Despite silicon’s (Si) abundance in the earth’s crust and in soils, and its notable concentration in many terrestrial plants, the essentiality (or at least quasi-essentiality) of Si in basic plant biology is still contested and its general importance largely ignored (Epstein, 1994, 1999, 2009). However, Si is coming to the fore as a true ‘Cinderella’ element, attracting the interest of researchers from an increasingly diverse array of fields for its evidently valuable roles in plant nutrition, physiology and defence. The beneficial effects of Si fertilizers on plant growth and crop yields are now well documented in the literature, but it is in the arena of amelioration of plant stresses, both abiotic and biotic, that Si is showing its true potential (see Ma, 2004; Datnoff et al., 2007 for reviews).

The abiotic stresses that Si fertilisation helps to alleviate include drought, water logging, frost, salinity and heavy metal toxicity (Liang et al., 2007). Biotic stresses against which Si provides some protection include infection by plant pathogens and herbivory by various arthropods and vertebrates (Datnoff et al., 2007; Kvedaras et al., 2009a). It is also becoming increasingly apparent that plants fertilised with Si may see little benefit unless the plant is under some form of imposed stress (Epstein, 2009). This is evident from studies, too numerous to cite here, at the whole-plant, physiological, cellular and molecular levels (Fauteux et al., 2006; Kvedaras et al., 2009a). However, Brunings et al. (2009) show that there may be important exceptions to this, e.g. in rice, where Si may be an integral part of rice metabolism, affecting gene regulation in the absence of stress, and is therefore possibly essential for this crop.

We believe it is not premature to speculate that Si will be shown to assist plants in resisting attack by parasitic animals (e.g. plant-parasitic nematodes) and plants alike. Recently, a study by Kvedaras et al. (2009b) showed that Si can improve host plant defence via the third trophic level by enhancing natural enemy attraction and biological control through induced plant defences, likely through a change in the volatile profile produced by plants when attacked by an insect herbivore. Research has also revealed that Si displays a marked resemblance to plant stress hormones such as jasmonate and salicylate in its ability to act as a modulator of induced resistance, such that plants respond more efficiently or earlier to pathogen or herbivore attack (Brunings et al., 2009; Fauteux et al., 2006; Kvedaras et al., 2009a). Such a role can only be fulfilled by Si in its soluble form as silicic acid within the plant, and not as hydrated insoluble (and immobile) plant silica (see synopsis of recent evidence by Walters & Bingham, 2007). However, this does not detract from the likely mechanical role of plant silica, especially in grasses, as a defence against insect herbivores. This was demonstrated most recently by the experiments of Massey & Hartley (2009). This raises the point that there is ample controversy within the field of plant Si research surrounding the mode of action (physical and/or chemical) of Si-mediated defence of plants against pathogens (e.g. Rodrigues et al., 2004; Walters & Bingham, 2007) and whether Si provides any defence against vertebrate and invertebrate herbivory (e.g. Hochuli, 1993; Vicari & Bazely, 1993; Sanson et al., 2007). Nonetheless, the weight of evidence now leans strongly in favour of plants using Si in an adaptive
role for defence against both biotic and abiotic stresses (Epstein, 2009).

This rich tapestry of discovery and debate within the field of plant Si research has provided a foundation for increasing interest in the fundamental aspects of Si’s role in plant biology and ecology. Alongside this and strongly linked to it, the potential for application of Si in agriculture is growing rapidly, especially in relation to its benefits in ameliorating environmental stresses. Such fundamental and applied aspects formed the subject matter for the IV Silicon in Agriculture Conference, held from 26 to 31 October, 2008, at the Wild Coast Sun on South Africa’s eastern seaboard near the town of Port Edward. The papers published in this special section form the basis of three of the plenary addresses (out of a total of 12 such addresses) presented during the conference, with that by Emanuel Epstein forming part of the opening session. In this editorial, we have cited and touched on the content of all three plenary papers (Brunings et al., 2009; Epstein, 2009; Kvedaras et al., 2009a). Broad subject areas covered by oral and poster presentations during the conference included the chemistry of Si in soils, Si and a/biotic plant stress and various other aspects, applied and basic, of Si in plants. The abstracts of all oral and poster papers presented at this IV Silicon in Agriculture Conference, along with those from the III conference in this series, are available as freely downloadable PDFs from the URL: http://www.siliconconference.org.za/Silicon_Links.htm.

As Si’s multifarious roles in biology and agriculture continue to be unravelled by physiologists, soil chemists, agronomists, cell and molecular biologists, plant pathologists, entomologists, ecologists and others, there is little doubt that the Silicon in Agriculture Conference series will continue as a forum for stimulating interaction and knowledge dissemination well into the future. The next (V) Silicon in Agriculture Conference will be held in Beijing, China during 2011.

References


