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SUGAR BEET EXPERIMENTS.

BY
ROBERT H. FORBES.

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Arizona Agricultural Experiment Station.

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EXPERIMENT STATION,
Tucson, Arizona.

SUGAR BEET EXPERIMENTS IN ARIZONA.

By Robert H. Forbes.

The establishment of a beet-sugar factory at Eddy, New Mexico, on one hand, and at Chino and Los Alamitos, in Southern California, on the other, has naturally led the people of Arizona to inquire as to the possibility of growing paying crops of sugar beets in the irrigated valleys of the Territory. In response to this demand for information, the Station, in the spring of 1897, through the efforts, particularly of Director Devol, undertook to ascertain the behavior of the sugar beet under our conditions of soil, irrigation and climate.

With this end in view, the co-operation of about three hundred farmers in various parts of the Territory was secured, and seed of standard varieties, mostly Vilmorin and Klein Wanzlebener, obtained from the Department of Agriculture at Washington, was supplied, along with directions for preparation of the soil, planting, and care of the growing plants. In Salt River Valley these directions were supplemented with regular inspections of the test plots by members of the Station force, who made suggestions from time to time. Carefully conducted experiments were also carried out on the Sub-station grounds near Phoenix, and similar work was attempted at Tucson.

As the beets matured they were sent to the chemical laboratory of the Station at Tucson for examination. In Salt River Valley most of the samples were collected by Dr. Claflin, foreman of the Phoenix Sub-station, who was careful to send representative samples of mature beets, as judged by the age and appearance of the plants. After washing, the sample lots, consisting of about ten beets each, were wrapped in oiled paper to prevent wilting, and sent by express to the laboratory, where they usually arrived in perfect condition on the following day. To places which could not be visited in this way. careful instructions were sent for taking and forwarding samples, which, as a rule, were received in good condition.

At the laboratory, the samples were weighed, the tops cut off, each beet quartered lengthwise, the sample quarters grated

and the juice expressed from the grated sample for examination with spindle and polariscope. The methods used, in brief, were those commonly employed in commercial work and the results are to be compared with those obtained at the factories. 167 samples were analyzed during the season and the results, excepting a few which were rejected for good reasons, appear in the following table.

EXPLANATION OF THE TABLE.

This table states the more important facts in the history of the samples received, and their average weight, richness and purity.

"Sugar in juice" is determined by the polariscope, this method being used because of its quickness.

"Sugar in beets" is found in this table by multiplying "sugar in juice" by the factor .925. This factor represents the average percentage of juice found in a number of Arizona samples, The factor .95 is more commonly used From the deduced percentage is calculated the value of beets as they are weighed at the factory.

By "purity" is meant the ratio of pure sugar to total solid substances estimated in the juice by means of a spindle. For instance, if the polariscope reveals 12 per cent of cane sugar and the spindle 15 per cent of total solids in solution, the purity will be 12-15, or 80 per cent. A high degree of purity is essential, because mineral salts, and other substances not sugar, prevent at least an equal weight of sugar from crystallizing during manufacture.

Acceptable beets should contain not less than 12 per cent of sugar with a purity not under 80, Good quality is usually associated with small sized beets, averaging 1½ pounds or less. An ideal acre containing 40,000 1¼ pound beets would yield 25 tons, which is, however, about twice the quantity commonly realized in this country with fair conditions.

In the table those samples of sufficient purity, richness, and size to make a profitable crop with a good stand are printed in italics.

TABLE OF ANALYSES.

