DISTRIBUTION AND DISSIPATION OF 1,3-D AND CHLOROPICRIN AFTER SHANK AND DRIP APPLICATIONS IN A CLAY LOAM SOIL

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Soil conditions (e.g., texture and water content) and tarps affect the efficacy of fumigation in controlling soil pests. Texture and soil moisture affect the volume of air filled space and continuous porosity. Tarps can reduce emission and improve pest treatment of surface soil – especially weed control. Use of plastic tarps, however, is expensive (about $700 per acre for purchase, placement, removal, and disposal of standard HDPE tarps). HDPE is not an effective barrier for some fumigants [e.g., 1,3-Dichloropropene (1,3-D)]. Virtually impermeable film (VIF) has the potential to reduce fumigant emissions. High soil moisture is a more effective barrier for reducing emission of fumigants than HDPE (Gan et al 1998; Ajwa et al., 2004). The Telone "label" requires adequate soil moisture above the injection depth of fumigation. High soil moisture may, however, cause poor distribution of fumigants in soils by reducing air-filled porosity. Thus effective combination of fumigation methods (shank injection and through drip irrigation) with tarps is essential for maximizing fumigation efficacy and minimizing emissions.

Objectives: 1. Determine the effect of fumigant application methods (shank injection and drip application) on fumigant distribution and dissipation of 1,3-D and chloropicrin (CP) in a clay loam soil; 2. Determine the effect of tarp (HDPE and VIF) under shank applications on fumigant distribution and dissipation.

Field Trial and Testing: A field trial was conducted in May, 2004 at Bright's Nursery, located in the San Joaquin Valley, near Merced, California to compare the efficacy of fumigation methods (shank injection and through drip irrigation) with tarps (standard HDPE and VIF). To accomplish the objectives of this research, we chose three adjacent treatment plots: shank injection with HDPE, shank injection with VIF, and drip application with HDPE. In shank injection, fumigant was applied by a commercial fumigation rig (Tri-Cal, Hollister, CA) at a depth of 45 cm with a shank spacing of 25 cm. Fumigants were applied in drip irrigation at a depth of 10 cm with a tubing spacing of 60 cm and an emitter spacing of 30 cm. Telone C-35 was used for shank injection at a rate of 544 lb/A and InLine was used through drip irrigation at a rate of 48 gal/A (544 lb/A).

In each plot, two sampling locations were selected, center (near shank injection line or drip tape) and edge (halfway between shank injection lines or drip tapes). Gas sampling probes were installed at depths of 10, 30, 50, and 70 cm. Samples were taken at approximately 1, 6, 12, 24, 48, 72, 96, 120 and 186 hours after completion of fumigant application. Drip application required 18 hours to apply the fumigants with 76 mm of water, resulting in approximately 800 mg/L of 1,3-D in water. Fumigants were collected on ORBO XAD tubes. Soil auger samples were taken at approximately 4, 24, 48 h, and 6-7 days following application. All samples were stored in coolers with dry ice in the field and in freezer after transfering to the laboratory. The XAD tubes were extracted with hexane and soil samples were extracted with ethyl acetate. Fumigant concentrations in the extracts were determined on a GC-MS system (Agilent 6890N GC with 5973 mass detector). Soil water content was measured gravimetrically.

Results and Conclusion: The soil type at Bright's Nursery is Yokohl clay loam overlaying clay pan. The top 15 cm is the dry tilled layer. From 15-60 cm, soil is fine textured with some plasticity, dark colored, and moist (15-25% volume wetness). At 60 cm and below, soil becomes moister, light reddish colored, and hardened. The bulk density is high (1.55 g/cm^3) below 60 cm. Water content in soils below this depth is higher than those above in shank injection plots. Water content following drip application is high throughout the profile.

Distribution of 1,3-D and CP are similar in both gas phase and soil liquid/solid phase except that 1,3-D concentrations are higher than CP. In the gas phase, fumigant distributions show different patterns between shank injection and drip application (Figures 1). The pattern appears directly related to the fumigant application depth and soil water content. Fumigant concentrations are generally higher in shank injection plots (max. 57 mg/L 1,3-D with VIF) than in the drip application (max. 12 mg/L of 1,3-D). Fumigant movement appears slower and uneven in drip application plots than the shank injection based on the differences of fumigant concentrations sampled at the center and edge locations. The plot with VIF tarp showed higher concentrations in the gas phase than the plot with HDPE. Peak concentrations were observed within 24 h for shank applications and these peaks were extended to 72 h for drip applications with spatial variation.

