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# PROGRESS IN CONTRIBUTING COLONIES OF SEEDLINGS RELEASED BY THE BRITISH WEST INDIES CENTRAL SUGAR-CANE BREEDING STATION

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## Introduction

This article is concerned primarily with the commercial results achieved or likely to be achieved by seedlings released from the Station rather than with methods adopted in breeding and selecting. It is, however, considered better for a clearer understanding to give a brief outline of the routine adopted in selection for and despatch to the several contributing colonies.

Seedlings of purely noble-cane (*Saccharum officinarum*) derivation which are selected in Barbados at the end of their second season of test are multiplied for further tests in Barbados and, at the same time, sent to the Plant Quarantine Station in Trinidad for quarantine prior to liberation to the other colonies. Seedlings of such derivation are expected to be of use only in fertile soils where mosaic disease is absent or at least controllable. Such conditions exist to a greater or lesser extent in all the colonies served by the Station so that a general distribution is recommended. During the period of quarantine, which lasts approximately eighteen months, a third season of test has taken place in Barbados. With the additional information derived from this more extensive series of tests the Station is able to advise the Plant Quarantine Station whether any of the seedlings sent there after the second test should be discarded. It may happen that some have already been released from quarantine, in which case the advice to discard prior to multiplication is sent direct to the authorities of the receiving colonies. It should be mentioned here that noble cane seedlings released from Barbados to the Plant Quarantine Station have in Barbados already been proved to be resistant to gumming disease (*Bacterium vasculorum*) while their susceptibility to mosaic is taken for granted.

Seedlings of nobilised derivation, i.e., derived from at least two *Saccharum* species, one of which is *Saccharum officinarum* are also sent to the Plant Quarantine Station after selection in their second year test. All, however, are not further tested in Barbados since many are not considered suited to Barbados conditions. Selections among second season test nobilised seedlings are for three broad categories, i.e. (1) general purposes, i.e. seedlings considered suited to at least a wider range of soil conditions than seedlings of purely noble cane derivation, (2) intrinsically infertile conditions, i.e. seedlings considered of a hardy nature and (3), areas where mosaic disease is dominant on susceptible varieties and require seedlings with commercial resistance to the disease: this includes both fertile and infertile cane growing areas. Categories (2) and (3) do not occur in Barbados and seedlings selected for them are not as a rule further tested in Barbados except they indicate suitability to Barbados conditions. Thus, the number of seedlings of nobilised derivation sent to the Plant Quarantine Station is always greater than that retained for further test in Barbados. As with seedlings of noble-cane derivation, so with the nobilisations further tested in Barbados, information after the third season's test can be given the Plant Quarantine Station or the receiving colony as to discarding prior to liberation or multiplication respectively.

## Despatch of Seedlings from the Cane Breeding Station

The Station was started in 1932. The contributing colonies are Barbados, Trinidad, Jamaica, the Windward and Leeward Islands. The first consignment of seedlings was sent in November, 1934, and one or two lots have been sent each year since. For convenience in presentation these are classified into seedlings of (1) noble and (2) nobilised derivation.

## (1) SEEDLINGS OF NOBLE CANE DERIVATION.

To date, forty-three of this class have been despatched to the Plant Quarantine Station. The majority of these has been discarded prior to field testing as a result of information derived in subsequent tests in Barbados or in view of obviously better—more especially nobilised—seedlings following them in the selection series. The best of this forty-three are :—B.2935, B.3013, B.3127, B.3439. Details about each are given later in this article.

The nobilisation work started in Barbados in 1928 has reached the point of producing seedlings appreciably superior to purely noble-cane derivatives. Purely noble-cane breeding was therefore topped in 1940 and it is unlikely that any noble cane seedling released subsequent to the B.34 series will become a commercial variety.

## (2) NOBILISED SEEDLINGS

These are derivatives of crossing wild species with the noble species *Saccharum officinarum* and back crossing progeny to noble species. Actually, the degree of back-crossing varies and further, crossing has been effected between derivatives of nobilisation of different species. All resulting seedlings are, however, for convenience referred to here as nobilised seedlings. In all, eighty nobilised seedlings comprising selections from the B.29 to the B.39 series inclusive have been sent to the Plant Quarantine Station. Of this eighty, twenty-eight were sent to Jamaica only with a view to obtaining mosaic disease resistance data, twenty-one of hardy appearance were sent to colonies which include in their cane growing areas, areas of poorer soil, i.e. Trinidad, Jamaica and Antigua, while thirty-one considered to be general purpose types were sent to all colonies. Jamaica has thus received the greatest number of seedlings: this in view of being the only contributing colony where areas exist in which mosaic disease on susceptible varieties is uncontrollable. Such areas occur in both fertile and infertile soils so that both thicker cane and also hardy types resistant to mosaic are necessary.

