



The narrow, long, slightly twisted cabbage leaves from molybdenum deficiency are the reason for the name "whiptail."



The photo illustrates the important role molybdenum performs in plant growth.



Another example of poor plant growth when molybdenum supplies are too low.

# MOLYBDENUM

# Mo

## A Micronutrient

### Section 1:

### DEFINITION OF MOLYBDENUM

The chemical symbol is Mo.

Molybdenum is a silvery-white, metallic element.

It is almost infusible—that is, it is almost incapable of being fused or melted.

The use of molybdenum as a fertilizer in growing crops is increasing so rapidly that it may soon be recognized as a major micronutrient.

The nutrient is vitally important, but only minute applications of the element are required. In fact, the application rate is in grams or ounces rather than pounds.

Two crop diseases stem from molybdenum deficiency:

1. Whiptail of cauliflower, broccoli, cabbage, etc.
2. Yellow spot of citrus.

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### Section 2:

### CHEMISTRY OF MOLYBDENUM IN PLANTS

It is generally accepted that molybdenum serves as a catalyst inside plants in their enzyme system.

The enzyme systems reduce nitrate nitrogen to ammonium, which is used in the synthesis of amino acids and protein.

Molybdenum functions in nitrogen fixation by the rhizobia bacteria-producing nodules on roots of leguminous plants and also the nonsymbiotic bacteria (symbiosis is the union or living together of two unlike organisms).

As far as has been established, molybdenum toxicity in plants is in relation to livestock production only.

Toxicity can be experienced in concentrations above 10 ppm (dry weight) in green forage.

Areas of severe molybdenum deficiencies are few, but they do exist—some in California, Florida, Africa, and Australia.

The normal functioning of the life processes of the microorganisms of both green plants and animals depend on available molybdenum.

Applying molybdenum salts to pasture crops must be done with extreme caution.

Molybdenosis disease affects cattle grazing on pastures containing toxic levels of molybdenum. This disease can be fatal to cattle, but it need not occur.

Within plants, molybdenum plays a crucial role in the nitrogen transformation processes.

Following is a list of some of the more sensitive crops to molybdenum deficiency:



An early symptom of molybdenum deficiency is the missing parts along the edge of the cabbage leaf.



The holes and missing parts in the cabbage leaves suggest molybdenum deficiency.



The narrow bottom leaves (both left and right sides) of the cabbage plant indicate molybdenum deficiency.



The narrow curled leaves on the red cabbage is whiptail disease, caused from molybdenum deficiency.



The cabbage plants have no deficiency. Notice all the leaves are fully developed.

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tomato, potato, lettuce, spinach, celery, beet, all brassicas, and rape.

The characteristic symptoms of deficiency in the brassica group are: narrow leaves with a slight twisting effect called whiptail disease.

In legume crops, the symptoms of deficiency are not as specific. They generally resemble nitrogen deficiency.

It is rare that grasses exhibit distinct molybdenum deficiency symptoms.

As a general statement, the most obvious symptoms of molybdenum deficiency in the early stages are similar to the symptoms of nitrogen deficiency in all crops except grasses and the brassicas.

The predominant symptom of molybdenum deficiency is whiptail disease in cauliflower, cracked stem of celery, etc.

Many growers do not recognize molybdenum deficiency symptoms.

The outstanding feature of molybdenum in crop production is the very small amount required to correct a deficiency.

Applications of the nutrient to correct a deficiency are made in grams or ounces.

To the untrained eye, the deficiency is often mistakenly diagnosed as insect damage.

Sometimes just rolling the seed in molybdenum powder is sufficient to satisfy crop needs.

Molybdenum is essential for crops to perform their proper functions.

Crops such as vegetables and legumes respond fast and favorably to applications of molybdenum.



**Twelve ounces (360 grams) of molybdic acid in 55 gallons (U.S.) of water is sufficient to treat more than 1,000 cabbage plants to correct molybdenum deficiency.**



**Here is a typical example of shredded leaf edges caused from molybdenum deficiency.**



**Another example of shredded leaf edges caused from molybdenum deficiency.**

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One foliar feeding with molybdenum salts is usually sufficient to satisfy a crop, and one application may last for several succeeding crops.

