



A comparative study of bio-efficacy of various medicinal plants against *Sitophilus zeamais* on *Zea mays* var. *REH-2017-26*

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Abstract

Sitophilus zeamais is primarily a stored grain pest of *Zea mays*. The pest feeds on grains, stem leaves and other plant parts. Although most damage takes during storage but the initial infestation takes place at the field. So, it can be considered as one of the constraint on the stored grains. Many pesticides have been developed to eradicate these pests which are actually good in their work but at the same time it harms the environment too. These pests not only affect the environment but the consumers are also at a higher risk because of this and it may cause the exacerbate pest control.

It is most vigorous pest that reproduces exponentially and damages more than 50-60% of yield. Germination viability, seed weight, and crop's market value is the prime things affected by this pest. Chemical based pesticides protect the yield BUT it has many harmful side-effects to environment. Bio-pesticides are the best way to eradicate this pest with least to no harmful effect on earth.

The present study has used the extracts from the following medicinal plants i.e. *Azadirachta indica*, *Moringa oleifera* (Moringa), *Carum copticum* (ajwain), *Allium sativum* and *Ocimum sanctum*. At an interval of 5 days these extracts were used for 4 times for checking their efficacy against *Sitophilus zeamais*. When results were observed it showed that *Azadirachta indica* was most effective with highest mortality of about 97.24% and *Carum copticum* was least effective with only 43.28% of mortality. However *Moringa oleifera* and *Ocimum sanctum* showed fewer efficacies than *Azadirachta indica* but was still more effective than *Allium sativum*. Percent infestation reduced drastically when *Azadirachta indica* was used.

The powders, essential oils and crushed plant parts are used as the bio-pesticides. This research actually provides a good insight of the fact that certain substances from medicinal plants can help in controlling pests and reduce the destruction caused to environment by chemical pesticides to zero. This is the need of the hour that we have to adopt bio-pesticides instead of chemical ones. It was obvious from the research that the botanical products are capable of controlling the growth of *Sitophilus zeamais*.

Keywords: *Sitophilus zeamais*, *Zea mays* var. *REH-2017-26*, medicinal plants

Introduction

Sustenance of life on earth is possible because of plants. However some pests like *Sitophilus zeamais* are most harmful for these plants as their larvae feed on the beans of these plants. These pests not only affect the quantity but also the quality of the plants and their products. Although chemical pesticides are a very good option to deal with these pests but these chemical pesticides have very harmful effect on the environment. Not only they develop pest resistance but also kill the non-targeted organisms too. So it's the need of the hour to save plants with alternative ways that could be environment friendly and as effective as the chemical pesticide. Bio-pesticides are such kind of alternative that can work on the target organism. Bio-pesticides are produced as the secondary metabolites that few medicinal plants produce for safety against nematodes, pests, viruses etc. Hence, such secondary metabolites can be used as bio-pesticides.

Material and Method

1. Collection of plant

On the basis of insecticidal properties and availability, the specimens of *Azadirachta indica*, *Moringa oleifera* (Moringa), *Carum copticum* (ajwain), *Allium sativum* and *Ocimum sanctum* were collected along with *Zea mays* var. *REH-2017-26* (grains collected from CSA University,

Kanpur), from different parts of Uttar Pradesh, India. *Azadirachta indica*, *Moringa oleifera* (Moringa), *Carum copticum* (ajwain), *Allium sativum* and *Ocimum sanctum* were then shed-dried. Using the ethyl acetate solution a homogenous solution spray was made of the plant extracts.

2. Assessment of physical characters of *Zea mays* var. *REH-2017-26*

Before storing the grain into air tight jars they were sun dried to avoid mouldiness. Complete, intact and un-infested grains were selected for the experiment.

2.1: Grain moisture content and its removal

Silva [10] method was used to check the moisture of grain. 20grams of grain was taken and placed on previously weighed crucibles. It was then heat dried at 105°C in hot air oven until the grain weight was constant. The difference between the initial and dried weight showed the moisture content.

