

Beyond strengthening the leaf surface - Silicon enhances herbivore-induced plant defense responses

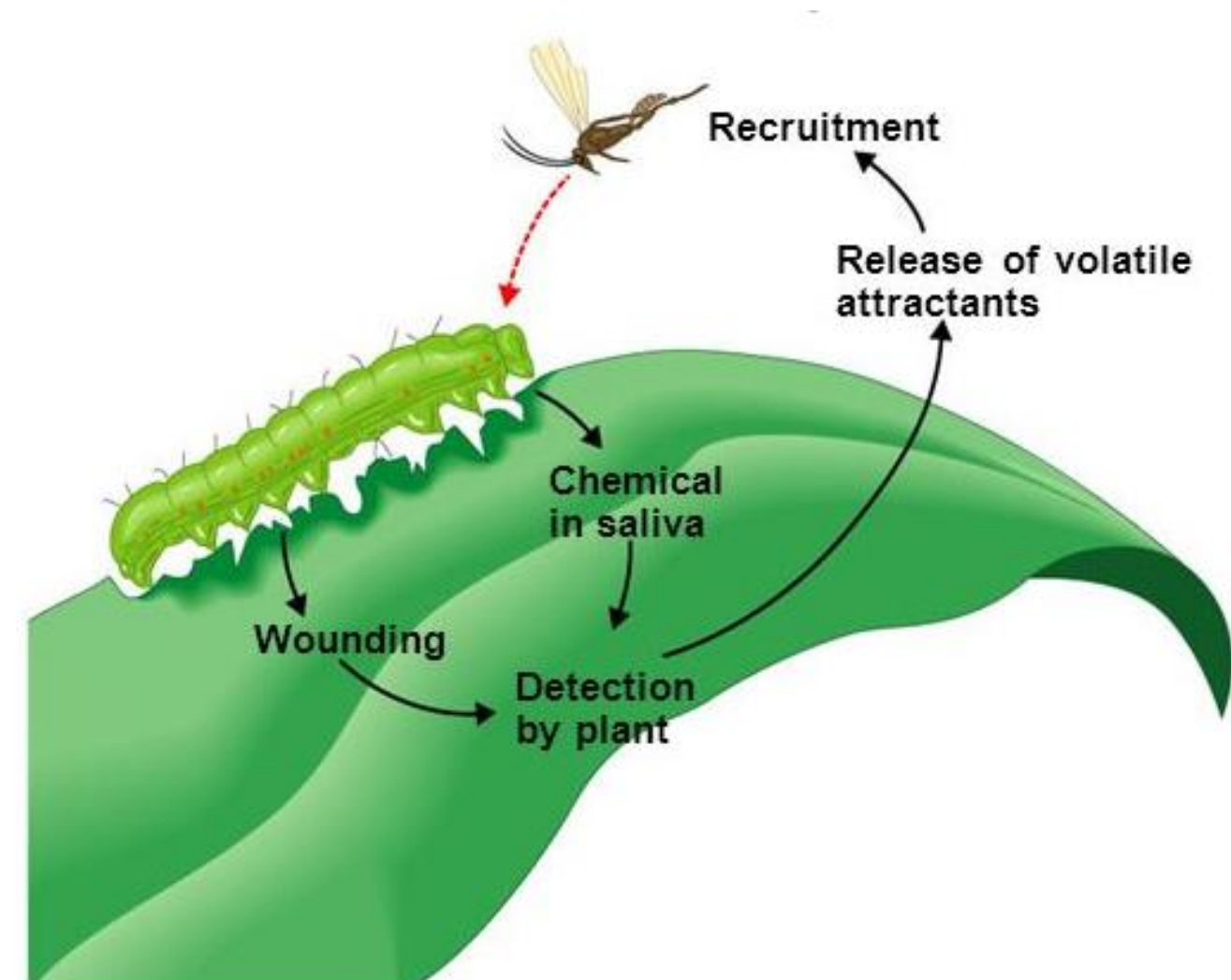
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Introduction

