FOLIAR DIAGNOSIS OF SUGARCANE - VARIATION OF LEAF POTASSIUM VALUE WITH AGE OF CANE AND RAINFALL REGIME

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Abstract

The top visible dewlap leaf potassium (K) of sugarcane ratoons varies in an irregular manner with age of cane. However, by increasing the number of leaf samplings, the fluctuation of the mean K values with age becomes less and less significant. As a result in Mauritius, where the running average leaf K concentration of 3 consecutive years of double leaf sampling is interpreted, age corrections of the analytical leaf K value will not have a noteworthy impact on the accuracy of foliar diagnosis for K status.

Examination of daily rainfall which fell 30 days prior to leaf sampling failed to reveal the exact significance of moisture regime on the K nutritional status of sugarcane. In some instances a high rainfall prior to leaf sampling gave rise to a high leaf K value, while in other instances at the same site the opposite was true.

Introduction

The practice of foliar diagnosis using the threshold value concept to monitor the nutrient status of sugarcane fields in Mauritius has been reviewed by Ng Kee Kwong *et al.*[9] Its accuracy is impeded by the variation of the top visible dewlap (TVD) leaf nutrient level with age of cane. To overcome this drawback, the TVD leaf* of sugarcane aged from three to seven months may be sampled in the absence of moisture stress, and age corrections are then applied to the leaf nutrient values to bring them to the standardized age of five months. Since leaf nitrogen (N) and phosphorus (P) concentrations decrease consistently with age of cane (Ng Kee Kwong *et al*[9]), the magnitude of the age corrections for these two elements can be established with reliability. The leaf potassium (K) level, however, varies in an irregular manner with age of cane and consequently no reliable age correction can yet be applied to the analytical leaf K values.

* henceforth referred to simply as leaf.

The cause of the irregular variation of leaf K with age of cane is not known with certainty. It has, however, been shown that K availability, uptake by plants and crop response to K fertilizers are influenced by the moisture regime (Krishnakumari *et al*,[5] Kuchenbuch *et al*,[6] Mengel and Von Braunschweig[8]). In addition K uptake by the plant is believed to be more sensitive than uptake of other nutrients to changes in soil moisture (Wood and Meyer[13]). Existing information in the literature thus points towards the fluctuation in water regime as a factor which may be causing leaf K concentration to vary irregularly with age of cane.

The present study was therefore initiated to ascertain whether the rainfall regimes prevailing prior to leaf sampling had any apparent effect on the leaf K values subsequently observed.

Materials and Methods

In 1976, 3N × 3K × 4 Harvest Date factorial trials were laid down at nine different locations in Mauritius. These trials were designed to determine the interactions between N, K and harvest dates. They also provided the necessary conditions for studying variations of leaf K with age of sugarcane and also with rainfall regime, as records of daily rainfall received in the geographical zones where the trials were located were kept by the sugar estates.

The three rates of N (applied as calcium ammonium nitrate) and K (as KCl) were 60, 120 and 180 kg N/ha, and 50, 149 and 249 kg K/ha, respectively. At planting, 250 kg triplesuperphosphate/ha were also applied in the furrows to all treatments. The sugarcane (either variety M 13/56 or M 377/56) was harvested at four different times, namely in the second half of June, the first half of August, the first half of October and in the second half of November.

Each treatment was replicated four times in a randomized block design with each plot consisting of 4 sugarcane rows 10 m long and spaced 1,5 m apart. At the peak growth stage of the sugarcane ratoons in 1978 and 1979, the middle 100 mm section of the TVD leaves free of mid ribs were sampled, dried at 90°C in a forced draught oven and then ground to pass a 0,5 mm sieve. Following digestion in H_2O_2/H_2SO_4 as outlined in McDonald[7], the leaf K concentration was read on a flamephotometer.

Results and Discussion

Age effect

The effect of tissue age on nutrient concentration is masked by modification in nutrient supply (Bates[2]). To exclude changes in nutrient supply resulting from variation in K fertilizer rates, only leaf K values observed at the K rate normally applied to sugarcane fields in Mauritius (149 kg K/ha) were considered for the purpose of the present study. As shown in Fig 1 the variation of leaf K level with age of cane did not follow any consistent trend. The pattern in fact differed from site to site even though two sites, e.g. Hermitage and St Julien, had similar annual rainfall and were planted with the same variety (M 377/56).

