Horehound workshop

Proceedings of a workshop held at the Victorian Institute for Dryland Agriculture in Horsham April 19 and 20 1999. Organized by John Weiss, Emma Wills and Nigel Ainsworth of the Keith Turnbull Research Institute, Victorian Department of Natural Resources and Environment, and sponsored by the Cooperative Research Centre for Weed Management Systems.

Editor: E. Wills, Keith Turnbull Research Institute, Department of Natural Resources and Environment, PO Box 48, Frankston, Victoria 3199, Australia.

Horehound (*Marrubium vulgare*): a comparison between European and Australian populations

John Weiss and **Jean-Louis Sagliocco**[A], Keith Turnbull Research Institute, Victorian Department of Natural Resources and Environment, CRC for Weed Management Systems, PO Box 48, Frankston, Victoria 3199, Australia.
[A] Previous address: CSIRO European Laboratory, Campus International de Baillarguet, 34980 Montferrier sur Lez, Cedex, France.

Summary

Horehound (*Marrubium vulgare* L.), a noxious weed throughout southern Australia, was imported from its native southern Europe during the 1800s. Horehound in its native habitat shows weed potential, but is scattered and occurs in less dense infestations than in Australian infestations where the plant is larger and more vigorous. The seed production and seed bank studies indicate that there is at least a one hundred-fold difference between the two populations. At Victorian infestations, either space or water appear to be the limiting factor affecting survival and recruitment while sustained herbivory pressure restricts horehound in its native range. Climate modelling based on overseas populations indicates that horehound in Australia maybe close to achieving its full distribution.

The insect fauna of horehound has been examined and a total of twenty-eight insects have been found feeding on the plant in Mediterranean Europe. In comparison only a couple of oligophagous insects are on horehound in Australia and in consequence four European insects have been identified as suitable agents for biological control. Two of these have been approved and released into the Australian environment.

Introduction

Horehound (*Marrubium vulgare* L.) is a perennial weed native to temperate Eurasia, Europe, the Middle East and the Mediterranean region including North Africa (Figure 1). It is also a weed in southern states of north America, including California and Texas, in South America (Argentina, Chile, Peru, Uruguay etc.) and in New Zealand (Weiss in press). It is now naturalized over most of the pastoral areas in Australia with rainfall greater than 200 mm. It occurs in all Australian states but is of most importance in Victoria and South Australia where an estimated 26 million hectares (as shown in Figure 2) are infested with horehound (Lane *et al.* 1980, Carter 1990)

Horehound leaves contain marrubin, a bitter alkaloid, which makes it unpalatable for grazing animals. Horehound burrs not only are of nuisance value to people, as they catch in clothing and socks, but they also contaminate wool, reducing the value of fleece.

Horehound was possibly first introduced into Australia from Europe via a shipment of botanical plants sent by Sir Joseph Banks. A record from Sir Joseph Bank's diary states that *M. vulgare* was sent to New South Wales on board the ship *Porpoise* on 11 October 1798 (Frost 1993). It appears to have been introduced for use as a garden herb, medicinal and beer brewing purposes. First recorded as naturalized by the 1840s.

Materials and methods

Potential distribution of horehound in Australia was determined using CLIMEX for Windows version 1.1 (Sutherst 1996). The distribution was based on the provided 'Mediterranean template' and the parameters for temperature, moisture and stress were expanding upon utilizing Australian and overseas information about stress limits and the distribution of horehound.

Comparative phenological studies of horehound were carried out at two sites in Europe (Cournonterral and La Crau in southern France) and two in Victoria (Wyperfeld National Park and Swifts Creek), Australia during the period of 1991–1996. Growth, reproductive capacity, size, and soil seed banks were measured seasonally or biennially. Individually marked plants were identified on each visit and details recorded. Soil cores were collected to measure the soil seed bank. These were washed free of soil and horehound seeds checked for viability.

Surveys of the insect fauna of Europe (Portugal, Spain, France, Italy and Yugoslavia) and Morocco were carried out during 1990–1996. The IIE, CNRS (Toulouse),

Figure 1. Distribution of horehound in Europe.

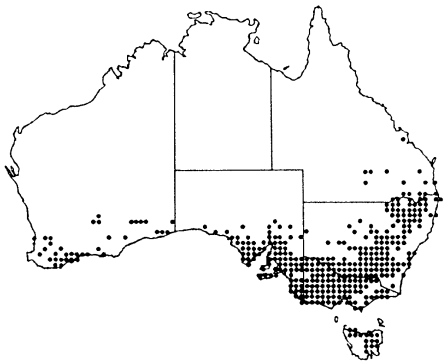

Figure 2. Present distribution of horehound in Australia (from Parsons and Cuthbertson 1992).

MNHM (Paris) and British National History Museum identified collected insects.

Results

Potential distribution

Figure 3 indicates the potential suitable climatic areas for horehound to infest in Australia.

