

Pith Development Studies in Sugarcane.

By R. VASUDEVA RAO, L. Ag., Assoc., I. A. R. I.

and

C. EKAMBARAM, B. Sc. (Ag.), Assoc., I. D. I.

1. Introduction. There is a general impression among the ryots that canes, when kept longer in the field after maturity, develop large amounts of pith with resultant loss in tonnage. A study was therefore undertaken to find out when pith begins to form, whether there is any increase in the same with the age of the crop, and whether it is influenced by environmental conditions like manuring or irrigation.

2. Material and Methods. At the Agricultural Research Station, Gudiyattam our late maturing varieties, viz Co. 331, Co. 349, Co. 411 and Co. 419 were taken up for study. Development of pith in these canes was examined once a month from October till their harvest in April - May in 1940-41 and 1942-43, and in October and April only in 1941-42. Ten canes were taken for each observation. The intensity of pith in each cane was recorded on the following lines

The densities of internodes situated at the middle and in the top quarter of the cane were recorded by determining their weight and volume, as per the technique described by Venkataraman and Ekambaram (1941).^{*} But always the entire length of the cane was split into two halves vertically, and the pith observed in each internode was recorded. In recording pith in each internode (by visual estimation), the intensity of pith observed was expressed as a fraction of its diameter, as say $\frac{1}{4}$, $\frac{1}{3}$, $\frac{1}{2}$, $\frac{2}{3}$, or $\frac{3}{4}$ diameter pith or full of pith. The number of internodes of pith under different denominations of pith detailed above were noted, and finally all of them were reduced to one single denomination and expressed in terms of number of internodes as full of pith. For example supposing a cane of 20 internodes contained 2 internodes full of pith, 4 internodes with $\frac{3}{4}$ diameter pith, 3 internodes with $\frac{2}{3}$ diameter pith, 2 internodes with $\frac{1}{2}$ diameter pith, 3 internodes with $\frac{1}{3}$ diameter pith, and 4 internodes with $\frac{1}{4}$ diameter pith, the total pith in the cane would be equivalent to $2 + 4 \times \frac{3}{4} + 3 \times \frac{2}{3} + \frac{1}{2} \times 2 + \frac{1}{3} \times 3 + 4 \times \frac{1}{4} = 10$ internodes full of pith, and this expressed as a fraction of its total number of internodes would give a measure of the intensity of pith.

Arrowed and unarrowed canes were studied separately.

In order to find out if restricted manuring and irrigation had any effect on pith formation, canes grown under normal and restricted conditions of manuring and irrigation were also examined separately.

The results obtained during the last three years for each variety are consolidated in tables I and II, in order to save space.

3. Results and discussion. In table I, the average intensity of pith monthly from October to April is recorded separately for arrowed, and

^{*} The Madras Agric. Jour, Vol. 29 (1941), No. 2, pp. 53- 57.

unarrowed canes. Items 1 to 9 relate to the pith as actually observed, when the cane is split open vertically. For example in November an arrowed cane of Co. 331 contained 18 internodes of which about 2 (2'2) internodes were fully pithy, one to two internodes (1'5) contained $\frac{3}{4}$ diameter pith, one to two internodes (1'7) contained half diameter pith, and one to two internodes (1'6) contained $\frac{1}{4}$ diameter pith, and two internodes contained $\frac{1}{4}$ diameter pith. Item 7 gives the total pith expressed in terms of number of internodes full of pith, and item 9 gives the proportion of cane full of pith. Items 10 and 11 give the densities of internode at $\frac{1}{4}$ and $\frac{1}{2}$ of the length of the cane from the top.

In this connection, it may be mentioned that density figures gave only a measure of the pithiness of the particular internode taken for study. As pith was not confined to a particular internode, but distributed over a number of internodes, density determination of a single internode did not give a general index of the pithiness of the cane as a whole. Hence for purposes of comparative study the pith observed in every internode of the cane and expressed in terms of number of internodes as detailed above, gave a reliable measure of pith.

(i) *Pith development in relation to arrowing, varieties and age.*

Pith was found in small quantities even in immature canes, six to seven months old, but any variety developed a large amount of pith on arrowing by October—November. For example in Co. 331 (table I), 0'46th part of arrowed cane was fully pithy, while in unarrowed cane, only 0'19th part was full of pith. Similarly, pith in arrowed cane of Co. 349 amounted to 0'48th part of the cane, while in unarrowed canes, it was only 0'20 to 0'27th part of the cane. In Co. 411 and Co. 419 arrowed canes contained pith in about 0'15 and 0'29th part of the cane respectively, while in unarrowed canes, it was almost negligible. Pith in arrowed canes was mostly confined to the top half of the cane. It is thus evident that canes on arrowing develop pith amounting to nearly half the cane in some varieties, while unarrowed cane develops only slight or no pith at all.

