ECOFRIENDLY MANAGEMENT OF LEAF CURL DISEASE OF CHILLI THROUGH BOTANICAL BIO-PESTICIDES

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Abstract

Chilli (Capsicum annuum L.) is an important spice crop grown all over the world. The importance of chilli leaf curl, a viral disease has been recognized for many years, wherever chilli crop is grown. An experiment was designed to evaluate the efficacy of a few botanical pesticides against leaf curl viral disease in chilli. Minimum disease incidence (34.63-37.88%) was recorded in plots, which received seedlings treated with Clerdendrum aculeatum (leaf extract) followed by three foliar sprays of Terminalia arjuna (bark extract). Whereas, seedling treatment with Clerdendrum aculeatum (leaf extract) followed by three foliar sprays of Terminalia arjuna (bark extract) were observed maximum per cent disease control (60.72-57.70%) along with fresh fruit yield (2.35-2.07 kg plot⁻¹) and an increase in fresh fruit yield (58.75-58.24%). Maximum plant height (55.83-55.19 cm), maximum plant canopy (72.31-67.55 cm), days of 50 per cent flowering (85.04-85.79DAT), maximum fruit weight (2.31-2.23g), maximum total number of fruit plant⁻¹ (72.29-70.63) and maximum number of seed fruit⁻¹ (58.35-57.70).

Key words: Ecofriendly, antiviral agents, leaf curl disease, chilli.

Introduction

Chilli (Capsicum annuum L.) is an important spice crop cultivated in many countries throughout the world. India produces approximately 12.60 thousand metric tons from an area of 792.1 thousand hectares (Annon., 2012-13). Uttar Pradesh occupies an area of 13.47 thousand hectares with production of 10.30 metric tons (Annon., 2012-13). India is rich in diversity of chilli varieties with different nutritional quality. Besides traditional use of chilli such as vegetables, spices, condiments, sauces and pickles; it is being used in pharmaceutics, cosmetics and beverages (Tiwari et al., 2005). The average productivity of chilli is very low in India comparison to other countries because the crop is infested with many insects and diseases. It is because most of chilli verities are susceptible to various pathogens; which cause heavy yield losses. Viruses are considered as one of the important limiting factor (Villalon, 1981). Among them, chilli leaf curl virus (Geminivirus) is most destructive viral pathogen in many parts of India, which is affecting chilli cultivation in terms of incidence and yield loss (Khan et al., 2006). Thus, the farmers are protecting such a high value crop from diseases with the use of huge amount of pesticides, which results in resurgence of the pests, phytotoxicity on fruits, human health hazards, destruction of beneficial microorganisms and environmental pollution. The recent emphasis is on the development of non-chemical / ecofriendly method for the management of this disease, which has provided impetus to more extensive exploration of natural resources and to identity effective plant extracts/botanical bio-pesticides for the managements of chilli leaf curl virus by reducing vector population in the field.

Materials and Methods

The experiment was conducted at Student’s Instructional Farm, N. D. University of Agriculture and Technology, Kumarganj, Faizabad. Seeds were collected from the Department of Vegetable Science, N.D. University of Agriculture and Technology, Kumarganj, Faizabad. The experiment was conducted during two consecutive years (2014 and 2015) consisting of 13 treatment combinations viz $T_1$: root treatment with Tinospora cordifolia (aerial stem extract) @ 10%, $T_2$: root treatment with Terminalia arjuna (bark extract) @ 10%, $T_3$: root treatment with Clerdendrum aculeatum (leaf extract) @ 10%, $T_4$: Three foliar sprays of Tinospora cordifolia (aerial stem extract) @ 10%,
**Disease management**

