INSPECTION MANUAL

Program History

U.S. farm lands produce more than 3 billion bushels of wheat, oats, barley, and rye from about 100 million acres each year. These four small-grain crops are all potential hosts to the organism causing black stem rust (BSR). Under suitable conditions (e.g., susceptible host plant varieties, virulent races of the pathogen, suitable environmental conditions) BSR may be responsible for losses in the United States of as much as 37 million bushels of grain a year. Without resistant crop varieties and effective barberry control programs, losses could grow to 10–30 times present losses. Although chemical control of BSR through the application of fungicides is possible, treatment of a low-value crop such as wheat is rarely initiated due to the relatively high cost.

Breeding varieties of small grains for resistance to BSR began in the United States around 1900 meeting with rapid success from crosses with wheat varieties from Russia and Turkey. By 1938, farmers were planting resistant wheat varieties in the areas of the United States where BSR had been most destructive and continued to develop new resistant crop varieties. The difficulty with this approach is that while an individual crop variety may be resistant to several races of BSR, there are more than 200 existing races of BSR. The presence of BSR-susceptible barberry bushes providing the opportunity for new hybrid races of BSR to develop complicates the problem further. The use of resistant crops alone would never provide farmers with adequate protection from BSR. With the increasing demand for U.S. wheat, an alternative method of defense against a catastrophe the magnitude of the BSR epidemic of 1916 was needed.

The eradication in northern grain-growing regions of susceptible barberry bushes was this alternative method. Eradication would delay the onset of the annual rust infestations and slow the development of new BSR races. Farmers could now safely use resistant varieties for longer periods. In addition, breeders would have additional time to develop new resistant varieties.

An early attempt at barberry eradication in New England in 1726 had failed because scientists of those times did not understand the exact nature of the relationship between barberry and BSR until 1865. In 1918, the U.S. Department of Agriculture (USDA) initiated a barberry eradication program in cooperation with 13 north-central States (Colorado, Illinois, Indiana, Iowa, Michigan, Minnesota, Montana, Nebraska, North Dakota, Ohio, South Dakota, Wisconsin, and Wyoming). In 1935, four additional states (Missouri, Pennsylvania, Virginia, and West Virginia) joined the program, followed by Washington State in 1944. This time, the program resulted in the destruction of several hundred million susceptible barberry and mahonia bushes in over 700,000 square miles.

Although barberry eradication is a cooperative project with State personnel, USDA has always played a leading role. USDA established Quarantine 38 (7 CFR Part 301.38), the black stem rust (BSR) quarantine with the following goals: To prevent the importation of susceptible Berberis and Mahonia varieties into the United States.

< To prevent the importation of susceptible Berberis and Mahonia varieties into the United States

< To regulate the interstate movement of susceptible Berberis and Mahonia varieties.

< To prevent the reintroduction of susceptible Berberis and Mahonia into eradication areas.

< To eradicate susceptible Berberis and Mahonia varieties from the United States.

USDA supported the eradication program by providing funding for it and performing the following crucial program activities— nursery inspections

< surveys

< destruction of susceptible plants

< certification of resistant plants

USDA’s funding for the barberry eradication program ended in 1980. Although several States continued some barberry eradication activities, the extensive eradication program also ended in 1980. When USDA’s Animal and Plant Health Inspection Service, Plant Protection and Quarantine (APHIS-PPQ) proposed ending the black stem rust quarantine in 1981, 17 States and the Crop Quality Council requested that PPQ retain the BSR quarantine. PPQ agreed in the absence of a more satisfactory solution. In 1985, PPQ and the regional plant boards reevaluated the needs of the BSR program, and PPQ decided to retain the quarantine with the following significant changes: Movement of rust susceptible nursery stock in the genera Berberis, Mahonia, and Mahoberberis into or through a protected area (i.e., former eradication areas that continued to conduct nursery inspections to maintain their “susceptible-free status”) would be prohibited.

< Movement of rust resistant nursery stock into or through protected areas would be regulated.

< Restrictions for growing or shipping susceptible or resistant varieties between unregulated states would be lifted.

