Stage specific and component centric nematode IPM in tuberose
(Polianthes tuberosa L.)

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ABSTRACT: Field experiments were conducted at Regional Research Station farm, Paiyur, India during 2012 - 2014 in tuberose Polianthes tuberosa L. under normal flow irrigated conditions to standardize the effective management practices for nematode disease complex for the North Western Zone of Tamil Nadu. Two year experimentation results revealed that dipping of mother bulbs in carbosulfan 1000 PPM followed by soil application of PF @ 2.5 Kg/ha mixed with 50 Kg of FYM every third month recorded a highest yield of tuberose florets of 2669.88 Kg/ha in the first year and 1605.87 Kg/ha in the combined year with a significant reduction in injury causing nematode population of 315.67 and 321.33/250 g of soil sample respectively at 60 and 120 days with a highest benefit cost ratio of BC ratio of 1:16.0 and found to be the best. The aforesaid treatment is also comparable with standard chemical check viz., dipping mother bulbs in carbosulfan 1000ppm + soil application of Carbofuran 3G @ 1 K.g.a.i/ha + drenching with carbendazim @ 2 g/lit., in terms of yield recording 1960.65 and 1219.17 Kg/ha in the first year and in the combined year with a significant reduction in nematode load of 297.5 and 316.30/250 g of soil sample at 60 and 120 days respectively.

Keywords: Root knot nematode, Meloidogyne incognita, Pseudomonas fluorescens, tuberose

INTRODUCTION

Tuberose, Polianthus tuberosa L. is commercially cultivated in open field conditions for its fragrant flowers. The loose flowers are used in garlands and floral decorations while spikes are used as cut flowers. Natural oil extracted from the flowers are used in the perfume industry. It is a half hardy bulbous perennial plant that perpetuates itself through bulblets. Root knot nematode, Meloidogyne incognita (Kofid et white) Chitw., was reported as one of the important factors affecting commercial cultivation of tube rose (Sunderababu and Vadivelu,1988). It was found to reduce the yield of the crop by more than 10%, (Khan and Parvatha Reddy, 1992) further, it was observed to make the plants highly susceptible to attack by Fusarium oxysporum f. sp. dianthi. Recent surveys also indicated the widespread nature of this nematode in most of the fields in Southern India where the tuberose is cultivated (Rao et al., 2001). Degeneration and/or death of plants due to root knot nematodes cause a greater financial loss to the farmer. This study was under taken to evaluate the TNAU bioinoculant viz., formulations (talc and liquid), combination of chemical and bioinoculants at different stages of crop growth in tackling the nematode population, effect of intercropping with Tagetus, delivery system of the native bio-control agent Pseudomonas fluorescens and Trichoderma viride, as mother bulb treatment, soil application, foliar spray and in combination so as to develop nematode centric IPM module in comparison with standard chemical practice and to standardize the effective management practices for nematode disease complex in tuberose of the North Western Zone of Tamil Nadu and Krishnagiri district in particular.

MATERIALS AND METHODS

Field experiments were conducted in RBD at Regional Research Station, TNAU, Paiyur farm (12°21’ N, 78°18’ E) with two crop year viz., 2012-13 and 2013-14 under normal flow irrigated conditions. The soil was sandy loam in texture with pH 8.1. The available NPK were 175, 25 and 27.5 kg/ha with organic Carbon of 0.5%. There were eight treatments in the first year and the IPM module was included in the second year (Table 1).

The data collected on growth characters like plant height at 60 DAS (cm), population of nematodes/nematode load in 250 ccs/g of soil at 60, 120, 180 DAS and at termination of crop, population of endo parasitic nematodes in 5 g roots at termination of the crop, florets yield Kg/ha and BC ratio were analyzed and presented in tables1 to 2 for first, second year and combined crop along with florets yield and benefit cost ratio respectively.
RESULTS AND DISCUSSION

A. First year trial

i) Plant height

The height of plants two months after sowing was the highest (37.00 cm) in the standard check viz., Dipping mother bulbs in carbosulfan (1000 PPM) + soil application of Carbofuran 3G @ 1 kg a.i/ha + drenching with carbenazim @ 2g/lit. (T_s) in the first year of the trial (Table 1). The next best treatments (36.13 cm) were dipping mother bulbs in carbosulfan (1000 PPM) followed by soil application of Pf @ 2.5 kg/ha mixed with 50kg FYM every third month (T_p) and Dipping mother bulbs in carbosulfan (1000 PPM) followed by soil application of Tv @ 2.5 kg/ha mixed with 50kg FYM every third month (T_v) which were on par (Table 1). The lowest height was observed in untreated plants (T_u).

ii) Nematode population

With regard to nematode population, at two months after sowing, the standard check viz., dipping mother bulbs in carbosulfan (1000 ppm) + soil application of carbofuran 3 G @ 1 Kg a.i/ha + drenching with carbenazim @ 2g/lit (T_s) showed lowest population of nematodes in the first year of the trial (Table-1). The next best treatment was dipping mother bulbs in carbosulfan (1000 ppm) followed by soil application of Pf @ 2.5 Kg/ha mixed with 50 Kg of FYM every third month.

