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Essential Plant Micronutrients

Zinc in Idaho

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Zinc (Zn) — like boron (B), chlorine (Cl), copper (Cu), iron (Fe), manganese (Mn) and molybdenum (Mo) — is a micronutrient necessary for plant growth. Zinc is called a micronutrient because plants require it in lesser amounts than nitrogen (N), phosphorus (P), potassium (K) and sulfur (S).

Zinc has many important roles in plant growth, and a constant and continuous supply is necessary for optimum growth and maximum yields. A lack of zinc will reduce seed formation. Zinc is needed for a plant's enzyme formation and is associated with hormone (IAA) formation. Plants take up zinc in the Zn++ ion form. Low levels of zinc in soils in parts of southern Idaho (Fig. 1) have been found to limit plant growth in beans, corn and onions. In contrast, crops grown in northern Idaho have not responded to zinc applications. However, as land continues to be intensively cultivated throughout the state, responses to zinc fertilizer are likely to increase.

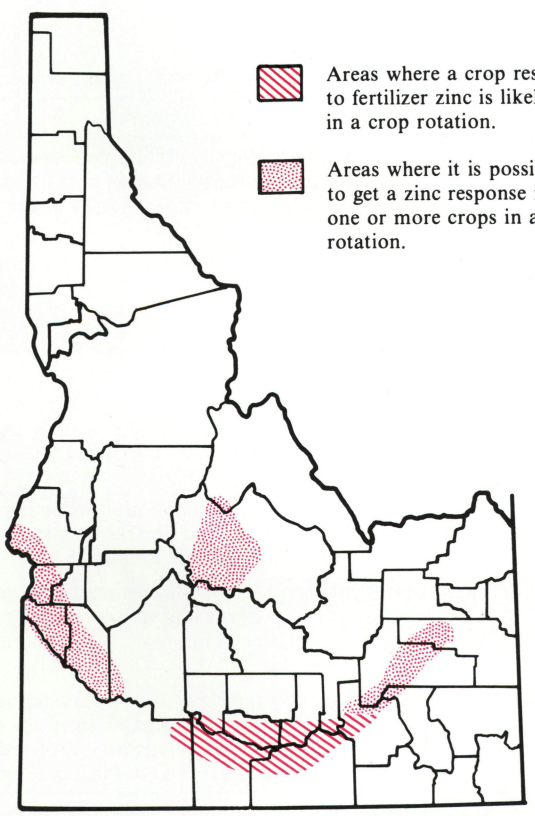

Fig. 1. Areas in Idaho where soils may be deficient in plant available zinc.

Crop Response

Zinc deficiencies are not common in acid soils as zinc is more available at lower pHs (pH below 6.5) than at higher pHs (pH above 7.5). Most zinc deficiency problems in Idaho are in southern Idaho where pHs are above 7.5. Zinc is often precipitated with carbonates and phosphates at high pHs and thus rendered unavailable. Most of the available zinc in soils is close to the surface as it is concentrated in the organic matter. The removal or burying of topsoil by land leveling, deep tilling or erosion can result in zinc deficiencies.

The addition of phosphate fertilizers can induce zinc nutritional deficiency problems in plants where zinc soil levels are marginal. The phosphorus actually enhances zinc demand which the soil cannot supply.

Climate is another important factor affecting crop response to zinc. Cool, wet weather can result in greater incidence of zinc deficiencies. As the weather becomes warm and dry, zinc deficiency symptoms usually will disappear.

Zinc Deficiency Symptoms

When a soil test shows a zinc deficiency, economic crop loss has probably taken place for certain Idaho crops. Zinc deficiency in beans and corn usually results in delayed crop maturity. An annual soil analysis can alert you to any potential deficiency of available zinc.

In a plant, zinc deficiency symptoms first appear on the younger leaves. Deficiencies in these younger leaves are shown in chlorosis and bronzing of the plant tissue. Characteristic zinc deficiency symptoms for crops commonly grown in Idaho are shown in Table 1.

