TEXAS AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 38.

MARCH, 1896.

CANAIGRE,

THE NEW TANNING PLANT.

Agricultural and Mechanical College of Texas.

POSTOFFICE:
COLLEGE STATION, BRAZOS CO., TEXAS.

All Reports from this Station are sent free to farmers of the State on application to J. H. CONNELL, DIRECTOR, P. O. College Station, Texas.

AUSTIN:
BEN C. JONES & CO., STATE PRINTERS.
1896

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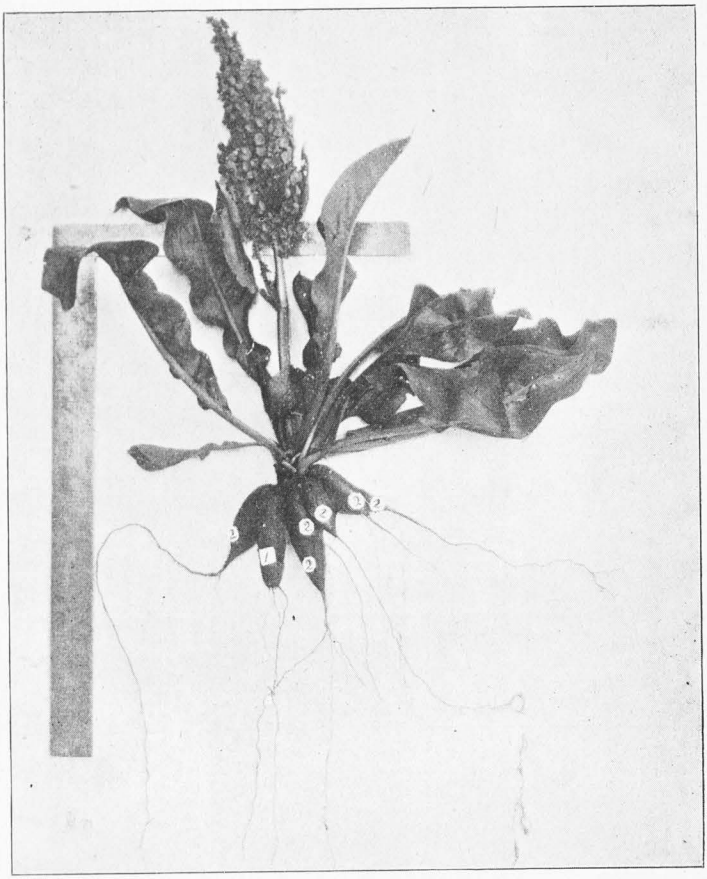

Fig. 1. Canaigre plant near end of first year's growth, showing complete root system.
1, seed root; 2, 2, etc., first crop of new roots.

Note.—Figures 1, 2 and 3 are by kindness of the Arizona Experiment Station.

CANAIGRE, THE NEW TANNING PLANT.

BY H. H. HARRINGTON AND DUNCAN ADRIANCE.

It is now about ten years since this plant first received important consideration; the first car load of the root having been shipped in 1887 from Tucson, Arizona, by Mr. R. J. Kerr, who has, since that time, become largely interested in the commercial development of the cultivated plant. But the Mexicans seem to have known of the tanning power of the root for a century or more; and they and the Indians made common use of it as a medicine, gathering in the wild state, but making no attempt to cultivate it and develop its great commercial value. The plant has before this been frequently described, and its appearance has become somewhat widely known; still, it is best to give again

A BRIEF DESCRIPTION.

