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Pest complex and the population dynamics of major pests of *Bhoot jolokia*

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ABSTRACT

The *Bhoot Jolokia*,a chilli cultivar, also known as ghost pepper is cultivated only in the Northeast India in the states of Assam, Nagaland and Manipur. Pest complex study of *Bhoot Jolokia* was carried out at Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat, Assam during 2013-2015.The major insect pests that attack *Bhoot Jolokia* were the sucking pests *viz.*, aphids, *Aphis gossypii* Glover; Thrips, *Scirtothrips dorsalis* Hood; Whitefly, *Bemisia tabaci* Gennadius and Leafhopper, *Amrasca biguttula biguttula* Ishida. Other pests include Cutworm, *Agrotis ipsilon* Hufuagel and Flea beetle, *Monolepta signata* Oliveir. During the period of investigation, altogether five species of coccinellid predators were encountered in the ecosystem *viz.*, *Coccinella transversalis* F., *Cheilomenes sexmaculata* F., *Brumoides saturalis* F., *Micraspis discolour* F. and *Harmonia dimidiata* F. Sticky traps used against sucking pests revealed greater activity from November to January. The peak period of aphids (132.0 aphids/trap), thrips (60.5 thrips/trap), whitefly (8.3 whiteflies/trap) and leafhopper (34.4 leafhopper/trap) was observed in January during the first year of investigation and November showed the maximum activity of aphids (126.9 aphids/trap), thrips (49.4 thrips/trap), whitefly (7 whiteflies/trap) and leafhopper (23.6 leafhopper) during the second year of investigation. The correlation studies indicated that *A.gossypii*, S. *dorsalis* , *B. tabaci* , *A. biguttula biguttula* had a negative correlation with maximum and minimum temperature, wind speed and rainfall. However, morning and evening relative humidity showed a positive correlation for all the sucking pests during both the years of study.

Key words: *Population dynamics, Bhoot Jolokia, Sucking pests, Sticky trap, Weather parameter*

Introduction

Bhoot Jolokia, is a wonderful gift of nature as its fruit is one of the hottest chillis in the world and at the same time, has a pleasant and palatable aroma. In 2007, Guiness Records certified the Ghost Pepper as the world's hottest chilli pepper, 400 times hotter than Tabasco sauce (Baruah *et al.,* 2014). This traditional crop of north eastern India is gaining importance in recent years. It is known by various names in different regions such as '*Bhoot Jolokia*' (or Bhut Jolokia) or 'Bih Jolokia' in Assam, 'Naga king chilli' in Nagaland, 'Omorok' in Manipur and 'Ghost pepper' by the western media (Meghvansi *et al*., 2010). The Assamese word 'Bhoot' refers to the typical, large pod size, while the term 'bih' means poison indicating the high hotness in the fruits of the plant (Bhagowati and Changkija, 2009). Among the various constraints in chilli cultivation, the attack of a multitude of insect pests and mites at different crop stages is of utmost concern (George and Giraddi, 2007). Surveys conducted by AVRDC, Taiwan in Asia revealed that the major pests that attack chilli are aphids (*Myzus persicae* Sulzer, *Aphis gossypi* Glover), mite (*Polyphagotarsonemus latus* Banks) and thrips (*Scirtothrips dorsalis* Hood) (Berke and Sheih,

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2000). Due to monoculture of chilli, pest build up is so much that farmers have to resort to minimum of 5-6 chemical sprays. Number of sprays have increased over the years to manage the sucking pests resulting in cost of cultivation that has increased enormously making cultivation of chilli highly risk and non profitable. In addition to these, the pesticidal sprays have become a threat to chilli ecosystem causing a negative impact to natural enemy fauna with a positive trend to resurgence of pests (George and Giraddi, 2007). The attractiveness of sucking pests to sticky traps has been utilized for its monitoring by earlier workers ((Idris *et al*., 2012 and Gencsoylu, 2007). Colour sticky trap is one of the tools under mechanical control in the IPM package which reduces the pest population successfully. Mainly three colours *viz*., blue, yellow and white have been identified as suitable colours for traps all over the world (Mudiyanselage, 2012). However, in view of the meager information on the role of abiotic factors, an effort was made to study the population fluctuation of the major pests of *Bhoot Jolokia* in relation to the meteorological parameters

