Stale seed bed technique and leguminous cover crops as tools in integrated weed management of irrigated cotton of southern India

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India is the only country in the world growing cotton of all staples

We are World No.2 in Production (351 lakh bales)

But our productivity is very less (526 kg/ha)

We have achieved 12.5 fold enhancement from 28 lakh bales in 1947-48 to 351 lakhs bales in 2016-17

Our demand is 475 lakhs bales in 2020 and we can achieve this by adoption of improved crop cultivars and production technologies
Weeds of cotton

- About 100 weed species were reported as associated with cotton

- only a dozen of them are responsible for significant yield losses.
Weed management in cotton

- First 60 DAS more critical
- Up to 85% yield reduction was reported
- Cultural, mechanical and chemical methods
- Chemical control – predominant - globally
  Worldwide, herbicides outrank insecticides and fungicides
- Present recommendation of pre emergence herbicide (pendimethalin) application followed by two or three inter cultivation is a common practice in INDIA
- However, providing timely weed control may not be possible as inter-row cultivation is weather dependent,
Herbicidal weed management

- P trimethalin, metolachlor, fluometuron, etc., as pre emergence spray.

- For post emergence application, fluazifop butyl, quizalofop ethyl, fenoxoprop (for grasses)

- Pyrithiobac sodium can be applied as pre and post emergence

- P trimethalin – HW – mixture of pyrithiobac + Quizalofop/fenoxoprop (Nalayini et al., 2012)
Benefits and concern of HTGM crops in chemical weed management

- Encourage the farmers to go for reduced or no tillage cultivation
- Flexibility in application
- Eliminate the use of some of the environmentally suspect herbicides
- Lesser cost of weed control
- Lesser herbicide carryover problems

Major concern: Escape of Transgenomes and development of super weeds
Concern with HTGM ...

- Gene flow from herbicide resistant crops to wild or semidomesticated relatives can lead to the creation of superweeds

The weed relatives of Cotton are

- *Gossypium tomentosum* (Hawaii)
- *Gossypium stocksii* (India)
Cotton, Hoke County, North Carolina
Glyphosate-resistant Palmer amaranth

Courtesy: Cotton Incorporated
As of today, 482 unique cases of HR weeds (146 dicots and 106 monocots) have evolved resistance.
Number of Herbicide-Resistant Species by Crop

Crop or Situation

- Wheat: 73
- Corn (maize): 61
- Rice: 51
- Soybean: 47
- Roadsides: 32
- Winter wheat: 32
- Spring Barley: 30
- Orchards: 27
- Canola: 21
- Cotton: 18
- Pastures: 18
- Railways: 15
- Vegetables: 14
- Peas: 13
- Grapes: 11

Source: Dr. Ian Heap, WeedScience.org 2016
Significance of IWM

- **Over reliance on fewer weed management strategy will result in evolution of herbicide resistance to the useful herbicides**

- **Once weeds develop resistance, replacement of herbicides is the only option in such a scenario.**
To preserve the utility of herbicides in agriculture ...

Active resistant management is essential. Which could be achieved through

- Herbicide rotation
- Mixing herbicides with different mode of action
- Combining nonchemical methods like solarization, mulching etc.,
- Stale seed bed method
- Mechanical removal
- Growing compatible intercrops
- Combination of all the above where ever possible
Objectives

• To exhaust weed seed bank before cotton sowing by stale seed bed technique
• To smother weeds by leguminous cover crops
• To integrate SSBT and leguminous cover crops as tools in IWM of Irrigated cotton and
• To standardize sustainable weed management package for irrigated cotton production system
What is stale seed bed technique?

• Preparing land one month in advance of cotton sowing and irrigating to induce weed seeds to germinate and targeting them after two weeks with pendimethalin + glyphosate each 1.0 kg/ha and sowing of cotton after two weeks of spraying is an efficient technique to exhaust weed seed bank and thereby reducing the weed pressure during actual cotton growth.
Treatments

Design : RBD                                     Replication : 4

1. SSBT  followed by Thornless mimosa (Mimosa invisa) + 1 Hw
2. SSBT  followed by   Sun hemp (Crotalaria juncea) 1Hw
3. SSBT  followed by   Daincha (Sesbania aculeata) + 1Hw
4. SSBT  followed by   Forage Cowpea (Vigna unguiculata) + 1Hw
5. SSBT  followed by   Desmanthus (Desmanthus virgatus) + 1 Hw
6. No SSBT (pendimethalin 1.0 kg ai as Pre emergence)+ Hw (twice)
Exhausting weed seed bank under Stale seed bed technique
SSBT  *Vigna unguiculata* as cover crop

Weeds were converted into organics by SSBT
Weed free cotton under SSBT and Sesbania aculeata as in situ cover crop
Comparing SSBT with cover crops against pre-emergence pendimethalin