It belongs to the same family as the common *Dock* (*Rumex Crispus*); itself being classified as *Rumex Hymenosepalus*. It will appear above ground in late fall or early winter, if there is moisture sufficient for its growth; although in dry climates it does not usually make an appearance until the last of January of first of February, and the top reaches maturity in March or April, after which it soon dies down. The roots continue to increase in tannic acid until it has reached at least eighteen months' growth. But it will probably be better, in the cultivated plant, to gather the year-old roots, as the increase of tannin after this time is not sufficient to justify the use of the land. The roots consist of a mass of tubers that grow in clusters, in very much the same way that sweet potatoes grow, which they very much resemble, both externally and in cross section, except the canaigre root is generally longer, 6 to 8 inches, and not so thick, maximum about 2½ inches, according to age. The cultivated roots, especially, are smooth on the surface, light yellow to dark brownish red in color, according to age. The cross-section shows nearly the same colors, usually one or more concentric rings separating the lighter exterior portion from the darker interior. In my first experience with the plant, I was inclined to believe that the amount of coloring matter was an approximate measure of the tannic acid present, but I afterward found this to be a mistake, both for older roots in comparison with each other—or in comparing different varieties. But differences in color will distinguish old roots from young ones.

The root in the green state is somewhat harder, though not very much, than a sweet potato. But as it dries, it gets hard, until it becomes even harder than the soft woods, shrivels up and loses a part of its tannic acid. If it undergoes fermentation in drying, there is a great loss of acid. Therefore, except in very dry climates, great care must be taken in drying even the sliced root, whether by the sun's heat or by artificial means.

PROPAGATION.

The canaigre bears seed, but not very many, and propagation has so far been made from the tubers; still, the plant may be grown from the seed (see Bull. 18, p. 41, N. M. Sta.), the sprout producing the first year a single root, requiring two years for a commercial crop.

Our analyses are based upon the field experiments of Mr. R. J. Kerr, whose comparatively long experience with Canaigre eminently qualifies him for co-operative work of this kind. The information which follows with reference to planting, cultivation and marketing is based upon his experience; as familiarity with the crop increases, it is to be expected that slight changes and improvements will be made in its development, but we believe this to be the most reliable information that can now be obtained applicable to the Coast country.

PLANTING.

Plow the ground thoroughly 6 or 8 inches deep, then harrow with a disc harrow, and finish with an Acme or common-tooth harrow, the idea being to get the ground well pulverized and smooth; bed up after the manner of bedding for sweet potatoes—beds 36 inches apart. Plant the whole root, 10 inches apart in the drill, and as shallow as possible, not over 2½ to 3 inches deep. In this way one car load of 12 tons, selected root, will plant 50 acres. The New Mexico Station advises the use of old roots for planting.

Planting should be done, to get an average yield, from May 15 to September 15, the earlier after the 15th of May the better the yield will be. Plant the roots in drills, either with an Aspinwall potato planter or by hand; cultivate four to six times during the season, or as often as necessary to keep the soil loose and free from weeds and grass.

Yield per Acre.—"Much depends on the selection of seed roots for planting, time in which they are planted, preparation of land before planting, and care taken of the crop after planting, what the yield will be. From my own experience, one pound to the stand, or plant, of new roots, one year's growth, is the lowest possible average. This would yield, in beds three feet apart and ten inches in drill, 17,640 pounds. This yield can be doubled if all the above points are strictly observed."

Cost of Raising per Ton, Green.—With improved machinery now on the market, such as planters, diggers, cultivators, etc., Canaigre can be raised at a cost not to exceed $2 per ton, placed in warehouse or f. o. b. cars.

Market Value of the Sliced and Dried Root.—"The sliced and dried Canaigre from the wild root, which is of all ages, from one year to ten years and over, varies in color from a light yellow to a very dark red (the older the roots, the more coloring matter they contain), are worth on the European market from eight English pounds ($40, about) per ton, upward, depending on the quality and condition of the material."

The Cultivated Canaigre.—The cultivated Canaigre in South Texas, one year's growth, is of a bright yellow color, being all of the same age, and will command a better price, and is more sought after, owing to the fact that it contains a higher percentage of tannin, with less coloring matter than the wild root.

Fig. 2. Canaigre plant at end of second year's growth.
1, seed root; 2, 2, etc., first crop of young roots; 3, 3, etc., second crop of young roots.

