SPACE PLANTING OF SUGARCANE IN RELATION TO SOIL MOISTURE

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From general field practice, it has been accepted that the inter-rows between lines of cane should be 4 ft. 6 ins. in width. At times alternative spacings have been tried, 5 ft., and even 6 ft., has been adopted, but a return to the 4 ft. 6 ins. to 5 ft. has been made, with little or no reason except that the mechanical cultivation of the inter-row has been most convenient at this spacing.

In 1948 a research project was commenced to look into the optimum distances to be given between the lines of cane and between the setts placed in the lines.

A trial planted with two varieties of cane was laid down with the following treatments:

Inter-row spacings of (*a*) 3 ft. 6 ins.
(*b*) 4 ft. 6 ins.
(*c*) 5 ft. 6 ins.

Each of the above inter-row spacings had 18-in. setts planted in the row at the following spaces between setts:

(*a*) No space between
(*b*) 1 ft. 6 ins. between
(*c*) 3 ft. between

Thus, after germination the population in stools per acre varied as follows, according to treatment:

The indication from this trial, which could not be statistically analysed, due to an error in planting, is that there would be a considerable saving in seed material with the wider spacings, provided the yield was not seriously affected, setts per acre being reduced from 8,370 in the continuous × 3 ft. 6 ins. spacing, to 1,792 in the 5 ft. 6 ins. × 3 ft. spacing.

The yields as shown for plant, first ratoon and second ratoon seemed not only to be unaffected but to rise somewhat with certain of the wider spacings.

As a result of these recordings it was advocated that space planting in the row would give more and bigger sticks per stool when planting for seed material and that a "gap", in a commercial field planting, of up to 3 ft. could be discounted, and thus save much labour in the gapping-up operations as carried out at that time.

It was, however, argued that, despite the recordings of the above trial, there must be some point in widening the spacing at which a reduction in yield would be recorded. Due to the lack of statistical evaluation in the above experiment, and to try and find the point at which a reduction was recorded, a further trial was planted in 1952.

In this trial a constant inter-row width of 5 ft. was

TABLE I

Spacing Treatment	No. of stools per acre	No. of sticks per stool at 5 mths	No. of sticks per stool at harvest	Tons cane per acre	1st Ratoon	2nd Ratoon
					Tons cane per acre	Tons cane per acre
3½ ft. inter-row continuous ...	8370	8.0	4.29	55.12	40.59	49.24
4½ ft. inter-row continuous ...	7448	10.3	5.78	62.42	42.40	53.60
5½ ft. inter-row continuous ...	5208	12.7	6.96	60.44	51.33	52.59
3½ ft. inter-row, 1½ ft. between setts	4158	16.1	9.53	55.95	52.26	50.30
4½ ft. inter-row, 1½ ft. between setts	3328	18.2	10.32	51.59	41.77	47.18
5½ ft. inter-row, 1½ ft. between setts	2632	22.0	13.55	54.83	52.37	50.84
3½ ft. inter-row, 3 ft. between setts	2970	21.7	13.79	57.80	49.39	53.44
4½ ft. inter-row, 3 ft. between setts	2288	29.5	17.73	59.14	50.88	53.94
5½ ft. inter-row, 3 ft. between setts	1792	30.3	19.66	49.25	40.74	44.11

taken and the treatments applied to the distance between 18-inch setts of cane were—

(*a*) No space between ends of setts;
(*b*) 3 ft. between sett ends;
(*c*) 5 ft. between sett ends;
(*d*) 7 ft. between sett ends.

The results of yields from this trial are given below in tons cane per acre.

TABLE II

Treatment	Plant cane 22-month crop	First ratoon 25-month crop	Second ratoon 20-month crop
No space	48.57	60.85	52.10
3 ft. space	44.23	54.75	45.42
5 ft. space	45.00	58.08	45.97
7 ft. space	42.27	59.01	48.93
Rainfall for crop in inches...	69.75	89.71	80.68

Although a reduction, due to the wider spacing, is shown in the plant cane crop, the first and second ratoon crops show no appreciable reduction in yield and no statistical significance could be proved in either crop.

Concurrently with the latter spacing trial, two variety trials were being grown. These two trials, situated in juxtaposition, carried the same series of varieties and were laid down to test whether the same comparisons of results would be obtained from planting a continuous line of setts, as from planting forty spaced setts on the same area of ground.

