RESEARCH ON SUGAR PLANTS AND SOME PRACTICAL ADAPTATIONS

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The title selected for this informal talk is "Research on Sugar Plants and Some Practical Adaptations." That is a broad subject and gives the opportunity to speak at length, but I will limit my remarks to a half dozen lines of work sponsored by the Division of Sugar Plant Investigations during the past two decades. An appraisal of the value of this research to American Agriculture will be recapitulated, showing that in this period a total approaching one billion dollars of conserved capital and added national wealth is directly attributable to it and indirectly many millions more have gone to "good neighbors." Nor are the results to be evaluated only in monetary units, since at present a half million of our people who might otherwise be on relief have means of livelihood because of this research, which, relatively, has cost little.

The realistic view demands that these benefits be credited as net gains with no deduction for compensating factors, such as possible other uses of the land and labor, or possible income of any kind derived indirectly. We have a long-established, firmly-rooted domestic sugar industry. That is a sufficient reason for the successful efforts to make it more efficient. Nor are the ramifications of these contributions to national wealth limited to the producers who benefited directly by the results of this research, as these producers in turn constitute a market for American goods greater than that which might come from potential producers elsewhere.

In comparison with other sugar-producing areas, the United States has made much progress in the improvement of the sugar plants during the past 20 years. In that period there has been a series of interruptions in growth of the several sugar industries, in the main resulting from natural causes adversely affecting the plants themselves. These natural causes, chiefly plant diseases, more than any other factors have threatened the continued existence of the industries. Their impact on the industries and their effects on growth have varied in duration and degree and have been different in character.

Intimate knowledge of these natural causes as they affect production units represented by plantations or farms is required if reliable interpretation of production statistics is to be made. Broad interpretations of production trends without such intimate knowledge, especially of extensive areas, are likely to be imperfect. The interruptions of productivity of our sugar industries during the past 20 years were characterized, for example, by practical collapse in Louisiana and the South, violent and unpredictable annual fluctuations of output in the western beet areas, and curtailment, lesser in amount than in Louisiana, followed by temporarily retarded recovery in Puerto Rico.

The ominous nature of the situation in the South in the period from 1918 and culminating in 1926 was apparent to all without need for intimate knowledge of the cause. But reaction to it by observers was not unanimous and the differences lay in ability to ascribe the cause and visualize the chances of any remedial measures. A well known economist immediately sounded the death knell of the industry and no prudent financing institution was willing to risk a dollar on it. The income of sugar farmers in Louisiana dropped to such a

pitiful figure that the State's leading advisor in agriculture complacently drew attention to the fact that a minor poultry industry was more profitable. However, a small group of growers was persuaded that the natural cause of the calamity could be determined and that some control could be found, and they met the challenge rather than passively submitting to what many took to be inexorable force. They seized upon the hope of remedial measures then offered and those in prospect, and with indomitable will literally lifted themselves by their own bootstraps. The remedy offered was a botanical specimen unprepossessing in appearance, which elicited some amused if not derisive comment at first, even by the man who later with self-effacing public spirit contributed the same means of salvation to thousands of his neighbors. He lost his own plantation because the remedy came too late.

Reduced to simple terms, the recent decline of the Louisiana sugar industry was due to the unnoticed introduction of the virus disease of sugarcane, mosaic, which met an unprepared industry not provided with adequate research facilities. The lesson in unpreparedness cost the industry more than can be measured in money. Adjustment of whole communities to a calamity bringing universal loss of revenue brought the gravest personal and family problems and, because of the lack of other enterprise to turn to, an unwholesome resignation. In the end, after costly delay, a reasonably satisfactory solution was found in the improvement locally of sugarcane varieties by breeding for resistance to disease and adaptation to our climate and soils. This involved an elaborate program of scientific work after literally combing the world for breeding material. Details of the main and accessory projects by a dozen specialists have been reported in numerous publications, and need not be enumerated here.

