

Precision Fumigation Technologies for Use in Strawberry

Nathan S Boyd and Alex G Rodriguez

Summary

The Weed Science team developed weed mapping technology that can effectively identify purple nutsedge and map persistent high-density hot spots within fields. Persistent hot spots offer opportunities to focus management efforts where patches are predicted to occur during the strawberry season based on maps obtained during the fallow period. Our research has also proven that satellite imagery can use vegetative indices to track strawberry plant growth and indirectly detect areas within fields with sting nematode infestations. This data could be used to direct soil sampling to confirm nematode presence and implement site specific nematode management.

Purple Nutsedge Patch Persistence

We developed a new way to find and map weeds in strawberry fields using artificial intelligence (AI) (Figure 1). The system combines digital cameras, GPS, and other components mounted on a tractor. As the tractor moves across the field, it records video of the plants. These videos are then processed by AI software that has been trained in the Weed Science laboratory to recognize and locate purple nutsedge.

From these videos, the system creates detailed maps showing exactly where *purple nutsedge* plants are located. The mapping system was tested in two commercial strawberry fields during the fallow period and during strawberry production. This allowed us to study how purple nutsedge infestations are distributed and how they persist over time.

Purple nutsedge tended to grow in clusters or “hot spots” rather than being spread evenly across the field. These hot spots varied in size and intensity, but they appeared consistently in certain areas. When we compared maps from different seasons, we found

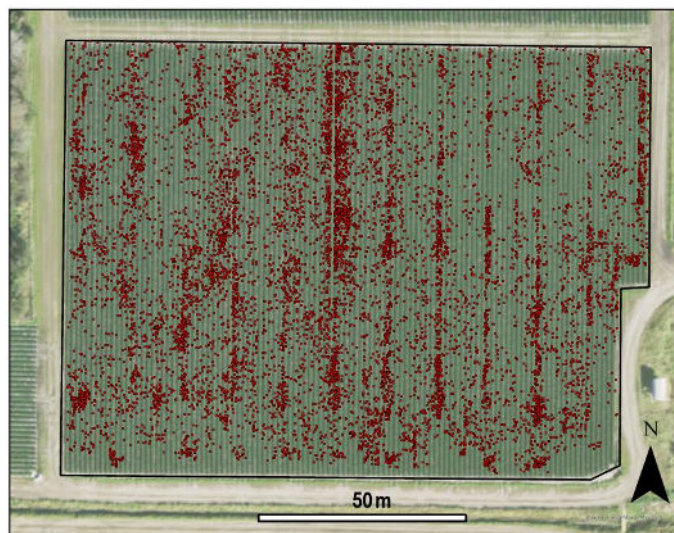


Figure 1. Population map of a commercial strawberry field during the fallow period, August 28th, 2024. Each red dot represents one purple nutsedge plant.

that most large hot spots during the strawberry season matched those seen in the previous fallow period. This means that infestations tend to persist in the same areas over time. However, some smaller hot spots also appeared in new locations. These could have resulted from dormant tubers sprouting later, from weed growth encouraged by the warm and moist conditions under the plastic mulch, or from the spread of tubers during tillage and cultivation. New patches appeared over time but the largest patches persisted over time (Figure 2).

This persistence is important because it means farmers could manage weeds more efficiently by focusing control efforts on these recurring problem zones instead of treating entire fields uniformly. For example, more intensive treatments such as targeted applications of metam potassium or