2.2: Grain weight

Infestation can only be studied with the help of grain weight. So, 100 grams of fresh grains were taken, weighed and noted out. The process was repeated after every 10 days for 2 months.

2.3 Removal of hidden infestation: The infestation of fungi, insects and other organisms were eliminated by heat sterilization of the grain at 70°C for 20 min.

3. Collection of Insect: Eggs of *Sitophilus zeamais* were collected from CSA University Kanpur U.P. that infested *Zea mays* var. *Azad Uttam*.

3.1. Rearing of pest: Eggs of *Sitophilus zeamais* were collected from the *Zea mays* var. *Azad Uttam* and then used as inoculums in *Zea mays* var. *REH-2017-26* for further experiment and observation. Rearing was done on *Zea mays* var. *REH-2017-26*. Neonate larvae were kept individually in a jar with ample amount of food and air supply in an environment with controlled temperature of 32°C with relative humidity of 60%. As soon as the larvae turned into adults they were kept in separate jar in pair for mating. The jars were covered with muslin cloth tied with rubber band for proper aeration. Periodical examination was done during whole experiment.

4. Treatments: T1- *Moringa oleifera*, T2- *Carum copticum*, T3- *Allium sativum* T4- *Azadirachta indica* T5- *Ocimum sanctum* T6- Control.

4.1 Spray solution formation

$$\text{Amount of pesticidal formulation} = \frac{\text{Concentration required (\%)} \times \text{Volume required (l)}}{\text{Concentration of toxicant in insecticidal formulation}}$$

5. Procedure of treatment application: The homogenous spray solutions were sprayed as soon as first symptoms of infestation were observed. Then after that these extracts were sprayed after an interval of 7 days for about 3 times to see their effectiveness against the pest *Callosobruchus maculatus*.

(a) Data collection: Data was collected from the setup of experiment that went under treatment, after every 7 days.

(b) Statistical analysis: Abbott’s formula was used for the correction of the experimental data and then analysis was done using the ANOVA method.

$$F\text{-Value} = \frac{\text{Variance of 1}^{\text{st}} \text{ data set}}{\text{Variance of 2}^{\text{nd}} \text{ data set}}$$

(c) Calculation of weight loss:

$$\text{These losses can be estimated by} = \frac{\text{Total yield of maize (q ha}^{-1}\text{)} - \text{Yield of healthy maize (q ha}^{-1}\text{)}}{\text{Total yield of maize (q ha}^{-1}\text{)}}$$

Economic Injury Level (EIL):

$$\text{Grain threshold} = \frac{\text{Cost of pesticidal treatment (Rs./ha)}}{\text{Cost of produce (Rs./q)}}$$

$$\text{Economic injury level} = \frac{\text{Grain threshold}}{\text{Regression coefficient}}$$

Observation

Table 1: Pre-oviposition, Oviposition, Fecundity, Incubation period, percentage of Hatchability, Larval period, percentage of Pupation and Pupal period of *Sitophilus zeamais* in *Zea mays*

<i>Sitophilus zeamais</i>	Pre-oviposition	Oviposition	Fecundity	Incubation-period	Hatchability %	Larval period (days)	Pupation %	Pupal period (days)
R1	5.66	3.35	85.42	3.66	45	35.76	93.25	5.33
R2	3.46	2.45	64.23	2.43	85.87	23.76	65.7	5
R3	8.3	4.67	45.66	7.33	67.84	45.66	78.92	4
R4	4.65	1.18	35.45	4.25	73	56.94	85.65	6.25
R5	3.66	2.45	66.33	6.77	65.96	55.54	56.87	4.33

