CROPLOGGING AS A MEANS OF CONTROLLING SUGARCANE FERTILIZATION IN SMALL HOLDINGS

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ABSTRACT

The results of logging sugarcane crops in small holdings distributed over 6 sugar factory zones in Andhra Pradesh (India) have been presented in order to indicate the relationship between nutrient indices of crops given different levels of N and cane yield. In the 152 holdings about which information has been presented in this paper, 3 varieties, viz, Co 419, Co 527 and Co 997 were involved. The findings indicated that 3-6 leaf sheath moisture in the first 4 months and at harvest may be taken as a reliable guide for prediction of cane yields and quality of the crop, respectively. Completion of N fertilization within 4 months and provision of adequate irrigation, especially, in this period were noted to result in maintenance of optimum sheath moisture values at appropriate times, leading to good cane yields of satisfactory quality.

INTRODUCTION

In any programme of crop improvement leading to higher production, mineral nutrition plays a key role. In the case of most crops, soil analysis is taken as the basic criterion to determine their fertilizer needs.

Foliar diagnosis or croplogging is being used increasingly in such countries as Hawaii, Guyana, and Mauritius to determine the nutritional requirements of sugarcane. The philosophy of croplogging was explained by Clements (1) in a series of lectures in India, and a review of foliar diagnosis results recorded in various countries was made by Samuels (7). Particulars of work on croplogging of 1-year crops were reported by Lakshmikantham et al. (4). Evans (2) reviewed in an extensive manner the work on foliar diagnosis or croplogging in different countries. Lakshmikantham (6) recently dealt with the prospects of using croplogging techniques in the fertilization of sugarcane under Indian conditions.

The results of a scheme in which 1-year sugarcane crops from small holdings in 6 sugar factory zones of Andhra Pradesh in India were logged, 1964 to 1970, are presented in this paper.

MATERIALS AND METHODS

Six sugar factory zones were included in the study. Ten holdings selected at random in each factory zone were logged once a month each year for various nutrients and moisture content. While N was estimated in 3-6 leaf blades counting from the top downwards, moisture, P, K, Ca, Mg and total carbohydrates were determined in related sheaths. The sampling was commenced from the age of 60 days and continued once a month till harvest. The central 6-inch leaf lamina without the mid rib was used for estimating N (3). At harvest, cane yield and juice sucrose content were recorded from each holding. Details of cultural and manurial treatments given to different crops were collected and were taken into consideration for calculating correlations between different factors and ultimate cane yields.

The first 3 factory zones are within a distance of 100 miles from Anakapalle, while the rest are about 200 miles away. The holdings in each factory zone were logged for 3 years. In each year new holdings were selected for logging from each factory zone. Thus 30 holdings in each factory zone were studied. All the logged crops were plant cane crops planted in February-March and harvested at the age of 12 months. Although 180 holdings were logged, particulars of only 152 holdings involving 3 varieties are dealt with in this paper.

Because studies on research farms located in these factory zones had shown a response to application of N only and that P and K did not influence cane yield or quality, only N was given to all the crops under investigation.

RESULTS AND DISCUSSION

Level of N and Cane Yield

In the Anakapalle, Bobbili and Samalkot zones, most of the holdings received the total quantity of N by about 4 months after planting, while for crops of the Chagallu, Tanuku and Vuyyur zones N application was staggered, even extending in some cases beyond 6 months. Gross correlations were worked out between the total quantity of applied N and the ultimate cane yield. The data are presented in Table 1.

Table 1. Influence of total applied N on cane yield.

Variety	Total N applied in kg/ha (range)	Cane yield in tons/ha (range)	Gross correlation between total N applied and cane yield
Co 419	80-192	72.0-164.0	+0.579*
Co 527	99-340	73.6-158.4	+0.640*
Co 997	126-320	83.3-150.0	+0.607*

* Significant at 5% level.

Although all the correlation coefficients were significant, only 34-41% of the variation in cane yields could be accounted for by this factor, obviously because the precise effect of irrigation could not be assessed. The lower efficiency of applied N in the case of Co 527 and Co. 997 appears to be due to inadequate irrigation in the first 4 months of the crop.

Earlier studies at this station indicated that N fertilization of sugarcane has to be completed before 4 months after planting to obtain optimum yield consistent with good quality. In Co 527 holdings, N application was continued beyond 5-6 months after planting in some cases. The gross correlation between cane yields and the quantity of N applied in the case of holdings in which the crops received all N before 4 months after planting was noted to be higher (r = +0.717) than the one obtained between the cane yield and total N applied, irrespective of its time of application (+0.640). This is an indirect, though not very precise, confirmation of earlier results recorded at this station.

