1935

A General summary of experiments with sugarcane.

C T. Dowell

AUGUST, 1935 LOUISIANA BULLETIN NO. 267

A GENERAL SUMMARY OF EXPERIMENTS WITH SUGARCANE

Part I—By W. G. Taggart, C. B. Gouaux and E. C. Simon
Part II—By C. W. Edgerton, E. C. Tims and P. J. Mills
Part III—By W. E. Hinds and B. A. Osterberger

LOUISIANA STATE UNIVERSITY
AND
AGRICULTURAL AND MECHANICAL COLLEGE

AGRICULTURAL EXPERIMENT STATIONS
C. T. DOWELL, Director

PART I

Work of the Sugar Experiment Station

By

W. G. Taggart, C. B. Gouaux, and E. C. Simon

Varieties

For many years the average yield of sugarcane in Louisiana ranged between 16 and 20 tons. The state sugar crop averaged around 300,000 tons of sugar per annum. During the period, one general type of sugarcane was grown, the so-called "Noble" cane, characterized by a large stalk diameter, low fiber content, and a sucrose content satisfactory for sugar production under Louisiana conditions.

When varieties of the "Noble" type of sugarcane became infested with diseases, the yield of sugar per annum decreased, reaching a low of 47,000 tons of sugar in 1926. At that time it was generally believed that the Louisiana sugar industry was doomed; many sugarcane growers went out of business, either voluntarily or through bankruptcy.

Had it not been for investigational work, there is no question but that the sugar industry of Louisiana would have vanished. Through the introduction of hybrid types of sugarcane, which were known at that time to be tolerant toward the prevailing diseases so destructive to the "Noble" canes, a new start was made and the sugar industry saved. These canes, P. O. J. 234, P. O. J. 213, and P. O. J. 36, were not thoroughly satisfactory but served as a stop loss until, through intensive investigational work, better varieties were secured. Of the P. O. J. canes, the variety P. O. J. 234 became the most widely planted on account of its early maturity and high sucrose content. This variety produced fairly satisfactory yields of plant cane, but its stubbling qualities were very weak, resulting in an average yield of sugarcane in the state of about 15 tons per acre, a yield which was entriely too low to enable the farmer to realize a proper return on his investment.

Through intensive investigational work of the Louisiana Experiment Station at Baton Rouge and in its test fields throughout the state, in co-operation with the office of Sugar Plant Investigations, United States Department of Agriculture, three new varieties of sugarcane more suitable to Louisiana conditions were secured and given to the industry. When grown under conditions most suitable to each variety, these canes, C. P. 807, Co. 281, and Co. 290, were all capable of producing more satisfactory crops in the field than the P. O. J. varieties, and of yielding satisfactory factory returns. Of the three varieties, Co. 281 is most generally suitable to the different sections of the Louisiana sugar district; Co. 290 is especially adapted to the Teche area, Lafayette area, and portions of the Mississippi alluvial lands of the lower part of the Louisiana sugarcane district; C. P. 807 grows well in the same sections as Co. 290. The high fiber content and the excessive cost of harvesting, due to its type of growth, make C. P. 807 the least popular of the three varieties.

While the varieties, C. P. 807, Co. 281, and Co. 290, made the growing of sugarcane a safer venture, they did not fulfill all of the requirements that are necessary to bring back full recovery to the sugar industry. Through further investigational work the canes, C. P. 28-11, C. P. 28-19, and C. P. 29-320 varieties, scientifically bred at the United States Sugar Plant Field Station, Canal Point, Florida, were secured. All three of these canes are disease resistant, high in sucrose content, and heavy yield-

ers in stubble crops—as rich or richer in sugar content of the juice as P. O. J. 234, but greatly surpassing this variety in tonnage per acre. Tests so far indicate that the tonnage per acre yields on the newer canes will be nearly as high as the tonnage obtained from our highest yielding commercial varieties, Co. 290 and C. P. 807, both of which are much lower in sucrose content that the three new canes.

In recent years it has become the custom to wait until October 15 to October 22 before beginning the grinding season. In a country where the cold hazard in late December or early January is as great as it is in Louisiana, this delay often proves very costly. The new variety, C. P. 29-320, has, for the past several years at Baton Rouge, shown a sucrose content that justifies our believing that when this cane comes under commercial cultivation, the sugar houses will be able to start their grinding operations not later than the first week in October. This will prove a double advantage: the first and most important advantage will be a reduction in the cold hazard; the second, an increase of approximately 20 per cent in the length of the grinding season.

The following two tables, based on results obtained at Baton Rouge, will serve to show the comparative merits of the above discussed varieties.

TABLE 1

Yield in Tons per Acre of Recently Introduced Cane Varieties.
(Tests at Baton Rouge.)

