Using Soil Fumigants with Totally Impermeable Film Mulch

Josh Freeman Assistant Professor of Horticultural Sciences NFREC - Quincy



Methyl Bromide

- Colorless, odorless gas at atmospheric pressure
- Boiling point 38°F
- Broad spectrum biocide
- Minimum 2% chloropicrin added as a warning agent
- Gold standard for soil fumigation for decades









Methyl Bromide Phase Out

- Listed as an ozone depleting substance by the Montreal Protocol
- Has been in phase out since 1989
- Growers were operating under EPA granted critical use exemptions due to a lack of suitable alternatives
 - Granted yearly
- Exemptions for vegetables are now gone

Fumigant Re-Registration

- Methyl bromide, Chloropicrin, MITC generators
 - Buffer zones
 - Personal protective equipment
 - Fumigant management plans



Buffer Zones

- An area surrounding application site that must be managed
- Buffer zones are dependent on application type, application equipment, application rate, application block size, mulch type
- Minimum buffer zone is 25'
- Air monitoring must take place during the buffer zone period

Buffer Zones

- Buffer zone period lasts for 48 hrs
- Re-entry into treated area prohibited for 5 days
- All non-handlers must be excluded from the buffer zone for 48 hrs
- Buffer zones may not include residences not controlled by the operator unless occupants provide written a written agreement to vacate during buffer zone period

Problems

- Loss of methyl bromide
- Lack of a suitable replacement
- Increased restriction on soil fumigant use



New Technology

- Virtually Impermeable Film (VIF)
 - Contains a nylon polymer layer that reduces fumigant permeation through the film
 - Widely used beginning with methyl bromide phase out
- Totally impermeable film (TIF)
 - Contains ethyl vinyl alcohol
 - Much less permeable than VIF



An oversimplified schematic of fumigant movement in a plasticulture bed with three different levels of soil preparedness





Totally Impermeable Film Mulch

- Greater retention leads to greater exposure
- Extended exposure could maintain efficacy with lower application rates
- A greater extension of VIF films
- Five to seven layer mulch



TIF Diagram



Reducing Fumigant Application Rates

 A program was developed to research the combination of TIF with various fumigants to determine the effect of TIF on fumigant retention and efficacy





Retention of Paladin by Various TIF Brands - Spring 2014



Paladin (dimethyl disulfide)

- One of the newer fumigant chemistries to be registered by EPA
- Good to excellent control of nutsedge
- Has a persistent sulfur odor that can be problematic in populated areas
- TIF has now been mandated with Paladin use in Florida

Paladin and TIF

- Treatment (broadcast rates)
 - Untreated black Raven Vaporsafe TIF
 - Untreated black Blockade VIF
 - 20 GPA (191lb/A) Paladin: Pic (79:21) TIF
 - 30 GPA (286 lb/A) Paladin: Pic (79:21) TIF
 - 40 GPA (382 lb/A) Paladin: Pic (79:21) TIF
 - 50 GPA (478 lb/A) Paladin: Pic (79:21) TIF
 - 50 GPA Paladin: Pic (79:21) VIF
 - 60 GPA (573 lb/A) Paladin: Pic (79:21) VIF

Materials and Methods

- Mulch was deployed on 14 June 2011
- Sandy loam soil
- BHN 602 tomato seedlings were transplanted on 25 July 2011
- 41 days post fumigation
- Beds were 8"tall and 30" wide





Materials and Methods

- Sclerotium rolfsii was cultured and sclerotia were collected
- Sclerotia were buried in sachet bags at a depth of 4 inches
- Bags were buried the morning following fumigation
- Bags were retrieved before planting
- Sclerotia were plated to determine fumigant efficacy

Paladin Retention Fall 2011



Days after treatment

Paladin:Pic(79:21) concentration (ppm isobutylene) under TIF – Fall 2011

	Days After Treatment										
	15	17	20	22	24	27	29	31	34	36	41
20 GPA TIF	10445	7937	5215	3414	929	598	11	10	0	0	0
30 GPA TIF	14122	14233	9962	7504	818	1703	430	186	2	0	0
40 GPA TIF	15000	15000	12972	8776	3103	3027	152	128	6	0	0
50 GPA TIF	15000	15000	15000	13375	10934	11639	9723	8075	1532	54	4
50 GPA VIF	782	659	306	149	15	13	1	1	0	0	0
60 GPA VIF	1306	1888	815	435	81	107	3	3	0	0	0



