Colza. The press cake, therefore, even if containing some crotonyl mustard oil, will probably prove to be harmless, the more so since it is the general practice not to feed such cakes alone but to mix them with other feeds.

The complex compound, yielding the volatile oil, may also be broken up in the cake, as in the maceration with water, provided the enzyme, causing the hydrolysis, is not destroyed by organic solvents or too high temperature used in the extraction of the fatty oil. Moist heat or steam at temperature below the boiling point of water and preferably not exceeding 70° C. (158° F.) is one of the means which will in a number of hours effect a speedy hydrolysis. Subsequent heating and drying at higher temperatures will then remove the volatile oil, thus freed. Prolonged storage of cake containing more than about seven percent of moisture will have a similarly destructive effect. This, however, is a very slow process, especially since the moisture and temperature must be kept low enough during the storage to prevent decomposition of the cake by molds or bacteria.

USE OF FOLIAGE FOR GREENS AND FORAGE.

The basal leaves of the young plant, forming a rosette of many members, are smooth, succulent and have a mildly pungent taste, not greatly unlike that of cabbage. They should prove valuable as greens for salad, etc. The plants which we planted in different locations did very well, grew fast and vigorous. They appeared to be quite hardy and may also prove to be a desirable forage crop.

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ROSE GERANIUM.

THE RESULTS OF EXPERIMENTS IN ITS CULTURE IN FLORIDA.

BY G. A. RUSSELL.*

Since the year 1914 the Office of Drug, Poisonous and Oil-Plant Investigations of the Bureau of Plant Industry, United States Department of Agriculture, has experimented with the growing of Rose Geranium in Florida. These experiments were conducted at the Field Station maintained at Orlando, in Orange County. During the period 1914 to 1917 several varieties of Rose Geranium (*Pelargonium odoratissimum*) were grown in small lots and the distilled oils examined for yield and quality. From the varieties under consideration one was selected which yielded an oil comparable to authentic commercial samples. It is with this variety that the experiments recorded here have to deal.

The original stock used in propagating when received at Orlando consisted of 100 plants which on receipt were put into the greenhouse and later transferred to a slat shade where they remained during the summer. In the early winter of 1915–16 cuttings were started in the greenhouse and in early May 1916 the plants were set in the field. Owing to forced growth in the greenhouse the plants were large and succulent, and on transferring them to the field 50 percent failed to live. Those plants that survived put on an excellent growth during the summer

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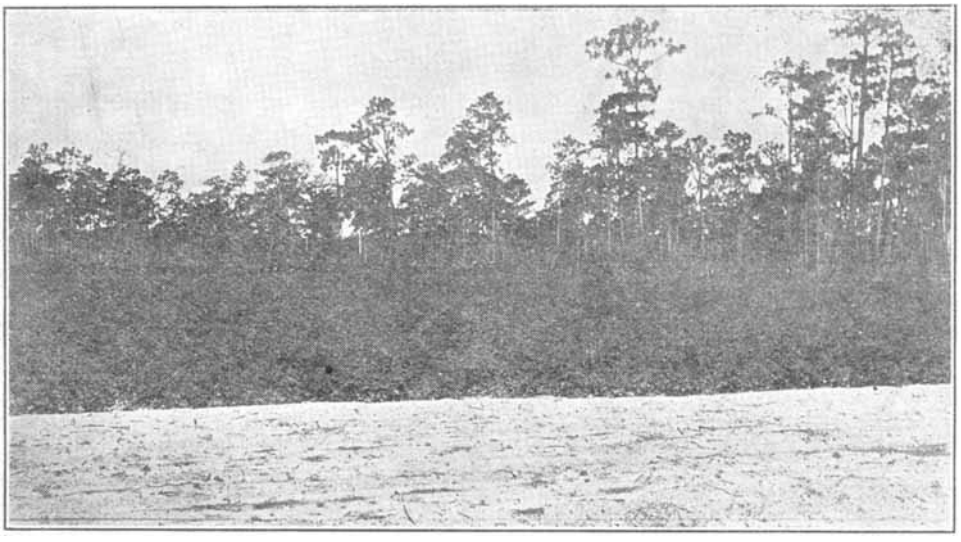
of 1916, and in the fall of that year were used as propagating stock for the 1917 plantings.

PROPAGATION BY CUTTINGS.