In the liquid/solid phase, fumigant concentrations in soil profiles were highest near the fumigant application depth within 4 h and then increased in the surface and decreased in the lower depths (Figure 2). Concentrations of 1,3-D and CP in shank injection with HDPE are generally higher than in plot with VIF, in contrast to that observed in the gas phase. Fumigant concentrations in drip application are generally lower than in shank injection with a continuous pattern of higher concentrations near the surface than the lower in the profile. This could be caused by faster degradation from higher water content.

Both fumigation methods (shank injection and drip application) and tarps have influences on fumigant distribution in both gas and liquid/solid phases. The high bulk density below 60 cm appears to have inhibited fumigant downward movement. Soil water content showed great impact on fumigant concentration and distribution through the soil profile. More work is needed to develop methods that maximize fumigant efficacy while minimizing emissions in field conditions.

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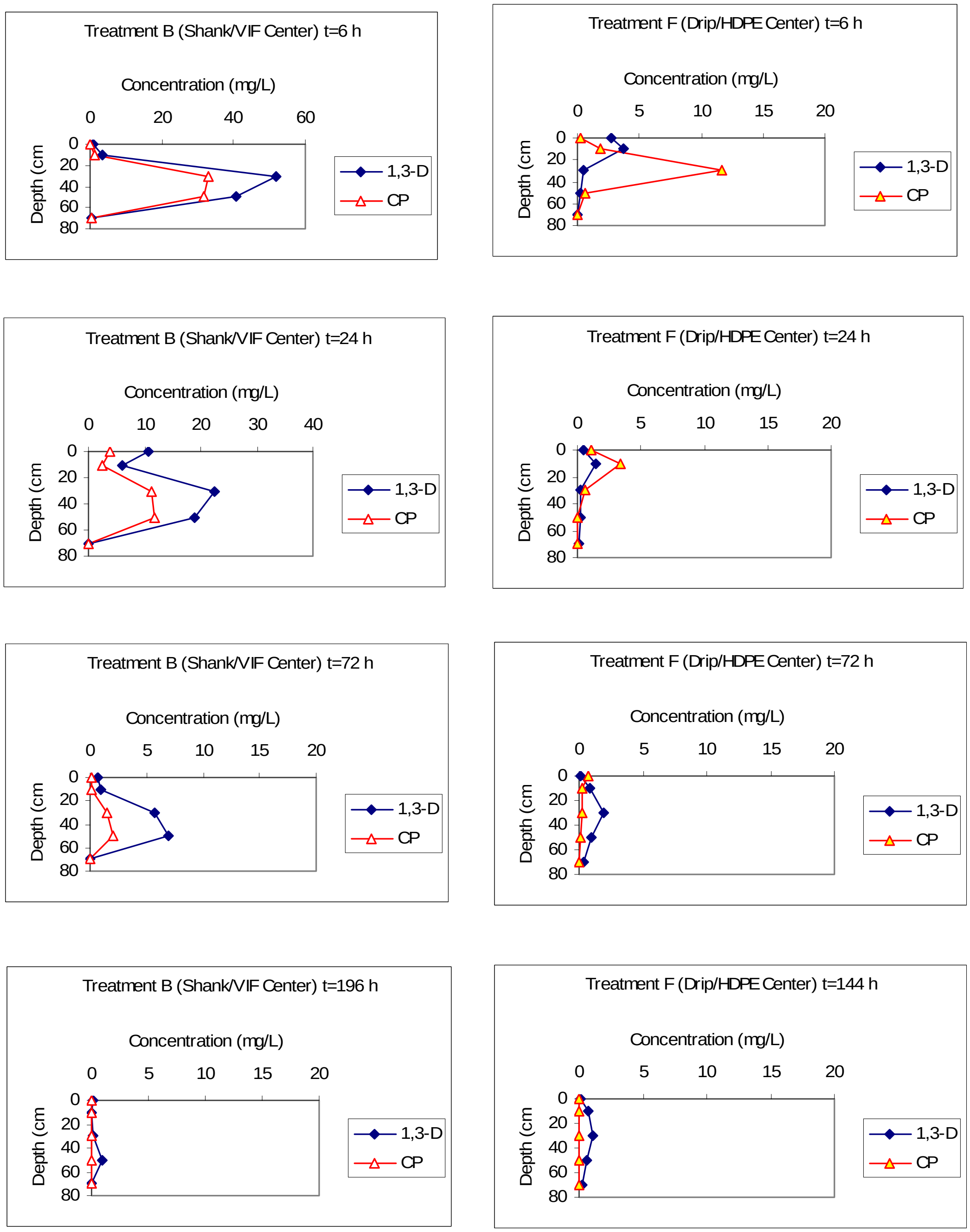

Figure 1. Fumigant concentration in soil gas phase after application. Plots on the left are for treatment of shank injection with VIF tarp. Plots on the right are for treatment of fumigation through drip irrigation with HDPE tarp. Locations are near injection line or the drip tape. t is the time after fumigant application.

