Integrating Precision Ag Tools for Smarter SCN Assessment and Management

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Overview

Soybean Cyst Nematode (SCN), *Heterodera glycines*, is a significant threat to soybean production worldwide. Feeding by this roundworm soybean roots, results in yield losses ranging from 10% to 40%. Most other legumes including dry beans and many cover crops are also susceptible to yield losses caused by SCN. Detecting and controlling SCN is challenging for the following reasons.

Persistent Soil Presence: SCN cysts contain eggs that can remain dormant yet viable in the soil for 8-10 years, even without a host plant, making eradication difficult.

Lack of Visible Symptoms: SCN often causes significant yield losses without visible above-ground symptoms, complicating detection.

Inconspicuous Life Stages: SCN cysts are female nematodes that contain eggs. This is the white spherical cyst that is visible and attached to the roots. Eventually the females die, and the egg filled cyst falls off the root as a brown tough cyst.

Misleading Symptoms: Above-ground symptoms like stunting and yellowing can be caused by various factors, not just SCN, leading to misdiagnosis.

Gradual Spread: SCN infestation starts in small patches and spreads slowly, requiring several years to cover a field.

SCN assessment in a field

Due to potentially variable egg distribution assessing the density and distribution of SCN in a field is challenging, and relying on soil sampling, but precision agriculture tools may enable more accurate, site-specific monitoring.

Machine learning and remote sensing to detect infested fields with computing complex AI models and ground-truth data, will be supplement to soil sampling which is time-consuming and expertise-intensive.

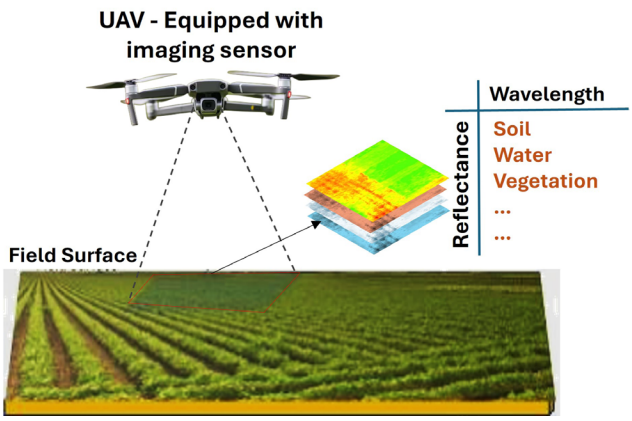

Figure 1. Detection might only be possible when it's too late and the field is completely infested.

Soil samples are still needed for accuracy. Systematic soil sampling, including grid, point, and zone sampling, is widely used. Grid sampling is detailed but labor-intensive, point sampling is quicker but less precise, and zone sampling balances detail and effort but can be expensive. Often nematode damage is worse in areas with low SEC's, i.e. those with sandier soil textures. Plants in these areas are already stressed due to the poor soil type leading to lower available soil moisture and nutrient availability. Therefore, nematode damage will show up there first.

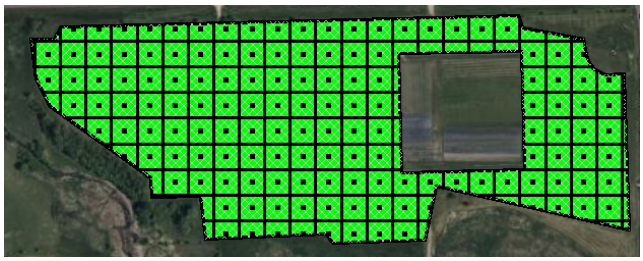

Figure 2.

- Grid sampling: accurate but time-consuming and expensive
- Impractical in large-scale fields

Figure 3.

- Arbitrary sampling using zigzag pattern
- Cheap, quick, no expertise needed

Figure 4.

- Mixing all samples together might not show actual SCN counts in field
- Most of the field (more than 50%) might be uncounted
- Blind sampling of a random set of points is labor intensive and gives results of limited value.

Soil sample recommendation

According to Iowa State University, SCN should be detected or its distribution in a field mapped by collecting 15-20 soil cores from every 20 acres. Cores should be 8-inches deep using a manual or hydraulic semi-automated soil probe in the fall preferably after harvest. More cores and smaller sampling areas yield more accurate results. Soils should be collected from agronomically similar management zones, i.e. similar soil textures and slopes.

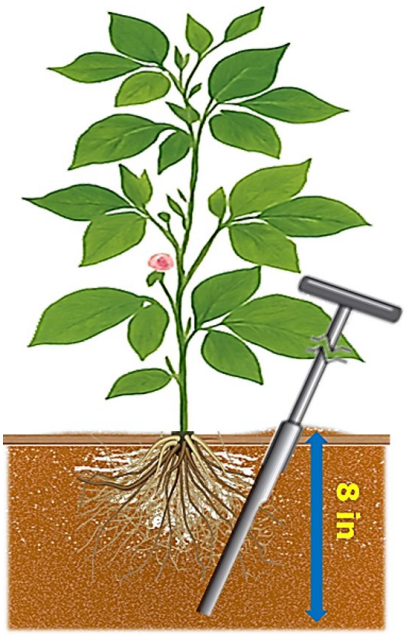

Figure 5.

