Development and testing of an integrated disease management package for multiple diseases of tomato

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ABSTRACT: Tomato crop is severely damaged by four diseases viz., damping off, bacterial blight, Alternaria blight and leaf curl. Integrated disease management (IDM) package was developed comprising of biological, cultural, physical and need based use of chemicals for targeting above four diseases. IDM package was tested for nursery pest management and main field problems after transplanting. One each of open pollinated variety and hybrid as well as two different cropping periods were considered for testing efficacy of IDM package. Detailed result of IDM module in experimental and farmer’s field along with chemical method and control is compared and discussed in detail in this paper.

Key words: Tomato, integrated, management of diseases.

Tomato is an important vegetable crop and grown throughout the year. Damping off, bacterial blight, Alternaria blight and tomato leaf curl virus (TLCV) are most important problems of tomato in this region and average intensity vary from 35-40% every year. Losses may go up to 60% due to bacterial blights and 80-86% by early blight (Pandey and Pandey 2003). The present investigation aimed to develop suitable and sustainable integrated disease management (IDM) package for multiple disease problems of tomato viz., damping off, bacterial blight, Alternaria blight and leaf curl, beginning from nursery raising to crop harvest. In present study the term IDM is more used than IPM due to major emphasis on diseases. Sharma (1998) also emphasized the integration and necessity of cultural, mechanical, behavioural, biological and chemical methods within IDM systems.

MATERIALS AND METHODS

Integrated disease management package was formulated considering the major problems based on intensive survey and surveillance of tomato growing area in last several years (Pandey and Pandey 2003). It was evaluated using two popular cultivars one open pollinated (OP) variety DVRT-1 and another hybrid cultivar BSS-419. Total 250 m² area for IDM module and 100 m² area for control was utilized for both the cultivars. Sowing and transplanting time of OP represented the early tomato in kharif season while hybrid representing main season of tomato in winter. The experiment was conducted at Indian Institute of Vegetable Research farm for two successive years in second year; it was also validated at farmer’s field. The IDM and control treatment was statistically compared with t-test. The relative incidence of damping off, bacterial blight, Alternaria blight, TLCV and yield constituted the basis of comparison in IDM module with non-IDM farmer’s practices (chemical methods) and control.

Nursery beds of 6 inches elevation and 80 cm wide were prepared by thoroughly mixing of farm yard manure (FYM). These beds were sufficiently moistened using bucket sprinkler irrigation manually. Beds were covered with 100 mm thick transparent polythene sheet and each side was perfectly air tight with moist soil. Solarization of nursery beds was carried out from 15 April to end of May. Neem cake @ 50 g/m² area, Pseudomonas florescence @ 5 g/m² area and Trichoderma viride @ 10 g/m² area were applied just prior to seed sowing. Integration of neem cake and bioagents was used because earlier Pandey et al. (2004) recorded 76.3% tomato seedling stand by applying neem cake @ 50 gram and T. viride @ 10 g/m² area in
tomato. Counted number of seeds was sown in lines by maintaining equilateral distance. Nursery beds were covered with the cage of 60 mesh nylon net to protect the seedlings from whitefly infestation and onward spread of TLCV. Pre and post emergence of damping off in nursery beds was computed by \textit{in vitro} and \textit{in vivo} germination of counted number of seeds. Nursery raising in month of June-July is always subjected to severe infection of bacterial leaf spot. Hence, one spraying of streptocycline @ 200 ppm at 20 days after sowing was given. Seed germination percentage in nursery beds was recorded 10 and 20 days after sowing, and bacterial leaf spot incidence after 25 days of sowing.

Tomato seedling was dipped in imidacloprid @ 0.3 ml/lit solution for 30 minutes just before transplanting. Marigold seedlings were transplanted at every 16 rows of tomato. Spot application of \textit{T. viride} @ 2.5 kg/ha was done after 1\textsuperscript{st} week of transplanting. Bacterial leaf spot was managed by removal of lower leaves followed by applying one spray of streptocycline @ 200 ppm at 12 days after transplanting (DAT). Initial two rouging of TLCV infected plants was done at 30 and 45 days after transplanting. Alternaria infected lower leaves was removed twice at seven days interval. Mancozeb @ 0.25% was sprayed just after each picking of infected leaves. Thiometoxame was sprayed twice @ 0.3 g/l at 35 and 55 DAT in DVRT-1 while 10 and 30 DAT in BSS-419. Occurrence of Alternaria foliar blight was observed fortnightly using 0-5 scale and average PDI was calculated. Incidence of TLCV was observed 60 days after transplanting in each test cultivar. Alternaria fruit rot (dry rot) and soft fruit rot infected by \textit{Phythium, Rhizoctonia, Sclerotium} and \textit{Myrothecium} spp. were considered for observations. Percent fruit rot incidence was calculated on the weight basis. In present IDM module biological, chemical, physical and cultural methods were applied as per need. Successful control of Rhizoctonia root rot of pea by integration of bioagents with chemicals has been reported by Hwang and Chakravarty (1993).