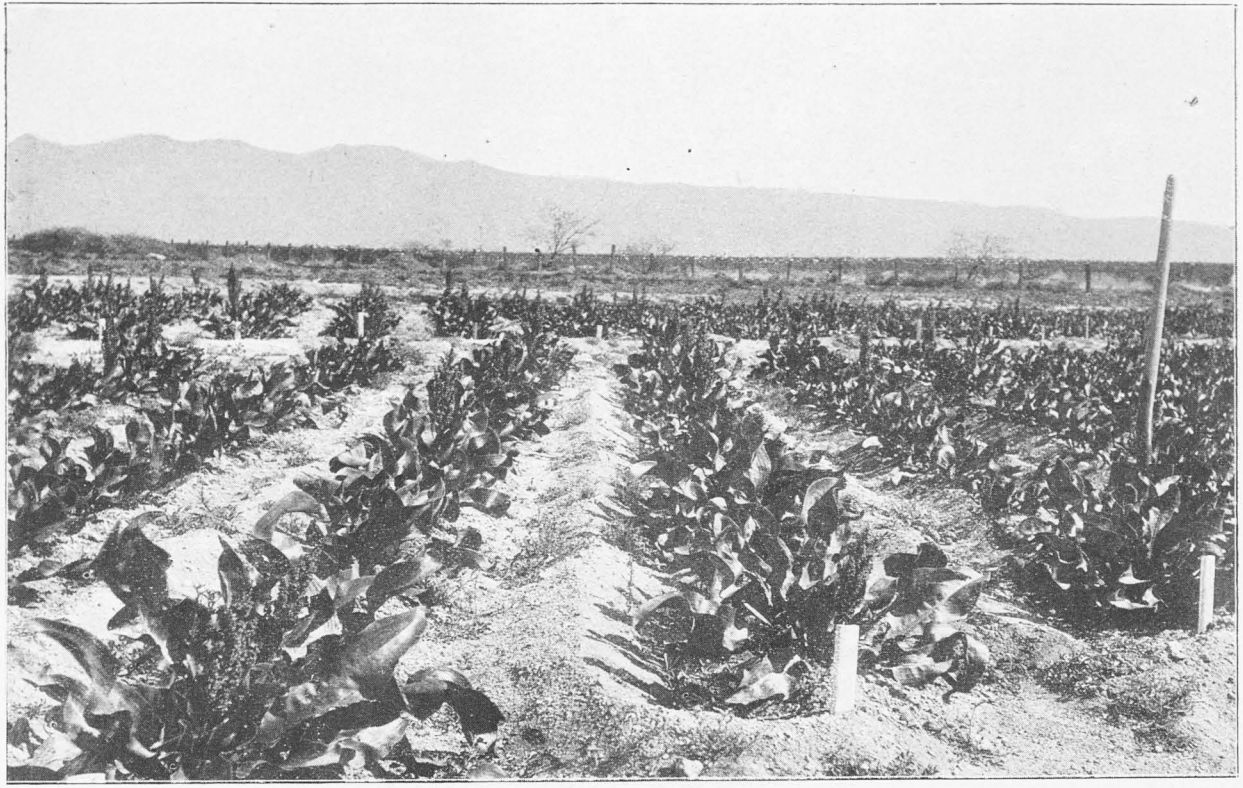

Fig. 3. View of irrigated canaigre plots, taken March 20, 1896, in blossoming season.

Freight Rates from Monahans, Ward County, to European ports—Liverpool, Hamburg and Havre—is $12 to $13 per ton; from Houston, the rate would not exceed $8 per ton.

