BIORATIONAL MANAGEMENT OF
SPODOPTERA FRUGIPERDA (J E SMITH) ON MAIZE

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ABSTRACT

The present study on the biorational management of Spodoptera frugiperda (J E Smith) on maize was conducted in the farm of Department of Agricultural Entomology, Dr Panjabrao Deshmukh Krishi Vidyapeeth, Akola during kharif 2019-20. The experiment was laid out in randomized block design with eight treatments replicated thrice. The treatments included- Nomuraea rileyi \(1 \times 10^8\) cfu/ g @ 30 g/ 10 l, Metarhizium anisopliae \(1 \times 10^8\) cfu/ g @ 50 g/ 10 l, Beauveria bassiana \(1 \times 10^9\) cfu/ g @ 40 g/ 10 l, NSKE 5%, Bt 85% @ 20 g/ 10 l, SLNPV 1 \times 10^9\) POB/ ml (500 LE), azadirachtin 1500 ppm @ 50 ml/ 10 l, and control (untreated). Four sprays were applied at 12 days interval. The results revealed that with fourth spray, Bt 85% @ 20 g/ 10 l was the most effective.

Key words: maize, Spodoptera frugiperda, Nomuraea rileyi, SLNPV, Bt, Metarhizium anisopliae, Beauveria bassiana, azadirachtin.

Maize is a cereal crop grown in > 160 countries in tropical, subtropical and temperate regions, with India having a productivity of 109 kg/ ha, which is much less than the US yield of 863 kg/ ha. This low productivity might be due to several reasons viz., environmental factors, low mechanization, pest and diseases etc. Of these, insect pests are the major constraints as these attacking maize not only directly as borers, sap suckers, stem and root feeders etc. but also indirectly as vectors of diseases. In India, the fall army worm Spodoptera frugiperda (J E Smith) was reported in May 2018 on maize for the first time from Karnataka (Sharanabasappa et al., 2018a). Molecular diversity of this from different states of India indicated prevalence of R strain (Mahadevaswamy et al., 2018). The total life of male and female was observed to be 32-43 and 34-46 days, respectively (Sharanabasappa et al., 2018b). The extent of its damage varied from 20 to 80% on maize (Sharanabasappa et al., 2019b). Considering adverse effect of insecticides there is need for environmentally safe and cost-effective management strategy in the form of biopesticides in IPM. The present study evaluates some biorational approaches including biopesticides against S. frugiperda on maize.

MATERIALS AND METHODS

The experiment was conducted on the farm of Department of Agricultural Entomology Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during kharif 2019-20. The experiment was laid out in randomized block design (RBD) with eight treatments and three replications, with plot size 5.4x 3 m and spacing of 60x 20 cm. Uday (Mahabeej-1114) cultivar was used and sowing was done on 5th July 2019. All the agronomical practices were carried out as per the recommendations except, plant protection. The treatments include: T1: Nomuraea rileyi \(1 \times 10^8\) cfu/ g - 30 g, T2: Metarhizium anisopliae \(1 \times 10^8\) cfu/g - 50 g, T3: Beauveria bassiana \(1 \times 10^9\) cfu/ g - 40 g, T4: Neem seed kernel extract (NSKE) 5% - 50 g, T5: Bacillus thuringiensis 85% - 20 g, T6: SLNPV \(1 \times 10^9\) POB/ml - 500 LE, T7: Azadirachtin 1500 ppm - 50 ml, T8: Control. (The doses used are in 10 l of water); Source: N. rileyi, M. anisopliae, B. bassiana- Plant Pathology department, Dr PDKV, Akola; neem seed kernel extract- neem seeds from area of Dr PDKV, Akola; SLNPV- Department of Agricultural Entomology, Dr PDKV, Akola; Bacillus thuringiensis var. kurstaki-Margo Company’s Delfin WG; azadirachtin 1500 ppm- MBF Company Neem Fighter. The spray solution was freshly prepared with the required quantity of water for spraying each plot estimated by spraying plain water in untreated control plot. The required quantity of biopesticides and botanical was worked out and spray solution was prepared by mixing them in water thoroughly. The following formula was used- \(V = \frac{C \times A}{\% a.i.}\) where, V= quantity of biopesticides and botanical, C= concentration of spray required, A= quantity of water, % a.i. = active ingredient in commercial product.
Table 1. Efficacy of biopesticides and botanicals against *S. frugiperda*