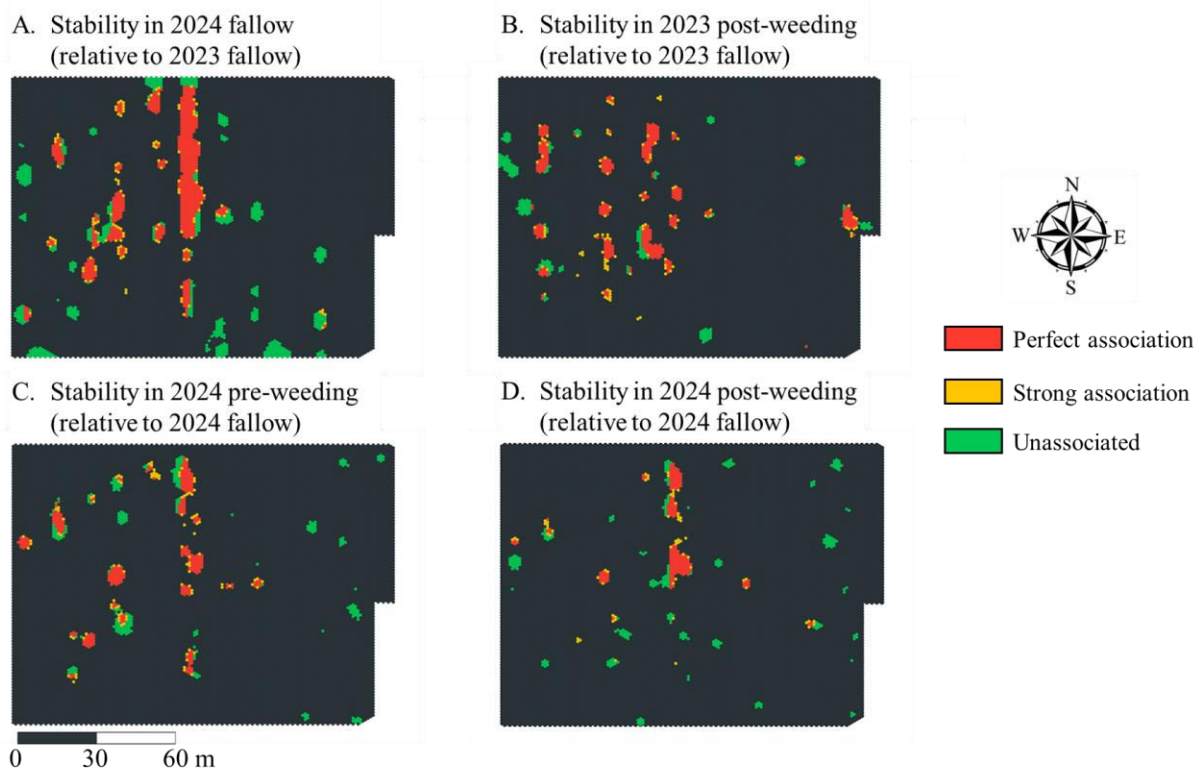


Figure 2. Hot spot stability of purple nutsedge in Field B evaluated across two temporal scales, between consecutive fallow periods (A) and between fallow and subsequent strawberry seasons (B-D).

supplemental preemergence herbicides could be applied in persistent hot spots, alongside standard fumigation practices. This would improve weed control while cutting costs and reducing chemical use compared to broadcast applications. Similarly, understanding where weeds tend to cluster could help farmers direct hand-weeding crews or other labor resources to the most infested areas. Ultimately, this knowledge could lead to predictive tools that help growers anticipate where *purple nutsedge* will emerge and plan precise, site-specific weed management strategies.

Sting Nematode Damage Hot Spots

We explored whether high-resolution satellite images could help farmers monitor damage caused by sting nematodes. The research took place on two commercial strawberry farms using detailed multispectral satellite images from PlanetScope to see if patterns in the crop canopy could reveal where nematodes were causing problems.

The results were promising. The satellite images were

able to pick up differences in plant growth and canopy color that matched areas affected by sting nematodes (Figure 3). In particular, vegetation indices were useful in spotting stressed areas. One of these indices, called MSAVI2, performed especially well. It consistently showed where the plants were struggling, even when overall field conditions varied or the canopy was uneven. This suggests that MSAVI2 is a reliable indicator for detecting plant stress caused by nematode infestations and for tracking overall crop growth.

However, the approach had some limitations. When the nematode populations were very low or when the plants did not yet show visible symptoms above ground, the satellite images were not able to detect the problem accurately. In those cases, the imagery alone was not sensitive enough to confirm the presence of nematodes. Therefore, satellite monitoring should not be used as a replacement for traditional soil testing, which remains the most accurate method for diagnosing nematode infestations.

