Control of common ragweed by mowing and hoeing

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Introduction

Common ragweed (*Ambrosia artemisiifolia* L.) is an annual species that depends on regular seed production for population persistence. By producing dormant soil seed banks (Basset and Crompton 1973, Toole and Brown 1946) this weed may overcome seasons with failure of seed production. Consequently, the only sustainable way to control common ragweed is preventing seed production (Bohren et al. 2008c, Karrer et al. 2011). Several actions and cutting experiments focus on the reduction of pollen produced by male inflorescences of ragweed (Benoit 2003). Only few aim at estimating both male and female flower regeneration (Bohren et al. 2008a, Milakovic et al. 2014b). Karrer et al. (2011) claim to focus more on control options that minimise seed production on regenerated shoots.

This overview on effects of mowing and hoeing is mainly based on a literature review and some provisional findings of the HALT experiments

Papers considering mowing as a control measure can be grouped according to their designs by explanatory factors:

A-simple designs:

cutting height,

cutting dates (timing),

cutting frequency,

+/- competition

B-mixed designs:

plant density *and* frequency,

timing *and* frequency,

height *and* frequency,

herbicide application *and* cutting,

competition *and* frequency

C-complex designs:

plant density *and* timing *and* frequency,

plant density *and* timing *and* frequency *and* competition

plant density *and* timing *and* frequency *and* competition *and* region

frequency *and* timing *and* herbicide application

Response variables were: simple resprouting, flowering of resprouts, number of male racemes on resprouts, biomass of shoots (uncut and/or resprouts), female flowers of shoots (uncut and/or resprouts), phenology of shoots/flowers (uncut and/or on resprouts), seed number of resprouts and seed viability of resprouts.

Experiments were either done under controlled conditions in the greenhouse (pots) or in the field differing in habitat type. Some experiments were performed in variable crops, others on roadsides (road shoulders).

Regeneration after cutting:

Regeneration after cut is well documented for common ragweed (Basset and Crompton 1975, Barbour and Meade 1981, Bohren et al. 2005, 2008a, Karrer et al. 2011, Tokarska-Guzik et al. 2011, Meiss et al. 2008). Generally the intensity of resprouting by lateral shoots is not limited throughout the year. Even from axils where their lateral shoots have already finished growth (spontaneously or after being cut), accessory buds can be developed prolonging the seasonal growth period (Karrer 2007, Karrer et al. 2011). Gebben (1965) found that the development of lateral shoots tend to be more intense at lower densities of *A. artemisiifolia* stands compared to crowded stands. Such can be interpreted as self-thinning process (Londsdale 1990) or suppression of lateral branches by shading neighbours of identical growth architecture (cohorts). Basset and Crompton (1975) report vegetative regrowth of plants by 80 % one week after they were cut at 5 cm (slightly above the cotyledons) end of May. They observed also 100 % ragweed regrowth 10 days after grain harvest with cutting height of 20 cm. Tokarska-Guzik et al. (2011) found 50% regeneration of ragweed individuals that were cut once in early developmental stages (max. 12 cm high) just above the cotyledonary node, both treatments that were cut above the first foliar leaf pair as well as those cut above the second foliar leave showed 100% resprouting. Meiss (2010) and Meiss et al. (2008) clipped solitary individuals at 5 cm height every month. This resulted in seven clipping dates and a significant reduction of total biomass by 40% – compared to the intact control. When added dense luzerne populations as competitors the reduction total ragweed biomass was near to 100%.

No significant effect on the allocation of reproduction (fecundity) were found after removing the apical meristem only (MacDonald and Kotanen 2010).

It is known that *A. artemisiifolia* can germinate in Europe throughout the whole vegetation period (end of March to October; Karrer et al. 2011, Kazinczi et al. 2008a). During the early season growth in height is low (Gebben 1965, Klein 2011) producing several short internodes with a dozen of foliar leaves (Karrer et al. 2011). But starting from mid of June rapid upright growth by elongating the youngest internodes und all newly developed internodes is regular under full light conditions (Klein 2011, Karrer et al. 2011). Seedling cohorts that start later in the year (May to August) generally produce less basal internodes, all of them elongated for rapid flowering. Growth in height stops at about mid of September (Kazinczi et al. 2008a, Klein 2011, Gebben 1965). Up to this date height increment of early cut specimens can be compensated by elongated lateral shoots (branches of first order) (Simard and Benoit 2011, Karrer 2012, unpublished). A comparison between mown and intact plants showed no significant differences with respect to the biomass produced all over the season, anyway if they were cut early or late (Simard and Benoit 2011).