Intensity of pith also varied greatly with varieties. A perusal of the table will clearly show that pith was maximum in Co. 349, followed by Co. 331. Co. 411 contained the least amount of pith. Besides, the nature of pith in Co. 411 was also different from that in other varieties. It consisted mostly of a central hollow core with white fistular strands, whereas in Co. 331 or Co. 349, it was a compact mass extending from a small central core to the periphery of the internode.

The study of the course of development of pith every month from October to April threw interesting light on the influence of age on pith development. Co. 331 arrowed canes contained large amount of pith even by December, and it was more or less the same up to March. Only in April there was a little further increase. In unarrowed canes, there was a slight increase in pith during April. In Co. 349 (table I) 0'39th part of arrowed canes was fully pithy even when in shot blade and allowing for

variation due to sample, there was only a slight increase in April. In Co. 411 the intensity of pith recorded each month did not show any definite increase with the age of the crop. In Co. 419, arrowed canes developed most of their pith even by November. There appeared to have been an increase of pith in the March sample, though it was less in the April sample. In unarrowed canes of Co. 419, pith was negligible; however, it was comparatively slightly more in April than in other months.

From a review of the results obtained it can be observed that cane varieties developed most of their pith by November—December and there was not any great increase with the age of the crop. Only a slight increase amounting to 10 to 20% over that already formed in December was observed in April in some cases. However, as even a slight increase in pith will cause reduction in yield, it is advisable to harvest the canes before April, by which time the cane will begin to deteriorate badly, because of the advent of summer.

(ii) *Pith development in relation to irrigation and manure.*

The results of the study of pith development in canes grown under normal and restricted conditions of manure and irrigation are recorded in table II.

The normal treatment received 100 lbs. Nitrogen, while the restricted treatment received 50 lbs. Nitrogen, both over a basal dressing of 5 tons of Farm Yard Manure. Irrigations were given once in twelve days for the normal and once in twenty-four days for the restricted treatment. A careful perusal of the data revealed that there was no increase in the pith of canes grown under restricted conditions; as a matter of fact, it was even slightly less than under normal conditions.

Summary and conclusions. The development of pith in cane varieties was studied periodically to determine if there is any increase in pith with the age of the crop, and whether it is influenced by environmental conditions like manuring and irrigation.

The results indicate that:

- (i) Cane varieties differ in the intensity of pith.
- (ii) Any variety develops large amount of pith in the top half of the cane immediately on arrowing or even just before arrowing. Development of pith in unarrowed canes is much less, and negligible in some varieties.
- (iii) Canes develop most of their pith by November—December, and some increase is observed only in April. It is, therefore, advisable to harvest the canes before the advent of the hot weather in April, when canes will also begin to deteriorate badly.
- (iv) There is no increase of pith in canes grown under restricted conditions of manuring and irrigation; on the other hand it is even less than that under normal conditions.
- (v) Intensity of pith in canes is seen to be more a varietal character, and is greatly increased by arrowing.

TABLE I. Showing the average intensity of pith in cane varieties for the seasons 1941 to 1943.

