Bull. Inst. Zool., Academia Sinica 5: 35-40 (1966)

FEEDING OF THE NYMPHS OF *MOGANNIA HEBES* ON SUGARCANE ROOTS AND ITS EFFECT ON BUD GERMINATON AND GROWTH

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Received for publication March 3, 1966

ABSTRACT

Feeding mechanism of nymphs of *Mogannia hebes* Walker on sugarcane root and the incidence of injury were studied by artificial infestation of the insects on cane stubbles of 1-year-old NCO:310. Stylet sheaths of definite shape were found in the root tissue after the nymph had withdrawn stylets. Although the penetration of stylets was not limited to a particular tissue; vascular bundles, especially the phloem and vessel, were considered the main objects of feeding. Depressed bud germination and growth were observed within 10 days of feeding. The degree of severity was found to be independent of the number of nymphs fed on the root, or the frequency of feedings per nymph during a period of caging. Serious influence on bud germination could also be caused by a few nymphs. Recovery of bud germination and growth was observed 8 days after the removal of nymphs from the infested stubbles. However, growth was still retarded if compared with healthy stubbles. Since the root feeding by nymphs tended to decrease the rate of germination and bud growth, it was concluded that translocated effects might occur during the uptake of sap from sugarcane roots.

INTRODUCTION

Nymphs of *Mogannia hebes* walker (Homoptera: Cicadidae) have been sporadically observed on the sugarcane ratoon of some districts during the recent years. Based on field surveys in southern part of Taiwan, it is believed that the depressed germination seems to be induced by nymphs of *M. hebes* which feed on sugarcane roots (1, 2). However, the nature of injury is still unknown, and there has been no clear evidence that lowered rate of bud germination is mainly caused by the species. Carter (3) stated that the secretion of the salivary gland is an essential part of the feeding process of sucking insects, and it is easy to demonstrate the stylet sheath or stylet track deposited in plant tissue. With the

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purpose to determine whether the species will also produce the stylet sheath during feeding and to find the incidence of injury, artificial infestation of the insect on cane roots was conducted in the laboratory.

MATERIALS AND METHODS

I. Feeding process of *M. hebes* nymphs was investigated by individual rearing of nymphs with fresh cane roots. Old nymphs collected from cane fields were starved for 24 hours before transferred to Petri dish containing several pieces of cane roots of about 5 cm long. After 20 to 180 minutes of feeding, the roots fed by the insects were removed and fixed in Carnoy's solution. Free-hand cross sections of roots were stained with safranin and light green-clove oil (4).

II. Twenty or 40 nymphs were caged on the root part of 1-year-old NCO:310, in order to determine the effect of feeding on bud germination. Caging of nymphs was done by passing the root through 1.3 × 5 cm plastic tube, which was then plugged with nonabsorbent cotton at both ends after introducing a nymph. Cane stubbles infested with the nymphs were kept in 96 × 195 × 92 cm moist chamber, where the relative humidity was adjusted at 85%. To maintain a specific number of nymphs throughout the period of infestation, nymphs caged were inspected at an interval of 2 days and the individuals died in the cage were replaced with new nymphs. Percentage of bud germination and the growth of buds in a 10-day feeding period and 8 days after the removal of nymphs were compared with uninfested stubbles. The number of stylet sheaths left in the root tissues was also counted at the completion of the experiment so that the frequency of stylet penetrations in relation to the degree of injury could be clarified. All experiments were carried out at room temperature of 25.1 C, in average.

RESULTS

I. Feeding process of M. hebes nymphs on sugarcane roots

1. Deposition of stylet sheaths in root tissue

Nymphs usually roamed on the bottom when they were confined in a Petri dish. On reaching the root, continuous movements of the beak on the surface of root were observed. Penetration of stylets into root tissue immediately occurred when the nymph had found a proper site of feeding. *Figs. 1* and *2* show the nymph feeding on cane root and the stylets thrusted into root tissue.

Straight penetration of stylet sheaths through the epiderm cells to the root tissue was observed (*Fig. 3, 4* and *5*). Stylet sheaths laid by the nymphs were brown in color and took safranin stain.

2. Feeding site of *M. hebes* nymphs on sugarcane root

As shown in TABLE I, stylet sheaths penetrated to the cortex, endodermes and vascular bundles were observed after 20 to 180 minutes of feeding. The results evidently indicate that vascular bundles were the main objects of feeding since 23.9%, 10.2% and 35.2% of the stylet sheaths laid were ended in the phloem, xylem and vessels, respectively. The results also show that penetration of stylets into vascular bundles was not influenced by the duration of feeding. For instance, 6 out of 8 nymphs were able to thrust their stylets into vascular bundles within 20 minutes, while only 2 out of 5 individuals produced the stylet sheaths ending in the same tissue even when the feeding time was prolonged to 160 minutes.

TABLE I

Number of penetrations of stylets of Mogannia hebes nymphs into root tissues of sugarcane during different length of feeding period.