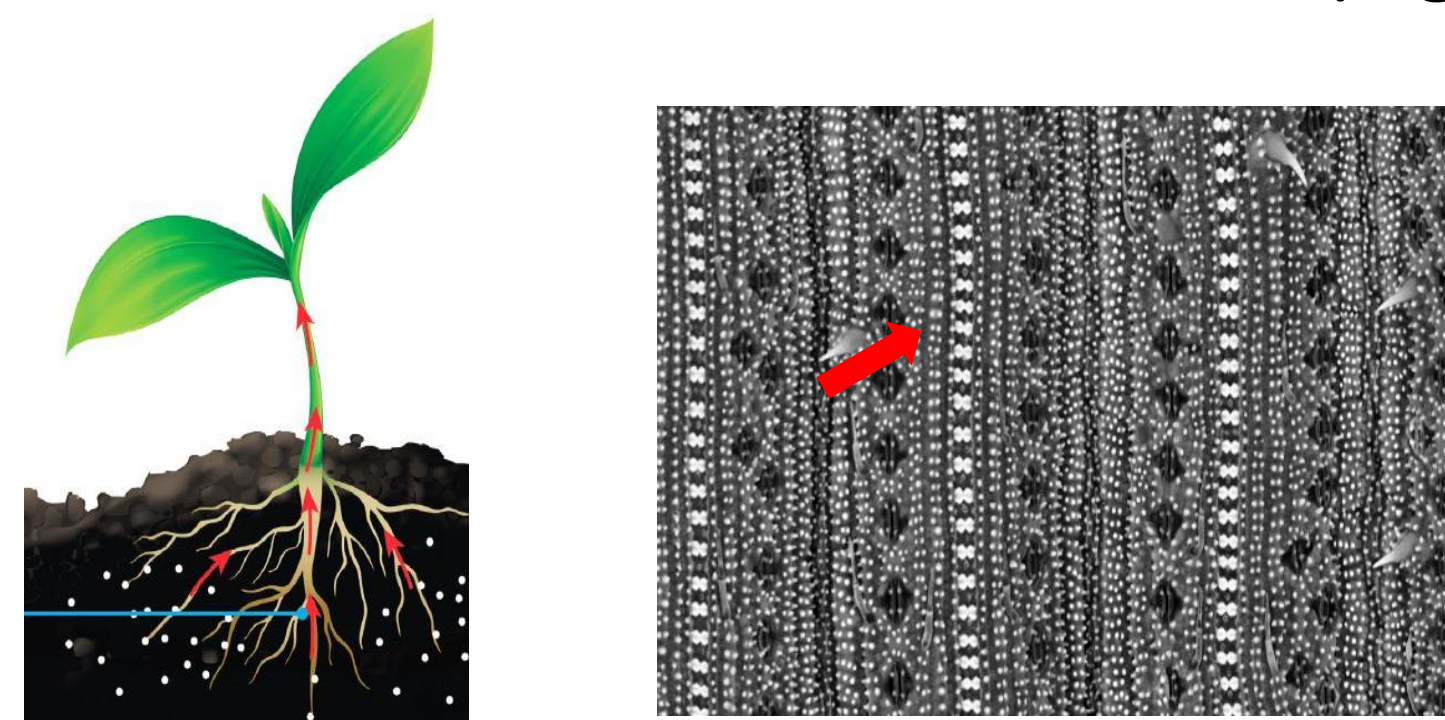
- ✓ Insect herbivory induces the production of defensive plant compounds (Fig. 1).



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Fig. 1. Plant defense responses triggered by caterpillar feeding.

- ✓ Plants supplemented with silicon (Si) have increased tolerance to herbivores (Fig. 2).



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Fig. 2. Si is up taken from the soil and deposited as Si bodies on leaf tissues.

- ✓ **Model system:** Fall armyworm, *Spodoptera frugiperda* (Lepidoptera: Noctuidae) feeding on corn and tomato.



- ✓ **Research question**

Does Si supplementation influence herbivore-induced defenses in plants?

Objectives

- ✓ To determine the effect of Si supplementation on the levels of herbivore-induced defenses in Si accumulator and non Si accumulator plants.
- ✓ To determine the effect of plant induced defenses on caterpillar growth.

