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RECLAIMING NITRE SOIL IN THE GRAND VALLEY

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Fig. 1. Method of reclaiming nitre land by flooding

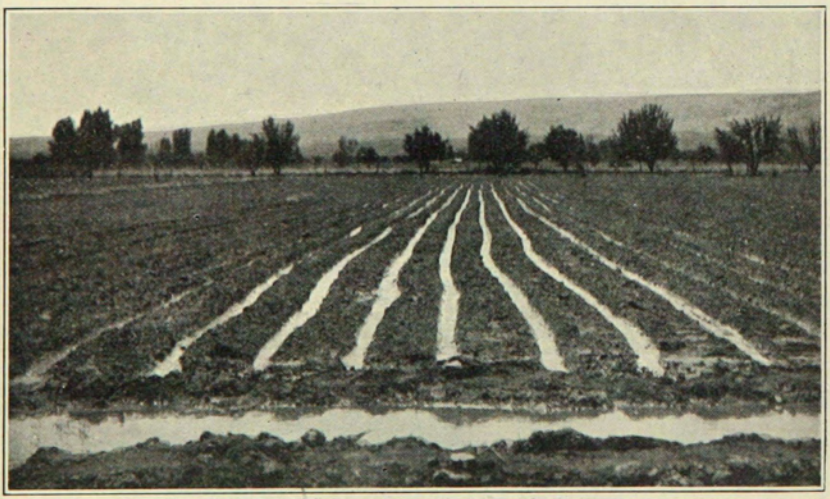

Fig. 2. Furrow method of reclaiming nitre land

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The experimental work of Dr. Headden and Professor Sackett* of this Station has proven conclusively that the origin of nitre, often called black alkali, so abundant in many of our Colorado soils, is due to the activity of the nitre-forming organisms. The nitre is not confined to any particular section of the State, but occurs in almost every district and in all types of soil.

A study of soil management, especially in the orchard areas of the Grand Valley, has led the writer to conclude that the excessive accumulation of nitre is greatly increased by clean cultivation, as extensively practiced by the fruit growers.

It is a well-known fact that in most semi-arid soils there is little or no fermentation of organic materials, due to the action of prolonged sunshine, light rainfall and dry atmosphere. This, coupled with the presence of a high percentage of alkaline salts, forms ideal conditions for the activities of the nitre-forming organisms. The additional fact that nitre rarely occurs in injurious quantities in soils on which alfalfa is grown continuously for a long series of years, would indicate that land kept constantly in clean culture furnishes the best conditions for the nitre-forming organisms.

The orchard survey of Grand Valley, made by the Horticultural Department, reveals the fact that more than one thousand acres of bearing orchards, and orchards just coming into bearing, have been destroyed by nitre during the last few years, and, in addition, a considerable portion of the remaining orchards in the Valley are showing signs of nitre poisoning.

These observations led the writer to undertake some work in Grand Valley to reclaim land that had become barren because of excessive nitre, and also to check the process of nitre-formation in orchards that were still healthy and productive, but which showed signs of nitre poisoning.

The presence of excessive nitre in the soil is readily distinguished by the characteristic reddish-brown discoloration, and the mealy or powdery texture which always accompanies this trouble.

In the orchards, the presence of nitre is also readily distinguished by the appearance of the foliage of the trees, especially the foliage on tender growing shoots. The margins of the leaves

*See Bulletins Nos. 155, 160, 178, 179, 184, 186, 193.

turn reddish-brown, while the central portion assumes a pale yellow, greenish color. When the nitre is present in large quantities, the whole leaf turns reddish brown, and, in severe cases, the nitre may even attack the branches and the whole tree. In many instances, only a portion of the tree is affected. This is due to the fact that nitre may be present only in small spots, and the roots, feeding in these, becomes poisoned, and the branches which receive food from the roots in these areas show the presence of the poison. Often, a half tree will die, while the remainder of the tree appears to be perfectly healthy.

Several thousand acres of land in Grand Valley that have been made unproductive by nitre poisoning, could have been saved, and could yet be saved if the growers practiced rational methods of soil management.

The object of this investigation was to determine the quickest and most economical method of correcting and reclaiming nitre land in the Grand Valley. Particular attention was paid to land occupied by fruit trees, or lands that had been occupied by fruit trees which had been killed by excessive nitre in the soil.

The work was started in June, 1914, and has been carried on for the last three seasons on a farm west of Grand Junction.

Arrangements were made to take over two acres of land on which an apple orchard had been killed and the trees removed several years previous. This piece of land, at the beginning of the experiment, was entirely barren of vegetation. Even the hardiest and most resistant weeds failed to grow on it. Samples of the soil analyzed by Dr. Headden, Station Chemist, showed excessive amounts of nitrates. The condition of barrenness had existed for several years without any apparent change in the character of the soil, so far as sustaining plant life was concerned. The water table of this plat of land during the irrigating season came to about four feet of the surface and in no way interfered with the growth or ripening of the ordinary farm crops. The land is nearly level, but with a slight fall toward the south. The soil is heavy and does not permit the water to percolate freely.

METHODS EMPLOYED

The land was well plowed, harrowed and prepared in the usual manner for seeding grain crops. A portion of the land, about one-fourth acre, running the whole length of the field, was enclosed with an embankment of earth, and water was led into this enclosure so that the whole strip was covered to the depth of several inches. The land was kept covered for ten days, permitting the water to gradually work its way thru the soil and drain off

slowly. After the water had been taken off and the embankment leveled down, the strip was seeded to oats. A fine stand of oats was obtained without any further work on the land. (See Fig. 1.)

