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Biometrical analysis of Tobacco caterpillar, *Spodopteara litura* (Fab.) larvae on Soybean genotypes

Kumari Pragya and SB Das

Abstract
Various morphological, biophysical and biochemical characters of host plant affects the growth and development of insects. In lepidopterous insects, the larval growth is completed through various numbers of moultings, resulting into various instars. These successive instars exhibits progressive growth in the size of body structures *viz.* head capsule width (HCW), body length (BL) and body width (BW) as defined by Dyar's law (1890) and Przibram's and Megusar's rule (1912). The present study is mainly focused on the applicability of Dyar's law and Przibram's and Megusar's rule on the progressive development of larval HCW, BW and BL of *S. litura* fed on highly and least susceptible genotypes (JS 22-05 and JS 21-71, respectively) of soybean to check the effect of susceptibility of genotypes on the progressive development of *S. litura* larvae. The results of present study revealed that the head capsule growth shown by different instars of *S. litura* larvae reared on highly and least susceptible genotype followed the geometrical progression as proposed by Dyar's law (1890) whereas, successive increase in body length and body width did not follow the geometrical progression as proposed by Przibram's and Megusar's rule and there was no effect of susceptibility of genotypes on the progressive increase of the HCW of *S. litura* larvae.

Keywords: Biometrics, S. *litura*, Soybean, Head capsule width, Body width, Body length, Przibram's and Megusar's rule, Dyar's law

1. Introduction
Insect growth and development is mostly influenced by the host, on which it feeds. This influence can be attributed to the morphological, biophysical and biochemical characters of host plant, which contributes to the host plant resistance towards the pest. Therefore, their arises a prime importance for the study of insect host plant relationship, which helps to know the possible effects of host plants on insects growth, development and survival (Jethva *et al*, 2011) [3]. In lepidopterous insects, the larval growth is completed through various numbers of moultings, resulting into various instars. These successive instars exhibits progressive growth in the size of body structures *viz.* head capsule width (HCW), body length (BL) and body width (BW) as defined by Dyar's law (1890) and Przibram's and Megusar's rule (1912). However, the width of head capsule is mostly used for determining the stage of the larval instar (Tanwar *et al*, 2010) [9]. Hence, measurement of HCW, BL and BW in successive moults, forms the basic pillar for the studies related to the bionomics of pest, which is further useful for the pest management (Ramaiah and Maheshwari, 2018) [6]. The present study is mainly focused on the applicability of Dyar's law and Przibram's and Megusar's rule on the progressive development of larval HCW, BW and BL of *S. litura* fed on highly and least susceptible genotypes of soybean, for working out the number of instars formed when the *S. litura* larvae is reared on soybean and to check the effect of susceptility of genotypes on the progressive development of *S. litura* larvae.

2. Materials and Methods
S. litura larvae collected from field was mass reared in laboratory conditions to get a uniform population. The neonates from the single egg mass were released and reared on highly susceptible (JS 22-05) and least susceptible (JS 21-71) soybean genotypes (Pragya *et al*., 2021) [5] forming two treatments with three replications each (10 larvae/replication). All the treatments were kept under controlled conditions at 27±2ºC temperature, 65±5% RH and with 14:10 light /dark cycle maintained inside BOD as suggested by Singh *et al.* (2015) [8]. In order to differentiate between instars, individual larvae were observed for the exuviae and HCW, BL and BW measurements were noted on the daily basis. The regression relationship between

instar and mean head capsule width was derived to test the applicability of Dyar,s law, whereas Prazibram's and Megusar's rule was tested by establishing the regression relationship between instars and mean body length/body width as suggested by Jethva *et al.* (2011) [3]. The regression equation used was $Log_{10}Y = a + bx$ where, Y = mean HCW/BL/BW; a = constant; b = logarithm of growth ratio and x = instars. Growth ratio, progression factor, differences and difference % were calculated as per the following equations:

1) Growth ratio = $\frac{\text{Value of succeeding instar}}{\text{Value of preceding instar}}$
2) Progression factor = Regression factor = b
3) Difference = Observed values of instar – Estimated value of instar
4) Difference (%) = $\frac{\text{Difference}}{\text{Estimated value}} \times 100$

