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Short communication

Weather based model for forewarning incidence of whitefly (*Bemisia tabaci* Gennadius) in cotton (*Gossypium hirsutum*) in Punjab

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Cotton (*Gossypium* spp.) is one of the most important fibre and cash crop of not only India but also of the world as it provides basic raw material to the textile industry. In India all the four species (*Gossypium arboreum* L., *G. hirsutum* L., *G. herbaceaum* L. and *G. barbadense* L.) of cotton, along with inter- and intra-specific hybrids are cultivated in the varied agro-climatic conditions, spreading between 8–32° N and 70– 80° E and covering around 10.5 million hectares (AICCIP, 2016). In Punjab it is the predominant fibre crop of the southern-west districts occupying an area of 4.13 lakh hectare with total production of 13.26 lakh bales (Anonymous, 2016). One of the major bottlenecks in cotton cultivation is attack of insect pests and diseases which significantly reduces the yield. Globally, cotton is attacked by 1326 species of insects and in India it is attacked by 162 species of insects (Hargreaves, 1948; Sundramurthy and Chitra, 1992).

The insect pest complex of cotton crop is broadly categorized into two groups namely sucking pests and bollworms, causing damage to various plant parts at different growth stages throughout the cropping season. Among the sucking insect pests; whitefly, jassid, mealybugs, etc. causes serious damage to cotton crop. Recently, whitefly, *Bemisia tabaci* (Gennadius) has become a serious pest of cotton and during *kharif* 2015, it appeared in epidemic form in Punjab and Haryana. The important factors which led to whitefly outbreak in Punjab and Haryana in 2015 were favourable environmental conditions for whitefly; delayed sowing (due to rains in the months of February and March 2015, which resulted in delayed harvesting of wheat); relatively mild 2014-15 winters which was conductive for the survival and multiplication of whitefly on moong, mash, Bassicas, brinjal, cucurbits, okra, potato, tomato and alternate weed host plants *like peeli booti, kangi booti, puth kanda* etc; and stresses due to various factors such as lack of irrigation, water logging, poor quality water, soil salinity, nutrient deficiencies, poor weed management etc. Ambient weather are predominantly responsible for the incidence and growth/ activity of pests either directly or indirectly as well as the crop (Singh *et al.,* 2012). So for developing weather based forewarning model, a thorough understanding of interaction between crop growth stage / meteorological parameters / pest dynamics is needed (Chandi *et al*., 2021). Developing a weather-based model for predicting whitefly incidence can enhance decision-making processes for pest control and provide greater opportunity to control the pest within integrated pest management programs (Damos and Soultani, 2010). So the present study was undertaken to develop a weather based forewarning model for whitefly incidence in cotton.

The whitefly population data (2004 to 2015) was collected from the selected farmer's field in the Bathinda and Faridkot districts of Punjab. The population of cotton whitefly adults were recorded from three fully formed leaves in upper canopy of 10 plants/plot at weekly intervals during 25 to 42 Standard Meteorological Week (SMW). The meteorological data (maximum and minimum temperature, maximum and minimum relative humidity (RH) and rainfall) of Bathinda and Faridkot were collected from the meteorological observatories at the regional research stations of Punjab Agricultural University. The data were analyzed to work out the favourable limits of the meteorological parameters conducive for the buildup of whitefly population. To correlate the whitefly population