The results below compare the two trials, and show the tons cane per acre and tons sugar per acre obtained from the plant, first ratoon and second ratoon crops.

Comparing the yields of these two variety trials, it will be seen that the plant cane yields for the continuous planted trial are all lower in tons cane per acre and in tons sucrose per acre than those obtained from the trial planted with 40 setts per plot or, in effect, with a 3 ft. space between sett ends. When these results were first recorded, it was thought that the gains in favour of the 3 ft. space plantings were realistic. However, after the analysis of the samples from each plot for sucrose, purity, fibre and reducing sugars, it became apparent that the continuous planted cane was over its prime at the time of cutting, in fact, beginning to die, whilst the 3 ft. spaced planted plots, cut at the same time, were still at the peak of their growth. Thus, the greater stick population had made such demands on the available water that in the drought year of 1953, the supply in the soil had been exhausted, causing the near-death of the cane. The wider spaced cane stools had had greater volume of soil per stool on which to draw and had been able to continue growth and had not suffered to the same extent in the same period.

The subsequent first and second ratoon crops, under more favourable rainfall conditions, showed a reversal of the plant cane results with many of the varieties.

To test the conclusions drawn from the plant cane results of these two trials, a further trial was planted similar in design to that planted earlier with (*a*) no space; (*b*) 3 ft.; (*c*) 5 ft.; and (*d*) 7 ft. space, but this trial was to be subjected to spray irrigation.

TABLE III

	CONTINUOUS PLANTED						FORTY SETTS PER LINE					
	Plant 24 months		First Ratoon 21½ months		Second Ratoon 22 months		Plant 24 months		First Ratoon 21½ months		Second Ratoon 22 months	
	Tons cane per acre	Tons sucrose per acre	Tons cane per acre	Tons sucrose per acre	Tons cane per acre	Tons sucrose per acre	Tons cane per acre	Tons sucrose per acre	Tons cane per acre	Tons sucrose per acre	Tons cane per acre	Tons sucrose per acre
N:Co.310 ...	29.45	3.73	57.38	10.08	49.80	5.95	36.80	5.23	57.00	9.93	48.36	6.73
N:Co.375 ...	16.61	1.84	51.07	7.20	31.45	3.62	25.70	2.92	46.89	6.48	33.89	4.02
N:Co.376 ...	26.54	3.07	65.85	11.42	50.12	7.20	32.39	4.04	58.98	10.03	50.86	7.20
N:Co.379 ...	25.95	3.33	39.53	6.53	21.79	3.18	30.50	4.42	38.00	6.25	24.93	3.61
N:Co.390 ...	21.95	2.68	47.70	7.42	34.56	4.03	28.72	3.80	41.55	5.97	30.18	3.63
Rainfall (for crop in ins.)	49.05		83.82		83.68		49.05		83.82		83.68	

The results from the plant cane and first ratoon crops of this trial, under spray irrigation, are given below.

TABLE IV

Treatment	Plant cane 21 months		1st ratoon 13 months	
Space between setts at planting	Tons cane per acre	Tons sucrose per acre	Tons cane per acre	Tons sucrose per acre
No space ...	49.50	8.42	51.11	N.A.
3 ft.	40.10	7.15	47.23	7.11
5 ft.	35.58	6.39	43.23	6.32
7 ft.	35.40	6.34	42.43	6.81
Total water applied ...	75.39		65.44	

It is apparent that, in this trial the true and expected recordings are shown. The significant decline in yield, as a result of spacing, is statistically proven and clearly shows that in all previous trials carried out under climatic conditions there has been a limiting factor imposed in the shortage of available water.

The water-holding capacity of these soils under the rainfall conditions of the period of growth, was such that a uniform crop of cane could be produced despite the spacing of the stools within the areas defined. As soon as the limiting factor of a deficiency of available water was removed by the use of spray irrigation in winter, the axiom of the greater the population the greater the yield, all things being equal, came into force.

It is, therefore, incorrect to assume that a gap of 3 ft. in a row of commercial cane can be ignored, and that supplying a plant cane field need not be carried out unless the gaps exceeded 3 ft. in length. This advice has been given as a result of the earlier work on spacing during a series of years when the rainfall was on the low side—see Tables II and III, plant cane.

