COLOUR POLYMORPHISM STUDIES IN LARVAE OF LEGUME POD BORER, MARUCA VITRATA GEYER (LEPIDOPTERA: CRAMBIDAe) ON PULSES

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INTRODUCTION

India is the largest producer of pulses in the world with 25 per cent share in global production but, the average productivity is very low because of many abiotic and biotic stresses. Legume pod borer, Maruca vitrata Geyer (Lepidoptera: Crambidae) is an important biotic constraint to grain legumes and considerably reduce their production and productivity. It already reported to feed on 39 host plants in Asia (Atachi and Djihou, 1994). It is one of the major pests of legume crops such as cowpea (Vigna unguiculata (L.) Walp.), pigeonpea (Cajanus cajan (L.) Millsp.), lablab (Lablab purpureus (L) Sweet.), greengram (Vigna radiata (L.) R. Wilczek), blackgram (Vigna mungo (L.) Hepper) and common bean (Phaseolus vulgaris L.) from the tropics to the temperate zone all over the world (Jackai, 1995; Shanower et al., 1999). Many environmental factors, biotic and abiotic interact to influence the insect growth, physiology and development. Generally, the insect colouration is an important evolutionary mechanism either to adapt the local environment in order to utilize the conditions and get self-protection from the natural enemies. Already in insects, numerous hypotheses have been proposed on the origin and maintenance of melanic phenotypes and one such well-known example is the industrial melanism in the peppered moth, Biston betularia (Majerus, 1998). Colour polymorphism and melanism were already proposed to be originating from complex interaction between genetic and environmental factors (Hazel, 2002; Solensky and Larkin, 2003), light (Faure, 1943), humidity (Goulson, 1994), diet and population density (Goulson and Cory, 1995; Gunn, 1998). The environmental factors like weather parameters and host plant nutrition play a vital role in colour polymorphism of insects. Hence, it is very important to have an idea about insect colouration in order to correctly identify the insect pest including the Maruca vitrata. In these contexts, the present study was carried out to find out the pattern of impact of weather parameters on the occurrence of different larval colour froms in M. vitrata.

MATERIALS AND METHODS

Studies on larval colour polymorphism of M. vitrata on pulses

Field studies were carried out on incidence of various larval colour morphs on different pulses during 2012 in crop fields at Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu. Five hosts such as pigeonpea (CO RG 7), greengram (CO GG 7), blackgram (CO BG 6), cowpea (CO 7) and lablab (Rohini) were raised separately under pesticide free environment and in such a way to ensure the continuous availability of flowering and pod formation stages since the pest incidence is coincided with these stages. A total of fifty larvae of M. vitrata were collected at random at monthly interval during flowering and pod formation stages. The larvae thus collected were brought to the laboratory and reared separately on respective hosts. They were kept on plastic basin (30 cm dia. and 10 cm height) on a dry filter...
paper and pods and flowers of respective hosts were provided as food. Three replications were maintained on each host. Based on the preliminary field observations, count was made on colour morphs of Maruca larvae. The incidence of different larval colour morphs during different months was recorded.

**Influence of weather parameters on colour morphs of M. vitrata**

The weather data on maximum temperature (ºC), minimum temperature (ºC), maximum relative humidity (%), minimum relative humidity (%), rainfall (mm), sunshine hours, wind velocity (kmph) and pan evaporation (mm) were obtained from Agro Climate Research Centre (ACRC), Coimbatore for the entire study period and their monthly average was worked out. The incidence of different larval colour morphs of M. vitrata recorded every month on each host was correlated with the weather parameters using individual colour morph as dependent variable (Y) and each of weather parameter prevailed during the previous 30 days of observation as independent variable (X).

Correlation coefficient \( r \), was computed by standard statistical formula by Karl Pearson was adopted (Panse and Sukhatme 1985).

\[
r = \frac{\sum XY - (\sum X \times \sum Y)/n}{\sqrt{\sum X^2 - (\sum X^2/n)} \sqrt{\sum Y^2 - (\sum Y^2/n)}}^{1/2}
\]

The Correlation coefficient \( r \) was tested for significant or non significant by Fisher ‘t’ test and is defined as

\[
r = \frac{r}{(1-r^2)^{1/2}} \times (n-2)^{1/2}
\]

**RESULTS**

**Classification and occurrence of larval colour morphs in different months (2012)**

The results on incidence of different colour morphs in larvae of M. vitrata collected from different pulses showed the occurrence of seven types (Plate 1) and they are described in Table 1.

