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SUGAR BEET EXPERIMENTS  
DURING 1899.

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By ALFRED J. McCLATCHIE.

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Tucson, Arizona, December, 1899.

**Arizona Agricultural Experiment Station**

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**EXPERIMENT STATION,  
Tucson, Arizona.**

## SUGAR BEET EXPERIMENTS DURING 1899.

By *Alfred J. McClatchie.*

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The experiments with sugar beets have been confined during the past year to the Station farm near Phoenix. The principal object in mind was to gather data upon the irrigation of the crop. Other points involved in the experiments were the determination of the best time to sow the seed, the definite limits of the season of satisfactory germination of the seed, the best time to harvest the beets, and the changes that take place in the beets as they remain in the soil during the latter part of the summer,

### AUTUMN-SOWN PLANTS.

The beets sown September 21, 1898, were harvested March 30, 1899. The period from November 1 to February 10 had been unusually unfavorable for the growth of any kind of vegetables. As a result, the beets had not attained a proper size when the warm weather of spring caused them to begin to blossom. The experience of the past two seasons shows that the beets started before the cool weather of December and January will begin going to seed during the latter part of March or early April, regardless of the size then attained. If the weather during the five or six months previous to that time is not too cool, a satisfactory root growth will be made before the tendency to put forth blossoms takes possession of the plants. The results from these autumn-sown beets were as follows; Average weight of beets, 8.3 ounces; yield of beets per acre, 7.9 tons; per cent sugar in beets, 11.5; purity coefficient, 79.8. If the beets had grown to the size they did during the preceding more favorable winter, the stand was sufficiently good for satisfactory tonnage. While waiting for them to reach a fair size, many of them began sending up seed stems. This probably accounts for the low sugar percentage.

Beets sown during October and November, 1898, made such a slow growth that they were not harvested. A sowing made during December, 1898, previous to cool rainy weather resulted in such a poor stand that the plat was plowed and resown during January.

#### WINTER-SOWN PLATS.

During January and February, 1899, about an acre of fine adobe soil was sown. The characteristics of this soil, as determined last year by the chemist, were as follows: Maximum water capacity, 57.62 per cent; per cent of material finer than 0.5 mm. (1-50 inch) in diameter, 99.82; per cent of humus, 1.56; per cent of nitrogen, 0.09. Two of the ten plats into which the acre was divided were sown to Vilmorin and the remainder to Klein Wanzlebener. The first sowing was made January 18, about the close of the rainy season, in soil irrigated and plowed during October, but not subsequently irrigated before planting.

The rest of the acre was thoroughly irrigated through furrows two feet apart just before being plowed for seeding. The soil became so thoroughly and deeply saturated by this method that the plowing and seeding were delayed some time, the intention having been to seed during early February. When the soil had dried sufficiently to bear a team, a harrow was run crosswise of the furrows filling them with the drier soil of the intervening ridges, and thus preventing the baking and cracking so characteristic of adobe soils. When it was plowed and harrowed, there were fewer clods than if the land had been flooded in accordance with the prevailing custom in the region. Two sowings were made, one February 13, and one February 26. The seeding was done with a Superior four-row drill.

All the ten plats of the acre were cultivated as nearly alike as practicable, their treatment differing principally in the times of irrigation\*. One object was to determine how early beets sown in moist, heavy soil during cool weather needed irrigation; and a second object, to determine how many subsequent irrigations were necessary.

Plat 1, sown January 18, was sampled June 12, giving the following results: Average weight of beets, 114 ounces; yield of beets per acre, 11.5 tons; per cent of sugar in beets, 12.8;



*Beet Plats, Near Phoenix, Arizona, May 16, 1899.*

purity coefficient, 79.2.

All the plats were sampled four times after the foregoing date. At the time of the first two samplings, the tonnage was computed. In each case, a considerable portion of each plat was dug, the beets counted and weighed to determine average weight and yield, and a fractional part sent to the chemist for analysis. Plats 2, 3, 4, and 5 were located where beets were grown the previous year; while the remainder of the plats were upon adjacent land that had been occupied by alfalfa until a few months before seeding to beets. Hence the results from the four mentioned are to be compared among themselves only, but are not comparable with the results from the remaining six plats. The results from the ten plats are shown on page 267.

#### EFFECT OF PREVIOUS CROP

Plats 2-5 inclusive gave lower yields than plats 6-10 sown later. This was due evidently to the fact that beets had been grown upon the former during the previous year, while the previous crop on the others was alfalfa. There seems to be no other reason why the two adjoining plats 5 and 6 treated very nearly alike after seeding should give different results. The beets of plats 2-5 had nearly two weeks start of plats 5-10, but were overtaken by the latter in about two months. The previous crop seems to have affected the character of the beets less than the yield; the average, however, being some higher from plat 6 than from the adjoining plat 5.

