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# Population dynamics and biology of whitefly (*Bemisia tabaci* Gennadius) on sunflower (*Helianthus annuus* L.)

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**Abstract**
A sunflower hybrid (KBSH 1) was sown on three different dates of sowing (third week of December, third week of January and third week of February) at Central Research Farm (CRF), BCKV, Gayeshpur and Farmers field. Among the three different dates of sowing, the population of whitefly (*Bemisia tabaci* Gennadius) (Homoptera: Aleyrodidae) was always higher on first date of sowing followed by intermediate and late sown crop. During first year the whitefly population reached its peak with population load of 5.08, 3.52 and 3.05/leaf at CRF and 6.49, 5.44 and 4.63/leaf at Madandanga farm on second week of February, first week of March and fourth week of March respectively. During second year the whitefly on sunflower, reached its peak with population load of 5.27, 4.45 and 3.71/leaf at CRF and 8.79, 7.29 and 5.21/leaf at Madandanga field on second week of February, first week of March and fourth week of March respectively. Life history of *B. tabaci* was studied under laboratory condition (ranged 22 to 29$^0$C and RH, 75±5%) on sunflower at Plant Health Clinic, BCKV, Nadia, West Bengal. The average developmental period of eggs, first, second, third and fourth instars of whitefly on sunflower were 8.80±1.14, 2.10±0.57, 4.90±0.74, 5.60±0.97 and 6.90±1.29 days respectively, with total nymphal period of 19.40±2.50; Fecundity, 27±2.70 eggs/female; adult longevity (male: 4.30±0.82, female: 5.40±0.97 days). However, the pre-oviposition period lasted for 1.20±0.42 days, oviposition 3.60±0.70 days and post-oviposition 0.60±0.70 days, respectively. Average length for the stages were (mean±SD) egg, 0.22±0.010; first instar, 0.29±0.013; second instar, 0.43±0.024; third instar, 0.69±0.022 and fourth instar, 0.84±0.017 mm respectively.

**Keywords:** Whitefly, Sunflower, Population Dynamics, Correlation, Biology, etc.

## Introduction
The commercial cultivation of sunflower started in India during 1972-73 with a few imported varieties from USSR and Canada. Now, the crop has been well accepted by the farming community. This crop has shown distinct superiority over other oilseed crops owing to its wider adaptability to different agro-climatic conditions, highest oil production per unit area, short duration, high potential yield and ability to withstand drought as compared to other rainfed crops. Average yield of sunflower (629 kg/ha) in the country is the lowest in the world due to several biotic and abiotic constrains. Among biotic constrains in sunflower production, insect pests and diseases are the major concern. As many as 251 insect and acarine species have been recorded on sunflower at global level (Rajamohan, 1976). In India more than 50 insect species have been found to damage the crop at different phenological growth stages of crop. But report on those from West Bengal was very scanty and none specifically on whitefly infesting the crop.

Whiteflies *Bemisia tabaci* (Homoptera: Aleyrodidae), are small plant-feeding insects with piercing-sucking mouthparts, and both immature and adult whiteflies feed on the undersides of leaves. Adult whiteflies have the ability to both walk and fly, and females lay eggs either singly in a haphazard manner or in spirals or circles on the undersides of leaves. Whitefly, ranks among the most noxious insects attacking several field and greenhouse crops around the world (Mound and Halsey, 1978). Both larva and adult of whitefly feed on the phloem sap of hundreds of plant species and cause damage by the excretion of the honeydew that falls on leaves and fruits. The honeydew serves as suitable growth medium for fungi that hamper photosynthesis and render agricultural product. Moreover, whitefly is a vector for many important plant virus diseases, like sunflower necrosis. But no report could be found from West Bengal on this pest infesting sunflower and none on biology of it on the crop from India also.