Sample No.	Name and Address of Grower.	Variety of Beets Grown.	Date of Planting.	Date of Harvesting.	Remarks.	Previous Crop.	Weight of Beets.		Sugar in Juice.	Sugar in Beets.	Purity.
							lbs.	oz.	per ct.	per ct.	per ct
1567	*Fowler Bros., Phoenix*	*Unknown*	*Feb. 12*	*June 12*		*Alfalfa.*		*12*	*15.2*	*14.1*	*76.7*
1599	Ex. Sta. 2, "	Wohanka, No. 2	April 2	Aug. 16	Best care.	"		12	11.3	10.5	69.6
1600	" " " "	" " 1	" "	" "	" "	"		13	12.6	11.7	75.4
1601	" " " "	White Silesian	Mar. 23	" "	" "	"		4	12.3	11.4	68.9
1602	" " " "	Carters Sugar Cane,	" "	" "	" "	"		7	14.6	13.5	76.4
1603	" " " "	Klein Wanzlebener	" "	" "	" "	"	1	1	10.7	9.9	65.5
1604	" " " "	Vilmorin Ameliore	" "	" "	" "	"		7	14.3	13.2	76.6
1605	" " " "	Klein Wanzlebener	" "	" "	" "	"	1	6	11.3	10.5	71.5
1606	" " " "	Lemaire	" 22	" "	" "	"		14	11.1	10.3	67.3
1607	" " " "	Lane	" 23	" "	" "	"	1	3	10.8	10.0	65.9
1608	" " " "	Klein Wanzlebener	" 22	" "	" "	"	1	13	8.5	7.9	61.1
1609	" " " "	Vilmorin	" "	" "	" "	"		13	10.2	9.4	66.0
1610	" " " "	Blahoticer	April 2	" "	" "	"	1	2	8.0	7.4	55.5
1611	" " " "	Vilmorin	" "	" "	" "	"		12	10.4	9.6	68.4
1612	*Myers Bros,* "	*Klein Wanzlebener*		*Aug. 17*	*Medium care*	"		*8*	*15.3*	*14.1*	*85.1*
1613	W. B. Green, "	Vilmorin	May 5	" "	No care	"	1	9	6.7	6.2	59.0
1614	Doc. Searcy, "	Klein Wanzlebener	Feb. 15	" "	" "	"	1	9	8.9	8.3	59.0
1615	" " "	" "	Mar. 10	" "	" "	"		15	12 5	11.6	71 7
1616	Fowler Bros, "	" "	Feb. 15	" "	Medium care	"	1	14	12.5	11.5	72.1
1617	" " "	Vilmorin	April 6	" "	" "	"	1	1	7.4	6.9	59.3
1618	" " "	"	Mar. 29	" "	" "	"		11	6.6	6.1	61.8
1619	" " "	"	" "	" "	" "	"	1	2	7.1	6.5	61.3
1620	Ariz. Imp. Co, Glendale	"	April 15	" 18	Best care	Virgin	1	10	4.5	4.2	44.8
1621	" " " "	Klein Wanzle bener	May 7	" "	" "	"	1	3	8.8	8.1	67.5
1634	" " " "	Vilmorin	Mar. 4	" 19	" "	"	2	4	5.5	5.1	51.5
1622	Byron Bliss, "	"	" 1	" 18	Medium care	Alfalfa.	1	14	5.6	5.2	46.6

TABLE OF ANALYSES.—CONTINUED.

