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Small Broomrape

Biology and Management in the Pacific Northwest

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Small broomrape (*Orobanche minor* Sm.) is a parasitic weed that recently has become troublesome in red clover seed production in Oregon. It was identified in a single red clover seed production field in 1998, and the number of infestations increased to 15 by 2000 and 22 by 2001.

A small broomrape infestation can cause severe crop destruction, yield loss, and seed contamination. Small broomrape is a federally prohibited noxious weed and is restricted from export as a seed contaminant. Red clover is an important rotational crop in grass seed production systems.

Description

Small broomrape is an herbaceous, fleshy annual that is a member of the Orobanchaceae (broomrape) family. Its easily identified orange or brown tubercles, or "spiders," are attached to host plant roots (Figure 1). Emerged flowering stalks are 5 to 20 inches tall and completely lack chlorophyll, often resembling purple asparagus (Figure 2).

Flowers usually are purple, but they can be white or yellow. Numerous florets are arranged along the stalk and open within 1 week of plant emergence. Leaves look like small, triangular scales.

Biology and impact

In order to germinate, small broomrape seed must receive a chemical signal from a potential host plant. Germination does not occur without a potential host present, and seeds can remain viable in soil for as long as 50 years.

Figure 1. Small broomrape tubercles or "spiders" attached to host plant roots.

Figure 2. Emerged small broomrape stalks in a red clover seed production field.

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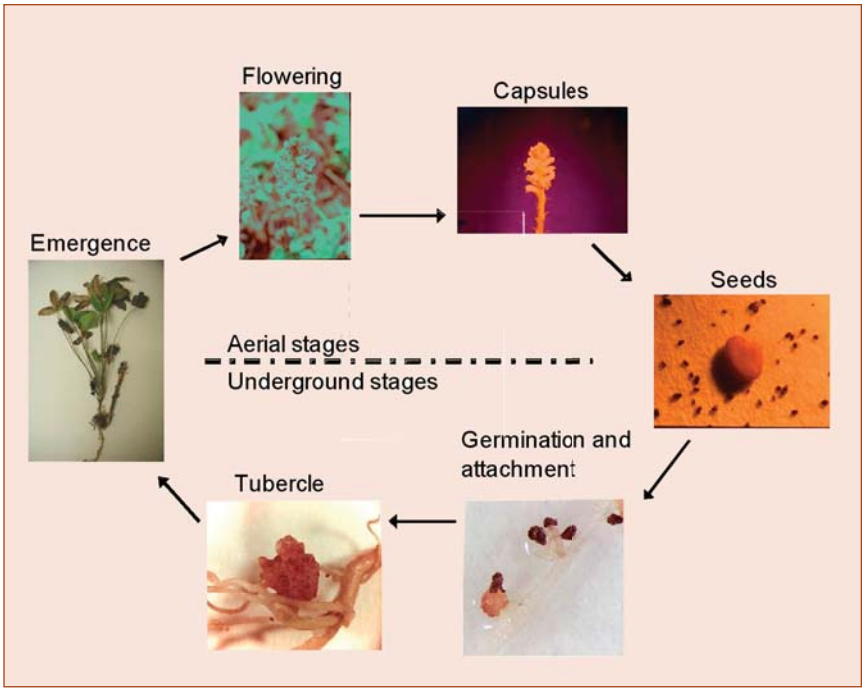

Figure 3. Small broomrape life cycle.