Data presented in tables 1 & 2 revealed significant effect of all the treatments on the management of chilli leaf curl virus. The disease symptoms could not be seen upto 15 days following transplanting in any treatment. After 30 days of transplanting, disease incidence recorded was lowest in seedling root treatment with *Clerendrum aculeatum* + three foliar spray of *Terminalia arjuna* and highest in seedling root treatment with *Terminalia arjuna* (5.70%) in comparison to controls (7.03%). After 45 and 60 days of transplanting, the disease incidence was rapidly increased in all the treatments resulting 75.89 per cent and 94.05 per cent severity in control, respectively. The maximum disease control was observed in root treatment with *Clerendrum aculeatum* + three foliar sprays of *Terminalia arjuna* 79.35%, 58.22% and 63.18% at 30, 45, and 60 DAT, Whereas, minimum disease control was recorded in seedling root treatment with *Terminalia arjuna* at 30 DAT (18.70%), 45 DAT (21.49%) and 60 DAT (13.53%) in 2014. Similar trends of treatments on disease management was also recorded in the crop season 2015. The effects of plant extracts/ botanical bio-pesticides were highest at early growth stage, thus the increasing trends of plant infection were observed over the time. The findings were supported with Bediako *et al.* (2014) and Bhyan *et al.* (2007).

The foliar treatments were recorded highly effective for reducing the leaf curl disease in compression to seedling root treatments in all the experimental years. The ability of foliar treatments was found increased when roots of seedling were treated with different plant extracts. The highest effect was observed in leaf extract of *Clerendrum aculeatum* followed by aerial stem extract *Tinospora cordifolia* and bark extract of *Terminalia arjuna*. The *Clerendrum aculeatum* leaf extract was found effective in reducing the leaf curl incidence and white fly population at early stage of crop upto 45 DAT. This is due to induce systemic resistance to delay the viral multiplication and symptoms expression.
Table 1: Effect of different plant parts extracts (bio-pesticides) on per cent disease incidence of chilli leaf curl virus during 2014 and 2015.

<table>
<thead>
<tr>
<th>S. no.</th>
<th>Treatments</th>
<th>Per cent disease incidence</th>
<th>Per cent disease control</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>15 DAT</td>
<td>30 DAT</td>
</tr>
<tr>
<td>1.</td>
<td>T&lt;sub&gt;1&lt;/sub&gt;- Root treatment with <em>Tinospora cordifolia</em> (aerial stem extract) @ 10%</td>
<td>0.00</td>
<td>5.30(13.30)</td>
</tr>
<tr>
<td>2.</td>
<td>T&lt;sub&gt;2&lt;/sub&gt;- Root treatment with <em>Terminalia arjuna</em> (bark extract) @ 10%</td>
<td>0.00</td>
<td>5.70(13.81)</td>
</tr>
<tr>
<td>3.</td>
<td>T&lt;sub&gt;3&lt;/sub&gt;- Root treatment with <em>Clerodendrum aculeatum</em> (leaf extract) @ 10%</td>
<td>0.00</td>
<td>4.93(12.83)</td>
</tr>
<tr>
<td>4.</td>
<td>T&lt;sub&gt;4&lt;/sub&gt;- Three foliar sprays of <em>Tinospora cordifolia</em> (aerial stem extract) @ 10%</td>
<td>0.00</td>
<td>3.80(11.24)</td>
</tr>
<tr>
<td>5.</td>
<td>T&lt;sub&gt;5&lt;/sub&gt;- Three foliar sprays of <em>Terminalia arjuna</em> (bark extract) @ 10%</td>
<td>0.00</td>
<td>5.13(12.54)</td>
</tr>
<tr>
<td>6.</td>
<td>T&lt;sub&gt;6&lt;/sub&gt;- Three foliar sprays of <em>Clerodendrum aculeatum</em> (leaf extract) @ 10%</td>
<td>0.00</td>
<td>3.73(11.13)</td>
</tr>
<tr>
<td>7.</td>
<td>T&lt;sub&gt;7&lt;/sub&gt;- Six foliar sprays of <em>Tinospora cordifolia</em> (aerial stem extract) @ 10%</td>
<td>0.00</td>
<td>3.27(10.42)</td>
</tr>
<tr>
<td>8.</td>
<td>T&lt;sub&gt;8&lt;/sub&gt;- Six foliar sprays of <em>Terminalia arjuna</em> (bark extract) @ 10%</td>
<td>0.00</td>
<td>3.33(10.52)</td>
</tr>
<tr>
<td>9.</td>
<td>T&lt;sub&gt;9&lt;/sub&gt;- Six foliar sprays of <em>Clerodendrum aculeatum</em> (leaf extract) @ 10%</td>
<td>0.00</td>
<td>2.67(9.40)</td>
</tr>
<tr>
<td>10.</td>
<td>T&lt;sub&gt;10&lt;/sub&gt;- T&lt;sub&gt;4&lt;/sub&gt; + T&lt;sub&gt;7&lt;/sub&gt;</td>
<td>0.00</td>
<td>2.07(8.27)</td>
</tr>
<tr>
<td>11.</td>
<td>T&lt;sub&gt;11&lt;/sub&gt;- T&lt;sub&gt;2&lt;/sub&gt; + T&lt;sub&gt;6&lt;/sub&gt;</td>
<td>0.00</td>
<td>2.60(9.28)</td>
</tr>
<tr>
<td>12.</td>
<td>T&lt;sub&gt;12&lt;/sub&gt;- T&lt;sub&gt;3&lt;/sub&gt; + T&lt;sub&gt;5&lt;/sub&gt;</td>
<td>0.00</td>
<td>1.60(7.25)</td>
</tr>
<tr>
<td>13.</td>
<td>T&lt;sub&gt;13&lt;/sub&gt;- Control (Untreated)</td>
<td>0.00</td>
<td>7.03(15.38)</td>
</tr>
<tr>
<td></td>
<td>SEm±</td>
<td>(0.244)</td>
<td>(0.278)</td>
</tr>
<tr>
<td></td>
<td>CD at (P=0.05)</td>
<td>(0.734)</td>
<td>(0.836)</td>
</tr>
</tbody>
</table>