## Materials and Methods
The experiment was conducted during 2012-13 and 2013-14 at the Central Research Farm (CRF) of Bidhan Chandra Krishi Viswavidyalaya (BCKV), Madandanga (CRF farm is located

at $22.95^0$ N latitude and $88.35^0$ E longitudes at an elevation of 12.0 meter from the mean sea level) and at Madandanga field (located at $23.58^0$ N latitude and $88.35^0$ E longitudes at an elevation of 12.0 meter from the mean sea level), Nadia, West Bengal, India. The land is topographically referred as a medium land. Crop was sown at three different dates with six replications on third week of December, third week of January and third week of February. Urea, single super phosphate (SSP), and muriate of potash (MOP) were used as a source of N, P and K. Half dose of N with full dose of P, K and boron were applied as basal dose, rest 50% N was top-dressed at 30 days after sowing (DAS). All the experimental plots had been covered by fishing nets from bud formation stage to harvesting for protecting the crops from ravages of damaging birds.

Number of whitefly was recorded at seven days interval (weekly) from five plants per plot. Five leaves (two from upper, two from middle and one from lower) had been chosen randomly for observation. Data thus collected were expressed as adult population per leaf. Data of the different meteorological parameters like temperature ($^0$C, maximum and minimum), relative humidity (%, morning and afternoon), rainfall (mm) and total sunshine hours in the experimental site was recorded regularly.

The biological study was conducted at the laboratory of Plant Health Clinic, Directorate of Research, BCKV. The biology of *Bemicia tabaci* was studied on sunflower (*Helanthus annus* L.). Laboratory environmental conditions consisted of 22-29°C temperature and 70±5% RH. Sunflower seeds were sown in pots. One week after plant emergence, excess plants were eliminated, retaining only one plant per pot. The pots were then kept in sunshine daily for 3-4 weeks. Afterward, the pots were shifted to the laboratory. To maintain a whitefly population with sufficient individuals to supply the laboratory necessities, sunflower plants cv. Aditya (Indo American Pvt. Ltd.) were grown in a greenhouse. To start the rearing program, whitefly adults collected from sunflower field at CRF, BCKV with the help of springer type aspirator and then were introduced into the greenhouse where sunflower plants were being grown. Adults were then collected from greenhouse plants and taken to the laboratory for biological studies on sunflower host. For oviposition, two pairs of whitefly adults, collected from sunflower plants were placed in a small cage (diameter of 2.5 cm on one side and other side was covered by muslin cloth); located on the lower side of a leaflet. KOH solution, 10% kept in a bottle, near the pot to absorb excess moisture from the cage. After 24 hrs, the cage and the adults were removed from the leaves. Excess eggs were removed from leaves, keeping only three-four eggs per leaf of plant. Total ten eggs from three leaves were observed by utilizing two plants of sunflower. The insects were observed daily to record the developmental changes. Nymphal growth was observed by taking measurements of body width and length with a graduated ocular micrometer lens under a compound light microscope (ZEISS AXI0SK0P40). When the nymphs reached the $4^{th}$ instar, the leaflet with the nymphs was covered with cage until adult emergence. After adult emergence, sex was determined by examining the body size and abdomen shape. Females were bigger and had a larger abdomen than the males. After death, the insects were observed under stereoscopic binocular microscope ZEISS stemi 2000-C to confirm the sex.

Adult biology was conducted on the leaves, with the help of a transparent glass cage, which was attached to the leaf. Observations were made daily. Also pre-oviposition, oviposition and post-oviposition periods were recorded. The eggs were counted under microscope and cage with whitefly pair (male and female) shifted to next leaf. The assessed biological parameters were: nymphal stage (duration, number of instars and length of each instar); adult stage (longevity of males and females, pre-oviposition, oviposition and post-oviposition period, number of eggs per female); egg stage (duration); total life cycle (time extent from egg to adult emergence and survival period).

## Results and Discussion

### Incidence pattern of whitefly (*B. tabaci*) on sunflower during 2012-13

The result regarding population dynamics of whitefly on sunflower during 2012-13 (Table1) indicated that the presence of whitefly on plants of first (second fortnight of December) and second sowing (second fortnight of January) were for six weeks at CRF and seven weeks at Madandanga, which on third sowing (second fortnight of February) it were seven and six weeks at CRF and Madandanga respectively.

