1942

Studies of the production of sweet potatoes for starch or feed purposes

William Duke Kimbrough

LOUISIANA BULLETIN 348. JUNE, 1942

Studies of the Production of Sweet Potatoes for Starch or Feed Purposes

BY

W. D. KIMBROUGH

LOUISIANA STATE UNIVERSITY
AND
AGRICULTURAL AND MECHANICAL COLLEGE
AGRICULTURAL EXPERIMENT STATIONS

W. G. TAGGART, *Director*

STUDIES OF THE PRODUCTION OF SWEET POTATOES FOR STARCH OR FEED PURPOSES

W. D. Kimbrough

INTRODUCTION

The Sweet Potato Starch Plant at Laurel, Mississippi, has demonstrated conclusively that high grade starch can be made from sweet potatoes. While being suitable for ordinary uses, this starch can be used in the manufacture of adhesives. The development of the sweet potato starch industry in this country has been retarded because of the competition it faced from cassava flour which has been imported and sold at a low price. The present war emergency may, at least temporarily, increase the interest in and necessitate an immediate increase in the production of sweet potato starch in this country.

Probably of greater importance than the production of starch is the potential value of dehydrated sweet potatoes as a livestock feed. Experiments are being conducted in several southern states with dehydrated sweet potatoes for farm animals and the results have been very promising. If the livestock industry in the South is to develop as it should and as it is expected to, something must be done about the feed problem. The use of the sweet potato may be the answer to a major part of this difficulty.

The methods of production of sweet potatoes for feed or starch differs from those used to produce crops for table stock. Total solid content and yield of all useable potatoes are the important factors for successful feed and starch production. If potatoes are not cracked too badly to wash easily and are not so stringy that they interfere with the machinery they can be utilized. Great care at digging time is not so essential as the potatoes are not kept for very long periods but the potatoes should be as free from dirt as possible. This means that larger yields may be obtained and cost may be reduced over that in the production of potatoes for the market or storage where very careful handling is essential.

REVIEW OF LITERATURE

There is very little available information either on the culture of sweet potatoes for starch and feed or the utilization of the sweet potatoes for these purposes. The first report of the production of sweet potato starch upon a commercial scale is that of Paine and others (6) who described

their process of the manufacture of this starch in a paper published in December 1938. Since that time some modifications have been made in the plant at Laurel, Mississippi. Guin and others (3) reported on the factors for success on starch sweet potato and general farms in Jones County, Mississippi in 1939. Their data showed that it cost 25 cents per bushel to produce sweet potatoes in that area.

Anderson (1) reported results of fertilizers for starch sweet potatoes in Mississippi. Hoffman and Lutz (4) reported work done on delayed harvest of sweet potatoes for industrial purposes. They state, "It appears practicable to harvest sweet potatoes for immediate starch manufacture as late as November 20 to 30, a month later than the usual harvesting date for sweet potatoes in the vicinity of Meridian, Mississippi." Ware (7) reported very interesting results concerning dehydration on sweet potatoes by methods that can be used on the farm. The shredded potatoes were easily air dried in the open when spread out on suitable material such as building paper. This method seems very promising.

It has been demonstrated (2, 5) that the time of planting sweet potatoes materially affects the total yield at a given date. The earlier the potatoes can be set to field without injury from cold the larger the yield.

THE PROBLEM

If starch or feed is to be made from sweet potatoes it must be profitable to both the growers and the manufacturers. The returns per acre must be profitable to the grower or he will not be interested in growing the crop, especially as it is one he may not be too familiar with. The starch mill should operate over as long a period as possible so that expensive equipment will not be standing idle longer than necessary. Therefore, information is needed on the effect of planting date and time of digging on the yield and starch content of sweet potatoes. This is important so that it may be known approximately how soon the factory may start and how far into the winter it may operate. Furthermore, spacing distance of sweet potato plants grown for industrial use is an important factor especially for earlier plantings when draws or slips are scarcer and more expensive.

The work reported in this paper was conducted to get much needed information concerning these important problems.

