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Influence of meteorological factors and natural enemies on activity of whitefly and mealybug in *Bt* cotton

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Abstract : The field study was conducted at CCS HAU, Cotton Research Station, Sirsa during *kharif* 2019 to study the impact of meteorological factors and bi-control agents on activity of two major sucking pests of *Bt* cotton *i.e.* whitefly (*Bemisia tabaci* Gennadius) and mealybug (*Phenacoccus solenopsis* Tinsley). The population of both sucking pests was recorded at weekly intervals during 25th SMW to 43rd SMW using the standard methods of observation. The population of whitefly was found active throughout the period of study, which showed two peaks in population *i.e.* during 29th SMW and 35th SMW. It was negatively correlated with maximum temperature while positively correlated with other weather parameters like minimum temperature, relative humidity and rainfall. Nymphal parasitization of whitefly was found in significant positive correlation with nymphal population of whitefly with peak parasitization in 35th SMW and 41st SWM. During experiment, the population of mealybug appeared for first time in 37th SMW that showed peak abundance during 42nd SMW. Mealybug was found in positive correlation with morning relative humidity however other weather factors *i.e.* evening relative humidity, temperature and rainfall were correlated negatively with it. Parasitization of mealybug was found to have highly significant positive correlation with population of mealybug and showed peak parasitization in 42nd SMW. Among meteorological parameters, morning relative humidity was observed in positive correlation with parasitization of mealybug whereas other factors were observed in negative relationship.

Keywords: Cotton, Mealybug, Meteorological factors, Parasitization, Whitefly

Cotton, *Gossypium* spp. belongs to family Malvaecae plays a vital role in agricultural, industrial, social and economic affairs of the world. It is one of the most important fiber crops being cultivated. It is grown as an annual crop in both tropical and warm temperate climatic conditions. In addition to be used in textile manufacturing, it produces seeds which are used for making many products such as hull, oil, lint and food for animals (Ozyigit *et al.* 2007). In India, the area under cotton is 133.41 lakh ha which is equal to 42 per cent of world area under cotton cultivation, with a production of 360 lakh bales of 170 kg each and productivity of 459 kg/ha during 2020-2021 (National Cotton Scenario, 2021). There are a number of factors that hamper the production of cotton in which insect pest infestation is major cause of yield reduction. In India, cotton is attacked by 12 major insect pests causing more than 50 per cent yield loss (Rao and Reddy, 1999). Among the sucking insect pests; whitefly, *Bemisia tabaci* (Gennadius) (Hemiptera; Aleyrodidae) and mealybug, *Phenacoccus solenopsis* Tinsley cause huge loss to cotton crop by sap sucking. Cotton leaf curl virus is also transmitted by whitefly, which causes significant loss in the early stages of crop growth (Duffus, 1987). The population build up of whitefly and mealybug is largely influenced by meteorological factors and parasitization activity of natural enemies. *Encarsia* spp. (Hymenoptera: Aphelinidae) has been observed as potential biological control agent of cotton whitefly in Haryana (Kedar *et al.*, 2014) which parasitizes whitefly nymphs turning them dark brown or black in colour (Gerling *et al.*, 2001). Similarly, *Aenasius* spp. is an important parasitoid of mealybug that controls the infestation of mealybug in field significantly on a large number of host plants (Prasad *et al.*, 2011; Vijya and Singh, 2018). The bio-control activities of these important parasitoids are affected severely due to weather aberrations and seasonal alterations in population dynamics of host insects. Keeping this in view, an experiment has been conducted to study an overall population dynamics of whitefly and mealybug on cotton along with their natural enemies to sort out the degree of relationship between pest population, weather factors and bio-control agent.

The study was conducted at CCS HAU, Cotton Research Station, Sirsa (Haryana) during *kharif* 2019 on *Bt* cotton hybrid RCH 650. All the cultural practices for raising the cotton crop were followed as per the recommendations of "Package of Practices for *Kharif* crops" of CCS Haryana Agricultural University, Hisar (Anonymous, 2017).

