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EFFECT OF NATIVE APHID SPECIES ON THE DEVELOPMENT OF INVASIVE RAGWEED *AMBROSIA ARTEMISIIFOLIA* (L.) IN HUNGARY

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Basky Z. – Effect of native aphid species on the development of invasive ragweed *Ambrosia artemisiifolia* (L.) in Hungary.

The common ragweed, *Ambrosia artemisiifolia* (L.) is a widespread invasive weed species in Europe. In order to estimate the debilitating effect of native arthropods on the invasive ragweed, the effect of three indigenous aphid species on plant development and pollen production was studied. Common ragweed plants grown in a greenhouse were artificially infested with five apterous individuals of either *Aphis fabae* Scopoli, *Brachycaudus helichrysi* (Kaltenbach) or *Myzus persicae* (Sulzer) at the 4-leaf stage. Feeding by all three aphid species over a five week period significantly reduced plant height, the number of male inflorescences, the length of racemes, pollen emission and plant dry weight. *Brachycaudus helichrysi* produced the largest colonies, followed by *A. fabae* and *M. persicae*. In a field experiment, the growth rate of *A. fabae* on caged ragweed plants was similar to that in the greenhouse, but the final numbers of *B. helichrysi* and *M. persicae* after 30 days was ten and seven times lower respectively than under greenhouse conditions. On exposed field plants, *B. helichrysi* was significantly more abundant than the other two species. However, no aphid species affected the height or dry weight of either caged or exposed plants during a 30 day period. However, during longer exposure (83 and 112 days) the exposed plants suffered more from aphid feeding and this resulted in significant plant height and dry weight decrease regardless of the aphid species. However, statistical significance is not necessarily equivalent to biological significance. Naturally occurring aphids can enhance the ability of native vegetation to counter the weed but their effect is not strong enough on its own to drive down the number of this invasive species.

KEY WORDS: Ragweed, aphid damage, *Brachycaudis helichrysi*, *Aphis fabae*, *Myzus persicae*.

INTRODUCTION

Ragweed was introduced into Hungary in the early 1920's (LENGYEL, 1923) from the USA and Canada. Regular weed surveys since the 1950s detected the spread of the species in Hungary. In 1997 ragweed became the most dominant weed species (1st in ranking), covering 4.7% of the arable crop area (BÉRES, 2004). Recently, 5 million of the 6.5 million arable hectares of crop area in Hungary has become infested by ragweed, 750,000 ha of which is classified as heavily infested (TÓTH *et al.*, 2004). Each plant can produce billions of pollen grains and airborne pollen counts may reach 1000 grains/m³ (FEHÉR and JÁRAI-KOMLÓDI, 1996). The pollen is highly allergenic, and is prevalent during August and September (BÉRES *et al.*, 2002; TÖRÖK *et al.*, 2003). Ten percent of the human population in Hungary suffers from ragweed pollen allergy (TÓTH *et al.*, 2004).

The new invader found few natural enemies. Three aphid species with low dispersal ability came to our attention because *Brachycaudus helichrysi* (Kaltenbach) caused chlorotic spots and leaf distortion on infested plants (BASKY, personal observation). On rare occasions, *Aphis fabae* Scopoli formed dense colonies on ragweed stems. *Myzus persicae* (Sulzer) was found on the lower surface of fully expanded leaves. These occasional observations raised the question whether indigenous aphids were able to have an impact on the development and pollen production of ragweed in Hungary. The aim of our investigation was to characterise the effects of aphid feeding on ragweed development and pollen emission.

MATERIALS AND METHODS

INSECTS AND PLANTS

Colonies of *A. fabae*, *B. helichrysi* and *M. persicae* were established from individuals collected from common ragweed. Aphids were reared on ragweed seedlings in a greenhouse where temperatures ranged from 20-30°C during daytime and 15-20°C at night with a photoperiod of 14:10 (L:D). Supplemental lighting was provided by Tungram HgMI 1000W/D1 standard daylight metal halide lamps giving 7500-8000 lx. Potted plants with aphids were covered with a wire frame that supported a fine organdie mesh.

APHID DAMAGE AND POLLEN EMISSION

Five apterous individuals of either *A. fabae*, *B. helichrysi* or *M. persicae* were placed on each of 20 potted ragweed seedlings at the 4-leaf stage with 20 uninfected plants serving as controls. After aphid transfer, an organdie wire frame cage enclosed both infested and uninfected plants. Ten plastic trays accommodated the 80 pots of the experiment. Plants were kept moist by filling the plastic trays with water daily.

Both the height of plants and the length of flower spikes (racemes) were measured 20, 27 and 35 days after infestation. On each sampling date, airborne pollen counts were estimated using a Hirst-type pollen trap (HIRST, 1952). Plants were placed individually into a 45×50×45 cm chamber connected to the trap. The distance between the intake of the trap and the ragweed inflorescence was 17 cm. Air sampling was conducted for 5 minutes per plant and the chamber was vacuum-purged for 2 minutes

between each measurement. After the pollen measurements, all plants were harvested. Plants were then transferred to individual Berlese funnels and held for 5 days at 25-30°C to extract the aphids and dry the plants. The recovered aphids were counted under a stereo microscope and each plant was weighed to 0.1 g.

