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CHLOROPHYLL LOSS IN LEAVES OF SOME PLANTS CAUSED BY LEAFHOPPER FEEDING*

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In order to determine the effect of leafhopper feeding and chlorophyll loss, studies were made on three different species, two typhlocybines and one idiocerine feeding on bauhinia, grewia and mango respectively. The chlorophyll loss turned out to be as high as 71% from the leaves, resulting into almost functional death of leaves. It was also assessed that the chlorophyll loss in leaves was proportional to the number of leafhoppers feeding. In case of typhlocybines the leaf areas affected were visible by white stippling marks, whereas in case of idiocerine leafhopper the stippling marks are not visible, but the chlorophyll is lost as usual during leafhopper feeding.

INTRODUCTION

It is fairly well-known that various species of leafhoppers, even in related genera, feed on different tissues of mainly leaves of their host/food plants [12]. Apart from rendering other losses, one of the direct results of leafhopper feeding is the chlorophyll loss in leaves. Smith [14] pointed out that chlorophyll loss in cells of the mesophyll was due to the salivary toxins injected by leafhoppers before feeding. Kennedy [7] concluded that deficiencies in chlorophyll in leaves can bring about limitations in photosynthesis, and thus affect the healthy growth of plants. Emerson [5] was of the opinion that there existed a direct relationship between the chlorophyll content and the amount of food formed. Poos and Johnson [11] discussed the role of leafhoppers in this context and reported that plant growth was inversely proportional to the number of leafhoppers feeding on it.

From the studies referred above it appeared that chlorophyll being a constituent of high biological significance in plant tissues, the role of leafhoppers in depriving the leaves from it could also bear important consequences. Whereas the various causes of chlorosis in plants and its effects have been sufficiently investigated, the extent of chlorophyll loss brought about by leafhoppers has not been studied. Nothing was known on this aspect of leafhopper biology so far in Pakistan. The present work was done to explore the extent of chlorophyll depletion by three different types of leafhoppers, an empoascan, an erythroneurine and an idiocerine feeding on three species of plants, i.e. grewia, bauhinia and mango respectively in Karachi, Pakistan.

MATERIAL AND METHOD

1. In case of *Bauhinia variegata,* and *Grewia asiatica* affected by feeding of leafhoppers *Zygina binotata* and *Austroasca* sp. respectively five leaves of equal sizes and same age, but with different levels of infestation were picked up for estimation of their chlorophyll content. Of the five leaves picked, one was completely free from infestation, and the other four with varying number of leafhoppers (both adults and nymphs) feeding on them. The leaves of mango were of three types, all covered with sleeves, of which one was kept completely free of leafhoppers, and the other two experimentally infested with 30 and 60 leafhoppers respectively, which were allowed to feed for a period of 40 days after which leaves were also removed for comparative chlorophyll estimation.

2. The leaves were crushed separately and their homogenates prepared in acetone. The optical density in each case was plotted on a spectrophotometer, and the estimation of chlorophyll made following the method of Maclachlan and Zalik [8]. The results have been presented in the Table 1.

DISCUSSION

The leafhopper species, *Zygina binotata* as stated by Naheed *et al.* [9] feed on the undersurface of leaves, and normally do not attack any other part of the plants *Bauhinia variegata.* Like all other mesophyll feeders, the signs of leafhopper feeding appear as 'stippling' marks or rounded whitish spots on the upper surface of leaves. The leafhop-

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Table 1. Chlorophyll loss in plant leaves due to feeding of leafhoppers.

Treatment No.	Average No. of leafhopper/leaf	Average stippling mark/leaf	Average chlorophyll content (mg/g)	Average loss of chlorophyll (mg/g)	Loss (%)	S.E.
In Bauhinia (by *Zygina binotata*)						
1	Nil	Nil	1.6387	–	–	±
2	15.63	368	1.5146	0.1241	7.73	±0.94
3	23.00	720	1.4504	0.1883	11.49	±1.3
4	30.55	1177	0.9488	0.6899	42.10	±0.67
5	36.75	2062	0.4709	1.1678	71.26	±2.76
In Grewia (by *Austroasca* sp.)						
1	–	–	1.8523	–	–	–
2	15.36	375.0	1.3727	0.4796	25.0	±2.08
3	23.12	806.6	1.0112	0.8411	45.41	±1.04
4	31.17	1296.0	0.9633	0.8890	47.99	±2.89
5	33.42	1707.6	0.8834	0.9689	52.31	±2.48
In Mango (by *Idiocerus clypealis*)						
1	Nil	–	1.5279	–	–	–
2	30	–	1.0745	0.4534	29.7	±1
3	60	–	1.0297	0.4982	32.5	±1

*For each treatment averages were drawn from 3 replicates.

pers usually heavily infest the plant during their peak periods. Table 1 indicates that the amount of chlorophyll destroyed is directly proportional to the number of leafhoppers feeding.

