Impacts of traffic pans, subsoiling tillage practices, and deep shank injection of alternative fumigants on Florida strawberry crop growth, yield and Sting nematode control.

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The results presented herein derive from a USDA NIFA funded project entitled "*Industry-Wide Testing and Transition to Methyl Bromide Alternatives in Florida Strawberry* ''.

The sting nematode is the most economically important nematode pest of strawberry in Florida. In recent years, even methyl bromide chloropicrin (50/50) has not always provided season-long protection from sting nematode in many fields. In these fields, additional preplant treatment with broadcast applications of 1, 3-D (Telone) has been effectively used during the summer off-season to help mitigate the sting nematode problem. New problems with sting nematode have continued to emerge however. In order to determine the cause for poor crop performance after soil fumigation with methyl bromide or 1, 3- D, field surveys were conducted of sting nematode problem fields. In each of 8 bedded fields surveyed with a long hand probe, a compacted zone (traffic pan) was observed to occur between a soil depth of 8 to 18 inches. In practical terms, the compaction zone occurs just below the depth of the deepest tillage operation or implement used in the field. Previous research has demonstrated that unless completely destroyed by deep ripping or subsoiling prior to soil fumigant injection, the presence of an undisturbed soil compaction layer restricts downward diffusion in soil of 1,3-D when applied above the restrictive layer. In addition to restricting fumigant movement, soil compaction is also well documented to be responsible for reducing rooting, infiltration, water storage, aeration, drainage, and crop growth, and plagues fruit and agronomic crop producers all over the world. In-row subsoiling prior to planting has become a valuable production tool and conservation tillage practice for many different crop producers to alleviate soil compaction and leave large amounts of crop residue in place. For purposes of this USDA NIFA funded project, it is assumed that further evaluations of new subsoiling, deep shank tillage (subsoiling) and fumigant application methods will not only improve overall strawberry crop response, as it has in other crops, but also provide season long nematode control and help reduce potential fumigant emissions from treated fields. In these studies a multiple-probe soil cone penetrometer system was used to measure the depth and degree of soil compaction.

Materials and Methods: Four strawberry field studies were conducted to evaluate the influence of subsoiling and fumigant nematicide application, alone and in combination, on strawberry crop growth, yield and sting nematode control. A variety of different fumigant alternatives to methyl bromide were used in combination with subsoiling in the fine sandy soils of west -central Florida, USA.

In each field trial, subsoiling (deep ripping) was carried out to a depth of 22 inches, to a compacted fine sandy soil in the strawberry productions areas of Dover and Plant City Florida. Each field had an 8 to 18 inch (20-35 cm) deep traffic pan (plowpan) and had history of frequently severe, reoccurring production problems caused by the sting nematode, *Belonolaimus longicaudatus*. Soils were subsoiled to a depth of

22 inches using a front and back staggered series of 5, forward swept subsoiling shanks. During the first or second pass of the subsoiler, Telone II (15-18 gpa) was applied to a depth of 20 inches. Two weeks following subsoiling and fumigant application, soil penetration resistances were measured using an electronic penetrometer before and after 0, 1, and 2 passes with the deep shank subsoiling implement. The measurement system for sensing soil cone penetrometer resistance was built and mounted on a steel frame attached at 3 points to the rear of a tractor, a rod and a penetration cone with a load cell raised and lowered using tractor supplied hydraulics. The load cell of the cone was connected, through a display, to a portable computer, where the data was stored, analyzed, and graphically displayed. Soil penetration resistances were measured as a continuum to a maximum depth of 22 inches. In addition, 4 inch diameter cylindrical soil cores were separately acquired using a hydraulically raised and lowered coring probe at replicate locations between adjacent ripper shanks. Each soil core, collected intact to a soil depth of 30-31 inches, was subdivided into 6 inch increments for nematode population density determination and particle size analysis with depth.

After subsoiling and deep shank fumigant application, distribution of 1, 3-dichloropropene (Telone II; 18 gpa) gases were measured at 6 soil depths (6, 12,18,24,30, and 36 in). For most field studies, mean VOC concentrations for each subsoiling treatment and depth location were averaged from at least 5 random measurements within each subsoiling treatment and experimental field location. For these studies, peak concentration measurements from the MiniRAE 2000 over a 30 second sampling period were used to characterize soil atmosphere gas concentrations, retention characteristics of fumigants over time, as well as relative differences in vertical, gas phase movement of the fumigant with time. For most field locations, fumigant concentrations were monitored until soil disappearance (typically 5-7 days). After fumigant application and dissipation from soil, bare root strawberries were planted and differences in plant growth quantified by measurement of the 'stunting effect' induced by Sting nematode over the course of the season. Weed density, disease incidence, and canopy dimension and the rates of convergence of plant growth within and between rows were also periodically assessed. At each site, the experimental design was a Randomized Complete Block with four replications. Data were analyzed using the general linear models (SAS, 2010), and means were separated using Fisher's Least Significant Difference Test ($P \leq 0.05$).

