

OBSERVATIONS ON FROST DAMAGE AT NAKAMBALA ESTATE

By J. B. RANGER, A. GULOTTI and D. MONTAGU

Zambian Sugar Co. — Nakambala Estate

General

Nakambala Estate is an irrigated sugar estate situated at 3,200-3,400 feet above sea level in the Southern Province of Zambia. Although occasional ground frosts occur in the district, at altitudes above 4,000 feet and in local frost pockets, the low temperatures which occurred in June 1968 were unprecedented in local records. Effects on the estate's and cane growers' first commercial crops appeared at first to be serious, but the improvement which subsequently occurred enabled harvesting to be completed without incident. The result of a six day freeze period when minimum temperatures ranged between 23.50°F and 29.50°F was a slight deterioration in TC/TS ratio, for a two to three week period, and the loss of approximately 4-8 weeks growth in cane which was allowed to standover.

Temperatures

Minimum air temperatures °F

June	11	48.9	June	21	36.50
"	12	45.6	"	22	38.00
"	13	42.2	"	23	40.25
"	14	28.1	"	24	42.50
"	15	27.9	"	25	45.00
"	16	29.4	"	26	46.00
"	17	29.5	"	27	53.50
"	18	23.50	"	28	58.25
"	19	28.00	"	29	46.25
"	20	33.25	"	30	47.25

Extent and type of damage

Of the 4,500 acres of cane that remained to be harvested at the time of frosting, 2,400 acres were moderately to severely affected. The worst affected areas, containing young plants or ratoons, were frosted down to ground level, but the main areas of damage occurred in relatively mature cane due for cutting within 4-10 weeks. In this cane most of the green top was destroyed and growing points had every appearance of having been killed.

The severity of damage was dependent on two main factors:

(a) Soil moisture

Fields on the perimeter of the estate, adjacent to the dry bushveld, and fields which were on dry-off prior to cutting suffered the greatest amount of damage. This was particularly noticeable on some cane farms where small acreages of irrigated cane were surrounded by large open tracts of dryland bush or cultivation. Where cane was being irrigated in the normal cycle (surface irrigation is predominantly practised) the damage was less severe and it was assumed that the moist soil, in radiating its heat less rapidly than dry soil, provided some protection to irrigated fields.

(b) Topography

The estate has an extremely even topography with an average maximum gradient of only 1%. Very precise levelling has been carried out for the surface irrigation scheme but where small differences in levels occurred i.e. in shallow pans and drainage lines, or where the cane had lodged, frost damage was more severe.

Observations on growing points and lateral buds

Growing points examined immediately after the frost period were soft and discoloured. Rotting of the tissues below the growing point had set in and this extended quite rapidly to the 2nd or 3rd node. Spindles could be pulled out from the stalks quite easily at this stage.



PLATE 1: Frosted stalk showing rotted core and growing point recovering.

Seven to ten days after the end of the frost period, growing points were re-examined and signs of regrowth and regeneration of the meristem were apparent. New tissue had appeared at the tip of the apparently dead growing point and a connective link was gradually being re-established around the centre core of rotted stalk. As the new growing point became established further rotting ceased and growth slowly re-commenced.

The lateral buds on a great deal of the frosted cane also appeared to have been severely damaged and immediately after the frost were soft and pulpy to the touch. In due course practically all of these buds produced lalas and some seed cane from a frosted field planted on an adjacent cane farm germinated quite normally.

TC/TS. Results of maturity tests (20 canes from each frosted field) are shown for the estate's three main varieties in charts 1-3. The average plot on each of these charts shows the following deterioration in TC/TS ratios

Variety	TC/TS
N:Co. 310	from 7.3 to 7.7
N:Co. 376	„ 8.0 to 8.25
Co. 419	„ 8.7 to 8.95

The charts also show that this deterioration was short lived and fields which had not been cut within two-three weeks improved to their former TC/TS ratio and then followed the normal ripening pattern.

Juice Acidity

The measurement of juice acidity and its relationship to cane deterioration after frost has been described by various workers (1-5). It was decided to carry out similar tests on the estate to establish possible priorities for cutting. 0.1N sodium hydroxide solution was titrated against 10 ml of juice, extracted by the sample mill from frosted samples, to pH.7.0, Charts 4 and 5 show in ml of 0.1N NaOH the titrations performed on N:Co.310 and Co. 419. There was a sharp increase in acidity for a two to three week period which followed the pattern of TC/TS deterioration. After approximately three weeks the acidity declined to what was considered to be a normal level and tests were discontinued.

