2005 Agent Training on Methyl Bromide Alternatives

February 24, 2005

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Biofumigant crops

Doug Sanders, and Luz Reyes

Cooperators:  David Monks, Katie Jennings, Frank Louws and Jim Driver
WHAT ARE THEY?

- Crops that produce secondary plant products that might have beneficial affect in managing plant pests.
- Brassicas or sorghums
- Produce
  isothiocyanate = Vapam
BIOFUMIGANT CROPS

- BOTH TOPS AND ROOTS CAN BE EFFECTIVE
- SAMS AT UT HAS DONE CONSIDERABLE WORK WITH VARIOUS BRASSICAS
- HE HAS SETTLED ON MUSTARD SEED MEAL AS A WAY TO STANDARDIZE THINGS
AUSTRALIAN WORK 1992 WITH Brassica spp.

- Total isothiocyanate (ITC) conc. from roots is 3.0 micro mol ITC/g soil.
- At a standard rate of application to soil 7,000 lbs dry weight/A.
- Which is equivalent to 156 nmol/g soil.
AUSTRALIAN WORK 1992 WITH Brassica spp.

- This is much less than the estimated ITC conc. released by metham sodium of 2060 nmol methyl ITC/g soil,
- Brassica would produce at a rate much lower = 320 lb methyl ITC/A.
OIL SEED RADISH AND SUDEX
IMPORTANT SUDEX IS NOT TO
BIG 3 FEET IS IDEAL
SUDEX READY TO CUT 30 DAS
DISK MOWER FOR FIRST CUTTING
SMALL PIECES IMPORTANT
SMALL AND SOFT STEMS
BREAKDOWN SOONER
SUDEX SECOND GROWTH 10 DAYS POST CUT
20 DAYS POST CUT
AFTER 2 CUT LOOSES
COMPETITIVE ADVANTAGE
OIL SEED RADISH
EXCELLENT SMOTHER CROP
### COVERS FOLLOWING SNAP BEANS IN MI

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Rate (lbs/A)</th>
<th>Biomass (lbs/A)</th>
<th>WBiomass (lbs/A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>OS radish</td>
<td>15</td>
<td>3683* a</td>
<td>34 a</td>
</tr>
<tr>
<td>Hairy vetch</td>
<td>25</td>
<td>2233 b</td>
<td>975 ab</td>
</tr>
<tr>
<td>Oats</td>
<td>48</td>
<td>2619 b</td>
<td>551 ab</td>
</tr>
<tr>
<td>Crimson clover</td>
<td>12</td>
<td>2923 ab</td>
<td>1470 bc</td>
</tr>
<tr>
<td>C mammoth red clover</td>
<td>12</td>
<td>1000 c</td>
<td>2083 c</td>
</tr>
<tr>
<td>Control</td>
<td>0</td>
<td>0</td>
<td>3966 d</td>
</tr>
<tr>
<td>LSD(0.05)</td>
<td>1020</td>
<td></td>
<td>988</td>
</tr>
</tbody>
</table>

* Indicates significant difference.
OSR NEEDS N TO GROW
OSR HAS SMALL ROOTS
SEED OSR AT 10 LBS/A
FLIAL MOWER BEST
SMALL PIECE ALLOW MORE
FUMIGANT RELEASE
OSR over winter 2003-4
RYE COVER SHOWING SIGNS OF CROP RESIDUE
COMPOSTS

COOP WITH FRANK
LOUWS, DAVID MONKS
COMPOST AN ALTERNATIVE
SPREADER AT RATES OF 15 TO 30 YARDS/A
SPREADER CALIBRATION AND UNIFORMITY IMPORTANT
A LOOK AT 30 YARDS/A
## TOMATO YIELD 2004, CLINTON, NC

<table>
<thead>
<tr>
<th>TREAT</th>
<th>TOTAL</th>
<th>MARK</th>
<th>XL</th>
<th>Plt DW</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMC</td>
<td>2903a</td>
<td>2697a</td>
<td>1006</td>
<td>257</td>
</tr>
<tr>
<td>CMC+T382</td>
<td>3131ab</td>
<td>2873abc</td>
<td>961</td>
<td>239</td>
</tr>
<tr>
<td>CMC+Telo</td>
<td>3341abc</td>
<td>3123abc</td>
<td>980</td>
<td>247</td>
</tr>
<tr>
<td>Compost2</td>
<td>2743a</td>
<td>2493a</td>
<td>804</td>
<td>262</td>
</tr>
<tr>
<td>Compost3</td>
<td>3130ab</td>
<td>2790ab</td>
<td>1369</td>
<td>191</td>
</tr>
<tr>
<td>Telone-C35</td>
<td>3984bc</td>
<td>3737bc</td>
<td>1107</td>
<td>194</td>
</tr>
<tr>
<td>Telone-C35+F</td>
<td>4262c</td>
<td>3870c</td>
<td>1291</td>
<td>236</td>
</tr>
<tr>
<td>Control</td>
<td>2496a</td>
<td>2213a</td>
<td>920</td>
<td>157</td>
</tr>
<tr>
<td>LSD .05</td>
<td>1031*</td>
<td>1034 *</td>
<td>529ns</td>
<td>87ns</td>
</tr>
</tbody>
</table>
WE HAVE HAD FALL STAND PROBLEMS LIKE THESE COLLARDS
Telone + Xtra Fert
McGill Compost
Telone
EC compost
McGill Compost
EC Compost
USEFUL WEB SITES

- http://info.ag.uidaho.edu/pps/toc.pdf
- http://www.google.com/u/washingtonstateuniversity?q=biofumiga nt+crops&submit=Submit
Economic Evaluation of Methyl Bromide Alternatives for Strawberry Production in Eastern North Carolina
• Cooperative effort between the Departments of Horticulture, Plant Pathology and Agricultural Economics

• Purpose: Evaluate the economic feasibility of various chemical alternatives that can be substituted for methyl bromide (MB) in strawberry production.

• Companion study focuses on tomatoes
Methodology & Assumptions

- The base cost model was developed for a 5 acre strawberry planting using MB as the fumigant.
- Production practices were based on the management practices recommended by research & extension specialists and reviewed by growers.
- Input prices were obtained from local dealers who regularly supply NC strawberry producers.
Methodology & Assumptions

- Machinery & equipment was purchased new at 2001 prices.
- Labor cost estimates reflected the true costs of labor and not just wage rates.
- 2/3’s of the strawberries were sold through PYO operations @ $0.90/lb and 1/3 were sold at a fruit stand @ $1.40/lb.
- Partial budget analysis was used evaluate alternate fumigants relative to MB.
## Strawberry Cost Estimates

<table>
<thead>
<tr>
<th>Production Stage</th>
<th>Cost Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land Preparation</td>
<td>$ 516</td>
</tr>
<tr>
<td>Pre-Plant Operations</td>
<td>4,399</td>
</tr>
<tr>
<td>Trans/Post-Plant Ops</td>
<td>2,035</td>
</tr>
<tr>
<td>Dormant Period</td>
<td>939</td>
</tr>
<tr>
<td>Pre-Harvest Operations</td>
<td>2,115</td>
</tr>
<tr>
<td>Harvest Operations</td>
<td>3,528</td>
</tr>
<tr>
<td><strong>Total Cost Estimate</strong></td>
<td><strong>$13,532</strong></td>
</tr>
</tbody>
</table>
# Partial Budgeting

## Negative Effects:

<table>
<thead>
<tr>
<th>Effect</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Added Costs</td>
<td>$ _______</td>
</tr>
<tr>
<td>Reduced Returns</td>
<td>$ _______</td>
</tr>
<tr>
<td>Total Negative Effects</td>
<td>$ _______</td>
</tr>
</tbody>
</table>