States must also enforce restrictions on the intrastate movement of regulated articles equivalent to those in the BSR quarantine for interstate movement. Other State responsibilities are:

< Employing inspectors with the responsibility for issuing and canceling certificates and compliance agreements

< Training inspectors

< Maintaining and enforce an inspection program

- Inspect every plant nursery within the State at least once a year
- Ensures that the nurseries are free of plants susceptible to BSR

< Enforcing the quarantine

- Issuance of certificates and limited permits
- Conducting periodic surveys to maintain the protected area free of rust-susceptible barberry plants

Biology

The fungus Puccinia graminis causes the disease black stem rust. Although plant pathologists take pains to distinguish between the symptoms and the causative organism, in common use, BSR can refer to both. This pathogen has a wide host range among species in the grass family, including wheat, oats, rye, barley, and timothy, as well as several other wild and cultivated grasses. BSR fungus can attack any aboveground part of wheat or other grasses, resulting in smaller, fewer, and lower quality kernels from reductions in root and foliage development. Because BSR is a heteroecious ("two houses") rust, it also has alternate hosts in a different plant family. In this case, the alternate hosts are various species and hybrids of Berberis and Mahonia (of the barberry family). Although damage to the alternate hosts is minor and mostly cosmetic, the economic significance of the disease to the grain crop varieties it infects is extensive.

BSR can exist in all areas where host crops are grown, but the disease is usually most damaging in moderately moist and northern areas. In the United States, this corresponds to the spring wheat areas of the upper Mississippi Valley and the areas to the north. The amount of damage depends upon the age of the plant at the time infection. Since northern farmers plant their grain crops relatively late in the spring, infection in this area occurs when the plants are young and causes extensive damage. The symptoms on wheat appear as long, narrow blisters, parallel to the axis of leaves, stems, and sheaths. As the blisters mature, the covering ruptures, revealing powdery masses of brick-red spores ("red rust" urediospores). The urediospores can splash or blow to other susceptible wheat or other small grain plants where additional infections occur. Several generations of urediospores can be produced in a single growing season; it is these repeating infections that cause the most damage to crops.

Urediospores do not survive the winter in northern areas. Late in the season, the lesions that had earlier produced urediospores become dark to black. The second spore type, the teliospores, form in the lesion and overwinter on stems and straw of wheat or other grass family hosts. The teliospores germinate in the spring producing basidiospores that can infect any susceptible barberry plants in the immediate vicinity. It is in the basidiospore stage in the life cycle of the rust that sexual recombination occurs, providing the opportunity for developing new races of BSR. Later in the spring, aeciospores form on the leaves of infected barberry plants. Aeciospores complete the life cycle of BSR by being blown by wind and to wheat or other susceptible grass family hosts and germinating. The life cycle then begins again.

In southern areas where the weather conditions are mild, BSR does not depend on having to complete its entire life cycle in a single growing season. In these areas the fungus can live from year to year by overwintering in the uredial stage on susceptible grains and grasses. It is possible for infestations to develop early in these areas. If these urediospores blow north in large numbers, epidemics of BSR may occur where susceptible grain hosts are present. In the south, the typical infestation involves the more gradual development of urediospores, while in the north, infection areas occurs later in the season. Eradication of susceptible barberry plants from northern grain-growing areas can reduce the negative impact by BSR for a number of reasons— Early season infections are rare; therefore, destructive epidemics are also extremely rare.

- The opportunity for the development of new BSR races in barberry is reduced significantly.
- BSR races and resistant varieties of grain maintain their stability for longer periods.
- Breeders have more time to develop new varieties of resistant wheat and barberry.
- Farmers can enjoy the benefits of planting resistant varieties with high yield potentials for longer periods.

Compliance Agreements

Compliance agreements may be executed with nurseries and/or shippers to facilitate the movement of regulated articles into or through protected areas in accordance with the requirements stated in Section 301.38–6 of the BSR regulations. Written compliance agreements may authorize the issuance of either limited permits (for the movement of regulated articles through protected areas) or certificates (for the movement of regulated articles into or through protected areas).

Limited Permits

Limited permits may be issued, either individually or under compliance agreement, for regulated articles not eligible for certification when the applicant can meet the following conditions: The destination(s) to which the regulated articles are to be moved must be specified on the limited permit.

< The destination(s) to which the regulated articles are to be moved must be outside of a protected area.

< The regulated article(s) to be moved must be placed in a closed, sealed container that prevents the unauthorized removal of the regulated article, and the container must remain sealed until the regulated article(s) reaches the final destination stated on the limited permit.

< At the final destination, the sealed container must be opened only in the presence of an inspector or with the authorization of an inspector obtained expressly for that shipment.

