PERFORMANCE EVALUATION OF SASRI VARIETIES N19 AND N25 IN TANZANIA

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Abstract

SASRI varieties N14, N19, N25 and N30 were introduced in Tanzania in 2000 and tested for adaptability in the local environment from 2002 to 2009, compared to standard commercial variety NCo376.

A total of 16 replicated trials were conducted in both irrigated and rainfed environments. Data collected included; cane yield, brix, pol, purity, fiber, sucrose and reaction to pests; sugarcane smut (*Ustilago scitaminea*), stem borers (*Eldana saccharina*) and white scale (*Aulacaspis tegalensis*).

Under rainfed conditions, N19 and N25 did not show consistent performance. However, under irrigated conditions, these varieties out-performed variety NCo376 in terms of Pol %, and cane and sugar yields. Variety N19 had relatively higher Pol % when compared to variety N25; however, N25 had higher cane yields. Both varieties had similar sugar yields.

Varieties N19 and N25 showed good levels of resistance to smut under both the inoculation technique and natural field conditions. The varieties also have good cane and sugar yields, reasonable levels of resistance to sugarcane smut and good ratooning ability, and are therefore recommended for commercial cultivation in Tanzania under irrigated cultivation.

Keywords: sugarcane, variety, smut, yield, sugar

Introduction

The sugarcane industry in Tanzania currently has about 43,000 ha under cultivation, scattered in diverse agroclimatic regions. In the 2008/09 crushing season the industry produced a total of 280,000 tons of sugar, which translates to 6.5 t sugar/ha. It is therefore evident that performance needs to be improved.

There are many factors that contribute to the poor performance of the sugarcane industry in Tanzania. However, the most important is considered to be low annual sugarcane yields, with an average of 70-80 tons of cane per hectare (TCH) under irrigation, and 45-50 TCH under rainfed conditions. In addition, harvested cane is of poor quality leading to high cane to sugar ratios.

The cause of low productivity is further explained by the predominant use of old varieties which have lost vigour and have succumbed to insect pests and diseases. These varieties include NCo376, which occupies about 50 and 95% of acreage under irrigated and rainfed systems, respectively. Other major varieties include Co617 (20%), B52–313 (10%) and EA70-97 (9%) of the entire industry.

Key insect pests of economic importance include *Eldana saccharina* Walker (Lepidoptera: Pyralidae), which is widely distributed, and white scale, *Aulacaspis tegalensis,* which is currently confined to two mill areas. Diseases include sugarcane smut *(Ustilago scitaminea)* and ratoon stunting disease (*Leifsonia xyli* subsp *xyli),* both of which are widely spread. Furthermore, more than 60% of acreage under cane is rainfed, which therefore exposes crops to moisture and other abiotic stresses, and reduces their ability to resist pest attacks.

Low sugarcane productivity and related problems are threatening the growth and sustainability of the industry because they lead to increased cost of producing sugar, and this reduces competitiveness.

The strategies advocated for the improvement of productivity and production efficiencies include use of better sugarcane varieties, control of pests and diseases and better soil and water management. The Tanzanian sugar industry therefore embarked on a variety importation programme with the aim of introducing elite sugarcane varieties for evaluation and selection for commercial use.

The South African Sugarcane Research Institute (SASRI) varieties N14, N19, N25 and N30 were introduced in 2000. These were tested in a total of 16 replicated experiments and were compared with the most widely used commercial variety, NCo376, under irrigated and rainfed conditions at Kilombero Sugar Company (KSC) and TPC Ltd mill areas. In addition, collaborating growers evaluated these varieties in a total of 21 commercial fields. Results obtained from the 16 replicated trials, together with those from commercial field evaluations by growers, are presented and discussed.

Materials and Methods

Elite sugarcane varieties N14, N19, N25 and N30 were tested in replicated trials and compared to standard varieties NCo376 at KSC, and NCo376, B52–313 and EA70-97 at TPC. Fourteen experiments were laid out in irrigated and two in rainfed commercial cane fields, which reflected actual commercial conditions and recommended management practices, i.e. level of fertilisation, irrigation intervals and weed management.

Experiment design

Balanced lattice designs were used. Plot size was 10 m long x 4 rows, 1.45 m apart at KSC, and 1.5 m apart at TPC; net plot area was two centre rows 8 m long. The experiments were replicated four times. Seedcane was supplied from hot water treated (HWT) nurseries.

