

IDENTIFYING CAUSES OF PEST CONTROL INCONSISTENCY WITH SOIL FUMIGATION IN FLORIDA STRAWBERRY.

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Various edaphic, environmental, biological, and cultural factors are known to influence gas phase movement and thus fumigant treatment performance and consistency. For example, in an attempt to determine the cause for poor crop performance and pest control consistency after soil fumigation with methyl bromide or 1,3- dichloropropene, field surveys of nematode infested problem fields demonstrated the presence of a compacted zone (traffic layer) which was later shown to dramatically inhibit downward diffusion and overall success of fumigant treatment. While In other studies, differences in soil penetration resistances, texture, and color were determined to be unrelated to the field distribution of nematode and plant damage. The objectives of the research reported herein was to determine if post harvest patterns of nematode field distribution and plant damage are correlated with physical characteristics of soil which could impact soil fumigation efficacy. More specifically, to determine if field contours of the impermeable spodic layer and frequent but transient subsurface flooding events were largely responsible for sting nematode survivorship of methyl bromide soil fumigation.

Approach: Two strawberry fields with long history of severe damage due to the sting nematode, *Belonolaimus longicaudatus*, were identified in Dover, Florida. In each field, final harvest strawberry plant sizes were enumerated into 3 size categories (large >16 in. diam; medium 8-16 in; and small <8 in diam.) within 25 or 50 ft linear section of row during 2004, 2005, and 2006. Utilizing this information, a plant size distribution map was developed for each year and used to determine whether specific locations within the field exhibiting excellent to poor strawberry growth are related to nematode density and specific physical characteristics of soil. Hyperspectral reflectance and other plant, field, and aerial imaging technologies were also used to characterize differences in plant sizes and nematode induced crop stresses. NDVI field maps were generated from near infrared (810 nm) digital images aerially acquired from an altitude of 3000 ft. In order to determine if changes in shallow water table was a primary cause of nematode control inconsistency, a monitoring network of wells was installed to measure depth to spodic horizon and changes in the shallow ground water table after rainfall and irrigation inputs. The monitoring network consisted of either 48 or 53 wells at the two field sites. At each site, wells were positioned within a 75 feet grid matrix, and water-levels regularly measured twice weekly from June thru August 2006. Ground water hydrology and topography was interpolated from the individual points of well data using ArcView and the geostatistical mapping software Surfer 8[®]. To determine if nematode problems simply originate from the untreated row middles and not necessarily due to soil characteristic, broadcast applications of methyl bromide chloropicrin (98/2;400 lb/a) and methyl bromide chloropicrin (68/1/31;350 lb/a) were applied in wide strips (50'x250') and immediately covered with HDPE plastic mulch at the two field sites. Broadcast Telone

II[®] (18 gal/a) was also strip applied 3 weeks prior to in-bed applications of methyl bromide chloropicrin (98/2; 400 lb/a). Statistical analyses and treatment comparisons were also made using SAS ANOVA, Correlation, Regression, and appropriate multiple range tests ($P < 0.05$).

Results: In neither field did preceding in-bed or broadcast fumigant treatment with chisel plowing improve strawberry plant sizing, particularly the percentage of large plants per unit length row (**Fig. 1**). This would suggest that factors other than the field traffic layer (soil compacted zone) are responsible for inhibited gas phase diffusion and nematode control inconsistency with soil fumigation. The post harvest percentage of larger plant sizes was increased, but not consistently, by in-row crop destruction treatments with Vapam (75 gal/a) or Kpam (60 gal/a) and by broadcast applications of either formulation of methyl bromide chloropicrin and Telone II (**Fig. 2**). Since Sting nematode problems were not satisfactorily resolved by any broadcast fumigant treatment, the actual mechanism for nematode survivorship from areas other than the untreated row middle must be investigated to further define causes of nematode control inconsistency. A simple ground truthing of plant size and nematode distribution within the field demonstrated a significant increase in soil density of Sting nematode with severity of plant stunting at each experimental site (**Fig. 3**). In this regard, the degree of plant stunting appears related to field areas where recolonization of the plant bed is earliest and most rapid.