Materials and Methods

The field experiment were conducted in the Experimental farm, Department of Horticulture, Assam Agricultural University, Jorhat to study the pest complex and population dynamics of major pests of *Bhut Jolokia.* Teatments comprised of different colour sticky traps *viz.* violet, red, yellow, orange, green, blue and white colour used for the first year of investigation. Traps were prepared from mineral water bottle of 1 liter capacity (cylindrical shape) and the bottles were painted with violet, red, yellow, orange, green, blue and white colour .These traps were covered with transparent polythene of 23 x 25 cm surface area and then sprayed with Gulf Crown MP3 sticky grease. Traps were placed at same height (10cm) above the canopy level maintaining 2m apart from each other. In the next year of investigation, the most effective colour trap was selected and installed in different plant heights (at the plant canopy level ,10cm, 20cm, 30cm, 40cm, 50cm and 60cm height above the canopy level), considering each height as a separate treatment.

To study the seasonal build up of population of the pests along with natural enemies associated with *Bhoot Jolokia* , different coloured traps were used during 2013-2014 and 2014-2015, respectively. The crop was regularly monitored to record the appearance of insect pests. The damage symptoms of some insect pests were also recorded.

Sampling was done at weekly intervals throughout the crop season. The transparent polythene sheets were collected after each sampling unit to record the trapped insects. A new polythene sheet was sprayed with grease and wrapped on each coloured trap as replacement for subsequent data. The collected sheets were brought to the laboratory and the numbers of insects were counted using magnifying glass.

To know the effect of meteorological parameters on the pest population, weekly data on insect population trapped were correlated with meteorological data *viz.,* maximum temperature, minimum temperature, morning relative humidity, evening relative humidity, rainfall and wind velocity. The meteorological data were collected from the Department of Agro meteorology, Assam Agricultural University, Jorhat.

Results

Seasonal incidence of insect pests on *Bhoot Jolokia*

Periodical surveys conducted during November to April, 2013-2014 and 2014-2015, respectively on incidence of insect pests of *Bhoot Jolokia,* the insect as well as natural enemies' population of nymphs and adults were recovered. In the present investigation, six numbers of insect pests under four orders with six families were observed during the cropping season (Table 1). The insect pests associated with *Bhoot Jolokia* were aphids *A. gossypii* (Homoptera : Aphididae), whitefly *B. tabaci* (Homoptera : Aleyrodidae), thrips *S. dorsalis* (Thysanoptera : Thripidae), leafhopper *A. biguttula biguttula* (Homopera : Cicadellidae), cutworm *Agrotis ipsilon* Hufnagel (Lepidoptera : Noctuidae) and flea beetle *Monolepta signata* Olivier (Coleoptera : Chrysomelidae). In case of natural enemies, five species of coccinellid predators were encountered in *Bhoot Jolokia* ecosystem during the present investigation and they were *Coccinella transversalis* Fabricius, *Cheilomenes sexmaculata* Fabricius, *Brumoides saturalis* Fabricius, *Micraspis discolor* Fabricius and *Harmonia dimidiate* Fabricius.

Influence of insect pests of *Bhoot Jolokia* and their correlation of trapped insects with meteorological parameters during, 2013-2015.

Table 1. Insect pests complex associated with *C. chinese* during 2013-2014 and 2014-2015

Common name	Scientific name	Order : Family	Feeding site	Status
1. Aphid	*Aphis gossypii* Glover	Homoptera : Aphididae	Leaf	Major
2. Thrips	*Scirtothrips dorsalis* Hood	Thysanoptera : Thripidae	Young leaf, seedlings to mature plant	Major
3. Whitefly	*Bemisia tabaci* Gennadius	Homopera : Aleyrodidae	Leaf	Major
4. Leafhopper	*Amrasca biguttula biguttula* Ishida	Homoptera : Cicadellidae	Leaf	Major
5. Cutworm	*Agrotis ipsilon* Hufnagel	Lepidoptera : Noctuidae	Young seedlings	Minor
6. Flea beetle	*Monolepta signata* Olivier	Coleoptera : Chrysomelidae	Leaf	Minor

Incidence of aphid, *A. gossypii* and its relationship with meteorological factors.