Table 1. Effect of various treatments on plant growth parameters and root knot nematode (Meloidogyne incognita) population in local tube rose - First year data (2012 - 2013)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Plant height at 2 MAS (cm)</th>
<th>Nematode population at 2 MAS (in 250g soil)</th>
<th>Nematode population at 4 MAS (in 250g soil)</th>
<th>Nematode population at 6 MAS (in 250g soil)</th>
<th>Yield of florets Kg/ha (Total of four months, Dec 2012-Mar 2013)</th>
<th>BC ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dipping mother bulbs in <em>Pseudomonas fluorescens</em> @ 10 g/kg of seed 24 hours before sowing followed by soil application of Pf @ 2.5 kg/ha at mixed with 50kg FYM every third month.</td>
<td>35.05</td>
<td>368</td>
<td>389.2</td>
<td>422.4</td>
<td>1072.98</td>
<td>3.12</td>
</tr>
<tr>
<td>Dipping mother bulbs in <em>Trichoderma viridae</em> (Tv) @ 4g/kg of seed 24 hours before sowing followed by soil application of Tv @ 2.5 kg/ha mixed with 50 kg FYM every third month.</td>
<td>35.14</td>
<td>382</td>
<td>378.7</td>
<td>434.2</td>
<td>1065.46</td>
<td>3.01</td>
</tr>
<tr>
<td>Dipping mother bulbs in carbosulfan (1000 PPM) followed by soil application of Pf @ 2.5 kg/ha mixed with 50kg FYM every third month.</td>
<td>36.13</td>
<td>304</td>
<td>297.7</td>
<td>348.7</td>
<td>2669.88</td>
<td>34.21</td>
</tr>
<tr>
<td>Dipping mother bulbs in carbosulfan (1000 PPM) followed by soil application of Tv @ 2.5 kg/ha mixed with 50kg FYM every third month.</td>
<td>35.99</td>
<td>322</td>
<td>333.3</td>
<td>374.4</td>
<td>1872.48</td>
<td>19.10</td>
</tr>
<tr>
<td>Soil application of neem cake @ 500kg/ha</td>
<td>35.05</td>
<td>374</td>
<td>295.3</td>
<td>353.6</td>
<td>1928.83</td>
<td>12.79</td>
</tr>
<tr>
<td>Intercropping with tagetus (for every two rows)</td>
<td>35.21</td>
<td>366</td>
<td>336.8</td>
<td>380.0</td>
<td>1889.62</td>
<td>30.14</td>
</tr>
<tr>
<td>Dipping mother bulbs in carbosulfan (1000 PPM) + soil application of Carbofuran 3G @ 1 kg a.i/ha + carbenazim @ 2g/lit (Standard check).</td>
<td>37.00</td>
<td>262</td>
<td>278.6</td>
<td>329.0</td>
<td>1960.65</td>
<td>33.71</td>
</tr>
</tbody>
</table>

Untreated control | 33.54 | 408 | 438.6 | 458.5 | 864.86 | - |

SED | 0.19 | 5.25 | 7.66 | 5.10 | 17.00 | - |

CD | 0.41 | 11.27 | 16.42 | 10.93 | 36.46 | - |
(T3). This was followed by dipping mother bulbs in carbosulfan (1000 ppm) followed by soil application of T.v @ 2.5 Kg/ha mixed with 50 Kg of FYM every third month (T4). The highest population was observed in untreated plants (T5).

