Pinot Leaf Curl

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Anomalies in growth and development of leaves and shoots of primarily Pinot wine grape varieties were observed in Sonoma and Napa Counties in 2009-2011. Terms to describe symptoms include "Pinot leaf curl", "main vein necrosis", "Pinot petiole necrosis", "Pinot shoot necrosis" and "Pinot disorder." Across all sites, initial leaf symptoms are consistent; therefore, Pinot leaf curl (PLC) is the term used by many growers to describe the abnormal leaf and shoot growth that may occur in grapevine varieties of Pinot.

Each spring, symptoms can be observed in specific blocks of Pinot Noir and Pinot Blanc and less consistently in Pinot Meunier. Over the past 3 years increase in the number of blocks with PLC-affected vines and severity of symptoms has resulted in an increased awareness and concern by growers who are at a loss as to how to prevent or reduce shoot damage. Cool, wet conditions during early shoot growth appear to result in increased incidence and severity of symptoms. Vines with severe PLC symptoms may have reduced crop load.

Onset of atypical leaf blade development is during early season shoot elongation and new leaves may continue to be affected through bloom. In some blocks, symptoms appear as early as 4 inches of shoot growth; more commonly, onset occurs after 3 or more leaves beyond the flower clusters have separated from the shoot tip. Affected blades are usually observed between the proximal (top) cluster and the shoot tip and several nodes may be involved. Most of the symptoms of PLC develop prior to bloom.

Blades appear to bend or fold downward across the middle of the blade, perpendicular to the main vein. The angle of the downward bend is acute; the tip of the center lobe may come into contact with the petiole *(photo B).* If symptom onset occurs shortly after a leaf has separated from the shoot tip, leaf expansion stops; when this occurs, blades may be an inch wide or smaller. From a distance, affected shoots appear to be stripped of leaves above the proximal (top) cluster. Lateral shoots push at all nodes with abnormal leaf blade development, temporarily resulting in broom-like growth until a single lateral becomes dominant *(photo C).*

Mild symptoms of PLC involve only the blade which either stops expanding, or becomes increasingly distorted as it continues to expand. Upon close examination of the underside of the blade, the center vein contains a darkened or necrotic region that prevents further elongation of the vein resulting in the downward curve of the blade as it grows (*photo A*). Symptom development may cease at this point. In vineyard blocks with annual occurrence of PLC, symptoms primarily range from very small to full-sized blades with either a slight or significant fold. Lateral shoots appear at each node, but usually remain less than 4 inches in length if the primary shoot continues to elongate.

Severe expression of PLC involves the shoot. The necrotic region that initiates at a leaf vein extends to the petiole and both blade and petiole abscise from the shoot *(photo E).* Several leaves may abscise from a single shoot from the node above the proximal cluster up to the shoot tip. A small necrotic area may also occur on the shoot at the point of attachment of the petioles and in the most severe occurrences of PLC, a node is killed and the shoot dies back to that point. Node necrosis often occurs at or just above a cluster and crop load is reduced when necrosis occurs at a cluster-bearing node *(photo D).*

Frequency of Occurrence

PLC does not occur in all Pinot vineyards in Sonoma and Napa counties. When present, symptomatic vines tend to be found in mature blocks and mild symptoms may occur in 80% of the vines. Commonly, after PLC is

observed in a block that previously had been unaffected, symptomatic vines are readily apparent in subsequent seasons.

The incidence of PLC varies by clone of Pinot Noir. In a block planted with 2 or more clones, differences in symptom severity by clone are obvious *(photo F).* In the last few years, Pinot Noir 828 had noticeably few if any symptoms whereas Pinot Noir 115 was affected. Rootstock does not appear to affect incidence of PLC; however a thorough rootstock survey in Pinot vineyards with and without PLC has not be conducted.

The incidence of PLC increases in cold, wet springs during early shoot growth. In 2010 and 2011, there were fewer total accumulated degree days in April and May than in previous years in the west county based on daily min-max temperatures collected at the NOAA climate station located in Graton. There were 330 and 359 Degree-Days Fahrenheit (DDF) accumulated in April and May 2010 and 2011 respectively as compared to an average of 593 DDF in the same two months over the 5 year period of 2003-2007. (Data are sourced from UC IPM Online).

Fungicide applications do not reduce incidence or severity of PLC

Symptoms appear somewhat similar to Botrytis shoot blight caused by *Botrytis cinerea* on foliage under cool, wet spring conditions. However, foliar applications of fungicides targeting botrytis do not reduce subsequent symptom development. Fungi known to be severe pathogens on grape foliage have not been associated with PLC in samples submitted to the lab of UCD Extension Plant Pathologist Doug Gubler. *Botrytis cinerea* is a weak pathogen; it is primarily a saprophyte, thus it colonizes decaying tissue which is the condition of plant tissue associated with PLC. Botrytis colonies may be seen on shoot and leaf tissue affected by PLC in wet weather which favors sporulation. In the lab, the fungus is isolated from nearly all petiole, blade and shoot samples collected from PLC affected vines.

The nitrogen connection

Nitrogen has been implicated in PLC. Results of leaf blade and petiole samples submitted to labs for nutritional analysis have indicated elevated nitrogen levels. Severe PLC can occur when nitrogen fertilizer is applied in Pinot vineyards followed by cool spring temperatures for extended periods just after bud break. However, PLC may occur in blocks that have not received applied N, or which receive light amounts, such as 2-4 pounds per acre annually. Elevated levels of putrescine – a nitrogen compound - has been associated with grapevine leaf chlorosis and necrosis in potassium deficiency and false potassium deficiency ('Spring Fever") by Doug Adams, Plant Biochemist in the Department of Viticulture and Enology. To date, the relationship of PLC and putrescine has not yet been determined.

Summary

Growers with extensive experience farming blocks affected by PLC in cool springs do not apply fungicides to prevent leaf drop or shoot necrosis. The exact role that nitrogen plays in PLC has not been determined, and if and when it is (depending on funding), then future work can investigate vineyard management practices that may reduce incidence of PLC.

The attached page contains photos taken in Pinot Noir blocks affected with PLC in May 2010 and 2011.
A: Darkened veins on underside of leaf blade. **B**: Curled leaf blades. **C**: Several shoots after leaves have dropped (note lateral shoots have emerged). **D**: Necrotic nodes and shoot dieback. **E**: Necrosis of veins on underside of leaf blade and at each end of petiole. **F**: Severe PLC in clone on right; less severe symptoms of PLC in clone on left.


A


B


C


D


E


F