Acrolein as Potential Alternative to Methyl Bromide in California-Grown Calla Lilies

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Cut flower and ornamental bulb industries rely heavily on a methyl bromide/chloropicrin (MB/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. Therefore, three different rates (100, 200, and 400 lbs/ac) of Acrolein (acrylaldehyde-2 propenal) were evaluated relative to an untreated control and the standard 2/1 mixture of MB/Pic to control weeds, and the soil-borne pathogens *Pythium* and *Fusarium oxysporum* in commercial calla lily systems in Central Coastal California in the 2006-2007 growing season. The economic viability of the tested Acrolein rates was evaluated by plant growth, yield and flower bulb quality assessments.
Preliminary results of this field trial showed that sensitivity of calla lily towards Acrolein was low. Acrolein at rates from 100 to 400 lbs/ac had no negative effect on crop quality and appearance at 21 days past germination. Acrolein at a rate of 400 lbs/ac was sufficient to kill about 50 % of the propagules of native *Pythium* spp. and 73 % of *Fusarium oxysporum* in soil immediately after fumigation, indicating that Acrolein can provide some control of these important plant pathogens. Weed control of Acrolein at 400 lbs/ac was similar than those provided by MB/Pic at 350 lbs/ac. However, Acrolein at the high rate controlled only 60 % of the volunteer crops (*Zantedeschia* spp.). Stand density evaluations suggested that efficacy of Acrolein for pathogen control decreased over the course of this field trial resulting in increasing death rates among calla lily crop as the disease pressure increased. Although a fair control of key pests, with exception of volunteer crops, was provided by Acrolein up to 4 months after planting, in particular pathogen control efficacy decreased markedly during the following months as indicated by significantly lower stand densities and flower counts. Long lasting pest control is crucial for an economical production of this 18-month crop. Therefore, significantly higher application rates than tested in this trial and improvement of its pathogenic action over the entire calla lily growing season by combination with other pesticides seem to be required for results equivalent to the standard MB/Pic fumigation.

Materials and Methods

Studies were initiated in June 2006 at commercial flower fields in Moss Landing, central coastal California to grow Calla lily (*Zantedeschia* spp.) following commercial standard production practices. Beds were shaped, 5 drip tapes (flow rate, 0.4 gpm/100 ft) were laid per bed, and beds were covered with standard high density polyethylene tarp (HDPE). The total plot area consisted of 4 beds (52” wide, or 72” center-to-center) each 250 ft long. Each bed was split into 5 plots.
Chemicals were drip-applied on June 8, 2006 consisting of the following preplant treatments: Untreated Control (0 lbs/acre), MB/Pic (67/33) at 200 lbs/ac, and Acrolein at 100, 200, and 400 lbs/ac. Each treatment was repeated four times.

Field was planted with calla lilies (*Zantedeschia* spp., variety 6472/19061) on June 26, 2006. Conventional practices for calla production and pest management for the area were followed. On July 6, 2006 (i.e., 4 weeks post application), soil was collected in each plot from 20 cores (dia ¾ inch) taken at 0-6 inches depth, mixed and evaluated for the soil-borne plant pathogens *Pythium spp*. and *Fusarium oxysporum*.
Five indicator calla lily bulbs were buried in each plot at 2 inch soil depth at 1, 7, 14 and 21 days post application, and evaluated for phytotoxicity symptoms after transplanting in the greenhouse. Weed counts were evaluated at 4 and 12 weeks after planting, and will be evaluated prior to each weed removal practice thereafter. Dominant weed species will be assessed. Stand counts were examined 8, 15, 21, and 41 weeks after planting. Flower counts were evaluated at peak flowering in July 2007. The economic viability of the tested MB alternative chemical will be estimated by flower bulb yield and quality evaluations after harvest in Fall 2007. The crop will be allowed to dry, bulbs will be harvested, counted and graded according to size (circumference) and weight for quality evaluation.

