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INTRODUCTION.

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It naturally followed that the behaviour of
in its new environment and the results of field experiments
looked

§ 1. INTRODUCTION.

The cultivation of Soya Beans was first started in 1927 on the College Farm, where it was grown with the object of discovering the economic value of this crop, if any, under Trinidad conditions of crop husbandry.

From ancient times the Soya Bean has been one of the principal staple foods of the peoples of the Eastern Hemisphere. An idea of its immense popularity can best be gauged by quoting figures of the acreage under cultivation in the principal Soya Bean growing countries:

TABLE I.

	1914	1918	1920
	Acreage	Acreage	Acreage
Manchuria	3,331,057	12,000,000	12,000,000
Japan	1,153,000	1,072,000	1,072,000
U. S. A.	169,000	169,000	190,000

Figures are not available for Korea, but it is reported to be the second largest producer of Soya Beans.

In the United States of America, the Soya Bean has roused considerable interest during recent years amongst farmers in the Corn Belt, where it is being grown on increasing acreages, primarily as a forage crop.

This is of course, contrary to normal practice in the East, where the oil, extracted from the seed, is the only matter of consideration. The plant is a native of Eastern Asia in its wild state, and therefore when grown in the U.S.A. or Trinidad is far remote from its natural habitat. However, provided the plant could adapt itself to local conditions of soil and climate, it was thought that it might prove a valuable asset to cane planters as a cover crop for sugar cane. At the time of its introduction to Trinidad, a special effort on the part of cane farmers was being made to find a better type of cover crop to suit their particular requirements.

It naturally followed that the behaviour of this crop in its new environment and the results of field experiments were looked forward to with more than usual interest.

An investigation on the Soya Bean was started in 1927 on the College Farm by Messrs. Hosking and Buckley with an attempt to isolate a pure line or pure lines suitable to climatic and soil conditions of this island as their primary object.

It was important that an early maturing type should be selected possessing, in addition, a rapidly spreading habit of growth, which would thus enable the space between the cane rows to be properly covered. If these two characters, which are incidentally essential in most forms of cover crop, could be combined in a single plant, then one might reasonably be expected to evolve an ideal cover crop for sugar cane. It was anticipated that the beans would be ready for harvesting three months after planting and would serve as a valuable food for stock. Moreover, the straw would be ploughed in as a green manure and together with the nitrogen assimilated by the nodules on the roots of this leguminous crop, the soil would be appreciably enriched with all the constituents necessary for plant growth.

Unfortunately, it was observed in the first year's growth that no nodules were formed on the roots of Soya Beans grown on the College Farm. This naturally suggested a line of investigation for further study, and accordingly, preliminary experiments were started in the following year. During 1929-30, the influence of liming and inoculation on nodule formation was studied, and the results of these experiments are dealt with in the last half of this work. The first half is devoted to a report on the selection and isolation of pure lines of Soya Beans, which is a continuation of the work started in 1927 by Messrs. Hosking & Buckley.

Deterioration. §3. CURRENT YEAR'S WORK 1929-30.

As in the two previous years Plots 3, 4, 5, situated in the Botanic Department of the College Farm, were used to carry out the Soya Bean experiments. For a seed bed the soil had been worked into a fair tilth, but recent rains had left it somewhat waterlogged. It will be remembered that this particular soil has a tendency to pan down in wet weather and dry out hard in dry weather. Soil analysis show that it is deficient in Organic matter and most of the essential plant foods and is a naturally "hungry" soil.

On November 11 Plots 3 and 4 were planted out, the seeds being placed at distances of 18" apart in the rows, giving a total of 41 seeds per row. The plots had previously been set up in ridges, 3' apart. The following day Plot 5 was planted out in the same way.

On Plots 4 and 5 a row at each end was left unplanted, so as to avoid any benefit which plants might receive, being on the outside row. On Plot 3, only 19 rows were required, so that there were 4 rows to spare at each end.

Apart from handweeding all three plots on November 26, and 27, in order to check the rapid growth of Nut grass, no cultivations were necessary during the growing period of the plants.

