EFFECTS OF SURFACE SEALS ON PEST CONTROL EFFICACY WITH 1,3-DICHLOROPROPENE / CHLOROPICRIN

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Introduction:

Soil fumigation has been used for many years for control of soil-borne pests including parasitic nematodes, disease pathogens, and weeds in high value cropping systems. The phase-out of methyl bromide has resulted in increasing use of alternative fumigants such as 1,3-dichloropropene (1,3-D) and chloropicrin. These compounds can have negative human health and environmental consequences related to worker and bystander safety and release of volatile organic compounds (VOC) that contribute to air pollution. Controlling fumigant emissions has become an important goal of regulatory agencies in California and has spurred research on techniques to effectively keep fumigants in the soil and/or to rapidly degrade the compounds before they are released into the atmosphere. Several soil moisture management techniques and adding chemical or organic amendments have been shown to reduce 1,3-D emissions; however, the effects of these techniques on pest management efficacy is not well documented. This paper will focus on preliminary evaluations of soil-borne pest control as affected by emission reduction techniques; the emission reduction component of this research will be presented separately (see Gao et al. in this proceedings).

Materials and Methods:

A trial was established in October 2006 at the USDA-ARS San Joaquin Valley Agricultural Sciences Center, Parlier, CA. The soil was a Hanford sandy loam. The trial was designed as a split block experiment with three replicates. Fumigation treatment (fumigated or unfumigated) was the main plot and surface seal treatments were the sub plots. Two weeks prior to fumigation, the field was cultivated to 76 cm depth and sprinkler irrigated to moisten dry surface soils. Cloth bags containing field bindweed (*Convolvulus arvensis*) and cheeseweed (*Malva parviflora*) seeds were buried 15 cm deep in each plot and bags containing 100g of citrus nematode (*Tylenchulus semipenetrans*) infested soil were buried at 7.5, 15, 30, 60, and 90 cm deep in fumigated plots and at 7.5 cm in unfumigated plots. On October 17, 2006, 499 kg ha^{-1} of 61% 1,3-D / 35% chloropicrin (Telone C35) was applied at a 45 cm depth using a commercial Telone rig with 51 cm spacing between shanks. Immediately following fumigation, the field surface, including non-fumigated area, was cultivated by a spring tooth harrow followed by a ring roller to close shank traces and pack the soil surface. Six surface seal treatments were tested and included:

1. Control (moist soil per label instructions)
2. Manure + HDPE [composted steer manure incorporated into the soil surface at 12,350 kg/ha (5 ton/ac), then covered with high density polyethylene (HDPE)]
3. Potassium thiosulfate (KTS) + HDPE (2:1 KTS/fumigant ratio, sprayed onto the soil surface in 1 mm water, then covered with HDPE tarp)
4. Pre-irrigation (applied 34 mm water with sprinklers 4 days before fumigation)
5. Intermittent water seals (applied 13 mm water with sprinklers immediately following fumigation, plus an additional 4 mm at 12, 24, and 48 h)
6. Intermittent KTS applications (applied 2:1 KTS/fumigant ratio immediately following fumigation, and 1:1 KTS at 12, 24, and 48 h using the same amount of water as treatment #5).

Pest bags were recovered two weeks after treatment and tested for seed viability (tetrazolium staining) and for viable nematodes (Baermann funnel protocol). Emergence and biomass production of resident weeds was monitored for several months following fumigation.

Results and Conclusions:
Control of citrus nematode was affected by surface seal treatments in the fumigated plots (Figure 1). Nematodes survived in the two deepest samples (60 and 90 cm) in the control (label conditions), manure amendment, and pre-irrigated plots. It is possible that too much soil moisture in the control and pre-irrigated plots limited the movement of the fumigants deep into the soil profile; however it is not clear why manure in the surface soil would limit downward movement of the fumigants. Surface seal treatments alone did not statistically reduce nematode survival in the top 7.5 cm; however, the two KTS treatments tended to have the lowest nematode survival even in the absence of the fumigants (data not shown).