Cost of Drying.—As before stated, the roots can not be shipped in the green state; they must be either sliced and dried or a concentrated extract made of the tannin. The cost of Mr. Kerr's slicing and drying machine, complete, to slice and dry fifteen tons of green root a day, was to him a little over $2000. The slicing machines alone cost from $125 to $300 at the factory. He writes me that in West Texas "the cost of slicing, drying and sacking is high, everything being so inconvenient, and will average about $1.60 to the ton of green root; whereas, if one has the cultivated, in East Texas, with a drying kiln and warehouses conveniently located, the cost would not exceed 75 cents per ton of green root." On account of the cost of slicing and drying, especially the latter, the farmer of small means can not undertake the cultivation of the crop, except in co-operation with others. One man could establish a slicer and dryer and depend mainly upon the surrounding farms for his supply of plant. Mr. Kerr expects to establish a dryer at Hockley, on the Houston and Texas Central Railroad, above Houston, and take the crop of the farmers, within a radius of 25 or 30 miles, at $5 per ton green; supplying wild seed root at cost, delivered at the nearest station of the party ordering, in car load lots. In this way, several farmers would order together a car of the seed root and pay their proportional share of the expenses. The slicing cuts into chips about one-twentieth of an inch thick, which must be dried at a low temperature and somewhat rapidly to prevent fermentation and loss of tannin.

Extract Factories would cost considerably more than slicing and drying machines; but, once in operation, their work would be more satisfactory. Centrally located, buying the Canaigre from surrounding farms, after the manner of central beet sugar factories, the extract factory could be handled entirely as a manufacturing enterprise.

Effect of Temperature in Drying.—To show the effect of drying at different temperatures, the following tests were made:

No. 1, dried at 150 degrees, Fahrenheit, gave 15.75 per cent of acid.

No. 1, dried in open air, gave 15.84 per cent. In this case there seems to have been no less of acid at 150 degrees.

No. 2, dried at 175 degrees, Fahrenheit, gave 13.75 per cent of acid.

No. 2, dried at 212 degrees, gave 13.75 per cent of acid.

No. 2, dried at 120 degrees, gave 19 per cent of acid. In this case there was great loss at 175 or 212 degrees; not only loss, but when dried at 120 degrees the sample retained its pure yellow color, and the tannin was much more readily dissolved. The above tests were made in a kiln dryer on a commercial scale. We then made the following tests in the laboratory:

Samples dried at the temperature of boiling water (212 degrees Fahrenheit): Sliced and allowed to pack in a beaker while drying, No. 22 gave 26 per cent; No. 23, 24 per cent; No. 24, 23.2 per cent. Dried in the open air, spread on paper, the samples gave, in the order named above, 27.3 per cent, 28.5 per cent, 29.4 per cent. It seems, therefore, that both in the kiln and laboratory dried, there is a loss of acid if the temperature is much above 150 degrees Fahrenheit; and while this temperature is safe, 120 degrees is better, provided the increased cost of drying at this

Fig. 4. View of canaigre slicing machine, owned by R. J. Kerr, Monahans, Texas.

Table of Analyses of Canaigre Root—continued.

Number of material.		Where Grown.	Per cent of acid in dried root
27	Six months old; from cultivated roots; grown on new land without fertilizer.	Pomona Plantation	21.5
28	Twelve months old; crown on cotton land	do	25.6
29	Two years old; grown on Galveston Island	do	13.4
30	One year old; grown on Galveston Island	do	10.8
32	Cultivated from wild root; left in ground two years; grown eight miles south of Houston on the G. H. & S. A. R. R.		20.7
33	Cultivated from cultivated roots; one year old; same locality as 32.		29.0
34	Cultivated from wild roots at Almada, eleven miles southwest of Houston; ground not sufficiently drained for canaigre.	Almada	14.5
35	Planted January, 1895; dug June, 1895	Pomona Plantation	19.9
36	Planted February 20, 1895, dug June, 1895	do	16.2
37	Two years old; from wild root on cotton ground	do	18.7
38	Two years old; from wild root	do	24.9
39	One year old; from cultivated roots; from same location as Nos. 37 and 38.	do	24.8
40	Cultivated one year; from nursery	Nursery, Victoria County	11.7
41	Cultivated one year	Florida	27.0
42	Cultivated ten months	do	25.8
43	Fermented and spoiled; sample had been ground.		
44	Delivered by H. C. Orr, Kansas City; stated it to be from cultivated roots of Eddy, New Mexico.	New Mexico	12.4
45 46	Both from cultivated roots; planted in February, 1895; did not show tops until March, and were dug in August.	Pomona Plantation	23.4
47	Eleven months old	do	25.3
48	Wild root; age unknown	Monahans	11.5
49	Wild root; age unknown	do	24.0
50	Wild root; age unknown	do	17.0
51	Wild root; old root	do	15.7
52	Wild root; age unknown	do	24.0
53 54	Wild root; mixture of different ages	do	14.6
†55	Wild root; age unknown	do	11.7
56	Wild root; age unknown	do	17.0
57	Wild white root; age unknown	do	13.6
58	Wild root; six to seven months old	do	14.6
59	Wild root; three years old and over	do	22.6
60	Wild roots mixed; from three months to three years old.	do	14.6
61	At least twelve years old; wild root; no small roots attached.	do	20.0
62	Six years old; large cluster of smaller roots	do	18.0
63	Two years old	do	15.5
64	One year old	do	12.5
65	Age unknown	do	19.7
67	Age unknown	do	22.5
68	Age unknown	do	27.6
69	Nine months old; wild root	Winkler County	12.0
70	Ten months old; grown on black, heavy soil	40 miles west of Houston.	16.5
71	Seven months old; cultivated	Florida	22.5
72	Twelve months old; cultivated	do	27.6