The current year's work includes results of the study on the following characters:-

(a) Germination.

One of the great drawbacks against the cultivation of Soya Beans in Trinidad, has been the poor germination capacity from which this crop suffers. In fact, in the light of present knowledge, the only way to ensure a good stand is to sow seeds which have been harvested only a month or so previously. It appears that seeds rapidly lose their viability in the Tropics, when stored for a longer period than this. At any rate, the results in the current experiment definitely point towards very rapid seed

deterioration. On Plot 3, which had been sown with different strains of 7 month old Venezuelan seed - a variety, which has already been noted as being an exceptionally bad germinator - only 2 seeds out of a total of 760 survived. On digging up the seeds to investigate the cause of this complete failure, only a mouldy mass could be found, showing that the seeds had decomposed without even germinating below the surface.

Plot 4, fortunately, gave results of a less disastrous nature, as will be seen in the accompanying Table:

		16	
(2)	13	32	}
3 (1)	11	27	
(2)	4	10	}
(3)	8	16	
4 (1)	15	27	}
(2)	18	44	
(3)	14	34	}
(4)	13	51	
(5)	9	22	}
5 (1)	6	10	
(2)	9	22	}
(3)	8	10	
(4)	13	32	}
(5)	11	27	
6 (1)	9	22	}
(2)	6	18	
(3)	1	2	}
7 (1)	6	20	
(2)	9	22	}
8 (1)	13	32	

The range of germination in the different strains lay between 2-50%, which necessitated a sowing over the whole plot, and this took place on November 27.

The appearance of the first plant on this plot was noted on November 16, or in other words, 5 days after planting.

TABLE II.

Showing Germination Results on Plot 4.

Strain (Sown on Nov- ember 11)	Germination out of 41 seeds on November 27.	Percentage of Germination (Average)
DIII. 1 (1)	14	34
(2)	20	50
(3)	17	41
DIII. 2 (1)	20	50
(2)	6	16
(3)	13	32
Chinese 3 (1)	11	27
(2)	4	10
(3)	6	16
4 (1)	15	37
(2)	18	44
(3)	14	34
(4)	13	32
(5)	9	22
5 (1)	6	16
(2)	9	22
(3)	8	20
(4)	13	32
(5)	11	27
6 (1)	9	22
(2)	6	16
(3)	1	2
7 (1)	8	20
(2)	9	22
EIII. type	(b) 13	32

The Range of germination in the different strains lay between 2-50%, which necessitated a supplying over the whole plot, and this took place on November 27. The appearance of the first plant on this plot was noticed on November 16, or in other words, 5 days after planting.

broad or narrow leaved, as TABLE III. Showing Germination Results on Plot 5.

Strain (Sown November 12)	Germination out of 41 seeds on November 27.	Percentage of Germination (Average)
B III. 1	13	32
2	7	17
3	4	10
E III. 1	17	41
2	12	30
3	8	20
Biloxi (1) branched, and (1) unbranched.	13	32
Chinese	33	80

The Strains on Plot 5 showed little difference in viability from those on Plot 4, except in the case of Chinese, which was infinitely superior to any other, giving a germination capacity as high as 80%. It is difficult to account for this surprising figure, but it may here be noted that the Chinese is a variety of small black seed, possessing a tough seed coat, and therefore probably less susceptible to changes of temperature and moisture. Further study in this direction might throw light on this point, and possibly assist in the breeding of better keeping strains. Until this is successfully achieved, it is strongly recommended that a small patch of Soya Beans should be grown continuously, to serve as a source of supply for fresh seed, and so avoid wholesale loss which is occasioned by sowing old and less viable seed.

(a) Period to Maturity.

(b) Leaf Size.

The previous workers had used leaf width as a basis for classification, and had divided the D III. strains into the three categories of Broad, Intermediate and Narrow leaves. However, the results could not be confirmed in this year's trial - it being impossible to state definitely whether a strain was

broad or narrow leaved, as the differences in leaf width were not sufficiently marked. It was therefore decided to ignore this method of classification altogether. The leaves had shrivelled up and fallen, except in the case of Dilxi where the leaves re-

(c). Habit of Growth.