The initiation of population on first date of sowing took place at third week of January at both CRF and Madandanga, when the plants were at 3-4 leaf stage, with the initial population load/leaf of 0.08 and 0.91 reaching its peak (5.08 and 6.49/leaf) at second week of February at CRF and Madandanga respectively. In case of second sowing at both sites, the pest population development started at third week of February with the initial population of 1.51 and 2.57/leaf reaching its peak at first week of March with maximum population of 3.52/leaf. However, on third date of sowing the population grew up to three weeks after initiation to reach its peak at fifth week of March, when the population load was 3.05 and 4.63/leaf at CRF and Madandanga respectively. The peak of population at first date of sowing was much higher, which reached at second week of February. The peaks of other dates of sowing were smaller, which reached at the level on first week of March and Fifth week of March.

**Table 1:** Population dynamics of whitefly (*Bemisia tabaci*) during 2012-13

| DOO | S1 | S2 | S3 | S1 | S2 | S3 |
|---|---|---|---|---|---|---|
| | CRF Gayeshpur | | | Madandanga | | |
| 17.01.12 | 0.08 | - | - | 0.91 | - | - |
| 25.01.12 | 2.08 | - | - | 5.11 | - | - |
| 02.02.12 | 3.20 | - | - | 5.76 | - | - |
| 10.02.12 | 5.08 | - | - | 6.49 | - | - |
| 16.02.12 | 1.36 | 1.51 | - | 3.77 | 2.57 | - |
| 23.02.12 | 0.52 | 2.67 | - | 3.01 | 2.85 | - |
| 01.03.12 | 0.00 | 3.52 | - | 1.09 | 5.44 | - |
| 09.03.12 | 0.00 | 2.12 | - | 0.00 | 3.44 | - |
| 17.03.12 | 0.00 | 2.09 | 2.27 | 0.00 | 3.24 | 2.28 |
| 23.03.12 | 0.00 | 1.31 | 2.67 | 0.00 | 2.43 | 3.76 |
| 31.03.12 | 0.00 | 0.00 | 3.05 | - | 0.07 | 4.63 |
| 06.04.12 | - | 0.00 | 1.80 | - | 0.00 | 1.29 |
| 14.04.12 | - | 0.00 | 0.88 | - | 0.00 | 0.41 |
| 21.04.12 | - | 0.00 | 0.03 | - | 0.00 | 0.03 |
| 28.04.12 | - | 0.00 | 0.01 | - | - | 0.00 |
| 03.05.12 | - | - | 0.00 | - | - | 0.00 |
| 10.05.12 | - | - | 0.00 | - | - | 0.00 |
| 16.05.12 | - | - | 0.00 | - | - | 0.00 |
| 22.05.12 | - | - | 0.00 | - | - | 0.00 |

**DOO-** Date of observation, **S1-** first sowing, **S2-** second sowing, **S3-** third sowing

**Incidence pattern of whitefly (*B. tabaci*) on sunflower during 2013-14**

The population fluctuation of whitefly was monitored from third week of January to fourth week of May in three different dates of sowing (Table2). In first date of sowing presence of whitefly on the crop was for eight weeks, which on second sowing was seven weeks at both sites. Whereas, on third date of sowing population were seven and six weeks respectively.

At both CRF and Madandanga data, indicated that the initiation of the population on first date of sowing took place at third week of January, when the plants were at 3-4 leaf stage, with the initial population load/leaf of 0.15 and 1.57/leaf, reaching its peak (5.27 and 8.79/leaf) at second week of February. In case of second sowing, at CRF and Madandanga, the pest population development started at third week of February with the initial population of 0.91 and 4.52/leaf reaching its peak at second week of March with maximum population of 4.45 and 7.29/leaf. On third date of sowing the population grew within one week of initiation to reach its peak at fourth week of March, where population load was 3.71/leaf at CRF. However, at Madandanga, it took two weeks after initiation to reach its peak with population load of 5.21/leaf.

