

INTEGRATED FUMIGANT AND NON-FUMIGANT SOIL DISINFESTATION SYSTEMS FOR FLOWER AND STRAWBERRY

S. Fennimore^{*1}, C. Wilen², M. Hoffmann¹, J. Gerik³, F. Martin⁴, S. Koike⁵, B. Westerdahl⁶, M. Stanghellini⁷

¹UC. Davis, Salinas CA, ²UCCE San Diego, CA, ³USDA-ARS Parlier, CA,
⁴USDA-ARS Salinas, CA, ⁵UCCE Salinas, CA, ⁶UC Davis, Davis CA,
⁷TriCal Inc. Hollister, CA

Summary. Dominus (AITC) and TRX58 (chemistry not disclosed) were evaluated in commercial flower fields for control of soil pests. Dominus and K-Pam were evaluated in strawberry for control of soil pests and fruit yield. Standards such as methyl bromide (MB) + chloropicrin (Pic) provided best pest suppression. TRX58 appears to be effective on soil pests such as *Fusarium oxysporum*, *Pythium ultimum* and weeds. Varied performance by Dominus on soil pests suggests there is much to be learned about this compound if effectiveness is to be improved.

Flowers

Studies were conducted in Carlsbad (delphinium, ranunculus), Oceanside, (delphinium) and Santa Paula, CA (several species) to evaluate alternative fumigants in commercial cut flowers.

Methods. Pic-Clor 60 at 29 GPA, Dominus at 40 GPA and Dominus + Tri-Clor at 28 + 9.4 GPA were drip applied by TriCal on Sept. 5, 2014 at Santa Paula, CA. Treatments were made to 20 by 200 ft high tunnels with 4 beds per tunnel. Treatments were replicated 3 times with one tunnel per plot. Weed control, pre and post soil sampling for pathogens, number of diseased plants and number of marketable stems were recorded.

Fumigants were shank applied by TriCal at Carlsbad CA on Oct. 2, 2014, and Oceanside, CA on Nov. 14, 2014. Treatments at Carlsbad were MBPic 50:50 350 lb/A, Pic-Clor 60 350 lb/A, Dominus 40 GPA, Dominus/Pic 67:33 40 GPA, TRX58 500 lb/A, TRX58/Pic 67:33 400 lb/A and nontreated. Plots were 11 ft wide by 160 ft long and each treatment was replicated 3 times. Fumigants shank applied at Oceanside were Pic-Clor 60 at 350 lb/A, Dominus/Pic 67:33 40 GPA, TRX58 at 400 lb/A and nontreated. Plots were 11 ft wide by 120 ft long and treatments were replicated 3 times. Data were *Fusarium* and *Pythium* control based on pre and post fumigation analyses, weed densities and hand weeding times. Number of 10 stem delphinium bunches were recorded at Oceanside.

Results. *Fusarium* CFU per 10 cc soil was 0 for Pic-Clor 60, 4,000 for Dominus + Tri-Clor, and 9,000 for Dominus post fumigation at Santa Paula. *Fusarium* counts post fumigation at Carlsbad were variable and not significant (Table 1). Post fumigation data reveal that MBPic, Pic-Clor 60 and TRX58 were the most

effective on *Pythium* and weeds at Carlsbad while Dominus and Dominus + Pic treatments were not different from the nontreated. At Oceanside the fumigants all controlled *Fusarium*, *Pythium* and weeds better than the nontreated (Table 2). Delphinium bunches were harvested at Oceanside with season yields of: Pic-Clor 60 130 bc, Dominus/Pic 149 ab, TRX58/Pic 171 a, nontreated 119 c per 120 ft. bed.

Strawberry

Efficacy of K-Pam, Dominus, and Pic-Clor 60 were evaluated alone and in combination for weed control, control of nematodes, *Pythium ultimum*, and *Verticillium dahliae* and strawberry fruit yields at Salinas, CA.

Methods. K-Pam, Dominus and Pic-Clor 60 were applied through two drip tapes per bed over a 2 hour period Oct. 11 and 15, 2014. Treatments were: K-Pam at 31 and 62 GPA, Dominus at 20 and 40 GPA, and sequential applications of Pic-Clor 60 at 20 GPA followed by (fb) Dominus at 20 GPA, Pic-Clor 60 at 20 GPA fb K-Pam at 31 GPA, and K-Pam at 31 GPA fb Dominus at 20 GPA. Treatments were replicated four times and arranged in a randomized complete block design. Strawberry ‘Monterey’ was transplanted on Nov. 17, 2014. Before fumigation, weed seed bags were placed at 2” and 6” deep and pathogen samples containing citrus nematodes, *Pythium* and *Verticillium* were placed 9” and 18” deep at 2 locations per plot. Samples were recovered 2 weeks after fumigation, and viability determined. Data collected were crop injury, weed control, and fruit yield.

Results. Weed densities January through April, 2015 indicated that all of the fumigants similarly reduced weed densities compared to the nontreated (Table 3). Weeds most common in all treatments were clover and oat. Marketable strawberry fruit yields through Aug. 20, 2015 ranged from 57,617 to 65,990 lbs/A but there were no significant treatment effects on yield (Table 3).