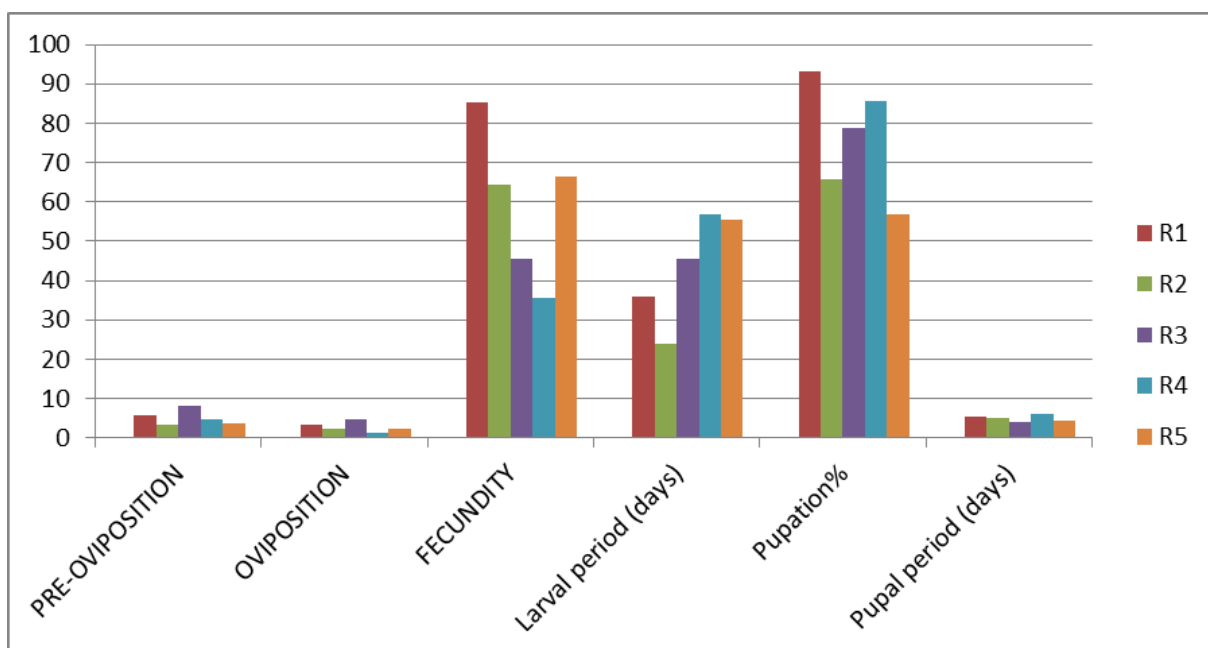


Chart 1: Pre-oviposition, Oviposition, Fecundity, Incubation period, percentage of Hatchability, Larval period, percentage of Pupation and Pupal period of *Sitophilus zeamais* in *Zea mays*

Table 2: Adult emergence, Longevity of male, Longevity of female, Sex ratio, Development period, Growth index, F1 progeny and No. of Generations of *Sitophilus zeamais* in *Zea mays*

Sitophilus zeamais	Adult emergence	Longevity male	Longevity female	Development period	Growth index	F1 progeny	No. Of generations
R1	95.75	45.87	45.63	36.76	2.098	38.67	8
R2	58.5	67.21	42.32	23.78	3.5096	87.93	6
R3	76	65.33	46.66	34.33	1.7805	53.97	7
R4	85.45	39.66	41.36	50.21	4.1626	75.67	5
R5	76.56	29.66	39.66	28.25	3.6874	54.66	6

