# PLASTIC FILMS ON CONTROLLING CHLOROPICRIN EMISSIONS IN A STRAWBERRY FIELD TRIAL

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**Introduction:** Fumigation is used for intensively soil pest control to achieve high yield in strawberry production. Chloropicrin (CP) is an important alternative fumigant to methyl bromide, but it is susceptible to rapid emission after being applied to soil. The emission of CP contributes volatile organic compounds (VOCs) which impairs air quality and the environment. Plastic tarps are often used over raised beds in strawberry field and low permeability films can retain fumigants under the tarp to improve efficacy and minimize volatilization losses. Thiosulfate fertilizer was found to decrease fumigant emissions effectively by reacting with fumigants to from non-volatile compounds. The objective of this study was to determine the effectiveness of two different tarps over the raised-bed and applying potassium thiosulfate (KTS) in furrows to reduce CP emission in a strawberry field trial.

**Materials and Methods:** A field trial was conducted in October 2006, near Santa Maria, CA. Four 4047 $m^2$ fields (treatments) were tested and each consisted of 20 beds that were 128 m long, 0.3 m high and 1.63 m wide from bed center-to-center with a furrow width of 0.46 m. Two high flow drip tapes (0.67 gpm/100 ft) per beds were buried at 3 cm soil depth and 46 cm spacing. In Field 1 and Field 2, raised beds were tarped with low density polyethylene (LDPE) (1.5-mil or 0.038-mm thickness; PolyPak Co., Los Angeles, CA). In Field 3 and Field 4, beds were tarped with virtually impermeable film (VIF) (1.38 mil; Bruno Rimini Ltd, Italy). Both films were clear. InLine was applied by drip-irrigation through the drip tapes at a rate of 224 kg $ha^{-1}$. Drip fumigation began at 9:00 am and was completed in 3 h with additional flushing of 20 min. Immediately following the CP application, potassium thiosulfate (KTS) solution (at 25 gal a.i./A) was applied by sprinkler for 30 min for Field 2 and Field 3. This amount of water concentrated in the furrows (30% of the total area) and wetted soil to about 5 cm depth. The treatments were summarized as: (i) LDPE tarp, (ii) LDPE tarp with KTS application to furrows, (iii) VIF tarp, and (iv) VIF tarp with KTS application. Fumigant emissions from beds and furrows as well as fumigant concentration under tarps and above soil surface were monitored for 5 d using passive flux-chamber methods. Four measurements were made for each sampling time at each field and the average values are reported. Air temperature and soil temperature were also measured during the trial.

**Results:** The emission fluxes from the beds are shown in Figure 1. Similar patterns were found for all four fields. Diurnal variation in CP emission flux occurred with greater emissions during the day and lower emissions at night corresponding to temperature changes. The emission rate was highest at the first sampling time, which was immediately following fumigant application (~3 h after fumigant injection began). This may be partially due to the shallow depth of drip tapes for delivering the fumigant and illustrates earlier emission peaks than deep shank-injection (at or below 45 cm) showing emission peaks in about 24 h. The differences of emission flux between the two tarps were small although VIF tarp showed lower values than LDPE tarp. For all the fields, the emissions of CP decreased rapidly after 3 days indicating rapid dissipation of CP from the soil.

The emission fluxes from furrows were 40 times lower than from beds (data not shown). A slightly higher CP emission rate from furrows occurred in the VIF treatment compared to the LDPE treatment. Application of KTS to furrows reduced the CP emission rate only in the field covered with VIF tarp.

Cumulative emission losses were estimated based on the measured emission flux from beds and furrows separately. For the tarped beds, emissions from the top and sides were estimated. The emission rates from the sides of the beds were assumed to be the same as the measured values from the top of the beds. Total emission losses of CP were 19% of applied from LDPE treatments, 17% from VIF treatment, and 11% from VIF/KTS treatment (Figure 2). The furrows had very low emission losses ($\leq$ 0.2% of applied) and were not different between the VIF and LDPE treatments. This indicates that CP emissions from furrows were not significant.

