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INTERNODAL PATTERNS AND THEIR SIGNIFICANCE IN SORGHUM BREEDING*

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ABSTRACT

Internodal patterns in exotic, Indian, hybrid and cross deritatives of sorghum have been investigated by fitting first, second and third degree polynomial curves. The behaviour of various groups and their comparison with high yielding hybrids indicate that the linear pattern may have an adaptive advantage. Besides alteration of plant type through recombination breeding for duration, dry matter production and distribution, the temperate-tropical crosses of sorghum also enable manipulation of internodal patterns.

THE contribution of short statured varieties to cereal improvement is now well recognized. Genes influencing height frequently modify plant type resulting in altered canopy structure (Qualset, Fick, Constantin and Osborne 1970). The genetics of plant height and the use of height genes in sorghum improvement have received considerable attention (Quinby, 1975). The patterns of internodal elongation, which in turn reflect patterns of growth and development, together with duration, dry matter production and distribution are important attributes in determining proneness to risk and productivity under fluctuating rains. The present study is an attempt to characterize patterns of internodal elongation in traditional tropical sorghums, the dwarf temperate versions, their cross derivatives and some commercial hybrids.

MATERIALS AND METHODS

The genotypes used in this study were selected to represent a diversity of eco-geographic types of sorghum viz., dwarf temperate (IS 2031, CK 60B, 2219B, and 2077B), tall tropical (*Aispuri* from India, IS 9985 from Sudan, IS 11758 and IS 11167 from Ethiopia and Giza 114 from Egypt, commercial hybrids (CSH-1, CSH-5, SPH-20 and SPH-61) and 50 advanced generation derivatives obtained from temperate × tropical crosses with higher order yield levels and diversity for plant and panicle attributes.

The material was grown in three row plots at the National Research Centre for Sorghum during the 1978 monsoon (July-October) season, under optimal management. Internodal lengths from three random plants of the middle row of each entry were measured. Internodes were assigned numbers from 1 to n from base upwards with 1 as the lower most internode and n as the one immediately below the peduncle. An examination of the association between internode number and internode length indicated three (Type I, II and III) patterns. In order to characterize these patterns, first, second and third order polynomial regressions were fitted for each entry. A coefficient of determination (R^2) of 0·75 was chosen as the minimum for a satisfactory curve fitting and classification of genotypes into appropriate groups.

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RESULTS

Data presented in Table 1 bring out established contrasting differences for height, maturity and mean internodal length between exotic (temperate) and Indian (tropical) groups of sorghum. The high yielding hybrid group follows temperate types but reflect some increase in mean internodal length. Compared to the parental forms, the cross derivatives are intermediate for most attributes. The hybrids are the highest yielding followed by the derivatives selected from temperate × tropical crosses. The first, second and third degree polynomial curves with observed and expected values are illustrated in Fig. 1.

TABLE 1

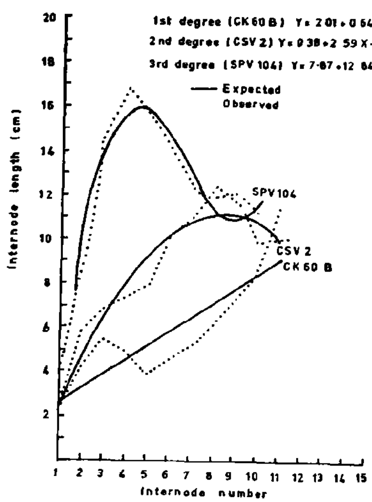
Internode and yield related attributes for tropical, temperate types and their derivatives

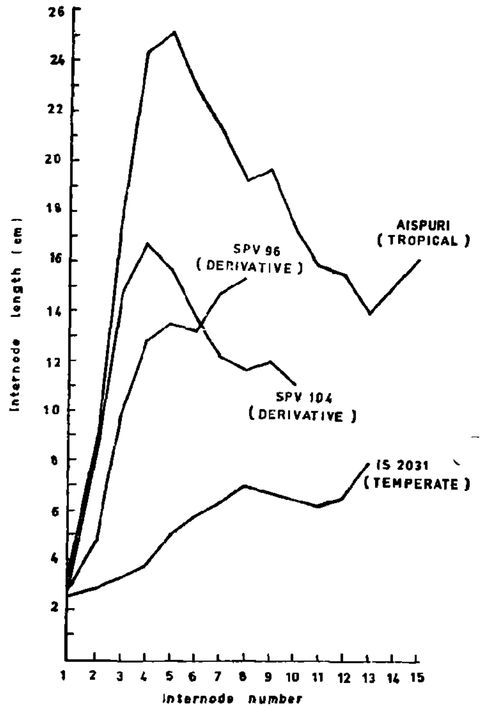
Group		Plant height (cm)	No. of inter-nodes	Average internode length (cm)	Days to flower	Grain yield (g/pl)
Temperate	(*4)	127.8	11.25	5.03	67.25	30.45
Tropical	(5)	290.4	14.40	17.56	83.20	40.10
Hybrids	(5)	175.4	11.40	8.54	67.66	84.88
Derivatives	(50)					
1. Type I	(15)	158.1	10.93	8.61	72.41	73.30
2. Type II	(20)	179.8	11.30	10.42	71.70	84.73
3. Type III	(15)	175.3	11.53	10.53	73.49	70.83
Mean		178.7	11.51	10.10	72.59	71.93
SED		9.2	0.75	1.42	1.30	13.65

