Both nymphs and adults of the maize orange leafhopper induce galls on their host plant

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The maize orange leafhopper, Cicadulina bipunctata, is a multivoltine insect that induces galls on various plants of the Poaceae. A previous study revealed that galls produced by this leafhopper were induced by dose-dependent stimulation on distant leaves from the feeding site, probably by chemical(s) injected from adults during feeding. In this paper, we examined the gall-inducing ability of C. bipunctata nymphs. The degree of gall induction gradually increased depending on the number of feeding nymphs and there were no significant differences from the positive control (feeding by five male adults) when seedlings were exposed to five or more nymphs. These results indicate that both adults and nymphs of C. bipunctata have the ability to induce galls on their host plants, a unique feature among gall-inducing insects. This feature may be related to the free-living, multivoltine and polyphagous habits of C. bipunctata.

Various herbivores such as insects and mites manipulate host plants and induce galls on them.¹³ Gall induction is adaptive for inducers and gall morphology is specific to the species inducing the gall.⁴,⁵ In general, only certain developmental stages or a particular generation of insect has the ability to induce galls.⁶ For example, feeding stimuli by the first instars of gall midges and gall wasps induce galls, whereas in sawflies, female adults inject chemicals responsible for gall induction during oviposition. In the case of aphids, fundatrices (stem mothers) induce initial galls on their primary hosts. Such specificities are closely related to the life history of gall inducers⁴ and are important in elucidating their adaptive strategies.

The maize orange leafhopper Cicadulina bipunctata (Homoptera: Cicadellidae) is a multivoltine insect that induces galls on various plants of the Poaceae including maize, rice and wheat.¹⁰ Galls produced by the leafhopper are characterized by growth stunting of the host plant and swelling of leaf veins.¹¹ In a previous paper, we determined that some chemicals injected by adults during feeding are probably responsible for gall induction and galls are induced not on feeding sites but on distant leaves by dose-dependent stimulation.¹² In this paper we focus on the gall-inducing ability of leafhopper nymphs.

Using the same experimental techniques as mentioned in the previous study,¹³ we exposed a 7 day-old maize seedling (variety “3081”; at the third leaf stage) to zero (negative control), two, five or ten first instar nymphs, or five male adults (positive control) of C. bipunctata for eight days. Then we examined the galled leaf position and degrees of gall induction and growth stunting 8 days later. We evaluated the degree of gall induction by assigning a symptom score (0: no visible symptoms, 1: leaf veins partially thickened, 2: leaf tissues heavily swollen) and by measuring plant height to assess the degree of stunted growth.

Both nymphal and adult feedings induced galls on veins of the third leaves (Fig. 1). The degrees of gall induction and growth stunting gradually increased depending on the number of feeding nymphs. The degree of gall induction and

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growth stunting were not significantly different from the positive control when seedlings were exposed to five or more nymphs (Fig. 1). These results indicate that leafhopper nymphs have the ability to induce galls at a similar efficiency as adults. Gall-inducing ability of both adults and nymphs is a unique feature of *C. bipunctata*. These results also support the dose-dependent stimulation for gall induction of *C. bipunctata* and density (insects/plant).

**Figure 1.** Degrees of gall induction (upper) and growth stunting (lower) on maize by the feeding of adults and nymphs of *C. bipunctata*. The degree of gall induction was assessed by a symptom score (0: no visible symptoms, 1: leaf veins partially thickened, 2: leaf tissues heavily swollen). Vertical bar indicates the standard deviation. Different letters above the bars indicate significant differences among treatments (a–c: Steel-Dwass test, p = 0.05, x–z: Tukey HSD test, p = 0.05).

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