During the month of December 1916, 40,000 cuttings were made and placed in open beds at the Field Station Farm. The soil was very sandy and resembled to a considerable extent that in which cuttings are started in greenhouses. The beds were placed near a pump in order to facilitate watering, if such procedure seemed necessary. Each bed was surrounded by boards 6 inches in height. The results obtained were excellent, practically all the cuttings striking root within a very short time. On February 2, 1917, freezing weather swept over Florida and the cuttings suffered to the extent of 50 percent loss. The morning following the first night of freezing the beds were covered with hay, which prevented a further loss the second night of the cold wave. The plants that survived the freeze were somewhat damaged but not killed. They were later set in the field.



Rose Geranium Growing at the Orlando Field Station, Office of Drug, Poisonous and Oil-Plant Investigations, Bureau of Plant Industry, United States Department of Agriculture.

On January 12, 1917, several hundred cuttings were made and set directly in the field. On February 3 these cuttings, which had struck root and were in excellent condition, were frozen back to the ground level. On February 24 it was noted that many of these frozen plants had put out leaves from buds near or at the ground level, and before April 1 a very good stand, averaging 75 percent, was obtained. This system of establishing plants direct in the field, without first establishing growth in the cutting-bed, was later found to work very satisfactorily. It is the most economical method of propagating, in a climate such as that of Orlando, Florida, provided the cuttings are placed in the soil in mid-winter following a rain.

PREPARATION OF SOIL AND TRANSPLANTING.

The soil on which the experiments were carried out is a light sandy soil, deficient in humus, and underlaid at a considerable depth by clay. The drainage is good and water rarely stands on the fields even after the severest rains.

In preparing the fields the soil was turned with a 14-inch turn plow to a depth of 7 inches, then well disked with a cutaway disc, harrowed down, and finally smoothed down with a plank drag. Rows were laid off 40 inches apart and the plants spaced in these rows 18 inches apart, thus allowing for 8,000 plants per acre.

The permanent fields were set on March 8, 1917, with plants from the cutting beds. As each plant was placed in position a small amount of fertilizer, from a mixture of 1,500 pounds of acid phosphate, 500 pounds of nitrate of soda, and 400 pounds of tobacco dust, was worked into the soil immediately adjacent to the plant. The loss of plants due to transplanting was less than 1 percent.

GROWTH OF PLANTS.

The plants thrived well after the slips were set in the field. In 1917 the area set amounted to 2 acres, containing approximately 16,000 plants of which less than 1 percent died from the effects of transplanting. Subsequent growth was rapid and within a few weeks the plants shaded the ground over a considerable area. In February and March of 1918 the season was dry and the plants were slow in starting growth, but when the rains came in April they grew rapidly.

During the hot rainy season of July 1918 a portion of one field stood under water for periods varying sometimes as long as 24 hours. The result was that all the plants in this submerged area died. Rose geranium appears to stand drought remarkably well, and also wet weather, provided the run-off is fairly rapid. After the first harvest in 1917 a small percentage of the plants died but this loss was so small (not over 3 percent) that the fields were considered perfect stands at the beginning of 1918. The last harvest of 1918 appeared to be more detrimental to the plants and at the close of that season it was found necessary to reset approximately 20 percent of the fields in order to secure a perfect stand. The loss in 1919 was very slight.

Since rainfall and temperature exert marked influence on the growth of plants, these data are brought together in Table I.

TABLE I.—TOTAL MONTHLY RAINFALL AND MAXIMUM, MINIMUM AND MEAN TEMPERATURES FOR 1917, 1918, AND 1919, AT ORLANDO, ORANGE COUNTY, FLORIDA.

	Rainfall.			Maximum temperature.			Minimum temperature.			Mean temperature.		
Month.	1917.	1918.	1919.	1917.	1918.	1919.	1917.	1918.	1919.	1917.	1918.	1919.
January	1.15	3.72	3.01	85	86	83	35	26	28	66.2	55.4	60.1
February	1.17	0.14	4.25	89	90	86	22	37	33	62.0	68.6	62.4
March	2.41	1.72	5.68	90	91	87	37	51	40	69.8	72.6	68.4
April	0.56	8.24	1.17	96	93	94	43	39	37	72.2	71.4	70.0
May	5.78	2.11	10.37	98	94	96	49	52	55	75.8	75.5	76.2
June	3.89	5.37	5.19	98	99	97	65	64	61	80.8	81.0	79.4
July	11.17	12.30	11.49	98	95	97	69	66	67	83.4	80.1	81.4
August	8.15	3.34	5.46	98	101	98	70	66	67	82.6	82.2	82.4
September	8.87	6.60	2.38	99	98	98	65	61	63	79.5	78.8	81.2
October	3.55	7.25	0.80	92	94	98	40	60	63	72.9	77.0	80.4
November	0.19	2.30	3.99	84	86	92	29	41	44	62.8	66.8	70.4
December	0.92	3.23	3.45	81	88	90	26	34	36	56.8	62.1	63.4

The rose geranium plant remains green throughout the year at Orlando except when frozen back. It does not, however, grow throughout the year but goes into a dormant stage during the winter months. This dormant stage varies in length depending on the temperature and rainfall during the winter. During the course of this experiment the plants were frozen back each year but the loss from this cause was extremely slight. As stated before, however, many cuttings were lost because of the freezing.

