

## Genetic Segregation of Red Cotton Bug

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### ABSTRACT

The present investigation is an effort put forth to study the reproductive nature and offspring production leading to the analysis of gene segregation and compare the morphological and homogeny development of Nymphal to the adult stage of red cotton bug (*D.cingulatus*). *D. cingulatus* adults and nymphs were collected from *Sterculia foetida* tree in PGP College in Paramathi, Namakkal District and maintained in plastic bottles. Time of Nymphal development, mortality, number of males and females was recorded. Then, sex ratio of the offspring produced after mating was calculated for analyzing the morphological characters through genetic segregation. The research revealed the percentage of eggs produced by females after cross bred with different males and sex ratio of different offsprings produced leads to the evaluation of diverse morphological characteristics of red cotton bug which occurs due to gene segregation. It is concluded that the mating results of *D. cingulatus* varies with morphological character spotted nature. Homogeny in spotted character mating leads to good number of off spring production and better sex ratio. It also confirms that physical characteristics of the red cotton bug also segregate during mating and genetically assigned.

**Key words:** *D. cingulatus*, Mating, Nymph, Adult and gene segregation.

Received 14.02.2019

Revised 08.03.2019

Accepted 19.04.2019

### CITATION OF THIS ARTICLE

VijayaPriya. S., Bhuvanewari. R., Kala. K., Sudhakar. S., and Gopinath. L. R. Genetic Segregation of Red Cotton Bug. Int. Arch. App. Sci. Technol; Vol 10 [2] June 2019: 42-48

### INTRODUCTION

*Dysdercus cingulatus* (Heteroptera: Pyrrhocoridae) is commonly known as the red stainer or red cotton bug. *D. cingulatus* grows to a length of 12 to 18 mm (0.47 to 0.71) inch. It is chiefly red in colour but has a white collar and three black spots and are very similar to *D. koenigii* but, *D. cingulatus* is slightly larger and the femora have varying amounts of black has completely red femora (1, 2). Egg and nymphal period lasts for about 7 and 26 days, respectively (3). Nymphs moult 6 times before reaching adult stage and the development is completed in 40-50 days. It appears late in the season of the cotton crop.

Red cotton bug appearance on cotton is after the commencement of the first open boll in the cotton fields. Dusky cotton bugs appear on cotton is when majority of bolls on the crop are open. As they occur at the end of crop season and the loss caused have been minimal, not much attention has been given to the counting their numbers than describing their status as low, medium and high. This is a multivoltine insect having five to six gonadotrophic cycles in lifespan and constitutes one of the main pests of cotton and other malvaceous plants. *D. cingulatus* develops faster when fed cultivated rather wild species and host plant properties such as the weight of feeds and growth habit (4). It has been investigated the chosen food plant and also the effect of the presence or absence of a

scutellar black spot on features of the life history (development, survival, sex ratio, fecundity and hatchability).

The animals face any kind of stress the immediate response of the animal is by its sense organs including mechanisms of sensory integration. Egg of the insects has not exempted from this mechanism. Nearly, about 200 in India have been recorded as pests of cotton plants (5). The insects of red cotton bug (*D. cingulatus*) is a serious pest of cotton many parts of the world including India (6,7). Cotton is one of the chief crops in India plagued with insect infestation. India is the considered as the second largest producer of cotton in the world after China accounting for about 18% of the world cotton production. It has the distinction of having the largest area under cotton cultivation in the world ranging between 12.2 million hectares and constituting about 25% of the world area under cotton cultivation. Profound infestations on the seeds affect the crop mass, oil content and the marketability of the crops (8).

## **MATERIAL AND METHODS**

### **COLLECTION AND MANINTENANCE**

*D. cingulatus* adults and nymphs were collected from *Sterculia foetida* tree in PGP College in Paramathi, Namakkal District, Tamil Nadu, India. Collected insects were maintained under laboratory conditions at 27±2 °C temperature, 70-75% relative humidity, 11L:13D photoperiod in plastic containers along with the seeds. Adults were identified and categorized into two spotted male two spotted females, three spotted males and three spotted females. Combinations of three-spotted males with two-spotted females (3M2F), two-spotted males with three-spotted females (2M3F), three-spotted males with three-spotted females (3M3F), and two-spotted males with two-spotted females (2M2F) were paired and facilitated their copulation and oviposition in separated plastic bottles in triplicates for each combination. Sterilized and loose soil was filled up in the plastic bottles up to 2 cm for facilitating oviposition. These pairs were maintained till their death and regularly monitored for copulation time, the number of eggs laid, the number of nymphs hatching, and adult longevity of both male and female. First Ten instar nymphs were then maintained from each category separately in three plastic containers for each category. Nymphs were maintained with water and *Sterculia foetida* seeds for every 24 hours. Time of Nymphal development, mortality, number of males and female was recorded. Sex ratio was calculated using following formula.

