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ORIGINAL ARTICLE

# The effect of mowing date on the development of common ragweed (*Ambrosia artemisiifolia* L.)

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***Abstract*** - Common ragweed (*Ambrosia artemisiifolia* L.) is native to North America; it was introduced into Europe by contaminated agricultural goods from the end of the 19th century. Since then due to its excellent ecological adaptability it has invaded whole Europe. Common ragweed is not only a noxious weed causing yield losses in agricultural crops; it invades disturbed urban areas and its highly allergenic pollen induces allergic rhinitis to sensitive people. In urban areas mowing is the most widely used mean of ragweed control.

Plants were mowed early (12 June) at BBCH 33 (3 visibly extended internode), late mowed plots were cut off on (25 July) .inflorescence visible BBCH 51 Mowing twice happened on 12 June and 25 July. At mean plant density of 91 plant/m$^2$ number of female flowers was 150/plant on an average, while that of the male inflorescences were 1676. Mowing treatments significantly decreased the above ground fresh biomass and plant height compared to the none-mowed control. The early mowing treatment did not decrease significantly the number of female flowers. Twice mowed and late mowed treatments significantly decreased the number of female flowers, that of the male inflorescences. Further studies are required to improve seed production decreasing effect of mowing treatments.

***Keywords*** - *Ambrosia artemisiifolia,* mowing, seed, male inflorescence production

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## Introduction

Common ragweed (*Ambrosia artemisiifolia* L.) is native to North-America; ragweed pollen was detected in more than 60.000 year-old interglacial deposits in Canada (Bassett and Crompton 1975). The massive spread of ragweed in different parts of the world coincided with major socio-economic transitions that increased the area of disturbed land. In the 18th and 19th centuries in Canada, the settlement of European immigrants led to increased agricultural activity, large scale deforestation and soil disturbance resulting in an increased quantity of ragweed pollen in the region (Bassett and Crompton 1975).

In Europe the first records of common ragweed are from Brandenburg, Germany, 1863 (Hegi 1995) and from

**Table 1 The effect of mowing on the fresh above ground biomass, plant height, number of female flowers, male inflorescences, and percent reduction in ragweed plants at Julianna major, Budapest, 2010.**

| Treatment | Valid No | Mean± S.E. | Minimum | Maximum | % reduction |
|---|---|---|---|---|---|
| | | Above ground biomass (g) | | | |
| None mowed | 220 | 28.33±1.37 a | 5.10 | 148.10 | n/a |
| Early mowing | 220 | 18.41±0.90 b | 1.10 | 78.20 | 35.02 |
| Twice mown | 220 | 7.47±0.38 c | 2.00 | 30.00 | 73.64 |
| Late mowing | 220 | 5.52±0.34 c | 1.00 | 33.10 | 80.52 |
| | | Plant height (cm) | | | |
| None mowed | 220 | 89.60±1.13 a | 53.00 | 163 | n/a |
| Early mowing | 220 | 81.36±1.10 b | 21.50 | 122 | 9.20 |
| Twice mown | 220 | 31.84±0.67 c | 12.00 | 53 | 64.47 |
| Late mowing | 220 | 27.45±0.68 d | 12.00 | 50 | 69.36 |
| | | Number of female flowers | | | |
| None mowed | 220 | 150.76±12.90 a | 0 | 1152 | n/a |
| Early mowing | 220 | 115.70±10.34 ab | 0 | 969 | 23.26 |
| Twice mown | 220 | 76.22±6.78 b | 0 | 535 | 49.45 |
| Late mowing | 220 | 65.01±5.90 bc | 0 | 358 | 56.88 |
| | | Number of male inflorescences | | | |
| None mowed | 220 | 1676.72±121.80 a | 0 | 18500 | n/a |
| Early mowing | 220 | 1075.93±68.65 b | 0 | 6492 | 35.84 |
| Twice mown | 220 | 228.41±19.67 c | 0 | 1319 | 86.38 |
| Late mowing | 220 | 161.36±16.64 c | 0 | 1594 | 90.38 |

Treatments with different letters are significantly different Tukey HDS test $P<0.05$

France, 1863 [4] (Chauvel et al. 2006). Studying the herbarium specimens Chauvel and coworkers proved that the American troops during the First World War have contributed its spread (Csontos et al. 2010).