It had been found that the plant harboured the pest only at vegetative stage and the attack had always been found to cease before capitulum formation stage. The incidence of pest usually started after one month of crop sowing and peak reached after four week of that when the leaves took its broadest shape. However, in second and third dates of sowing it took lesser time after initiation of population than in the first date of sowing. However, the pest attack though was higher in first date of sowing but symptom development on the crop was not so prominent. Some sooty mould development due to honey dew secretion by the pest could be noticed on the crop but it did not take serious shape.

The finding was more or less similar with the finding of Chavan *et al.* (2013) who reported that whitefly population commenced from transplanting with 0.37 whiteflies/leaf and reached to peak level 6.01whiteflies/leaf at 11$^{th}$ standard meteorological week on tomato. Such study on sunflower had been taken by Men *et al*. (1997) from India, but the study was at kharif season. Latif and Akthar (2013) also peak reported that population of whitefly gradually increased with the increased environmental factors (*viz*., temperature, relative humidity) up to certain age of the cultivated crops then declined with increasing age of the crops. Similarly, Konar and Paul (2006) found that whitefly became active from October to March-April in gangatic plains of West Bengal, India.

**Table 2:** Population dynamics of whitefly (*Bemisia tabaci)* during 2013-14

| DOO | S1 | S2 | S3 | S1 | S2 | S3 |
|---|---|---|---|---|---|---|
| | CRF Gayeshpur | | | Madandanga | | |
| 16.01.13 | 0.15 | - | - | 1.57 | - | - |
| 23.01.13 | 1.27 | - | - | 3.51 | - | - |
| 31.01.13 | 2.64 | - | - | 4.72 | - | - |
| 08.02.13 | 5.27 | - | - | 8.79 | - | - |
| 15.02.13 | 3.64 | 0.91 | - | 6.95 | 4.52 | - |
| 20.02.13 | 1.72 | 1.45 | - | 2.15 | 6.61 | - |
| 28.2.13 | 1.20 | 3.89 | - | 0.05 | 7.29 | - |
| 06.03.13 | 0.21 | 4.45 | - | 0.03 | 6.07 | - |
| 13.03.13 | 0.00 | 3.91 | 2.79 | 0.00 | 2.43 | 3.75 |
| 22.03.13 | 0.00 | 2.59 | 3.71 | 0.00 | 1.35 | 5.21 |
| 27.03.13 | 0.00 | 0.72 | 2.36 | 0.00 | 0.51 | 3.76 |
| 05.04.13 | - | 0.00 | 0.19 | - | 0.00 | 1.59 |
| 11.04.13 | - | 0.00 | 0.07 | - | 0.00 | 1.19 |
| 20.04.13 | - | 0.00 | 0.07 | - | 0.00 | 0.11 |
| 27.04.13 | - | 0.00 | 0.07 | - | 0.00 | 0.00 |
| 03.05.13 | - | - | 0.00 | - | - | 0.00 |
| 11.05.13 | - | - | 0.00 | - | - | 0.00 |
| 18.05.13 | - | - | 0.00 | - | - | 0.00 |
| 23.05.13 | - | - | 0.00 | - | - | 0.00 |

**DOO-** Date of observation, **S1-** first sowing, **S2-** second sowing, **S3-** third sowing

**Table 3:** Developmental periods and other parameters in the life cycle of whitefly *Bemesia tabaci* (Gennadius) on sunflower

| Sl. No. | Parameters | | Period (days) | Length (mm) |
|---|---|---|---|---|
| | | | Mean ±SD | Mean ± SD |
| 1 | Pre Oviposition | | 1.20±0.42 | - |
| 2 | Oviposition | | 3.60±0.70 | - |
| 3 | Post oviposition | | 0.60±0.70 | - |
| 4 | Eggs | | 8.80±1.14 | 0.22±0.010 |
| 5 | Total Nymphal Period | | 19.40±2.50 | - |
| i | 1$^{st}$ instar | | 2.10±0.57 | 0.29±0.013 |
| ii | 2$^{nd}$ instar | | 4.90±0.74 | 0.43±0.024 |
| iii | 3$^{rd}$ instar | | 5.60±0.97 | 0.69±0.022 |
| iv | 4$^{th}$ instar | | 6.90±1.29 | 0.84±0.017 |
| 6 | Adult longevity period | Male | 4.30±0.82 | 0.87±0.031 |
| | | Female | 5.40±0.97 | 0.97±0.027 |
| 7 | Total life period | Male | 32.50±2.37 | - |
| | | Female | 33.60±2.32 | - |