Data collection
Data collected included cane yield (TCH), Brix %, Pol %, sucrose %, purity %, fibre %, tons sugar per hectare (TSH) and reaction to pests and diseases.

Reaction to smut
Assessment on the reaction of varieties to smut was done by exposing candidate varieties to high smut pressure by artificially inoculating seedcane with fresh smut spores and planting in a nursery. All test varieties were planted between infester rows of an artificially infected susceptible variety (NCo376).

The experiment design was a randomised complete block (RCB) replicated three times. Plot sizes were two rows 1.2 m apart and 6 m long. Assessments were made monthly, beginning two months after germination of the plant crop, and continued on subsequent ratoon crops up to the third ratoon. In each ratoon crop, assessments were discontinued when the crop reached the age of six months and the crop was cut.

Total numbers of stalks were counted and number of infected stalks were calculated as percentages and subjected to analysis of variance. The reaction of test varieties in the form of numbers of infected stalks was compared with the most susceptible (NCo376) and resistant (EA70-97) varieties.

Reaction to E. saccharina
In order to assess *E. saccharina* damage, a random sample of sugarcane stalks were split length-wise and examined for borer damage. The total number of internodes bored were counted and expressed as percentages of the total internodes (pooling all stalks). Assessments of *E. saccharina* damage were made in variety trials and commercial fields at TPC whenever pest incidences were observed.

Grower's evaluation
Collaborating growers (KSC) evaluated the performance of N19 and N25 in commercial fields ranging in size from 25-30 ha. The first fields were planted in 2003/04, and thereafter one field for each variety was planted in each of the following years up to 2009/10. Data collected included average cane and sugar yields.

Results and Discussion

A total of 35 crops were harvested from 16 experiments, of which 16 were crops of plant cane (four from TPC and 12 from KSC), nine were first ratoon crops (two from TPC and seven from KSC), six were second ratoon crops (one from TPC and five from KSC), and three and one crops were third and fourth ratoons, respectively, from KSC. All ratoons were harvested at 12 months of age.

Pol %
Data on Pol %, which is not shown, were obtained from 72 sampling occasions for each variety, used to determine the potential sucrose content of the variety. N19 had the highest Pol with a

mean of 16.3% (range 11.5-19.8%) followed by N25 with a mean of 15.2% (10.6-18.4%) and last NCo376 with a mean of 14.8% (10.8-17.1%).

N19 had significantly higher Pol % (P=0.05) than NCo376 in 20 out of 35 crops and was significantly higher than N25 in 13 out of 35 crops.

Figure 1 shows Pol of N19 and N25 expressed as a percentage of NCo376 against Pol % of NCo376 as an environmental index. Figure 1 indicates that N19 had lower Pol than that of NCo376 at low environmental potential (less than 13.8%). Above this point, N19 had higher potential relative to that of NCo376. Similarly, N25 had a Pol % inferior to that of NCo376 when the environmental potential was below 14.8%; above which the performance of N25 relative to that of NCo376, improved, but was still lower than that of N19.