There were no statistical differences in field bindweed and cheeseweed seed viability among the surface seal treatments (Figure 2). The fumigants did not reduce cheeseweed viability compared to untreated plots, however, field bindweed viability was slightly reduced in all fumigated plots regardless of surface seal treatment. Emergence of resident weeds [primarily redmaids (*Calandrinia ciliate)* and annual bluegrass (*Poa annua*)] two months after treatment was strongly affected by both fumigation and surface seal treatment (Figure 3). In the fumigated plots, weed emergence was reduced by all surface seal treatments except for the control (label condition) treatment which did not differ from the untreated subplot. Interestingly, pre-irrigation and the sequential KTS treatments reduced weed emergence even in the absence of fumigant. Weed biomass three months after treatment was variable but tended to be lowest in fumigated plots sealed with manure/HDPE, KTS 2:1/HDPE, and sequential KTS.

This study suggests that emission reduction techniques can have both positive and negative impacts on pest control efficacy. Additional research is needed to determine more precisely the relationship between effective emission reduction and pest control efficacy under commercial production conditions.

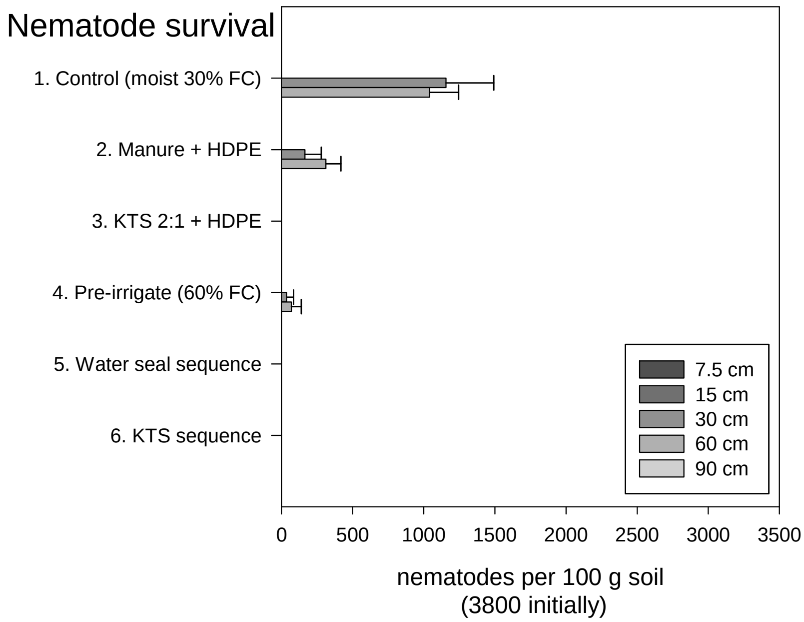

Figure 1. Effects of surface seal treatments on citrus nematode (*Tylenchulus semipenetrans*) control in sachets of infested soil buried in each plot. In the fumigated plots, citrus nematode survived at 60 and 90 cm in several treatments. In unfumigated plots, nematode survival was approximately 2100 per 100 g soil at 7.5 and 15 cm depths (data not shown).

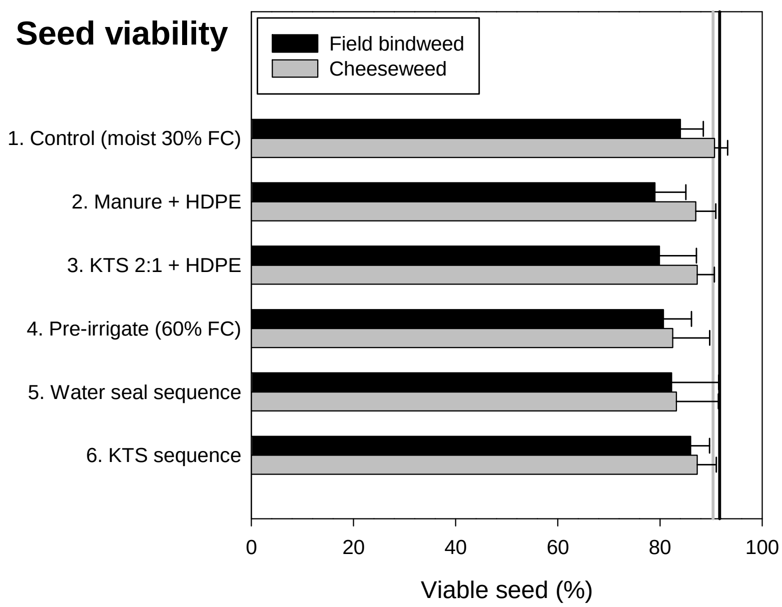

Figure 2. Effect of surface seal treatments on viability of field bindweed (*Convolvulus arvensis*) and cheeseweed (*Malva parviflora*) seed buried at 15 cm deep in plots. Viability did not differ among surface seal treatments in unfumigated plots and averaged 90 and 92% for mallow and bindweed, respectively (reference lines).