Molybdenum toxicity has never been recorded as having adverse effects on people.

Molybdenum toxicity has been recorded affecting ruminants (grazing animals).

Fertilizing pastureland with 200 pounds copper sulfate per acre will neutralize the toxic effect of molybdenum.

Another method used to neutralize molybdenum toxicity in sick grazing animals is to inject copper sulfate directly in the bloodstream. The disease is called molybdenosis.

Whiptail disease can be corrected easily with molybdenum salts, providing the proper amount is used and the correction applied promptly.

The production of nitrogen nodules on leguminous plant roots is dependent on molybdenum supply.

A delicate balance seems to exist within the plant between nitrogen, iron, manganese, and molybdenum. All appear to be interdependent on each other.

Molybdenum deficiency affects the manufacture of chlorophyll within the cells of green plants.

Molybdenum deficiencies are nearly as common today as are deficiencies in nitrogen.

Because molybdenum deficiencies are so common today, the symptoms should be better recognized.



Healthy broccoli plants must have adequate molybdenum.



Severe molybdenum deficiency is seen in the long narrow cauliflower leaves.

## Molybdenum—Mo

### Section 3:

### CHEMISTRY OF MOLYBDENUM IN THE SOIL

Native supplies of molybdenum in the soil are very small.

There is usually only one to three ppm, which is less than six pounds an acre in the first eight inches of soil.

Molybdenum toxicity strong enough to affect cattle is less than 10 ppm an acre, or about 20 pounds.

Molybdenum availability to plants is highest when the soil pH is nearly neutral.

In this respect, molybdenum is unlike most of the other essential trace minerals, which are more easily available to plants in acid soils.

Applying sulfuric acid to the soil as a treatment can reduce the availability of molybdenum mainly because it lowers the pH.

The availability of molybdenum is influenced by the following factors:

1. The pH of the soil, presence of sulfates in the soil, soil phosphates, manganese, and also because of the very small reserves of molybdenum normally in the soil.
2. Applying lime to acid soils usually increases the availability of molybdenum.
3. Through ion exchange, fixed (unavailable) molybdate can be displaced by phosphates.

This chemical reaction indicates that the same soil-fixation compounds may be involved in changing both molybdenum and phosphate into unavailable compounds.



**After correction for molybdenum deficiency, the cauliflower plants have no deficiency.**



**Brassica crops (cabbage family) are especially sensitive to molybdenum deficiency. If not corrected, entire crops such as cauliflower can fail completely.**

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Molybdenum deficiencies occur more often in acid soils than on neutral soils.

One and one-half pounds molybdenum per acre is an average application.

The maximum application of molybdenum is not more than six pounds per acre.

The total native supply of molybdenum in mineral soils is very small. And like phosphorus, the molybdenum is fixed (unavailable).

Liming acid soils helps to increase the supply of molybdenum for plant use.

Because of the very low native supply of molybdenum in soils, soil tests are not effective in analyzing for molybdenum and therefore are *not* recommended.

Rhizobia bacteria in the soil cannot perform their valuable functions for legume crops without molybdenum.



The distorted cauliflower leaves indicate severe molybdenum deficiency.



This brassica crop has no deficiency.



The partial leaf (bottom right) is the result from molybdenum deficiency.

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### Section 4:

### FORMS OF MOLYBDENUM UTILIZED BY PLANTS

Following is a list of the most frequently used molybdenum fertilizer compounds:

1. Molybdic acid (powdered or liquid)
2. Sodium molybdate
3. Ammonium molybdate

In addition, for special cases, molybdenized phosphate or molybdenized calcium are used to supply molybdenum.

Regular commercial fertilizers seldom contain more than a few parts per million of this element.

Molybdenum fertilizers are effective in foliar feeding and are recommended for this purpose.