Long term effects

Observations on lala growth continued in stand-over cane until the following March. Dominant lalas gradually became established and by March many canes had branched into two millable stalks — consisting of the original regrown stalk and a lala equal in length and thickness to the original stalk.

Sample mill tests carried out in March showed the following differences in TC/TS between the main stem and the lala.

Whole Main Stalk	Lala
N:Co.310 8.68	9.42
Co.419 8.68	11.01
N:Co.376 9.39	11.83

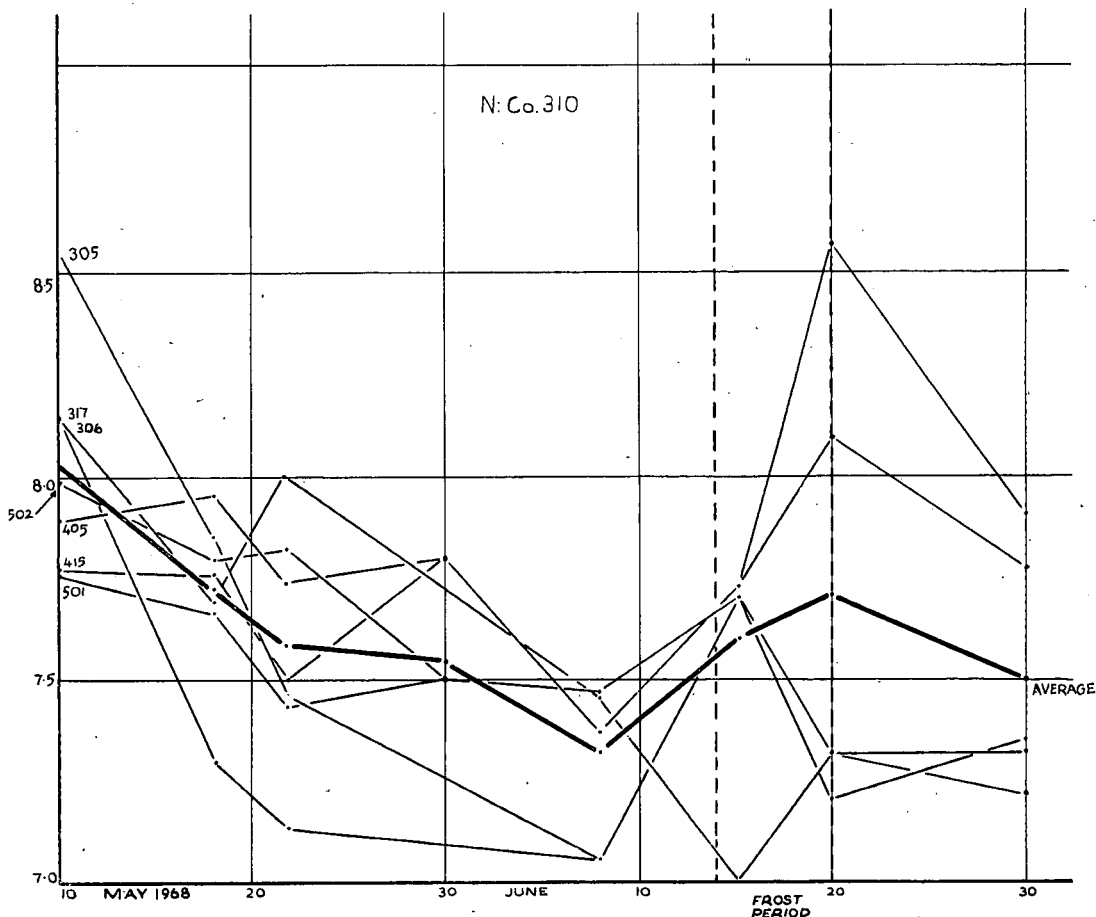


CHART 1.

Although some of these lalas have tended to break off during rain storms, particularly around field edges, the majority should be harvestable at the commencement of crop in May 1969.