All seedlings received by Jamaica have been tested for reaction to mosaic disease. This has served (1) to give some idea of reaction by seedlings to the disease in Jamaica as compared with reactions in Barbados (2) to indicate mosaic resistance inheritance trends with a view to guiding future breeding work for Jamaica, and (3) to ascertain the degree of resistance shown by

individual seedlings with a view to allocating each to field trials.

It has already been found that reactions to mosaic in Jamaica are different to those in Barbados and this is probably due to the existence of different strains of the virus in the two colonies. It follows that mosaic disease resistance tests in Barbados will not serve for Jamaica and information on mosaic disease resistance inheritance will have to be derived from Jamaica.

At present, in the absence of sufficient data on mosaic disease resistance inheritance, selections for resistance are based purely on the parentage of the seedlings. With the accumulation of data in Jamaica from the seedlings despatched, this selection should in future become more effective.

In general it may be stated that in Jamaica the majority of the seedlings sent has proved susceptible to mosaic disease. It is to be admitted, however, that the tests so far conducted in Jamaica were situated in an area where mosaic disease is especially virulent and that the results of these tests need not necessarily and indeed, are not likely to be an indication of reaction to mosaic in the majority of the cane growing areas in Jamaica. To meet this situation, a new scheme of testing seedling resistances is to be put into effect whereby all seedlings showing sufficient growth promise in the early multiplication stage (which is being done in an area of light mosaic infestation) will be further multiplied and observed in areas representative of the entire Jamaican sugar-cane growing areas. During this stage of multiplication and observation, reactions to mosaic disease will be noted. It is felt that many of the seedlings already condemned for susceptibility to mosaic under the pre-existing conditions of severe test will survive as showing appreciable commercial resistance to the disease in the majority of the cane areas in Jamaica.

### **Progress with Seedlings in the Contributing Colonies**

Since the period of quarantine lasts about eighteen months and the colonies, on receipt of quarantined material, have to multiply the limited amount of planting material received, it follows that Barbados is ahead in the testing programme by at least two years. Thus, for more recent seedlings, conclusive data for Barbados only is available. With the experience gained in the performances of seedlings of previous consignments, both in and out of Barbados, it is possible

to forecast reasonably accurately from the data derived in Barbados for these recent seedlings how they will perform elsewhere. Accordingly, performances of seedlings will be considered under three heads, i.e. (1) seedlings which have been tested in field trials in all colonies and for which definite conclusions on commercial value may be made (2) seedlings so far tested extensively in Barbados only and for which some forecasts as to their usefulness to other colonies may be made and (3) outstanding seedlings of more recent origin than those in (2) which are expected to do well in all colonies.

#### SEEDLINGS EXTENSIVELY TESTED

Under this head it should be noted that seedlings of the series B.29 to B.34 inclusive only have been well tested. This includes both noble and nobilised seedlings which, after their quarantine period, have been recommended for test by the Station. Thus, of the thirty-two noble and sixteen nobilised seedlings originally sent, seven and six respectively only were recommended for field test. The outstanding seedlings in the tests proved to be—B.2935, B.3439, B.34104, and to a lesser extent B.3013, B.3127, B.3254, B.3172, B.34110. These are described here, special emphasis being placed on the first three.

##### B.2935

This is a noble cane seedling, its parentage being Ba. 11569 and Ba.6032. It germinates rapidly, bunches quickly and tillers reasonably well, cane growth is fast, arrowing scanty or absent, trashes well with a fair fall of trash; canes are long and thick with average number in the stool: ratoons well only in good ratooning soils: easily milled, low megasse yield and poor burning properties, juice quality average.

Susceptible to mosaic and root diseases, resistant to gumming disease. Suited to good soils only in lower rainfall areas, where it gives high yields of plant and ratoon cane.

