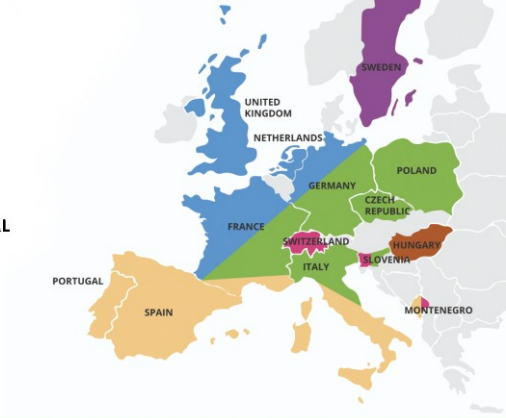
SUPER-G
SUSTAINABLE PERMANENT GRASSLAND

MEDITERRANEAN
BOREAL
ALPINE
PANNONIAN
CONTINENTAL
ATLANTIC



Use of hemiparasitic plants (*Rhinanthus sp*.) to support pollinators and plant species diversity in grasslands

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- **DESCRIPTION:** Hemiparasites, living in permanent grasslands, are annual green plants that are capable of photosynthesis but extract water and minerals from their hosts with specialized roots equipped with contact organs called haustoria (Těšitel et al., 2015). Although there are several genera of hemiparasites in European grasslands (e.g., Melampyrum, Rhinanthus, Pedicularis, Odontites), the most used species in botanical studies is yellow rattle (Rhinanthus minor L.). Unfortunately, this species has low competitive ability against vigorous tall grasses and is vulnerable to competitive exclusion in productive grasslands. A related species, Greater yellow rattle [R. alectorolophus (Scop.) Pollich], is a taller and more vigorous plant that once was a common weed of cereals before the introduction of herbicides in the 1960s. It typically occurs in extensively managed grasslands and road verges in central Europe. Rhinanthus alectorolophus plants can grow up to 80 cm high on arable land, but usually reach a height of up to 40 cm in permanent grasslands.

- **RATIONALE:** Hemiparasitic plants are considered ecosystem engineers increasing vegetation diversity and are being used in practical conservation management systems (Těšitel et al., 2018). The mechanisms by which hemiparasites enhance diversity are as follows: (a) lowering competitive ability of dominant, vigorous grasses; (b) creating gaps in swards after their death; and (c) increasing mineral nutrient availability in the soil from their quickly decomposing litter.

Fig.1: On the left: Rhinanthus alectorolophus after emergence in a red fescue sward in late April. On the right: Flowering Rhinanthus alectorolophus is an attractive species for bumble bees and other pollinators
Photos: Stanislav Hejduk

R. alectorolophus grows more vigorously than R. minor and produces large quantities of seeds, providing potential for large-scale application.

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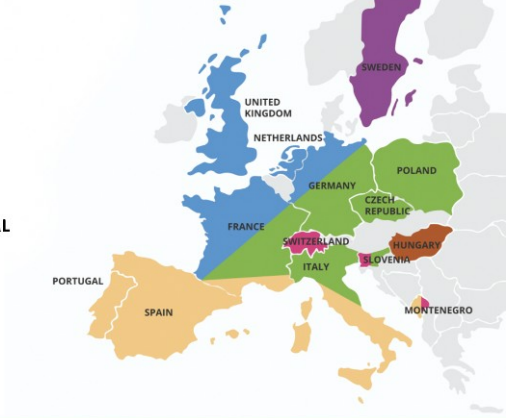

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- **MECHANISM OF ACTION:**

All Rhinanthus species are connected to their hosts (preferably grasses) by suckers (haustoria), from which they draw water and mineral nutrients (root parasites). They produce green leaves that undergo photosynthesis (analogous to mistletoe) and therefore require access to light. Lush, nutrient-rich grass growth poses a risk to hemiparasites through shading. They are therefore more common in unfertilised grasslands, which tend to be harvested later and provide an opportunity for hemiparasitic plants to mature.

Fig.2: On the left: Haustoria of Rhinanthus joined to the roots of a host plant (photos of J. Těšitel)
On the right: The effect of Rhinanthus introduction to grassland (temporal loss of most grasses, creating gaps and providing an opportunity for forbs to establish) after 3 years.
Photos: Stanislav Hejduk

The root system of hemiparasites is greatly reduced (compared with other plants) and therefore, in the absence of a host plant they can only survive as dwarf plants. In the spring, typically in April, they join the roots of host plants through haustorias, from which they draw significant amounts of water and mineral nutrients. Hemiparasites are often threatened by drought at the time of emergence, when a large proportion of seedlings can die. When connected to the host, they leave the stomata on their leaves open even during the dry season, thereby severely weakening their host. Dicotyledonous plants (Centaurea sp., Trifolium sp., Salvia sp., Origanum sp., Plantago sp. etc.) are able to defend themselves from the parasitic plants. They are therefore supported by the presence of hemiparasites, thereby reducing competition from grasses. Flowering time for Rhinanthus depends on the latitude, altitude and the weather, and takes place from mid-May to the end of June. Seeds ripen approximately 4-6 weeks after full flowering.