The Triumph variety has been used in the production of starch so far. It has been grown for a number of years as a table variety and was selected because it was the best variety for starch of which seed was readily available. No sweet potato had been selected or developed in this country because of its adaptability to starch or feed production. For this reason information concerning varieties is important.

PROCEDURE

The sweet potatoes used in these experiments were grown on the Experiment Station at Baton Rouge in a fairly uniform Lintonia silt loam soil. Plots 40 x 4 feet replicated five times were used. All plots received 400 pounds of 4-12-4 fertilizer per acre.

Dates of planting used were approximately April 10, May 10, June 10, and July 10. Potatoes were dug July 15, August 15, September 15, October 15, November 15, and December 15.

Samples for analysis were taken the day after digging. Moisture, reducing sugars, total sugars, and starch determinations were made on the samples taken.

In the spacing tests the following intervals between plants in the row were used: 12 inches, 18 inches, 24 inches, and 36 inches.

Triumph was the principal variety worked with but during the course of the experiment Porto Blanco, Wennop, and L 4-5 were also used.

Yields are given as total useable bushels per acre, for starch or feed, which includes jumbos, No. 1's and No. 2's, but does not include the strings. A bushel of sweet potatoes for this purpose is considered to be 60 pounds.

DATE OF PLANTING EXPERIMENT

As was previously stated, the date of setting sweet potato slips or cuttings to the field influences the yield of potatoes produced. Total yield is not as important when growing table stock sweet potatoes as the yield of marketable potatoes. Total yield is, however, the important factor in the production of sweet potatoes for feed or starch, for the price per bushel is lower on this type of potato and a high yield must be produced economically to give good per acre returns to the grower. Large, so-called jumbo potatoes are satisfactory and in fact the whole crop except the strings and any decayed potatoes may be used for the production of feed and starch.

The data obtained on the effect of date of planting on yield and carbohydrate content of sweet potatoes dug the middle of October are given in Table 1. These data show that the earlier the potatoes were planted the larger the yields produced. The results of these tests demonstrate that potatoes grown for manufacture of feed and starch should be planted as soon as possible after danger from cold injury is past. For south Louisiana it is recommended that the plantings be made from the middle of April to the middle of May. Yields obtained in these tests were sufficient to give a profitable return per acre at prices paid for feed and starch potatoes. There was little difference found in the sugar content of sweet potatoes when planted at different dates and there was not a great deal of difference in starch content except that the starch content tended to be lower in potatoes planted in July.

TABLE 1. Effect of Date of Planting on Yield of Sweet Potatoes Dug October 15

Variety	Date of planting	Yield in bushels per acre	Moisture per cent	Sugar—Per cent		Starch per cent
				Reducing	Total as invert	
Triumph*.....	April.....	449.4	68.7	0.15	1.75	22.2
	May.....	345.9	67.7	0.14	1.54	22.5
	June.....	239.3	68.3	0.16	1.60	22.5
	July.....	99.4	68.6	0.14	1.57	21.6
Wennop†.....	April.....	527.8	69.1	0.21	1.77	21.7
	May.....	441.5	69.6	0.24	1.71	20.9
	June.....	299.0	70.6	0.29	1.86	20.4
	July.....	156.7	72.0	0.46	1.93	18.4
L 4-5‡.....	April.....	497.6	63.74	0.71	1.71	26.5
	May.....	401.6	65.09	0.26	1.69	25.4
	June.....	316.7	66.00	0.30	1.63	24.3
	July.....	183.5	67.20	0.32	1.54	23.0

*Four year average 1938-1941.
†Three year average 1938-1940.
‡Two year average 1940-1941.

TIME OF DIGGING EXPERIMENT

For starch and feed purposes the grower is interested in obtaining a very large yield per acre therefore the plants should grow as long as possible. If this could be done all potatoes would be dug late in the season. If all the potatoes were harvested at about the same time there would be congestion in the delivery of potatoes to the mill, which would cause delays and probable spoilage of some potatoes. The mill, on the other hand, must run for as long a period as possible so as to reduce overhead and to produce more starch and utilize more potatoes. Therefore, information concerning yields and composition of potatoes dug at different times is of practical importance. Data on these questions are given in Tables 2 and 3. These data are not averaged as all digging dates were not the same every year for the different planting times.