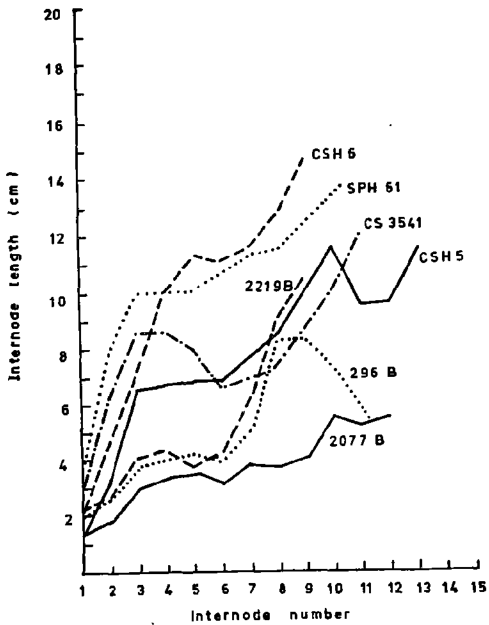
*Number in parentheses indicate number of entries studied in each group.

Data from Table 1 reveal that all temperate types and commercial hybrids follow a linear pattern of internodal elongation and fit the first degree curve. On the other hand, a third degree polynomial was required with regard to the tall tropical forms; IS 9985 exhibiting a second degree polvnomial was a relatively shorter tropical type. In case of the cross derivatives all the three types of curves were possible, the first degree types being relatively shorter. The parental extremes and the behaviour of derivatives are represented in Fig. 2 which indicate recombination and transmissibility of patterns of internodal elongation.

The internodal patterns of parents and hybrids are presented in Fig. 3. In case of all the commercial hybrids, the male parent is common and the females differ-2077A, 2219A and 296A for CSH-5, CSH-6 and SPH-61 (CSH-9) respectively. All the female parents and hybrids fit the first degree polynomial.







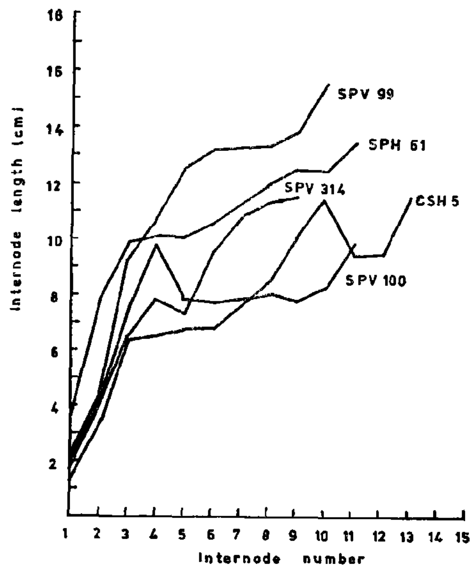


FIG. 1. Expected and observed internodal patterns in sorghums of diverse origin.
FIG. 2. Comparison of internodal patterns in some tropical and temperate sorghums and some derived types. FIG. 3. Internodal patterns of hybrids and their parents
FIG. 4. Internodal patterns of some high yielding hybrids and varieties.

Third order fitting is feasible with CS 3541, the common male parent. Plant to plant variability was also noticed in this genotype. Tallness is usually dominant, but the present study furnished information on heterosis for internodal length as well. CSH-9, which is the highest yielding and most stable hybrid, recently recommended for release on all India basis, conformed to a linear pattern of internodal elongation, all internodes being longer compared to both parents.

Comparative internodal patterns of three high yielding derivatives, SPV-99, SPV-100, and SPV-314 together with CSH-5 and SPH-61 are illustrated in Fig. 4 and all of them conform to the linear pattern.

Discussion

The major factors which contribute to productivity and stability of production, particularly under rainfed culture are duration of crop growth period and total dry matter production and its distribution (Rao *et al.*, 1975). Plant height being related to growth, is an essential component of growth analysis. Cassady(1967) recorded that the *Dw3* mutant height gene did not influence node number and hence maturity, but did affect other attributes. Brooks (1967) and Schertz (1970) observed that elongation is not uniform at all internodes in isogenic mutants. What is of significance is, whether any particular pattern of elongation from base upwards could be of selective value.

Longer internodes at the base in tropical sorghums do reflect a quicker rate of growth and consequently an advantage to stand above weeds. But the consequent low leaf number at the base does not provide adequate cover to smother weed growth. In the dwarf temperate sorghums, while the basal leaf number is high, their initial growth rate is slow. What is, therefore, needed is a recombination between the two and the commercial hybrids seem to satisfy this to some extent. Consequently, in handling temperate-tropical crosses, an appropriate recombination of internode number and length could be an essential criterion for selection.

The commercial hybrids conformed to the linear pattern of internodal elongation. Apart from the adaptive advantages of heterozygosity (Singhania and Rao, 1976), the linear pattern of elongation may cause a lesser set-back to growth under environmental stress. The derivatives of temperate × tropical crosses chosen in the study were all high yielding and were grown under optimal conditions and hence it is not possible to relate internodal pattern to yield under stress. But it may be inferred from experience and superior performance of hybrids under stress that a linear pattern of appropriate internodal lengths may be advantageous. Such a pattern has to be combined with duration as well as optimal dry matter production and distribution. Intermediate derivatives from temperate tropical crosses furnish such an opportunity. That an intermediate plant type may furnish phenotypic optimum was put forth by Rao *et al.*, (1973). Thus, besides providing opportunities to select for altered duration, dry matter production and distribution (Anantharaman *et al.*, 1978), the temperate-tropical crosses enable alteration of internodal patterns which could be of further selective value in breeding for higher yields and stability of performance.

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