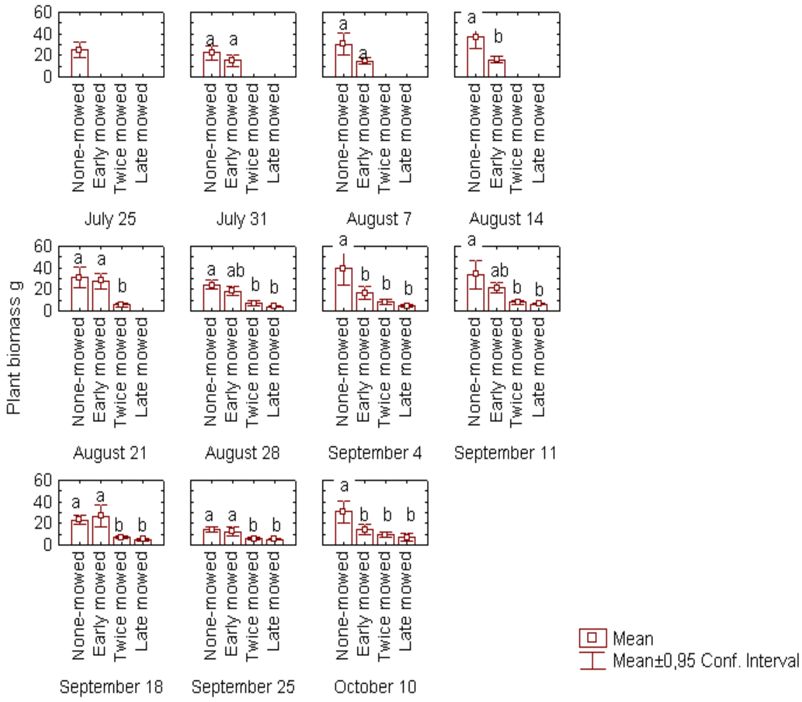


**Figure 1.** The effect of mowing on the above ground fresh biomass of the ragweed plants. Treatments with different letters are significantly different Tukey HDS test $P$<0.05

the key factor of introduction of common ragweed to France was anthropogenic (Chauvel et al. 2006). The commercial trade between America and Europe and the transportation of food products and war equipments by

Common ragweed was first recorded in Hungary in 1908, and it was reintroduced again in the early 1920's from the USA and Canada. Regular weed surveys since the 1950-ies detect the extension of the species in