These data show that the longer the growing season of the potatoes the higher the yields produced. For example potatoes set in April and dug the middle of August produced fair yields and the starch content was fair. Plots harvested in September gave a greater yield than those dug in the previous month. The data show that under the conditions of this experiment a growing period of four months is necessary to produce a fair yield of potatoes. For this reason the mills cannot start operations before August or probably not until September. From the growers' standpoint October and November are the best months for the harvest of sweet potatoes so far as yield is concerned. The weather is usually favorable for harvest in south Louisiana in October and part of November. As

TABLE 2. Effect of Time of Digging on Yield and Composition of Triumph Sweet Potatoes Planted at Different Times.

Date of planting	Date of digging	Yield in bushels per acre	Moisture per cent	Sugar—Per cent		Starch per cent	Pounds of starch per acre
				Reducing	Total		
1938							
April	July	217.8	74.12	0.18	1.55	18.1	2365.3
April	August	378.1	71.19	0.16	1.93	20.4	4627.9
April	October	539.2	68.61	0.17	1.79	23.1	7473.3
May	August	215.3	69.31	0.19	2.05	22.4	2893.6
May	September	346.0	68.89	0.15	1.83	23.1	4795.6
May	October	401.5	66.11	0.16	1.57	23.1	5564.8
May	November	478.5	67.56	0.16	1.86	22.3	6402.3
June	August	49.7	72.75	0.22	1.93	18.9	563.6
June	September	133.8	68.31	0.28	1.68	23.1	1854.5
June	October	237.6	65.16	0.16	1.54	24.7	3521.2
June	November	254.2	68.21	0.17	1.79	22.5	3431.7
1939							
April	July	158.5	70.32	0.21	2.06	21.1	2006.6
April	August	290.1	68.03	0.16	1.56	22.7	3951.2
April	September	379.8	70.20	0.16	2.17	19.9	4534.8
April	October	521.6	69.41	0.14	1.63	22.1	6916.4
May	August	195.0	69.42	0.16	1.50	22.9	2679.3
May	September	430.4	71.30	0.15	1.89	18.9	4880.7
May	October	426.5	68.60	0.14	1.53	22.8	5834.5
May	November	439.3	67.66	0.18	1.92	23.9	6299.6
June	September	122.2	68.41	0.15	1.67	22.5	1649.7
June	October	185.5	67.56	0.16	1.77	24.4	2715.7
June	November	290.6	69.47	1.17	1.83	22.5	3923.1
1940							
April	September	378.0	71.64	0.21	2.27	18.9	4286.5
April	October	303.0	66.74	0.15	1.57	23.1	4200.0
May	September	123.2	71.10	0.24	2.02	18.5	1367.5
May	October	236.0	66.50	0.15	1.23	23.6	3341.8
May	November	337.9	67.51	0.13	2.38	21.7	4399.5
June	September	196.1	70.67	0.20	1.72	19.5	2294.4
June	October	262.6	69.61	0.15	1.49	20.5	3230.0
June	November	363.7	69.14	0.14	2.39	19.7	4298.9

(Table 2 continued on next page)

TABLE 2. Effect of Time of Digging on Yield and Composition of Triumph Sweet Potatoes Planted at Different Times.—Continued

Date of planting	Date of digging	Yield in bushels per acre	Moisture per cent	Sugar—Per cent		Starch per cent	Pounds of starch per acre
				Reducing	Total		
1941							
April	August	292.3	68.52	0.21	2.24	21.7	3805.7
April	September	349.9	68.70	0.17	2.05	21.0	4408.7
April	October	433.7	70.00	0.12	1.99	20.4	5308.5
May	August	148.6	70.62	0.17	1.99	19.3	1720.8
May	September	228.5	71.44	0.15	1.98	19.7	2700.9
May	October	320.7	69.66	1.12	1.81	20.5	3944.6
May	November	446.2	72.92	0.16	2.05	17.1	4578.0
June	September	129.0	71.73	0.32	1.66	18.9	1462.9
June	October	271.3	71.04	0.18	1.59	20.2	3288.2
June	November	385.8	68.73	0.13	2.01	21.3	4930.5

TABLE 3. Effect of Time of Digging on Yield and Composition of L 4-5 Sweet Potatoes Planted at Different Times.

