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# Infestation levels and seasonal incidence of major pests of cotton and their natural enemies in West Bengal

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**Abstract**
Cotton (*Gossypium* spp.) is a major cash crop that is inherently attacked by a number of pests owing to increased and injudicious rate of insecticide application. Employ proper and timely management strategy and to minimize the injudicious use of pesticides in cotton it is necessary to study the incidence behaviour of the pests. An experiment was conducted in the year 2017-18 at the Institutional research farm (C-Block) of Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Nadia, West Bengal aiming to evaluate the infestation level and seasonal incidence of major pests of cotton and their natural enemies. From the results it is concluded that the sucking pests of cotton *viz.* jassids, whitefly and red cotton bug incidence begins from the first week of crop growth and continues to achieve peak growth in the months September and October. Major borer pest *viz. Helicoverpa armigera* maintained a relatively low population during vegetative stage but increase in population was observed in boll stage.

**Keywords:** seasonal incidence, cotton, *Amrasca biguttula biguttula, Bemisia tabaci, Earias vittella, Helicoverpa armigera*

## Introduction
Cotton (*Gossypium* spp.) is a major cash crop of global importance, mainly cultivated in tropical and subtropical areas in over 80 countries. It is cultivated under diverse agro-climatic conditions around the globe of over 38 million hectares, of which approximately 24% is in India. Cotton production contributes around 29.8% to India's agricultural gross domestic production. The fiber derived from cotton, utilized as an important raw material for textile industry. India is largest cotton growing country in the world with area under cotton around 34 per cent (12.20 million ha) followed by China (5.5 million ha). Around 33% of foreign exchange and 65% of textile raw materials is provided by cotton (Mayee and Rao, 2002) [1]. India ranks first with respect to area of cultivation in the world (12 million ha.) and fourth in production (31 million bales) (Mayee, 2011) [2]. Even though India has largest area under cotton still the productivity is low. Among various factors contributing to low productivity, biotic constraints are vital, of which insect pests assume vital importance. According to Kannan and Uthamasamy, 2004 [3] the low yields (up to 35-40%) are mainly attributable to insect pests. India uses Rs. 2800 crores worth of chemical pesticides in cotton crop (Ghosh, 2002) [4]. As many as 1300 species of insect and mite pests have been reported to attack cotton at various stages of growth, across the globe (Hargreaves, 1948 and Atwal, 2002) [5, 6]. However, in India the number is limited to 130 to 200 species (Agarwal *et al*., 1984 and Balakrishnan *et al*., 2010) [7, 8]. Among them, the boll worms *viz*., American boll worm, *Helicoverpa armigera* (Hubner), Spotted boll worm, *Earias vittella* (Fabricius), Spiny boll worm, *Earias insulana* (Boisduval) and Pink boll worm, *Pectinophora gossypiella* (Saunders) pose greater threat to cotton production. Besides these, a complex of sucking pests *viz*., Green leaf hopper, *Amrasca biguttula biguttula* (Ishida), Aphid, *Aphis gossypii* (Glover) and Whitefly, *Bemisia tabaci* (Gennadius), are also known to cause a great devastation (Gosh, 2001) [9] and account for the yield loss of 22.85 per cent (Satpute *et al.*, 1990) [10]. Insecticides valued at US$ 660 million are used annually on all crops in India, of which more than half are used on cotton (Manjunath, 2004) [11]. Cotton consumes about 48 per cent of pesticides used in India and 22.5 per cent of the pesticides used in the world (Saiyed *et al*., 2005) [12]. In natural or artificially manipulated biological control measures have failed to achieve acceptable containment of pest population without the support of chemical treatment in most cases. (Rafee, 2010) [13]. The experiment is conducted to find the infestation levels of various pests of cotton in West Bengal in order to employ proper and timely management strategy and to minimize the injudicious use of pesticides in cotton.

## Materials and Method

The experiment was conducted at the Institutional research farm (C-Block) of Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Nadia, West Bengal. The farm is located at 23.5° N latitude, 89° E longitude and 9.75 m above mean sea level. The field experiments were conducted for two consecutive years during *kharif* and *rabi* season for cotton during 2017 and 2018. The study was focused on the major insect pest in cotton (cv. Surabhi). The crop was grown in three plots of 10 m x 2 m size with 60 cm x 50 cm spacing. The recommended dose of fertilizers @ 120:60:60 (N: P: K) kg/ha were applied where nitrogen was given two equal split *i.e.* one at time of sowing and one of time of the earthing up. Full dose of phosphate and potash were given at the time of sowing. Irrigation and weeding were done as and when required. The study was aimed to estimate the percentage of infestation by jassids (*Amrasca biguttula biguttula*), white fly (*Bemisia tabaci*), Red Cotton Bug (*Dysdercus cingulatus*) and boll worm (*Helicoverpa armigera* and *Earias vittella*) and natural enemies *viz*., ladybird beetle (*Menochilus sexmaculata* Fabricius.), green lacewing (*Chrysoperla carnea* Stephens.) and Spider (unidentified) including for understand the infestation level. The crop under this experiment was kept free from any chemical pesticides throughout the season. The observations mean per cent of leaf, boll and plant damage were observing on ten plants from each plot. The above damage was observed weekly interval after appearance of the pest to till harvest of the crop.

