Integrated Management of Viral Diseases in Field-Grown Tomatoes in Southern Italy

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Abstract

Tomato spotted wilt virus (TSWV) is a Tospovirus affecting field tomato crops worldwide. The virus is transmitted by some species of thrips. The most damaging vectors in Italy are Frankliniella occidentalis and Thrips tabaci. Only the first instar larvae can acquire the virus from an infected plant. After acquisition, the virus replicates in the vector, and the viruliferous thrips is capable of transmission for the duration of its life. Apart from TSWV, other serious threats for tomato production in Italy are the aphid transmitted Cucumber mosaic virus (CMV) and Potato virus Y (PVY), both with necrotic and non necrotic variants. Epidemics caused by TSWV, PVY and CMV occur regularly in southern Italy, where hundreds of millions of tomato plants are grown commercially every year. Insecticides applied on a calendar basis for insect control are not very effective in preventing these vector-borne viral diseases because the viruses can be transmitted to the plant before insects (thrips and aphids) are killed by insecticides. Field experiments were conducted during summer of 2005 and 2006 in the main tomato growing area of the Basilicata region, Lavello (PZ), to determine the separate and integrated effects of UV-reflective mulch (UVRM), Acibenzolar-S-methyl (Actigard) and insecticides for the management of vectors and diseases on tomato. TSW disease pressure was great during 2005 summer but very low in 2006. Disease incidence was measured as percentages of plants infected with each of the three viruses. Aphid populations were evaluated by counting the number of aphids on sampled tomato shoots on one third of the plants on each plot. Tomato yield was evaluated from one third of the plants on each plot. Statistical analysis (analysis of variance) was performed using the SYSTAT 9 Software. The UVRM alone was effective in reducing disease incidence both for aphids and thrips transmitted viruses. A synergistic effect of Actigard with UVRM was observed against the three viruses. The use of the insecticides resulted in a further reduction in the incidence of the three viral diseases on UVRM, and reduced incidence of diseases caused by CMV and PVY in the black mulch and bare soil plots. The combination of UV-reflective mulch, acibenzolar-S-methyl, and insecticides was the most effective in reducing tomato spotted wilt incidence in tomato. The UV-reflective mulch was very effective in delaying and reducing colonization of aphids and subsequent virus incidence. There was no significant difference in the tomato yield between UVRM and black mulch plots. In contrast, yield was strongly reduced in the bare soil plots.

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INTRODUCTION

Tomato spotted wilt virus (TSWV) is a Tospovirus that adversely affects field tomato crops worldwide. The virus is transmitted exclusively by some species of thrips. The most damaging vectors in Italy are Frankliniella occidentalis and Thrips tabaci. Only the first instar larvae can acquire the virus from an infected plant. After acquisition, the virus replicates in the vector and the viruliferous thrips is capable of transmission for the duration of its life. Apart from TSWV, other serious threats for tomato production in Italy are the aphid transmitted Cucumber mosaic virus (CMV) and Potato virus Y (PVY), both with necrotic and non-necrotic variants. Epidemics caused by TSWV, PVY and CMV occur regularly in southern Italy, where hundreds of millions of tomato plants are grown commercially every year. Insecticides applied on a calendar basis for insect control are not very effective in preventing these vector-borne viral diseases because the viruses can be transmitted to the plant before insecticides kill the insect vectors (thrips and aphids). Therefore, field experiments were conducted during summer of 2005 and 2006 in the main tomato growing area of the Basilicata region, Lavello (PZ), to determine the separate and integrated effects of UV-reflective mulch (UVRM), Acibenzolar-S-methyl (Actigard) and insecticides for the management of vectors and diseases on tomato.

