METHYL BROMIDE ALTERNATIVES FOR CALIFORNIA-GROWN CALLA LILIES

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Cut flower and ornamental bulb industries rely heavily on a methyl bromide (MB)/chloropicrin (Pic) mixture as a key pest management tool. The loss of MB will seriously affect the cut flower and bulb industry, and, in the future, will require growers to use alternative fumigants. In the past, MB alternative research for cut flowers and ornamental bulb crops received little attention relative to other crops. Therefore, fumigant pesticide combinations or pesticide sequences with a high potential to replace the standard 2:1 mixture of MB/Pic for management of a multi-pest complex were tested as preplant treatments under two different types of plastic mulch in commercial Calla lily systems in Central Coastal California.
The economic viability of the tested alternative fumigants will be estimated by yield and flower bulb evaluations at harvest. The long-term objectives of this research are to (1) develop sustainable alternative fumigant systems for California Calla lily production systems, (2) determine ecologically sound and economically viable alternative fumigant rates and combinations, and to (3) establish demonstration plots for educational outreach and training of growers and pesticide applicators on alternative fumigants. The results are expected to be beneficial for other areas where cut flowers and ornamental bulbs are produced.

Materials and Methods

The study was initiated in May 2006 at a commercial flower field in Moss Landing, near Watsonville, California, following conventional practices for Calla lily (*Zantedeschia* spp.) production. The total plot area, consisting of 24 beds (52" wide, or 72" center-to-center) each 630 ft long, was split into 2 parts: (1) the shank experiment (300 ft long) and (2) the drip experiment (340 ft long). The fumigants were applied in May and June 2006 for the shank and drip experiments, respectively. The fumigant treatments for both experiments are summarized in Tables 1 and 2.
Prior to the fumigation, nylon bags with common weed seeds (*Polygonum arenastrum, Stellaria media, Portulaca oleracea, Malva parviflora, Kochia scoparia,* and *Cyperus esculentus*) and selected flower bulbs (Calla lilies, Gladiolas, Irises, Ranuncula), and soil with known populations of *Pythium* spp., *Rhizoctonia, Verticillium dahliae, Fusarium oxysporum, Phytophthora cactorum,* and citrus nematodes (*Tylenchulus semipenetrans*) were installed in research plots at 2" soil depth. Soils were subsequently fumigated and covered with standard high density polyethylene mulch (STD) and virtually impermeable film (VIF). Metam potassium was applied sequentially through the drip irrigation system

to ½ of the treatments and the nonfumigated control 6 days past the drip application. Inoculum pouches were retrieved 8 days past the last fumigation and analyzed for survival of weed seeds, flower bulbs, and soil-borne pathogens following standard procedures.

Calla was planted at the entire plot area 3 to 4 weeks after fumigation for the drip and shank experiment, respectively. Conventional practices for Calla production and pest management for the area were followed. Weed counts were evaluated prior to each weed removal practice. Stand counts were evaluated 8 and 12 weeks after planting.

Plant growth and yield parameters (crop density/vigor, harvest flower/stem count, stem length, and stem disease incidents) will be evaluated at regular intervals during the season. Flowers will be harvested by hand, and total stem numbers per plot will be determined. The crop will be allowed to dry, bulbs will be harvested, counted and graded according to size (circumference) and weight for quality evaluation.

Results

Total stand counts of Calla lilies showed significantly higher numbers in all fumigated plots relative to the untreated plots for shank and drip-applied fumigants. Among the fumigants tested, MB/Pic and Telone C35 resulted in highest Calla stand counts, followed by Midas and Pic (Fig. 1). Generally, plastic mulch type (i.e., STD and VIF) did not affect stand counts of Calla lilies.

In the shank experiment, *V. dahliae* was significantly lower in all fumigated plots relative to the untreated plots. There was no significant difference in *V. dahliae* control between the fumigant treatments and the STD and VIF mulch, although untreated and MB/Pic fumigated plots showed higher *V. dahliae* survival under STD mulch than under VIF (Fig. 2). Similar to the shank experiment, *V. dahliae* control was significantly higher in drip-fumigated plots relative to untreated plots (Data not shown). No difference was found between all fumigant treatments and the two different types of plastic mulch. Sequential application of metam potassium did not improve control of *V. dahliae*, except in the untreated plots. Control of pathogenic citrus nematodes was similar by all fumigant treatments tested for the shank and the drip experiments, ranging between 90-100%. No differences in nematode control were observed between STD and VIF mulch. Sequential application of metam potassium did not increased nematode control, only if applied to untreated soil.

Results for the efficacy of shank- and drip-applied alternative fumigants to control other important soil-borne pathogens, seeds of major weeds and flower bulbs, representing potential volunteer crops, will be presented.