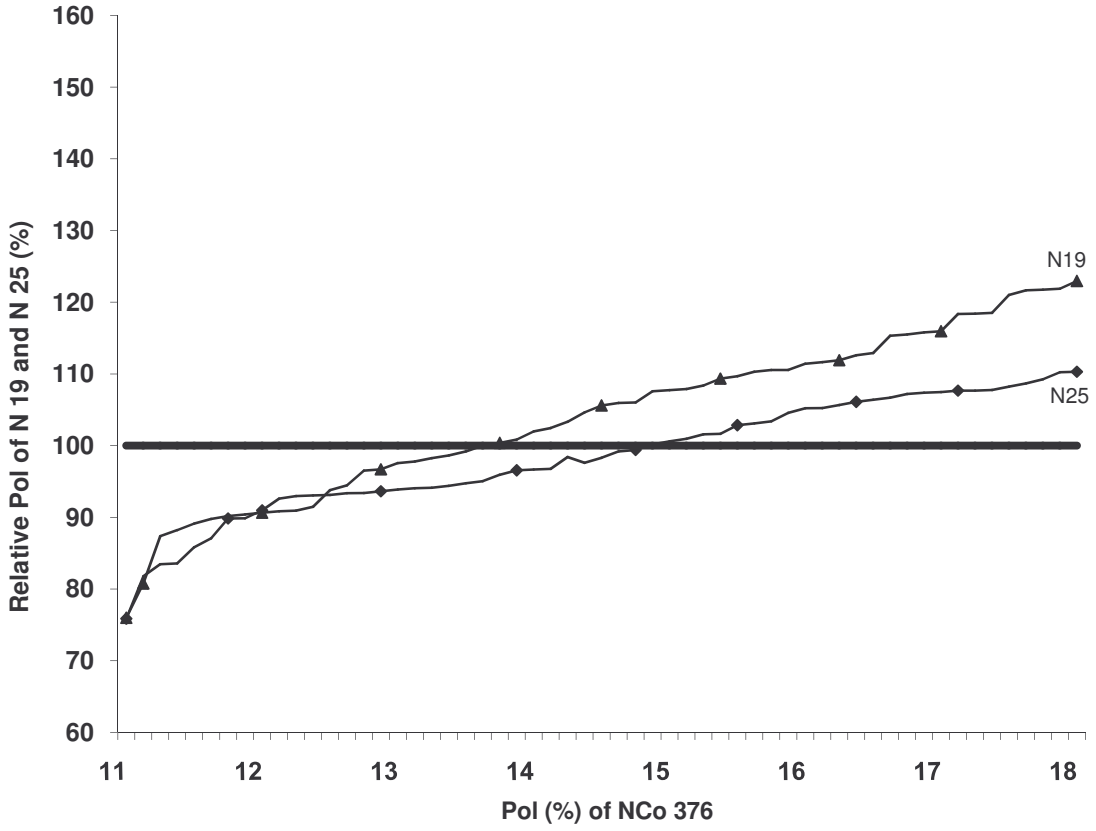

Figure 1. Pol N19 (▲) and N25 (♦) relative to NCo 376 (—).

Cane yield (t/ha)

Plant cane
Data on cane yield is not shown.

At KSC, NCo376 had a mean yield of 126.4 t/ha from 12 crops, with individual crop yields ranging from 96.3-172.6 t/ha; N19 had a mean of 127 t/ha (range 90-164 t/ha); N25 had a mean yield of 149 t/ha (range 84-253 t/ha). N25 significantly out-yielded NCo376 and N19 (P=0.05) in four out of 12 crops.

At TPC four crops were harvested. NCo376 had a mean yield of 189 t/ha (range 157-246 t/ha); N19 had a mean yield of 188 t/ha (range 136–166 t/ha); N25 had an average yield of 218 t/ha (range 178-275 t/ha). N25 significantly out-yielded N19 and NCo376 (P=0.05) in one out of four crops.

First ratoon
At KSC from seven crops harvested, NCo376 gave a mean yield of 105.4 t/ha (range 54.2-130 t/ha); N19 had a mean yield of 114.1 t/ha (range 52.8-193.1 t/ha); N25 produced a mean of 135.7 t/ha (range 83.3-189.7 t/ha). N19 significantly out-yielded NCo376 and N25 (P=0.05) in one out of seven crops while N25 significantly out-yielded both N19 and NCo376 in three out of seven crops.

At TPC, two crops were harvested. NCo376 had a mean yield of 110.2 t/ha (range 93.3-127.1 t/ha); N19 had a mean yield of 110.2 t/ha (range 69.0-151.5 t/ha); N25 had a mean yield of 150.8 t/ha (range 104.1-197.5 t/ha). N25 significantly out yielded NCo376 and N19 in one out of two crops (P=0.05).

Second ratoon
Five crops were harvested at KSC, in which NCo376 had a mean yield of 62.1 t/ha with a range of 47.9-85.1 t/ha; N19 had a yield of 80.6 t/ha and a range of 67.3-104.0 t/ha; N25 produced a mean yield of 106.2 t/ha with a range of 58.6-151.2 t/ha. N25 significantly out-yielded NCo376 and N19 in four and three out of five crops respectively (P=0.05).

At TPC only one crop was harvested; NCo376 and N19 had similar yields of 169 t/ha, while N25 produced 196.2 t/ha, significantly out-yielding the former two (P=0.05).

