# THE IMPACT OF SOYBEAN CYST NEMATODE ON SOYBEAN PHYSIOLOGICAL PARAMETERS: NITROGEN FIXATION ACTIVITY, ROOT AND LEAF GROWTH

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## Abstract

Soybean cyst nematode (SCN), *Heterodera glycines*, is responsible for over $1 billion soybean yield loss annually in the United States. Studies have shown that the nematode can reduce soybean $N_2$-fixation activity (NFA), but the dynamics of the NFA reduction and effects on soybean growth parameters are unknown. A greenhouse study was performed to track the effects of SCN on NFA, root growth, and leaf growth parameters among three soybean lines within a sampling period of 25 days. The soybean lines: one resistant – PI88788 – and two susceptible – Williams 82 and Ellis – were infested with 10,000 SCN eggs/seedling at planting, and non-infested seedlings were grown as control. Eight replicates of each soybean line (infested and non-infested) were used. Starting from 20 days after planting, data on NFA of soybean (rhizosphere ethylene concentration) were taken twice per week. Root length and surface area, leaf chlorophyll levels, leaf area, and nitrogen content were also determined. There was a significant decrease in the NFA of Williams 82 on average across the sampling period resulting from SCN infestation. The NFA of PI88788 was significantly reduced by SCN on two sampling dates, but not significantly across the 25-day average. Percent decrease in NFA of Williams 82 and PI88788 ranged from 2 to 25% and 7 to 26%, respectively, compared to non-infested. No effect in NFA of Ellis was observed, although root surface area was significantly reduced by 30%, compared to non-infested. Leaf chlorophyll levels and leaf area of Williams 82 were significantly reduced by SCN by 5 and 30%, respectively. Leaf nitrogen content was not significantly reduced by infestation on any of the soybean lines. This study shows that nematodes can cause various physiological effects that can affect plant health and growth.

Table 1: Nitrogen fixation activity of soybean lines as influenced by soybean cyst nematode

| Treatment | Ethylene (uL $L^{-1}$) gas concentration | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Sep 4 | Sep 6 | Sep 9 | Sep 11 | Sep 13 | Sep 16 | Sep 18 | Sep 20 | Sep 23 | Mean |
| PI88788 (check) | 7.8 | 9.1 | 8.2 | 10.9 | 10.4 | 7.6 | 7.6a | 7.3 | 6.5a | 8.4 |
| PI88788 (SCN treated) | 6.9 | 6.9 | 7.1 | 8.4 | 8.7 | 5.6 | 6.1b | 6.8 | 5.4b | 6.9 |
| Percentage decrease (%) | 12 | 24 | 13 | 23 | 16 | 26 | 20* | 7 | 17* | 18 |
| Williams 82 (check) | 7.6a | 8.2 | 6.9 | 9.1a | 9.5 | 8.9 | 9.5 | 9.5a | 7.7 | 8.5a |
| Williams 82 (SCN treated) | 5.7b | 6.8 | 5.3 | 7.4b | 7.8 | 7.2 | 7.7 | 7.6b | 6.8 | 6.9b |
| Percentage decrease (%) | 25* | 17 | 23 | 19* | 18 | 19 | 19 | 20* | 12 | 19* |
| Ellis (check) | 5.5 | 5.0 | 6.6 | 7.9 | 7.4 | 5.7 | 7.5 | 7.2 | 5.6 | 6.5 |
| Ellis (SCN treated) | 5.3 | 5.4 | 6.3 | 8.0 | 7.0 | 7.4 | 6.8 | 7.5 | 5.5 | 6.6 |
| Percentage decrease (%) | 3.6 | -8 | 4.5 | -1.3 | 5.4 | -29.8 | 9.3 | -4.2 | 1.8 | -2.1 |

Numbers with different letters are significantly different ($\alpha$= 0.5) from each other according to Student's t-test
Asterisk indicates statistically significant treatment effect occurred

