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# A Quantitative Method of Determining Pith-Formation in Sugarcane.

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**Introduction.** All sugarcane growers are aware of the occurrence of pith in some sugarcane varieties. The pith usually commences from the central region of the sugarcane. Histologically, pith-formation proceeds by the loss of cell-sap and drying up of the innermost tissue of the central cylinder, and the magnitude of pith formed varies from a central streak or fistular strand to the entire region becoming dry and corky. The natural causes of pith-formation are believed to be either varietal or due to deterioration-phases commonly attendant on over-maturity. In any case, it is of primary importance to the sugarcane grower to know when pith-formation forms in a particular variety, and how far it develops with time, to enable the choice of the right variety and to fix upon the most beneficial time of harvest. Moreover, pith-formation is an economic loss to the grower, as it saps the juice and reduces cane-weight resulting in the loss of cane tonnage. A study of the commencement and relative progress of pith formation in different varieties of sugarcane is of great value in preventing loss of cane out-turn, a factor of vital interest to the grower. So far the only method of estimating pith-formation consisted in cutting open the cane, and examining the longitudinal and transverse sections for pith formed. Such qualitative observations, although affording a clue, could never be so precise or exact as quantitative determinations. The enunciation of a suitable quantitative technique engaged the serious attention of the senior author of this paper, and the method of density determinations described hereunder, proved to be a reliable means of estimating the relative degrees of pith formation in canes. As a natural consequence of pith formation the cane becomes light, and the volume remaining the same, the density is consequently lowered.

**Methods and details of density study in sugarcane.** Density was determined by the cutting and removal of a certain fixed internode of a cane, weighing it in a sensitive balance, and finding its volume by displacement in a graduated jar, and arriving at the weight per unit volume. The internodes were always cut at two distinct marks. The leaf insertion region formed one end of the internode, and the growth ring marked the other. The position of the cane at which the internode is cut is a point of importance. Generally pith formation is found to be more at the top half of canes than at the bottom. In the present study, the internodes were cut at one-fourth the length of the cane from the top, one-fourth the length of the cane from the bottom and the respective densities determined. The actual pith-formation in the internode as observed when cut open was also recorded in all cases in order to see how far the quantitative density-determinations, supported the visual observations.

As generally pith is associated with canes left to stand on the field after maturity, the density studies were confined to the late varieties and the results are embodied in Table I. The recorded observations on each variety on both 'arrowed' and 'unarrowed' canes were made on the same date. The readings given in the table are the average of two canes.

The figures in Table I disclose that the density of the top internode of Co. 349 'arrowed' which was full of pith, was the least. The density was also equally low in tops of Co. 331 and Co. 417 'arrowed' which were fully pithy. The bottom internodes of all varieties except Co. 408, and tops of 'unarrowed' canes, which contained little or no pith, always showed high densities above unity. Co. 408 'unarrowed' bottom which had a low density of 0·886 contained large amount of pith. A positive correlation between the density of a cane and its pith formation appeared therefore to clearly exist. However for further and fuller confirmation of this indication densities of numerous samples in each variety were recorded, and the extent of the deviations from their means, and the significance of the differences between means worked out. The results are embodied in Table II.

Differences between means of columns 2 and 4 (Table II) were not significant, and the pith formation as observed was also very little in both. Differences between means of columns 1 and 3 were highly significant and the pith formation as observed was also much greater in 1 than in 3. Differences between means of columns 3 and 5 were not significant and the pith formation was more or less the same in both. Again the differences between means of columns 5 and 7 were not significant and the pith formation in both was very little.

The standard deviations or the dispersion of the population from the mean, and the coefficient of variations were small showing that the densities at a particular part of the cane are more or less uniform.

It is therefore established that the density determination is a reliable measure of pith-formation in canes, and consequently to compare the relative pith-formation between varieties it would be quite enough to find the densities of internodes at some fixed part of the cane. But the part of the cane selected must be so judiciously chosen as to give a correct index of its pithiness. Table III gives figures of the density of every internode from top to bottom of Co. 331 'arrowed' and 'unarrowed' cane respectively.

A scrutiny of figures in Table III shows that pith-formation is most in top-half of the cane and least at the bottom-half. It will be undoubtedly ideal to find the density of the whole cane in all cases but such a procedure

TABLE I.