Third ratoon
Three crops were harvested at KSC, where NCo376 produced a mean yield of 51.5 t/ha (range 43.1-61.4 t/ha) against those of N19 75.9 t/ha (range 68.1-85.1 t/ha) and N25 at 79.8 t/ha (range 64.3-106.9 t/ha). N25 significantly out-yielded NCo376 and N19 in two crops, whereas N19 significantly out yielded NCo376 in one out of three crops (P=0.05).

Fourth ratoon
One crop was harvested at KSC. NCo376 had a yield of 54.5 t/ha, which was significantly lower than that produced by N19 at 76.9 t and N25 at 98.7 t/ha. The yield difference between N25 and N19 was also significant (P=0.05).

Out of 35 crops, seven crops were harvested from two experiments planted under rainfed condition at KSC. Both N19 and N25 had similar yields to those of NCo376 in six out of seven crops under rainfed conditions. However, N25 significantly out-yielded both N19 and NCo376 in cane yield in one out of the seven crops harvested.

In general, N25 had superior cane yields in 35 crops harvested from experiments, and significantly out-yielded NCo376 in 16 crops (46%) and N19 in nine crops (26%).

Sugar yield t/ha

Plant cane
Data on sugar yield is not shown.

At KSC 12 crops were harvested. NCo376 had a mean sugar yield of 14.2 t/ha, with individual crop yields ranging from 11.1-22.1 t/ha; N19 had a mean yield of 16.1 t/ha with a range of 11.8-26.0 t/ha; N25 had a mean yield of 15.5 t/ha with a range of 11.6-26.8 t/ha. N19 significantly (P=0.05) out-yielded NCo376 in seven out of 12 crops and N25 in five out of 12 crops. N25 significantly out-yielded NCo376 in three out of 12 crops (P=0.05).

At TPC three crops were harvested. NCo376 had a mean yield of 31.0 t/ha, with a range of 26.6-34.9 t/ha; N19 had a mean yield of 33.2 t/ha with individual crop yields ranging from 25.5-37.9 t/ha; N25 produced a mean yield of 34.8 t/ha, with a range of 29.7-37.9 t/ha. N19 and N25 significantly (P=0.05) out-yielded NCo376 in one out of three crops.

First ratoon
Seven crops were harvested at KSC. NCo376 had a mean yield of 13.9 t/ha with a range of 8.6-21.6 t/ha; N19 had a mean yield of 16.6 t/ha with individual crop yields ranging from 8.6-31.9 t/ha; N25 produced a mean yield of 18.2 t/ha with a range of 9.6-27.4 t/ha. N19 significantly out yielded NCo376 and N25 in four and one crops respectively, whereas N25 out-yielded N19 and NCo376 in four and five crops respectively.

At TPC two crops were harvested. NCo376 had a mean yield of 18.8 t/ha. ranging from 18.0-19.5 t/ha; N19 had a mean of 19.8 t/ha with a range of 13.4-26.2 t/ha; N25 had a mean of 25.7 t/ha with a range of 18.7-32.6 t/ha, and significantly out-yielded (P=0.05) N19 and NCo376 in one crop, whereas both N25 and NCo376 significantly out yielded N19 in another crop.

Second ratoon
At KSC, five crops were harvested where NCo376 had a mean sugar yield of 8.3 t/ha ranging from 5.8-11.8 t/ha; N19 produced a mean of 11.7 t/ha with a range of 7.6-19.6 t/ha; N25 produced a mean yield of 13.9 t/ha with a range of 6.2-21.0 t/ha. Both N19 and N25 significantly (P=0.05) out-yielded NCo376 in four out of five crops.

At TPC only one crop was harvested. NCo376 and N19 had yields of 27.3 t/ha and 27.5 t/ha respectively, and both were significantly (P=0.05) out-yielded by N25 with a yield of 33.1 t/ha.

Third ratoon

Three crops were harvested at KSC only. NCo376 had a mean of 6.0 t/ha (range 5.0-7.0 t/ha); N19 had a mean yield of 8.3 t/ha with a range of 8.0-8.6 t/ha; N25 had a mean of 9.8 t/ha ranging from 8.2-12.7 t/ha. Both N19 and N25 significantly (P=0.05) out-yielded NCo376 in two out of three crops.

Fourth ratoon

One crop was harvested at KSC. NCo376 produced 8.8 t/ha, N19 produced 13.4 t/ha and N25 produced 17.1 t/ha. N19 significantly out-yielded NCo376, and N25 significantly (P=0.05) out-yielded both N19 and N25.