Patraccini et al. (2011) documented that the survival rate (resprouting after cut) was generally very high: plants cut two or three times showed resprouting rates between 75 and 100%. Plants that were cut at plant height 80 cm survived by 100%, the 50 cm cut height gave also 100% and the 20 cm plants about 70% survivers. The latter were cut more often (3-4 times) as they reached the cutline earlier. Clipping even in the 4 times version resulted only in a death rate of 25 to 33%. In all clipping experiments by Milakovic (summarised in Karrer et al. 2011, Milakovic et al. 2014a and 2014b) death rates of uncut and cut plants was very low (0-5%) throughout spring and summer. Only starting from mid of September mortality increased successively until October.

Beres (2004) and Kazinczi et al. (2008b) also reported a strong allocation to shoots after early cut (in May or June) finally compensating totally the biomass loss. A later cut (in July or August) resulted in a significant decrease of total biomass.

Considering its summer annual life cycle, *A. artemisiifolia* turned out to be very vital by compensating efficiently biomass loss from cutting. However, cutting per se cannot control common ragweed.

Regeneration of male flowers after cutting:

Aiming at the reduction of ragweed pollen load in the air (Buttenschøn et al. 2010, Bohren et al. 2005, Delabays et al. 2005, Karrer et al. 2011), blooming of male flowers must be prevented. Of course cutting is an option as the male racemes are produced generally at the top of the main shoot as well as on the lateral shoots (Bassett and Crompton, 1975). Several experiments focussed on this response variable rather than on seed production.

The clipping experiment by Patracchini et al. (2011) resulted in a partial biomass reduction of the surviving plants but did not prevent flowering. In the high-stress treatment (4 times clipping at 20 cm), more than 67% of the plants survived to the last clipping and, among these, more than 97% flowered. Moreover, plants that reached 80 cm height and experienced 2 cuts survived at rates between 50 to 100%, and 100% of the survivors flowered. Flower initiation on regenerative lateral shoots happens quite quickly. Plants that were cut directly above the cotyledons failed to produce buds of male inflorescences after 2 weeks after the cutting date, but plants cut above the first or second foliar leaf pair showed already 60-80% and 80-90 %, respectively (Tokarska-Guzik et al. 2011). Such quick recovery from being cut was also demonstrated by Beres (2004), Bohren et al. (2008a), Delabays et al. (2008a), Simard and Benoit (2011), Karrer et al. (2011), Karrer and Milakovic (2011) and, Bassett and Crompton (1975).

Beres (2004) and Kazinczi et al. (2008b) found a significant reduction of male flowers by 87 % when ragweed was cut only once mid of July or even by 90 % for plants cut three times. Milakovic et al. (2014a) found in a glasshouse experiment 8 times smaller inflorescences numbers in early September in plants cut mid-August (at the beginning of male flowering), compared to the uncut control.

Simard and Benoit (2011) found that mowed plants produced generally less pollen per unit inflorescence length and increasing plant density also reduces pollen production per inflorescence unit. In total, plants cut 2 times produced 6 times less pollen than intact plants. Mowing high density plants show 3-5 times reduced lenghts of male inflorescences compared to intact single plants (low density). In general, the anthesis was delayed by mowing by 17 days, whereas higher densities had no effect (Simard and Benoit, 2011). They summarized that the total pollen production was reduced by 88.7 % when plants were mown twice (May and July). This fact, together with the experiments by Klein (2011) illustrates well that the compensatory growth of lateral shoots tends to allocate biomass to shoots primarily and less to pollen production i.e. when cut early in the year. When cut, later in the year (late July to September), they tend to allocate biomass rather to lateral shoots that bear female flowers at their lower nodes (Bohren et al. 2008a, Klein 2011, Karrer et al. 2011). Allocation of biomass to male inflorescences seems to be typical for uncut individuals in the early phase of stem elongation and initiation of inflorescences. But it makes sense that the plants allocate resources from pollen production towards the production of female flowers (ripening seeds) in late summer and autumn as the air is already overloaded with viable pollen at that time (Jäger 2000).

