

## Scentless Chamomile (*Matricaria perforata*) - A New Target Weed for Biological Control

D.P. Peschken, A.G. Thomas, G.G. Bowes, D.W. Douglas

Research Station, Agriculture Canada, Box 440, Regina, Saskatchewan S4P 3A2 Canada

### Abstract

Scentless chamomile, *Matricaria perforata*, was investigated in regard to its suitability as a new target for biological control. This weed depends entirely on seeds for reproduction. Therefore, a reduction in seed production would help to control the weed. Scentless chamomile occurs across Canada and is a major weed in the three prairie provinces where it is still spreading. It reduces yield significantly in such major crops as spring and winter wheat. Available chemical and mechanical control methods are inadequate. The weed is resistant to the relatively inexpensive and commonly used herbicides. Mechanical control is not always successful and leads to soil erosion. Scentless chamomile is an introduced weed. Two insects and two fungal species occur in Europe, which are host specific according to the literature. In a screening program of candidate biological control agents, *Chamomilla recutita* should be tested first, because it is very closely related to the target weed and used for medicinal purposes. No other serious conflict of interest is known. It is concluded that the characteristics of the problem created by scentless chamomile and the availability of biological control agents indicate that this weed is a suitable target for biological control.

### Introduction

In some cases, little research may be needed before a decision is made whether or not to target a weed for biological control. Such was the case with the prickly pears in Australia (*Opuntia* spp.; Cactaceae) and St. John's wort in California (*Hypericum perforatum* L.; Clusiaceae). With other weeds, particularly those which are new and spreading, preliminary investigations are advisable, especially when considering the high initial cost of a successful biological control project. It was estimated to be \$ 2 million 15 years ago (Harris 1973).

We studied scentless chamomile, *Matricaria perforata* Merat (Compositae), as a potential new target. Other names found in the literature for this weed are: *Matricaria inodora* L., *Matricaria maritima* L. var. *agrestis* (Knaf.) Wilmott, *Matricaria maritima* ssp. *inodora* (L.) Clapham, *Tripleurospermum maritimum* (L.) Koch (Rauschert 1974). The following criteria were considered: (a) biology and habitat; (b) size of area infested; (c) damage; (d) available chemical and mechanical control methods; (e) origin of the weed, available control agents; and (f) conflict of interest and relationship to crop plants.

### Biology of Scentless Chamomile

Scentless chamomile is a winter or summer annual and sometimes a short lived perennial. It grows to a height of about 1 m. Prime habitats are disturbed, moist sites, such as margins around the many shallow ponds and poorly-drained, uncultivated depressions which dot the Canadian prairies, and low sites in fields prone to flooding. Weed control by cultivation on these sites often fails and crops may not be planted in every year. In such habitats, scentless chamomile forms dense, semi-permanent stands. The weed is also found in other, well drained, disturbed areas such as in crops, on roadsides and in the corridors where pipelines have been placed underground. It flowers from the end of June until September (Frankton and Mulligan 1987). Reproduction and spread depend on seed. In its favoured habitat, scentless chamomile produces up to 1.2 million seeds/m<sup>2</sup>. Therefore, the aim of biological control should be to reduce seed production.

## Size of Area Infested

Farmers from Esterhazy, Saskatchewan reported to have noticed scentless chamomile in about 1905. From there chamomile spread to the western margin of the province in the dark brown, black and grey soil zones with a few occurrences in the brown soil zones. It is also very frequent in Alberta, less so in Manitoba. However, it has not yet reached all prime habitats. For example, in 1981 near Edenwold, which is one of the most seriously infested regions, it was found in only 80% of the margins around shallow ponds, and in 55% of low, moist areas in cultivated fields. There are in excess of 600 000 ha of such favoured habitats in Saskatchewan alone (estimate based on data collected by the Saskatchewan Assessment Management Agency). Thus, scentless chamomile occurs over a large area in some of its favoured habitats. Once it occurs in all prime habitats, the problem will intensify.