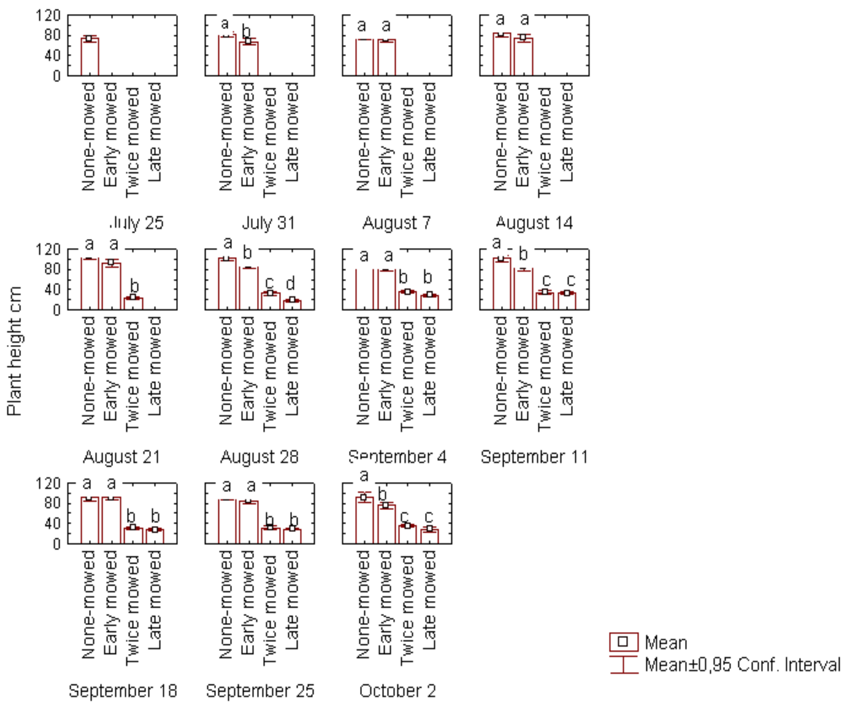


**Figure 2.** The effect of mowing on the plant height of the ragweed plants. Treatments with different letters are significantly different Tukey HDS test $P$<0.05

Hungary. The proportion of the agricultural area covered by ragweed in 1950 was 0.39 %, at that time ragweed was the 21st most frequent weed by area. Strong socio-economic transitions occurred in Hungary after the Second World War at the end of 1950-ies when private farms of different size were forced to unite in socialist cooperatives and state farms. Because of the lack of capital agricultural machineries were not available at the newly organized big farms, which led to improper soil cultivation contributing to the establishment of the ragweed. From the beginning of the 1960-ies the occurrence of combine-harvesters resulted in further extensive spread of ragweed seeds between fields. Under these circumstances in 20 years ragweed became the 8th most frequent weed species in Hungary. During the 30-40 years history of the cooperatives and the state farms they became prosperous; the infrastructure was built up and highly educated expert specialists lead the agricultural production in Hungary. From the beginning of the 1990-ies under the formation of the young democracies the lands of the big state farms and cooperatives were divided and redistributed to the former owners or descendants. The new owners neither have the skill nor the capital to buy equipments necessary for proper cultivation. At the same time construction of new roads, motorways, shopping centers etc. created large disturbed areas where ragweed easily became established. These circumstances resulted in further spread of ragweed in Hungary. The National Weed Survey in 2007-2008 revealed the presence of ragweed on 5.3 % of the arable crop area (Csontos et al. 2010). During the last 20 years common ragweed spread all over Europe. It was reported from Lithuania, Russia, Ukraine, Poland, Germany, Austria, Czech Republic, Slovakia, Croatia, Slovenia, Serbia, Switzerland, Italy, Asia and Australia (Bohren 2011). In Europe the Carpathian Basin, the Rhone Valley and the Po Valley are the most heavily infested regions (Csontos et al. 2010).

Recently, a prediction on the future potential for range expansion of *A. artemisiifolia* under climate change scenarios was published. The prediction used a process-based model of weed growth, competition and population dynamics, and indicated a possible northward shift in the available climatic niche for *A. artemisiifolia*, while the southern European limit for *A.artemisiifolia* was not expected to change (Storkey et al. 2014).

One third of the Hungarian population suffers from allergy, two thirds of them have pollen sensitivity and at least 60 % of this pollen sensitivity is caused by *A. artemisiifolia*, 50-70 % of the allergic people are sensitive to ragweed pollen. *Ambrosia artemisiifolia* is the main aero allergenic plant in Hungary as about the half of the total pollen production 35.9-66.9 % is made up by its pollen (Makra et al. 2005).

The main purpose of *Ambrosia* control is to reduce the production of allergenic pollen and seed (Bohren 2011). Different means of control can be applied in waste lands, and natural conservation areas, agricultural fields, along the roads and ditches and human impacted disturbed areas in towns. Mowing is a widely used