The amplitude of the fluctuation of leaf K value with cane age also varied from site to site (Fig 1). In some instances and irrespective of cane variety, the changes in leaf K concentration with age of cane did not exceed the analytical standard error (SE) of 0,05. Nevertheless, as demonstrated by grouping all sites with the same variety, increasing the number of observations (leaf samplings) would invariably bring the fluctuations of the mean leaf K value well within the limits of the analytical SE (Fig 2). In Mauritius foliar diagnosis is based on the running average leaf K concentration of three consecutive years and is therefore based on at least six different leaf samplings (Ng Kee Kwong *et al.*[9]). Age corrections, if they could be applied to the leaf K data, would not have a noteworthy effect on the precision and reliability of the diagnosis. This inference concurs with the view of Bates[2] that for the best interpretation, a series of plant samples should be taken over a considerable portion of the growing season.

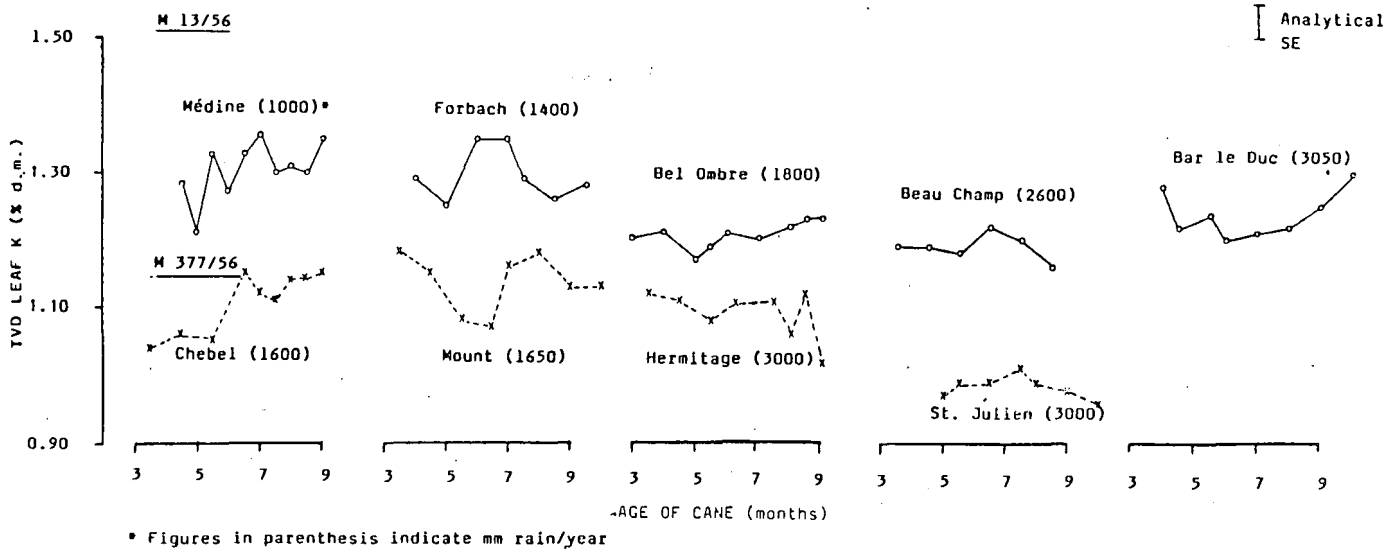

FIGURE 1 Variation of top visible dewlap (TVD) leaf K with age of cane varieties M 13/56 and M 377/56 at different sites varying in rainfall regime.