## Damage

Scentless chamomile is primarily a weed of cultivated land, but it is also found in hay fields and pastures (Alberta Agriculture 1982). It forms semi-permanent stands as previously mentioned. From there the light seeds are spread by wind and water and by harvesting machinery to the well drained areas of the fields. We determined the number of viable seeds in four fields in 3-cm deep soil samples, along a total of 11 transects leading 18 m into fields from the seed sources. These consisted of prime habitats of the weed, i.e., dense infestations around uncultivated low, moist areas. There were an average of about 100 000 viable seeds/m<sup>2</sup> at the source and at 18 m, i.e., well into the field, 1000 seeds/m<sup>2</sup> were found (Fig. 1). Eighty-four percent of buried seed remain viable after five years, and 25% after 10 years (Alberta Agriculture 1982).

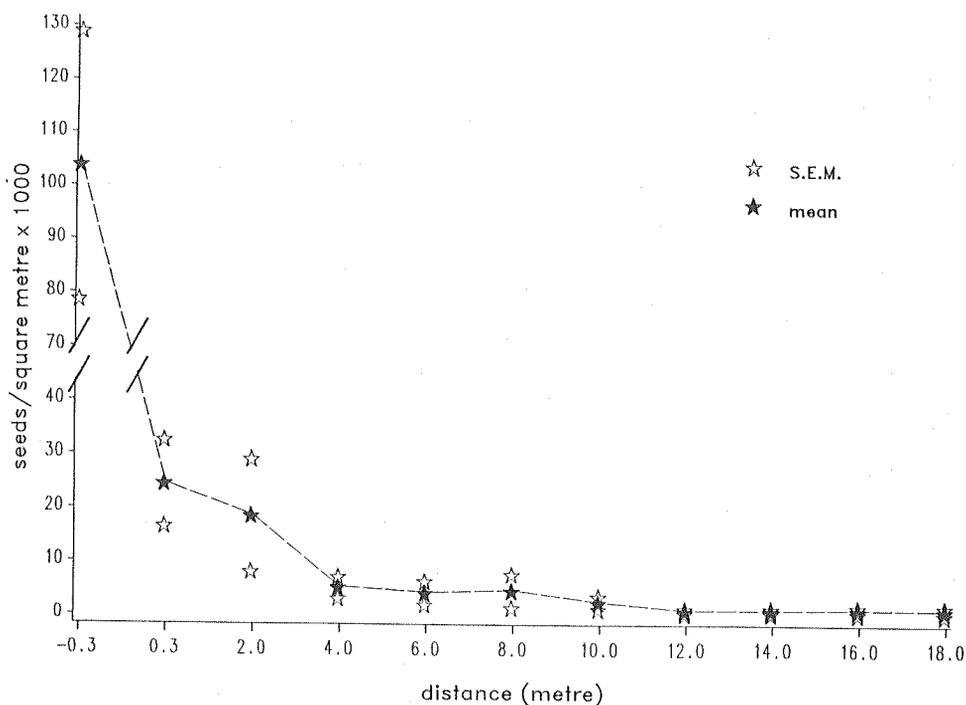


Figure 1. Average number of viable seeds of scentless chamomile found along transects leading 18 m into fields from dense infestations of the weed. A total of 11 transects in four fields were sampled.

Preliminary results from two field experiments indicate that scentless chamomile, especially the winter annuals, is quite competitive in spring wheat, less so in winter wheat. Yield reduction was investigated in one randomized block experiment, replicated eight times, on level, well-drained plots on the Indian Head Experimental Farm, Saskatchewan (Fig. 2). Dense winter annuals reduced yield of winter wheat significantly and that of spring wheat to almost zero. The spring annuals were very competitive in spring wheat and reduced yield by almost 90%. Winter wheat was able to suppress the spring annual scentless chamomile and no significant reduction in yield was recorded. Loss in yield of spring wheat in low, moist areas of three farmers' fields near Wynyard, Saskatchewan, was determined. A total of 90 samples were collected with densities of scentless chamomile ranging from 0 to over 40 blooming plants/m<sup>2</sup>. In high weed densities, the yield of wheat was reduced up to 60% (Fig. 3).

