food was provided to the larvae. The observation on the casting of exuvae was made under microscope. During each instar, immediately after each moulting, head capsule width and length, body length, width and weight of each larva was measured with the help of ocular and stage micrometer to the nearest value of 0.1053 mm. The application of Dyar's rule (1890) was tested for the number of larval instar when fed on different host plants. The regression relationship between the instar and mean value of head capsule width, head capsule length, body

length, body width and body weight of larva in different instars was calculated using the formula. Log10 Y = a + bx. Where, Y = Head capsule width/ head capsule length/ body length/ body width /body weight of larva (mean), a = constant, b = logarithm of growth ratio, x = number of instars. Growth ratio was calculated by dividing the mean value of head capsule width/ length by the value of mean of head capsule width/ length of larva of preceding instar.

RESULTS AND DISCUSSION

The results presented in Table 1 revealed that the larvae of *S. frugiperda* when reared on maize passed through six instars. The larval head capsule width was 0.22, 0.42, 0.71, 1.13, 1.29 and 2.94 mm respectively and length was 0.25, 0.44, 0.74, 1.18, 1.41 and 3.64 mm, respectively for I, II, III, IV, VI, and VI instars, respectively. In sorghum, larval head capsule width was 0.20, 0.41, 0.67, 1.06, 1.24 and 3.05 mm, respectively and length was 0.22, 0.45, 0.74, 1.13, 1.30, 3.55 mm for I to VI instars, respectively. In pearl millet larval head capsule width was 0.19, 0.29, 0.52, 0.83, 1.23 and 2.80 mm, respectively and length was 0.22, 0.29, 0.58, 0.88, 1.28, 3.50 mm for I to VI instars, respectively. In sugarcane, head capsule width was 0.22, 0.43, 0.67, 0.94, 1.22 and 2.70 mm, and length was 0.24, 0.47, 0.70, 0.99, 1.27, 2.96 mm, respectively and for I to VI instars, respectively. Dyar (1890) indicated that the width of head capsule of lepidopterous larvae was constant for any instar of a given species. The successive larval instar of a given species also showed regular geometrical progression in the growth of head capsules. The growth ratio of the mean head capsule width of each instar and that of preceding one indicate growth directly i.e., greater the ratio greater the growth. The ratio is also known as Dyar's ratio. The present investigation on morphometrics of head capsule width of *S. frugiperda* are in line with findings of Ramaiah et al. (2020) who evidenced that the head capsule widths of *S. frugiperda* fed on artificial diet from I to VI instars were 0.09± 0.01, 0.23 ± 0.03, 0.45 ±0.03, 0.73 ±0.04, 1.3 ± 0.14, and 2.4 ± 0.23 mm, respectively with mean ratio of 1.94. Montezano et al. (2019) revealed that the head capsule width of I, II, III, IV, V and VI females and males larval instar fed on artificial diet was 0.35, 0.57, 0.87, 1.29, 1.89 and 2.80 mm and; 0.35, 0.56, 0.87, 1.25, 1.81 and 2.64 mm, respectively.

The larval body length of *S. frugiperda* for I to VI instars reared on maize was measured to be 1.68, 4.20, 9.30, 11.90, 22.10 and 35.90 mm, respectively. In sorghum, measured to be 1.63, 5.30, 8.90, 13.60, 19.70 and 34.40 mm, respectively. In pearl millet, noticed to be 1.60, 4.05, 7.30, 11.10, 17.8, 21.1 mm, respectively. In sugarcane, measured to be 1.70, 4.10, 6.60, 10.50, 20.40, and 31.00 mm, respectively. Present investigation is comparable with the findings of Kalyan et al. (2020) who exhibited that the larval length of I, II, III, IV, V and VI instars of *S. frugiperda* varied from 1.5-2.0, 3.0-4.0, 5.5-6.5, 9.0-10.5, 15.0-18.0 and 32.0-36.0 mm, The larval body breadth of *S. frugiperda* for I to VI instars reared on maize noticed to be 0.17, 1.02, 1.55, 3.05, 3.3, 3.95 mm, respectively. In sorghum 0.19, 1.20, 1.50, 1.95, 2.55 and 3.35 mm, respectively. In pearl millet 0.19, 0.99, 1.07, 1.80, 2.40 and 3.30 mm, respectively. In sugarcane 0.18, 0.90, 1.20, 1.50, 2.70 and 3.5 mm, respectively. The larval body weight of *S. frugiperda* for I to VI instars reared on maize measured to be 0.61, 2.20, 15.20, 60.10, 182.5 and 327.9 mg, respectively. In sorghum measured to be 0.57, 1.73, 10.20, 36.90, 103.40 and 317.50 mg, respectively. In pearl millet, measured to be 0.53, 2.12, 7.80, 29.70, 120.9 and 196.4 mg, respectively. In sugarcane measured to be 0.62, 2.25, 9.00, 23.30, 144.90 and 285.50 mg, respectively. The results of present investigation are analogous with the findings of Maruthadurai and Ramesh (2020) who evidenced that the larval body weight of *S. frugiperda* was 0.46, 0.39 0.34 and 0.23 g on fodder maize, green amaranth, para grass and Guinea grass, respectively.