Methods

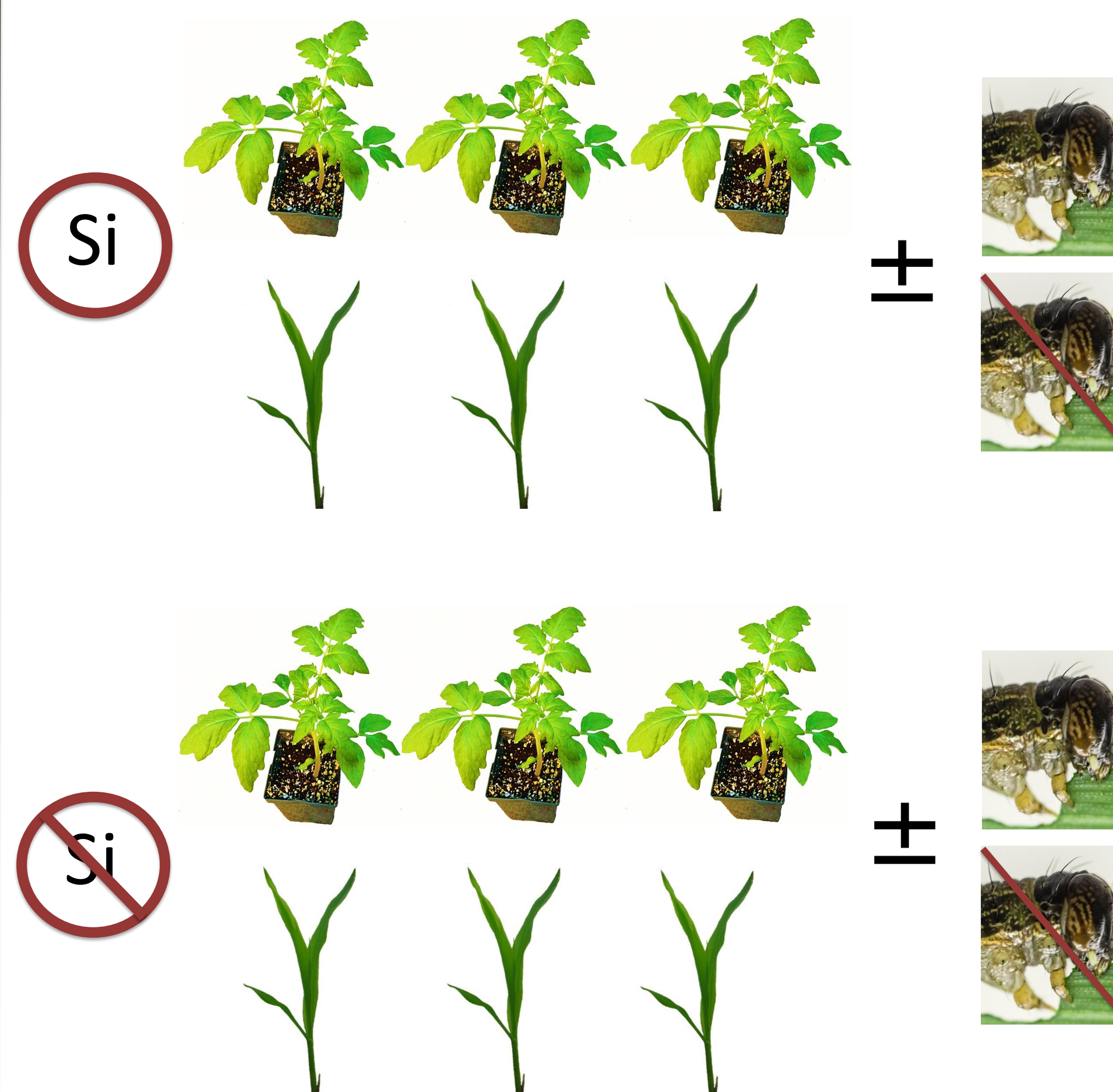


Fig. 3. Experimental setup. Tomato and corn plants with or without Si were exposed to herbivory. The damaged tissue was used to test for plant defense responses and caterpillar growth.

- ✓ Plant defensive enzymes:

- Polyphenol oxidase (PPO)
- Trypsin proteinase inhibitor (Trypsin PI)

- ✓ Trichome density
- ✓ Silicon content in new leaf tissues
- ✓ Caterpillar growth

Significance

Boosting the endogenous plant defense mechanisms may help reduce the use of pesticides in agriculture.

Results

1. Si supplementation increases herbivore-induced defenses in tomato and corn (Fig. 4-5).

Polyphenol oxidase (PPO)

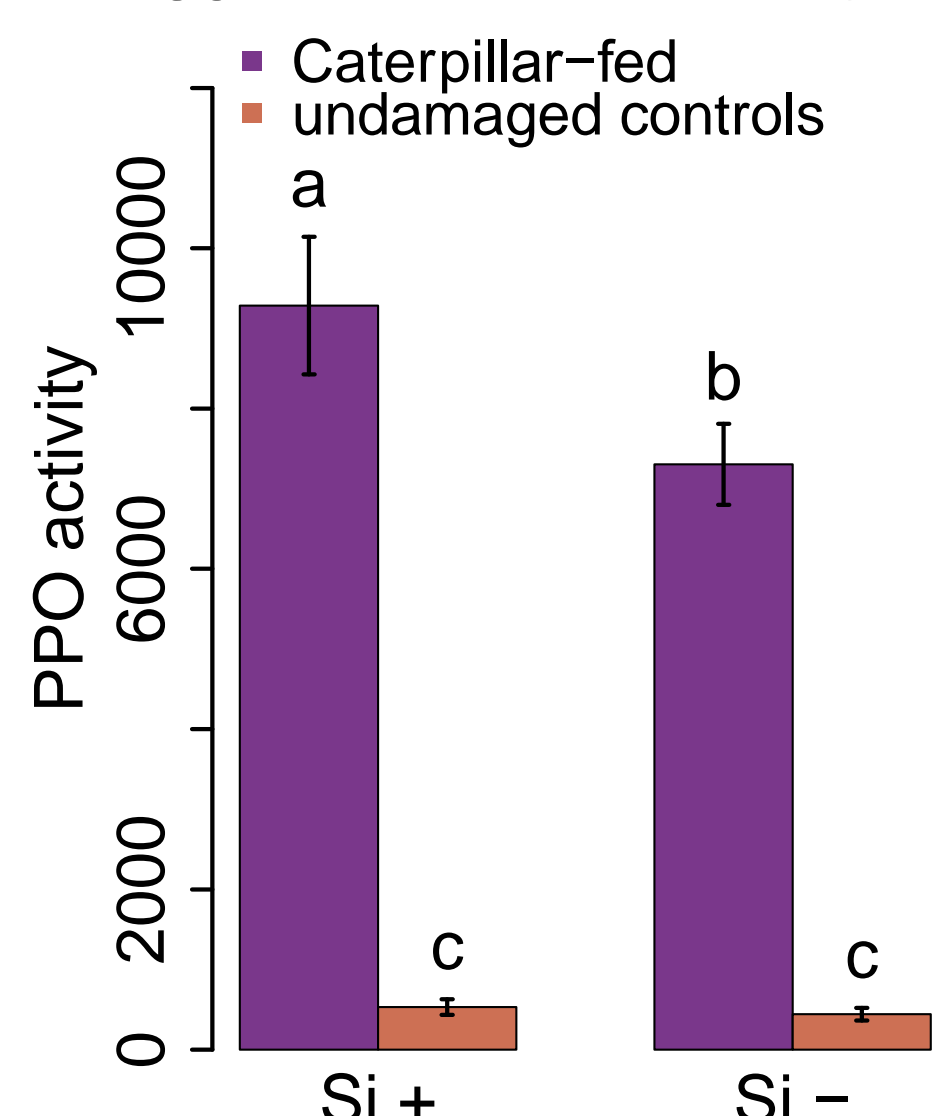


Fig. 4. PPO activity in tomato ($F = 1.97$; $P = 0.153$).