MATERIALS AND METHODS

A randomized complete block experiment with four replications was conducted in the summer of 2005. The same experiment was repeated in 2006 again with four replicates. The tomato crop was produced using typical commercial practices. A split-split-plot treatment arrangement was used to determine the separate and combined effects of each tactic on the efficacy to reduce TSWV, CMV and PVY incidence. Tomato cultivar was ‘ULISSE’. Six-week-old transplants were spaced every 33 cm in raised beds covered with UV reflective mulch (UVRM, treatment A), black plastic mulch (BPM, treatment B) or no mulch (NM, treatment C). Plot size for each split-split plot was 3 twin-rows 5 m long by 5 m. The whole plots were separated by a 1.5 m buffer zone. Insecticide and Acibenzolar-S-methyl treatments are reported in Table 1. TSW disease pressure was great during 2005 summer and very low in 2006. For this reason, only results of the 1st year experiment are reported. Percent disease incidence was determined by visual inspection of each plant in the two middle rows of each plot. A week after disease assessment date, TSW visual symptoms were verified from 5 symptomatic plants/plot using ELISA. The same was done to assess CMV and PVY disease incidence. Aphid populations were evaluated by counting the number of aphids on sampled tomato shoots on one third of the plants in the middle of each plot. Tomato yield was evaluated from one third of the plants on each plot. Statistical analysis (analysis of variance) was performed using the SYSTAT 9 Software.

RESULTS AND DISCUSSION

Evaluation of Aphid Infestations

Three classes of aphid populations were identified: 1) number of aphids = 0 (indicating no infestation) (Fig. 1a); 2) number of aphids < 10 (indicating a delay in aphid colonisation) (Fig. 1b); number of aphids > 10 (aphid colonisation) (Fig. 1c). UVRM determined a strong control of aphid infestations. We suppose that this was due to aphids being disoriented by the UVRM, which prevented the primary infestation of tomato plants and the consequent colonisation of the same. On black mulch, we observed an early infestation of aphids compared with the no mulch treatment, maybe due to the absence of weeds, which could have had a role in the primary diffusion of aphids. On bare ground (treatment C), by contrast, the presence of weeds at the beginning reduced the number of aphids on tomato vegetation (aphids being distributed between tomato and weeds), and subsequently the same weeds represented a reservoir of insects for the secondary infestations. In the UVRM treatment, moreover, no significant differences among the different insecticide and Actigard treatments were detected, meaning that the UVRM was
so effective in controlling aphid infestations that any additional insecticide effects were nullified. In contrast, insecticides used alone or in combination with the Acibenzolar-S-methyl, reduced insect-borne viral diseases when applied to tomatoes grown on BPM or NM.

**Evaluation of TSW Incidence**

The percentage of symptomatic plants on UVRM treatment was significantly lower than on BPM or NM (Fig. 1d), we suppose as a consequence of reduced thrips infestation from the disorientating effect of the UVRM. In all treatments, the use of Actigard with insecticides (in particular *Imidacloprid* and *Lufenuron + Thiamethoxam*) gave good control of viral infection (data not shown), because of a reduced inoculum due to the control of viruliferous insects populations combined with the systemic acquired resistance (SAR) induced by Actigard (Sticher et al., 1997; Görlach et al., 1996). In the BPM and NM treatments, TSW incidence was reduced by the insecticides applied as a drench during transplanting and after the differentiation of the 1st flower truss (treatments a – e; data not shown). These results were confirmed by ELISA performed to verify the percentage of plants infected by TSWV, CMV and PVY.

**Evaluation of Production**

The effect of mulching on tomato production was evaluated. Concerning marketable product, the per plant production in BPM treatment was greater than that obtained by the use of UVRM (Fig. 1e). The lower per plant production in the UVRM treatment compared with the BPM treatment maybe due to the lower soil heating of UVRM compared with the black mulch. However, there was no difference in overall yield per plot between the UVRM and BPM because of the difference in numbers of healthy plants. The still lower production in the NM treatment can be attributed to the greater incidence of disease, the competition between tomato and weeds, which were already present by 30 days after transplanting, the heating effect of mulch on soil, which is favourable to the development of roots, and to the regulation of soil water content (reducing soil evaporation).