The experiment was laid using randomized block design (RBD) with three replications. The population of whitefly nymphs and mealybugs (parasitized and non-parasitized) were recorded at weekly intervals, from 25th SMW to 43rd SMW. The population of whitefly, *Bemisia tabaci* nymphs (parasitized and non parasitized) was recorded on three leaves per plant representing the top, middle and lower canopy of randomly selected five plants. The population of mealybug, *Phenacoccus solenopsis* was recorded from 10 cm top shoot length on randomly selected five plants (Kedar *et al.*, 2011). Correlation analysis of data was worked out using Online Statistical Software Package for Agricultural Research Workers (OPSTAT) (Sheoran *et al.,* 1998).

Influence of meteorological factors on seasonal abundance of whitefly nymphs and mealybugs

The peak nymphal population of whitefly was recorded in third week of July (29th SMW) *i.e.* 8.36 nymphs/leaf and first week of September (35th SMW) *i.e.* 8.21 nymphs/leaf as shown in Fig. 1.1. It lies in accordance with the findings of Kadam *et al.* (2015) who recorded the peak activity of whiteflies in 36th SMW. Similarly, Janu and Dahiya (2017) found peak abundance of whitefly in cotton during 34th SMW in Hisar (Haryana), while Shera *et al.*, (2013) recorded highest number of whitefly in 30th SMW in cotton ecosystem.

Among meteorological factors, maximum temperature was found in non-significant negative correlation with whitefly (r = -0.178) whereas minimum temperature (r = 0.149) and rainfall (r = 0.376) were found to have non-significant positive correlation. Morning (r = 0.531*) and evening relative humidity (r = 0.755**) revealed significant positive correlation with whitefly as per data presented in Table 1.1. These findings are in consonance with Arif *et al.* (2006) who concluded significant positive correlation of whitefly with temperature and non-significant positive correlation with rainfall in cotton. Shera *et al.*, (2013) confirmed positive correlation of whitefly with minimum temperature, morning and evening relative humidity in cotton. Rolania *et al.*, (2018) also admired substantial negative correlation of whitefly with maximum temperature and extremely significant positive relationship with minimum temperature and evening relative humidity while, non-significant positive correlation was observed with rainfall on cotton hybrid HS-6 in Haryana conditions.

Highest population of mealybug was observed in third week of October (42nd SMW) during the experiment conducted (Fig. 1.2). The present findings are in conformity with the earlier findings made by Singh and Kumar (2012) who reported peak population of mealybug during October on cotton and okra. Similar findings were concluded by Harde *et al.* (2020) who found highest infestation of mealybug in 42nd SMW in cotton ecosystem.

In the present study, negative correlation of mealybug population was recorded with maximum temperature (r = -0.657**), minimum temperature (r = -0.687**), evening relative humidity (r = -0.515*) and rainfall (r = -0.351). However, non-significant positive correlation

