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ZINC DEFICIENCY OF CORN IN MINNESOTA

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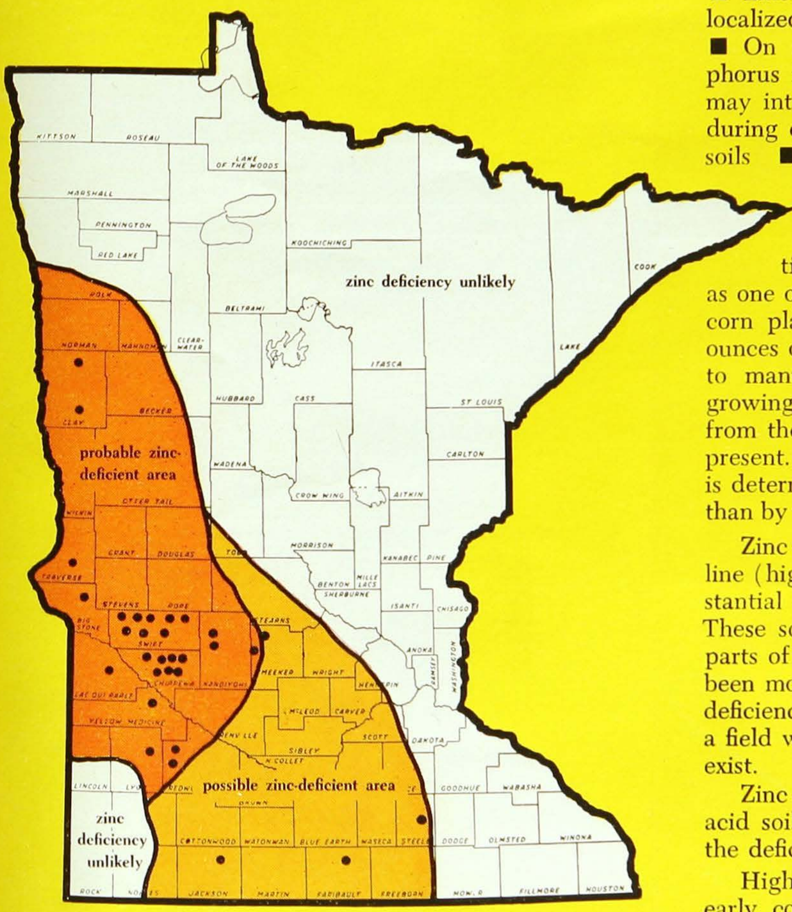

• zinc deficiency observed

■ Zinc deficiencies now occur in relatively small localized areas on "high lime" soils in Minnesota ■ On soils low in available zinc, excessive phosphorus fertilization and type of crop preceding corn may intensify zinc deficiency ■ Cool, wet weather during early growth favors the condition on affected soils ■ Zinc fertilization is economically practical where needed.

All plants require zinc for normal growth and seed production. Since relatively small amounts are essential, zinc is known as one of the "trace" or "micronutrient" elements. The corn plants grown on 1 acre contain only about 3 ounces of zinc, which is less than the amount needed to manufacture a 10-quart galvanized pail. Since growing plants are unable to extract *all* of the zinc from the soil, it is essential that a larger quantity be present. The ease with which a plant can obtain zinc is determined more by the "available zinc" in the soil than by the total soil zinc.

Zinc deficiencies are usually first observed on alkaline (high pH) peat and mineral soils containing substantial amounts of free lime (calcareous in nature). These soils are found extensively in western and in parts of southern Minnesota where the deficiency has been most frequently observed (see map). Often the deficiency is observed only in small localized areas of a field where high lime and poor drainage conditions exist.

Zinc deficiency is less likely to occur on neutral or acid soils, although several reports have shown that the deficiency may occur on these soils in Minnesota.

High soil moisture and cool temperatures during early corn growth may intensify the deficiency on high lime soils. Research from other states has shown that excessive phosphorus fertilization may hasten or intensify the deficiency on high lime soils. Reports of these soils in west-central Minnesota indicate that corn following sugar beets is more likely to be zinc deficient than corn following corn or other crops.