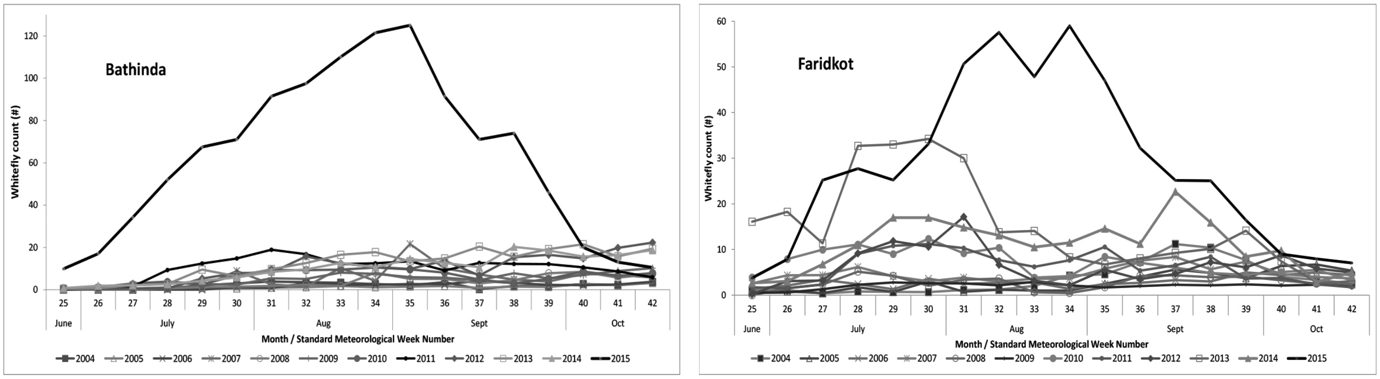

Fig 1: Variation in whitefly population count at Bathinda and Faridkot

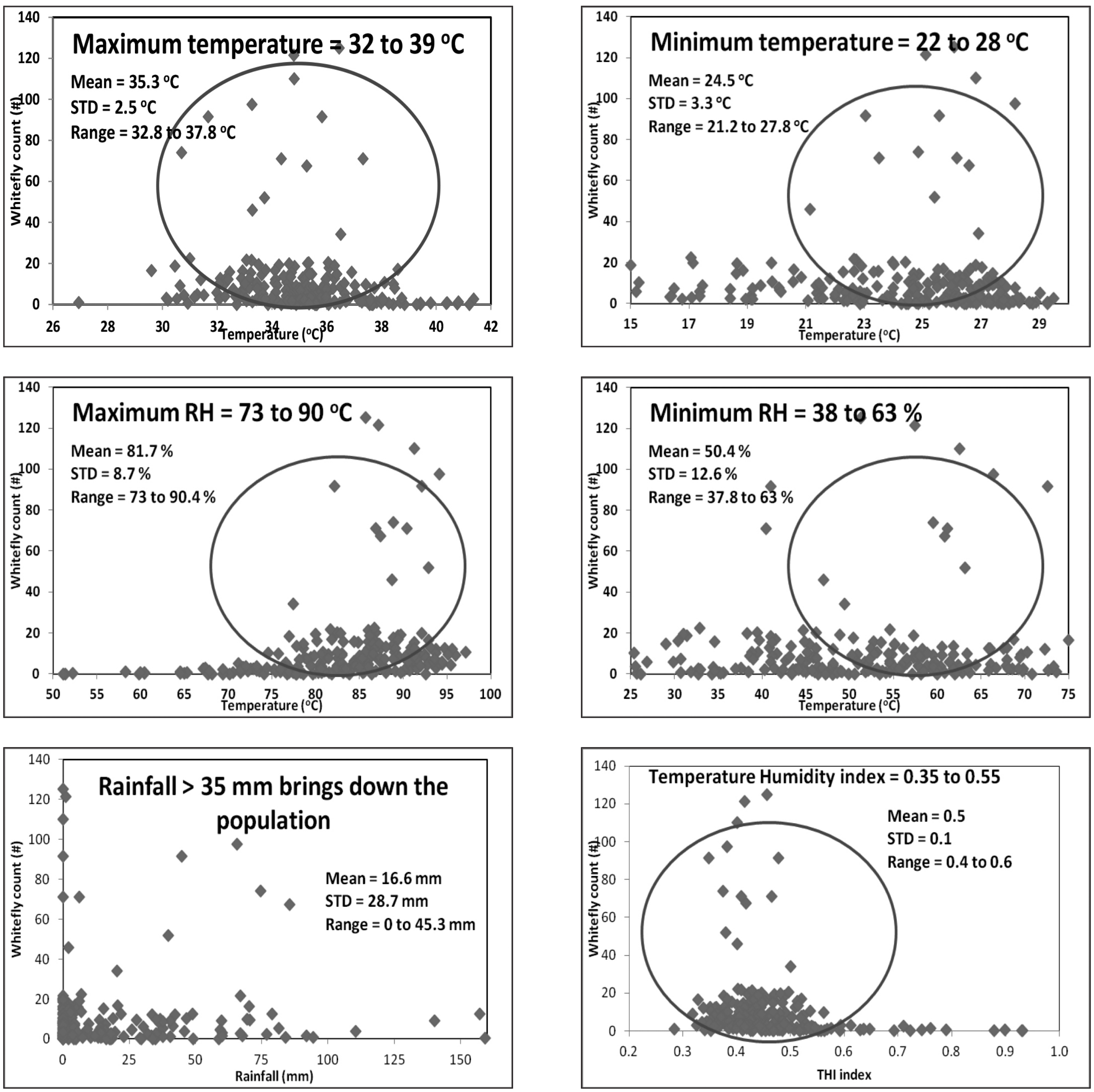

Fig 2: Favourable ranges of meteorological parameters for the buildup / breakdown of whitefly population at Bathinda
STD = Standard Deviation

