EFFECT OF FOUR SOURCES OF SILICON ON RESISTANCE OF SUGARCANE VARIETIES TO *ELDANA SACCHARINA* (LEPIDOPTERA: PYRALIDAE)

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Soil amendment with various sources of silicon (Si) have been shown to increase resistance of sugarcane to several stem borers (Anderson and Sosa, 2001; Elawad *et al*., 1985; Gupta *et al*., 1992; Pan *et al*., 1979; Savant *et al*., 1999), including that of South African sugarcane to its major pest, *Eldana saccharina* Walker (Lepidoptera: Pyralidae) (Keeping and Meyer, 2002). This study examined the effect of four sources of silicon (calcium silicate from the USA; calcium silicate from Namibia [referred to here as 'local']; Slagment®; and flyash) on resistance of four sugarcane varieties to *E. saccharina*.

In January 2002, a trial with a split-split plot design was established in a shade house at Mount Edgecombe, in the KwaZulu-Natal province of South Africa, using sugarcane of the varieties N26, N30 (both susceptible), N21 and N33 (both resistant) grown in 25 L pots containing leached and sieved river sand. Si sources were incorporated into the sand before planting, at the following concentrations: USA calcium silicate, local calcium silicate and Slagment: S_1 (lower level) = 5000 kg/ha (62 g/pot), S_2 (higher level) = 10 000 kg/ha (124 g/pot); flyash: S_1 = 15 000 kg/ha (186 g/pot), S_2 = 30 000 kg/ha (372 g/pot). Use of the sources at these concentrations provided effective S_1 and S_2 concentrations of plant-available Si of 600 kg/ha and 1200 kg/ha, respectively. Controls (S_0) contained no Si. Whole plots were varieties, sub-plots were silicon sources, and sub-sub plots Si treatment levels. All treatments were replicated six times. Methods of trial establishment, maintenance, moisture stressing, and inoculation with *E. saccharina* eggs to produce a high-level infestation followed Keeping and Govender (2002). Leaf samples were taken four times and stalk samples twice over the course of the trial, to track plant Si uptake in controls and treatments for all variet ies. Sand samples, taken six times from N26 pots only (to eliminate varietal effects), were used to track changes in H_2SO_4-extractable soil Si for each source and treatment level. At 14 months and 43 days after inoculation, the entire trial was harvested to determine borer performance (number and mass of *E. saccharina* larvae and pupae) and stalk damage (length of stalk bored and number of internodes bored).

Significant differences (P<0.001; df=11, 36; ANOVA) in leaf and stalk Si% were detected among Si sources and among treatment levels within source, with plant-Si% values showing a largely consistent increase in accordance with control, low and high treatment levels (Figure 1). The largest increase in plant-Si% (particularly stalk-Si%) resulted from treatment with local calcium silicate, followed by that from USA calcium silicate; plant-Si% from Slagment and flyash treatments was somewhat less and more variable (Figure 1). The lower uptake from Slagment was unexpected in light of its efficacy in raising the Si status of the growing medium (river sand) well above that of the other sources (e.g. 3.7 times higher than that of the USA Ca silicate S_2 treatment; Figure 1).