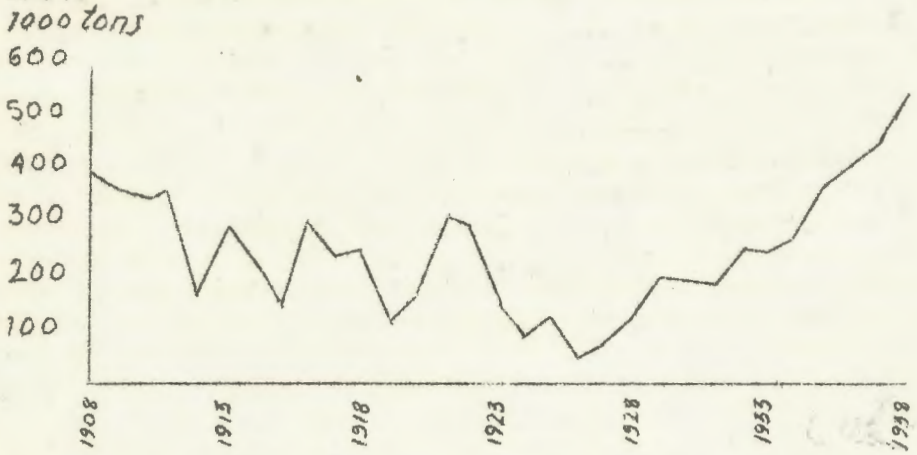

Fig. 1. Sugar Production From Cane, United States, showing crop failure due to disease, and reconstruction of the industry with disease-resistant varieties to all-time high sugar production arising from record acre yields.

The practical adaptation of this research is graphically shown by the production figures in Figure 1, which indicate that beginning with the year 1927, when the first new variety was increased to acreage reflected in the statistics, there has been a constant rise as variety succeeded variety in the gradual development of better sorts by breeding. The actual increase in production was from less than fifty thousand to nearly five hundred thousand tons of sugar, the acreage in cane[1] for the ten-fold increase being only about double.

1/ Some of the acreage planted in 1926 was not harvested.

A similar visitation of disease caused by the same or related viruses occurred in Puerto Rico, where studies were begun by the Division of Sugar Plant Investigations earlier than in the Gulf States. Because of great local variation in weather, indirectly affecting the efficiency of natural dissemination of the virus the problem in Puerto Rico resembled that in Louisiana only in part. In some districts it is possible by a system of almost constant roguing to grow susceptible varieties of cane even today. Because of the expense and potential danger, that is not a wholly satisfactory system and requires further attention. Other districts representing a large percentage of the total area in cane required substitution of resistant varieties.

The history of discovery and development of resistant varieties for Puerto Rico was analogous to that on the mainland, except that, due to more exacting demands of climate in the latter area, finding suitable breeding material required a more thorough search. Without the background of fundamental research carried on by the Division, the sugar industry in Puerto Rico would be in a far less flourishing condition today and the same can be said of the relatively new industry in Florida, which faces other unsolved problems because of its position intermediate between tropical and temperate zone conditions. Parenthetically, the sugarcane virus disease problems the world over and their solution by "variety revolution" or other means received their present conception, and the inspiration and methods of control, because of the appropriations by Congress of money for this research.

Beyond mere repair of the disease injury, the improved tone and tempo of sugarcane yields so easily perceived in many plantations of Cuba and the West Indies generally, South American countries, and to some extent in Africa, Oceania and Asia, even the little industry in southern Spain, trace a measure of their current impetus to this research. Twenty-two countries have safely received improved plant material for which the Division acted as a clearing house, whatever its origin, by maintaining a quarantine station. Encouragement lent by the improved performance of the resistant or tolerant varieties led, by natural reasoning, to consideration of further improvement by other means and has resulted in substantial gains to levels never before reached, this in the face of a declining world price of sugar. The sum total of benefits to humanity by conservation of effort and in lessened cost of an indispensable commodity would be a staggering amount.

To arrive at the estimate of American dividends paid by this research we credit to it all production with plant material released by the Division used where sugar production had quite failed owing to low yield, and a part of production on lands that, because of low yield, were jeopardized but not actually abandoned. On the latter the significant increases in production since the improved, disease-resistant varieties have been planted are very great and are just as directly attributable to this research.

In addition, we credit the capital investment in factories, machinery, plantation railways, and specialized implements and equipment in the areas definitely marked for abandonment or already abandoned. If solutions had not been found for these field problems, all fabrication equipment would have had junk value only. On that basis we boldly assert that the Gulf States sugar and sirup industries owe to this research over a period of 14 years three-hundred and fifty million dollars and the present employment of 60,000 workers, with an average of three dependents each, or a total of 240,000 persons.