Fig. 2. Zinc deficiency in beans evidenced by yellowish-brown leaves.

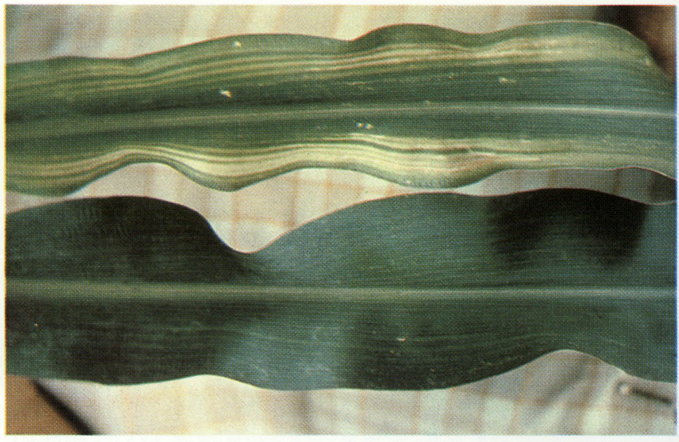

Fig. 3. Zinc deficiency in corn appears as interveinal striping.

Alfalfa and Clover — Deficiencies are not common; however, a lack of zinc in these crops will inhibit seed production. Zinc deficiencies first appear as bronze-colored specks around the margins of upper leaves. As the deficiency progresses, the bronze spots become white, and the leaves die. Under severe zinc deficiency conditions, the bronze spots will appear across the whole surface of the leaflets.

Beans — Deficiencies are widespread in southern Idaho. Plants deficient in zinc do not develop to normal size. Symptoms usually first appear on the second set of trifoliate leaves or develop on primary leaves on some snap bean varieties. The older leaves may eventually turn gray or brown and die earlier than normal. From a distance, zinc deficient areas in bean fields appear yellowish-brown in color (Fig. 2). Lack of zinc will delay pod maturity and decrease yield, unless the season is long enough for maturity to be attained.

Corn — Deficiency symptoms are easily recognized. In its mildest form, zinc deficiency appears as an interveinal striping in the younger plant leaves (Fig. 3). Mild and even severe deficiency symptoms may disappear as the weather warms up. With a severe deficiency, broad bands of bleached tissue will appear on the lower half of the plant leaves.

Potatoes — Plants lacking zinc appear to be stunted, with young leaves cupped and rolled inward (sometimes called "fern leaf"). Grayish-brown irregularly shaped spots will often appear on the older leaves. In advanced cases, the plants usually die within 2 weeks.

Tree Fruits — Deficiencies in fruit trees are commonly called "rosette." Symptoms are a distinct shortening of the internodes toward the tips of shoots and small narrow leaves (Fig. 4). The leaves are frequently bent upward.

Correcting Zinc Deficiencies

If a zinc deficiency is possible, you should have the soil tested for available zinc. When the soils test less than 0.6 ppm in the top 12 inches (or 0.8 ppm zinc in the top 9 inches), addition of fertilizer containing zinc is recommended, especially when growing a crop sensitive to zinc deficiency.

Zinc deficiencies are usually most pronounced on beans, corn, grapes, hops, potatoes and fruit trees. Crops which seldom show zinc deficiencies include alfalfa, barley, wheat, sugarbeets (Fig. 5), mint, peas, lentils and berries. Most of the zinc fertilizer used in Idaho is applied to beans and corn.

Zinc Fertilizer

Several zinc fertilizer materials are commercially available (Table 2). Zinc sulfates and zinc chelates are probably the most common zinc fertilizer materials used in Idaho. The zinc materials can either be soil-incorporated or used as a foliar spray.

Zinc sulfate is probably the cheapest source of zinc fertilizer. Zinc chelates are organic sources of zinc in which the zinc ions are protected by a claw-like chemical ring. This reduces the possibility of zinc being precipitated with phosphates and carbonates in the soils.