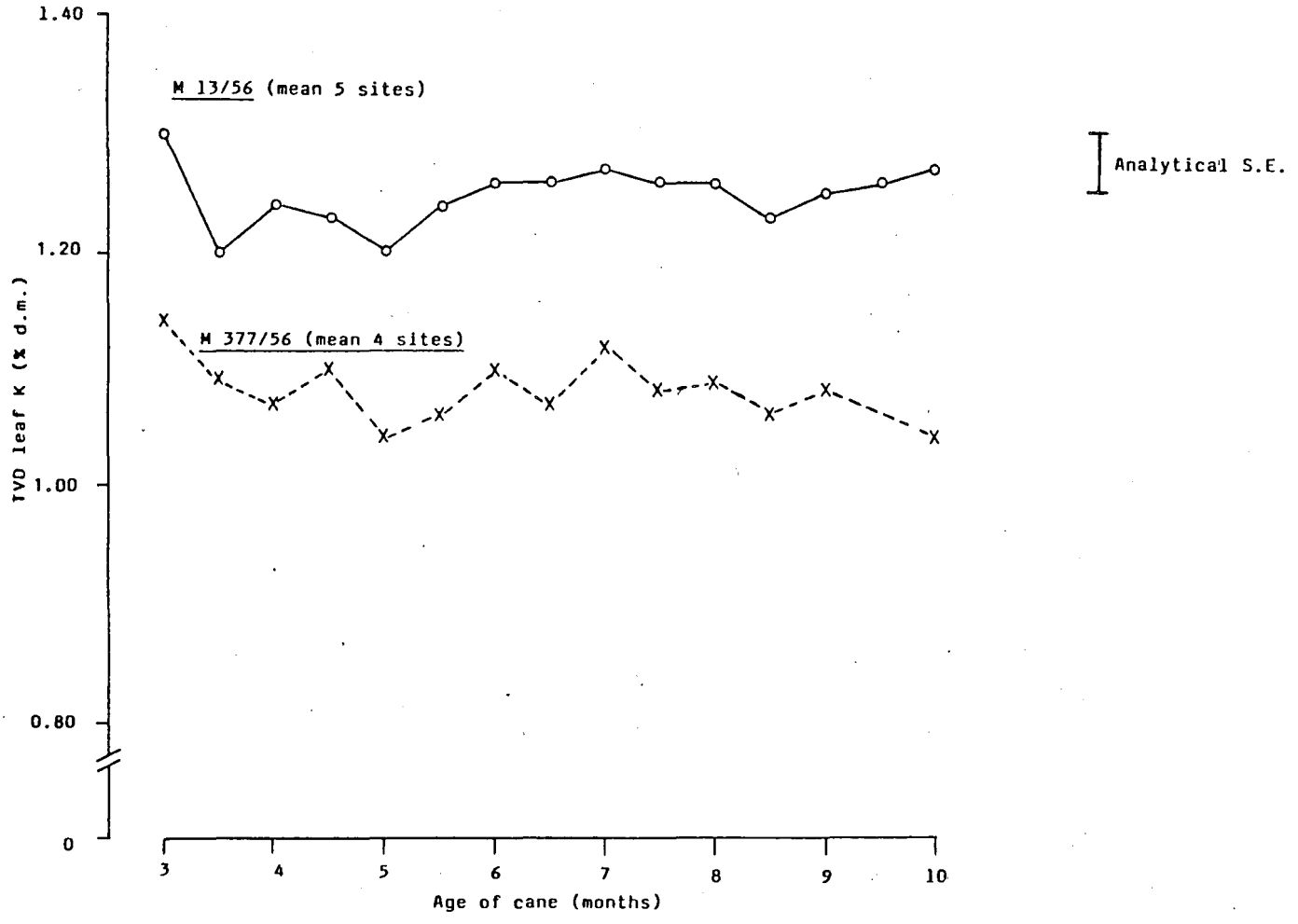

FIGURE 2 Average variation of top visible dewlap (TVD) leaf K with age of sugarcane varieties M 13/56 and M 377/56.

The two varieties studied exhibited marked differences in their leaf K concentration (Figs 1 and 2). These differences were greater than the magnitude of the variation of leaf K value with age of cane. The present study therefore shows that the accuracy and reliability of varietal corrections to adjust foliar analytical K value to the common denominator, namely sugarcane in general, should have a greater impact on the precision of the diagnostic system used in Mauritius.

Influence of rainfall regime

The irregular changes of leaf K concentration with cane age as illustrated in Fig 1 cannot be accounted for by a simple consideration of the rainfall regime prevailing 30 days prior to leaf sampling. As reviewed by Sekhon[11] diffusion becomes smaller under increasing moisture stress. Thus, particularly in the low rainfall regions of Mauritius, e.g. at Forbach receiving only 1 400 mm rain per year, a higher rainfall prior