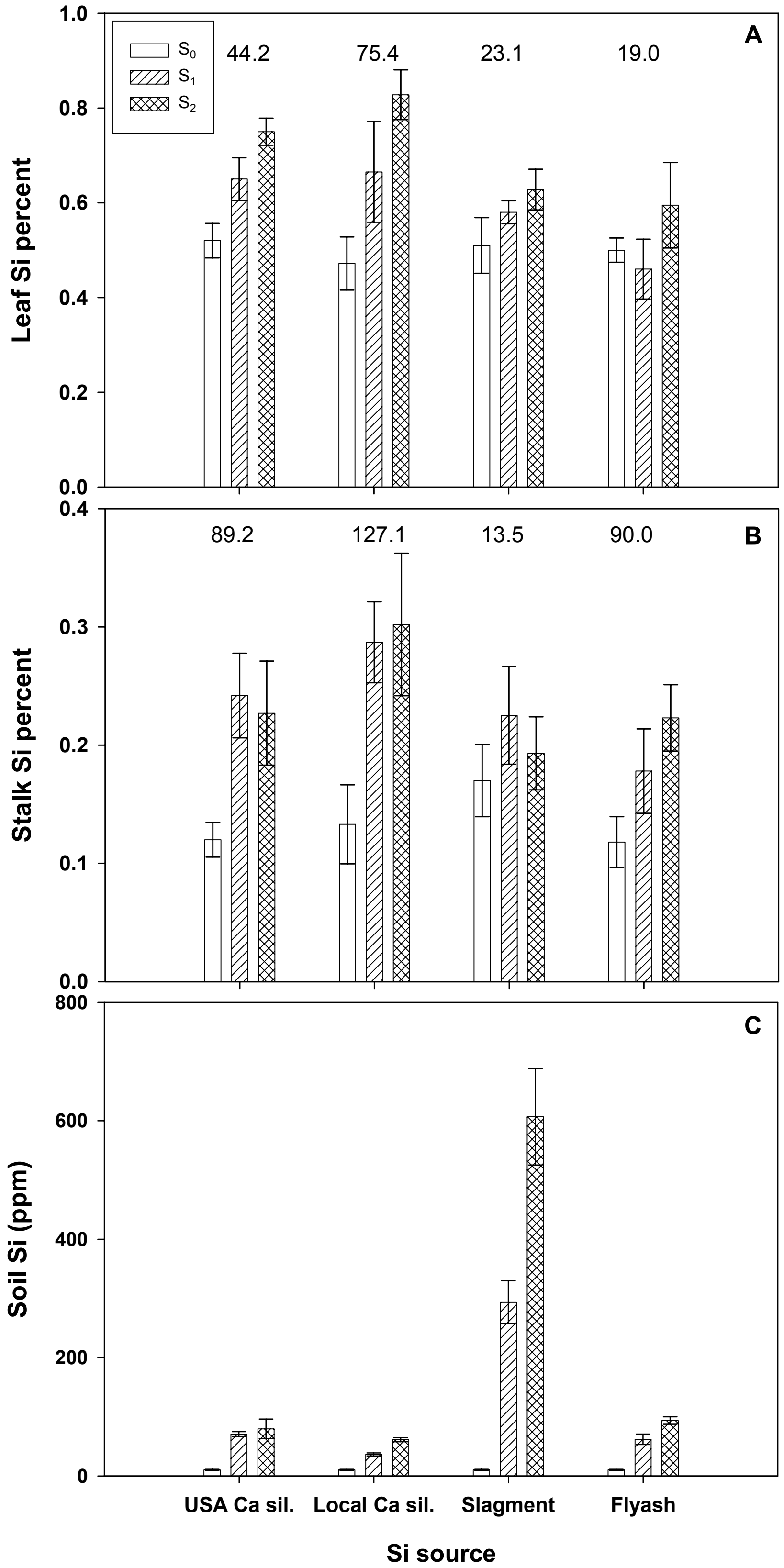

Figure 1. Mean leaf Si per cent (A), stalk Si per cent (B) and soil Si (C) recorded from samples taken on 19 August, 20 August and 5 March 2002, respectively, from each Si source at control (S_0), 5000 kg/ha (S_1) and 10 000 kg/ha (S_2) treatment levels. Error bars are standard errors. Figures above bars in A and B are the percentage increase in Si% between S_0 and S_2.

Although varieties differed in Si uptake from each source, there was no evidence that it was higher in susceptible than resistant varieties. However, there were indications (from the untreated controls) that the resistant varieties had an inherently higher stalk Si content than their susceptible counterparts (Si% mean, range: N21: 0.14, 0.11-0.21; N33: 0.19, 0.16-0.22; N26: 0.08, 0.06-0.09; N30: 0.11, 0.09-0.14). Significant differences between cultivars in leaf Si content (Deren *et al*., 1993) and in Si accumulation capacity (Savant *et al*., 1999) have been demonstrated for sugarcane.

Combining data from all Si sources and varieties, treatment with Si significantly reduced borer damage in terms of both stalk length bored and internodes bored (df=2, 173, $P<0.0001$, ANOVA). Within variety and within source, the trend throughout was a decrease in damage with increasing Si treatment level. All higher level (S_2) treatments in all varieties (except N33 with flyash) recorded a reduction in damage compared with the controls, with the difference being significant in seven of these (Figure 2). In agreement with the greater plant uptake of Si from local and USA calcium silicate (Figure 1), these sources also had the largest effect in reducing susceptibility in N21, N26 and N30 (Figure 2). Slagment achieved its greatest effect in N33 (Figure 2). In certain cases, borer damage recorded from the lower treatment level (S_1) exceeded that of the control (S_0) or was less than that of the higher treatment (S_2), but in only one instance (flyash with N33) did both treatment levels exceed the control in this regard (Figure 2). Indeed, the effect of flyash in reducing damage in all varieties was variable and non-significant (Figure 2).

Across all sources, significant reductions ($P<0.05$; LSD test) in stalk length bored between controls and treatments were recorded most frequently for the susceptible varieties N26 (two sources) and N30 (three sources) (Figure 2). On average, the S_2 treatment reduced damage by 34.4% in the susceptible varieties and by 25.7% in the resistant varieties. This differential effect of Si may be due to an initially lower plant-Si content in the susceptible varieties compared with the resistant ones. A significant interaction mean square ($P<0.0001$; df=5, 173; ANOVA) was obtained for variety x source x treatment level for length stalk bored, supporting the assertion that the effect of Si source and its application level are not independent of variety.