Production of female flowers and seeds, seed viability:

Sustainable control measures against ragweed must focus on preventing seed production (Bohren et al. 2005). Yet, only in very few experiments this response variable was measured when testing different cutting treatments.

As there is a preference of ragweed to produce female flowers in the middle and lower part of the plant (Gebben 1965) cutting near the base never can really prevent seed production by 100 %. Traditional cutting height used to manage the road shoulders rarely goes below 5 cm. On the other hand we know that common ragweed tends to germinate directly along the roadside rather early not facing tall competitors (Joly et al. 2011, Simard and Benoit 2010). In such habitats the early development of the plant is rather free from competition but not optimal with reference to relative growth ability. Those plants show short internodes at the base of their shoots and therefore several buds remain below the cutting height that are able to develop regenerative shoots. Milakovic et al. (2014a) found that early cuts (until mid of July) will not reduce total seed number, probably because the resprouts overcompensate the biomass losses from cutting and produce many axillary shoots with female flowers. In this glasshouse experiment, total seed numbers per plant were reduced by ca. 2-4 times compared to the control in cutting regimes with a late first cut mid-August. Field experiments by Milakovic et al. (2014b) showed as well that a cut in August is essential: 3-5 times smaller total numbers of seeds per plant were found in plants cut in August, compared to the uncut control.

Simard and Benoit (2011) reported that number and mean seed mass decreased 3-4 times with increasing plant density and by mowing. Mown plant seeds were 0.65 times less viable, whereas seeds from high density plants did not differ in this respect to single plants. Thus allocation to seed biomass (weight and number of seeds) was only reduced by mowing not by higher densities.

If cut once a year the timing is rather important. Bohren et al. (2005) and Delabays et al. (2005) argued that one cut only in the first half of September yielded no viable seeds on the few resprouts. In more detailed experiments from 2005 to 2007, Bohren et al. (2008a) had to revise some advices given that the year-to-year variation in the ripening dates of seeds showed the possibility that in years with optimal climatic conditions ragweed already can produce viable seeds in late August. Consequently, the first cut should be set not later than August 20th. But this enabled the resprouts to produce viable seeds between August and October.

All mowing treatments in Bohren et al. (2008a) resulted in a decrease of the total number of seeds and their viability. When cut early (i.e. in June) ragweed regenerated seeds with only 50 % viability compared to intact plants. Seed viability decreased to 30 % for shoots that developed from later cutting dates.

Vincent and Ahmim (1978) and Vincent et al. (1992) showed that seed production was significantly reduced only at very low cutting heights of 2 cm which is not realistic in the field.

Integrated treatments:

On crop fields production techniques contribute to the reduction of weeds like common ragweed: crop rotation, mowing, mulching, hoeing, harrowing and tilling systems are applied. Hoeing is only applied in specific crops mostly at early stages of development (Verschwele in the HALTAMBROSIA-project, Buttenschøn et al. 2010). Karrer et al. (2011) promote hoeing for ragweed control in oil pumpkin fields. Common ragweed is said to be easily controlled by rotary hoeing when less than 1/4” (MSU, weed science; http://www.msuweeds.com/worst-weeds/common-ragweed/).

Mechanical plus chemical treatments are generally used in crop fields; several treatments were tested in the EUPHRESCO-project (Holst 2009). Hoeing once induced the highest values for ragweed biomass produced, whereas hoeing two times did some harm. The effect of biomass loss by this treatment was about the same as herbicide application followed by hoeing. But the most effective combination was applying herbicide and afterwards hoeing. If herbicides are used as combined treatments it is most effective to use herbicide in early developmental stages followed by mechanical measures. The same was found in the U.S. (Donald 2000) for weeds in soybean where herbicides were combined with mowing. Two times mowing after herbicide treatment worked well in reducing weeds like common ragweed to a tolerable very low level.

Bohren et al. (2008b, 2008c) combined serial cuts and subsequent herbicide treatments of common ragweed. The treatment with Florasulam 10 weeks after cut on 19th of June gave high efficacy by low seed numbers and seed viability between 0.5 to 2.5 %. Other cutting/herbicide combinations gave less valuable or insufficient success.