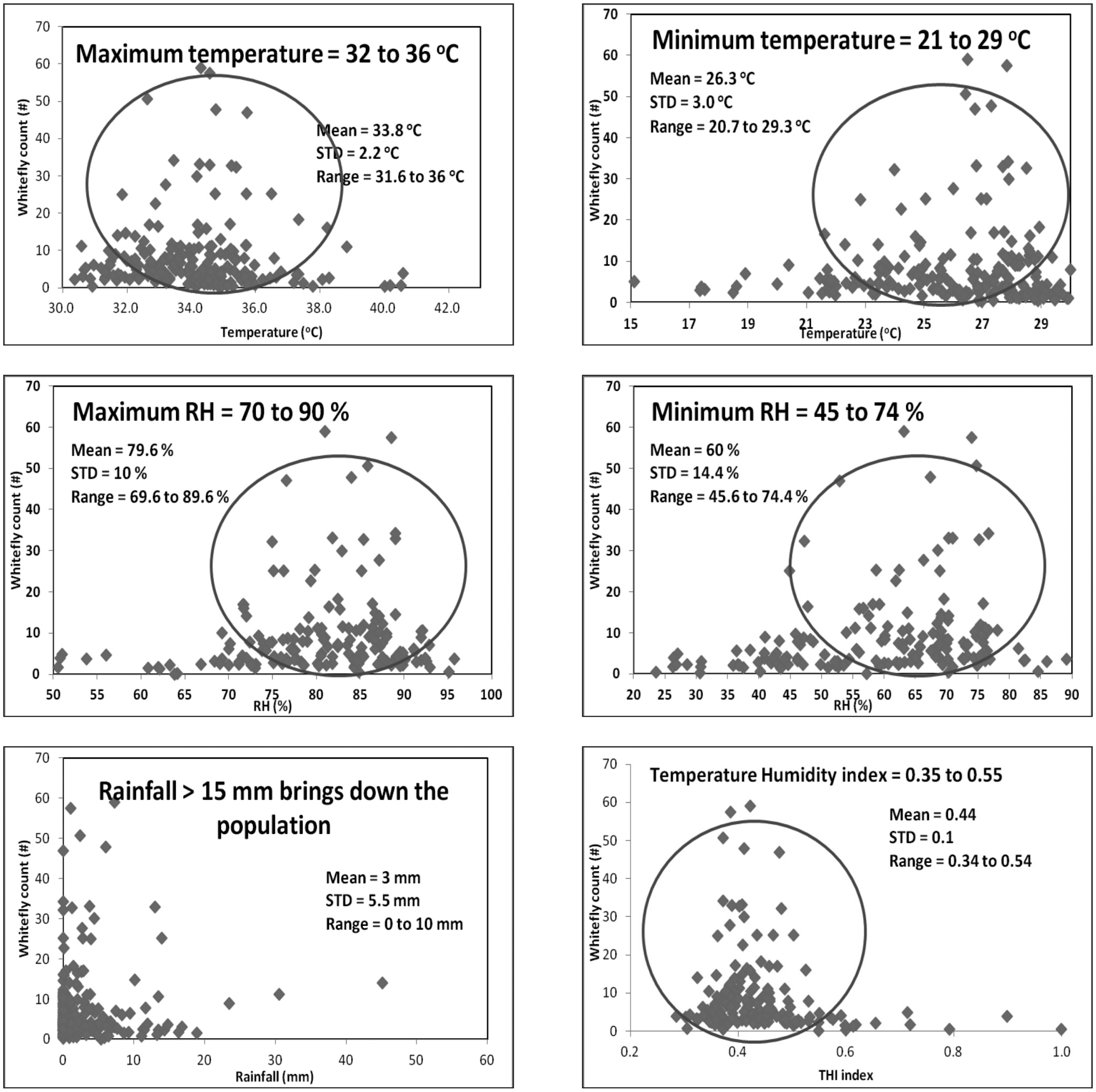

Fig 3: Favourable ranges of meteorological parameters for the buildup / breakdown of whitefly population at Faridkot (2004 to 2015) *STD = Standard Deviation*

collectively to temperature and humidity, a temperature humidity index (THI) was computed as:

THI (Temperature humidity index) = Mean temperature / Mean humidity

Inter-seasonal variation in whitefly population

The peak incidence of whitefly occurred during 2015 in epidemic form when the whitefly remained above 20 adults/3 leaves starting from 27 SMW up to 40 SMW at Bathinda and 38 SMW at Faridkot (Fig 1). Also the incidence was so severe that whitefly remained above 50 adults/3 leaves at Bathinda and Faridkot during 28-38 and 31-34 SMW, respectively.