CULTIVATION.

It was found that rose geranium must be cultivated frequently. The plant does not grow well if it has to compete with weeds and in order to keep these down it is necessary to cultivate and hoe several times during the year. As soon as the plants had recovered from the shock of transplanting they were cultivated with a drag-tooth harrow. Later in the season they were cultivated with a shovel-tooth harrow. This latter tool removed all the weeds between the rows but stirred the soil to a considerable depth, which is not desirable during dry weather; therefore, the drag-tooth harrow was used at times since it stirred only the top soil. It also removed many weeds, but the plants needed hoeing in the row in order to keep down such weeds as could not be reached by the cultivator.

FERTILIZATION.

At the time of planting in 1917, fertilizer was applied as stated above, approximately 500 pounds of the mixture being applied per acre. In 1918 no fertilizer was used. In 1919 high-grade tankage was applied to a portion of one plot and the spent herb of the rose geranium was used as a compost on another portion of the same plot. Check plots were staked off adjacent to the fertilized plots. The results of one year's fertilization are not conclusive but are included here as Table II in order to make a complete record of the experiments.

TABLE II.—THE EFFECT OF FERTILIZER ON THE YIELD OF ROSE GERANIUM HERB AND OIL DURING ONE YEAR'S TRIAL (1919).

Fertilizer used.	Number and date of harvest.	Weight of green herb. Pounds.	Weight of oil. Pounds.	Yield of oil. Percent.
	1st:			
Check	Apr. 2, 1919	618	0.36	0.057
High-grade tankage	Apr. 9, 1919	818	0.46	0.055
Compost	Apr. 24, 1919	724	0.44	0.059
	2nd:			
Check	July 16, 1919	541	0.36	0.065
High-grade tankage	July 15, 1919	708	0.48	0.065
Compost	July 18, 1919	895	0.46	0.051

The high-grade tankage used in this experiment analyzed 10 percent ammonia, and it was applied at the rate of 450 pounds per acre. The spent herb was that obtained in 1918 which had been piled and allowed to compost during the winter of 1918–19. The herb was only partly decomposed and the decomposed part was made up chiefly of leaves and small stalks, the large stalks remaining intact. This compost was spread between the rows of plants partly as a mulch and partly as a fertilizer. After the second harvest, July 18, 1919, it was found necessary to remove the large undecomposed stalks since they interfered with cultivation

to such an extent that the horse-drawn cultivator could not be employed and excessive hand labor was necessary to keep down the weeds.

No definite conclusions can be drawn from one year's experiments, but it appears from the results obtained in 1919 that both high-grade tankage and compost of the herb will increase the weight of green herb with probably a somewhat decreased percentage of oil. The increased yield in herb and the decreased percentage of oil is especially marked in the second harvest of the plot treated with the compost. The plot treated with the tankage yields high in herb and also in percentage of oil, the yield of oil being nearly equal to that from the check plot.

HARVESTING.

Harvesting was always done by hand labor. This process is wasteful of labor but allowable in experimental work of this sort where the area to be harvested is not large. The plants were cut off with a corn knife approximately 4 inches from the ground, thrown into piles, then loaded on a wagon and hauled at once to the distilling plant. A mower was tried in the harvesting but with indifferent success, the main objection being that this machine had a tendency to lag when the cutting knives hit the woody plant stalk and thus the entire plant would be pulled out of the ground. Probably the best machine for the purpose would be a reaper, with a cutting mechanism that could be adjusted to a suitable height and which would lay the cut material off in piles of a size suitable for easy loading on a wagon.

DISTILLING.

Distillation was conducted with steam in the usual manner. The retort was constructed of boiler plate and held about 600 pounds of green material chopped rather fine, the bulky branched green plants being run through an ordinary feed cutter before distilling. The condenser was of the "multiple-tube" type and well cooled. The capacity of the condenser was such that it required one hour of distilling to drive over all the oil that could be obtained under practical working conditions. The oil distilled off at the following rate:

1st 20 minutes' distillation, 62.5 percent of total oil.
2nd 20 minutes' distillation, 25.7 percent of total oil.
3rd 20 minutes' distillation, 11.8 percent of total oil.