**RESULTS AND DISCUSSION**

**Effect on nursery diseases**

The IDM package in nursery beds comprised soil solarization, use of neem cake, bioagents application, nylon netting and streptocycline spray to manage the major diseases. As there was no seed treatment, \textit{in vitro} germination was recorded 82.7% and 88.6% in OP and hybrid respectively for both IDM and control. The significant difference was observed between \textit{in vitro} and \textit{in vivo} germination in tomato. Pre-emergence damping off was only 8.1% in IDM treatment while 15.4% in control OP cultivar. The significant difference was observed between \textit{in vitro} and \textit{in vivo} germination in tomato. Pre-emergence damping off was negligible in both the treatments. The extent of pre-emergence damping off in control was more than the post emergence. Comparing \textit{in vitro} germination with first observation at 10 days after sowing in OP tomato, it is clear that pre-emergence damping off can be successfully managed using the IDM module. There was significantly difference in pre emergence damping off management in hybrid tomato. Pre-emergence damping off was nearly 1.9% in IDM module against 8.4% in control bed with hybrid tomato (Table 1). Post emergence damping off was also significantly less in IDM (5.4%) than control nursery bed (6.0%). Therefore, it was apparent that the developed IDM module was successful in reducing pre and post emergence damping off in OP and hybrid tomato during \textit{kharif} and winter season respectively. Soil solarization of nursery beds has been found very effective in reducing the damping off in tomato, chilli, brinjal and early cauliflower (Pandey and Pandey 2004).

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Seed germination (%)</th>
<th>Pre-emergence damping off (%)</th>
<th>Post-emergence damping off (%)</th>
<th>Bacterial leaf spot incidence</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OP</td>
<td>Hybrid</td>
<td>OP</td>
<td>Hybrid</td>
</tr>
<tr>
<td>IDM</td>
<td>82.7</td>
<td>88.6</td>
<td>8.1</td>
<td>1.9</td>
</tr>
<tr>
<td>Control</td>
<td>82.7</td>
<td>88.6</td>
<td>15.4</td>
<td>8.4</td>
</tr>
<tr>
<td>t-cal.</td>
<td>-</td>
<td>-</td>
<td>23.6</td>
<td>19.1</td>
</tr>
<tr>
<td>t-tab.</td>
<td>-</td>
<td>-</td>
<td>1.7</td>
<td>1.9</td>
</tr>
</tbody>
</table>

Table 1. Effect of IDM on seed germination, damping off and bacterical leaf spot incidence in nursery
Bacterial blight incidence in nursery with OP variety DVRT-1 was much pronounced in control where the PDI was 51.6% in comparison to IDM treatment where it was only 30.6%. Percent disease index of bacterial blight in IDM module was significantly reduced against control beds. Hybrid tomato was also significantly managed by the IDM treatment showing bacterial blight incidence 44.4% in comparison to 64.2% in control. It was also clear that hybrid (BSS-419) was more susceptible to bacterial blight in comparison to OP variety (DVRT-1). However, the weather conditions were more congenial for bacterial blight in kharif season. Data indicate that IDM module is significantly superior over control in reducing bacterial incidence in kharif as well as winter tomato. Pandey and Pandey (2004) reported that soil solarization alone is also effective in reducing the bacterial leaf blight of tomato and chilli seedlings.

**Effect on diseases of main field**

Tomato leaf curl virus incidence in tomato was drastically minimized by IDM schedule. TLCV incidence was 6.5% against 30.35% in control plot in open pollinated variety. Similar trend of disease control was also observed with hybrid where TLCV incidence was 5.75% in IDM module and 17.65% in corresponding control (Table 2). Whitefly population was also significantly reduced in IDM than in control treatment in both the cultivars. It was clear the TLCV incidence was more pronounced in kharif planted tomato where whitefly population and weather conditions were more congenial than winter season. Murugan (2002) reported that damage due to TSWV and TLCV was 45-65% higher in sole crop than tomato intercropped with mustard. The present IDM package is significantly superior over control and effective in management of leaf curl virus of tomato.

Alternaria foliar blight severity in IDM and control plots indicated that although the IDM blocks having significantly less occurrence but the difference were not very promising between the treatments. The PDI of early blight was 23.25 in IDM while 24.25 in control plot for OP tomato. The mean PDI was 65.3 in IDM while 69.4% in control for hybrid tomato. Alternaria foliar blight occurrence was almost similar in IDM and control around the maturity of crop. Alternaria fruit rot was only 5.2% in IDM as compared to 12.1% in control for OP cultivar. However, there was statistically not much difference in Alternaria fruit rot incidence in IDM and control plots for hybrid which was 65.3% and 69.4% respectively. The disease severity was very high in hybrid because of its high susceptibility and more congenial weather to early blight. The level of disease control was less in hybrid than OP tomato. Soft fruit rot caused by *Phythium, Rhizoctonia, Sclerotium* and *Myrothecium* spp. were significantly reduced in both the cultivars. Soft fruit rot incidence was 5.8% in OP while 8.7% in hybrid under IDM plot. The incidence was significantly high and varied from 16.6 to 18.0% in respective control. It is clear from observation that prevailing IDM module could not exert prominent impact on Alternaria foliar blight but effective in management of Alternaria fruit rot and soft fruit rot diseases of tomato.