† Nos. 55 and 56 were taken from different types of soil, two miles apart.

Effect of Freezing.—Mr. Kerr sent us a sample for analysis "that had probably been frozen a dozen times or more," but, on analysis, showed about the same amount of tannin as found in other samples from the same locality. This was unexpected; our first thought being that the tannin would be more or less destroyed. We, therefore, took three samples and placed in a cold storage vault for twenty-four hours. Before freezing, they contained, respectively, 14.6, 17.3 and 22.6 per cent of tannin; after freezing, they showed, in the order named, 14.1, 17.3, 22.9 per cent of tannin. The first sample named was six to seven months old, the next was one year old and over, the third was a mixture of roots of widely different ages—three months to three years and over. It appears, therefore, that, regardless of the age of the root, freezing has no effect on the tannin; but, according to Mr. Kerr, the sliced and dried root is very much lighter when frozen.

Cultivation decreases the amount of coloring matter, although still maintaining a pure yellow color, and seems to increase the tannic acid to a wonderful degree. To see the effect of this, compare Nos. 1, 4, 38, 39, with one another; or, in a general way, the first part of the table down to No. 47, inclusive, with the latter part of the table; that is, the samples gathered from Monahans, in West Texas. These samples, taken together, represent the root as gathered for market and shipped to Europe by Mr. Kerr, who shipped, during February and May, four or five car loads of the dried root per week.

Chemical Analysis of Soils.—

Moisture and organic matter	1.38 parts
Sand and silica	96.70 parts
Oxide of iron	0.44 parts
Oxide of aluminum	0.27 parts
Phosphoric acid	0.13 parts
Calcium oxide	0.25 parts
Magnesium oxide	0.40 parts
Potassium oxide	0.04 parts
Sodium oxide	.0.02 parts

This was taken from the Pomona plantation at Hockley, and is a fair representation, also, of the soil of the surrounding farms. It is a sandy soil, rich in phosphoric acid.

Ash in Samples, grown on the above soil, from roots of different ages, is as follows:

One month old	1.46 per cent
Two months old	.995 per cent
Five months old	.928 per cent
Six months old	.858 per cent
Twelve months old	.805 per cent

This shows a great decrease of ash in the roots as the plant grows old; the ash on analysis gave the following percentage ingredients:

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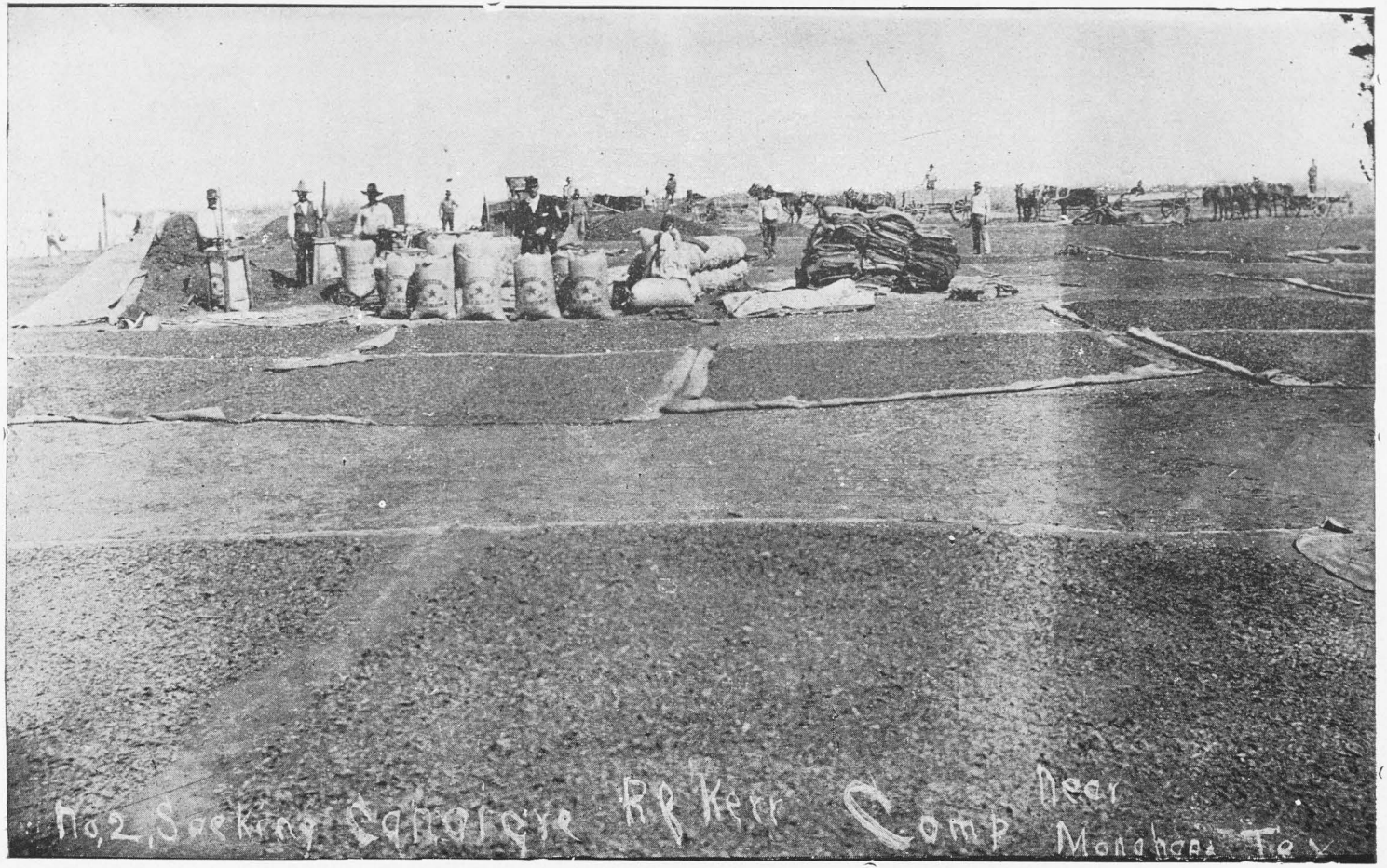

Fig. 5. Sacking canaigre at Monahans, Texas.

Analyses of Canaigre Ash.

