

MOSAIC INVESTIGATION AT CENTRAL CAMBALACHE

PRELIMINARY REPORT

By CARLOS E. CHARDÓN, Commissioner of Agriculture and Labor

The first records of the sugar-cane mosaic in Porto Rico date back to 1915, when Stevenson reported its appearance in the Arecibo valley. It was probably present there a few years because already at that time the infection of the fields was well advanced. In a few years, the epidemic spread, and in 1919 it practically covered all the Island except the isolated valley of Yabucoa. At the present date a great advance has been made in the way of controlling the malady, and while in certain places the "roguing" method has been effective in checking the disease, in others, the displacement of the old "cristalina" and "rayada" types of cane by the immune Uba and the resistant P. O. J. seedlings have been the total salvation of the sugar growers. If conditions favoring the successful exploitation of these immune and resistant varieties would exist all over the Island, then the whole mosaic problem would be satisfactorily solved, but unfortunately, there are important sugar regions in the Island where the Uba cane will not yield a dependable amount of sugar. I am referring to the alluvial soils of the north coast, the valleys of Arecibo, Manatí and la Plata Rivers. These valleys comprise thousands of acres of excellent soil and include the best of the fields of centrals Cambalache, Caños, Plazuela, Monserrate, San Vicente, Carmen and Tea Sugar Company.

Mosaic is more or less widespread in the fields of these seven centrals and it certainly constitutes an important factor in the production of sugar. I know of one of these centrals whose production dropped from 183,000 bags to 87,000 bags in one year, chiefly due to the ravages of the mosaic as it has been confessed to me by its president. On the supposition that only 50 per cent of that loss is due to the mosaic, and with sugar at \$4 a quintal, the loss to that factory alone will amount to \$480,000.

It has been stated before that the immune Uba will not yield on these soils a dependable amount of sugar, although it is true that there have been exceptions to the rule; however, in the great majority of

cases, the sugar yield has been disastrous. Dealing with rich, alluvial soils like these, where heavy rains are frequent, it is very doubtful whether the Uba will ever be a promising variety here, and consequently the possibility of controlling the mosaic by the use of the immune Uba, is for the present discarded. The P. O. J. seedlings have been tried in the upper portions of the Arecibo valley, especially in central Los Caños. Our sugar technologist, Mr. A. Rosenfeld, has already read a very interesting paper on the behavior of these varieties under Porto Rican conditions. Good results have been accomplished with P. O. J. 36 and P. O. J. 213, and the early maturing P. O. J. 234 is very promising. However, P. O. J. 105, known here as "Egyptian" and which is the most wide-spread of them all, has proven to be rather low in sucrose and a poor ratooner. In fact, the propagation of "Egyptian" cane is not recommended any longer. The other varieties of Java would had been propagated more, had it not been for the spectacular appearance in the Island of the B. H. 10-12 and the S. C. 12/4. The luxuriant vegetation and enormous sugar yield of these two varieties are surprising and they promise to cover a wide area of the Island in the next few years.

The sugar yield of these two varieties, B. H. 10-12 and S. C. 12/4, at Central Cambalache surpasses all previous records and they have been propagated extensively in the Arecibo valley, covering at the present time about 700 acres. In the next two years they will cover practically all the alluvial soils in the Cambalache field. Mosaic, however, has always been prevalent in the Arecibo region and since "rouging" has never been practiced here, the disease is wide-spread in these new fields of B. H. 10-12 and S. C. 12/4, sometimes passing the 80 per cent infection mark. It will be clearly seen that the situation requires deep consideration. It is true that second ratoons of these two varieties have not yet shown any signs of shrinking internodes or canker states. Thus far their behavior has been very satisfactory and somewhat approaching the conditions of the P. O. J. seedlings, which are 100 per cent infected here in Porto Rico, but which do not seem to be affected by the disease. What will be the final outcome of this extensive propagation of infected B. H. 10-12 and S. C. 12/4 at Central Cambalache, I am not able to foresee, but at any rate, it is an interesting experiment carried on an enormous scale which promises to be rich in valuable infor-

mation for the sugar men of the world, especially Cuba. If results show that these two varieties are resistant to the disease (somewhat approaching the P. O. J. seedlings) it will be a great step in advance in the control of mosaic in the Island. If, on the contrary, these varieties fail in the future, then it will be a serious problem to get rid of them and plant again healthy or resistant varieties. If the latter thing happens, the expenses of replacing the field with other varieties will be very heavy, while if on the contrary the former happens, the benefit to the central will be enormous. Which of these two alternatives will ultimately prevail?

