The potential of silicon soil amendment to reduce severity of Fusarium wilt of cotton

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Introduction

Fusarium wilt of cotton caused by the fungus *Fusarium oxysporum* f. sp. *vasinfectum (Fov)*, is an important constraint to sustainable cotton production in Australia. Once a farm is infested with *Fov* it cannot be eradicated, therefore effective and ongoing management is essential for continued productivity.

Silicon (Si) fertilisation has been reported to improve plant resistance to disease and pathogenic fungal attack in numerous crops.

The aim of this work is to examine the potential of silicon amendment to reduce severity of Fusarium wilt of cotton.

Materials and Methods

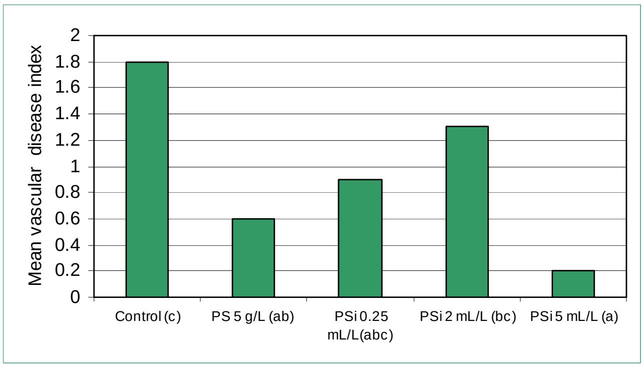
Glasshouse Trials

Trial 1. Gossypium hirsutum cotton cultivar Siokra V17 was sown directly into a field soil/sand mix in seedling flats naturally infested with *Fov*. Potassium silicate (PQ Australia Pty. Ltd.) was applied at 0.25, 2 and 5 mL/L. Two control treatments were water only and potassium sulphate (Sigma-Aldrich) applied at 5 g/L. After 9 weeks seedlings were harvested and examined internally for disease which was rated for severity using a **vascular disease index where 0 = no infection, 1 = base of stem infected below soil level, 2 = infection up to node 0, 3 = infection above node 0, 4 = infection up to top node and 5 = dead plant.**

Trial 2. As described for trial 1 but with some variations. Powder formulations of Si were mixed uniformly through the soil/sand mix prior to sowing. Eight seeds were planted into 10 cm pots.

Field Trial

This trial consisted of 4 rows, each row containing 6 treatment plots that were 10 m in length. All treatment plots were separated by buffers. Treatments applied were 1= magnesium silicate granules 150 kg/ha; 2= magnesium silicate granules 75 kg/ha + magnesium silicate powder 3.5 g/L; 3= potassium silicate powder 150 kg/ha + potassium silicate liquid 10 mL/L + foliar application potassium silicate liquid 2.5 mL/L fortnightly for 8 weeks; 4= As for treatment 3 + potassium silicate liquid foliar application applied monthly until bolls formed; 5= untreated control; 6= potassium sulphate 8 g/L. Magnesium silicate granules and potassium silicate powder were applied by hand to a furrow 10 cm deep in the centre of the raised bed. Magnesium silicate powder suspended in water, and potassium silicate and potassium sulphate solutions were applied to the furrow using a watering can (1 L/m row). Hills were then reformed. Seeds were sown (cv Sicot F-1) and after germination, potassium silicate liquid was applied to foliage using a watering can. The experiment was irrigated and managed commercially. The 5th terminal leaf was collected for nutrient analysis prior to harvest. After harvest, stems were cut horizontally and rated for vascular discolouration where 0 = no vascular discolouration and 1 = 5% or less vascular discolouration.



Graph 1: The effect of weekly application of potassium silicate and potassium sulphate solution on mean vascular disease index

Where PS = potassium sulphate (0.45 g K /seedling flat) and PSi = Potassium silicate solution (maximum K applied = 0.1 g/seedling flat).
Treatments followed by different letters are significantly different from one another (P=0.024)

Treatment	Mean VDI[A] ± SE
Control	1.64 ± 0.38 a
Magnesium silicate (0.7 g/L soil)	0.50 ± 0.32 b
Acidified calcium silicate (1 g/L soil)	0.40 ± 0.40 b
Potassium silicate solution (5 mL/L tap water)	0.15 ± 0.35 b

Table 1: The effect of silicon amendment on mean vascular discolouration index

Means followed by the same letter are not significantly different at the P=0.05 level

Foliar application of potassium silicate

Pre-plant application of granular/powdered Si formulations

Results and Discussion

Results of glasshouse trials suggest that **both Si and potassium may play a role in suppression of Fusarium wilt of cotton seedlings**, with potassium silicate applied at 5 mL/L providing the lowest level of disease (Graph 1). Both liquid and dry formulations of Si significantly reduced disease severity (Table 1). It is important to note that the **effectiveness of Si was influenced by inoculum level of the pathogen**. At higher inoculum levels, Si amendment was not effective in reducing disease severity (data not shown).

Under **field conditions Si uptake was significantly increased** following Si soil amendment in an alkaline soil; however there was **no effect of Si on disease severity or seed cotton yield** (Table 2). This trial site is known for its high inoculum load, and for this reason has been used routinely for screening germplasm and new lines for wilt resistance. It is possible that *Fov* inoculum levels were too high for an effect of Si to be realized. Also, increasing nutrient availability in an alkaline soil can be difficult and may have contributed to poor uptake. It may be that the **threshold level of Si** required in cotton for disease control may not have been met in this trial. Another consideration is that **placement of fertiliser**, which dictates availability of Si for uptake, may not have been optimal as it was applied to a 10 cm trench dug into the raised bed. Rapid drying of the soil surface layers may have reduced the availability of Si in these layers. Deeper application or application uniformly within the plot may have lead to an increased level of Si uptake and Si remaining available during the growing season.

Further research is required to determine the threshold level of Si for disease control and the most suitable Si source and fertiliser placement conducive to silicon uptake.

Treatment[A]	Si content 5th terminal leaf % dm[B]	% 0 and 1's[BC]	Yield kg/10m
1	0.0635 (0.025) a	66 (0.95)	4.47
2	0.071 (0.027) a	73 (1.022)	4.29
3	0.0652 (0.026) a	68 (0.965)	4.13
4	0.066 (0.026) a	69 (0.995)	4.00
5 Untreated control	0.0385 (0.020) b	67 (0.96)	3.85
6 K_2SO_4 Control	0.0362 (0.020) b	68 (0.96)	4.38
LSD (P=0.05)	(0.002)	ns	ns

Table 2: The effect of silicon based products and potassium sulphate on silicon content of the 5th terminal leaf, disease severity assessed as % 0 and 1's, and seed cotton yield of Sicot F-1 grown in soil naturally infested with *Fusarium oxysporum* f. sp. *vasinfectum*

[A] =Treatments where 1= magnesium silicate granules 150 kg/ha; 2= magnesium silicate granules 75 kg/ha + magnesium silicate powder 3.5 g/L; 3= potassium silicate powder 150 kg/ha + potassium silicate liquid 10 mL/L + foliar application potassium silicate liquid 2.5 mL/L fortnightly for 8 weeks; 4= As for treatment 3 + potassium silicate liquid foliar application applied monthly until bolls formed; 5= untreated control; 6= potassium sulphate 8 g/L.
[B] = Data in parentheses are transformed percentage data (ASIN(SQRT(X/100)).
[C] = % 0 and 1's indicates % of plants with 5% or less vascular discolouration when stems are cut at the end of the season. Means followed by the same letter are not significantly different at the P=0.05 level.

More information

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