References

1. The effects of freezing temperatures on the 1963-64 sugar cane crop—Haft Tapeh, Iran—Kenneth A. Sund. —Proc. 12th Congress of the International Society of Sugar Cane Technologists—Puerto Rico 1965.
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3. Testing sugar cane varieties for cold tolerance in Louisiana. J. G. Irvine. Proc. 12th Congress of the International Society of Sugar Cane Technologists—Puerto Rico 1965.
4. The effect of freeze damage on some of the non-sugar constituents of sugar cane. J. J. Friloux; N. A. Cashen and S. J. Cangani. SUGAR Y AZUCAR Jan. 1965.
5. Freezing and Mill Cane—J. G. Irvine—Sugar Journal. Jan. 1968.

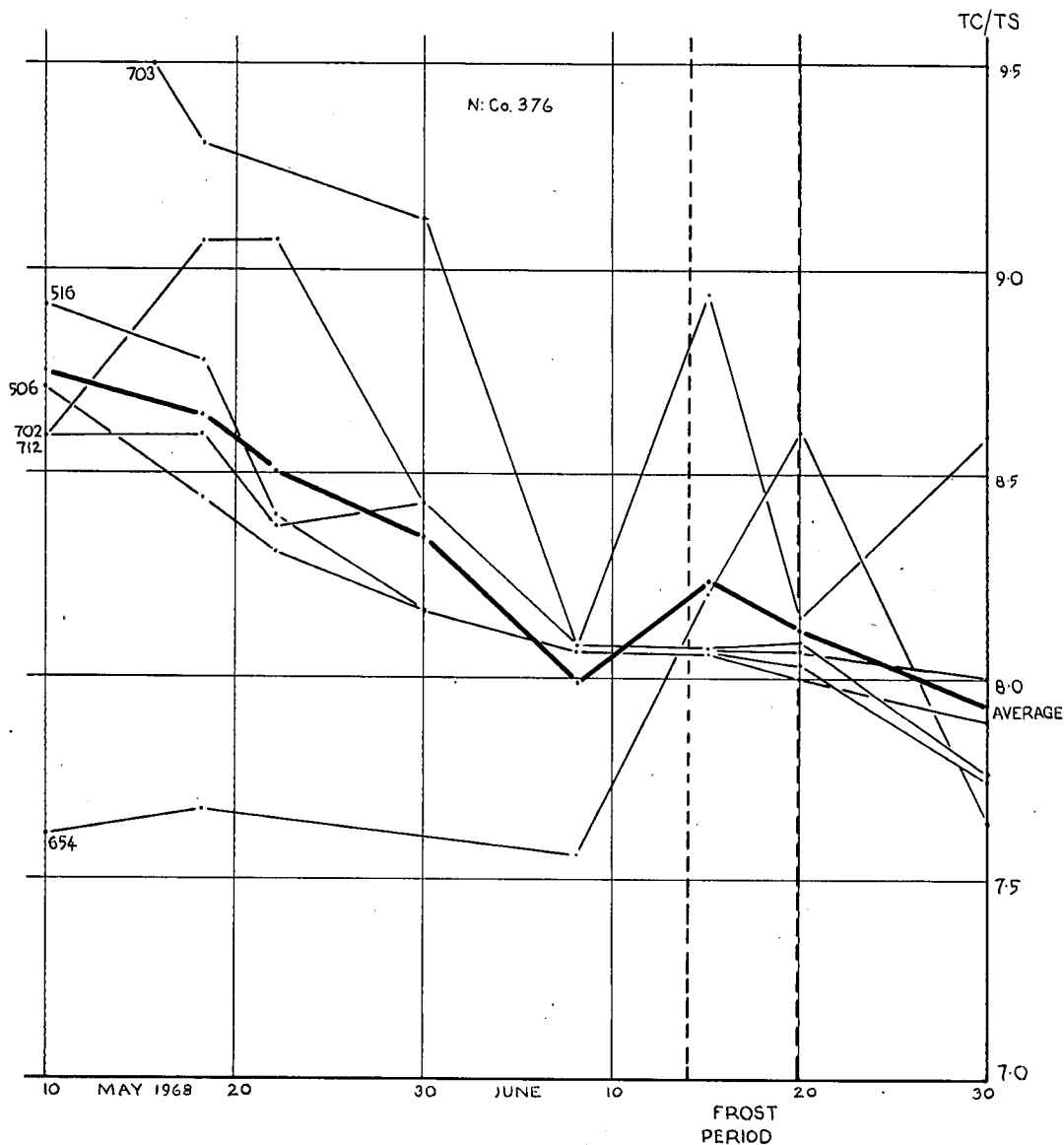


CHART 2.