Today many progressive farmers attempt to plant a crop every year and a rotation of several crops is desirable. There are relatively few crops acclimatized to the Canadian prairies. Flax and lentil can be grown profitably on fields where weeds are well controlled. However, they are even less competitive with scentless chamomile than wheat. Thus, scentless chamomile limits further the choice of crops that can be grown in a rotation.

#### Available Chemical and Mechanical Control Methods

Chemical control is difficult. Of the relatively inexpensive and commonly used selective herbicides, only those containing bromoxynil (3,5-dibromo-4-hydroxybenzotrile) control scentless chamomile (Saskatchewan Agriculture 1988). Bromoxynil herbicides are effective only against the seedling stage. Therefore, they have to be applied early in the growing season, and a second application may be necessary to control other weeds. The bromoxynils do not kill the winter annuals. Clopyralid and chlorsulfuron are effective against all stages of scentless chamomile. However, clopyralid is only registered for canola and costs about twice as much as most commonly used herbicides, from \$54 to \$85/ha (Saskatchewan Agriculture 1987). Chlorsulfuron persists from one to several years. Its use is recommended only where wheat and barley are grown in succeeding years in Saskatchewan and Alberta (Alberta Agriculture 1987, Manitoba Agriculture 1988, Saskatchewan Agriculture 1988). In the areas where scentless chamomile is a problem, chlorsulfuron is rarely used because of the diversity of crops in the rotations.

Most farmers rely on mechanical control which is effective when soil is dry. On fields with an initial moisture content of 13 to 32%, one cultivation in well drained areas of a field removed 94 to 99% of the winter annual rosettes and two cultivations removed 99 to 100%. On two low-lying, moist areas in a field, three to four cultivations spread over the growing season were necessary to kill all rosettes. In moist conditions which are frequent in the low-lying areas in fields, cultivation does not shake the soil of the extensive fibrous root system and the plants are merely transplanted. We determined the number of seeds in three fields in a total of 15 cultivated, low, moist sites. There were an average of 5000 viable seeds/m<sup>2</sup>, which indicates that control by cultivation was not effective.

Harvesting machinery scatters the weed seeds along with the thrashed straw onto the fields. Therefore, farmers frequently drive harvesters around scentless chamomile infestations, swath them separately and burn them. This helps to prevent spreading of the seed over the remainder of the field but will not control the weed in low areas. Where chamomile is not yet frequent, farmers get off their machinery and hand-weed, which is very time consuming.

Scentless chamomile may become a problem on the whole field when it can not be controlled by cultivation, because of a succeeding moist fall and spring. Such fields may have to be taken out of production and summerfallowed. Therefore, scentless chamomile adds pressure to use summerfallowing for weed control. This is a method whereby a field is not seeded to any crop for one season but cultivated every 3 to 6 wks to control weeds. Fallowing contributes to soil erosion by water and wind, to salination and loss of organic matter. Weed control without summerfallowing is a recommended as good soil husbandry.

