Incorporating Rat Damage Assessments into the Variety Development Program

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INTRODUCTION

Maximum sugar production at the lowest cost is a primary goal of the Hawaiian sugarcane industry. One way to lower production cost is by increasing the per-acre yield of sugar. The Hawaiian Sugar Planters' Association (HSPA) continues to be a leader in the development of higher yielding, disease-resistant and culturally adapted sugarcane varieties through its breeding and selection program.

Various factors (e.g., weeds, adverse weather, diseases, pests) reduce the yields of commercial sugarcane varieties. Rats, in particular, cause significant damage and sugar losses. In 1985 industry-wide losses attributed to rat damage were estimated at 20,000 tons of sugar valued at $6.6 million. Recent economic belt-tightening and cutbacks in control programs have resulted in even heavier rat losses at some plantations than in previous years. However, in spite of such losses susceptibility to rodent damage is not a selection criterion in the current HSPA varietal development process. More accurate assessments of rat damage and development of rat-tolerant varieties would help to reduce losses and increase yields. This paper reviews research conducted in this area by staff at the Hawaii Field Station and outlines a program for incorporating rat damage assessments into HSPA's sugarcane variety development program.

ASSESSMENT OF RAT DAMAGE

Assessing rat damage should be the first step in any attempt at reducing rat depredations and sugar losses. It provides information on damage levels in current and upcoming varieties, the impact of damage on yields, and justification and cost-effectiveness of control programs.

The USDA's Denver Wildlife Research Center's Hawaii Field Station has developed a cost- and labor-efficient technique to estimate rat damage and yield losses in sugarcane. This method, the point-distance-nearest neighbor distances (PDNND) density estimation technique, basically involves measuring the distances of the three closest rat-damaged sugarcane internodes from a reference point. Between 2 and 10 minutes of labor is required for each sample. Ten to 20 samples usually are pooled to obtain one density estimate per field, expressed as the number of rat-damaged internodes per square meter. A sampling protocol handout and computer program to calculate the density estimate are available upon request from the Hawaii Field Station. This sampling technique is nondestructive and thus allows damage surveys to be conducted at any time during the crop cycle. It is applicable for small variety test plots (e.g., FT-5, FT-7) as well as for field cane grown under different cultural and geographic conditions. It also provides an absolute damage estimate at a fraction of the effort of other methods (e.g., the cut-and-pull, v-cut, area count).

Damage Assessments in Variety Test Plots

Beginning in 1980, personnel at the Hawaii Field Station used the PDNND technique to sample rat damage in FT-7 tests for selected plantations on the islands of Hawaii and Kauai. Major objectives were to determine damage levels in different

varieties, to identify "rat-resistant" characteristics of sugarcane, and to quantify sugar losses. Although most of the varieties examined are no longer in commercial production, the results have renewed our interest in using this technique to quantify damage to current and upcoming sugarcane varieties.

Rats demonstrate preferences for certain sugarcane varieties over others when given a choice, as dramatically evidenced in 164 FT-7s sampled during 1980-82. Over all plantations, variety H57-5174 consistently sustained the highest damage, followed by H59-3775, H70-144, H62-4671, H68-1158 and H56-4848, respectively. Rat damage was also higher for H59-3775 and H70-144 than for H68-1158 or H56-4848 in similar paired comparisons. One physical characteristic of sugarcane that may contribute to the preference of rats for certain varieties is rind hardness. For example, variety H57-5174 has a softer rind than H56-4848. Variations in stalk size (diameter) were slight between varieties. However, where damage levels were light, smaller stalks were preferred by rats.

Damage data from paired variety tests and adjacent field cane suggest that FT-7 tests can be used to predict damage preferences in block plantings of commercial varieties. Correction factors should be incorporated to adjust for artificially high damage levels in FT-7 plots. Although rat damage was 53% less in adjacent field cane than in FT-7 plots of the same variety, the relative preferences observed in the small plots were similar to those in large blocks. For instance, H68-1158 and H56-4848 were consistently less damaged than other commercial varieties in both FT-7 plots and large blocks.

Limited sampling in currently established varieties H74-1715 and H65-7052 indicate damage levels equal to or greater than that recorded for H59-3775 or H70-144, two of the varieties that sustained some of the highest damage in past studies. One variety that appears to be less preferred by rats is H78-0292, which sustained only about one-tenth as much damage as H74-1715 in limited paired comparisons. Rat damage in H56-4848 continues to be light at Hamakua Sugar Company when compared with H65-7052.

ESTIMATION OF YIELD LOSSES

To determine the economic impact of rats in sugarcane, physical damage must be related to sugar losses. Teshima and Hilton (1971) reported a direct relationship between sugar (pol) loss and the percent stalks damaged by rats, borers and other causes based on field 10-ft cut-and-pull samples and factory sugar recovery methods. Assuming a linear correlation, they found higher pol losses for rat damage combined with other factors, and higher losses from rat damage occurring in unirrigated than in irrigated plantations.

However, reductions in yield may not be proportional to existing damage levels. Damage-tolerant varieties, although not necessarily resistant to rat damage, may show reduced yield losses due to compensatory growth, geographic or cultural factors, or resistance to secondary infection, e.g., souring, borers (Fellows et al. 1984).

Assessing rat damage in plantation FT-7 variety tests presents an opportunity for better understanding of the impact of rats on yields of standard and developing sugarcane varieties industry-wide. Yield measurements from HSPA's existing variety testing program are readily available and can be related to rat damage with little additional effort or expense. The PDNND sampling technique can be used to determine the density of rat damage in replicated plots of whatever varieties are of interest. A damage-yield regression equation can then be calculated using HSPA's yield data. The slopes of the regression equations from a series of FT-7s can be averaged to obtain a single damage-loss estimator for each variety.

Based on 41 FT-7s of variety H59-3775 sampled during 1980-82, it was estimated that Mauna Kea Agribusiness lost an average of one ton sugar per acre or 10% of the potential yield. Accounting for 70% factory recovery, that amounted to $256 per acre for that variety on that plantation alone. Expected losses for other varieties heavily damaged by rats at other plantations are undocumented but could also be substantial. The methods outlined could be readily used to estimate such losses.

RECOMMENDATIONS

Estimates of damage and sugar losses to rats for current and promising sugarcane varieties are lacking. Failure to iden-

tify damage-susceptible varieties prior to commercial cultivation could be costly, especially for a one- or two-variety plantation. Rat resistance or susceptibility should be considered in the selection of new sugarcane varieties. Further investigation into shorter cropping varieties, resistant physical characteristics (e.g., rind hardness, stalk size), resistance to souring and/or borers, potential for compensatory growth following damage, and other "damage-tolerant" varietal traits may help identify characteristics that can be manipulated to reduce depredations and losses.

To get the greatest return on an investment in sugar in the decisive 1990s and beyond, basic and alternative approaches to increasing yields need to be considered. Screening potential commercial varieties for rat damage and incorporating rat-tolerant varietal characteristics into the breeding and selection process could provide an alternative nonchemical approach to reducing sugar losses to rats.

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