Copper Deficiency in Beef Cattle:

Pasture-Applied Copper Study in Coos County, Oregon

by Amy Peters, Livestock Extension Agent

Introduction

Copper deficiency has been diagnosed in grazing beef cattle in coastal Oregon. Copper deficiency can cause herd health problems, lower production, and cost producers money. Periodic monitoring of copper status is essential for proper supplementation.

Signs and symptoms of copper deficiency include: change in hair coat color, diarrhea, decreased weight gain, unthrifty appearance, anemia, fractures, lameness, and decreased disease resistance. The specific signs depend on the cause of the deficiency, and this contributes to confusion in diagnosis. Copper deficiency lowers the immune system and can make cattle more susceptible to disease, as well as less responsive to vaccines.

Copper is responsible for many functions in the animal. One function is hemoglobin formation. Hemoglobin is a protein in the red blood cells that contains iron and carries oxygen to tissues. Copper also plays a role in bone cell function, pigment production, hair, hoof and horn formation, and animal growth.

Your veterinarian can confirm a deficiency by taking blood samples or liver biopsies. Serum copper analysis is used primarily to identify advanced deficiency. Since copper is stored in the liver, liver samples may be necessary for monitoring the effectiveness of a copper supplementation program. To pinpoint the problem, other tests may include soil, water, and forage sample analysis.

Copper Requirements in Cattle

Cattle diets should contain about 4-10 parts per million (ppm) of copper, with calves on the lower range and cows at 10 ppm. Less than this amount results in a primary copper deficiency. Primary copper deficiency occurs when the basal diet is low in copper. Secondary copper deficiency occurs when there is an interrelationship with other minerals, most commonly sulfur, molybdenum, and iron. Diet and water sources high in S or Mo can interfere with copper uptake. Mineral ratios in the diet are important for animal performance. An example of an acceptable Cu:Mo ratio is 5:1 to 10:1 in the diet. A copper to molybdenum ratio of 2:1 or less can cause severe interference with copper absorption and result in copper deficiency.

Although molybdenum and sulfates are the most common substances to interfere with copper uptake, other situations have also been recognized. Soil ingestion due to overgrazing, excess cadmium, excess zinc, and excess calcium, particularly as limestone, can all cause copper deficiencies in cattle. Liming acidic soils can increase molybdenum uptake by plants.
One study reported that molybdenum concentrations of 4 ppm in the plant can decrease copper availability by 60 to 80%.

Trace mineral deficiencies are not created or cured “over night”. Deficiencies are created over a period of months. If calves are born from cows with marginal liver stores of trace minerals, then calf immune function and performance can be compromised. When cattle are stressed, the demand for micronutrients is critical. Work with your veterinarian and OSU Extension to prevent copper deficiency and also the possibility of toxicity.

**Copper Supplementation in Cattle**

There are several methods of supplementing copper including the following:

- **Mineral or salt mix.** This is an economical means of providing supplemental copper. The rate of consumption can be controlled. If cattle are eating more salt than expected, switching to a copper-free salt can be fed for a time. Copper-supplemented protein blocks can also give good control. Diagnosed copper deficient herds are supplemented with 0.2% to 0.5% copper, for cows consuming 1 oz. of the product per head per day.

- **Injection.** These subcutaneous injections are hard on the cow, marginally effective, and last for 4-6 months or less.

- **Bolus.** Copper boluses are given orally and persist in the reticulum-rumen. They contain a measured amount of copper oxide in the form of small needle particles which results in slow release of copper over a prolonged period of time. The copper bolus may take more time to raise blood copper levels than other methods; a problem if cattle are already deficient. Copper boluses may also contribute to lower forage fiber digestibility and poorer cow and calf performance.

- **Foliar Applied.** Applying copper directly to pasture plants is a method of supplementation recently studied on the South Coast. With this method, the copper sulfate is applied directly on the pasture grass.

**Foliar-Applied Copper Study**

The study site was located near Coos Bay, Oregon on a beef cattle ranch with a history of copper deficiency problems. Traditional methods of copper supplementation including copper injections, salt/mineral mix, and boluses, had all been tried in the past with varying degrees of success. There was interest in foliar-applied copper as a quicker way to increase blood copper levels in the herd.