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Potential for applying the management option

The option can be applied in any biogeographic region. Rhinanthus species are present in habitats throughout Europe. Hemiparasites are present in some of the most species-rich grasslands in the world, including the White Carpathians in the Czech Republic, the Carpathians in Romania, Pannonic sand steppes in Hungary and the wet, extensively managed grasslands in Poland and Estonia. They are applicable to moderate and low intensity systems in which plant species diversity is promoted.

Support

The use of hemiparasites is not supported by European Commission agri-environment schemes. The option usually needs financial support from protected areas management or from other sources as the seeds and fencing can be costly. Over a longer time-scale, the option can reduce harvest and biomass removal costs and shorten the time needed for sites to reach a target environmental condition.

Practical considerations

The Rhinanthus seeds must undergo a period of moisture and low temperatures during the winter season (cold stratification) to germinate early in the spring. Therefore, they are sown in the autumn (preferably October - November) on the surface of mineral soil following surface cultivation to disrupt or remove the litter layer using harrows or rakes. Since this type of surface cultivation is sometimes difficult, grazing by sheep, cattle or horses before and after the overseeding can be an effective method to aid germination. The treading action of hooves can help to mix the litter and the mineral soil and thus accelerate its decomposition, and after sowing, the same action can improve seed to soil contact and consequently spring emergence of the plants. Appropriate use of livestock grazing can significantly reduce establishment costs.

To improve the persistence of hemiparasites, mowing should be postponed until the end of June or the beginning of July. Seeds ripen unevenly and are shed easily at full maturity, which makes their harvesting difficult. On the other hand, when harvesting hay, seeds easily reach the surface of the soil.

In the Czech Republic (Continental region), there have been successful experiments with Rhinanthus alectorolophus, which have confirmed its potential to suppress the growth and proliferation of the problematic grass species, *Calamagrostis epigejos*.

This grass is associated with abandoned grasslands (no mowing or grazing) or late mowing in July or August, which is intended to promote the emergence of endangered plant species. However, many modern farming methods do not support endangered species and often fail to prevent the spread of aggressive grasses that are well suited to late cutting.

Example of good practice

In the Czech Republic *Rhinanthus alectorolophus* has been used as a tool to enhance biodiversity on road verges and for suppressing *Calamagrostis epigejos*, *Festuca arundinacea* and some other tall, vigorous grasses in high nature value grasslands. It took three years to create enough gaps in the sward for forbs and invertebrates to re-establish (sowing once). Rhinanthus restricted sward height and biomass and reduced grassland harvesting costs in areas where forage production is not desirable. It also reduced the maintenance costs associated with these grasslands.

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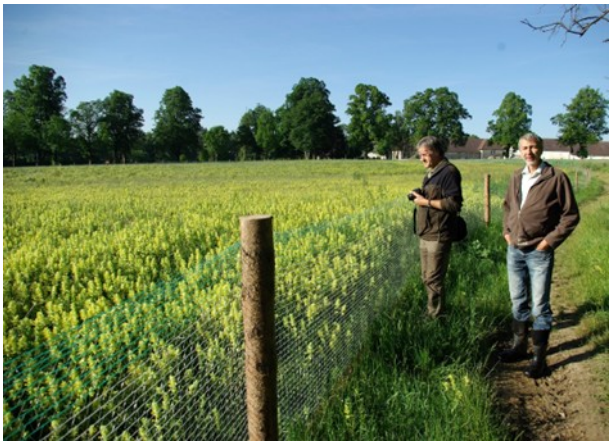
- **ADVANTAGES:**

No herbicides are needed, as Rhinanthus species are annual plants, and their presence in the sward can be easily controlled by an early cut at flowering stage. Rhinanthus species also produce good quantities of nectar for pollinators and provide selective control of grasses.

- **DISADVANTAGES/ RISKS:**

Seed production is not common, and seeds can be expensive. During flowering, Rhinanthus inflorescences are attractive to wildlife (high nectar content) and the newly seeded areas need to be fenced off to avoid overgrazing by deer.



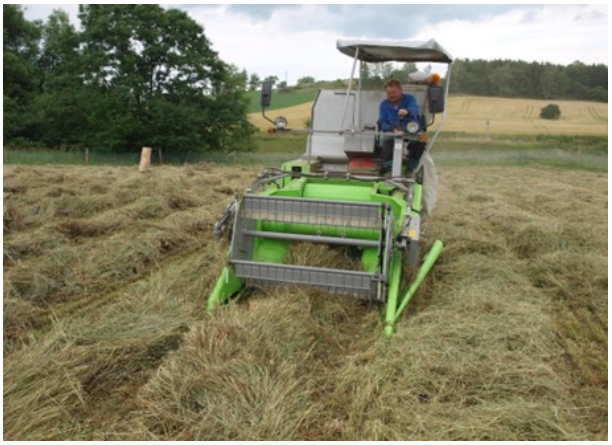


Fig.3: On the left: Multiplication field for Rhinanthus alectorolophus cultivated along with perennial ryegrass. On right: Two-stage harvest of Rhinanthus seeds.
Photos: Stanislav Hejduk

Fig.4: On the left: Successful introduction of the Rhinantus alectorolophus into a meadow with expanding Calamagrostis epigejos after the first introduction of the hemiparasite (1.6.2018). On the right: Seeds of Rhinanthus alectorolophus ready for sowing.
Photos: Stanislav Hejduk

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