Overall disease control performance of IDM module was calculated in terms of yield. Average yield on OP variety (DVRT-1) for IDM was 290.92 q/ha as compared to control (149.32 q/ha). Yield in IDM block was almost double than control and statistically highly significant. Almost similar trend was also observed in hybrid tomato (BSS-419) where the yield was 339.95 q/ha and 205.36 q/ha in IDM and control respectively (Table 2). It indicates that present IDM module in effective is management of diseases and increase in yield.

**Table 2. Effect of IDM on different diseases and yield of tomato**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>TLCV incidence</th>
<th>Alternaria leaf blight</th>
<th>Alternaria fruit rot</th>
<th>Soft fruit rot</th>
<th>Yield (q/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OP / Hybrid</td>
<td>OP / Hybrid</td>
<td>OP / Hybrid</td>
<td>OP / Hybrid</td>
<td></td>
</tr>
<tr>
<td>IDM</td>
<td>6.75 / 5.75</td>
<td>23.25 / 57.65</td>
<td>5.2 / 65.3</td>
<td>5.8 / 8.7</td>
<td>290.92 / 339.95</td>
</tr>
<tr>
<td>Control</td>
<td>3.35 / 17.65</td>
<td>24.25 / 59.70</td>
<td>12.1 / 69.4</td>
<td>16.6 / 18.0</td>
<td>149.32 / 205.36</td>
</tr>
<tr>
<td>t-cal.</td>
<td>39.4 / 20.4</td>
<td>0.4 / 2.1</td>
<td>10.8 / 0.7</td>
<td>4.6 / 7.9</td>
<td>24.9 / 30.6</td>
</tr>
<tr>
<td>t-tab.</td>
<td>1.7 / 1.7</td>
<td>1.7 / 1.8</td>
<td>1.9 / 1.8</td>
<td>2.0 / 1.9</td>
<td>1.8 / 1.8</td>
</tr>
</tbody>
</table>
Validation of IDM package at farmer's field

Validation of developed IDM module at farmer's field indicated that marketable yield of tomato in IDM and non-IDM was 315.9 and 327.2 q/ha respectively which was close to each other but superior over control (121.42 q/ha). Here non-IDM comprised farmer's practices while control means absolutely free from any plant protection measures. Farmers practices where they used pesticides indiscriminately in non-IDM module without knowing any knowledge of diseases and insect pests. Cost of cultivation in non-IDM practices was Rs.31775 while comparatively less (Rs.30630) in IDM (Table-3). The cost benefit ratio was almost same and ranged between 1:2.09 to 1:2.08 for IDM and non-IDM. However, C: B ratio was significantly very high in both the module in comparison to control (1:0.58). It was also concluded that the need based plant protection measures applied in IDM programme was more cost effective and achieved economic yield with less environmental pollution than sole chemical methods. Hewson et al. (1998) stated that level of control and crop yield from IDM programme are often better than conventional method. Peshin and Kalra (1997) concluded that average yield in the IDM villages were 6.31 t/ha as compared to control 5.25 t/ha in non-IDM villages and the average pesticide expenditure of IDM trained farmers was significantly lower than non-IDM farmers. Similar trend had been observed in present investigation. The present validated IDM technology in tomato is being successfully adopted by many tomato growers of selected villages for the management of major diseases encountered every year. However, 10-15% deviation from the present IDM module is essentially required due to unpredictable sudden outbreak of late blight, grey leaf spot and white rot disease in tomato.

REFERENCES


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Table 3. Cost benefit ratio of tomato on demonstration trial of IDM at farmer's field

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Marketable yield (q/ha)</th>
<th>Disease/infested field (Qha)</th>
<th>Gross return* (Rs.)</th>
<th>Cost of Production (Rs.)</th>
<th>Net benefit (Rs.)</th>
<th>C:B ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>IDM module</td>
<td>315.9</td>
<td>17.5</td>
<td>94770</td>
<td>30630</td>
<td>64140</td>
<td>1:2.09</td>
</tr>
<tr>
<td>Non-IDM module (Farmers practices)</td>
<td>327.2</td>
<td>29.4</td>
<td>98160</td>
<td>31775</td>
<td>663585</td>
<td>1:2.08</td>
</tr>
<tr>
<td>Control</td>
<td>121.4</td>
<td>59.3</td>
<td>36420</td>
<td>23000</td>
<td>13420</td>
<td>1:0.58</td>
</tr>
</tbody>
</table>

*Uniform cost of cultivation @ Rs. 23000/ha and flat rate of sale @ Rs. 3/kg.