Paladin Retention by TIF – Spring 2011

				20	11					
		Days after treatment								
	16	18	21	23	25	28	30	32	35	37
20 GPA TIF	550	188	7	2	0	0	0	0	0	0
30 GPA TIF	7166	3177	630	233	39	6	14	7	3	2
40 GPA TIF	15000	10233	2580	3365	1242	86	54	73	38	25
50 GPA TIF	15000	15000	8372	8810	6559	3994	628	578	157	95
50 GPA VIF	5699	1721	290	90	59	20	27	42	16	13
60 GPA VIF	6832	1714	363	128	73	24	34	47	32	17

Paladin:Pic (79:21) concentration (ppm isobutylene) under TIF – Spring

Paladin:Pic (79:21) TIF Fumigation – Fall 2011

Treatment	Medium	Large	X-Large	Marketable	Nutsedge/ft ²
Untreated VIF	2638 d	6365 c	9202 b	18205 c	21.4 a
Untreated TIF	4985 c	14381 b	22446 a	41812 b	5.9 b
20 GPA 79:21 TIF	8748 a	19572 a	24956 a	53276 a	0.0 b
30 GPA 79:21 TIF	8397 a	19215 a	24660 a	52272 a	0.0 b
40 GPA 79:21 TIF	7532 ab	19045 a	28369 a	54946 a	0.0 b
50 GPA 79:21 TIF	6539 bc	19614 a	27921 a	54075 a	0.0 b
50 GPA 79:21 VIF	7731 ab	16541 ab	27261 a	54534 a	0.0 b
60 GPA 79:21 VIF	7211 ab	16862 ab	24436 a	48509 ab	0.5 b

^z Means not followed by the same letter are significantly different at $P \le 0.05$ by Duncan's multiple range test.

Paladin:Pic (79:21) TIF Fumigation – Buried Bag Assay – Fall 2011					
Treatment	<i>Sclerotium rolfsii</i> % germinating sclerotia				
Untreated VIF	57.5 a				
20 GPA 79:21 TIF	0.0 c				
30 GPA 79:21 TIF	10.0 bc				
40 GPA 79:21 TIF	2.5 bc				
50 GPA 79:21 TIF	15.0 b				
50 GPA 79:21 VIF	0.0 c				
60 GPA 79:21 VIF	2.5 bc				

^z Means not followed by the same letter are significantly different at $P \le 0.05$ by Duncan's multiple range test.





1,3-D and Chloropicrin

- Pic Clor 60 has tremendous use in Florida vegetable production
- This combination can have marginal control of nutsedge
- Good to excellent on nematodes and diseases

Pic Clor 60 and TIF

- Fumigant applied June 27, 2014
- Loamy fine sand
- Athena cantaloupe was transplanted July 30, 2014
- 33 days post fumigation
- Beds were 8"tall and 30" wide

Materials and Methods

- Treatment (broadcast rates)
 - Untreated black Blockade VIF
 - 250 lb/A Pic Clor 60 Blockade VIF
 - 100 lb/A Pic Clor 60 Vaporsafe TIF
 - 150 lb/A Pic Clor 60 Vaporsafe TIF
 - 200 lb/A Pic Clor 60 Vaporsafe TIF
 - 250 lb/A Pic Clor 60 Vaporsafe TIF



Pic-Clor 60 Concentration Under TIF Films



Effect of Pic-Clor 60 Rate on Nutsedge Density







TIF Fumigation Cost

- Paladin + Pic 79:21 478 lb/Acre VIF (\$2.03/lb)
 \$407 + \$390 (film) = \$797
- Paladin + Pic 79:21 334 lb/Acre TIF
 TIF \$285 + \$453 (film) = \$738
- Pic Clor 60 250 lb/Acre VIF (\$3.70/lb)
 \$385 + \$390 = \$775
- Pic Clor 60 200 lb/Acre TIF
 \$308 + \$453 = \$761

TIF Conclusions

- Rate reductions 20-50% possible with Pic Clor
 60 and Paladin
- Utilizing TIF will increase plant back interval by 4-7 days with Paladin
- 60% buffer zone credit with Pic Clor 60
- Based on a 20% rate reduction and a 15% increase in film costs TIF saves input costs with Pic Chlor 60 and Paladin based on fumigant cost savings alone

Questions?