SURFACE WATER APPLICATIONS FOR REDUCING EMISSIONS FROM TELONE C35: THEIR EFFECT ON WEED POPULATIONS

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Introduction:

Telone C35, which contains 61% 1,3-dichloropropene (1,3-D) and 35% chloropicrin (CP), has been tested as a promising alternative fumigant product to methyl bromide in various cropping systems. However, some of the alternative fumigants, such as 1,3-D, are volatile organic compounds (VOCs) that can react with oxides of nitrogen in the presence of sunlight and form harmful ground level ozone. This has resulted in heavy regulations being placed on these fumigants. Therefore, it is essential to minimize emissions to avoid negative impacts on the environment and human health. Soil surface barriers such as standard high density polyethylene (HDPE) plastic are commonly used to control fumigant emissions. However, HDPE does not effectively reduce 1,3-D emissions and/or are expensive. High barrier film such as virtually impermeable film (VIF) has demonstrated great potential in reducing emissions because of its extremely low permeability to fumigants.

It is reported that high water content in surface soil provided a more effective barrier to 1,3-D movement than the tarps and reduced emissions. Water seal (applying water to soil surface) has been demonstrated to reduce 1,3-D emissions. However, surface water applications can have implications for weed management as weed seeds would be subjected to hydrothermal processes that would either reduce or increase their germination. The objective of this study was to determine weed populations in field plots with surface water applications in shank-applied Telone C35 treatment, plots with plastic tarps (HDPE and VIF), and plots with a combination of water application and HDPE tarp.

Materials and Methods:

A field study was conducted at the USDA-ARS San Joaquin Valley Agricultural Science Center, Parlier, CA in the summer of 2005. The soil was cultivated 75 cm deep before fumigation. Telone C35 was applied by shank injection to a depth of 46 cm at a rate of 610 kg ha^{-1} by a commercial applicator. Immediately following the Telone C35 application, the soil surface was disked and harrowed to disrupt any shank traces and create a smooth surface then the appropriate tarp or water treatments were applied. Treatments were: 1) Control (dry soil without tarp or water applications); 2) HDPE tarp over dry soil; 3) VIF tarp over dry soil; 4) Pre-irrigated soil (56-mm water was sprinkled on the surface 48 h prior to fumigation); 5) Pre-irrigated soil + HDPE tarp (56-mm water was sprinkled on the surface 48 h prior to fumigation. This amount of water wet the soil to 30-cm depth to its water holding capacity); 6) Initial water application immediately following fumigation (19-mm water was sprinkled on the dry soil surface); 7) Intermittent water applications [initial 19-mm water sprinkled immediately following fumigation + 4.2-mm water sprinkled on soil surface at 1^{st} sunset (8 h), 1^{st} sunrise (22 h), noon (28 h), 2^{nd} sunset (32 h), and 2^{nd} sunrise (48 h) following fumigation].

Individual plots were 9 m x 9 m for water application treatments and 9 m x 3 m for the control and tarped treatments. Tarps with a width of 3.7 m were placed over the fumigated soil immediately after post-fumigation tillage using a standard fumigation rig with the shanks removed. Tarp application was by a single pass perpendicular to the fumigation direction (across the plots) and tarp edges were inserted 20-cm deep into the soil. Sprinkler water was applied to each plot with four Hunter PGP® rotary sprinklers. The soil was wet to near field capacity to a 10-cm depth. The fumigated area was divided into 3 blocks. Treatments were tested with three replicates in a randomized complete block design. Between blocks, and treatments with and without water applications, a 3-m wide buffer zone was used. Tarps were removed two weeks after fumigation. The whole experimental field was sprinkler irrigated for weed recovery investigation. Irrigation was repeated in another two weeks.

Weed population in the plots was assessed by taking emergence count by species on September 28, 2005 (60 days after the tarps were removed, i.e., 85 days after fumigation). Each weed in the entire plot was counted by species and recorded. The data was converted to number of weeds/m^2 because of differences in plot sizes. Data for total weed density were subjected to ANOVA and means were separated by Fisher's LSD at a 0.05 and 0.10 level using the PROC GLM procedures of SAS.