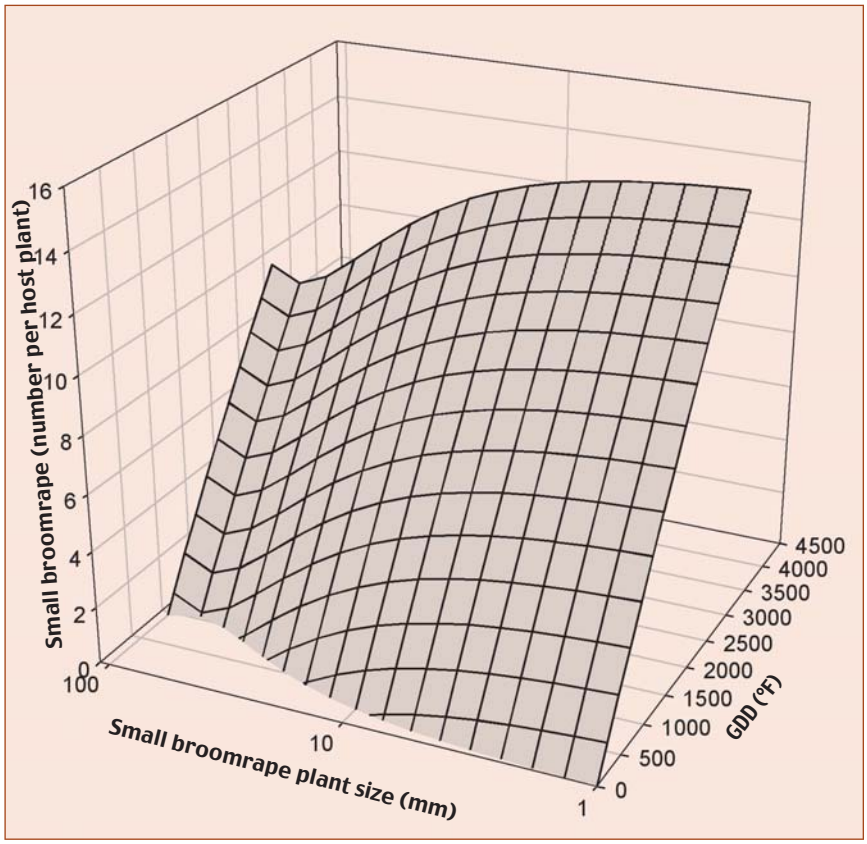

Figure 4. A model for small broomrape size and number per red clover plant in relation to growing degree days (GDD).

After germination, an organ called the haustorium penetrates the root of the host plant. Once attached, nutrients and water are translocated from the host to the small broomrape tubercle.

In Oregon, small broomrape plants remain below ground, accumulating resources from host plants, for about 5 months (January to May). Host plants can be severely drained of resources, and crop failure may result. Next, the flowering stalk emerges, and viable seed is produced in as little as 3 weeks after emergence. The complete life cycle of small broomrape is shown in Figure 3.

Small broomrape development and the number of plants attached to hosts are strongly associated with the accumulation of growing degree days (GDD). GDD are accumulated heat units that drive many biological processes. GDD can be used to predict parasitic growth stage (Figure 4).

A small broomrape plant can produce as many as 1 million dustlike seeds (Figure 5), which are difficult to remove from crop seed. Small broomrape seed can be transported via water, wind, animals, contaminated crop material, machinery, etc.

In addition to red clover, small broomrape parasitism has been documented on other Oregon

Figure 5. Red clover seed (left) and small broomrape seed (right).

crops such as alfalfa, carrot, crimson clover, and white clover (Table 1). Common weeds such as prickly lettuce, spotted catsear, and wild carrot also can be hosts. This extensive host range enables small broomrape to produce seed in many environments, even when a nonhost crop is grown on an infested site. This makes management of host plants essential.

Management

Small broomrape is a relatively new and unconventional pest in Oregon agriculture. In recent years, much research has been conducted to develop effective best management practices (BMPs). These practices include sanitation, cutting or mowing, manual removal, burning, and herbicide applications.

Prevention/early detection

Small broomrape seed remains viable in the soil for many years; therefore, prevention of introduction to new sites is the best long-term control method. Movement of small broomrape seed in crop seed and on farming implements is a common way to start new populations. Best management practices for prevention include:

- Planting certified weed-free crop seed
- Disinfecting machinery, tools, and workers before leaving infested sites
- Scouting potentially infested fields regularly in the spring based on an accumulated GDD model. Small broomrape is easily identified in the field. Attachment to host plant roots begins at approximately 800 GDD, and emergence begins at approximately 2,000 GDD. Local accumulated GDD and associated small broomrape development data can be accessed at http://pnwpest.org/cgi-bin/ddmodel.pl?clm

Cutting/mowing

Cutting or mowing emerged small broomrape plants and removing them from the site (followed by equipment sanitation) effectively limits seed production. However, it is too late in the parasite's life cycle to prevent loss of resources from the host plant. Mowing or cutting small broomrape more than 4 weeks after emergence will spread mature seed and contaminate equipment.

Manual removal

Pulling plants is effective only if flowering stalks are removed from the site. Uprooted flowering stalks can produce viable seed.

Burning

A well-timed burn effectively limits seed production, but it does not prevent belowground growth or damage to the host plant, nor does it significantly reduce the amount of viable seed in the soil. Consult the appropriate regulatory agency for rules and restrictions before burning.

Crop selection

Host crops: Host plants such as red clover are common cover crops. They can be used as trap crops to reduce the small broomrape seed bank on infested sites. Fall-planted host crops stimulate small broomrape germination and attachment during winter and early spring. Killing the cover crop with herbicides in the spring damages the weed directly and halts the flow of resources to the parasite.

Nonhost crops: Planting nonhost crops effectively limits small broomrape seed production. However, seed will persist in the soil if it is not signaled to germinate, and control of weedy hosts in nonhost crops is critical.

False host crops: Certain plant species, called false hosts, release exudates that stimulate parasitic germination but not attachment. Parasites not attached to host roots die because they have no source of nutrients and water. Several common Oregon crops, such as fescue and wheat, are false hosts

Table 1. Small broomrape hosts, nonhosts, and false hosts in Oregon. The approximate percentage of small broomrape germination induced by false hosts in greenhouse experiments is shown in parentheses.