Experiences by Kazinczi et al. (2008b), Delabays et al. (2005) and Bohren et al. (2005) indicate also that hoeing alone (i.e., if not performed intensively enough) showed poor control efficacy. Nevertheless soil disturbance by hoeing can promote further emergence of ragweed seeds.

Competition by desirable plants (crops, lawn) acting against weeds and ragweed i.e. is documented to work well (Kazinczi et al. 2008b, Holst 2009). Using competing plants against ragweed combined with mowing showed high efficacy in reducing or totally deleting all ragweed individuals in different trials. Meiss et al. (2008) and Meiss (2010) documented that ragweed grown together with high densities of Lucerne and cut 7 times was outcompeted by 100 % after few cutting dates. The same holds for the competition experiment with ragweed grown at different densities together with 3 different restoration seed mixtures by Milakovic et Karrer (2010) and (2011)) (see also Karrer et al., 2011). Almost all ragweed plants died during the first half of the experiments, obviously caused by the additive effect of damage due to cut and competition. In the glasshouse experiment conducted by Milanova et al. (2010), *Lolium perenne* and *Dactylis glomerata* showed to be successful in outcompeting common ragweed when whole turfs were planted: number of emerged common ragweed plants was decreased by 40% and 36%, respectively. The fresh biomass per pot was best reduced by *Lolium perenne* planted as whole turf or sown (96% and 97%, respectively). In this experiment Lucerne showed also an inhibitory effect on the growth of common ragweed, reducing its fresh biomass per pot by 91%.

The growth type of the competing plants must be optimally adapted to the intensive cutting regime. Therefore the seed mixtures used for the experiments consisted of 20 to 40 % *Lolium perenne* which is well adapted to frequent cuts by intensive basal tillering. This grass develops a dense lawn near the soil surface and regenerates within few days thus shading the resprouts of ragweed from its basal nodes. The very few resprouts that recovered could not produce a reliable number of seeds.

Conclusions

Control options against common ragweed comprise of herbicide applications and several non-chemical measures, both summarized by Buttenschøn et al. (2010). Hand pulling is generally the cheapest and most efficient control option against small populations (less than 100 individuals).

Fumanal et al. (2007) made clear that pollen and seed production was closely related to plant volume and biomass, thus providing a means of estimating potential pollen and seed production in given target areas. Such biological data could be integrated into population management strategies or into airborne pollen modelling.

Cutting experiments designed to decrease the pollen production do not consider the problem of seed production from regenerated shoots.

Basset and Crompton (1975) overdue their conclusion from the quick 100 % regeneration after one cut when they claim "several cuts during August". Based on the experience of Bohren et al. (2008a), Karrer et al. (2011), Simard and Benoit (2011), Karrer and Milakovic (2011) and Pixner (2012), Karrer and Pixner (2012) a three weeks interval between the cuts from July to September should be enough to prohibit the development of ripened seeds above the cutting line. Even post-harvest ripening of seeds on shoots left to the habitat could be avoided by 100 %.

Of course, the cutting height is problematic, because the regrowth from nodes below the lowermost realistic cutting height of 5 cm (Simard and Benoit 2011, Karrer et al. 2011, Milakovic et al. 2014b) can produce seeds anyway. Thus, regrowth should be counteracted by desired strong competitors like *Lolium perenne* (Karrer et al. 2011, Milakovic and Karrer 2009, Milakovic and Karrer 2010).

Preliminary Recommendations:

EPPO (2008) recommend fairly the same option for ragweed control like Bohren et al. (2008 c) and Karrer et al. (2011). A late first mowing just at the beginning or shortly after the start of male blooming is accepted by all scientists. Considering the detected post-harvest ripening of seeds on cut branches (Pixner 2012, Karrer and Pixner 2012, Karrer et al. 2012) we would recommend subsequent cuts every 3 weeks. Four (EPPO 2008) or more weeks (Bohren et al. 2008a) would enable serious seed production from cut branches. This means at least four cuts from mid/end of July until end of September.

