THE BEHAVIOUR OF THE ROOT-SYSTEM OF SUGARCANE AT AND AFTER HARVEST

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The growth of sugarcane roots in soils of different textures was observed and measured behind the windows of the Mount Edgecombe root laboratory, before, at, and after the harvest of the plant crop of two varieties at the end of July 1967. The growth of new shoots was also recorded after harvest.

In addition, a tracer radioisotope 32P of sufficient activity, was applied in very small volume (50 microlitres) directly to the surface of old roots at various depths ranging from two to five feet (60-150 cm) below the surface. This was to test whether or not the old roots could taken in and translocate materials which might be of value to the new shoots.

The results were as follows:

1. The old root-system at and after harvest

Within about 3 days after cutting the crop all visible active roots had stopped growing. Typical patterns of this are illustrated in Fig. 1.

No further growth was observed for several weeks and the old system was apparently dead. Indeed some roots had started to disintegrate as a result of attack by micro-organisms. However, between six and seven weeks after harvest, three of the many roots which have been active immediately before or at harvest each produced a new branch which grew slowly for about a fortnight and then died. These were in different soils and two were of one variety of cane and one of the other variety.

In other words, although the old root-system after harvest was apparently dead, some of the roots were only moribund. These, as already mentioned, were of recent origin and were not completely suberised at the time of harvest.

2. The new root-system and shoots of the ratoon

About a week after harvest, when active growth of old roots had apparently ceased, all the soils were irrigated to a depth of at least some $6\frac{1}{2}$ ft. (2 metres) so that all the plants on the different plots could have an equal start from the standpoint of soil moisture. Equal amounts of fertilizer were applied before this re-wetting of the profiles.

At the time of the irrigation, new roots were already just visible 12 inches below the surface of the light soils, that is, about six inches below the nodes of the stool. No roots were visible in the windows of the undisturbed heavy soil. The roots extended slowly but steadily in the cold surface soils. These roots were derived from the young small shoots which are barely visible above the soil at harvest and must have been initiated just before harvest. The main flush of new roots occurred almost a month later as many new shoots appeared above ground. They, too, grew slowly in the cold soil ($\frac{1}{4}$-$\frac{1}{2}$ inch a day). As would be expected, shoot growth was also slow because of the winter cold.

Thus the new roots which were visible in the windows after harvest had their origin as follows. Some, which had been present at or immediately after harvest, had their origin at the basal nodes of very small shoots left behind by the cutters. Most developed after harvest from the basal nodes of new shoots which started into growth after harvest.

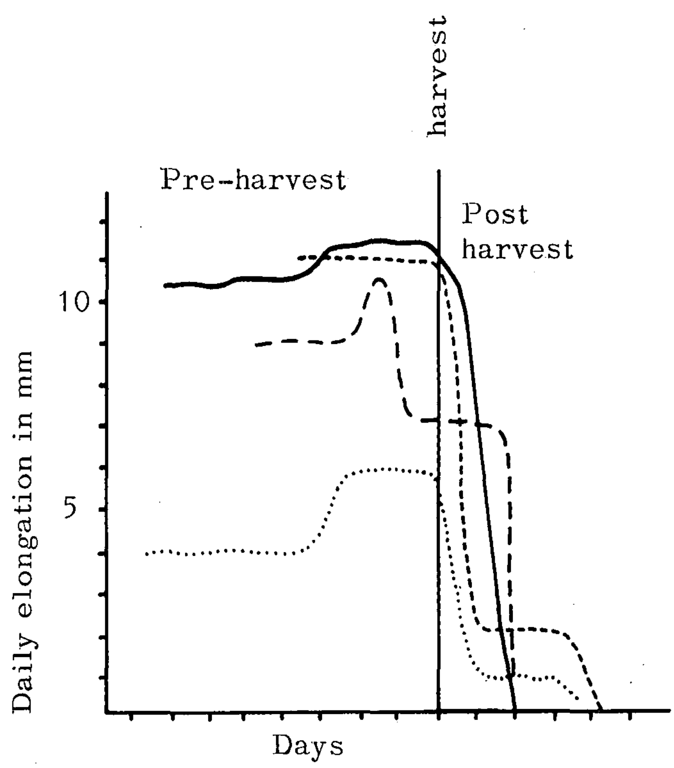

Fig. 1: The slowing to a stop of growth of active roots when the cane crop is harvested.