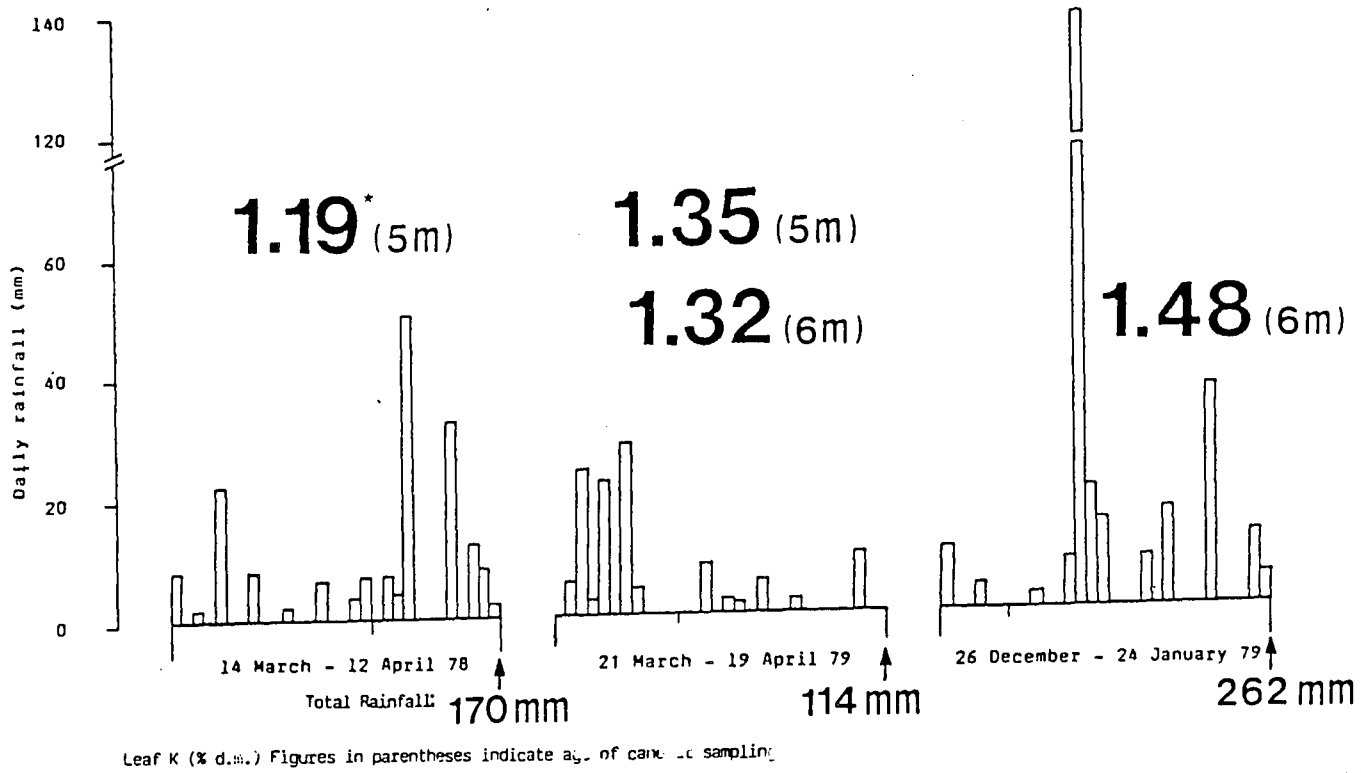

FIGURE 3 Daily rainfall pattern observed 30 days prior to leaf sampling of sugarcane (variety M 13/56) at Forbach (annual rainfall : 1400 mm/year).