The results on the monthly occurrence of different larval colour morphs showed that the occurrence of type 1 was found to me maximum during May (2.7 larvae) followed by 2.3, 2.1 and 2.0 larvae during September, October and January. In other months it ranged from 0.0 to 1.7 during June and December respectively (Fig. 1).

The maximum incidence (5.4 larvae) of larval type 2 was recorded in July and was statistically significant than other months of observation. This was followed by 5.1 and 5.0 larvae during August and April respectively. This type was totally absent during May and June.

The larval type 3 showed its maximum occurrence during February (6.5 larvae) and May (6.3 larvae) and were statistically on par and superior to other months of observation. However, the incidence of 5.5 larvae was recorded in March, 5.2 in July and 3.0 larvae during January and November as against the

<table>
<thead>
<tr>
<th>Host</th>
<th>Colour morph*</th>
<th>Type 1</th>
<th>Type 2</th>
<th>Type 3</th>
<th>Type 4</th>
<th>Type 5</th>
<th>Type 6</th>
<th>Type 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pigeonpea</td>
<td>Pale green larva with series of brownish spots on dorsal side of the body</td>
<td>1.4(1.4)</td>
<td>2.0(1.6)</td>
<td>1.7(1.5)</td>
<td>12.2(3.6)</td>
<td>16.5(4.1)</td>
<td>12.1(3.6)</td>
<td>4.1(2.1)</td>
</tr>
<tr>
<td>Greengram</td>
<td>Pale green larva with series of brownish black spots on dorsal side of the body</td>
<td>0.8(1.2)</td>
<td>1.4(1.4)</td>
<td>1.3(1.3)</td>
<td>12.7(3.6)</td>
<td>17.3(4.2)</td>
<td>13.0(3.7)</td>
<td>3.5(2.0)</td>
</tr>
<tr>
<td>Blackgram</td>
<td>Pink larva with series of black spots on dorsal side of the body</td>
<td>2.5(1.7)</td>
<td>7.3(2.8)</td>
<td>0.0(0.7)</td>
<td>9.8(3.2)</td>
<td>18.3(4.3)</td>
<td>9.5(3.2)</td>
<td>2.8(1.8)</td>
</tr>
<tr>
<td>Cowpea</td>
<td>Greenish yellow larva without any spots on the body</td>
<td>1.7(1.5)</td>
<td>3.1(1.9)</td>
<td>4.4(2.2)</td>
<td>8.1(2.9)</td>
<td>9.6(3.2)</td>
<td>17.6(4.3)</td>
<td>5.5(2.5)</td>
</tr>
<tr>
<td>Lablab</td>
<td>Yellow larva with series of brownish black spots on dorsal side of the body</td>
<td>1.7(1.5)</td>
<td>2.0(1.6)</td>
<td>9.5(3.2)</td>
<td>6.8(2.7)</td>
<td>8.1(2.9)</td>
<td>15.0(3.9)</td>
<td>6.9(2.7)</td>
</tr>
<tr>
<td>SEd</td>
<td>Dark green larva with series of black spots on dorsal side of the body</td>
<td>0.5192</td>
<td>1.0481</td>
<td>1.3924</td>
<td>2.1903</td>
<td>2.6531</td>
<td>2.9806</td>
<td>2.7513</td>
</tr>
<tr>
<td>CD (P = 0.05)</td>
<td>Pale green larva with spots</td>
<td>1.0464</td>
<td>2.1124</td>
<td>2.8062</td>
<td>4.4143</td>
<td>5.3471</td>
<td>6.0071</td>
<td>3.5900</td>
</tr>
</tbody>
</table>

*Mean of 12 months of observation and two times of observation per month; *Figures in the parentheses are “X + 0.5 transformed values; In a column mean(s) followed by a common letter are not significantly different at 5 % level in LSD
least occurrence during December (0.4 larvae).

Significantly highest number (16.9) of type 4 larval colour morph was recorded during August which was statistically superior over other periods of observation. This was followed by 13.8, 12.5, 12.0 and 11.3 larvae during December, February, January and October and September respectively and the lowest incidence registered in June (2.0 larvae).

The peak incidence of type 5 larvae recorded during April (22.3) followed by March (21.0). The subsequent levels of incidence coincided with December (18.4), January (16.5) and October (16.0) respectively when compared to 7.2 larvae in June.

