cdfa CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

California Pest Rating Proposal for

Maize dwarf mosaic virus

Current Pest Rating: C

Proposed Pest Rating: C

Kingdom: Viruses and viroids, Category: Riboviria

Family: Potyviridae

Comment Period: 8/18/2020 through 10/02/2020

Initiating Event:

On August 9, 2019, USDA-APHIS published a list of "Native and Naturalized Plant Pests Permitted by Regulation". Interstate movement of these plant pests is no longer federally regulated within the 48 contiguous United States. There are 49 plant pathogens (bacteria, fungi, viruses, and nematodes) on this list. California may choose to continue to regulate movement of some or all these pathogens into and within the state. In order to assess the needs and potential requirements to issue a state permit, a formal risk analysis for Maize dwarf mosaic virus is given herein and a permanent pest rating is proposed.

History & Status:

Background:

A new maize disease was first recognized in Iowa in the 1960's and named Maize dwarf mosaic virus (MDMV) (Jansen and Ellet, 1963; Janson et al., 1965). From 1972 until 1989, MDMV was thought to be a strain of Sugarcane mosaic virus (SCMV) that did not infect sugarcane and was specific to corn and other grasses (Pirone, 1972). However, based on characteristics of host range and differential host plants, as well as serology, MDMV was shown to be distinct from SCMV. Today the taxonomy of MDMV is based on infectivity to Johnsongrass, specificity of sorghum differential cultivars, and amino-acid sequence in the N-terminus of virus coat protein polypeptide chain (Shukla et al., 1989).

MDMV is a positive sense ssRNA virus in the family Potyviridae and the genus Potyvirus. Named after potato virus Y, this is a large genus of plant viruses and includes many of the most severe viral diseases of crop plants. Potyvirus virions are flexuous filaments the infection produces cylindrical inclusion

bodies that look like pinwheels and scrolls in infected plant cells. They are transmitted in nature mainly by aphids in the nonpersistent manner, and some are transmitted through the seed. MDMV causes economic losses in maize (including broom maize), sweetcorn, sorghum (including silage sorghum and grain sorghum), Johnson grass, and Sudan grass.

Hosts: Avena sativa (oats), *Bromus catharticus* (prairiegrass), *Chloris barbata* (purpletop chloris), *Panicum miliaceum* (millet), *Paspalum conjugatum* (buffalo grass), *Pennisetum glaucum* (pearl millet), *Saccharum officinarum* (sugarcane), *Sorghum bicolor* (sorghum), *Sorghum halepense* (Johnson grass), *Sorghum sudanense* (Sudan grass), *Stenotaphrum secundatum* (buffalo grass), *Tripsacum dactyloides* (eastern gamagrass), *Urochloa plantaginea* (marmeladegrass), and *Zea mays* (maize).

Symptoms: Symptoms are generally similar across the different hosts of MDMV. Virus-infected plants are off-color, dwarfed, and sterile, and sometimes die prematurely. The severity of symptoms depends on the susceptibility of the genotype being grown and on the time of infection, with early infections more serious than later. Leaves that have completed their growth before infection remain symptomless (only the inoculated leaf and younger leaves show discoloration), thus it is possible to estimate at what stage of growth the infection occurred. The internodes on the stalk of infected maize plants, formed after infection, are shorter and sometimes become rosette-like at the apices.

Mosaic usually appears first at the base of the youngest leaf still unfolding in the sheath. Chlorotic dots and streaks can appear near the main vein that gradually enlarge and spread. Streaks and dots can merge into chlorotic stripes or lines that extend along the length of the leaf blade. Upper leaves which grow after infection became chlorotic and yellowish.

Sterility is a symptom in maize infected with MDMV. Sterility is due to a delay of the silking and tasseling stages compared with healthy plants (Scott and Nelson, 1972). Lower pollen viability and shorter pollen germ tubes of maize plants infected with MDMV have also been reported (Mikel et al., 1982). Incomplete fertilization of ears of maize plants, sometime leaving entire rows of grain incomplete, is also a symptom of MDMV.

Mosaic is a common symptom on sorghum, but the degree of symptom expression depends on plant genotype susceptibility and on climatic conditions. The first signs of mosaic are on the base of the youngest leaf, still in the sheath. Chlorotic dots and streaks can later merge and spread over the leaf blade forming chlorotic stripes or lines. Under cool conditions, mosaic on sorghum can include red stripes that can become necrotic. Other symptoms on sorghum include dwarfing, excess tillering, and necrosis (Jarjees and Uyemoto, 1983). Symptoms on Johnsongrass are similar to sorghum. Chlorotic streaks run along the veins of the leaves, and they often turn reddish.