Bearing in mind that one of the main objects of the experiment is the production of a variety of Soya Bean suitable as a cover crop in Trinidad, it naturally follows that the plant must be branched as much as possible to comply with these requirements. The harvested plants were placed in paper bags and allowed to dry indoors for 2 days before being thrashed by hand. The harvesting of the first ripe plant (Chinese) took place on

January 31st, - this working out at 82 days from the time of sowing to maturity. It was noticed that there were two distinct habits of growth (1) branched, and (2) unbranched.

As each individual plant ripened, so it was harvested. In the case of the former the stem exhibited a "trailing" habit and invariably lay along the ground for a few inches before assuming the perpendicular, - whether this is a varietal character or is due to the effect of the wind strains were particularly bad in this respect, and accounted for all the plants discarded on the score of lateness of growth. The D III.4 and D III.5 is a varietal character or is due to the effect of the wind strains were particularly bad in this respect, and accounted for all the plants discarded on the score of lateness of growth. The strain D III.4 was a notably strong brancher, and this being a desirable feature it is not surprising that it figures so prominently in the list of this year's selections (see Table VI.)

At the other end of the scale there were plants with single unbranched stems, possibly quite useful for seed production, but quite useless where a cover crop is concerned. The middle course must again be taken and D III.6 and 7, E III. type, B III. and E III. all exhibited this character to varying extents, and since they gave but poor yields it was thought unnecessary to consider them for selection. The following table (IV.) compares the days to maturity between the parents and progeny of the different strains.

(d). Period to Maturity.

One of the essentials of a good cover crop is that it should possess earliness in maturing, in fact the suitability or otherwise of a cover crop is judged largely by the length of its period to maturity.

In the current experiment plants were handpulled when the majority of pods had changed from green to yellow and just prior to shedding. In this condition the leaves had shrivelled up and fallen, except in the case of Biloxi where the leaves remained green and the leaf stem remained attached to the main stem, even when the pods had fully ripened.

The harvested plants were placed in paper bags and allowed to dry indoors for 2 days before being thrashed by hand. The harvesting of the first ripe plant (Chinese) took place on January 31st, - this working out at 82 days from the time of sowing to maturity.

As each individual plant ripened, so it was harvested, until March 3, when the few remaining plants which were still unfit for harvesting were considered useless from a practical point of view, and so were discarded. The D III.4 and D III.5 strains were particularly bad in this respect, and accounted for all the plants discarded on the score of lateness of growth. It was observed that the branched habit and bushiness of growth peculiar to these strains tended to retard ripening, as sunlight was partially excluded by the thick canopy of leaves.

It appears therefore, that one cannot expect to find extremes of earliness to maturity and of branched habit of growth in one and the same plant, as these two factors are apparently incompatible. The middle course must again be taken and a strain moderately strong in both these qualities must be the final choice.

The following Table (IV.) compares the days to maturity between the parents and progeny of the different strains.

D III.	(1)	84	
	(2)	97	
	(3)	88	
B III.	(1)	87	
	(2)	97	
	(3)	97	
Biloxi			
Chinese			

TABLE IV.

Comparison of Days to Maturity of Parents and Progeny.

Strain	Days to Mature.	
	1928-1929	1929-1930
D III. 1 (1)	103	100
(2)	99	102
(3)	99	100
2 (1)	99	100
(2)	98	99
(3)	97	100
3 (1)	103	102
(2)	103	100
(3)	103	102
4 (1)	109	107
(2)	103	103
(3)	103	107
5 (1)	99	102
(2)	94	102
(3)	103	99
6 (1)	105	98
(2)	97	98
(3)	97	98
7 (1)	98	99
(2)	99	99
E III. Type	100	97
B III. wa (1)	94	97
(2)	97	97
(3)	98	97
E III. (1)	97	97
(2)	97	97
(3)	97	97
Biloxi		95
Chinese	94	95

(e). Pubescence.

As expected, the D III. 1, 2, and 3 strains, which were pure for white last year, gave progeny of 100% white pubescence this year.

