OBSERVATIONS ON THE EFFECTS OF FROST ON SOME SUGARCANE VARIETIES

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Abstract

Plants of 11 sugarcane varieties were grown in pots during the winter at a Natal Midlands site. Grass minimum temperature went below zero on 40 nights during the period of the experiment. Proportionately fewer primary shoots survived the winter in the more tropical varieties than in those commonly grown in or recommended for the midlands. There was a close relationship between shoot survival and both increase in shoot height during the winter and degree of necrosis of the spindle leaf. The relationship between shoot survival and attributes observed early in the winter — the leaf striping caused by frost and degree of necrosis of the first leaf — was comparatively weak.

Introduction

Sugarcane is grown at altitudes between 750 and 1 100 m in the Natal Midlands, where it is commonly subjected to low temperatures during the winter. In some localities the temperature at ground level occasionally falls to below −10°C. It is estimated that from a quarter to a third of the crop is affected by frost each year. On average the grass minimum temperature falls below zero on 35 days per year at Seven Oaks and on 40 days per year at Jaagbaan. At Windy Hill, where the midlands plant breeding selection programme is located, the average figure is only nine days per year. Moreover frost usually occurs rather unevenly in the field, particularly in undulating topography. Accordingly the present study was carried out to observe whether a comparative measure of varietal response to cold could be obtained by placing young plants in pots on the ground in an area where frost occurs fairly frequently during the winter.

Evidence of varietal differences in resistance to frost damage of leaves in young plants and of inheritance of resistance has been reported by Arceneaux *et al*[1], whilst Irvine[2] and Roth[3] exposed the stalks of older plants to temperatures below zero in freezing chambers and described subsequent signs of injury. Irvine[2] reported varietal differences in frost damage which were in good agreement with field observations.

Methods

The experiment was carried out in Pietermaritzburg. Eleven sugarcane varieties were used. Five of the varieties, NCo 293, NCo 376, NCo 382, N7 and N12, are grown on an appreciable scale or seem likely to perform well in the midlands. One variety, N13, is new and has so far been recommended only for the coastal belt. Five varieties, CB36/14, J59/3, N52/219, N11 and N14, can be regarded as the most tropical of the whole group. CB36/14 and J59/3 are of Brazilian and Cuban origin repectively and the other three varieties in this group have been released for use in the hotter sugarcane areas, situated in the Transvaal and Swaziland.

Pots were 20 cm deep with a diameter of 15 cm and were filled with a potting mixture of compost and vermiculite with added ammonium sulphate. There were six pots per variety and two single-budded setts were planted per pot on 18 April 1980 (day zero). Pots were watered on alternate days. To ensure rapid sprouting of buds and early growth of shoots the pots were initially kept at Mount Edgecombe (near the coast) in a glasshouse for the first four weeks after planting and out of doors for the following three weeks.

On 10 June 1980 (day 53) the pots were taken to the experiment site in Pietermaritzburg and placed on the ground which was grassed. The six pots of each variety were placed together but the varieties were not placed in any particular order. The total area used was 15 m². Daily grass minimum temperatures were recorded with a thermometer placed on the ground next to the pots.

Height of the primary shoot of each plant (soil to uppermost visible collar) was measured on day 60 and again on day 134. Numbers of tillers were counted on days 54, 73 and 110.

On day 71 the leaves of the primary shoots were rated for amount of the chlorotic striping characteristic of frosting: 1, slight chlorosis; 10, extensive striping, covering most of the leaf area. Necrosis of the first leaf on the primary shoot was rated on day 81 as follows: 1, 10 mm dead tissue, 10, 100 mm dead tissue. On day 93 the amount of dead tissue in the unfolding or spindle leaf was rated: 1, little dead tissue; 10, total exposed length of spindle leaf dead. On day 135, primary shoots were dissected to determine whether the growing point was alive.

Results and Discussions

Grass minimum temperature at the experiment site fell below zero on 40 nights between early June and the end of August, when the conditions of growing points was examined (Figure 1). The temperature had dropped below zero on 12 occasions by the time that the leaves were rated for symptoms of frosting on day 71. It had dropped below zero a further nine times by day 81, when degree of necrosis of the first leaf was measured and a further six times by day 93, when amount of dead tissue in the spindle leaf was noted.

The proportion of shoots surviving the winter is probably the best measure of response to cold for local conditions, because it largely determines the extent to which the crop can resume normal growth with the onset of warmer weather. In Figure 2 the varieties are arranged from left to right in descending order of shoots surviving the winter. The tropical varieties are all on the right of the graph with shoot survival varying between 17 and 38%. Only 40% of shoots survived in NCo376, but in the other four varieties seemingly adapted to midlands conditions shoot survival varied between 60 and 100%. Fifty-eight percent of shoots survived in N13, suggesting that this variety may have at least a moderate ability to withstand cold.