Sample No.	Name and Address of Grower.	Variety of Beets Grown.	Date of Planting.	Date of Harvesting.	Remarks.	Previous Crop.	Weight of Beets.		Sugar in Juice.	Sugar in Beets.	Purity.
							lbs.	oz.	per ct.	per ct.	per ct
1623	Isaac Eyer, Glendale	Vilmorin	Mar. 8	Aug. 18	Medium care	Alfalfa.	1	8	6.7	6.2	52.3
1624	S. B. Stoner, "	"	" "	" "	" "	"	1	9	8.1	7.5	60.3
1625	J. W. Forney, "	White French	Feb. 21	" "	" "	"	2	0	6.2	5.7	59.9
1626	" " "	Vilmorin	April 1	" "	" "	"	1	2	8.1	7.5	67.4
1628	V. E. Messenger, "	"	Mar. 15	" "	No care.	Virgin	2	3	3.3	3.0	34.1
1629	R. P. Pierce, "	"	" 12	" 19	" "	Grain.	1	10	4.0	3.7	36.8
1630	J. H. Byer, "	"	.....	" "	" "	.....		10	4.6	4.3	35.9
1631	H. B. Lehman, "	"	" 10	" "	" "	Alfalfa.	1	8	6.6	6.1	51.9
1632	A. Boyd, "	"	" 15	" "	Medium care	Garden.	1	8	5.9	5.5	56.3
1633	I. Miller, "	"	" 10	" "	No care	"	1	5	5.6	5.2	45.8
1635	Henry Jennings, Peoria	"	" 8	" "	" "	Virgin	1	1	6.0	5.6	49.5
1636	J. McMillan, "	"	April 11	" 20	Medium care	Alfalfa.	1	4	7.7	7.1	64.6
1637	Geo. Copp, Glendale	"	Mar. 15	" "	No care.	Garden.		12	7.0	6.5	58.7
1638	" " "	"	April 15	" "	" "	Virgin		5	4.7	4.3	44.3
1639	" " "	Yellow kind	.....	" "	" "	"	1	2	3 0	2.8	33.6
1640	D. E. Terrell, "	Vilmorin	.....	" "	" "	Garden.		7	9.0	8.3	64.8
1641	Glendale Imp. Co. "	"	.....	" "	.....	Alfalfa.	1	4	4.1	3.8	32.0
1642	Jessie Forsythe, "	Klein Wanzlebener	Mar. 24	" "	Medium care	Grain.	1	1	9.3	8.6	67.7
1643	A. H. Smith, "	" "	.....	" "	" "	.....		6	13 3	12.3	74.2
1644	Geo. Christie, Phoenix	" "	.....	" "	No care.	Garden.		8	7.4	6.9	60.8
1645	C. C. Green, "	" "	April 8	" "	" "	Alfalfa.		7	13.0	12.0	68.4
1646-47	W. Scott, Scottsdale	" "	Mar. 25	" 23	Medium care	Grain.	1	2	7.1	6.6	61.7
1650	" "	" "	" 26	" "	.....	"		4	6.7	6.2	61.5
1648-49	Geo. Blount, "	" "	April 10	" "	Best care.	Virgin		4	12.3	11.4	78.1
1651	Rev. Blaney, "	Vilmorin	.....	" "	Medium care	"		4	14.5	13.4	80.1
1653	J. T. Priest, Tempe	Klein Wanzlebener	.....	" "	No care.	Alfalfa.	1	4	11.3	10.5	77.1