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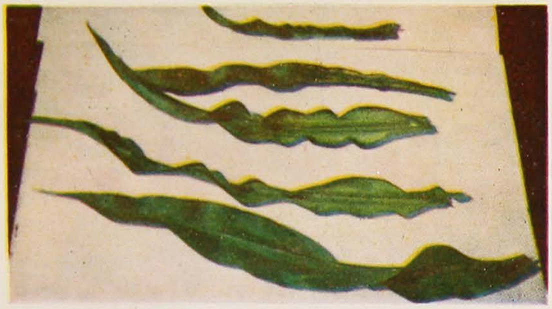
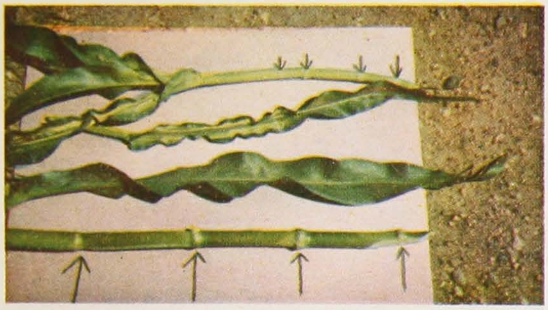


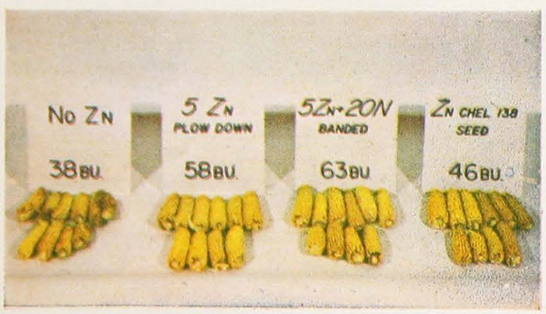
A normal corn leaf at the bottom contrasted with upper leaves of increasing zinc deficiency.



Normal leaf and stalk (bottom) as compared with a zinc-deficient pair. Note the shortened internodes of the stalk and the bleached area on the leaf.

This field plot shows the contrast between a zinc-fertilized area (right) and an untreated area (left).

The striping here is not typical of zinc deficiency, although it may resemble early stages of the deficiency. It is common, and often difficult to diagnose.



Typical ears taken from a replication of a test plot in 1964. Note the poorly-filled ears from the check plot.

Recognizing Zinc Deficiency in Corn

Characteristic zinc deficiency symptoms of corn are shown on the opposite page. Generally the plants remain green during the first month but have a stunted growth. Then in June or early July, thin, longitudinal, pale yellow stripes develop between the edge of the leaves and the midrib. These stripes extend from the base to the top of the leaf and often occur in irregular patterns. The first leaves affected are the older (lower) leaves which are striped and comparatively narrow. The younger (upper) leaves may remain green unless the deficiency is severe.

In severe deficiencies, the lower leaves may develop the pale yellow striping shortly after emergence. These pale stripes may then become bleached and appear to dry up. A reddish-bronze coloration is sometimes evident over portions of the seriously deficient leaves. The ears produced by severely deficient plants are poorly filled with chaffy kernels.

In mild deficiencies, only minimal striping of the lower leaves is observed, and bronzing does not occur. A minimum of stunting may be present, and as the growing season progresses, growth appears to be nearly normal with only slightly reduced yields.

The degree of zinc deficiency may vary considerably in a single field depending on local soil conditions. In areas where the deficiency is severe, poor and untimely pollination may occur. Although the entire field may be treated with zinc, such treatment is usually essential only on those portions of the field on which the corn plants are visibly affected.

Results of Field Experiments in Minnesota

In 1962, three field experiments were established in south-central Minnesota to determine the most effective methods of zinc application and the rates needed to correct deficiency of corn. At two of the experimental plot locations, severe zinc deficiency symptoms had been observed on growing corn during the previous year. The third soil site was one suspected of being deficient in available zinc. All three soils were calcareous; one was a peat soil in northwestern Meeker County, the other two were fine textured mineral soils in southern Kandiyohi County.