**Densities and pith formation of some late varieties.**

Date of planting 26—2—39. Date of observation 25, 26—4—40

| Serial No. | Variety. | Arrowed canes. | | | | Unarrowd canes. | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Top internode. | | Bottom internode. | | Top internode. | | Bottom internode. | |
| | | Density. | Pith as observed. | Density. | Pith as observed. | Density. | Pith as observed. | Density. | Pith as observed. |
| 1 | Co. 419 | 0·918 | 1/3 to 1/2 diameter pithy | 1·066 | No pith | 1·067 | Very slight | 1·070 | No pith |
| 2 | Co. 417 | 0·881 | Very much pithy | 1·049 | Very slight | 1·042 | Small core forming | 1·066 | Very slight |
| 3 | Co. 416 | ... | Not arrowed | ... | Not arrowed. | 1·028 | No pith | 1·059 | No pith |
| 4 | Co. 413 | 0·948 | 1/3 to 1/2 diameter pithy | 1·057 | No pith | 1·069 | Very little pith | 1·072 | Do. |
| 5 | Co. 411 | 0·989 | 1/2 diameter ,, | 1·081 | Little pith | 1·071 | Slight | 1·056 | Small central core |
| 6 | Co. 408 | 0·943 | More than 1/2 diameter pithy | 1·065 | 1/2 diameter pithy | 1·063 | Small central core | 0·886 | 1/4 to 1/2 diameter pithy |
| 7 | Co. 349 | 0·852 | Full of pith | 0·939 | 1/3 ,, ,, | 1·072 | Small core of pith | 1·082 | Small core of pith |
| 8 | Co. 331 | 0·858 | Very much pithy | 1·027 | Small core of pith | 1·049 | Do. | 1·050 | Do. |
| 9 | J. 247 | ... | Not arrowed. | ... | Not arrowed | 1·010 | Central core of pith | 0·977 | 1/3 diameter pithy |

will entail enormous time and labour. Hence some position, say ¼th or ½ the length of the cane from the top can be taken for determining density.

**Summary and conclusion.** (i) Density determination is found to be a reliable measure of pith formation in canes, and the full technique is described in detail with illustrative figures.

(ii) The internode, say at one-fourth or one-half of the length of the cane from the top can be cut, always at some fixed marks, viz. the leaf-insertion region, and the growth ring, and the density determined.

(iii) It is always best to record the pith-formation as actually observed by splitting open the cane against its density. The one gives a visual indication, while the other is an exact measure of pith-formation.

TABLE II

**Densities of certain varieties, their means, and standard deviations.**

| Serial No. | Co 331 arrowed | | Co 331 unarrowed | | Co 417 unarrowed | | Co 419 unarrowed | |
|---|---|---|---|---|---|---|---|---|
| | Top 1 | Bottom 2 | Top 3 | Bottom 4 | Top 5 | Bottom 6 | Top 7 | Bottom 8 |
| 1 | 0·902 | 1·035 | 0·863 | 1·021 | 1·031 | 1·058 | 1·055 | 1·065 |
| 2 | 0·881 | 1·023 | 0·884 | 1·009 | 1·021 | 1·030 | 1·038 | 1·027 |
| 3 | 0·879 | 1·017 | 1·008 | 0·987 | 1·035 | 1·010 | 1·077 | 1·068 |
| 4 | 0·876 | 1·038 | 0·995 | 1·050 | 1·017 | 1·043 | 1·055 | 1·049 |
| 5 | 0·861 | 1·016 | 1·044 | 1·013 | 1·046 | 1·043 | 1·062 | 1·069 |
| 6 | 0·887 | 1·014 | 1·049 | 1·023 | 1·036 | 1·038 | 1·048 | 1·051 |
| 7 | 0·880 | 1·054 | 1·051 | 1·038 | 1·043 | 1·036 | 1·071 | 1·062 |
| 8 | 0·866 | 1·050 | 1·052 | 0·999 | 1·025 | 1·061 | 1·066 | 1·039 |
| 9 | 0·823 | 1·028 | 0·989 | 1·026 | 1·002 | 1·040 | 1·056 | 1·037 |
| 10 | 0·889 | 1·037 | 0·962 | 1·062 | 1·030 | 1·058 | 1·075 | 1·073 |
| 11 | 0·818 | 1·026 | 0·888 | 1·035 | 1·039 | 1·045 | 1·045 | 1·012 |
| 12 | 0·878 | 1·052 | 1·001 | 0·999 | 1·027 | 1·025 | 1·066 | 1·058 |
| 13 | 0·842 | 1·033 | 1·048 | 1·052 | 0·982 | 1·056 | 1·075 | 1·030 |
| 14 | 0·828 | 1·007 | 1·016 | 1·044 | 1·043 | 1·042 | 1·030 | 1·009 |
| 15 | — | — | 1·023 | 0·989 | 1·013 | 1·044 | 1·061 | 1·042 |
| M. N. | 0·865 | 1·031 | 0·992 | 1·023 | 1·026 | 1·042 | 1·059 | 1·046 |
| S. D. | 0·0257 | 0·0142 | 0·0544 | 0·0282 | 0·0166 | 0·0058 | 0·0127 | 0·0229 |
| C. V. | 2·971 | 1·377 | 5·484 | 2·757 | 1·616 | 0·559 | 1·199 | 2·190 |
| Pith formation | two-thirds to whole core thickness. | Very small central core of pith. | Varying from a small central core to ¾ diameter | Small central core. | Very small central core to ¼th diameter. | Very small central core. | Very small central core. | Very small central core. |