The incidence of *A. gossypii* was recorded from November to April in 2013-2014 and 2014-2015, respectively. The peak population was recorded in January with an average population of 132.0, 61.6 and 59.8 aphids in case of yellow, green and red sticky traps, respectively. However, during 2014-15, when the sticky traps were placed at different heights, November was the congenial period of aphid population. During the peak period, the maximum and minimum temperature was 28.4ºC and 16.6ºC with average relative humidity of 94 per cent.

Correlation studies of the present investigation (November, 2013 to April, 2014) revealed that the mean aphid population attracted to yellow, green and red sticky traps had a significant negative relationship with maximum temperature(r=-0.961, -0.870,-0.866), minimum temperature (r=-0.985,-0.929,-0.942) and wind speed (r=-0.941, -0.838, -0.925). However, the morning relative humidity showed a significant positive correlation with yellow sticky trap (r=0.956) and red sticky trap (r=0.875) and non significant positive correlation with green sticky trap (r=0.787). Similarly, the evening relative humidity showed a non significant positive correlation with green sticky trap (r=0.710) and red sticky trap (r=0.867) and significant positive correlation (r=0.867) with yellow sticky trap. However, rainfall exhibited a significant negative correlation with green and red sticky traps (r=-0.829 and -0.913) and a non significant impact was with yellow sticky trap (r=-0.782) (Table 3).

During November, 2014 to April, 2015, the data indicated that the mean aphid population caught in traps placed at the plant canopy level, 10 and 20cm height above the canopy level had a significant negative correlation with wind speed (r=-0.860,-0.856 and -0.855), significant negative correlation was observed with maximum temperature (r=-0.552, -0.548 and -0.551), minimum temperature (r=-0.536,-0.533 and -0.536) and rainfall (r=-0.503,-0.505 and -0.509). However, morning relative humidity showed a non significant positive relationship with traps placed at same canopy level, 10 and 20cm height above canopy level (r=0.775, 0.770 and 0.758). A similar trend was followed in case of evening relative humidity (r=0.057, 0.055 and 0.050) also (Table 4).

Table 2. List of natural enemies (predators) of insect pests of *C. chinense* during 2013-2014 and 2014-2015

Species	Order	Family
Coccinella transversalis F.	Coleoptera	Coccinellidae
Cheilomenes sexmaculata F.	Coleoptera	Coccinellidae
Brumoides saturalis F.	Coleoptera	Coccinellidae
Micraspis discolour F.	Coleoptera	Coccinellidae
Harmonia dimidiata F.	Coleoptera	Coccinellidae

Incidence of thrips, *S. dorsalis* and its relationship with meteorological factors

The incidence of the pest was observed on a new transplanted crop during both the years of investigation (November, 2013-April, 2014 and November, 2014-April, 2015).

Correlation studies between mean thrips population caught in three most effective colour traps (yellow, blue and white sticky traps) and weather parameters during November 2013 to April, 2014 showed that the average pest population exhibited a negative correlation with maximum temperature (r=-0.691, -0.627 and -0.624), minimum temperature (r=-0.757, -0.703 and -0.737), wind speed (r=-0.867,-0.857 and -0.856) and rainfall (r=-0.786,-0.829 and -0.763) but morning relative humidity (r=0.857, 0.824 and 0.853) and evening relative humidity (r=0.882, 0.863 and 0.875) exerted a significant positive correlation (Table 3) with the pest population.

Table 3. Co-relation co-efficient of various insect pests caught in three most effective coloured sticky

