Puccinia chondrillina Bubak & Syd

INVASIVE SPECIES ATTACKED: Rush skeletonweed (*Chondrilla juncea*)

TYPE OF AGENT: Leaf & stem rust (fungus)

COLLECTABILITY: Not permitted

ORIGIN: Italy (Europe-adventive)

DESCRIPTION AND LIFE CYCLE

General development:

Sexually reproducing fungus appears in clusters on rosette leaves that give rise to airborne spores that in turn develop into brown pustules. Attacking pustules appear on upper and lower leaf surfaces of seedlings and spring or fall rosettes. Wind and rain dispersal contributes to rapid reproduction; completing every 12 - 16 days.

Fig. 1. *P. chondrillina* on rush skeletonweed leaves in rearing tent

Detailed development:

Overwintering spores (teliospores) germinate in the spring producing one or two club-shaped structures (basidium) where spores develop at the tips of diminutive stalks. The spores develop into the aecial stage which requires sexual reproduction involving pollination. After pollination, they germinate at 18 - 20^{0}C to become self-reproducing (urediospores) and within 3 - 16 hours, penetrate the leaf tissue. The self-fertile spores have an advantage of rapid spread, capable of multiple generations each season. At 20 - 30^{0}C, they reproduce every 7 - 10 days, depending on weather conditions. By mid-summer, usually when flowers are beginning to form, overwintering spores (teliospores and urediospores) are produced, developing mainly near the base of the flower shoots, appearing elongated, black and leather-like. Spores (urediospores) are light-weight and powdery, which easily disperse in wind and rain. Winter kill or slow spring emergence of rosette basal foliage stalls early spring spore development. Pustules are common by late summer or early fall. In mild, moist winter climates, steady spread can occur all winter, followed by rapid spread in the spring, then slowing during the dry summer months. Dry summer climates reduce the generations produced each year.

Fig. 2. *P. chondrillina* on rush skeletonweed stems at a field site

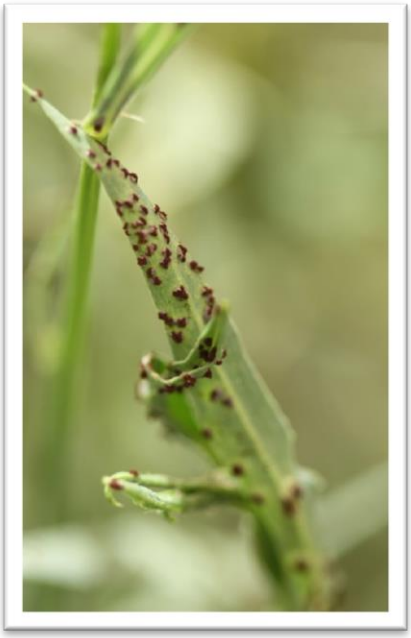

Fig. 3. Close up *of P. chondrillina* rust

There are several strains of this rust and some plants may be immune to it. In these instances the plants will have the rust present and as it tries to infect the plant, immune plants will exhibit small brown dimples as they restrict further development. When attacking somewhat resistant plants, the pustules develop a yellow halo with restricted spore production. On plants with no immunity, large brown pustules develop over the entire plant. In cold climates, the sexual reproductive generation may reappear with gene reconfigurations as it tries to develop strains that can break through the immune plants' protective mechanisms, resulting in numerous *Puccinia chondrillina* strains.

Overwintering stage:

In cold climates the rust develops thick walled spores (teliospores), common to areas north of southern Idaho. The following spring, teliospores must germinate to initiate further development. In mild climates (Washington State and south) it overwinters in dormant forms of self-producing spores or as sexual reproductive spores.

EFFECTIVENESS ON HOST PLANT

In European experimental plots:

- Infected mature plants died at a rate of 50 - 70%;
- Seedling death occurred at 90-100%;
- Mature rosette mortality increased 2.1 - 4.6 times;
- Infected plants produced fewer flower shoots and basal rosettes; and
- Root regeneration was reduced to 13.3%.

Field site symptoms include rapid kill to seedlings and weak, thin-rooted rosettes. On mature plants, leaves die back and stems become deformed, producing fewer branches, fewer flowers, and less viable seed.

Fig. 4. *P. chondrillina* dispersal location north of Vernon (Interior Douglas-fir zone)

Well established plants rarely show reduced vigour, therefore, heavy attack over multiple years may be required for control. In some stands plant density is reduced 56 - 87% in five years. Dispersal has been reported as 3 km in one year, 5 km in two years and 10 km in three years. In the Mediterranean, Australia and California it is the most effective controlling agent for rush skeletonweed.

Fig. 5. *P. chondrillina* dispersal location north of Vernon (Interior Douglas-fir zone)

HABITAT AND DISTRIBUTION

Native:

P. chondrillina is widespread in Eurasia occurring on rush skeletonweed in Iran, Turkey, Greece, Yugoslavia, Italy, France, Spain, and Portugal. In south Russia, it also occurs on a second *Chondrilla* species.

North America:

The U.S.A. supported screening of a *P. chondrillina* strain that originated from Italy. The resulting approved rust was released first in 1976 in Calif. Subsequent releases occurred over the next two years in Oreg. (1977) and in Wash. (1978). A different strain of *P. chondrillina* was accidentally introduced into the eastern U.S.A. and is now found distributed from Md. to Va, however, the date it was introduced is not known.

P. chondrillina is capable of inhabiting all areas where rush skeletonweed is established. The most effective sites are warm and moist which allow for rapid reproduction with multiple generations per year. Overnight dew production increases spread and effectiveness. Some plants show whole or part immunity to the rust fungus strains in North America.

Fig. 6. *P. chondrillina* dispersal location near Passmore (Interior cedar hemlock zone)

British Columbia:

P. chondrillina is established in the Interior cedar-hemlock and Interior Douglas-fir zones. Low level attack in the Vernon area may indicate insufficient moisture in this dry habitat. A higher level of attack may be achieved with increased moisture.

BRITISH COLUMBIA RECORD

Origin:

The Canadian strain of *P. chondrillina* is believed to be the same as that found in Washington State (identified as PC-16) but further investigation is required to confirm.

History:

The first recorded occurrence of *P. chondrillina* was in 1992 in Vernon. *P. chondrillina* generally occurs in rush skeletonweed stands so no redistributions have been made.

Field results:

In the north Okanagan sites, winter can kill rosettes with overwintering spores which reduces this biocontrol agent's impact. It is commonly found sharing the same host plants as the biocontrol agent *Eriophyes chondrillae*. In biocontrol agent rearing tents near Vernon of yet another biocontrol agent, *P. chondrillina* was very prolific, suggesting the mesh screen tents may have artificially increased the humidity or moisture levels required for the rust to develop and reproduce. *P. chondrillina* does not appear to be significantly effective as a sole biocontrol agent at sites in B.C.

Collection for redistribution:

Infected plants can be clipped and distributed among plants at new locations. Mixing the self-producing urediospores with talc or oil and applying by dusting or spraying can be done. Moisture levels should be increased for at least three hours by lightly misting the plants or covering them with plastic bags.

Natural distribution of *P. chondrillina* is common and usually requires no further assistance.

NOTES

- *P. chondrillina* was the first introduced plant pathogen that successfully established for biocontrol on invasive plants in North America.

REFERENCES

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