International Journal of Entomology Research
www.entomologyjournals.com
ISSN: 2455-4758
Received: 21-11-2021, Accepted: 06-12-2021, Published: 22-12-2021
Volume 6, Issue 6, 2021, Page No. 282-286

Effect of seasonal variation on the population dynamics of whitefly (*Bemisia tabaci*) on tobacco

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Abstract
The whitefly *Bemisia tabaci* Gennadius (Homoptera: Aleyrodidae) is an important pest throughout the world for the field crops. It is the natural vector of geminivirus disease of different hosts. The *Bemisia* is a species complex having many biotypes and it has two extant cryptic species. In the present study, effect of seasonal variation on the population dynamics of whitefly was investigated on tobacco plants. Meteorological data were recorded regularly throughout the year, for a consecutive 3 years. Whitefly population per plant was recorded at experimental field of Basirhat District of West Bengal, India. A second trial was also carried out at field condition of North 24 Parganas District of West Bengal, India. For the maintenance of the insect, large wooden cages covered with galvanized insect-proof wire mesh were used and kept in the glasshouse. The result revealed that the whitefly population dynamics were influenced by many parameters, among which temperature, relative humidity, total rainfall, evaporation, number of rainy days, and bright sunny hours are important factors. In this study, it was observed that the minimum temperature has two peaks, one during the month of June, and the second peak during the month of September. The September peak is highest one. Observations on three years data indicated that the whitefly population was highest during August-October and it reached its maximum peak at September with a short peak during June in a year.

Keywords: whitefly, population dynamics, temperature, relative humidity, tobacco

Introduction

The whitefly *Bemisia tabaci* Gennadius (Homoptera: Aleyrodidae) is an important pest throughout the world for the field crops (Brown, 1994a,b; Butler and Henneberry, 1994; Byrne *et al.*, 1992; Mehta *et al.*, 1994) [1-5]. In 1889, in Greece, it was first collected and then described from tobacco, *i.e. Nicotiana* spp., and it was then named as as *Aleurodes tabaci* (Gennadius) (Russell, 1957) [6]. In 1905, in India, the first record of *Bemisia tabaci* was observed on cotton (Misra and Lambda, 1929; Reddy and Rao, 1989) [7, 8].

One hundred and twenty eight (128) plant species have been reported as hosts of the whitefly (Ali *et al.*, 1995) [9]. The most important host for culture of whiteflies is brinjal among vegetables. *Lantana sp.* and sunflower among ornamentals, *Achyranthes sp.*, *Citrullus sp.* and *Xanthium sp.* among weeds, *Mulburry sp.* among fruit and forest plants are most important hosts to maintain whitefly population during off-season in cotton cultivation. The whitefly population develops during different months in different crops like cucurbits, tomato, sunflower, chillies, potato, rapeseed, okra beans, brijal and menthe. Some weed plants like *Xanthium strumarium* L., *Achyranthes aspera* var *porphyristachya* (L.)Mart., *Mentha longifolia* (L.) Huds., *Sida* sp. L., *Abutilon indicum* (L.)Sweet, *Amaranthus spinosus* L., *Euphorbia hirta* L., *Eleusine indica* (L.)Gaertn., *Datura metel* L., *Digera muricata* L., *Solanum nigrum* L., *Convolvulus arvensis* L., *Malva parviflora* L., *Corchorus capsularis* L., growing in and around crop field also harbour adult whiteflies population. Studies on host preferences revealed that the oviposition and larval survival have been found maximum on soybean (Naresh and Nene, 1980) [10]. Although cowpea under Indian condition is the least preferred host, the vector breeds well on cowpea under West African conditions (Vetten and Allen, 1983) [11]. In Pakistan, very high level of *B. tabaci* population was found on mungbean crop (200-250 whiteflies per plant) during June to August (Malik, 1992) [12].

At different periods in day time, the *B. tabaci* population varies significantly on plant. In Black gram, at noon when the light intensity is maximum the *B. tabaci* number is lowest, and the highest during late evening hours or early morning times (Subrahmanyam and Varma, 1986) [13]. Longevity of whiteflies is found to be maximum in French bean (Varma *et al.*, 1989) [14].

The *B. tabaci* move by two main ways, short movement and long distance movement. The short movement is an active movement covering distances measuring in meters (Melamed-Madjar *et al.*, 1979; Fauquet *et al.*, 1986) [15, 16]. The long distance movement is a passive one controlled mainly by the wind (Youngman *et. al.*, 1986) [17]. The largest flight distance is 7 km. The flight activity mainly occur during morning hours, sometimes a second short peak can be observed in late afternoon time (Fauquet *et al.*, 1986) [16]. Besides attracted to the yellow part of the spectrum, they are also attracted by ultraviolet light (Mound, 1962) [18].

Bemisia tabaci is the natural vector of geminivirus disease of different hosts (Chatterjee, 2021; Chatterjee and Ghosh, 2007a, 2007b) [19-21]. Control of *B. tabaci* can be achieved by using different insecticides (Hoque *et al.*, 2003; Pun *et al.*, 2005) [22, 23]. Beside this some predators of whitefly like *Encarsia formosa* (parasitic wasp) and *Macrolophus caliginosus* (assassin bug) are also used to control this vector (Enkegaard *et al.*, 2001; Gerling, 1993) [24, 25].