Test plots were established in a representative bottom-ground pasture dominated by bentgrass, velvetgrass, and tall fescue. Treatments were applied in April 1997 and included three levels of copper sulfate (1, 5, and 10 lb/acre), a lime application, and a non-fertilized control. Copper sulfate (Nortrace®) was applied once in a powdered form directly to the plants using a hand-held fertilizer spreader. Lime treatment rate was 2 tons/acre. Lime was included as a treatment since it makes copper less available through an increase in molybdenum. Pasture samples were taken in June 1997, December 1997, and June 1998 by clipping to ground level.
Soil samples were taken of the pasture test plot prior to copper or lime application. Animals did not have access to the copper fertilized plot.

Serum blood samples of 10 cows and 10 calves were taken by a local veterinarian in 1997 and 1998 to confirm copper deficiency and monitor copper status in the herd. Liver samples of cattle that had died were also used to determine copper status. The 1998 samples were taken after copper boluses had been used for several years and the animals had access to a mineral mix that contained 0.5% copper. These samples were not part of the study but were used as additional information on herd copper status.

Results and Discussion

Pasture. Although the soil copper value was adequate, forage plant copper was not adequate, indicating copper was not effectively taken up by the plants. Through application of copper to pasture, copper in the forage was increased to an acceptable level. The 5 lb. and 10 lb. rates were found to meet animal requirements (Fig. 1).

Soil. Soil test results indicated an extremely low pH of 4.6 (Fig. 2). Most high quality pasture species need a minimum pH of 5.5. The phosphorous and potassium levels were also low. The calcium content was lower than magnesium, which indicates a possible problem (calcium should be higher than magnesium). The SMP lime requirement test that is used to estimate the amount of lime required to raise the pH of soil was very low. To raise the test soil pH to 5.5 would take more than 6 tons lime per acre. The soil sample was also high in organic matter which can make copper less available to the plant and, therefore, the animal.

Blood. Cow and calf blood samples were used to confirm deficiency and compare copper supplementation effectiveness. Normal blood copper levels should be at least 0.7 ppm. Most of the cows were below this level and, therefore, copper deficient. Only one cow had an adequate amount of copper in her blood. Only one calf had an adequate amount of copper and all others were deficient or marginal (Fig. 3). Animals were tested for both copper and selenium. Selenium was measured in addition to copper for two reasons: 1) we are in a selenium deficient area, and 2) selenium helps copper become available to the cells. An adequate amount of selenium for calves is 120 ng/ml. Most were deficient.

Conclusion.

Application of copper directly to the pasture plants increased forage copper levels. The 5 lb. rate provided adequate copper for cattle for 6 months. Based on soil test results and pasture condition observations, improving pasture and grazing management should help address copper deficiency problems in grazing cattle. Pastures should be fertilized according to soil test results, reseeded if lacking desirable forage species, and properly grazed, allowing plants time to rest and recover after grazing. Correcting soil fertility and grazing management issues can provide higher quality forage which contains higher mineral levels.

Further research should examine if foliar-applied copper will increase the copper level in the animals. Cattle would need to be allowed to graze areas treated with foliar-applied copper. Blood or liver samples taken before and after treatment could help provide more information on this method of copper supplementation.
Fig. 1  Pasture samples were clipped on three dates in 1997 and 1998 from non-fertilized plots (control), or plots treated once with 1, 5, or 10 lbs. per acre or 2 tons per acre of lime.

<table>
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<tr>
<th>Soil Sample Results</th>
<th>Recommended Rate</th>
<th>High or Low</th>
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<tr>
<td><strong>pH</strong></td>
<td>4.6</td>
<td>5.5 to 7.0</td>
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<td><strong>Phosphorous (P)</strong>-ppm</td>
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<td><strong>Potassium (K)</strong>-ppm</td>
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<td><strong>Calcium (Ca)</strong>-meq/100g</td>
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<td><strong>Magnesium (Mg)</strong>-meq/100g</td>
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<td><strong>Copper</strong>-ppm</td>
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<td>0.6</td>
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<td><strong>SMP buffer</strong></td>
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</tbody>
</table>

Fig. 2. Soil sample results from pasture study site near Coos Bay, Oregon.
Fig. 3. Blood samples were taken from one copper deficient herd where forage plots were established.

References

Maas, J. 1997. Copper Deficiency, University of California Cooperative Extension Livestock Health Fact Sheet No. 7.


Nortrace® Citraplex® 20% Copper, Balcom Chemicals, Loveland Products Inc., Greeley, CO.