Table 1. Deficiency symptoms of some important Idaho crops.

Crops	Deficiency symptoms
Beans*	Mottling (yellowing) of the interveinal areas of younger leaves; the mottled areas may become gray and die; plants fail to develop to normal size
Corn*	Yellow interveinal striping in the leaves; production of light yellow to almost white bud leaves; early destruction and death of older leaves
Grain	Symptoms are indefinite; plant tissue analysis should be used instead of visual analysis
Legumes	In alfalfa and clovers, bronze-colored spots first appear around the margins of the upper leaves; eventually the bronze areas become white and necroctic (dead)
Potatoes** (Russet only)	Affected plants are stunted; young leaves are cupped, rolled inward and appear smaller than the other leaves; internodes are short
Sugarbeets	General yellowing appears between the veins of younger leaves, progressing to necrotic spots having a silver color in interveinal areas and along leaf margins
Trees: fruit	Conspicuous shortening of the internodes toward the tips of shoots and small narrow leaves; with severe cases, older leaves may drop off leaving "rosettes" of leaves at the tips of shoots

*Corn and beans tend to outgrow zinc deficiency symptoms in the Magic Valley beginning about July 20.

**Potatoes (Russets) usually die 2 weeks after symptoms appear.

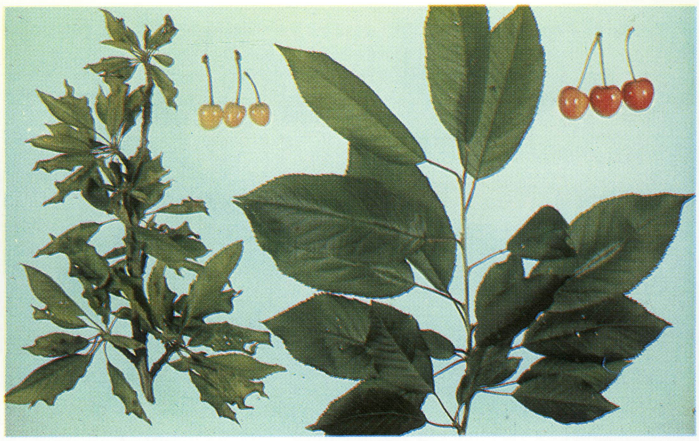

Fig. 4. Distinctly shorter internodes and small, narrow leaves are symptoms of zinc deficiency in tree fruits.

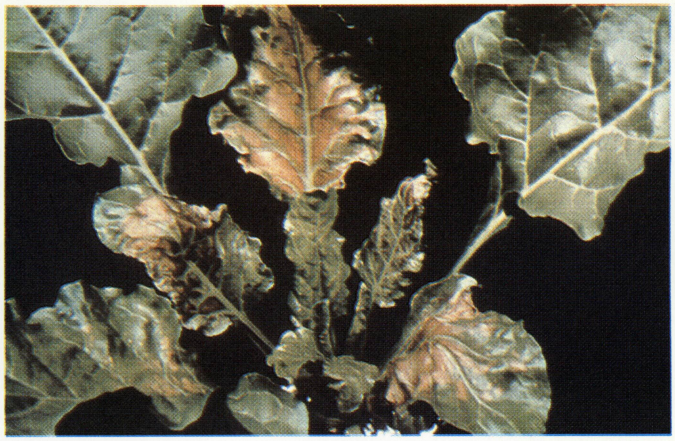

Fig. 5. Although zinc deficiency is more difficult to spot, root crops such as sugarbeets show symptoms of yellowed and wilted leaves.

Chelated zinc remains mobile, allowing it to move freely in the soil solution for uptake by plant roots. The material is expensive, though. Zinc chelates can be either soil-incorporated or applied as a foliar spray.

