THE USE OF BACTERICIDES IN PLANT AGRICULTURE WITH REFERENCE TO USE IN CITRUS TO MITIGATE HLB

Stephanie L. Slinski, Ph.D., Bactericide Project Manager, CRDF
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The purpose of this communication is to discuss the use of bactericides in plant agriculture to control disease epidemics and the approaches that have been tested to control Huanglongbing (HLB) in citrus trees. The Citrus Research and Development Foundation (CRDF) has made this topic a priority in responding to HLB in Florida citrus. HLB is a disease devastating the citrus industry in Florida and throughout the world. Presently, no chemical treatment or resistant plant is available that will control the disease. For the Florida citrus industry to survive this epidemic, a chemical control will be necessary to suppress the disease, keeping the trees in production until groves can be replanted with resistant or tolerant varieties. This is similar to approaches taken during plant disease epidemics in other crops, which were eventually controlled by the planting of resistant varieties. Oxytetracycline, streptomycin sulfate and copper have been the main chemicals available to treat bacterial plant diseases in the US. The use of copper is limited to foliar diseases in regions where copper resistance is not widespread. Streptomycin and oxytetracycline are routinely used on some crops when copper is inadequate. Oxytetracycline has also often been used in the past to help manage plant disease epidemics. Research using bactericides on citrus suggests that chemical control may improve citrus tree health and contribute to sustaining the citrus industry in the current epidemic.

Introduction

The disease HLB has been known in many regions of the world for over a century. This disease was only introduced into Florida a decade ago, but has since reached epidemic proportions. HLB in Florida is presumably caused by the bacterium *Candidatus* Liberibacter asiaticus (*C*Las), which is transmitted by an insect, the Asian citrus psyllid (ACP, *Diaphorina citri* Kuwayama). The bacterium is injected directly into the vascular system of the tree by the vector and can spread systemically down to the roots and throughout the tree canopy. The number of Florida citrus groves still in production has shrunk dramatically because of HLB due to a decrease in marketable fruit and significantly higher than previous production costs resulting from tree decline. The citrus industry employs around 62,000 people and has an economic impact of approximately 10.8 billion dollars[1]. The January 2016 all-orange crop estimate of only 69 million boxes was less than half of the pre-epidemic numbers. With the rising costs to keep the diseased trees in production, the sustainability of the industry is in question. What will ultimately ensure the continued existence of the industry are resistant citrus varieties, but no resistant variety is presently being propagated in nurseries. Even if a resistant variety were identified today, it would take many years to replant more than 500,000 acres of citrus and for those trees to reach maturity. Plant disease epidemics like HLB are relatively common, and while ultimately epidemics are controlled using resistant or tolerant plant varieties, a chemical control is often used as a stopgap.

Agricultural Bactericides

Plant diseases caused by bacteria are very difficult to control, especially when a bacteria like *C*Las resides in the phloem of the plant vascular system, and few bactericides are available to treat bacterial diseases. Although copper has been used in agriculture for several centuries as a foliar treatment to protect plants from fungal and bacterial diseases, when used systemically at bactericidal levels, copper is toxic thus, copper has not been demonstrated to be an effective treatment for HLB. A type of bactericides that has been found to provide a level of control of HLB and many other bacterial diseases is antibiotics. The two main antibiotics labeled for use in agriculture are streptomycin sulfate and oxytetracycline. Two forms of oxytetracycline are used, oxytetracycline hydrochloride and oxytetracycline calcium, but once in solution the molecules are identical. These materials have been used since the 1950s and are also important in human and animal medicine, but presently only a fraction of one percent of total domestic antibiotic use is for plant agriculture[2].

The main uses for both oxytetracycline and streptomycin sulfate in agriculture are for prevention of fire blight (*Erwinia amylovera*) in apples and pears. Streptomycin is the preferred bactericide, since it is kills the bacteria on contact (bactericidal), whereas oxytetracycline is bacteriostatic, suppressing bacterial growth. Bacteriostatic bactericides require a longer duration of exposure to suppress growth long enough to reduce the bacterial titer. Alternating chemicals with different modes of action is the primary strategy for resistance management. Streptomycin-resistant *E. amylovera* strains now occur in some areas because streptomycin was the only chemical available in the past. Oxytetracycline has been labeled for use against fire blight to manage resistance in some regions and recently, kasugamycin has been approved for use in most US states for the same purpose.

Oxytetracycline is also used against bacterial spot of peach and nectarine (*Xanthomonas arboricola* pv. *pruni*) and in non-bearing plants, where it is mainly

applied by injection to prevent infection or to treat important landscape or specimen plants. Oxytetracycline has been used historically to control important bacterial and phytoplasma diseases in emergency situations, such as coconut lethal yellowing disease, X-disease of peaches and cherries, peach yellow leaf

Return to top of page