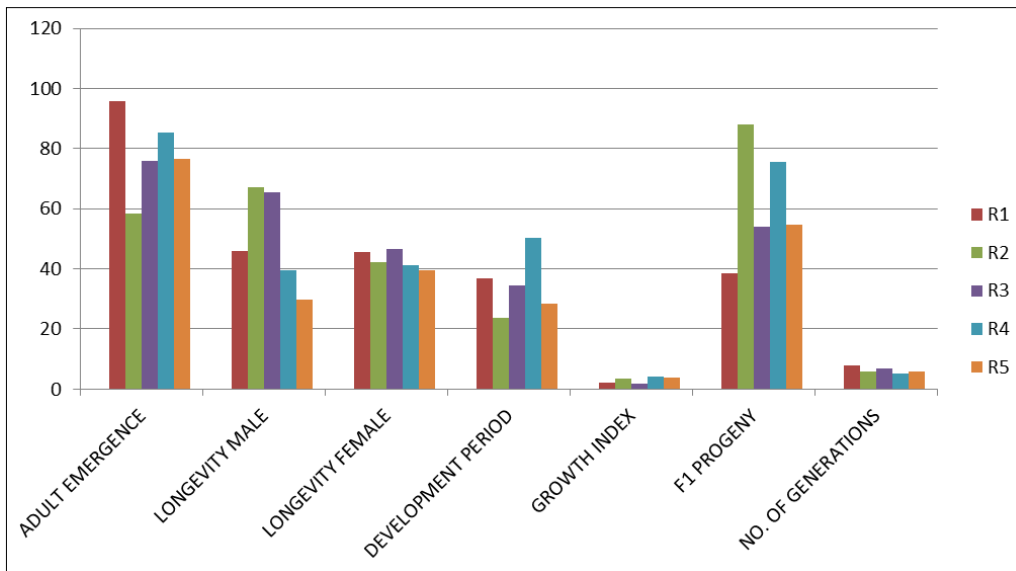


Chart-2: Adult emergence, Longevity of male, Longevity of female, Sex ratio, Development period, Growth index, F1 progeny and No. of Generations of *Sitophilus zeamais* in *Zea mays*

Table 3: Percentage of grain damage and loss of weight due to *Sitophilus zeamais* in *Zea mays* along with grain hardness and moisture percentage.

Sitophilus zeamais	Grain damage (%)	Loss of weight (%)	Grain hardness (kg/grain)	Grain moisture (%)
R1	46.98	36.33	7.14	12.06
R2	56.87	38.45	5.18	11.66
R3	38.76	25.66	6.33	9.33
R4	54.66	40.02	5.76	13.00
R5	29.76	20.00	5.23	10.66

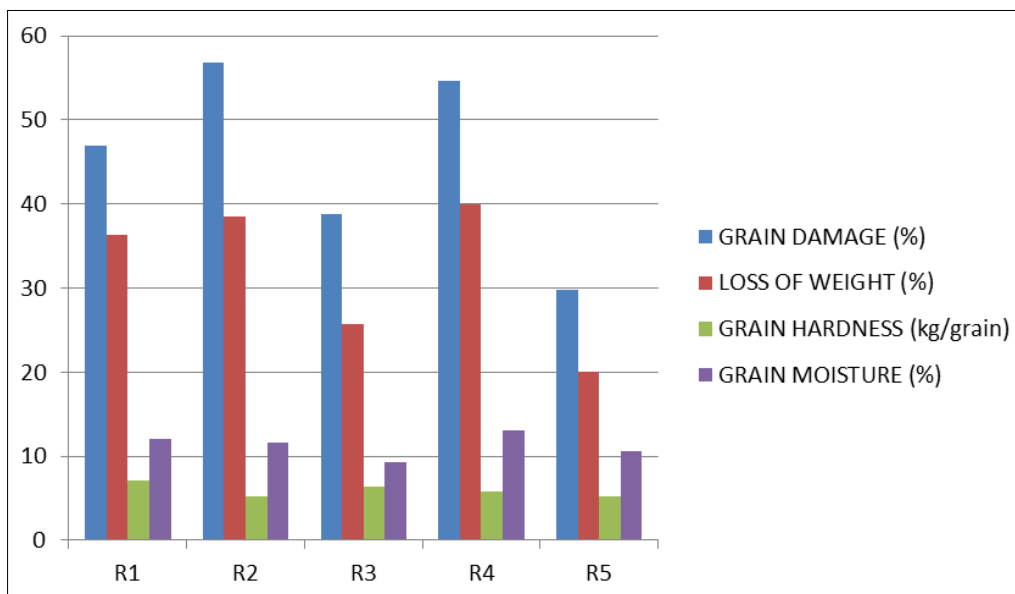


Chart 3: Percentage of grain damage and loss of weight due to *Sitophilus zeamais* in *Zea mays* along with grain hardness and moisture percentage