Application Methods and Rates

The three principal methods of correcting micronutrient deficiencies in the field are by (1) soil application, (2) foliar application and (3) application of the micronutrient to the seed at the time of planting. Zinc deficiencies are most commonly corrected by application of the zinc fertilizer to the soil. While foliar applications of zinc are often beneficial, soil application remains effective much longer. Seed applications of zinc, although successful on some plants, have not been shown to produce a yield response on crops grown in Idaho.

Table 2. Common zinc fertilizer materials available for use on Idaho crops.

Zinc materials	Chemical formula	% Zinc (Zn)	Rates of Zn per acre		
			3 lb Zn	5 lb Zn	10 lb Zn
			Amount of material to apply (lb/acre)		
Inorganics					
Basic zinc sulfate	$ZnSO_4 \cdot 4Zn(OH)_2$	55	5.5	9.1	18.2
Zinc carbonate	$ZnCO_3$	52	5.8	9.6	19.2
Zinc oxide	ZnO	78	3.8	6.4	12.8
Zinc phosphate	$Zn_3(PO_4)_2$	51	5.9	9.8	19.6
Zinc sulfate heptahydrate	$ZnSO_4\ 7H_2O$	23	13.0	21.7	43.5
Zinc sulfate monohydrate	$ZnSO_4 \cdot H_2O$	35	8.6	14.3	28.6
Organics					
Zinc chelates	$Na_2ZnEDTA$	14	21.4	35.7	71.4
	NaZnNTA	13	23.0	38.5	76.9
	NaZnHEDTA	9	33.3	55.5	111.1
	ZnMPP	7-12			

*depends on % Zn

Soil Treatments — Soil application of zinc is the most common and generally the most successful method for Idaho crops. Zinc sulfates are the most commonly used inorganic sources in Idaho. Zinc chelates are the most widely used organic sources. Significant responses to soil-applied zinc are usually reported for beans and occasionally reported for corn, potatoes, onions and hops.

Soil-applied zinc fertilizers may be either broadcast and then plowed into the soil or banded. Zinc must be worked into the soil. Banded applications of zinc are acceptable when the band is placed to the side of and below the seed. Banded chelates are often more effective than inorganic materials.

When using zinc fertilizer sources, a rate of 5 to 15 pounds of zinc per acre is recommended for crops with a high zinc requirement (beans, corn, onions, potatoes and hops) while lower application rates of 2 to 5 pounds of zinc per acre may be required for grain crops (Table 3). When using organic soil-applied zinc sources, application rates for high zinc demanding crops drop to 0.25 to 3.0 pounds of zinc per acre; however, these lower rates are adequate only if the fertilizer is perfectly distributed and well mixed into the root zone.

Foliar Treatments — Foliar applications of zinc are commonly used in tree fruits. Foliar-applied zinc can also be used to prevent zinc deficiencies in rapidly growing annual crops. Foliar applications in annual crops is a temporary remedy which should be used for emergencies only.

Success with foliar sprays to correct deficiencies is generally good with most Idaho crops. Exceptions to this are Russet Burbank potatoes which have not responded to foliar zinc. Since zinc is not mobile in the plant, repeated spraying may be required to get zinc into new growth. More than one foliar application of zinc during the growing season may be needed to achieve the same effect as 10 pounds of zinc broadcast or banded into the soil before planting. Many crops, though, including corn and beans, usually only require one application of foliar zinc because the plants tend to outgrown the zinc deficiency as the season progresses.

Foliar spraying is important for perennial crops such as tree fruits. Foliar application rates of 0.25 to 1.0 pounds of zinc per acre should be used on corn, onions and potatoes. Foliar zinc must be applied to potatoes before the

appearance of deficiency symptoms in order to be effective. Lower concentrations are recommended for sensitive crops such as beans to prevent excessive burning or loss of leaves. Annual row crops generally require about 1 pound of foliar-applied zinc per acre. This 1 pound can be divided by the number of times zinc will be sprayed during the season to give the correct rate for each application.