No significant relationship was observed between the depth to spodic horizon and percentage of large plants per unit length row in either of the two fields (**Fig. 4**). The depth to spodic did appear to be shallowest within areas where sting nematode damage was most severe. At first glance, this relationship does not appear to directly support the transient subsurface flooding hypothesis. In general, the relative height of subsurface ponding upon the spodic horizon directly corresponds with the depth to spodic; ie water appears to cascade down the spodic slopes to accumulate within areas of spodic depression. To fully explain the distribution of sting nematode damage suggests yet another working hypothesis other than transient subsurface flooding. At soil depths of 0 to 26 inches, Sting nematode is reported to diminish in density with depth. Studies to document sting nematode densities below this depth have not been conducted. The relationship which appears to be expressed suggests that the nematode has depth limitations, possibly as a result of conditions of continuous soil saturation. In this instance, sting nematode does not occur at deeper depth due to control by flooding. If this were the case, at shallower depths, even the shallow ponding of water could play a vary significant sheltering affect upon sting nematode survival following soil fumigation in the fall when rainfall is frequent with a rise in subsurface water table. The current hypothesis suggests specific zone where sting nematode is depth distributed which is saturated at the time of fumigation, thereby sheltering the nematode, restricting the penetration and diffusion of fumigant, culminating in the survival of the nematode and cause of fumigation failure.

SUMMARY:

- Given the inability to monitor nematode population density and distribution in real time, other indirect measures based on ground truth surveying of differences in strawberry plant size proved to be highly correlated with nematode distribution.
- Final harvest soil population densities of sting nematode were positively correlated with reduced crown diameter of strawberry plants.
- Accurate maps of strawberry plant size distribution was very accurately characterized ($R^2 > 90\%$) by infrared imaging (810 nm) and NDVI indexing.
- The final harvest, end of season distribution of nematode stunted plants was not related to depth to spodic horizon or to change in shallow ground water table.
- Improvements in strawberry plant sizing was not observed with any fumigant treatment following deep chisel plowing of soil to destroy the compacted traffic layer.

Fig. 1 Post harvest percentage of large plants (>16 in. diam.) per 25 linear ft of strawberry row within plots chisel plowed to a soil depth of 16 inches prior to broadcast or in-bed treatments of either methyl bromide chloropicrin (98/2;400 lb/a); methyl bromide chloropicrin (68/1/31); or Telone II (18 gal/a) at two different commercial farms in Dover, FL during April 2006.

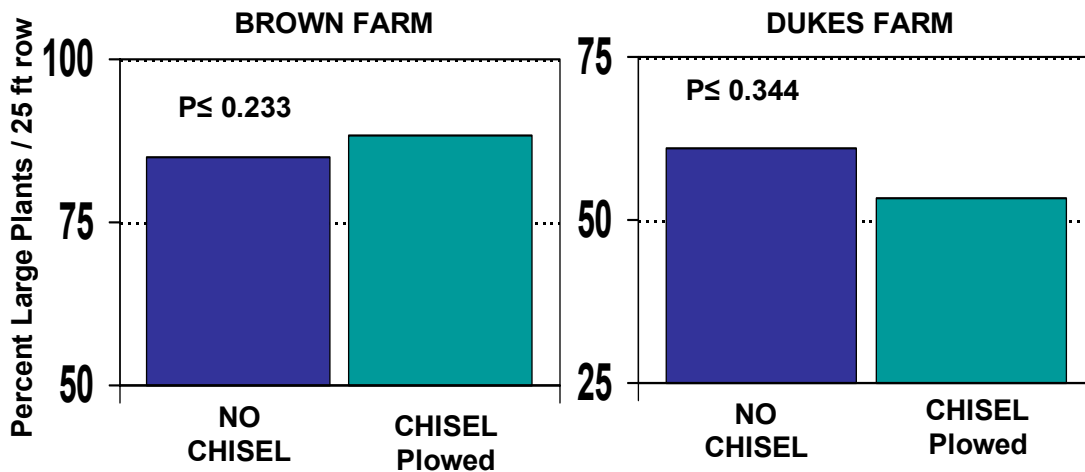


Fig. 2 Post Harvest percentage of large plants (>16 in. diam.) per 25 linear ft of strawberry row within plots broadcast treated with either methyl bromide chloropicrin (98/2;400 lb/a); methyl bromide chloropicrin (68/1/31; 350 lb/a); or Telone II (18 gal/a) at two different commercial farms in Dover, FL during April 2006.