## Statistical analysis

Data on the incidence of major pests and natural enemies were statistically analysed for seasonal variations and then correlated through computation of correlation coefficients for the weather factors. The significant correlation between incidence of sucking pests along with their natural enemies and weather factors were further subjected for regression analysis.

## Result and Discussion

The activities of major pests were monitored at weekly intervals on the cotton hybrid Surabhi (Non Bt) from 30$^{th}$ SW (July 23-29) to 52$^{nd}$ SW (Dec 24-31). Incidence of major pests and natural enemies is presented in Fig 1.

Jassids (*Amrasca biguttula biguttula*) incidence first appeared in the month of July (30$^{th}$ SMW) (0.90 No./3 leaves) which gradually increased reaching a peak (4.73 No./3 leaves) on second week of September (37$^{th}$ SW). The population growth pattern was uneven. Then it declined (0.08 No./3 leaves) at the 3$^{rd}$ week of November (47$^{h}$ SW) with no incidence observed during December population had positive and highly significant correlation with maximum and minimum temperature, minimum relative humidity and total rainfall (r = 0.553, 0.717, 0.709 and 0.715 respectively). The multiple regression analysis revealed that weather parameters contributed for 61.33 per cent of total variation in its incidence (Table 1).

The incidence of whiteflies (*Bemisia tabaci*) commenced from third week of July (30$^{th}$ SW) (2.13 No./3 leaves) and gradually increased reaching a peak (4.54 No./3 leaves) in the first week of October (40$^{th}$ SW). Then it declined but remained active till boll opening stage (0.14 No./3 leaves) on 4$^{th}$ week of December (52$^{nd}$ SW). Its incidence was positively and significantly correlated with maximum and minimum temperature, minimum relative humidity and rainfall (r = 0.820, 0.814, 0.763 and 0.431 respectively). The multiple regression analysis revealed that the weather parameters contributed for 81.36 per cent of total variation in their population (Table 1).

Incidence of Red Cotton Bug (*Dysdercus cingulatus*) was observed during third week of July (30$^{th}$ SW) (2.15 No./plant) but increased gradually to (9.25 No./plant) during fourth week of October (43$^{rd}$ SW). Its activity declined but there after remained active till boll opening stage (2.20 No./plant) on 4$^{th}$ week of December (52$^{nd}$ SW). Temperature (minimum) and relative humidity (minimum) had significantly positive correlation (r = -0.457, and -0.447 respectively). Weather parameters contributed 66.93 per cent of total variation in the incidence of Red cotton bug (Table 1).

American bollworm (*Helicoverpa amigera*) first appeared on 1$^{st}$ week of August (32$^{nd}$ SW) (0.23 No./plant) which gradually increased reaching a peak (5.83 No./plant) on third week of November (46$^{th}$ SW). Then it declined (0.78 No./plant) at the 3$^{rd}$ week of December (51$^{st}$ SW) with no incidence observed during last week of December. Relative humidity (maximum), minimum temperature and rainfall had significantly negative correlation (r = -0.525, -0.579 and -0.720). Weather parameters contributed 58.48 per cent of total variation on the incidence of *Helicoverpa* sp (Table 1).

Spotted bollworm (*Earias vittella*) appeared during 1$^{st}$ week of crop i.e., 3$^{rd}$ week of July (30$^{th}$ SW) (1.10 No./plant) which gradually increased but maintained a low incidence throughout but reaching a peak (4.10 No./plant) during third week of September (38$^{nd}$ SW). Thereafter it declined (0.20 No./plant) during 4$^{th}$ week of November (48$^{th}$ SW) with no incidence observed during of December. Temperature (minimum and maximum), and rainfall had significantly positive correlation (r = 0.735, and 0.769 and 0.751 respectively). Weather parameters contributed 80.94 per cent of total variation in the incidence (Table 1).

Ladybird beetle *(Menochilus sexmaculata*) first appeared during 1$^{st}$ week of crop with a population of (0.15 No./plant) which gradually reached the maximum (2.78 No./plant) during first week of September (36$^{th}$ SW). There after it declined but remained till the end of crop (0.90 No./plant) during 4$^{th}$ week of December (52$^{nd}$ SW). Temperature (minimum and maximum) and rainfall had significantly positive correlation (r = 0.507, 0.549 and 0.532 respectively). weather parameters contributed for 49.56 per cent of total variation in its incidence (Table 1).