Tissue	Feeding period, minutes									Total	Percent
	20	40	60	80	100	120	140	160	180		
Cortex	2	1	2		1	7	2	1		16	18.2
Endodermes		2	2		2	1	2	2		11	12.5
Phloem	1	2	3	3	3	3	4		2	21	23.9
Xylem	1		2	2	4					9	10.2
Vessel	4	3	6	3	2	4	2	2	5	31	35.2
Total	8	8	15	8	12	15	10	5	7	88	

II. Influence of artificial infestation on bud germination

TABLE II indicates the depressed bud germination as a result of feeding of *M. hebes* nymphs. After 10 days of feeding, the average germination rate in the stubbles fed by 20 or 40 nymphs reached 55.2% or 43.3% only, which was apparently lower than that observed in uninfested stubbles. The influence became more profound if growth rate of buds between the infested and uninfested stubbles was compared. Buds sprouted from the infested stubbles were normal and healthy, though their growth was extremely retarded regardless of the number of nymphs caged.

TABLE II

Influence of artificial infestation of Mogannia hebes nymphs on bud germination and growth of cane stubbles of NCO:310. Moist chamber test.

Nymphs per stubble	No. of stubbles tested	10 days after infestation		8 days after removal of nymphs	
		Percent germination	Bud growh in cm	Percent germination	Bud growth in cm
20	7	55.2	0.8	89.1	1.3
cages only	6	92.8	5.0	92.8	5.8
40	6	43.3	0.7	68.3	1.6
cages only	6	100.0	5.0	100.0	6.6
Control	3	92.1	7.6	92.1	12.3

The data (TABLE II) also show that there was an obvious increase in the percentage of bud germination 8 days after the removal of nymphs. About 34% and 25% increase in bud germination was found on the stubbles which had been fed by 20 and 40 nymphs, respectively. Buds germinated also recovered their growth, but there was still a significant difference in the length of buds if compared with uninfested stubbles.

The results summarized in TABLE III were obtained from one experiment in which cane stubbles were infested with *M. hebes* nymphs at the rate of 40 per stubble. Bud germination in the 10 infested stubbles was as low as 49.6%, while 87.9% and 91.9% were

respectively found in the uninfested stubbles and those with empty cages. Retarded growth of buds was also observed since the length of buds measured only one-third of that in two check stubbles. Either the difference in per cent germination or the rate of bud growth between the injured and healthy stubbles was significant at the 1% level, according to Duncan's Multiple Range Test (5). Germination rate of the injured stubbles 8 days after the removal of nymphs increased to 77.4%, but the buds emerged did not grow as rapidly as those of check stubbles and the difference was also significant at the 5% level.

TABLE III

Percentage of germination and the growth of buds when cane stubbles of NCO:310 were infested with Mogannia hebes nymphs at the rate of 40 per stubble. Moist chamcer test.

Treatment	No. of stubble tested	After 10-day feeding				8 days after removal of nymphs		
		Percent germinated	P	Bud growth in cm	P	Percent germinated	Bud growth in cm	P
Caged nymphs	10	49.6	1%	1.01	1%	77.4	1.98	5%
Cages only	10	91.9		3.48		91.9	4.83	
Control	10	87.9		3.01		87.9	4.10	

As shown in TABLE IV, only 30.8% of the nymphs caged had fed on the roots and there were considerable differences in the number of nymphs fed and the frequency of feedings per nymph among the 10 infested stubbles. The most frequent feeding occurred on No. 1 stubble, where 23 nymphs had deposited 139 stylet sheaths in root tissue during

TABLE IV

Effects of the feeding frequency of Mogannia hebes nymphs on bud germination and growth of cane stubbles of NCO:310 at the rate of 40 per stubble.

Stubble No.	After 10-day feeding					8 days after removal nymphs	
	No. of nymphs fed	No. of stylet sheaths	Feedings per nymph	Percent germinated	Bud growth in cm	Percent germinated	Bud growth in cm
1	23	139	6.04	87.5	2.84	87.5	4.25
2	17	34	2.00	100.0	1.34	100.0	2.73
3	10	40	4.00	0.0	0.0	85.7	0.62
4	9	30	3.33	75.0	0.97	75.0	2.17
5	11	19	1.73	0.0	0.0	36.3	0.53
6	8	20	2.50	22.0	0.75	44.0	1.28
7	11	45	4.09	80.0	1.35	90.0	1.58
8	9	27	3.00	16.6	0.70	100.0	1.42
9	11	26	2.36	75.0	1.15	75.0	3.92
10	14	69	4.92	40.0	0.95	80.0	1.52
Average	12.3	44.9	3.65	49.6	1.00	77.4	1.98

a 10-day feeding period, and the least feeding, 1.73 feedings per nymph, was found with No. 5 stubble. However, there existed no correlation between the degree of injury and the number of nymphs fed, or the frequency of feedings per nymph. Bud germination was as high as 87.5% in the stubble fed by 23 nymphs with stylet thrusts of 6.04 times, but lower than 50% germination was caused by 8 to 14 nymphs among which the thrusts of stylets varied from 1.73 to 4.92 times.