## Positive Effects:

<table>
<thead>
<tr>
<th>Effect</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced Costs</td>
<td>$ _______</td>
</tr>
<tr>
<td>Added Returns</td>
<td>$ _______</td>
</tr>
<tr>
<td>Total Positive Effects</td>
<td>$ _______</td>
</tr>
</tbody>
</table>

## Total Effects (+/-) Returns

<table>
<thead>
<tr>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>$ _______</td>
</tr>
</tbody>
</table>
## Estimated Fumigation Costs per Acre

<table>
<thead>
<tr>
<th>Fumigant</th>
<th>Total Costs</th>
<th>Reduced Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methyl Bromide</td>
<td>$1,267</td>
<td>$0</td>
</tr>
<tr>
<td>Metam Sodium (Shank)</td>
<td>$1,196</td>
<td>$71</td>
</tr>
<tr>
<td>Chloropicrin</td>
<td>$1,175</td>
<td>$92</td>
</tr>
<tr>
<td>Telone-C35</td>
<td>$1,107</td>
<td>$160</td>
</tr>
<tr>
<td>InLine (drip)</td>
<td>$1,059</td>
<td>$208</td>
</tr>
<tr>
<td>Telone II</td>
<td>$988</td>
<td>$279</td>
</tr>
<tr>
<td>Metam Sodium (drip)</td>
<td>$904</td>
<td>$363</td>
</tr>
<tr>
<td>Non-fumigated (check)</td>
<td>$767</td>
<td>$500</td>
</tr>
</tbody>
</table>
## Estimated Average Yields per Acre

<table>
<thead>
<tr>
<th>Fumigant</th>
<th>Avg. Yld.</th>
<th>Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chloropicrin</td>
<td>28,377 lbs</td>
<td>2000 - 01</td>
</tr>
<tr>
<td>Telone-C35</td>
<td>26,806 lbs</td>
<td>1996 - 01</td>
</tr>
<tr>
<td><strong>Methyl Bromide</strong></td>
<td><strong>26,673 lbs</strong></td>
<td><strong>1996 - 01</strong></td>
</tr>
<tr>
<td>Metam Sodium (Shank)</td>
<td>26,604 lbs</td>
<td>1996 - 01</td>
</tr>
<tr>
<td>InLine (drip)</td>
<td>24,193 lbs</td>
<td>2000 - 01</td>
</tr>
<tr>
<td>Metam Sodium (drip)</td>
<td>24,103 lbs</td>
<td>2000 - 01</td>
</tr>
<tr>
<td>Telone II</td>
<td>22,253 lbs</td>
<td>2000 - 01</td>
</tr>
<tr>
<td>Non-fumigated (check)</td>
<td>20,010 lbs</td>
<td>1996 - 01</td>
</tr>
</tbody>
</table>
## Estimated Returns per Acre

<table>
<thead>
<tr>
<th>Fumigant</th>
<th>Additional Returns</th>
<th>Net Returns</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chloropicrin</td>
<td>$1,768</td>
<td>$16,687</td>
</tr>
<tr>
<td>Telone-C35</td>
<td>$291</td>
<td>$15,210</td>
</tr>
<tr>
<td>Metam Sodium (Shank)</td>
<td>$3</td>
<td>$14,922</td>
</tr>
<tr>
<td><strong>Methyl Bromide</strong></td>
<td>$0</td>
<td><strong>$14,919</strong></td>
</tr>
<tr>
<td>Metam Sodium (drip)</td>
<td>-$2,164</td>
<td>$12,755</td>
</tr>
<tr>
<td>InLine (drip)</td>
<td>-$2,230</td>
<td>$12,689</td>
</tr>
<tr>
<td>Telone II</td>
<td>-$4,167</td>
<td>$10,752</td>
</tr>
<tr>
<td>Non-fumigated (check)</td>
<td>-$6,052</td>
<td>$ 8,867</td>
</tr>
</tbody>
</table>
Conclusions:

- There are economically feasible alternatives to MB in strawberry production in the southeastern U.S. Technical issues may remain.
- Chloropicrin showed the “best” potential for growing conditions in eastern N.C. relative to MB ($1,768/A).
- Telone C35 showed a modest improvement relative to MB ($291/A) under low pressure conditions.
- Shank-applied Metam Sodium showed virtually the same total effects as MB ($3/A).
Contacts:

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EFFICACY OF MB ALTERNATIVES FOR VERTICILLIUM AND WEED MANAGEMENT IN TOMATOES

Frank Louws
Lisa Ferguson
Kelly Ivors
Jim Driver
Katie Jennings
Dreama Milks
Paul B. Shoemaker
Dave Monks.

Department of Plant Pathology and Horticulture
North Carolina State University
Tomato Research
PRIMARY SOILBORNE DISEASES

Verticillium wilt race 2
OBJECTIVE:

To compare shank applied and drip applied products to manage Verticillium wilt of tomatoes in Western North Carolina.
<table>
<thead>
<tr>
<th>Treatment</th>
<th>Application Method</th>
<th>Rate (broadcast)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-fumigated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MB: chloropicrin (67:33)</td>
<td>Shank</td>
<td>400 lbs/A</td>
</tr>
<tr>
<td>Telone-C35</td>
<td>Shank</td>
<td>35 gal/A</td>
</tr>
<tr>
<td>InLine</td>
<td>Drip</td>
<td>26 gal/A</td>
</tr>
<tr>
<td>Metam sodium</td>
<td>Sprayed + Till</td>
<td>75 gal/A</td>
</tr>
<tr>
<td>Metam sodium drip</td>
<td>Drip</td>
<td>75 gal/A</td>
</tr>
<tr>
<td>MI: Chloropicrin (60:40)</td>
<td>Shank</td>
<td>300 lb/A</td>
</tr>
<tr>
<td>(50:50)</td>
<td></td>
<td>250 lb/A</td>
</tr>
<tr>
<td>(33:67 - Shank &amp; EC)</td>
<td></td>
<td>300 lb/A</td>
</tr>
<tr>
<td>Chloropicrin (96%)</td>
<td>Shank</td>
<td>113-195 lb/A</td>
</tr>
<tr>
<td>Chloropicrin Plus (75%)</td>
<td></td>
<td>256 lb/A</td>
</tr>
<tr>
<td>Chloropicrin EC</td>
<td>Drip</td>
<td>200 lb/A</td>
</tr>
<tr>
<td>Chloropicrin EC + Metam sodium</td>
<td>Drip + 1 week delay</td>
<td>200 lb/A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>75 gal/A</td>
</tr>
</tbody>
</table>
Experimental Design

- 100 ft plots, planted and harvested inner 15 plants
- RCBD with 4 replications in a field with a history of Verticillium pressure
- Weekly evaluations for Verticillium wilt incidence
- Weekly (6-8) harvests
- 3 year trial
2002 Incidence of Verticillium Wilt

Verticillium wilt incidence (%)

Days after transplanting

Methyl bromide 67:33
Telone-C35
InLine
metam sodium shank
metam sodium drip
iodomethane 60:40
chloropicrin shank
compost + Trichoderma
compost
no treatment
chloropicrin EC
chloropicrin EC + metam sodium
2003 Incidence of Verticillium Wilt

Verticillium wilt incidence (%)

Days Since Aug 1 2003

- Methyl Bromide 67:33
- Non-fumigated
- Telone-C35
- InLine
- Metam sodium drip
- Metam sodium spray
- Chloropicrin
- Chloropicrin EC
- Chloropicrin Plus
- Iodomethane 33:67
- Iodomethane 50:50
- Iodomethane 33:67 EC
Terminal rating
$Y = 53.3267 - 0.347083X$
$R^2 = 0.880$