FIELD EXPERIMENT

Common ragweed emerged in the beginning of May. Two weeks later at the 4-leaf stage, 80 plants were selected and enclosed in cages. All other plants were removed from this caged area to leave a single ragweed plant in the middle. Using a fine brush, five apterous adult individuals of *A. fabae*, *B. helichrysi* or *M. persicae* were placed on the top of each ragweed plant. Twenty randomly selected cages were infested with each aphid species and 20 cages were left uninfested. In the uncaged treatments, 80 common ragweed plants at the 4-leaf stage were labelled, but surrounding plants were not removed. Twenty plants were then artificially infested with 5 apterous adults of either *A. fabae*, *B. helichrysi* or *M. persicae* and 20 plants were left uninfested as controls.

One month later, plant height was measured and plants were harvested and processed as described under "Aphid damage and pollen emission". Plant dry weight was measured and the aphids were counted.

STATISTICAL ANALYSIS

Data were analysed using the STATISTICA Program Package (STATSOFT, 2003). ANOVA was used to compare treatment effects within experiments and the Tukey HSD

test was used to separate means. Stepwise regression analysis was used to test the effect of aphid species as a categorical predictor of pollen emission by plants.

RESULTS AND DISCUSSION

APHID DAMAGE AND POLLEN EMISSION

Although plant height was not affected by any aphid species after 20 days ($F = 2.56$; $df = 376$; $P = 0.06$), it was significantly reduced at 27 and 35 days after infestation by all three aphid species ($F = 9.43$ and 13.69 respectively; $df = 3$ and 76 ; $P < 0.001$ in both cases; Fig. I, A). The number of male inflorescences was reduced after 35 days of aphid feeding ($F = 317.41$; $df = 3:76$; $P < 0.001$; Fig. I, B). Raceme length was reduced first by *A. fabae* (being significant at 27 days, $F = 3.30$; $df = 3:76$; $P < 0.02$), and after 35 days of feeding by all three aphid species ($F = 7.44$; $df = 3:76$; $P < 0.001$; Fig. I, C). After 35 days of infestation, pollen emission by aphid-infested plants was reduced by two thirds or more, regardless of the aphid species ($F = 5.90$; $df = 3:76$; $P < 0.001$; Fig. I, D) and plant dry weight was also reduced ($F = 11.73$ $df = 3:76$; $P < 0.001$; Fig. I, E). Plants infested with *B. helichrysi* bore more aphids after 35 days than did those with *A. fabae* or *M. persicae* ($F = 23.50$; $df = 3:76$; $P < 0.001$; Fig. I, F).

FIELD EXPERIMENT

Neither plant height ($F = 1.35$; $df = 3:76$; $P = 0.26$), nor dry weight ($F = 1.61$; $df = 3:76$; $P = 0.19$) was significantly affected by the artificial aphid infestation in the field

