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Incidence of major sucking pests of cotton during *kharif* 2016 and 2017

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Abstract
The present study was conducted at Chaudhary Charan Singh Haryana Agricultural University, Hisar, Haryana (India). Present investigations revealed that the sucking pests (whitefly, leafhopper, thrips) remained active throughout the crop season with little differences among them. It was observed that the sucking pests remained active from 25th to 41st standard meteorological weeks (SMW *i.e.*, June to October) during *kharif* 2016 and 2017.The data on the population/incidence of cotton whitefly revealed that whitefly did not crossed it's economic threshold level on all the 6 genotypes of cotton during *kharif* 2016 while it crossed the economic threshold level during *kharif* 2017 in all the 6 cotton genotypes. The maximum adult population of whitefly was recorded at 32nd SMW during both the kharif seasons of 2016 and 2017. The maximum mean incidence was recorded in RCH-650 BGII during 2016 and 2017. Mean leafhopper population, on all the six genotypes was ranged from 2.02-5.35 and 3.16-5.33 nymphs/leaf during 2016 and 2017, respectively. During 2016, the peaks were observed on 27th and 29th SMW, while peaks were recorded during 2015 in 26th and 29th SMW. Genotype HD-432 had 2.12 and genotype AAH-1 had 3.32 nymphs/leaf during 2016 and 2017, respectively. The thrips population was commenced at 25th SMW during 2016 and 2017, respectively. The peak incidence of thrips population was recorded on 33rd and 31st during 2016 and 2017, respectively. All the sucking pests' population was higher in *Bt* hybrids.

Keywords: Leafhopper, smw, thrips, whitefly

Introduction
The insect pests constitute one of the major limiting factors in the production as the crop is vulnerable to attack by about 162 species of insect-pests and mites [1]. Infestation occurs from seedlings to maturity and some time the population of insect pests is so enormous that it becomes havoc to the crop and badly affects the economy of our country. Sucking pests *viz*., jassids, *Amrasca biguttula biguttula* (Ishida); whitefly, *Bemisia tabaci* (Genn.); aphids, *Aphis gossypii* (Glover) and thrips, *Thrips tabaci* (Linn.) are the serious pests and cause losses in tune of 21.20 to 22.86 per cent [2, 3, 4] and also vectors for a number of viral diseases [5]. Amongst the sap sucking insects pests damaging this crop, whitefly, *B. Tabaci* (Hemiptera: Aleyrodidae), a highly polyphagous insect-pest, has become serious, causing heavy losses during certain years. High population of the pest has the potential to remove significant amounts of phloem sap resulting in to the reduction of plant vigour. Damage by this pest is caused in two ways: (a) the vitality of the plant is lowered through the loss of cell sap, and (b) normal photosynthesis is interfered with the growth of sooty mould on the honeydew excreted by the insect. Due to sooty mould growth is reduces the quality and marketability of harvested products. Honeydew falling on open bolls makes the lint sticky which creates problems during ginning [6]. The pest is also known to transmit cotton leaf curl virus causing significant yield losses if the infection is in the early stages of crop growth [7]. Leafhopper *A. biguttula biguttula* (Hemiptera: Cicadellidae), is also a sap sucking insect pest which causes losses due to injection of toxins. The attacked leaves turn pale and then rust-red. With change in appearance, the leaves also turn downwards, dry up and fall to the ground. Owing to the loss of plant vitality, the cotton bolls also drop off, causing up to 35 per cent reduction in yield. Due to thrips, *T. tabaci* (Thysanoptera: Thripidae), leaves become wrinkled and fall off and the plants bear very few bolls [8].

Materials and Methods
The studies were carried out under unsprayed conditions on the six genotypes (Table-1). Before sowing, the seeds of all genotypes were soaked in water for 2 hours.

Thereafter, the seeds were dibbled with line-to-line spacing of 67.5 cm and plant-to plant at 60 cm in case of hybrids, line-to-line spacing of 67.5 cm and plant to plant at 30 cm in case of the varieties. Two to three seeds of respective genotypes were put at a depth of 3-4 cm in each hill in the well prepared soil. Sowing was done on 30th May, 2016 and 28th of May, 2017 in a randomized block design (RBD). The experiment was replicated four times in a plot size of 6 rows of 6 meters. Thinning was carried out one month after sowing. All the other cultural practices like fertilizer application, weeding, hoeing; irrigation, *etc*. were adopted as per the recommendation of Package of Practices of *Kharif* crops of CCS Haryana Agricultural University, Hisar [9]. The observations on sucking pests' *viz*., white fly, leafhopper and thrips were recorded at weekly intervals, starting from the first week of June, 2016 and 2017 to the picking of the cotton.