<table>
<thead>
<tr>
<th>Tr. No.</th>
<th>Treatment</th>
<th>% infestation of <em>S. frugiperda</em></th>
<th>Overall mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>DBS</td>
<td>DAS</td>
</tr>
<tr>
<td>1</td>
<td>Nomuraea rileyi 1x10⁸ cfu/ g 30 g</td>
<td>63.33</td>
<td>33.00</td>
</tr>
<tr>
<td>2</td>
<td>Metarhizium anisopliae 1x10⁸ cfu/ g 50 g</td>
<td>78.33</td>
<td>27.67</td>
</tr>
<tr>
<td>3</td>
<td>Beauveria bassiana 1x10⁸ cfu/g 40 g</td>
<td>68.33</td>
<td>26.00</td>
</tr>
<tr>
<td>4</td>
<td>Neem seed extract (NSKE) 5% 50 g</td>
<td>65.00</td>
<td>51.00</td>
</tr>
<tr>
<td>5</td>
<td>Bt 85% 20 g</td>
<td>71.67</td>
<td>23.33</td>
</tr>
<tr>
<td>6</td>
<td>SNPV 1x10⁹ POB/ml 500 LE</td>
<td>65.00</td>
<td>75.67</td>
</tr>
<tr>
<td>7</td>
<td>Azadirachtin 1500 ppm 50 ml</td>
<td>70.00</td>
<td>36.33</td>
</tr>
<tr>
<td>8</td>
<td>Control -</td>
<td>63.33</td>
<td>75.00</td>
</tr>
</tbody>
</table>

*F* test: NS Sig Sig Sig Sig Sig Sig Sig Sig Sig Sig Sig Sig Sig Sig Sig Sig Sig Sig Sig Sig |
SE(m): 3.27 3.19 3.77 3.56 3.54 3.70 3.62 3.38 3.18 3.06 2.85 2.29 2.95 2.92 3.25 |
CD (p=0.05): 9.92 9.68 11.44 10.80 11.38 10.75 11.22 10.97 10.25 9.64 9.29 8.63 8.90 8.95 8.86 10.02 |

* Figures in parentheses are arcsin transformed values; DBS- Day before spraying, DAS- Day after spraying
Table 2. Efficacy of biopesticides and botanicals against *S. frugiperda*

<table>
<thead>
<tr>
<th>Tr. No.</th>
<th>Treatment</th>
<th>% infestation of fall armyworm</th>
<th>3 DAS</th>
<th>7 DAS</th>
<th>10 DAS</th>
<th>Overall mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T₁</td>
<td>Nomuraea rileyi 1x10⁸ cfu /g</td>
<td>32.20</td>
<td>29.02</td>
<td>33.93</td>
<td>31.72</td>
<td></td>
</tr>
<tr>
<td></td>
<td>30 g</td>
<td>(34.57)</td>
<td>(32.60)</td>
<td>(35.62)</td>
<td>(34.57)</td>
<td></td>
</tr>
<tr>
<td>T₂</td>
<td>Metarhizium anisopliae 1x10⁸ cfu /g</td>
<td>25.93</td>
<td>23.68</td>
<td>27.02</td>
<td>25.54</td>
<td></td>
</tr>
<tr>
<td></td>
<td>50 g</td>
<td>(30.61)</td>
<td>(29.11)</td>
<td>(31.32)</td>
<td>(30.35)</td>
<td></td>
</tr>
<tr>
<td>T₃</td>
<td>Beauveria bassiana 1x10⁸ cfu /g</td>
<td>22.97</td>
<td>19.51</td>
<td>23.40</td>
<td>21.96</td>
<td></td>
</tr>
<tr>
<td></td>
<td>40 g</td>
<td>(28.64)</td>
<td>(26.21)</td>
<td>(28.93)</td>
<td>(27.93)</td>
<td></td>
</tr>
<tr>
<td>T₄</td>
<td>Neem seed extract (NSE) 5% 5 g</td>
<td>49.27</td>
<td>46.20</td>
<td>50.90</td>
<td>48.79</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5 g</td>
<td>(44.58)</td>
<td>(42.82)</td>
<td>(45.52)</td>
<td>(44.31)</td>
<td></td>
</tr>
<tr>
<td>T₅</td>
<td>Bt 85% 20 g</td>
<td>16.54</td>
<td>13.39</td>
<td>16.79</td>
<td>15.57</td>
<td></td>
</tr>
<tr>
<td></td>
<td>20 g</td>
<td>(23.99)</td>
<td>(21.46)</td>
<td>(24.19)</td>
<td>(23.22)</td>
<td></td>
</tr>
<tr>
<td>T₆</td>
<td>SI/NPV 1x10⁹ POB/ml 500 LE</td>
<td>83.07</td>
<td>84.6</td>
<td>84.43</td>
<td>84.03</td>
<td></td>
</tr>
<tr>
<td></td>
<td>50 ml</td>
<td>(65.70)</td>
<td>(66.89)</td>
<td>(66.76)</td>
<td>(65.70)</td>
<td></td>
</tr>
<tr>
<td>T₇</td>
<td>Azadirachtin 1500 PPM 50 ml</td>
<td>41.46</td>
<td>37.99</td>
<td>42.12</td>
<td>40.52</td>
<td></td>
</tr>
<tr>
<td></td>
<td>215</td>
<td>(40.08)</td>
<td>(38.05)</td>
<td>(40.47)</td>
<td>(39.53)</td>
<td></td>
</tr>
<tr>
<td>T₈</td>
<td>Control</td>
<td>82.85</td>
<td>84.44</td>
<td>84.39</td>
<td>83.89</td>
<td></td>
</tr>
<tr>
<td></td>
<td>217</td>
<td>(65.54)</td>
<td>(66.77)</td>
<td>(66.72)</td>
<td>(65.53)</td>
<td></td>
</tr>
</tbody>
</table>