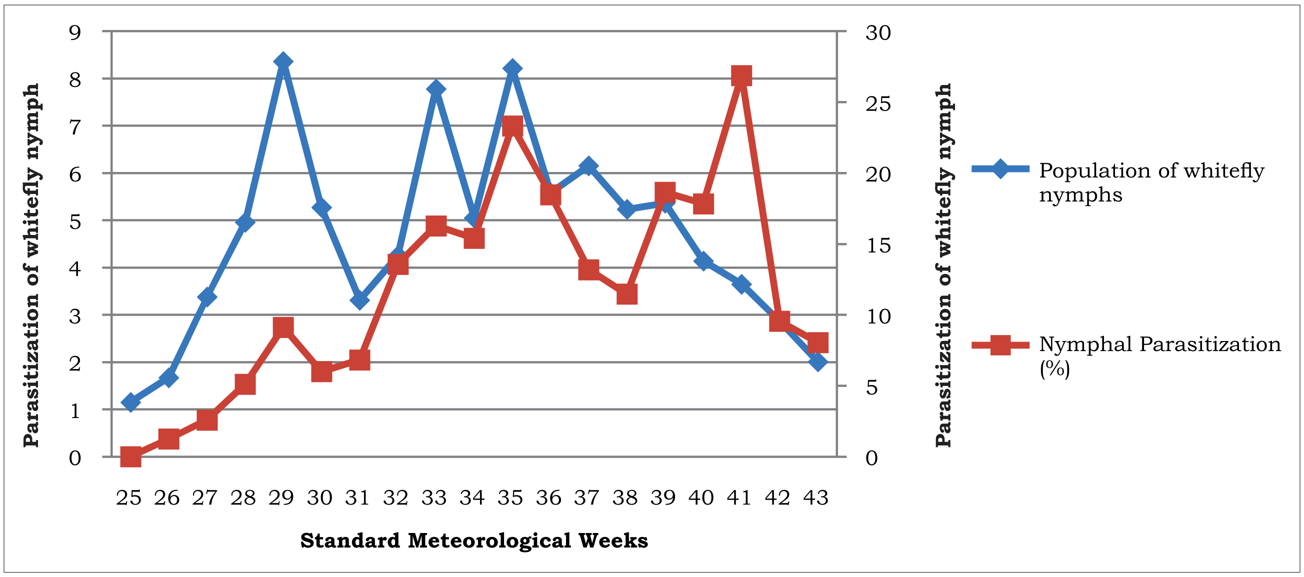

Fig. 1.1 Seasonal abundance of whitefly nymphs and their parasitisation

Table 1.1 Correlation between meteorological factors, sucking pests and their parasitization

Insect/Parasitization/ Weather parameters	Temperature		Relative Humidity		Rainfall	Whitefly nymphs	Mealybug
	Max.	Min.	Morning	Evening			
Whitefly (nymphs)	-0.178	0.149	0.531*	0.755**	0.376	-	-
Mealybug	-0.657**	-0.687**	0.137	-0.515*	-0.351	-	-
Nymphal parasitization of whitefly	-0.409	-0.181	0.313	0.208	-0.250	0.507*	-
Parasitization of mealybug	-0.689**	-0.760**	0.100	-0.522*	-0.283	-	0.929**

*significant at 5% level of significance **significant at 1% level of significance