#### EFFECT OF TIME OF SEEDING.

The beneficial effect of early seeding is shown in the results from plat 1 sown January 18. The beets of this plat had made such a growth by the time those sown in similar soil February 26 were up, that they attained a much larger size before being checked by the hot weather of June. There seems to have been no other reason for the yield being so much greater than in plats 9 and 10, for example. The important point, as shown by the result, is to get the beets started as early during the cool weather as practicable, that as much growth as possible may be made before the hot summer weather. It will be

TABULAR RECORD OF PLATS.

| Plat.    | Date of seeding. | Date of first irrigation. | Date of second irrigation. | Date of third irrigation. | June 26.                         |                       |                             |         | July 29.                         |                       |                             |         | August 10.                          |                             | September 20. |                             |         |
|----------|------------------|---------------------------|----------------------------|---------------------------|----------------------------------|-----------------------|-----------------------------|---------|----------------------------------|-----------------------|-----------------------------|---------|-------------------------------------|-----------------------------|---------------|-----------------------------|---------|
|          |                  |                           |                            |                           | Average weight of beets. Ounces. | Yield per acre. Tons. | Per cent of sugar in beets. | Purity. | Average weight of beets. Ounces. | Yield per acre. Tons. | Per cent of sugar in beets. | Purity. | Available sugar per acre in pounds. | Per cent of sugar in beets. | Purity.       | Per cent of sugar in beets. | Purity. |
| 1        | Jan. 18          | Mar. 3                    | April 10                   | May 5                     | 14.0                             | 14.6                  | 12.7                        | 82.4    | 18.5                             | 18.0                  | 13.0                        | 84.6    | 3850                                | 12.7                        | 79.3          | 10.4                        | 77.5    |
| 2        | Feb. 13          | May 7                     | .....                      | .....                     | 6.0                              | 5.5                   | 14.2                        | 79.5    | 6.4                              | 6.5                   | 15.0                        | 73.1    | 1235                                | 14.8                        | 75.4          | 9.8                         | 68.6    |
| 3        | "                | Mar. 29                   | May 30                     | .....                     | 5.4                              | 4.8                   | 15.7                        | 88.5    | 5.5                              | 5.8                   | 17.2                        | 80.2    | 1510                                | 15.2                        | 77.1          | 13.0                        | 71.4    |
| 4        | "                | "                         | 20 June 28                 | .....                     | 7.1                              | 7.3                   | 12.5                        | 77.5    | 7.0                              | 7.2                   | 14.3                        | 70.3    | 1195                                | 15.1                        | 80.9          | 12.5                        | 70.2    |
| 5        | "                | May 8                     | .....                      | .....                     | 7.1                              | 7.2                   | 15.2                        | 81.9    | 7.0                              | 7.2                   | 15.9                        | 72.0    | 1415                                | 13.8                        | 72.5          | 11.1                        | 62.4    |
| 6        | Feb. 26          | May 5                     | .....                      | .....                     | 8.0                              | 8.8                   | 14.7                        | 79.9    | 9.6                              | 9.6                   | 16.0                        | 79.7    | 2305                                | 14.4                        | 75.6          | 14.0                        | 79.0    |
| 7        | "                | 20                        | .....                      | .....                     | 8.8                              | 8.8                   | 14.9                        | 83.4    | 8.9                              | 8.9                   | 17.0                        | 83.5    | 2615                                | 14.7                        | 77.8          | 13.5                        | 75.0    |
| 8        | "                | 20                        | .....                      | .....                     | 8.9                              | 10.2                  | 11.9                        | 76.6    | 9.0                              | 10.3                  | 15.6                        | 75.0    | 2145                                | 12.3                        | 74.1          | 11.4                        | 70.9    |
| 9        | "                | 5 June 15                 | .....                      | .....                     | 8.0                              | 10.9                  | 12.9                        | 84.9    | 8.0                              | 11.0                  | 14.9                        | 74.3    | 2155                                | 14.3                        | 78.7          | 13.5                        | 74.4    |
| 10       | "                | April 10                  | May 29                     | June 15                   | 10.4                             | 10.4                  | 11.3                        | 79.5    | 11.0                             | 11.0                  | 11.4                        | 74.8    | 1670                                | 12.2                        | 67.9          | 12.0                        | 78.6    |
| Averages |                  |                           |                            |                           | 8.46                             | 8.95                  | 13.6                        | 81.4    | 9.1                              | 9.74                  | 15.0                        | 77.1    | 2010                                | 14.0                        | 75.9          | 12.1                        | 72.3    |

seen from the results from plat 1 that beets started in January will be ready for factory user early in June,

#### EFFECT OF IRRIGATION.

Plat 1 was irrigated whenever it gave indications of being much in need of water. Notwithstanding the fact that it was sown during a cooler time than the remaining plats, the first need occurred a much less number of days after seeding than in the case of others. This was due to the fact that the soil was not artificially irrigated just before seeding, and illustrates the importance of so doing.