Trypsin PI in corn

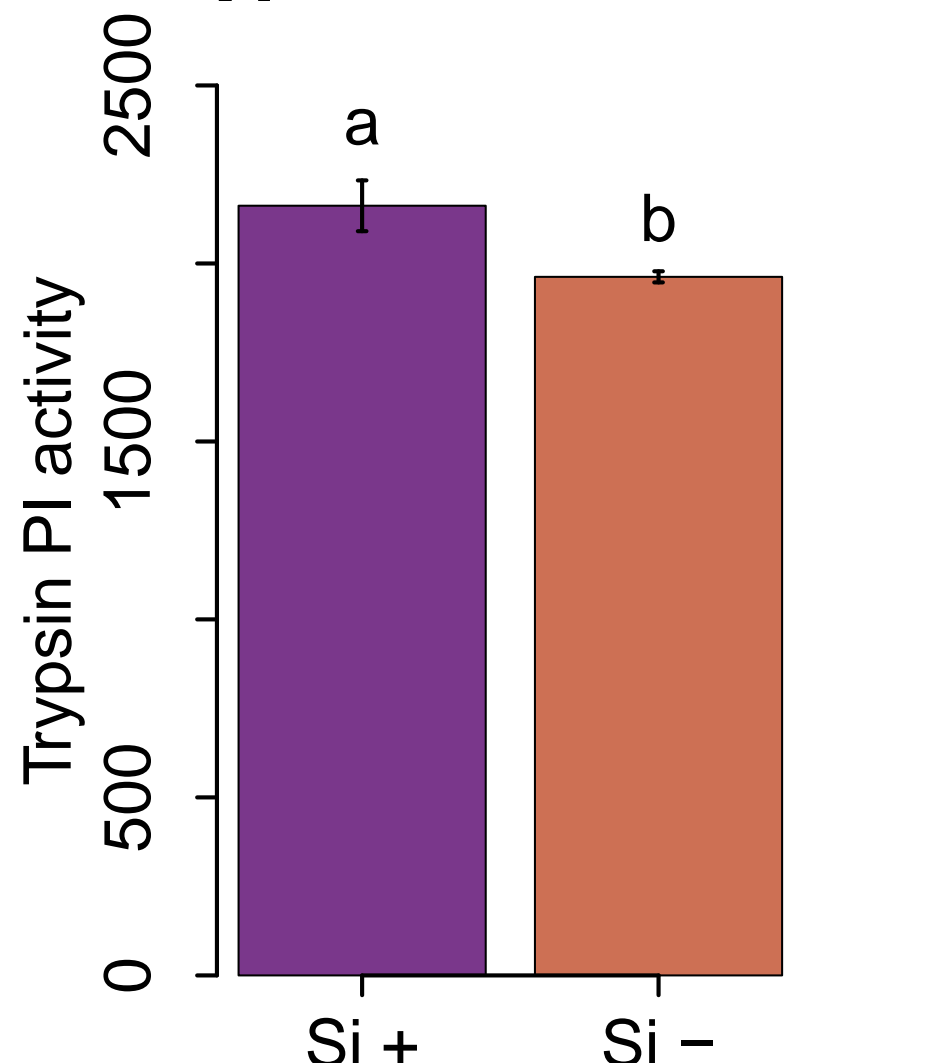


Fig. 5. Trypsin PI activity in corn ($F = 74.1$; $P < 0.001$).