The maximum of type 6 larvae observed during the entire period of observation and a maximum of 25.0 larvae were recorded in July and were statistically superior over other months. This was followed by 19.0, 18.3 and 16.5 during July, May and November respectively as against the least incidence during April (8.3 larvae).

In November significantly maximum number (9.5 larvae) of type 7 larvae was recorded. In other months of observations it varied from 0.7 to 7.6 larvae during May and July respectively. The minimum of 2.0 larvae was collected during March.

### Occurrence of larval colour morphs in different pulses (2012)

Among different larval colour morphs of *M. vitrata*, the occurrence of all types of colour morphs, except type 6 (yellow with black spots) was found to be almost similar on all pulses (0.8 to 18.3) (Table 2). The frequently occurring colour morph in the field was type 6 (yellow coloured larva with black spots) and its maximum incidence was in cowpea (17.6) followed by lablab (15.0) as against 9.5 on blackgram. On blackgram, the occurrence of type 3 colour morph (pink with black spots) was completely absent.

### Impact of weather factors on larval colour morphs Type 1

The results on correlation relationship of type 1 larva with weather factors showed a significant negative correlation with rainfall (Table 3). The results of multi regression analysis
showed all weather parameters together influenced the incidence of type 1 larvae by 90.1 per cent ($R^2 = 0.901$). Incidence of colour morph ($Y$) = $-25.006 - 0.226X_1 - 0.178X_2 - 0.257X_3 - 0.072X_4 - 1.727X_6 - 0.087X_7 + 1.826X_8$.

The regression equation clearly indicated that increase of one per cent maximum RH and one mm of evaporation could increase the incidence of type 1 larvae by 0.627 and 1.826 numbers respectively whereas, increase in one hour of sunshine could reduce the incidence to 1.727 numbers respectively (Table 4).

**Type 2**

A highly significant positive relationship was derived between type 2 larvae and maximum RH ($r = -0.716^*$) (Table 3). The results of multi regression analysis showed 80.9 per cent ($R^2 = 0.809$) variation in incidence of type 2 larvae of *M. vitrata* was influenced by weather parameters. The multi regression equation fitted to predict the type II larval incidence is

Incidence of colour morph ($Y$) = $102.690 - 1.690^*X_1 + 2.139^*X_2 - 1.092^*X_3 + 0.122X_4 - 0.466X_5 + 1.800^*X_6 - 0.466X_7 - 2.711^*X_8$.

These results indicated that reduction of one degree of maximum temperature, one per cent of minimum RH and one mm of evaporation could increase the population of type 2 larvae by 1.690, 1.092 and 2.711 respectively (Table 5). The raise in one degree of minimum temperature and one mm of rainfall is expected to increase the type 2 larval incidence by 2.139 and 1.800 numbers respectively.

**Type 3**

Correlation analysis showed that type 3 larvae exerted a significant positive effect with minimum temperature ($r = -0.597^*$) (Table 3). The results on multi regression analysis showed about 52.1 per cent ($R^2 = 0.521$) was the contribution by all analysed weather parameters on incidence of type 3 larvae of and the resulted equation is depicted below.

Incidence of colour morph ($Y$) = $-132.442 - 9.450^*X_1 + 5.855X_2 + 1.638^*X_3 - 1.965X_4 - 1.103^*X_5 - 2.401^*X_6 + 6.158^*X_8$.

Out of eight variables analysed, when the other variables are at their mean level, one degree rise in maximum temperature and one per cent increase in minimum RH, one kmph increase in wind speed and one hour of sunshine are expected to reduce the number of type 3 larvae by 9.450, 1.965, 1.103 and 2.401 numbers respectively (Table 6). But increase of one degree minimum temperature, one per cent of maximum RH and one mm of evaporation are expected to increase the incidence by 5.855, 1.638 and 6.158 numbers respectively.

**Type 4**

The incidence of type 4 larvae of had a significant positive correlation with maximum temperature ($r = -0.606^*$) (Table 3). The multi regression analysis showed all weather factors together influenced the variation in incidence of type 4 larvae by 63.2 per cent($R^2 = 0.632$).

Incidence of colour morph ($Y$) = $132.442 - 9.450^*X_1 + 5.855X_2 + 1.638^*X_3 - 1.965X_4 - 1.103^*X_5 - 2.401^*X_6 + 6.158^*X_8$.