Table 2: The SPAD-502 chlorophyll meter values of non-infested and SCN-infested soybeans

| Treatment | SPAD-502 chlorophyll meter readings | | | | | | |
|---|---|---|---|---|---|---|---|
| | Sep 2 | Sep 5 | Sep 12 | Sep 17 | Sep 19 | Sep 22 | Mean |
| PI88788 (check) | 30.7 | 30.1 | 30.6 | 31.2 | 32.7 | 33.8 | 31.5 |
| PI88788 (treated) | 29.8 | 29.4 | 29.9 | 31.1 | 31.7 | 32.7 | 30.8 |
| Percentage decrease (%) | 3.0 | 2.0 | 2.0 | 0.3 | 3.0 | 3.0 | 2.0 |
| Williams 82 (check) | 31.4 | 32.7 | 32.1 | 33.4 | 34.6a | 35.3a | 33.2a |
| Williams 82 (treated) | 30.3 | 32.0 | 30.6 | 32.2 | 31.7b | 33.4b | 31.7b |
| Percentage decrease (%) | 4.0 | 2.0 | 5.0 | 4.0 | 9.0* | 5.0* | 5.0* |
| Ellis (check) | 33.8 | 33.4 | 31.0 | 33.7 | 33.9 | 35.0 | 33.5 |
| Ellis (treated) | 32.2 | 32.0 | 29.5 | 31.7 | 32.8 | 33.8 | 32.0 |
| Percentage decrease (%) | 5.0 | 4.0 | 5.0 | 6.0 | 3.0 | 3.0 | 4.0 |

Numbers with different letters are significantly different (α= 0.5) from each other according to Student's t-test
Asterisk indicates statistically significant treatment effect occurred

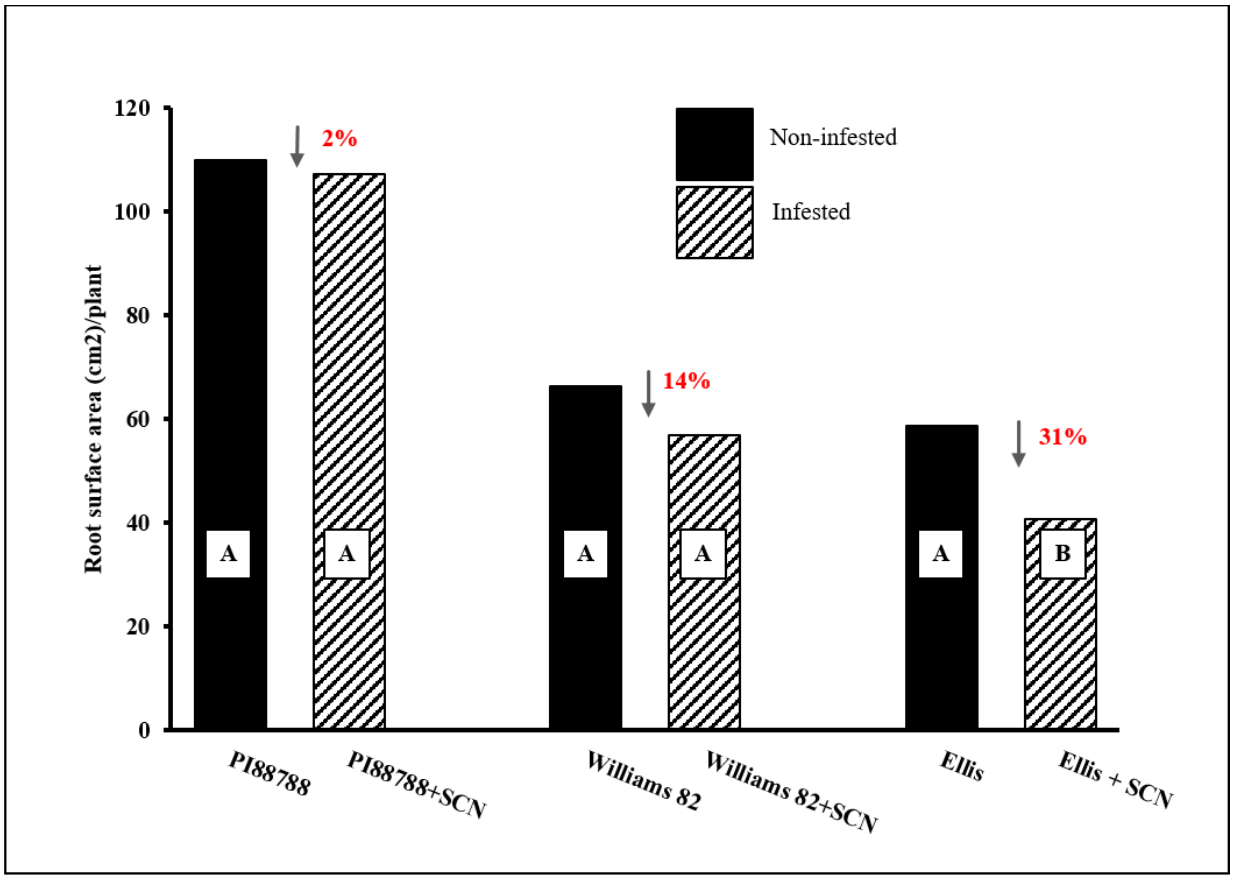


Figure 1. Root surface area ($cm^2$) of non-infested and SCN-infested soybeans. Columns with different letters are significantly different ($\alpha$= 0.5, Student's t-test) from each other.