1654	J. T. Priest, Tempe	Klein Wanzlebener..	.....	Aug. 23	No care.	Alfalfa.	2	0	7.2	6.7	66.8
1652	T. C. Jordan, Phoenix	" " ..	May 20	" "	Medium care	Virgin	.....	.....	.....	.....	.....
1655	F. A. Hough, Tempe	Vilmorin.....	April 4	" "	No care.	Garden		12	6.5	6.0	56.5
1662-63	Daniel Kloss, "	"	" —	" 24	Medium care	.....		14	6.5	6.0	55.5
1656	C. M. Smith, Yuma	Klein Wanzlebener....	Mar. 29	" 28	.....	.....	1	12	9.6	8.9	65.8
1657	" " "	Lemaire.	April 6	" "	.....	.....	1	7	10.6	9.8	73.2
1658	G. Cosner, Tempe.	Vilmorin.....	May 10	" "	No care.	Alfalfa.		8	7.8	7.2	63.6
1659	Frank Tyler, Thatcher	Klein Wanzlebener....	April 16	" "	.....	.....		4	11.9	11.0	74.0
1660	" " "	Lemaire.	" "	" "	.....	.....		6	13.7	12.7	76.9
1661	" " "	Vilmorin.....	" "	" "	.....	.....		9	12.1	11.2	73.7
1664-65	J. Jungerman, Tempe	Vilmorin Improved .	April 15	" 24	Medium care	Virgin	2	1	6.3	5.8	53.1
1666	" " "	" "	" "	" "	" "	"	3	12	2.9	2.7	33.1
1667	" " "	" "	" "	" "	.....	.....	3	14	2.5	2.3	32.3
1668	" " "	" "	" "	" "	.....	.....	5	7	2.8	2.6	29.8
1669-70	H. L. Duffey, "	" "	.....	" "	No care.	Alfalfa.	1	4	4.5	4.2	46.7
1671	W. S. White, "	Vilmorin.....	Mar. 23	" "	" "	"		13	6.1	5.6	51.4
1672	G. S. Johnson, "	Klein Wanzlebener....	Mar. 1	" "	" "	"	1	10	5.7	5.2	54.2
1674	V. Gant, "	Vilmorin Improved...	April 23	" "	" "	.....		5	9.3	8.6	67.1
1675	C. H. Rich, "	" "	Mar. 24	" "	" "	Garden.	1	5	6.4	5.9	58.0
1676	" " " "	" "	April 7	" "	" "	"		15	7.0	6.5	54.3
1677-78	G. W. Nichols, "	" "	April 17	Aug. 25	" "	"	1	5	5.6	5.2	53.8
1679	C. A. Corbell, "	" "	April 20	" "	" "	"		7	7.7	7.1	54.4
1680	D. T. Hibbert, Mesa	" "	Mar. 20	" "	" "	"		4	7.5	6.9	49.9
1682	Noah Brimhall, "	" "	May 1	" "	" "	"	1	3	6.0	5.6	51.5
1683	Chas. Dana, "	" "	.....	" "	" "	"		12	4.7	4.3	34.8
1684-85	Eli Openshaw, "	" "	....	" "	" "	Alfalfa.	1	2	6.3	5.8	57.0
1688	F. Sanders, Lehi.....	" "	Mar. 27	Aug. 26	Medium care	"	2	1	7.0	6.5	60.9
1689-90	" " "	" "	May 6	" "	" "	"	1	4	7.5	6.9	65.7
1691	A. W. Sharp, Mesa	" "	Mar. 15	" "	No care.	"	1	2	6.8	6.3	55.8
1692	A. J. Chandler, "	Klein Wanzlebener.....	" "	" "	Best care.	Grain.	1	2	11.9	11.0	73.9
1693 94	" " " "	Vilmorin.....	" "	" "	" "	"	1	2	9.8	9.1	70.5
1695-96	" " " "	Klein Wanzlebener ...	" "	" "	" "	"	1	10	12.2	11.3	76.3
1698	J. M. Cosby, "	Vilmorin Improved...	May 20	" "	No care.	Garden.		8	4.1	3.8	47.6
1697	J. E. Bettler, "	" "	Mar. 20	" "	Medium care	.....		6	10.7	9.9	79.2
1700-01	V. E. Allison, "	Vilmorin..... ...	April 7	" "	Best care.	Garden.		9	9.7	9.0	69.7
1702	M. R. Moore, Arizola	Vilmorin Improved...	April 3	" "	.....	.....		9	10.0	9.3	63.9

TABLE OF ANALYSES.—CONTINUED.