2. Si supplementation increases the number of trichomes in tomato but not in corn (Fig. 6-7).

Trichomes

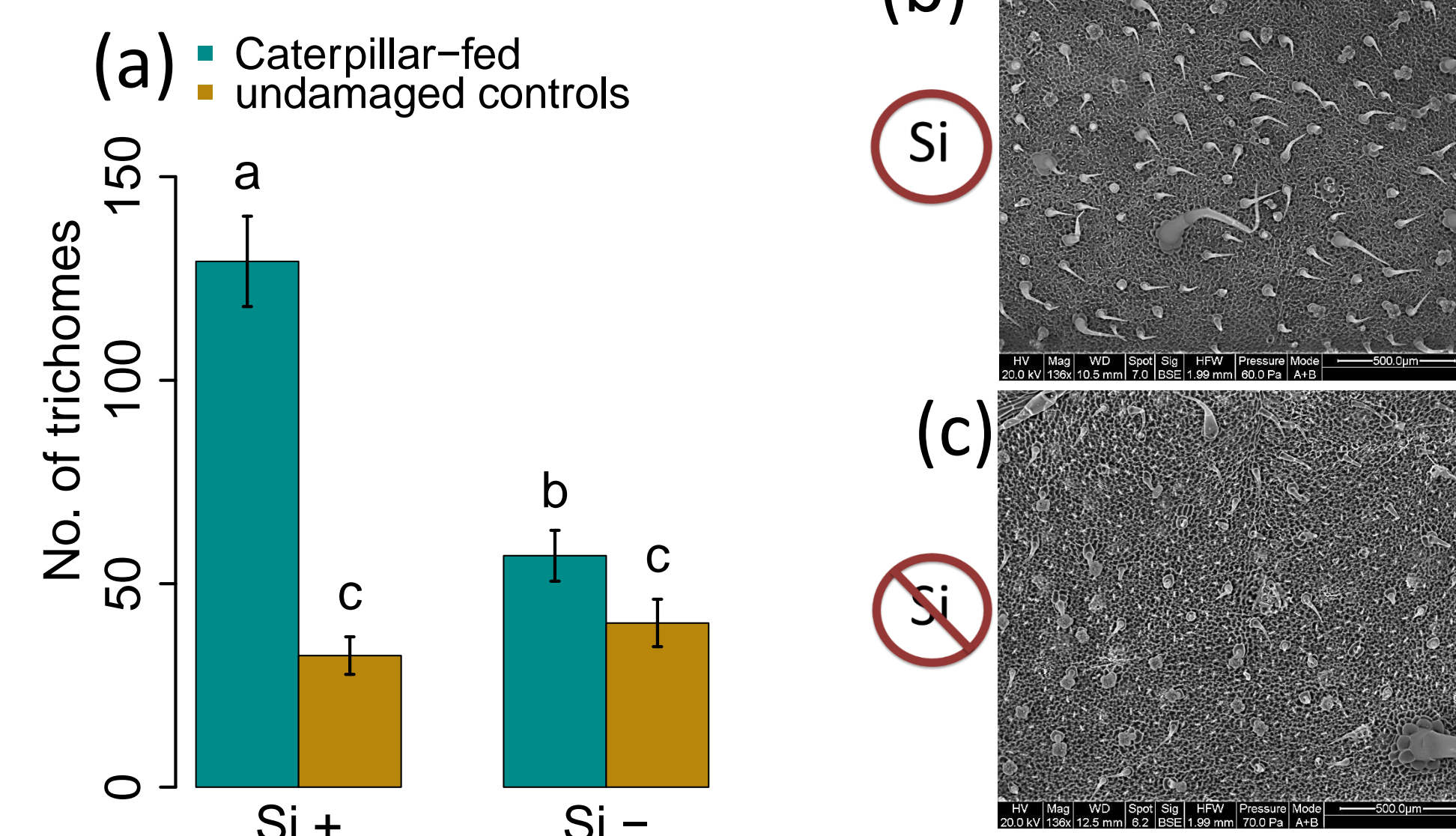


Fig. 6. (a) Number of trichomes in tomato. (b) & (c) SEM of trichomes.