In Barbados this seedling entirely supplanted the low rainfall area standard variety—Ba.11569 and in 1940 occupied over 40 percent. of the cane growing area. It was largely responsible for the recent increased sugar crop in the Island. In St. Kitts it eliminated S.C.12/4 and Ba.11569 in the lower rainfall areas and came to occupy over 50 percent. of the sugar-cane area. In Antigua, it eliminated B.4507 in the better drained low-rainfall limestone soils (about 20 percent of the cane area) although Ba.11569 held its place

against it in limestone soils with poorer drainage and liable to encourage root diseases. In Trinidad it has little value under the generally prevailing conditions of high rainfall and heavy soils while in Jamaica its susceptibility to mosaic debars it from serious consideration, B.2935 will almost certainly be replaced by B.3439 and B.34104 While the latter in some areas will probably be replaced by B.37161 and B.35245.

##### B.3439.

This also is a noble cane seedling, its parentage being Ba.11569 (Queensland) 813.

It germinates readily, bunches early and heavily, cane growth is fast, canes are many in the stool and medium width, arrowing intensity is variable, from very heavy to complete absence, trashes well and gives exceptionally heavy fall of trash, canes keep very sound during crop. Ratooning in general very good, although occasionally patchy ratoon springs may be seen: milling and juice qualities in general excellent.

Resistant to root and gumming diseases, reaction to mosaic variable. This is probably the best general purpose noble cane ever produced in Barbados although curiously enough it is less suited to Barbados itself than to the other contributing colonies.

In Barbados its performance relative to other varieties is entirely dependent on the season. In a season of early and prolonged rainfall practically every cane arrows. (It is to be noted that conditions in Barbados are more favourable to arrowing than anywhere else in the West Indies). This intense arrowing precludes any increase in tonnage from late growth. Although juice qualities are excellent, tonnages are not so good relative to the other scanty arrowing types. In average and more especially below average rainfall years, arrowing is much less marked and growth is prolonged throughout the season. Under these circumstances, B.3439 gives relatively high cane yields. It is at all times a good ratooning cane. In Barbados it is susceptible to mosaic disease.

In Antigua it has performed exceptionally well and consistently in tests carried out under widely different soil and rainfall conditions, and it is safe to say that for some years at least it will function as the chief standard commercial variety, replacing both B.2935 and Ba.11569.

In St. Kitts it appears to be definitely superior to B.2935 in cane yield, juice quality, soundness during crop and fall of trash. It is probable that it will be grown

to the exclusion of the latter and may also encroach on part of the B.H. 10 (12) acreage.

In Trinidad, according to Turner's Summary of Results of Varietal Experiments, 1941, it has outyielded the standard B.H.10 (12) on five types of clay soils and on the so-called Washington series and also the standards Co.213 and Uba on comparatively infertile soils of the Usine Ste. Madeleine. The latter is a striking proof of its wide range in adaptability.

In Trinidad, where weeding costs are high, the habit of B.3439 of closing in rapidly as opposed to the slow closing in of B.H.10 (12) is a further advantage. It is probable that B.3439 will come to occupy a large percentage of the sugar-cane growing area in Trinidad.

In Jamaica, it is showing a high degree of resistance to mosaic, a surprising feature for a noble cane. Results of its reaping in field trials are available only for the 1940 crop. Here, it was reaped at four places, as plant canes. At all places, it emphatically outyielded the standard, B.H.10 (12), in sugar yields per acre. With these superior yields as plant canes and the high degree of resistance to mosaic and provided it ratoons well, B.3439 is certain to be grown on a large scale in Jamaica, displacing both B.H.10 (12) and P.O.J.2878 and may even succeed under the difficult soil and climatic conditions of the Trelawney cane areas.

Certainly, no noble cane produced in Barbados has had such a wide range of adaptability, from good soils of high and low rainfall to infertile soils, and areas where mosaic disease is virulent. Its commercial exploitation has only begun, but already it seems evident that it will soon be the major variety in the British West Indies.

#### B.34104.

This is a nobilisation, its parentage being Co.281 x B.H.10 (12). The second season's test from which it was selected was reaped in Barbados on the 7th of February, 1936, that is to say, very early in the crop period. The standard was B.2935 and results from B.2935 and B.34104 were as follows :—

	Canes Tons per acre	Sucrose percent in juice	Average number canes per plot
B.2935	34	15.35	105
B.34104	38	19.70	198

Thus the cane yield was somewhat better than the standard and the juice quality exceptionally high. It is to be noted that the individual canes are much lighter

than the standard. Indeed, it is a medium-thin cane type and, at that time in Barbados, there was a decided prejudice against thin-cane types. Accordingly, it was despatched to the Plant Quarantine Station and recommended for release as a hardy type to Trinidad, Antigua and Jamaica. At the same time, in Barbados it was planted in the breeding plots to serve as a future parent plant.