Sample No.	Name and Address of Grower.	Variety of Beets Grown.	Date of Planting.	Date of Harvesting.	Remarks.	Previous Crop.	Weight of Beets.		Sugar in Juice.	Sugar in Beets.	Purity.
							lbs.	oz.	per ct.	per ct.	per ct
1703	L. E. Redden, Tempe	Vilmorin Improved...	Mar. 20	Aug. 26	No care.	Alfalfa.		9	15.7	14.5	73.1
.....	Tucson Exp't. Station	All kinds.....	" 13	" 31	.....	.....		15	8.6	7.9	60.2
.....	" " "	" "	May 19	" "	.....	.....		5	13.2	12.2	75.5
1718	G. S. Marable, Yuma	Klein Wanzlebener...	April 8	" "	.....	.....	5	0	8.6	7.9	61.8
1719	" " " "	" "	" "	" "	.....	.....	1	6	11.4	10.6	68.0
1720	" " " "	Lane's Improved.....	" "	" "	.....	.....	5	4	4.3	3.9	40.5
1721	" " " "	" "	" "	" "	.....	.....	1	7	12.2	11.3	70.6
1724	J. R. Potts, Buckeye	Unknown.....	May 1	Sept. 7	.....	.....		8	11.9	11.0	73.2
1725	H. W. Blaisdell, Yuma	"	.....	" 9	.....	.....	6	2	8.2	7.6	61.2
1726	*A. T. Prather, Duncan*	*Vilmorin Ameliore..*	*May 7*	" "	.....	.....	*1*	*9*	*13.4*	*12.4*	*75.2*
1727	Yuma H. Fruit Ranch	Unknown	.....	" 11	.....	.....	2	0	9.3	8.6	56.0
1728	P. M. Smith, Arizola	Klein Wanzlebener...	Mar. 22	" 14	.....	.....	1	5	7.2	6.7	57.6
1729	B. Perkins, Thatcher	Lemaire.	April 13	" "	.....	.....	1	15	9.2	8.5	68.4
1740	*J. McNeil, Show Low*	*Klein Wanzlebener...*	*May 16*	.....	.....	.....	*1*	*5*	*12.1*	*11.2*	*80.0*
1746	S. D. Smith, Snowflake	" "	" 7	.....	.....	.....		12	13.2	12.2	74.7
1747	R. Romeo, Tombstone	Vilmorin Ameliore	.....	.....	.....	.....	2	10	11.0	10.2	71.7
1748	" " "	Klein Wanzlebener....	April 1	.....	.....	.....	2	1	11.5	10.6	72.8
1749	*A. Shupp, Skull Valley*	*Vilm'n & Kl'n Wanz.*	*May 15*	.....	.....	.....		*14*	*13.3*	*12.3*	*80.5*
1753	W. LeBaron, Florence	Vilmorin Improved...	April 3	.....	.....	.....	1	0	8.9	8.2	64.6
1754	*C.P.Anderson,St Johns*	*Klein Wanzlebener..*	*April 30*	.....	.....	.....		*15*	*15.5*	*14.3*	*82.6*
1757	*J. McLaws, St. Joseph*	" "	*May 1*	.....	.....	.....	*1*	*4*	*16.3*	*15.1*	*81.0*
1760	John Wise, Ft. Thomas	" "	.....	.....	.....	.....		5	13.3	12.3	78.4
1762	J. K. Rodgers, Pima	Unknown.....	.....	.....	.....	.....		11	6.4	5.9	58.2
1763	*E. D. Solomon, Taylor*	Klein Wanzlebener....	*May 1*	*Oct. 1*	.....	.....		*13*	*13.0*	*12.0*	*79.6*
1766	J. J. McKoin, Mojave	Lemaire.	" "	" "	.....	.....	1	0	9.5	8.8	71.0
1767	" " " "	Klein Wanzlebener....	" "	" "	.....	.....	1	8	9.5	8.8	69.8

									lbs.	oz.	per ct.	per ct.	per ct
1768	*M. Pederson, St. Johns*	*Klein Wanzlebener....*	*May*	*1*	*Oct.*	*7*	....	....	*1*	*15*	*12.1*	*11.2*	*79.7*
1774	G. Scott, Dudleyville	Vilmorin..................	April	9	"	15	....	....		15	9.5	8.8	68.1
1776	W. G. Scott, St. Johns	Klein Wanzlebener....	May	1	"	"	....	....	1	13	12 2	11.3	76.1
1777	Rogers Br., Snowflake	" "	"	7	"	16	....	....		7	17.7	16.4	90.6
1779	E. Jones, St. Johns.....	" "	"	1	"	15	....	....	1	2	12.2	11.2	70.9
1801	F. F. Ingersoll, Rillito	Unknown..............	....		....	.....	....	....		15	12.3	11.4	77.4
1802	*J. Pearce, Snowflake*	*Klein Wanzlebener...*	....		....		....	....	*1*	*4*	*16.5*	*15.2*	*87.3*

DISCUSSION OF THE TABLE.

At first sight the above results are very largely discouraging, but careful analysis, and allowance for certain unfavorable conditions, will reveal some hopeful features. In the first place, the experimental plots were all small, and in most cases the stand was poor, so that numerous insects devoted themselves with sad effect to the tender leaves of a few plants. It is stated that any cause which destroys leaf surface hinders the development of a high percentage of sugar, since sugar is formed in the leaves in increasing proportion as the plant becomes mature. It is known, in this connection, that isolated beets, or even those in the outside rows of a field, contain less sugar than those from less exposed positions in the center of a field. Larger plots and better stands, other things being equal, would doubtless show better quality in our beets.