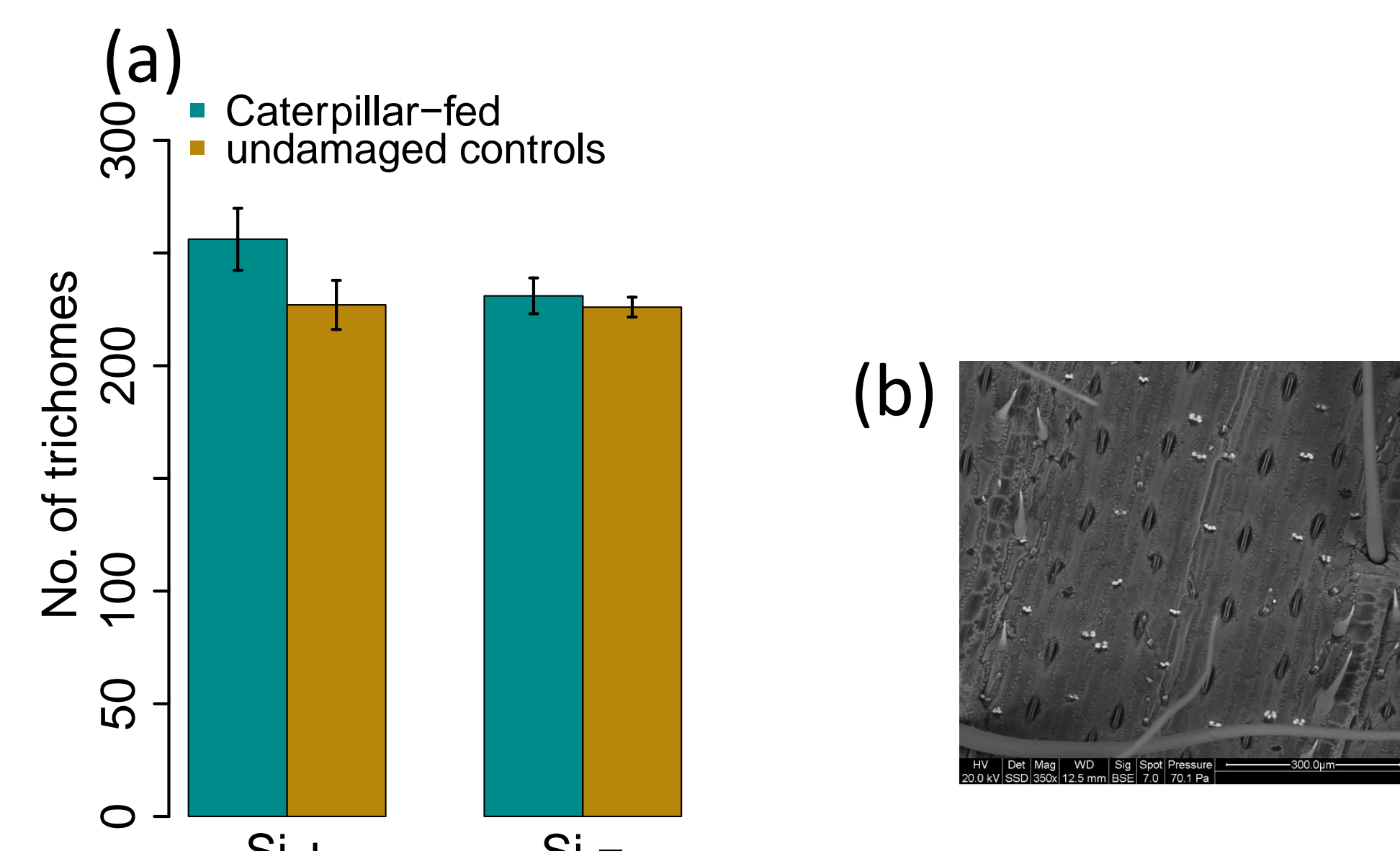


Fig. 7. (a) Number of trichomes in corn. (b) SEM of corn trichomes.

3. Si supplementation increases Si content in corn and tomato leaves (Fig. 8-9).

Si content

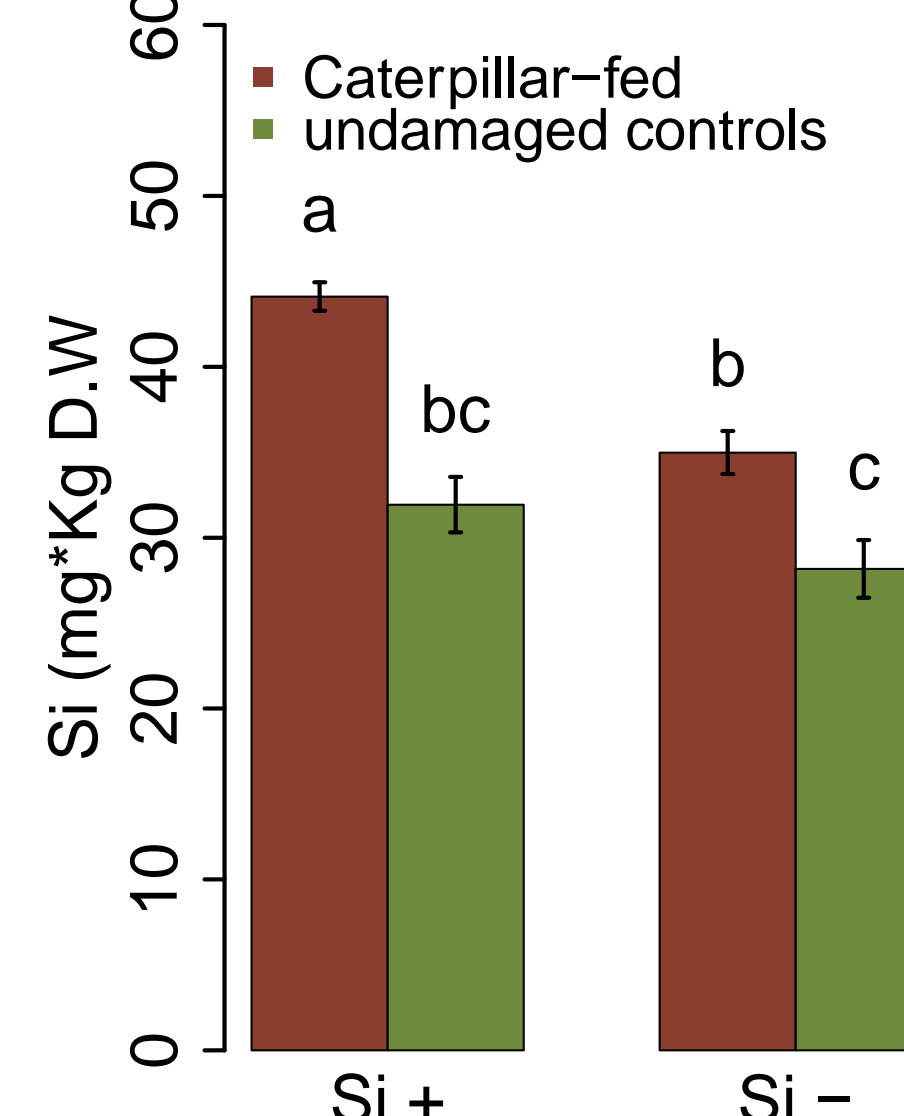


Fig. 8. Si content in tomato plants ($F = 30.22$; $P < 0.001$).