*Figures in parenthesis are angular transformed value.
Table 2: Effect of different plant parts extracts (bio-pesticides) on percent disease incidence of chilli leaf curl virus during 2014 and 2015.

<table>
<thead>
<tr>
<th>S. no.</th>
<th>Treatments</th>
<th>Per cent disease incidence</th>
<th>Per cent disease control</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>15 DAT</td>
<td>30 DAT</td>
</tr>
<tr>
<td>1.</td>
<td>T&lt;sub&gt;1&lt;/sub&gt; - Root treatment with <em>Tinospora cordifolfoia</em> (aerial stem extract) @ 10%</td>
<td>0.00</td>
<td>6.27(14.50)</td>
</tr>
<tr>
<td>2.</td>
<td>T&lt;sub&gt;2&lt;/sub&gt; - Root treatment with <em>Terminalia arjuna</em> (bark extract) @ 10%</td>
<td>0.00</td>
<td>6.80(15.11)</td>
</tr>
<tr>
<td>3.</td>
<td>T&lt;sub&gt;3&lt;/sub&gt; - Root treatment with <em>Clerodendrum aculeatum</em> (leaf extract)</td>
<td>0.00</td>
<td>5.20(13.18)</td>
</tr>
<tr>
<td>4.</td>
<td>T&lt;sub&gt;4&lt;/sub&gt; - Three foliar sprays of <em>Tinospora cordifolfoia</em> (aerial stem extract) @ 10%</td>
<td>0.00</td>
<td>4.60(12.38)</td>
</tr>
<tr>
<td>5.</td>
<td>T&lt;sub&gt;5&lt;/sub&gt; - Three foliar sprays of <em>Terminalia arjuna</em> (bark extract) @ 10%</td>
<td>0.00</td>
<td>6.20(14.41)</td>
</tr>
<tr>
<td>6.</td>
<td>T&lt;sub&gt;6&lt;/sub&gt; - Three foliar sprays of <em>Clerodendrum aculeatum</em> (leaf extract) @ 10%</td>
<td>0.00</td>
<td>4.70(12.51)</td>
</tr>
<tr>
<td>7.</td>
<td>T&lt;sub&gt;7&lt;/sub&gt; - Six foliar sprays of <em>Tinospora cordifolfoia</em> (aerial stem extract) @ 10%</td>
<td>0.00</td>
<td>4.20(11.83)</td>
</tr>
<tr>
<td>8.</td>
<td>T&lt;sub&gt;8&lt;/sub&gt; - Six foliar sprays of <em>Terminalia arjuna</em> (bark extract) @ 10%</td>
<td>0.00</td>
<td>4.40(12.11)</td>
</tr>
<tr>
<td>9.</td>
<td>T&lt;sub&gt;9&lt;/sub&gt; - Six foliar sprays of <em>Clerodendrum aculeatum</em> (leaf extract) @ 10%</td>
<td>0.00</td>
<td>3.57(10.89)</td>
</tr>
<tr>
<td>10.</td>
<td>T&lt;sub&gt;10&lt;/sub&gt; - T&lt;sub&gt;1&lt;/sub&gt; + T&lt;sub&gt;7&lt;/sub&gt;</td>
<td>0.00</td>
<td>3.23(10.36)</td>
</tr>
<tr>
<td>11.</td>
<td>T&lt;sub&gt;11&lt;/sub&gt; - T&lt;sub&gt;2&lt;/sub&gt; + T&lt;sub&gt;6&lt;/sub&gt;</td>
<td>0.00</td>
<td>3.70(11.09)</td>
</tr>
<tr>
<td>12.</td>
<td>T&lt;sub&gt;12&lt;/sub&gt; - T&lt;sub&gt;3&lt;/sub&gt; + T&lt;sub&gt;5&lt;/sub&gt;</td>
<td>0.00</td>
<td>1.90(7.92)</td>
</tr>
<tr>
<td>13.</td>
<td>T&lt;sub&gt;13&lt;/sub&gt; - Control (Untreated)</td>
<td>0.00</td>
<td>8.60(17.06)</td>
</tr>
</tbody>
</table>

