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Sudeepa Kumari Jha
Ph.D. (Ag.) Entomology scholar, BAU Kanke, Ranchi, Jharkhand, India

Manoj Kumar
Asstt. Prof.-cum-Jr. Scientist Department of Entomology, DRPCAU, Pusa, Bihar, India

Correspondence
Sudeepa Kumari Jha
Ph.D. (Ag.) Entomology scholar, BAU Kanke, Ranchi, Jharkhand, India

Fluctuation in whitefly *Bemisia tabaci* population in relation to environmental factors

Sudeepa Kumari Jha and Manoj Kumar

Abstract
The present study in review paper was to assess the effect of different environmental factor on the population of whitefly *Bemisia tabaci*. With this aim, we study the different works done in India and abroad during 1982 to 2017 and found that different environmental factors affect the population in different extent even variation was found in same factors in different location or different time.

Keywords: whitefly, temperature, humidity, rainfall, wind speed

Introduction

The whitefly is one of the most economically important pests of tomato in many tropical and sub-tropical regions [9]. In warmer region, it is serious pest in open field vegetable production but crop grown under protected cultivation (polyhouse) are equally suffering from whitefly. In addition, it has recently become a serious pest of protected Horticulture in temperate regions [34]. Whitefly is popularly known by different names i.e. cotton whitefly, sweet potato whitefly, and tobacco whitefly. Currently its host range has crossed 600 plant species including cotton, vegetable, ornamental plants and several other agriculture crop [31]. Among the total host plant species listed by Mound and Halsey [29] almost half belongs to the five families: Fabaceae, Asteraceae, Malvaceae, Solanaceae and Euphorbiaceae. Life cycle has been found to be negatively correlated with temperature and relative humidity indicating that the pest was biologically more active during the drier part of the growing crops [12]. Damage is caused by both nymph and adults in three ways viz; the vitality of the plant is lowered through the loss of cell sap, normal photosynthesis is interfered due to the growth of sooty mould on the honey dew excreted by the insect and transmits a number of viral diseases including leaf curl virus. Thus, it not only suck the plant sap while feeding but also transmit tomato leaf curl virus (TLCV), which results in curling of tomato leaves [6].

Review

Seasonal Incidence:- Maximum temperature and rainfall influenced the whitefly, *Bemisia tabaci* population under the South Indian conditions [30] while under the North Indian conditions minimum temperature and minimum relative humidity influenced the population [22]. Temperature had a significant effect on both eggs and nymphs population of whitefly on tomato while relative humidity had no significant effect [1]. Adult whitefly present throughout the growing period in the tomato field and their population was highest at the end of rainy season [5]. Population density of whitefly was highest during mid February and highest infestation levels were maintained from mid February to mid March when temperature, relative humidity, sunshine and rainfall were 17 -22 ºC, 65-73 %, 8 - 9 hrs per day and 5mm, respectively [11]. Okra yellow vein mosaic virus disease severity increased with the rise in minimum temperature while whitefly population decreased with increase in relative humidity [4]. Maximum whitefly population on tomato found during first week of March [21] while whitefly population on tomato appeared during second week of January and remained active until the crop was harvested. Peak population was observed during the last week of February, when maximum and minimum temperature were 30.5 and 16.8° C, respectively, average relative humidity 61.5 % and rainfall 162 mm [7]. In West Bengal, whitefly population fluctuation on brinjal cv. Pusa purple long was highest during 32nd standard week [16]. On green gram crop both maximum and minimum temperature and relative humidity had a significant positive correlation with whitefly population in increasing the diseases transmission [47].

Population of *B. tabaci* in green house tomato remained at low level during the winter but increased steadily from February to March [26]. Whitefly was highly active on brinjal during October to November and the developmental stages were longer during December to January [13]. Peak incidence of whitefly varies from year to year in general, it was not uniformly distributed [44] while on brinjal crop incidence of whitefly was maximum during January (2nd SW) and lowest in March (12th SW) [27]. Peak population of whitefly when maximum and minimum temperature ranged from 35 – 26 ºC, relative humidity ranges from 84 to 67 per cent, zero rainfall, wind velocity of 6.30 km per hr, total sunshine hours of 9.4 hrs per week, and an evaporation of 52.20 mm [40]. The temperature dependent development model of whitefly, *Bemisia tabaci* Q biotype on three host plants (bell pepper, oriental melon and eggplant) at nine temperatures (15, 17.5, 20, 22.5, 30, 32.5 and 35 ºC) and reported a non-linear relationship between development rate and temperature [17]. On okra crop the population of whitefly gradually increased with environmental temperature and humidity upto a certain age of cultivated crop and then declined with increasing age of the crop [25]. Increasing temperature and moderate relative humidity were favourable for Mungbean Yellow Mosaic Virus disease incidence which is caused by *B. tabaci* [36]. On brinjal incidence of whitefly started from November (7.27 whitefly per three leaves) and reached to peak level (25.73 whitefly per three leaves) during January [15]. Seasonal incidence of whitefly, on brinjal crop reached to peak level (15.33 whitefly per leaf) coinciding with the last week of April [33]. Whitefly population on brinjal was highest during January (2nd SW) and lowest in March (12th SW) [18]. Population of whitefly on cotton crop in Pakistan (Sindhu) was very low in 2nd week of April, but at peak during last week of July [42].