The differential effect of Si on resistance of varieties to *E. saccharina* was also evident when borer numbers were examined. Si applied at the higher level reduced borer numbers in the resistant varieties by 13.2% (averaged across all sources and both varieties), but the differences between treatments and controls were non-significant. However, significant reductions ($P<0.05$, LSD test) in borer numbers between S_0 and S_2 were obtained in the susceptible varieties, with a mean reduction of 30.8% (across all sources and both varieties). The interaction between variety, source and treatment level for borer numbers was significant ($P<0.0001$, df=5, 173; ANOVA).

The results support conclusions from previous pot (Keeping and Meyer, 2002) and field (JH Meyer, unpublished data) trials that soil Si amendments can contribute significantly to reducing stalk damage and yield loss due to *E. saccharina*. Existing trials aim to provide further field confirmation of these results, and to determine the costs and benefits of Si application in reducing borer damage and improving yields using locally available Si sources.

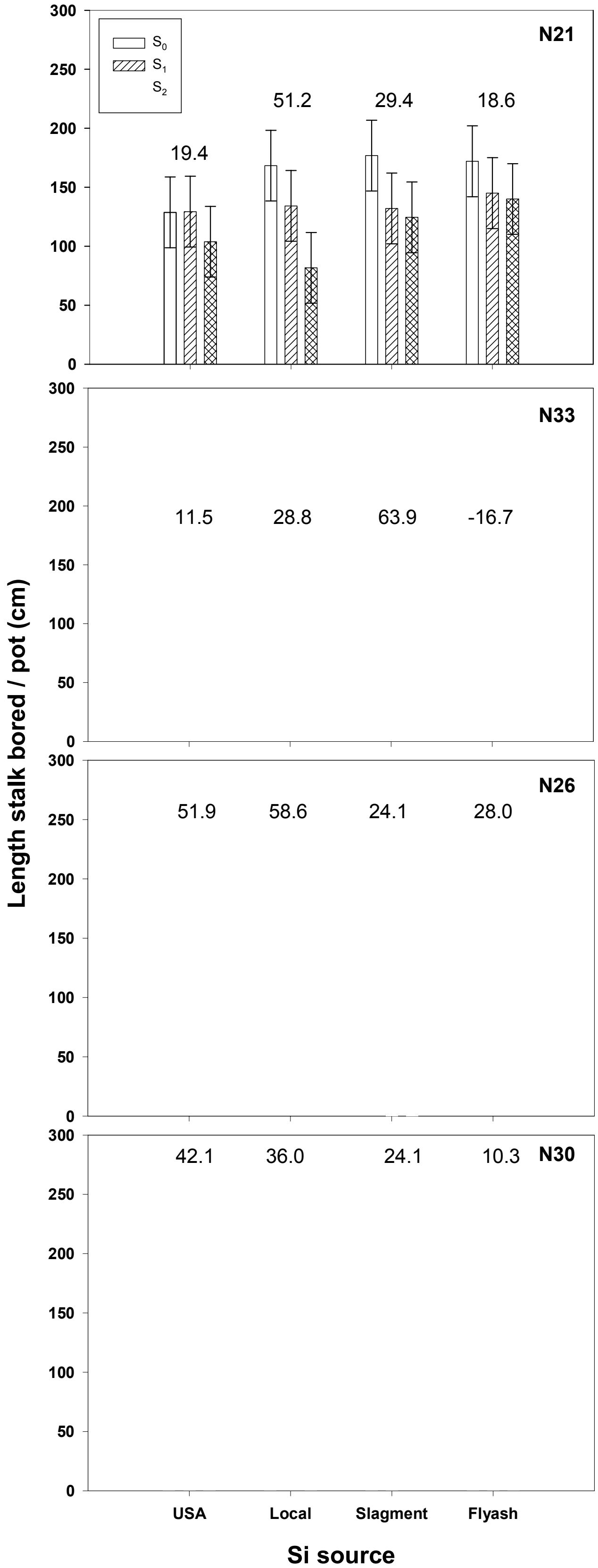

Figure 2. Effect of two levels (S_1 = 5000 kg/ha; S_2 = 10 000 kg/ha) of four sources of Si on stalk damage by *E. saccharina* in four varieties of sugarcane. Controls (S_0) received no Si. Error bars are 95% comparison intervals. Figures above bars are the percent decrease in stalk length damaged between S_0 and S_2.

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