In recent years when the rainfall has been above average every stool of cane will be reflected in the yield reaped and, under irrigation, could materially affect the yield.

In the light of the recent results it could be concluded that under irrigation, and where the water table is high, as on the alluvial flats, the distance between rows of continuous planted cane should be reduced rather than widened, and on shallow hilltops where the available water is at its lowest the cane rows should be widened rather than reduced.

However, in the latter case other factors such as weed control, and the standard setting of implements, restrict the increasing of inter-row planting. On the high water table flats, however, and where irrigation is used to obtain the maximum crop, the narrower spacing of the rows may well give not only substantially increased yields, but also, due to the increased competition at a certain stage of growth, cause a period of ripening with an added sucrose per cent cane where none previously has been recorded.

Mr. du Toit in the chair, said that he was glad to see that there were some planters present. The results given showed that when there was adequate moisture present, the best crop was obtained from continuous stick planting. Mr. Halse had reminded him that during the 1930's there were similar experiments carried out at Umfolozi. There it was found that the five foot inter-row distance was better than 6 ft. or 7 ft. In point of fact investigation into space planting and width of row was still older. Between 1906 and 1911 a series of experiments was carried out at Winklespruit. Those results also showed that the 5 ft. inter-row distance was the best. A later experiment at Darnall, however, showed that the 6 ft. row was slightly better. In all these old experiments it was found that continuous stick planting was better than spacing the setts in the row.

Mr. Bjorking asked if this was only a space trial experiment or was it tried out also with different lengths of setts bearing different numbers of buds and the placement in the setts in the row as far as the position of the buds was concerned.

Mr. Pearson replied that this had not been tried out in the experiment mentioned but apparently in the West Indies particular care was taken to orient eyes relative to the sun.

Dr. McMartin said that some years ago he had investigated placement of buds in experiments designed to test the use of fungicides. It was found that early counts of shoots showed an advantage if the eyes were placed pointing upwards, but in the final yield no difference was recorded. This subject of spacing and yield was of particular interest to growers who received small quantities of new canes for propagating. It would appear that considerably less cane could be planted than is usually the case. Referring to Table I he pointed out that the 4½ ft. inter-rows with continuous stick planting gave 5.78 sticks per stool. At 4½ inter-row, 3 ft. between stools, gave 17.73 sticks per stool. This was very important in propagating new varieties. What was required when propagating new canes was as many sticks as possible for further re-planting.

Mr. Rault said that remembering the effect of hours of sunshine on sucrose in cane, would there be any difference between wide and narrow spacing as far as sucrose per cent cane was concerned?

Mr. Pearson said that although the figures had not been shown, there was no difference in tons of sucrose

per acre with the various spacing treatments. In other words the sucrose per cent cane remained the same. Referring to Table III where tons of sucrose per acre had been given, it would be seen that the tons sucrose per acre had increased from plant to first ratoon and thereafter dropped.

Dr. Cleasby referred to a possible interaction between fertiliser application and the spacing of rows. An experiment along these lines would be harvested at Tongaat this year.

Mr. Pearson said that from experiments carried out with different spacings and different fertilizer applications he thought the indications were that, with sufficient water, one got a greater yield with closer spacing.

Mr. Main inquired if different spacings had been tried out with different varieties.

Mr. Pearson said that in the results shown in Table I, two different varieties were tried out. N:Co.310 was included in every trial, but with other trials other varieties had also been used.

Mr. Main said that in fields where the fertility was high, one got enormous stools and he thought that spacing setts was not possible with enormous yield. Different cane varieties also would require different inter-row spacing depending upon how soon the foliage closed up. He thought it had been proved that the amount of sunlight available had an important bearing on the amount of sugar produced per acre. In India, even the wind was taken into consideration, and the rows oriented accordingly, as they found that when the cane was upright it had a better sugar yield. Another point to be considered was the amount of cultivation required, the wider spacing requiring far more cultivation than narrow spacing. With the use of rotary hoes it was possible that a much narrower spacing between rows would be useful. Another thing to be considered was the actual weed population. Another point was how long the ratoons have been grown in the plant cane and first ratoon experiment shown for there did not appear to be much difference between the various crops. In his experience of the Umfolozi flats narrow line spacing just did not work at all. He thought more information was required upon the whole question.