The spiders first appeared during 1$^{st}$ week of crop (1.50 No./plant) which gradually increased but maintained a low incidence throughout but reaching a peak (2.12 No./plant) during third week of October (42$^{nd}$ SW), thereafter it declined but remained till 4$^{th}$ week of December (52$^{nd}$ SW). Its incidence was negatively and significantly correlated with minimum temperature and rainfall (r = -0.417 and -0.528 respectively) (Table 1).

Green lacewing (*Chrysoperla carnea*) first appeared during 2$^{nd}$ week of August (34$^{th}$ SW) (0.05 No./plant), then increased but maintained a very low incidence throughout but reaching a peak during October (0.20 No./plant) (41$^{st}$ SW). Then it declined (0.05 No./plant) at the 3$^{rd}$ week of November (47$^{th}$ SW) with no incidence observed during December. Relative humidity (maximum) had significantly positive correlation (r = 0.414) (Table 1).

Ants appeared during 1$^{st}$ week of August (33$^{rd}$ SW) (2.00 No./plant), then increased gradually reaching a peak during last week of October (4.67 No./plant) (43$^{rd}$ SW). Then it

declined (0.50 No./plant) at the 1st week of December (49h SW) with no incidence observed in the successive weeks of December. Rainfall had significantly positive correlation (r = 0.555).

From the above results it is concluded that the sucking pests of cotton *viz*. jassids, whitefly and red cotton bug incidence begins from the first week of crop growth and continues to achieve peak growth in the months September and October. Maximum and minimum temperature, minimum relative humidity are found to be positively correlated to the population growth. It can be inferred that the increase in the population during these months might be attributed to the presence of succulent plant parts due to rainfall. The results were in agreement to the findings of Nemade *et al*., 2018 [14]; Momtaz *et al*., 2018 [15]; Majeed *et al*., 2016 [16]; Kalkal *et al*., 2015 [17]; Bhute *et al*., 2012 [18]; Boda and Ilyas, 2017 [19]; Mohapatra, 2008 [20]; Saleem *et al*., 2018 [21] and Kalkal *et al*., 2013 [22].

The major borer pest *viz Helicoverpa armigera* maintained a relatively low population during vegetative stage but increase in population was observed in boll stage. The findings were in agreement with Karar *et al*., 2020 [23]; Divya *et al*., 2009 [24]; Javed *et al*., 2013 [25]; Akhtar *et al*., 2020 [26]; Filho *et al*., 2019 [27]; Kumar *et al*., 2017 [28]; Sétamou *et al*., 2020 [29]; Bhatt and Karnatak, 2018 [30] and Karar *et al*., 2020 [31].