I am rather inclined to take an intermediate position. Diseased S. C. 12/4 has been found to suffer in its growth, although no effects of the disease have been found in the canes. A few generations of the disease conditions may affect the cane and consequently, the tonnage. B. H. 10-12 has thus far proven to be little affected by the disease. Whether this variety will ever degenerate or not, I am no able to state now.

No matter what the future results of these varieties will be, it has seemed wise to start nurseries of a great number of varieties of cane and practice "roguing" in order to have at hand sufficient quantity of healthy seed so that in case of a failure of the diseased B. H. 10-12 and S. C. 12/4, new fields of new varieties could be promptly planted. It has seemed that this is a very judicious measure which will only cost a few thousand dollars, but which may be of great help if not the whole salvation, in an emergency case.

While the writer was Sugar Technologist of the Insular Experiment Station there were started a series of field experiments early in 1922, the results of which will be discussed here. Later on, upon my appointment as head of the Department of Agriculture and Labor, Mr. Mariano Mari, an inspector of my department, took immediate direction of the experiments. During my absence they have been conducted with great care by Mr. Mari, who has exhibited great zeal and enthusiasm in the work. I am also under obligation to Mr. Andrés Oliver, president of Central Cambalache, for his hearty cooperation with the Department, and to Mr. José R. Aponte, for the valuable suggestions in connection with the work. Mr. Aponte's experiments with the mosaic since the early days of 1915 have been well known to the sugar planters of that region.

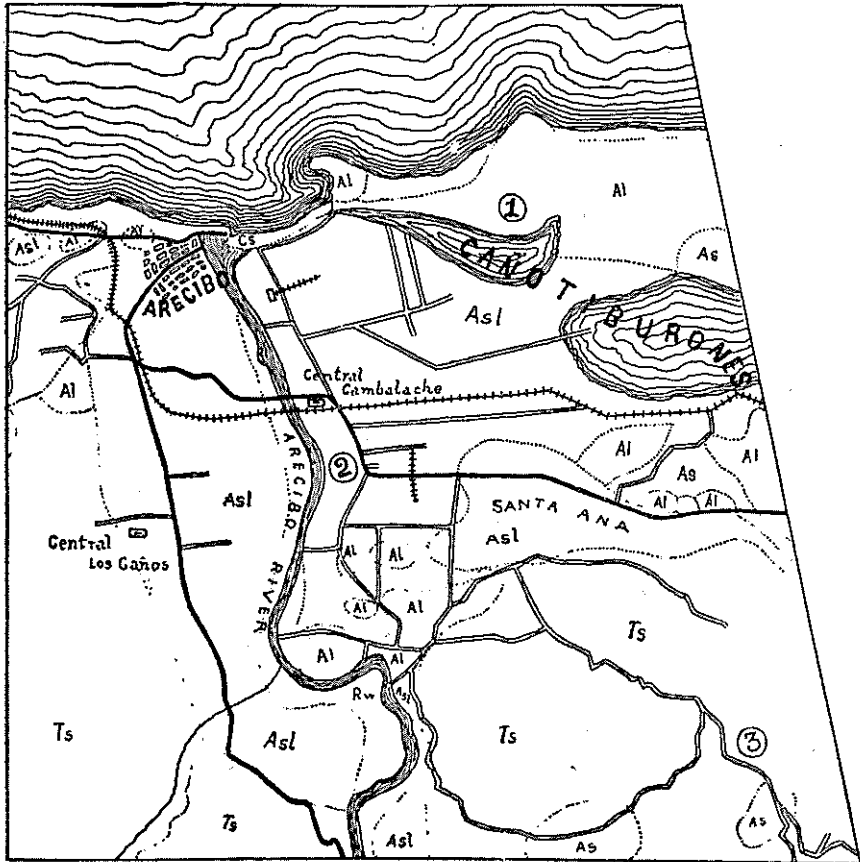
In the Arecibo valley there seem to be conditions favoring the spread of mosaic. In the first place, the soils are low, level and very fertile; cane grows well and it is a well-known fact that mosaic spreads more rapidly in fields where active growth is going on. In the second place, rains are frequent and heavy in certain portions of the year, weeds are very abundant and consequently, conditions are appropriate for the growth and development of *Aphis maidis*. The aphids have been found abundant on grasses in various fields. All these facts explain why it is quite common to find mosaic spreading rapidly in young plantations. With these adverse conditions prevailing, it was very difficult, if not impossible, to select a field for the nurseries where mosaic did not spread from adjoining fields. The selection of these fields for the nurseries needed to be determined with certainty before a large permanent nursery could be started.

