



## Curling and Puckering of Leaves of *Terminalia arjuna* in N-W States of India: Insect Pest, Natural Enemies and Control Measures

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### ABSTRACT

There is no past history of insects attacking arjun in north India. During field visit, curling and puckering of leaves of *T. arjuna* were observed. The damage was noticed in 2012 but insect remained unreported as it could not be identified. The attack has been continuing since then. There is no previous history of curling and puckering of arjun leaves in Chandigarh, Haryana, Punjab and Himachal Pradesh. The adults on the leaves were sent to Forest Research Institute (FRI), Dehradun for identification. Dr. Sudhir Singh, Head, Division of Entomology of FRI identified the insect as *Phylloplecta hirsuta*. [syn. *Megatrioza hirsuta* (Crawford) (= *Trioza hirsuta*)]. The insect belongs to order Hemiptera, Superfamily Psylloidea and family Triozidae. The adult of the pest has light shining yellowish body with white transparent wings that extend well beyond pointed abdomen. The members of family Triozidae are commonly called jumping plant lice and form galls on plants by their feeding action. The life history, identification and control measures have also been suggested.

### Key Words:

Arjun, Curling and puckering, Insect feeding, Jumping plant lice, *Megatrioza hirsuta*.

### INTRODUCTION

Arjun tree, *Terminalia arjuna* (Wight & Arn) of family Combretaceae, is an unique gift of India to the rest of the world. A medium sized tree 20 to 25 meters high, arjun is widely distributed in India from sea level to sub Himalayan ranges. It has mythological, cultural, aesthetic, ecological, medicinal and economic significance. It is planted in cities, parks and gardens on large scale for shade, ornamental value and on religious considerations. It is a panacea of health benefits and is in use in India for more than 3000 years. The bark of this tree is a cardiac tonic, cardiac

stimulant and has anti-hypertensive and anti-ischemic properties. Arjun tree is commonly seen in parks and gardens and finds an important place in plantation programme of the country. It is planted as an eco-friendly plant along railways, roads, canals, cities, parks and gardens for shade and aesthetic value. It loves to grow in moist conditions and tolerates high pH conditions upto 9 and is, therefore, the first choice of the foresters when it comes to planting eco-friendly trees in water logged areas and salt affected soils. It is food for tasar silk moth, very good fodder for animals and good timber as well. In forest health management insect pest management is essential

(Chander et al. 2015) so is the case with individual standing tree species in urban areas. This paper deals insect attack on *Terminalia arjuna*.

### **Insect Pest of *Terminalia arjuna***

There is no past history of insects attacking arjun in north India which caught attention. A tiny insect called *Trioza fletcheri* however, has been causing serious damage to arjun plants in nursery by forming galls on leaves (Chander 2015). Leaf Miner is another insect which is causing damage to grown up tree leaves (not in nurseries) in Chandigarh and Haryana by mining the leaves. The insect still remains unidentified.

During field visit, curling and puckering of leaves of *T. arjuna* were observed (Fig. 1). The damage was noticed in 2012 but insect remained unreported as it could not be identified. The attack has been continuing since then. There is no previous history of curling and puckering of arjun leaves in Chandigarh, Haryana, Punjab and Himachal Pradesh. The symptoms of curling on arjun leaves were observed in June, 2012 in the form of small thickening of the leaves. Close examination of the leaves showed the presence of ugly wooly white sucking nymphs. They later became gallinaceous as they grew. They were few in number initially but as the rainy season set in,

their number increased and their activity was at peak during the hot and humid weather of July to September. Due to active sap sucking action of the nymphs, the leaves were rolled, thickened and they took the form of curling and puckering. Such leaves catch the attention as they attain pinkish red colour. The curling however, does not reach upto the midrib. This provides nearly stable surface for the nymphs to settle and feed on the sap comfortably. The nymphs insert their piercing and sucking mouth parts while sitting comfortably on the stable surface and suck sap from there. The curling/folding provides shelter and protects them from their predators. The actively feeding nymphs urinate continuously. This fluid gets collected in the rolled portion of the leaf and some nymphs while avoiding the fluid move to the margins. The fluid if drained, gives the impression as if the leaf had been filled with milky water. Besides milky fluid, the folded leaf contains powdery mass, exuviae of the moulted nymphs and honey dew globules. Fully grown nymphs have white waxy skin and measures upto 5.0mmx3.0mm. On the grown up plants only the terminal tender leaves were curled and puckered. Not even a single leaf other than the terminal ones was found attacked. However, in nurseries in juvenile plants, the symptoms were observed on all leaves.