	One month old.	Two months old.	Five months old.	Six months old.	Seven months old.	One year old.	Seventeen months old.
Matter insoluble in hydrochloric acid.	11.71	11.84	12.94	13.06	15.12	14.96	15.30
Oxide of iron.....	1.57	2.13	1.93	1.37	2.57	2.32	1.91
Phosphoric acid.....	8.97	8.59	7.89	7.60	6.70	6.75	6.15
Manganese oxide	0.24	0.81	1.20	0.91	0.80	0.81	0.40
Calcium oxide (lime)..	11.38	11.40	11.48	11.80	10.68	10.87	10.43
Magnesium oxide.....	9.71	10.27	10.23	10.57	9.73	9.25	9.69
Carbon dioxide.....	7.40	7.10	6.95	6.15	6.12	6.39	6.40
Potassium oxide.....	29.27	28.86	27.69	27.65	27.44	27.13	27.22
Sodium oxide	10.59	10.29	9.52	9.80	7.09	7.63	7.92
Chlorine	1.25	0.76	1.41	2.59	2.89	2.18	2.47
Sulphur trioxide	8.84	8.78	8.92	8.47	11.25	11.71	11.81

The above table shows a decrease of phosphoric acid and potash as the plant grows older; more marked in the case of potash than with phosphoric acid. Insoluble matter appears to increase as the plant increases in age. The lime shows a tendency to diminish. These results, so far as potash and phosphoric are concerned, agree with the results of the Arizona Station in showing that the plant makes a much larger demand upon the potash of the soil than upon phosphoric acid. But the ash does not show the large amount of phosphoric acid that was obtained by the California Station (Bull. 105, p. 9.)

Plant Food Removed.—Taking the percentage of ash in one-year-old root as an average, and the crop at ten tons per acre of green root, there would be removed 161 pounds of mineral matter, or total ash; of this, $6\frac{3}{4}$ per cent is phosphoric acid—equal to about 11 pounds per acre, against $43\frac{1}{2}$ pounds of potash. This agrees in the main with most root crops in demanding a potash fertilizer, while the amount of phosphoric acid needed is comparatively small.

CLIMATIC CONDITIONS.

The plant is indigenous to West and Northwest Texas, to Arizona, Southern California, New Mexico and Mexico. Under cultivation, it grows well in South Texas and South Florida. It will probably do well anywhere where there is not an excess of moisture combined with a cold climate. In such a climate, freezing appears to rot the seed root; but we have not determined the full effect of these conditions. Mr. Kerr says that in Texas he "would not advise planting over 100 or 125 miles from the coast," and gives as his reason that "all, or nearly all, Canaigre growing in the wild state grows in a very sandy, loose soil; and a freeze of six inches or more does not seem to impair the tops or roots. During the months of December and January, 1895 and 1896, the sand froze, after a heavy rain, to a depth of six inches [at Monahans, Ward County] at least a dozen different times. Strange as it may seem, after the ground and tops (the latter like icicles) thawed out, they were unimpaired; the tops looked as fresh as ever. This is partly due to the dry atmosphere here, but mostly due to the sandy character of the soils. During the hard freeze of 1894 in South Texas, the tops froze clean off

my crop at Pomona [Hockley]; but only roots that were within an inch or so of the surface froze, and the roots that froze decayed at once. The tops sprouted again and were up green within ten days, showing no sign of having ever been frozen. This, I think, is due to our humid atmosphere and heavier soils (of the coast regions.) That which I planted in Northern Florida, at the same time, stood the freeze that froze the orange trees down to the roots; the soil there being of much the same character as the soil here in which it grows wild. The tops there were not injured, yet their climate is very similar to ours in Southeast Texas (Hockley.)"

The above is valuable information for those who intend planting the Canaigre; and still it may be that in North Texas, if the root is planted a little deeper, the freeze will not materially damage it, even though the tops should be killed in winter. Or the crop may be planted in spring and still prove a paying investment.

METHOD OF ANALYSIS.

We followed substantially the Lowenthal method, as modified by Collingwood (Bull. No. 7, Arizona Sta.; see also Allen's Com. Organic Analysis, vol. III, part I, p. 109.) But we used Mercks' hide powder instead of gelatin to exhaust the tannin, and find that the kind of hide powder has a marked influence on results. The method is faulty, but, perhaps, comes nearer than any other to giving the actual tanning value, as used by the tanners. The following comparative analyses were made:

Comparative Methods of Analyses—Per Cent of Acid Removed.