## **RESULTS AND DISCUSSION**

Average numbers of eggs laid by different red cotton bug crossed ranged from 46.67 to 93. The highest number of eggs were produced when 2 spotted male crossed with 2 spotted female followed by 3 spotted male crossed with 3 spotted female and 2spotted male crossed with 3 spotted female and least number of eggs were produced when 3spotted male crossed with 2 spotted female. Percentage of laid eggs hatched from different red cotton bug crossed ranged from 52.45 to 82.79. The highestpercentage of eggs hatched were produced when 2 spotted male crossed with 2 spotted female followed by 3 spotted male crossed with 3 spotted female and 2spotted male crossed with 3 spotted female and least percentage of eggs hatched were produced when 3 spotted male crossed with 2 spotted. Incubation period of eggs laid by different red cotton bug crossed ranged from 3.67 to 6.67. The highest incubation period of eggs were produced when 3 spotted male crossed with 3 spotted female followed by 2 spotted male crossed with 2 spotted female and 2 spotted male crossed with 3 spotted female and least incubation period of eggs were produced when 3spotted male crossed with 2 spotted. Total number of eggs and percentage eggs hatched showed highly significant difference among different crossing with P value <0.0001 and incubation period was significance different (P value 0.0012). However the F value ranged from 14.863 with incubation to 803.88 with eggs laid and percentage eggs laid was 153.59 (Table 1).

**Table 1. Total eggs laid, hatched and its incubation period of different red cotton bug crossed**

	Eggs laid	% of eggs hatched	Incubation period
3SMx2SF	46.67 ± 1.53	67.12 ± 1.45	3.67 ± 0.58
2SMx3SF	67.33 ± 1.15	52.45 ± 3.06	4.67 ± 0.58
3SMx3SF	78.00 ± 1.00	78.21 ± 1.17	6.67 ± 0.58
2SMx2SF	93.00 ± 1.00	82.79 ± 1.19	5.67 ± 0.58
P value	< 0.0001	< 0.0001	0.0012
F value	803.88	153.59	14.863

**Morphological traits of parents (2SM-Two spotted male; 3SM-Three spotted male; 2SF-Two spotted female; 3SF-Three spotted female)**

Total numbers of offspring of different red cotton bug crossed ranged from 31.33 to 77. The highest number of offspring were produced when 2 spotted male crossed with 2 spotted female followed by 3 spotted male crossed with 3 spotted female and 2 spotted male crossed with 3 spotted female and least number of offspring were produced when 3 spotted male crossed with 2 spotted female. Total numbers of male offspring of different red cotton bug crossed ranged from 23.67 to 28. The highest number of male offspring were produced when 2 spotted male crossed with 2 spotted female followed by 2 spotted male crossed with 3 spotted female and 3 spotted male crossed with 3 spotted female and least number of male offspring were produced when 3 spotted male crossed with 2 spotted female (Table 2).

**Table 2 : Total offspring, Male, Female and sex ratio of different cotton red but crossed**

Parents	Total number of off springs	Total Male	Total female	Sex Ratio
3SMx2SF	31.33 ± 1.53	23.67 ± 0.58	7.67 ± 1.15	312.70 ± 40.50
2SMx3SF	35.33 ± 2.52	26.33 ± 1.53	9.00 ± 4.00	347.07 ± 190.62
3SMx3SF	61.00 ± 1.00	24.33 ± 1.53	36.67 ± 2.52	66.77 ± 8.90
2SMx2SF	77.00 ± 1.73	28.00 ± 1.00	49.00 ± 2.65	57.33 ± 5.18
P value	< 0.0001	0.0095	< 0.0001	0.0100
F value	444.13	7.730	165.13	7.602

**Morphological traits of parents (2SM-Two spotted male; 3SM-Three spotted male; 2SF-Two spotted female; 3SF-Three spotted female)**

