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Silicon – a role in agriculture too

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A group of Japanese scientists report that they have isolated the gene that affects how efficiently the rice plant takes up silicon from the soil. This is important because silicon plays an important role in the yield of rice plants.

Silicon, one of the most abundant of the elements of the earth, has held centre stage for its role in semiconductors and electronics. But it has also played a role no less important in helping grasses and cereals, the rice plant being a leader, to stand erect and receive the sun!

Silicon

Silicon, which occurs in clay, feldspar, granite, quartz and sand, makes up 26% of the weight of the earth's crust. It occurs mainly as silica, which is the oxide, or as silicates, which have one or more metal atoms too. The pure metal is the main element in semiconductors and silica and silicates are used in glass, cement, ceramics.

And important property of silicon is that like carbon, its atomic structure has four electrons in the outer shell. Now, atoms have a tendency to form compounds by sharing or exchanging outer shell electrons so that they end up with two or eight outer electrons. Carbon, being 'halfway', with four outer electrons, is able to strike a variety of 'bargains', some exchange, some share, and so on, and hence the versatility of carbon in forming compounds. This is also the reason that life itself could evolve!

Silicon too, though heavier than carbon, has these four outer electrons and shows similar versatile chemical behaviour. The reason silicon based life itself does not seem to be possible is that a silicon-cycle, unlike the carbon-cycle, is not viable at temperatures that could sustain life. But silicon still shows interesting chemical properties and compounds, including ***silicones***, a class of chain molecules that are useful in special rubbers and gels. Some bacteria and other life forms also have silica based skeletons and some bacteria use silicates in their metabolism.

Plants and silicon

Many plants take up silicon from the soil. A plant that hold more than one gram of silicon in a kg of dry weight is considered a *silicon accumulator*. The tomato, cucumber and soybean are poor accumulators but many plants, like wheat, oat, rye, barley, sorghum, corn, and sugarcane contain about ten gm/kg. The rice plant is the leader, with over a hundred gm/kg.

This extraction of silicon from the soil, at levels greater than even essential nutrients (like nitrogen, potassium,phosphates), can deplete the soil of silicon. Soil hence needs addition of silicates to get the silicon content back to required levels. The silicon content helps contain disease and pests and most important, helps the tissue of the plant stiffen and stand erect.

Silicon is taken up by the roots and carried up to the shoot and finally deposited in the cell wall material in the form of a chain molecule consisting of silica and water. This forms double layers of silica with cuticle or cellulose on the surface of leaves, and stems.

The silicon increases resistance to disease and pests. It also gives the frame work of the plant the firmness to stand tall and intercept the maximum sunlight. This directly results in faster photosynthesis and greater yields. A mutant version of rice which has low silicon content is found to be susceptible to disease and pests and has a yield only a tenth of its wild cousins.

The Japanese scientists report in this week's ***Nature*** that they worked on this deficient strain of rice and have isolated the gene that encodes for a silicon transporter in the plant roots. Popular varieties of rice can then be engineered to have greater silicon content and greater yields. The group also suggests that plants with greater silicon content would improve silicon nutrition in humans, who need silicon for bone and connective tissue.