Results

Pathogen control: Acrolein reduced *Pythium* numbers relative to the untreated control by about 50 %, while MB/Pic fumigation led to a complete control of this pathogen (Fig. 1). No changes in *Pythium* control was found between different Acrolein rates. *Fusarium* survival decreased markedly with increasing Acrolein rates. Reductions in pathogen numbers were significant for the highest Acrolein rate tested in this study. Acrolein reduced *Fusarium* numbers by 4, 50 and 73 % for the 100, 200, and 400 lbs/ac application rates, respectively, while numbers of this pathogen were reduced by 97 % in MB/Pic fumigated soils. These results indicate that Acrolein at higher application rates has the potential to significantly reduce *Fusarium* numbers in soil. Within each treatment and the untreated control, *Fusarium* survival showed a high variation between the field replications. *Fusarium* numbers ranged from 24 to 848 PPG in plots treated with 400 lbs/ac Acrolein. Corresponding numbers for the 100 and 200 lbs/ac rate were 576 to 1388, and 156 to 1348, respectively. In MB/Pic treated soils *Fusarium* numbers ranged from 4 to 60 PPG. High variation in pathogen survival data could be related to a high spatial variation of these pathogens in the soil and/or distribution and stability patterns of Acrolein in the soil environment.
Stand evaluations: At 8 weeks after planting, calla lily stand densities were similar in the Acrolein (100 to 400 lbs/ac) and MB/Pic (350 lbs/ac) treated plots with numbers varying from 6,400 to 7,200 thousand plants per acre (Fig. 2). Stand counts were significantly reduced in untreated plots with only 50% of the densities found in fumigated plots (avg. 3,900 thousand plants/ac). At 15 weeks after planting, calla lily stand densities in plots treated with 400 lbs/ac Acrolein were similar to MB/Pic treated plots with numbers varying from 6,100 to 6,500 thousand plants per acre. In plots treated with 100 and 200 lbs/ac Acrolein, stand densities were significantly lower compared to MB/Pic treated plots. Relative reductions ranged from 21 to 11 % for the 100 and 200 lbs/ac Acrolein rate, respectively. Stand counts were significantly reduced in untreated plots to 880 thousand plants per acre, representing an 86% reduction relative to the MB/Pic standard. At 41 weeks after planting Calla lily stand densities were significantly lower in all treatments relative to the first stand evaluation at 8 weeks past planting. In the MB/Pic

plots Calla stand densities were reduced by 47 % during the winter months (months of dormancy) amounting to an average of 3,600 thousand plants/acre. Relative to the MB/Pic standard, stand densities in all tested Acrolein treatments were significantly reduced by 36 to 42% (avg. 2,100 and 2,300 thousand plants per acre). In untreated soils, stand densities were only 200 thousand plants per acre, representing a 94% reduction relative to the MB/Pic standard.

Weed control: There were no statistical differences in total numbers of resident weeds in plots treated with MB/Pic at 350 lbs/ac and all Acrolein treatments at 100 to 400 lbs/ac (Fig. 3), although numbers of weeds seemed to be higher in the 100 lbs/ac Acrolein treatment compared to all other fumigant treatments. Dominant weed species at this location and year were *Malva parviflora* and *Senecio vulgaris* L. (Common groundsel), as well as Calla volunteers.

Results for the efficacy of drip applied Acrolein at 100 to 400 lbs/ac to control dominant weed species, Calla volunteers, and on flower count evaluations will be presented.