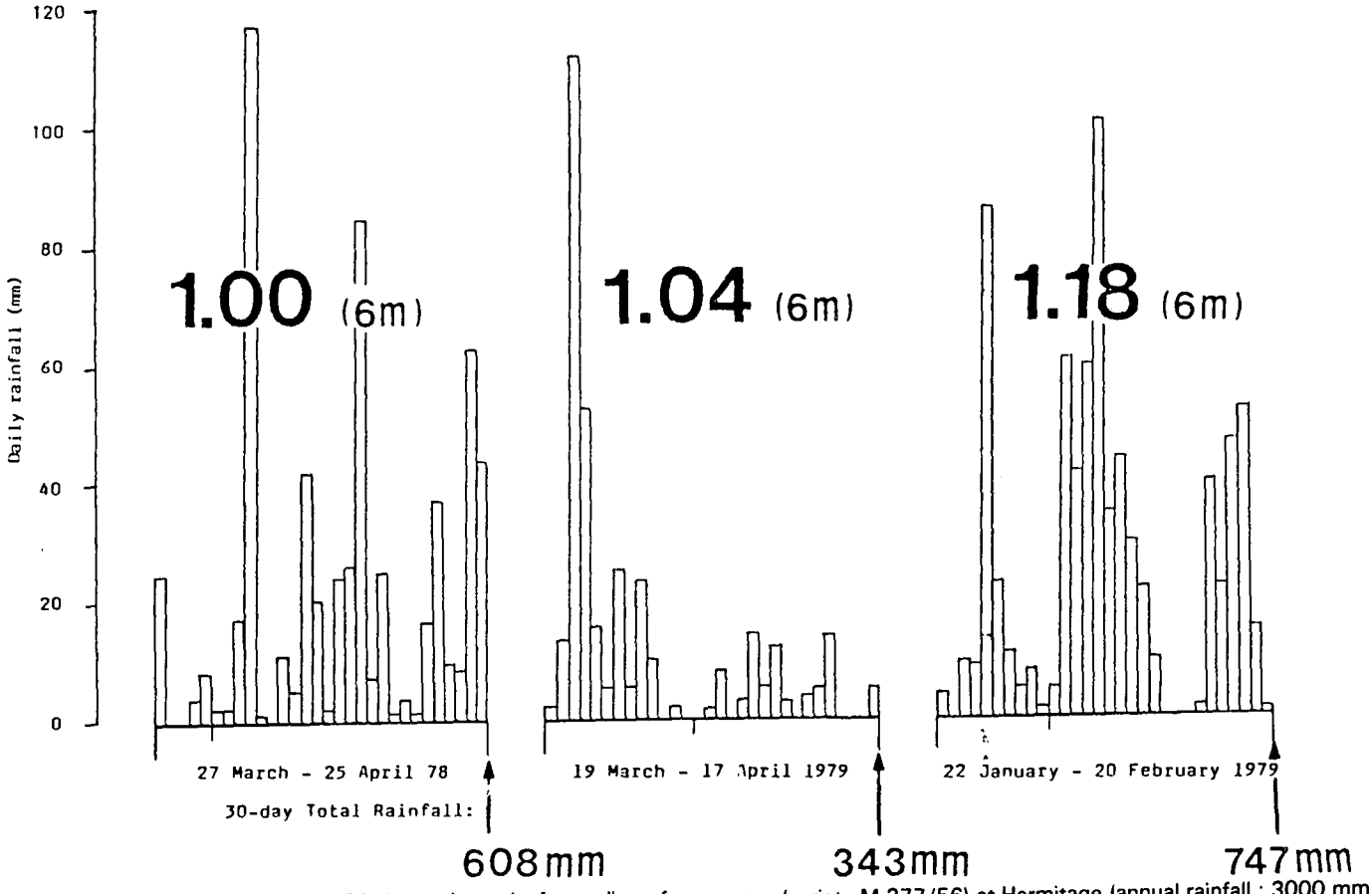

FIGURE 4 Daily rainfall observed 30 days prior to leaf sampling of sugarcane (variety M 377/56) at Hermitage (annual rainfall : 3000 mm/year).

to leaf sampling should enhance K availability thereby causing a higher leaf K concentration to be obtained. This had been found but in some instances only. For example, following a total rainfall of 262 mm over the 30 days preceding leaf sampling in January 1979, a leaf K concentration as high as 1,45% d.m. was observed in sugarcane aged 6 months. This was in contrast to only 1,32% d.m. for the sugarcane of the same age and variety, but sampled in April 1979, when as little as 114 mm of rainfall had been received over the 30 day period prior to leaf sampling (Fig 3).

In other instances the opposite was true, e.g. at the same locality and with cane of the same variety, the leaf K of 5 month old sugarcane was lower in April 1978 than in April 1979 despite the fact that more rain was received 30 days before leaf sampling in April 1978. Though there may be marked changes in nutrient concentration as the season progresses (Bates[2]), this variation of nutrient concentration with season cannot explain in the latter case the differences in leaf K values observed, because the leaves were sampled at a corresponding period (April) during the boom stage of sugarcane growth.

In still other instances, e.g. at Hermitage, which usually receives a high rainfall of 3 000 mm per year, similar leaf K concentrations were observed despite the amount and pattern of rainfall being completely different (Fig 4). The clay mineralogy of soils in the high rainfall zones of Mauritius is dominated by oxides of aluminium and iron. They thus have low cation retention properties and in such soils as observed by Gillman *et al*[3], leaching of K should assume increasing significance with rainfall. A priori therefore, in the high rainfall regions of Mauritius a low leaf K concentration should frequently be associated with a wet rainfall regime prior to leaf sampling. The fact that the opposite was more often true as illustrated in Fig 4 strengthens the view that, unlike other plant K parameters such as K recovery or K efficiency which increased with soil moisture (Barber[1], Mengel and Von Braunschweig[8], Van der Paauw[12]), the trend in sugarcane leaf K concentration cannot be predicted by the moisture regime at or near the time of leaf sampling.

Conclusion

The need for finding age corrections for K may be offset by repeated sampling of the leaves during the boom stage of growth. In so doing the amplitude of variation of leaf K concentration with cane age can be reduced to near insignificance. The numerous factors such as temperature and root growth that may operate to create a nutrient dilution or concentration effect in plants have been discussed by Jarrel and Beverly[4] and Schaff and Skogley.[10] The present study showed that for a given variety the integral effect of all those factors on sugarcane leaf K concentration and on its fluctuation with age of cane cannot be deduced by a simple consideration of rainfall regime only.

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