Results:

The pre-irrigated soil with the HDPE tarp provided the best weed control (Fig. 1A). The plots with initial water application immediately following fumigation had the same number of weeds as the non-treated control plots. The HDPE and VIF plots had the same number of weeds and were not significantly different from the control plots or the intermitted water application plots. The major weeds in the plots were mallow (*Malva* sp.), pigweed (*Amaranthus* sp.), carpetweed (*Mollugo verticillata*), and shepherdspurse (*Capsella bursa-pastoris*). All these weeds were effectively controlled by the pre-irrigated soil + HDPE treatment (data not shown). The lowest densities of mallow were observed in the pre-irrigated soil + HDPE treatment (Fig. 1B). Comparing treatments 4 and 5, it can be inferred that addition of the plastic to the pre-irrigation treatment helped further limit mallow densities. Water application after fumigation generally resulted in higher emergence of all these species except carpetweed. Carpetweed populations under intermittent water applications were similar to the control treatments.

Conclusion:

This study showed that a combination of pre-irrigation + HDPE + Telone C35 could result in good weed control and also reduce populations of generally difficult to control species such as mallow. Better control under this treatment could be due to a combination of factors such as softening of the seed coat by the water thus allowing the fumigant to penetrate the seed and/or lethal temperatures produced by the HDPE tarp causing seed-kill (Fig. 2). It can be seen in Figure 2 that the soil temperature in the 15-cm soil depth in the pre-irrigation + HDPE plots reached as high as 46.6 C which can be lethal to several weed species.

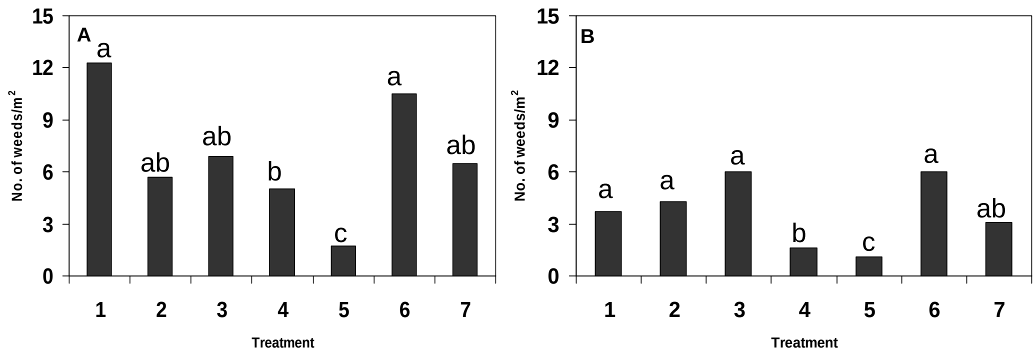

Figure 1. (A) Total weed emergence in the treatment plots. (B) Total densities of mallow (*Malva* sp.) only in the treatment plots. Means followed by the same letter are not different at a 0.10 and 0.05 level of significance for (A) and (B), respectively. See treatment list in the text above for explanation of treatment numbers.

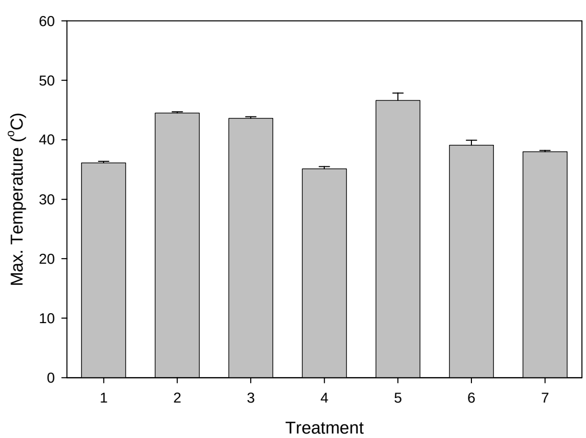

Figure 2. Maximum soil temperatures ± standard error (at the 15 cm soil depth) obtained in the treatment plots during the experimental duration.