Weed bioassays: for burning nettle all fumigant treatments were better than the nontreated; however, the most effective fumigant treatments included Pic-Clor 60 (Table 4). All fumigant treatments similarly suppressed knotweed, purslane and yellow nutsedge, compared to the nontreated.

Nematodes and fungal pests: K-Pam and Pic-Clor 60 treatments provided the most effective control of nematodes, whereas Dominus applied alone had the highest numbers of surviving nematodes (Table 5). Pic-Clor 60 treatments were most effective for control of *Pythium* and *Verticillium*. High survival of *Pythium* and *Verticillium* was observed in Dominus treatments (Table 5). K-Pam treatments show intermediate control efficacy for both pathogens.

Acknowledgements. We are grateful for financial support from the USDA-NIFA Methyl Bromide Transitions Program 2013-51102-21524, TriCal, Amvac, and to cooperating growers.

Table 1. *Fusarium*, *Pythium* pre and post fumigation samples and weed densities and weeding times at the Carlsbad, CA flower trial in 2014-15.

Treatment	Rate	<i>Fusarium</i> (p/g soil)		<i>Pythium</i> (p/g soil)		Weeds	Weed time
		Pre	Post	Pre	Post	No. ft ⁻²	Hr. A ⁻¹
MBPic	350 lb/A	183	0	17	0 c	0.1 bc	69 e
Pic-Clor 60	350 lb/A	1365	0	17	0 c	0.0 c	99 cde
Dominus	40 GPA	259	47	35	80 a	1.2 a	223 ab
Dominus + Pic	40 GPA	328	38	28	36 b	0.9 abc	169 bc
TRX-58	500 lb/A	469	201	16	0 c	0.0 c	87 de
TRX-58/Pic	400 lb/A	210	74	35	1 c	0.2 bc	157 bcd
nontreated	0	350	721	13	39 b	1.0 ab	266 a

Table 2. *Fusarium*, *Pythium* pre and post fumigation samples and weed densities and weeding times at the Oceanside, CA flower trial in 2014-15.

Treatment	Rate	<i>Fusarium</i> (p/g soil)		<i>Pythium</i> (p/g soil)		Weeds	Weed time
		Pre	Post	Pre	Post	No. ft ⁻²	Hr. A ⁻¹
Pic-Clor 60	350 lb/A	1184	286 bc	439	0 b	14 b	12 b
Dominus + Pic	40 GPA	1112	424 b	867	0 b	12 b	10 b
TRX-58/Pic	400 lb/A	1030	89 c	803	0 b	5 b	11 b
nontreated	0	1197	2515 a	811	40 a	38 a	19 a

Table 3. Weed densities and strawberry fruit yields at Salinas, CA.

Treatment	Rate GPA	Weed densities	Fruit yield (through 8/20/15)
		Number (ft ⁻²)	Lbs. A ⁻¹
Dominus	20	0.3 b	62,655 a
Dominus	40	0.2 b	61,293 a
K-Pam fb Dominus	31 fb 20	0.3 b	62,268 a
K-Pam	31	0.3 b	57,617 a
K-Pam	62	0.4 b	62,158 a
Pic-Clor 60 fb Dominus	20 fb 20	0.2 b	65,990 a
Pic-Clor 60 fb K-Pam	20 fb 31	0.3 b	64,031 a
Nontreated	0	3.8 a	60,393 a

Table 4: Average percentage of weed propagule viability at Salinas, CA.

Treatment	Rate GPA	B. nettle	Knotweed	Purslane	Y. nutsedge
Viability (%)					
Dominus	20	16 c	4 c	4 bc	14 b
Dominus	40	11 cde	12 b	3 bc	0 c
K-Pam fb Dominus	31 fb 20	32 b	8 bc	4 bc	3 c
K-Pam	31	17 c	3 c	6 b	2 c
K-Pam	62	13 cd	4 c	3 bc	0 c
Pic-Clor 60 fb Dominus	20 fb 20	3 de	1 c	1 c	1 c
Pic-Clor 60 fb K-Pam	20 fb 31	2 e	5 bc	3 bc	1 c
Nontreated	0	81 a	77 a	79 a	81 a

Table 5: Soil pest bioassays: Nematodes, *Verticillium*, and *Pythium* survival at 9 and 18 inches deep at Salinas, CA.

Treatment	Rate GPA	Citrus nematode		<i>Verticillium</i>		<i>Pythium</i>	
		9 inches	18 inches	9 inches	18 inches	9 inches	18 inches
Dominus	20	155 b	203 b	1 c	0 b	100 b	199 b
Dominus	40	186 b	319 b	21 b	13 b	207 b	234 b
K-Pam fb Dominus	31 fb 20	3 b	3 b	0 c	0 b	0 b	1 b
K-Pam	31	0.4 b	36 b	0 c	0 b	0 b	84 b
K-Pam	62	0.1 b	131 b	5 bc	8 b	4 b	50 b
Pic-Clor 60 fb fb Dominus	20 fb 20	0.4 b	1 b	0 c	1 b	0 b	0 b
Pic-Clor 60 fb fb K-Pam	20 fb 31	2 b	0.1 b	2 bc	1 b	0 b	0 b
Nontreated	0	1844 a	1767 a	39 a	55 a	1332 a	1146 a