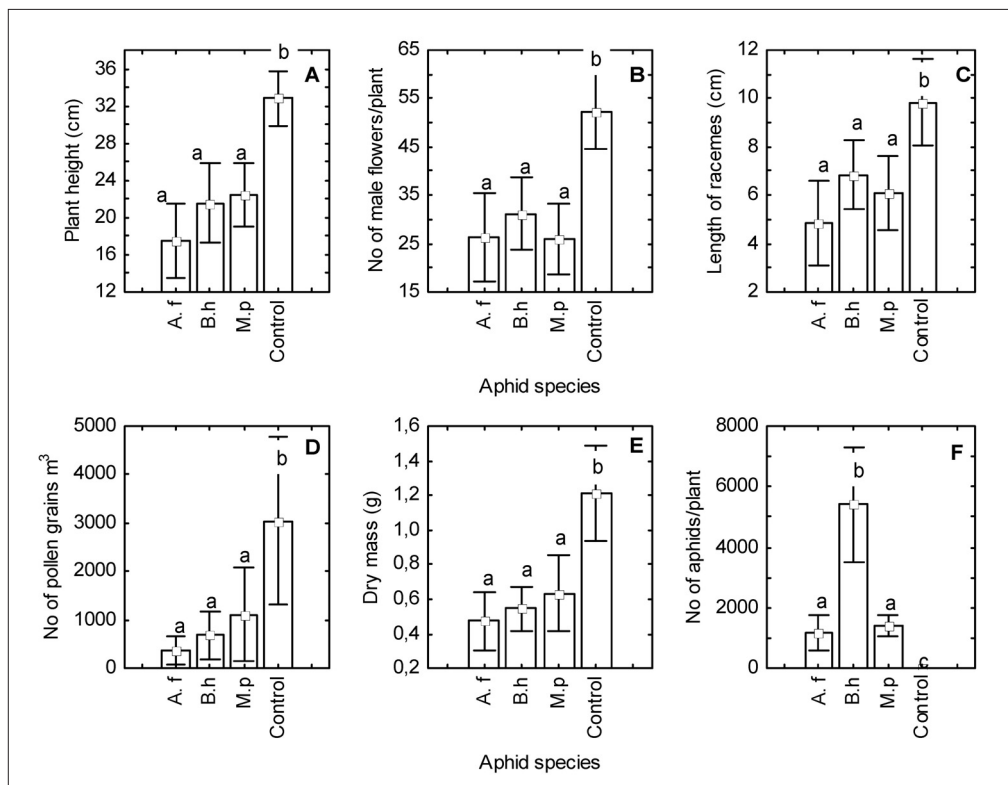


Fig. I – Mean [\pm 95% confidence interval ($P = 0.05$)] height of common ragweed plants (A), mean number of male flowers (B), mean length of racemes (C), mean number of pollen grains/m³ (D), mean dry mass of the plants (E) and mean final number of aphids (F) 35 days after infestation with either 5 *Aphis fabae* (A.f.), 5 *Brachycaudus helichrysi* (B.h.) or 5 *Myzus persicae* (M.p.). Columns bearing the same letter were not significantly different (Tukey HSD, $P < 0.05$).

cages. However, the final number of aphids varied according to species ($F = 17.49$; $df = 3:76$; $P < 0.001$), *A. fabae* achieving significantly higher aphid numbers in 30 days than either *B. helichrysi* or *M. persicae*. The latter two did not differ from each other.

On the uncaged plants, artificial aphid infestation did not significantly affect either plant height ($F = 1.27$; $df = 3:76$; $P = 0.29$) or dry mass ($F = 0.96$; $df = 3:76$; $P = 0.41$). However, artificial aphid infestation did affect the final numbers of *A. fabae* and *B. helichrysi* found on plants 30 days later ($F = 3.81$; $df = 3:76$; $P < 0.01$ and $F = 3.37$; $df = 3:76$; $P < 0.02$, respectively), but not the final number of *M. persicae* ($F = 2.07$; $df = 3:76$; $P = 0.21$). The mean number of *A. fabae* and *B. helichrysi* was 26 and 30, respectively, while that of *M. persicae* was 3.5 on the artificially infested exposed plants.

DISCUSSION

Five individuals of each aphid species proved to be a sufficient initial infestation rate to ensure colony establishment on common ragweed under greenhouse conditions. Aphid feeding reduced pollen production by retarding plant development, resulting in reduced plant weight. The larger the aphid colony, the more reduced was the pollen emission of plants.

Under field conditions the rainy, cool weather after emergence of the ragweed was favourable to plant development but adversely affected the growth rate of *B. helichrysi* and *M. persicae* populations [i.e. not the growth of individuals]. The reproduction of *B. helichrysi* and *M. persicae* was c. 10 times lower in the field cages than in the greenhouse. In spite of the cool weather, the performance of *A. fabae* in the field was similar to that in the greenhouse; very large colonies of *A. fabae* developed on the stems of the vigorously growing ragweed plants in the cages.

Since the cages excluded aphid natural enemies, it seems likely that only weather conditions affected the performance of the aphids. Under field conditions, plant development was more vigorous than in the greenhouse, resulting in increased plant height and dry weight; therefore, even at high density, aphids (*A. fabae*) were not able to retard plant development.

Aphis fabae is a species of temperate regions and is not present in the Mediterranean area (BLACKMAN and EASTOP, 1984). *Brachycaudus helichrysi* is a Palearctic species; it is widespread in the Mediterranean region where it is anholocyclic (BLACKMAN and EASTOP, 1984). This indicates that the temperature requirement of *B. helichrysi* is higher than that of *A. fabae*. The results of the field cage experiment support the assumption that the climatic requirement of *A. fabae* was better fulfilled during late spring under our field conditions than that of *B. helichrysi*.

Under exposed conditions, nothing prevented alate aphids from settling on any plant. *Brachycaudus helichrysi* often colonised ragweed plants infested with other aphids; no such additional colonisation occurred in the case of *A. fabae* and *M. persicae*. *Brachycaudus helichrysi* became the most abundant species (both on the infested and uninfested exposed plants) followed by *A. fabae* and *M. persicae*. There is no direct competition between the aphid species for feeding sites as *B. helichrysi* feeds in the youngest growing axillary shoots of the plants, *A. fabae* feeds on the stems, and *M. persicae* feeds mainly on the

lower surfaces of fully expanded leaves. However, even though aphids do not feed at the same sites on the plant, they may still interact with one another via induced changes in plant physiology (QURESHI and MICHAUD, 2005). Therefore, it is possible that systemic alterations of phloem contents by *B. helichrysi* deterred other species from settling or establishing on *B. helichrysi* infested plants.

In a later field study (BASKY, 2007), when artificially infested caged and uncaged ragweed plants were exposed to aphids and natural enemies for a longer period (2-3 months), the height and the dry weight of the plants was significantly decreased due to feeding damage by *A. fabae* and *B. helichrysi* regardless of the level of caging.

However, statistical significance is not necessarily equivalent to biological significance. We can conclude that naturally occurring aphids can enhance the ability of native vegetation to counter the weed but their effect is not strong enough on its own to drive down the number of this invasive species.

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