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By

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PART IV. Vegetation experiments to determine the fertilising value of the solid products prepared out of cane molasses.

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In the previous communications attention was drawn to the fertilising value of the products obtained from cane molasses (vide Parts II and III) and to their possible use as a source of supplying nitrogen to the soil. With a view to determining the availability of the nitrogen fixed by these products in the soil and their general effect on plant growth, some vegetation experiments were carried out. The present paper relates to these experiments.

EXPERIMENTAL.

Pot culture experiments with the solid product obtained from cane molasses by fermentation with the soil flora.—Earthenware pots were made up, in the usual manner, each with 30 lbs. of soil-sand mixture (3 of soil to 1 of sand). The soil was obtained from an adjoining uncultivated area. The pots were divided into a number of groups for the different treatments as follows :—

(1) Treated with the fermented product at the rate of 1.5 tons of organic carbon per acre ; the fertilizer was applied ten days before transplanting.

(2) Treated with liquid molasses on equivalent carbon basis with that of the fermented product, the molasses was applied two weeks before transplanting.

(3) Treated with molasses as in (2) *plus* calcium carbonate in quantities calculated on equivalent calcium basis with that of the product.

(4) Treated with Hongay cake powder—this was added on equivalent nitrogen basis assuming that the new product fixes 1 of nitrogen for every 20 of carbon applied.

(5) Treated with Hongay cake as in (4) *plus* calcium carbonate as in (3).

In both (4) and (5) treatments, the cake was applied two weeks before transplanting.

(6) Treated with ammonium sulphate, applied as top dressing in quantities calculated on equivalent nitrogen basis as in (4).

(7) Treated with calcium carbonate in amounts calculated as in (3).

(8) Untreated control.

Thus there were 8 treatments, each treatment having 8 pots. Three different types of crops were used for the experiment.

Except in treatments (6) and (8), the manures were thoroughly incorporated into the soil to a depth of 4″—6″, and the contents of the pots periodically stirred with the necessary amount of water, so that the rotting was quite uniform and active in all the cases. Since the soil was known to be deficient in phosphate, super phosphate was applied to all the pots at the rate of 2 cwts. per acre 10 days before transplanting.

Paddy (a short duration crop) Ragi (variety—K_1, also a short duration crop) and a common variety of lucerne were used in these experiments. The seeds were sown in separate seed-beds. When the seedlings had attained a height of 4″—5″, they were transplanted to the experimental plots. Six seedlings were transplanted in each pot, which were later thinned down to four.

Observations.—It was noted that in the earlier stages of growth, the plants in treatment No. 1 were looking decidedly healthier than those in the other treatments. But later on, with the approach of flowering and grain formation, these were showing signs of nitrogen deficiency, as compared with those of the Hongay cake series. (At the stage when the plants showed nitrogen deficiency, a few of the pots were treated with ammonium sulphate as top dressing, and it was found that within a few days, the plants recovered remarkably well, thereby showing that it was a case of nitrogen starvation).

Observations on growth (height) and tillering at various stages were made, but the differences were not significant and have therefore not been recorded here. The yields of grain and straw in the different treatments are presented in Table I.

TABLE I.

Yield of grain and straw—Total of 32 plants in each case.

Treatment	Ragi		Rice	
	Grains (gms.)	Straw (gms.)	Grain (gms.)	Straw (gms.)
1	60	106	72	104
2	56	96	64	96
3	42	88	56	72
4	64	136	88	104
5	72	144	80	96
6	80	136	80	112
7	32	64	32	48
8	32	72	32	48

It may be noted from these results that the product obtained by fermentation is superior to the original molasses from the point of view of supply of nitrogen to the plants. Nevertheless, the yields in this case are not quite comparable with those obtained either with Hongay cake or ammonium sulphate. Although an amount of nitrogen equivalent to that applied in the form of Hongay cake or ammonium sulphate is fixed by the product in the soil, the nitrogen thus fixed is not fully available for plant growth.

In the lucerne series, at periodic intervals, cuttings were taken and the yields, in each case, are presented in Table II.

TABLE II.

Yield of Lucerne, in gms.