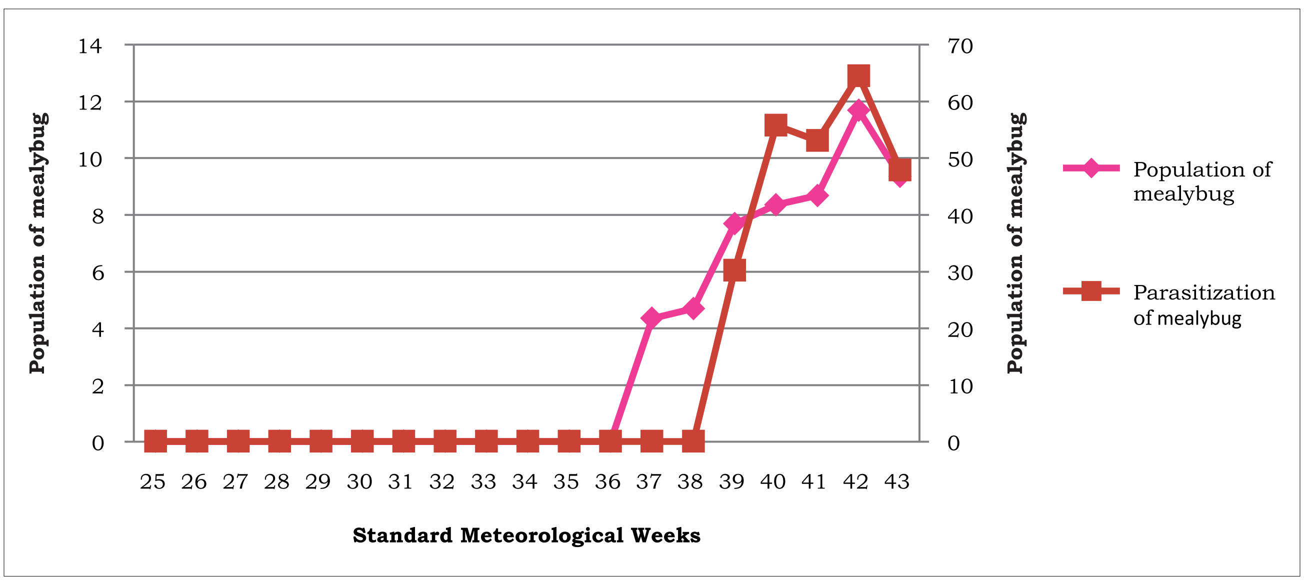

Fig 1.2 Seasonal abundance of mealybug and its parasitzation

was evident with morning relative humidity (r = 0.137). This lies in accordance to Singh and Kumar (2012) who found negative correlation of mealybug population with minimum temperature and evening relative humidity. Harde *et al.* (2020) too inference non-significant negative association of mealybug with rainfall and evening relative humidity.

Influence of meteorological factors on seasonal abundance of parasitization of whitefly nymphs and mealybug

The nymphal parasitization of whitefly due to its parasitoid, *Encarsia* spp. started to appear from 26th SMW which reached to its peak in 35th SMW (23.31% parasitization) and 41st SMW (26.87 % parasitization) (Table 1.2). At that time, the average temperature in field was ranging from 26.2 °C to 31.7°C. This findings is strongly supported by Shaojian *et al.,* (2006), who reported that the biological potential of *E. bimaculata* is maximum when the temperature ranging from 26°C to 32°C. Naveed *et al.*, (2007) too inference more nymphal parasitization of *B. tabaci* in cotton crop from August to October month. These results are in consonance with Rawal *et al.,* (2018) who also observed the highest nymphal parasitization of *B. tabaci* by *Encarsia* spp. during 31st and 43rd SMW with 36.75 and 39.23 per cent parasitization, respectively. Amit (2019) reported maximum nymphal parasitization of *B. tabaci* in 36thSMW and 41st SMW on cotton in Sirsa district of Haryana.

The nymphal parasitization of whitefly

Table 1.1 Correlation between meteorological factors, sucking pests and their parasitization

Insect/Parasitization/	Temperature		Relative Humidity		Rainfall	Whitefly	Mealybug
Weather parameters	Max.	Min.	Morning	Evening			nymphs
Whitefly (nymphs)	-0.178	0.149	0.531*	0.755**	0.376	-	-
Mealybug	-0.657**	-0.687**	0.137	-0.515*	-0.351	-	-
Nymphal parasitization of whitefly	-0.409 -	-0.181	0.313	0.208	-0.250	0.507*	
Parasitization of mealybug	-0.689**	-0.760**	0.100	-0.522*	-0.283	-	0.929**

*significant at 5% level of significance **significant at 1% level of significance

Table 1.2 Seasonal abundance of natural enemies and sucking pests along with meteorological parameters during various standard meteorological weeks

SMW*	Temp (°C)		R.H. (%)		Total	Whitefly nymphs		Mealybug	
	Max.	Min.	Morning	Evening	rainfall (mm)	Non-Parasitized	Parasitized	Non-Parasitized	Parasitized
25	37.6	26.2	69.3	45.4	14.0	1.15	0.00	0.0	0.00
26	39.6	26.9	61.3	40.6	0.0	1.67	1.24	0.0	0.00
27	38.4	27.1	68.0	47.4	12.5	3.38	2.59	0.0	0.00
28	36.5	26.2	70.9	57.6	8.40	4.96	5.11	0.0	0.00
29	33.1	21.9	82.5	65.0	66.8	8.36	9.12	0.0	0.00
30	33.2	22.0	83.2	67.4	92.7	5.27	5.99	0.0	0.00
31	34.7	22.9	80.3	64.7	0.0	3.31	6.82	0.0	0.00
32	36.8	24.6	71.4	55.7	5.20	4.25	13.57	0.0	0.00
33	34.1	21.9	79.1	66.3	39.5	7.78	16.27	0.0	0.00
34	35.8	27.1	70.9	58.5	0.0	5.05	15.39	0.0	0.00
35	36.1	27.3	77.1	60	0.0	8.21	23.31	0.0	0.00
36	36.1	27.0	79.3	58.3	0.0	5.58	18.47	0.0	0.00
37	36.9	27.4	78.5	54.0	0.0	6.15	13.18	4.34	0.00
38	34.6	25.1	77.6	57.2	0.0	5.23	11.46	4.68	0.00
39	33.5	22.1	75.1	57.8	0.0	5.36	18.64	7.67	30.17
40	31.7	21.0	83.9	56.7	0.0	4.14	17.83	8.34	55.72
41	32.9	19.5	71.1	43.0	0.0	3.65	26.87	8.67	53.02
42	32.5	19.9	72.6	41.0	1.20	2.87	9.54	11.67	64.45
43	32.0	17.2	79.1	38.1	0.0	2.01	8.05	9.34	47.86

