Pea Seed-borne Mosaic Virus (PSbMV) in Field Peas and Lentils

Figure 1. Malformed terminal rosette caused by PSbMV. (Photo by Michael Wunsch, NDSU)

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Pea seed-borne mosaic virus (PSbMV) is an economically damaging viral pathogen of field peas and lentils that can cause significant losses in seed yield and quality, especially when infections occur before or during bloom. The disease has been observed on field peas and lentils in North Dakota and on field peas in Montana. PSbMV is seed-transmitted and spread between plants by aphids or via direct contact between healthy and infected plants. When aphid populations are high, even planting a few infected seeds can lead to severe epidemics. Infested seed and aphid movement from infested crops are important contributors to the local spread of PSbMV.

Pathogen

This virus was renamed to *Potyvirus pisumsemenportati* (source: International Committee on Taxonomy of Viruses). PSbMV has at least six different strains (P1, P2, P3, P4, U-1, and U-2) and is distributed worldwide. The P1 strain is the most common strain that causes significant economic damage. PSbMV was presumably introduced into North Dakota and Montana through seed imported from other regions.

Symptoms

In peas, PSbMV causes stunting, reduced internode length, malformed leaves and terminal rosettes (Fig. 1, 2). The virus can delay plant maturity, leading to uneven crop maturation (Fig. 3, 4). Infected leaves can exhibit clearing and swelling of veins, slight downward curling of margins, chlorosis and/ or a mottled or mosaic discoloration (Fig. 5). Pods are often deformed (Fig. 6), and seeds produced from infected plants can exhibit pronounced discoloration (Fig. 7), split seed coats (Fig. 8), shriveling and reduced size.

Figure 2. Malformed terminal rosette caused by PSbMV; note the shortened internode lengths. (Photo by Kevin McPhee, NDSU)

Figure 3. Delayed maturity and mild malformation caused by PSbMV. (Photo by Michael Wunsch, NDSU)

Figure 4. Severe malformation and delayed maturity in peas infected with PSbMV. (Photo by Michael Wunsch, NDSU)

PSbMV causes similar symptoms in lentils, including stunting, shortening of internodes, reduced leaf size, downward curling of leaflets, chlorosis or necrosis of shoot tips, mild mosaic discoloration of leaves, and deformed pods. Seeds produced by infected plants are often smaller. PSbMV-related seed discoloration is less common in lentils than in peas.

The severity of PSbMV symptoms varies widely. Infected peas and lentils do not always develop symptoms of PSbMV, and infected plants sometimes remain completely asymptomatic, even in susceptible cultivars. Some strains of the virus cause mild, transient symptoms that are readily apparent for only a few weeks before bloom, while other strains of the virus result in clear symptom expression throughout crop development.

The number of virus transmission generations through seed alone (without new transmission events through aphids) can also affect symptom expression, resulting in asymptomatic plants with virus detected only in flowers and seeds. Infected seeds are often asymptomatic. Although PSBMV-infected seeds often reduce seed size and weight, infected seeds can be found across the entire range of seed sizes.

Figure 5. Clearing of veins and slight downward curling of leaf margins caused by PSbMV. (Photo by Michael Wunsch, NDSU)

Figure 6. Mosaic discoloration with minor vein clearing on leaves caused by PSbMV. (Photo by Lyndon Porter, USDA ARS)

Figure 7. Seed discoloration caused by PSbMV. (Photo by Kevin McPhee, NDSU)

Figure 8. Splitting of seed coats caused by PSbMV. (Photo by Julie Pasche, NDSU)

Figure 9. Nymph of the pea aphid, *Acyrothosiphon pisum*.
(Photo by Patrick Beauzay, NDSU)

Figure 10. Heavy aphid pressure. (Photo by Sam Markell, NDSU)

Detection

PSbMV and other viruses can be difficult to identify accurately based on visual symptoms. Two or more viral diseases often occur together, leading to a combination of symptoms. Abiotic stresses such as nutritional imbalances, herbicide toxicity and insufficient or excessive water can result in foliar symptoms similar to those caused by viruses. Seed quality losses caused by PSbMV can easily be confused with damage caused by fungal pathogens or damage incurred during harvest or storage.

For accurate detection of PSbMV, laboratory analysis is required. Nucleic-acid-based techniques (reverse-transcriptase PCR [RT-PCR]) and serological techniques (tissue blot immunoassay [TBIA] and enzyme-linked immunosorbent assay [ELISA]) are sensitive and accurate. However, when levels of virus infection are low, or when virus expression is transient or limited to parts of the plant not tested, false negative results still may be reported with these techniques.

The evaluation of seed lots for PSbMV is best performed using nucleic acid-based or serological techniques. Bioassays in which seeds are planted in the greenhouse and levels of seed-borne PSbMV are determined by assessing plants for visual virus symptoms can result in false-negatives. Plants infected with PSbMV sometimes do not develop symptoms or may develop only mild, transient symptoms difficult to identify. However, when maximum accuracy is needed, a combination of both approaches should be used, with all plants in a bioassay tested for PSbMV using laboratory-based techniques.

