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UNIVERSITY OF IDAHO

Agricultural Experiment Station

Department of Horticulture

THE SERVICE OF SOILS

By F. A. HUNTLEY

DEMOCRATIC TIMES' JOB ROOM
MOSCOW, IDAHO

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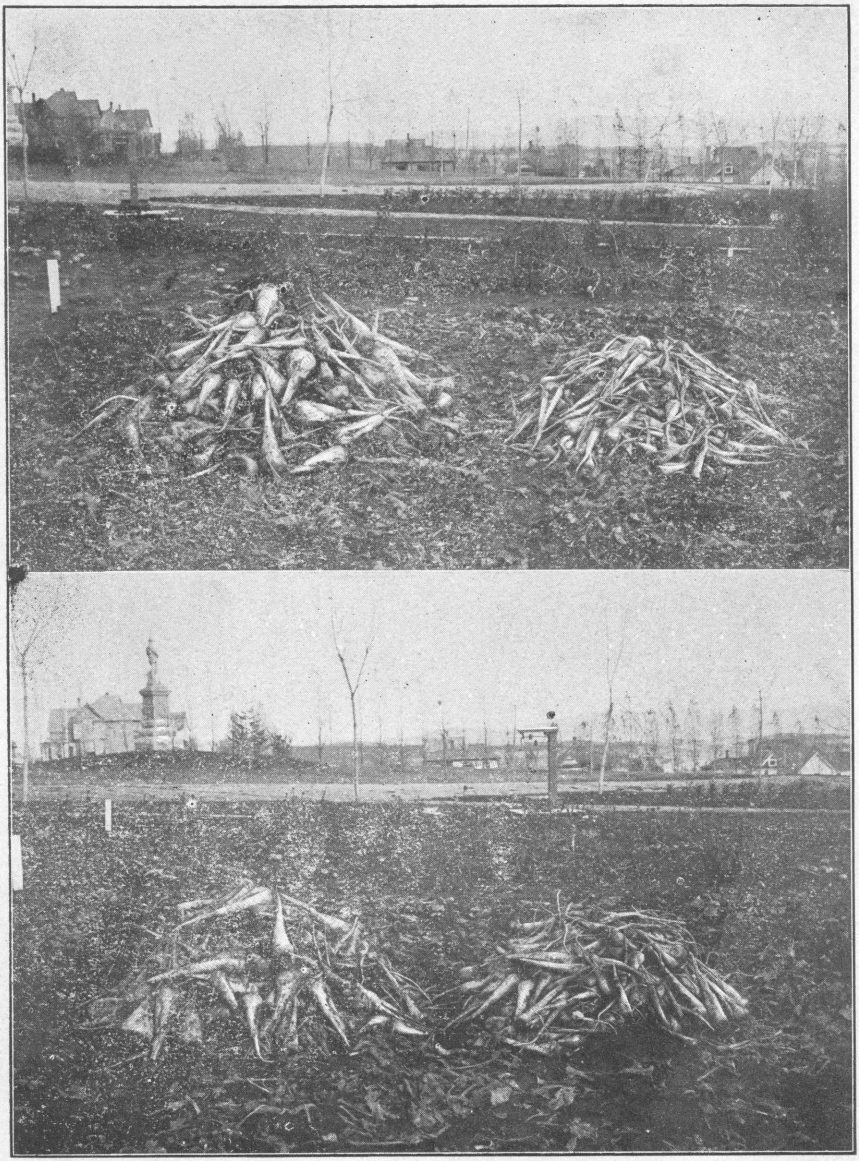
BULLETINS

The regular Bulletins of the Station are sent free to all citizens of Idaho who request them. Late Bulletins are:

25. Composition of Arsenical Insecticides.
26. (1) Crude Petroleum, (2) The Elm Louse, (3) The Pear Leaf Blister Mite.
27. Mushrooms or Toadstools; a Natural Food Product.
28. Some Idaho Soils.
29. (1) Annual Report of Director, (2) Meteorological Records.

* Died November 22.



Manured Soil. KLEINWANZLEBENER (Upper view) VILMORIN (Lower view) Unmanured Soil.