Mr. Pearson said that as far as spacing on the flats was concerned, a trial had recently been put down at the Umhlatuzi Valley Estate. It was to be expected that the 3 ft. rows would fill in completely in a very short time. The shading of the ground would thus greatly alleviate the necessity for much weeding. He had found, too, that with wide spacing a boy could weed plant cane much more easily than that planted as a continuous line. From Table II it could be seen that at the narrow inter-row spacing and also with the wider spacing even with 7 ft. spacing there was ample trash available to give protection from weeds as there is a constant relation between tons cane and tons trash. As far as tons sucrose per acre was concerned, in Table III it was shown from this point of view there was no particular advantage in spacing out cane in the row.

Dr. Dodds referring to Table III thought it was evident that soil moisture had an enormous effect on the yield. He wanted to know if there was any new way of measuring soil moisture directly apart from Bouyoucos blocks and the like, which do not seem to have come into favour.

Mr. Pearson said the only effective way up to now was to take a soil sample and determine the moisture content by drying. Tentiometers and Bouyoucos blocks were limited in their application and the correlation between soil moisture and these apparatuses did not seem to be very accurate. He found that in England they had discarded the gypsum block as being unreliable, and the determination of the water actually required for a certain crop was done by the lysimeter method and then these results were applied to field experiments.

Dr. Brett said it appeared from Table III that other factors besides rainfall might influence the results of spacing trials. Although the second ratoon crop appeared to have received adequate moisture, the forty-sett plots had on the average out-yielded those planted continuously. Possibly in this case growth in the continuous-planted plots had been restricted by competition between stools for the available soil nutrients.

Mr. Pearson said that he thought that they did not use enough fertilizer in the experiment particularly in the case of second ratoons. These plots were near to plots of a nitrogen trial, and the result of experience on the fertilizer trial showed that it was obvious that not sufficient fertilizer had been applied to the cane mentioned in Table II.

Dr. Douwes Dekker said that when he showed Natal cane fields to an old Java planter, the latter expressed surprise at the rather wide spacing of Natal rows. Mr. Pearson's paper seemed to provide an explanation, by stressing the relationship between optimum spacing and available water. According to this relationship, it would be possible to plant at a smaller inter-row distance in Java, where plenty of water for irrigation purposes was always available.

Dr. McMartin asked if the cultivation methods used in Java were similar to those used in South Africa, as he thought the methods used had some effect on the results.

Mr. Pearson said that when the trials were first started it was quite a common practice in the sugar industry in Natal to plant double-sticks. The rate of

seed cane used per acre had now been considerably reduced by showing that single-stick and even wider spacing would give adequate yield under limited conditions.

Mr. Barnes said that he was far more interested in what it would cost him to produce a ton of sucrose. It was not only a question of the yield but of relative cost. It would be of great advantage if trials of this nature could be related to a standard schedule of costs. As far as the seed required was concerned, if this amount of seed could be reduced the cane thus saved could be crushed, and the sucrose paid for by the mill. It was not solely a case of productivity in terms of yield, but of productivity in terms of money.

Mr. Main asked if this type of experiment could be continued and he stressed the point that the financial yield from ordinary commercial planting was the most important aspect to be considered.

Mr. Pearson said that the question of costs was a question of great importance. Sticks from wider spacing were heavier than those from close planting and labourers found that they could harvest the cane more quickly. Handling and loading was much easier with the bigger sticks.

The Chairman said that Mr. Rault had asked about sucrose per cent cane and Mr. Pearson had said that there was no particular outstanding difference in results in wider spacing of rows and stools as compared with closer planting. He thought however, that on the whole there was a slight increase in sucrose per cent with the wider spacing and wider row. He had also seen figures from other countries pointing to that. Dr. Cleasby had asked about the interaction between fertilizer and space planting. Mr. Pearson had correctly said that there was a uniform amount of fertilizer applied in the space planting tests referred to. However, from one experiment tried in the past where phosphate and spacing were varied interaction between fertilizer and spacing was found. Mr. Main had made a plea for a continuation of these experiments and he thought that this should well be continued. He pointed out that various varieties had been tried out at various spacings on the Umfolozi flats and at the Experiment Station.