Its performance in the colonies to which it was originally recommended for test has been so striking that it has now been sent to all colonies and in Barbados is now in a comprehensive series of tests. This is a good example of a thin-cane hardy type of seemingly general adaptability. The description is as follows:—

Germination excellent, tillering early and profuse, growth at first slower, but later, when tillering slows down, becomes fast, canes medium-thin, well above average number per stool, leaves form a dense canopy and weed growth suppressed, trashing excellent and very high fall of trash, leaves and leaf sheaths almost devoid of prickles and hairs which, with its good trashing, makes it easily cut and handled, arrowing variable from rather heavy (higher elevations in Barbados) to complete absence (parts of Trinidad) ; cane yields always high, ratooning excellent : milling quality very good, juice quality possibly the best of any Barbados seedling in commercial planting.

In Barbados, so far resistant to mosaic, gumming and root diseases, —in Jamaica, highly susceptible to mosaic, in Barbados, shows resistance to moth borer attack.

In Barbados, extensive results from trials will not be available until the 1942 crop but it is felt that it will suffer from lack of moisture in the lower rainfall areas (a phenomenon especially noticeable in early heavy tillering types) and from marked arrowing in the higher rainfall areas. In the former areas it is unlikely to equal B.37161 and in the latter it is doubtful if it will equal B.35245, B.35187 and B.37161. At best, the writer anticipates that it might have a limited use as an early cane throughout the island, thus displacing B.3439. For Jamaica, the results of the 1941 trials, in which B.34104 appears, are not yet to hand, but on the writer's visit at the end of 1940, it was quite obvious that in growth, B.34104 was outstanding, its only rival being B.3439. The situation, however, is complicated by the fact that B.34104 shows high susceptibility to mosaic in Jamaica. (Parenthetically, its susceptibility in Jamaica should be compared with

its resistance in Barbados and the reverse reactions by B.3439 to the disease in both colonies may be noted). Recent information tends to indicate for Jamaica that its susceptibility SCUMS to be associated with a high tolerance, but further conclusive information is awaited. At the moment, it might seem that in Jamaica B.34104 could serve as an early cane in both fertile and infertile areas where mosaic is not so virulent, B.3439 serving as the main crop cane in such areas and as the general standard in severe mosaic areas.

In Trinidad and Antigua, B.34104 has been fairly well tested. In Trinidad, unfortunately it has been directly compared with B.3439 on Ste. Madeleine clay only. Here, in one trial both varieties gave higher sugar yields than the standards, while in the other B.34104 outperformed the standard Co.213 with B.3439 closely following. Actually, there was little to choose between B.3439 and B.34104. In other trials (1941 series) in which it was tested and in which B.3439 did not appear, B.34104 was superior to all other varieties tested including the standards--B.H.10 (12) and Co.213.

In Antigua, the situation is somewhat similar. That is to say, B.34104 and B.3439 rarely appear in the same trials, although each is superior in their own set of trials. They do appear together in two trials, in one of which there is nothing to choose between them although both are better than the standard Ba.11569, and in the other B.3439 outyields B.34104 and both outyield the standard--Ba.11569.

It would appear conclusive that both B.3439 and B.34104 are superior to standards and other seedlings tested over a wide range of soil and rainfall conditions, but no conclusive evidence is yet to hand to indicate which is better than the other and under what soil and rainfall conditions. Further experimental evidence is required to settle these doubts and in Trinidad, for the 1940/42 trials, no fewer than fourteen include both seedlings in addition to standards and other seedlings, and for the 1941/43 series nineteen trials are designed to include among others these two seedlings. A similar policy has been adopted in Antigua.

Of the less important seedlings under this head, B.3013 and B.3127 are both noble-canes which between them occupy about 10 percent. of the cane growing acreage in Barbados. Both the been tested in Trinidad, St. Kitts and Antigua but, while B.3013 has shown some promise, it is inferior to B.3439. B.3127 has been disappointing. Both B.3013 and B.3127 are being replaced in Barbados by later seedlings while neither

will become commercial canes in the other islands. The seedlings, B.3254, B.3172 and B.34110 are all nobilisations of Java glagah (*Saccharum spontaneum*). In Jamaica, they have shown high resistance to mosaic disease and otherwise reasonably promising growth. They are being tested in variety trials.