THE SERVICE OF SOILS

By F. A. HUNTLEY

GENERAL CONDITIONS.

It is obvius that a soil to promote plant growth and development to a high degree should contain all the elements of fertility in sufficient abundance for all demands. Another consideration of no less importance is that a soil should have a texture or physical condition capable of receiving and retaining moisture and admitting air, to facilitate the movements and combinations of gaseous elements and render them available as plant food. In common practice too little attention is given to the improvement of the physical properties of soils.

The most necessary fertilizing elements often deficient in soils are nitrogen, phosphoric acid, potash, and lime. One or more of them may be deficient and the others abundant. When any or all of them are present in abundance they are not always in combinations to render them available for use by plants. They must be rendered soluble, chemically soluble, by the combined action of moisture and air and in combination with other elements before plants can make use of them. The combined elements enter the plant in a perfectly fluid state by being absorbed as soil moisture by the roots. The physical or texture condition of a soil guages to a great extent the degree or proportion of availability of the elements, and may be such as to facilitate or hinder the development of plant growth. It is

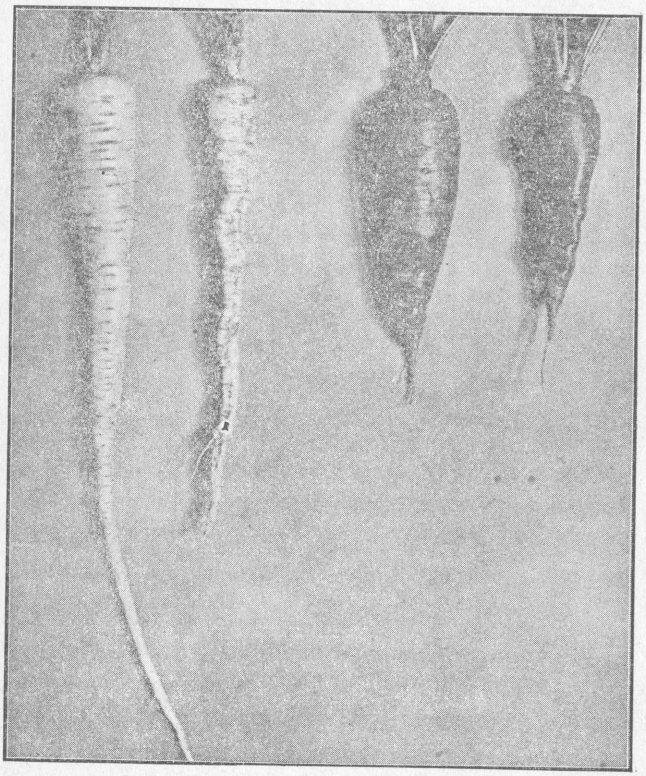
important, therefore, to contribute favorably to the growth of plants by providing a soil medium in every way suitable to the demands of vigorous growth. Humus in the soil is the physical governing property most to be desired. The presence of sand in suitable proportion also assists the capillary action of soils by protecting the soil moisture, facilitating drainage, admitting air, and liberating the fertilizing elements present. A combination of humus and sand furnishes what is called a sandy loam, and for most crops this character of soil is capable of best returns. The soils of the northern part of this state are fairly well supplied with humus, though in a too finely pulverized condition to produce the physical properties which are highly desirable. A combination of sand and humus seldom exists in this part of Idaho excepting on limited areas of bottom lands. Usually in the more arid sections of the state a reasonable proportion of sand is present, but there is generally a deficiency of humus. It remains only to supply these soils with freshly decayed vegetable matter to make them more intensely fertile. Barnyard manure is one of the best all-round fertilizers in general command, since it not only supplies the fertilizing elements in proper abundance, but through the process of decay it furnishes humus and produces the desired physical properties.

In the following pages will be found explained some experiments attending the use of barnyard manure in the production of root crops, onions and tomatoes.