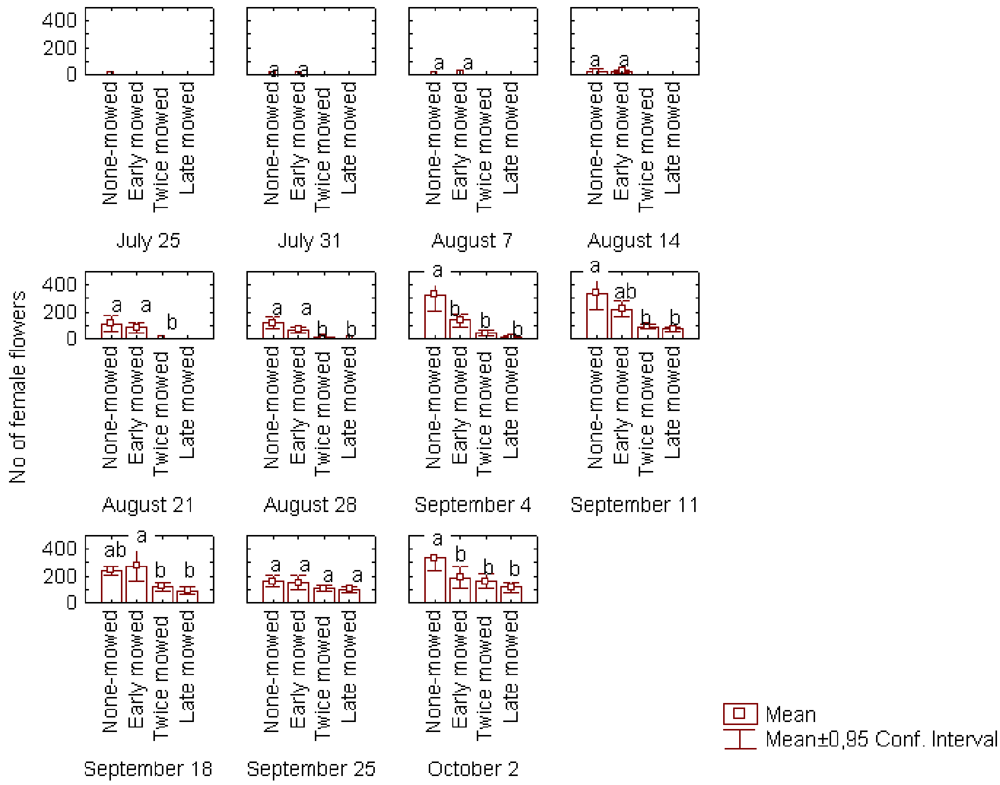


**Figure 3.** The effect of mowing on the number of female flowers of the ragweed plants. Treatments with different letters are significantly different Tukey HDS test $P<0.05$