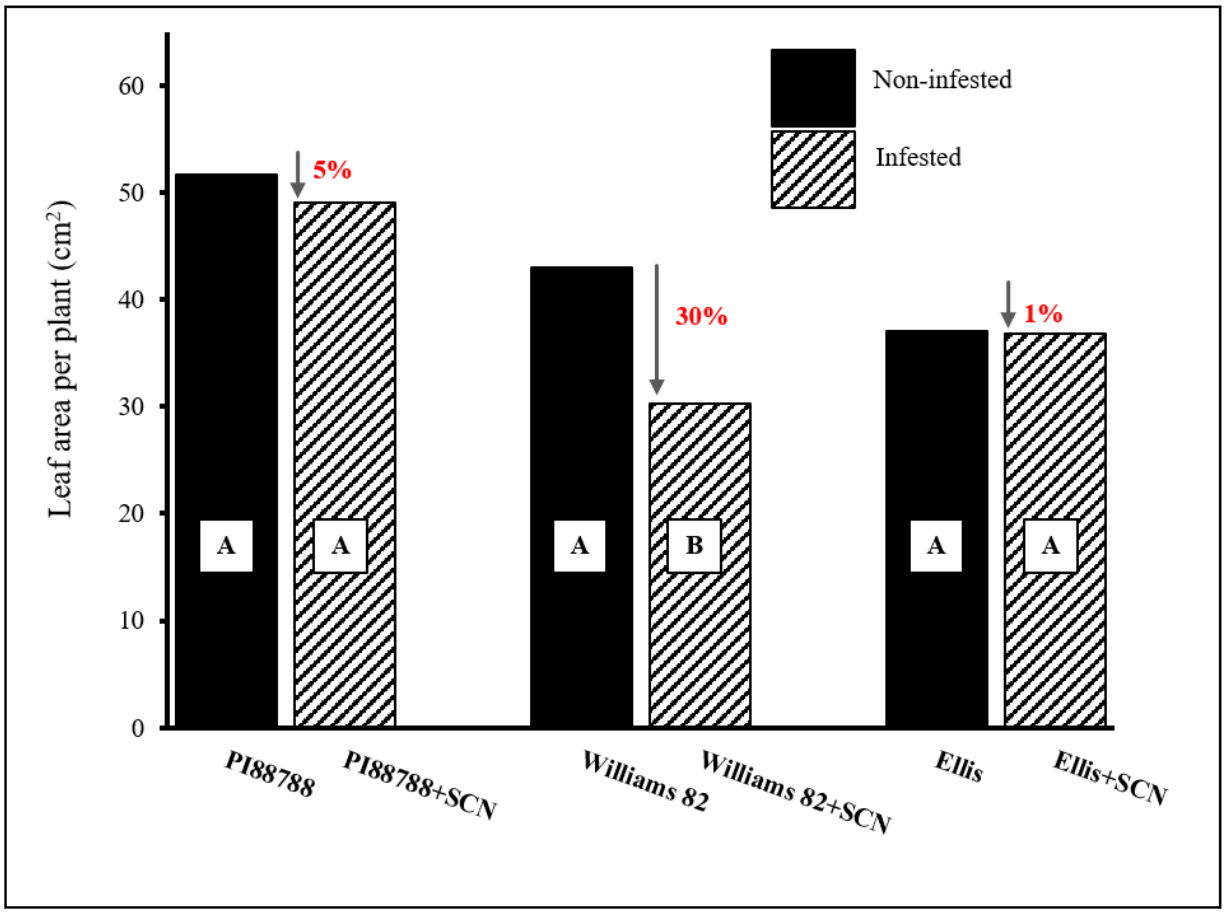


Figure 2. Effect of soybean cyst nematode (SCN) infestation on soybean leaf area. Total leaf area of Williams 82 was significantly reduced by SCN, while that of PI88788 and Ellis was not significantly impacted. Columns with different letters are significantly different (α= 0.5, Student's t-test) from each other.