Early rating (4-Jul)
$Y = 46.0016 - 0.342942X$
$R^2 = 0.761$

2002 Verticillium Wilt Incidence and Yield
2003 Verticillium Wilt Incidence and Yield

Tomato yield (ton/A)

Verticillium incidence (%)

Y = 32.948 - 0.168896X
EMS = 2.0913
R² = 0.658

Y = 37.1854 - 0.198X
EMS = 2.08896
R² = 0.658

Y = 58.6444 - 0.345401X
EMS = 3.71207
R² = 0.392
2002 Incidence of Verticillium Wilt

- no treatment
- Telone-C35
- InLine
- metam sodium shank
- metam sodium drip
- iodomethane 60:40

Verticillium wilt incidence (%)

Days after transplanting

Mktble Yld
- Telone-C35: 37.0 cd
- InLine: 39.4 bcd
- metam sodium shank: 43.9 ab
- metam sodium drip: 43.3 abc
- iodomethane 60:40: 49.1 a

* * *

43.3 abc
2002 Incidence of Verticillium Wilt

Verticillium wilt incidence (%)

- chloropicrin shank
- chloropicrin EC
- chloropicrin EC + metam sodium

Days after transplanting

Mktble Yld
- 43.3 abc
- 41.6 bcd
- 48.6 a
2003 Incidence of Verticillium Wilt

Verticillium wilt incidence (%) vs. Days Since Aug 1 2003

- Methyl Bromide 67:33
- Non-fumigated
- Telone-C35
- InLine
- Chloropicrin
- Chloropicrin EC
- Chloropicrin Plus
2003 Incidence of Verticillium Wilt

- Methyl Bromide 67:33
- Non-fumigated
- Metam sodium drip
- Metam sodium spray

Verticillium wilt incidence (%) vs. Days Since Aug 1 2003
2003 Incidence of Verticillium Wilt

Verticillium wilt incidence (%)

Days Since Aug 1 2003

Methyl Bromide 67:33
Non-fumigated
Iodomethane 33:67
Iodomethane 50:50
Iodomethane 33:67 EC
IR-4 Trials 2004
<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Non Fumigated</td>
</tr>
<tr>
<td>2</td>
<td>Non Fumigated (hand Weeded)</td>
</tr>
<tr>
<td>3</td>
<td>MB 67:33 (400 lb/A)</td>
</tr>
<tr>
<td>4</td>
<td>SEP 100 (75 lb a.i.)</td>
</tr>
<tr>
<td>5</td>
<td>Propozone (60 gal/A)</td>
</tr>
<tr>
<td>6</td>
<td>Telone C35 (35 gal/A)</td>
</tr>
<tr>
<td>7</td>
<td>Propozone drip (60 gal)</td>
</tr>
<tr>
<td>8</td>
<td>Chloropicrin (150 lb/A)</td>
</tr>
<tr>
<td>9</td>
<td>Chloropicrin (150 lb/A) + Kapam (75 gal/A 1 wk later)</td>
</tr>
<tr>
<td>10</td>
<td>Chloropicrin Plus (256 lb/A)</td>
</tr>
<tr>
<td>Pre-plant Treatment</td>
<td>Rate (broadcast equiv)</td>
</tr>
<tr>
<td>---------------------------------------------</td>
<td>------------------------</td>
</tr>
<tr>
<td>Propozone (Drip applied)</td>
<td>60 gal/A</td>
</tr>
<tr>
<td>Methyl bromide: chloropicrin (67:33)</td>
<td>400 lbs/A</td>
</tr>
<tr>
<td>SEP 100</td>
<td>75 lbs a.i./A</td>
</tr>
<tr>
<td>Propozone (Shank applied)</td>
<td>60 gal/A</td>
</tr>
<tr>
<td>Control (hand-weeded)</td>
<td>---------</td>
</tr>
<tr>
<td>Telone-C35</td>
<td>35 gal/A</td>
</tr>
<tr>
<td>Chloropicrin (99%) + K-Pam (7 days later)</td>
<td>150 lb/A 75 gal/A</td>
</tr>
<tr>
<td>Chloropicrin (99%)</td>
<td>150 lb/A</td>
</tr>
<tr>
<td>Chloropicrin Plus (75%)</td>
<td>256 lbA</td>
</tr>
<tr>
<td>Control (non-weeded)</td>
<td>---------</td>
</tr>
</tbody>
</table>
1. Non Fumigated  
2. Non Fumigated (hand Weeded)  
3. MB 67:33 (400 lb/A)  
4. Chloropicrin (150 lb/A)  
5. Chloropicrin (150 lb/A) + Sulfentrazone  
6. Chloropicrin (150 lb/A) + Pre Dual + Post TSS  
7. Chloropicrin (150 lb/A) + Pre Dual + Post Halsosulfuron  
8. Chloropicrin (150 lb/A) + Pre Dual  
9. Chloropicrin (150 lb/A) + Pre Goal  
10. Chloropicrin (150 lb/A) + K-pam (drip after 1 wk 75 gal/A)  
11. Telone C35 (35 gal/A)  
12. K-pam (Broadcast - 75 gal/A 1 wk later)
<table>
<thead>
<tr>
<th></th>
<th>WEED INCIDENCE 19 AUG 2004 (Weeds/plot)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Non Fumigated</td>
</tr>
<tr>
<td>2.</td>
<td>Non Fumigated (hand Weeded)</td>
</tr>
<tr>
<td>4.</td>
<td>Chloropicrin (150 lb/A)</td>
</tr>
<tr>
<td>5.</td>
<td>Chloropicrin (150 lb/A) + Sulfentrazone</td>
</tr>
<tr>
<td>8.</td>
<td>Chloropicrin (150 lb/A) + Pre Dual</td>
</tr>
<tr>
<td>9.</td>
<td>Chloropicrin (150 lb/A) + Pre Goal</td>
</tr>
<tr>
<td>10.</td>
<td>Chloropicrin (150 lb/A) + K-pam (drip after 1 wk 75 gal/A)</td>
</tr>
<tr>
<td>11.</td>
<td>Telone C35 (35 gal/A)</td>
</tr>
<tr>
<td>12.</td>
<td>K-Pam (Broadcast - 75 gal/A 1 wk later)</td>
</tr>
</tbody>
</table>
CONCLUSIONS:

Short term: Leading chemical alternatives include:
• Telone-C35 + herbicides
• chloropicrin (alone) + herbicides
• metam sodium/potassium
• iodomethane:pic (when registered).

Shank applied products tended to perform better than the drip applied products.
Methyl Bromide Alternatives To Manage Weeds

D. Monks, S. Culpepper and D. Langston
Options to Improve Weed Control

- Herbicide(s) preplant under plastic
- Herbicide(s) banded over top of crop and plastic
- Hand removal

MB = bromide, MS = metam sodium, Pic = chloropicrin.

LSD = 1.8; data pooled over herbicide treatments.

Bar chart showing the number of plants per ydsq for different treatments. The treatments include:
- None
- MB (375 lb)
- C35 (18 G)
- C35 (36 G)
- MS (56 G)
- MS (75 G)
- Pic (282 lb)
- T2 (10 G) fb Pic (150)
- C35 (10 G) + MS (37 G)
- C35 (20 G) + MS (56 G)

LSD = 0.99.

MB = bromide, MS = metam sodium, Pic = chloropicrin.
Non-treated  

C-35 Broadcast  
25 GPA  

C-35 In Bed  
35 GPA  

Nutsedge Response to Fumigants in Pepper. 33 d After Fumigating. TyTy, 2002.*

LSD = 0.76.