The mean pupal length of *S. frugiperda* varied significantly when reared on different cereal host plants, it was significantly maximum on maize (15.10 mm) followed by sorghum (14.20 mm), sugarcane (13.10) and lowest on pearl millet (12.30 mm). The results of present investigation are in close conformity with findings of Kalyan et al. (2020) who revealed that the pupal length of *S. frugiperda* varied from 14.0 to 19.0 mm on maize. Tendeng et al. (2019) showed that the length of pupae varied between 14 to 18 mm. The mean pupal width of *S. frugiperda* varied significantly when reared on different cereal host plants, significantly highest pupal width was recorded on maize (4.0 mm) followed by sorghum (3.70 mm), sugarcane (3.30) and lowest on pearl millet (3.05 mm). The significantly maximum pupal weight of *S. frugiperda* was noticed on maize (185.90 mg) followed by sorghum (144.40 mg), sugarcane (124.80 mg) and lowest on pearl millet (104.70 mg). The present results are comparable with those of Maruthadurai and Ramesh (2020) who revealed that the pupal weight was 0.17 g on fodder maize. Barcelos et al. (2019) evaluated that the weight

Table 1. Morphometrics of *S. frugiperda* as influenced by cereal hosts

Larval head capsule width and length (mm)

Hosts	Maize				Sorghum				Pearl millet				Sugarcane			
Larval instars	Width± SE	Growth ratio	Length± SE	Growth ratio	Width± S.E.	Growth ratio	Length± SE	Growth ratio	Width± S.E.	Growth ratio	Length± SE	Growth ratio	Width± S.E.	Growth ratio	Length± SE	Growth ratio
I	0.22 ±0.007	-	0.25± 0.007	-	0.20± 0.004	-	0.22± 0.002	-	0.19± 0.002	-	0.22± 0.004	-	0.22± 0.009	-	0.24± 0.01	-
II	0.42 ±0.004	1.91	0.44± 0.004	1.76	0.41± 0.002	2.05	0.45± 0.004	2.05	0.29± 0.004	1.53	0.29± 0.01	1.32	0.43± 0.005	1.95	0.47± 0.007	1.96
III	0.71 ±0.01	1.69	0.74± 0.01	1.68	0.67± 0.01	1.63	0.74± 0.01	1.64	0.52± 0.005	1.79	0.58± 0.004	2.00	0.67± 0.01	1.56	0.70± 0.01	1.49
IV	1.13 ±0.01	1.59	1.18± 0.01	1.59	1.06± 0.02	1.58	1.13± 0.02	1.53	0.83± 0.008	1.60	0.88± 0.008	1.52	0.94± 0.002	1.40	0.99± 0.005	1.41
V	1.29 ±0.008	1.14	1.41± 0.009	1.19	1.24± 0.02	1.17	1.30± 0.01	1.15	1.23± 0.01	1.48	1.28± 0.01	1.45	1.22± 0.01	1.30	1.27± 0.007	1.28
VI	2.94 ±0.02	2.28	3.64± 0.06	2.58	3.05± 0.05	2.46	3.55± 0.05	2.73	2.8± 0.08	2.28	3.50± 0.01	2.73	2.7± 0.08	2.21	2.96± 0.06	2.33

