



Physiological Leaf Roll of Tomato

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A fact sheet prepared by *The Pacific Northwest Vegetable Extension Group* (http://mtvernon.wsu.edu/path_team/vegpath_team.htm), which includes specialists from the University of Idaho, Oregon State University, Washington State University, and USDA-ARS who contribute expertise in plant pathology, horticulture, and entomology to help identify and offer solutions to vegetable problems in Idaho, Oregon, and Washington.

Many areas in the Pacific Northwest experienced unusually hot and dry conditions during the 2009 summer growing season, including record dry and warm conditions west of the Cascade Mountains. PNW Vegetable Extension Group members throughout Idaho, Oregon, and Washington received many reports of moderate to severe leaf rolling on tomato plants in home gardens and commercial fields (Figure 1). Although the leaf roll symptoms were similar to those caused by certain viruses (curly top and tomato yellow leaf curl, for example), plants with leaf roll symptoms in the Pacific Northwest in 2009 tested negative for viruses. Based on this and other characteristics described below, the symptoms were attributed to a disorder on tomatoes known as “physiological leaf roll.”

Current knowledge of tomato physiological leaf roll indicates tomato yield and fruit quality are not affected by this physiological disorder. However, tomato growers become concerned by the symptoms and seek to manage their production system to minimize this disorder. This fact sheet provides information to help distinguish between tomato physiological leaf roll and infectious plant diseases that can cause yield and fruit quality losses.

Symptoms

Physiological leaf roll starts with upward cupping at the leaf margins followed by inward rolling of the leaves (Figure 1). Lower leaves are affected first, and can recover if environmental conditions and cultural factors are adjusted to reduce stress (see Management Strategies below). If the conditions favoring leaf roll are prolonged, affected leaves may not recover. In severe cases, whole plants can be affected. If environmental conditions and cultural factors are adjusted after prolonged leaf rolling, new growth that develops subsequently may not exhibit leaf roll symptoms (Figure 1B).

Causes

Many university extension publications (see References below) provide information about this physiological condition. Several causes are reported. The severity of leaf roll appears to be cultivar dependent. Cultivars selected for high yield tend to be most susceptible. Indeterminate cultivars of tomato are reported to be more sensitive to this disorder than determinate cultivars. Determinate varieties of tomatoes, also called “bush” tomatoes, stop growing when their first

fruit sets, whereas indeterminate varieties, also called “vining” tomatoes, grow and flower until killed by frost or other harsh environmental conditions. In some cases, the condition is believed to occur most commonly when plants are pruned during dry soil conditions. In other cases, causes listed include growing high-yielding cultivars under high nitrogen fertility programs, phosphate deficiency, or extended dry periods. The disorder is also attributed in some areas to excess soil moisture coupled with prolonged high air temperatures.

In a study in Florida, removal of young vegetative shoots and fruit hands caused rapid and severe rolling of the lower leaves of ‘Floradel’ tomato plants, and symptoms progressed to the upper leaves. Sugar and starch accumulation in the lower leaves was positively correlated with the degree of leaf rolling, and overhead shading decreased the severity of leaf roll. A report from Kansas indicated that when spring weather is mild at planting, top growth may be more vigorous than root growth. If drier summer weather follows, the foliage may transpire water faster than the root system absorbs water from the

soil, and the plant will compensate by rolling its leaves to reduce the transpiration surface area. This situation may reflect Pacific Northwest tomato growing conditions in 2009.

Regardless of the cause of physiological leaf roll, the symptoms are generally the same in that the margins of the leaves roll up and curl inward (Figure 1). Leaf roll symptoms first appear on the older (lower) leaves, and may disappear after a few days. Not all leaves on a plant may exhibit rolling, but eventually the rolling can involve most leaves on a plant and persist through the season. The margins of adjacent leaflets may touch or overlap. Rolled leaves become rough and leathery but are otherwise normal in size and appearance. There is no discoloration of leaf veins associated with this condition. Plant growth, fruit yield, and fruit quality are not believed to be affected by physiological leaf roll (Figure 1C).

Management Strategies

Management strategies recommended for physiological leaf roll include:



Figure 1. A) Severe physiological leaf roll symptoms on a tomato plant. B) Tomato plants with physiological leaf roll on the older (lower) leaves and normal new (top) growth that developed after air temperatures cooled. C) Some tomato cultivars are less susceptible to physiological leaf roll than others, and plants may show mild physiological leaf roll without fruit yield and quality affected. *Photos courtesy of Pacific Northwest Vegetable Extension Group members.*

- planting determinate cultivars;
- planting in well-drained soils and maintaining uniform, adequate soil moisture (~1 inch per week during the growing season depending on the area of production);
- being careful not to over-fertilize--especially with nitrogen fertilizers--and providing appropriate phosphorus fertilizer (refer to your soil test results for specific fertilizer recommendations);
- avoiding severe pruning; and
- maintaining temperatures below 95°F by using shading or evaporative cooling.

Additional details on fertilizer programs are available for specific regions of production and specific tomato cultivars (e.g., <http://hort-devel-nwrec.hort.oregonstate.edu/tomato.html#fertilize>).

Accurate plant diagnosis is essential before management practices are initiated. Some tomato pathogens can cause symptoms very similar to physiological leaf roll, so it is important not to confuse an abiotic disorder like physiological leaf roll with infectious diseases of tomato. For example, *curly top virus* causes upward leaf rolling but, in addition, the leaves may show chlorosis (yellowing), become thickened and crisp, and the growing points may cease to develop. *Tomato mosaic virus* can cause prominent leaf roll but mostly during early growth stages and is accompanied by mosaic mottle symptoms. *Tomato yellow leaf curl virus* causes upward rolling of leaves depending on the plant growth stage at the time of infection. Tomato yellow leaf curl has been observed in California, but nowhere in the Pacific Northwest. While rarely causing symptoms in tomato, aster yellows phytoplasma can cause leaf roll on the upper leaves. Informative photos on tomato diseases can be found on several university Web sites (see References below). The *Compendium of Tomato Diseases*, published by APS Press (<http://www.shopapspress.org/>), has valuable information and photos on tomato problems, as does the *Online Guide to Plant Disease Control* (<http://plant-disease.ippc.orst.edu/>).

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