Variety	Plant	1st Stub.	2nd Stub.	4th Stub.	5th Stub.	6th Stub.
P. O. J. 234	23.34	18.33	3.54	**	**	**
C. P. 807	36.30	26.68	18.77	19.20	**	**
Co. 281	30.27	30.46	23.30	21.74	19.53	17.79
Co. 290	44.43	35.03	33.32	33.69	38.95	**

** Indicate no plantings.

TABLE 2

Field and Mill Data on Recently Introduced Cane Varieties at Baton Rouge

Plant Cane

Variety	Tons per Acre	Brix	Sucrose	Purity	Extraction
P. O. J. 234	23.34	15.80	12.43	78.67	71.43%
C. P. 28-11	29.11	17.40	13.42	77.13	67.57%
Co. 281	30.27	16.40	13.47	82.13	71.15%
C. P. 29-320	31.76	17.10	13.51	79.01	71.30%
C. P. 28-19	32.38	17.60	14.38	81.70	69.92%
C. P. 807	36.30	15.50	12.76	82.32	67.37%
Co. 290	44.43	15.80	11.90	75.32	73.76%

In Table 1 we find that P. O. J. 234 gave fairly satisfactory yields, both in plant cane and first stubble, but is definitely of no economic value as second stubble. On the other hand, the other three varieties are rendering good yields through fourth,

fifth, and sixth stubble, where such stubble crops were obtainable. While there are no data on the yields of C. P. 807, fifth and sixth stubble, and Co. 290 sixth stubble, Co. 281 continued to give higher yields in sixth stubble than the state tonnage yield for all varieties.

Table 2 compares the tonnage yield and juice analyses of P. O. 234 plant cane with the newer varieties now under cultivation in Louisiana.

An important factor in the utilization of varieties is the rate at which they deteriorate (lose their sucrose content). This factor is very important, for it is entirely possible for a very high sucrose sugarcane to deteriorate to such an extent that it may become unpofitable to mill.

When windrowed as a precaution, later to be taken from the windrow and sent to the sugar mill, Co. 281, under normal conditions, shows the least amount of deterioration of the commercial varieties cultivated in Louisiana. The windrowing quality of the cane is well known to the planters, and the variety is used by them as a safeguard against heavy losses when winter conditions are severe. Windrowing tests conducted before and after the December freezes in 1934 confirm previous observations, indicating that when Co. 281 was windrowed before the temperature went to 22 degrees F., the variety kept satisfactorily; but that when the cane was windrowed after severe freezes of below 22 degrees F. had affected it, it was damaged to such an extent that keeping qualities in the windrow were materially lessened.

When harvested before a freeze, the variety C. P. 28-19 has been found to behave in somewhat the same manner as Co. 281. A limited amount of data indicates that it does not keep quite as well as Co. 281.

The variety C. P. 28-11 has shown a very great cold resistance under the conditions of 1934.

The recommendations of the Louisiana Sugar Experiment Station regarding the necessity of delivering freshly cut cane to the mills are now generally accepted throughout the state, and have been responsible for savings beyond measure to the cane grower. In Table 3 an illustration is given of the losses that may occur if cane is not milled soon after cutting.

TABLE 3

Deterioration Test

Variety	Cut and Analyzed Nov. 15 '34	Analyzed Nov. 21, '34
Co. 281	12.58	11.79
C. P. 28-19	14.94	13.05
Co. 290	13.46	11.28
C. P. 28-11	14.08	9.71
C. P. 29-320	14.61	10.95
P. O. J. 36-M	12.78	9.74

Approximate loss in dollars per ton of mill cane in a six-day period:

Co. 281, $.146 C. P. 28-19, $.483 Co. 290, $.368 C. P. 28-11, $.845
C. P. 29-320, $.683 P. O. J. 36-M, $.515

Here it is clearly demonstrated that in six days a cane grower can have a profitable year turned into a disastrous one through neglect on his part to deliver freshly cut sugarcane to the manufacturer.

Date of Planting

Varieties respond differently to plantings made in late summer. While it is not practical to plant cane as early as August 15 without a complete change in our rotation system, it is possible this early to plant such varieties as Co. 281, Co. 290, and C. P. 807. At Baton Rouge the best results from a field standpoint have been obtained from plantings of these varieties made from September 1 to September 15. The P. O. J. varieties do not respond to early plantings and should not be planted before October 1.

We have found that there is a period, varying somewhat from season to season, in which germination of sugarcane is not as satisfactory as when the cane is planted either before or after this period. The period at Baton Rouge hinges around November 1.

This earlier date of planting is highly advantageous from a practical standpoint in that it enables the cane grower to distribute his heavy field work over a longer period. With the contemplated commercial cultivation of C. P. 29-320 and the anticipated earlier starting of the mills through the use of this cane, which would tend to concentrate fall work greatly, the knowledge that we can plant certain varieties from two to five weeks earlier than has been customary becomes invaluable.

Rotation

Under the conditions of our field work, when the soil has been put in a state of high productivity, no more profitable returns were secured from cane when two crops of summer legumes had been grown and turned under than when one crop of summer legumes had been turned under. A crop of *Melilotus indica* grown on the plant cane, as reflected in the stubble crop, was equal to one-half ration of nitrogen applied to both plant and stubble cane. The possibility of deriving a profit from nitrogen applied to stubble cane following *Melilotus indica* on plant cane is doubtful. In contrast, when no *Melilotus indica* was grown on the plant cane, the stubble responded to nitrogenous fertilizer.