Generally, in sugar yield, N19 performed relatively better as it significantly out-yielded NCo376 in 18 crops (51%) and N25 in one crop (3%). N25 nevertheless gave high sugar yields on account of high cane yields, and significantly out-yielded NCo376 in 15 crops (43%) and N19 in six crops (17%).

The performances in cane and sugar yields of N19 and N25 in different ratoons compared to those of NCo376 are shown in Figures 2 and 3, respectively. Ratoon yield was calculated as a simple average by pooling the yields of 12 plant cane crops, seven first ratoon crops, and so on. In Figure 2, it is evident that there is a yield decline in old ratoons; however, each variety had a different rate, and NCo376 had the highest rate of decline. A similar trend is shown in Figure 4 where the performances of N19 and N25 were compared with NCo376 in commercial test fields harvested at KSC.

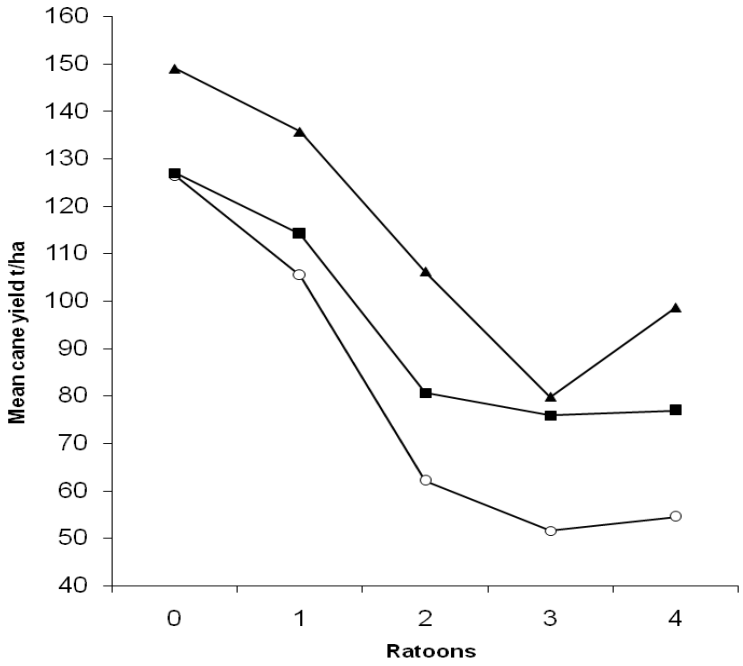

FIGURE 2 Performance of N25 (▲) and N19 (■) in cane yield of different ratoons compared to NCo 376 (○) at KSC. (Number of crop per ratoon 0 = 12, 1 = 7, 2 = 5, 3 = 3, 4 = 1)

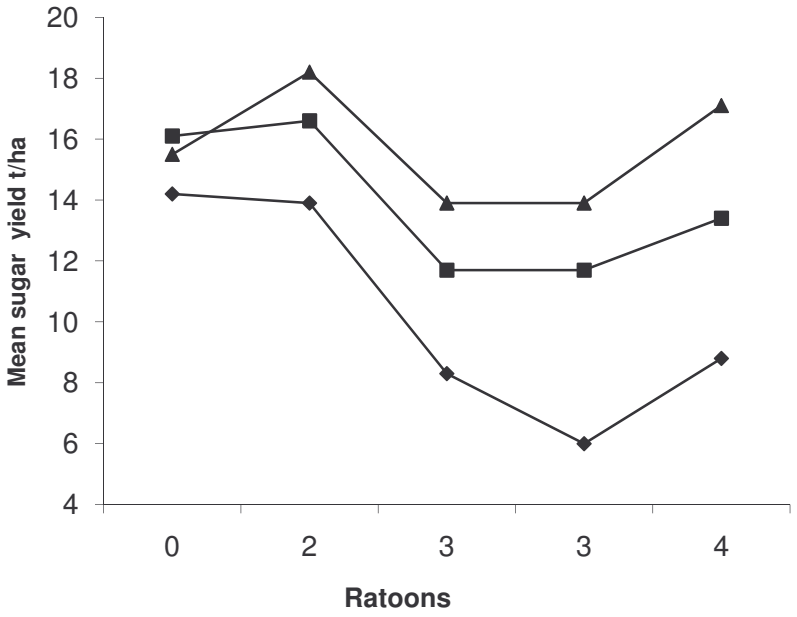

FIGURE 3 Performance of N25 (▲) and N19 (■) in sugar yield of different ratoons as compared to NCo376 (♦) at KSC (Number of crop per ratoon 0 = 12,1 = 7, 2 = 5, 3 = 3, 4 = 1)

Commercial field evaluation

Average yield of cane and sugar in t/ha from commercial fields for six seasons are shown in Table 1.