The VIF tarp may retain higher fumigant concentrations than LDPE tarp but this was not apparent in this field trial (Figure 3). Diurnal changes were also found for CP concentration under the tarp, similar to emission flux. The normalized flux (CP emission flux from the beds divided by CP concentration under the tarp) was calculated to evaluate tarp permeability (Figure 4). The normalized fluxes were higher for LDPE tarp (average 7.97 cm $h^{-1}$) than VIF (average 5.15 cm $h^{-1}$), suggesting a greater potential of CP passing through the LDPE film than the VIF, and were highly temperature-dependent.

**Conclusion:** This study shows that emissions of chloropicrin were mainly through the beds from drip-irrigation, suggesting that emission reductions efforts should be focusing on the tarp over beds. The benefits of KTS application in the furrows were not significant in this field trial. The large field variability illustrates that further efforts are needed to confirm the performance of VIF tarp to achieve low emissions. The high emissions at the initial period of fumigation suggest that intensive sampling is needed to more accurately estimate emission losses especially using flux chamber methods.

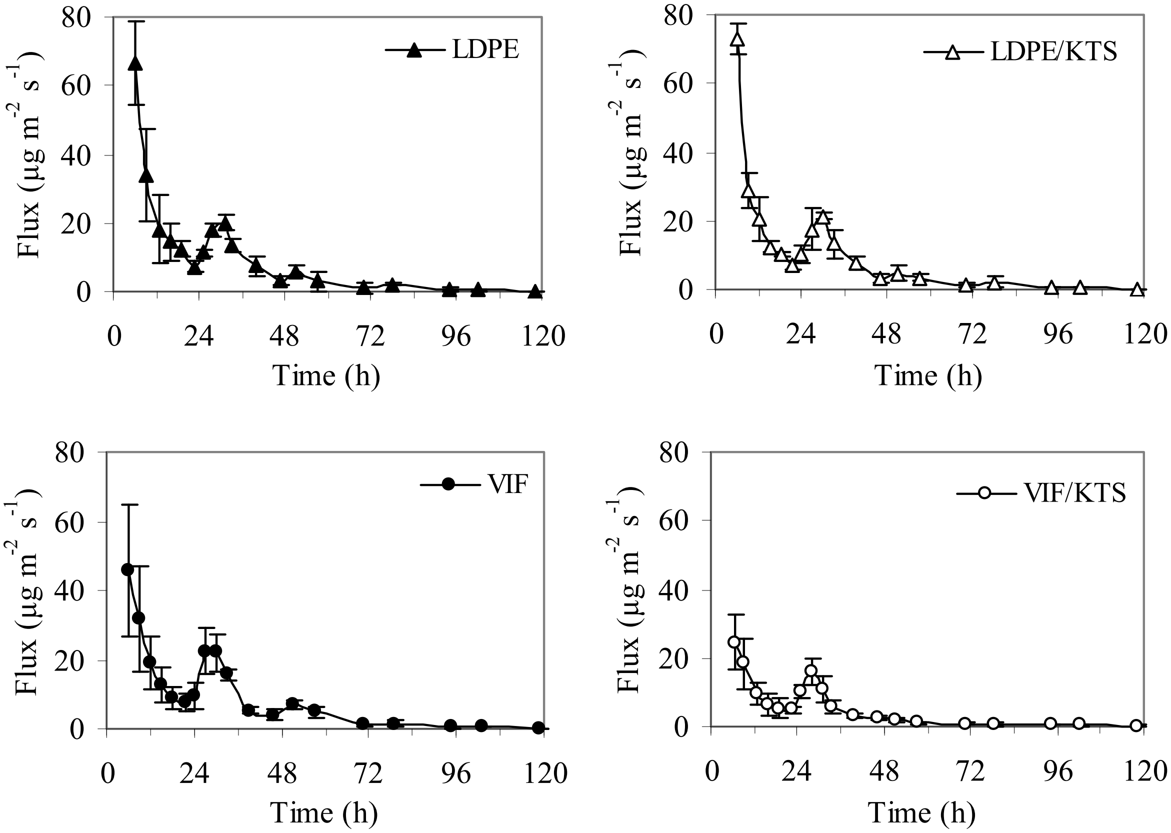


**Figure 1.** Emission flux (µg $m^{-2}$ $s^{-1}$) of chloropicrin measured from top of the beds in Santa Maria strawberry field trial. Error bars are the standard error of the mean (n=4).