With regard to nematode population, at 120 and 180 days after planting revealed that it was lowest in treatment of dipping mother bulbs in carbosulfan (1000 ppm) followed by soil application of Pf @ 2.5 Kg/ha (T3) and application of neem cake @ 500 Kg/ha (T5) but next only to standard check of dipping mother bulbs in carbosulfan (1000 ppm) + soil application of carbofuran 3G @ 1 Kg a.i./ha + drenching with carbendazim @ 2 g/litre (T7).

iii. Yield characters

Yield of florets of four months of the first year of the experimental trial were pooled and the total yield was highest in treatment of dipping mother bulbs in carbosulfan (1000 ppm) followed by soil application of Pf @ 2.5 kg/ha @ 2.5 kg/ha mixed with 50 kg FYM every third month. (2669.88 kg/ha) and application of neem cake @ 500 kg/ha (1928.83 kg/ha), but next only to standard check of dipping mother bulbs in carbosulfan (1000 ppm) + soil application of carbofuran 3 G @ 1 kg a.i./ha + drenching with carbendazim @ 2 g/litre of water (1960.65 kg/ha).

iv. Benefit-cost ratio

The benefit cost ratio is calculated based on the ratio formed by dividing the benefit Interns of increased crop value under protection, by the cost of protection component. A highest BC ratio of 1:34.21 was recorded in the treatment viz., Dipping mother bulbs in carbosulfan (1000 PPM) followed by soil application of Pf @ 2.5 kg/ha mixed with 50 kg FYM every third month (2669.88 kg/ha) and application of neem cake @ 500 kg/ha (1928.83 kg/ha), but next only to standard check of dipping mother bulbs in carbosulfan (1000 ppm) + soil application of carbofuran 3G @ 1 Kg a.i./ha + drenching with carbendazim @ 2 g/litre (1:33.71).

B. Second year trial

i. Nematode population/Load

In continuation of the first year trial, an additional treatment of IPM module was included based on the best of the first four treatments plus half the dose of neem cake (T5) and T6 of the first year was included in the confirmatory second year trial. The nematode population at two months in the second crop year revealed that the least population of 322/250 g soil was observed in the treatment soil application of neem cake @ 500 kg/ha and Intercropping with tagetus (for every two rows) respectively while the injury causing Meloidogyne nematode population in roots was least (12/5g of roots) in the treatment viz., Dipping mother bulbs in carbosulfan (1000 PPM) followed by soil application of Pf @ 2.5 kg/ha mixed with 50 kg FYM every third month and a maximum population of 33/5 g of roots was extracted in untreated control (Table 2).

With regard to soil nematode population, at 120 days of the second crop year revealed that the injury causing Meloidogyne nematode population was lowest (327/250 G of soil) in treatment viz., Intercropping with tagetus (for every two rows) while in roots it was significantly lower in the aforesaid treatment as well as in IPM Module (Table 2) registering 17 and 16 Meloidogyne/5g of roots which were on par with each other. The highest nematode population was recorded in untreated control (467/250 gram of soil).

The final nematode count/load in 250 g soil at termination of the local tuberose variety crop revealed that the nematode population scenario in the soil among different treatments has significant effects. Lowest population of injury causing Meloidogyne nematode was evident in the IPM module treatment viz., dipping mother bulbs in carbosulfan (1000 PPM) followed by soil application of Pf @ 2.5 kg/ha mixed with 50 kg FYM every third month + T5 (1/2) dose viz., Soil application of neem cake @ 250 kg /ha + T6, Viz., Intercropping with Tagetus (for every 2 rows) which has been included based on the best performance of the treatments of the first year recorded 322 numbers/250 G of soil (Table 2) followed by standard chemical check viz., dipping mother bulbs in carbosulfan (1000 PPM) + soil application of carbofuran 3G @ 1 kga.i./ha + carbendazim @ 2g/lit., (335 numbers/250 grams of soil) and highest nematode load of 488/250g soil was observed in untreated control. In case of roots, a significant least nematode root population of 14/5 grams of root sample was recorded in the IPM module treatment followed by the standard check viz., dipping mother bulbs in carbosulfan (1000 PPM) + soil application of carbofuran 3G @ 1 kga.i./ha + carbendazim @ 2g/lit., and Intercropping with tagetus (for every two rows) which recorded 17 and 19 numbers/5 grams of root sample respectively.