Host plants	Nonhost plants	False host plants
Alfalfa	Curly dock	Barley (2)
Arrowleaf clover	Sugarbeet	Bentgrass (8)
Carrot		Corn, field and sweet (9, 10)
Celery		Fescue, fine and tall (1, 11)
Crimson clover		Flax (40)
Lettuce		Oat (7)
Prickly lettuce		Orchardgrass (9)
Red clover		Ryegrass, annual (3)
Spotted catsear		Ryegrass, perennial (1)
White clover		Snap bean (16)
Wild carrot		Sugar pea (19)
		Wheat (70)

for small broomrape. They can reduce the small broomrape seed bank while producing a marketable commodity.

Growth chamber and greenhouse experiments have shown that most winter wheat varieties grown in Oregon (except 'Connie') deplete the small broomrape soil seed bank (by as much as 70 percent). In addition, red clover grown in infested plots previously planted to wheat showed less small broomrape attachment than did red clover in plots where no false host had been planted.

Wheat also can be intercropped with red clover. This system allows wheat to be harvested in the red clover establishment year, while reducing the potential parasite infestation. The following year, red clover seed, free of small broomrape, can be harvested.

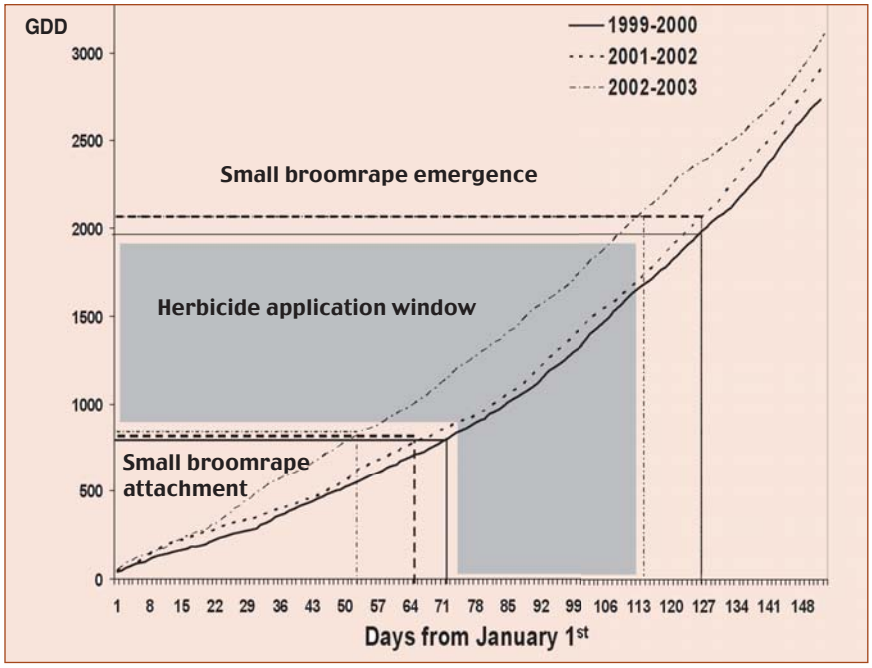

Figure 6. Growing degree days (GDD) in three red clover growing seasons in a field near Portland, Oregon based on soil temperature 2 inches under the soil surface. Vertical and horizontal lines link the observation date and GDD when small broomrape was observed at each stage.

Herbicides

Recent research has identified herbicide options for removal of small broomrape from red clover. These products are in the herbicide registration process. Consult the latest edition of the *Pacific Northwest Weed Management Handbook* for current options.

Glyphosate (several trade names) effectively controlled small broomrape in noncrop and cover crop removal applications. Glyphosate is a nonselective herbicide that injures or kills most plant species, so it cannot be used in red clover.

Glyphosate and other tested herbicides were most effective when applied after parasitic attachment, but before flower stalk emergence. Research has demonstrated that when herbicides active on small broomrape are applied to host plant foliage, they are translocated to the parasite, causing injury and death. Soil-applied herbicides have limited activity on small broomrape.

A predictive model for small broomrape parasitism in red clover has been developed to assist with herbicide application timing (Figure 6). The model is based on the strong relationship between GDD and parasite size that was observed in climatic conditions realistic to Oregon. GDD can accurately predict stage of small broomrape development, while the calendar date of developmental stages varies from year to year.

According to the model, small broomrape attachment occurs at approximately 800 GDD, and shoot emergence occurs at approximately 2,000 GDD. Thus, the window for herbicide application to host plants is approximately 1,000 to 1,900 GDD.

Glossary

Exudates—Compounds given off by plant roots.

Growing degree days (GDD)—Heat units accumulated from January 1 each year. GDD are calculated daily as:

$$\frac{\text{max daily temp (°F)} - \text{min daily temp (°F)}}{2} - 32$$

Base temperature is 32°F for small broomrape GDD.

Haustorium—A specialized rootlike organ used by parasitic plants to draw water and nutrients from host plants.

Tubercle or spider—Underground small broomrape growth form.