Aiming at prohibiting the seed production a first cut latest mid of August and one or two subsequent cuts would give optimal results (Bohren et al. 2008a, Karrer et al. 2011, Karrer 2012).

References

Barbour, B. and Maede, J.A. (1981). The effect of cutting date and height on anthesis of common ragweed *Ambrosia artemisiifolia* (Asteraceae). Proc Northeastern Weed Sci Soc 85: 82-86.

Basset, I.J. and Crompton, C.W. (1975). The biology of Canadian weeds 11. Ambrosia artemisiifolia L. and A. psilostachya DC. Can. J. Plant Sci. 55, 463-476.

Béres, I. (2004). Integrated weed management of common ragweed (*Ambrosia artemisiifolia* L.). (Az ürömlevelű parlagfű (*Ambrosia artemisiifolia* L.) elleni integrált gyomszabályozási stratégiák). Hung. Weed Res. and Technol. 5:3-14.

Bohren, C., Delabays, N., Mermillod, G., Keimer, C., Kündig, C. (2005). *Ambrosia artemisiifolia* in der Schweiz - eine herbologische Annäherung. Agrarforschung 12(2): 71-78.

Bohren, C., Delabays, N., Mermillod, G., Baker, A., Vertenten, J. (2008a). *Ambrosia artemisiifolia* L: Optimieren des Schnittregimes. Agrarforschung 15(7): 308-313.

Bohren, C., Delabays, N., Mermillod, G. (2008b). *Ambrosia artemisiifolia* L.: Feldversuche mit Herbiziden. Agrarforschung 15 (5), 230-235.

Bohren, C., Mermillod, G., Delabays, N. (2008c). *Ambrosia artemisiifolia* L. - Control measures and their effects on its capacity of reproduction. Journal of Plant Diseases and Protection, Special Issue 21: 307-312.

Buttenschøn , R. M., Waldispühl, S., Bohren, C. (2010). Guidelines for management of common ragweed, *Ambrosia artemisiifolia*. http:/www.EUPHRESCO.org, 47 pp.

Delabays, N., Bohren, C., Mermillod, G., Keimer, C., Kündig, C. (2005). L'ambroisie à feuilles d'armoise (*Ambrosia artemisiifolia* L.) en Suisse: aspects malherbologiques. Revue Swiss Agric 37: 17-24.

Delabays, N., Bohren, C., Mermillod, G., Baker, A., Vertenten, J. (2008a). Briser le cycle de l'ambroisie (*Ambrosia artemisiifolia* L.) pour epuiser son stock semencier dans les sites infestes. I. Efficacite et optimisation des regimes de coupe. Revue Suisse Agric 40(3): 143-149.

Delabays, N., Bohren, C., Mermillod, G., Baker, A., Vertenten, J. (2008b). Lutte contre l'ambroisie (*Ambrosia artemisiifolia* L.): briser le cycle de la plante pour epuiser son stock semencier das les sites infestes. II. Efficacite des herbicides, seuls ou en association avec une fauche. Revue Suisse Agric 40(4): 191-198.

Donald, W.W. (2000). Timing and frequency of between-row mowing and band-applied herbicide for annual weed control in soybean. Agronomy journal 92(5): 1013-1019.

EPPO (2008). National regulatory system Ambrosia artemisiifolia. OEPP/EPPO Bulletin 38: 414–418.

Fumanal, B., Chauvel, B., Bretagnolle, F. (2007). Estimation of pollen and seed production of common ragweed in France. Ann Agric Environ Med 14: 233-236.

Gebben, A.I. (1965). The ecology of common ragweed, Ambrosia artemisiifolia, L. in southeastern Michigan. Michigan, University of Michigan. Doctor of Philosophy: 234 pp.

Holst, N. (ed.) (2009). Strategies for Ambrosia control Euphresco project AMBROSIA 2008-09 Scientific Report: 67 pp.

Jäger, S. (2000). Ragweed (Ambrosia) sensitisation rates correlate with the amount of the inhaled airborne pollen. A 14-year study in Vienna, Austria. Aerobiologia 16: 149-153.

Joly, M., Bertrand, P., Gbangou, R., White, M., Dubé, J., Lavoie, C., (2011). Paving the Way for Invasive Species: Road Type and the Spread of Common Ragweed (Ambrosia artemisiifolia). Environmental Management 48(3): 514-522.