The zinc treatments consisted of various rates of zinc sulfate either broadcast and plowed under, or banded using a corn planter fertilizer attachment. Two treatments of zinc chelate ($Na_2ZnEDTA$) coated to the seed corn were included with three replications of each treatment on each field. Nitrogen, phosphorous, and potash was prevoiusly added to insure adequate amounts of these nutrients.

Results of the various treatments on two fields in Kandiyohi County are shown in the table to illustrate the first-year effectiveness of the zinc treatments. On plot No. 3, only a few of the plants showed zinc deficiency symptoms. A significant increase in corn yield was not obtained from any of the rates or methods of zinc application on this soil. Nevertheless, yields on those plots treated with zinc were 2 to 7 bushels per acre higher than those where no zinc was applied. There was little if any increase in yield from applying zinc where corn exhibited no symptoms.

The effect of 1962 zinc fertilization on the yields of 1962 and 1964 field corn grown on two zinc-deficient soils in southern Kandiyohi County

	Ear corn yield on:		
	Slight zinc-deficient plot (No. 3)	*Serious zinc-deficient* plot (No. 1)	
1962 Treatment	1962	1962	1964
lb./acre	bushels per acre		
No zinc	72	43	40
Zinc broadcast and plowed under			
5 zinc (15 zinc sulfate)	77	69	58
10 zinc (30 zinc sulfate)	79	66	56
20 zinc (60 zinc sulfate)	79	76	56
40 zinc (120 zinc sulfate)	74	67	60
Zinc and nitrogen as banded starter			
10 zinc (30 zinc sulfate)	71	59	53
20 N plus 5 zinc (15 zinc sulfate)	73	63	58
20 N plus 10 zinc (30 zinc sulfate)	82	64	65
20 N plus 20 zinc (60 zinc sulfate)	77	63	62
Zinc chelate coated on seed corn (7½ oz. $Na_2ZnEDTA$ per bushel)			
Seed treatment alone	75	55	51
Seed treatment plus 10 of zinc (30 zinc sulfate) plowed under	80	74	67

During the 1962 growing season, severe symptoms of zinc deficiency were observed on the corn plants in the seriously zinc-deficient plot No. 1. Since the plot was located in the most deficient area of the field, the results are not truly representative of entire field situations and may only apply to local areas of serious zinc deficiency.

Broadcasting and plowing under zinc sulfate at 15 pounds per acre resulted in a 16-bushel-per-acre yield increase, although some stunting and leaf striping was evident.

The 30-pound-per-acre rate eliminated essentially all the vegetative symptoms and resulted in a yield increase of 23 bushels per acre. Rates of zinc sulfate greater than 30 pounds per acre caused no significant increase in yield.

Research has shown that when zinc is applied in a starter fertilizer, it is usually more effective when mixed with some form of ammonium nitrogen. The nitrogen apparently increases zinc uptake by the growing corn plants. This interaction was evident in the 1962 yields when comparisons were made between the treatment rates of 30 pounds of zinc sulfate per acre, either with or without nitrogen.

Zinc banded near the seed was not as effective in correcting the zinc deficiency symptoms of the corn plants as was that broadcast and plowed down. Yields of ear corn from the banded zinc treatment rows were slightly lower than those from the broadcast treatment rows.

Seed treatment (coated) with zinc chelate (Na_2Zn-EDTA) slightly increased the yield of corn grain and zinc uptake by plants. Substantial yield increases were obtained when both the seed treatment and 30 pounds of zinc sulfate were applied.

On plot No. 2 located on a peat soil in northwestern Meeker County, severe zinc deficiency symptoms were observed. Yield increases from the use of zinc were significant, but were reduced considerably by an early fall frost.

Residual Effects of Soil-Applied Zinc

Carryover or residual effect on succeeding crops is of primary interest to corn growers who have zinc-deficient soils. Research shows that a soil application of zinc may benefit crops for several years, although much of the applied zinc may be converted to unavailable forms.