Residual Effects — Recommended applications of 10 pounds per acre of soil-applied zinc last 3 to 5 years for all but very sandy soils low in organic matter. Little residual effect of zinc in the soil is left from foliar applications because of the low rates and since most of the applied zinc is intercepted by the plant and does not reach the soil.

Soil Analysis and Plant Tissue Testing

Soils should be tested for available zinc 3 years after a soil application is made and when the 4th-year crop will be high in zinc demand. A soil test for zinc is recommended before every bean crop. If foliar applications with a zinc compound were necessary on a crop the previous year, a soil test is also recommended for zinc.

A good soil test for zinc is available. For sufficient zinc, the soil should test at 0.6 ppm in the upper 12 inches (0.8 ppm in the upper 9 inches) for crops which are readily susceptible to zinc deficiencies.

The zinc status of plants can be monitored throughout the growing season with plant tissue testing. Monitoring zinc levels in high value cash crops can help to prevent severe zinc deficiency symptoms from developing in sensitive crops (Table 4). Be sure you sample the correct plant part at the correct stage of plant growth and get a sample representative of the field. Remember, a tissue or soil analysis can be no better than the sample taken.

Table 3. Recommended zinc application rates for crops to be grown in zinc-deficient soils.

Crop	If Idaho soil test reads below	Amount zinc to apply per acre
Irrigated alfafa	0.6 ppm*	5 to 10 lb
Dryland alfalfa	0.6 ppm*	5 lb
Barley	Has not been shown to respond to zinc applications in Idaho unless land has been leveled	
Beans	0.6 ppm*	10 lb
Corn, forage and sweet	0.6 ppm*	10 lb
Onions	0.6 ppm*	10 lb
Peas and lentils	Have not responded to zinc applications in northern Idaho	
Potatoes	0.6 ppm*	10 lb
Sugarbeets	0.6 ppm*	10 lb
Dryland wheat	Has not responded to zinc applications in northern or southeastern Idaho	
Irrigated wheat	0.6 ppm* on leveled land	2 to 5 lb
Mint	0.6 ppm*	10 lb
Fruit trees	0.6 ppm*	10 to 15 lb foliar-applied
Hops	0.6 ppm*	20 to 25 lb in new yards; 1 to 3 lb in established yards
Vineyards	0.6 ppm*	20 to 25 lb before planting; 1 to 3 lb foliar-applied in established yards
Raspberries and strawberries	Have not responded to zinc applications in Idaho	

*0.6 represents 0 to 12 inches. If 0 to 9 inches use 0.8 ppm.

Table 4. Procedures for sampling Idaho crops for zinc tissue levels.

Crop	Stage of growth	Plant part to sample	# plants to sample	CNR* ppm Zn
Potatoes	early tuber set, 50 to 60 days after planting	Petiole of most recently mature leaf 4th or 5th from top	20 to 30	10 to 20
Sugarbeets	beets 2 to 3 inches in diameter; July 15 to 30	petiole of most recently matured blade	30 to 40	8 to 12
Onions	bulbs 1 inch in diameter; about July 1	most recently matured leaves, 3rd or 4th from center	50 to 75	15 to 25
Dry beans	mid season bud stage	youngest mature leaf or whole tops	20 to 30	20 to 25
Alfalfa	1/10 bloom	top ½ of shoots	40 to 50	10 to 14
Sweet corn	silking	1st leaf below primary ear	30 to 50	10 to 15
Grain (wheat, barley, oats)	after heading	leaves 2nd node below head	50 to 100	20 to 25
Hops	early bloom	1st leaf sidearms	30 to 50	12 to 20
Mint	early bloom	1st unbranched stem from top	25 to 60	20 to 25
Fruit trees: apples, cherries, peaches, pears, prunes	early August	midterminal leaves	50 to 100	15 to 20
Strawberries	August	recently mature petiole	50 to 75	25 to 50

*CNR — critical nutrient ranges for zinc in plant tissue.

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