These conditions can be met in a variety of ways. It will be up to the inspector issuing the limited permit or drawing up the compliance agreement to insure that the agreements section of the compliance agreement contains language sufficient to insure that the four conditions stated above are met.

Certificates

Certificates may be issued, either individually or under compliance agreement, for regulated articles that are eligible for movement into or through protected areas, when the applicant can meet the following conditions:

- Plants of the genus Berberis must show at least 2 years’ growth, and must be identified as being rust resistant by belonging to a species and/or variety listed in Section 301.38–2[b].

- Plant parts capable of propagation (seeds, fruits, etc.) of the genus Berberis must be identified as being rust resistant by coming from plants belonging to species and/or varieties listed in Section 301.38–2[b].

- Plants, seedlings, and plant parts capable of propagation (seeds, fruits, etc.) of the genera Mahoberberis and Mahonia must be identified as being rust resistant by belonging to a species and/or variety listed in Section 301.38–2[c].

- Seed of any of the genera listed above can only be issued a certificate when it can be determined that the property at which the seed is produced contains only rust resistant species and/or varieties of these genera (Section 301.38–2[a] and [b]). In addition, visual inspections must have been conducted to confirm that all Berberis, Mahoberberis, and Mahonia plants within one-half mile of the property at which the seed is produced are rust resistant.

If the identity of plants can be determined by tags or labels attached to the individual plants or pots, the certificate may be a stamp affixed to an appropriate shipping document. If the individual plants are not labeled as to species and/or variety, each plant (or pot) must have affixed a sticky-back certificate or other evidence that the plant meets the APHIS requirements for certification as stated above.

General Aids to Identification

Inspectors must be able to distinguish between susceptible and resistant species of barberry. This is necessary to insure that plants are correctly labeled, that plants are true to type, and in order to identify unlabeled plants. In many cases, recognizing a few simple characteristics will enable the inspector to identify rust-susceptible barberry species. The rust-susceptible species most likely to be encountered is the common European barberry, Berberis vulgaris. Other rust-susceptible species that may be encountered will frequently have characteristics similar to those that distinguish the common barberry. Five types of characteristics will be most helpful in distinguishing rust-susceptible from rust-resistant barberry varieties. A guide to how these characteristics may be used is shown in the table below:

RUST SUSCEPTIBLE RUST RESISTANT

LEAVES	saw tooth edge	smooth edge
BARK	grey	reddish brown
BERRIES	in bunches	singly or in twos
SPINES	groups of three	single
STEMS	straight	angled at nodes

When all of the characteristics commonly associated with a susceptible or resistant species occur together, a correct identification can be almost always made. Barberry plants found to have sawtooth-edged leaves, grey outer bark, berries occurring in bunches, spines in groups of three, and straight stems will usually belong to a rust-susceptible species. Barberry plants found to have smooth-edged leaves, brown to reddish-brown bark, berries single or in twos, single spines, and strongly angled stems will usually belong to rust-resistant species.

Unfortunately, many of the plants encountered in the field will not be as easily identified. In some cases the characteristics may be indistinct leaves may be “sort of rough” on the edge, or stems may change color, depending on age. In other cases, the plant may have some characteristics associated with rust-susceptible species and other characteristics associated with rust-resistant species. This may be due to the fact that the plant is not one of the “typical” species, or that the plant belongs to a hybrid variety resulting from a cross between susceptible and resistant species.

When plants having characteristics that are not as well defined as those listed above, and/or have a mixture of types of characteristics are encountered, further effort will be required to identify the particular species or variety to which the plant belongs. To aid in making this identification, two additional types of identification systems are provided. The first is taken from an earlier barberry survey manual and requires matching of characteristics of the unknown plant with those contained in a series of pictures with descriptions of a number of more common berberis and mahonia species.

The second identification system involves the use of a key developed by Agriculture Canada. Identification using this system involves following the key and making choices depending on the characteristics that are present in the unknown plant. This is a more conventional, and often more accurate, method but does require that the identifier understand a number of terms that are used by taxonomists to describe plant characteristics.

Some people will find that one or the other of these two identification systems will work best for them. Many people will find that being able to use both systems will be most effective. Regardless of which identification system is used, there will be occasions in which the unknown plant does not fit any of the descriptions that are provided. This may be due to a poor specimen, inexperience on the part of the identifier, or to the fact that the plant in question is not included in either of the keys. If this is the case, contact David Long in St. Paul, MN to submit a specimen of the plant for testing of its resistance to black stem rust.