The increased per acre production in Puerto Rico, beginning in 1919 when the first mosaic resistant variety was supplied, has been steady and has now reached over 100 percent.* While the prompt clarification of the perplexing disease problems, the early resistant varieties, and guidance were directly contributed by the Division of Sugar Plant Investigations, continuance of the work by local research institutions and added improvement must be recognized; therefore, one-half of the annual increments in per-acre yield since that date, a total of two hundred and twenty-five million dollars, is the claim. In this industry, which as a whole was not threatened with extinction, credit for salvage of capital investment is relinquished, except for factories supplied by the worst-affected 70,000 acres, and the workers thereon, respectively ten million dollars and livelihood for 25,000 workers. That these workers and dependents, 100,000 people, would have found other gainful employment in the present depressed period for the agricultural industries is less likely than the alternative, enlistment in the army of unemployed.

This record of the southern sugarcane industry laid prostrate by a virus disease finds counterpart in the ravages of sugar-beet curly top in western United States. The effects of the disease have been grave enough and so widespread in many years of the decade preceding 1934 as to bring about sharp decline in the average acre-yields of a whole state. In such years of disease outbreak, the factory records reveal that average acre-yields in some districts have dropped precipitously from the expected 15 tons or more to 5 tons or less. Such figures, based on harvested acreage, obviously give no record of thousands of acres abandoned.

As throwing light on the impact of curly top on the beet-sugar industry, one may trace the history of sugar-beet culture in western reclamation projects or other agricultural areas in the West—such as the Truckee Project, Salt River Project, Delta and other Utah areas, the San Joaquin Valley of California, the Yakima Valley of Washington, and many others. The story is much the same for all—introduction of the crop, a brief period of fine prospects, and finally crop failure because of curly top, and ultimate abandonment of sugar-beet growing by farmers.

The history of factories erected with high hope and welcomed by farmers on the irrigated lands as providing a market for the pivotal cash crop in the agricultural program also portrays the emergency situation that curly top brought about. Each venture represented the investment of upwards of one-half million dollars. The subsequent history of these beet-sugar factories is a drab picture of idle years or, at best, sporadic activity as one season's crop or another by some vicissitude of climate managed to escape a disease epidemic. A factory erected in the Yakima Valley operated only a few days in a single season, then was closed and eventually dismantled. Curly top practically made the beet-sugar industry in western United States lead a gypsy existence in its futile quest to find some reasonably secure areas in which to grow the sugar beet.

No business could long continue under these conditions and by 1929 the western beet-sugar industry was at its lowest ebb and bankruptcy was imminent for many enterprises.

But these failures of capital to yield returns, the losses of original investments, and the collapse of many ventures in spite of constant outlay of new capital, signify far more than mere money losses. In essence, they are faithful indices of far-reaching and profound effects upon the agricultural

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*Fig. 2, page 163a.

population and on the agricultural system of the West. On the human side, they involve disappointment, wastage of human effort, and wreckage of farm families. Wherever a factory was forced to stand idle because of the sugar-beet crop failure because of curly top, the livelihoods if not the fortunes of several hundred farmers around the factory were jeopardized.

In 1929, Congress recognized the emergency situation and appropriated a considerable sum for investigation of the beet leaf hopper and the virus it transmits. These funds for research on the disease have permitted an augmented attack on the whole problem and prompt capitalization on all the promising leads developed by earlier research of this Division. It was possible in 1931 to demonstrate the first progress in the development of curly-top-resistant varieties. By 1933, steps were under way to increase the seed of a variety that was introduced in 1934, under the designation U. S. 1, for use by farmers.

Since that time, other curly-top-resistant varieties have followed in quick succession--U. S. 34, U. S. 33, U. S. 12--each representing an improvement in curly-top resistance and adaptation. The industry has fully cooperated to bring each of these improved varieties promptly to the growers, as is shown by the record that of about 300,000 acres subject to curly top, 235,000 acres were planted in 1939 with varieties arising from this research, and much of the remainage acreage was planted with curly-top-resistant varieties in some degree akin to government releases.

The removal of the threat of failure to the beet crop, through the continued improvement in resistance of beet varieties, is signalized by the rebuilt factory in the Yakima Valley--erected on the foundation of a factory formerly dismantled--the erection of new factories in California, Utah, Idaho, and the re-entrance of the sugar beet into districts of California, Nevada, Idaho, Utah, New Mexico, and western Colorado.