**Fig. 1.** Curling and puckering of leaves in *Terminalia arjuna*

A close vigil was kept in the field for locating the adults of the sucking insect but they were not available. The insect could not be identified on the basis of the nymphs. Therefore, to get the adults two fresh polybag raised arjun seedlings showing symptoms of curling along with one healthy seedling were enclosed in an insect proof net. The curled and puckered leaves were plucked from the nursery plants but they dried within a day under ordinary temperature conditions due to very high temperature. Therefore, the curled leaves were put in the lower portion of refrigerator for studying the insect. The nymphs survived in that temperature as the leaf remained fresh (Fig. 2a). The adults emerged from the leaves kept in refrigerator after a fortnight (Fig. 2b). On the other hand, the plants enclosed in the net were freed from the net after a month. The plants had vanished but the dead adults were recovered from the net as they could not escape. The adults were sent to Forest Research Institute (FRI), Dehradun for identification. Dr. Sudhir Singh, Head, Division of Entomology of FRI identified the insect as *Phylloplecta hirsuta*. [syn. *Megatrioza hirsuta* (Crawford) (= *Trioza hirsuta*)]. The insect belongs to order Hemiptera, Superfamily Psylloidea and family Triozidae. The adult of the pest has light shining yellowish body with white transparent wings that extend well beyond pointed abdomen. The members of family Triozidae are commonly called jumping plant lice and form galls on plants by their feeding action.

*Megatrioza hirsuta* is a major pest of *Terminalias* (Mathur 1949), and Beeson (1941). However, in Chandigarh, Haryana, Punjab and Himachal Pradesh only *T. arjuna* was affected beyond threshold limit. In the forest *Terminalia elliptica* (= *Terminalia tomentosa*, *Terminalia alata*), is attacked by the pest. However, only small margins are folded and the attack is below the threshold limit. Other *Terminalias* namely *Terminalia chebula* and *Terminalia bellirica* were free from the pest attack.

Gupta and Gupta (2013) observed that *Trioza hirsuta* infests plants during last week of

April but in the areas of study, no activity of the insect was seen till about first fortnight of May. But by then new flush of leaves had already appeared by 15<sup>th</sup> of May and the activity of the insect became visible after that in the form of laying eggs. The eggs are laid on the ventral side of the leaves singly on either side of the leaf midrib. A female lays 48-180 ova during her lifespan, with an average of 98.6 ova (Dhiman and Singh 2007). Towards the beginning of June, with the increase in humidity in the atmosphere, activity of the nymphs was noticed. The terminal leaves started thickening after about a fortnight due to the feeding action of the nymphs. However, the curling effect was noticed towards the end of June. The leaves were completely folded as the monsoon set in. The nymphs feed on the dorsal side of the leaves and fold them outside in. They feed on the same leaf till their maturity. The activity of the insect was at peak during July and August. As the rains recede, no more young leaves are formed. The availability of the sap decreased and the population came down. The active feeding continued upto November. However, adults continued emerging in captivity upto the end of December. Infact the insect feeds upto November only and thereafter, only the maturation activities from nymphs to adult and egg laying by the adults take place. These eggs pass the winter in diapauses. The number of nymphs varied from 2 to 16 in each folded leaf. More than one generations are produced in a year. The curled leaves once exhausted became brown, hard and corky upon drying. The dead leaves remained on trees till the end of January.

As regards, the mechanism of leaf thickening it is similar to gall formation; the saliva of the insect contains hydrolyzing enzymes and soluble proteins, which induce lot of changes in the cellular contents. This acts as stimulus for the induction of galls). The stimulus weakens the defense mechanism of the plant. The actively feeding nymphs vigorously take oxygen from the site of attack and bring the cells and tissues under stress. The hormonal balance changes and the auxin activity increases. Auxins result in repeated cell division (hyperplasia) and enlargement in cell

size (hypertrophy). In response to this, the plant releases lot of phenolics which get deposited over the feeding nymphs (Raman 2012). The fluid excreted by the actively feeding nymphs results in the folding of the tender leaves.

Dhiman and Singh (2006) studied moulting behaviour of nymphal instars of *Trioza hirsuta* and reported that only nymphal stages contribute in making the gall (folding of leaves). Moulting of first instar to fourth instar nymphs occurs inside the gall, but 5<sup>th</sup> instar nymphs come out of the gall and select suitable site for moulting mostly on leaf surface as it requires exposure to air. Before moulting, the instar powerfully clings the host surface with claws. After emergence, the exuvium is left attached with host surface leaf in case of 5th instar. The insect passes winter in egg stage. In this regard it was observed that the coming out of fifth instar nymphs from the curled portion coincided with the availability of food inside the curled leaf. Due to voracious sucking of the sap by the pest, the leaf was exhausted of all nutrient, and sensing this the grown up nymphs came out. Another interesting phenomenon observed was that it is the collective decision of all nymphs to come out. Once they come out, no more nymphs remain inside the curled leaf. The nymphs finally moult to become adult to fly in search of new leaves for starting the phenomenon of curling a fresh. The adults leave exuviae sticking to leaves on their outer side as a matter of proof of flight to freedom. Such leaves dry up and become corky after about a fortnight. The insect passes winter in the form of eggs and where do they survive, could not be known.