	No. 36.	No. 42.	No. 47.	No. 48.	No. 49.	No. 50.	No. 51.
Digested eighteen hours with cold water.	9.93	14.51	11.15	15.36	13.58	9.93	10.24
Digested six hours at about 170° Fahrenheit.	13.82	14.21	11.77	14.97	13.69	10.5	10.5
Boiled twenty minutes and allowed to stand twelve hours.	13.31	14.34	12.5	15.1	13.3	10.75	10.5
Boiled one hour	13.58	14.85	12.84	15.36	13.82	12.8	10.75

It appears from the above that boiling one hour extracts the tannin more completely than any of the other methods used. It was thought that digesting at 170 degrees for six hours would, perhaps, give the best results. There is, however, no great difference in the last two methods.

THE CROP AS AN INDUSTRY.

It requires considerable means, or else co-operation of several farmers, to grow and market the crop successfully. A great step in advance will be made if large tanneries, in addition to the small ones we now have, could be established at several different towns in the State. These would not only furnish a home market for a new product, but would be followed by boot and shoe factories, and many additional leather manufactories; enough to supply not only the needs of the State, but surrounding States and Mexico. The number of hides shipped from Texas runs into the millions, and a large part of the number come back to us in the form of manufactured leather, supporting capital and labor and carrying prosperity to other people. We should carefully avoid the

Fig. 6. Drying canaigre in the sun, at Monahans, Texas.

Fig. 7. Canaigre loaded for market, at Monahans, Texas.

mistake with this new industry that we have so long made with cotton. To tan the hides of Texas at home would, perhaps, require 100,000 acres of Canaigre, and with the tanneries would follow all kinds of leather manufactories. Thus, the business men and capitalists of our larger cities have an opportunity to make a profitable investment, with great benefit to the State. I understand that a large tannery is soon to be established at San Antonio and one at Houston, the latter so soon as the necessary Canaigre supply can be guaranteed by the growers in the surrounding country. Mr. Eugene Dittman, who owns a tannery at New Braunfels, says very truly that it would be greatly to the interest of the State if anything could be done to prevent branding; and it should be the duty of every man with influence to do all in his power to stop it. Texas leather manufacturers are excessively particular as to the quality and condition of the leather which they buy. Faulty hides, produced by branding, are of slow sale to Texas leather dealers. This will always operate as a hindrance to the establishment of large tanneries. This one fault removed, and the prejudice against Texas hides would disappear; and tanning could be done cheaper here with Canaigre than in any other part of this country. Mr. Dittman agrees with other practical tanners that the quality of leather produced by Canaigre, or its extract, is of the very best; "a very fine, mellow leather, with a very fine yellow color, of great durability; pronounced by all leather consumers here (New Braunfels) as of extra good quality." Mr. Dittman obtains his Canaigre extract from Deming, New Mexico, and likes it better than either the bark extract or Gambier, both of which he gets from Boston.

PROFITS.

If we assume that it will cost $3 a ton to raise Canaigre and gather it (Mr. Kerr estimates $2) and that it can be sold at $5 a ton, a crop of ten tons to the acre would bring a profit of $20 per acre, not counting interest on the investment or cost of repairs. I do not know of any ordinary crop that will bring anything like this gain. Then, with Canaigre, the farmer is, to a large extent, independent of the weather conditions at the time of gathering, since a month or six weeks' difference of time will have no great influence.

CONCLUSIONS.

1. The crop seems particularly adapted to West and South Texas, but may be profitable in North and East Texas.

2. It can not be readily adopted by the farmer of limited means, but on the co-operative plan is almost sure to give good returns.

3. While the root continues to increase in tannic acid for some time, it will pay best to gather when a year, or a season, old.

4. Freezing does not seem to injure the tannin in the root.

5. Our results indicate a demand for potash as a fertilizer, but this would vary with the soil.

6. Cultivation increases the tannin, gives a root better in color and appearance.

7. The tannin of Canaigre is adapted for tanning the finest grades of leather, giving a leather of fine finsh, color and durability.

8. A low temperature—preferably 120 or 130—is best for drying the sliced chips.

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