In the Annual Report of the Insular Experiment Station for 1921-22, on page 68, the writer pointed out a condition which has later proven to be very helpful in connection with this work. It reads as follows:

“It has been observed that in regions of heavy infection, the percentage of infection in fields near the sea is remarkably low. This fact was very evident in Mayagüez, where fields planted to varieties other than Uba or Swinga, showed over 90 per cent infection or even higher. In a number of fields near the seashore at Guanajibo the mosaic infection was only 10 to 16 per cent, and in one case, a field near the Reform School, was as low as 6 per cent.

“The cause for this low infection is not clear, although the idea has been advanced that the wind from the sea carries particles of salt which are deposited in the leaves, and which serve as repellents against the insects that transmit the disease. It is also possible that the flora of these sandy areas, which are known to be very different from the flora of ordinary cane fields, might lack the necessary host plants of the insects that transmit the disease.”

Whatever the cause for this low infection near the seashore may be, the fact is that conditions exist there which are unfavorable to the spread of mosaic. A whole search was made of fields of Camalache in order to ascertain if this conditions was prevalent there. In this connection the Soil Map, published by the Bureau of Soils in 1902 and which covered a whole strip of soil 20 miles wide from Arecibo, to Ponce, was found very useful, a reproduction of which is here published (fig. 1). Three of its soil types are worth mentioning here:



Soil Map (From "Survey, Bureau of Soils, 1902")

Arciño loam (Al), which covers portions of the north coast, especially east of Arciño and bordering Caño Tiburones on the north. It consists of a black, tenacious loam of variable depth with a tenacious yellow loam for subsoil. This soil is considered of poor agricultural value, but bordering Caño Tiburones it is very deep and rich in organic matter, like the *poyalcs* of the south coast, and with ideal conditions for the planting of cane.

Arciño silt loam (Asl) comprises the alluvial valley of the Arciño river and one of the most important agricultural regions of Porto Rico. It is rich brown, silty loam of great depth and uniformity. It is all planted to sugar cane for centrals Cambalache and Los Caños and cover several thousand acres of excellent soil.

The *Tanama stony loam* (Ts) is a red, tenacious loam which is abundantly found in the terciary *pepino* formation, as a result of the weathering of the original limestone plateau which extended from Martín Peña to Aguadilla and far into the interior of the Island. The soil is rather poor and was all planted to bananas and minor crops, but wherever communications are easy they are now planted to sugar cane.

The percentage of mosaic infection in these three types of soils was found to be very variable. It may be assured that these peculiar conditions are not to be ascribed to the soils themselves, but rather to topographic and climatic condition which affect the rate of secondary infection. Thus the percentage of infection found in fields of the *Arecibo loam* was remarkably low, and thus coinciding with the writer's previous observation along the coast of Guanajibo. On the contrary, the fields in the *Tanama stony loam* were heavily infected with mosaic, and the only variety which deemed to thrive well here was the D-109. Intermediate conditions were found prevalent in the *Arecibo Silt Loam*, although, as was stated before, the B. H. 10-12 and S. C. 12/4 were heavily infected.

With the purpose of ascertaining experimentally these facts, three fields were selected representing these three types of soils: Field A, in the *Arecibo loam*, Field B, in the *Arecibo silt loam*, and field C, in the *Tanama stony loam*. They were carefully prepared for planting, using the *banco y carril* system, which consists of double rows separated by deep drainage ditches, the holes being 6' mult 5' in the banks. Two seeds were planted in each hole.

The field comprised over half an acre of the *Arecibo loam* type and was a few hundred yards from the shore of Caño Tiburones. It was a black loam with high organic content and excellent for growing cane.

The field was planted to 8 standard varieties of cane from the Insular Experiment Station on March 14, 1923, and harvested December 31, 1923, when the cane was a little over nine months old. The standard variety of that region being Yellow Caledonia, rows this variety were planted alternating with the varieties to be tested. Four plants of each variety were left standing to obtain sucrose mill tests at the end of a year. The results were as follows:

Variety	No. of plants	Diseased	Infection	Field	Sucrose (%)	Purity
Rayada.....	70	1	1.42%	24.24 tons	15.03	90.81
D-117.....	40	1	2.50%	32.40	13.15	81.67
P. R.-412.....	136	1	0.72%	38.23	11.58	74.90
P. R.-414.....	52	2	3.86%	36.54	13.54	81.56
Cristalina.....	50	1	2.00%	36.00	15.48	89.22
B-3412.....	48	1	2.09%	41.65	12.68	81.80
P. R.-433.....	34	1	2.94%	44.12	16.87	91.19
S. C. 12/4.....	35	2	5.61%	42.85	15.94	90.10
Caledonia.....	373	4	1.12%	39.73	13.04	81.42

¹The sugar tests were made March 23, 1924, by the chemist of Central Cambalache, Mr. Román Benítez, with the laboratory hand mill.