3. Result and Discussion

3.1 Applicability of Dyar's law on Head capsule growth of *S. litura* larvae

The results of present study manifested that the larval development was completed by forming six instars, when reared on soybean as evident by the division of HCW into six distinct groups each indicating an instar, on the basis of differences in the measurements of a stage to that of the succeeding one. No variation in the size of HCW within the instar was observed along with non-overlapping of size from the first to last instar. The present findings corroborates the findings of Sasvihalli (2013) [7] and Naik *et al.* (2017) [4]. However it contradicts the findings of Gupta *et al.* (2015) [2] and Ramaiah and Maheshwari (2018) [6], as they reported only five instars on mango and castor, respectively. Further, the data in Table 1 revealed that the observed HCW for successive instars of *S. litura* larvae reared on highly susceptible (JS 22-05) and least susceptible (JS 21-71) soybean genotype was 0.260, 0.431, 0.729, 1.174, 1.514 and 1.589 mm and 0.246, 0.381, 0.681, 1.123, 1.458 and 1.537 mm, respectively which was in close proximity to the estimated HCW 0.309, 0.457, 0.676, 1.000, 1.479 and 2.188 mm and 0.275, 0.407, 0.603, 0.891, 1.318 and 1.950 mm, respectively. The observed (1.46 and 1.47, respectively) and estimated (1.48 and 1.49, respectively) progression factors for JS 22-05 and JS 21-71 as shown in Table 1, were found to be in close proximity with each other, and also with the Dyar's factor *i.e.* 1.45. Therefore, head capsule growth shown by different instars of *S. litura* larvae reared on highly and least susceptible genotype (JS 22-05 and JS 21-71, respectively) followed the geometrical progression as proposed by Dyar's law (1890) and there was no effect of susceptibility of genotypes on the progressive increase of the HCW of *S. litura* larvae. Moreover, straight regression line was obtained for larvae reared on both highly and least susceptible genotypes ($\log_{10}$ HCW = -0.68 + 0.17x and $\log_{10}$ HCW = -0.73 + 0.17x, respectively) when the $\log_{10}$ HCW were plotted against each of instars as depicted in Fig. 1. Similar findings were reported by Ahmed and Nabi (2000) [1], Jethva *et al.* (2011) [3], Vashisth and Chandel (2013) [10] and Ramaiah and Maheshwari (2018) [6].

3.2 Applicability of Przibram's and Megusar's rule on successive instar wise growth of body length and body width of *S. litura*

a. Highly susceptible genotype

Successive increase in body length and body width of *S. litura* larvae fed on highly susceptible genotype (JS 22-05) ranged from 1.897 to 39.300 mm and 0.094 to 7.153 mm, and did not follow the geometrical progression as proposed by Przibram's and Megusar's rule.

The body length and body width observed (1.97 and 3.55, respectively) and estimated (1.86 and 2.19, respectively) progression factors shown in Table 2 and 3, were not in close proximity with each other and also exhibited much deviation from the factor proposed by Przibram and Megusar *i.e.* 1.26. The regression equations (Fig. 2 and 3) obtained were $\log_{10}$ BL = -0.15 + 0.27x and $\log_{10}$ BW = -0.92 + 0.34x, respectively. Similar findings have been reported by Jethva *et al.* (2011) [3].

b. Least susceptible genotype

Successive increase in body length and body width of *S. litura* larvae fed on least susceptible genotype (JS 21-71), did not followed the geometrical progression. The observed (1.95 and 3.64, respectively) and estimated (1.86 and 2.19, respectively) progression factors shown in Table 2 and 3, were not in close proximity with each other and also exhibited much deviation from the factor proposed by Przibram and Megusar *i.e.* 1.26. The regression equations (Fig. 2 and 3) obtained were $\log_{10}$ BL = 0.09 + 0.27x and $\log_{10}$ BW = -0.95 + 0.34x, respectively. The present findings corroborates the findings of Jethva *et al.* (2011) [3].

Moreover, present study revealed that the progressive increase in body length and width was not affected by susceptibility of genotypes as evident by the approximately similar values for growth ratio of body length and body width on highly and least susceptible genotypes.

Table 1: Impact of soybean genotypes on progressive development of head capsule width of *S. litura*

Head capsule width for *S. litura*											
JS 22-05 (Highly susceptible)						JS 21-71 (Less susceptible)					
Instar	Observed	Growth ratio	Estimated	Difference	Difference %	Instar	Observed	Growth ratio	Estimated	Difference	Difference %
First	0.260	-	0.309	-0.05	-15.96	First	0.246	-	0.275	-0.03	-10.68
Second	0.431	1.66	0.457	-0.03	-5.71	Second	0.381	1.55	0.407	-0.03	-6.48
Third	0.729	1.69	0.676	0.05	7.78	Third	0.681	1.79	0.603	0.08	13.02
Fourth	1.174	1.61	1.000	0.17	17.40	Fourth	1.123	1.65	0.891	0.23	26.00
Fifth	1.514	1.29	1.479	0.04	2.38	Fifth	1.458	1.30	1.318	0.14	10.60
Sixth	1.589	1.05	2.188	-0.60	-27.38	Sixth	1.537	1.05	1.950	-0.41	-21.17
Progression factor	-	1.46	1.48	-	-	-	-	1.47	1.49	-	-