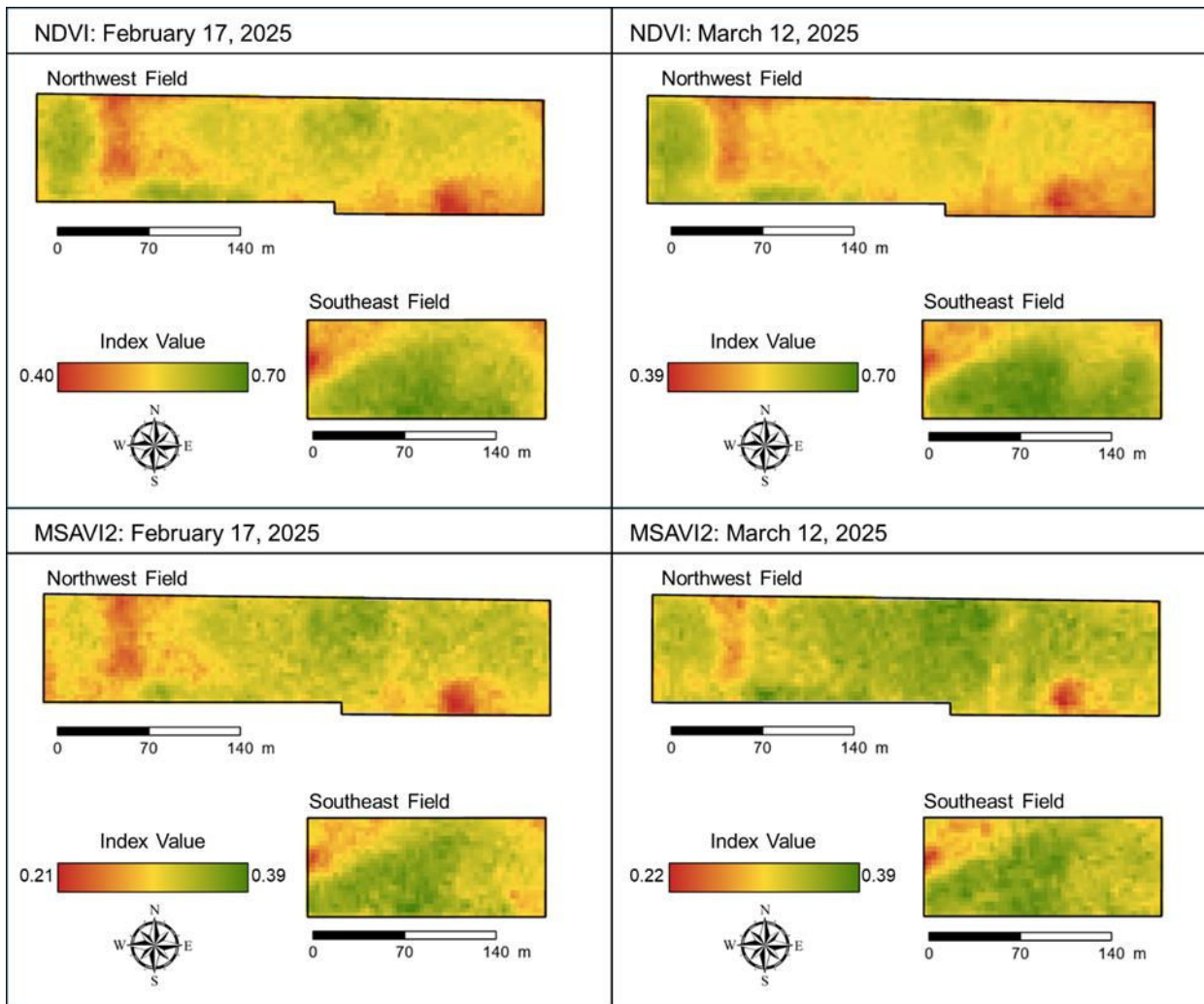


Figure 3. NDVI (above) and MSAVI2 (below) maps of the fields of interest in Farm A, derived from PlanetScope imagery acquired on February 17 and March 12, 2025. The images show areas of reduced crop growth which correlated with sting nematode presence.

Despite these limitations, satellite imagery could play an important supporting role. It can direct *where* to collect soil samples by pointing out areas where the plants appear weaker or less developed or most importantly it can also be used to monitor how nematode damage changes over time. This could help identify patterns of infestation and guide long-term management decisions including targeted fumigation.

In summary, high-resolution multispectral satellite imagery can serve as a valuable early warning and monitoring tool for strawberry growers dealing with sting nematodes. It helps visualize crop stress from above and provides a more complete picture of what's happening across large fields which would be

difficult to achieve with soil sampling alone. Although satellite imagery cannot replace soil sampling, it offers a powerful new layer of information for monitoring nematode damage and supporting smarter, more efficient management in strawberry production.

Takeaways

We demonstrated that AI-based mapping can accurately detect and track persistent purple nutsedge patches over time as well as detect new patches in strawberry fields. Our research also demonstrated that nutsedge patches tend to be persistent over time. These insights open the door to smarter, more efficient, and more sustainable weed

management strategies that focus efforts exactly where they are needed most.

We also showed that satellite images can detect differences in plant growth using vegetative indices. This technique can accurately track patches of suppressed crop growth within strawberry fields that correlate with sting nematode damage. Soil samples are needed to confirm the presence of nematodes but the aerial images accurately illustrate field-wide patterns and can be used to direct soil sampling and management. Further research is needed to prove that these maps could be used to guide site specific applications of deep shank fumigation during the fallow period.

Contact

Dr. Nathan S Boyd
UF/IFAS Gulf Coast Research and Education Center
P: 813-419-6613
E: nsboyd@ufl.edu