ii. Yield characters

There was no significant difference exit between the treatments of the continued second crop year with respect florets yield per hectare (Table 2).
Table 2. Effect of various treatments on plant growth parameters and root knot nematode (*Meloidogyne incognita*) population in local tube rose—Second year data (2013 - 2014)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Nematode population at the start of second crop year</th>
<th>Nematode population at 60 DAS in the second crop year</th>
<th>Nematode population at 120 DAS in the second crop year</th>
<th>Nematode population at termination the second crop year</th>
<th>Yield of florets Kg/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dipping mother bulbs in <em>Pseudomonas fluorescens</em> (Pf) @ 10 g/kg of seed 24 hours before sowing followed by soil application of Pf @ 2.5 kg/ha mixed with 50 kg FYM every third month.</td>
<td>413 (2.616) 27 (1.424)</td>
<td>435 (2.639) 23 (1.355)</td>
<td>423 (2.626) 23 (1.352)</td>
<td>422 (2.625) 27cd</td>
<td>701.75</td>
</tr>
<tr>
<td>Dipping mother bulbs in <em>Trichoderma viridiflava</em> (Tv) @ 4/kg of seed 24 hours before sowing followed by soil application of Tv@2.5 kg/ha mixed with 50 kg FYM every third month.</td>
<td>422 (2.625) 22 (1.348)</td>
<td>440 (2.645) 19 (1.268)</td>
<td>428 (2.631) 32 (1.500)</td>
<td>434 (2.638) 26ef</td>
<td>693.73</td>
</tr>
<tr>
<td>Dipping mother bulbs in carbosulfan (1000 PPM) followed by soil application of Pf @ 2.5 kg/ha mixed with 50 kg FYM every third month.</td>
<td>377 (2.576) 13 (1.079)</td>
<td>327 (2.515) 12 (1.052)</td>
<td>345 (2.538) 28 (1.440)</td>
<td>397 (2.602) 23bc</td>
<td>541.86</td>
</tr>
<tr>
<td>Dipping mother bulbs in carbosulfan (1000 PPM) followed by soil application of Tv @ 2.5 kg/ha mixed with 50 kg FYM every third month.</td>
<td>322 (2.508) 12 (1.038)</td>
<td>336 (2.526) 22 (1.335)</td>
<td>367 (2.564) 32 (1.500)</td>
<td>345 (2.538) 22bc</td>
<td>510.27</td>
</tr>
<tr>
<td>Soil application of neem cake @ 500 kg/ha</td>
<td>316 (2.500) 10 (0.935)</td>
<td>322 (2.508) 23 (1.355)</td>
<td>333 (2.522) 30 (1.471)</td>
<td>356 (2.551) 20bc</td>
<td>581.45</td>
</tr>
<tr>
<td>Intercropping with tagetus (for every two rows) every third row will be planted with tagetus alternating with tube rose plant.</td>
<td>372 (2.571) 9 (0.869)</td>
<td>322 (2.508) 18 (1.244)</td>
<td>327 (2.515) 17 (1.211)</td>
<td>343 (2.535) 19b</td>
<td>452.13</td>
</tr>
<tr>
<td>Dipping mother bulbs in carbosulfan (1000 PPM) + soil application of Carbofuran 3G @ 1 kg a.i/ha + carbendazim @ 2g/lit (Standard check)</td>
<td>333 (2.522) 17 (1.211)</td>
<td>333 (2.522) 16 (1.189)</td>
<td>354 (2.549) 22 (1.331)</td>
<td>335 (2.525) 17bc</td>
<td>477.69</td>
</tr>
<tr>
<td>Untreated control</td>
<td>424 (2.625) 11 (0.9903)</td>
<td>435 (2.639) 33 (1.515)</td>
<td>467 (2.669) 37 (1.564)</td>
<td>488 (2.688) 34d</td>
<td>657.14</td>
</tr>
<tr>
<td>IPM module: Best of the treatments from the first four of the first year trial i.e.,</td>
<td>310 (2.491) 18 (1.244)</td>
<td>352 (2.547) 17 (1.217)</td>
<td>360 (2.556) 16 (1.182)</td>
<td>322 (2.508) 14d</td>
<td>615.04</td>
</tr>
<tr>
<td>Dipping mother bulbs in carbosulfan (1000 PPM) followed by soil application of Pf @ 2.5 kg/ha mixed with 50 kg FYM every third month + Tv (1/2) dose viz., Soil application of neem cake @ 250 kg/ha + Tv,Viz., Intercropping with Tagetus (for every 2 rows) - every third row will be planted with Tagetus alternating with tube rose plant.</td>
<td>313 (2.522) 17 (1.211)</td>
<td>333 (2.522) 16 (1.189)</td>
<td>354 (2.549) 22 (1.331)</td>
<td>335 (2.525) 17bc</td>
<td>477.69</td>
</tr>
</tbody>
</table>

Figures in parenthesis are log transformed values

C. Combined crop year data results

i. Nematode population/load in the combined crop year data.