- Take soil cores 2 to 4 inches from the plant stem.
- Collect 10-12 soil cores mixing them together to have one sample for each targeted spot

- Collect samples from 8-12 inches deep, which is considered the most active depth for root growth and microbial activity (Kleczewski, et. al., 2023)

In a recent study at SDSU's Southeast research farm in Beresford, a EM-38 mk2 sensor was used to measure soil electrical conductivity (EC) for better SCN detection. This method helps create precise management zones, allowing us to collect soil samples based on these zones rather than randomly. By targeting specific areas with distinct soil characteristics and potential nematode hotspots (with lower number of soil samples), saving both money and labor while achieving more accurate results compared to traditional methods.

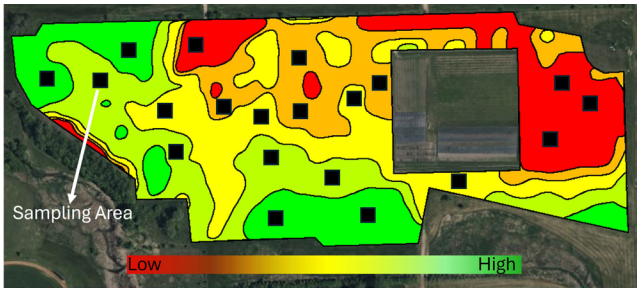

Figure 6. Collecting samples from distinct areas based on EC Zones

Why use a soil EC sensor

Variations in soil characteristics can be estimated by EC. Significant correlation with soil texture, specifically with clay content, can identify distinct zones, and it is strongly correlated with soil pH. Moreover, results indicate that soil EC has a strong relationship with other important soil nutrients, including N, P, K and SOM, which are essential for soybean growth.

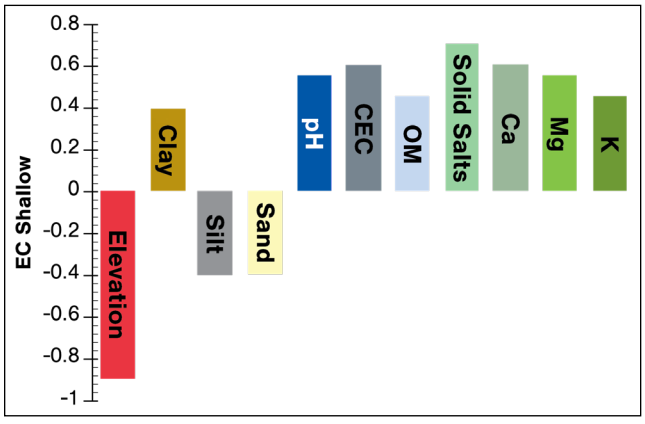

Figure 7. EC is highly correlated with soil texture and nutrient level in soil

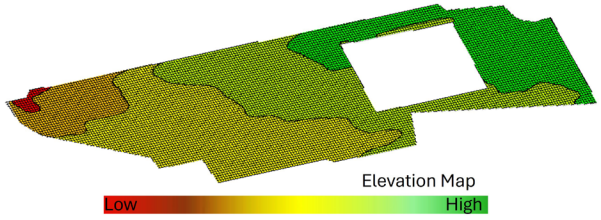

Figure 8. Generating topography map in addition to EC

Electrical conductivity mapping is a fast, reliable, and cost-effective method that can provide insight into the soil texture. Soil EC values are stable over time, and the data may be used for several years to create soil texture maps.

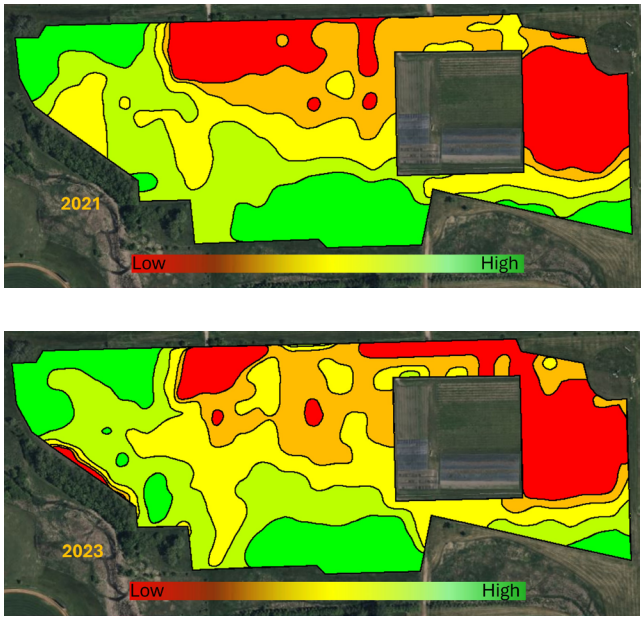

Figure 9. EC management zones would change slightly over time

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