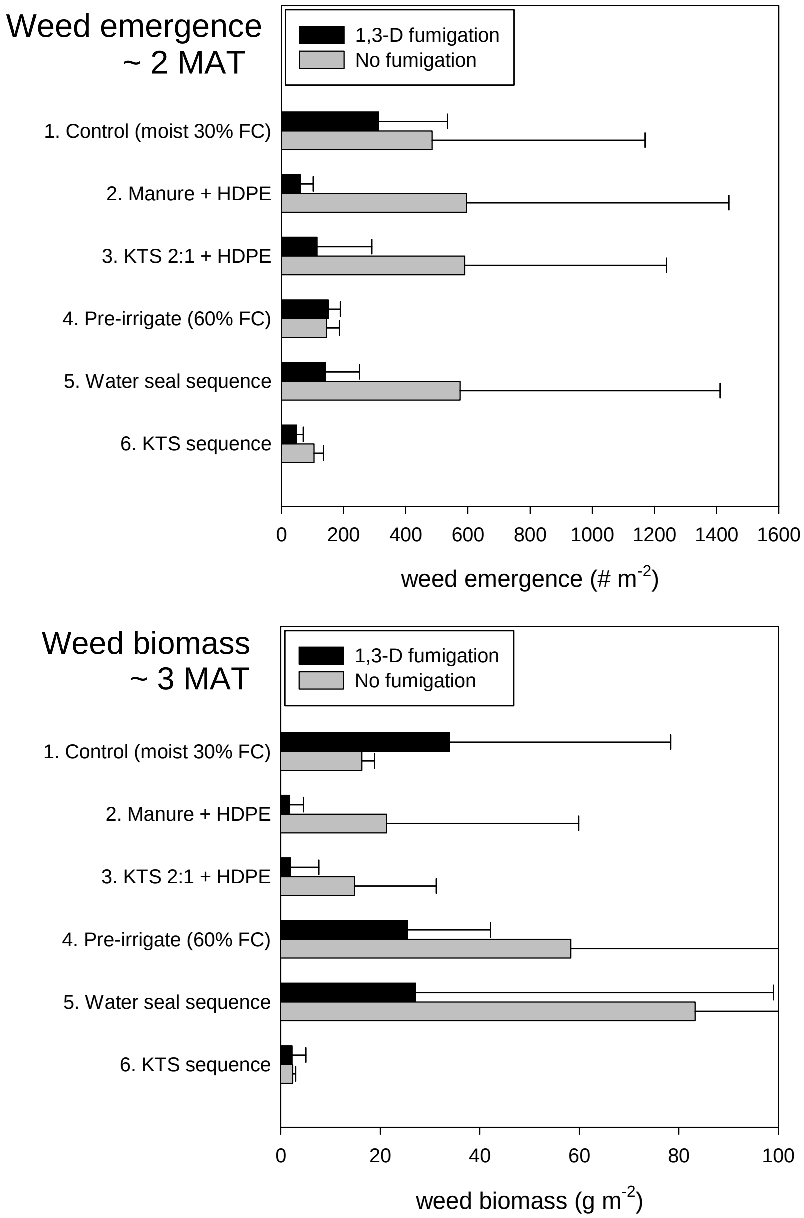

Figure 3. Effects of surface seal treatments and 1,3-D fumigation on weed emergence and weed biomass production. Weed emergence (upper figure) was statistically lower in all fumigated plots compared to unfumigated plots except for treatments 1 and 4. Weed emergence also tended to be reduced by the pre-irrigation and KTS sequential treatment even when no fumigant was applied. Total weed biomass was variable but tended to be lowest in the fumigated plots combined with manure + HDPE and KTS + HDPE and in the KTS sequential treatments (lower figure). Biomass production was highest in fumigated plots when extra moisture was used to reduce emissions.