

Report on the outcomes of a Virtual Mobility¹

Action number: CA21134

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Virtual Mobility Details

Title: Towards Agroecological Weed Management in European Cropping Systems: Achievements, Challenges and Future Opportunities

Description of the work carried out during the VM

Description of the virtual collaboration and activities carried out during the VM, with focus on the work carried out by the grantee. Any deviations from the initial working plan shall also be described in this section.

The work carried out within this activity built upon the existing collaboration with Prof. Göran Bergkvist and his research group at the Swedish University of Agricultural Sciences (SLU). A three-month STSM stay at SLU in 2025 enabled more intensive joint work on non-chemical weed management, with a particular focus on species of the genus *Ambrosia*. During the stay, results from studies investigating the effects of competition from a mixture of *Lolium perenne* and *Trifolium pratense*, as well as mowing, on *A. artemisiifolia* and *A. trifida* were analysed. The work included statistical analysis and modelling of the responses of both species to competition and mowing, as well as an assessment of their capacity to regenerate following the applied management measures. In parallel, laboratory tests of allelopathic effects were conducted, relevant literature was reviewed, and work on manuscript preparation was undertaken. The results and progress of the research were also presented at a seminar at SLU, while the stay included visits to experiments focused on weed control without the use of herbicides. This collaboration resulted in the publication Savić, A., Ringselle, B., Barroso-Bergadà, D., Bohan, D. A., & Bergkvist, G. (2025). Burial depth and temperature effects on the germination and viability of giant ragweed (*Ambrosia trifida*

¹ This report is submitted by the grantee to the Action MC for approval and for claiming payment of the awarded grant. The Grant Awarding Coordinator coordinates the evaluation of this report on behalf of the Action MC and instructs the Grant Holder Manager to verify the grant documents compliance and proceed with the payment.

L.) seeds. *Weed Research*, 65(1), e70004. Part of the results from this project was also presented as an oral contribution at the 20th European Weed Research Society Symposium, providing an opportunity to disseminate the outcomes of the collaboration to the wider weed science community. The presentation also contributed to the visibility of COST Action CA21134 by highlighting research activities and scientific cooperation developed with support from the Action.

The collaboration also continued through a second paper, prepared together with Göran Bergkvist and Darwin T. Hickman, “Responses of *Ambrosia artemisiifolia* and *A. trifida* to competition and mowing: Ecological and agronomic implications”, which is currently submitted for publication. The experience and results developed through this joint work provided the basis for continuing the collaboration within the present activity.

Within the framework of this activity, an online Zoom meeting was held on 4 September 2026 with Prof. Göran Bergkvist and Darwin T. Hickman from the Swedish University of Agricultural Sciences (SLU). The meeting represented a continuation of the previously established collaboration and made it possible to link the joint experience and results obtained to date with the topic addressed in the final synthesis. Following the meeting, communication continued by email through further exchanges of views and comments. Eirini Daouti and Alexander Menegat were also included in this exchange, thereby broadening the discussion to include the experience of researchers working in other European production systems.

During the Zoom meeting, previous experience and results were considered within the broader context of long-term weed management and reduced dependence on herbicides. The discussion covered crop rotation structure, crop competitiveness, the role of perennial grasses and legumes, cover crops, and mechanical measures, as well as the importance of reproduction and the soil seed bank for the long-term dynamics of weed populations. Particular consideration was given to the extent to which experience from different cropping systems can be applied under different European production conditions, taking into account the length of the growing season, temperature, rainfall distribution, crop rotation structure, and the availability of suitable crops and machinery.

The work was further developed through a review of relevant scientific literature. One of the central topics was crop rotation structure and the way in which different crops

modify conditions for weed emergence, growth, and reproduction over multiple growing seasons. The alternation of winter and spring crops was considered, together with broader differences among crops in terms of establishment timing, duration of the growing period, and competitive traits. Particular attention was given to the inclusion of perennial grasses and legumes, as they modify system conditions over a longer period and introduce a different management regime. During the discussions, the role of cover crops and the competitive ability of main crops in restricting weed development was considered. Particular emphasis was placed on the fact that crop rotation diversification is not merely a matter of increasing the number of crops, but rather of selecting and combining crops that differ in establishment timing, duration of the growing period, and competitive traits.

In addition, consideration was given to how changes in cropping-system structure can be linked with mechanical and other non-chemical measures. The importance of application timing, weed growth stage, and practical constraints affecting the effectiveness of interventions was discussed. The potential use of robotics and precision technologies to support non-chemical weed management was also included in the discussion. At the same time, it was emphasised that a reduction in weed abundance immediately following the application of a particular measure does not necessarily lead to a long-term decline in the population. Weeds that survive the applied measures or emerge later in the growing season may complete reproduction and contribute new seed inputs to the soil. In this context, soil seed-bank dynamics were also considered, particularly the balance between new seed inputs and seed losses through germination, mortality, predation, and loss of viability.