Transmission: Potyviruses overwinter in perennial cultivated and weed hosts or in seed. They are transmitted by their insect vectors from their perennial hosts, or from plants produced from virus-infected seed, to the healthy plants of the new crop. MDMV is transmitted by numerous aphids from infected wild or cultivated host plants. MDMV can be detected at low levels in the pericarp and endocarp of maize (Mikel et al., 1984).

In California, the important vectors include the corn leaf aphid (*Rhopalosiphum maidis*), the greenbug (*Schizaphis graminum*), and the green peach aphid (*Myzus persicae*). The number of infected plants in a field can begin at a low level with slow increase, but the spread can become exponential. Often, 100% of the plants in a field become infected with potyviruses as aphids can spread the virus so quickly (Agrios, 2005). Persistence of MDMV in aphids is usually between 30 minutes and 4 h. It has been reported that MDMV may be spread by urediospores of *Puccinia sorghi* (Wechmar et al., 1992).

Damage Potential: The control of potyviruses is very difficult. Using virus-free seed, planting resistant varieties, destroying infected volunteer plants or weeds within and around crop fields can help. Although many grasses are infected by this strain of the virus, the principal overwintering reservoir host in California is johnsongrass. Most outbreaks of maize dwarf mosaic in corn can be traced to nearby johnsongrass (Davis, 2011).

MDMV causes economic losses in maize, and sorghum, including silage sorghum, grain sorghum and broom maize. Infection on maize plants affects leaf area, fertility and mature weights, seed yield, total yield, seed quality (viability), and susceptibility of infected plants to other pathogens/diseases. Leaf area reduction, along with a decrease in plant height, have a large influence on crop productivity. Leaf area reduction in maize plants infected with MDMV is up to 11%, but after early infection and early water stress, the leaf area could be reduced by 33% or more. The height of maize plants infected with MDMV is reduced by up to 23% (Olsen et al., 1990).

Sterility, which is more frequent with infected maize plants, contributes to the economic impact of MDMV. Reduced growth and development, and changes in some plant development stages (Dimitrijevic, 1969; Scott and Nelson, 1972; Mikel et al., 1981) can lead to sterility in up to 25% of infected plants (Tosic and Misovic, 1967), but in the case of maize inbred lines the sterility can be even higher (Tosic et al., 1990a).

Sterility, loss of kernels, lower weight of kernels and a lower number of ears per plant, are all observed with MDMV infection (Mikel et al., 1982). Fresh weigh, ear length, ear diameter and ear yield can be drastically reduced by MDMV, especially after an early infection. (Olsen et al., 1990). Yield reduction in sweetcorn of 75% or more has been reported (Forster et al., 1980). Yield of grain sorghum due to MDMV infection can be reduced by up to 79% (Giorda and Toler, 1986).

Worldwide Distribution: Africa: *Burkina Faso, Cameroon, Côte d'Ivoire, Egypt, Ethiopia, Kenya, Mauritius, Morocco, Niger, Nigeria, South Africa, Zambia, Zimbabwe*. Asia: *China, Georgia, India, Iran, Iraq, Israel, Kazakhstan, Pakistan, Philippines, South Korea, Taiwan, Turkey, Uzbekistan, Yemen*. Europe: *Bosnia and Herzegovina, Bulgaria, Croatia, Czechia, France, Germany, Greece, Hungary, Italy, Poland, Romania, Russia, Serbia and Montenegro, Spain, Ukraine*. North America: *Canada, Cuba, Haiti, Honduras, Mexico, United States* (Alabama, Arkansas, California, Delaware, Florida, Georgia, Hawaii, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Nebraska, New Hampshire, New Jersey, New Mexico, New York, North Carolina, North Dakota, Ohio, Oklahoma, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas,

Vermont, Virginia, Washington, Wisconsin). Oceania: *Australia*. South America: *Argentina, Brazil, Chile, Colombia, Peru, Venezuela* (CABI-CPC, 2020).

Official Control: EPPO A1 list for Jordan (EPPO, 2020), USDA-PCIT harmful organism list for: Australia, Bermuda, Georgia, Indonesia, Japan, Mauritius, Nauru, New Zealand, Nicaragua, Panama, Syrian Arab Republic, Taiwan, Timor-Leste (USDA-PCIT, 2020). MDMV in seed is a pest of concern for California trading partners and it is listed in the PQ Phytosanitary field inspection manual for corn seed for export.

California Distribution: Fresno, Madera, Monterey, Sacramento, Santa Clara, Solano, Yolo

California Interceptions: None

The risk Maize dwarf mosaic virus would pose to California is evaluated below.

Consequences of Introduction:

1) **Climate/Host Interaction:** MDMV survives in perennial plant hosts and seeds. Climate is not a limiting factor for the pathogen but can affect populations of its insect vectors on a seasonal or regional basis.

   Evaluate if the pest would have suitable hosts and climate to establish in California.