1. Whitefly; *Bemisia tabaci* (Genn.)
Adults of whitefly were recorded on 3 leaves/plant (one each from upper, middle and lower plant canopy) from randomly selected 5 plants per plot at weekly intervals. Whitely adults were counted by visual observations.

2. Leafhopper; *Amrasca biguttula biguttula* (Ishida)
The nymphal population of leafhopper was recorded on 3 leaves/plant representing the top, middle and bottom canopy of the plant from randomly selected 5 plants per plot at weekly intervals. Leafhopper population was counted by visual observations.

3. Thrips; *Thrips tabaci* (Lind.)
The nymphal population of thrips was recorded by visual observations on randomly selected 5 plants per plot on 3 leaves/plant representing the upper, middle and lower plant canopy at weekly intervals. Thrips population was counted by visual observations.

Table 1: List of the genotypes of cotton evaluated for their reactions to insect pests during *kharif* seasons, 2016 and 2017

Sr. No.	Genotypes
1	HD-432 (non-*Bt*)
2	AAH-1 (non-*Bt*)
3	H-1098-i (non-*Bt*)
4	HHH-223 (non-*Bt*)
5	RCH-650 BG II (*Bt*)
6	Bioseed-6588 BG II (*Bt*)

Results and discussion

Whitefly (*B. tabaci*)

The results on periodic fluctuation of whitefly during 2016 on cotton are presented in Fig. 1. Whitefly adult population was nil during 28rd and 24th Standard meteorological weeks (SMW). Data indicated that pest remained active on the crop from 25th to 40th SMW (*i.e.* June to October, 2016). Population build up was recorded in 25th SMW but the adult population was below the economic threshold (ET) (6 adults /leaf). Whitefly crossed ET in 28th SMW in RCH 650 BGII while in all other genotypes whitefly remained below ET. During 29th SMW whitefly adult population remained below ET in all the genotypes. During 30th SMW whitefly adult population remained above ET in RCH-650 BGII. Two peaks were observed during the 32nd and 38th SMW on all the genotypes with mean number of 6.86 and 6.67 adults per leaf, respectively. During these peaks maximum adult population was recorded on RCH 650 BGII which was followed by Bio-6588 BGII. During 41st SMW whitefly adult population remained below ET in all the genotypes. Average number of whitefly adult population was also calculated for all the genotypes and it ranged from 2.40 to 5.48 adults/leaf. Maximum adult population was recorded on RCH-650 BGII and minimum adult population was recorded on HD-432.

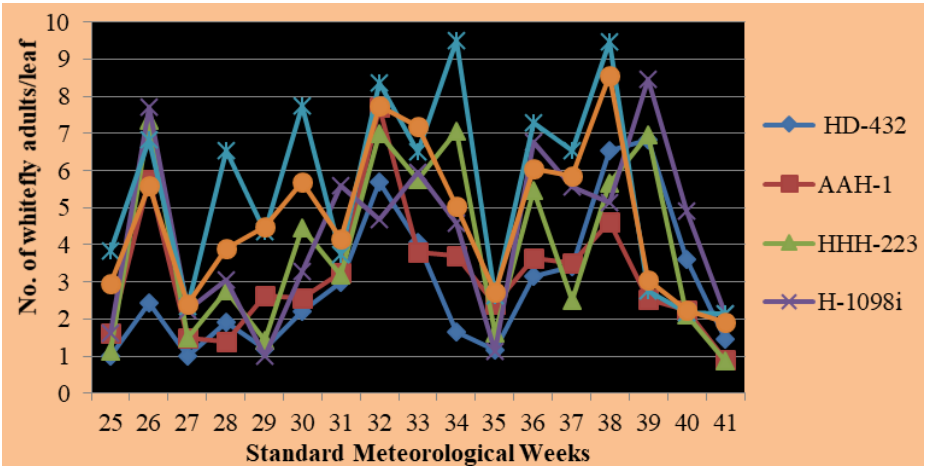

Fig 1: Population dynamics of whitefly adults during different SMW in *Bt* and non-*Bt* cotton genotypes during *kharif* 2016