SSBT and cover crop

Pendimethalin treated (no ssbt and nocover crop)
Crotalaria juncea as cover crops
Sesbania as cover crop
Mimosa invisa as covercrop
Vigna unguiculata as cover crop
Cover crop removed and applied
Nodule formation at harvest of cover crops
Weed count on 30 DAS as influenced by SSBT and Cover crops

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Weed count/ m² on 30 DAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. SSBT followed by <em>Mimosa invisa</em> + HW</td>
<td>67.25</td>
</tr>
<tr>
<td>2. SSBT followed by <em>Crotalaria juncea</em> + HW</td>
<td>63</td>
</tr>
<tr>
<td>3. SSBT followed by <em>Sesbania aculeata</em> + HW</td>
<td>46.75</td>
</tr>
<tr>
<td>4. SSBT followed by <em>Vigna unguiculata</em> + HW</td>
<td>49.75</td>
</tr>
<tr>
<td>5. SSBT followed by <em>Desmanthus virgatus</em> + HW</td>
<td>74</td>
</tr>
<tr>
<td>6. pendimethalin 1.0 kg as pre emergence + HW (Twice)</td>
<td>198.7</td>
</tr>
<tr>
<td>SED</td>
<td>17.51</td>
</tr>
<tr>
<td>CD (p=0.05%)</td>
<td>37.33 **</td>
</tr>
</tbody>
</table>
Weed count on 80 DAS as influenced by SSBT and Cover crops

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Weed count/ m² on 80 DAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. SSBT followed by <em>Mimosa invisa</em> + HW</td>
<td>174 (13.02)</td>
</tr>
<tr>
<td>2. SSBT followed by <em>Crotalaria juncea</em> + HW</td>
<td>182 (13.54)</td>
</tr>
<tr>
<td>3. SSBT followed by <em>Sesbania aculeata</em> + HW</td>
<td>171 (12.68)</td>
</tr>
<tr>
<td>4. SSBT followed by <em>Vigna unguiculata</em> + HW</td>
<td>158 (12.22)</td>
</tr>
<tr>
<td>5. SSBT followed by <em>Desmanthus virgatus</em> + HW</td>
<td>220 (14.7)</td>
</tr>
<tr>
<td>6. (pendimethalin 1.0 kg) as pre emergence + HW (Twice)</td>
<td>312 (19.10)</td>
</tr>
<tr>
<td>SED</td>
<td>1.364</td>
</tr>
<tr>
<td>CD (p=0.05%)</td>
<td>2.908 **</td>
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Yield attributes and Seed cotton yield as influenced by SSBT and Cover crops

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Bolls/plant</th>
<th>Boll wt (g/boll)</th>
<th>SCY (kgs/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. SSBT followed by <em>Mimosa invisa</em> + HW</td>
<td>28</td>
<td>6.15</td>
<td>2147</td>
</tr>
<tr>
<td>2. SSBT followed by <em>Crotalaria juncea</em> + HW</td>
<td>33.4</td>
<td>6.08</td>
<td>2368</td>
</tr>
<tr>
<td>3. SSBT followed by <em>Sesbania aculeata</em> + HW</td>
<td>24.8</td>
<td>6.28</td>
<td>2112</td>
</tr>
<tr>
<td>4. SSBT followed by <em>Vigna unguiculata</em> + HW</td>
<td>34</td>
<td>6.03</td>
<td>2494</td>
</tr>
<tr>
<td>5. SSBT followed by <em>Desmanthus virgatus</em> + HW</td>
<td>28.2</td>
<td>5.92</td>
<td>2275</td>
</tr>
<tr>
<td>6. Pendimethalin 1.0 kg pre emergence + HW</td>
<td>24.9</td>
<td>5.82</td>
<td>2016</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>SED</th>
<th>CD (p=0.05%)</th>
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<tbody>
<tr>
<td></td>
<td>1.635</td>
<td>3.49</td>
<td>105.36</td>
</tr>
<tr>
<td></td>
<td>0.17</td>
<td>NS</td>
<td>226.58</td>
</tr>
</tbody>
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Conclusion

- SSBT technique and application of pendimethalin and glyphosate each at 1.0 kg ai/ha is effective in exhausting weed seed bank in irrigated cotton.
- Growing of leguminous cover crops to smother weeds is the most sustainable method to manage weeds.
- Combination of SSBT with application of pendimethalin and glyphosate each at 1.0 kg ai/ha with leguminous cover crops like Vigna unguiculata / Crotalaria juncea is recommended as effective tools in IWM of irrigated cotton.
PPFM shall be useful for developing microbial consortia exclusively for sulfur and P nutrition. Besides, these bacteria have the ability to produce plant growth substances and N-fixation.