Insect pests	Maximum temperature (°C)	Minimum temperature (°C)	Relative humidity (Morning %)	Relative humidity (Evening %)	Rainfall (mm)	Wind speed (kmph)
APHIDS *Aphis gossypii* Glover						
Yellow sticky trap	-0.961**	-0.985**	0.956**	0.867*	0.782	-0.941**
	y=-10.54x+386.2	y=-9.347x+233.4	y=-7.794x-625.9	y=-3.923x-290.7		y=-42.50x+173.4
Green sticky trap	-0.870*	-0.929**	0.787	0.710	-0.829*	-0.838
	y=-4.077x+157.6	y=-3.763x+100.5			y=-11.46x +58.05 *	y=-16.15x+74.88
Red sticky trap	-0.866*	-0.942**	0.875*	0.772	-0.913*	-0.925**
	y=-3.983x+154.3	y=-3.745x+99.58	y=-2.989x+232.2		y=-12.4x+58.03	y=-17.5x+76.28
THRIPS *Scirtothrips dorsalis* Hood						
Yellow sticky trap	-0.691	-0.757	0.857*	0.882*	-0.786	-0.867*
			y=-3.383x-277.4	y=-3.409x-155.1	y=-18.95x+70.32	
Blue sticky trap	-0.627	-0.703	0.824*	0.863*	-0.829*	-0.857*
			y=-2.473x-197.3	y=-2.537x-110.4	y=-9.824x+42.52	y=-16.26x+60.11
White sticky trap	-0.674	-0.737	0.853*	0.875*	-0.763*	-0.856*
			y=-2.279x-184.0	y=-2.289x-101.1	y=-8.099x+36.22	y=-14.64x+52.27
WHITEFLY *Bemisia tabaci* Gennadius						
Yellow sticky trap	-0.976**	-0.942**	0.790	0.788	-0.533	-0.751
	y=-0.782x+26.65	y=-0.652x+14.75				
Red sticky trap	-0.725	-0.696	0.423	0.555	-0.321	-0.423
Green sticky trap	-0.620	-0.548	0.436	0.306	-0.045	-0.211
LEAF HOPPER *Amrasca biguttula biguttula* Ishida						
Yellow sticky trap	-0.933**	-0.896*	0.826*	0.935**	-0.534	-0.778
	y=-2.495x+88.68	y=-2.071x+50.58	y=-1.640x-131.6	y=-1.819x-81.89		
Orange sticky trap	-.933**	-0.913*	0.749	0.820*	-0.540	-0.724
	y=-2.012x+71.41	y=-1.702x+41.12		y=-1.288x-55.94		
Green sticky trap	-0.926**	-0.885*	0.710	0.790	-0.448	-0.667
	y=-1.654x+58.76	y=-1.366x+33.41				

**Correlation is significant at 0.01 level
*Correlation is significant at 0.05 level

During November, 2014 to April, 2015 also, correlation studies were made between the average thrips caught in traps placed at different heights with weather parameters. The data revealed that mean thrips population caught in traps placed at same canopy level, 10 and 20cm height above canopy level had a negative correlation with maximum temperature (r=-0.564,-0.550 and -0.638), minimum temperature (r=-0.562,-0.452 and -0.560), wind speed (r=-0.849,-0.764 and -0.798) and rainfall (r=-0.534,-0.398 and -0.437), respectively.

However, a positive correlation was observed with morning (r=0.712, 0.744 and 0.795) and evening relative humidity (r=0.001, 0.156 and 0.06) when the traps were placed at different heights. November was the congenial period of thrips activity with mean thrips population of 49.4, 39.4 and 24.6 when traps were placed at same canopy level,10 and 20cm height above canopy level, respectively (Table 4).

Incidence of whitefly, *B. tabaci* and its relationship with meteorological factors

The activity of *B. tabaci* was recorded from November, 2013 to April, 2014 and November, 2014 to April, 2015. In the first year of investigation, January was the congenial month of whitefly activity whereas in the next year November was the peak period of activity.

Correlation studies from November, 2013 to April, 2014 revealed that mean whitefly population caught in yellow, red and green sticky traps had a negative correlation with maximum temperature (r=-0.976, -0.725,-0.620), minimum temperature (r=-0.942,-0.696,-0.548), wind speed (r=-0.751,-0.423 and -0.211) and rainfall (r=-0.533,-0.321 and -0.045). However, the morning (r=0.790, 0.423 and 0.436) and evening relative humidity (r=0.788, 0.555 and 0.306) had a non significant positive impact with yellow, red and green sticky traps (Table 3).