Date of planting	Date of digging	Yield in bushels per acre	Moisture per cent	Sugar—Per cent		Starch per cent	Pounds of starch per acre
				Reducing	Total		
1940							
April	September	296.3	64.34	0.63	1.97	25.1	4462.3
April	October	417.3	64.57	0.27	1.62	25.2	6309.6
May	September	190.1	66.10	0.60	1.83	22.2	2532.1
May	October	346.8	65.64	0.24	1.57	24.4	5077.2
May	November	422.2	64.40	0.20	2.46	24.2	6130.3
June	October	317.8	66.70	0.32	1.60	23.3	4442.8
June	November	476.1	66.21	0.26	2.79	21.0	5998.9
1941							
April	August	284.8	63.55	0.31	1.71	27.5	4699.2
April	September	420.6	61.88	0.28	1.63	28.7	7242.7
April	October	577.9	62.71	0.26	1.79	27.8	9639.4
May	August	166.1	63.35	0.30	1.71	27.9	2780.5
May	September	272.7	64.13	0.28	1.64	27.0	4417.7
May	October	456.4	64.53	0.27	1.81	26.4	7229.4
May	November	637.7	66.12	0.21	2.27	24.0	9182.9

earlier diggings are likely necessary from the standpoint of the mill, proportionate allotments should be made all the growers supplying the mill and these should come from early planted potatoes.

It is known that yield and composition of sweet potatoes will vary greatly with the weather conditions. The starch content in a variety of sweet potatoes may vary as much as 10 per cent. The starch content in sweet potatoes of the Triumph variety was not as high under the conditions of this experiment as has often been found elsewhere. Anderson (1) reports considerably high starch contents in potatoes of the Triumph variety grown in Mississippi.

Weather conditions in south Louisiana are usually suitable for drying of sweet potatoes in the open in September and October.

DELAYED DIGGING TEST

In connection with the time of digging test studies have been made in connection with delaying of digging time until a period after the vines have been killed by frost. At the present time it is not feasible to dig and store potatoes that are to be used for starch and feed. If, however, the potatoes could be kept in the ground and dug as needed the mills could be kept running longer. With this in mind some potatoes were not dug until the middle of December. Preliminary tests had shown that with the soil type used in these experiments and under climatic conditions of Baton Rouge the potatoes could not be held in the ground until January 15. Data obtained from potatoes planted in June are given in Tables 4,

TABLE 4. Effect of Delayed Digging on the Composition and Percentage Rot in Triumph Sweet Potatoes Planted June 10.

Year grown	Date of digging	Yield in bushels per acre	Rot per cent	Moisture per cent	Sugar—Per cent		Starch per cent
					Reducing	Total	
1938	October	237.6	0.0	65.16	0.16	1.54	24.7
"	November	254.2	0.0	68.21	0.17	1.79	22.5
"	December	269.4	0.0	68.93	0.28	3.63	20.7
1939	October	185.5	0.0	67.56	0.16	1.77	24.39
"	November	290.6	0.0	69.47	0.17	1.83	22.50
"	December	231.9	0.0	69.38	0.18	2.46	20.52
1940	October	262.6	0.0	69.61	0.15	1.49	20.52
"	November	363.7	0.0	69.14	0.14	2.39	19.71
"	December	283.9	3.6	71.37	0.16	2.94	17.60
1941	October	271.3	0.0	71.04	0.18	1.59	20.19
"	November	385.8	0.0	68.73	0.13	2.01	21.27
"	December	414.6	0.2	69.49	0.19	2.82	19.77

5, and 6. Data from July plantings were omitted as this planting date is not recommended for potatoes to be used for starch or feed.

TABLE 5. Effect of Delayed Digging on Composition and Percentage of Rot in Wennop Sweet Potatoes Planted June 10.