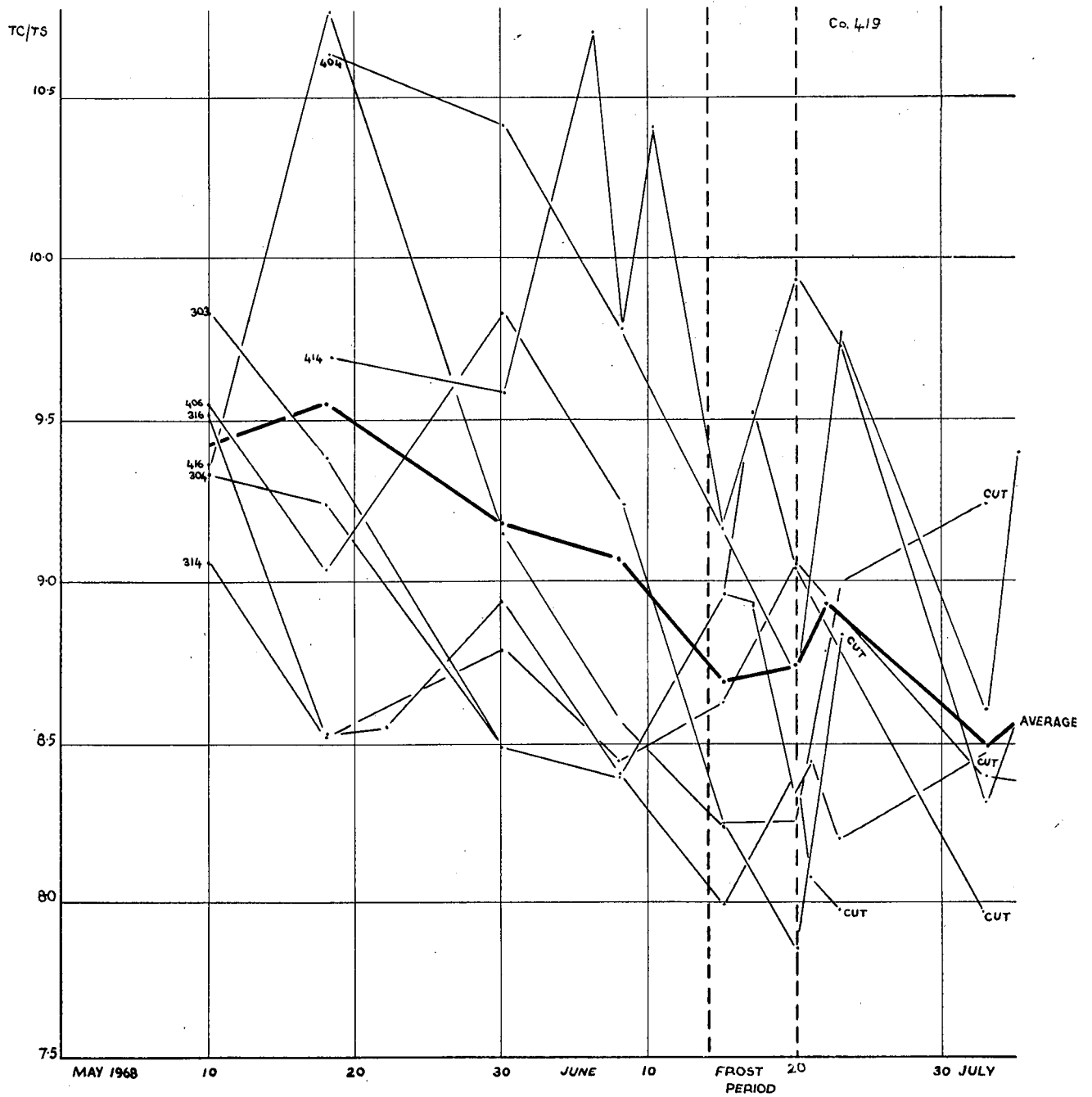


CHART 3.