Plant phenology

Table 1 presents a summary of the phenology and demography of two populations of horehound in France and two in Victoria. Horehound in southern France is much smaller with only about one-third the number of stems, and produce about half the seeds that the Victorian populations do. Most importantly though, the density of plants in Victoria is about 20 to 50 times more, 200 to 1000 times as many seedlings occur and 70 to 250 times as many seeds are in the soil seed bank than southern France.

Insect fauna in Europe

Twenty-eight species of insects, predominantly from four orders were found on *M. vulgare* in Europe and Morocco. Figure 4 show the relevant feeding behaviour of the European horehound insect fauna. One other insect, a rare weevil, and a leaf-spotting fungus have been reported (Sagliocco and Weiss 1996) but were never found during the surveys.

Discussion

Distribution in Australia and Europe

The present and potential distribution maps of horehound in Australia (Figures 2 and 3) are very similar indicating that horehound maybe close to reaching its maximum potential distribution in Australia. Horehound has the potential of increasing in Western Australia and parts of New South Wales, but in South Australia, Victoria and most of New South Wales, it will more likely increase the density of present infestations rather than move into new localities.

In Europe, horehound generally grows on wasteland, on well-drained calcareous souls. The persistence of permanent plant populations depends on low plant competition, which is favoured by sheep grazing, and sufficient seed dispersal by animals. In western Europe, large horehound populations are very rare, but are found where sheep or horse grazing occurs.

Horehound phenology

Although Australian plants are significantly larger and have more stems, the amount of seed produced per plant is not dramatically greater than that in Europe. The number of seeds produced per stem is roughly equivalent in both populations. However, as the density of plants is 20–50 times more, this greatly increases the seed bank and recruitment potential of seedlings. The extreme low level of seeds in the soil in Europe is most likely due to predation and destruction by the foraging ant species.

Horehound in both Europe and at Swifts Creek, Victoria, has consistent populations with very little seasonal or yearly fluctuations. In comparison, horehound in the drier more drought prone Mallee at Wyperfeld, undergoes dramatic 'boom–bust' cycles. Mature plants die off during severe droughts and the infestations rely on the very large seed bank to recolonize when sufficient rainfall occurs. This presumably indicates that these areas are close to the limits of horehound tolerance and ability to establish. Without the large seed bank reservoirs deposited during more favourable years, and subsequent recruitment, it is most likely that the infestation would die out after a series of dry periods. Control strategies in these dry areas should concentrate on removing the seed bank, by fire for example (Weiss 1996), or by reducing the seed production of the plants using biological control agents.

Seed germination

Lippai *et al.* (1996) reported on the effects of temperature and water potential on the germination of Victorian horehound seeds. They indicated that Australian horehound is not a drought tolerant germinator but more opportunist, germinating whenever sufficient rains occur. In contrast horehound seeds from America require much more specific environmental factors prior to germination including fluctuating temperatures of at least 15°C or stratification.

This contrast is possibly due to environmental differences the seeds are subjected to in North America and Australia, which is substantiated by increased germination following moist chilling of North American seeds, but not of Australian seeds. It would be interesting to see what factors influence the germination of European horehound. Anecdotal evidence indicates that horehound seeds survive in the soil seed bank for between 7 and 10 years (Weiss in press).

Potential biological control agents

In Australia prior to 1994 only a couple of arthropods (mites, mealy bugs and one bug) fed on horehound. The native brightly coloured orange and black horehound bug, *Agonoscelis rutila*, is often seen on the weed in great numbers, but does not have any significant impact.

In comparison twenty eight species have been found to feed on *M. vulgare* in Europe and Morocco. As areas such as Greece, the Middle East and other countries of northern Africa also rich in *Marrubium* genera have yet to be investigated, the total number of insects feeding

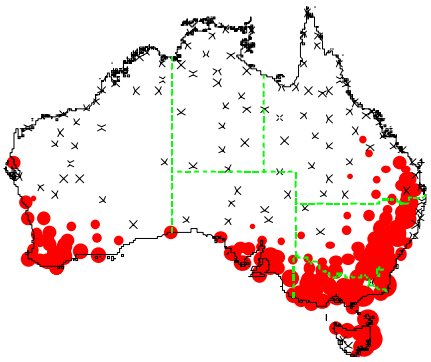

Figure 3. Potential distribution of horehound in Australia (as predicted using CLIMEX® Version 1.1)

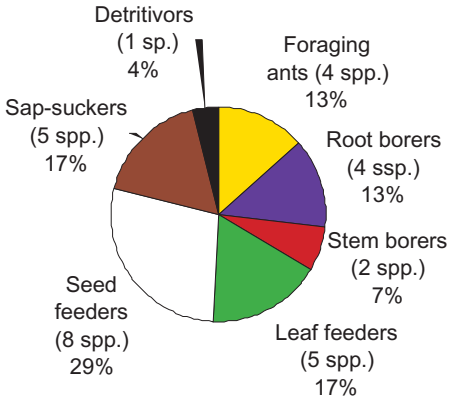

Figure 4. The different groups of insects recorded feeding on *Marrubium vulgare* in Europe.

Table 1. Demography and seed banks of horehound in Europe and Australia.