3. The possible activity of the old roots

Of the twelve "working" windows equipped with removable panes and backed by clear plastic sheet, only six had old primary roots in positions which could be easily checked for the possible presence of new roots. For this reason only six trials were carried out, and these were started when sufficient leaves had been formed to provide adequate sampling material for counting. This was 44 days after harvest. Fifty microlitres of 32P in solution was applied directly to the surface of the old roots by means of a fine hypodermic syringe. This was done at various depths below the surface, as already mentioned. The droplet of solution did not adhere to the suberised surface at the point of application but extended as a thin film for a short distance down the vertical face of the root.

No new roots were observed in the vicinity of the applications for many weeks afterwards so there was apparently little or no chance that the 32P could have entered the plants directly through new roots. There were certainly no new roots some five feet below the surface at this time. Indeed the deepest visible root in the lightest soil, that is under the most favourable conditions for rapid growth, had reached only some 20 inches below the surface and was many feet away laterally from the most superficial test root.

Five days after application of the 32P, the leaves of the plants to which the roots were connected, were sampled. High counts of the tracer were found in all. After a further seven days, the tops were resampled and very much higher activity of tracer was found. These tests were conducted with bulk samples from all the leaves of the shoots on a stool.

Separate samples from the leaves of each of the 22 shoots on one stool were sampled individually with the results as shown in Table I.

the result of active transfer by micro-organisms, in particularly by fungi which might move the 32P over long distances through their hyphae.

Whatever the true explanation of the results there can be no doubt that new shoots were being supplied with materials from depths beyond the apparent range of the new root-system. This translocation from deep in the soil is in good agreement with the well-known phenomenon often seen in dryland farming in Natal, in which good ratooning follows the cutting of a crop which is suffering to some extent from lack of water. Thus although the available moisture from pre-harvest roots may be insufficient for large plants it may be adequate for a time to supply the new small shoots of the ratoon crop. In other words it has survival value when drought follows harvest.

Hudson[1] who worked with plants growing in soil in glass fronted boxes has recorded that "after 'harvest' the majority of the 'old' roots remained viable and absorbing though the immediate effect of ratooning (under high soil moisture tension) was a cessation of primary and secondary growth within 2 or 3 days".

TABLE I
The percentage distribution of 32P between the 22 tillers arising from one stool of sugarcane

A From the shoot nearest the point of attachment of the old roof	Two tillers arising from A	Shoots and their tillers arising at various distances from the point of attachment of the old roots					
				0.33			
	25.3	1.28	0.47			0.16	0.007
				0.32			
47.0			0 48	0.31	0.72	0.11	0.003
	20.5	1.24	0.45	0.34		0.05	0.007
			0.48	0.26			0.008

This table shows the percentage distribution of the 32P between the separate tillers. Thus about half of the total detectable 32P was found in a single shoot which was apparently nearest the point of attachment of the old roots, and most of the remaining 32P was found in the two secondary tillers arising from it. The remainder was distributed among the other tillers at varying distances from the node carrying the old roots. It would appear that if 32P is indeed translocated by the old roots that it moves mainly into the nearest shoot and is redistributed first within the tillers arising from that shoot, and then in lesser degree to other shoots and their tillers on the same stool.

The experiments are too few in number to be absolutely certain that the old roots actually translocated the 32P. The fact that some old roots are only moribund, but not yet dead, suggests that translocation for a limited time is quite possible and it certainly offers the simplest explanation of the results. Nevertheless, there is still the possibility, albeit slight, that there is transport of the tracer through the soil to new roots. This might occur as

Evans[2] who studied roots in natural soil has remarked that old roots gradually cease to function and that deeper roots function for longer periods than superficial roots.

On the other hand, experiments in Hawaii[3] with plants growing in solution culture showed that old roots died after ratooning and were no longer active in taking up 32P or water.

My results agree with those of the first two workers and not with those in Hawaii. It is possible that the difference arises from the behaviour of roots in solution culture as compared with natural soil.

Conclusions

1. Within some three days after harvest the active growth of existing roots ceases.

2. Although the roots of the previous crop die after harvest some die only slowly, at least over a period of some eight weeks. Such moribund roots appear to retain some activity; in particular they seem to be able to translocate 32P and water from considerable depths in the soil to the newly developing shoots of the ratoon crop. However, the possi-

bility of such translocation by other means could not be entirely excluded in these experiments in natural soils.

3. Providing that water is available in the surface soil, a new root-system is immediately established from the basal nodes of small shoots which are either newly developed or left untouched at harvest. If no water is available in the surface layers it seems likely that some growth of shoots can be maintained by translocation of water from deeper levels by some of the roots of the previous crop.

4. The ratoon crop appears to derive some benefit from the persistence of the old root-system, particularly if the roots of the earlier crop have penetrated deeply into the soil. This would appear to be important to the survival of the stool in a dry spell succeeding harvest, but relatively unimportant when new roots can be established immediately in moist soils.

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References

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