It can not be said that curly top is vanquished, because with severe exposure in the worst years it still takes some toll and prevents the crop from delivering the maximum which soil and climatic conditions might warrant. Beet farmers may now plant these new varieties with confidence that the crop will be carried through to a reasonably high yield in spite of disease, and they look forward to new and even better adapted varieties as further research fits the curly-top-resistant types to the great range of conditions encountered in the broad expanses of our sugar-beet areas.

If one seeks to appraise the benefits of this research effort, which has involved a dozen or more scientific workers and has had the wholehearted cooperation of the industry, he must take into account the dire condition into which curly top had forced the western producers. He must also have enough confidence in the American way of life to want American industry not only to be maintained but to grow.

The capital investment in farm lands, farm equipment, irrigation systems, factories, factory equipment, transportation and power facilities directly concerned in sugar-beet production and beet-sugar manufacture in the United States as a whole may be placed at $350,000,000. The capital investment in important subsidiary industries which furnish supplies and services to the beet industry and the livestock industry directly concerned in utilizing sugar-beet byproducts as feed would greatly increase this figure. Nearly one-fourth of this entire investment, amounting to between $80,000,000 and $100,000,000, was jeopardized. Is it not fair to credit the research which turned the tide from bankruptcy to

a surge of growth and development, as typified by the recent $25,000,000 expansion of the western industry, with saving and safeguarding a major share of this national wealth?

Moreover, progress in agricultural research refuses to confine itself to the narrow limits of the single problem-reaching solution, but it serves as a leaven for a whole agricultural complex. The farmer with a promising crop is the one who gives it good culture, he secures the means whereby he can fertilize his crop, he arrives at the position which enables him to devote acreage to legumes to rebuild his soil. One finds specific illustration of the intimate coordination of research in the yoking of the Division's research on curly top with its investigations on sugar-beet-seed production. Dependence upon Europe for seed, a condition which lasted nearly a century, was recognized by many informed and able men as imprudent, but attempts to remedy this incongruous situation were sterile until seed of the curly-top-resistant varieties were produced commercially by the "American" method. The linking of two objectives in our program secured, in no small measure, the practical adaptation of this research.

Investigation sponsored by this Division had shown that sugar-beet seed could be efficiently produced in the United States by a new method which differed radically from the conventional European method which was lavish in its requirement of hand labor. Our investigations revolutionized the methods so that today we produce sugar-beet seed in the United States by short occupancy of the land in much the same way that winter wheat is produced, abundant use of machine dispensing with the hand-labor, "gardener" methods of Europe.

With the advent of curly-top-resistant varieties, the efficient method for increase of seed had been perfected by our investigations. We can be justifiably proud of the record that every pound of curly-top-resistant seed used on American farms has been home-grown. In 1939, more than 6,000,000 pounds of curly-top-resistant seed were produced. The American method of sugar-beet-seed production has also found use with improved varieties arising out of breeding work of commercial companies and with leaf-spot-resistant varieties coming from other research projects of this Division. In 1939, a total sugar-beet seed production in the United States reached a high of nearly 14,000,000 pounds, just a small amount below our total donestic requirements.(Fig. 3, p. 163a.)

History has repeated itself and Europe is again engulfed in war. But, in contrast to 1914, when the American industry was almost totally dependent upon Europe for the seed to plant the sugar-beet crop, we enter 1940 with a full-fledged sugar-beet seed industry which had its origin in American research and, in a way, was a byproduct of the investigations on curly top.

The files of the Bureau of Plant Industry of 1915, 1916, and 1917 give a vivid picture of that hectic period of World War days when, by dint of the strenuous effort of the Department of Agriculture, the Department of State, and only by the consent of the British government, passage through the blockade of Germany was secured for meagre amounts of sugar-beet seed, absolutely essential if a sugar-beet crop was to be grown in the United States. Such seed as filtered through came in under bond that it would not be re-sold, and a bond that the sacks would be returned was exacted! Such are the grim realities of war time, where such an item as return of gunny sacks could determine whether an American food crop could be grown!