The previous workers had particularly requested that the behaviour of the D III. 4 and 5 strains with respect to colour of pubescence should be noted, as it was thought that they were in a very heterozygous condition. Such was the case this year, as both strains segregated freely into brown and white pubescence. However one row could accommodate only a portion of the last year's progeny for each strain, and without the whole progeny being planted out, it was impossible to draw any valid conclusions from the proportion of white to brown pubescent plants. It has already been shown that brown pubescence is dominant to white in the simple Mendelian ratio of 3 : 1, therefore in selecting certain white pubescent plants from D III. 4 and 5, one can reasonably expect their progeny to be homozygous for white. In addition a few brown pubescent plants were picked out from the very heterozygous D III. 4 and 5 strains to be grown on next year in the hope that they may prove homozygous for brown. It may be remembered that in last year's work these two strains were noted as being probably homozygous for brown pubescence, and were classified accordingly. As regards vegetative growth, the white pubescent plants of the D III.5 and 6 strains bore a distinct resemblance to plants of the D III. 1, 2, 3 strains, in that the habit of growth was more upright and there was less tendency to branch. In common with the white pubescent strains of the previous year, the bean weight per 100 seeds was slightly higher than for the brown strains (see Table V.)

Chinese	95	26.40	8.51	9.20
				8.07

(f). Yield.

Poor condition of the seed at time of sowing may be given as the factor directly responsible for the vast decrease

in yield in the current experiment. A Range of from 50-90% reduction in yield clearly indicates the extent to which this took place. In addition, lack of rain while the plant was in the seedling stage may also be offered as a contributory factor to account for the abnormally low yields.

Comparative yields of Parent and Progeny appear in the following table:-

TABLE V.

Comparison of Yield and Bean Weight of Parent and Progeny.

	Yield in Grams		Wt. per 100 beans		Pubescence of Progeny.	
	Parent	Progeny	Parent	Progeny		
D III. 1 (3)	65	25.35	13.07	9.85	White	
D III. 2 (1)	70	35.25	10.69	9.65	White	
		24.91		9.32	White	
		21.35		9.80	White	
D III. 4 (1)	120	32.95	9.25	8.10	White	
		21.30		7.32	White	
		25.15		5.53	Brown	
	(2)	95	22.0	9.61	5.76	Brown
			13.0		9.10	Brown
			19.5		5.50	Brown
			36.65		9.43	5.12
(3)	95	21.70	9.43	5.33	Brown	
		25.8		8.97	5.37	Brown
(4)	90	25.8	8.97	5.37	Brown	
(5)	75	7.17	11.45	10.70	White	
D III. 5 (1)	50	11.95	9.96	8.72	Brown	
		13.55		7.40	6.52	White
Biloxi	95	29.00	29.00	29.00		
		20.52		28.46		
Chinese	95	26.40	8.51	9.30		
		26.20		8.07		
		23.55		9.12		

NOTE. The Progeny columns only include figures from the current year's selections.

It appears obvious from the great diversity of yields in the different strains, that this factor is thoroughly heterozygous in varieties of Soya Bean. The weight per 100 beans has similarly been considerably reduced in every case with the exception of Chinese. This figure has remained fairly constant, or to be more accurate, has shown a very slight increase.

A point worth noting perhaps is the fact that in the D III. 4 strain the white pubescent selections show a much higher bean weight than the brown in almost every case. The white pubescent D III. 1 and 2 selections show a similar figure to the white pubescent selections of D III. 4 for bean weight, which figure is extremely constant throughout these selections.