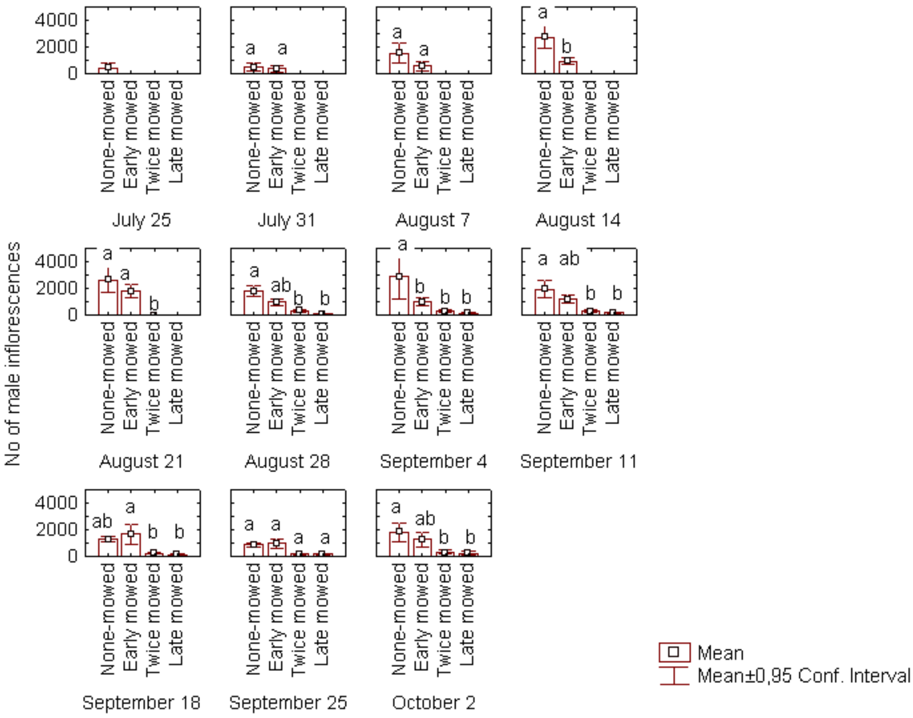


**Figure 4.** The effect of mowing on the number of male inflorescences of the ragweed plants. Treatments with different letters are significantly different Tukey HDS test $P<0.05$

mechanical method to control *Ambrosia* where application of herbicides is not desired (Bohren 2011).

The aim of this study was to evaluate the effect of early and late mowing and repeated mowing on biomass, pollen and seed production of common ragweed plants.

## Materials and methods

The ragweed mowing experiment was carried out in the experimental field of the Plant Protection Institute of the Hungarian Academy of Sciences, Nagykovácsi (47º 32' N, 18º 56' E) near Budapest. The experimental area has been abandoned for three years; the only disturbance being the autumn ploughing in October 2009, and the seed bed preparation on 18 April 2010. Secondary tillage was carried out with a harrow and a cultivator. After the emergence of ragweed plants, 20 plots (10m x 10m each, separated by 1m bare land) were established on 5 May 2010. The strips were kept weed free by regular cultivator treatments. Ragweed plant density was measured on 10 randomly selected 1 $m^2$ areas in the experimental field.

Plots were randomly allocated to one of three treatments and the non-treated control. Experimental treatments included – none mowed control, early mowing ( 3 visible extended internode BBCH 33 (Hess et al. 1997), on 12 June), late mowing at growth stage visible inflorescence BBCH 51 (25 July) and mowing twice treatment plants were mowed on both occasions. Mowing was done by a hand-held mowing machine (Husqvarna, 128 R) that cut plants at 5-7 cm above ground. Each treatment was replicated four times. From 25 July until 3 October 2011, 5 randomly selected plants were cut off weekly at the soil surface level from each plot (20 plants/treatment), transferred into the laboratory, where the above ground fresh biomass (with precision of 0.1g) and the plant height (cm, precision 1 mm) were measured, the male inflorescences and the female flowers counted.

## Results

### Intact control plants

Based on the plant count on 10 by 1 $m^2$ plot the mean ragweed density of the experimental area was 91 plant/$m^2$. The mean above ground fresh biomass and height of the non-mowed intact plants for the season was 28.33 g and 89.60 cm, respectively. The mean number of female flowers and male inflorescences of the non-mowed intact plants was 150.76 and 1676.72 respectively (Table 1). There was a large variation between minimum and maximum values of the number of female flowers and male inflorescences. The plant weight and plant height did not have such extreme values (Table 1).

### Above ground fresh biomass and plant height

Mowing treatments based on the whole season samples resulted in significant fresh biomass and plant height reduction compared to the none-mowed control (Table 1). The tendency was similar when the data of the sampling dates were separately evaluated except for the early mowed treatment (Figs. 1-2). The twice mowed and the late mowed treatments significantly reduced both the fresh biomass and the plant height compared to the none-mowed control (Table 1). When the data of sampling dates were separately evaluated significant fresh plant biomass and plant height reduction occurred at each sampling date due to the twice mowed and the late mowed treatments (Figs. 1-2).

### Female flowers and male inflorescences

Early mowing did not reduce significantly the number of female flowers compared to the intact none-mowed control plants for the whole season (Table 1). When data were evaluated by sampling dates in 8 sampling dates out of 10 no significant reduction occurred in the number of female flowers due to early mowed treatment compared to the intact control plants (Fig. 3).

The number of male inflorescences significantly decreased due to early mowing compared to intact none-mowed plants for the whole season (Table 1). In spite of the significant reduction for the whole season, the evaluation by sampling dates showed significant differences on 14 August and 11 September only (Fig. 4).