Date of Sowing

Highest banded winged whitefly population level (1.8 per leaf) in cotton crop when planted in late April and lowest population levels (0.2 per leaf) when crop was planted in late June [43]. High degree of leaf curl disease (LCD) incidence (83 %) in tomato was in winter crop planted in October as compared to the summer crop planted in February, where only 14 % incidence of LCD was recorded. During the summer crop, whitefly population was less at the initial stage of the crop, whereas during the winter crop, whitefly population was very high at the similar stage of the crop. The variation in the population was due to the difference in temperature and relative humidity [46]. Whitefly population was lowest in July sown cotton [2] while maximum incidence of whitefly on potato in first three dates of planting i.e. 15th September, 30th September and 15th October [8]. the early sowing of mesta was found effective in preventing the crop from attack of whitefly [10]. The okra crop sown in month of January, February, September, October, November, December had considerably less whitefly population (0.74 -0.81 per leaf) than in rest month such as March, April, May, June, July and August (0.82 - 1.30) [45].

Correlation

The weather factors such as maximum, minimum temperature and morning relative humidity have shown positive correlation while evening humidity has shown negative correlation with whitefly population on castor in Andhra Pradesh [37]. In West Bengal, whitefly population fluctuation on brinjal cv. Pusa purple long was significantly and negatively correlated with average temperature, non-significantly and negatively correlated with average humidity and rainfall [16]. Peak activity of whitefly during second week of September and there was significant positive correlation between whitefly and maximum temperature, relative humidity and rainfall in greengram [23]. On cotton under semi arid region Maximum temperature had a significant positive effect and evening relative humidity had a significantly negative effect on whitefly population [14]. On potato negative correlation between whitefly population and weather parameters like maximum temperature (- 0.375), minimum temperatures (-0.552), sunshine hrs (- 0. 255), R.H. (- 0.148) and mean temperature (-0.040) [32] and maximum and minimum temperature range of 29º – 32 ºC and 18º – 22 ºC, respectively were highly favourable for the population buildup of whitefly on cotton [35]. Population of whitefly was maximum at 35th (0.72) and 37th (0.55) meteorological week and positively correlated to minimum temperature and rainfall [3]. Whitefly population was significantly correlated with rainfall (r =-0.779) during *kharif* sesame [24]. On okra, incidence of whitefly started from 1st week of August (1.2 whitefly per plant) and reached to peak level (8.6 whitefly per plant) during 3rd week of September [28]. Whitefly population was positively correlated with mean temperature and negatively with relative humidity. The positive correlation enhanced the rate of development and reproduction of whitefly and maximum ovipositional activity between 33 - 37 ºC. The negative association between whitefly population and relative humidity and rainfall is due to the adult which are largely controlled by rain, particularly when there were heavy shower and strong wind [39]. On okra crop two peaks population of whitefly i.e. 1st peak in 4th week of March and 2nd peak in 3rd week of April. The regression analysis showed a negative correlation of whitefly population with temperature and humidity [38]. The insect showed a negative correlation with both maximum and minimum temperature and wind speed while positive correlation with mean relative humidity and total rainfall [27]. Whitefly population showed positive correlation for temperature (min. & max.) and sunshine hrs, while the correlation was negative with relative humidity (min. & max.) and rainfall [41]. On brinjal among various weather parameters - maximum, minimum and average temperature has highly negative influence on whitefly population [15]. Whitefly population was significantly and positively correlated with temperature while negatively correlated with rainfall [20]. Whitefly population on brinjal was a significant negative correlation with maximum and minimum temperature while positive correlation with relative humidity and rainfall [18]. The weather parameters except wind speed highly influenced the whitefly population. Temperature (max. and min) and sunshine hrs had a negative correlation while morning and evening relative humidity and wind speed had positive correlation. The correlation coefficient (r) was computed as -0.481, -0.483, 0.514, 0.483, 0.007, -0.641 for max. temperature, min. temperature, morning relative humidity, evening relative humidity, wind speed and sunshine hrs, respectively. The weather parameters were found to contribute around 55.70 per cent impact on population of *Bemisia tabaci* when acted together [19].

Conclusion

One of the main reason of fluctuation in whitefly population may be abiotic factors like temperature, humidity, rainfall and wind speed. Date of sowing also affect the population of whitefly because of change in abiotic factors.

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