Year grown	Date of digging	Yield in bushels per acre	Moisture per cent	Rot per cent	Sugar—Per cent		Starch per cent
					Reducing	Total	
1938	October	307.1	68.71	0.0	0.32	1.90	21.4
"	November	370.0	70.95	0.0	0.29	1.66	23.1
"	December	390.6	70.94	0.0	0.42	4.68	17.6
1939	October	309.5	70.72	0.0	0.32	1.85	21.15
"	November	339.0	69.19	0.0	0.26	1.93	22.68
"	December	355.0	73.00	0.0	0.29	2.06	18.27
1940	October	280.4	72.37	0.0	0.36	1.83	18.45
"	November	406.6	71.93	0.0	0.33	2.82	17.73
"	December	458.8	72.21	0.2	0.36	3.22	16.65

These data show that potatoes left in the ground until the middle of December had a higher moisture content, more total sugar and less starch than those dug in October or November. Potatoes dug in November tended to have a little less starch than those dug in October. Digging conditions in December were usually bad due to the soil being muddy. The percentage of rotten potatoes varied somewhat from year to year but was not high in any year. This might have been higher in potatoes that had been planted earlier.

It is believed that digging should not be put off until December. The mills might prefer, however, to run with inferior potatoes rather than not run at all.

TABLE 6. Effect of Delayed Digging on Composition and Percentage Rot in L 4-5 Sweet Potatoes Planted June 10.

Year grown	Date of digging	Yield in bushels per acre	Moisture per cent	Rot per cent	Sugar—Per cent		Starch per cent
					Reducing	Total	
1940	October	317.8	66.70	0.0	0.32	1.60	23.27
"	November	476.1	66.21	0.0	0.26	2.79	20.97
"	December	348.5	68.64	2.0	0.46	3.75	19.35
1941	October	315.5	65.30	0.0	0.27	1.66	25.32
"	November	433.6	66.84	0 0	0.25	2.32	23.43
"	December	468.7	66.71	0.7	0.31	2.98	22.50

SPACING TEST

As best yields are obtained from sweet potato plants set to the field as early as possible after danger from cold is over, the spacing distance of plants is important, because plants are scarcer and more expensive early in the season. For starch and feed large sized potatoes are not undesirable, and may even be preferable. This means that spacing for these purposes can be different from that used in growing potatoes for food purposes. To get some information on this subject a spacing test was run. The data obtained are shown in Table 7.

TABLE 7. EFFECT OF PLANTING DISTANCE ON THE YIELD OF TRIUMPH SWEET POTATOES DUG IN OCTOBER.

Date of planting	Inches spacing	YIELD IN BUSHELS PER ACRE			
		1939	1940	1941	3-Yr. Ave.
April*	12	521.6	307.3	424.3	417.7
	18	466.5	303.0	433.7	401.1
	24	456.5	440.0	380.9	419.3
	36	387.9	388.9	368.3	381.7
May*	12	426.5	220.3	362.7	336.5
	18	477.9	236.0	320.7	344.9
	24	413.6	202.0	338.6	318.1
	36	376.9	205.4	343.5	308.6
June†	12	185.5	289.1	295.8	256.8
	18	173.4	262.6	271.3	235.8
	24	237.2	252.2	246.9	245.4
	36	148.3	209.1	201.9	186.4

*No significant differences in yield for 3-year average.
†23.0 bu. required for significance at the .05 point for 3-year average.

No significant differences in yield were found in the three year average for the different spacing used in this test when plants were set to the field in April or May. Plants spaced 36 inches apart produced significantly lower yields than those from other spacings used when the plants were set in June. The data indicate that slips may be set two feet or even three feet apart in the rows and not materially affect the yield when set to the field at the proper time. Replanting, if not delayed, may be more important and more effective than where closer spacing is used because of the larger interval between plants.