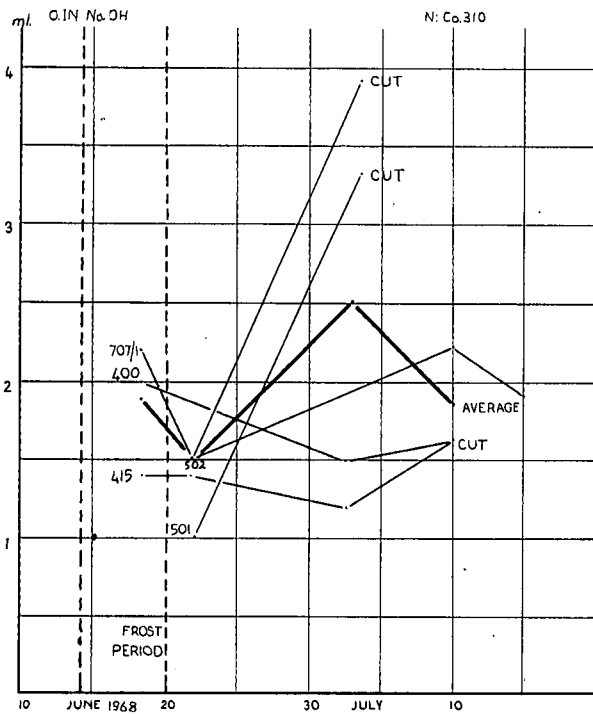


CHART 4: Acidity ratios for variety NCo310.

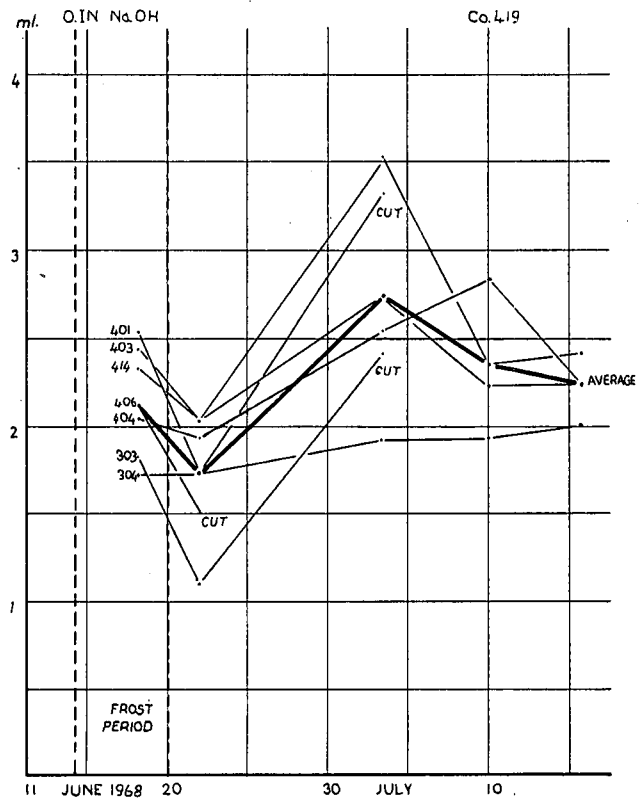


CHART 5: Acidity ratios for variety Co419.

Discussion

Mr. Andries: From the tons cane to tons sugar ratio N:Co310 appears to have been most affected by frost, which is contrary to reports from elsewhere in the world on this cane, as it is regarded as highly frost resistant.

Mr. Ranger: We also noticed that Pindar was affected and yet this is grown in frost areas in Australia.

Dr. Gosnell: In a heavy frost last year in Rhodesia N:Co310 and N:Co376 proved highly resistant. CP 29/116 proved very susceptible and Co462 slightly less so.

Mr. Ranger: Co419 was visually the worst affected cane. It lost colour quickly and a high proportion of growing points were damaged, but on a TC/TS ratio damage was not severe.

Mr. Browne: In trials in the Natal midlands all varieties seemed equally susceptible. However, healthy cane, although visually badly affected, recovered well.

Good husbandry seemed to be more important than variety.

Mr. Wilson (in the chair): Has any difference in resistance been noticed between trashed and burnt cane?

Dr. Gosnell: Of two estates in Rhodesia superficially the one trashed was far more affected by frost than the one burned.

But where burnt and trashed fields were next to one another damage appeared to be approximately the same in both. Where fields were separated topographical factors were important.

Mr. Browne: In a light frost, trashed plots seem to be more affected.

Mr. du Toit: The effects of frost seem to be unpredictable, both on the growing point of the plant and on sucrose content. Mr. Ranger points out that sucrose actually improved.

We would, for safety, recommend that frosted cane be cut immediately provided it is millable.

Mr. Gilfillan: In fields that were drying off and that suffered from frost, was irrigation carried out afterwards?

Mr. Ranger: No, we allowed the fields to continue to dry out as we thought that further irrigation might aggravate the damage.