The use of commercial nitrogen has not been profitable on plant cane, and hardly profitable on first year stubble when the best rotation practice has been followed. Nitrogen has been definitely profitable on second year stubble, and in this respect we find that when *Melilotus indica* has been grown on the plant cane, its value is clearly shown in a decreased demand for nitrogen on the stubble cane.

Yields of plant cane have been as good following cowpeas turned under as those following soybeans turned under; however, yields from stubble cane have been better following soybeans turned under.

On Louisiana plantations where soils have been built up through the proper treatment, similar crop returns should be secured. On the average Louisiana sugar plantation, where production is low owing to a poor soil condition, more fertilizer will be required to secure the most profitable returns. These two widely varying conditions should not be confused, for, while more fertilizer can be used advantageously on the lesser yielding soils, the amount of fertilizer which can be used profitably is limited; or, in other words, maximum profitable sugarcane yields cannot be secured through the application of commercial fertilizers alone.

Flat Cultivation

Work along the lines of flat cultivation at Baton Rouge has shown that it is not necessary to have the high ridges that were once thought to be so essential to suc-

cessful cane growing in Louisiana. The results of our experiments strengthen the findings of earlier work which forms the basis for our recommendations of deep soil preparation, a moderate ridge, and shallow cultivation. (We are not recommending the growing of cane on the flat.—See Louisiana Extension Circular 151 for full details of our recommendations on cane culture.)

Rapid Propagation

The P. O. J. canes were used to rectify a disease situation which all but wiped out the Louisiana sugar industry. A second crisis was averted by the introduction of canes better suited to Louisiana. In the case of the P. O. J. canes, a great deal of money was lost before a seed supply could be built up. This same thing might have occurred in 1934 and 1935, if this station had not developed a method for the very rapid increase of new and desirable varieties.

We have developed and given to the cane growers the Single Eye Method of summer planting. This is a practical method by which as many as 1,300 stools of cane have been produced from an initial single stool within one year. By this method we are able to place a variety under general commercial cultivation five or six years earlier than by ordinary methods of planting.

Rapid Field Testing for Maturity

Heretofore a great deal of money has been lost, because there was no rapid method for determining the maturity of cane in different sections of the field or for determining the economic point for topping. Planters had to rely largely on their returns from the sugar house, and by the time these were secured, fields of cane that were either immature or had been improperly topped had been cut.

Through the use of the Zeiss Hand Refractometer we were able to develop a simple, practical, and rapid method for determining the maturity of cane in the field, and also for ascertaining the proper point at which cane should be topped in order to secure the most economic returns. We feel that this work is doubly valuable to the cane industry of the state for two reasons. First, it enables the growers to keep personally informed as to the wide variation in maturity, even within a small area, thereby eliminating controversies between growers and manufacturers. Second, it gives the cane growers a simple, rapid, and practical method for determining what fields of cane are mature enough to harvest.

Corn

Experiments conducted at Baton Rouge have clearly shown that the yields of corn, following stubble crops of the varieties of sugarcane now grown commercially in Louisiana, have been considerably less than were secured when the "Noble" canes were in general use. This, no doubt, is due to the fact that the stubble pieces from the newer sugarcanes decompose so much more slowly than did the stubble pieces from the "Noble" canes.

Experimental data have proved that a limited amount of nitrogen can be used to offset this lower yield of corn following stubble crops of the newer sugarcane varieties. An application of 15 pounds of nitrogen per acre to corn following such stubble cane has given profitable returns under average growing conditions. Except under ideal conditions, a heavier dose of nitrogen has not proved profitable.

In the case of corn plantings following stubble cane of the newer varieties, a

quick-acting fertilizer is needed. A slow-acting nitrogenous material may not become available until after the corn crop has been severely stunted.

The following table illustrates the preceding statements. From the data presented, it can be readily seen that an application of 100 pounds of nitrate of soda was highly profitable; 200 pounds gave an increase over 100 pounds, but the increase was not large enough to pay for the extra 100 pounds of fertilizer. In a contrast between the corn following sugarcane and corn following a crop of soybeans turned under, even an application of 100 pounds of nitrate of soda to the corn following the legume turned under was not profitable.

Fertilization of Corn Following Stubble Cane of the Newer "Hybrid" Varieties

Check	100 lbs. Nitrate of Soda	200 lbs. Nitrate of Soda
27.79	39.41	41.83

Fertilization of Corn Following Corn and Soybeans, the Soybeans Being Turned Under to Improve the Soil Fertility

Check	100 lbs. Nitrate of Soda	200 lbs. Nitrate of Soda
48.34	49.84	51.46

There are cases in which nitrogenous fertilizer can be used on plant cane and on corn following a crop of legumes turned under. When a planter finds such a practice to be profitable on his lands, he should take advantage of the fact. The planter should realize that he has not done his part by his land and should immediately plan his cropping system so that the land will be systematically built up to a stage of maximum profitable productivity.