From the above regression equation it is cleared that hike of one degree of maximum temperature, one per cent of minimum RH, one kmph of wind speed one hour of sunshine would lead to increase in incidence of type 4 Maruca larvae by 9.450,

<table>
<thead>
<tr>
<th>Variable</th>
<th>Beta wt.</th>
<th>Regression coefficient</th>
<th>Standard error</th>
<th>'t' value</th>
<th>'t' probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>a (Intercept)</td>
<td>-</td>
<td>132.442 $^**$</td>
<td>179.487</td>
<td>0.738</td>
<td>0.514</td>
</tr>
<tr>
<td>$X_1$ - Maximum temperature (°C)</td>
<td>-3.103</td>
<td>-2.488 $^**$</td>
<td>6.097</td>
<td>-1.550</td>
<td>0.219</td>
</tr>
<tr>
<td>$X_2$ - Minimum temperature (°C)</td>
<td>3.642</td>
<td>7.511 $^**$</td>
<td>2.462</td>
<td>1.118</td>
<td>0.345</td>
</tr>
<tr>
<td>$X_3$ - Maximum RH (%)</td>
<td>1.870</td>
<td>0.760 $^**$</td>
<td>1.162</td>
<td>0.654</td>
<td>0.560</td>
</tr>
<tr>
<td>$X_4$ - Minimum RH (%)</td>
<td>-3.609</td>
<td>-0.810 $^**$</td>
<td>0.795</td>
<td>-1.109</td>
<td>0.383</td>
</tr>
<tr>
<td>$X_5$ - Wind speed (kmph)</td>
<td>2.235</td>
<td>1.287 $^**$</td>
<td>1.621</td>
<td>0.794</td>
<td>0.485</td>
</tr>
<tr>
<td>$X_6$ - Sunshine hrs</td>
<td>0.195</td>
<td>0.240 $^{NS}$</td>
<td>2.051</td>
<td>0.117</td>
<td>0.914</td>
</tr>
<tr>
<td>$X_7$ - Rainfall (mm)</td>
<td>0.197</td>
<td>0.085 $^{NS}$</td>
<td>0.478</td>
<td>0.177</td>
<td>0.870</td>
</tr>
<tr>
<td>$X_8$ - Evaporation (mm)</td>
<td>-1.323</td>
<td>-2.022 $^**$</td>
<td>3.487</td>
<td>-0.580</td>
<td>0.603</td>
</tr>
</tbody>
</table>

R$^2$ value = 0.600, 'F' value = 0.727; **Significant at 1%, NS – Non significant

<table>
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<tr>
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<th>Beta wt.</th>
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<td>-1.323</td>
<td>-2.022 $^**$</td>
<td>3.487</td>
<td>-0.580</td>
<td>0.603</td>
</tr>
</tbody>
</table>

R$^2$ value = 0.521, 'F' value = 0.407; **Significant at 1%, NS – Non significant
1.965, 1.103 and 2.401 numbers respectively. Whereas, increase of one degree minimum temperature, one per cent maximum RH and one mm evaporation would lead to increase of type 4 by 5.855, 1.638 and 6.158 numbers respectively (Table 7).

### Type 5

Incidence of type 5 larvae of was negatively influenced by minimum RH ($r = -0.596^*$) but showed highly positive relationship with sunshine hours ($r = 0.716^{**}$) (Table 3). The results on regression analysis resulted the following equation and showed that all abiotic factors together determine the variation in type 5 larval incidence by 63.2 per cent ($R^2 = 0.632$).

$$\text{Incidence of colour morph (Y)} = -163.885^{**} + 3.101^{**}X_1 - 3.487^{**}X_2 + 2.119^{**}X_3 - 1.870^{**}X_4 + 1.988^{**}X_5 + 3.064^{**}X_6 - 0.627^*X_7 + 2.617^{**}X_8$$

Out of eight variables analysed, it is expected to increase in number of type 5 *Maruca* larvae by 3.101, 1.988, 2.119, 2.617 and 1.988 with one degree increase in maximum temperature, one per cent increase of minimum RH, one kmph of wind speed, one mm rainfall and one mm evaporation respectively. Whereas, 3.487, 0.627 and 1.870 of type 5 *Maruca* larvae are expected to increase due to one degree decrease in minimum temperature, one per cent decrease in minimum RH and one hour decrease in sunshine respectively (Table 8).