After distillation was completed the oil was separated from the water, dried by means of anhydrous sodium sulphate and then filtered. The dry oil had a much darker color than authentic oils purchased in the open market. This dark color was due to contamination which entered the oil as it was distilled in the iron retort. In order to remove the objectional color the oil was filtered through animal charcoal. Thus treated it could not be distinguished in color from the commercial oils. Small lots of herb distilled in a copper retort fitted with a glass condenser produced oils which in color could not be distinguished from authentic commercial samples.

Distillation was conducted immediately after the herb was cut, that is, within not less than two hours. In some instances a load of plants reached the laboratory late in the day, in which case the herb was spread out under cover and distilled early the next morning. No differences in the yield of oil were noted. In

order to determine the effect on oil yield by drying, one lot of 1,000 pounds was divided into two parts, one-half being distilled while fresh, and the other half after drying 8 days under cover. The former yielded 0.032 percent of oil, the latter 0.039 percent, calculated on the green weight, thus indicating that in drying under cover there is no loss of oil.

YIELDS OF HERB AND OIL.

The yield of herb of rose geranium each year during the time of the experiment was considered fair, but the yield of oil was somewhat disappointing. In Florida harvesting occurs necessarily during the rainy season, because if the plants are allowed to remain in the field until the rainy season is past they become extremely woody and the leaf area is measurably decreased by loss of the lower leaves which turn brown and drop from the plant. This is unfortunate since experience has shown that the yield of oil is higher after a day or two of bright sunshine than after a rain. The adhering moisture accounts for part of the decreased percentage in yield of oil but in addition it is to be noted that the heavy rains wash off considerable oil from the pubescent leaf. A typical distillation period is given in Table III which illustrates the effect of dry and rainy weather on the oil yield.

TABLE III.—YIELD OF OIL OF ROSE GERANIUM THROUGHOUT A TYPICAL DISTILLATION PERIOD IN FLORIDA.

Date distilled.	Yield of oil. Percent.	Weather conditions on day just previous to harvest.	Condition of growth of plants.
August 22, 1917	0.035	Rainy	Very woody
August 22, 1917	0.047	Rainy	Very woody
August 23, 1917	0.061	Dry	Woody
August 23, 1917	0.060	Dry	Woody
August 24, 1917	0.070	Dry	Large—woody
August 24, 1917	0.070	Dry	Large—woody
August 25, 1917	0.067	Dry	Large—woody
August 25, 1917	0.070	Dry	Large—woody
August 28, 1917	0.063	Dry	Large—woody
August 29, 1917	0.041	Rainy	Large—woody
August 29, 1917	0.048	Rainy	Large—woody
August 30, 1917	0.062	Rainy	Large—woody
Sept. 5, 1917	0.049	Dry	Large—woody
Sept. 6, 1917	0.051	Dry	Large—woody
Sept. 7, 1917	0.109	Dry	Very leafy
Sept. 8, 1917	0.100	Dry	Very leafy
Sept. 10, 1917	0.089	Dry	Very leafy
Sept. 11, 1917	0.067	Dry	Somewhat woody
Sept. 12, 1917	0.059	Rainy	Somewhat woody
Sept. 13, 1917	0.052	Rainy	Somewhat woody
Sept. 14, 1917	0.076	Dry	Somewhat woody

It will be observed that when the harvest occurred on a day following a rain, the yield of oil was much less than when it occurred after a day of sunshine or perhaps light showers. It was realized also that the condition of the plants as regards leaf area would influence the yield of oil; hence their condition in this respect was carefully noted. The conclusion drawn was that heavy rains caused the decrease in yield of oil rather than the condition of the plants. The yield of oil is given in Table IV.

TABLE IV.—YIELD OF GREEN HERB, OIL, AND THE PERCENTAGE OF YIELD OF OIL OF ROSE GERANIUM DURING A PERIOD OF THREE YEARS AT ORLANDO, ORANGE COUNTY, FLORIDA.

Number and date of harvest.	No. of plot.	Area of plot. Acres.	Yield of fresh herb. Pounds.	Yield of oil. Pounds.	Percent yield of oil.
1—Aug. 25, 1917.....	A	1	16,720	9.33	0.055
1—Sept. 12, 1917.....	B	1	7,332	5.55	0.075
1—June 1, 1918.....	A	1	5,183	3.22	0.062
2—Sept. 15, 1918.....	A	1	2,435	1.35	0.055
1—June 15, 1918.....	B	1	3,722	2.93	0.079
2—Sept. 18, 1918.....	B	1	2,387	1.95	0.082
1—June 15, 1919.....	A	1	4,499	2.55	0.056
1—Sept. 12, 1919.....	B	1	6,712	3.48	0.051

A study of this table reveals some interesting facts relative to the yield of fresh herb. The first year's crop harvested from Plot "A" was extremely heavy, being 16,720 pounds; the second year's crop from the same field totaled 7,618 pounds; and the third year's crop 4,499 pounds. It appears, therefore, that the amount of fresh herb obtainable decreases each year with the life of the field. This decrease is not so marked in Plot "B;" in fact, the yield is fairly constant each year.