PART II

Testing Canes for Disease Resistance in Louisiana*

By

C. W. Edgerton, Plant Pathologist, and
E. C. Tims, Associate Pathologist.

On account of climatic conditions, it is not possible to carry on breeding work with sugarcane in Louisiana. Being outside the tropics, sugarcane does not normally produce flowers, and viable seed have as yet never been produced. This means that the planters of Louisiana must depend on other regions for new cane varieties. Most of the new canes that are now being brought into the state come from the breeding station of the United States Department of Agriculture at Canal Point, Florida.

Practically no information is available on the new seedlings when they are brought to the State Experiment Station at Baton Rouge. The parentage of the canes is known, but other information is very meager. Practically nothing is known in regard to their adaptability to Louisiana conditions or their resistance to the diseases which are of economic importance.

* This article has also been sent to the meeting of the International Society of Sugarcane Technologists which is to be held in Brisbane, Australia, in August, 1935.

Practically complete and accurate information about these new seedlings must be obtained in a comparatively short period of time. By the end of the second year after they are received, the agronomist has sufficient information in regard to the sucrose content and yielding characteristics to know whether they have any promise. The few that do show promise are placed in increase plots, and the next year those that are left are ready to go to the test fields throughout the state for further tests and for rapid increase. By the end of the first year in the test fields, the plant pathologist must be able to state fairly definitely how resistant or susceptible each of these is to the diseases of major importance. In a former generation, the canes that were received by the Experiment Station from various locations in the tropics were cultivated on a small scale from year to year. This was believed to be necessary in order to determine how these canes would react during favorable and unfavorable years. At best this method was slow and the results obtained were not very reliable unless the canes were grown for a numbr of years, and in years both favorable and unfavorable for cane growth. At the present time, information which is more reliable can be obtained in the two years in which the canes are being grown in the increase plots before they are ready to be released for general planting.

The diseases which are considered of the greatest economic importance in Louisiana are as follows: (1) the stubble deterioration complex of factors, (2) red rot, and (3) the mosaic disease. The comparative resistance of each seedling to each one of these must be definitely known before a variety can be released for general planting.

Stubble deterioration is very important in Louisiana. It includes all of those factors which kill out or lower the vitality of the cane stubbles from the time the cane is harvested in the fall until normal growth can take place in the spring, usually a period of about four months. Included among these factors are the susceptibility to cold and excessive soil moisture, the susceptibility to the root rot complex of factors, and to such stalk-rotting organisms as the red rot fungus and a few others that are known to attack the stubble pieces before the young shoots become established in the spring. A variety which is not very resistant to stubble deterioration is worthless in Louisiana. This was one of the most important weaknesses of the old D. 74, a variety which was grown in Louisiana for many years.

As the deterioration which may occur in the winter is very closely associated with weather conditions, it is not easy to determine the stubbling characteristics of a cane by field tests. Following a favorable winter almost any variety may make a very satisfactory stubble or ratoon crop. Following an unfavorable winter, however, recovery of the stubble may be poor and unsatisfactory. This means that a cane may be grown in the field for a number of years and appear apparently satisfactory, and then, rather suddenly, when some unfavorable condition occurs, it may fail. Varieties which respond in this way are dangerous canes. If planted on a large scale, it is just a matter of time until crop failures result.

A method* has been worked out in Louisiana which enables us to determine the stubble deterioration characteristics of a cane in favorable as well as in unfavorable years. Some of the canes now in cultivation, such as P. O. J. 234 and P. O. J. 213, are known to be very susceptible to stubble deterioration, while others, such as Co. 290 and Co. 281, are known to be very resistant. In testing new canes, it is possible to compare them, then, with both resistant and susceptible canes, and the comparative

*Edgerton, C. W., Tims, E. C., and Mills, P. J., Stubble deterioration of sugarcane. Louisiana State Agricultural Experiment Station Bulletin 256. 1934.

resistance can be very readily obtained. To determine this resistance, stubble pieces, usually about 100, are dug at specified times during the winter, generally in December, late February, and the latter part of March or the first of April. The number of good and dead eyes on the stubble pieces, the number of pieces showing some discoloration, and the number apparently dead are determined. The stubble pieces are then split open and one-half of each is placed in a moist chamber for not more than four or five days. By that time those affected with red rot will have spores on the cut surfaces, and the red rot infection can be determined by microscopic examination. If these pieces are left in the moist chamber more than four or five days, spores may be present which come from secondary infections following the splitting of the stalks. It has been found from tests carried through several years that poor stubbling canes will show a lower percentage of good eyes and a higher percentage of dead stalks even in very favorable years than will good stubbling canes. When the results for the three examinations are available, a direct comparison may be made with the cane of known stubbling characteristics. If the results obtained with a new seedling are similar to those obtained with either P. O. J. 234 or P. O. J. 213, the cane is considered susceptible to stubble deterioration, but if it compares well with Co. 281 or Co. 290, it may be considered a safe cane. In two years results can be obtained which are more reliable than results obtained over several years in general field tests.