Table 4: % damage in *Zea mays* after multiple rounds of treatment:

Plants	After 1 st treatment	After 2 nd treatment	After 3 rd treatment	After 4 th treatment
<i>Moringa oleifera</i>	4.02	4.56	4.86	5.01
<i>Carum copticum</i>	5.84	6.79	8.22	8.75
<i>Allium sativum</i>	4.85	5.17	5.39	5.62
<i>Azadirachta indica</i>	3.53	3.60	3.64	3.66
<i>Ocimum sanctum</i>	5.76	6.74	7.95	8.32
Control	7.34	8.58	10.04	11.75

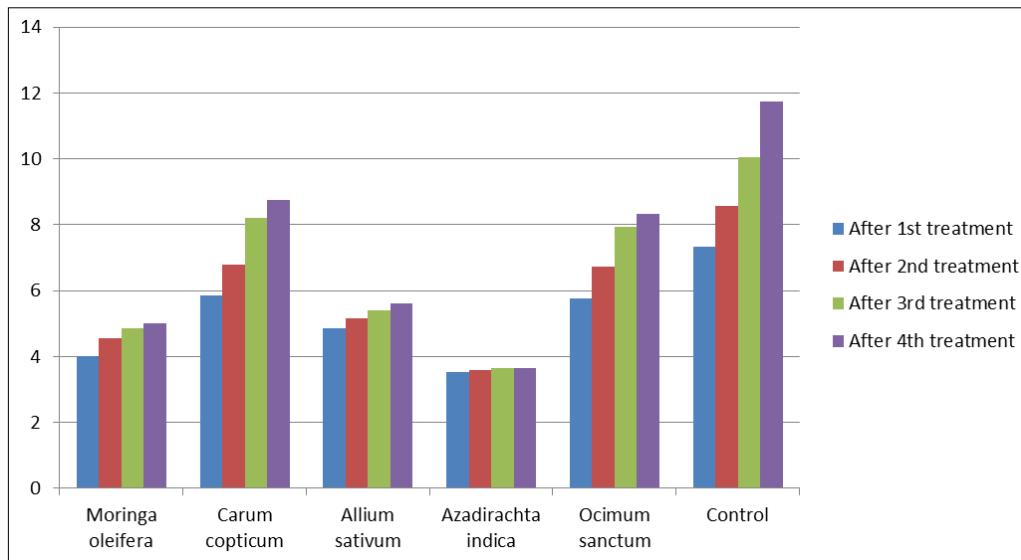


Chart 4: % damage in *Zea mays* after multiple rounds of treatments

Table 5: Mortality % of 3rd instar larva of *Sitophilus zeamais* after treatment

Treatments	Mortality % of 3rd instar larva of <i>Sitophilus zeamais</i> after treatment
<i>Moringa oleifera</i>	82.36
<i>Carum copticum</i>	43.28
<i>Allium sativum</i>	62.38
<i>Azadirachta indica</i>	97.24
<i>Ocimum sanctum</i>	75.33
Control	26.94