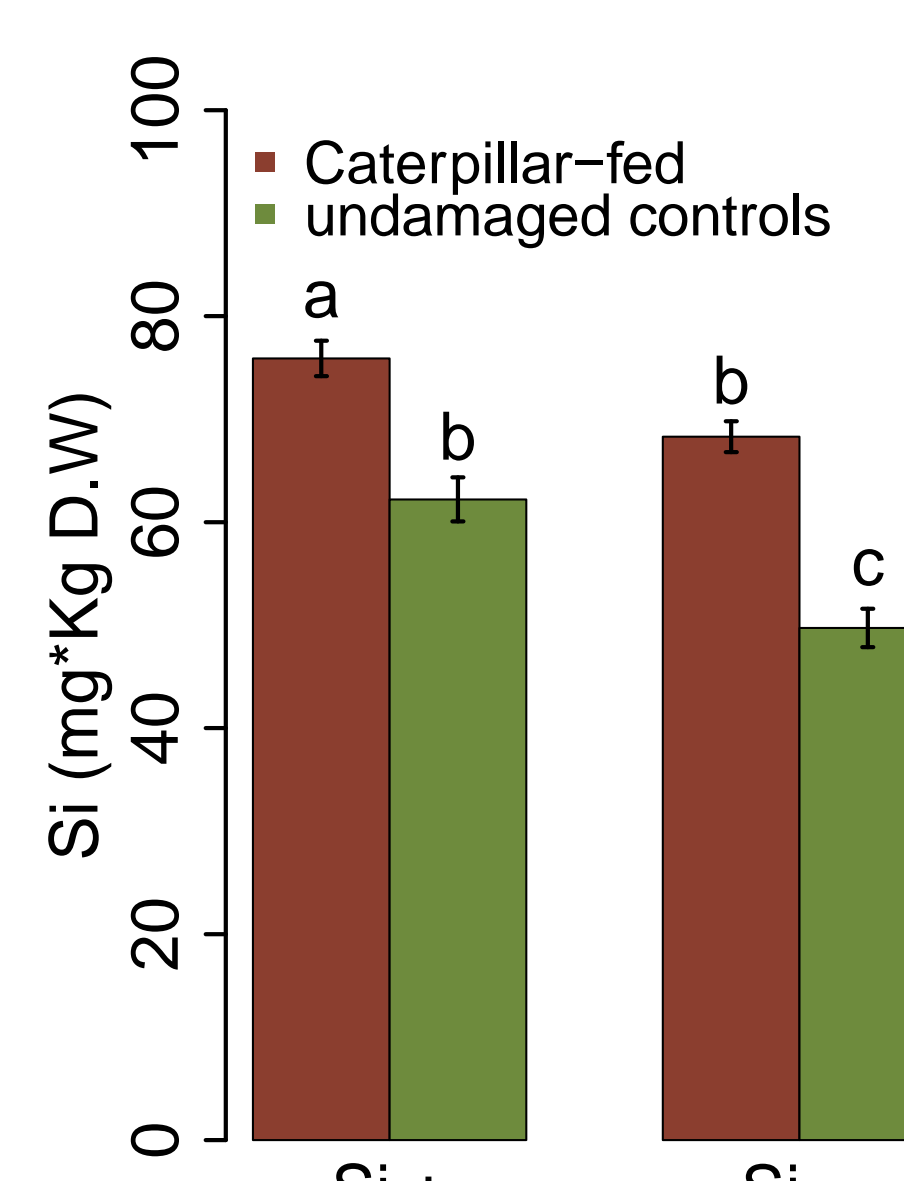


Fig. 9. Si content in corn plants ($F = 22.14$; $P < 0.001$).