Table 1: Shank Injection Treatments

Fumigant[a]	Rate[b]	HDPE [c]	VIF [c]
1. Untreated		+	+
2. MB/Pic (67/33)	350 lb/A	+	+
3. Pic	300 lb/A	+	+
4. 1,3-D + Pic (Telone C35)	400 lb/A	+	+
5. IM + Pic (Midas)	300 lb/A	+	+

[a] Pic = chloropicrin, IM = iodomethane (Midas = 33% IM + 67% Pic).
[b] Rate per treated area. Treatments will be shank injected following commercial standard method.
[c] High density polyethylene (HDPE) and Virtually impermeable film (VIF) will be used in all treatments.

Table 2. Drip Fumigation Treatments

Fumigant[a]	Rate[b]	HDPE[c]	VIF[c]
1. Untreated		+	+
2. MB/Pic (67/33)	200 lb/A	+	+
3. MB/Pic (67/33) plus metam potassium	200 lb/A + 35 gal/A	+	
4. Pic EC	200 lb/A	+	+
5. Pic EC plus metam potassium	200 lb/A + 35 gal/A	+	
6. 1,3-D + Pic[d] (InLine 32/62)	300 lb/A	+	+
7. 1,3-D + Pic[d] (InLine) plus metam potassium	300 lb/A + 35 gal/A	+	
8. IM + Pic (Midas (EC 33/67)	200 lb/A	+	+
9. IM + Pic plus metam potassium	200 lb/A + 35 gal/A	+	
10. Metam sodium	35 gal/A	+	+

[a] Pic = chloropicrin; InLine = 32% Pic plus 62% 1,3-dichloropropene; Midas = 67% Pic plus 33% iodomethane (IM). Emulsifiable concentrate (EC) formulations of these fumigants will be applied.
[b] Rate per treated area. Metam potassium applied sequentially through drip irrigation systems 6 days after InLine, Pic, or Midas.
[c] High density polyethylene (HDPE) and Virtually impermeable film (VIF).

Fig. 1. Stand counts of Calla lilies in shank-fumigated soils at Moss Landing, CA. Error bars represent standard errors.

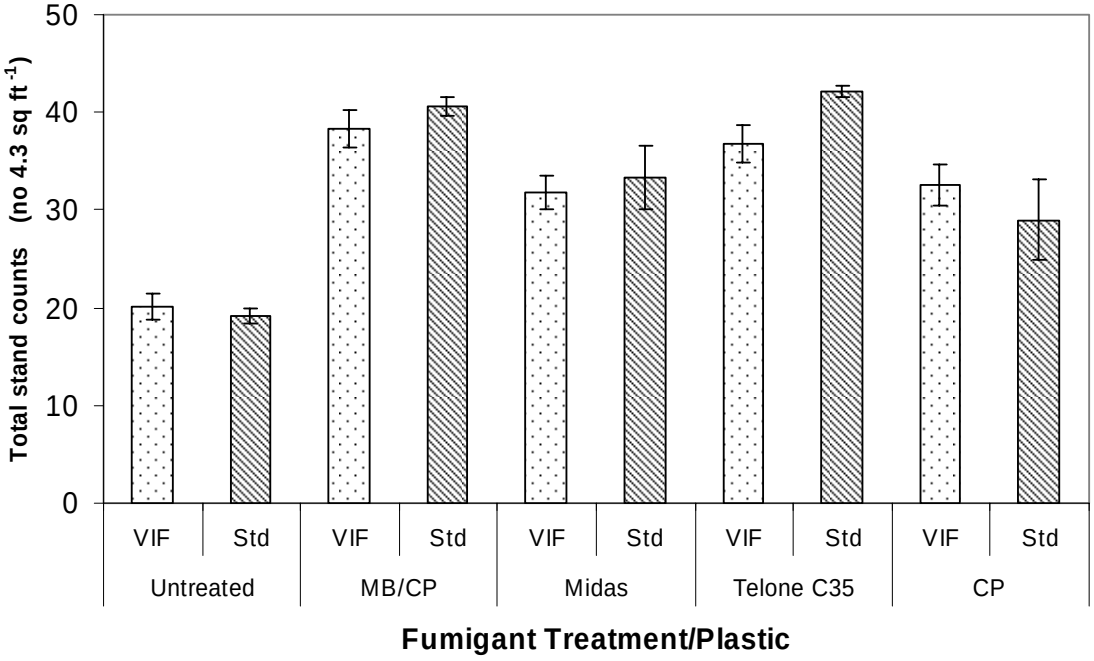

Fig. 2. *Verticillium dahliae* survival in shank-fumigated soils at Moss Landing, CA. Error bars represent standard errors.