RESULTS: Cone penetrometer resistance was reduced and strawberry yields remained unchanged following the deep tillage / subsoiling operation and fumigant application at most experimental site locations. At the Driscoll site (JS Farm), subsoiling significantly (P 0.05) reduced penetration resistances by 30-45%, (in figure from 7.0 to 5.0 and 4.3 MPA) , to depths to which the subsoiler was pulled through the field (Fig. 1). Although subsoiling had an immediate loosening effect, its effect was not evident in 3 of the 4 experimental sites. In only one field experimental site did subsoiling, in combination with deep shank injection of Telone II (18 GPA), increased relative strawberry yield. No interactions between subsoiling and fumigant application was observed at any of the four experimental sites. Based on comparison of 1, 3-D gas concentrations (estimated by isobutylene) at six soil depths, significant enhancement in overall depth distribution was only observed day after fumigant application (Fig. 2). Vertical movement of 1,3-D gases was clearly enhanced along shank traces two days post application. (Fig. 2). Sting nematode population densities were significantly (P=0.05) reduced at all soil depths except in the soil surface horizon (0-6 inches) at the JS Farm, Dover FL location (Fig. 3). In most fields, no differences were observed in plant size distribution or in relative strawberry yields observed between subsoiling treatments. These results would suggest that destruction of the traffic pan will not necessarily improve overall nematode control, particularly in deeper soil horizons, and as a result, improve crop yield response consistency.

KEY POINTS:

- As a preplant tillage operation, subsoiling had a significant (P=0.05) loosening effecting on soil compaction and penetration resistances with soil depth.

- As a preplant tillage operation, subsoiling significantly (P=0.05) improved gas movement, distribution and observed peak concentration of 1,3-D soil air concentration post application.

- Subsoiling did not provide broadcast nematicidal efficacy of Sting Nematode in the shallow surface soil horizon of 0-6 inches, or generally, of any significant strawberry yield enhancement.

Fig 1. Soil resistance forces (MPa) measured to a soil depth of 65 cm in fields recieving no subsoil and those recieving one and two passes of the 60 cm deep subsoiling implement. Site Location: MB Labor Field, Dover, FL August 30, 2010