### Type 6

A significant negative correlation exhibited by type 6 larvae with minimum temperature ($r = 0.607^*$) but rainfall positively influenced on its occurrence ($r = 0.622^*$) (Table 3). The following equation from regression analysis showed that all weather factors together contributed to the incidence of type 6 larvae by 81.9 per cent ($R^2 = 0.819$).

$$\text{Incidence of colour morph (Y)} = -167.325^{**} + 4.675^{**}X_1 + 0.240X_2 - 0.476X_3 + 1.214^{**}X_4 + 2.780^{**}X_5 + 5.120^{**}X_6 + 0.089X_7 - 9.055^{**}X_8$$

Among all variables analysed, it is clear that, one degree increase in maximum temperature, one per cent increase in minimum RH, one kmph increase in wind speed and one hour increase in sunshine could increase the number of type 6 larvae by 4.675, 1.214, 2.780 and 5.120 respectively. But, 9.055 number of type 6 *Maruca* larvae is expected to increase when one mm reduction in evaporation alone (Table 9).

### Type 7

The incidence of type 7 exerted a positive association with minimum RH ($r = 0.670^*$) whereas, the association was negative with sunshine hours ($r = -0.686^*$) (Table 3). The results of the multiple regression analysis showed a $R^2$ value of 0.774 revealing that 77.4 per cent variation in the incidence of type 7 larval colour morph was influenced by weather parameters.

$$\text{Incidence of colour morph (Y)} = 92.175^{**} + 2.610^{**}X_1 - 3.470^{**}X_2 - 1.556^{**}X_3 + 1.045^{**}X_4 - 2.080^{**}X_5 - 1.247^{**}X_6 + 0.015X_7 + 1.917^{**}X_8$$

Out of eight variables analysed, it is expected to increase in number of type 7 *Maruca* larvae by 2.610, 1.045 and 1.917 respectively (Table 10). On the other hand, a decrease of one degree minimum temperature, one per cent maximum RH, one kmph of wind speed and one hour sunshine are expected to increase the type 7 *M. vitrata* larvae by 3.470, 1.556, 2.080 and 1.247 respectively.
Table 10: Multiple regression analysis of type 7 larvae of *M. vitrata* and weather parameters (n = 12)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Beta wt</th>
<th>Regression coefficient</th>
<th>Standard error</th>
<th>‘t’ value</th>
<th>‘t’ probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>a (Intercept)</td>
<td>-</td>
<td>92.175**</td>
<td>100.173</td>
<td>0.920</td>
<td>0.425</td>
</tr>
<tr>
<td>X1 - Maximum temperature (°C)</td>
<td>1.930</td>
<td>2.610**</td>
<td>3.403</td>
<td>0.767</td>
<td>0.499</td>
</tr>
<tr>
<td>X2 - Minimum temperature (°C)</td>
<td>-2.724</td>
<td>-3.470**</td>
<td>2.850</td>
<td>-1.218</td>
<td>0.310</td>
</tr>
<tr>
<td>X3 - Maximum RH (%)</td>
<td>-2.285</td>
<td>-1.566**</td>
<td>1.345</td>
<td>-1.164</td>
<td>0.329</td>
</tr>
<tr>
<td>X4 - Minimum RH (%)</td>
<td>2.759</td>
<td>1.045**</td>
<td>0.921</td>
<td>1.135</td>
<td>0.339</td>
</tr>
<tr>
<td>X5 - Wind speed (kmph)</td>
<td>-2.140</td>
<td>2.080**</td>
<td>2.850</td>
<td>-1.218</td>
<td>0.329</td>
</tr>
<tr>
<td>X6 - Sunshine hrs</td>
<td>0.020</td>
<td>0.015**</td>
<td>0.553</td>
<td>0.026</td>
<td>0.981</td>
</tr>
<tr>
<td>X7 - Rainfall (mm)</td>
<td>0.744</td>
<td>1.917**</td>
<td>4.038</td>
<td>0.475</td>
<td>0.667</td>
</tr>
<tr>
<td>X8 - Evaporation (mm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

R^2 value = 0.774, ‘F’ value = 1.285; **Significant at 1%, NS – Non significant

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1a. Type 1 1b. Type 2 1c. Type 3 1d. Type 4