EFFECT OF CARE.

In order to call attention to the effect of proper cultivation upon the quality of the beets, those samples collected by Dr. Claflin in Salt River Valley were divided into three sets consisting of those which had received most care, some care, and little or no care, respectively. In order that the comparison should be more reliable it was made upon the Klein Wanzlebeners and Vilmorins separately, as follows:

Showing Effect of Care	*Average weight of Beets*	*Sugar in Juice.*	*Sugar in Beets.*	*Purity.*
	oz.	per ct.	per ct	per ct.
Klein Wanzlebeners·				
Receiving most care, 7 samples	19	10 81	10 00	70.8
" medium " 5 "	15.6	11.47	10.61	73.3
" least " 6 "	16.6	9.81	9 07	66.2
Vilmorins				
Receiving most care, 7 samples	17.1	9.19	8.50	65.8
" medium " 15 "	19 3	7.71	7.23	62.4
" least " 26 "	14.9	6.51	6.02	53.1

This summary plainly shows that those beets receiving little or no attention are much inferior to the others in richness and purity, though, for reasons to be noticed, even the best of care did not produce satisfactory results.

This only confirms the well known fact that industry and skill are essential in beet culture,—more so, probably, than in the production of any other great staple. This is especially true in irrigated regions, where the conditions are unusual, and ordinary methods of culture must be modified.

EFFECT OF VARIETY.

The above table also shows that the quality varies conspicuously with the variety of beet. The Vilmorins are seen to be inferior to the Klein Wanzlebeners in every class, both as to richness and purity. 49 samples of Vilmorins, and 18 samples of Klein Wanzlebeners were received from Salt River Valley and the averages were:

	Average Weight.	*Sugar in Juice*	*Sugar in Beets.*	*Purity.*
	oz.	per ct.	per ct.	per ct.
Klein Wanzlebeners, 49 samples	18.2	10.48	9.69	65.5
Vilmorins, 18 samples	16.9	7.19	6.65	57.2

In a few instances Vilmorins have done better than Klein Wanzlebeners grown side by side with them, but as a rule the German beets appear to do better with us than their French rivals. A few samples of other varieties, Wohanka, Lemaire, White Silesian, and Carter's Sugar Cane, have also been received, but not in sufficient number to lead to definite conclusions.

In the United States, the Klein Wanzlebeners seem generally most popular. Recent letters from the factories give them the preference at Watsonville, Cal.; Lehi, Utah; Eddy, New Mexico; and on "light dry soils" at Los Alamitos, Cal. At Norfolk and Grand Island, Neb., equal value is given to the Dippe la Plus Riche, and Horning's Improved varieties, while at Los Alamitos it is stated that Vilmorins give better results on "heavy, moist, alkaline soils."

EFFECT OF CLIMATE.

It appears that most of the good samples received came from the more northerly or elevated points in the Territory, including St. Johns, St. Joseph, Holbrook, Duncan, Snowflake,

Taylor, Show Low, Thatcher, Mojave, Skull Valley, Tombstone and Ft. Thomas.

Selecting the Klein Wanzlebeners received from these places and comparing them with those obtained from Phoenix, Glendale, Tempe and Mesa, in the Salt River Valley, we obtain the following comparison:

Showing Effect of Climate.	*Average weight of Beets*	*Sugar in Juice.*	*Sugar in Beets.*	*Purity.*
	oz	per ct.	per ct.	per ct.
Klein Wanzlebeners				
From more northerly or elevated localities 14 samples.	18	13 35	12 35	78 8
From Salt River Valley, 18 samples	18 2	10.48	9.69	69 5

Knowing the great influence of temperature upon the composition of the beet. it is difficult to lay these differences in favor of more elevated or northerly localities to any other cause than the cooler climate of these places. Most of the plantings in Salt River Valley were made in March and April, so that the beets were subject to hot weather almost throughout their history. An average mean temperature of about 70° F, during the summer months is stated to be best for beet culture in Europe, although successful crops are raised in this country at higher temperatures. The average mean monthly temperatures for Phoenix, Prescott and Fort Thomas during several years past are shown in the following table. Phoenix is in the Salt River Valley, Prescott represents the cooler northern parts of the Territory from which beets were received, and Fort Thomas is in the fertile, irrigated portion of Graham County in Southeastern Arizona.