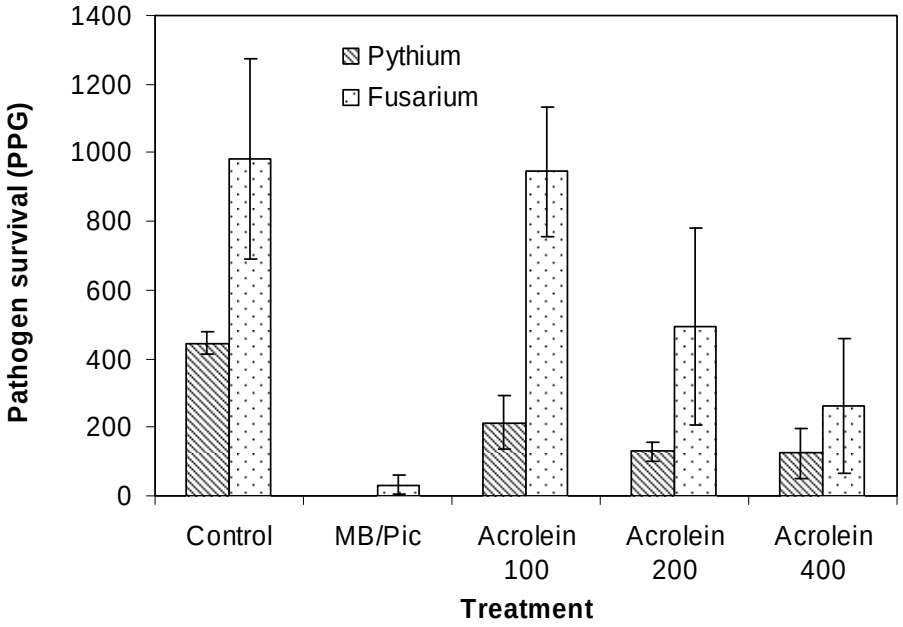

Fig. 1. Pathogen survival in soils treated with Acrolein and MB/CP at Moss Landing, California. Error bars represent stand error.

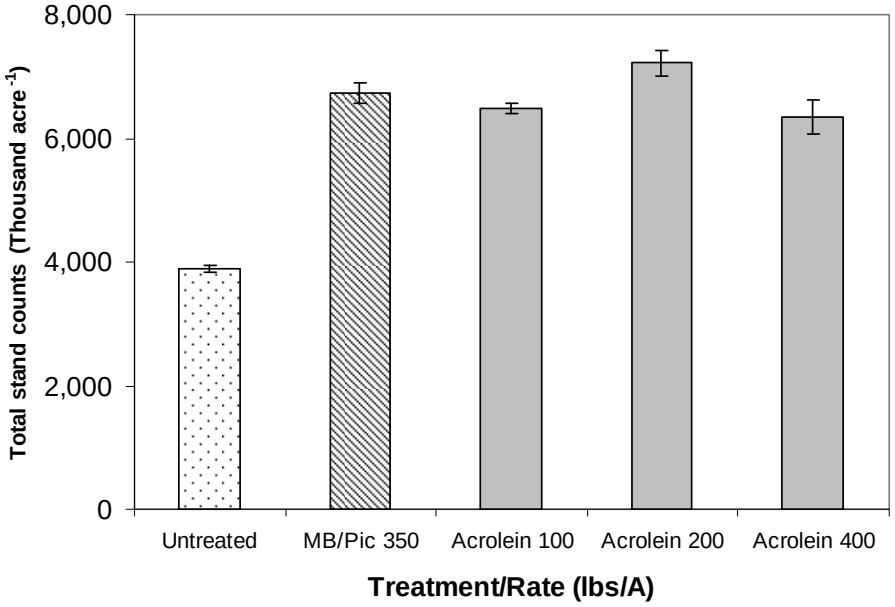

Fig. 2. Calla lily stand densities at 8 weeks after planting (Thousand plants/acre) in soils treated with Acrolein and MB/Pic at Moss Landing, California. Error bars represent standard error.

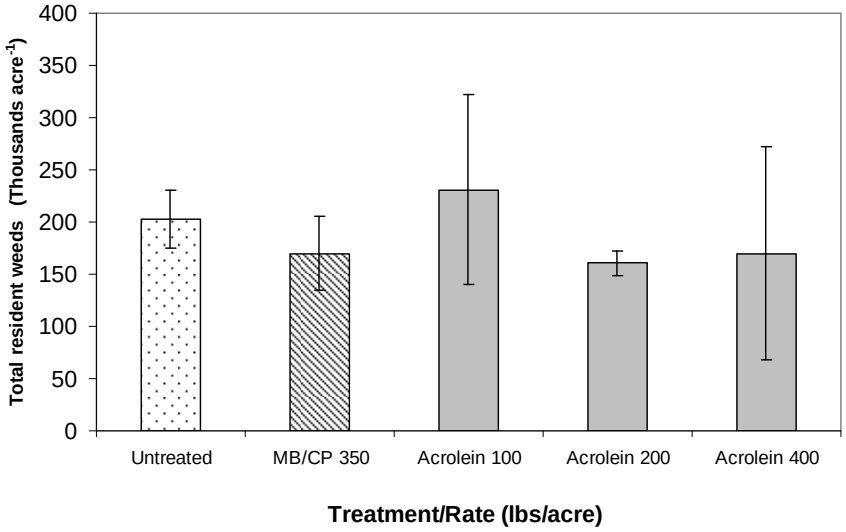

Fig. 3. Total resident weed densities from July to September 2006 (Thousands/acre) in soils treated with Acrolein and MB/Pic at Moss Landing, California. Error bars represent standard error.