#### SEEDLINGS SO FAR EXTENSIVELY TESTED IN BARBADOS ONLY

This second head concerns seedlings which have so far been extensively tested in Barbados only. The findings from these tests are given here and an attempt is made to give some indication as to the possible usefulness of the outstanding seedlings to the other colonies.

This head comprises seedlings of the B.35 and B.37 series. On account of a change in the technique of testing first year seedlings a delay of one year was involved, resulting in there being no first year seedlings reaped in 1936 and therefore no B.36 series. Nineteen noble cane seedlings and twenty-nine nobilisations of the B.35 and B.37 series were despatched to the Plant Quarantine Station.

Of this number all noble cane seedlings and ten nobilisations were further tested in Barbados.

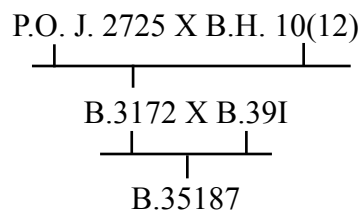
The others will be further tested in Jamaica, Trinidad and Antigua. These tests indicated that, while some of the noble cane seedlings gave promise of competing with the then existing standards — B.2935,

B.726, B.H.10 (12), B.3013, none had any chance of equalling, let alone bettering the nobilisations which have since emphatically outyielded these standards. It is extremely improbable that any noble cane seedlings of the B.35 or B.37 series will become commercial varieties in the contributing colonies.

Of the nobilisations tested, the following are outstanding—B.35187, B.35245, B.37161. These are described here.

B. 35187.

Its derivation in Barbados is as follows:—



Germination is excellent, growth habit at first recumbent, later semi-erect, tillering fairly heavy, cane growth with adequate moisture rapid but severely retarded where moisture is not adequate, canes above average in the stool and very thick and long; no arrowing, cane keeping quality very good; ratooning very strong, cane yields in heavier soils with higher rainfall very high: juice late in reaching its optimum but very high quality when ripe.

In Barbados no case of mosaic seen in spite of full exposure to the disease in test plots and commercial plantings, immune to gumming disease and resistant to root diseases.

This variety is suited as a late cane to high rainfall and to a lesser extent intermediate rainfall areas and as a late cane in valley soils. It must have a long favourable growing season to give its high tonnages and ripen its juice. In Barbados, it is being recommended to displace B.H.10 (12) in red soil areas.

Outside Barbados, it is doubtful, on account of late ripening, if it will be of any use in Trinidad except as a late cane in the black marl soils of the Usine Ste. Madeleine. In Jamaica, if it shows commercial resistance to mosaic disease, it should serve as a late cane in good soil areas throughout and replace partly B.H.10 (12) and, with B.3439, P.O.12878 in mosaic areas. In St. Kitts it should be tested as a late cane against B.H.10 (12) in high rainfall areas and in Antigua it should be tested in better class soils as a late cane throughout the island.

#### B.35245

Its parentage is as follows :-Ba.11569 X P.O.1234. Germination very good, stooling and growth at first slow, later rapid; growth habit upright; canes very thick and long, arrowing scanty or absent, canes keep well during crop; ratooning exceptionally strong: cane yields especially ratoon yields very high in intermediate and high rainfall areas : juice quality excellent early in crop.

In Barbados, highly susceptible to mosaic disease and slightly susceptible to the leaf form of gumming disease, resistant to root diseases.

It is recommended in Barbados for commercial planting to replace B.726 i.e. as an early variety in the high and intermediate rainfall districts.

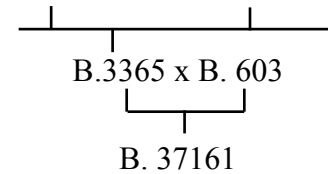
Outside of Barbados, it is expected that its marked susceptibility to mosaic will exclude it from Jamaica. In Trinidad and Antigua it should be tested under all

soil conditions. In St. Kitts it should be tested in the intermediate and higher rainfall areas.