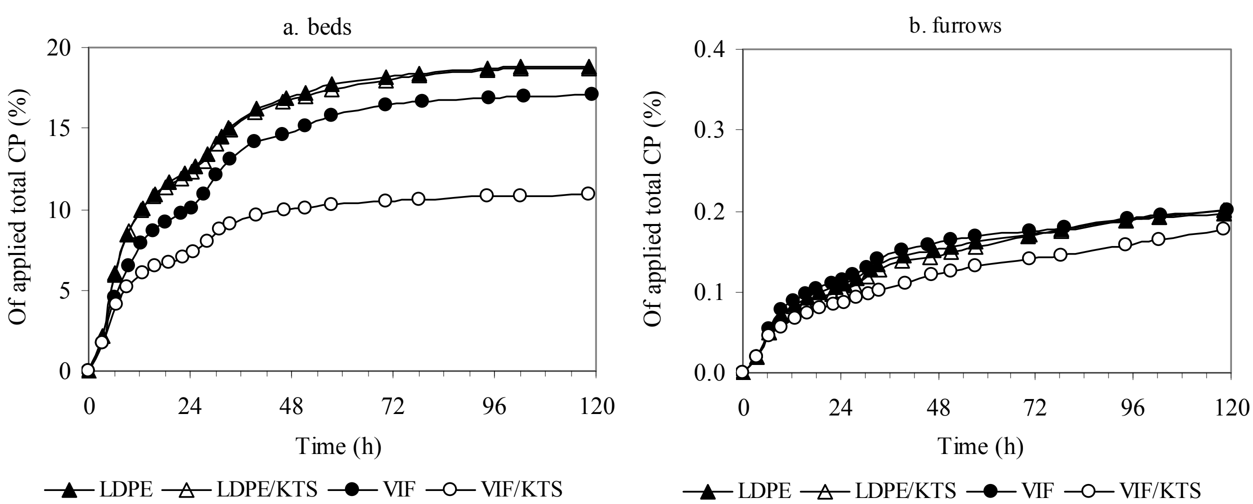


**Figure 2.** Cumulative emission (%) of chloropicrin from (a) the beds and (b) furrows in Santa Maria strawberry field trial.