Some information on the resistance of cane seedlings to the red rot disease is obtained from the stubble deterioration tests, but this is not usually sufficient, as the disease affects the standing cane as well as the stubble pieces and the planted cane. Information on the resistance of a cane plant to the progress of the fungus must also be available. The fungus may spread very rapidly in a stalk when infection occurs and yet not easily gain entrance to a standing stalk in the field. Such a cane is resistant to infection. The rate of growth of the fungus in a cut stalk may also vary considerably from that in a standing stalk. To come to any conclusion, then, in regard to susceptibility to red rot, stalks must be inoculated both in the field and in the laboratory. Pronounced susceptibility to red rot as determined by either method is undesirable, and canes showing such susceptibility can have but little value for future plantings. Susceptibility to red rot has been a very important factor in discarding the variety, P. O. J. 213, and has definitely eliminated certain promising seedlings.

The problems concerned with the mosaic disease are more complex than those concerning some of the other troubles, and it is not as easy to speak with certainty in regard to the susceptibility of a variety to the disease. Information obtained during a period of several years suggests that strains, possibly comparable to the physiologic strains of fungi, probably occur with the mosaic diseases of sugarcane. From a symptom standpoint, there are two very definite types of mosaic. These are being called the green type and the yellow type. In the latter, chlorophyll is very deficient in the light-colored areas. Much information has been obtained during the past few years in regard to the susceptibility of different varieties to the two types, the period of incubation of the virus in the plants, and the amount of infection procured following juice inoculations. It is also believed that distinct strains of the virus occur which usually produce similar symptoms, but which attack certain varieties more readily than others. This means that a variety may remain immune or very resistant for a number of years and then suddenly become very susceptible. This occurred in Louisiana with the varieties, P. O. J. 213 and Co. 281.

The knowledge of the ability of a variety to throw off the disease, or to recover, is also important. The percentage of recovery of some varieties from the mosaic disease is very high. Of the new varieties which show considerable promise at the present time, C. P. 29-320 shows this peculiarity to a marked degree.

Mosaic normally spreads very rapidly in Louisiana and the relative susceptibility of varieties can usually be procured rather easily by obtaining the percentage of infection and the rate of increase of the disease in the test plots during the two years that the seedlings are being increased. On susceptible varieties the spread of the disease is very rapid. In recent years no new seedlings showing marked susceptibility to mosaic has been considered a commercial cane. Besides the field determination of susceptibility, the recovery from mosaic is obtained by tagging and watching infected plants. Furthermore, inoculations are made in the field with different mosaic types. The percentage of infection obtained from inoculation and the period of incubation are important factors in determining mosaic resistance. A variety in which the period of incubation is long is ordinarily more resistant than one in which this period is short.

It is believed that the system employed at the present time in Louisiana eliminates to a very large extent the selection of seedlings which later might become dangerous. It has already eliminated a number which in many ways seemed to have considerable promise. If carried on consistently in the future, the planters need not worry about severe disease epidemics and crises similar to those which have occurred from time to time in the sugar industry in the past.

Disease Resistance of Commercial Canes

By

E. C. Tims, P. J. Mills, and C. W. Edgerton

Since the crop failures in the period between 1924 and 1927, many hundreds of cane varieties and seedlings have been brought into Louisiana for trial. Out of this large number only a very few have shown sufficient promise to be released for general planting. Before a cane can be released, it must meet certain standards. It must show a satisfactory sucrose content, it must be adapted to Louisiana soils and climate and yield satisfactorily under most conditions, and it must show a satisfactory resistance to the diseases that are of major importance. To be released, a cane must equal or be superior to others which are being grown commercially. None of the canes which have been released in recent years is perfect nor do any approach very close to perfection. It should not be assumed that any of these will become permanently established. A cane has its value even if it raises the sugar production in the state for only a very limited number of years. It is assumed that better canes will be produced, and the sugar planters should not hesitate to discard canes, even though they have benefited them very materially, for others which will do better.

During the period since 1924 certain canes have become established as commercial canes. Some of these are already passing out of the picture and others will follow. The canes which have been released during this period are as follows: P. O. J. 234, P. O. J. 213, P. O. J. 36, P. O. J. 36M, Co. 281, Co. 290, C. P. 807, C. P. 28-11, C. P. 28-19, and C. P. 29-320.

As susceptibility to disease is one of the most important factors when selecting canes for planting purposes, it is important to know how well the present released

varieties meet the present standards in regard to resistance to disease. The diseases or disease complexes which are most important and which should be considered include susceptibility to stubble deterioration factors, red rot, and mosaic. Any cane which shows a low resistance to any of these is not a satisfactory variety.

Stubble Deterioration: The resistance of the released canes to stubble deterioration factors has been brought out in a recent bulletin* and it is only necessary to give the general results at this time. The comparative resistance of these varieties is about as follows: *Very susceptible*: P. O. J. 213, P. O. J. 234; *Resistant to highly resistant:* P. O. J. 36, P. O. J. 36M, Co. 281, Co. 290, C. P. 807, C. P. 28-11, C. P. 28-19, C. P. 29-320.