*Figures in parenthesis are angular transformed value.

**SEM±**

<table>
<thead>
<tr>
<th></th>
<th>(0.137)</th>
<th>(0.172)</th>
<th>(0.294)</th>
<th>(1.07)</th>
<th>(0.197)</th>
<th>(0.319)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CD at (P=0.05)</td>
<td>(0.411)</td>
<td>(0.516)</td>
<td>(0.882)</td>
<td>(3.23)</td>
<td>(0.590)</td>
<td>(0.956)</td>
</tr>
</tbody>
</table>
Table 3: Effect of different plant parts extracts (bio-pesticides) on growth parameters of chilli crop during 2014 and 2015.

<table>
<thead>
<tr>
<th>S. no.</th>
<th>Treatments</th>
<th>Plant height (cm)</th>
<th>Plant canopy (cm)</th>
<th>Days of 50% flowering</th>
<th>Fruit weight (g)/fruit</th>
<th>Total no. of fruit/plant</th>
<th>No. of seed/fruit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>T&lt;sub&gt;1&lt;/sub&gt; - Root treatment with &lt;i&gt;Tinospora cordifolia&lt;/i&gt; (aerial stem extract) @ 10%</td>
<td>43.47</td>
<td>41.85</td>
<td>39.37</td>
<td>37.42</td>
<td>53.32</td>
<td>29.40</td>
</tr>
<tr>
<td></td>
<td></td>
<td>41.10</td>
<td>38.96</td>
<td>37.15</td>
<td>35.53</td>
<td>51.00</td>
<td>27.35</td>
</tr>
<tr>
<td>2.</td>
<td>T&lt;sub&gt;2&lt;/sub&gt; - Root treatment with &lt;i&gt;Terminalia arjuna&lt;/i&gt; (bark extract) @ 10%</td>
<td>43.23</td>
<td>42.63</td>
<td>40.19</td>
<td>39.35</td>
<td>54.33</td>
<td>31.26</td>
</tr>
<tr>
<td>3.</td>
<td>T&lt;sub&gt;3&lt;/sub&gt; - Root treatment with &lt;i&gt;Clerdendrum aculeatum&lt;/i&gt; (leaf extract) @ 10%</td>
<td>48.13</td>
<td>48.18</td>
<td>55.42</td>
<td>53.43</td>
<td>57.82</td>
<td>38.41</td>
</tr>
<tr>
<td></td>
<td></td>
<td>44.23</td>
<td>44.37</td>
<td>52.27</td>
<td>50.30</td>
<td>56.05</td>
<td>35.37</td>
</tr>
<tr>
<td>4.</td>
<td>T&lt;sub&gt;4&lt;/sub&gt; - Three foliar sprays of &lt;i&gt;Tinospora cordifolia&lt;/i&gt; (aerial stem extract) @ 10%</td>
<td>49.7</td>
<td>49.71</td>
<td>58.32</td>
<td>56.35</td>
<td>59.90</td>
<td>40.07</td>
</tr>
<tr>
<td></td>
<td></td>
<td>52.87</td>
<td>53.41</td>
<td>62.37</td>
<td>60.38</td>