Total numbers of female offspring of different red cotton bug crossed ranged from 7.67 to 49. The highest number of female offspring were produced when 2 spotted male crossed with 2 spotted female followed by 3 spotted male crossed with 3 spotted female and 2 spotted male crossed with 3 spotted female and least number of offspring were produced when 3 spotted male crossed with 2 spotted female. Sex ratio of total offspring of different red cotton bug crossed ranged from 57.33 to 347.07. The highest sex ratio of offspring were produced when 2 spotted male crossed with 3 spotted female followed by 3 spotted male crossed with 2 spotted female and 3 spotted male crossed with 3 spotted female and least number of offspring were produced when 2 spotted male crossed with 2 spotted female. Total offspring, male, female and sex ratio of different cotton bug showed highly significant difference among different crossing with P value < 0.0001 followed female offspring was significance different (P value 0.0100), male offspring (P value 0.0095). However the F value ranged from 7.602 with sex ratio to 444.13 with number of offspring followed female offspring was 165.13, male offspring was 7.730 (Table 3).

**Table 3. Total offspring, Male, Female and sex ratio of different cotton red but crossed**

Parents	Total number of off springs	Total Male	Total female	Sex Ratio
3SMx2SF	31.33 ± 1.53	23.67 ± 0.58	7.67 ± 1.15	312.70 ± 40.50
2SMx3SF	35.33 ± 2.52	26.33 ± 1.53	9.00 ± 4.00	347.07 ± 190.62
3SMx3SF	61.00 ± 1.00	24.33 ± 1.53	36.67 ± 2.52	66.77 ± 8.90
2SMx2SF	77.00 ± 1.73	28.00 ± 1.00	49.00 ± 2.65	57.33 ± 5.18
P value	< 0.0001	0.0095	< 0.0001	0.0100
F value	444.13	7.730	165.13	7.602

**Morphological traits of parents (2SM-Two spotted male; 3SM-Three spotted male; 2SF-Two spotted female; 3SF-Three spotted female)**

Two spotted offspring of different red cotton bug crossed ranged from 22 to 44.33. The highest number of offspring were produced when 2 spotted male crossed with 2 spotted female followed by 3 spotted male crossed with 3 spotted female and 2 spotted male crossed with 3 spotted female and least number of offspring were produced when 3 spotted male crossed with 2 spotted female. Three spotted offspring of different red cotton bug crossed ranged from 7.33 to 32.67. The highest number of male offspring were produced when 2 spotted male crossed with 2 spotted female followed by 3 spotted male crossed with 3 spotted female and 3 spotted male crossed with 2 spotted female and least number of three spotted offspring were produced when 2 spotted male crossed with 3 spotted female. Two and Three spotted offspring of different red cotton bug showed highly significance difference among different crossing with P value <0.0001. However the F value ranged from 43.235 with two spotted offspring and 121.61 with three spotted offspring (Table 4).

Table 4: Two and Three spotted offspring of different cotton red but crossed

Parents	Two spotted	Three spotted
3SMx2SF	22.00 ± 2.65	9.33 ± 1.15
2SMx3SF	28.00 ± 2.00	7.33 ± 0.58
3SMx3SF	31.33 ± 3.06	29.67 ± 2.52
2SMx2SF	44.33 ± 2.08	32.67 ± 3.06
<b>P value</b>	<b>&lt; 0.0001</b>	<b>&lt; 0.0001</b>
<b>F value</b>	<b>43.235</b>	<b>121.61</b>

**Morphological traits of parents (2SM-Two spotted male; 3SM-Three spotted male; 2SF-Two spotted female; 3SF-Three spotted female)**

Two spotted male offspring of different red cotton bug crossed ranged from 12 to 19.97. The highest number of offspring were produced when 2 spotted male crossed with 3 spotted female followed by 2 spotted male crossed with 2 spotted female and 3 spotted male crossed with 2 spotted female and least number of offspring were produced when 3 spotted male crossed with 3 spotted female. Two spotted female offspring of different red cotton bug crossed ranged from 5.33 to 26.33. The highest number of offspring were produced when 2 spotted male crossed with 2 spotted female followed by 3 spotted male crossed with 3 spotted female and 2 spotted male crossed with 3 spotted female and least number of offspring were produced when 3 spotted male crossed with 2 spotted female. Sex ratio two spotted offspring of different red cotton bug crossed ranged from 63.10 to 327.38. The highest number of offspring were produced when 3 spotted male crossed with 2 spotted female followed by 2 spotted male crossed with 3 spotted female and 2 spotted male crossed with 2 spotted female and least number of offspring were produced when 3 spotted male crossed with 3 spotted female (Table 5).

