# Silicon supplementation — a sustainable drought stress management strategy in lentils

**Sajitha Biju, Dorin Gupta and Sigfredo Fuentes**
School of Agriculture and Food, Faculty of Veterinary and Agricultural Sciences, The University of Melbourne, Dookie campus, Victoria, Australia

## Key points

- Drought stress increased the infrared thermal canopy temperature (IRTc) for all lentil cultivars, while the addition of silicon significantly decreased the IRTc under drought stress.
- The lower IRTc in the silicon-treated plots may have been due to a silicon-mediated increase in plant water uptake under drought stress.

## Background

Drought is a major physical stress, which negatively impacts the growth and productivity of lentils. Lentils are an important legume food crop, grown in semi-arid Mediterranean climatic regions worldwide.

Silicon is an essential plant nutrient and its beneficial effects on physical stress tolerance have been reported across several plant species. Moreover, laboratory experiments at The University of Melbourne, Parkville campus, have shown that silicon supplements across a range of lentil cultivars grown in a growth chamber under drought conditions, have proven to be beneficial in improving drought stress tolerance.

## Aim

The field trial aimed to investigate the role of silicon in mitigating drought stress in lentils by assessing the variations in infrared thermal canopy temperature (IRTc) and yield traits.

## Methods

Experiments were carried out under field conditions with selected lentil cultivars:

- ILL 6002 — drought-tolerant
- PBA Jumbo 2 — moderately tolerant
- ILL 7537 — drought susceptible.

Each cultivar was subjected to severe drought stress at the onset of flowering (GSR1).

The treatments were control (C), which was well irrigated, drought stress (D), drought stress with supplemented silicon (DSi), and silicon alone (Si). The experiment was laid out in a randomised block design, with three cultivars and three replicates, using a split plot arrangement across three blocks.

Plants were spaced at 25cm apart in each row. Buffer zones (0.5m) were established to minimise potential silicon contamination via lateral movements in soil.

Silicon was applied to the treatment plots in granular form (source: sodium metasilicate) and was mixed manually with soil one week before sowing. Plots were managed in line with standard growing practices (including seed and fertiliser rates). Seeds were inoculated with Group F rhizobia (*Rhizobium leguminosarum*) and were hand sown at a sowing depth of 2.5cm, at a sowing rate of 120 plants/m$^2$ during May 2018.

Drought-stress treatment plots (D and DSi) were subjected to drought stress by withholding water at flowering (GSR1) for 14 days during mid-October 2018.

The volumetric soil moisture content in each plot was measured using a soil moisture sensor (Theta probe, ML2) on a fortnightly basis throughout the growing season, to ensure the severity of drought stress.

Infrared thermal canopy temperature (IRTc) is considered as a meaningful parameter to identify the severity of drought stress, with higher IRTc readings indicative of plant stress. IRTc was measured from thermal images captured using infrared camera FLIR T-series (Model B360) after 14 days of drought stress treatment. The thermal images were processed and analysed using a customised code written in MATLAB R2018b and the Image Analysis Toolbox to estimate IRTc.

All plots were harvested during December 2018. Above-ground biomass and yield traits (pod number, pod weight, seed number, seed yield) were measured after drying at 40ºC for 72 hours. Statistical analysis of the data (not presented) was carried out using analysis of variance (ANOVA), followed by a Tukey pairwise comparison test between cultivars and treatments using Minitab®v18

## Results

In this trial, drought stress increased the IRTc for all lentil cultivars, while the addition of silicon significantly decreased the IRTc under drought stress (see Figure 1). This provided evidence the addition of silicon augmented drought