This strip has now borne full crops for the last three seasons, and shows no indication of returning to its former condition. No crop has been taken off the land, but each has been plowed under.

The balance of the land was seeded to oats, rye, rape, sorghum and winter vetch. After seeding, the land was corrugated, the furrows were placed close together to obtain the maximum of exposure, and then water was permitted to run in these furrows for thirty-six hours. (See Fig. 2.) The seed started to grow along the edges of the water, especially the oats and rye, but the ridges remained barren. The irrigation was continued at intervals of several days during the first season. The results obtained showed that a certain amount of the nitrates had been washed out by irrigation. However, the ridges remained barren and showed the characteristic brown color and powdery texture. At the end of the season the field was almost as barren as before. The rape, sorghum and winter vetch made a poorer showing than the oats and the rye, and were discarded as unsuited for the work.

The corrugating method of washing the soil was continued during the last two summers, with the oats and rye as crops, and the field is now practically reclaimed, tho there are isolated spots which are still more or less barren. The crops on the reclaimed portions were very rank and dark green in color and showed that a large amount of nitrates was still present in the soil. (See Fig. 3.)

Fig. 3. A crop of rye on reclaimed land

FLOODING GIVES QUICKEST RESULTS

There are two conclusions which we can draw from this work. First, that the quickest way of reclaiming nitre land is by flooding. Second, that the corrugating method, while beneficial, is too slow, and, in the long run, more expensive than the flooding method. Lands that are in the first stages of nitre poisoning may be restored by using the corrugating system of irrigation, but on land made unproductive by excessive nitre, and especially if the character of the soil and the lay of the land are such as to permit of rapid drainage, and where rapid, complete reclamation is desired, the flooding method is recommended.

COVER CROPS HELP CHECK NITRE IN BEARING ORCHARDS

At the same time that the work of reclaiming this particular piece of land was undertaken, experiments were carried on to correct the nitre condition of soils in bearing orchards, by the use of cover crops. This method of soil treatment is particularly applicable to orchards, and since most of the orchard land is deficient in vegetable matter, due principally to clean cultivation, the plowing under of cover crops is the cheapest and most effective means of supplying this deficiency, and at the same time checking the tendency to form nitre.

Two orchards in the first stages of nitre trouble were selected and were seeded to hairy vetch. The seeding was done early in September, and the plants made a rather poor showing during the fall. The poor stand was due to three causes: First, the lack of water; second, to the dense shade caused by the apple trees; and, third, to the tramping of the land in harvesting the fruit.

In spite of these drawbacks, the vetch showed up well the following spring, particularly in one of the orchards, where it completely covered the ground and attained a height of over 5 feet. (See Fig. 4.)

The vetch was plowed under during the second week in June, when it was in full bloom. Both of these orchards were in the first stages of nitre trouble, and to all appearances, the trouble was checked.

In plowing under large green crops in the orchard, there is some danger of too rapid fermentation and heating which may cause injury to the trees. This generally happens if the plowing under is delayed until the latter part of June, or until July. For this reason, the plowing under of large green crops should be done as early as possible.

Fig 4. A cover crop of hairy vetch in a Grand Valley orchard

CLEAN CULTIVATION RESPONSIBLE FOR PRESENCE OF NITRE

As indicated above, the presence of excessive nitre in so many of the orchards in Grand Valley, is in the main, due to the prevailing system of soil culture. It has been a universal custom in the Valley, up to within a few years ago, to practice clean cultivation in the orchards, and this practice seems to have given the best results. The clean culture method is advisable only so long as the soil conditions remain favorable to tree growth and fruit production, and when these show signs of decline, corrective measures must be taken. The corrective remedy lies in the use of cover crops, alternating with clean culture. The use of cover crops is now more extensively practiced in the Grand Valley orchards, and with its more extended use, we shall look for less nitre poisoning.

DRAINAGE IMPORTANT

In connection with the reclamation of nitre land, it should be borne in mind that drainage is of vital importance. If irrigating waters percolating thru the soil have a means of escaping readily, the nitre salts will be carried off by them, as they are very soluble. Lack of proper drainage makes evaporation the only source by which water is eliminated from the land, and this is sure to cause

trouble, as the salts remain in the soil after the water has evaporated. If proper drainage is provided, the salts, to a large extent, will be carried off in the waters thru the subsoil and into the drainage.

The nitre trouble is only one of the problems which confront the land owners; another and equally important one is seepage. Cheap and abundant irrigation water have led to over-irrigation. This, togeher with the natural seepage from canals and laterals has filled up the subsoil with water and brought the alkaline salts to the surface. In many instances the water table is within 4 feet of the surface, and on some of the lower land the water reaches the surface. Where these conditions exist, drainage is the only remedy. The occurrence of nitre in the soils of the Grand Valley and other sections of the State, has little or no relation to drainage but is a distinct and separate problem.

While the apple tree roots, in most cases, do not extend deeper than 4 or 5 feet, (practically all the feeding roots are confined to the upper 3 feet of soil), capillary action carries the water too close to the feeding roots and interferes with the proper drainage and aeration of the soil in the feeding zone. Further, the high water table usually occurs during the growing season, and thus directly affects the growth of the trees. A high water table is less harmful during the winter months when the trees are dormant.

The importance of good drainage and the use of cover crops in connection with orchard operations should be known by every fruit grower in the Valley.

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