Green manuring, the plowing under of green crops, is likely to prove the most economical means generally of improving the soils of this state. Alfalfa produces well over the irrigated sections, and the clovers do well where the natural moisture is sufficient for cultivated crops. These plants are among the best nitrogen producers, and facilitate the best combinations of soil fertility. I believe it is not an exaggeration to claim that most crops common to the field and garden can be made to produce more than double for an average term of years by judiciously following a plan of green manuring, or the liberal application of barnyard manure.

EXPERIMENTS WITH ROOT CROPS.

Experiments were begun on these grounds four years ago to determine the benefits to be derived by increasing the supply of humus in the soil, mainly for the purpose of improving physical conditions. The most available material for application was



PARSNIPS
Mellow Soil — Hard Soil

CARROTS
Mellow Soil — Hard Soil

barnyard manure. To avoid as much as possible the use of concentrated fertilizing elements, well decomposed coarse manure was selected, which had lain exposed to the action of sunshine

and rain until much of the strength had been wasted. This was applied to the land in the spring at the rate of a heavy two-horse load to two square rods of surface, and then plowed under to a good depth. The land selected had never been fertflized. A corresponding area adjacent was left unfertilized to be used for duplicate comparative tests of the various crops following. The whole fertilized area was then devoted to tomato culture and miscellaneous garden crops for two years before these recorded tests were made, for the purpose of improving the physical condition of the soil, and to reduce and maintain the fertilizing elements in approximately original proportions. As was expected the manured portion has always continued moist through the dry summer months, and remains mellow and easy to cultivate, and does not pack and become solid under the influence of rain and sunshine, while the unmanured portion opposes all these conditions.

The following records are for the seasons of 1890 and 1891, being the third and fourth seasons following the application of the manure. Dr. S. Avery, late chemist, and Hal T. Beans, assistant chemist of the station, co-operated in this work by furnishing analyses of the two types of soil represented, and of the sugar beets grown upon the relative areas.

It may be well to state that it was not designed particularly to conduct a sugar beet experiment, but to demonstrate the value of humus in the soil for the production of root crops. Other root crops consisting of parsnips, carrots, salsify and table beets shared in the tests. The experiments with sugar beets were made the most extensive in the belief that this subject contained more of general interest than the production of other root crops.

A space of twelve square rods of ground was platted for sugar beet planting, including an area of each of the two characters of soil. Seeds of two varieties were sown, the Kleinwanzlebener and Vilmorin. Seasonable thinning and cultivation followed. Rows were fourteen inches apart, which might be considered a little too close for field culture. Greater distance between rows would have made less demand on the soil moisture

proportioned to individual numbers, with the result of increasing the size of the beets. Therefore it is presumed that the tonnage would not have varied to any great extent if the rows had been a little farther apart with the same distance between plants.

The analyses of the two types of soils are here republished from Bulletin No. 28, though they were originally intended for use in connection with this subject. The following analyses and explanations were furnished by Mr. Beans:

UNFERTILIZED PLOTS, CHEMICAL ANALYSIS.

Insoluble matter 74.775 Soluble silica 5.690	80.465
Potash (K_2O)	.563
Soda (Na_2O)	.247
Lime (CaO)	.939
Magnesia (MgO)	.886
Manganese oxide (MnO)	.009
Ferric oxide (Fe_2O_3)	4.009
Alumina (Al_2O_3)	6.157
Phosphorus pentoxide (P_2O_5)	.192
Sulphur trioxide (SO_3)	....
Carbon dioxide (CO_2)	.041
Water and organic matter	6.250
Total	99.886
Humus	3.103
Nitrogen	.159
Hygroscopic moisture	2.010

"This sample is surface soil from the unfertilized plats on the University campus. It is a representative sample of the Palouse type of soils. There is an abundant supply of all the plant foods. The lime content is good though not large. The humus content is excellent and the nitrogen sufficient."

FERTILIZED PLOTS, CHEMICAL ANALYSIS.