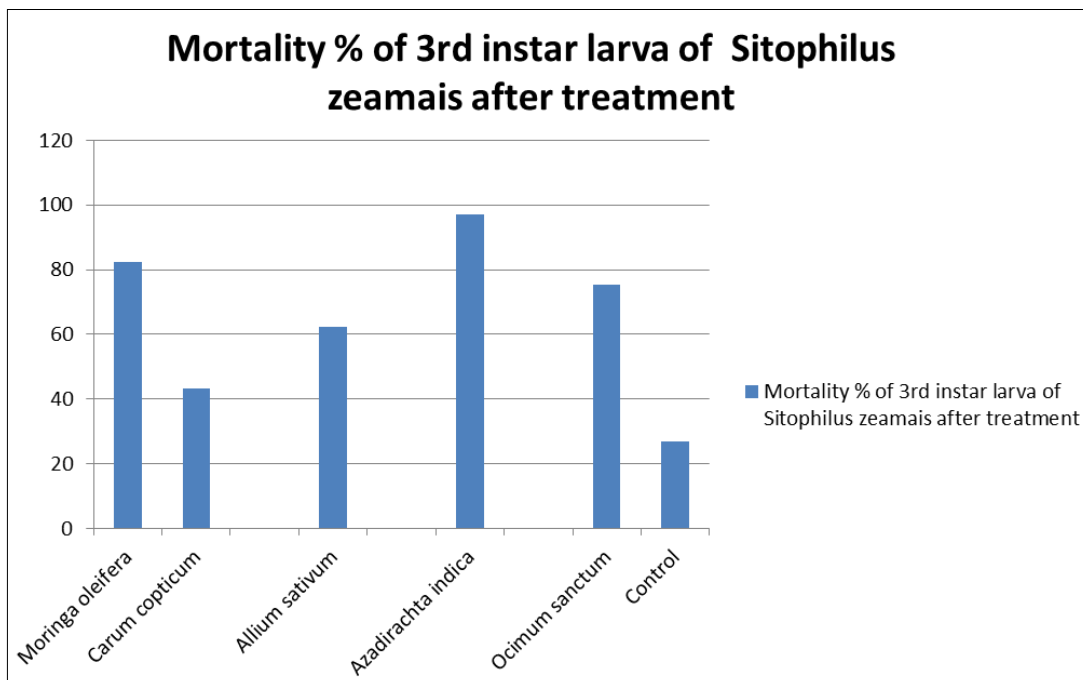


Chart 5: % of 3rd instar larva of *Sitophilus zeamais* after treatment.

Result and Discussion

The control of *Callosobruchus maculatus* was done by bio-pesticides, i.e. extracts of *Moringa oleifera*, *Carum copticum*, *Allium sativum* and *Azadirachta indica*. The results confirmed that *Sitophilus zeamais* a serious pest of *Zea mays*. The bio-pesticide screening is viable because of the comparison of the untreated plot with the treated one. When results were observed it showed that among four of these *Azadirachta indica* was most effective with highest mortality of about 97.24% and *Carum copticum* was least effective with only 43.28% of mortality. However *Moringa oleifera* (82.36%) showed fewer efficacies than *Azadirachta indica* but was still more effective than *Allium sativum* and *Ocimum sanctum* with 62.38% and 75.33 % of mortality. Damage % on *Zea mays* after application of 1st, 2nd, 3rd and 4th round of *Moringa oleifera* was 4.02, 4.56, 4.86 and 5.01, for *Carum copticum* it was 5.84, 6.79, 8.22 and 8.75, for *Allium sativum* it was 4.85, 5.17, 5.39 and 5.62, for *Ocimum sanctum* it was 5.76, 6.74, 7.95 and 8.32 and for *Azadirachta indica* it was 3.53, 3.60, 3.64 and 3.66. Percent infestation reduced drastically when *Azadirachta indica* was used.

Conclusion

However all five botanical extracts performed very well in the experiment but *Sitophilus zeamais* could be best controlled by *Azadirachta indica*. However, a combination of many other medicinal plants may result into a very effective bio-pesticide. *Azadirachta indica*, *Moringa oleifera* (Moringa), *Carum copticum* (ajwain), *Allium sativum* and *Ocimum sanctum* together showed remarkable results in controlling the pest.

Unlike chemical pesticides, bio-pesticides are not a threat to environment as they are formed by the secondary metabolites produced by the plant itself. Bio-pesticides are the best and most effective way of destroying the targeted pest and bio-pesticides are also environment-friendly.

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