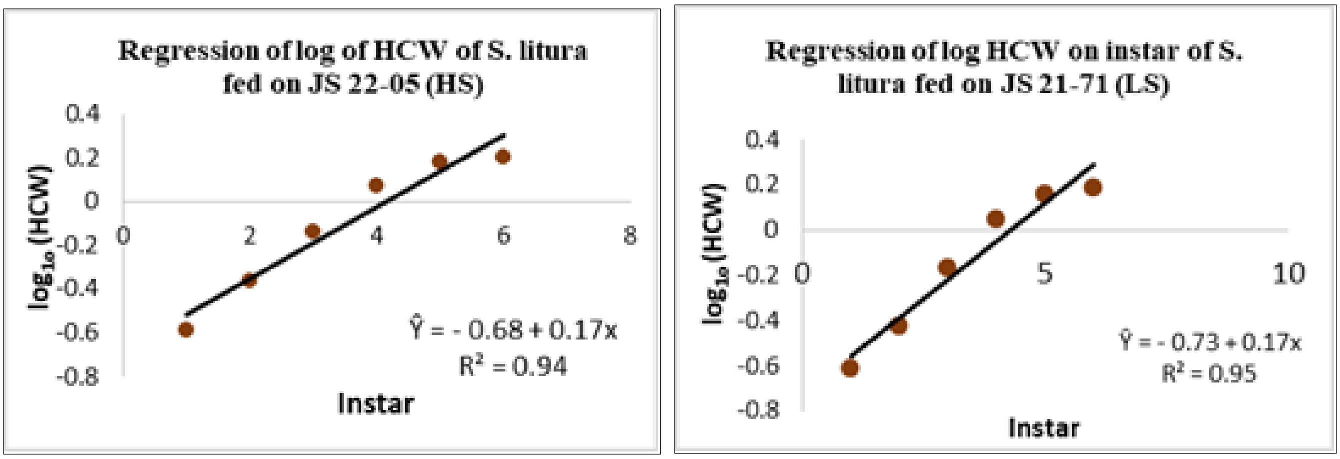

Fig 1: Regression of log of HCW of *S. litura* larvae reared on JS 22-05 (HS) and JS 21-71 (LS)

Table 2: Impact of soybean genotypes on progressive development of body length (BL) of *S. litura* larvae

Body length for *S. litura*											
JS 22-05 (Highly susceptible)						**JS 21-71 (Less susceptible)**					
Instar	**Observed**	**Growth ratio**	**Estimated**	**Difference**	**Difference %**	**Instar**	**Observed**	**Growth ratio**	**Estimated**	**Difference**	**Difference %**
First	1.897	-	2.630	-0.733	-27.878	First	1.703	-	2.291	-0.588	-25.661
Second	5.353	2.822	4.898	0.455	9.294	Second	4.403	2.585	4.266	0.137	3.216
Third	9.560	1.786	9.120	0.440	4.823	Third	8.487	1.928	7.943	0.544	6.845
Fourth	26.833	2.807	16.982	9.851	58.004	Fourth	24.033	2.832	14.791	9.242	62.483
Fifth	32.700	1.219	31.623	1.077	3.406	Fifth	29.533	1.229	27.542	1.991	7.228
Sixth	39.300	1.202	58.884	-19.584	-33.259	Sixth	34.167	1.157	51.286	-17.119	-33.380
Progression factor	-	1.967	1.862	-	-	-	-	1.946	1.862	-	-