The average infection in field I is 1.67 per cent, that is, out of 838 plants only 14 became infected. This is remarkably low, especially if the percentage of infection is compared with those of fields II and III. These results corroborate the idea that regions near the seashore are practically free from mosaic and are consequently ideal for the propagation of selected varieties which are to be extensively used in the field later on.

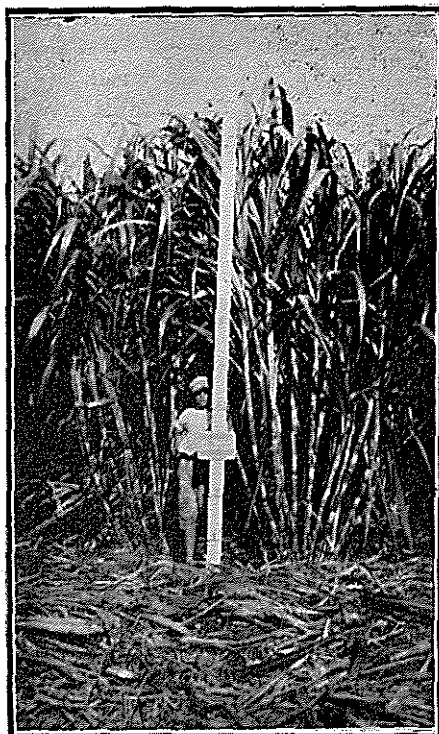
A point of interest which must not be overlooked here is the fact that the variety P. R. 433 surpassed all the others both in yield and sugar content. It has behaved so far, as one of the most promising canes of the P. R. series.

FIELD II

One and a quarter acre of soil, adjoining the Arecibo river on the east bank was selected as the land more suitable to a nursery. It was formerly pasture land, and approaching virgin conditions more than any other place in the whole region. On account of its proximity to the river it was never known to have grown cane before. The soil was a good representation of the well known *vega* lands of Arecibo, the *Arecibo silt loam*.

The field was very well prepared in the usual *banco carril* system but drainage ditches were not found necessary. Twenty-one varieties were brought from the Insular Experiment Station and planted March 15-17, 1923. They were harvested at various intervals from November 21 to December 15 of the same year; that is, barely nine months old. No sucrose tests were made with the varieties, but a careful count of secondary infection was made. Diseased plants were "rogued" out systematically and a complete record

SELECT VARIETIES OF BARBADOS AND DEMERARA



B. 3405



B. 3412



D. 109



D. 117

of the infection of each variety was made. The following results of infection and tonnage were obtained:

Variety	No. of plants	Diseased	Infection	Yield
D-109.....	60	7	8.75%	48.33 tons
P. R.-662.....	45	2	3.03%	25.00
P. R.-649.....	36	9	14.28%	27.77
S. C. 12-4.....	52	6	5.89%	50.95
P. R.-545.....	45	8	13.79%	44.09
B. H. 10-12.....	60	7	9.46%	50.00
B-3405.....	66	15	15.62%	54.54
D.-625.....	42	11	18.96%	45.23
P. R.-329.....	86	8	7.61%	30.23
P. R.-507.....	33	1	2.17%	31.25
B.-208.....	60	16	18.18%	43.33
B.-3412.....	62	16	16.16%	53.22
P. R.-414.....	78	7	7.21%	56.92
P. R.-561.....	86	19	18.09%	60.70
D.-117.....	65	15	17.24%	43.75
B.-3696.....	55	8	11.57%	42.59
P. R.-440.....	67	7	8.75%	53.03
P. R.-328.....	71	21	16.28%	57.14
P. R.-433.....	116	13	7.28%	53.10
P. R.-412.....	73	13	9.92%	47.22
P. R.-492.....	45	10	16.12%	63.72

Out of 2,103 plants, 219 became infected, or 10.41 per cent. From the above figures it is impossible to deduct the relative resistance of each of the varieties to the mosaic, but it is apparent that there is a great variation in their susceptibility. Much light has been thrown on the question of resistant varieties by the researches of Prof. F. S. Earle. Had not "roguing" been practiced on this field, the percentage of infection would have been much higher, perhaps double or more.

