USDA Agricultural Research Service

Substrate Silicon Amendments for Containerized Production

USDA-ARS, Toledo, OH

I ♥ Silicon

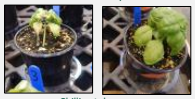
Silicon (Si)

14 Si 28 Silicon

- Beneficial element
- Plant-available form is silicic acid
- Si can alleviate the effects of abiotic and biotic stresses

Powdery mildew suppression

Tolerance to heavy metals



Chilling tolerance

Si application methods

- Substrate components
  - Rice hulls, coconut coir
- Substrate amendments
  - Plant or mineral based
  - Rice hulls, slags, clay silicates
- Liquid fertilization
  - K, Ca, or Na silicates
- Foliar sprays
  - K, Ca, or Na silicates

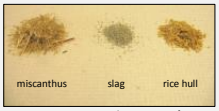
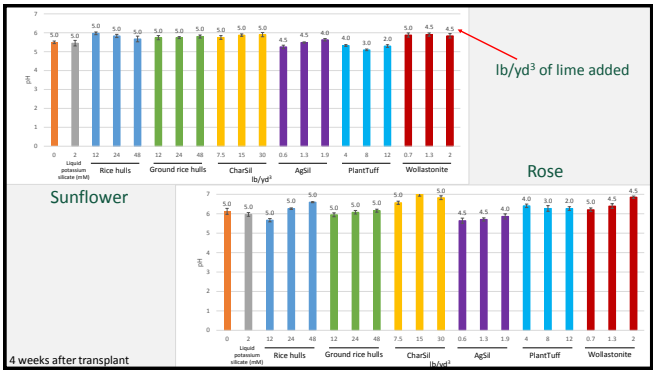


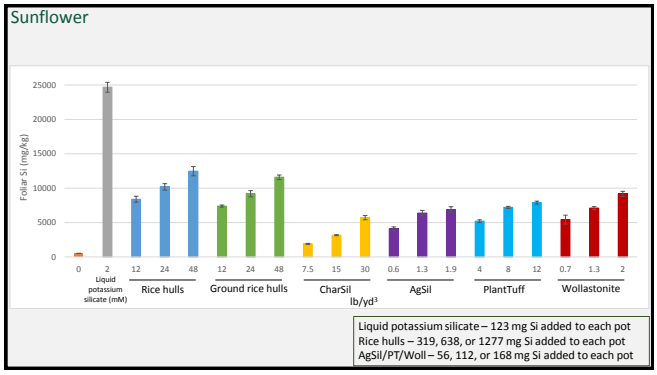
Photo courtesy of J. Frantz

Substrate amendments can provide extended release of Si throughout the production cycle, but information on incorporation rates and effects on plant growth are not well known.

Methods

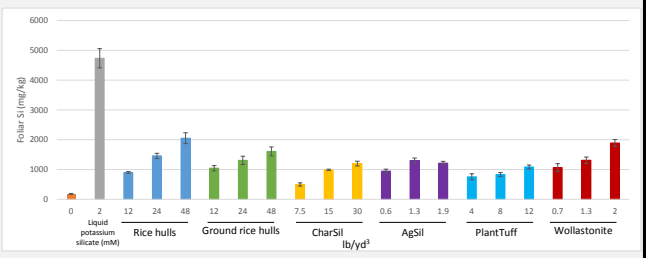
- Sunflower 'Pacino Gold'
  - 85 peatmoss : 15 perlite base substrate
- Rose 'Daniela'
  - 100% peatmoss base substrate
- 4.5" pots
- Lime added to adjust initial substrate pH to 6.2-6.5
- Si amendments added to base substrate at 3 incorporation rates
- Fertilized with 15-5-15 at 150 mg·L^{-1} N
- 72 °F day/ 68 °F night air temperature
- 14 h photoperiod; supplemental lighting when ambient irradiance <300 µmol·m^{-2}·s^{-1} (DLI = 10.8 mol·m^{-2}·d^{-1})





Liquid potassium silicate – 123 mg Si added to each pot
Rice hulls – 319, 638, or 1277 mg Si added to each pot
AgSil/PT/Woll – 56, 112, or 168 mg Si added to each pot

Rose



Liquid potassium silicate – 123 mg Si added to each pot
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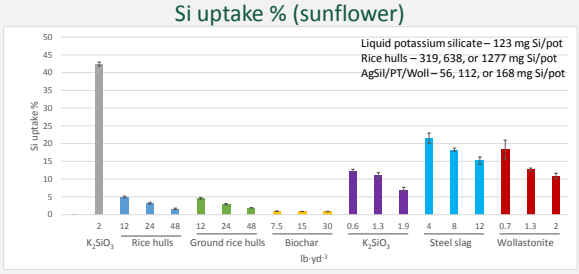
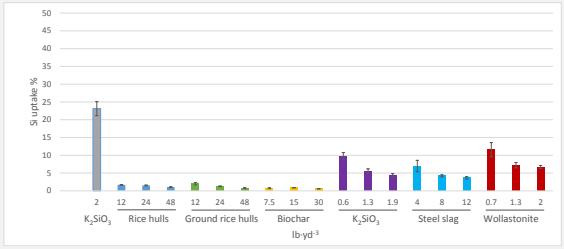
Si uptake % (sunflower)



- Foliar Si of the non-amended control was subtracted first, to account for background Si in the substrate
- Ranged from 0.9% (highest rate of biochar) to 23.7% (lowest rate of steel slag)
- Uptake % decreased as Si amendment rate increased
- Remainder localized in stems, roots, substrate solution, or bound to the amendment source

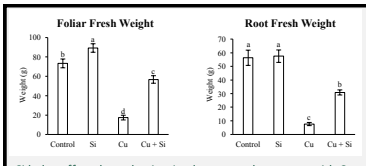
Si uptake % (rose)



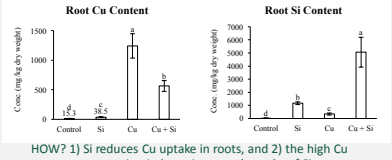
- Foliar Si of the non-amended control was subtracted first, to account for background Si in the substrate
- Ranged from 0.6% (highest rate of biochar) to 11.6% (lowest rate of wollastonite)

Summary

- Very little differences in growth when the liming potential of the Si amendments was considered (and adjusted for)
- The increased surface area of the ground rice hulls did not increase Si uptake compared to intact rice hulls
- Over a short production cycle, <25% of Si was incorporated into leaves
  - We would like to investigate the longevity of these amendments in the substrate
- Other factors can be considered when selecting a Si amendment
  - Cost, availability, liming potential, micronutrient availability, etc.

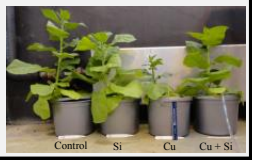


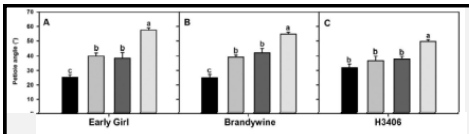
Si helps offset the reduction in plant mass that occurs with Cu toxicity



HOW? 1) Si reduces Cu uptake in roots, and 2) the high Cu concentration induces increased uptake of Si

Scott Leisner's lab
(Univ. of Toledo)





Temp: 30 30 37 37 (°C)
CO_2: 400 700 400 700 (ppm)

- Collaborative research with Scott Heckathorn (Univ. of Toledo)
- The combined effect of high temperature and elevated CO_2 resulted in leaf hyponasty
- This could have implications for greenhouse and indoor production under high temperatures and elevated CO_2 conditions