Increase in height of shoot between days 60 and 134 and degree of survival of spindle leaf (10 — rating of death of spindle leaf) were both fairly closely associated with shoot survival (see Figure 2). Simple correlation coefficients were, respectively, 0,87 and 0,88 ($P<0{,}001$). Death of spindle leaf

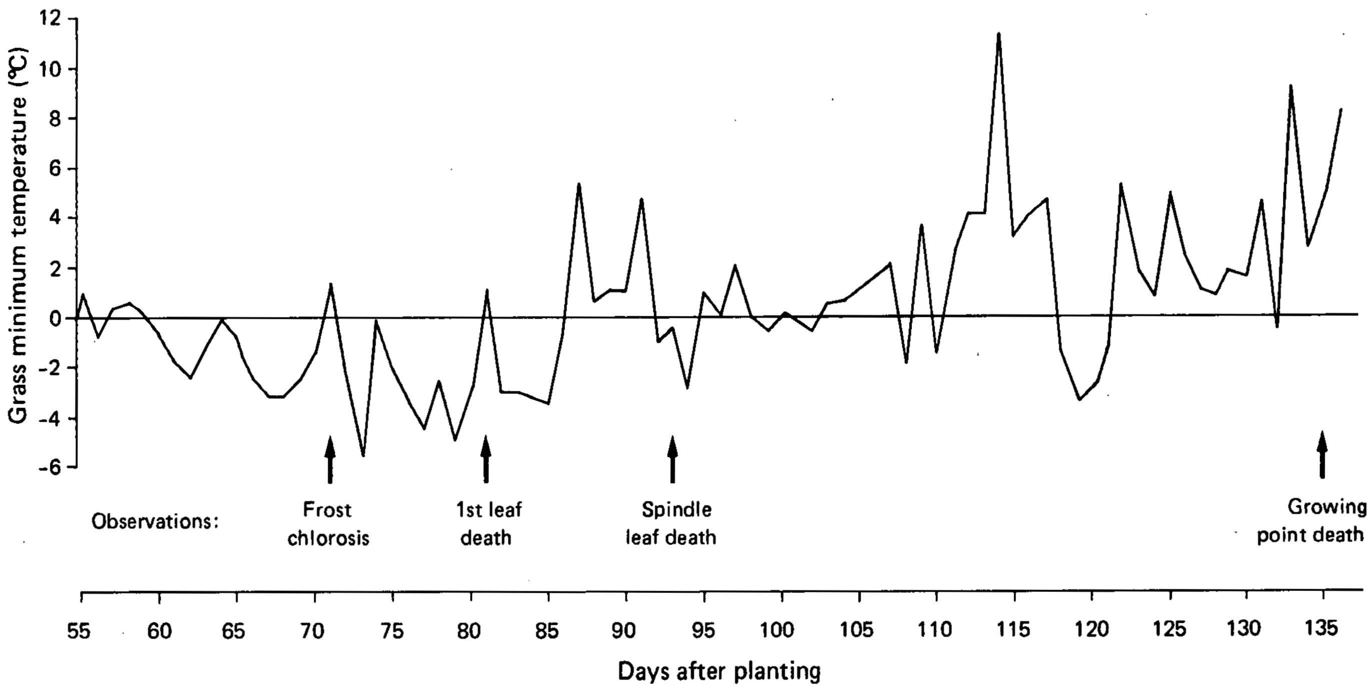

FIGURE 1 Daily grass minimum temperatures recorded at the experimental site. Times of experimental observations are shown.

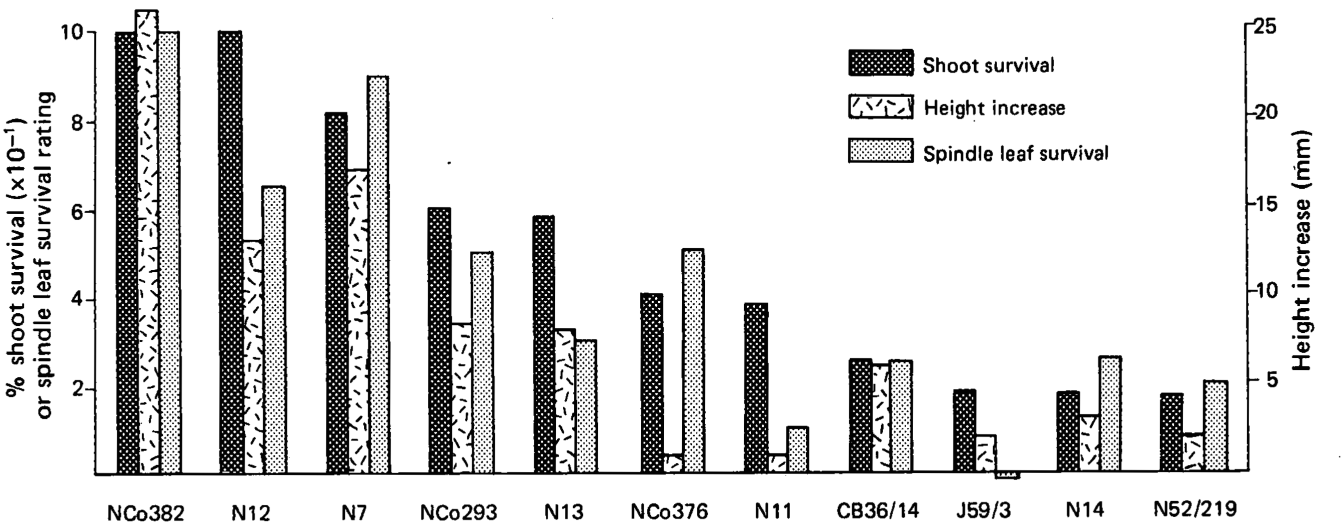

FIGURE 2 Proportion of primary shoots surviving, survival rating of spindle leaf, and increase in shoot height in eleven varieties.