**CONCLUSIONS**

The UVRM alone was effective in reducing disease incidence both for aphid and thrips transmitted viruses. The UV-reflective mulch was very effective in delaying and reducing colonization of aphids and thus the subsequent incidence of viral disease. A synergistic effect of Actigard with UVRM was observed against the three viruses. The use of the insecticides resulted in a reduction of disease incidence when used alone or combined with Actigard, especially on BPM and NM, since UVRM was highly effective in controlling aphid infestations. The combination of UVRM, Acibenzolar-S-methyl, and insecticides was the most effective in reducing tomato spotted wilt incidence in field-grown tomato, as previously reported (Momol et al., 2004). There was no significant difference in the tomato yield between UVRM and black mulch plots. In contrast, a strong yield reduction was observed in the bare soil plots.

**Literature Cited**


Table 1. Treatments and dosages of application.

<table>
<thead>
<tr>
<th>Plot</th>
<th>Treatment</th>
<th>Amount of marketable product</th>
<th>Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>Actigard (<em>Acibenzolar S-methyl</em> 50%)</td>
<td>5 g / 100 l H₂O</td>
<td>Spray, I treatment (tr) at transplanting. II-III and IV trs. every 15 days</td>
</tr>
<tr>
<td>b</td>
<td>Admire (<em>Imidacloprid</em>)</td>
<td>2.7 g / 1000 plants as above</td>
<td>Drench before transplanting as above</td>
</tr>
<tr>
<td>c</td>
<td>Actigard + Admire</td>
<td>Actara 400 g / 100 l H₂O and MATCH 200 ml/hl</td>
<td>Actara: drench before transplanting Match: 2 applications 10-12 days after the differentiation of the 1st flower truss as above</td>
</tr>
<tr>
<td>d</td>
<td>Actara (<em>Thiamethoxan</em> 25.00 % p/p) + Match (<em>Lufenuron</em> 5.32 % p/p)</td>
<td>Actara 400 g / 100 l H₂O and MATCH 200 ml/hl</td>
<td>Actara: drench before transplanting Match: 2 applications 10-12 days after the differentiation of the 1st flower truss as above</td>
</tr>
<tr>
<td>e</td>
<td>Actigard + Actara + Match</td>
<td>as above</td>
<td>Calypso: Spray, I tr. soon after transplanting, then every 12 days Success: at the appearance of the thrips infestation</td>
</tr>
<tr>
<td>f</td>
<td>Calypso (<em>Thiacloprid</em> 40.4%) + Success (<em>Spinosad</em> 11.6%)</td>
<td>40 g/hl a.i. 100 ml/hl a.i.</td>
<td>Calypso: Spray, at the appearance of the thrips infestation, then every 12 days Success: at the appearance of the thrips infestation</td>
</tr>
<tr>
<td>g</td>
<td>Calypso (<em>Thiacloprid</em> 40.4%) + Success (<em>Spinosad</em> 11.6%)</td>
<td>40 g/hl a.i. 100 ml/hl a.i.</td>
<td>Calypso: Spray, at the appearance of the aphids infestation, then every 12 days Success: at the appearance of the thrips infestation</td>
</tr>
<tr>
<td>h</td>
<td>None</td>
<td>-</td>
<td>-</td>
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</tbody>
</table>
Figures

Fig. 1. a) percentage of plants with no aphids. F = 56.39; d.f. = 2, 72; p<0.0013;
b) percentage of plants with up to 10 aphids. F = 51.87; d.f. = 2, 72; p<0.001;
c) percentage of plants with more than 10 aphids. F = 3.43; d.f. = 2, 72; p<0.001;
d) percentage of plants with TSW symptoms. F = 4.83; d.f. = 2, 72; p<0.001;
e) Plant production (Kg/plant). F=37.36; d.f. = 2, 71; p<0.001.