MB = bromide, BC = broadcast, C35 = Telone C35, Pic = chloropicrin.
Nutsedge Response to Fumigants in Pepper. 81 d After Fumigating. TyTy, 2002.*

LSD = 2.5

MB = bromide, BC = broadcast, C35 = Telone C35, Pic = chloropicrin.
Acceptable LONG-TERM Methyl Bromide Alternatives will likely Require Herbicide Input
Three herbicide options in tomato

1. Tillam
2. Sandea
3. Envoke
Sandea - Tomato

- 0.5 to 0.75 oz following final bed shaping and just prior to laying plastic. Do not transplant for at least 7 d after treatment.

- 0.5 to 0.75 oz POST no sooner than 14 d after transplant. Directed application suggested.

Sandea 0.67 oz/A POST  
Non-treated
Other Weeds

eastern black nightshade
groundcherry
hairy galinsoga
ivyleaf morningglory
jimsonweed
pitted morningglory
redroot pigweed
sicklepod
velvetleaf
Effect of Amaranth Free Period on Tomato Fruit Grade

Fruit grades

- Jumbo
- Large
- Medium
- Cull

% of Total fruit weight

Weeks weed-free

0 1 2 3 4 6 all season
Effect of Amaranth on Tomato Fruit Grade

Fruit grades
- Jumbo
- Medium
- Large
- Cull

Weeks weedy

% of Total fruit weight

All season

Weeks weedy
Nontreated Check
Sencor
High rate Sandea
High rate Envoke
Harmony GT
(not registered)
Goal
Dow AgroSciences

- Recently registered in NC, SC, VA, FL
- When laying drip tape and plastic minimize soil disturbance
- Application must occur at least 30 days prior to planting
Goal
Weeds

• Use rate is 1 to 2 pints/Acre
• Weeds controlled include Florida pusley, common purslane, Carolina geranium, cutleaf eveningprimrose, pigweed, ragweed, and nightshade and some annual grasses.
Dual Magnum
Syngenta

- Registered for PRE control of weeds in tomato
- Bareground – PPI or preplant to the soil surface before transplanting
- Post-directed to transplants after the first settling rain or irrigation
Dual Magnum

• Bedded transplants
  – Apply to soil surface before laying plastic
  – Apply to row middles

• Use rate on coarse soils is 1 to 1.33 pints per acre
Dual Magnum
Weeds controlled

- Many annual grasses
- Pigweed species
- Nightshade species
- Groundcherry species
Envoke

- Recently registered in FL and GA for control of nutsedge and grass in tomato
- A NC registration is expected soon
- Use rate is 0.1 to 0.2 oz/Acre post-directed to tomato grown on plastic
Envoke

- Wait 2 weeks after transplanting before applying Envoke
- Apply prior to fruit set and at least 45 days prior to harvest
- Include a nonionic surfactant
Treatments

- Methyl bromide
- Chloropicrin
- Chloropicrin + Dual PRE
- Chloropicrin + Goal PRE
- Telone C35
<table>
<thead>
<tr>
<th></th>
<th>No herbicide</th>
<th>W/Dual</th>
<th>W/Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nontreated</td>
<td>21</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Methyl bromide</td>
<td>0</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Chloropicrin</td>
<td>25</td>
<td>0</td>
<td>5</td>
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<tr>
<td>Telone C35</td>
<td>2</td>
<td>--</td>
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</table>
## Response of weeds to herbicides.

<table>
<thead>
<tr>
<th>Herbicides</th>
<th>Dual PD</th>
<th>Devrinol preplant</th>
<th>Sencor PD</th>
<th>Treflan preplant</th>
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</thead>
<tbody>
<tr>
<td>Radish or mustard, wild</td>
<td>E</td>
<td>F-G</td>
<td>E</td>
<td>P</td>
</tr>
<tr>
<td>Redroot pigweed</td>
<td>E</td>
<td></td>
<td>E</td>
<td>E</td>
</tr>
<tr>
<td>Velvetleaf</td>
<td>N</td>
<td>N</td>
<td>E</td>
<td>P</td>
</tr>
<tr>
<td>Lambsquarters, common</td>
<td>F</td>
<td>G</td>
<td>E</td>
<td>G</td>
</tr>
<tr>
<td>Eastern black nightshade</td>
<td>E</td>
<td>N</td>
<td>P</td>
<td>P</td>
</tr>
<tr>
<td>Hairy galinsoga</td>
<td>E</td>
<td>G</td>
<td>E</td>
<td>P</td>
</tr>
<tr>
<td>Morningglory</td>
<td>N-P</td>
<td>P</td>
<td>F-G</td>
<td>P</td>
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<tr>
<td>Purslane</td>
<td>E</td>
<td>G</td>
<td>E</td>
<td>F-G</td>
</tr>
<tr>
<td>Yellow nutsedge</td>
<td>G-E</td>
<td>N</td>
<td>N-P</td>
<td>P</td>
</tr>
<tr>
<td>Annual grasses</td>
<td>E</td>
<td>E</td>
<td>N-P</td>
<td>E</td>
</tr>
</tbody>
</table>
## Response of weeds to post-directed herbicides.

<table>
<thead>
<tr>
<th>Herbicides</th>
<th>Matrix</th>
<th>Paraquat</th>
<th>Sencor</th>
<th>Sandea</th>
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<tbody>
<tr>
<td>Radish or mustard, wild</td>
<td>E</td>
<td>F</td>
<td>P-F</td>
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<tr>
<td>Redroot pigweed</td>
<td>G</td>
<td>E</td>
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<tr>
<td>Velvetleaf</td>
<td>E</td>
<td>E</td>
<td>E</td>
<td>E</td>
</tr>
<tr>
<td>Lambsquarters, common</td>
<td>F-G</td>
<td>G</td>
<td>E</td>
<td>P-F</td>
</tr>
<tr>
<td>Eastern black nightshade</td>
<td>P</td>
<td>E</td>
<td>F</td>
<td>P</td>
</tr>
<tr>
<td>Hairy galinsoga</td>
<td>G-E</td>
<td>E</td>
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<td>E</td>
</tr>
<tr>
<td>Morningglory</td>
<td>F-G</td>
<td>G-E</td>
<td>F-G</td>
<td>F-G</td>
</tr>
<tr>
<td>Jimsonweed</td>
<td>E</td>
<td>E</td>
<td>E</td>
<td>E</td>
</tr>
<tr>
<td>Yellow nutsedge</td>
<td>F</td>
<td>N-P</td>
<td>E</td>
<td></td>
</tr>
<tr>
<td>Annual grasses</td>
<td>F-G</td>
<td>F-G</td>
<td>N-P</td>
<td>N</td>
</tr>
</tbody>
</table>
Weed control
In the row

Methyl bromide
Devrinol
Dual
Goal
Sandea
Poast, Select
Cucumber or Cantaloupe

• Alanap POST: pre control of certain broadleaf weeds.
• Sandea POST: post control of nutsedge and many broadleaf weeds.
Strawberry Response to Preplant herbicides

Graph showing the strawberry injury in response to different preplant herbicides and application rates. The x-axis represents the herbicides and application rates (1 pt, 2 pt, 2 oz, 4 oz, 1 qt), and the y-axis represents the strawberry injury percentage (0 to 14%). The graph includes data for 10 days, 35 days, and 60 days post-application.
Goal

- Carolina geranium, cutleaf eveningprimrose, and some annual grasses. Maybe will assist with resistance management in the row.
Nontreated  Ultra Blazer @ 2 pint/Acre

1 month after treatment
Postemergence Study
Materials and Methods

• Chandler plug plants
• Planted on October 12, 2004
• Sprayed on October 14, 2004
• Location – Horticultural Crops Research Station, Clinton, NC
• Spray info - 20 GPA at 32 psi, even tip, 3 mph
Strawberry Response to Herbicides

Strawberry injury (%)

