Selenium: Essential for Animals, Not for Plants

By Robert Mikkelsen

Selenium (Se) is essential for many physiological functions in humans and animals, but not for plants. In humans, it is present in more than 20 proteins that are involved in roles such as cancer protection, anti-oxidants, maintaining defenses against infection, and regulating growth and development. Since Se is obtained primarily in food, its accumulation by plants is of interest.

The accumulation of Se by plants has been studied worldwide, even though it is not classified as an essential nutrient. Many regions grow crops that contain insufficient Se to meet human and animal nutritional requirements. In these locations, efforts have been made to increase plant Se concentrations. Other areas have problems with excessive Se found in vegetation. When plants contain very high Se concentrations, animals that consume these plants can be at risk of toxicity (called selenosis).

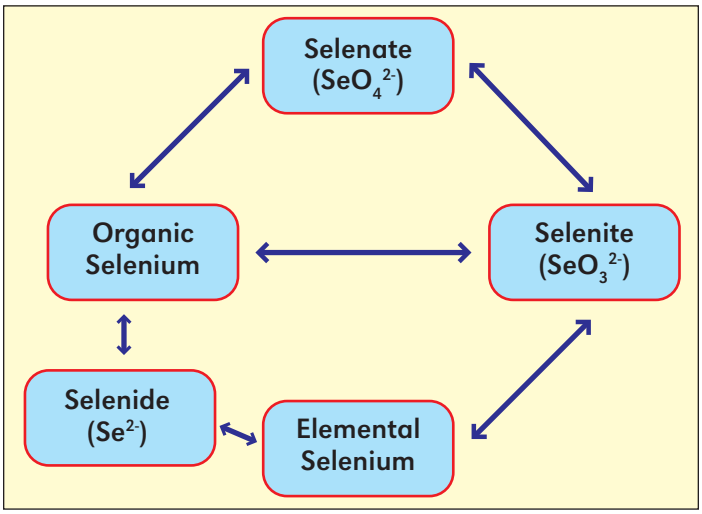
The uptake of Se by plants is governed by many soil and plant factors. The most important factors determining uptake are the chemical form and the concentration in the soil. Other important factors in determining the accumulation of Se by plants include soil properties such as pH, clay content, soil mineralogy, and the concentration of competitive ions.

The capacity of different plant species to accumulate Se also varies widely. For example, Se-accumulating plants such as some species of the genus *Astragalus* can contain up to 20,000 parts per million (ppm) Se, whereas most agricultural crops contain less than 1 ppm.

The chemical state of Se in soil is a very important factor in the ability of plants to acquire it. It is found in several different oxidation states:

Selenate (Se^{6+}): This form (SeO_4^{2-}) is the most readily taken up by plants. It is very soluble and behaves quite similarly to sulfate (SO_4^{2-}). Selenate is most likely to be found in well-aerated, neutral pH soils. Selenate is translocated directly from the roots to the leaves and stored in the cell chloroplasts before being converted to organic compounds such as selenomethionine. An abundance of sulfate in the soil inhibits the uptake of selenate since they both compete for uptake at the same transport sites of roots.

Selenite (Se^{4+}): This form (SeO_3^{2-}) is more typically found in aerated soil with acid to neutral pH. Selenite is much more reactive with various soil minerals than selenate, making it less soluble in the soil solution. When plants take up selenite, much of it is converted to organic compounds (such as selenomethionine) before being translocated in the xylem.



Selenium cycle in soil.

Elemental Selenium (Se^{o}): Metallic selenium is quite insoluble and not available for plant uptake.

Selenide (Se^{2-}): This form of selenium is found primarily in soils under strongly reducing conditions (such as flooded soils). It may be present in a combination with a variety of minerals and organic compounds. It is mostly unavailable for plants in this form.

When Se concentrations in human or animal food are considered too low, Se-fortified fertilizer has been used to boost the supply. Wide-spread Se fertilization is routinely performed in Finland and New Zealand to boost the Se concentration in forages and cereal crops. There are other areas of the world where the Se concentration is low and fertilizer fortification with Se may be useful.

The range between Se deficiency and toxicity for humans and animals is fairly small. Careful study should be done before a program is initiated to boost the Se concentration of crops to avoid excess accumulation and potential toxicity. BC

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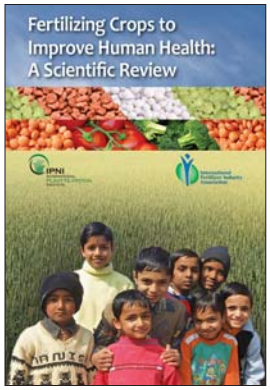

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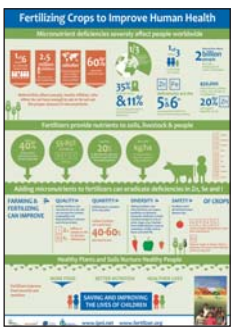

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