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IPNI

Agronomic fact sheets on crop nutrients

Selenium

NO. 17

AUSTRALIA AND NEW ZEALAND GRAINS EDITION

Selenium (Se) is not an essential nutrient for plants but is required for many physiological functions in humans and animals. Animals obtain Se primarily from the food that they consume, therefore it's accumulation by plants is very important as it impacts animal and human health.

Selenium in Plants

Selenium is not classified as an essential plant nutrient as it is not involved in any essential functions for plants. However, it is essential in more than 20 human proteins, and is involved in a diverse number of roles such as cancer protection, anti-oxidants, maintaining defences against infection, and regulating proper growth and development[1].

Selenium behaves very similarly to sulfur (S) and can be substituted for S in many plant proteins and enzymes. Plant species that have a high S requirement also have a tendency to accumulate larger amounts of Se. At very high Se concentrations, this substitution causes metabolic problems and can become toxic for plants.

Some plant species are able to accumulate very high levels of Se. These plants include those within the *Brassica* genus, brazil nuts, whole grains, and edible seeds. A number of non-agricultural plants are able to accumulate Se to concentrations where it is toxic when consumed by livestock. Accumulator plants may accumulate up to 3,000 ppm Se, compared to less than 1 ppm in most food crops.

Selenium in Soils

Selenium is found in both organic and inorganic forms in soil (**Figure 1**). However, plants only utilize Se from the soil in the inorganic form. The forms of Se in the soil include:

Selenate (Se^{6+}): is the most readily available form of Se. Selenate is most likely to be found in well- aerated, neutral pH soils.

Selenite (Se^{4+}): is found in aerated soils with acid to neutral pH.

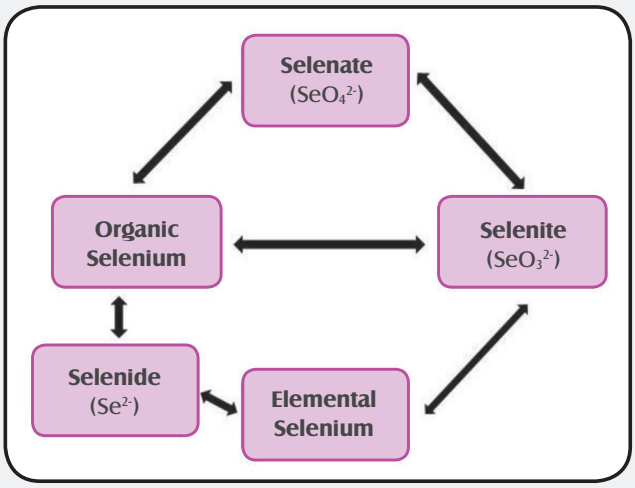

Figure 1. Selenium cycle in soil.

Selenite is much more reactive with various soil minerals than selenate, making it less soluble in the soil solution and less subject to leaching[2].

Elemental Selenium (Se^{o}) and **Selenide** (Se^{2-}): are found in acidic, waterlogged soils and are not available for plant uptake[3]. These are the forms of Se that are returned to the soil in the manures of livestock.

Organic matter is an important reservoir for Se in the soil. Microbes transform Se into soluble Se or volatile Se compounds that are unavailable for plant uptake[4].

Selenium Deficiency

There are no known functions of Se in plants, therefore the only concern related to Se deficiency in plants is for the animals that consume them. Animals need an adequate supply of Se in their diet to avoid a number of health problems that can lead to premature death. There are no symptoms of Se deficiency in

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High Se-accumulating crops include those within the Brassica genus. Other high-Se foods include Brazil nuts, whole grains, and edible seeds. A useful resource to determine the nutrient content of food (including selenium) can be found at http://ndb.nal.usda.gov/ndb/nutrients/index

plants, and performing soil and plant tissue tests to diagnose low Se is an unreliable and indirect method of estimating the Se status of animals. Assessing animals themselves is a much more appropriate way to detect Se deficiency in animals.

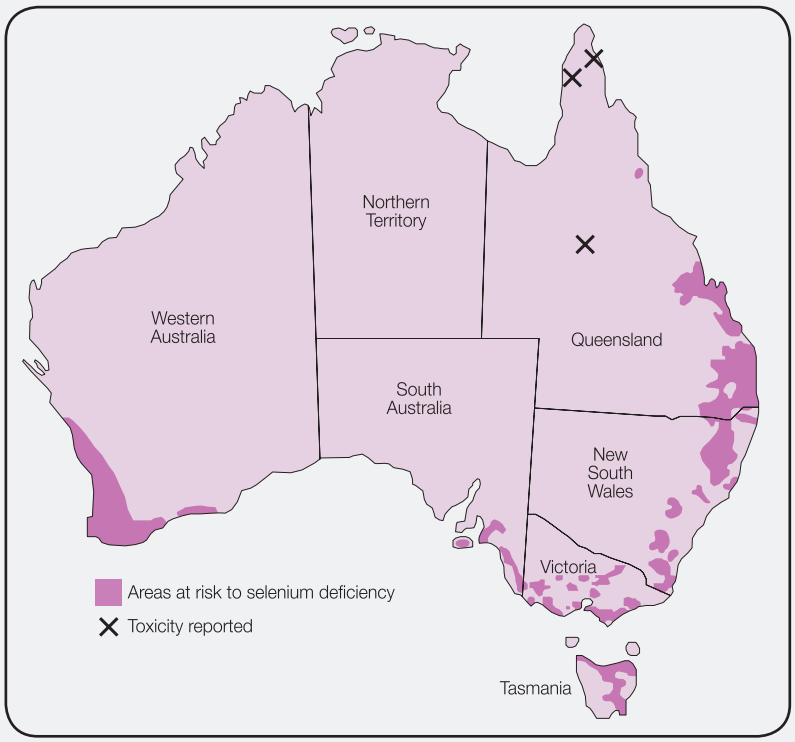
Many grazing areas in Australia are at risk of causing Se deficiency in livestock. Deficiency is more common in acid, waterlogged soils as Se is less likely to be converted to a plant available form in anaerobic soils. The concentration of Se in the soil is not the only cause of Se deficiency in animals. The dilution of Se in livestock feed is another problem that may lead to deficiency in animals. This can occur after the addition of growth stimulating fertilizers, such as nitrogen (N), or a change in the grass to legume percentage in feed. Grasses take up more Se than legumes, therefore if the animal's diet decreases in grass and increases in legumes then their overall Se intake is reduced, increasing the risk of deficiency, despite the amount of dry matter remaining constant or even increasing.

Fertilizing with Selenium

Plants are never fertilized with Se to boost yields, only to supplement the Se concentration in the harvested or grazed crop[5]. Some soils support crops that contain Se at concentrations too low to meet human and animal nutritional requirements. Selenium fertilizers can be top-dressed at a maximum permitted rate of 10 kg/ha to increase the Se concentration of the feed.

Because selenate is so readily available for plant uptake and the risk of toxicity to humans from excessively high Se concentrations, many farmers prefer to use the less soluble selenite fertilizer where supplementation is needed. Sodium selenate is a quick release form of the nutrient that has a residual effect of about 15 months. Barium selenate is a slow release form of Se and has a residual effect of around four years. A mixture of the two forms is registered for use in Australia[6].

Soil properties influence plant uptake of Se from soil. Selenium uptake generally decreases with increasing amounts of clay, iron oxide and organic matter in the soil. To avoid soil factors that make Se supplementation difficult, foliar and seed applications of supplemental Se are successfully used to boost plant Se concentrations.



The distribution of selenium deficiency in Australia[7].

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Further Reading

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