- **Dactal**: 7.5 lb
- **Devrinol**: 4 lb
- **Dual**: 1.5 pt
- **Sinbar**: 2 oz

- **5 days**
- **30 days**
- **90 days**
Non Treated
Summary – in the row

- Dacthal, Devrinol and Dual banded over the crop and plastic for PRE control have potential to improve non nutsedge weeds with alternative fumigants.
- UltraBlazer, and Goal have potential for use under plastic for non nutsedge weeds.
- Goal has a label in NC, GA and FL with possible expansion in other states.
Summary – in the row

• Stinger gives effective postemergence control:
  vetch, clover, prickly lettuce, annual sowthistle, cocklebur, galinsoga, common ragweed

• Poast or Select gives effective postemergence control:
  annual and perennial grasses
Vetch
Stinger @ 2/3 pint
Weed Control Between Rows
Several Options for Middles

Non chemical
- Ryegrass
- Winter grains (for example winter rye or wheat)

Chemical options
- Preemergence
  - Dacthal
  - Devrinol
- Postemergence
  - Gramoxone
  - Poast
  - Select
  - Stinger
  - Roundup WeatherMax
  - Aim
Summary - middles

• Program
  – Cover crop
  – Preemergence with a postemergence herbicide

Crops with limited Data

- Pepper – Goal is registered; weeds establish easily
- Squash
- Watermelon

*Sandea is too injurious to these crops.
Methyl Bromide Alternatives: 
Virtually Impermeable Film

Powell Smith
Extension Entomologist
Clemson University, Edisto REC
Blackville, SC
Methyl Bromide as a Fumigant

- MeBr was identified as an ozone depleter in 1985.
- Gradual phase-out to ease economic losses.
- Developed countries to achieve 100% reduction by 2005 (Montreal protocol of 1997).
Some uses have been defined as critical and use is allowed (at least until a satisfactory replacement is developed).

Mainly quarantine and preshipment fumigation uses.

New protocol wording allowed ‘Critical Use Exemptions’.

If no viable alternatives existed, a ‘case’ could be submitted for use at a defined level to be continued.

Use rates for SE states estimated to allow MeBr use to continue on strawberries and selected vegetables.
Critical Use Exemptions

- Allow research into alternatives while allowing growers to continue use.
- New fumigation materials used in conjunction with MeBr - chloropicrin, herbicides, etc.
- New fumigants - MeI, dazomet, MITC-materials.
- Old fumigants with new partners - Telone products.
- Improve fumigation efficiency.
- Maintain efficacy but reduce rate.
How Does Fumigation Work?

- It is a disinfestation (disinfection) process.
- Cleansing of an inanimate surface of harmful microbes.
- Reducing pathogens to below a critical threshold so disease won’t develop (as soon).
  - Not 100% reduction - pathogen rebound.
  - Some beneficial microbes must remain.
Important Parameters for Disinfestation

- Nature of the surface - unmanageable; soil is nonhomogenous; large surface area.
- Level of organic matter.
  - Humus - little management; varies with soil type.
  - Detritus - manageable; crop or weed residue.
  - Biota - little control; varies with soil type and use.
- Contact time - manageable??
- ‘Dose’ - rate of fumigant - manageable??
Soil Microbes

- Soil is a complex environment with an extremely numerous and diverse biota.
- 25,000 to 30,000 lbs per acre ft. of life.
  - 13,000 - 14,000 lb of fungi.
  - 12,000 lb of bacteria.
  - 1,800 lb of actinomycetes.
  - 200 lb of protozoa.
  - 50 lb of nematodes.
- Algae, mites, & insects - variable but significant.
- All organic - absorb/deplete fumigant dose.
Contact Time

- Key element in any disinfection process.
- Within 48 hrs. MeBr under PE mulch film has exerted lethal effect because concentration has declined to sub-lethal levels. (good cond.)
- Effect = rate x time.
- Damage to plants after 7 day plant back period?
  - Bad fumigation conditions?
  - NH₃-toxicity - (NH₂)CO + H₂O → NH₃ + CO₂; NH₄⁺.
  - Nitrifiers in soil - NH₃ → NO₃⁻; slow to reestablish.
- Increased contact time = more efficacy at reduced rates.
Methyl Bromide Uses Globally

Fig. 2. Distribution of global methyl bromide use among different applications during 1992 (51,68).
Methyl Bromide Users - Worldwide

United States: 25,528 t (39%)
Europe: 19,217 t (30%)
Others: 6,107 t (10%)
Asia: 1,745 t (2.8%)
Japan: 1,930 t (3%)
Africa: 2,617 t (4%)
Latin America and the Caribbean: 7,179 t (11%)

Fig. 1. World global methyl bromide use (metric tons) in 1991 (62).
Italy - A Case Study

- Italy is EU’s biggest user.
  - 7,600 MT in 1995.
  - Sicily is largest regional user - 4,000 MT-1995.
- After research showed rate reduction potential, Virtually Impermeable Film was mandated for MeBr fumigation in 2000.
- MeBr use in 2001 - 3,700 MT.
  - Sicily’s use in 2001 = 2,000 MT.
  - No reduction in acreage.
EU to United States

Conversion Factors:  \( \text{g/m}^2/\text{hour} \) to \( \text{oz/yd}^2/\text{hr} \)

multiply number of grams by 0.0313

Today 1 euro = $1.31:  \( \text{E/m}^2 \) to \( \$/\text{yd}^2 \)

multiply by euros by 1.17
What is VIF?

- A composite product.
- Co-manufactured sheets of LDPE or HDPE and nylon or vinyl polymer.
- Physical characteristics similar to PE.
  - Less stretchy; tends to be brittle.
  - Reaction to temperatures is different.
- Me Br diffusion Characteristics.
  - PE - > 50 g/m²/hr (1.57 oz/yd²/hr).
  - VIF - < 1 g/m²/hr (0.0313 oz/yd²/hr).
In Italy

- HD/LD PE film - $0.06/yd²
- VIF - $0.12/ yd²

Films applied with fumigant in Italy.
- PE with full rate of MeBr = $0.70/ yd².
- VIF with 1/2-rate of MeBr = $0.47/ yd².
What’s Available in the US?

- European product
  - PE + nylon
  - PE + ethylene-vinyl alcohol polymer

- North American
  - Some metallized films have much lower MeBr diffusion rates than regular PE film.
  - Some grower and industry claims indicate that rates of MeBr under such films can be reduced by as much as 1/2.
A growing body of research in the US indicates that use of VIF will allow rate reduction of MeBr without loss of efficacy.

Current problems
- Consistency of performance among films and batches.
- Laying characteristics different from PE film.
  - Requires changes in fumigation process - slow down.
  - Poor soil to film contact in some cases.
  - Greater problems with wind after laying film.
Replicated study to compare two VIF’s and a metallized film to conventional PE film using reduced rates of MeBr.