The yield of oil per acre is not encouraging and is not sufficiently large to warrant the cultivation of rose geranium as a money crop. The price of the oil as quoted in the *Oil, Paint and Drug Reporter* for the years of this experiment is given in Table V.

TABLE V.—PRICE OF OIL OF ROSE GERANIUM.

Year.	Source of oil.	Price in dollars per pound. Low.	High.	Average.
1917.....	Turkish	3.25	4.65	3.92
1917.....	African	3.90	6.00	4.48
1917.....	Bourbon	3.25	5.50	4.33
1918.....	Turkish	4.25	5.50	4.87
1918.....	African	5.75	11.50	7.53
1918.....	Bourbon	5.50	10.50	7.30
1919.....	Turkish	4.25	5.50	4.29
1919.....	African	9.00	11.50	10.38
1919.....	Bourbon	7.00	10.50	9.05

With the figures of Table V as a basis it is easy to calculate the monetary returns per acre from one acre of rose geranium. In actual practice it has been found that the trade accepts an oil from a new source at a somewhat lower figure than the lowest price for the oil already on the market. Hence in making calculations to establish approximate returns during the life of this experiment, these returns must be calculated on the average price paid for the lowest priced oil, namely, the Turkish oil.

TABLE VI.—THE MONETARY RETURNS PER ACRE AS CALCULATED ON THE ABOVE BASIS.

Plot.	1917.	1918.	1919.
A.....	$36.57	$22.25	$10.93
B.....	21.75	23.76	14.92

It will be seen from a study of Table VI that the gross returns are small from one acre of rose geranium. It is believed that Plot B very closely represents what

can be expected from the cultivation of rose geranium as a money crop. The costs of producing this crop have not been accurately worked out, since no commercial plantings were attempted, and it appears extremely doubtful if any net profit could be expected when the gross returns are so small.

THE CHEMISTRY OF THE HEPTANE SOLUTION.

BY EDWARD KREMERS.

4. THE HYDROHALOGENS.

(*Continued from December Number, p. 1163.*)

BY D. C. L. SHERK.

Preparation and Properties of the Solutions.—In this work heptane which had been specifically purified by the hydrohalogens was used. For solutions of hydrogen fluoride, chloride and bromide the heptane purified by hydrogen chloride was used; for the solution of hydrogen iodide that purified by iodine or hydrogen iodide was used.

First a solution was prepared and the strength determined. This was then used for later experimental work in testing the reactivity of the solutions. Solubility determinations of the gases in heptane were made for a series of temperature intervals from 0° to 40°. Small portions of the purified heptane were saturated with the respective gases and the hydrohalogen titrated in these solutions directly. The vessels for the solubility determinations were light globes with a somewhat drawn out neck. Through this narrow neck a capillary tube dipped into the heptane filling the bulb. A slow stream of gas was passed through the weighed bulb for a half hour until saturation was complete. The bulb was then quickly sealed and weighed, after temperature adjustments had taken place. The bulb was broken under alkali solution in a large wide-mouth glass-stoppered bottle.

1. *Hydrogen Fluoride Solution.*—The gas was prepared by warming a mixture of calcium fluoride with two equivalents of sulphuric acid in a copper vessel. The gas was contaminated with a slight trace of sulphur dioxide from the action on the metal.

The solution was prepared by conducting the gas, after drying by bubbling through sulphuric acid, directly into the heptane. The solution obtained in this way was used in testing the action on metals. In the attempt to obtain large evolutions of gas more sulphur dioxide became mixed and accordingly no saturated solutions were prepared and no solubility determinations were made at this point. The solution assayed about 0.05 percent acid. This solution fumed strongly in air and kept well in glass-stoppered vessels. There was no appreciable action on the glass; although there was a tendency to wet the glass unequally.

2. *Hydrogen Chloride Solution.*—The gas was prepared by the action of sulphuric acid on ammonium chloride in a Kipp generator. The gas was passed through sulphuric acid to remove acid spray and dried by a phosphorus pentoxide tube about 40 cm. long. This tube was filled with alternate layers of glass wool covered with the drying agent, the phosphorus pentoxide. Before the gas entered the