Shelf-life of different formulations of *Steinernema masoodi* under laboratory condition

KC Jangid, AU Siddiqui and SS Bhati

Abstract
The present investigation was carried out to determine shelf life of different formulations of *Steinernema masoodi* viz., Calcium Gel Alginate Capsules, Water Dispersible Granules and Vermiculate under laboratory condition. Results revealed that maximum 92 percent of IJs of *S. masoodi* were recovered from CGAC formulation after one month at 10 °C and subsequently after two and three months recovery was 80 and 68 percent, respectively. While at 25 °C, 84, 72 and 60 percent recovery was obtained from CGAC formulations after one, two and three months, respectively. However, in WDG formulations maximum recovery of IJs of *S. masoodi* was 88, 72 and 60 percent after one, two and three months, respectively. At 10 °C. While at 25 °C recovery of IJs of *S. masoodi* were obtained 80, 68 and 56 percent after one, two and three months. In case of vermiculate formulations 80, 56 and 40 percent IJs of *S. masoodi* were obtained after one, two and three months at 10 °C, respectively. While at 25 °C recovery of IJs of *S. masoodi* was 76, 68 and 32 percent after one, two and three months from vermiculate formulation, respectively.

Keywords: Entomopathogenic nematode, *Steinernema masoodi*, Shelf life, Formulations, CGAC, WDG, Vermiculate

1. Introduction
Entomopathogenic nematodes (EPNs) of the genera *Steinernema* and *Heterorhabditis* were found effective for the control of soil-inhabiting insects [1]. They are safe for non-target organism and to the environment [2]. Formulation technology of EPNs has made significant progress in the past 15 years. In recent years efforts were made to develop effective formulations to increase the survivability of effectiveness of entomopathogenic nematode. Therefore, the aim of this work was to evaluate the suitability of *S. masoodi* under different formulations and varying storage period viz; calcium gel alginate capsules, water dispersible granules and vermiculate.

2. Materials and Methods
Several formulation have been developed to improve the activity of nematode on plant and in stored crops [3,4] EPN’s strains that tolerated desiccation better than other were selected [5] and antidesiccants in the aqueous mixture improved persistence [6]. EPN’s can be formulated either with active nematode in various substances or with reduced mobility. In case of later, the EPN’s were kept in partially anhydrobiotic condition till these are used for application, i.e., water or inert material.

Calcium gel alginate capsule formulation was prepared by mixing: sodium chloride (1.5g) in 100 ml water with a laboratory stirrer, until a homogenous solution was obtained. The nematodes were added to the alginate mixture in an equal to a volume of 2.5 percent of the water in the gel formulations. Water dispersible granule formulations were prepared by mixing: Talc powder (2g), Bentonite powder (3g), Casein powder (1g), Tween-80 (20g) and 15 ml water. The nematode suspensions were added to the granule mixture in homogeneously. Vermiculate formulations prepared by aqueous nematode suspensions were mixed homogeneously with vermicompost, and the mixture was placed in thin polyethylene bags. The developed formulations were stored in BOD incubator at 10 °C & 25 °C temperature.

3. Results and Discussion
Experimental results presented in Table-1 and Fig.-1a&1b revealed that the maximum 92 percent recovery of IJs was obtained from CGAC followed by 88 and 80 percent from WDG.
and vermiculate formulations respectively, at 10 °C after one month. However, at 25 °C 84, 80 and 76 percent recovery IJs of *S. masoodi* was obtained in CGAC, WDG and vermiculate formulations respectively after one month. However, after second month, maximum 80 percent recovery of IJs of *S. masoodi* was obtained in CGAC followed by 72 and 56 percent from WDG and vermiculate respectively at 10 °C. While at 25 °C highest 72 percent recovery of IJs of *S. masoodi* was obtained from CGAC followed by 68 and 52 percent from WDG and vermiculate respectively. After third month 68, 60 and 40 percent recovery of IJs of *S. masoodi* was obtained in CGAC, WDG and vermiculate formulations respectively, at 10 °C. While at 25 °C, 68, 60 and 40 percent recovery was observed from CGAC, WDG and vermiculate respectively.

Among different formulations Calcium Gel alginate Capsules (CGAC) showed better shelf life at 10 °C temperature and different time interval as compared to other formulations tested. The findings of these investigations coincide with results of [7,8] who reported that shelf life of *S.masoodi* was extended up to three months, at 10 °C. Similar studies in this regards were conducted by [9,10,11,12] who also found that of *S. feltiae* gradually enter a dormant stage in the calcium gel alginate capsules and survived up to 10 week at 25 °C.

Table 1: Shelf-life of different formulations of *Steinernema masoodi* at different temperature.

<table>
<thead>
<tr>
<th>Formulations</th>
<th>10 °C Temp.</th>
<th>Percent recovery of IJs</th>
<th>25 °C Temp.</th>
<th>Percent recovery of IJs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Month</td>
<td></td>
<td></td>
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<tr>
<td>Calcium Alginate Gel capsule</td>
<td>23,000 IJs</td>
<td>92 percent</td>
<td>21,000 IJs</td>
<td>84 percent</td>
</tr>
<tr>
<td>Water dispersible granules</td>
<td>22,000 IJs</td>
<td>88 percent</td>
<td>20,000 IJs</td>
<td>80 percent</td>
</tr>
<tr>
<td>Vermiculate</td>
<td>20,000 IJs</td>
<td>80 percent</td>
<td>19,000 IJs</td>
<td>76 percent</td>
</tr>
<tr>
<td>2nd Month</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calcium Alginate Gel capsule</td>
<td>20,000 IJs</td>
<td>80 percent</td>
<td>18,000 IJs</td>
<td>72 percent</td>
</tr>
<tr>
<td>Water dispersible granules</td>
<td>18,000 IJs</td>
<td>72 percent</td>
<td>17,000 IJs</td>
<td>68 percent</td>
</tr>
<tr>
<td>Vermiculate</td>
<td>14,000 IJs</td>
<td>56 percent</td>
<td>13,000 IJs</td>
<td>52 percent</td>
</tr>
<tr>
<td>3rd Month</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calcium Alginate Gel capsule</td>
<td>17,000 IJs</td>
<td>68 percent</td>
<td>15,000 IJs</td>
<td>60 percent</td>
</tr>
<tr>
<td>Water dispersible granules</td>
<td>15,000 IJs</td>
<td>60 percent</td>
<td>14,000 IJs</td>
<td>56 percent</td>
</tr>
<tr>
<td>Vermiculate</td>
<td>10,000 IJs</td>
<td>40 percent</td>
<td>8,000 IJs</td>
<td>32 percent</td>
</tr>
</tbody>
</table>

25,000 IJs of *S. masoodi* /formulations

Fig 1: a Shelf-life of different formulations of *Steinernema masoodi* at 10 °C

Fig 1b: Shelf-life of different formulations of *Steinernema masoodi* at 25 °C
4. Conclusion

Studies on shelf life of different formulations showed that maximum recovery of infective juveniles of EPN was obtained from WDG at 10 °C, CGAC at 25 °C and vermiculate at 10 °C after first, second and third months. So it's proved that 10 °C temperature and WDG, CGAC & vermiculate formulations are best for EPN storage.

5. Acknowledgement

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6. References