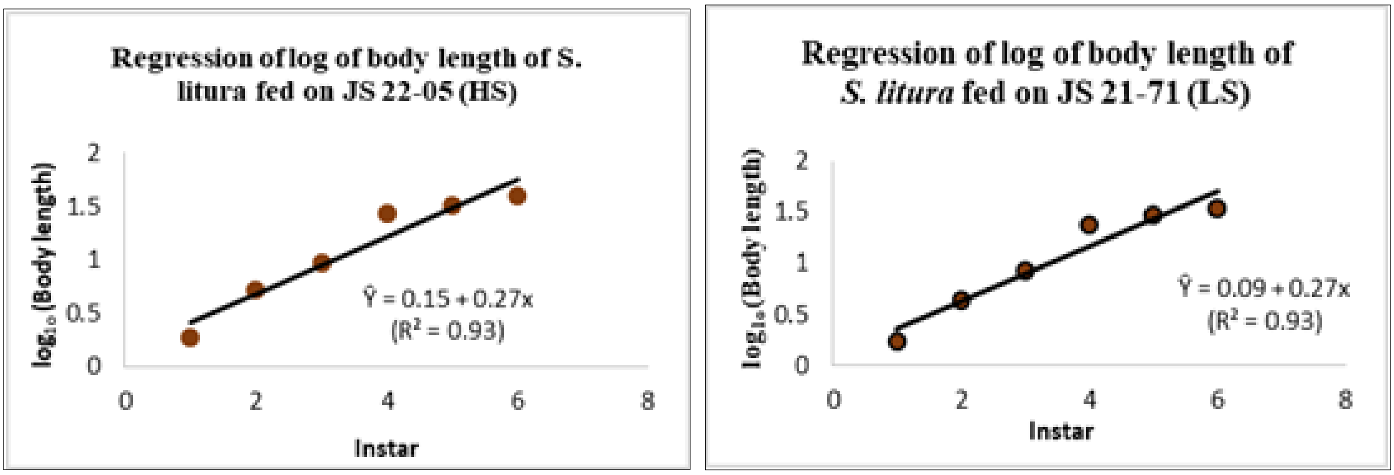

Fig 2: Regression of log of body length of *S. litura* larvae reared on JS 22-05 (HS) and JS 21-71 (LS)

Table 3: Impact of soybean genotypes on progressive development of body width (BW) of *S. litura* larvae

Body width for *S. litura* larvae											
JS 22-05 (Highly susceptible)						**JS 21-71 (Less susceptible)**					
Instar	**Observed**	**Growth ratio**	**Estimated**	**Difference**	**Difference %**	**Instar**	**Observed**	**Growth ratio**	**Estimated**	**Difference**	**Difference %**
First	0.094	-	0.263	-0.169	-64.262	First	0.087	-	0.245	-0.158	-64.558
Second	1.012	10.766	0.575	0.437	75.865	Second	0.979	11.253	0.537	0.442	82.298
Third	2.850	2.816	1.259	1.591	126.384	Third	2.633	2.689	1.175	1.458	124.105
Fourth	3.527	1.238	2.754	0.773	28.058	Fourth	3.233	1.228	2.570	0.663	25.778
Fifth	6.577	1.865	6.026	0.551	9.151	Fifth	6.120	1.893	5.623	0.497	8.831
Sixth	7.153	1.088	13.183	-6.030	-45.739	Sixth	6.900	1.127	12.303	-5.403	-43.915
Progression factor	-	3.554	2.188	-	-	-	-	3.638	2.188	-	-

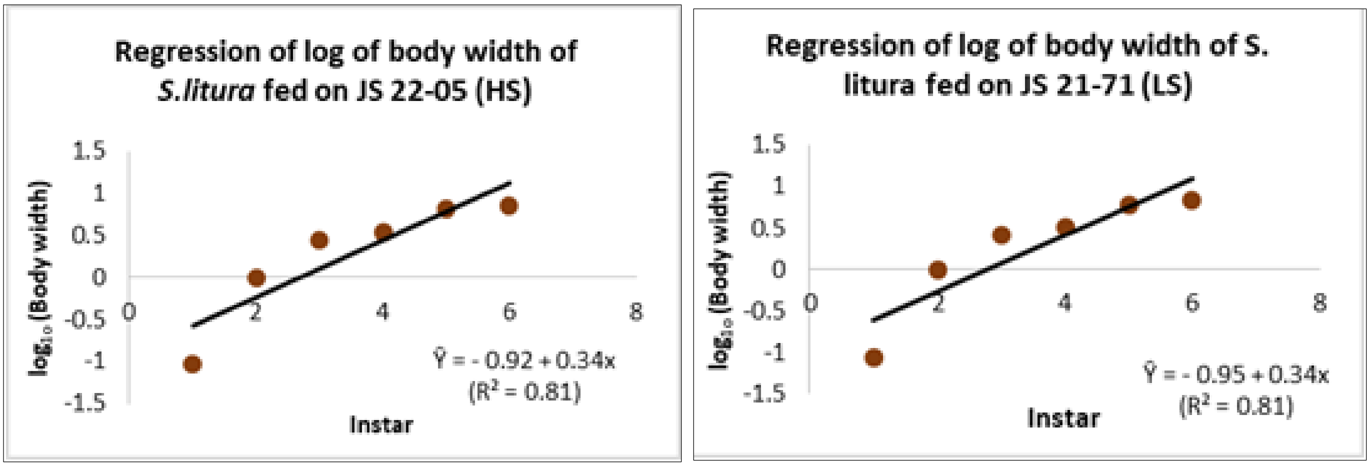

Fig 3: Regression of log of body width of *S. litura* larvae reared on JS 22-05 (HS) and JS 21-71 (LS)

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