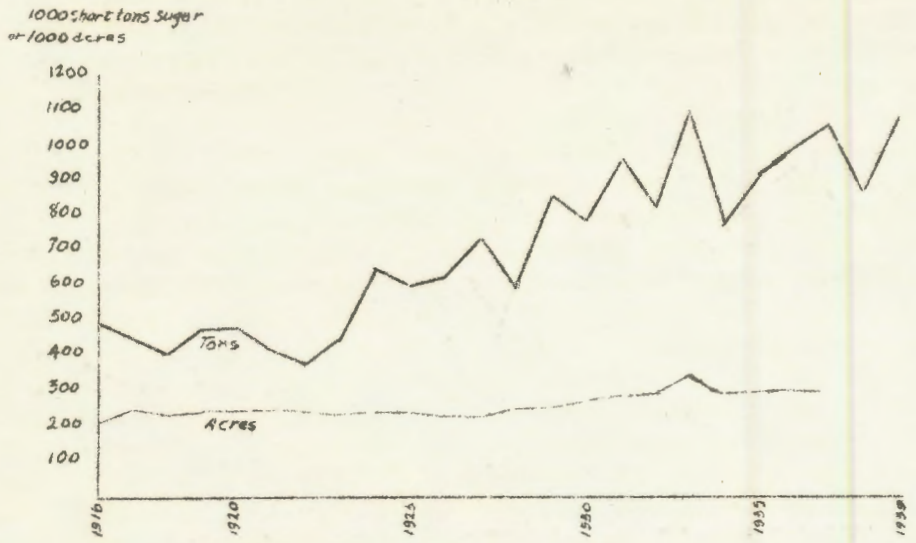
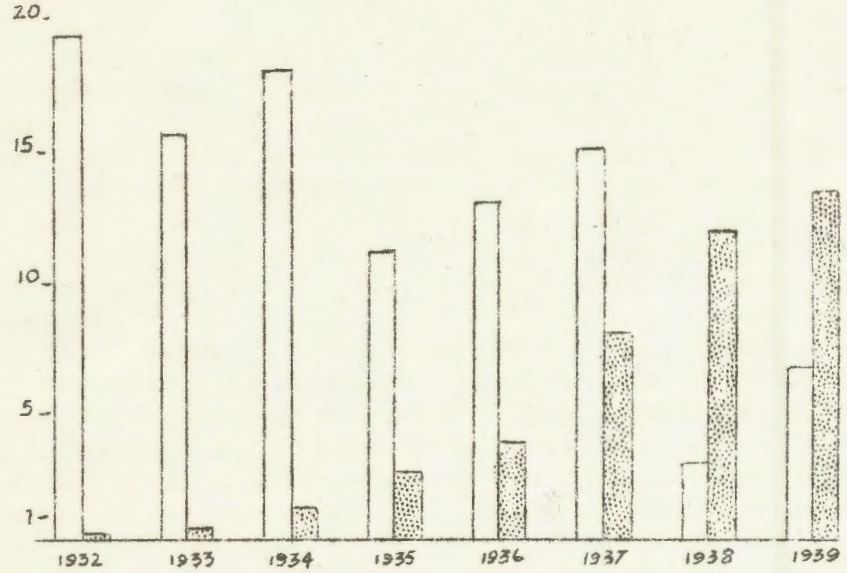


Fig. 2. Sugar Production from Cane, Puerto Rico, showing crop failure due to disease, and reconstruction of the industry with disease-resistant varieties to all-time high sugar production arising from record acre yields.



☐ Imports, in millions of pounds, for 12 months ending June 30.

▨ Domestic production, in millions of pounds, for planting in the year shown.

Fig. 3. Rapid Development of American Sugar-Beet-Seed Industry Brings Curtailment of Imports.

With the growth and functioning of an American seed industry, which is providing better seed to the American farmer than any that can be imported, and as a credit to American research and American ability to capitalize on research findings, the beet-sugar industry has freed itself from this foreign noose.

When the present European war largely cut off European supplies, the beet industry's house was nearly in order and seed supplies assured. Certainly by 1941, it is possible for all branches of the beet-sugar industry to have adequate home-grown supplies.

What appraisal is fair for the benefits that the domestic sugar-beet enterprise has contributed and will continue to contribute to our national welfare? As was not the case in the World War period, the beet-sugar industry can now, if demand for sugar requires, expand to do its part in supplying the nation's food--an impossibility 25 years ago because of the throttling effect of lack of adequate seed supply.

In direct benefits, the sugar-beet seed enterprise returns to farmers about $1,100,000 annually and a new source of farm income has been created.

PROMISING RESEARCH IN PROGRESS

Among the **numerous** projects under way but not yet practically adapted in the sense of large-scale translation into commercial practice, the work on cold tolerance of sugarcane and on black root and leaf spot of the sugar beet are examples of research that may soon be capitalized upon.