The data on occurrence of whitefly population on different genotypes during *kharif* 2017 (Fig. 2) revealed that there was no significant difference in whitefly population during 28rd and 24th SMW. The whitefly population commenced from 25th SMW but it remained below ET (6 adults/leaf) upto 28th SMW in all the genotypes. Whitefly population crossed the ET in 29th SMW in all the genotypes. Maximum population was recorded in Bio-6588 BGII (22.91 adults/leaf) which was followed by RCH-650 BGII (21.38 adults/leaf). Minimum whitefly population was recorded in HD-432 (12.21 adults/leaf). Whitefly population increased upto 32nd SMW. During 32nd SMW peak of whitefly population was observed. During this peak maximum whitefly population was recorded in HHH-223 (35.01 adults/leaf) and minimum population was recorded in HD-432 (9.65 adults/leaf). As compared to previous *kharif* season, whitefly population was higher in all the genotypes during the period of study. After 32nd SMW whitefly population declined to minimum 2.39 adults/leaf in 41th SMW. Significant difference was found in mean whitefly population on all the genotypes. Maximum whitefly

population was recorded on *BT* genotype RCH-650 BGII (10.79 adults/leaf) which was followed by HHH-223 (10.78 adults/leaf). Minimum whitefly population was recorded on genotype non-*Bt* genotype HD-432 (5.41 adults/leaf) which was followed by AAH-1 (6.62 adults/leaf). The present study concluded that the adult population of whitefly was higher on on *BT* cotton hybrids and then it was followed by non-*Bt* cotton hybrid and American cotton variety. The present findings are in agreement with [10] and [11] who reported that the incidence of whitefly was observed in the month of June.

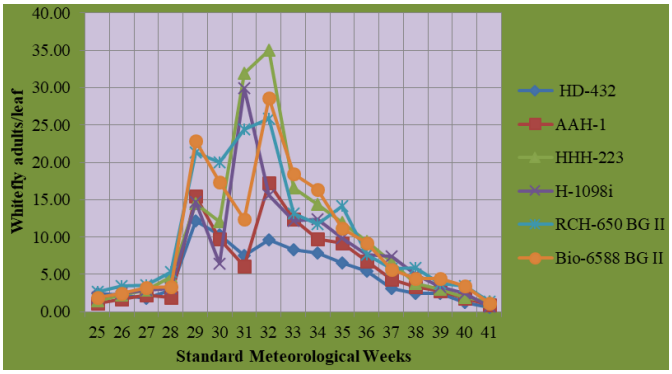

Fig 2: Population dynamics of whitefly adults during different SMW in *Bt* and non-*Bt* cotton genotypes during *kharif* 2017

Leafhopper (*A. biguttula biguttula* Ishida)

Data presented in Fig. 3 indicated that leafhopper remained active on the crop throughout the period of study *i.e.* from 25th to 41st standard meteorological weeks (SMW) (*i.e.* June to October, 2016). It was observed that there was no significant difference in the population of leafhopper at 28rd and 24th SMW. Leafhopper population build up was recorded in 25th SMW and it crossed the economic threshold (2 nymphs/leaf) level in genotypes H-1098-i, RCH-650 BGII and Bioseed-6588. Minimum population was recorded in HD-432 and AAH-1 (0.67 nymphs/leaf) and it was on par with HHH-223 (0.69 nymphs/leaf). Maximum population of leafhopper was recorded in RCH-650 BGII. Leafhopper population remained above ET in genotypes H-1098-i, RCH 650-BGII and Bio-6588 BGII throughout the period of study. In HD-432 leafhopper population crossed the economic threshold in 30th SMW. First peak of leafhopper population was observed during 27th SMW with mean number of 5.60 leafhopper nymphs/leaf. During this peak maximum leafhopper population was observed in RCH-650 BGII which was on par with Bio-6588 BGII. Second peak was observed during 29th SMW with mean number of 7.44 nymphs and adults/leaf. Maximum leafhopper population was recorded in H-1098-i which was at par with Bio-6588 BGII and RCH-650 BGII. Leafhopper population declined after 29th SMW upto 33rd SMW. It increased in 34th SMW and afterwards it started declining. Leafhopper showed differences in their mean population among different genotypes. Highest mean population was recorded in *Bt* genotype RCH-650 BG II (5.35 nymphs/leaf). It was followed by Bio-6588 BGII (4.62 nymphs/leaf), H-1098i (4.28 nymphs/leaf), non-*Bt* hybrid, HHH-223 (3.24 nymphs/leaf), AAH-1 (3.05 nymphs/leaf) while minimum mean population was recorded in non-*Bt* variety HD-432 (2.02 nymphs/leaf). Mean leafhopper population/leaf varied amongst the *Bt* and non-*Bt* genotypes during period of study.