‘F’ test Sig Sig Sig Sig

SE(m)± 3.17 3.22 3.36 3.25
CD at 5% 10.11 9.76 10.20 10.02
CV (%) 13.76 13.70 13.64 13.7

*Figures in parentheses corresponding arc sin transformation values; DBS- Day Before Spraying; DAS-Day after spraying.

Neem seed extract was prepared following standard methodology. Pretreatment observations were made one day before spray, with further observations made on 3rd, 7th, and 10th days after spray (DAS) taking 10 plants/plot selected randomly and % worked out. The data were subjected to statistical analysis as per Gomez and Gomez (1984).

RESULTS AND DISCUSSION

The pretreatment observations of *S. frugiperda* were found statistically non-significant – ranging from from 63.33 to 78.33/10 plants. Three DAS, the treatments were found to significantly superior over control; minimum incidence of 23.33% was observed with T₅: Bacillus thuringiensis 85%-20 g; and T₆: SI/NPV 1x10⁹ POB/ml - 500 LE was inferior to control (75.67%). Seven DAS, again T₅ was found superior (15.33%), statistically at par with T₃, T₂ and T₁ recorded 22.97% and 25.93% infestation respectively. Whereas the treatments T₁, T₃ and T₄ concentration with 32.20%, statistically at par with T₅, T₆ and T₇ was inferior to control. At 7 and 10 DAS, similar trend was observed. Thus, with mean % incidence after second spray six treatments were significantly effective, with T₅ resulting in minimum infestation (14.87%), found at par with T₃, T₂ and T₁. After third spray, at 3 DAS the least incidence was observed with T₅, statistically at par with T₃, T₂ and T₆ was inferior. Seven DAS after third spray the incidence reduced to 13.65%, found statistically at par with T₃ and T₂. Ten days after third spray again similar trend was observed. Thus, after third spray T₅ resulted in minimum infestation of 13.65%, found statistically at par with T₃ and T₂. Similar results were obtained with fourth spray leading to 13.50% incidence with T₅ (Table 1).

The cumulative effect of treatments given in Table 2 reveal that at three days after spray, T₅ proved effective by recording minimum infestation of *S. frugiperda* (16.54%). However, this treatment was found statistically at par with T₃ and T₂ recorded 22.97% and 25.93% infestation respectively. Whereas the treatments T₁, T₃ and T₄ concentration with 32.20%,
41.46% and 49.27%, infestation respectively. The control plot recorded 82.85% infestation. T₅₆ treatment was inferior to control and recorded maximum (83.07) % infestation. The data on cumulative effect of different treatments at seven days after spray revealed similar trend. T₅₆ Bacillus thuringiensis 85%- 20 g led to minimum incidence (13.39%), and found statistically at par with, T₃₆ and T₆₀ treatment was inferior to control. Polanczyk et al. (1999) evaluated in vivo activities of Bt strains on S. frugiperda, and observed that suspensions of Bt aizawai HD 68 and Bt thuringiensis 4412, containing 3x 10⁶ cells/ ml, induced effective mortality. Similar results were obtained by Hernandez (1988). Ramanujam et al. (2020) with field trials observed efficacy of three sprays of M. anisopliae ICAR-NBAIR Ma-35 and B. bassiana ICAR-NBAIR Bb-45. Ahirwar et al. (2013) in soybean reported that B. thuringiensis var. kurstaki was the most effective. Ramos et al. (2020) with biological control assays revealed that, both B. bassiana and M. anisopliae caused (100%) mortality. Gutierrez et al. (1996) evaluated entomopathogenic fungi and observed that isolates of Metarhizium anisopliae, Paecilomyces fumosoroseus, and Paecilomyces javanicus were highly pathogenic. Mallapur et al. (2018) in studies on N. rileyi revealed effective reduction of incidence of S. frugiperda.

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REFERENCES

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