The improvement of temperate zone sugarcane to meet the hazard of unseasonably early cold has taken more definite form since the discovery in central Asia of cold-resisting wild cane in 1936. Progress has been made in overcoming the problems of cross-breeding due to the very different time of blooming of parent canes. Utilizing the reversed seasons north and south of the equator, the male parent was planted in the northern hemisphere, the female parent in the southern hemisphere, and while blooming simultaneously pollen was sent by airplane to cross-pollinate plants in the southern hemisphere. The seed was shipped by air to Washington and planted there and in Florida and Louisiana. The first-generation hybrids bloomed in the United States at a season intermediate between the two parents. To make backcrosses between the hybrids and commercial cane it was necessary to advance artificially the blooming time of the latter from late December to late September. This was accomplished by using a photoperiod house at Canal Point, Fla., a device that created autumn light conditions in summer and accelerated the blooming by three months. Thousands of the second-generation seedling will be ready for cold-resistant tests in 1940, and many are of good type and appear promising for sugar-production tests in 1941.

The traditional acceptance of the idea that the eastern sugar-beet region is one of high cost compared with the Intermountain and Pacific regions, and that the regions are unequally dependent upon protection afforded in various ways, including geographic location, may have some basis in two bugbears. These are difficulties of establishing and maintaining stands because of black root and difficulty of practical control of leaf spot, which is a problem in parts of the West also. There is no need to doubt that with intensive experimental tests of principles already well crystalized in control of black root, as seed treatments, rotations that starve the pathogenic organisms plus other field sanitation measures, and with adequate consideration of the separate needs of different districts in the humid area, the disheartening toll taken by this disease

complex can be greatly lowered. Because of local environmental differences in the districts of the humid area, a cure-all applicable everywhere should not be expected and therefore, more intensive tests are needed.

The leaf-spot-resistant sugar-beet variety U. S. 217, released in 1938, has demonstrated a high degree of resistance and under exposure to the disease has shown decisively better performance than the European brands with which it has been compared. Where leaf spot was not a factor the variety has been exceeded in root yield, and hence in sugar per acre, by certain improved tonnage types. A new leaf-spot-resistant release, U. S. 200 X 215, produces greater tonnage than U. S. 217, with practically equivalent sucrose percentage. To produce this variety, two inbred strains, which in themselves, regardless of leaf-spot-resistance, approximate European brands in performance, were intercrossed in order to take advantage of first-generation hybrid vigor. Tests in 1938 showed that the resistant variety exceeded the nonresistant check, taken as representative of European brands, by 333 pounds of sugar to the acre. The variety has as yet been produced only on a limited scale, something over 200,000 pounds of seed being available for 1939 commercial plantings.

It will be noticeable to you that the foregoing remarks have been limited to citing research activities of the Division of Sugar Plant Investigations. I am more conversant with details of those activities than with the numerous contributions to progress by others, and it is with no intention to slight their valuable basic steps, or parallel or accessory work on the same problems, that illustrations of practical adaptation of research were selected from those sponsored or vigorously pushed by the Division.

The raison d' etre of this talk is to emphasize in an impersonal way an idea that should be quickly recognized by biologists: the increasing control over living plant forms and their environments because of advances in biological and other science. Economic implications in the illustrations cited, with understanding of their extensive or limited use, are very great. The basis of the sugar industries is the mutable sugar-producing plant and very impressive are these recent demonstrations of opportunities to quickly change the character of plants in different producing areas with attendant changes in costs of production. Advances in plant breeding, unpredictable as to their impact upon the National economy, just as improvements in mechanics or chemistry, are sometimes far reaching and are likely to throw into confusion the calculations of economic planning.

REPORT ON 1939 TESTS OF U. S. 200 X 215

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By G. H. Coons, Dewey Stewart, H. W. Bockstahler, J. O. Culbertson, G. W. Deming, J. O. Gaskill, J. G. Lill, and S. B. Nuckols.