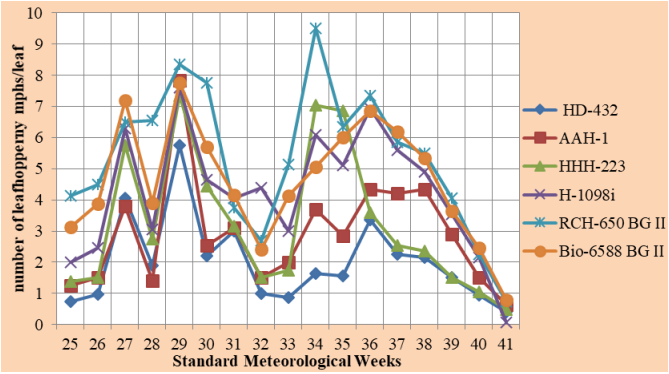

Fig 3: Population of leafhopper during different SMW in Bt and non-Bt cotton genotypes during *kharif* 2016

Similar trend was observed in population dynamics of leafhopper during 2017 (Fig. 4). It was observed that there was no significant difference in the population of leafhopper at 28rd and 24th SMW. Leafhopper's population build up was recorded in 25th SMW and it crossed the economic threshold (2 nymphs/leaf) level in genotype HHH-223 (2.18 nymphs/leaf) while in genotypes HD-432, RCH-650 BGII and Bioseed-6588 leafhopper population crossed the ET during 26th SMW. In other genotypes it crossed the ET in 27th SMW. Leafhopper population remained above the economic threshold throughout the period of study except 32nd SMW. Leafhopper population attained first peak during 26th SMW. During this peak mean leafhopper population was recorded to be 6.99 nymphs/leaf. Minimum population was recorded in genotype HHH-223 (1.51 nymphs/leaf) which was followed by H-1098i (1.66 nymphs/leaf). Second peak was observed in 29th SMW during which mean leafhopper population was recorded to be 6.52 nymphs/leaf. During 2nd peak also HHH-223 was found to be superior of all the genotypes and followed by HD-432 and AAH-1. Population of leafhopper declined in 30th SMW and increased in 31st SMW. It again decreased in 32nd SMW and kept on increasing upto 35th SMW. Leafhopper showed differences in their mean population among different genotypes. Highest mean population was recorded in *Bt* genotype Bio-6588 BGII (5.33 nymphs/leaf). It was followed by RCH- 650 BGII (4.84 nymphs/leaf), HD-432 (4.62 nymphs/leaf), non-*Bt* hybrid, HHH-223 (4.12 nymphs/leaf), H-1098i (3.78 nymphs/leaf) while minimum mean population was recorded in non-*Bt* genotype AAH-1 (3.16 nymphs/leaf). Mean leafhopper population/leaf varied amongst the *Bt* and non-*Bt* genotypes during the period of study. The studies are in accordance with the [12] who reported that the leafhopper population appeared in the month of June. The population increased gradually and reached to its peak in 28th and 33rd SMW. Similar results were observed by [10] that the maximum range of leafhopper population recorded during 28th (0.58 to 3.67 adults/leaf) and 32nd SMW (0.61 to 1.27 adults/leaf).This may be due to different environmental condition. [13] Reported that the population of leafhopper increased by 11.5 per cent in *Bt* cotton compared to non-*Bt* cotton during early season under natural condition.The observations are not in agreement with [14] who reported that the incidence of leafhopper population was started in second fortnight of July and remained upto picking of cotton.

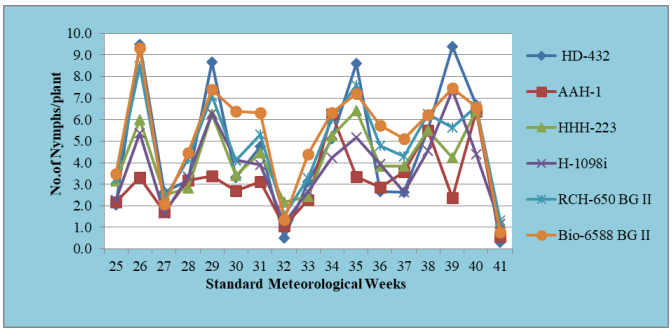

Fig 4: Population of leafhopper during different SMW in *Bt* and non-*Bt* cotton genotypes during *kharif* 2017