Month	*Jan.*	*Feb.*	*Mar.*	*Apr.*	*May*	*June.*	*July.*	*Aug.*	*Sept.*	*Oct.*	*Nov.*	*Dec*
Mean temperature, — degrees Fahrenheit.												
Phoenix	49	54	61	67	74	82	90	88	80	70	61	55
Prescott	34	38	44	51	39	66	74	72	65	54	42	39
Ft. Thomas.	47	48	55	61	70	79	86	83	75	62	49	44

From this it appears that in the Salt River Valley the climate through June, July, August and September, is, so far as we now know, too warm for beet culture. It is, however, quite possible to avoid much of the extreme summer heat by early planting. One of our best samples, No. 1567 on the large list, was planted Feb. 12th and it is probable that in certain localities the danger from frost would not prevent earlier sowings than this. Even very young beets will stand a little frost. It is stated in Bulletin 44 of the Nebraska Station that their young plants, some of them just coming up, stood 4.2 degrees of frost without harm, and it is generally admitted that the beet plant is less injured by temperatures below the normal than by those above.

At Prescott the temperatures through May, June, July, August and September approach very closely those of some of the best beet raising countries, and without doubt explains the better quality of our samples from Northern Arizona. It is to be regretted that the irrigated valleys of this region are mostly small and remote from railroads.

At Fort Thomas, also, beginning with March, there are about four months of good beet weather with possibilities of a longer season. Scarcely anything is known of the behavior of beets here, but it would be worth while to ascertain, since the upper Gila Valley has railroad connections.

EFFECT OF SOIL.

It is more difficult to show any connection between the quality of beets produced and the many varieties of soil upon which they were grown- The analysis, however, of a series of twenty representative Salt River Valley soils, recently completed, reveals the general chemical character of the soils of this region. The following statements may be made concerning the more important soil constituents, namely, potash, lime, phosphoric acid, nitrogen, and humus.

Potash is everywhere present in abundance. We have found from .47 to 1,96 per cent in our samples, the lowest figure being ample for a fertile soil.

Lime, also, is present in great plenty, the samples showing

from .57 to 4.20 per cent.

Phosphoric acid is usually present in sufficiency, though never very abundant. In some cases a serious lack has been noticed. The average for the Valley is .13 per cent.

Nitrogen, however, is deficient almost everywhere, the average being .048 per cent, and in only two cases rising above .10 per cent, which, depending upon certain conditions, is considered to be a needful amount to insure nitrogen fertility. Humus, also, as is the case with all arid soils, is contained in scant quantity, averaging .70 per cent for the series.

For the remedy of these defects, no more practical method can be used than growing leguminous crops on the land, such as alfalfa, clover, cow peas and others. This class of plants is instrumental in taking nitrogen from the air and converting it into compounds which in part finally remain in the soil. The roots and stubble, or the whole plant if used as green manuring, yield humus when they decay, while the numerous roots penetrate and loosen the earth, thereby fitting it to support subsequent crops with better success. It is a matter of experience with many farmers of this region that desert land should be planted to alfalfa before attempting other crops, an observation which to some extent bears out the results of chemical examination. In order to note the effect of alfalfa grounds upon sugar beets, all those samples grown upon virgin desert soil were compared with those from ground which had previously been in alfalfa. The figures for the Vilmorin variety only, were numerous enough to afford a comparison:

Vilmorins.	*Weight of Beets.*	*Sugar in Juice.*	*Sugar in Beets.*	*Purity.*
Averages.	oz.	per ct.	perct.	perct
From virgin soil, 10 samples	21 3	6 01	5 56	52 3
From alfalfa soil, 21 samples	17.6	7.83	7.24	60.2

The above differences in sugar and purity, favoring beets from alfalfa ground, are very possibly due to the beneficial influence of this crop upon the chemical and physical character of the soil.