Disease Cycle

Transmission

PSbMV is seed-borne and seed-transmitted, and it is usually introduced into new regions through the movement of virus-infected seeds. Seed transmission rates of up to 100% have been reported for PSbMV in field peas, with rates of 30% or higher commonly observed. Seed transmission rates as high as 44% have been reported for PSbMV in lentils, although the efficiency of seed transmission of PSbMV in lentils may differ based on the strain.

Aphids facilitate secondary spread of PSbMV. Aphids transmit the virus from diseased to healthy plants within fields and can spread it to neighboring fields. When aphid populations are high, even low levels of infected seeds can result in severe PSbMV epidemics. More than 20 aphid species, including the pea aphid (*Acyrothosiphon pisum*; Fig. 9, 10), are known to transmit PSbMV. Aphids transmit the virus nonpersistently, acquiring and transmitting it during short feeding periods.

The virus can also be introduced to fields from infected volunteers and other infected hosts. PSbMV infects and causes disease in chickpeas, faba beans and vetches (*Vicia* spp.), and it can latently infect alfalfa, sugar beets, and several wild plants common to Montana and North Dakota, including black medic (*Medicago lupulina*) and shepherd's purse (*Capsella bursa-pastoris*). PSbMV generally does not cause economic losses in chickpeas.

Economic Importance

In peas and lentils, PSbMV can cause economic losses in seed yield and quality. PSbMV seed quality losses are most pronounced in peas, where it causes discoloration, cracked coats, shriveling and size reductions.

PSbMV seed quality losses are less pronounced in lentils, where seed discoloration is less common. Yield losses are proportional to levels of seed-borne infection and the timing of secondary virus transmission, with the most severe losses occurring when secondary virus spread occurs before or during flowering. A combination of reduced seed number and weight causes PSbMV-related yield losses.

In field trials conducted in Australia on field peas, yield losses of 15%-21% were observed when initial levels of seed-borne PSbMV infection were low (1%-2%) and when aphids arrived at or shortly before bloom. At higher levels of seed-borne PSbMV infection (6.5%-8%), yield losses of 13% or more were observed irrespective of when aphids arrived.

Pest Management

Clean Seed

Using virus-free seed is the most effective strategy for managing PSbMV and the best method for controlling it when resistant cultivars are not available. Only seed testing negative for PSbMV in laboratory tests should be used.

PSbMV-infected plants do not always express symptoms or may express the symptoms only transiently, which means diagnosing the disease accurately based on visual symptoms can be difficult. Where PSbMV is detected, the seed should not be saved. Infected seed is often symptomless, and it cannot be fully eliminated from seed lots based on appearance or size.

Resistant Varieties

Resistance to PSbMV has been identified in lentils and field peas, and incorporated into some commercial pea cultivars developed in other regions. Commercial lentil and pea cultivars adapted to North Dakota likely differ in their susceptibility to PSbMV, but the relative susceptibility of locally adapted commercial cultivars is unknown. Cultivars can be tested for genetic resistance to the virus by sending plant tissue to commercial labs for testing.

Insecticides

Insecticides can help reduce the secondary spread of PSbMV by reducing populations of virus-transmitting aphids, but insecticides provide only partial control. Insecticides may provide unsatisfactory results, especially when PSbMV-infected seeds are planted. Nonpersistently transmitted viruses such as PSbMV are carried transiently by aphids, and killing infected aphids with insecticides may result in only a modest reduction in transmission events. Systemic insecticides, which are primarily transported in the sap-conducting (phloem) cells of plants, often provide inconsistent control of nonpersistently transmitted viruses such as PSbMV, which are acquired from and transmitted to epidermal cells on the leaf surface, not phloem cells.

Insecticides are most likely to be successful when applied to prevent the establishment of economically damaging aphid populations, especially when seed-borne transmission of PSbMV has occurred in one field and suppression of secondary spread to neighboring fields is desired.

Insecticide applications are based on aphid populations. Scouting for pea aphids should be conducted at least weekly from late vegetative growth through pod development using a visual count or a 15-inch sweep net.

When peas are grown near alfalfa fields, scouting should be intensified after alfalfa cuttings; alfalfa can be a latent (asymptomatic) host of PSbMV, and cutting alfalfa often results in an influx of aphids into neighboring legume crops. The number of pea aphids in the upper 8 inches of plant tips should be counted on 10 plants from four different areas of the field (a total of 40 plants) or from 25 sweeps with an insect sweep net (every 180 degrees) conducted at four different areas of the field (a total of 100 sweeps).

In field peas, an insecticide application would be justified if aphids reach the economic threshold of more than an average of one to two aphids per plant or 10 aphids per sweep. In lentils, insecticide treatment for pea aphid control should be considered: (1) when the economic threshold of an average of 30 to 40 aphids per sweep is observed, (2) when few natural enemies are present, and (3) when aphid numbers do not decline during a two-day period. If the economic threshold is exceeded, a single application of insecticide usually will be sufficient.

Control at the early pod stage protects the pod-forming and elongation stages, which are very sensitive to aphid damage. Insecticides registered for control of pea aphids in pulse crops can be found in the current NDSU Extension publication “E1143 – North Dakota Field Crop Insect Management Guide” at https://www.ndsu.edu/agriculture/extension/publications/north-dakota-field-crop-insect-management-guide.

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