Thrips (*T. tabaci*)

There was non-significant difference in the population of thrips on different genotypes during 28rd and 24th SMW in *kharif* 2016 (Fig. 5). The pest infestation commenced in 25th SMW but the population was very low till 31st SMW. Its population started to rise during 32nd SMW and 33rd SMW but it remained below ET throughout the period of study. After 33rd SMW it declined to minimum (0.92 thrips/leaf) in 40th SMW. Mean thrips population varied in different genotypes. HHH-223 was found to be superior of all genotypes having minimum (1.78 thrips/leaf) number of thrips population. It was followed by HD-432 (3.75 thrips/leaf). Maximum population (4.50 thrips/leaf) was recorded on RCH 650 BGII. The data on occurance of thrips population on different genotypes during *kharif* 2017 (Fig. 6) revealed that during 28rd and 24th SMW, there was no significant difference in the population of thrips on different genotypes.

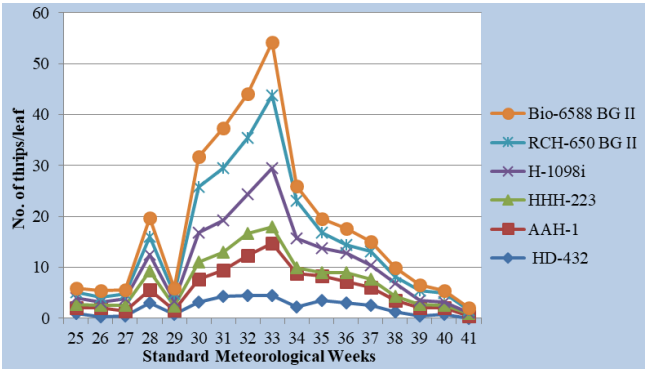

Fig 5: Population of thrips during different SMW in *BT* and non-*Bt* cotton genotypes during *kharif* 2016

The pest infestation commenced in 25th SMW but population of thrips was very low till 30st SMW. Thrips population crossed the ET in 31st SMW in genotypes HHH-223, H-1098i, RCH-650 BGII and Bio-6588 BGII. In genotypes HD-432 and AAH-1, thrips population remained below ETL throughout period of study. Peak of thrips population was observed during 31st SMW. The genotype Bio-6588 BGII recorded maximum population of thrips which was 17.82 thrips/leaf. The genotype Bio-6588 BGII which was followed by HHH-223 (15.89 thrips/leaf). Afterwards thrips population declined and reached at minimum of 0.66 thrips/leaf in 40th SMW. All the genotypes differ significantly in thrips population. Minimum thrips population was recorded on non-*Bt* hybrid AAH-1 which was followed by HD-432. Maximum thrips population was recorded on *Bt* genotype RCH-650 BGII which was followed by Bio-6588 BGII. The present findings are in agreement with [15]

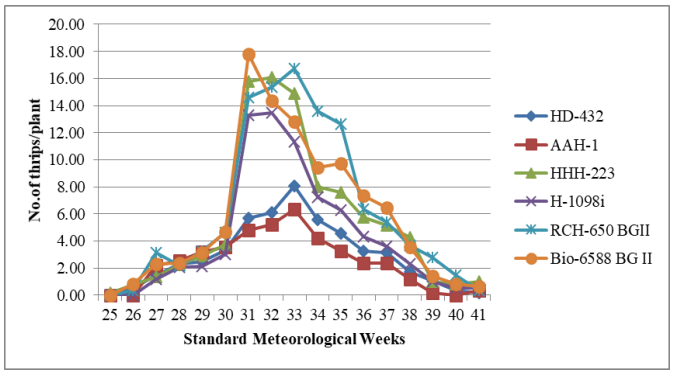

Fig 6: Population dynamics of thrips during different SMW in *Bt* and non-*Bt* cotton genotypes during *kharif* 2017

Who reported incidence of thrips started in the month of August. [12] Reported that the peak incidence was observed at 33rd SMW these results are in line with the present findings. [16] Conducted the experiment at Parbhani (MH) during 2007-08 and observed that thrips remained active from 32nd to 52nd SMW and reached to its peak at 40th SMW with 110.10 thrips/3 leaves. Similar results were attained by [17] who reported that the thrips attained its peak during third week of August [18]. Reported that incidence started in month of June and remained active upto 52nd SMW. The findings of [19] are not in conformity with our present study and they reported that the maximum thrips population was observed during the 39-41 SMW.

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