*Standard Meteorological Week

was found to have non-significant negative correlation with maximum temperature (r = -0.409), minimum temperature (r = -0.181) and rainfall (r = -0.250) while morning (r = 0.313) and evening relative humidity (r = 0.208) showed non-significant positive correlation as per data tabulated in table 1.1. These results are strongly favoured by Rawal *et al.*, (2018) who observed non-significant negative correlation of nymphal parasitization of *B. tabaci* with rainfall, maximum and minimum temperature, while non-significant positive correlation was evident with morning relative humidity. Amit (2019) reported positive correlation between nymphal parasitization of whitefly and relative humidity in Sirsa (Haryana), while temperature and rainfall had non-significant negative correlation. Mehra and Rolania (2020) showed non-significant negative correlation of parasitization of *B. tabaci* with maximum and minimum temperature and rainfall in cotton. However, non-significant positive correlation was evident with morning and evening relative humidity which is in line with the conclusion of experiment conducted.

The parasitization of mealybug was at peak in 42nd SMW that admires with the results found by Harde *et al.*, (2020) who observed maximum parasitization of mealybug in 41st SMW and 43rd SMW in cotton ecosystem. The parasitization of mealybug was observed to have highly significant negative correlation with maximum and minimum temperature as well as non-significant negative relationship with evening relative humidity and rainfall though non-significant positive correlation was evident with morning relative humidity. Harde *et al.,* (2020) too reported non-significant negative correlation of mealybug with minimum temperature, evening relative humidity and rainfall in cotton.

Influence of natural enemies' activity on population abundance of whitefly nymphs and mealybug

Nymphal parasitization of whitefly was found in significant positive correlation with whitefly (r = 0.507*) as given in Table 1.1. Similar conclusion was drawn by Amit (2019) who reported the high intensity positive relationship of nymphal parasitoid with nymphal population of whitefly in cotton in Sirsa (Haryana). Kedar (2014), Rawal *et al.*, (2018) and Mehra and Rolania (2020) too reported *Encarsia* spp. as potential parasitoid for biological management of *B. tabaci* in various field crops.

Mealybugs in present findings were found in highly significant correlation (r = 0.929**) with its per cent parasitization, which is admired by Arve *et al.*, (2011) and Harde *et al.*, (2020) who in their experimental results observed positive correlation between mealybugs and its parasitoid in cotton. Tanwar *et al.*, (2008), Mohindru *et al.*, (2009) and Ram *et al.*, (2009) in close too reported *Aenasius* spp. as potential parasitoid of polyphagous pest mealybugs in different crops grown.

CONCLUSION

Cotton crop is attacked by various sucking insect pests due to which heavy reduction in economic production is experienced. Natural enemies present in field exert control over the population of insect pests and keep the crop free from their harmful effects. The activities of both sucking pests and their natural enemies are affected by meteorological parameters. The study revealed peak population of whitefly during July to September while number of mealybug was highest during October. Their parasitization was too at peak during these months as higher numbers of prey were available to parasitoids. Among the meteorological parameters, morning relative humidity was found in positive correlation with both pests and their biocontrol agents while other meteorological factors showed negative relationship. The population of sucking pests and their respective natural enemies showed highly significant positive relationship with each other.

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