Response of Carduus nutans L. to infestation by Rhinocyllus conicus Froel. (Coleoptera: Curculionidae) and mechanical damage

by

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ABSTRACT

Rhinocyllus conicus does not normally destroy the entire thistle head; many heavily infested heads develop to maturity but with significant seed reduction. Terminal head seed reduction by larval feeding may be offset by a greater number of lateral heads being produced which could effectively increase the thistle's seed production. Response of *Carduus nutans* (musk thistle) to infestation by *R. conicus* was investigated by larval inoculation of thistle heads and compared with the effect of mechanical damage. Terminal heads subjected to both types of damage (up to 10 larvae or mechanical probes per head) were shown to produce fewer seeds than the control. Treated plants were shorter than untreated controls, but reduction in total seed production per plant was not significant. Weevil damage to terminal heads did not disrupt apical dominance. Weight of emergent adult weevils decreased with crowding; no difference was detected between sexes.

INTRODUCTION

Pruning a plant by complete removal of the apical meristem disrupts apical dominance and generally stimulates more productivity of the remaining above ground plant parts (Devlin 1969). When *R. conicus* larvae attack the terminal bud of musk thistles, the partial or complete destruction of the flowering head may not depict the actual level of damage. Complete destruction of the head occurs at a sufficiently high level of infestation. Total abortion of terminal heads destroys a potentially large number of seeds, but this may not be advantageous if apical dominance is disrupted. Although *R. conicus* does not normally destroy the entire thistle head, many of the heavily infested heads that develop to maturity do not produce a normal complement of seeds. This suggests that plant reserves directed to these heads are not efficiently utilized. The extent of host debilitation by weevil infestation and allocation of plant reserves have not been previously examined. Musk thistle response to *R. conicus* infestation was therefore investigated by larval inoculation of thistle heads and compared with the effect of mechanical damage.

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METHODS AND MATERIALS

During the winter of 1975, 150 field-collected musk thistle rosettes (ca. 25 cm diameter) were placed in 15 cm pots on a well-drained greenhouse bench maintained at 21±2°C. This had the effect of vernalization and resulted in flowering. Treatments were imposed when the terminal bud of each plant began to produce colored phyllaries. Infestation was obtained by permitting the overwintered weevils, collected from the field the previous summer, to oviposit directly on the flower bracts of caged plants. Levels of weevil infestation were determined by counting the holes and mines produced by the larvae entering the bracts. Mechanical damage was performed by forcing round wooden toothpicks directly into the receptacle of the thistle head 7 days after weevil attack. The probes were initially imbedded 6 mm within the receptacle; these were increased an additional 6 mm 7 days later. Treatments were: a damage free control; inoculation of 1, 4, 7 and 10 larvae per head, and mechanical damage using 1, 4, 7, and 10 probes (toothpicks); and 1 treatment in which the terminal head was excised. This was replicated 10 times. Each thistle head was enclosed in a cloth sack following senescence, and immediately following the natural death of the plants all heads were removed and dissected. The following observations were taken to assess thistle response to weevil and mechanical damage: total stem length; total heads/plant; head sizes; seed production/head; seed production/plant; stem diameter 5 cm above ground, and no., sex, and weight of emergent adult weevils. In addition, visual observations were made of any morphological expression of thistle response to terminal head damage.

RESULTS AND DISCUSSION

The vernalized musk thistles began bolting (vertical stem growth) ca. 3 wk after being placed in the greenhouse and were ready for treatment 3 wk later. Thistle head development from bud to senescence required ca. 5 wk. Plant survival (94.7%) and successful bolting (85.2%) provided 121 plants for experimentation. A single larva (or probe) did not produce any visible effect on thistle heads, 4 or more caused obvious abortion of some phyllaries. The characteristic tufts of thistle heads produced by larval feeding (Surles 1972) was evident at all levels of weevil infestation but not for the mechanical probe treatments. Excision of terminal heads induced stem elongation of the first lateral heads, projecting these heads beyond the height of the first lateral heads, projecting these heads beyond the height of the excised bud. However, there was no significant difference between stem length for plants with terminal heads excised and the other treated plants. Stems of the control plants were significantly taller ($P<0.05$) than those of all the treated plants, indicating that damage to the terminal buds, mechanical or weevil-induced, resulted in plant height reduction (Table 1). There was no significant difference among treatments for average stem diameter (8.4mm) or average number of thistle heads produced (2.9), although plants which had their terminal heads excised produced fewest heads.

The proportion of successful larval development was very high; 178 adult weevils were produced (81 female, 85 male, 12 escaped) from 215 mines, representing 82.8% survival. Remains of the larger 2nd or 3rd instars were not recovered, indicating that larval mortality occurred primarily during the 1st instar. Since larval mortality did not differ significantly relative to the levels of infestation, an average musk thistle head of 21.5 mm average diameter can readily accommodate 10 *R. conicus* larvae. Weight of weevils was reduced by crowding (Table 2); but mean weight between sexes was not significantly different (female, 13.44mg; male, 13.83mg).

Terminal head seed production was significantly decreased ($P<0.05$) by both weevil and mechanical damage. Lowest levels of seed production also oc-

Table 1. Response of *Carduus nutans* to terminal head damage, mechanical or *Rhinocyllus conicus*-induced.

Treatment	Means[1]			
	Stem length (mm)	No. heads/ plant	Terminal head seed weight (mg)/mm diameter	Total seed weight (g) plant
Control	825.2 a	3.1 a	25.6 d	1.12 a
Larval feeding:				
1	711.0 b	2.9 a	28.5 d	1.20 a
4	736.0 b	3.0 a	28.6 d	1.06 a
7	634.1 b	3.3 a	16.2 bcd	1.06 a
10	757.2 b	3.4 a	11.2 ab	0.78 a
Mechanical damage:[2]				
1	721.8 b	2.8 a	22.4 bcd	1.06 a
4	749.6 b	2.4 a	17.1 bcd	0.64 a
7	690.0 b	3.0 a	24.6 bcd	1.28 a
10	567.8 b	2.7 a	12.4 abc	0.63 a
Terminal head removed	639.2 b	2.0 a	———	0.70 a

[1] Means of each column followed by the same letter do not differ significantly ($P<0.05$; Duncan's multiple range test).
[2] Mechanical damage caused by inserting round wooden toothpicks into thistle receptacle.

Table 2. Effect of crowding on the weight of newly emergent *Rhinocyllus conicus* adults.

Treatment	Mean weight (mg)[1]/weevil
1 weevil	15.56 a
4 weevils	14.08 ab
7 weevils	13.39 ab
10 weevils	13.12 b

[1] Means followed by the same letter do not differ significantly ($P<0.05$); Duncan's multiple range test.

curred at treatments with 10 larvae or 10 mechanical probes. Although this was also evident for total seed production/plant, the differences were not significant. Removal of the terminal head did not result in significantly more productive lateral heads. This is especially important because weevil attack often aborts terminal heads besides decreasing plant height and seed production of thistle populations (Kok and Surles 1975). The thistle plants subjected to moderately low levels of infestation under laboratory conditions apparently did not suffer substantial reduction in total head or seed production. Under field conditions, however, heavier weevil infestations are common on both terminal and secondary heads resulting in a greater impact on the thistles. Since the thistles do not respond by producing more seeds than normal, even low levels of larval feeding can have a debilitating effect by causing the plants to use energy reserves for wound-healing and subsequently develop non-productive flower heads.

REFERENCES

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FOOTNOTES

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