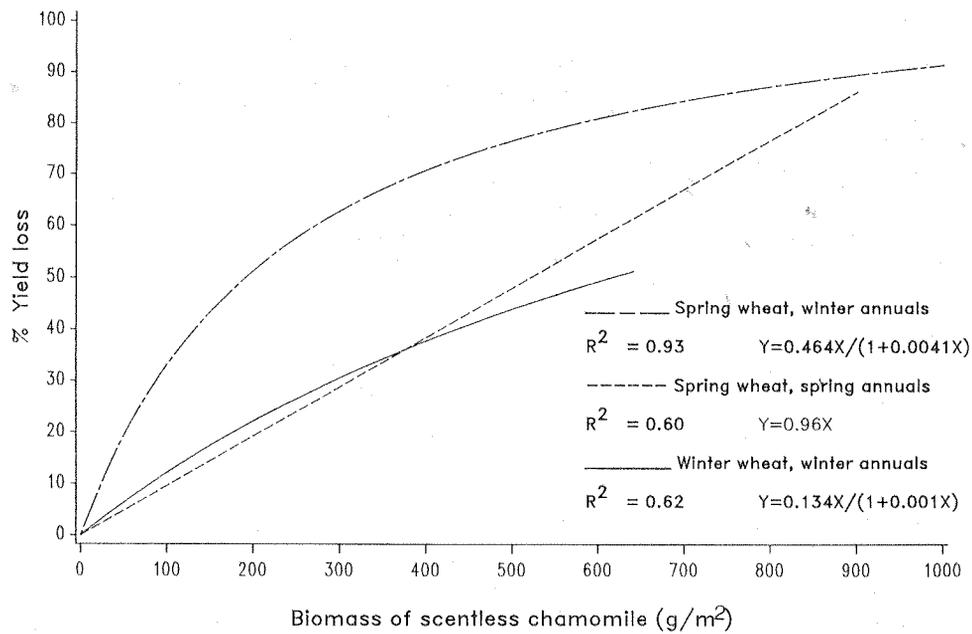


Figure 2. Average percentage loss in kernel yield caused by winter annual scentless chamomile in winter wheat, and by spring and winter annuals in spring and winter wheat on plots at Indian Head, Saskatchewan. The furthest reach of the regression lines indicate the maximum biomass sampled on the plots (randomized block design, eight replicates).

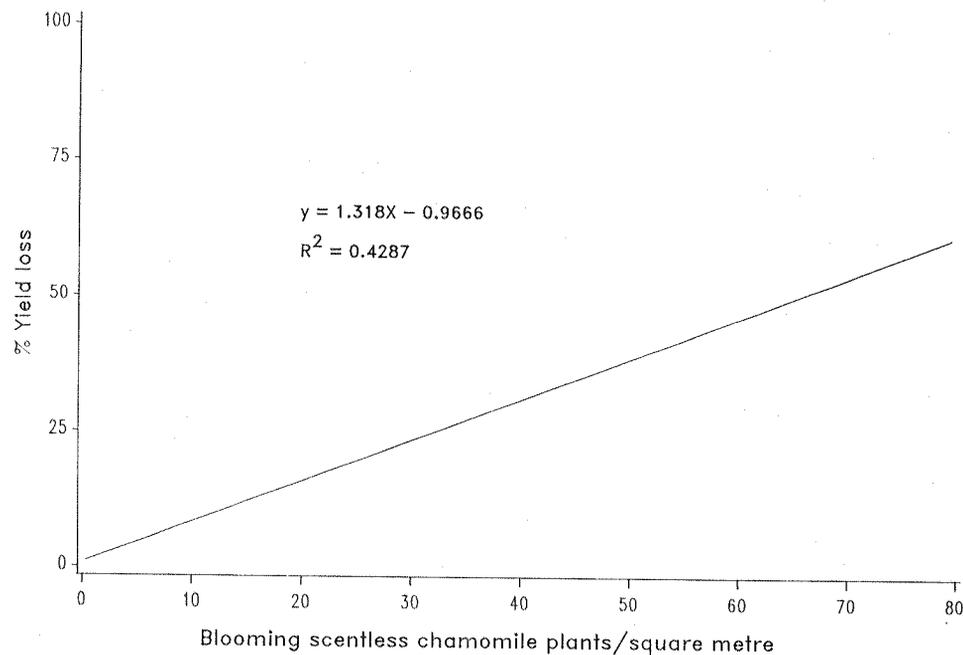


Figure 3. Percent loss in kernel yield caused by scentless chamomile in spring wheat growing in low moist sites in three farmers' fields near Wynyard, Saskatchewan. The average yield loss is based on a total of 100 samples taken in density categories of scentless chamomile ranging from 0 to over 40/m<sup>2</sup>.

## Origin of Scentless Chamomile and Available Control Agents

Introduced weeds are considered more suitable for biological control than native weeds because the former lack specific control organisms in their adopted range. Usually host specific biological control agents can be found in the native range. Scentless chamomile was introduced from Europe (Frankton and Mulligan 1987). A survey was conducted for organisms that might already occur in Saskatchewan. At three locations near Regina, a total of 3600 plants were examined in the field and 1800 were dissected including their flowers and seed heads. In addition, 725 scentless chamomile plants from 13 other locations in Saskatchewan were dissected, including 1150 seed-heads, and many dense infestations were sampled using a sweep net in the course of four years (M.G. Maw, pers. commun., 1987). No specialized insects or outbreaks of any insects or diseases were found. Surveys in other provinces of Canada have not yet been carried out. However, it can be assumed that, similar to other introduced weeds, scentless chamomile is a wide open niche for any biological control agent that might be established.

