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ADVANCES IN CONTROL OF YELLOW LEAF SYNDROME

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SUMMARY

Yellow Leaf Syndrome (YLS) of sugarcane is now known to be caused by a virus, Sugarcane Yellow Leaf Virus (ScYLV). It is a phloem-limited luteovirus that is transmitted by two aphid species. Recently developed diagnostic techniques have allowed researchers to screen for the virus and to determine its distribution in commercial varieties in Hawaii. The virus is more widespread than previously thought and many fields that remained symptomless were found to be infected. Research is continuing to determine the effect of the virus on yield in both YLS and symptomless plants of several varieties.

INTRODUCTION

Yellow Leaf Syndrome is the name given to a disease that appeared in Hamakua on variety 65-7052 in 1989. Midribs of affected plant leaves were bright yellow and leaf die-back progressed from the tips downward with increasing browning of the entire leaf. Whole fields of 65-7052 were yellow. At that time it was not known whether it was caused by an infectious agent or whether there was a nutrient or toxicity problem. Subsequently, the same symptoms were reported from other countries[1,3,5] and especially Brazil where it is still causing significant yield losses[5]. It is now thought that the problem has been present for many years and was earlier reported under various other names.

Much research has been devoted to YLS over the last few years and at a recent ISSCT sugarcane pathology workshop in South Africa scientists discussed their results and compared ideas from the various countries. The disease is now known to be caused by a virus, Sugarcane Yellow Leaf Virus, in the luteovirus group of viruses.

SUGARCANE YELLOW LEAF VIRUS

A virus was suspected as the cause of YLS when it was observed that the disease was transmitted through seed cane and when hot water treatment of the seed did not cure it of the YLS. Subsequently, virus particles were observed in sugarcane leaves with YLS by means of electron microscopy[3,5]. The virus particles are icosohedral (balls with 20 flat triangular facets) about 25 nm in diameter and are confined to the phloem tissue of the plant[4,5]. Their genetic material is a single strand of RNA. The virus has been named Sugarcane Yellow Leaf Virus and belongs to a group of viruses called luteoviruses that frequently cause yellowing symptoms in their plant hosts[5]. So far, two aphid species have been found to transmit ScYLV from plant to plant; the sugarcane aphid, *Melanaphis sacchari*, and the corn leaf aphid, *Rhopalosiphum maidis*[3,4]. Both insect species are present in Hawaii. Infected plants do not always show YLS symptoms, especially if the plants are stress-free and growing vigorously. Observations to date suggest that YLS symptoms appear most often in virus-infected plants when they are under water stress or other stress conditions. ScYLV has now been observed, either serologically or microscopically, to be associated with YLS in many countries. In some cases, other yellowing symptoms have been confused with YLS, but the YLS symptoms of ScYLV-infected plants are distinctive. A similar looking disease in South Africa is caused by a phytoplasma[2].

RESEARCH RESULTS

Although the virus cannot be eliminated from infected plants by hot water treatment, we have succeeded in curing plants by placing them in a warm (40°C) incubator for two weeks followed by meristem tip tissue culture and regeneration of plantlets. This is a time consuming procedure and would be too expensive for large-scale use.

Dr. B. E. Lockhart of the University of Minnesota first observed ScYLV particles in plants with YLS using electron microscopy and subsequently developed an antiserum that can be used to diagnose the virus in plants. A modification of this technique using tissue imprints on nitrocellulose membranes has been used successfully in Hawaii and elsewhere to screen large numbers of plants for presence of the virus[3]. Another diagnostic technique using polymerase chain reaction was developed by Dr. M. Irey of the United States Sugar Corp[3]. These new diagnostic techniques make it possible to identify and study the effects of virus infection.

Surveys of the Hawaiian sugarcane plantations (Table 1) were carried out using the tissue blot immunoassay technique (TBIA). ScYLV was found in all of the main commercial varieties, although some were more extensively infected than others[4]. Variety 78-4153 remains healthy in most locations where it is planted. Contrarily, no uninfected source of 87-4094 was found. Plants have now been regenerated from meristem tip tissue culture of 87-4094 and so far appear to be virus-free. Varieties 65-7052 and 73-6110 are infected throughout Hawaii, although a few uninfected locations were found in west Maui. Both infected and uninfected sources of 77-4643 were found. Therefore, it appears that sugarcane varieties differ in their susceptibility to the virus. They also appear to differ in degree of symptom expression. Variety 65-7052 was the first to show extensive YLS and was later found by electron microscopy to carry a low concentration of virus particles. The opposite was true for 73-6110, which did not show symptoms and was thought to be resistant to the

disease. Later research with electron microscopy and serological diagnostics showed it to be extensively infected and to contain high concentrations of virus. Eventually, YLS symptoms did appear in 73-6110 under stress conditions.

Studies are now underway to measure the effect of the virus on growth and yield of several varieties. Brazilians have recorded yield losses due to ScYLV and it seems likely that extensive leaf yellowing and infection of phloem tissue would have a detrimental effect on sugarcane growth, but it is not yet known whether infected, but symptomless plants are affected or to what degree. Transmission studies using the aphid vectors will enable us to determine whether there are varietal differences in susceptibility and symptom expression.

Surveys are underway to identify any alternate plant hosts of ScYLV that could serve as natural reservoirs of the virus. Weeds, especially grasses and sugarcane relatives, are being tested. So far, only a few sugarcane relatives have been found to be infected. These are *Saccharum robustum*, *S. officinarum*, *S. sinensis*, and *S. spontaneum*. None of the *Erianthus* species or grasses tested so far carried the virus.

The objectives of continuing research into YLS in Hawaii, the mainland and in other countries are to determine the losses due to ScYLV infection, identify resistant or tolerant sugarcane varieties, determine the effect of environmental conditions on symptom expression, and prevent or restrict spread of the virus to uninfected sugarcane.

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Table 1. Survey of Hawaiian sugarcane varieties for ScYLV

Variety	Location	No. of sites	ScYLV	YLS symptoms
H65-7052	Maui	3	positive	yes
H65-7052	W. Maui	12	negative	no
H65-7052	W. Maui	2	positive	no
H65-7052	Oahu	4	positive	yes
H72-1365	Kauai	11	positive	no
H72-1365	Oahu	4	positive	no
H73-6110	Maui	7	positive	yes
H73-6110	W. Maui	8	positive	no
H73-6110	W. Maui	1	negative	no
H73-6110	Oahu	2	positive	no
H74-4527	Kauai	5	positive	no
H74-4527	Oahu	2	positive	no
H77-4643	Kauai	2	positive	no
H77-4643	W. Kauai	6	negative	no
H77-4643	W. Kauai	1	positive	no
H77-4643	Oahu	2	positive	no
H77-4643	Oahu	3	negative	no
H78-4153	Maui	9	negative	no
H78-4153	Kauai	1	negative	no
H78-4153	W. Kauai	3	negative	no
H78-4153	W. Kauai	1	positive	no
H78-4153	Oahu	4	negative	no
H87-4094	Maui	1	positive	yes
H87-4094	Kauai	6	positive	no
H87-4094	W. Kauai	1	positive	no
H87-4094	Oahu	4	positive	no