Nomenclature	Parent	In Grams	100 Beans	
D.W.1	D III.(4) 1	32.95	8.12	102
D.W.2	D III.(4) 1	21.30	7.32	102
D.W.3	D III.(4) 5	7.17	12.70	102
D.W.4	D III.(5) 4	15.55	8.52	102
D.B.1	D III.(4) 3	36.65	8.12	102
D.B.2	D III.(4) 4	25.80	5.27	102
D.B.3	D III.(4) 1	26.15	5.53	102
D.B.4	D III.(4) 2	22.00	5.76	102
D.B.5	D III.(4) 3	21.70	5.33	104
D.B.6	D III.(5) 1	11.95	8.72	102
D.Bh1	D III.(4) 2	13.00	9.10	95
D.Bh2	D III.(4) 2	19.50	5.50	111
D 1	D III.(2) 1	35.25	9.65	102
D 2	B III.(1) 3	25.35	9.21	102
D 3	D III.(2) 1	24.91	9.32	102
D 4	D III.(2) 1	21.35	8.80	102
D 5	D III.(2) 2	21.15	7.60	91
Biloxi I.		29.00	29.00	11
Biloxi II.		20.52	28.46	98
Chinese I.		26.40	9.30	98
Chinese II.		26.20	8.07	91
Chinese III.		23.55	9.12	92

Note:

W = White Pubescence
 B = Brown Pubescence

Bh1 = Black Hilum
 Bh2 = Brown Hilum

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54. SELECTIONS AND THEIR NEW NOMENCLATURE.

REFERENCE TO STORAGE.

TABLE VI.

Showing a list of the selections under their New Nomenclature with a Summary of their more important characters.

New Nomenclature	Parent	Yield in Grams	Weight per 100 beans	Days to Maturity
D.W.1	D III.(4) 1	32.95	8.10	111
D.W.2	D III.(4) 1	21.30	7.32	108
D.W.3	D III.(4) 5	7.17	10.70	95
D.W.4	D III.(5) 4	13.55	6.52	98
D.B.1	D III.(4) 3	36.65	5.12	111
D.B.2	D III.(4) 4	25.80	5.37	102
D.B.3	D III.(4) 1	25.15	5.53	102
D.B.4	D III.(4) 2	22.00	5.76	108
D.B.5	D III.(4) 3	21.70	5.33	104
D.B.6	D III.(5) 1	11.95	8.72	102
D.Bh1	D III.(4) 2	13.00	9.10	95
D.Bh2	D III.(4) 2	19.50	5.50	111
D 1	D III.(2) 1	35.25	9.65	105
D 2	D III.(1) 3	25.35	9.85	102
D 3	D III.(2) 1	24.91	9.32	102
D 4	D III.(2) 1	21.35	9.80	102
D 5	D III.(2) 2	21.13	7.60	95
Biloxi I.		29.00	29.00	95
Biloxi II.		20.52	28.46	98
Chinese I.		26.40	9.30	98
Chinese II.		26.20	8.07	95
Chinese III.		23.55	9.12	98

Note:

W = White Pubescence

Bh1 = Black Hilum

B = Brown Pubescence

Bh2 = Brown Hilum

§ 5. SUGGESTIONS FOR FUTURE WORK WITH SPECIAL
REFERENCE TO STORAGE.

The above selections were made in the current year's experiment, paying due consideration to yield, days to maturity and general suitability as a cover crop under Trinidad conditions.

It is recommended that all the progeny of the Darjeeling selections be planted out the next year, if possible, since this is the only certain method of discovering whether any pure strains have been isolated. The isolation of a strain pure for brown pubescence should be attempted out of the brown pubescence strains available.

D Bh 1 and D Bh 2 were picked out as the two heaviest yielding strains in the D III (4) 2 group, exhibiting differences in Hilum colour, contrary to what was found last year. A mixture of brown and black hilum was found in a strain which was noted as being pure for black. It is therefore suggested that these two strains be grown on and a study made on their future behaviour for hilum colour.

Five of the best plants from the D III. 1, 2, and 3 strains which are known to be homozygous for white pubescence were also included among the selections.

Although possessing the undesirable habit of unbranched growth two plants of the Biloxi strain were picked out by virtue of their large yield and comparative earliness in maturing.

In addition three of the heaviest yielding Chinese were selected. It is understood that there still exists a prejudice against the small black seed of the Chinese strain, but in spite of this drawback it has been decided to continue growing it, since its superior keeping qualities alone are sufficient to warrant its cultivation on a commercial scale in the Tropics in preference to any other variety yet known. This last statement brings one to a point arising out of the current year's experiment on which further intensive study is urgently needed. The question of

storage of Soya Beans in the Tropics is referred to. As an instance of poor lasting qualities the results of the current year's experiment provide a good example; for the germination of only 7 months old seed ranged from 50 to as low as 2%.