The susceptibility of P O. J. 213 and P. O. J. 234 to stubble deterioration factors is so pronounced that they are being classed as dangerous canes and should not be planted except in localities where stubble deterioration is not important.

Mosaic: Some information on the resistance of the released varieties to mosaic has been brought out in a recent bulletin,† and again it is only necessary to give the general results which have been obtained. The comparative resistance of these varieties at the present time based on the reduction in yield is about as follows: *Very susceptible*: P. O. J. 213; *Moderately susceptible*: P. O. J. 36, P. O. J. 36M, Co. 281; *Moderately resistant*: P. O. J. 234, Co. 290, C. P. 29-320; *Resistant*: C. P. 807, C. P. 28-11, C. P. 28-19.

The susceptibility of P. O. J. 213 is sufficiently pronounced to make it unsatisfactory for planting purposes.

The canes in the moderately susceptible group, P. O. J. 36, P. O. J. 36M, and Co. 281, are injured to a considerable extent by mosaic. Of these, Co. 281 is at present the most valuable cane. This cane is so important that it cannot be discarded at the present time. There is no variety to take its place. However, as time goes on, varieties may be developed which will gradually eliminate Co. 281. The resistant and moderately resistant varieties are not at present being injured seriously by mosaic. There is always a possibility, however, that resistant varieties may become more susceptible as they are grown for longer periods and such varieties must be carefully watched.

Red Rot: It is not possible to group cane varieties as satisfactorily in regard to their resistance to red rot as it is with the other diseases. This is due to the fact that the disease is caused by a living organism which is very variable. In nature strains of the organism exist which show a great difference in virulence and there is no reason why new strains should not develop from time to time. This means that a variety which was resistant at one time might be quite severely attacked at another time or under different conditions. However, enough evidence is available to give some idea of the comparative resistance of the released cane varieties and these varieties may be grouped on this information. *Very susceptible*: P. O. J. 213. *Very susceptible to moderately susceptible:* P. O. J. 36, P. O. J. 36M, C. P. 807; *Moderately susceptible to moderately resistant:* Co. 290, C. P. 29-320; *Resistant:* P. O. J. 234, Co. 281, C. P. 28-11, C. P. 28-19.

Severe losses from red rot with a very susceptible cane like P. O. J. 213 can be expected. Losses with canes in the very susceptible to moderately susceptible group may occasionally occur. Canes in the other groups are less apt to be materially in-

* Edgerton, C. W., Tims, E. C., and Mills, P. J., Stubble deterioration of sugarcane. La. Ag. Expt. Sta. Bulletin 256. 1934.

† Tims, E. C., Mills, P. J., and Edgerton, C. W., Studies on sugarcane mosaic in Louisiana. La. Ag. Expt. Sta. Bulletin 263. 1935.

jured by the red rot. However, even a cane that is moderately susceptible may suffer under some conditions.

When all the diseases are considered, it is seen that the newer varieties, C. P. 28-11, C. P. 28-19, C. P. 29-320, and Co. 290, more nearly meet the standards for disease resistance than do the other varieties.

PART III

Recommendations for Control of the Sugarcane Borer In Louisiana

By

W. E. Hinds, Entomologist, and
B. A. Osterberger, Assistant Entomologist,

Louisiana Agricultural Experiment Station, Baton Rouge, Louisiana

Introduction

During the past ten years especially, the entomologists of the Louisiana Experiment Station have been studying intensively the problem of controlling the sugarcane moth borer* in this state. This borer is particularly destructive to sugarcane and corn but less injurious to rice in Louisiana. Occasionally the borer has caused complete destruction of crops of cane and of corn over considerable acreage. During recent years the damage has decreased considerably below the average of approximately 20 per cent loss which was estimated to occur from about 1915 to 1925.

Out of the mass of observations and experimental results have come a number of rather definite conclusions regarding control measures which have been found generally effective and practicable in plantation practice. These conclusions will be stated as briefly as possible in the form of definite recommendations without an attempt to include therewith many details regarding the grounds on which they are based or the specific conditions under which they may apply. For such details, we must refer to various bulletins of the Louisiana Experiment Station and to numerous articles in the Journal of Economic Entomology and in The Sugar Bulletin. The recommendations are arranged in the order in which they should be applied through the season.