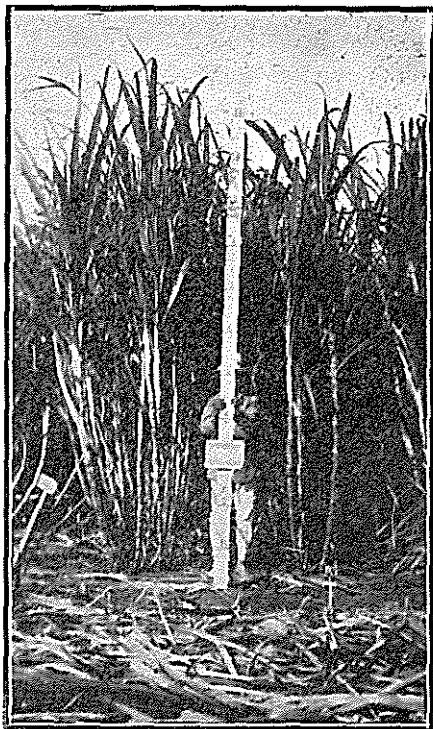
The enormously high yields of many of the above varieties only 9 month old, are due to the high fertility of the soil. Had some of these varieties reached maturity and been allowed to grow for 15 or 16 months, their yield might possibly have established record production for Porto Rico.

The B. H. 10-12 and S. C. 12/4 looked fine, but were exceeded in tonnage by a number of other seedlings P. R. 651, P. R. 328, P. R. 440, and again, P. R. 433 were heavier yielders than B. H. 10-12 and S. C. 12/4, but it is doubtful whether their sucrose content was higher. B-3405 and B-3412 did very well also, but experience elsewhere has shown that they are too late maturing and low in sucrose.

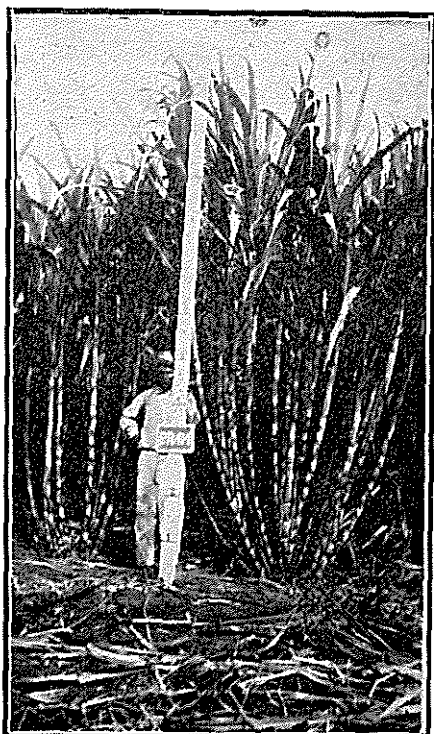
SELECT VARIETIES OF PORTO RICO
(Produced at the Experiment Station, Rio Piedras)



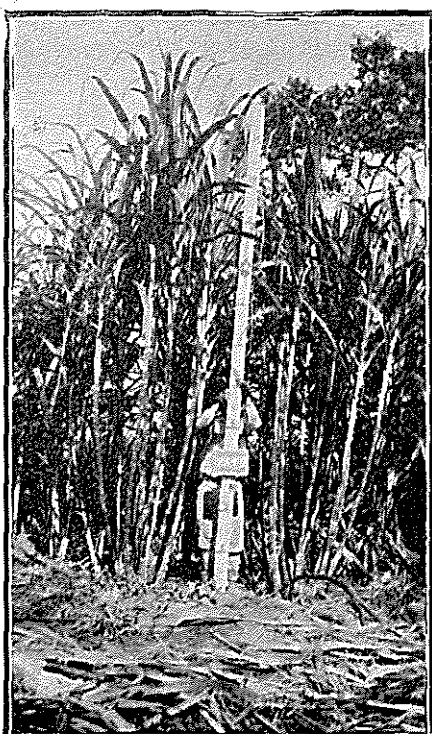
P. R. 561



P. R. 662



P. R. 402



P. R. 414

Some of the best varieties are shown in figs. 2 and 3, accompanying this paper.

As a result of this experiment it may be safe to conclude that the *vega* soils of Arecibo are not appropriate for nursery plantings since the plants are very likely to get infected secondarily.