Mowing twice and late mowing treatments resulted in significant female flower and male inflorescence reduction for the whole season compared to intact none-mowed control plants (Table 1). When data were evaluated by sampling dates number of female flowers and that of the male inflorescences were significantly decreased by mowing twice and late mowing compared to none-mowed intact plants from the sampling on 21 August till the end of the season (Figs. 3-4).

## Discussion

Plants in the vegetative stage are growing quickly, producing stems, roots and leaves. From the end of May till the middle of July the growth of ragweed plants is very intensive, when the formation of flower buds starts (LIT). In the generative stage the plant's energy is directed into the production of flowers and seeds. However, in case of ragweed after occurrence of the flower buds the growth of the plant continues (Deen, Swanton, and Anthony Hunt 2001). When flowering is the most intensive, in the middle of August, the growth of the plants slows down (Leiblein and Lösch 2011).

Early mowing on 12 June affected the vigorously growing plants in the vegetative phase. Cutting the plants did not reduce regenerative ability, but enhanced ramification and delayed the initiation of flowering. Removing the stem apex in the vegetative phase resulted in 3-5 vigorous side shoot development. Mowing reduced the plant size above ground level, however, the below ground root system remained intact; containing the resources accumulated all over the growing season (Paquin and Aarssen 2004). The height of the vigorously growing side shoots almost reached that of the main shoots of the intact plants six weeks later. Early mowing significantly reduced the vegetative biomass of the plants; however, it did not result in significant reduction of the female flowers and male inflorescences.

The late mowing on 25 July was carried out when the majority of the generative parts, the male inflorescences and the female flowers developed. By this time the majority of the resources accumulated all over the season in the root system allocated into the shoots and supported the development of the generative organs of the common ragweed. Cutting the shoots on 25 July resulted in significant reduction in plant weight, plant height, and number of female flowers and male inflorescences compared to the intact plants. The percent reduction of female flowers and male inflorescences compared to intact control plants was 56 and 90 %, respectively.

On the twice mowed plots the first mowing happened on 12 June and the second one on 25 July. The first mowing reduced the above ground plant size of the vigorously growing plants, while by the time of the second mowing on the newly developed shoots, the female flowers and the male inflorescences developed, which were cut the second time six weeks later. The twice mowed treatment reduced more efficiently the number of male inflorescences than that of the female flowers. However, the reduction of the biomass, the number of female flowers and that of the male inflorescences did not differ significantly from those of late mowed treatment. More heavy damage caused by twice mowed treatment did not result in higher vegetative biomass and generative biomass reduction on common ragweed plants. It is in agreement with the results of (MacKay and Kotanen 2008), where the more heavily damaged plants by herbivores were not smaller or less fecund. Ragweed is highly tolerant to defoliation, so it can survive in mowed lands and roadsides (MacDonald and Kotanen 2010). In the same experiment the high level of tolerance of *A. artemisiifolia* to leaf and apical meristem damage was proven. The authors found evidence that plastic allocation of biomass buffers reproduction against any negative effect of leaf damage. In their experiment the more heavily damaged plants produced more seeds than expected. We also observed that the twice mowed plants responded to severe defoliation by diverting from further shoot growth to female flower production. From mid August in the generative stage the ramification of racemes was the manifestation of the growth of the mowed ragweed plants. We observed unusual occurrence of female flowers on the racemes between the male inflorescences.

## Conclusions

Although early mowing in the beginning of June significantly decreased the above ground biomass and number of male inflorescences, it did not influence significantly the number of female flowers. However, a single late mowing before the end of July significantly decreased the above ground biomass and numbers of female flowers and male inflorescences. Decreasing number of female flowers has great importance to deplete the seed bank of the soil. Based on the results of the present study and literature data it can be supposed that seed decreasing efficiency of mowing treatments could be improved by proper timing of two mowing treatments: 1) mowing in the last week of July and 2) mowing after the middle of August.

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