- no crop.
- buried RKN and YNS at two depths.
- measure MeBr under films at 2, 4, 24, 48, 72, and 96 hrs.
- PE - 0, 0.5, and 1.0 rate of MeBr (200 lbs 67/33).
- VIF’s and Met Film - 0.5 and 0.75 rate.
Methyl Bromide
Critical Use Exemptions

Stephen J. Toth, Jr.
Associate Director
Southern Region IPM Center
North Carolina State University

Photo from NCSU Communication Services
Methyl Bromide Phase-Out

- Under the Federal Clean Air Act and an international treaty to protect the ozone layer (Montreal Protocol on Substances that Deplete the Ozone Layer), the production and import of methyl bromide will be phased out in the United States on January 1, 2005.
Methyl Bromide Phase-Out

U.S. Methyl Bromide Consumption and Phaseout Schedule

Source: U.S. EPA
Methyl Bromide Transition Program

• The USDA and Land-grant Universities have been supporting research for the discovery and implementation of practical pest management alternatives for commodities (i.e., fruit, vegetables, nurseries) affected by the phase-out of methyl bromide

• The USDA has spent over $146 million to date on research and outreach
MeBr Critical Use Exemptions

- Parties to the Montreal Protocol recognized that methyl bromide users in some countries needed a temporary safety net to provide the time necessary to transition to alternatives.
- The parties addressed the possibility that alternatives to methyl bromide may not be available for all uses by 2005.
MeBr Critical Use Exemptions

• Parties to the Montreal Protocol agreed to allow limited production and import of methyl bromide after January 1, 2005
• The Parties agreed to a specific timeline and data requirements for “critical use exemptions”
MeBr Critical Use Exemptions

• In May 2002, EPA called for applications for critical use exemptions from U. S. users

• The information on application form used to determine if the specific use is “critical” because no technically or economically feasible alternative to methyl bromide is available

• A workshop was held August 7-8, 2002 in Raleigh, NC to develop applications for strawberries (field and nursery), tomatoes, peppers and cucurbits in the Southeastern U. S.; coordinated by North Carolina State University faculty
MeBr Critical Use Exemptions

- EPA submitted a two-year exemption request for the U.S. to begin in 2005
- U.S. request for 2005 for 39% of the U.S. baseline consumption of methyl bromide
- Request for 16 crops/uses: food processing, commodity storage, forest seedlings, orchard seedlings, orchard replant, turf and sod, tomatoes, peppers, eggplant, strawberry fruit, strawberry nurseries, cucurbits, ornamentals, ginger, transplant trays used in greenhouse production systems, and sweetpotatoes
MeBr Critical Use Exemptions

- U. S. nomination of critical methyl bromide uses for exemption in 2005 and 2006 submitted to the Ozone Secretariat of the United Nations
- In November 2003, Parties to the Montreal Protocol met to review recommendations; however, could not reach a decision
- In March 2004, Parties to the Montreal Protocol met again and granted limited critical use exemptions for 2005 to 11 developed countries (including the United States)
MeBr Critical Use Exemptions

- The United States has been allocated 19.6 million pounds for 2005 (equivalent to 35% of the 1991 baseline)
- This 35% is composed of 30% new production and 5% existing stocks
- **This critical use exemption is for 1 year only!**
- Parties also authorized a small supplemental request for 2005, amounting to 2% of the 1991 baseline
MeBr CUE for Cucurbits

- Pre-plant uses for Alabama, Arkansas, Georgia, North Carolina, South Carolina, Tennessee and Virginia growers with moderate to severe yellow or purple nutsedge infestation
- Includes cucumbers, melons and squash
MeBr CUE for Peppers & Tomatoes

- Pre-plant uses for Alabama, Arkansas, Georgia, North Carolina, South Carolina, Tennessee and Virginia growers with one or more of the following limiting conditions: moderate to severe yellow or purple nutsedge infestation, and/or presence of an occupied structure within 76 meters of a grower’s field the size of 100 acres or less
MeBr CUE for Strawberry Fruit

- Pre-plant uses for Alabama, Arkansas, Georgia, North Carolina, South Carolina, Tennessee, Virginia, Ohio and New Jersey growers with one or more of the following limiting conditions: moderate to severe yellow or purple nutsedge infestation, and/or presence of an occupied structure within 76 meters of a grower’s field the size of 100 acres or less
MeBr CUE for Strawberry Nurseries

- Pre-plant uses for North Carolina and Tennessee growers with the presence of an occupied structure within 76 meters of a grower’s field the size of 100 acres or less.

Fred S. Witte
MeBr CUE Allocation Process

- In August 2004, EPA proposed a process for allocating methyl bromide authorized under critical use exemptions
- EPA has received comments from interested parties and is currently formulating a decision for allocating methyl bromide
- An EPA ruling was released in the December 23, 2004 *Federal Register* which outlined the process for allocating methyl bromide under critical use exemptions
MeBr Critical Use Exemptions for 2006

- Additional critical use exemptions were requested for 2006 in applications submitted in 2003
- U. S. requested 37% of the 1991 baseline for the 2006 calendar year (17 uses, including cucurbits, peppers, strawberries and tomatoes)
- The Parties authorized 27% and the remaining 10% will be considered at a one-day meeting in June 2005
MeBr Critical Use Exemptions for 2007

- Additional critical use exemptions were requested for 2007 in applications submitted in 2004
- U. S. is requesting 29% of the 1991 baseline for the 2007 calendar year (15 uses, including cucurbits, peppers, strawberries, and peppers)
- The Methyl Bromide Technical Options Committee (MBTOC) will consider the request and make recommendations to the Parties; the Parties will meet in Nov. 2005 to consider the recommendations and authorize methyl bromide for critical needs in 2007
MeBr Critical Use Exemptions for 2008

- Waiting on notice calling for methyl bromide critical use exemption applications for the 2008 calendar year
- Will evaluate the needs for methyl bromide critical use exemptions for 2008 and submit applications for crops with critical needs for methyl bromide in 2008 (Summer 2005?)
- Southeastern Consortium provides the infrastructure (i.e., contacts with scientists, industry, growers, etc.) to complete and submit critical use exemption applications
Soil Fumigant Cluster Assessment

Stephen J. Toth, Jr.
Associate Director
Southern Region IPM Center
North Carolina State University

Photo by Bob Nichols
Soil Fumigant Cluster Assessment

- EPA has begun work on a comparative human health risk assessment for several soil fumigants
- Soil fumigants are used in similar ways; thus, expected to result in similar human exposures
- Advantageous to review them concurrently to ensure that: 1) assessment approaches are consistent, and 2) risk management decisions consider risks and benefits of each chemical on an equal footing
Soil Fumigant Cluster Assessment

Fumigants included in cluster assessment:

- Chloropicrin
- Dazomet
- Iodomethane *
- Metam sodium/potassium
- Methyl bromide
- Telone (1,3-dichloropropene) **

* New active ingredient not registered at this time
** Deemed eligible for reregistration in 1998
Soil Fumigant Cluster Assessment

Upcoming Schedule and Milestones:

- **April/May 2005**: 60-day public comment period on preliminary risk assessments
- **June/July 2005**: Agency consideration of public comments on preliminary risk assessments; completion of preliminary benefits assessments and risk management options (with input from stakeholders)
Soil Fumigant Cluster Assessment

Schedules and Milestones:

- **August/September 2005**: 60-day public comment period on revised risk assessments, preliminary benefit assessments, and preliminary risk management options

- **October/December 2005**: EPA consideration of public comments on revised risk assessments and preliminary benefits assessment and risk management options; development of risk management decision in consultation with all stakeholders
Soil Fumigant Cluster Assessment

Important Points:

• A very ambitious schedule for completion of the soil fumigant cluster assessment
• Short time frames for stakeholders to respond to preliminary/revised assessment decisions by EPA
• The need for information on soil fumigant usage will be considerable (see handout)
Methyl Bromide Critical Use Exemptions: *Process, Decisions, and Implementation*

Methyl Bromide Alternatives Agents Training

February 24, 2005

North Carolina State University

Raleigh, North Carolina
FFVA

- Voluntary Agricultural Trade Association
- Represent Producers of Vegetables, Fresh and Processed Citrus, Tropical Fruit, Sugar Cane, and Sod.
Methyl Bromide Phaseout – Clean Air Act

- Petition 1991 by NRDC, EDF, and WWF to list Mebr and other compounds as ozone depleters.
- Rule Adopted Dec 10, 1993 regulating Mebr as a Category I Ozone Depleter with an ODP of greater than 0.2.
- Rule set a freeze at the 1991 baseline and set the schedule for phaseout on Jan 1, 2001
Methyl Bromide Phaseout – Montreal Protocol

- Methyl Bromide Added to Controlled Substance List – 1992, Copenhagen Amendments.