4. Plant defenses reduce caterpillar growth (Fig. 10). Si on plant leaves wears caterpillar mandibles (Fig. 11)

Caterpillar growth

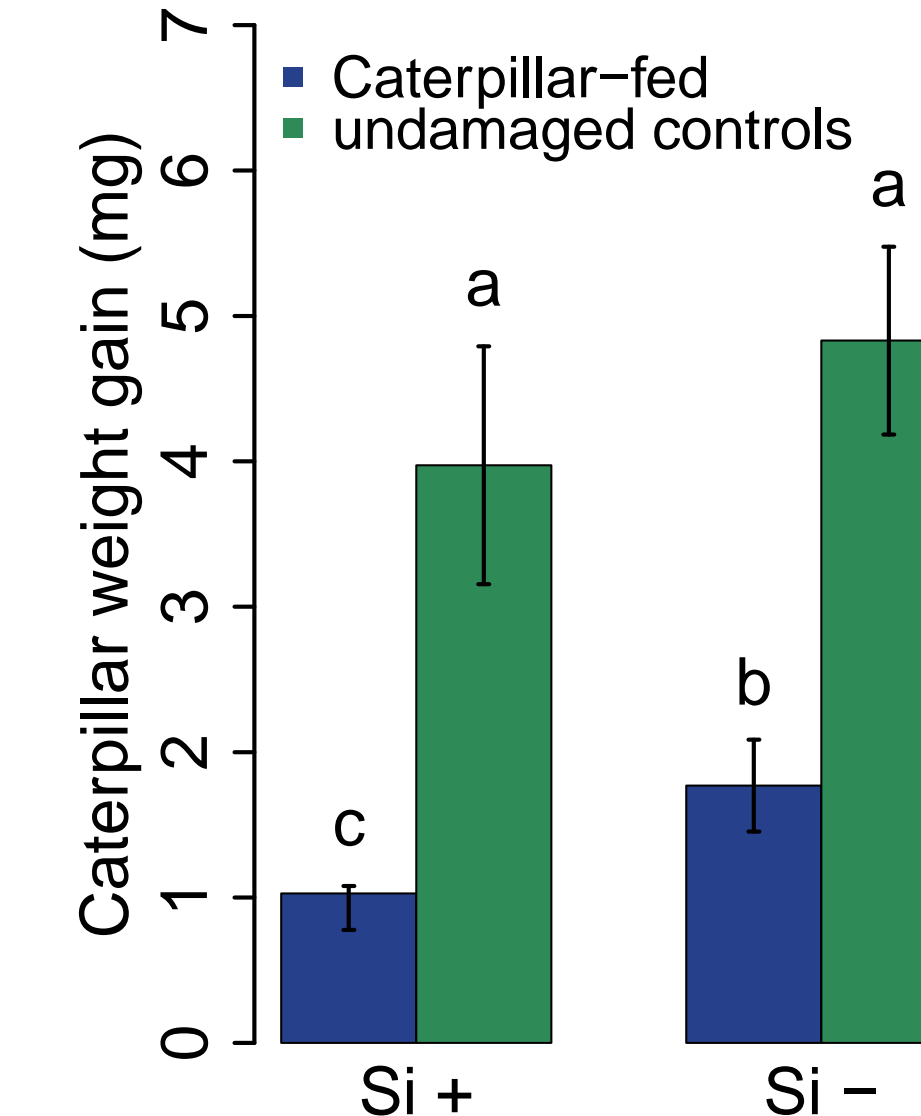


Fig. 10. Caterpillar weight gain in tomato plants ($F = 5.67$; $P < 0.05$).

Mandible wear

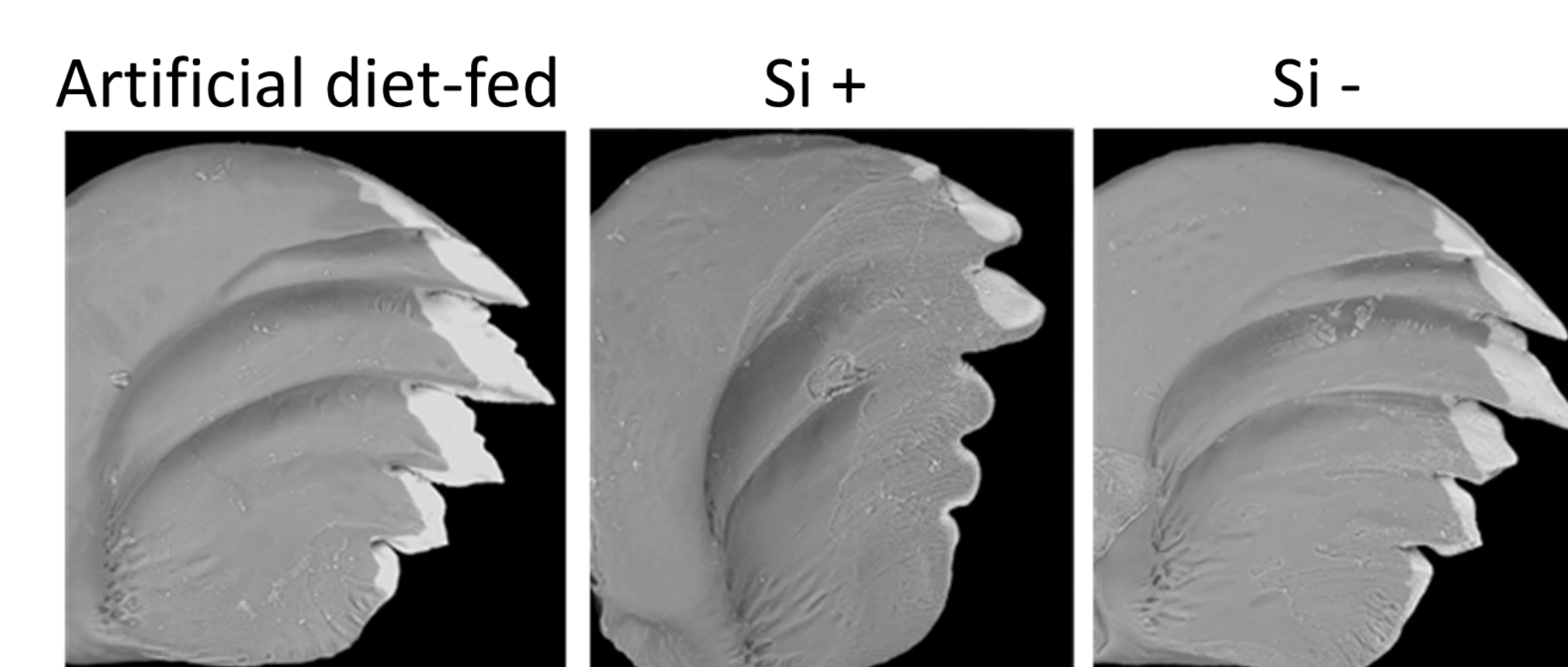


Fig. 11. Backscatter electron image of the fall armyworm mandibles from caterpillars fed on different diets. Whiter outer areas correspond to mineral-enriched regions.

Conclusions

Si boosts defenses upon insect herbivory in both Si-accumulators and non Si-accumulator plants.

Acknowledgments

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