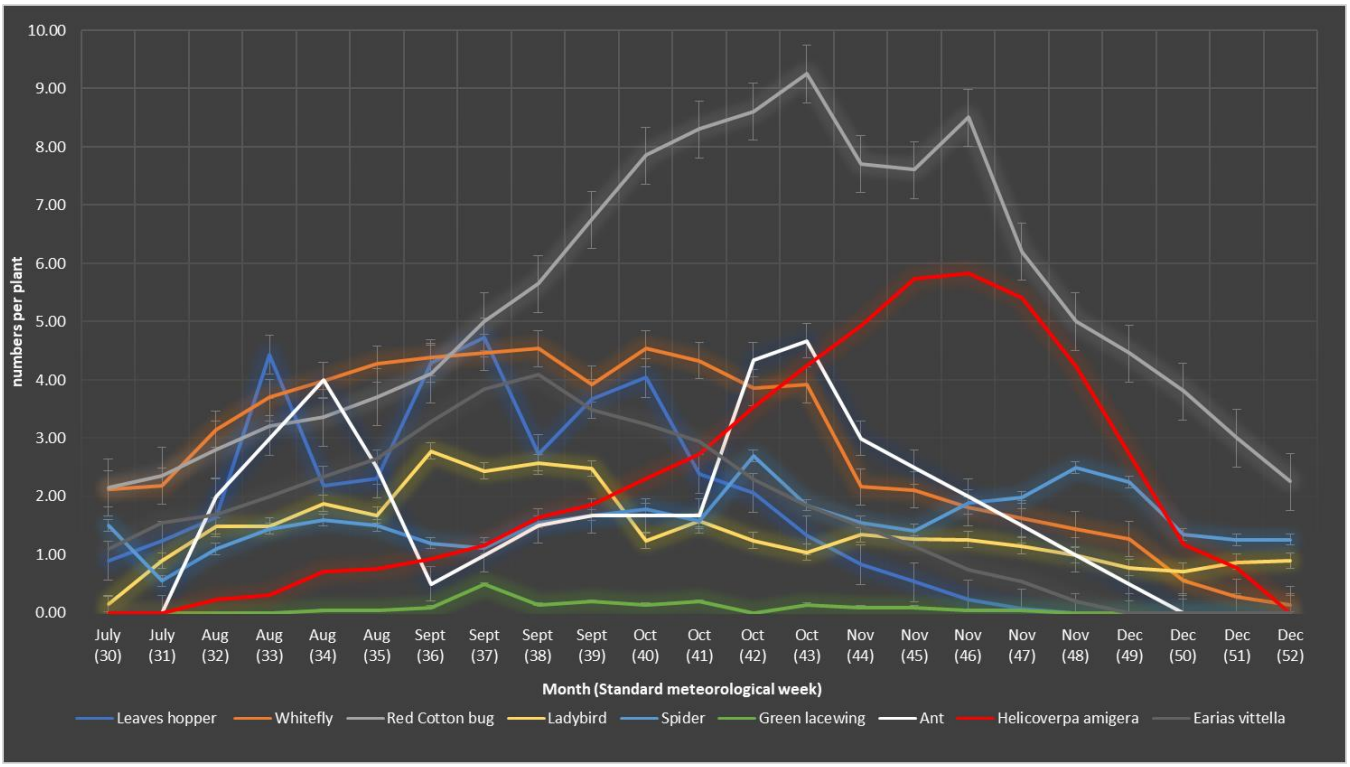


**Fig 1:** Mean infestation levels of major pests of cotton and natural enemies in West Bengal for the year 2017 and 2018

**Table 1:** Correlation coefficients/regression equations - insect pests and natural enemies vs. weather factors (2017-18) in West Bengal

| Insect pests/ Natural enemies | Temperature (°C) | | Relative humidity (%) | | Total rainfall (mm) | BSS | R2 | Regression equation |
|---|---|---|---|---|---|---|---|---|
| | Max. | Min. | Max. | Min. | | | | (Y = A + Bx1 + Cx2 + Dx3 + Ex4 + Fx5 + Gx6 + Hx7) |
| Jassid | 0.553** | 0.717** | 0.078 | 0.709** | 0.715** | -0.557** | 61.33% | Y = 2.54 - 0.08x1 + 0.12x2 + 0.10x3 - 0.04x4 + 0.03x5 + 0.13x6 |
| Whitefly | 0.820** | 0.814** | 0.074 | 0.763** | 0.431* | -0.011 | 81.36% | Y = 19.433 + 0.03x1 + 0.18x2 + 0.02x3 + 0.14x4 + 0.02x5 + 0.28x6 |
| Red Cotton Bug | 0.457* | 0.339 | 0.21 | 0.447* | -0.66 | 0.461* | 66.93% | Y = -36.03 + 0.39x1 - 0.13x2 - 0.05x3 + 0.21x4 + 0.10x5 + 0.59x6 |
| American Bollworm | -0.389 | -0.579** | -0.525** | -0.218 | -0.720** | 0.636** | 59.93% | Y = -31.44 - 0.53x1 + 0.80x2 - 0.07x3 + 0.52x4 - 0.27x5 + 0.30x6 |
| Spiny Bollworm | 0.735** | 0.769** | 0.319 | 0.162 | 0.751** | 0.024 | 80.94% | Y = -20.79 - 0.22x1 + 0.33x2 + 0.005x3 + 0.20x4 + 0.008x5 + 0.34x6 |
| Lady bird Beetle | 0.507* | 0.549** | 0.167 | 0.192 | 0.532** | 0.045 | 49.56% | Y = -11.79 - 0.13x1 + 0.18x2 - 0.006x3 + 0.13x4 - 0.008x5 + 0.14x6 |
| Spider | -0.325 | -0.417* | -0.28 | -0.26 | -0.528** | 0.566** | 46.37% | Y = 0.018 - 0.30x1 + 0.027x2 - 0.01x3 + 0.06x4 - 0.04x5 + 0.24x6 |
| Green Lacewing | 0.146 | 0.271 | 0.477* | -0.007 | 0.254 | -0.255 | 46.01% | Y = 0.003 + 0.009x1 - 0.01x2 + 0.005x3 - 0.003x4 + 0.003x5 + 0.009x6 |
| Ant | 0.388 | 0.312 | 0.089 | 0.21 | .555** | 0.117 | 63.33% | Y = -13.39 + 0.89x1 - 0.65x2 - 0.07x3 - 0.09x4 + 0.15x5 - 0.18x6 |

(** Significant at 0.01%, *Significant at 0.05%)

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