Three plats—3, 4 and 10—were irrigated just after being thinned. The results compared with adjoining plats irrigated later indicate that this early watering did not benefit the beets but rather, on the whole, injured them. The effect of irrigation is best seen by a comparison of the approximate yields of sugar per acre.

The highest yield of sugar from the February-sown plats is from plat 7 irrigated but once—May 20th—when the beets were about three months old. Plat 10, irrigated three times, gave a heavier yield of beets, but they were comparatively poor in quality, and the yield of sugar was less than two-thirds that of plat 7. With one exception, all of the plats irrigated for the first time during May, gave better results than the same planting irrigated earlier. Judging by these results, beets growing in heavy soil irrigated before sowing should not be irrigated until they are from two to three months old.

#### CHANGES IN QUALITY.

The changes that occurred in the quality of the beets, as indicated by the chemist's analyses, are shown in the following table:

|                         | June 26. | July 29. | Aug. 10. | Sept. 20. |
|-------------------------|----------|----------|----------|-----------|
| <i>Plat 1</i>           |          |          |          |           |
| Sugar in beets.....     | 12.7     | 13.0     | 12.7     | 10.4      |
| Purity coefficient..... | 82.4     | 84.5     | 79.3     | 77.5      |
| <i>Plat 2</i>           |          |          |          |           |
| Sugar in beets.....     | 14.2     | 15.0     | 14.8     | 9.8       |
| Purity coefficient..... | 79.5     | 73.1     | 75.4     | 68.6      |

|                  |   |      |      |      |      |
|------------------|---|------|------|------|------|
| <i>Plat 3</i>    |   |      |      |      |      |
|                  | Sugar in beets .....                      | 15.7 | 17.2 | 15.2 | 13.0 |
|                  | Purity coefficient.....                   | 88.4 | 80.2 | 77.1 | 71.4 |
| <i>Plat 4</i>    |   |      |      |      |      |
|                  | Sugar in beets.....                       | 12.5 | 14.3 | 15.1 | 12.5 |
|                  | Purity coefficient.....                   | 77.5 | 70.3 | 80.9 | 70.2 |
| <i>Plat 5</i>    |   |      |      |      |      |
|                  | Sugar in beets .....                      | 15.2 | 15.9 | 13.8 | 11.1 |
|                  | Purity coefficient.....                   | 81.9 | 72.0 | 72.5 | 62.4 |
| <i>Plat 6</i>    |   |      |      |      |      |
|                  | Sugar in beets.....                       | 14.7 | 16.0 | 14.4 | 14.0 |
|                  | Purity coefficient.....                   | 79.9 | 79.7 | 75.6 | 79.0 |
| <i>Plat 7</i>    |   |      |      |      |      |
|                  | Sugar in beets .....                      | 14.9 | 17.0 | 14.7 | 13.5 |
|                  | Purity coefficient.....                   | 83.4 | 83.5 | 77.8 | 75.0 |
| <i>Plat 8</i>    |   |      |      |      |      |
|                  | Sugar in beets .....                      | 11.9 | 15.6 | 12.3 | 11.4 |
|                  | Purity coefficient.....                   | 76.6 | 75.0 | 74.1 | 70.9 |
| <i>Plat 9</i>    |   |      |      |      |      |
|                  | Sugar in beets .....                      | 12.9 | 14.9 | 14.3 | 13.5 |
|                  | Purity coefficient.....                   | 84.9 | 74.3 | 78.7 | 74.4 |
| <i>Plat 10</i>   |   |      |      |      |      |
|                  | Sugar in beets .....                      | 11.3 | 11.4 | 12.2 | 12.0 |
|                  | Purity coefficient.....                   | 79.5 | 74.8 | 67.9 | 73.6 |
| <i>Averages.</i> |   |      |      |      |      |
|                  | Sugar in beets .....                      | 13.6 | 15.0 | 14.0 | 12.3 |
|                  | Purity coefficient .....                  | 81.4 | 77.7 | 75.9 | 72.3 |
|                  | Yield of sugar per acre<br>in pounds..... | 1860 | 2090 | 1870 | 1460 |

It will be observed that the beets, as a whole, were at their best during the latter part of July. From then on deterioration occurred, the crop containing September 20 but about two-thirds of the available sugar that was present July 29. For a reason that does not seem apparent, the average purity coefficient was considerably higher June 26 than July 29 when the beets contained a greater percentage of sugar. This would indicate that the absorption of salts during this period was much more rapid than the formation of sugar. The slight increase in size and the decided increase in sugar content caused, however, about 12 per cent increase of the available sugar per acre. In only two cases did the purity coefficient increase during July,—that of plat 1 which received water as it seemed to be needed, and that of plat 7 which gave the highest yield of sugar of any of the February-sown plats. It would be indicated by this that in beets growing normally the purity increases with the sugar content.