During 2014-2015, correlation studies revealed that mean whitefly population caught in traps placed at same canopy level, 10 cm and 20 cm height above canopy level had a negative correlation with maximum temperature (r=-0.562,-0.600 and -0.612), minimum temperature (r=-0.430,-0.375 and -0.406),

Table 4. Co-relation co-efficient of various insect pests caught in yellow sticky traps in three most effective heights with meteorological parameters from November, 2014 to April, 2015

Insect pests	Maximum temperature (°C)	Minimum temperature (°C)	Relative humidity (Morning %)	Relative humidity (Evening %)	Rainfall (mm)	Wind speed (kmph)
APHIDS *Aphis gossypii* Glover						
Same canopy level	-0.552	-0.536	0.775	0.057	-0.503	-0.860* y=-43.38x+155
10cm height above canopy level	-0.548	-0.533	0.770	0.055	-0.505	-0.856* y=-39.21x+141.3
20cm height above canopy level	-0.551	-0.536	0.758	0.050	-0.509	-0.855* y=-36.15x+131.2
THRIPS *Scirtothrips dorsalis* Hood						
Same canopy level	-0.564	-0.562	0.712	0.001	-0.534	-0.849* y=-20.06x+62.47
10cm height above canopy level	-0.550	-0.452	0.744	0.156	-0.398	-0.764
20cm height above canopy level	-0.638	-0.560	0.795	0.06	-0.437	-0.798
WHITEFLY *Bemisia tabaci* Gennadius						
Same canopy level	-0.562	-0.430	0.743	0.190	-0.351	-0.723
10cm height above canopy level	-0.600	-0.375	0.776	0.286	-0.218	-0.627
20cm height above canopy level	-0.612	-0.406	0.776	0.257	-0.256	-0.663
LEAF HOPPER *Amrasca biguttula biguttula* Ishida						
Same canopy level	-0.530	-0.546	0.703	0.003	-0.547	-0.856* y=-10.52x+29.99
10cm height above canopy level	-0.510	-0.519	0.685	0.023	-0.536	-0.843* y=-8.512x+24.59
20cm height above canopy level	-0.556	-0.540	0.779	0.054	-0.503	-0.861* y=-5.632x+20.09

**Correlation is significant at 0.01 level

*Correlation is significant at 0.05 level

wind speed (r=-0.723,-0.627 and -0.663) and rainfall (r=-0.351,-0.218 and -0.256). However, a non significant positive correlation was observed in morning relative humidity with traps placed at same canopy level, 10 and 20cm height above the canopy level (r=0.743,0.776 and 0.776). A similar trend was followed in case of evening relative humidity (r=0.190, 0.286 and 0.257) also (Table 4).

Incidence of leafhopper, *A. biguttula biguttula* and its relationship with meteorological factors

The peak period of leafhopper incidence was observed in January, 2014 during November, 2013 to April, 2014 whereas the peak activity of the pest was found in November in the second year of investigation (November, 2014 to April, 2015). Correlation studies between mean leafhopper population caught in three most effective colour traps (yellow, orange and green sticky traps) and weather parameters (Table 3) showed a significant negative correlation with maximum temperature (r=-0.933,-0.933 and -0.926), minimum temperature (r=-0.896,-0.913 and -0.885) during the first year of investigation (November, 2013 to April, 2014). A non significant negative relationship was observed in case of wind speed (r=-0.778,-0.724 and -0.667) and rainfall (r=-0.534,-0.540 and -0.448) respectively. However, morning relative humidity (r=0.826) and evening relative humidity (r=0.935) exhibited a significant positive correlation in case of yellow sticky traps but orange sticky traps showed a non significant positive association with morning relative humidity (r=0.749) and a significant positive correlation with evening relative humidity (r=0.820). In case of green sticky traps, there was a non significant association with both morning relative humidity (r=0.710) and evening relative humidity (r=0.790) respectively.

During November, 2014 to April, 2015, correlation studies were made between the mean populations of leafhopper caught in traps placed at different heights and weather parameters (Table 4). Results showed that mean leafhopper population caught in traps placed at the plant canopy level, 10 cm and 20 cm height above the canopy level had a non significant negative correlation with maximum temperature (r=-0.530,-0.510 and -0.556), minimum temperature (r=-0.546,-0.519 and -0.510) and rainfall (r=-0.547,-0.536 and -0.503) but it was significant with wind speed (r=-0.856,-0.843 and -0.861). However, a positive correlation was seen with morning relative humidity (r=0.703, 0.685 and 0.779) and evening relative humidity (r=0.003, 0.023 and 0.054) when the traps were placed at the plant canopy level, 10 and 20cm height above the canopy level, respectively.