- Meeting of the Parties (MOP) in 1995 set 2010 Phaseout for Industrialized Nations with a Provision for “Critical Use Exemptions”

Critical Use Exemption

- Montreal Protocol, Article 2H (5) -- Provides that the 2005 phaseout shall not apply “to the extent the Parties decides to permit the level of production or consumption that is necessary to satisfy uses agreed by them to be critical uses”.

Critical Use Exemption

- Clean Air Act (as amended in 1997) -- "to the extent consistent with the Montreal Protocol," the Administrator may exempt methyl bromide for critical uses.
Critical Use Exemption -- Criteria

Criteria for determining critical use exemptions were made as decisions by the Parties to the Montreal Protocol, Decision IX/6 at the 9th MOP (November 1997) and Decisions Ex.1/3 and Ex.1/4 at the first Extraordinary Meeting of the Parties (March 1994)
Montreal Protocol Decision:
MOP IX/6

Review Based on:

- There are no technically and economically feasible alternatives or substitutes available to the use that are acceptable from the standpoint of environment and health and are suitable to the crops and circumstances of the nomination; and,

  1. All technically and feasible steps have been taken to minimize the use and emissions of Mebr,
  2. Mebr is not available in sufficient quantity from existing stocks of banked or recycled Mebr, and
  3. An appropriate effort is in place to evaluate, commercialize and secure national regulatory approval of alternatives and substitutes.
Montreal Protocol Decision: Ex. 1/3

- Set the Allowable Amounts for Production or Consumption in 2005
  - Annex II A – List of Approved Critical Uses for Each Party
  - Annex II B – Level of Production and Consumption for Parties with Critical Use Exemptions
Provided for additional Mebr beyond that approved for production or consumption (difference drawn from existing stocks).

Limited use for approved critical uses to the total amount approved in aggregate for critical uses by each party.

Required the Parties to endeavor to allocate Mebr for crops as designated in Annex II A for critical uses.

Required report to the Parties of the method used to ensure conditions of granting the CUE are followed.
Critical Use Exemption -- Application Process

- No Specific Guidance
- Each Party Devised Their Individual Process
- US Lead Agency – EPA, Office of Air and Radiation
- Cooperated with EPA OPP
U. S. Application Process

- EPA Information Request – Requires OMB Approval

- Several Meetings with Stakeholders in 2000 & 2001

First Round of U. S. Applications: 2002

- Total of 54 Applications
- Much Variability in Information Provided
- Florida Petitions
  - Tomato
  - Strawberry
  - Solanaceous Crops Other than Tomato (Pepper & Eggplant)
Application Review Timeline – First Round

- Sept 10, 2002 -- Completed Application submitted to EPA, OAR
- Feb 2003 – US Nomination to UNEP
- April 2003 – MBTOC Review
- June 2003 – UNEP review of MBTOC/TEAP Recommendation
- November 2003 – Consideration of Recommendations by the meeting of the Parties
- February 2004 – Additional review and recommendations from MBTOC
- March 2004 – First Extraordinary Meeting of the Parties

- Requested Exemption for 2005 and 2006
- Requested Lump Sum Exemption for 9,921 tonnes (3,783 ODP tonnes)

- Covered 16 Industry Sectors, Including:
  - Commodity Storage
  - Cucurbits
  - Eggplant
  - Food Processing
  - Forest Tree Seedling Nursery
  - Ginger
  - Nursery Seedbed Trays
  - Orchard Nursery
  - Orchard Replant
  - Ornamental Nursery
  - Pepper
  - Strawberry
  - Strawberry Nursery
  - Sweet Potato
  - Tomato
  - Sweet Potato

- Represented 38% of 1991 Baseline
Second Round of U. S. Applications: 2003

- Included New Applications for 2005 CUE
- New Formats – Additional Information
- FFVA Petition – consolidated into a single petition across the same commodities
Application Review Timeline – Second Round

- August 8, 2003 – Completed Application submitted to EPA, OAR
- Feb 2004 – US Nomination to UNEP
- April 2004 – MBTOC Review
- July 2004 – UNEP review of MBTOC/TEAP Recommendations
- November 2004 – Consideration of Recommendations by the Meeting of the Parties (Approval of 2005 Supplemental Request)
- April 2005 – Additional review and recommendations from MBTOC on Sectors to be considered at Second Extraordinary Meeting of the Parties
- June 2005 – Second Extraordinary Meeting of the Parties

- Requested Exemption for 2006 and Supplemental Information on 2005 CUE Needs
- 2005 Supplemental Request – 610.665 tonnes

Commodities:

- Dry Commodities – Structures
- Dry Commodities – Processed Food
- Dried Fruits and Nuts
- Eggplant
- Ornamentals
- Peppers
- Tomato
- Smokehouse Ham
- Strawberry – Field
Montreal Protocol Review

- No Concrete Guidelines for Review Process
- In-house Closed Review Process
- Administered by UNEP through MBTOC and TEAP
- Pressure Created by Impossible Timelines
- Review Recommendations Considered for Final Approval (Consensus) at Meetings of the Parties
<table>
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<tr>
<th>Date</th>
<th>Organization</th>
<th>Country</th>
<th>Status</th>
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<td>MBTOC</td>
<td>South Africa</td>
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<td>5/03</td>
<td>MBTOC/TEAP</td>
<td>Great Britain</td>
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<tr>
<td>11/04</td>
<td>MOP</td>
<td>Czech Republic</td>
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</table>
Key Decisions

- Decision Ex.1/3: Sets initial Quantity for 2005 US CUE, Total CUE 35% of 1991 Baseline
  - 30% 1991 Baseline, Approved for Production and Consumption
  - 5% 1991 Baseline, Approved for CUE use from Available Stocks

- Decision XVI/2: Sets Supplemental Amounts for 2005 CUE, Additional 2%.
U. S. Clean Air Act, Allocation Process

- International Decisions Required Prior to Adoption of Final Rule

- Two Parts:
  1. Process Framework for Administration
  2. Quantities to be Exempted have to be identified
Rule Making Process

- Very Complex
- Constrained by International Scheduling
- Additional Pressure Created by Political Situation

- Very Prescriptive
- Huge Fines
- Complex Self-certification Process
- No Definite Identification of “Approved Critical User”
- Penalized CUE Petitioners in Regard to use of Existing Stocks
Federal Register Notice – Final Rule, December 23, 2004

- Became Effective January 1, 2005
- Sets 2005 CUE Control Period, Jan 1 – Dec 31, 2005
- Provides Criteria for Identification of “Approved Critical User”
- Identifies Quantities and Distribution of Critical Use Allowances
- Identifies Entities with Critical Stocks Allowance
- Provides for Record Keeping and Reporting to Meet the Requirements of the Montreal Protocol and the Clean Air Act.
Implementation

- Growers Have Responsibility to Certify Prior Purchase of Mebr or Contract for Application Services for Mebr, that they are an “Approved Critical User”.

- Criteria for Meeting Conditions is “reasonable expectation” that Conditions will exist without use of Mebr”

- Conditions of Use for Specific Industry Sectors are Defined in Appendix L to Subpart A of 40 CFR, Part 82.

- Creates a Record Keeping Burden on Distributors, Dealer, and Custom Applicators.
Issues

- Pre-purchased Materials or Services
- Tracking of Critical Use Allocations Through the Control Period
- Lag Time at the End of the Control Period
- Existing Stocks
NRDC Rule Challenge

- Requested Administrative Stay of Rule on Dec 23, 2004

- At the Same Time Filed a Request for Judicial Review with the U. S. Court of Appeals for the District of Columbia.

- Filed an Emergency Motion for Stay Pending Review and Expedited Consideration on Jan 24, 2005.
NRDC Rule Challenge

- Allegations:
  - EPA Unlawfully Allows Existing Stocks to be Used for Non-critical Uses.
  - EPA Is Unlawfully Allowing Production or Importation of New Methyl Bromide in 2005.