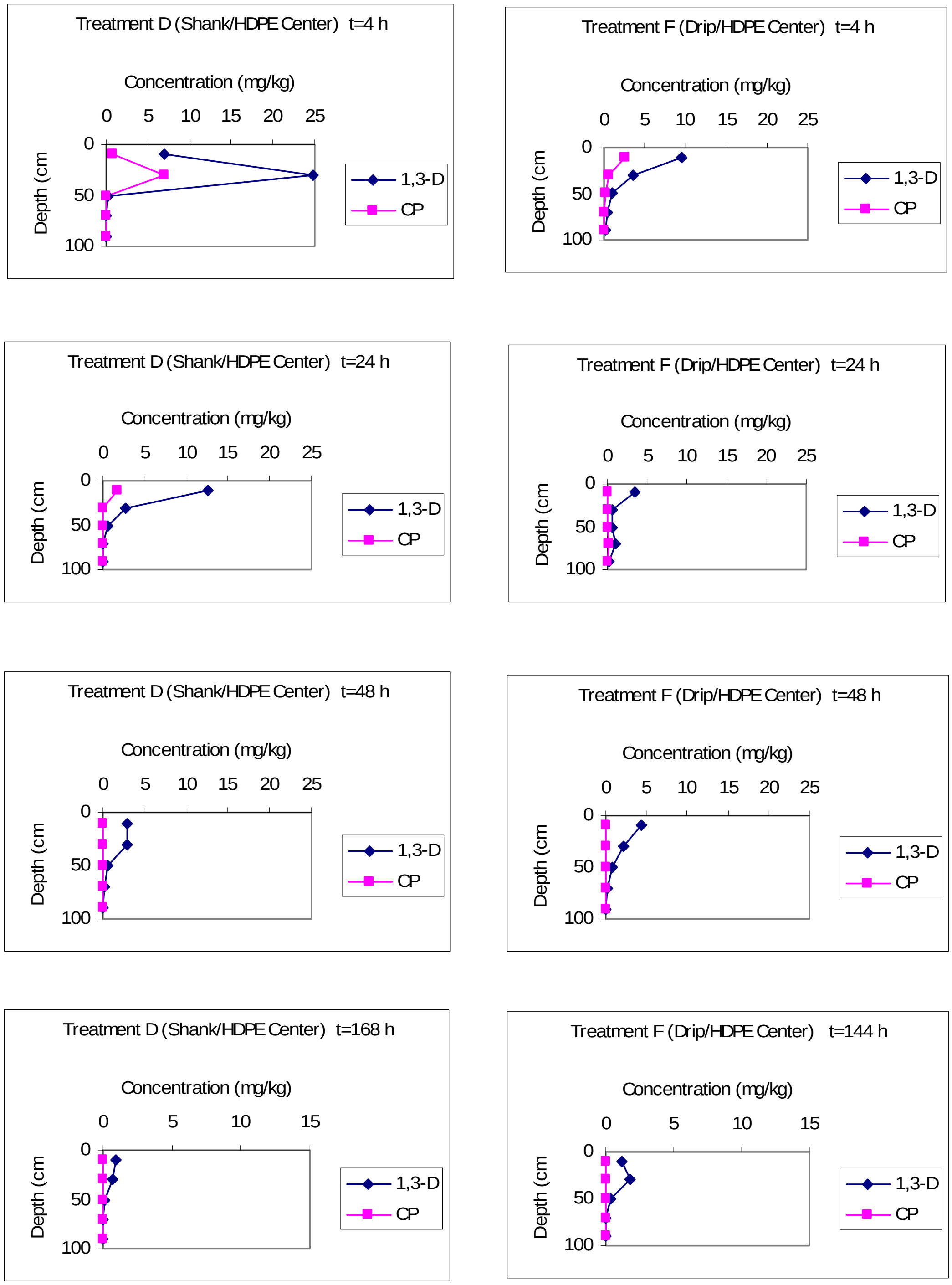

Figure 2. Fumigant concentration in liquid/solid phase after application. Plots on the left are for treatment of shank injection with HDPE tarp. Plots on the right are for treatment of fumigation through drip irrigation with HDPE tarp. Locations are near injection line or the drip tape. t is the time after fumigant application.