Recommendations

1. *Cut out "dead-hearts" caused by first generation borers* when they appear abundantly in cane. Dead-hearts are caused principally by borer larvae and indicate that first generation larvae are becoming full-grown. The time for cutting out occurs usually during the last week of May or the first week of June. In every case the best time should be determined accurately by cutting out sample lots of at least 25 dead-hearts every four or five days after May 20 and recording for each sample in tabular form the date, field, variety of cane, numbers of stalks cut, and the numbers

* *Diatraea saccharalis* (Fabricius)

of large borer larvae, of pupae, and of empty pupal skins found. The most effective and economical time for a single cutting is just when some pupae have become nearly black in color or when the first empty pupal skins occur. Repeated rogueing may be advisable at 7 to 10 day intervals. Not all dead-hearts appear at one time, though the problem is to secure as large a proportion as possible of dead-hearts without allowing the escape of moths, or to repeat the rogueing as numerous additional dead-hearts develop. Only extra-dependable laborers should be used and they should be trained to cut the dead-heart stalks low enough to be sure of getting the borer stages therein. Knives with stout blades from 6 to 8 inches long are needed for this work. As each dead-heart is removed, it is best to slit it immediately and destroy the borer stage therein. This practice assures the immediate destruction of the borer and also shows the workman whether he is cutting low enough to get all borer stages. It will always be true that many borer burrows will be found empty. This may be due to the fact that one larva may cause more than one dead-heart, or possibly the larva or pupa may have been removed by predaceous enemies. If dead-heart stalks are removed from the field, there is always some question about the thoroughness of their destruction or the possibility of moths emerging therefrom before destruction is accomplished. Areas requiring rogueing of dead-hearts should also receive parasite colonization (No. 3) in about two weeks after the rogueing began. No attempt should be made to remove dead-hearts later in the season than for first generation borers. As the cane becomes larger, a very much smaller proportion of borer-infested stalks show dead-heart type of injury and the expense for rogueing is greatly increased also.

2. *Destroy heavily infested early corn* in gardens or fields before first generation moths can emerge therefrom. It happens very frequently that early borer infestation is concentrated in a marked degree upon early developing corn. A maximum of good in reducing the emergence of first generation moths can be accomplished, therefore, by destruction of such corn at the proper time. The extent of this infestation is found very easily just at the time the first corn tassels appear. Very fine leaf perforations across unfolded leaves are due to feeding of young borer larvae within the leaf-roll. Burrows or excrement masses showing in the leaf axils in the lower part of the stalks are also sure evidences of cane borer infestation. If more than one-fifth of all stalks show these signs, it is considered advisable to cut out all of the corn and feed it to farm animals. Be careful to cut at or below the ground surface and also, particularly, to remove all stunted stalks. It is advisable to run all of the corn through feed choppers such as are available on most sugar plantations in Louisiana. If the corn is fed, without being chopped, the harder butt portions will likely be left uneaten. These may be destroyed by feeding to hogs or by running through ensilage cutters or cane grinders. Deep burial, burning or complete submergence under water will also effectively prevent the emergence of moths from such infested material.

Recommendations 1 and 2 may accomplish a very substantial reduction in the number of first generation moths maturing. The expense therefor is small and the benefits should continue throughout the season.

3. *Colonize egg parasites (Trichogramma minutum Riley)* upon the borer eggs as they are being laid for the second generation. Colonized areas should include all areas of corn or cane where evidence of first generation development occurrd in any considerable abundance. As a general rule, this will include the earliest planted areas of corn and the most advanced thrifty-growing fields of cane. Among the varieties now being produced commercially in Louisiana, first stubble fields of such varieties as C. P. 807, Co. 281, and Co. 290 should be considered favorable areas for parasite

colonization, as a general rule. The time for colonization usually occurs between June 5th and 25th for second generation eggs. The release of 5,000 to 6,000 parasites per acre is considered sufficient for June colonizations. Corn is likely to call for slightly earlier colonization on account of the somewhat more rapid development of borers which occurs commonly in corn. The third generation of borers in Louisiana may begin in corn fields as early as the 1st of July, but does not usually begin in cane until after the 20th of July. The easiest method of determining exactly when parasites should be released is to follow the development of the borer stages at the maturity of the first generation in corn and by examining dead-hearts in cane. As soon as empty pupal skins can be found in fairly frequent numbers, it is time to release parasites in that area. A similar method for determining the time for later releases may be followed if care is taken to distinguish between the empty skins remaining from first generation emergence and those produced by the emergence of second generation moths. This can usually be determind quite positively from the condition of the burrows and the age of the stalks in which the borers occur.

Later colonization may be made in either corn or cane as borer infestation conditions indicate to be advisable. This work may be continued, particularly in plant cane areas, to the 10th of September. After the middle of July, it is considered advisable to increase the number of parasites released to about 10,000 per acre.

The proportion of borer egg hatches turning black shows how effective the parasites are at any period during the season. After parasites are released under proper conditions, the planter may rest assured that they will return him a handsome profit on the small cost involved for colonization. Parasite colonization must be repeated each year because this egg parasite is absolutely dependent upon finding the eggs of some possible host species in which they may continue development slowly for two, three or more generations during the winter season. At this time no cane borer eggs exist in the field. The egg parasite does not hibernate as an adult, but continues its activity during periods of warm weather, and the development may be extended to six weeks or more for a generation of parasites in the winter in Louisiana fields. Therefore, from about November 15th to the last of March each year it is practically impossible to find any Trichogramma in cane fields. This break in their host egg supply eliminates Trichogramma from cane fields each year and reduces the number of parasites surviving the winter to a very small number which may find the eggs of some moth or butterfly species around winter gardens or evergreen shrubbery, etc. Fom such locations the parasites must multiply in the spring and again spread into the large areas of corn and cane.