**Table 5. Male , Female and sex ratio of two spotted offspring of different red cotton bug crossed**

Parents	Male	Female	Sex ratio
3SMx2SF	16.67 ± 1.53	5.33 ± 1.53	327.38 ± 87.21
2SMx3SF	19.67 ± 1.53	8.33 ± 3.51	273.33 ± 136.50
3SMx3SF	12.00 ± 1.00	19.33 ± 2.89	63.10 ± 11.36
2SMx2SF	18.00 ± 1.00	26.33 ± 1.15	68.35 ± 1.88
<b>P value</b>	0.0005	< 0.0001	0.0070
<b>F value</b>	19.485	46.845	8.574

**Morphological traits of parents (2SM-Two spotted male; 3SM-Three spotted male; 2SF-Two spotted female; 3SF-Three spotted female)**

**female; 3SF-Three spotted female**

Male, female and sex ratio of two spotted offspring of different cotton bug showed highly significant difference among different crossing with P value <0.0001 followed sex ratio of two spotted offspring was significance different (P value 0.0070), male of two spotted offspring (P value 0.0005). However the F value ranged from 8.574 with sex ratio of two spotted offspring to 46.845 with female two spotted offspring and male two spotted offspring was 19.485 (Table 6).

**Table 6: Male , Female and sex ratio of two spotted offspring of different red cotton bug crossed**

Parents	Male	Female	Sex ratio
3SMx2SF	16.67 ± 1.53	5.33 ± 1.53	327.38 ± 87.21
2SMx3SF	19.67 ± 1.53	8.33 ± 3.51	273.33 ± 136.50
3SMx3SF	12.00 ± 1.00	19.33 ± 2.89	63.10 ± 11.36
2SMx2SF	18.00 ± 1.00	26.33 ± 1.15	68.35 ± 1.88
<b>P value</b>	0.0005	< 0.0001	0.0070
<b>F value</b>	19.485	46.845	8.574

Morphological traits of parents (2SM-Two spotted male; 3SM-Three spotted male; 2SF-Two spotted female; 3SF-Three spotted female)

Three spotted male offspring of different red cotton bug crossed ranged from 6.67 to 12.33. The highest number of offspring were produced when 3 spotted male crossed with 3 spotted female followed by 2 spotted male crossed with 2 spotted female and 3 spotted male crossed with 2 spotted female and least number of offspring were produced when 2 spotted male crossed with 3 spotted female. Three spotted female offspring of different red cotton bug crossed ranged from 0.67 to 22.67. The highest number of offspring were produced when 2 spotted male crossed with 2 spotted female followed by 3 spotted male crossed with 3 spotted female and 3 spotted male crossed with 2 spotted female and least number of offspring were produced when 2 spotted male crossed with 3 spotted female. Sex ratio three spotted offspring of different red cotton bug crossed ranged from 45.16 to 433.33. The highest number of offspring were produced when 2 spotted male crossed with 3 spotted female followed by 3 spotted male crossed with 2 spotted female and 3 spotted male crossed with 3 spotted female and least number of offspring were produced when 2 spotted male crossed with 2 spotted female. Male, female and sex ratio of three spotted offspring of different red cotton bug by crossed showed high significant difference among different crossing with P value <0.0001 followed sex ratio of three spotted offspring was significance different (P value 0.1065), male of three spotted offspring (P value 0.0006). However the F value ranged from 2.829 with three spotted offspring of sex ratio followed 18.402 with three spotted offspring of male, 100 with three spotted offspring of female (Table 7).

**Table 7. Male , Female and sex ratio of three spotted offspring of different red cotton bug crossed**

Parents	Male	Female	Sex ratio
3SMx2SF	7.00 ± 1.00	2.33 ± 0.58	311.11 ± 83.89
2SMx3SF	6.67 ± 0.58	0.67 ± 0.58	433.33 ± 378.59
3SMx3SF	12.33 ± 1.53	17.33 ± 1.15	71.06 ± 5.91
2SMx2SF	10.00 ± 1.00	22.67 ± 3.51	45.16 ± 11.03
<b>P value</b>	0.0006	< 0.0001	0.1065
<b>F value</b>	18.402	100.00	2.829

Morphological traits of parents (2SM-Two spotted male; 3SM-Three spotted male; 2SF-Two spotted female; 3SF-Three spotted female)