Favourable ranges meteorological parameters for incidence of whitefly in Cotton

Temperature*:* The data on weekly maximum and minimum temperature was analyzed w.r.t. weekly population count of whitefly (from 25–42 SMW) to work out the favourable ranges of temperature for the incidence of whitefly population at Bathinda and Faridkot (Fig 2 and 3). The perusal of the data revealed that favourable range of maximum temperature for incidence and buildup of whitefly was 32-37 ^{o}C (mean = 35 ^{o}C, STD (Standard deviation) = 2.5 ^{o}C) at Bathinda and 32-36 ^{o}C (mean = 33.8 ^{o}C, STD = 2.2 ^{o}C) at Faridkot. Similarly, the favourable range of minimum temperature for incidence and buildup of whitefly was 22-28 ^{o}C (mean = 25 ^{o}C, STD = 3.1 ^{o}C) at Bathinda and 21-29 ^{o}C (mean = 26.3 ^{o}C, STD = 3.0 ^{o}C) at Faridkot. Earlier studies conducted by Prabhjyot-Kaur *et al.* (2009) revealed that maximum temperature >32^{o}C and minimum temperature >25^{o}C were favourable for the incidence of whitefly in cotton.

Relative humidity (RH): The data on weekly maximum and minimum relative humidity (RH) was analyzed w.r.t. weekly population count of whitefly (from 25 – 42 SMW) to work out the favourable ranges of RH for the incidence of whitefly population at Bathinda and Faridkot (Fig 2 and 3). The data revealed that favourable range of maximum RH for incidence and buildup of whitefly was 73-90% (mean = 81.7%, STD = 8.7%) at Bathinda and 70-90% (mean = 79.6%, STD = 10%) at Faridkot. Similarly, the favourable range of minimum RH for incidence and buildup of whitefly was 38-63% (mean = 50.4%, STD = 12.6%) at Bathinda and 45-74% (mean = 60%, STD = 14.4%) at Faridkot. Earlier studies conducted by Umar *et al. (*2003) and Shera ***et al.*** (2013) revealed that minimum RH was positively correlated with whitefly population in cotton.

Temperature humidity index (THI): The temperature humidity index (THI) was analyzed w.r.t. weekly population count of whitefly (from 25 – 42 SMW) to work out the favourable ranges of THI for the incidence of whitefly population at Bathinda and Faridkot (Fig 2 and 3). The data revealed that favourable range of THI for incidence and buildup of whitefly was 0.35-0.55 (mean = 0.5, STD = 0.1) at Bathinda and 0.35-0.55 (mean = 0.44, STD = 0.1) at Faridkot.

Rainfall: The weekly rainfall was analyzed w.r.t. weekly population count of whitefly (from 25–42 SMW) at Bathinda and Faridkot (Fig 2 and 3). The results revealed that rainfall in small amounts is helpful in the increasing of whitefly population. However, any heavy rainfall event, i.e., >35 mm at Bathinda and >15 mm at Faridkot caused a reduction in the population of whitefly. Similar results on negative effect of rainfall on whitefly population were reported by Kaur ***et al.*** (2009) and Shera *et al.* (2013).

The whitefly can occur between end June to October and flourishes when maximum/minimum temperature is within the range of 32-37/21-29^{o}C and maximum/minimum relative humidity is within the range of 73-90/38-74%. To capture the combined effect of temperature and moisture within the air Temperature humidity index (THI) was developed. The THI within the range of 0.35-0.55 is favourable for incidence and build up of whitefly population. Rainfall in light showers helps the whitefly growth but a heavy downpour of >35mm reduces the whitefly population. This weather based forewarning model can help in reducing the indiscriminate use of pesticides in cotton/other crops.

Conflict of Interest Statement: The author(s) declare(s) that there is no conflict of interest.

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