It is now too well known to need emphasis that oily seeds quickly lose their viability in the tropics, and this appears at the present moment to be the limiting factor to the general cultivation of Soya Beans in this island. Similar results have been experienced in other West Indian islands and the question of storage requirements thus presents a problem of paramount importance. In British Guiana Professor Dash has successfully prolonged the viability of Soya Bean seeds by conservation in cold storage. This practice is being adopted with the current year's selections until they are required for sowing. Another possible solution which has already been suggested is to leave the beans in the pods and thrash them out shortly before they are required for sowing. In Manchuria and China, where Soya Beans are grown on such a large scale, and the seed handled in bulk, great care has to be taken in drying the seed thoroughly before storing, otherwise heating with consequent loss in viability will result. Even where the method is adopted of spreading the seed in thin layers on the floor to assist in drying, trouble may still arise if badly ventilated containers are used for subsequent storage.

Piper and Morse, the authors of the 'Soybean' (1) recommend that seed of two years old or more should always be tested for germination before planting out in the field.

In all probability either the width of the testa, oil content of the seed, or degree of humidity, or a combination of these factors are responsible in some degree for the change which occurs to Soya Bean seed when stored for any length of time in the Tropics. However, enough has already been said to indicate clearly the urgent need for a thorough investigation to be carried out on storage problems in the very near future.

66. RESULTS OF THE INVESTIGATION INTO ROOT

NODULE FORMATION FROM:

(a) Field Experiments.

As seen in the Diagram of the plots (page 3) 10 rows of Plot 5 were planted out with the D III. strain on December 27.

A line drawn across the centre of the rows divided the inoculated from the uninoculated seed. The former was allowed to stand in a solution of the bacteria radiculicola for 10 minutes prior to sowing. Poor germination necessitated all the 10 rows being supplied.

On December 27 as many plants as were fully grown were carefully dug up, and without exception the roots of every inoculated plant were found to possess an abundance of nodules, while there was a total absence in the case of the uninoculated plants. Previous history of this plot shows that it carried a crop of Soya Beans in 1928-29, but did not receive a dressing of lime at the same time as Plots 3 and 4 in 1928, but was dressed with lime at the rate of 10 tons per acre in 1927.

(b) Pot Experiments.

The pot experiments were carried out on the same lines as in the previous year, there being 8 pots with 4 different treatments twice repeated. The arrangement may be summarised as follows:-

Pots A & E Unlimed Uninoculated

B & F Unlimed Inoculated

C & G Limed Uninoculated

D & H Limed Inoculated

8 Pots were filled with surface soil from Plot 2 of the Botanic Department. Pots C, D, G, H received 5.7 ounces of lime each, which was equivalent to a dressing of 10 tons per acre. This lime was afterwards discovered to be slow acting and of very poor quality, and therefore does not represent a normal 10 ton dressing. In the second series of pot experiments, as much as 1/5 of the contents of the pot were composed of lime, which represented a far

closer approximation of a normal 10 ton dressing.

On October 29 each pot was sown with 4 seeds - 2 of the D III. (4) 5 strain and 2 of the Venezuelan Heavy weight strain. All the latter failed, and so D III.(4) 5 seeds were used as supplies. However, this strain was also weak in germinating, and only a few plants succeeded in passing the seedling stage. These were examined for nodule formation on the roots, and it was found that there was a complete absence of nodules on the uninoculated plants. The few nodules which were formed all arose from inoculated plants.

On December 6th a second series of 8 pots was then started, in which the limed pots were filled with soil and lime in a 4 : 1 Ratio. In this case, all the pots were planted out with Chinese seeds, on account of their superior viability. On January 20 - six and a half weeks after sowing the plants were lifted and the roots examined for Nodules with the following results:

TABLE VII.