	France		Victoria, Australia	
Demography	Cournonterral	La Crau	Swifts Creek	Wyperfeld NP
Density of plants m^{-2}	0.4	0.2	6.9	9.9
Mean height of plant (cm)	14.6	9.6	36.1	27.1
Mean no. of stems	6.3	6.8	35.2	18.9
Mean no. seed produced per plant	878	174	1746	498
Mean no of seed produced per stem	139	26	50	26
Mean no. of seedlings m^{-2}	0.11	0.32	69.5	196.3
Mean soil seed bank (seeds m^{-2})	116.9	61.2	15 290	7880

on *M. vulgare* is expected to be much higher.

So far, through the surveys and the field observations, five insect species have been identified as having a potential for the biocontrol of horehound in Australia. These species are:

- *Wheeleria spilodactylus* (Curtis)
- *Chamaesphecia mysiniformis* (Boisduval)
- *Meligethes rotroui* Easton
- *Phytoecia melanocephala* Fabricius
- *Carcharodes boeticus* Rambur

Two of these agents have been host specificity tested and approved for release into the Australian environment, the others are awaiting further studies.

The horehound plume moth, *Wheeleria spilodactylus*, was first released in 1994 and is now established at over 100 localities throughout southeastern Australia (South Australia, Victoria, Tasmania and New South Wales). The caterpillar feeds on the growing tips of the plants and then works its way down the shoot, progressively defoliating the stem. This weakens the plant and reduces the number of seeds and flowers produced. Ainsworth discusses research on the impact of this moth in later papers in this workshop.

The horehound clearwing moth, *Chamaesphecia mysiniformis*, was released in Victoria in March 1997. Larvae feed within the growing tissue of the root and lower stems. Larval infection affects the flow of water and nutrients through the plant, weakens it, reduces growth and increases the likelihood of the plant dying (especially when water stressed). As this Spanish insect emerges in early / mid summer when daily temperatures exceed 30°C establishment of this agent may be restricted to the more arid and warmer sites in inland New South Wales and the Mallee parts of South Australia and Victoria.

The European horehound insect fauna and the distribution and establishment of biological control agents for horehound in Australia is discussed by Sagliocco and Wills in later papers in this workshop.

Conclusion

The reasons for the dense horehound infestations in southern Australia are most likely a combination of factors. Horehound in Europe has few vectors to transport the seed calyxes apart from the occasional sheep, while in Australia kangaroos, sheep, rabbits, farm machinery and watercourses all aid in the transport of the seed to new areas. Because of different land management techniques competition from other plant species maybe higher in Europe than in Australia. Horehound seeds have a limited ability to germinate in conditions where moisture availability, or where temperatures are low. However, mature plants can survive dry and drought conditions effectively as animals preferentially graze more palatable pasture species, reducing competition for available water. In Australia with the high density of feral bees pollinating horehound leading to prolific seeding, the high germination rates, and the large seed bank enable horehound to colonise newly disturbed areas and to recruit new seedlings into the weed infestation when conditions are favourable. In comparison, horehound in Europe is restricted by the high specific herbivory pressure, which reduces the ability of mature plants to produce a large quantity of seeds hence the seed bank is much reduced. The low level of specific herbivory in Australia by insects and disease by pathogens is probably the major reason for the high level of infestation in Australia.

Acknowledgments

The Australian Wool Research Development Corporation provided the funds for the European research of this project, the Victorian Department of Natural Resources and Environment and the South Australian Animal and Plant Control Commission supported the Australian research.

References

Carter, R.J. (1990). Biology and control of horehound, *Marrubium vulgare*. Proceedings of the 9th Australian Weeds Conference, p. 382-6. (Crop Science Society SA Inc.).

Frost, A. (1993). 'Sir Joseph Banks and the transfer of plants to and from the South Pacific 1786–1798'. (Melbourne Colony Press).

Lane, D.W.A., Riches, K. and Combellack, J.H. (1980). A survey of the distribution of noxious weeds in Australia. Dept of Crown Lands and Survey, Frankston.

Lippai, A., Smith, P.A., Price, T.V., Weiss, J. and Lloyd, C.J. (1996). Effects of temperature and water potential on germination of horehound (*Marrubium vulgare*) seeds from two Australian localities. *Weed Science* 44, 91-9.

Parsons, W.T. and Cuthbertson, E.G. (1992). 'Noxious weeds of Australia', p. 496-9. (Inkata Press, Melbourne).

Sagliocco, J-L. and Weiss, J. (1996). Biocontrol of horehound (*Marrubium vulgare* L.). Work in Europe 1990–1996. Project DCV 14. Final Report to International Wool Secretariat.

Sutherst, R.W. (1996). CLIMEX®: Predicting the effects of climate on plants and animals. Version 1.1. (CSIRO).

Weiss, J.E.R. (1996). Control of horehound, *Marrubium vulgare* L., in Wyperfeld National Park, Victoria. Proceedings of the Eleventh Australian Weeds Conference, p. 417-19. (Weed Science Society of Victoria Inc., Frankston).

Weiss, J. (In press). 'Best practise management guide: horehound (*Marrubium vulgare*)'. (CRC for Weed Management Systems).