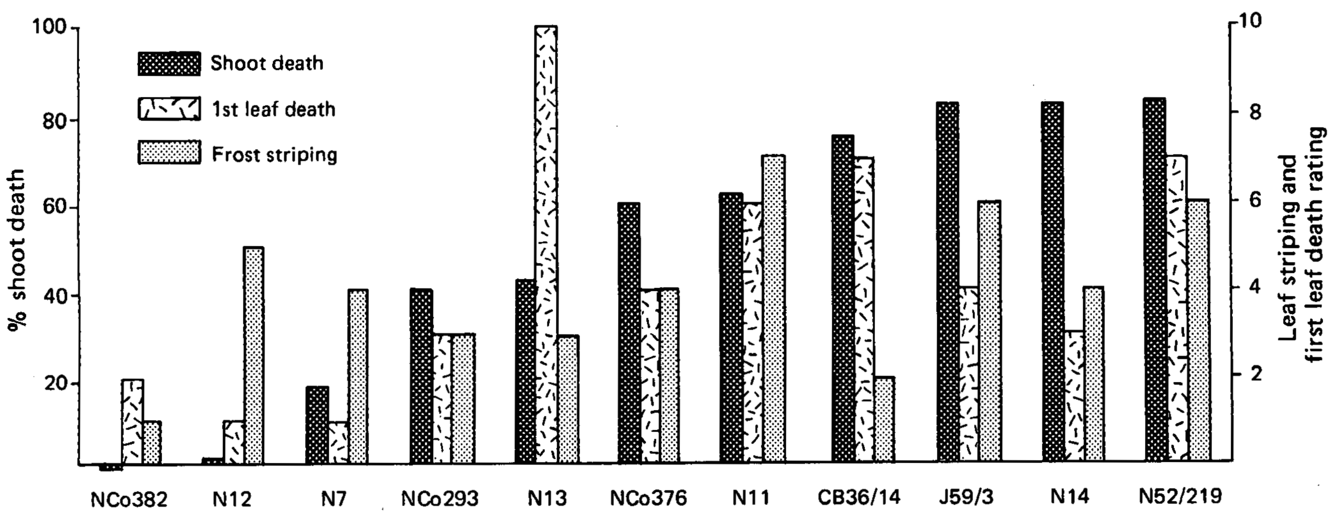

FIGURE 3 Proportion of primary shoots dying, degree of death of first leaf, and amount of frost striping of leaves in eleven varieties.

and death of shoots, which was determined by observing the state of the growing point, were presumably direct responses to freezing temperatures. However, the smaller increase in shoot height in the more tropical varieties could have been a reflection of both a smaller proportion of living growing points and a more limited varietal ability to undergo extension growth at low temperatures. (Individual shoots had not been identified so it was not possible to relate increase in height to condition of growing point).

The proportion of shoots dying is plotted in Figure 3 together with amounts of necrosis of the first leaf and of striping due to frost. The varieties are in the same order as in Figure 2. The values of both these latter attributes were generally greater in the tropical varieties than in the other varieties but the degree of association between the attributes and death of shoots was rather weak. The correlation coefficient for shoot death with first leaf death was 0,53 (P, 0,05-0,1) and that for shoot death with leaf striping was 0,41 ($P>0,1$).

The number of tillers formed varied appreciably amongst varieties. There appeared to be little relationship between this attribute and either proportion of primary shoots dying or type of variety, that is whether tropical or supposedly adapted to midlands conditions. This was perhaps not surprising, because amount of tillering could be influenced both by varietal differences in tendency to tiller and by damage to growing points.

Conclusions

The considerable range found here in proportion of shoots surviving the winter suggests the existence of appreciable differences in cold tolerance amongst varieties grown in South Africa. Moreover, if it can be assumed that varieties adapted to areas with fairly cold winters will commonly be more resistant to frost damage than those adapted to hotter regions, then the present results suggest that young plants growing in pots on a site subject to frost can be used to screen varieties for frost tolerance. It would appear that both necrosis of the spindle leaf and increase in shoot height can be used to assess response to cold, because they were so closely related to proportion of growing points dying. However, the early indicators of cold damage, such as necrosis of the first leaf and chlorotic striping may be rather unreliable criteria of varietal response to cold. The present study was limited in scope and further work should be done, perhaps with a larger number of varieties, to confirm that responses to cold in pots hold good in the field.

REFERENCES

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