	Number of Nodules								Number of Plants
	1	2	3	4	5	6	7	8	
Limed Inoculated	3	1	1			1			6
Unlimed Uninoculated		2	1	1	2			1	7

Nodules were entirely absent on the roots of uninoculated plants. The soil in the second series of 8 pots was allowed to dry out thoroughly for 5 weeks, just as it would in the normal dry season. It was then watered liberally and sown with 1930 Chinese seed on January 24th without any further liming or inoculation. In this way it was intended to test the resistance of the organism during the dry season and its powers of reestablishment at the coming of the wet season. Results at the present seem to indicate that the effect of soil inoculation is but short lived. Fellers in his work on "Longevity of Bacillus Radicicola on Legume Seeds"

found that Soya Beans inoculated with a nodule infusion retained viable organisms on their seed coat 6-9 months. (2) Therefore, if nodulation is to be maintained on successive crops seed inoculation must be resorted to at frequent intervals to renew the supplies of the organism which the plant requires for nodule formation. On February 26 the plants were lifted and examined for nodule formation with the following results:-

TABLE VIII.

A Unlimed Uninoculated	4 plants	No nodules.
B Unlimed Inoculated	4 "	3 "
C Limed Uninoculated	4 "	0 "
D Limed Inoculated	4 "	0 "
E Unlimed Uninoculated	3 "	0 "
F Unlimed Inoculated	4 "	0 "
G Limed Uninoculated	4 "	0 "
H Limed Inoculated	3 "	3 "

soil where it was known that nodules had at one time been formed. Certain definite conclusions can be drawn from the results of these inoculation experiments. In the first place the total absence of nodules on uninoculated seed is proof of the fact that the bacillus radicola does not exist in an active form naturally in the College soil. It was thought that its absence might be due to lack of lime in the soil, and acid conditions generally, as Soya Beans grown on the Usine Ste. Madeleine Estate, Trinidad, produced a good natural formation of nodules on the roots, and analysis of this soil showed it to be a calcareous loam containing up to 3% of Calcium Carbonate. If lime were added to soil on the College soil, one might reasonably expect to be able to create conditions suitable to the formation of nodules on the roots. However, no difference could be detected in size or numbers of nodules on the limed and unlimed inoculated plants, and this is a similar result to that obtained

in last year's trial. ⁽²⁾ From the above that nodules can only be

expected. The experiment this year was taken a step further, and soil which had carried Soya Beans the previous year, and had been limed two years ago, was planted out with inoculated and uninoculated seed. It was conjectured that continuous growing of Soya Beans might induce natural inoculation, since this is reported to have occurred when Soya beans are grown extensively. ⁽¹⁾ In fact, one of the commonest methods of introducing the bacteria is by the use of inoculated soil from a field where the plants have previously developed nodules. ⁽³⁾ That in their opinion Soy beans

may give That lime has a neutral effect in the production of nodules on the roots has already been proved for the College soil, but it does not follow that in soil where the bacteria have been already established the presence of lime will not have a preserving effect on the organism and lengthen its range of effectiveness. However, in the series of College experiments both in the field and in pots, lime was found to have no influence on the formation of nodules on the roots of the subsequent crop, - moreover, on soil where it was known that nodules had at one time been formed, lime seemed to have no effect in establishing or stimulating these nodule forming bacteria. ⁽⁴⁾ of Soya Beans. Among other things, he

found the Numerous theories have been put forward to account for the complexities surrounding the phenomenon of nodule formation, and of these the following is one of the most original and certainly worthy of mention in connection with the current experiments; ⁽³⁾ "Lack of nodules on Soya Bean plants is taken as in ⁽⁵⁾ a indication that due to a lack of light the Carbohydrate production of the plant was insufficient or only sufficient for the immediate needs of the plant, and that none of it could be spared for the activities of the legume organisms. Therefore symbiosis as it is ordinarily understood did not take place to any extent. Whether the organism penetrated the root hairs, and there died or remained inactive, or whether they would not or were not allowed to penetrate the root is for further detailed work to study."