Two year combined data also revealed the trend of the first year experimental results with regard to nematode population at two months, that the standard check viz., dipping mother bulbs in carbosulfan (1000 ppm) + soil application of carbofuran 3 G @ 1 kg a.i/ha + drenching with carbendazim @ 2g/lit showed lowest population of 297.5 nematodes/250g of soil (T7) and treatment dipping mother bulbs in carbosulfan (1000 ppm) followed by soil application of Pf @ 2.5 kg/ha mixed with 50 kg of FYM every third month (T3) which registered 315.67 nematodes/250 g of soil which was on par (Table-3).

With regard to nematode population, at 120 days of the combined two crop year it was lowest in the standard check treatment viz., dipping mother bulbs in carbosulfan (1000 ppm) + soil application of carbofuran 3 G @ 1 kg a.i/ha + drenching with carbendazim @ 2g/lit (T7), soil application of neem cake @ 500 kg/ha (T5), dipping mother bulbs in carbosulfan (1000 ppm) followed by soil application of Pf @ 2.5 Kg/ha mixed with 50 kg FYM every third month (T3) and Intercropping with Tagetus (for every two rows) and the injury causing nematode Meloidogyne population ranges from 316.30 to 350.13/250g of soil sample and the range data is on par (Table 3).

In the combined data, the final nematode count/load in 250 g soil at termination of the local tuberose variety crop revealed that the nematode population scenario in the soil among different treatments has significant effects. Lowest population of injury causing Meloidogyne nematode was evident in the IPM module treatment viz., dipping mother bulbs in carbosulfan (1000 PPM) followed by soil application of Pf @ 2.5 kg/ha mixed with 50 kg FYM every third month + T5 (1/2) dose viz., Soil application of neem cake @ 250 kg/ha + T5 viz., Intercropping with Tagetus (for every 2 rows) which has been included based on the best performance of the treatments of the first year recorded 322.00 numbers/250G of soil (Table 3) followed by standard chemical check viz., dipping mother bulbs in carbosulfan (1000 PPM) + soil application of carbofuran 3G @ 1 kga.i/ha + carbendazim @ 2g/lit, (322.00 numbers/250grams of soil) and highest nematode load of 473.23/250g soil was observed in untreated control. In case of roots, a significant least nematode root population of 14/5 grams of root sample was recorded in the IPM module treatment followed by the standard check viz., dipping mother bulbs in carbosulfan (1000 PPM) + soil application of carbofuran 3G @ 1 kga.i/ha + carbendazim @ 2g/lit., which recorded 17 numbers/5 grams of root sample (Table-3).

ii. Yield characters

Total yield of florets was highest in treatment viz., Dipping mother bulbs in carbosulfan (1000 PPM) followed by soil application of Pf @ 2.5 kg/ha mixed with 50kg FYM every third month (1605.87 Kg/ha) in the combined crop year data (Table 3) which was comparable and on par with Soil application of neem cake @ 500kg/ha (T5), Dipping mother bulbs in carbosulfan (1000 PPM) + soil application of Carbofuran 3G @ 1 kga.i/ha + carbendazim @ 2g/lit (Standard check-T7), and Dipping mother bulbs in carbosulfan (1000 PPM) followed by soil application of Tv @ 2.5 kg/ha mixed with 50 kg FYM every third month (T4).The yield ranges from 1191.38 to 1255.14 Kg/ha in the aforesaid treatments.

iii. Benefit cost ratio

A highest BC ratio of 1:16.02 was recorded in the treatment viz., Dipping mother bulbs in carbosulfan (1000 PPM) followed by soil application of Pf @ 2.5 kg/ha mixed with 50kg FYM every third month (Table-1) followed by standard check treatment i.e., Dipping mother bulbs in carbosulfan (1000 PPM) + soil application of Carbofuran 3G @ 1 kga.i/ha + carbendazim @ 2g/lit (1:14.10). In nutshell, dipping of mother bulbs in carbosulfan 1000 PPM followed by soil application of Pf @ 2.5 Kg/ha mixed with 50 Kg of FYM every third month recorded a highest yield of tuberose florets of 2669.88 Kg/ha in the first year and 1605.87 Kg/ha in the combined year with a significant reduction in injury causing nematode population of 315.67 and 321.33/250g of soil sample respectively at 60 and 120 days with a highest benefit cost ratio of BC ratio of 1:16.0 and found to be the best. The generated components of IPM findings are in conformity with earlier workers (Ali et al., 2002; Chawla et al., 2006).

REFERENCES


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