Sheath Moisture, Leaf N and Cane Yield

Previous studies at this research station demonstrated the dominating influence of sheath moisture in the formative (60-120 days) phase and leaf N in the grand period of growth (150-270 days), on final cane yields. Other factors, e.g. P and K contents of the sheath (leaves 3-6) were not found to significantly affect cane yields. In this investigation no correlation between P, K, Ca and Mg and final cane yield was observed. Therefore, only the gross correlations between sheath moisture, leaf N and cane yield were determined for each variety separately. The data are presented in Table 2. Stalk population

Table 2. Gross correlation coefficients between various factors and cane yield.

	Varieties		
Factors	Co 419	Co 527	Co 997
Cane yield and			
stalk population at harvest	+0.793**	+0.744**	+0.781**
sheath moisture in the formative phase	+0.669*	+0.445*	+0.407*
sheath moisture in the grand period of growth	+0.429*	+0.404*	+0.192
leaf N in the formative phase	−0.499*	+0.016	+0.478*
leaf N in the grand period of growth	+0.123	−0.003	+0.388*

* Significant at 5% level.
** Significant at 1% level.

at harvest was taken into consideration since it also showed a positive and significant association with cane yields.

In all 3 varieties correlation between stalk population and cane yield was highly significant and accounted for more than 60% of the variation in cane yield. Percent sheath moisture in the formative phase exhibited positive and significant correlation with cane yield in all 3 varieties. Percent leaf N in the grand period of growth did not show the significant correlation with cane yield found in previous studies at this station. A significant positive correlation of leaf N in the formative phase with cane yield was observed only in Co 997.

The details of the relationship between sheath moisture in the formative phase of growth and cane yield are presented in Table 3. It will be seen from the data in the table that when sheath moisture was maintained at a higher level in the formative phase, better cane yields were recorded by all 3 varieties under study. While the maximum sheath moisture in Co 997 did not exceed 82.9%, it went up to 86.4% in Co 419, indicating the genetic influence of varieties.

Effect of Sheath Moisture and Stalk Number on Cane Yield

The results from 69 holdings of Co 419 were further examined by multivariate analysis to arrive at a prediction formula using the 2 significant factors,

Table 3. Influence of sheath moisture in the formative phase on cane yield.

Variety	Range of % sheath moisture in the formative phase	Mean % sheath moisture	Mean % leaf N	Mean cane yield in tons/ha
Co 419	83.5-84.4	84.15	1.70	94.85
	84.5-85.4	84.84	1.74	114.11
	85.5-86.4	86.06	1.80	147.71
Co 527	77.0-78.9	78.05	1.93	95.30
	79.0-80.9	80.13	1.77	108.67
	81.0-82.9	82.14	1.75	117.50
	83.0-84.9	84.20	1.76	130.10
Co 997	77.0-78.9	78.34	1.95	103.00
	79.0-80.9	80.22	1.78	102.20
	81.0-82.9	82.01	1.72	114.60

viz, stalk population at harvest and sheath moisture in the formative phase. The analysis revealed that these 2 factors accounted for as much as 70% of the variation in final cane yields. The regression coefficients are presented in Table 4.

Table 4. Influence of stalk number at harvest and sheath moisture in the formative phase (60-120 days) on cane yield of variety Co 419.

Factor	Regression coefficient (tons/acre)	S.E.
Cane yield and		
stalk number at harvest	1.247**	0.1800
sheath moisture in the formative phase	3.656**	0.614

** Significant at 1% level.

Within the range of stalk population at harvest of different holdings, viz, 22060-45330 stalks/acre, cane yield significantly increased at 1.25 tons/acre/1000 stalks over the mean of 34,160 stalks/acre. For every unit increase of sheath moisture in the formative phase, over the mean of 85.22% and up to 87.1% (the maximum recorded), cane yields significantly increased at the rate of 3.66 tons/acre.

To see how long the beneficial effect of sheath moisture will last, the data at the end of the growth phase (270 days) were examined, holding the stalk population constant. The results are presented in Table 5.

The influence of stalk number was dominant as shown by the highly significant regression coefficient indicating increased cane yields at 1.37 tons/acre for every 1,000 stalks above the average of about 34,000/acre at harvest. The significant regression coefficient of total sheath moisture indicated that increased cane yields are to be realised from crops that maintained higher sheath moisture, in general, during the formative and growth phases. However, the significance of the first degree distribution coefficient conditioned the beneficial effect of

Table 5. Particulars of regression coefficients of stalk population at harvest and sheath moisture from 60-270 days on cane yield, variety Co 419.