DISCUSSION

The purpose of this study was to investigate the feeding process of *M. hebes* nymphs on sugarcane roots and to ascertain whether the feeding would give detrimental effect on bud germination. Depressed bud germination and retarded bud growth (TABLES II and III) were probably caused by the translocated effects of feeding on the roots when the results of deposition of stylet sheaths during the uptake of root sap (*Fig. 2*) and the most frequent feedings at the vascular bundles of cane roots irrespective of the time of feedings (TABLE I) were considered. Recovery of bud germination and growth after removing nymphs (TABLES II and III) also suggested that the effect was only limited to the presence of the insect. However, the rate of bud growth was always inferrior if compared with healthy stubbles. This was similar to the case being observed in the field.

Results shown in TABLE IV seem to prove that the incidence and severity of injury were not directly related to the number of nymphs fed, nor the frequency of feedings per nymph during a definite period of caging. Physiological differences among the stubbles might have some effects on bud germination, though it was negligible since almost complete germination of the buds was observed in 10 days with the uninfested stubbles. The result that lower than 50% germination was caused by 8 to 14 nymphs suggested that a few nymphs were also able to give serious damage if feeding was prolonged to enough time.

The present results seem to meet the criteria to some extents for establishing the toxicogenicity of an inset as proposed by Carter (3). Although the results have included some aspects of feeding process of *M. hebes* nymphs and nature of the injury, it apparently requires further studies on salivary secretions, effects of feeding by different nymphal stages and other factors associated with the insect.

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LEGEND OF FIGURES

Fig. 1. A nymph of *Mogannia hebes* feeding on sugarcane root. × 6
Fig. 2. Stylets thrusted in the root tissue. × 100
Figs. 3 and 4. Stylet sheaths deposited in the root tissue, showing the shape. × 100
Fig. 5. A stylet sheath ending in the vessel. × 400


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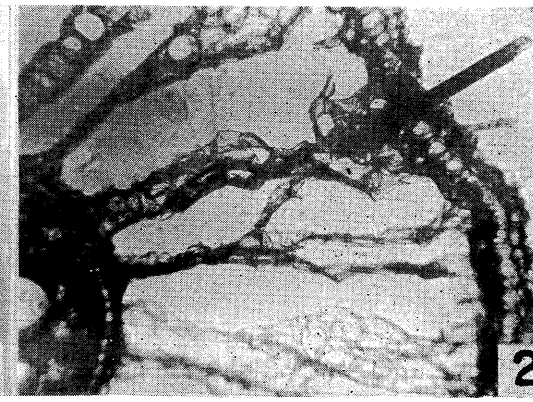
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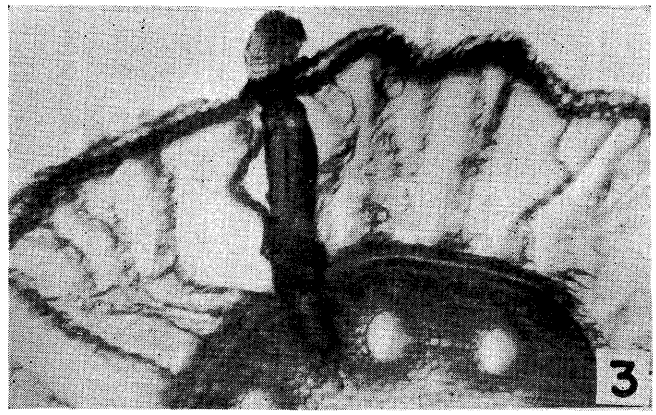
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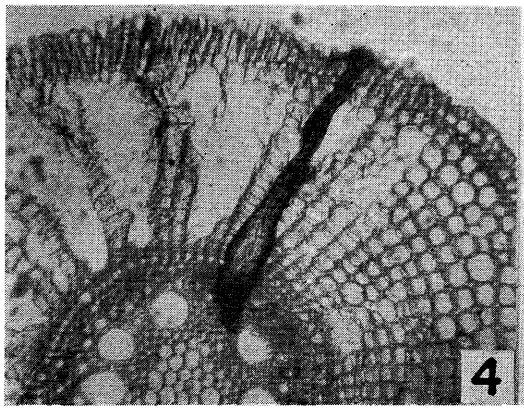
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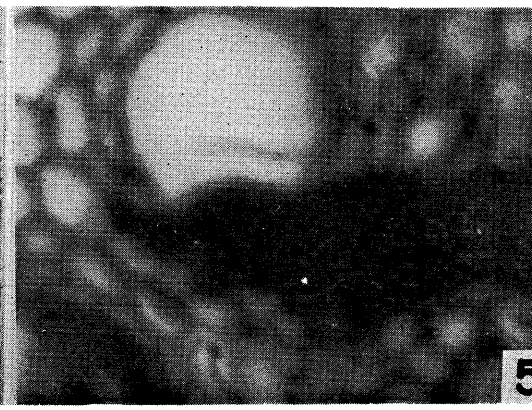
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