Insoluble matter 73.584 Soluble silica 5.265	78.849
Potash (K_2O)	.677
Soda (Na_2O)	.418
Lime (CaO)	.999
Magnesia (MgO)	.766
Manganese oxide (MnO)	trace
Ferric oxide (Fe_2O_3)	3.719
Alumina (Al_2O_3)	6.237
Phosphorus pentoxide (P_2O_5)	.176
Sulphur trioxide (SO_3)	....
Carbon dioxide (CO_2)	.037
Water and organic matter	8.365
Total	100.243
Humus	3.975
Nitrogen	.212
Hygroscopic moisture	1.893

"This sample is surface soil from fertilized Station plats adjacent to that from which the other sample was taken. The plat was heavily manured three years ago with stable manure.

"The effect of the fertilizer is especially noticeable in the increased percentages of potash, humus and nitrogen.

"While the percentage of phosphoric acid in this sample is less than in the other, it is probable that the fertilized soil contains more of this substance in an available form.

"Last year these Station plats were used for sugar beet experiments and it was found that the yield from this soil was over twice that from unfertilized soil.

"This sample contains the highest percentages of humus and nitrogen of the Idaho soils thus far analyzed."

A condition of very great importance shown by this analysis is the durability of added fertility.

ANALYSES OF BEETS GROWN ON THE TWO TYPES OF SOIL.

These were furnished by Dr. Avery, followed by his remarks on results:

	Sugar in juice.	Sugar in beet.	Purity
Unfertilized—			
Plot 1. Kleinwanzlebener, averages	17.3	16.5	88.7
Plot 2. Vilmorin, averages	16.6	15.8	87.5
Fertilized—			
Plot 11. Kleinwanzlebener, averages	16.3	15.5	85.6
Plot 12. Vilmorin, averages	15.1	14.3	81.2

"Beets grown in a very dry soil, producing small roots, usually show a higher per cent of sugar than beets grown under more favorable conditions. This fact has been observed in fields where the crop was not worth marketing on account of poor yield.

"In the above experiments the differences in per cents of the beets analyzed, between fertilized and unfertilized plots, are slight in comparison to the differences in yield.

"Suppose fertilized plot yields 40,000 pounds of beets containing 15 per cent of sugar. This represents 6,000 pounds of sugar.

"Suppose unfertilized plot of same size yields 10,000 pounds of beets containing 16 per cent of sugar. This represents 1,600 pounds of sugar. Difference in favor of fertilized plot 3,400 pounds."

To show the strikingly visible comparison of yields and size of beets, photographs were taken as shown by the first pictures in this bulletin. Each one of the four piles represents the product of an accurately measured square rod. The yields, computed per acre, were as shown by these figures:

UNFERTILIZED PLOTS.

Plot No. 1—

Variety, Kleinwanzlebener.
Yield, 11 tons and 720 pounds per A.
Beets per square rod, 728.

Plot No. 2—

Variety, Vilmorin.
Yield, 13 tons, 560 pounds per A.
Beets per square rod, 507.

FERTILIZED PLOTS.

Plot No. 11—

Variety, Kleinwanzlebener.
Yield, 26 tons, 320 pounds per A.
Beets per square rod, 619.

Plot No. 12—

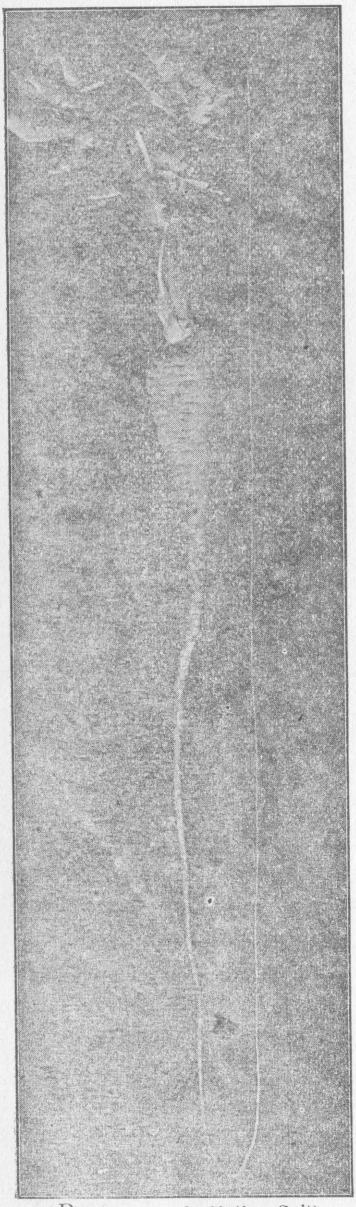
Variety, Vilmorin.
Yield, 15 tons, 1840 pounds per A.
Beets per square rod, 380.