FIELD III

This field comprised about one-tenth of an acre and a place where a former "corral" of cattle was located, was selected. Although the soil was rather poor, being of the characteristic *Tanama stony loam*, it was improved with animal manure. The manure very materially improved the physical texture of the soil.

On March 18, 1923, the following varieties were planted, using healthy seed from the Insular Experiment Station: D-625, P. R. 561, P. R. 328, P. R. 433, D-117, B-3696, P. R. 545, P. R. 417 and P. R. 412. A few cases (6) were noticed in May 25 and the diseased plants pulled out immediately. The next infection was made in June 14, when 69 plants out of 471 were found infected or 14.6 per cent infection. The spread of the disease was so rapid in July and August that it was impossible to keep a record of the infection. In December, about 90 per cent of the plants were infected.

Thus the attempt to establish a nursery in this region of the interior of the Island failed utterly. Variety P. R. 412 completely broke down under the effects of the mosaic. The other varieties were more or less affected.

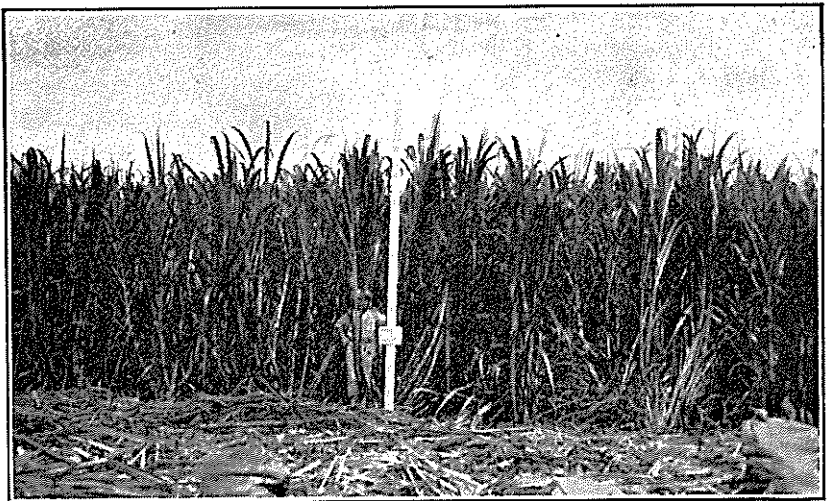
As a result of this convincing test it seems to be hopeless to attempt nurseries in the interior regions of the north coast. Observation has shown that the best variety for this zone is D-109. Uba and the P. O. J. seedlings (with the exception of P. O. J. 105) are heavy yielders here. B. H. 10-12 and S. C. 12-4 do not thrive well under these conditions.

CONCLUSIONS

1. The practice of planting extensively B. H. 10-12 and S. C. 12-4 in the alluvial soils of the north coast of Porto Rico without taking the necessary precautions against mosaic has become a common practice.

2. The yields have increased greatly but a large percentage of the plantations are diseased. These diseased fields do not show any

FAMOUS VARIETIES SANTA CRUZ 12/4 AND HYBRID BARBADOS 10/12



These two varieties, because of the tonnage and sugar yield, are the most favored among our planters.

decrease in production which may be ascribed to mosaic and the ratoons are developing normally and vigorously.

3. It is not known whether these two varieties will in the future exhibit the same degree of resistance that they have shown so far. It seems logical that they will begin to break down in the next few years.

4. Extensive nurseries need to be started in order to have sufficient healthy seed at hand in case there is need of a rapid replacement of the B. H. 10-12 and S. C. 12-4 for other varieties.

5. Experiments in three different regions representing three soil types and three different climatic and topographic conditions disclose the fact that in certain *poval* lands near the coast the mosaic disease is held in check by unknown adverse condition.

6. These regions seem to be most suitable for establishing the nurseries of different varieties which in the future may meet a disaster or an emergency.

This preliminary report covers only the first year's experience with mosaic at Central Cambalache. Following conclusion No. 6 above stated, a large nursery of 26 acres comprising 52 varieties was planted north of Caño Tiburones, adjoining former field I. The results of the second year's experience will be published later, but as a matter of information it may be said that the percentage of infection in these 26 acres has been so far only 0.43 per cent. These results from the second year's experience show that it is safe to propagate varieties on a large scale in this region.

The benefit which may be derived by the central from these 26 acres of healthy seed is something which the future will decide. Will it be a worthless expenditure of money or will it turn out to be a deciding factor in the years to come?