One gathers from the above that nodules can only be expected in highly fertile soils, where there is an excess of plant nutrients over and above that required for ordinary growth of the plant. On the other hand, quite contrary views are adhered to by authorities such as Piper and Morse, ⁽¹⁾ who assert that the bacteria are essential for good growth on soils poor in Nitrogen. In such cases, where Nitrogen is deficient, the plant will show a yellowing of the leaves and only indifferent growth will be made. They continue to state that in their opinion Soy beans may give good results on rich land, even though the bacteria are not present in the soil, but in such cases the Nitrogen will be taken from the soil and it will not be increased as is the case where bacteria are present. Thus, where Soya Beans are grown regularly, and no nodules are produced, the whole object of growing a leguminous crop, i.e. the enriching of the soil with nitrogenous matter accumulated in the root system, is defeated. ⁽²⁾ According to J. H. Vorhees in the Journal of Agricultural Research, 1925, ⁽⁴⁾ the extent of nodule formation is largely dependent on the variety of Soya Beans. Among other things, he found that the Soya Bean *Bacillus radicum* organism did not tend to become adapted to specific host varieties of Soya Beans, but from results of field and laboratory studies E. F. Fred and O. C. Bryan found no evidence to conclude that the nodule bacteria of Soya Beans are highly specific. ⁽⁵⁾ On the contrary it was found that bacteria of one variety will readily infect another. No attempt was made to confirm these results in the present series of experiments, but for future work this might prove a profitable source of investigation. Following on the failure of lime to influence nodule production, the effects of other recognised plant foods or stimulants either of Phosphate or Potassic origin should be tested, since it has been reported ⁽⁵⁾ that soil treated with Sulphur Dioxide and 1% Formaldehyde showed nodule formation inhi-

bited on the upper parts of the roots of Peking Soya Beans. Therefore, it is more than probable that there are one or more substances, which, when applied to the soil will encourage the growth of the Soya Bean radicle towards profuse nodule production on the roots.

It must not be forgotten that in China and Manchuria, where the bulk of the world's Soya Beans originate, the crop is grown primarily for the oil, which is extracted from the seeds - the value of the plant residues from a manurial point of view is of minor importance, in fact, seldom given consideration. Possibly the growers of Soya Beans in these countries are not aware of the benefits to the soil which can be derived from the nodules of leguminous crops, and they therefore make no effort to encourage nodule formation more than the natural limit of the plant by any such artificial means as soil or seed inoculation.

On the other hand they may be fully aware of the fact that reduction in oil content follows on successful inoculation. (7) This interesting result was proved by Fellers (1918) in his work on Soya Beans at the New Jersey Experiment Station. He showed that inoculation decreased the oil content in direct proportion to the completeness of infection, the average decrease being 3%. At the same time he found that the protein content increased to an extent of 7%, when the oil content was decreased by 3%. In his opinion the oiliness and smooth nature of the Soya Bean seed is responsible for most of the trouble experienced in obtaining successful inoculation with this crop. However, this difficulty could be easily overcome if the soil instead of the seed were inoculated.

In this way the bacteria could gain easy access to the plant by means of the vast quantity of fibrous root hairs. Natural inoculation of soil, it is reported by Fellers, spreads very slowly, as it was repeatedly observed that the plants on uninoculated plots at a distance of a foot or two from inoculated plots, were seldom found inoculated. Unless a reliable commercial

culture of good quality can be obtained, he recommends the adoption of the soil transfer method for soil inoculation. (8)

In conclusion, it must be admitted that the detail functions of inoculation and root nodule formation are still imperfectly understood, and it is quite obvious that if Soya Beans are going to become popular in Trinidad as a cover crop to be ploughed in as green manure, then a more complete knowledge of this subject must be rapidly acquired.

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 Alfred T. Perkins.

5. Soil Science, 1922, Vol. 14,
 "The formation of Nodules by different varieties of Soy Bean." E. F. Fred & O. C. Bryan.

6. Journal of the American Society of Agronomy, 1925, Vol. 17, p. 64
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7. Soil Science, Vol. VII, p. 81.
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8. Soil Science, Vol. VII, p. 53.
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§ 7. RAINFALL GRAPH.

