MAGNESIUM Deficiency in Certain Soil Types Reduces Potato Yields

During recent years potato growers in different sections, particularly in States along the Atlantic seaboard, have complained to Department of Agriculture and experiment station workers that "something is the matter with my potato field." From Aroostook County, Maine, for example, one of the leading table and seed-stock potato-producing sections of the United States, reports emanated in the spring of 1929 to the effect that a "new potato trouble" or "sickness" had shown up in potato fields. An inspection of many potato fields by Federal and State specialists in late June of that season disclosed abnormal foliage symptoms, the most conspicuous of which was a chlorotic condition, there being a marked change in the color of the foliage, from a normal green to varying shades of yellow. The failure of the potato plants to develop their normal green color was associated with the lowest leaves or those formed when the plants were comparatively young.

FIGURE 67.—Lack of available magnesium in soil caused breaking down of potato leaf, chiefly at the tips and margins.

In severe cases it was observed that the chlorotic condition or yellowing became progressively worse, sometimes involving the entire plant. As a rule, however, mainly the lowermost leaves were affected, the yellowing beginning at the tips and outside margins and later invading the leaf between the veins. Later foliage appeared to "grow out" of the trouble, so far as the yellowing was concerned. It was noted also that there developed a thickening of the leaves with a distinct brittleness, easily detected when crushed in the hand. Latest stages involved a bulging of the leaves between the veins, some rolling of the entire leaf leading to a breaking down of the internal structure with brown dead tissue in evidence (fig. 67). The culmination of the trouble proved to be loss of foliage necessary to starch formation. An examination of the soil where the trouble occurred showed high soil acidity. Yields where the trouble occurred were greatly curtailed.

What appeared to be a similar disturbance was noted several years ago in Suffolk County, N.Y. Yellowing of foliage, stunted growth, and reduced yields were the pronounced effects. Here again the lowermost leaves were affected, later foliage more nearly approaching a normal green color. The soil on which the yellowing first appeared was lighter in texture than the general run of good potato soils in Suffolk County. As the trouble became more pronounced, soils of better quality also were more or less involved. To some extent a similar condition was noted in potato fields in New Jersey, although the yellowing was not so pronounced or so general as observed elsewhere. In New Jersey and on Long Island the trouble was ascribed to excessive soil acidity and to the use of heavy row applications of fertilizer capable of accentuating soil acidity.

Two Types of Injury Disclosed

In the spring of 1931 reports emanated from the Norfolk and Eastern Shore sections of Virginia concerning a so-called potato "trouble". A survey was made of upwards of 60 potato fields; two types of injury were disclosed. The more prevalent type consisted of yellowing or chlorosis of the lower leaves, the upper leaves retaining a more nearly normal color. The plants were affected while relatively young, the yellowing apparently inducing a stunted growth. This condition was particularly noticeable on sandy slopes subject to light washing. Plants growing in low places possessed a much better appearance, having normal color and profuse blooms. The affected plants showed little, if any, blossoming. In fields where manure, green rye, or alfalfa had been turned under there was no sign of the yellowing or stunting. The yellowing of the foliage in Virginia was found to have been most pronounced after a period of relatively low temperature and excessive rainfall, suggesting a retardation of growth on the one hand and, on the other, soil leaching of plant-food constituents, possibly those connected with the formation of chlorophyl, the green coloring matter of plants.

In a majority of the fields examined the soil was quite acid, as was the case in Maine, New Jersey, and Long Island. It was also ascertained that the majority of growers in the different sections on whose farms the trouble occurred had used a fertilizer which, when added to the soil, developed a degree of acidity considerably greater than the soil naturally possessed.

In the use of fertilizer, a ton to the acre being commonly applied for potatoes in the different sections, it was found that the increasing tendency to take advantage of the cheapest sources of nitrogen had led to the inclusion of large amounts of ammonium compounds, chiefly ammonium sulphate, in fertilizer mixtures, which intensified the acidity of the soil close to the roots of the potato plants. Another factor to be considered is the effect of soil acidity on the leaching of basic soil materials, such as lime and magnesia compounds, from the surface soil. This would probably become more marked in the case of magnesium compounds, owing to the fact that fairly large amounts of calcium are applied to the soil if superphosphate is an ingredient of the fertilizer mixture.

Reports concerning the yellowing of potato vines, premature ripening, and reduced yields, have come from other potato-producing sections, which suggest that certain factors might be common to the soil types affected along the Atlantic coast. These factors have been found

to be generally as follows: (1) High soil acidity; (2) use of heavy applications of acid-forming fertilizer applied in the row at time of planting; (3) need of organic matter; (4) leaching effect following heavy rainfall; (5) leached or thinly eroded areas; (6) ineffective liming; and (7) seasonal conditions, chiefly rainfall.

Deficiency of Magnesium Discovered

Investigational work to determine the cause of the trouble showed that some plant-food element associated with chlorophyl formation was deficient in the soil or fertilizer. Field tests have shown clearly that the deficient element was magnesium, as the addition of suitable magnesium compounds to the fertilizer prevented the yellowing and stunted growth. The potato plants in fields so treated were normal in every respect and produced much greater yields than those in the fields receiving the same quantity of fertilizer to which no magnesium compound was added.