First nymphal development stage duration of different red cotton bug crossed ranged from 2.67 to 3. The highest nymphal development stage were produced when 2 spotted male crossed with 2 spotted female and commonly by 3 spotted male crossed with 3 spotted female, 3 spotted male crossed with 2 spotted female, 2 spotted male crossed with 3 spotted female (Table 8). Second nymphal development stage duration of different red cotton bug crossed ranged from 2.33 to 4.33. The highest second nymphal development stage were produced when 3 spotted male crossed with 2 spotted female and commonly by 3 spotted male crossed with 3 spotted female, 2 spotted male crossed with 2 spotted female and least number of second nymphal development stage were produced when 2 spotted male crossed with 3 spotted female. Third nymphal development stage duration of different red cotton bug crossed ranged from 3.67 to 4.67. The highest third nymphal development stage were produced when 3 spotted male crossed with 3 spotted female and commonly by 3 spotted male crossed with 2 spotted female, 2 spotted male crossed with 2 spotted female and least number of third nymphal development stage were produced when 2 spotted male crossed with 3 spotted female. Fourth nymphal development stage duration of different red cotton bug crossed ranged from 3.33 to 5.33. The highest fourth nymphal development stage were produced when 3 spotted male crossed with 2 spotted female and 2 spotted male crossed with 2 spotted female and least number of fourth nymphal development stage were produced when 2 spotted male crossed with 3 spotted female, 3 spotted male crossed with 3 spotted female. Fifth nymphal development stage duration of different red cotton bug crossed ranged from 5.33 to 7.33. The highest Fifth nymphal development stage were produced when 3 spotted male crossed with 2 spotted female followed by 3 spotted male crossed with 3 spotted female and 2 spotted male crossed with 2 spotted female and least Fifth nymphal development stage were produced when 2 spotted male crossed with 3 spotted female. Adult stage duration of different red cotton bug crossed ranged from 17.33 to 24. The highest adult stage were produced when 3 spotted male crossed with 2 spotted female followed by 2 spotted male crossed with 2 spotted female and 3 spotted male crossed with 3 spotted female and least adult stage were produced when 3 spotted male crossed with 2 spotted female (Table 8).

**Table 8. Different Nymphal stage duration of different red cotton bug crossed**

Parent	I	II	III	IV	V	Adult
3SMx2SF	2.67 ± 0.58	4.33 ± 0.58	4.33 ± 0.58	5.33 ± 0.58	7.33 ± 0.58	24.00 ± 1.00
2SMx3SF	2.67 ± 0.58	2.33 ± 0.58	3.67 ± 0.58	3.33 ± 0.58	5.33 ± 0.58	17.33 ± 0.58
3SMx3SF	2.67 ± 0.58	3.33 ± 0.58	4.67 ± 0.58	3.33 ± 0.58	6.67 ± 0.58	20.67 ± 0.58
2SMx2SF	3.00 ± 0.00	3.33 ± 0.58	4.33 ± 0.58	5.33 ± 0.58	6.33 ± 0.58	22.33 ± 2.31
<b>P value</b>	0.8084	0.0196	0.2725	0.0026	0.0175	0.0015
<b>F value</b>	0.3237	5.945	1.562	11.891	6.203	13.879

Morphological traits of parents (2SM-Two spotted male; 3SM-Three spotted male; 2SF-Two spotted female; 3SF-Three spotted female)

**CONCLUSION**

Due to its rapid multiplication nature it has become dangerous pest especially the cotton since it is the highest preference. It is to be noted that such attack leads to vigorous growth compared to wild (9). Controlling their spread needs indepth understanding of their ecology and reproductive nature. Knowledge on polymorphism of insects is an important factor in their population dynamics, evolution and their adaptation (10, 11, 12), quite often such polymorphism are not strictly genetic. However the present study made an attempt to analyze the genetic segregation in red cotton bug through breeding of different polymorphs. According to Orr (2001) traits within a pure species do not have necessary role in genetic flow, but in the present study it is clear segregation of genes relevant to morphological character of spots on the bug. On the other hand the present research was able to identify that homogeneity in mating leads to more or less similar life cycle where has heterogenic mating leads to reduced or increased life cycle which further indicates gene segregation. Mating results of *D. cingulatus* varies with morphological character spotted nature. Homogeny in spotted character mating leads to good number of off spring production and better sex ratio. Among the two spotted and three spotted *D. cingulatus* homogeny mating two spotted mating is The highest number offspring production and The highest number of female. The heterogenic mating of *D. cingulatus* leads to less number of off spring production with poor sex ratio. Among the two and three spotted male heterogenic matting two spotted male produced comparatively better number of offspring and number of females. However high number two spotted offspring were produced by homogeny mating than the heterogenic mating of *D. cingulatus*. All these confirm that physical characters also segregate during mating and genetically assigned.

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