Using Soil Fumigants with Totally Impermeable Film Mulch

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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 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
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

![Chart showing PPM isobutylene equivalent retention of Paladin by various TIF brands over different days after fumigation.]

Days After Fumigation:
- 26 days: Significant retention for Berry and Raven, not significant for Guardian.
- 29 days: Significant retention for Berry.
- 32 days: Significant retention for Raven.
- 40 days: Significant retention for Raven.
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 (191 lb/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

Isobutylene (ppm) vs. Days after treatment

Legend:
- 20 GPA TIF
- 30 GPA TIF
- 40 GPA 1.1 TIF
- 40 GPA TIF
- 50 GPA TIF
- 50 GPA VIF
- 60 GPA VIF

Note: Different letters indicate significant differences at the 0.05 level.
Paladin:Pic(79:21) concentration (ppm isobutylene) under TIF – Fall 2011

<table>
<thead>
<tr>
<th>Days After Treatment</th>
<th>15</th>
<th>17</th>
<th>20</th>
<th>22</th>
<th>24</th>
<th>27</th>
<th>29</th>
<th>31</th>
<th>34</th>
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<td>20 GPA TIF</td>
<td>10445</td>
<td>7937</td>
<td>5215</td>
<td>3414</td>
<td>929</td>
<td>598</td>
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<td>15000</td>
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Paladin Retention by TIF – Spring 2011

Isobutylene (ppm) vs. Days after Fumigation

Lines with different letters indicate significant differences in retention.
### Paladin:Pic (79:21) concentration (ppm isobutylene) under TIF – Spring 2011

<table>
<thead>
<tr>
<th>Days after treatment</th>
<th>16</th>
<th>18</th>
<th>21</th>
<th>23</th>
<th>25</th>
<th>28</th>
<th>30</th>
<th>32</th>
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<td>30 GPA TIF</td>
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<td>3177</td>
<td>630</td>
<td>233</td>
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<td>6</td>
<td>14</td>
<td>7</td>
<td>3</td>
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<td>60 GPA VIF</td>
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<td>24</td>
<td>34</td>
<td>47</td>
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<tr>
<td>Treatment</td>
<td>Medium</td>
<td>Large</td>
<td>X-Large</td>
<td>Marketable</td>
<td>Nutsedge/ft²</td>
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<tr>
<td>Untreated VIF</td>
<td>2638 d</td>
<td>6365 c</td>
<td>9202 b</td>
<td>18205 c</td>
<td>21.4 a</td>
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<td>Untreated TIF</td>
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<td>5.9 b</td>
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<td>19572 a</td>
<td>24956 a</td>
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<td>60 GPA 79:21 VIF</td>
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<td>0.5 b</td>
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</table>

\(^2\) Means not followed by the same letter are significantly different at P ≤ 0.05 by Duncan’s multiple range test.
<table>
<thead>
<tr>
<th>Treatment</th>
<th>Sclerotium rolfsii</th>
<th>% germinating sclerotia</th>
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<tbody>
<tr>
<td>Untreated VIF</td>
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<td>57.5 a</td>
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<tr>
<td>20 GPA 79:21 TIF</td>
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<td>0.0 c</td>
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<tr>
<td>30 GPA 79:21 TIF</td>
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<td>40 GPA 79:21 TIF</td>
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<tr>
<td>50 GPA 79:21 VIF</td>
<td></td>
<td>0.0 c</td>
</tr>
<tr>
<td>60 GPA 79:21 VIF</td>
<td></td>
<td>2.5 bc</td>
</tr>
</tbody>
</table>

2 Means not followed by the same letter are significantly different at P ≤ 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
Effect of Pic-Clor 60 Rate on Nutsedge Density

Emerged Nutsedge per Square Foot

- UTC
- 250 lb VIF
- 100 lb TIF
- 150 lb TIF
- 200 lb TIF
- 250 lb TIF

60 day
100 day
150 day
200 lb TIF
250 lb TIF

UTC: a
250 lb VIF: ab
100 lb TIF: abc
150 lb TIF: abc
200 lb TIF: b
250 lb TIF: c
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?