<td>63.90</td>
<td>45.02</td>
</tr>
<tr>
<td>5.</td>
<td>T&lt;sub&gt;5&lt;/sub&gt; - Three foliar sprays of &lt;i&gt;Terminalia arjuna&lt;/i&gt; (bark extract) @ 10%</td>
<td>51.03</td>
<td>49.81</td>
<td>60.23</td>
<td>59.64</td>
<td>61.87</td>
<td>42.32</td>
</tr>
<tr>
<td></td>
<td></td>
<td>53.93</td>
<td>53.37</td>
<td>64.18</td>
<td>62.29</td>
<td>66.30</td>
<td>47.07</td>
</tr>
<tr>
<td>6.</td>
<td>T&lt;sub&gt;6&lt;/sub&gt; - Six foliar sprays of &lt;i&gt;Clerdendrum aculeatum&lt;/i&gt; (leaf extract) @ 10%</td>
<td>54.67</td>
<td>53.98</td>
<td>68.23</td>
<td>66.52</td>
<td>70.09</td>
<td>50.64</td>
</tr>
<tr>
<td>7.</td>
<td>T&lt;sub&gt;7&lt;/sub&gt; - Six foliar sprays of &lt;i&gt;Tinospora cordifolia&lt;/i&gt; (aerial stem extract) @ 10%</td>
<td>53.70</td>
<td>53.69</td>
<td>65.49</td>
<td>63.39</td>
<td>68.39</td>
<td>49.01</td>
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<tr>
<td>8.</td>
<td>T&lt;sub&gt;8&lt;/sub&gt; - Six foliar sprays of &lt;i&gt;Terminalia arjuna&lt;/i&gt; (bark extract) @ 10%</td>
<td>55.83</td>
<td>55.19</td>
<td>72.31</td>
<td>67.55</td>
<td>72.29</td>
<td>58.35</td>
</tr>
<tr>
<td>9.</td>
<td>T&lt;sub&gt;9&lt;/sub&gt; - Six foliar sprays of &lt;i&gt;Clerdendrum aculeatum&lt;/i&gt; (leaf extract) @ 10%</td>
<td>38.30</td>
<td>37.67</td>
<td>33.67</td>
<td>30.24</td>
<td>40.35</td>
<td>24.64</td>
</tr>
<tr>
<td>10.</td>
<td>T&lt;sub&gt;10&lt;/sub&gt; - T1 + T7</td>
<td>0.41</td>
<td>0.40</td>
<td>0.48</td>
<td>0.31</td>
<td>0.20</td>
<td>0.33</td>
</tr>
<tr>
<td>11.</td>
<td>T&lt;sub&gt;11&lt;/sub&gt; - T2 + T6</td>
<td>0.31</td>
<td>0.30</td>
<td>0.31</td>
<td>0.30</td>
<td>0.20</td>
<td>0.33</td>
</tr>
<tr>
<td>12.</td>
<td>T&lt;sub&gt;12&lt;/sub&gt; - T3 + T5</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
<td>0.00</td>
<td>0.01</td>
<td>0.33</td>
</tr>
<tr>
<td>13.</td>
<td>T&lt;sub&gt;13&lt;/sub&gt; - Control (Untreated)</td>
<td>1.19</td>
<td>1.16</td>
<td>0.40</td>
<td>0.92</td>
<td>0.88</td>
<td>2.71</td>
</tr>
</tbody>
</table>

SEm± CD at (P=0.05)