Morphometrics

Stages	Maize			Sorghum			Pearl millet			Sugarcane		
	Length (mm)	Breadth (mm)	Weight (mg)	Length (mm)	Breadth (mm)	Weight (mg)	Length (mm)	Breadth (mm)	Weight (mg)	Length (mm)	Breadth (mm)	Weight (mg)
	Mean ± SE	Mean± SE	Mean± SE	Mean± SE	Mean± SE	Mean± SE	Mean± SE	Mean± SE	Mean± SE	Mean± SE	Mean± SE	Mean± SE
I Instar	1.68± 0.05	0.17±0.001	0.61± 0.03	1.63± 0.05	0.190.003	0.57± 0.02	1.60± 0.06	0.19± 0.004	0.53± 0.02	1.70± 0.06	0.18± 0.005	0.62± 0.02
II Instar	4.20± 0.20	1.02±0.002	2.20± 0.13	5.30± 0.26	1.20± 0.05	1.73± 0.10	4.05± 0.20	0.99± 0.01	2.12± 0.27	4.10± 0.23	0.90± 0.02	2.25± 0.17
III Instar	9.30± 0.44	1.55± 0.05	15.20± 1.18	8.90± 0.40	1.50± 0.03	10.20± 0.82	7.30± 0.26	1.07± 0.03	7.80± 0.80	6.60± 0.22	1.20± 0.08	9.00± 0.51
IV Instar	11.90± 0.58	3.05± 0.05	60.10± 2.01	13.60± 0.56	1.95± 0.05	36.90± 1.98	11.10± 0.31	1.80± 0.08	29.70± 1.78	10.50± 0.05	1.50± 0.01	23.30± 1.27
V Instar	22.10± 0.40	3.30± 0.13	182.5± 12.11	19.70± 0.47	2.55± 0.05	103.40± 8.48	17.80± 0.64	2.40± 0.06	120.90± 11.08	20.40± 0.79	2.70± 0.08	144.90± 10.45
VI Instar	35.9± 0.54	3.95± 0.11	327.9± 16.89	34.40± 0.60	3.35± 0.07	317.50± 16.87	21.1± 0.50	3.30± 0.08	196.40± 6.51	31.00± 0.06	3.50± 0.06	285.50± 14.90
Pupa	15.10± 0.45	4.00± 0.29	185.90± 0.19	14.20± 0.44	3.70± 0.25	144.40± 0.18	12.30±0.47	3.05± 0.30	104.70± 0.20	13.10± 0.44	3.30± 0.29	124.80± 0.19

Adults	Body length (mm)	Wing span (mm)	Body length (mm)	Wing span (mm)	Body length (mm)	Wing span (mm)	Body length (mm)	Wing span (mm)
Male	13.50± 0.56	37.30± 0.44	13.10± 0.54	35.40± 0.45	12.50± 0.57	32.60± 0.42	12.60± 0.54	34.30± 0.44
Female	12.20± 0.44	39.50± 0.55	11.90± 0.45	37.20± 0.56	11.50± 0.44	34.80± 0.53	11.70± 0.43	36.50± 0.55

of pupae was 80, 80 and 120 mg on cultivars of saccharine sorghum viz., BRS 506, BRS 509 and BRS 511, respectively.

The mean male adult body length of *S. frugiperda* varied significantly when reared on different cereal host plants, it was significantly maximum on maize (13.50 mm) followed by sorghum (13.10 mm), sugarcane (12.50 mm) and lowest on pearl millet (12.60 mm). whereas female adult body length was significantly maximum on maize (12.20 mm) followed by sorghum (11.90 mm), sugarcane (11.50 mm) and lowest on pearl millet (11.70 mm). The mean male adult wing span of *S. frugiperda* varied significantly when reared on different cereal host plants, it was significantly maximum on maize (37 mm) followed by sorghum (35 mm), sugarcane (32 mm) and lowest on pearl millet (34 mm). whereas female adult body length was significantly maximum on maize (39 mm) followed by sorghum (37 mm), sugarcane (34 mm) and lowest on pearl millet (36 mm). The above results show congruence with findings of Aarthi Helen et al. (2021) described that mean body length of male and female from head to abdominal tip was 15.99 and 15.16 mm, respectively. Average wing span of male and female was 31.95 and 30.82 mm, respectively.

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AUTHOR CONTRIBUTION STATEMENT

D R Bankar and V K Bhamare conceptualized and designed the study, D R Bankar conducted the study, analyzed the data, and authored the report under the supervision of V K Bhamare.

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CONFLICT OF INTEREST

No conflict of interest.

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