Factor	Regression coefficient	S.E.
Cane yield and		
stalk population	1.3706**	0.1981
total sheath moisture	0.3655*	0.1768
linear coefficient of sheath moisture distribution	−0.0904*	0.0352
quadratic effect of sheath moisture distribution	−0.0415	0.0533

* Significant at 5% level.
** Significant at 1% level.

sheath moisture in that it should be more in the early period of the crop cycle only. The favourable effect practically ceased beyond 210 days of age of the crop. Influence of unit increase in sheath moisture at different ages on the rate of increase of cane yields (stalk population kept constant at 34,000/acre) is shown in Fig. 1.

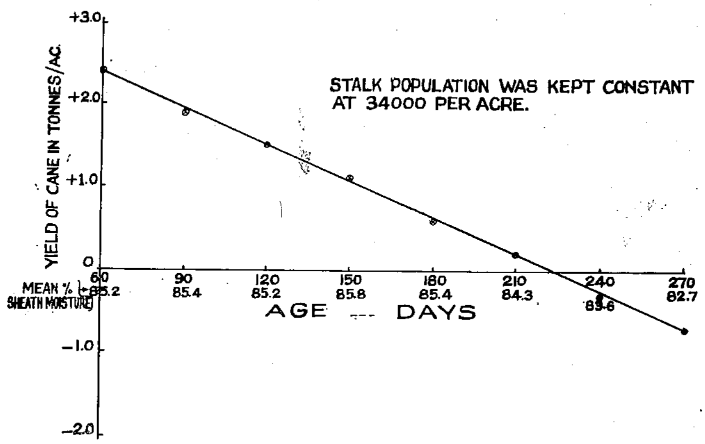

Fig. 1. Influence of unit increase in sheath (3-6) moisture at different ages of sugarcane on the rate of increase of cane yield (CO 419).

These findings, thus emphasized the predominant influence of sheath moisture in the formative phase (60-120 days) on ultimate cane yields. This sheath moisture is an integrated effect of N application and adequate irrigation. Early completion of fertilizer application (before 120 days) and provision of adequate irrigation are, therefore, essential for obtaining optimum cane yields.

Juice Quality

At the time of harvest, representative samples of the cane were analysed for sucrose content. There was considerable variation in juice sucrose values among the Co 419 holdings, the range being from 12.00-19.50%. Similarly, nutrient and moisture composition of cane samples at harvest showed marked variations among the holdings. In order to determine the association, if any, between leaf sheath moisture, leaf N, sheath P, K, Ca and Mg and juice quality, regression coefficients were calculated. Sheath moisture and leaf N only were found to have significant negative relationship with juice sucrose content. Hence, results in respect of these two factors alone have been furnished in Table 6.

Table 6. Influence of sheath moisture and leaf N at harvest on juice sucrose in variety Co 419.

Factor	Regression coefficient	S.E.
Juice sucrose and		
sheath moisture	0.08470**	0.0946
leaf nitrogen	1.0465**	1.1689

** Significant at 1% level.

About 47% of the variation in juice sucrose could be accounted for by the 2 factors under study.

In Co 527 and Co 997, also, there was a significant negative correlation between sheath moisture and leaf N at harvest and juice sucrose. The relevant data are furnished in Table 7. These results indicate the need for early completion of N fertilisation in order to reduce the level of sheath moisture and leaf N by harvest time. The data in Table 8 of juice quality as related to time of application of N also support this conclusion.

Table 7. Correlation coefficients between sheath moisture, leaf N and juice sucrose.

Factors	Co. 527	Co 997
Juice sucrose and		
sheath moisture	−0.332*	−0.4657*
leaf N	−0.315*	−0.6196*

* Significant at 5% level.

Table 8. Influence of time of application of N on juice quality.

Particulars	Mean % 3-6 leaf sheath moisture at harvest	Mean % 3-6 leaf N at harvest	Mean % juice sucrose
Co 527			
Application of about 250 kg N/ha prior to 4 months after planting	76.70	1.45	18.80
Application of about 250 kg N/ha partly or wholly later than 4 months after planting	78.30	1.64	15.51
Co 997			
Application of about 230 kg N/ha prior to 4 months after planting	77.1	1.38	18.61
Application of about 230 kg N/ha partly or wholly later than 4 months after planting	78.7	1.62	17.00

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