Ambrosia artemisiifolia and *A. trifida* were used as specific examples to link species biology with the selection of management measures. Previous joint work on these species made it possible to incorporate into the discussion issues related to emergence, competition, regeneration following mowing, reproduction, and seed behaviour in the soil. Comparison of the two species was particularly useful because of their differing status in Europe. For the widely distributed *A. artemisiifolia*, management is primarily concerned with reducing already established populations and preventing their further replenishment, whereas for *A. trifida*, which is still more restricted in its distribution,

greater importance is attached to early detection, prevention of seed production, and limiting the establishment of new populations.

On the basis of these examples, the discussion was expanded to consider the extent to which individual measures can be applied across different European production systems. The length of the growing season, temperature, and rainfall distribution influence the possibility of successfully establishing and developing cover crops, while weather conditions and soil status determine the feasibility and effectiveness of mechanical measures. Differences in production structure, available crops, and machinery further affect the selection and combination of management measures.

The broader effects of changes in the cropping system were also considered during the joint discussion. Changes in crop rotation, the inclusion of cover crops or perennial crops, and the choice of tillage practices affect not only weeds, but may also alter crop yield, the occurrence of other harmful organisms, nutrient availability, and soil processes. There were no significant deviations from the original plan; the planned activities were implemented to the intended extent. During the work, the focus of certain questions was refined, particularly the relationship between the short-term effects of individual measures and their potential influence on reproduction, the soil seed bank, and the long-term dynamics of weed populations. The joint discussion also helped to distinguish more clearly between questions for which knowledge is already available and those that require additional multi-year and multi-location research.

Description of the VM main achievements and planned follow-up activities

Description and assessment of whether the VM achieved its planned goals and expected outcomes, including specific contribution to Action objective and deliverables, or publications resulting from the VM. Agreed plans for future follow-up collaborations shall also be described in this section.

The planned objectives of the activity were achieved. A synthesis of the proposed topic was prepared, based on relevant literature, the results of previous collaboration, and joint discussions with Göran Bergkvist, Darwin T. Hickman, and other members of the group. One of the concrete outcomes was the identification of questions requiring further research, particularly in relation to the long-term effects of combining different management measures, changes in weed communities and the soil seed bank, and the applicability of these approaches across different European production systems. At the same time, several constraints that should be taken into account when planning future research were identified, including the length of the growing season, crop rotation

structure, the availability of suitable crops and machinery, and potential effects on crop yield.

The activity contributed to the objectives of the COST Action by continuing international collaboration and facilitating knowledge exchange aimed at the development of preventive and non-chemical approaches to weed management. A particular contribution was the integration of previous results on species of the genus *Ambrosia* into the broader issue of reducing dependence on herbicides and achieving long-term weed management at the cropping-system level.

The results of the collaboration to date already include one published paper and a second joint manuscript that is currently under review. The intention is to continue the collaboration by further developing the questions raised during this activity, particularly through the preparation of a joint review paper with a broader focus on long-term weed management and reducing dependence on herbicides. In addition, there is scope to define new joint research questions and future experiments addressing the long-term effects of different combinations of management measures across different production systems. In this way, the collaboration established to date provides a basis for its further development through joint publications and new research activities. As a continuation of the collaboration, it was agreed to further develop the topics that emerged during the joint discussion, particularly through a more detailed literature review and a more precise definition of the concept for a future publication.

Future collaboration may focus on defining joint research questions that require multi-year and multi-location experiments. Of particular interest are long-term changes in weed populations and the soil seed bank, the stability of the effects of combined management measures over multiple growing seasons, and their applicability across different production systems. These questions may provide the basis for new joint experiments, projects, and publications. Thus, the work carried out to date does not conclude with this activity, but instead provides a foundation for further developing the collaboration by linking existing results with new research ideas and joint efforts toward their implementation.

This topic directly builds upon one of the central directions of CA21134, particularly the activities of WG4 focused on redesigning cropping systems for production without

chemical pesticides. Such an approach is consistent with the core concept of the TOP-AGRI network that the transition towards pesticide-free production requires a change in the way crop protection is planned, rather than merely a gradual reduction in individual chemical treatments. Weed management represents a particularly important component of this redesign because the effects of changes in crop rotation and other components of the cropping system often become apparent only over several growing seasons. Considering weed populations within this longer-term framework contributes to a better definition of the issues that need to be addressed when developing systems without herbicide use. At the same time, collaboration among researchers working under different European production conditions makes it possible to assess the constraints and opportunities associated with such approaches from multiple perspectives, which is consistent with the objective of CA21134 to connect, through a European network, the expertise required for the development of new crop protection strategies.

These discussions gave me several ideas that I would like to develop further in my future work. In particular, they helped me see new possibilities for extending the collaboration with Göran Bergkvist, Darwin T. Hickman, and other colleagues, and for developing new joint activities when suitable opportunities arise. I see this activity as a useful step toward building further scientific collaboration, exchanging expertise across different European research environments, and identifying new directions that could lead to future joint initiatives.