- Requested Actions:
  - Stay the Rule to the Extent it Allows Existing Stocks to be Used for Non-critical Uses.
  - Stay any Production of Methyl Bromide Pending Review of the Rule.
What Does the Future Hold?

- More Uncertainty
- Hearing Scheduled by the House Ag Committee on Critical Use Exemption Process, March 10, 2005
- Contentious Debate over the 2006 and 2007 CUE at the International Level.
- More Work for Everybody
Methyl Bromide Transition
Competitive Grants Program

Dennis D. Kopp
USDA/CSREES

Raleigh, NC
February 25, 2005
Sequences

- 1994-2001 - Problem and MB ban denial. Hope for a “political” solution and research focused on “saving” MB
- 2000 - Methyl Bromide Transition Program
- Future research needs to evolve focus on relevant, applicable and sustainable alternatives
USDA Programs supporting MB Research & Extension Work

• Agricultural Research Service Field Stations across the country

• Competitive funds:
  – Methyl Bromide Transitions – Integrated Res.
  – IR-4 Methyl Bromide Research grants
  – Organic Transitions Programs
  – SARE Farmer Grants
  – EQUIP grants
USDA Methyl Bromide Transitions
Competitive Grant Res. Program

• Initiated in 2000 as one of 5 new “Integrated Pest Management Research” Programs
• The intent is to enable the United States to comply with the Montreal Protocol.
• Funding is allocated through a Competitive research grant program called Methyl Bromide Transitions
Goals of MBT Program

• Discover, develop, and demonstrate Methyl Bromide alternatives
• Develop integrated research, education, and/or extension programming
• Develop tools and data to aid rapid, well-informed regulatory decisions
• Develop economic assessments for impact data for use in Critical Use Exemptions and the costs/benefits of transitions
MBT Competitive Funding Supports ~~~

- Short- to intermediate-term Projects
- Approaches should lead to more sustainable systems
- Research supporting CUE data gaps
- Relevant programs and activities in:
  - research, education, and extension
  - field trials and/or demonstration projects of MB alternatives
USDA Methyl Bromide Transitions
Competitive Grant Res. Program

• Since 2000, USDA/CSREES has funded a total of 32 research projects
• Funding level at nearly 3 million dollars a year (= ca. $14 M since 2000)
• MBT has cultivated new working partnership between the USDA, agricultural colleges and universities, commodity groups, the regulatory community and farmers.
FY 2004 MBT Grant Awards

• In FY 2004 MBT program funded the 8 top-ranked projects of the 28 submitted proposals
• These 8 projects provided research resources for 26 additional scientists and extension educators at 15 research facilities in 9 states
• These 8 projects contributed to the training of the next generation of agricultural scientist involving:
  – 30+ agricultural technicians
  – 25+ graduate students
  ~ working to solve complex real-world problems
Impacts and Outcomes

The MBT Program has ~~~~

- Contributed to an appreciable reductions in MB usage
- Reduced MB usage = reduced risk to the ozone layer
- Demonstrated innovative and viable alternatives in certain MB dependent production systems
- Protected American farmer’s income by maintaining international competitiveness
- Contributed positively to the U.S. balance of trade
- Helped maintain low consumer supermarket prices on fresh fruits and vegetables
Impacts and Outcomes
The MBT Program has ~~~~

• Contributed to the L-G University Mission by meaningfully engaging the talents of research scientists and extension educators on relevant applied agricultural issue.

• Contributed to the education and graduate training of the next generation of agricultural scientist and technicians through solving real-world problems
Where to Next?

• Soil pest were a production problem before MB was used as a pesticide
• MB usage will end in the near future
• We need to realignment shrinking research resources to problem areas
• Changing focus from pesticide to pest
• How about: “Soil Pest Management in Specialty Crop Production” ????
Single tactic control of a single pathogen in a mono-cultured crop

Multiple crops over time and space to foster high biodiversity, multi-pest suppression, and vigorous plant health
Can we implement a compost-based production system as an alternative to methyl bromide fumigation?

John Vollmer
• on farm research
• organic transition

Michelle Grabowski
MS student
Treatments

Compost
Methyl Bromide
Telone C35
Unfumigated Control

- Plots (4 beds 40 ft long)
- Data collection inner 20 ft of inner 2 beds
- Latin Sq. design
- Same location for 3 consecutive years (i.e. no crop rotation)
- Fall plant. Harvest = April - June
Controlled Microbial Compost

- Management intensive system
- Compost pile monitored and adjusted daily for temperature, moisture and CO2 content

Recipe: 30% Dairy manure
30% Waste Hay
30% Waste Silage
5% Finished compost
5% Clay soil
Legume-Grass Cover Crop

Year 1: 30 yd$^3$/acre
Year 2: 20 yd$^3$/acre
Year 3+: 15-20 yd$^3$/acre
**Marketable Yield**

- **Control**
- **Methyl Bromide**
- **Compost**
- **Telone C-35**

* Indicates yield is significantly different than MB

- Year 1: Control 80, Methyl Bromide 93, Compost 65, Telone C-35 NA
- Year 2: Control 65, Methyl Bromide 101, Compost 104, Telone C-35
- Year 3: Control 66, Methyl Bromide 90, Compost 104, Telone C-35
Microbial ecology

Objective:

• To characterize the population dynamics of pathogens and biocontrol agents in roots and soil from both the transplant and field production systems.

• To research biological methods and processes to enhance disease management.
Pathogens to Control

- Isolated and characterized over 1200 fungi
  (G. Abad; F. Louws; L. Ferguson; G. Fernandez)
  - Fungal complex varies with crop production site
  - Clean plants are difficult to obtain

- Rhizoctonia fragariae: AG-G, AG-A, AG-I
- Pythium irregulare, Pythium spinosum, Pythium artotrogus, Pythium HS
- Fusarium solani and Fusarium oxysporum
- Described new Phytophthora species
Why do growers fumigate?

Healthy                           Black Root Rot Complex
Can we get specific suppression

Fungal isolation frequency (%) from roots of 4-week-old plug transplants for each treatment.

<table>
<thead>
<tr>
<th>Fungal genus/species</th>
<th>Diseased Roots</th>
<th>Healthy Roots</th>
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<tbody>
<tr>
<td></td>
<td>Control (n=19)</td>
<td>T22 (n=10)</td>
</tr>
<tr>
<td><em>Trichoderma</em></td>
<td>36.8</td>
<td>70.0</td>
</tr>
<tr>
<td><em>P. irregulare</em></td>
<td>21.6</td>
<td>0.0</td>
</tr>
<tr>
<td><em>Phytoph. cactorum</em></td>
<td>36.8</td>
<td>30.0</td>
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</table>

T22 = *Trichoderma harzianum*; T382 = *T. hamatum*
Effects of *Trichoderma* biocontrols on root health and growth of 4-week-old plug transplants.
Can we bias the soil community to favor T382 populations?

Population of *T. hamatum* in field soil. Compost was inoculated with T382 and incorporated into field soil after two weeks.
**RESEARCH COMPONENTS**

- Disease suppression
- Plant growth promotion
- Good Yields

- Cover crops
- Compost

- Biologicals
- Knowledge of pathogens
- (Biased) Soil community
EXTENSION & IMPLEMENTATION COMPONENTS

- Disease suppression
- Plant growth promotion
- Good Yields
- Weed suppression
- Nutrient cycling/CEC

Farming system

- Cover crops
- Compost
- Certified plants
- Crop rotation
- Nutrient mgmt
- Certified organic

Ecological function

- Biologicals
- Knowledge of pathogens
- Soil community
- Crop diversity

Biodiversity