The count shows a smaller number of beets per square rod in each case of the Vilmorin. This was due to the use of seed of inferior germinating power, which was not discovered until too late for correction.

The same plot of ground which has been designated as the manured area produced a crop of sugar beets the present season under very much the same conditions as last year. The variety was Kleinwanzlebener, and yielded at the rate of 17 tons and 1360 pounds per acre. No fertilizers whatever have been used on this ground since the time it was first prepared for these experiments. The crops received no irrigation. Frequent shallow cultivation, aided by the supply of humus in the soil, maintained sufficient moisture for uninterrupted growth during the late exceptionally dry season.

OTHER ROOT CROPS.

It is not necessary to dwell at length upon the experiments with the other root crops. All that has been said regarding sugar beet culture applies with equal force to similar products. The illustration of parsnips and carrots shows their character-



PARSNIP (In Mellow Soil)

istic development in mellow and in heavy soils. They were allowed to grow more numerous in the row than the sugar beets. It was very noticeable in the unmanured soil that the force of expansion during growth left a deep crack in the soil between the roots and almost throughout the length of every row. Thus the dry air was freely admitted and growth ceased almost entirely during the driest part of the season. The soil of the manured portion did not crack in dry weather owing to the presence of humus which gave it the proper texture to expand only at points of direct pressure. This situation maintained a freshness of vegetation for the whole season. The illustration of parsnips and carrots shows characteristic root development in soils of hard and loose texture.

The parsnip illustrated with a root five feet and four inches in length is one of numerous samples taken from manured soil. It is evident that the long growth penetrated the earth through the channel left by the trail of an earthworm. Earthworms, or angleworms as they are called, are gener-

ally very numerous in the soils of this region, and they have been observed to be more numerous and active in their work in ground that has been manured. They are generally beneficial to a soil by providing air spaces which facilitate the disintegration of the crude elements of fertility. Their work is largely confined to the subsoil, and they do not disturb the roots of plants to the extent of causing injury. Since they are most active in manured soil it is a part of economy to encourage their presence.

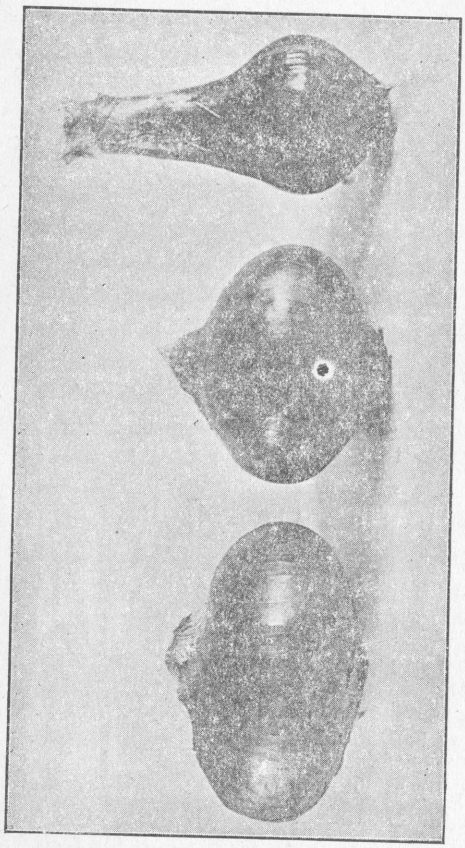
ONIONS.