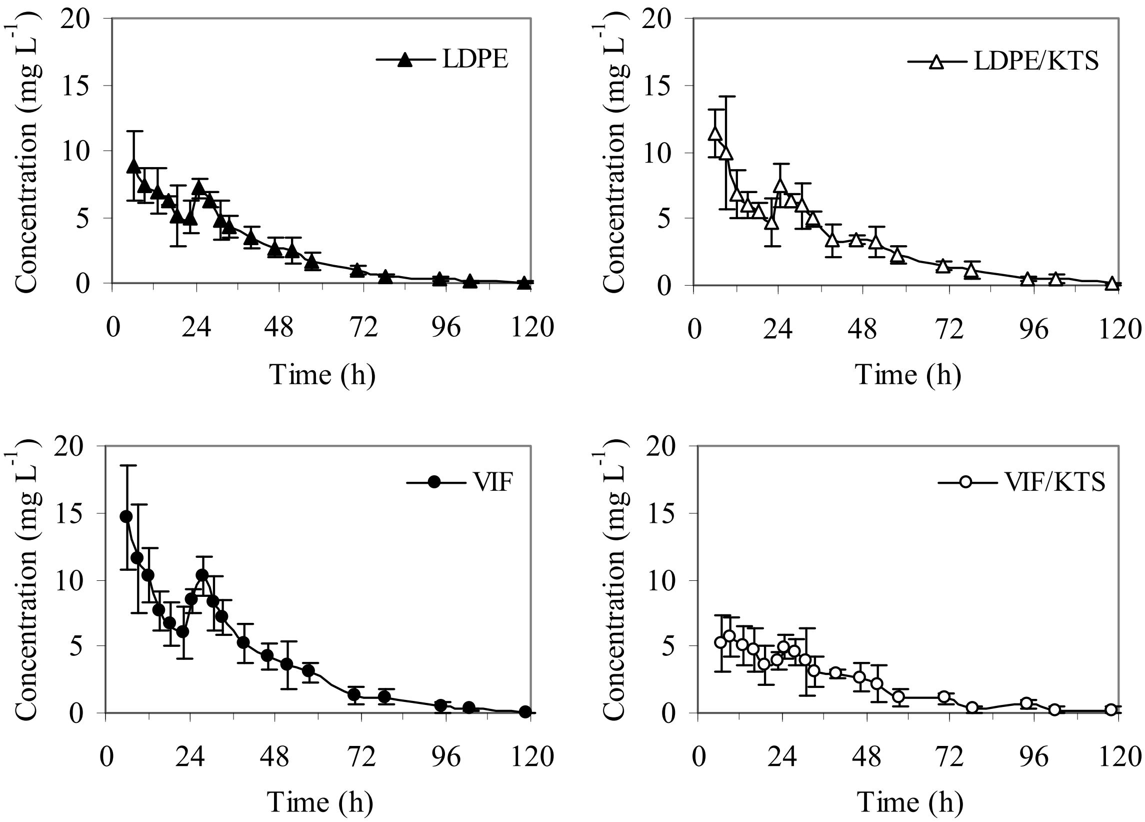


**Figure 3.** Concentration (mg $L^{-1}$) of chloropicrin under the tarp and above soil surface measured from top of raised beds

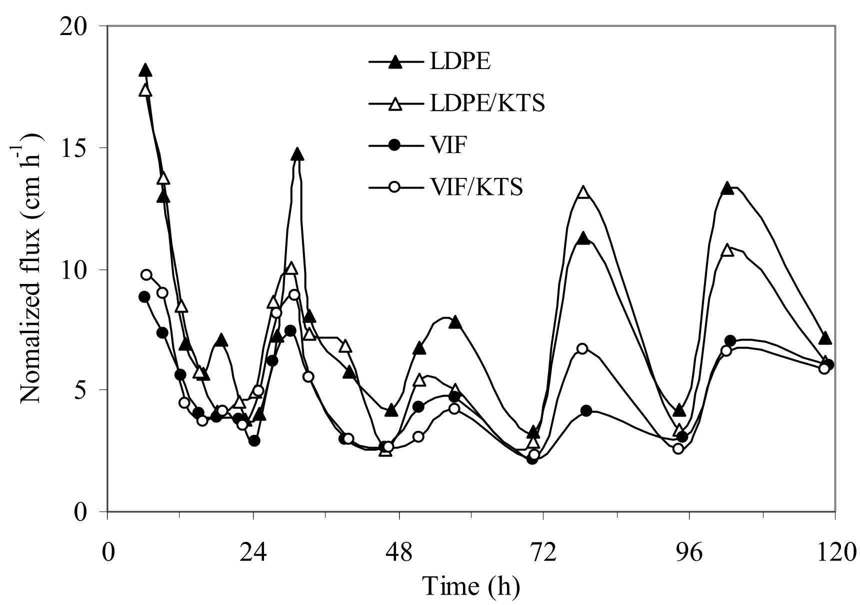


**Figure 4.** Normalized flux (emission flux divided by concentration under tarp) of chloropicrin emissions) in Santa Maria strawberry field trial.