The *Bemisia* is a species complex having many biotypes and it has two extant cryptic species (Perring, 2001) [26]. The *B. tabaci* biotype relationships can be clarified by the electrophoretic pattern differences (Brown, 2000; Brown *et al.*, 1995a; Burban *et al.*, 2000; Costa and Brown, 1991; Liu *et al.*, 1992; Prabhaker *et al.*, 1987) [27-32]. In India, different

biotypes of *B. tabaci* are found, among which biotype B of *B. tabaci* is most studied one (Brown *et al.*, 1995b; Palaniswami and Nair, 1995; Perring *et al.*, 1993) [33-35].

In the present study, effect of seasonal variation on the population dynamics of whitefly was investigated. Whiteflies were rared on tobacco plants and its population growth were measured for a consecutive 3 years depending on meteorological data like the temperature, total rainfall, relative humidity, number of rainy days, bright sunny hours and rate of evaporation. Studies were carried out at experimental field of Basirhat District of West Bengal, India, and also a second trial at North 24 Parganas District of West Bengal, India.

Material and Methods

Maintenance of whitefly culture

For the maintenance of the insect large wooden cages were prepared and covered with galvanized wire mesh which are insect proof. A stock of whitefly (*Bemisia tabaci* Gennadius) was reared on the healthy tobacco plants (*Nicotiana tabacum* cv. *xanthi*). The tobacco plants with the insects were kept in the wooden cages in glasshouse. The conditions maintained in the glasshouse was 30^0C temperature with a photoperiod of 18:6 (L:D) h and 60% relative humidity. In this study, the adult whiteflies emerged from nymphs were used.

Seasonal variation *vis-a-vis* whitefly population

Meteorological data

Meteorological data regarding the temperature, total rainfall, relative humidity, number of rainy days, bright sunny hours and rate of evaporation were recorded regularly throughout the year, for a consecutive 3 years.

Population dynamics of whitefly

Whitefly population per plant was recorded monthly basis from ten plants of tobacco. Studies were carried out at experimental field of Basirhat District of West Bengal, India. Further, a second trial was also carried out at field condition of North 24 Parganas District of West Bengal, India.

For comparison in controlled condition, a set of experiments were also conducted in a large wooden cages, where the whiteflies were rare to understand the population growth and population dynamics.

Result and Discussion

Maintenance of whitefly culture

The result revealed that the whiteflies were efficiently maintained in the glass house condition in wooden cages (Figure 1). The 30^0C temperature with 60% relative humidity was optimum for insect growth. The photoperiodic induction with 18 hour light and 6 hour dark was sufficient for insect growth. In this study, it was observed that the adult whiteflies were emerged from nymphs in good number maintaining this glasshouse condition.

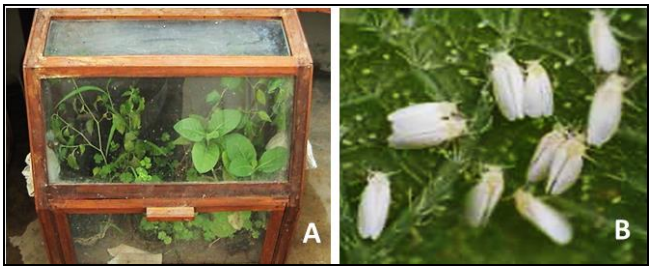

Fig 1: Rearing of whiteflies in insect-proof wooden cage (A), tobacco whiteflies on leaf (B).

Seasonal variation *vis-a-vis* whitefly population

Meteorological data

Among meteorological parameters, the data taken into considerations were: temperature (minimum and maximum, as compared with the average temperature in last ten years data), relative humidity (minimum and maximum, as compared with the average temperature in last ten years data), total rainfall (in mm), evaporation (in mm), number of rainy days, and bright sunny hours (Figure 2).

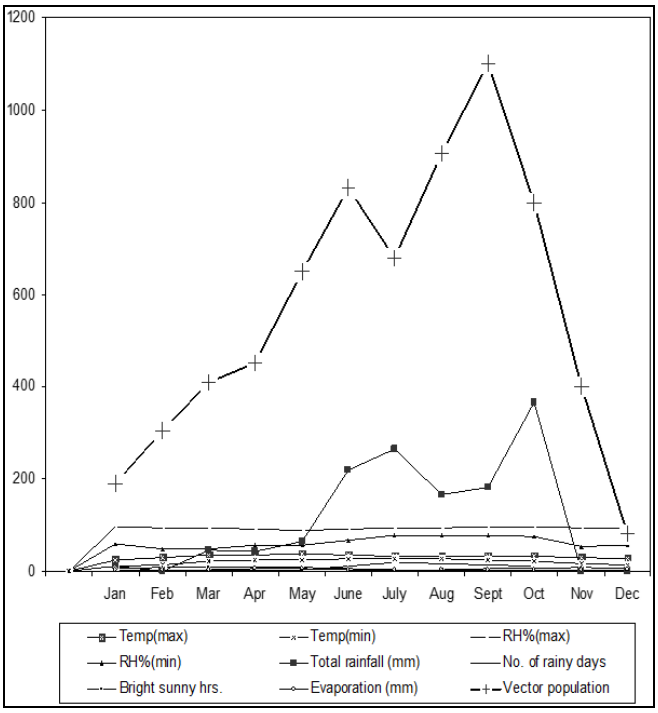

Fig 2: Population build-up of whitefly under different meteorological situations throughout the year.

