

Yield and Variety Decline in Sugarcane

Sugarcane is a clonally propagated crop with a multiple year crop cycle. In major production areas, sugarcane is often grown as a monoculture. This means that in many places, plants are in the ground almost continuously. Can this affect productivity? Two types of reductions in productivity now have been recognized. Continuous cultivation of sugarcane can result in a general reduction in productivity that has been termed “yield decline.” In addition, there are many documented cases of loss of productivity for an individual variety. So, there is a “variety decline” that can result from continuous cultivation of any given variety. These “declines” are complicated phenomena, but we are slowly learning more about them.

Extensive research has been conducted in Australia on yield decline. They defined yield decline as “the loss of productive capacity of soils under sugarcane monoculture.” Soil physical, chemical, and biological properties can be altered by monoculture. As a pathologist, I tend to focus on the biology of the system, and in Australia, the biological factors were found to be the most important determinants of yield decline. Sugarcane can become infected with systemic pathogens during clonal propagation, and this can reduce yield potential. However, modern diagnostic techniques can detect this type of problem, and healthy seedcane programs are designed to prevent it. Yield decline is associated with changes in the community of microorganisms associated with roots that are detrimental to growth. Recognized pathogens, such as nematodes and root-rotting fungi, can be involved, but sugarcane monoculture apparently can result in detrimental changes in the composition of the large and diverse community of microbes living on or near the surface of roots in the zone known as the rhizosphere. Roots are leaky, and root exudates provide a source of nutrition that has a strong effect on the microbial community. The organisms that make up this community are not recognized as pathogens, but some combinations of organisms can result in the inhibition of root system development and reduced yield. It has been demonstrated that continuous sugarcane cultivation results in a loss of diversity in the rhizosphere microbial community, and some of the organisms that are reduced in population are those that can provide natural biological control of root pathogens.

How can you tell if yield decline is occurring in a sugarcane production area? In Louisiana, substantially higher yields can be obtained when sugarcane is planted and grown in “new ground” (soils with no recent history of sugarcane cultivation). Fumigation of soil with a general biocide, such as methyl bromide, will result in large yield increases, if yield decline is active. Fumigation is hazardous and expensive, so in sugarcane, it has only been used to demonstrate the presence of yield decline.

The ultimate question is: can anything be done to alleviate yield decline? Unfortunately, there are, as yet, not many effective

control options. The incorporation of organic materials, such as filter press cake, composts, or other agricultural and municipal “wastes” can help. These materials have an established microbial community that can disrupt the rhizosphere microbial community associated with yield decline. However, the sources of organic amendments are limited, so the area that can be treated is often small compared to the total production area. There may be opportunities to incorporate residues from crops produced during any fallow period. Rotation to some other crops can help, but there must be enough income from the alternate crop to offset the loss of sugar production during the rotation period.

Varieties have productive life-spans that vary in length. People have recognized and speculated on the causes of variety decline ever since modern sugarcane industries were established. Is there any link between yield and variety decline? An accumulation of systemic pathogens, such as the pathogen that causes ratoon stunting disease, can adversely affect productivity. However, these problems now can be detected. A tissue culture based healthy seedcane program can prevent variety decline due to recognized pathogens. Another possible linkage may exist in the soil microbial community between the two declines.

Sugarcane varieties are clones, so all plants under cultivation are genetically identical. It was demonstrated in India that the root exudates of different varieties support very different communities of microorganisms. In Hawaii, it was demonstrated that continuous cultivation of an individual variety caused a population shift towards isolates of *Pythium*, a recognized root rot pathogen, that were more damaging to that variety. It is apparent that continuous cultivation of a specific sugarcane variety can cause shifts in the rhizosphere microbial community. A variety might select for a community that is more detrimental to that specific variety. If this is occurring, widespread cultivation of a variety could hasten its demise, whereas variety diversity could prolong productivity of individual clones.

There are certainly other factors affecting variety decline. Do sugarcane varieties get old like we humans do? We certainly lose vigor as we get older. Sweet potato is a very different plant from sugarcane, but it is clonally propagated. Research in sweet potato suggests that accumulated mutations result in a decrease in yield potential. It is unknown whether this occurs in sugarcane, but molecular techniques might be able to address this question in the future.

It has been demonstrated that “declines” can affect sugarcane productivity, particularly when grown as a monoculture. As we learn more about these complex problems, practical solutions may be found to reduce their impact.

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