Treatment	Cutting Number (average of eight pots in each case) 1	2	3	4	5	Total yield for 8 pots
1	29	38	68	58	75	2144
2	17	18	36	27	37	1240
3	12	22	40	28	36	1104
4	13	17	30	17	22	792
5	20	30	43	30	35	1264
6	16	21	38	21	32	1024
7	7	11	20	17	23	624
8	7	14	24	19	27	728

It may be observed that, in the case of lucerne, the application of the product results in the largest increase in yield. Perhaps the presence of the product in the soil greatly facilitates symbiotic fixation of nitrogen in the soil by the bacteria present in the root nodules, resulting in the large increase in yield.

Plot experiments.—A uniform plot of land in a virgin area was divided into plots of 10 ft. square. Four replicate plots were chosen at random for each of the following treatments.—

A. Treated with molasses—the liquid product was applied after dilution with the necessary amount of water.

B. Treated with the solid product (the molasses-lime compound described in Part III).

C. Treated with the solid product obtained by fermentation of molasses with soil flora (Vide Part II).

The molasses was applied at the rate of 5 tons per acre and others in quantities calculated on equivalent carbon basis with molasses.

D. Treated with Hongay cake—the Hongay cake was applied in quantities calculated on equivalent nitrogen basis with that of the fermented product (C), assuming that 20 of carbon in the product fixes one of nitrogen.

E. Treated with ammonium sulphate—it was applied in quantities calculated as in D.

F. Treated with calcium carbonate—it was applied in quantities calculated on equivalent calcium basis with the fermented product.

G. Unmanured control.

In all the treatments except in those of C and E, the manure was applied three weeks before transplanting. The fermented product (*C*) was applied 2 weeks before transplanting. The rotting of these in the soil was further facilitated by periodic ploughing of the soil with necessary amount of water. Ammonium sulphate (*E*) was applied as top dressing one week after transplanting. Superphosphate was applied to all the plots at the rate of 2 cwts. per acre.

Ragi seeds (H_{22}—a short duration crop) were used in these experiments. The seeds were sown in a separate seed bed and transplanted when they were about 4″—5″ height. The seedlings were subsequently thinned down to about 200, so that the number in each plot was the same. They were sown on 29-8-1937 and the seedlings transplanted on 21-9-1937. The plots were harvested on 15-1-1938. The following were the yields in the different treatments.

TABLE III.

Yield of ragi in gms.—total for the 4 plots in each treatment.

Treatment	Grain	Straw
A	4810	10872
B	4733	11098
C	4863	10192
D	5704	16194
E	3258	8607
F	2242	6002
G	3560	9173

As observed in the pot experiments, the treatment of the soil with molasses or with the products obtained from molasses results in a large increase in crop yield. Although in the first three treatments the yields were greater than those in the control, they were not comparable

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As observed in the pot experiments, the treatment of the soil with molasses or with the products obtained from molasses results in a large increase in crop yield. Although in the first three treatments the yields were greater than those in the control, they were not comparable with the cake series. This shows again that the nitrogen fixed by these products in the soil is not completely available for plant growth. Although varying amounts of nitrogen are fixed by these products, the amounts made available in these treatments, *A*, *B* and *C* are nearly the same as indicated by the yields. The nitrogen loss from the soil is greater in the case where large quantities are fixed, so that the amount of nitrogen retained in the soil and later on made use of by the plant, is nearly the same in all cases.

Preliminary laboratory experiments have already shown that the nitrogen fixed in the soil by molasses and the products obtained from it, gets rapidly lost from the soil system, so that all the nitrogen is not available for plant growth. The mechanism of this loss and the means of preventing it are under investigation, and it is hoped that by devising suitable pre-treatments of the soil, it will be possible to retain the fixed nitrogen in the soil for a longer time. Such a procedure would greatly increase the fertilising value of these products.

SUMMARY.

(1) Pot experiments with different crops have shown that application of the fermented product prepared from cane molasses leads to increased yield of crop. The product is superior to the original molasses.

(2) Application of fermented product to lucerne pots results in marked increase in crop yield. This may be due to increased nitrogen fixation by the symbiotic bacteria present in the nodules of lucerne.

(3) Plot trials with ragi have shown that application of molasses and the products obtained from it leads to increase in crop yield.

(4) The nitrogen fixed by the products prepared from molasses is not fully available for plant growth, the major part being lost from the soil system.

(5) The effective retention of the fixed nitrogen in the soil for a longer time would greatly add to the fertilising value of these products.

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