From each variety a total of 21 crops were harvested, of which six were crops of plant cane, five were first ratoon crops, four were second ratoon crops, and three were third ratoon crops. Two and one crops each were from fourth and fifth ratoons respectively. The average yield per variety in both cane and sugar was calculated in t/ha.

In the first year (2003/04) the yield reported was from a plant cane crop; however, in subsequent years the annual average yield for each variety was made up of several crops of different ratoons harvested from different fields.

The data on cane yield shows evidence of seasonal variation in the performance of the three varieties; however, response of varieties to the season was similar. N25 had better performance in cane yield followed by N19. NCo376 had consistently low annual average yields.

On sugar yield, N19 and N25 had similar yields, which were much better than those of NCo376. In the best season when N19 yielded 12.2 t/ha of sugar and N25 yielded 13.2 t/ha, NCo376 produced 8.3 t/ha. This was less than 32 and 38% of that of N19 and N25, respectively.

Table 1. Average annual yields of N19 and N25 compared to NCo376 in commercial fields at Kilombero Sugar Company in Tanzania.

Season	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10
Variety	Cane yield (t/ha)					
N19	62.8	73.6	93.6	77.8	71.1	78.8
N25	106.7	94.5	111.3	83.3	82.0	98.6
NCo376	77.3	75.6	69.7	67.9	51.8	57.4
	Sugar yield (t/ha)					
N19	9.2	10.5	12.2	10.4	9.8	9.6
N25	11.1	12.4	13.2	10.9	10.9	12.9
NCo376	9.1	10.4	8.3	8.9	6.8	7.5
Fields harvested per variety	1	2	3	4	5	6

Figure 4 shows the yield performance in cane yield of different ratoons in commercial fields. It is clear that there is declining performance of old ratoons in all varieties, which is more evident in variety NCo376. The rapid decline of ratoon performances explains the low productivity in annual average yields of NCo376 as the yield proportion of old ratoons increases.

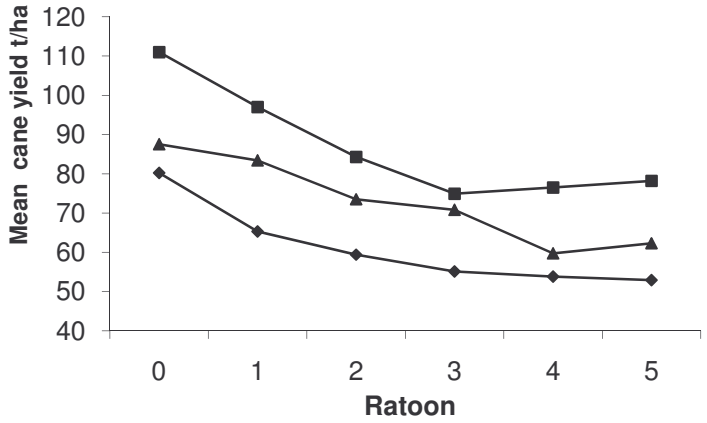

FIGURE 4 Performance of N25 **(■)** and N19 **(▲)** in cane yield of different ratoons compared to NCo 376 **(♦)** in commercial fields at KSC (Number of crops per ratoon, 0=6, 1=5, 2=4, 3=3, 4=2, 5=1)

Reaction to smut

Data on smut infection was obtained from a total of 15 sampling occasions, of which four occasions were made on plant cane, first ratoon and second ratoon, respectively. Three sampling occasions were made on the third ratoon. Figure 5 shows the reaction of test varieties to smut as a percentage of infected stalks in different ratoons compared with those of NCo376 (susceptible) and EA70-97 (resistant) in an inoculation experiment.

In the plant cane and the first ratoon, levels of infection were low and there were no significant differences between varieties. However, when the number of infected stalks reached 20% in NCo376 there were significant differences between NCo376 and EA70-97, together with N30, N25 and N19, all of which had less than 5% infected stalks. N14 had significantly higher rates of infection compared with N30, N19, N25 and the resistant variety EA 70-97, but had significantly lower infection rates than NCo376 (P=0.05).

