EVALUATION OF EMERGING ALTERNATIVE CHEMICALS FOR CONTROL OF PATHOGENS AND WEEDS.

James S. Gerik* and Bradley D. Hanson
USDA-ARS; San Joaquin Valley Agricultural Sciences Center
Parlier, CA

Cut flower growers in California have routinely used methyl bromide with and without chloropicrin for pre-plant soil fumigation for the control of soilborne pathogens and weeds. Recent research to identify alternatives to methyl bromide for flower growers has mostly involved trials using combinations of 1,3-dichloropropene, chloropicrin, and metham sodium. Recently other emerging alternative chemicals have been proposed as replacements for methyl bromide; these include 2-bromoethanol (Alfa Aesar, Ward Hill, MA), dimethyl disulfide (Cerexagri, King of Prussia, PA), furfural (Agriguard, Cranford, NJ), propylene oxide (Aberco, Seabrook, MD), and sodium azide (American Pacific Corporation, Cedar City, Utah). Here we report the effect of these chemical, in combination with metham sodium (AMVAC, Newport Beach, CA), on the control of soil pathogens and weeds.

Two trials were established on a cut flower farm in Goleta, CA in January and February, 2006. In both trials, chemicals were applied in 3.8 cm of irrigation water through 4 irrigation tapes evenly spaced over the width of the bed (150 cm). The tape was Ro-Drip model 5-8-40 (Roberts Irrigation Products, San Marcos, CA) which delivers 500 LPH/100 m @ 0.69 bar and has emitters on a 20 cm spacing. All plots were covered with polyethylene sheeting before chemigation. The experimental design was a randomized complete block with 6 replications. The treatments in both trials were the same and included methyl bromide: chloropicrin (50:50) 336 kg ha^{-1}; 2-bromoethanol 448 kg ha^{-1}; dimethyl disulfide 448 kg ha^{-1}; furfural 672 kg ha^{-1}; propylene oxide 448 kg ha^{-1}; and sodium azide 168 kg ha^{-1}. Two plots in each replication were treated only with water. One week following the application all of the chemical treated plots and one of the water treated plots were treated with metham sodium at 355 kg ha^{-1}. All rates reported are for the active ingredient. Chemigation of the first trial was completed on 19 January 2006 and the soil was Baywood loamy sand; (sand: 88%, clay: 9%, silt: 3%). The second trial was completed on 22 February 2006 and the soil was Camarillo fine sandy loam (sand: 71%, clay: 16%, silt: 13%). Approximately 2 weeks following the metham sodium treatments soil samples were collected and were returned to the laboratory. Populations of *Pythium* spp. and *Fusarium oxysporum* were determined by dilution plating on selective media. Counts of germinated weeds were made two weeks following the last application in trial 1 and after 8 weeks in trial 2. No crop growth data were collected due to extenuating circumstances.

The results from trial 1 show that the chemicals applied in the first application gave no increased benefit for weed and pathogen control, compared to the metham sodium alone treatment. Weed counts in all of the chemical treated plots were at or near zero compared to the water control plots which had hundreds of weed per square meter (data not shown). Populations of *Pythium* spp. and *F. oxysporum* were greatly reduced by all chemical treatments compared to the water control (Table 1), and the first chemical applications did not reduce the populations further compared to the metham sodium alone treatment.

The results from trial 2 are somewhat different, at least for the pathogen population data. While all chemical treatments had lower populations of both pathogens compared to the water control (Table 2), the populations of *Pythium* spp. in plots treated with methyl bromide:chloropicrin, 2-bromoethanol, and propylene oxide were lower than the plots treated with metham sodium alone, and all the plots that received a chemical treatment during the first application had lower populations of *F. oxysporum* compared to the plots treated with metham sodium alone. All the chemical treatments had lower weed populations compared to the water control (Table 3), but none of the chemicals applied during the first application reduced weed populations more than the metham sodium only treatment.

The differences observed in the two trials may be due to soil texture. The soil in the second trial is heaver than the first. It is known that metham sodium is more effective in light sandy soil, such as was the case in the first trial, compared to the loam soil in the second trial. Besides soil texture, the only other major difference that was observed between the two trials was the temperature of the water used to apply the chemicals. The water temperature in the first trial was 10° C compared to 17° C in the second trial. It is possible that the temperature difference had an effect on the results, but one would expect that metham sodium would be more effective when applied with the warmer water.

It appears that additional benefit can be derived by application of one of the emerging chemicals; 2-bromoethanol and propylene oxide look particularly promising. Mostly, they all performed as well as methyl bromide:chloropicrin when followed by a sequential application of metham sodium. None of these emerging chemicals are yet registered for field use and more work will be needed before registration.

Table 1. Populations of *Pythium* spp. and *Fusarium oxysporum* after application of several chemical treatments in Trial 1.

Treatment	*Pythium* spp. (cfu/g)	*F.oxysporum* (cfu/g)
mb:pic + metham sodium	0.67 b [z]	19.0 b
2-bromoethanol + metham sodium	2.67 b	16.8 b
dimethyl disulfide + metham sodium	0.67 b	0.0 b
furfural + metham sodium	0.00 b	22.3 b
propylene oxide + metham sodium	0.00 b	11.2 b
sodium azide + metham sodium	3.33 b	5.6 b
water + metham sodium	0.00 b	1.1 b
water + water	124.00 a	704.6 a

[z]Means not followed by the same letter are significantly different according to Fisher's protected LSD test (P=0.05).

Table 2. Populations of *Pythium* spp. and *Fusarium oxysporum* after application of several chemical treatments in Trial 2.

Treatment	*Pythium* spp. (cfu/g)	*F.oxysporum* (cfu/g)
mb:pic + metham sodium	3.33 d [z]	38.0 c
2-bromoethanol + metham sodium	4.00 d	17.0 c
dimethyl disulfide + metham sodium	7.33 cd	22.3 c
furfural + metham sodium	10.00 cd	20.2 c
propylene oxide + metham sodium	1.33 d	11.2 c
sodium azide + metham sodium	34.00 b	46.8 c
water + metham sodium	23.33 cb	128.5 b
water + water	106.00 a	253.3 a

[z]Means not followed by the same letter are significantly different according to Fisher's protected LSD test (P=0.05).

Table 3. Populations of weeds (number m^{-2}) after application of several chemical treatments in Trial 2.

Treatment	yellow nutsedge	broad leaf [x]	grass [y]
mb:pic + metham sodium	1 b [z]	21 b	11 b
2-bromoethanol + metham sodium	4 b	18 b	14 b
dimethyl disulfide + metham sodium	3 b	85 b	17 b
furfural + metham sodium	11 ab	56 b	17 b
propylene oxide + metham sodium	2 b	23 b	9 b
sodium azide + metham sodium	6 b	26 b	39 b
water + metham sodium	13 ab	43 b	29 b
water + water	25 a	266 a	120 a

[x]Broad leaf weeds consisted mostly of knotweed (48%) and ragweed (29%).

[y]Grass weeds were mostly annual bluegrass.

[z]Means not followed by the same letter are significantly different according to Fisher's protected LSD test (P=0.05).