Agronomic evaluation tests were conducted in 1939 on U. S. 200 X 215 and allied varieties by members of the staff of the Division of Sugar Plant Investigations in cooperation with Experiment Stations and with other cooperators, as shown, at 10 locations. In addition, Prof. J. H. Torrie of the Wisconsin Agricultural Experiment Station, Mr. M. J. Buschlen of the Farmers and Manufacturers Beet Sugar Association and Mr. H. D. Brown of the Canada and Dominion Sugar Company, Chatham, Ontario, conducted similar tests with the varieties supplied by the Division and have given permission to include in this report the data which they obtained. Mr. G. M. Bradford of the Monitor Sugar Co. of Bay City, Michigan, conducted two tests in which U. S. 217 and U. S.

200 X 215 were compared with several European brands, and he has supplied the data for use in this report. A total of 15 tests—6 in Colorado, 1 in South Dakota, 2 in Minnesota, 1 in Wisconsin, 4 in Michigan, and 1 in Ontario—are summarized.

Comparisons in table 1, except those for Bay City, and Au Gres, Michigan, are with 'Synthetic Check', a variety obtained by pooling equal quantities of 9 European brands and using this mixture to produce seed crop. In our experience, 'Synthetic Check' has shown a performance equivalent to the best European tonnage types and superior to many brands on the market. The 1939 results bear out this opinion, and in the absence of leaf spot, "Synthetic Check" proved a very strong competitor in several localities. In the Bay City and Au Gres tests, the average of all European brands included in the test is used instead of 'Synthetic Check'.

(Table 2)

Comparisons are also shown for U. S. 200 X 215 and some locally used brand or variety usually obtained from the Beet Sugar Company in whose territory the test was conducted. In the case of the Bay City and Au Gres test the European brand highest in sugar per acre was taken as the "Local Check".

Seed of U. S. 200 X 215 as used in all 1939 tests was commercial seed grown by the Western Seed Production Corporation in Arizona. The seed was produced from a planting stock made by mixing in proportions 1:3, commercial stock seed of U. S. 200 (highly leaf spot resistant inbred, high in sucrose, moderate in yielding capacity) and stock seed of U. S. 215 (a moderately resistant inbred, moderately high in sucrose, and of very high yielding capacity).

There is no way of determining with any degree of exactness how much intercrossing took place between the two inbreds in the seed field. U. S. 200 X 215, although indicated as a hybrid, consists of some unknown percentage of hybrids, along with selfs of the two inbred strains. Some experimental evidence exists that the cross of these two inbreds gives increased productiveness, and the introduction of this variety into commercial use represents an attempt to use in a practical way any advantage which might thus accrue from hybridizing.

In general, the data as summarized in tables 1 and 2 confirm the conclusions of the 1938 tests, namely, that U. S. 200 X 215 may be used to replace European brands in common use without reduction in sugar yields and that under conditions of leaf spot exposure, the variety may be expected to forge greatly ahead.

Table 1. SUMMARY OF 1939 TESTS OF U.S. 200 X 215
Conducted by Division of Sugar Plant Investigations
and cooperators.
Comparison with 'Synthetic Check' which approximates European tonnage types.
(Actual weight basis; results given as 10-plot averages except as noted.)

1939 Location of Tests	Acre Yield (Calculated) Indic.-avail. Sugar		Acre Yield (Calculated) Roots		Sucrose		Apparent purity coefficient		Stand[4]	
	US 200 X 215	Check	US 200 X 215	Check	US 200 X 215	Check	US 200 X 215	Check	US 200 X 215	Check
	pounds	pounds	tons	tons	%	%			%	%
Colorado:										
Ft. Collins Sta.(Sprinkler)	4,343	3,742	17.69	17.20	13.81	12.51	88.9	87.1	93.8	91.1
do. College Farm	4,147	4,231	13.04	13.79	17.16	16.52	92.52	92.64	92.8	93.3
Ft. Morgan[1]	6,447	6,114	20.98	21.52	17.24	16.23	89.20	87.6	88.5	84.7
Ault	5,109	5,438	16.50	17.53	16.78	16.88	92.2	91.8	88.0	87.8
Rocky Ford (Sprinkler)	5,733	5,026	25.27	25.08	12.72	11.54	88.70	87.08	121.0	116.0
do. West Ranch	5,386	5,715	17.64	19.06	16.53	16.31	92.59	92.18	124.0	105.0
Belle Fourche, S. Dak	3,882	4,347	13.3	14.6	17.0	17.3	85.7	85.6	63.0	61.0
Crookston, Minn.[2]	(2,644)	(2,880)	10.69	11.18	12.44	12.76	----	----	84.7	88.0
Waseca, Minn.	2,851	2,792	11.05	11.70	15.46	14.48	83.45	82.36	87.4	83.0
Madison, Wisc.	3,794	3,892	12.81	12.22	17.60	18.6	84.4	84.8	101.8	97.2
East Lansing, Mich.	3,026	2,803	10.0	9.2	17.4	17.5	87.2	87.1	82.5	91.9
Saginaw, Mich.	3,756	3,055	12.95	11.98	16.23	14.57	89.61	87.8	91.0	78.1
Bay City, Mich.[2][3]	(4,041)	(3,646)	12.38	11.23	16.32	16.24	----	----	103.0	101.0
Au Gres, Mich.[2][3]	(5,404)	(4,777)	16.01	14.85	16.88	16.09	----	----	128.0	126.0
Chatham, Ont.	2,534	2,020	9.46	7.8	15.40	15.0	86.7	86.5	87.6	67.6
Average	4,206	4,032	14.65	14.60	15.93	15.50	88.43	87.71	95.8	91.4
Difference	+174		+.05		+.43		+.72		+4.4	