These results indicate that in our climate the desired qualities of beets are present in a winter-sown standing crop from about the middle of June to about the middle of August, and that it would be advisable to have all beets dug by the latter date,

#### LIMITS OF SEEDING SEASON.

The possibility of growing beets from seed sown during spring and summer was again tested. A plat in heavy adobe soil sown and irrigated April 10 gave, August 10, the following results:—Yield per acre, 7.8 tons; per cent sugar in beets, 14.8; purity 79.7; available sugar per acre, 1750 pounds.

Seed sown in an adjoining plat June 1 failed to germinate. The same plat sown October 5 did well until devastated by grasshoppers. Seed sown September 12 in a gravelly loam germinated well and at the close of the year were growing quite thriftily. Seed sown during December germinated satisfactorily, but as the first leaves appeared above the surface of the soil, many were killed by frost, as was the case the previous year. Beets that have formed a few leaves after the first pair, have endured all the low temperatures that have occurred here during the past two years, but the young seed-leaves do not endure heavy frosts. If the temperature falls below 26° at the soil surface the latter are injured, while older beets have frequently endured 15 to 20° during the past two years. Consequently it is hardly practicable to secure a good stand of beets here from seed sown during December and early January.

The results of the experiments of this year and last show that beet seed will not germinate satisfactorily in our climate from early May to the middle of September. While the maximum temperature of each day is above 105° F., a stand of beets cannot be secured. Some of the seed may germinate, but the most of it will not, and any young plants that appear soon succumb to the heat. Difficulties are encountered in securing a stand during weather when the maximum temperature is much above 95° P. Thus it is now definitely settled, as a result of our experiments, that summer-planting of beets is impracticable in southern Arizona.

Between the middle of September and the middle of May there is no serious difficulty in getting beet seed to germinate satisfactorily. During the early and the latter part of this period it is necessary to irrigate the seed row, in order to bring the beets up. The best method is to furrow the field as the seed is sown, and irrigate at once. From November to March seed germinates without irrigation, if the field has been irrigated previous to plowing and the seed be sown promptly after the soil is prepared. The best time to secure a good stand is from about the middle of January to about the end of February. Just previous to this time, some of the young plants are liable to be killed by frost, and later than this there is danger of the surface of the soil drying before germination occurs.

The facts concerning the germination of beet seed in the vicinity of Phoenix may be summarized as follows:

January 1 to 15—seed germinates, but danger from frost

January 15 to 31—seed germinates well, little danger from frost

February 1 to 15—an excellent time to sow seed.

February 15 to 28—a fairly good time to sow seed.

March 1 to 15—somewhat difficult to secure stand.

March 15 to 31—seed needs to be irrigated up.

April—seed still germinates well if irrigated.

May—difficult to secure a good stand, even with irrigation,

June to September—impracticable to secure a stand of

sugar beets.

September 1 to 15—difficult to secure a stand.

September 15 to 30—good stand can be secured with irrigation.

October—stand can be secured with irrigation.

November 1 to 15—somewhat difficult to secure a stand without irrigation,

November 15 to 30—seed germinates without irrigation, but danger of frost.

December—seed germinates, but young plants apt to be killed by frost.

## SUMMARY OF RESULTS.

1. The yield is lower in a field that has been occupied by beets the previous year.

2. The best results from winter-sown beets were obtained from a sowing made during the latter part of January. In heavy soil fair results are secured from seed sown as late as early April.

3. Winter-sown beets are not benefited and may be injured, by early irrigation, provided the soil has been irrigated previous to seeding. The best results were secured from plats irrigated when the beets were two to three months old.

4. Winter-sown beets improve in quality until the end of July, after which they ordinarily steadily deteriorate, making it important that they be harvested during August or before.

5. Autumn-sown beets begin blossoming by early April regardless of the size then attained, and consequently must be harvested before that time. September sowings give fair results, provided the following winter be mild.

6. Beet seed germinates fairly well at any time from the middle of September until May. During the remainder of the year it is impracticable to secure a stand, a daily maximum temperature of over 95° F. reducing the number of seeds that germinate, and a daily maximum temperature of over 105° preventing germination or killing the young plants.

7. From December to March a good stand can be secured without irrigation of the seed row; during the remainder of the germinating period mentioned irrigation of the seed is necessary.

8. The young seed-leaves of beets will be killed by temperatures below 26° to 28° F. at the surface of the soil; while older beets endure minimum temperatures of as low as 12° to 15° F.