In the course of parasite colonization experiments during the three seasons of 1932 to 1934, inclusive, we have been able to secure reports from plantation owners and mill operators covering 39 colonized fields and 31 check fields, comparable with the colonized areas. The average net profit from parasite colonization, as shown in these 70 test fields has amounted to over $18.00 per acre. This is based upon an average increase in all colonized fields of 528 pounds of sugar per acre, and the average value to Louisiana planters during this period of 3.8 cents per pound for sugar. The cost for parasite colonization is approximately $1.00 per acre at the rate of 5,000 to 6,000 parasites per acre.

4. *Dust cane* (not corn) *with high-grade light sodium fluosilicate* early in July where parasite colonization was not done, or where this was done too late to check the hatching of second generation eggs. The abundance of hatching of eggs is again shown by the presence of fine leaf perforations in the top leaves of the stalks late in June or early in July. If these perforations are very numerous, it indicates that a

large number of eggs have hatched. Thereafter control by parasites is not possible in that generation. It is possible, however, to reduce the number of borer stages developing by dusting the cane with sodium fluosilicate applied by saddle guns, from mule back, and using 12 to 15 pounds per acre. Apply this dust in the late evening when the air is quite still and the leaves are fairly dry. Such dusting, properly applied, and followed by dews and light rains, should destroy more than half of the borer larvae in the cane during the next two weeks. This dusting does not destroy the egg parasites occurring in the field, and the practice of dusting may well follow parasite colonization and will add to the efficiency of the parasite. The planter should not be alarmed if the more nearly matured leaves at the base of the cane stalks turn yellow soon after the dust is applied. Such leaves are in process of maturing. The sheath has loosened from the stalk and it appears that these leaves are no longer of functional value in the growth of the plant. They will soon die of their own accord. The growth of the stalk is not checked if these basal leaves are stripped away entirely. One dust application at this special period for checking the second generation of borers, and where parasites are not generally abundant, is all that we recommend.

5. *Plant borer-free seed cane* whenever possible to secure it. A minimum of borer infestation in the seed cane reduces the amount of seed required to assure a full stand in the following crop. This reduces the number of gaps or skips in the plant cane and in subsequent stubble crops also. Furthermore, it reduces the initial borer infestation in the plant cane crop. Experimental work has shown that borer-free seed cane increases the yield in subsequent crops by from 10 to 20 per cent above yields secured from using even lightly-infested seed.

6. *In harvesting cane,* it is important that the cutting should occur at or below the ground level. Low cutting eliminates practically all borer stages from the stubble and thus reduces the number of borers entering hibernation or surviving in the stubble where they are not likely to be destroyed during the winter by climatic conditions or by any artificial methods of disposal of cane trash.

7. *General clean-up* should be practiced in all cane plantation areas to destroy scattered stalks around hoists, along railway lines, and roadways and at factory yards.

Cane borers have been found to survive the winter in considerable numbers in old dried corn stalks. Such survival may be prevented by the practice of burning the stalks when they are fairly dry. Survival is decreased by merely breaking down the corn stalks early in the fall so that they rot out more thoroughly by being in close contact with the moisture on the ground.

The cane borer also hibernates extensively in areas of Johnson grass and other larger stemmed grasses which may occur along ditchbanks, headlands, and adjacent to cane and corn areas. Attention should be given to fall or winter clean-up of such areas in such a manner as to destroy the borer stages hibernating therein. Infestation in rice stubble may be eliminated by flooding the fields during the winter season.* Attention to these points may be necessary in areas where sugarcane is not grown.

8. *Burn cane top trash as thoroughly as possible* so as to destroy all borer larvae passing the winter therein. In all cane areas where borers are known to have been abundant at harvest time, it is advisable to have workmen throw the trash to the tops of the ridges soon after harvesting. Leaving such trash on the row during the early part of the winter protects the stubble from heat during December and reduces the sprouting at that season. Heavy sprouting during December is generally considered very unfavorable for the stands of cane in the following spring. Allow

*Recommended by U. S. Bureau of Entomology workers.

the trash to remain on the ridges until the latter part of January. By this time minimum winter temperatures will probably have occurred and the stubble will have been protected not only from heat but also from excessive cold. Then with only a few warm days the trash will be sufficiently dry to allow a very thorough burning and complete destruction of borer stages therein. The burning of top trash has no effect whatever upon the survival of the cane borer egg parasite. It is the most effective method yet found for destroying a large proportion of the borer stages in hibernation.

Borer survival has been found by extensive experimental work to be decreased by at least 75 per cent in areas receiving what we would call an average plantation burn, and may be reduced much beyond that point by the thorough type of burning suggested above.

By utilizing as many as possible of the foregoing recommendations, sugarcane growers in Louisiana may be assured that borer damage will be greatly decreased.