In the third ratoon, the level of infection in NCo376 was 40% and that of N14 was above 25%. N30 and N19 were above 5%, and N25 had a similar level to EA70-97 at just below 5% infected stalks.

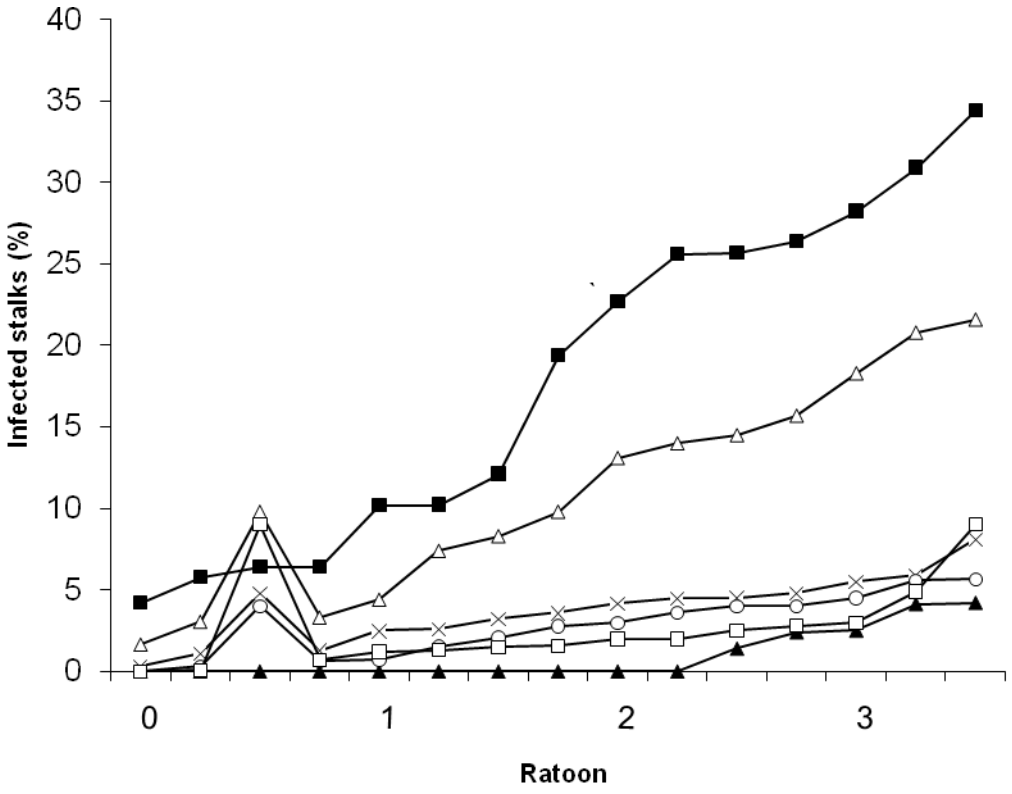

FIGURE 5. Reaction to smut of NCo 376 (■), N19(x) N25(○) N30 (□), N14 (Δ) and EA70-97 (▲) in dfferent ratoons

Variety trials

Reactions of the test varieties to smut were compared to those of NCo376 in variety trials under natural field conditions shown in Table 2. High levels of infection were observed in NCo376, and the differences compared with N19 and N25 were significant (P=0.05) on nine out of 11 occasions.

Table 2. Reaction of N19 and N25 to smut compared with NCo376 ratoons.

Variety	Ratoons			
	0	**1**	**2**	**3**
Experiment 1	% infected stalks			
N25	4.0	5.8	4.5	8.1
N19	4.2	5.5	8.1	8.6
NCo376	40.0	34.4	10.2	25.6
$LSD_{0.05\pm}$	7.15	6.95	3.31	4.63
Experiment 2	% infected stalks			
N25	0.7	5.6	3.0	3.6
N19	1.3	3.2	11.8	5.9
NCo376	25.7	26.4	41.7	42.1
$LSD_{0.05\pm}$	2.90	6.21	6.44	5.86
Experiment 3	% infected stalks			
N25	4.0	2.8	5.6	
N19	4.8	4.5	2.6	
NCo376	6.4	28.2	19.4	
EA 70-97	0.0	0.0	1.4	
$LSD_{0.05\pm}$	NS	3.57	4.9	

Reaction to E. saccharina

Incidences of *E. saccharina* damage were not frequent enough and not well enough distributed in the experiments to allow for more systematic comparisons on the reactions of test varieties.