   Score: **3**
   - Low (1) Not likely to establish in California; or likely to establish in very limited areas.
   - Medium (2) may be able to establish in a larger but limited part of California.
   - **High (3) likely to establish a widespread distribution in California.**

2) **Known Pest Host Range:** There are many hosts, all of which are members of the family Poaceae (grasses).

   Evaluate the host range of the pest.

   Score: 2
   - Low (1) has a very limited host range.
   - **Medium (2) has a moderate host range.**
   - High (3) has a wide host range.

3) **Pest Reproductive Potential:** This disease relies primarily on its aphid vectors for movement and exponential growth during epidemics has been reported.

   Evaluate the natural and artificial dispersal potential of the pest.

   Score: 3
   - Low (1) does not have high reproductive or dispersal potential.
   - Medium (2) has either high reproductive or dispersal potential.

- High (3) has both high reproduction and dispersal potential.

4) **Economic Impact:** Losses from MDMV in California have mainly been reported on corn. To reduce disease, growers are advised to remove johnsongrass within a quarter of a mile around the corn field and to delay planting until aphid flights are over (Davis, 2011). This virus is also a concern for export seed.

Evaluate the economic impact of the pest to California using the criteria below.

Economic Impact: A, B, C

A. The pest could lower crop yield.
B. The pest could lower crop value (includes increasing crop production costs).
C. The pest could trigger the loss of markets (includes quarantines).
D. The pest could negatively change normal cultural practices.
E. The pest can vector, or is vectored, by another pestiferous organism.
F. The organism is injurious or poisonous to agriculturally important animals.
G. The organism can interfere with the delivery or supply of water for agricultural uses.

Economic Impact Score: **3**
- Low (1) causes 0 or 1 of these impacts.
- Medium (2) causes 2 of these impacts.
- High (3) causes 3 or more of these impacts.

5) **Environmental Impact:** It is likely that MDMV can infect native and naturalized grasses, although impacts have not been reported.

Environmental Impact:

A. The pest could have a significant environmental impact such as lowering biodiversity, disrupting natural communities, or changing ecosystem processes.
B. The pest could directly affect threatened or endangered species.
C. The pest could impact threatened or endangered species by disrupting critical habitats.
D. The pest could trigger additional official or private treatment programs.
E. The pest significantly impacts cultural practices, home/urban gardening or ornamental plantings.

Environmental Impact Score: 1
- Low (1) causes none of the above to occur.
- Medium (2) causes one of the above to occur.
- High (3) causes two or more of the above to occur.

Consequences of Introduction to California for Maize dwarf mosaic virus: Medium

Add up the total score and include it here. **12**

-Low = 5-8 points
-**Medium = 9-12 points**
-High = 13-15 points

6) **Post Entry Distribution and Survey Information**: Evaluate the known distribution in California. Only official records identified by a taxonomic expert and supported by voucher specimens deposited in natural history collections should be considered. Pest incursions that have been eradicated, are under eradication, or have been delimited with no further detections should not be included.

Evaluation is 'high'. Detections have been made in seven counties

Score: -3
-Not established (0) Pest never detected in California or known only from incursions.
-Low (-1) Pest has a localized distribution in California or is established in one suitable climate/host area (region).
-Medium (-2) Pest is widespread in California but not fully established in the endangered area, or pest established in two contiguous suitable climate/host areas.
-High (-3) Pest has fully established in the endangered area, or pest is reported in more than two contiguous or non-contiguous suitable climate/host areas.

7) **The final score is** the consequences of introduction score minus the post entry distribution and survey information score: (Score)

Final Score: *Score of Consequences of Introduction – Score of Post Entry Distribution and Survey Information* **= 9**

Uncertainty: None

Conclusion and Rating Justification:

Based on the evidence provided above the proposed rating for Maize dwarf mosaic virus is C.

References:

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Responsible Party:

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***Comment Period: 8/18/2020 through 10/02/2020**

***NOTE:**

You must be registered and logged in to post a comment. If you have registered and have not received the registration confirmation, please contact us at permits[@]cdfa.ca.gov.

Comment Format:

- Comments should refer to the appropriate California Pest Rating Proposal Form subsection(s) being commented on, as shown below.

  Example Comment:

  Consequences of Introduction: 1. Climate/Host Interaction: [Your comment that relates to "Climate/Host Interaction" here.]

- Posted comments will not be able to be viewed immediately.
- Comments may not be posted if they:

  Contain inappropriate language which is not germane to the pest rating proposal;

  Contains defamatory, false, inaccurate, abusive, obscene, pornographic, sexually oriented, threatening, racially offensive, discriminatory or illegal material;

  Violates agency regulations prohibiting sexual harassment or other forms of discrimination;

  Violates agency regulations prohibiting workplace violence, including threats.

- Comments may be edited prior to posting to ensure they are entirely germane.
- Posted comments shall be those which have been approved in content and posted to the website to be viewed, not just submitted.

Proposed Pest Rating: C