Karrer, G. (2007). Common Ragweed. Ambrosia artemisiifolia. Das Untersuchungsobjekt. – available from: http://www.niederosterreich.at/bilder/d22/Karrer_Ragweed_1kurz.pdf.

Karrer, G. (2012). Ragweed in Austria: Problems and Regulations. - Ambrosia2012, Colloque Européen des actuers et décideurs de la lute contre l'ambroisie. Lyon, 29.-30.3.2012, Abstract and presentation-available from: http://www.ambroisie.info/docs/colloque-2012/Karrer_G.pdf.

Karrer, G. and Milakovic, I. (2011). Optimization of cutting regimes for control of ragweed along road-sides. - In: Bohren, C.; Bertossa, M.; Schoenenberger, N.; Rossinelli, M.; Conedera, M. (eds): 3rd International Symposium on Environmental Weeds and Invasive Plants, October 2 to 7, 2011. Monte Verità, Ascona, Switzerland. Birmensdorf, Swiss Federal Institute for Forest, Snow and Landscape Research WSL. Abstracts: p 113.

Karrer, G., Milakovic, I., Pixner, T. (2012). Can Post-harvest Ripening of Seeds hamper the Efficacy of Control Measures against Common Ragweed? – Institute of Evolutionary Biology and Environmental Studies, University of Zurich and the Plant Ecology Group of the Institute of Integrative Biology, ETH Zurich (Eds.) PopBio 2012: Revisiting important questions and defining new horizons. 25th Annual Conference of the Plant Population Biology Section of the Ecological Society of Germany, Switzerland and Austria. Abstracts: p. 25.

Karrer, G., Milakovic, M., Kropf, M., Hackl, G., Essl, F., Hauser, M., Mayer, M., Blöch, C., Leitsch-Vitalos, M., Dlugosch, A., Hackl, G., Follak, S., Fertsak, S., Schwab, M., Baumgarten, A., Gansberger, M., Moosbeckhofer, R., Reiter, E., Publig, E., Moser, D., Kleinbauer, I., Dullinger, S. (2011). Ausbreitungsbiologie und Management einer extrem allergenen, eingeschleppten Pflanze – Wege und Ursachen der Ausbreitung von Ragweed (Ambrosia artemisiifolia) sowie Möglichkeiten seiner Bekämpfung. Endbericht, BMLFUW, Wien. 315 pp. German version available from: https://www.dafne.at/dafne_plus_homepage/.

Karrer, G. and Pixner, T. (2012). The contribution of post-harvest ripened ragweed seeds after cut for control. In: GEIB Grupo Especialista en Invasiones Biológicas (Ed.) NEOBIOTA 2012, 7th European Conference on Biological Invasions Pontevedra (Spain) 12-14 September 2012, Halting Biological Invasions in Europe: from Data to Decisions, Abstracts: p. 229. Available from http://neobiota2012.blogspot.co.at/p/book-of-abstracts.html.

Kazinczi, G., Béres I., Novák R., Bíró K. (2008a). Common ragweed (Ambrosia artemisiifolia L.): A review with special regards to the results in Hungary: I. Taxonomy, origin and distribution, morphology, life cycle and reproduction strategy. Herbologia, 9(1): 55-91.

Kazinczi, G., Novák, R., Pathy, Z., Béres, I. (2008b). Common ragweed (Ambrosia artemisiifolia L.): A review with special regards to the results in Hungary. III. Resistant biotypes, control methods and authority arrangements. Herbologia 9(1): 119-144.

Klein, T. (2011). Untersuchungen über ausgewählte „neue" Unkrautarten in Österreich im Jahre 2007, University of Natural Resources and Life Sciences Vienna. MSc thesis: 165 pp.

Londsdale, W.M., (1990). The self-thinning rule: dead or alive. Ecology 71 (4): 1373-1388.

MacDonald, A. and Kotanen, P. (2010). The effects of disturbance and enemy exclusion on performance of an invasive species, common ragweed, in its native range. Oecologia 162(4): 977-986.

Meiss, H. (2010). Diversifying crop rotations with temporary grasslands: potentials for weed management and farmland biodiversity. Inst. f. Landschaftökologie. Giessen, Univ. Giessen, PhD: 1-234 pp.