The feeding action of *Megatrioza hirsuta* harms arjun plants in a number of ways. The affected curled and puckered terminal dry and fall of. This affects the photosynthetic activity of the plant. The tip of the shoots becomes redundant and this affects the growth of the plant. Seed production is also affected as the terminal shoot becomes dead. It is worth mentioning that the fruits in all *Terminalias* are borne on the tips of the branches. With the tops gone, the seed production

is also affected. The pest is particularly very serious on nursery plants. About ten percent plants die in Haryana nurseries and the rest eighty percent lose their growing tips. Such plants are deformed, become bushy and they never attain straight bole. Tasar silk cultivation, fodder supply to the animals and growth of the plant is affected.

The damage to grown up arjun plants is the result of feeding action of *T. hirsuta* alone. However, the death and killing of growing tips of nursery plants in nursery is the combined effect of feeding action of *T. hirsuta* and *Trioza fletcheri*. Both of these insects which have almost similar feeding habits have been found coexisting on the same host and same parts of the plant. Hence, the relationship between two near relatives is very interesting. *T. fletcheri* forms scattered galls on the leaves. However, the feeding action of *T. hirsuta* results in folding of entire leaf. While feeding on the same leaf, *T. hirsuta* dominates in folding feeding action. The folded leaf contains a few galls formed by *T. fletcheri* whereas the unfolded leaves contain a number of separate galls suggesting that there exists competition between these two *Trioza*s and the competition pushes *T. fletcheri* to other leaves. *T. fletcheri* does not distinguish between old and new leaves but has tilt towards older ones. Another very interesting phenomenon in nursery plants affected in the nursery is the presence of a number of thrips alongwith *Trioza hirsuta* and *Trioza fletcheri*. It is not known as to what is the role of thrips on the affected leaves. However, thrips found associated in this phenomenon could not be identified.

Nature seems to keep a check on the population of *T. hirsuta*. There is no record of occurrence of *Trioza hirsuta* in areas of study, and so is the case with its natural enemies. The affected leaves which were preserved under refrigerated conditions provided good opportunity for the study of natural enemies of *T. hirsuta*. It was found that many nymphs became inactive in fourth instar. They attained light blue colour initially which later changed to light pink. Only one insect emerged from the body of each nymph. Dr. Sudhir



Singh, Head Division of Entomology of Forest Research Institute, Dehradun identified the insect as *Psyllaephagus phyllopectae*. It is a member of family Encyrtidae of order Hymenoptera. This is the new distribution of *P. phyllopectae* from Chandigarh, Haryana, Punjab and Himachal Pradesh. Earlier it has been reported from Karnataka and Uttarakhand (Gupta et al. 2009). The adult of *P. phyllopectae* has metallic shining greenish blue colour with transparent white round wings and yellowish brown antennae. So, *P. phyllopectae* is nymphal parasite of *Trioza*

*hirsuta* which spends its egg, larval and pupal stage in the body of its host.

Besides parasites, some predators of *T. hirsuta* were also found preying upon the eggs and young nymphs in Chandigarh. There are three coccinellid beetles namely Ladybird (*Coccinella septempunctata*), Three Striped Beetle (*Brumus suturalis*) and Wavy Striped Ladybird (*Cheilomenes sexmaculata*). These lady birds keep on sitting and waiting on curled leaf. (Fig. 2c). However, it was not established whether they wait for 5<sup>th</sup> instar larva to predate upon or not.



**Fig. 2.** Adult, its predator and parasite of *M. hirsuta*

### Control Measures

The following measures are suggested for keeping the insect pest under check.

- The best measures to keep the pest under check is to pluck the folded leaves, put them in a dug pit and cover the leaves with about half foot dug soil. Care has to be taken that the nymphs or any other stage of the insect do not escape.
- Parasitization by endoparasite *Psyllophagus phyllopectae* can be rated as very good. Hence, to encourage natural control by it, no insecticides should be used.

- The natural control by predatory lady birds should be encouraged.
- The insecticides should be discouraged. However, in nurseries rogor organophosphate insecticide @ 0.01 percent be sprayed at weekly interval. In Haryana nurseries, this insecticide provided only temporary relief against the pest.

## SUMMARY

The occurrence of leaf curl of leaves of *Terminalia arjuna* and its causal insect pest in Chandigarh, Haryana, Punjab and Himachal Pradesh is the first report from this region. More interesting is the occurrence of the nymphal parasite *Psyllophagus phyllopectae* of *Trioza hirsuta* and three lady bird beetle predators. Besides academic implications, the study has practical field implications as well.

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