Alkaline salts vary, according to their nature, in their effects upon beets Observations made by the California Station upon experimental crops grown at Chino and at Tulare indicate that although common salt is injurious to quality, alkaline carbonates and sulphates may be present in large amount without hindering the production of excellent beets, both as to richness and purity.

Salt River Valley is not excessively alkaline, probably much less so than the Pecos Eiver Valley in New Mexico, where the industry is now under way. The adverse effect of alkali with us, if any, will doubtless be found due to the hard crust which it causes at the soil surface, especially with lack of proper cultivation, and which is destructive to young plants at the time of first coming up. This is doubtless partly responsible for the poor stands reported by many of those raising experimental sugar beets in Arizona this year. It is said that poor stands are also encountered in the Pecos River Valley. It is stated in this connection that night irrigation prevents the formation of a hard crust and aids in overcoming the difficulty.

FACTORY CONSIDERATIONS.

It must be remembered, however, that the successful culture of sugar beets is not the only condition essential to the establishment of a factory in a given locality. Cheap fuel, limestone of exceptional purity, and an abundant supply of excellent water, containing as little as possible of soluble salts, are all of nearly as much importance as the supply of sugar beets themselves.

All these essential conditions being happily met, there are various other considerations having more or less influence upon the establishment of a factory. The feeding of beef and dairy stock, and of hogs and sheep, with the extracted sugar beet pulp is a dependent industry of much importance. In the neighborhood of a factory, this supply of provender would be a valuable addition to the stock-feeding resources of, for instance, the Salt River Valley, and would give additional impetus to what is already one of the most profitable industries of that region.

It is intended to obtain definite information upon the practical points named above, in connection with our future work on sugar beets.

CONCLUSIONS.

Finally, it must be stated that in spite of the redeeming facts pointed out in this discussion, the results for 1897 are not very encouraging. It is instructive in this connection to compare our figures with those obtained by co-operative experiments similarly carried on by other experimental stations. The following table, which is revised for this purpose from Bulletin 15 of the Washington Experiment Station, affords this comparison:

State.	Season.	No. of Bulletin.	No. of Samples.	Av. Sugar in Beets.	Average Purity.
Indiana	1891	39	65	12.3	78.1
Michigan	1891	82	39 Counties	13.2	86.3
Wisconsin	1890-92	55	59 "	11.8	76.0
Minnesota	1892	27	109	14.2	83.3
Missouri	1891	17	62	10.0	64.0
Kansas	1891	31	147	10.0	72.3
Nebraska	1891	21	53	13.6	81.5
Wyoming	1893	17	33	16.2	80.9
Oregon	1891-93	23	160	13.2	79.5
Washington	1894	15	1544	15.2	83.8
Arizona, Klein Wanzlebener Samples	1897	26	32	11.8	73.6

It is seen by this table that after rejecting all figures excepting those for Klein Wanzlebener beets, which seem best suited to our conditions, we still stand pretty low in the list of states, Missouri and Kansas, however, falling below us in average richness and purity of beets. If, however, our year's work has enabled us to notice such wide variations in the quality of beets, due to variety, cafe, soil, and climate, it is more than probable that it will be worth while to continue our effort and make the most of those advantages which our experience has shown us to possess. The Station proposes to so continue with the work and will be guided by the following facts noted in the discussion:

1. In order to lessen the unfavorable effects of insects upon the quality of the beets, large plots of about one acre

each should be planted.

2. If possible, the care of these plots should be in the hands of a skilled beet agriculturist.

3. With reference to temperature, cooler locations and early planting must be carefully considered.

4. Klein Wanzlebeners, so far as now known, yield best results in Arizona.

5. Alfalfa ground should be selected in preference to virgin soil.

Through these suggestions we believe that the Station, and others, will have better results to report next year.