**TABLE III**

**Density of every internode of Co. 331 (one entire cane from the top to bottom).**

Date of planting 22—2—39 Date of observation 18—5—40

| Co. 331 arrowed | | | Co. 331 unarrowed | | |
|---|---|---|---|---|---|
| Inter-node No. | Density | Pith as observed | Inter-node No. | Density | Pith as observed |
| 1 | 0·688 | Completely pithy | 1 | 0·981 | 1/3 diameter pith |
| 2 | 0·769 | Full of pith | 2 | 0·981 | 2/3 " " |
| 3 | 0·810 | Nearly full of pith | 3 | 0·950 | do. |
| 4 | 0·825 | More than 3/4 diameter pithy | 4 | 0·966 | 3/4 diameter pith |
| 5 | 0·902 | 3/4 diameter pithy | 5 | 0·940 | Nearly 1/2 diameter pith |
| 6 | 0·935 | 1/2 " " | 6 | 0·886 | 3/4 diameter pith |
| 7 | 0·961 | do. | 7 | 0·884 | do. |
| 8 | 0·959 | do. | 8 | 0·846 | Nearly 3/4 diameter pith |
| 9 | 1·018 | Small central core | 9 | 0·890 | Slightly more than 3/5 diameter |
| 10 | 1·034 | do. | 10 | 0·968 | 3/5 diameter pith |
| 11 | 1·035 | do. | 11 | 0·966 | 1/3 " " |
| 12 | 1·027 | do. | 12 | 0·970 | do. |
| 13 | 1·026 | do. | 13 | 1·028 | 1/5 " " |
| 14 | 1·047 | do. | 14 | 1·024 | Small central core |
| 15 | 1·041 | do. | 15 | 1·009 | 1/4 diameter pithy |
| 16 | | | 16 | 1·008 | Small central core |
| 17 | | | 17 | 1·020 | do. |
| 18 | | | 18 | 1·014 | do. |
| 19 | | | 19 | 1·026 | do. |
| 20 | | | 20 | 1·053 | Very small central core |

# Rotation and Mixed Crops with Sorghum.

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**Introduction.** Sorghum is the chief cereal crop grown under rain-fed conditions in the Madras Presidency. It is grown on an area of more than 4½ million acres. It is usually grown in rotation with the commercial crops—cotton, groundnut (*Arachis hypogea*, L.), tobacco or chillies (*Capsicum* spp.). A pulse crop like red gram (*Cajanus cajan*, (L) Millsp.) or Bengal gram (*Cicer arietinum*, L.) is grown in rotation with it in some parts of the presidency. These as well as other pulses are often grown mixed with sorghum, thereby saving land, labour and cultivation expenses, and obtaining a variety of produce. The crops grown mixed with sorghum and in rotation with it depend upon the nature of the soil and season, and the local conditions and demand. Irrigated sorghum is usually grown as a pure crop.