1e. Type 5 1f. Type 6 1g. Type 7

Plate 1: Colour morphs of *M. vitrata* larvae

DISCUSSION

Colour polymorphism is one of the fascinating facets of many organisms that maintain unique variations for the growth and development. Coexistence of two or more colour morphs are reported in mantoids, cicadids, damselflies, lepidopterans (Rowell, 1971; Dearn, 1990; Majerus, 1998). Similarly, existence of colour polymorphism is widely evident in Orthopterans through crypsis and background matching and homochromy (Rowell, 1971) in order to protect themselves from their natural enemies and survival. The present study on the existence of different colour morphs of *M. vitrata* is a new kind of approach for the presence of strain or biotypes. Totally seven different larval colour morphs were recorded *M. vitrata* from the field irrespective of months and five pulse hosts. Among different larval colour morphs of *M. vitrata*, the occurrence of all types of colour morphs, except type 6 (yellow with black spots) was found to be almost similar on all pulses (0.8 to 18.3). The frequently occurring colour morph in the field was type 6 (yellow coloured larva with black spots) which was maximum in cowpea (17.6) followed by lablab (15.0) as against 9.5 on black gram. On black gram, the occurrence of type 3 colour morph (pink with black spots) was completely absent. This is in consonance with the results of Nagarajarao and Abraham (1956) who encountered totally ten different body colour morphs in the field populations of *H. armigera* on all sampled crops with an average of 6.1 colours. The present study clearly revealed that all colour morphs were not appeared on all host plants and revealed dominance of a specific colour morph across different host plants. In *H. armigera*, Nagarajarao and Abraham (1956) and Reddy (1968) recorded larval colour variation ranged from velvety black to yellowish green. Similarly, other larval colours viz., green, fawn, pink, yellow or brown and very dark to light green or pink were also observed by Brodley (1977) and Uthamasamy et al., (1988) and additionally, NagarajaRao and Abraham (1956), Gopalan and Venugopal (1972), Lewin et al. (1973) and
Correlated to the larval colouration of the influence of temperature, RH and rain fall was significantly different. Among different weather parameters tested, it is clear that more than 50.0 per cent of all seven colour morphs (52.1 to 90.1%) weather factors together contributed to the incidence of more colour morphs recorded in 2.0 larvae in June and 16.9 larvae in August 2012 respectively. The maximum occurrence of type 5 colour morph recorded in 2.0 larvae in June and 16.9 larvae in August 2012 respectively. The maximum occurrence of type 5 colour morph recorded in 2.0 larvae in June and 16.9 larvae in August 2012 respectively. The maximum occurrence of type 5 colour morph recorded in 2.0 larvae in June and 16.9 larvae

Environmental temperature is very important. According to Valverde and Schielzeth (2015) in club-legged grasshopper, Gomphocerus sibiricus, light colour morphs are produced at high amounts of radiant heat whereas dark coloured individuals are developed at low amounts of radiant heat. Apart from high temperature and humidity, high food moisture content and low individual density are also known to drive green body colouration in grasshoppers (Rowell, 1971; Dearn, 1990). These clearly revealed that the colour variation is also attributed to nutrition status of associated host, genetic factors and location. Ramos and Morallo-Rajjesus (1976) reported that when H. armigera larvae reared on cotton, corn, tomato and tobacco, exhibited distinct body colours and markings. Levels of pigments in the insect diet also play an important role in the insect colouration. According to Ramos and Morallo-Rajjesus (1976), β-carotene in the artificial diet influence in different larval colour forms of M. vitrata. Maragal (1990) observed the green coloured morphs when the Helicoverpa larvae feed on flower petals rich in yellow colour. These might also be due to variation in the within a basic colour in quantitative fashion that occur in larval progenies. In the cryptic variations of major colours, the specific inheritance pattern will also be a complex phenomenon. Similarly conclusions were given by (Jameson and Pequegnat, 1971) also.

Generally in larva of lepidopterans, the colouration is reported to be a highly dynamic trait. During post ec dysal life stage of each larvae, the thickness of cuticle is increased and the intensity of deposited colouring material would also varied and resulted in different colourations. For instance, the cuticle thickness in the final instar of Manduca sexta larvae increased approximately to four fold (Chapman, 1998) and proportionally the melanin deposition also increased (Hiruma et al., 1984). Additionally, dark colouration is also reported due to the presence of a nitrogen-richquinone polymer which also considerably imposes on antimicrobial activity (Nappi et al., 1990). These clearly revealed that the colour variation is also attributed to nutrition status of associated host, genetic factors and location. Ramos and Morallo-Rajjesus (1976), β-carotene in the artificial diet influence in different larval colour forms of M. vitrata. Maragal (1990) observed the green coloured morphs when the Helicoverpa larvae feed on flower petals rich in yellow colour. These might also be due to variation in the within a basic colour in quantitative fashion that occur in larval progenies. In the cryptic variations of major colours, the specific inheritance pattern will also be a complex phenomenon. Similarly conclusions were given by (Jameson and Pequegnat, 1971) also.

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