A survey was made of the European literature for potential biological control agents. Over 70 insects and fungi were recorded from scentless chamomile. Of these, 14 insect and 5 fungal species had a narrow host range and two insects and two fungi seem host-specific and warrant further study. The most promising insect, *Apion hookeri* Kirby (Coleoptera: Curculionidae) (Freese 1987), was compared to *Chrysolina hyperici* Forester (Coleoptera: Chrysomelidae). This beetle is a successful biological control agent against St. John's wort, in several parts of the world (Julien 1982). Using the scoring system developed by Harris (1973) and Goeden (1983), *A. hookeri* scores 47 points in comparison to 53 for *C. hyperici* if points awarded for proven effectiveness of the latter are not used in this comparison. Thus, *A. hookeri* scored high. The other apparently monophagous insect is *Ceutorhynchus edentulus* Schltz. (Coleoptera: Curculionidae) which is widely distributed in eastern and central Europe (Lohse 1983). The two disease organisms are *Entyloma matricariae* Rostr. (Ustilaginales), a smut (Lindeberg 1959), and *Protomyces matricariae* Syd. (Taphrinales) (Buhr 1964). So far, the only host we found recorded for these two fungi is scentless chamomile. It can be assumed that additional candidate agents can be found in the course of a European field survey.

## Conflict of Interest and Relationship to Crop Plants

Scentless chamomile is rarely grown as a flower but is not offered in major Canadian seed catalogues. The closest relative among cultivated crops is *Chamomilla recutita* (L.) Rauschert, which is sometimes used and even grown for medicinal purposes (Rauschert 1974). This plant used to be in the same genus as scentless chamomile and therefore should be tested first in any screening program.

## Discussion

In the past, most biological weed control projects using the classical or inoculative approach have targeted weeds of rangeland (Andres *et al.* 1976, Julien 1982). Usually on such land of relatively low productivity, economic controls are not available, one weed is dominant and insects are easier to establish where they are not disturbed annually by cultivation. However, the inoculative approach has also been successful against two annual weeds of disturbed areas using insects (Andres *et al.* 1976, Huffaker *et al.* 1983) and against a perennial using fungi (Cullen 1978).

The scentless chamomile problem seems to have the parameters which indicate that additional means of control should be explored and that success may be achieved by the biological method. The weed is aggressive in terms of its ability to reduce yield in major crops of the Canadian prairies and to spread into new areas. The cost of a successful biological control project does not increase in proportion to the size of the area infested by the weed; i.e., the initially large cost of biological control by the inoculative method decreases on a per unit area basis if a large region is involved (Harris 1975). Since scentless

chamomile does thrive and cause damage in an extensive agricultural region, the biological method offers a favourable cost/benefit ratio.

The weed forms dense, semi-permanent stands where biological control agents could be established. Several arthropod and fungal agents, which are host-specific according to the literature, occur in Europe. One of these, *A. hookeri*, attacks about 50% of the flower heads and in these destroys about 35% of the seed despite over 90% weevil mortality from parasitoids, in a study area in Germany (Freese 1987).

It can be expected that *A. hookeri* will develop higher densities and destroy a higher percentage of the seed in Canada than in its native Europe, when it is established without its parasitoids. Furthermore, *A. hookeri* is numerous on cultivated and uncultivated sites (Andres Freese, pers. com. 1987). This is an important characteristic of a biological control agent against a weed on both such sites. Thus, *A. hookeri* compares well in its potential with *Microlearinus lareynii* (Jacquelin du Val) and *M. lypriformis* Wollaston (Coleoptera: Curculionidae) which caused a significant reduction of the area infested by *Tribulus terrestris* L. (Zygophyllaceae) on cropped and uncropped sites in California. These two weevils destroyed 46% of the seed (Huffaker *et al.* 1983).

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