During 1932 cooperative field experiments were started on prominent soil types in Maine, New York, New Jersey, and Virginia to determine to what extent magnesium compounds were needed by these soil types. The soil types under study are the Caribou loam in Maine, the Sassafras loam in New York and New Jersey, and the Norfolk sandy loam and Sassafras sandy loam in Virginia.

As a result of these tests it has been definitely shown that some soils in Aroostook County, Maine, are subject to magnesium deficiency. The Maine Agricultural Experiment Station reports increased yields as high as 66 barrels to the acre brought about by the addition of magnesium sulphate to the ordinary 4–8–7 fertilizer. Cooperative tests conducted in 1932 and 1933 afford a further idea of the magnesium requirements of potatoes grown on Caribou loam. While not so marked in 1932, there was in 1933 an increase of 24 bushels because of the application of magnesium in one of the field tests, and in another an increase of 76 bushels. In other tests on Caribou loam the increases were not so significant.

On Long Island and in New Jersey no marked responses have been secured from the use of magnesium and lime compounds in the fertilizer. The practice of making light applications of limestone carrying some magnesium to lower the acidity of the soil has been followed for some time in these potato-growing sections, and this may account for the failure to secure increased yield from the use of magnesium compounds.

In Virginia, on a field of Norfolk sandy loam which was markedly acid, the effect of adding magnesium sulphate to the fertilizer proved highly beneficial, an increased yield of 48 bushels to the acre resulting. On another field of Norfolk sandy loam where the soil was decidedly less acid no significant response from magnesium was obtained.

In magnesium experiments on Sassafras sandy loam in 1932 and 1933 in the vicinity of Cape Charles, Va., application of different magnesium compounds or lime carbonate failed to give significant differences in yield. This can be explained on the basis that dolomitic limestone was applied in the fall of 1931 following the Virginia potato-field survey. It appears in these tests that dolomitic limestone, when finely ground and applied enough in advance, was helpful both in lowering the soil acidity and furnishing enough magnesium for the potato plants.

Chemical analyses of potato foliage, both normal and chlorotic, have shown clearly that the intake of magnesium is much less with the latter. When the magnesium content of potato foliage dropped below 0.15 percent, mild yellowing usually occurred. When the magnesium content registered 0.1 percent and lower, the injury to the plants was serious both in vine growth and yields.

In connection with the magnesium-deficiency studies it will be of interest to refer to figure 68, which shows the regional distribution of magnesium in rivers and lakes over the United States. While an approximation only of the magnesium present and bearing indirectly on the soil relationship, the chart serves to bring out the low content of this element along the Atlantic Coastal Plain, where light soils subject to heavy leaching prevail and where, moreover, magnesium-deficiency troubles have been most prevalent.

There are several ways of adding magnesium to a soil deficient in this element—(1) applying dolomitic limestone to the soil direct, (2) adding

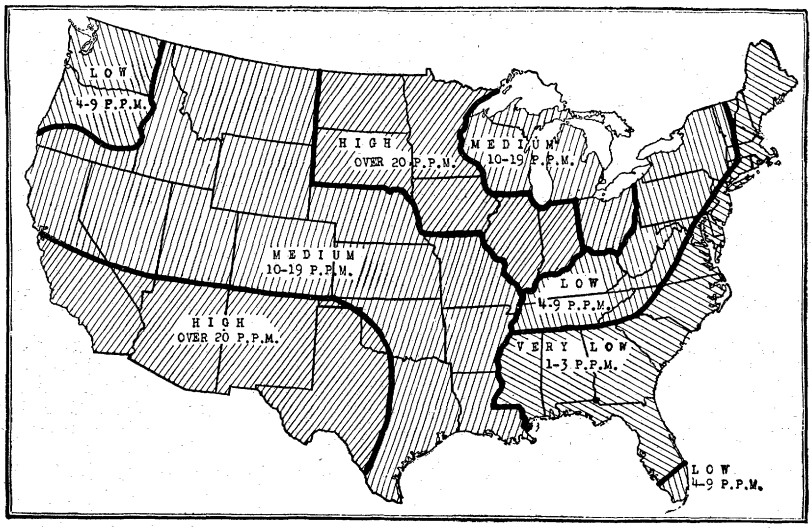

FIGURE 68.—Regional distribution of magnesium in river and lake waters. Based on compilation of analytical data from United States Geological Survey Professional Paper No. 135.

dolomitic limestone to the fertilizer, or (3) adding some quickly available magnesium compound to the fertilizer, such as ordinary or calcined magnesium sulphate, double sulphate of potash-magnesia, or one of the commercial preparations supplying soluble magnesium.

The use of magnesium compounds to correct magnesium deficiency is an important matter for the potato grower and fertilizer manufacturer to consider. Both should be guided not only by the immediate magnesium needs of the potato crop, but more important still they should give serious consideration to a soil-management program which will tend to put the soil in better condition by lowering the acidity of the soil and still avoid any danger from scab. The farmer should increase the organic-matter content of the soil and at the same time make provision for an adequate supply of magnesium for the needs of his crops by using some magnesium in his fertilizer or liming materials.

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