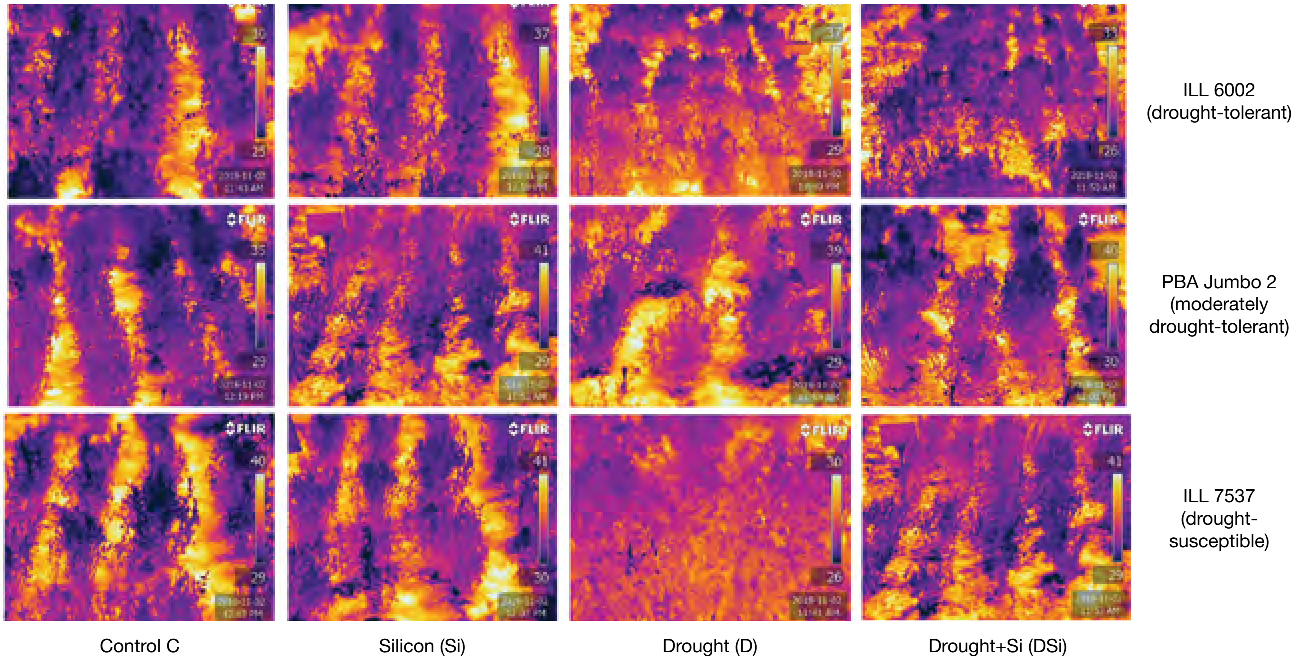


**FIGURE 1** Infrared thermal images from different treatment plots in the field. Purple coloured regions indicate low canopy temperature (non-drought-stressed) and yellow-coloured regions indicate high canopy temperature (drought-stressed)

tolerance in the lentil plots. The lower IRTc in the silicon-treated plots may have been due to an increased capacity for extraction of plant available water when plots were placed under drought stress, compared to the untreated plots.

The above-ground biomass of all the lentil cultivars was enhanced by adding silicon under both drought and non-drought conditions (Note: data not presented as statistically analysed data is soon to be published in a peer reviewed journal). This is consistent with previous findings in lentil seedling research which show an increased capacity for silicon-treated plants to extract water compared to untreated plants.

Grain yield from the plots of the drought susceptible cultivar (control plot) was 0.09t/ha compared with the yield of the drought-susceptible cultivar in the drought-stressed plots (D) (0.03t/ha). The moderately drought-tolerant cultivar yielded 0.26t/ha in the drought-stressed plots supplemented with silicon (DSi) treatment compared with 0.15t/ha from the drought-stressed plots with no silicon (D). A similar pattern was observed for the drought-tolerant cultivar (0.26t/ha from the drought-stressed plots supplemented with silicon (DSi) and 0.17t/ha from the drought stressed plots (D)). Silicon supplementation resulted in 0.33 to 0.55-fold increase in the grain yield values of all the lentil cultivars studied.

These results show the impact of silicon supplementation on enhancing the yield in lentil cultivars under drought stress, with increased biomass and decreased IRTc observed in the lentil plots supplemented with silicon. The higher yield in these plots can be attributed to the increased ability of the silicon-supplemented plants to extract more available soil water.

## Outcomes and implications

Supplementing lentil crops with silicon before sowing improved plant growth and development, and boosted grain yields in drought-stressed lentils in this trial. Silicon supplementation to crops may be a sustainable management strategy to enhance yield and productivity in environments likely to experience drought stress. Further research is underway to extend these findings to determine the potential for silicon supplements to different lentil-growing areas across Australia.

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## Contact

**Dr Dorin Gupta** Faculty of Veterinary and Agricultural Sciences, Dookie campus, The University of Melbourne

**M:** 0470 515 433

**E:** dorin.gupta@unimelb.edu.au