Figure 6 indicates the level of damage of different varieties as assessed at different ages of the crop from 11 to 18 months under irrigated conditions in one season only at TPC. B52-313 and NCo376 are known to be susceptible to *E. saccharina,* and Co64-15 depicts a reasonable level of resistance. As shown in Figure 6, B52-313 had a high percentage of internodes bored at 11 months, which increased and at 18 months reached the highest level of 24.8% internodes bored. N19 had a low level of damage at 11 months, which also increased after 13 months and reached the same level as B52-313 and NCo376 at 18 months. N25 had slightly lower levels of damage, which were nevertheless still higher than those of Co64-15.

The data is not conclusive; however, it is an indication that both N25 and N19 may be susceptible to *E. saccharina* and appropriate management measures need to be instituted.

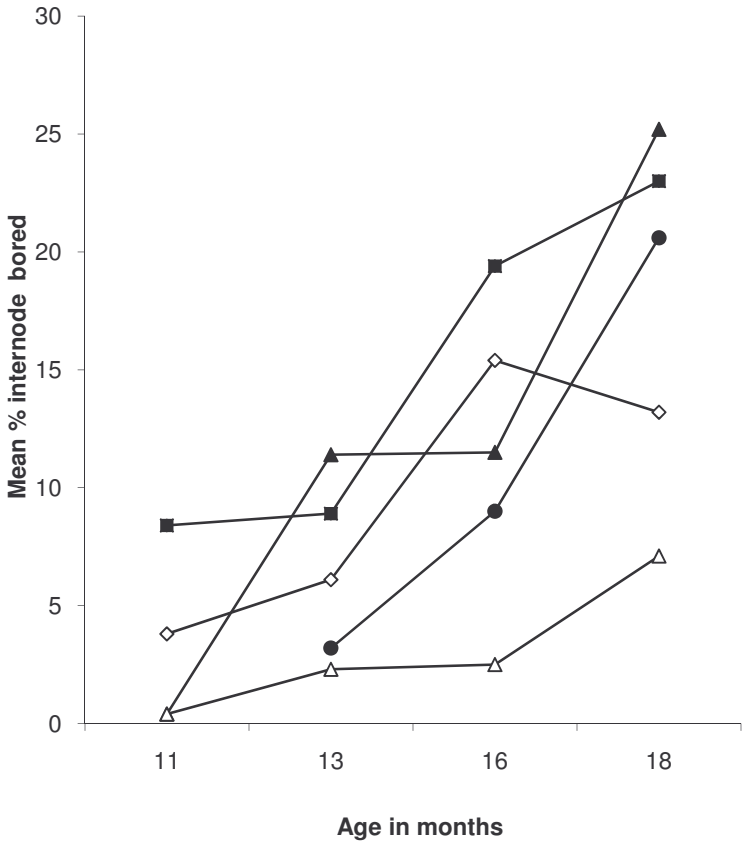

FIGURE 6. Eldana Infestation on sugarcane varieties N25 (◊), N19(▲), B52-313(■), CO 64-15(∆) and Nco 376 (●) at different ages at TPC

Reaction to A. tegalensis

It was not possible to determine the reaction of N19 and N25 to sugarcane white scale, *Aulacaspis tegalensis* (Homoptera: Diaspididae), which is a major pest at TPC. White scale devastated cane crops at TPC estates in the late 1960s, when the dominant varieties were NCo376 and NCo421 (Fewkes, 1972). This led to a large reduction in acreage under these varieties. The pest is currently controlled by planting varieties with a free trashing habit, together with natural enemies.

Conclusion

The results presented confirm the superior performances of N25 and N19 in terms of cane and sugar yields over those of NCo376. Further, N25 and N19 had low smut incidences which were

similar to those of the resistant variety EA70-97. However, results on the reaction of N19 and N25 to *E. saccharina* were not conclusive, and their reactions to *A. tegalensis* have yet to be determined.

Varieties N19 and N25 have been released in Tanzania for commercial production in irrigated culture.

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