**Biological study**

The whitefly had six life stages as egg, four nymphal instars and adult. Whitefly adults laid eggs on the under surfaces of young leaves. Whitefly eggs were oval in shape and somewhat tapered towards the distal end. The broader end had a short stalk that was inserted by the ovipositing female into the leaf. The egg was gleaming white when first laid and darkened over time. The distal end of the egg became dark brown just before the hatching. Average length of egg was 0.22±0.010 mm (Table3). The average incubation period recorded was 8.80±1.14 days (Table 2). When the eggs hatched greenish-yellow, flattened, oval first instar nymphs emerged. The first nymphal instar was capable of limited movement and was called the crawler. The crawler had three pairs of legs, a pair of antennae and small eyes. It was whitish-green in colour and had two yellow spots, visible in the abdomen through the integument (skin). The crawlers usually moved only a few centimetres in search of a feeding site. They initiated feeding on the lower surface of a leaf. After starting feeding, they moulted to the second nymphal instar. It was oval in shape and measured approximately 0.29±0.013 mm in length

Second and third nymphal instars were immobile. During this stationary stage they looked like soft scale insects, greenish-yellow in color, oval, flattened but slightly pointed towards the tail. They had no leg or distinguishing features, they sucked sap from the plant. The length recorded for second and third instar was 0.43±0.024 and 0.69±0.022, respectively. Late in the third instar and through the fourth instar nymphs developed obvious red eyes were evident and were referred to as red-eyed nymphs. They are yellowish white in body colour. Late in the fourth instar they stopped feeding and pupate, after that an adults of yellowish white colour emerged. The sides of red-eyed nymphs were boat-shaped. The empty white cases the adults emerged from could be seen under the leaf. The average duration recorded for fourth instar was 6.90±1.29, while the approximate length of instar was 0.84±0.017 mm.

Adults emerged in the morning, males first and it takes two to three hours before adults could fly. Adults held their wings vertically tilted. They had white wings and yellow bodies. Adult whiteflies emerged through a T-shaped slit in the integument of the last nymphal instar. The remaining white, transparent shell is known the exuvia. The pre oviposition period lasted 1.20±0.42 days, oviposition 3.60±0.70 days and post oviposition 0.60±0.70 days, respectively. However, Fecundity recorded was 27±2.70 eggs/female. The present finding is in line with Patel *et al*. (1992) on okra who reported the durationof egg stage, 1st instar, 2nd instar, 3rd instar nymphs and pupal periods lasted for 6-8, 5-6, 3-4, 2-3 and 5-6 days with adult longevity 6-12 and 2-11 days for males and females, respectively. Similarly, Salas and Mendoza (1995) on tomato investigated duration in days as: egg 7.3±0.5; 1st instar 4.0±1.0; 2nd instar 2.7±1.1; 3rd instar 2.5±0.7; and 4th instar-pupa 5.8±0.3. The total life cycle from egg to adult emergence was 22.3 days. Adult longevity was 19.0±3.3 for female and 19.4±5.8 days for males. The pre-oviposition and oviposition period lasted for 1.4±0.7 and 16.7±3.2 days. Fecundity: 194.9±59.1 eggs/female, sex ratio was 1:2.7 males: females. Also, Thomas *et al.* (2011) studied biology and morphometrics of *B. tabaci* on leucaena, *Leucaena leucocephala* (Lam.) in New Delhi and reveled that developmental periods of the egg, and the first to fourth instars of 6.7±0.18, 4.2±0.18, 3.8±0.14, 3.0±0.0 and 5.2±0.18 days, respectively, with a total life cycle duration of 22.9±0.58 days; fecundity (62.60±61.53 eggs/female) and longevity (male: 13.50±0.12 days, female: 16.50±0.12 days), with a sex ratio (male: female) 1:4.So the present can be treated as a new addition to the information pool on white fly infesting sunflower at least from West Bengal.

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