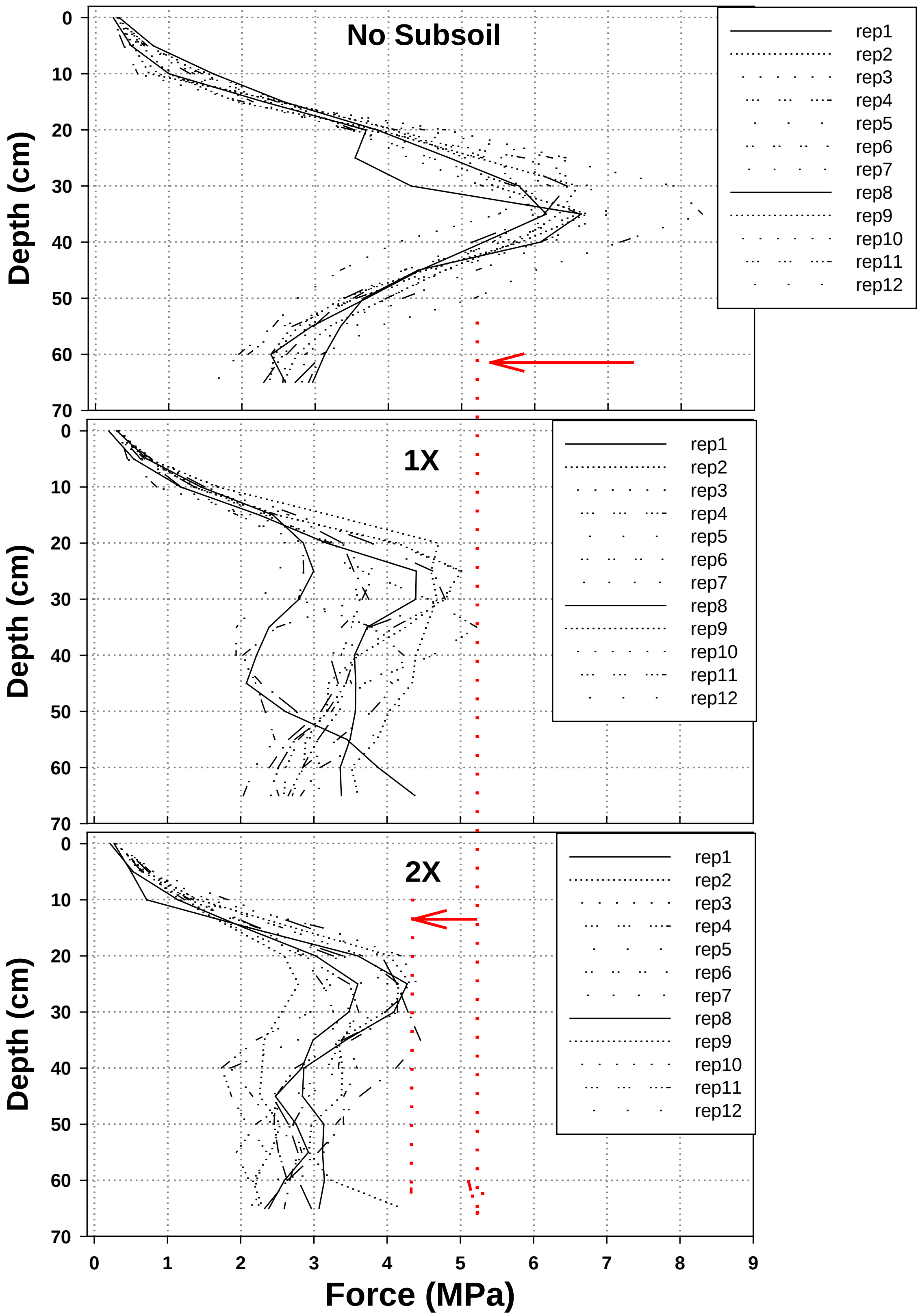

Fig. 2. Isobutylene gas concentrations (ppm) at 6 soil depths 1 to 4 days post application of PicClor 60 (250 lb/ta). Broadcast fumigant applications were made to a soil depth of 48 cm to field areas at the time of recieving either one or two passes of the 60 cm deep subsoiling implement. Site location: CY Farm, Glen Harwell Rd, Dover, FL July 26, 2010

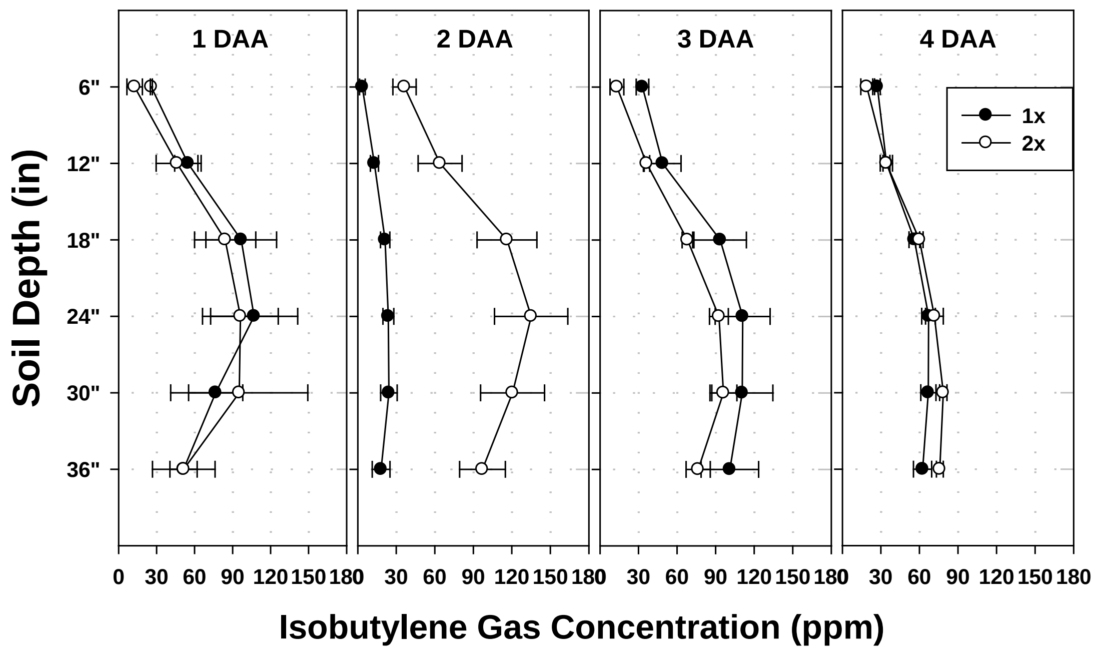

Fig. 3. Population densites of the Sting nematode, *Belonolaimus longicaudatus*, at four zones of soil depth in treatments recieving no subsoil and those receiving one and two passes of a 24 inch, deep shank, subsoil implement. Broadcast applications of Telone II (18 gpa) were made to a soil depth of 48 cm to only field areas recieving either one (1X) or two passes (2X) of the 60 cm deep sub-soiling implement. Site Location: JS Dairy Farm, Dover, FL August 31, 2010