#### B.37161.

Its derivation in Barbados is as follows:—

P.O. J. 2379 x B.H. 10(12)



Germination excellent, tillering at first very slow and the bulk of the crop made up of mid and late season canes, cane growth exceptionally fast, canes medium to thick, arrowing rather marked at higher elevations, canes keep very well during crop: cane yields under all conditions exceptionally high, ratooning strong; juice purities very high early and throughout crop although brixes only average.

In Barbados so far resistant to mosaic and immune to gumming disease, resistant to root diseases: susceptible to small moth borer although damage does not tend to spread from larval channels in the canes.

This seedling has given outstanding yields under all conditions in Barbados outyielding the standards by 20 percent. to 80 percent. in sugar yields. It seems to have a special preference for heavy soils but can successfully withstand long periods of drought.

Outside of Barbados it should be tested in all colonies under all ecological conditions, but its usefulness in Jamaica will depend on how it reacts to mosaic disease and in Trinidad on how far it can compete with weed growth in the early stages of its growth when it tillers very slowly. Certainly, in Barbados its yields are sensational and it is certain to do well in Antigua and St. Kitts.

Before leaving this section there is one seedling -B.37193--which was despatched to the Plant Quarantine Station but in Barbados reserved only as a parent for breeding and distributed as a fodder cane. Its parentage is the same as B.37161. In the breeding plots and when grown as a fodder cane, it looked so well that it has since been multiplied in Barbados for inclusion in more extensive trials during season 1941/43. In its only test in Barbados, the second year test with B.2935 as standard reaped in 1939, it gave approximately similar cane yields as B.2935 with appreciably better

brix. It is a thin to medium width cane but is unusual in that it does not arrow, even in the breeding plots. It is possible that it may serve as a general purpose cane and it is recommended for tests in all ecological areas in the contributing colonies.

#### OUTSTANDING SEEDLINGS OF RECENT ORIGIN

Under this third head, brief reference is made to those among the seedlings of the B.38 and B.39 series despatched to the Plant Quarantine Station which were outstanding in the second season of test in Barbados.

In the B.38 series, fifteen nobilisations only were sent to the Plant Quarantine Station. The best of those in Barbados were-B.38209, B.38192, B.38233. The first noted was in the thick cane trial with B.2935 as standard, the two others were in the thin cane trial with Co.213 as standard. Their performances are noted in Table 1. These three seedlings should be given special attention in multiplication and testing.

In the B.39 series twenty seedlings were selected and despatched to the Plant Quarantine Station and all are nobilisations.

Of this lot the outstanding seedling is B.39200, which, in its second season of test was compared with the standard B.2935. (See Table 2.)

This seedling, on account of an early tillering and squat habit of growth covers in early and for this reason, in addition to its good cane yield and juice quality and the fact that it has Co.213 in its parentage, promises to do well over a wide range of conditions.

Several other seedlings of this series did well in Barbados but none was so outstanding as the above.

#### Future Policy

In future no more noble cane seedlings will be despatched for the simple reason that they are not so good as the nobilised seedlings.

Further, it seems that the second season's test in Barbados gives a reasonably accurate indication of the general value of seedlings for all contributing colonies so that in future, selection standards will be more strict with a likelihood of smaller numbers of seedlings being despatched. The exception at the moment to this policy is of course selection of seedlings for resistance to mosaic to serve Jamaica. Large numbers under this head will still be sent to give information on mosaic disease inheritance trends for Jamaica conditions in addition to increasing the chances of getting individual seedlings with mosaic resistance and otherwise good commercial characteristics.

Table 1.-Thick Cane Trial Reaped February, 1940.

Variety	Derivation	Yield. Tons per acre	Average No. Canes per plot	Per cent. Of Canes Arrowing	Juice Brix
B.2935		20.4	77	0	20.2
B.38209	Ba.11569 X B.34116	24.6	106	0	21.5
	B.34116 = Co.281 X B.H.10(12)				
Thin Cane Trial : Reaped February 1940					
Co.213		30.5	210	45	19.0
B.38192	MD.47 X Co.281	35.9	190	28	21.2
	(MD.47 = P.O.J. 2364 X B.606)				
B.38233	P.O.J. 213 X P.O.J.2878	41.8	193	10	21.2

Table 2.

Variety	Derivation	Yield. Tons per acre	Average No. Canes per plot	Per cent. Of Canes Arrowing	Juice Brix
B.2935		24.5	103	0	20.4
B.39200	B.35206 X B.603				
	(B.35206 = Co.213 X B.391)	31.0	130	4	22.1