Discussions

Earlier, several workers from different regions of India and world reported a number of insect pests that attack the chilli during different growth stages of the crop. Sunitha T. R. (2007) revealed the occurrence of cutworm, aphids, thrips, termites, fruit borer and non insect pests *viz.*, mites and snails as the major pests in capsicum field at Dharwad, Karnataka. The presence of chili thrips, green peach aphid, two spotted spider mite, whitefly, tomato fruit borer, armyworm and leaf miner in chilli was reported from Pakistan by Sarwar during 2012. A total of 10 species of insect and mite pests associated with capsicum were recorded from Bengalaru by Roopa and Kumar (2014). The recorded species belonging to 8 different families in six different orders were *S. dorsalis, M. persicae, Trialeurodes vaporariorum, A. crenulata, M. signata, Myllocerus discolor, Thysanoplusia ni, Spodoptera litura, Helicoverpa armigera* including one mite pest *P. latus.*

Kumar *et al.* (1997) reported that the average temperature of 18.06ºC (maximum and minimum temperature of 22.8º and 13.3ºC) under the influence of high relative humidity ranged from 80.71 to 86.5% provided a conducive condition for multiplication of aphid, *A. craccivora.* A combination of ambient maximum temperature (26.4 to 29ºC), minimum temperature (8.4 to 12.6ºC) and high Relative humidity ranging from 75-85% during January favored the multiplication of mustard aphid. *Lipaphis erysimi* was also reported by Kulat *et al.*, (1997) from Nagpur.

Biswas *et al.*, 2004 reported negative correlation between aphid vector population *viz. M. persicae* and *A. gossypi* and minimum temperature but positive correlation with maximum and minimum relative humidity. Similar results were also obtained by Prasad *et al.* (2008) who reported that the incidence of *A. gossypi* had significant negative association with maximum and minimum temperature and rainfall whereas there was positive association with morning relative humidity. A negative correlation between mean aphid infestation index (*L. erysimi*) with maximum temperature, evaporation, sunshine and wind velocity while it was positively correlated

with maximum and minimum relative humidity in a significant way was also confirmed by Subhash Chander,1995 and Samdur *et al.*,1997 from IARI, New Delhi.

Earlier workers also reported that the population of *S. dorsalis* appeared on the chilli crop soon after transplanting (Meena *et al.,* 2013). These findings are in conformity with Roopa and Kumar (2014) who reported a negative correlation with maximum and minimum temperature. Similar results were also obtained by Patel (1992) who reported negative correlation between thrips population and temperature. The results were in conformity with the findings of Patel *et al.* (2009) who reported the peak activity of thrips in November and February-March but there were contrary results in relation to correlation coefficient values. Their findings revealed significant positive relationship with bright sunshine hours and rainfall.

Roopa and Kumar (2014) reported that maximum incidence during second week of November where as Dhaka and Pareek (2008) also reported the peak activity of *B. tabaci* in the first week of October. Nandihal *et al.* (1993) observed significant negative correlation in between whitefly and maximum and minimum temperature but noticed significant positive correlation with morning relative humidity. All the weather parameters collectively influenced the whitefly population from 42.9 to 70.6 per cent. Observations in the present studies were also in close conformity with the results obtained by Meena *et al.* (2013) who reported positive correlation with maximum and minimum relative humidity during both the years. Similarly, Prasad *et al.* (2008) reported that both maximum and minimum temperature and rainfall were found to exert significant negative influence on whitefly population. It could be concluded that the total influences of all the weather parameters were found to be high and significant on whitefly.

Prasad *et al.* (2008) reported peak incidence of leafhopper *A. biguttula biguttula* Ishida from mid September to November. They also reported that total influence of weather parameters was high and significant against leafhopper (51-78%) with significant and positive correlation related to morning and evening relative humidity. Findings were also in close conformity to those of Dhaka and Pareek. (2008) who recorded that maximum temperature had significant but negative correlation whereas morning and evening relative humidity had significant and positive effect on jassid population. A negative correlation between jassid population with temperature and rainfall was observed by Patel *et al.* (1997) and Prasad and Longiswaran (1997).

Acknowledgement

The insect pests recorded on *C. chinense* were collected during during 2013 and 2014. The collected insect pests were killed by using chloroform and preserved by using both dry and wet preservation methods. The specimens were sent to IARI, New Delhi, which were identified by Dr. V.V. Ramamurthy, Division of Entomology, Indian Agricultural Research Institute, New Delhi-110012

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