1/ Fort Morgan test based on 5 replications.
2/ Gross sugar.
3/ Tests at Bay City and Au Gres, Michigan had 6 replications. Mean of all commercial varieties in test used as check.
4/ Stand in percent computed on basis of 12-inch spacing.

Table 2. SUMMARY OF 1939 TESTS OF U.S. 200 X 215
Conducted by the Division of Sugar Plant Investigations
and cooperators.
Comparison with European brand or variety supplied by the local beet sugar company.
(Actual weight basis; calculated from 10-plot averages except as noted.)

1939 Location of Tests	Acre Yield (Calculated)				Sucrose		Apparent purity coefficient		Stand 4/	
	Indic.-avail. Sugar		Roots							
	US 200 X 215	Check	US 200 X 215	Check	US 200 X 215	Check	US 200 X 215	Check	US 200 X 215	Check
	pounds	pounds	tons	tons	%	%			%	%
Colorado:										
Ft. Collins Sta.(Sprinkler)	4,343	4,035	17.69	18.20	13.81	12.64	88.9	87.7	93.8	93.3
do. College Farm	4,147	4,348	13,04	13.96	17.16	16.62	92.52	93.12	92.8	91.7
Ft. Morgan 1/	6,447	6,896	20.98	22.60	17.24	17.06	89.2	89.4	88.5	85.7
Ault	5,109	5,472	16.50	18.10	16.78	16.59	92.2	91.1	88.0	89.6
Rocky Ford (Sprinkler)	5,733	4,944	25.27	21.03	12.72	13.21	88.70	89.20	121.0	120.0
do. West Ranch	5,386	5,723	17.64	17.33	16.53	17.66	92.59	92.66	124.0	111.0
Belle Fourche, S. Dak.	3,882	4,096	13.3	13.8	17.0	17.3	85.7	85.8	63.0	57.0
Crookston, Minn.2/	(2,644)	(2,464)	10.69	10.28	12.44	12.00	---	---	84.7	69.7
Waseca, Minn.	2,851	2,484	11.05	10.83	15.46	14.02	83.45	81.85	87.4	66.2
Madison, Wisc.	3,794	3,869	12.81	11.82	17.6	18.6	84.4	87.5	101.8	94.5
East Lansing, Mich.	3,026	2,540	10.0	8.5	17.4	17.1	87.20	87.05	82.5	84.8
Saginaw, Mich.	3,756	2,983	12.95	11.53	16.23	14.74	89.61	87.45	91.0	72.0
Au Gres, Mich.	(5,404)	(4,941)	16.01	14.95	16.88	16.53	---	---	128.0	125.0
Bay City, Mich.	(4,037)	(3,811)	12.382	11.52	16.32	16.55	---	---	103.0	103.0
Chatham, Ont.	2,534	2,718	9.46	9.54	15.4	16.3	86.7	87.4	87.6	79.0
Average	4,206	4,088	14.65	14.27	15.93	15.79	88.43	88.35	95.8	89.5
Difference	+118		+.38		+.14		+.08		+6.3	

1/ Based on 5 replicates.

2/ Gross sugar.

3/ Tests at Bay City and Au Gres, Michigan are based on 6 replicates. Commercial variety showing highest sugar per acre used as check.

4/ Stand in percent computed on basis of 12-inch spacing.