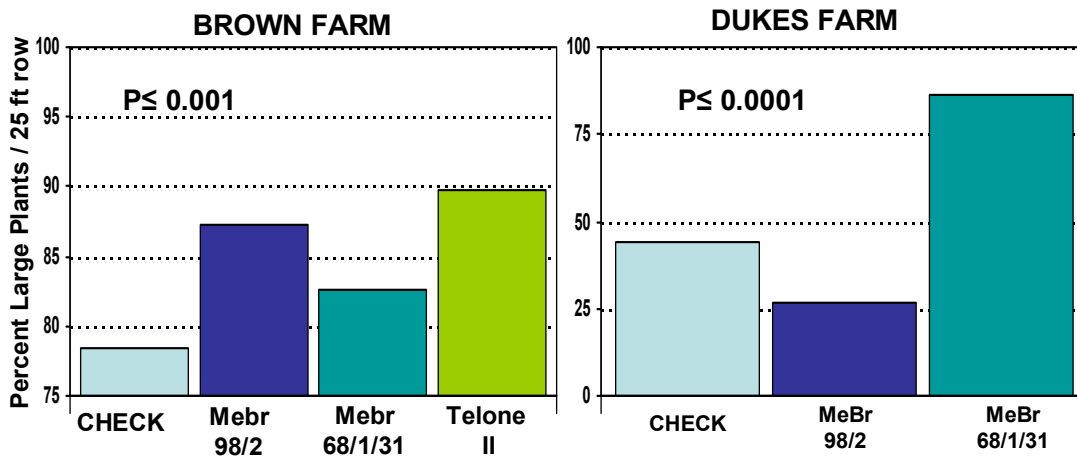


Fig. 3 Final harvest soil population density of the Sting nematode, *Belonlaimus longicaudatus*, derived from field samples of plants of Large crown diameter (>16 in. diam.), Medium (8 to 16 in. diam.), and Small (< 8 in. diam.) crown diameter in each of two commercial strawberry fields in Dover FL during April 2006. Note difference in scale.

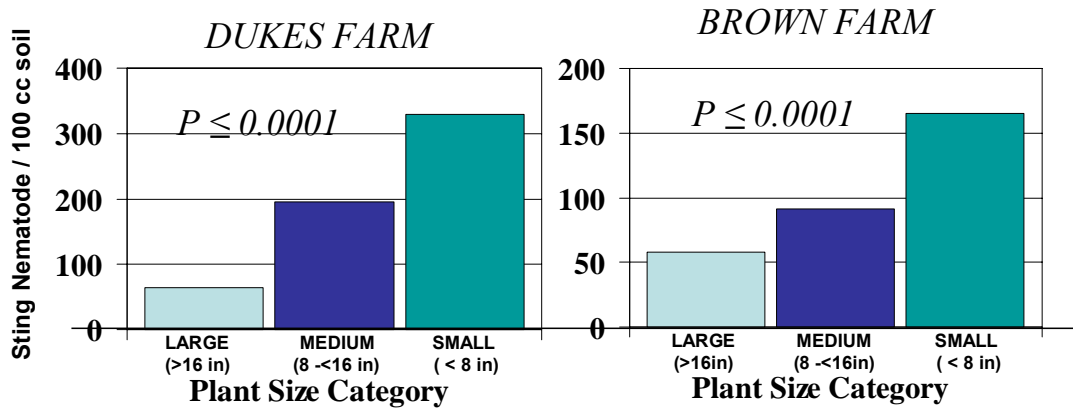


Fig. 4. Relation between depth to impermeable spodic layer and percentage of large plants per 25 linear feet of strawberry row in a commercial strawberry field in Dover, FL. April 2006.