S. No.	Particulars.	Co. 331 arrowed						Co. 331 unarrowed.							
		Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April
1.	No. of internodes, full of pith	Nil	2.2	4.6	4.1	4.4	3.0	3.8	Nil	0.6	0.2	Nil	0.3	Nil	Nil
2.	" $\frac{3}{4}$ diameter pith	"	1.5	1.4	1.7	2.1	2.7	1.9	"	1.2	0.7	0.6	0.3	"	0.6
3.	" "	"	Nil	1.0	1.2	1.1	1.0	2.0	0.4	0.3	0.7	1.4	1.2	0.9	1.6
4.	" "	"	1.7	1.2	1.1	1.4	0.8	1.7	0.8	1.3	1.7	2.3	1.3	1.1	1.4
5.	" "	"	1.6	0.8	1.2	0.6	0.5	1.5	0.8	1.6	1.0	1.8	1.8	1.7	3.4
6.	" "	"	2.0	0.8	0.3	1.8	1.7	3.0	1.5	2.7	1.3	1.1	4.1	3.3	4.6
7.	Total pith expressed in terms of number of internodes full of pith	"	5.1	7.4	7.1	7.9	6.7	8.7	1.3	3.5	2.8	3.5	3.6	2.6	4.9
8.	Total number of internodes	"	18	20	20	21	17	19	15	16	17	20	21	19	26
9.	Proportion of cane full of pith	"	0.28	0.37	0.36	0.37	0.39	0.46	0.09	0.22	0.17	0.18	0.17	0.14	0.19
10.	Density of I. N. at top $\frac{1}{4}$ cane	"	0.998	0.911	0.901	0.810	0.783	0.809	0.960	0.940	0.978	0.967	1.017	1.047	1.048
11.	Density of I. N. at middle of the cane	"	1.062	1.040	1.032	1.005	0.985	0.991	1.028	1.021	1.010	0.994	0.997	0.965	0.985
		Shot blade	Co. 349 arrowed						Co. 349 unarrowed						
1.	No. of internodes full of pith	2.2	3.6	4.2	3.4	3.2	3.0	3.9	Nil	Nil	Nil	Nil	Nil	Nil	0.8
2.	" $\frac{3}{4}$ diameter pith	3.3	2.6	3.0	2.2	2.2	2.7	1.8	0.4	0.1	0.4	0.7	0.1	0.5	0.8
3.	" "	2.4	0.9	0.9	2.5	2.5	0.8	2.8	1.3	1.4	0.3	2.0	1.3	1.8	2.6
4.	" "	2.0	1.0	2.4	2.3	2.0	1.5	2.1	1.0	1.6	2.6	2.5	2.8	0.8	4.9
5.	" "	1.2	1.3	1.3	1.4	1.9	0.7	1.7	1.4	2.8	2.5	3.6	5.3	0.8	4.2
6.	" "	0.3	0.8	0.8	0.4	0.3	Nil	1.0	0.6	1.0	1.2	0.6	2.4	1.0	1.8
7.	Total pith expressed in terms of number of I. N. full of pith	7.8	7.3	8.9	8.6	8.2	6.5	9.1	2.3	3.0	2.9	4.4	4.8	2.6	7.5
8.	Total number of internodes	20	19	19	19	19	15	19	16	16	18	21	25	22	28
9.	Proportion of cane with full pith	0.39	0.38	0.47	0.45	0.43	0.43	0.48	0.14	0.19	0.16	0.21	0.19	0.12	0.27
10.	Density of I. N. at top $\frac{1}{4}$ cane	0.805	0.876	0.805	0.840	0.824	0.829	0.823	0.927	...	0.911	0.980	1.022	1.046	1.034
11.	Density of I. N. at middle of the cane	0.951	1.012	0.963	0.963	0.934	0.922	0.938	0.990	...	0.993	1.014	1.019	1.001	1.023

S. No.	Particulars.	Co. 411 arrowed				Co. 411 unarrowed								
		Nov.	Dec.	Jan.	Feb.	Mar.	April	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April
1.	No. of internodes with full pith	0.8	2.4	0.7	Nil	0.3	0.2	Nil	Nil	Nil	Nil	Nil	Nil	Nil
2.	" " $\frac{1}{2}$ diameter pith	1.1	1.1	1.3	0.7	0.5	0.9	"	"	"	"	"	"	"
3.	" " "	0.8	0.8	0.3	0.8	1.0	0.9	0.1	"	"	"	"	"	"
4.	" " "	1.2	1.0	1.1	0.5	0.8	1.2	Nil	"	"	"	"	"	0.2
5.	" " "	0.8	0.9	0.3	0.9	1.3	0.7	0.2	"	"	"	"	"	2.4
6.	" " "	1.1	1.0	1.8	0.8	1.3	2.9	Nil	"	"	"	0.7	"	1.0
7.	Total pith expressed in terms of No. of internodes with full pith	3.3	4.8	3.1	1.8	2.5	3.0	0.1	"	"	"	Nil	"	Nil
8.	Total number of internodes	22	23	21	19	20	21	20	20	24	25	28	26	33
9.	Proportion of cane with full pith	0.15	0.21	0.15	0.10	0.13	0.14	0.005	Nil	Nil	Nil	Nil	Nil	0.04
10.	Density of internodes at top $\frac{1}{2}$ cane	1.068	1.034	0.995	1.017	0.975	0.994	1.023	1.053	1.050	1.059	1.073	1.054	1.022
11.	Density of internodes at middle of cane	1.072	1.070	1.053	1.044	1.035	1.039	1.039	1.042	1.060	1.055	1.077	1.500	1.025
		Co. 419 arrowed				Co. 419 unarrowed								
1.	No. of internodes with full pith	1.8	3.2	1.3	2.1	2.0	1.3	Nil	Nil	Nil	Nil	Nil	Nil	Nil
2.	" " $\frac{1}{2}$ diameter pith	2.0	2.1	2.4	1.0	1.3	2.0	0.2	"	0.3	"	"	"	0.3
3.	" " "	1.1	0.4	0.7	1.0	2.1	0.8	2.25	0.3	0.05	0.1	"	0.3	0.5
4.	" " "	0.5	0.6	0.7	0.5	1.0	0.6	Nil	Nil	Nil	Nil	"	0.3	0.4
5.	" " "	0.7	0.2	0.2	0.1	0.1	0.5	0.15	0.4	0.25	"	"	0.5	0.9
6.	" " "	Nil	0.05	Nil	Nil	Nil	0.3	0.05	0.6	0.20	0.1	"	Nil	0.6
7.	Total pith expressed in terms of No. of internodes with full pith	4.5	5.5	4.0	3.8	4.9	3.8	0.4	0.5	0.24	Nil	"	0.4	1.2
8.	Total number of internodes	18	20	19	16	17	18	17	17	20	22	23	25	28
9.	Proportion of cane with full pith	0.25	0.28	0.21	0.24	0.29	0.21	0.02	0.03	0.01	0.004	Nil	0.02	0.04
10.	Density of internodes at top $\frac{1}{2}$ cane	1.041	0.928	1.009	0.901	0.878	0.914	1.020	1.053	1.043	1.064	1.074	1.060	1.045
11.	Density of internodes at middle of cane	1.082	1.076	1.078	1.075	1.052	1.054	1.055	1.055	1.061	1.063	1.072	1.023	1.060