Residual zinc effect on corn following the 1962 zinc treatments was studied in 1964. (See table) Soybeans were planted in the plot area in 1963, but were severely damaged by a residual herbicide carryover. No additional zinc was applied in 1963 or 1964.

The 1964 increases in corn yield from the residual 1962-applied zinc were much the same as those obtained 2 years previously. As little as 15 pounds of zinc sulfate per acre, broadcast in 1962, resulted in an increased corn yield of 26 bushels per acre in the first year and of 18 bushels per acre in 1964. There were no significant differences in the yields on those plots receiving higher rates of zinc.

The plots with zinc banded in 1962 also showed a good residual effect. The field had been plowed across the plots both in the fall of 1962 and of 1963 and apparently this did a thorough job of mixing the zinc with the soil. Because of soil variability in a single field, the yield response due to zinc carryover shown above would probably occur only in local areas of severe zinc deficiency and not over an entire field.

Correction of Zinc Deficiency

If zinc deficiency symptoms occur in a field it is generally difficult to correct them in that year, although Nebraska researchers advise an injection of nitrogen-zinc sulfate-water solution. However, *zinc should be applied before planting a sensitive crop such as corn the following year.* In most cases it is not economical to apply zinc fertilizer until a definite deficiency has been observed in the field.

Several zinc carriers available to farmers are economically effective in correcting zinc deficiency of corn. The most widely used materials are zinc sulfate and zinc chelate ($Na_2ZnEDTA$), although any water-soluble form of zinc is beneficial. Most fertilizer dealers can readily obtain a supply of suitable zinc materials. Granular zinc is available in easy-to-handle compounds, and these can be blended with most commercial fertilizers.

Commercial fertilizers containing several micronutrients may not contain enough zinc to correct zinc deficiencies of corn unless specifically manufactured for that purpose. Most research workers agree that the best way to use micronutrients is to identify the deficiency in the crop and then add only those elements needed in quantities sufficient to correct the deficiency.

The recommended rate of zinc application for corn is 5 to 10 pounds of *zinc* per acre when an inorganic carrier such as zinc sulfate is used. (Zinc sulfate contains from 26 to 40 percent zinc.) When a chelated form of zinc is used, the rate of application should be 0.5 to 1 pound of *zinc* per acre. Chelated zinc compounds usually contain from 6 to 14 percent zinc. New products of higher analysis will probably be available in the future.

Broadcast and plowed down zinc fertilizer has been shown to be more effective for corn than the starter application. Generally, only the deficient areas of a field need treatment, but it is essential that the zinc be plowed under or at least thoroughly worked in to get maximum results in the first growing season.

Zinc fertilizer may also be banded slightly below and to the side of the corn seed using a fertilizer attachment on the corn planter. Greater benefits may be obtained when the zinc is mixed with fertilizer containing nitrogen with little, or preferably no phosphate.

Zinc for Corn Following Sugar Beets on Calcareous Soils

When corn follows sugar beets on some calcareous soils of west-central Minnesota, the corn frequently fails to develop normally and may develop zinc deficiency symptoms. The previous sugar beet crop appears to lower the availability of soil zinc.

When corn follows sugar beets on these soils, some zinc should be applied to the soil. This can be done when the fertilizer is broadcast for the sugar beets, or at planting time with a fertilizer attachment on the corn planter. Rates of application are the same as those suggested above.

Zinc effectiveness may be shown by applying the same rates of fertilizer to the entire field. On part of the field, apply zinc along with the fertilizer and make careful observations both during the corn growing season and at harvest.

Points to remember:

☐ Learn to identify zinc deficiency symptoms ☐ Consult your county agent if in doubt ☐ Apply zinc according to the extent of symptoms and preferably only in the areas affected ☐ Apply in sufficient quantities (amounts less than 1 pound inorganic zinc per acre are seldom beneficial) ☐ *Always* leave untreated areas in the field as a check to determine zinc effectiveness.

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