VARIETIES

During the course of this experiment four varieties of sweet potatoes were used, although Triumph was the principal one and was considered to be the standard. Porto Blanco, a mutation of the Porto Rico, was grown for two years, but it was found to be inferior to Triumph in starch content and was not superior in yielding ability. The Wennop

variety was tested for three years. Potatoes of the latter variety were reported by Paine and others (6) to have a higher starch content than in those of the Triumph variety. This was not found to be true under the conditions of these experiments for the Triumph potatoes were usually as high or higher in starch content than those of the Wennop variety. The Wennop was found to be in general a better yielding variety than the Triumph. The main difficulty with the potatoes of this variety is that they contain a relatively large amount of latex or milky material. When this material dries it retains soil which is very difficult to wash off and is injurious to the machinery in a starch plant.

For the last two years the seedling L 4-5, developed by Dr. Julian C. Miller of this Station, has been tested. For a comparison of the variety Triumph and the seedling L 4-5 the data in Table 3 and the 1940 and 1941 part of Table 2 may be used. This seedling has been very promising indeed. The L 4-5 has been found to be not only as good a yielder as the Triumph but better as a late variety. Furthermore potatoes of this variety have consistently had a higher starch content than those of the Triumph. It is realized that two years is not a long enough time to be certain about the yielding capacity of a variety, but the present indications are that the L 4-5 will likely replace the Triumph as a starch and feed variety.

It should be pointed out that until very recently no attempt had been made in this country to breed for sweet potatoes especially adapted to starch or feed purposes. A successful method for obtaining true seed from sweet potatoes in the continental United States was worked out by Dr. Julian C. Miller and has made an extensive breeding program possible. Since 1939 the U. S. Department of Agriculture and several southern experiment stations have been conducting a cooperative program from which may be expected improvement in both table stock and starch and feed potatoes. This means that we may expect a variety that will be superior to L 4-5. As past experience has shown, in general the better a variety is, the more difficult for the plant breeder to improve on it.

CONCLUSIONS

The results that are given show that high yields of sweet potatoes produced for feed and starch purposes are dependent on cultural practices. This may be especially important during war times when certain imports are cut off or restricted. More starch per acre can be produced from sweet potatoes than from any other crop grown commercially in this country. This is also true for carbohydrate livestock feed. The highest yields can be obtained by setting plants to the fields as soon as possible after danger from cold injury has passed. In south Louisiana this means that slips should be set from April 15 to May 15. However, at this time plants are scarce and expensive. As large potatoes are preferable for starch and feed manufacture, early plants can be set farther apart than would be suitable for potatoes grown for table use. For this reason spacings two to three

feet apart are recommended. Experimental data show that it is doubtful if profitable yields can be produced in growing periods shorter than four months. The results of these tests show that the longer the potatoes can grow the larger the yields. However, for the mills to run over as long a period as possible the digging of the potato crop must extend over as long a period as possible. This can be arranged between the mill managers and growers so as to be fair to all concerned. From experience and tests, diggings more than a month after a killing frost are very likely to give inferior potatoes.

Tests to date show that the seedling L 4-5 is very promising and seems likely to replace Triumph as a starch and feed variety. In the future improved seedlings may be expected from the present breeding program.

LITERATURE CITED

1. Anderson, W. S. Fertilizer for starch sweet potatoes. Miss Agr. Expt. Bul. 367. 1942.

2. Beattie, J. H., V. R. Boswell and E. E. Hall. Influence of spacing and time of planting on the yield and size of the Porto Rico sweet potato. U.S.D.A. Circ. 372. 1934.

3. Guin, Marvin, D. W. Parvin, and A. J. Huff. Factor for success on starch sweet potatoes and general farms in Jones County, Mississippi, 1939. Miss. Agr. Expt. Sta. Bul. 352. 1940.

4. Hoffman, Geo. P. and J. M. Lutz. Preliminary results on delayed harvest of sweet potatoes for industrial purposes. Amer. Soc. Hort. Sci. 39: 303-307. 1941.

5. Miller, J. C. and W. D. Kimbrough. Sweet potato production in Louisiana. La. Agr. Expt. Sta. Bul. 281. 1936.

6. Paine, H. S., F. H. Thurber, and R. T. Balch. Manufacture of sweet potato starch in the United States. Indus. and Eng. Chem. 30; 1331-1343. 1938.

7. Ware, L. M. Drying sweet potatoes. Ala. Agr. Expt. Sta. Hort. Dept. Mimeo. No. 7. 1942.