<p>| 0.41  | 0.40  | 0.48  | 0.31  | 0.30  | 0.31  | 0.01  | 0.03  | 0.57  | 0.78  | 0.95  | 7.91  |</p>
<table>
<thead>
<tr>
<th>S. no.</th>
<th>Treatments</th>
<th>2014</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Fresh yield (kg/plot)</td>
<td>Per cent increase fresh fruit yield/plant (kg/plot)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>45 DAT</td>
<td>60 DAT</td>
</tr>
<tr>
<td>1.</td>
<td>T&lt;sub&gt;1&lt;/sub&gt;- Root treatment with &lt;i&gt;Tinospora cordifol foia&lt;/i&gt; (aerial stem extract) @ 10%</td>
<td>0.61</td>
<td>0.74</td>
</tr>
<tr>
<td>2.</td>
<td>T&lt;sub&gt;2&lt;/sub&gt;- Root treatment with &lt;i&gt;Terminalia arjuna&lt;/i&gt; (bark extract) @ 10%</td>
<td>0.61</td>
<td>0.74</td>
</tr>
<tr>
<td>3.</td>
<td>T&lt;sub&gt;3&lt;/sub&gt;- Root treatment with &lt;i&gt;Clerodendrum aculeatum&lt;/i&gt; (leaf extract) @ 10%</td>
<td>0.63</td>
<td>0.77</td>
</tr>
<tr>
<td>4.</td>
<td>T&lt;sub&gt;4&lt;/sub&gt;- Three foliar sprays of &lt;i&gt;Tinospora cordifol foia&lt;/i&gt; (aerial stem extract) @ 10%</td>
<td>0.73</td>
<td>0.89</td>
</tr>
<tr>
<td>5.</td>
<td>T&lt;sub&gt;5&lt;/sub&gt;- Three foliar sprays of &lt;i&gt;Terminalia arjuna&lt;/i&gt; (bark extract) @ 10%</td>
<td>0.71</td>
<td>0.87</td>
</tr>
<tr>
<td>6.</td>
<td>T&lt;sub&gt;6&lt;/sub&gt;- Three foliar sprays of &lt;i&gt;Clerodendrum aculeatum&lt;/i&gt; (leaf extract) @ 10%</td>
<td>0.79</td>
<td>0.96</td>
</tr>
<tr>
<td>7.</td>
<td>T&lt;sub&gt;7&lt;/sub&gt;- Six foliar sprays of &lt;i&gt;Tinospora cordifol foia&lt;/i&gt; (aerial stem extract) @ 10%</td>
<td>0.85</td>
<td>1.03</td>
</tr>
<tr>
<td>8.</td>
<td>T&lt;sub&gt;8&lt;/sub&gt;- Six foliar sprays of &lt;i&gt;Terminalia arjuna&lt;/i&gt; (bark extract) @ 10%</td>
<td>0.86</td>
<td>1.05</td>
</tr>
<tr>
<td>9.</td>
<td>T&lt;sub&gt;9&lt;/sub&gt;- Six foliar sprays of &lt;i&gt;Clerodendrum aculeatum&lt;/i&gt; (leaf extract) @ 10%</td>
<td>0.94</td>
<td>1.15</td>
</tr>
<tr>
<td>10.</td>
<td>T&lt;sub&gt;10&lt;/sub&gt;- T&lt;sub&gt;1&lt;/sub&gt; + T&lt;sub&gt;3&lt;/sub&gt;</td>
<td>1.00</td>
<td>1.22</td>
</tr>
<tr>
<td>11.</td>
<td>T&lt;sub&gt;11&lt;/sub&gt;- T&lt;sub&gt;2&lt;/sub&gt; + T&lt;sub&gt;6&lt;/sub&gt;</td>
<td>1.01</td>
<td>1.23</td>
</tr>
<tr>
<td>12.</td>
<td>T&lt;sub&gt;12&lt;/sub&gt;- T&lt;sub&gt;3&lt;/sub&gt; + T&lt;sub&gt;5&lt;/sub&gt;</td>
<td>1.06</td>
<td>1.29</td>
</tr>
<tr>
<td>13.</td>
<td>T&lt;sub&gt;13&lt;/sub&gt;- Control (Untreated)</td>
<td>0.43</td>
<td>0.53</td>
</tr>
</tbody>
</table>

SEm±: - - 0.06 1.60 - - 0.04 1.66
CD at (P=0.05): - - 0.17 4.66 - - 0.12 4.85
reported by Verma and Mukerjee (1975).

References