Bulletin No. 22 issued from this Department, on the subject of "Onion Growing," deals at some length with information on the general cultivation of onions. Other experiments with onions the past season are here made a matter of record. The illustration shows three typical specimens of bulbs of the variety Red Wethersfield whose forms of growth were determined by different conditions. The large flat bulb at the left is a well developed type of this variety. It shows the influence of well manured soil, early seeding, and good cultivation. It is well ripened, solid, and of a texture to indicate good keeping qualities. The one in the middle of the picture is a fair sample of early seeding in unfertilized soil. During dry weather its growth was checked for lack of soil moisture. It was produced by two growing periods, early and late, and its undesirable form was the result. While it might be counted a fairly good bulb it lacks firmness of texture and proves to be a poor keeper. The bulb on the right in the picture shows what late seeding and poor soil will do for the onion.

IRRIGATION.

An irrigation test was made with onions the past season. The site selected for the experiments had only a moderately fertile soil, and hardly favorable for good gardening. Four standard varieties were selected for planting, but the Wethersfield had to be dropped out finally on account of building operations which encroached upon the ground. A portion of each

plat received irrigation by the open furrow method. Irrigation, alternated with good cultivation, kept the soil in a favorably moist condition. Results of the tests were as follows:



NOT IRRIGATED.

VARIETY	AREA TESTED	POUNDS	NUMBER OF BULBS	BUSHELS PER ACRE (Computed)
Y. G. Danvers	250 sq. ft.	158	491	510
Aust. Brown	" " "	152	450	394
Prizetaker	" " "	188	422	609

IRRIGATED.

VARIETY	AREA TESTED	POUNDS	NUMBER OF BULBS	BUSHELS PER ACRE (Computed)
Y. G. Danvers	250 sq. ft.	205	491	662
Aust. Brown	" " "	163	450	417
Prizetaker	" " "	230	422	742

The computed yields figured a little more or less than the whole number of bushels given in the last column of figures, and for convenience the few pounds of variation are omitted.

TOMATO CULTURE.

Some of the most essential points bearing upon this subject are here offered as conclusions after liberal experimenting.

Early sowing of seed, about March 1st, will prove desirable if plenty of room is allowed for extensive root development by thinning the plants to a good distance in the seed bed. It is important to save and transplant a well developed root system with as much of the soil of the seed bed adhering as possible. Transplanting to pots or cans, using rich mellow soil, will insure uninterrupted vigorous growth if done before the plants have formed a slender growing habit. Final transplanting to the open ground with the mass of roots and earth unbroken will promote vigor, early maturity, and a long season of fruiting.

Our practice of always pruning the terminal succulent growth from the top at the time of transplanting, has had the effect of promoting stockiness and vigor. This should never be neglected on transplanting from the seed bed to the open ground. Slender-grown plants should have their tops shortened about one-half. Vigorous buds at the base of the leaves will then produce a top of stronger habit. Frosted tops should always be cut back in the same manner.

The distance between plants is determined by the habit of growth of the variety and the method of training. Varieties of spreading habit may be set about seven feet apart each way, or

six feet one way and eight feet the other. Varieties similar in habit to the Dwarf Champion will do well in rows five feet each way, and large growing varieties pruned and trained to stakes will also bear as close planting. Good drainage of soil and continuous moisture through the season are conditions necessary for securing heavy yields of fruit. It is very generally believed that a soil for tomatoes should not be enriched by the application of barnyard manure or green manuring. This is a mistaken notion, as it has been shown beyond a doubt that manured soil insures larger development of plants, greater productiveness and earlier fruiting, than soils only moderately fertile.

Many inquiries have come to this department from various localities asking for a remedy for a disease popularly called "tomato blight." It is recognized by the leaves and stems changing to a yellowish color, after which the plant droops to a lingering death. No remedy has yet been found that will restore a diseased plant to health. All affected plants should be destroyed as soon as the disease becomes apparent. Trials on these grounds during the last four years have shown that the use of vigorous plants and well manured soil, with good cultivation, is a reliable preventive against tomato blight. We have had many cases of this disease here and have been experimenting to find a remedy. Thus far we have found preventive measures the only reliable safeguard against tomato blight. The explanation is this: Plants sustained in vigorous growth with an abundant supply of humus and all the essential fertilizing elements, which are often deficient in ordinary soils, have the power to resist this disease. Tomato blight is caused by a bacterium which circulates with the juices of the plant. Sluggish growth favors its development.