In case of *Bauhinia variegata,* the loss of chlorophyll ranged from 7.73 to 71.26% ($\bar{X}$ 33.145), when the average leafhoppers were 26.43. As the individual plants had been observed affected by a much heavier population, the loss of chlorophyll could be still heavier. As pointed out by Naheed *et al.* [9] in such severe infestations the entire leaf gets deprived of all of its chlorophyll content, dries up and falls off.

The feeding mechanism, symptoms, and nature of damage to the plant falsa, *Grewia asiatica* by *Austroasca* sp. is similar to one caused by *Zygina binotata* to *Bauhinia variegata.* The infestation of 15.36 to 33.42 leafhoppers per leaf resulted into chlorophyll loss of 25.9 to 52.31%. It has been observed that the new leaves which appear in March–April, soon get infested by the leafhoppers, and loose their greenish appearance due to the feeding of *Austroasca* sp. In July–August, another leafhopper species *Zygina rubronotata,* which is relatively rare from March to July, starts infesting the plant, rapidly accompanied by a large-scale fungal infection. The plant suffers from heavy attack of leafhoppers almost throughout the year.

Idiocerus clypealis is known to feed on phloem tissue of mango leaves, and so the nature of damage is not identical to that of the two species described above. No 'stippling' marks appear, and so the damage symptoms are not easily recognised. The leafhoppers are found on the plant almost throughout the year, but a serious infestation is observed from beginning of April to end of October, in Karachi area. Apart from depriving the plant of its nutrients, and reducing the vigour of the plant, the leafhopper also reduces the chlorophyll content from leaves up to 32.5%, when 60 leafhoppers per leaf are allowed to feed for 40 days.

Several workers all over the world have studied the relationship between chlorophyll loss due to leafhopper feeding and various aspects of plant health. Smith [14] specifically related that white stippling marks, that usually appear on the upper surface of leaves due to feeding of typhlocybine leafhoppers are the result of destruction of chlorophyll in mesophyll cells. Saxena [13] stated that the enzyme chlorophyllase in *Empoasca kerri,* and *Amrasca devastans* acts upon the chlorophyll of leaf tissue to yield diffusable substances. Putman [12] reported that in another typhlocybine species *Typhlocyba pomaria,* the

contents of affected cells quickly break down into a homogenous mass, from which chloroplasts disappear and chlorophyll is bleached away. Poos and Johnson [11], Delong [4], and Wilson [15] all reported that loss of chlorophyll was closely related with leafhopper feeding. Jayaraj [6] described that surface area of root and stem in castor plant are greatly reduced due to feeding of leafhoppers. Peinkowski and Medler [10] reported that loss of chlorophyll in alfalfa is proportional to the number of leafhoppers present. In spite of several studies on the significance of chlorophyll loss due to leafhopper feeding, estimates of loss percentage brought about by leafhoppers was not studied so far. The present work had demonstrated that the loss could be high and may have serious consequences, as alongwith chlorophyll, other nutrients, which are so important for the quantity and quality of developing fruit on the plant, are also lost in the process of leafhopper feeding. In a few studies, made in Pakistan, on this aspect of leafhopper ecology, e.g. the quantitative losses to yield have been stated to be fairly high [2]. Ahmed *et al.* [3] studied the effects of insecticidal control of leafhoppers of potato on the quantity and quality of potato tubers and concluded that not only yield, but the nutritional value of potato tubers is also seriously affected by leafhopper feeding. Ahmed [1] observed that *Idiocerus clypealis* feeding on mango plants reduced the growth rate of young plants, by affecting the rate of appearance of new leaves, slowing down the development of length and breadth of leaves, and finally limiting the overall height of young plants. It would be worthwhile if the ultimate impact of chlorophyll loss is studied on the quantity, and quality of fruit of those host plants which are known to be heavily infested by leafhoppers, e.g. grape vines and apple in N.W.F.P. and Baluchistan, potato, tomato, tobacco, and several other plants species all over the country.

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