TABLE II. Showing the average intensity of pith in canes under normal and restricted conditions during 1941-1943.

S. No.	Particulars.	Co. 421 arrowed		Co. 421 unarrowed		Co. 419 arrowed		Co. 419 unarrowed	
		Normal	Restri-cted.	Normal	Restri-cted.	Normal	Restri-cted.	Normal	Restri-cted.
1.	No. of internodes with full pith	2.9	2.5	Nil	Nil	1.0	1.2	Nil	Nil
2.	" $\frac{3}{4}$ diameter pith	1.4	1.6	"	"	2.4	1.6	"	"
3.	" $\frac{2}{3}$ "	2.8	1.5	0.8	"	1.1	1.0	"	"
4.	" $\frac{1}{2}$ "	0.9	1.8	1.5	0.3	0.9	0.9	"	"
5.	" $\frac{1}{3}$ "	0.45	1.3	1.8	0.8	0.3	0.5	0.03	"
6.	" $\frac{1}{4}$ "	0.55	0.8	0.7	0.5	0.1	0.1	0.03	"
7.	Total pith expressed in terms of No. of internodes with full pith	6.6	6.2	2.1	0.5	4.1	3.7	Nil	"
8.	Total No. of internodes	18	19	22	21	18	18	24	22
9.	Proportion of cane with full pith	0.37	0.33	0.10	0.02	0.23	0.20	Nil	Nil
10.	Density of internodes at top $\frac{1}{4}$ cane	0.852	0.887	1.056	1.070	1.029	1.035	1.066	1.060
11.	Density of internodes at middle of the cane	1.025	1.028	0.992	1.041	0.988	0.993	1.071	1.061

Abstracts.

Plant viruses. (By Kenneth M. Smith, Ph. D. (Cantab), D. Sc., F. R. S., *Endeavour*, Vol. IV, January 1945, p. 229.) The word 'virus' which is derived from the Latin and means a poison has come to be associated exclusively with a particular type of disease agent. Viruses are put in a class by themselves and the characters which distinguish them from the visible pathogenic organisms are as follows: first their extremely small size ranging from just below the limit of vision down to molecular sizes, second their close association with the living cell—no virus having been so far cultivated in a cell-free medium, and third, their interesting relationship with insects, upon which many viruses are dependent for their transference to new hosts.

The economic significance of viruses is very great. No form of living organism seems to be immune from their attack and the sum total of disease, loss and suffering due to their activities is almost equal to that caused by the pathogenic bacteria. In addition viruses are of very great scientific interest and have attracted the attention of workers from many different fields. The physicist, physical chemist, the biochemist and the serologist have all made their contribution to recent advances in our knowledge of viruses. Viruses have also a considerable philosophic interest, occupying as they do a borderland position between the "living" organism and the "non-living" chemical. They possess on the one hand such indubitable properties of life as the power to multiply and mutate, while on the other hand they show many properties such as the power to crystallize which are more properly associated with a chemical substance.

Although the majority of animal viruses and probably all the plant viruses are well below the limit of resolution by visible light, the application within the last few years, of the exact methods of the physicist to the study of viruses has resulted in a great increase of knowledge regarding the virus particle itself. By