For a successive three years study, the result revealed that in this region the minimum and maximum temperatures varies throughout the season. The maximum temperature was high from the month March to October, and it reach highest during August to September. Number of rainy days is found in the month of April to September and it is maximum in June-July. The relative humidity was found to be started rising from April and it continues upto September. This condition is also found to be good for the emergence of the nymph of the whitefly vector. All other data also supports this vector growth from April to October.

But most interesting result was found for the case of minimum temperature, where two peaks were found: one during May to July, and the second during August to October. In case of both the peak, the first peak reached its highest in the month of June, and the second peak touched its highest in the month of September. In comparison between this two, the September peak is more pronounced one.

Population dynamics of whitefly

Whitefly population *vis-a-vis* meteorological factors have been presented in Figure1. Observations on three years data indicated that the whitefly population was highest during August-October and it reached its maximum peak at September with a short peak during June in a year. On the other hand, whitefly population declined gradually with the start of winter and became lowest in the month of December-January (Figure 2).

The result revealed that the whitefly population dynamics are influenced by many parameters, among which temperature, relative humidity, total rainfall, evaporation, number of rainy days, and bright sunny hours are important factors. The most important factors were the minimum temperature and the minimum relative humidity as was observed in the earlier studies (Krishnareddy, 1989; Pimple and Summanwar, 1986; Subrahmanyam, 1979; Varma and Subrahmanyam, 1986) [36-39].

In this data, it was observed that the minimum temperature has two peaks, one during the month of June, and the second peak during the month of September. The September peak is highest one. Further, the whitefly population was highest during August-October and it reached its maximum peak at September with a short peak during June. Thus, these two peaks of minimum temperature and whitefly population coincide each other in both the cases, for short peak ad also for highest peak. This overlapping of the peaks indicated that the minimum temperature is the major factor of influence in the whitefly population dynamics in this region.

In Punjab, the whitefly remains active in all the seasons throughout the year as observed by early studies (Singh *et al.* 1994) [40]. The whiteflies requires minimum time to complete their development in 27-30^{0}C temperature range (Gerling *et al.*, 1986) [41]. Under Indian condition the vector population is usually maximum between July and September following a period of 10-12 days with temperature between 24^{0}C and 33^{0}C and a relative humidity between 66 and 99% (Pimple and Summanwar, 1986) [37]. Extreme temperature along with rain as well as low humidity (under 60%) impair oviposition.

Under hot and humid conditions the *B. tabaci* thrives best. In subtropical areas, this *B. tabaci* vector population differs in distinct seasons. During unfavourable winter season and the dry summer season, the insects present on bushy perennial plants like *Lantana camara* in small numbers. In tropical areas where no distinct winter season prevails, the insects present throughout the year, but the population dynamics fluctuates with prevailing weather (Varma *et al.*, 1989) [14].

In Northern India, as in the sub-tropical areas, the *B. tabaci* population mostly influenced by the minimum temperature and the minimum relative humidity (Krishnareddy, 1989; Pimple and Summanwar, 1986; Subrahmanyam, 1979; Varma and Subrahmanyam, 1986) [36-39]. In Southern India, as in the tropical areas, the insect populations are favoured by the high temperatures, low rainfall and low humidity (Murugesan and Chelliah, 1977) [42]. Time taken for completing the life cycle varies depending on season and host. Under Delhi conditions, this requires about 11 days in summer and upto 83 days in winter for completion of the life cycle of the insect and in one year about 15 generations are found (Varma *et al.*, 1992) [43].

Conclusion

In the present study, effect of seasonal variation on the population dynamics of whitefly was investigated. For a successive three years study, the result revealed that in this region the minimum and maximum temperatures varies throughout the year. The relative humidity was found to be started rising from April and it continues upto September. This condition is also found to be good for the emergence of the nymph of the whitefly vector. All other data also supports this vector growth from April to October. The result revealed that the whitefly population dynamics are influenced by many parameters, among which temperature, relative humidity, total rainfall, evaporation, number of rainy days, and bright sunny hours are important factors. The most important factors were the minimum temperature and the minimum relative humidity. Observations indicated that the whitefly population was highest during August-October and it reached its maximum peak at September with a short peak during June in a year. On the other hand, whitefly population declined gradually with the start of winter and became lowest in the month of December-January. But most interesting result was found for the case of minimum temperature, where two peaks were found: one during the month of June, and the second peak during the month of September. The September peak is highest one. The two peaks of minimum temperature and whitefly population coincide each other in both the cases, for short peak ad also for highest peak. This overlapping of the peaks indicated that the minimum temperature is the major factor of influence in the whitefly population dynamics in this region.

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