Meiss, H., Munier-Jolain, N., Henriot, F., Caneiil, J. (2008). Effects of biomass, age and functional traits on regrowth of arable weeds after cutting. J Plant Dis Prot, Special Issue 21: 493-500.

Milakovic, I. and Karrer, G. (2009). Sowing of competing vegetation as a control measure for Ambrosia artemisiifolia L. in: International Congress on Biological Invasions, Fuzhou, 2.-6.11.2009. Book of Abstracts: p. 279.

Milakovic, I. and Karrer, G. (2010). Influence of competing vegetation and the cutting regime on the population density and flowering characteristics of Ambrosia artemisiifolia L. – In: BASTIAANS, L., BOHREN, C., CHRISTENSEN, S., GEROWITT, B., HATCHER, P., KRÄHMER, H., KUDSK, P., MELANDER, B., PANNACCI, E., RUBIN, B., STREIBIG, F., TEI, F., THOMPSON, A., TORRESEN, K., VURRO, M. (Eds.) Proceedings of the 15th European Weed Research Society (EWRS) Symposium, 12-15 July 2010, Kaposvar, Hungary, p. 200. Pannonia Print LTD. Budapest. ISBN: 978-963-9821-24-8.

Milakovic, I. and Karrer, G. (2011): Competitive suppression of common ragweed in early successional stages of revegetation. In: Bohren, C.,Bertossa, M., Schoeneberger, N., Rossinelli, M., Conedera, M. (Eds.), 3rd International Symposium on Weeds and Invasive Plants, Ascona, Switzerland, October 2 -7 2011. Abstracts: p. 111.

Milakovic, I., Fiedler, K., Karrer, G., (2014a). Fine tuning of mowing regime, a method for the management of the invasive plant Ambrosia artemisiifolia L. at different population densities. Weed Biology and Management 14:232-241.

Milakovic, I., Fiedler, K., Karrer, G. (2014b) Management of roadside populations of invasive *Ambrosia artemisiifolia* by mowing. Weed Research 54(3):256-264.

Milanova, S., Vladimirov, V., Maneva, S. (2010). Suppressive Effect of Some Forage Plants on the Growth of Ambrosia artemisiifolia and Iva xanthiifolia." Pestic. Phytomed. (Belgrade) 25(2): 171-176.

Patracchini, C., Vidotto, F. Ferrero, A. (2011). Common Ragweed (Ambrosia artemisiifolia) Growth as Affected by Plant Density and Clipping. Weed Technology 25(2): 268-276.

Pixner, T. (2012). Die Reaktion von Ambrosia artemisiifolia L. auf unterschiedliche Schnittrhythmen. Dipl. Thesis, University of Natural Resources and Life Sciences Vienna. 129 pp.

Simard, M-J. and Benoit, DL. (2010). Distribution and abundance of an allergenic weed, common ragweed (Ambrosia artemisiifolia L.), in rural settings of southern Quebec, Canada. Canadian Journal of Plant Science 90(4): 549-557.

Simard, M-J. and Benoit, DL. (2011). Effect of repetitive mowing on common ragweed (Ambrosia artemisiifolia L.) pollen and seed production. Ann AgricEnviron Med 18(1): 55-62.

Tokarska-Guzik, B., Bzdęga, K., Koszela, K., Żabińska, I., Krzuś, B., Sajan, M., Sendek, A. (2011). Allergenic invasive plant Ambrosia artemisiifolia L. in Poland: threat and selected aspects of biology. Biodiversity: Research and Conservation 21(1): 39-48.

Toole H.E. and Brown E. (1946). Final results of the Durvel buried seed experiment. J. Agric. Res. 72: 201-210.

Verschwele, A. et al. (2012, unpubl.). Experiments on-chemical control options.

Vincent, G. and Ahmim M. (1985). A Note on the Behavior of Ambrosia-Artemisiifolia after Mowing. Phytoprotection 66: 165-8.

Vincent, G., Deslauriers, S., Cloutier, D. (1992). Problems and eradication of Ambrosia artemisiifolia L. in Quebec in the urban and suburban environments. Allerg Immunol (Paris) 24(3): 84-89.