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A Comparative Study of Various Medicinal Plants against *Prostephanus truncatus* on *Zea mays var. Azad kamal*

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

Plants help in the sustenance of life on earth. However some pests like *Prostephanus truncatus* are harmful for crops as their larvae feed on the beans of the plants. These pests affect the quantity and quality of the plants and their products. Chemical pesticides are an option to deal with the pests but chemical pesticides harm the environment. They develop pest resistance and kill the non-targeted organisms too. So it's the need of the hour to save plants by using alternate ways, which are environment friendly and are as effective as the chemical pesticide.

The present study has used the extracts from the following medicinal plants i.e *Nigella sativa* (Kalonji), *Piper nigrum* (Pepper), *Illicium verum* (Star anise), *Trigonella foenum-graecum* (Fenugreek) and *Curcuma longa* (Turmeric). The extracts from these plants were used for 4 times at an interval of 7 days to check the efficacy of these plants against *Prostephanus truncatus* on Azad Kamal, a variety of *Zea mays*. During the observation of results it was seen that *Piper nigrum* was most effective with 99% mortality after 4 treatments; followed by *Illicium verum, Nigella sativa, Curcuma longa* and *Trigonella foenum-graecum* with mortality rate of 97%, 92.3%, 87.5% and 76.3% respectively. Percent infestation reduced drastically when mixed extract of plants were used.

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Keywords: Bio-efficacy; medicinal plants; Prostephanus truncates; synthetic pesticides; Nigella sativa.

1. INTRODUCTION

Prostephanus truncatus is primarily a stored grain pest. The pest feeds on grains, stem leaves, beans and other plant parts of several plants. The initial infestation takes place at the field and during storage these pests cause severe damage. Hence, it is one of the constraints on the stored grains. A few synthetic pesticides are capable to eradicate this pest fully however these pesticides are a threat to environment which may cause eco-degradation as well as bio-accumulation and bio-magnification. These pesticides not only affect the environment but the consumers are also at a higher risk. These pesticides aggravate the pest control too [1-5].

It is most vigorous pest that reproduces exponentially and damages more than 55-65% of yield. The prime things of the grain affected by these pests are germination viability, seed weight, and crop's market value. Chemical based or synthetic pesticides protect the yield better than natural bio-pesticides but it has many harmful effects on the environment. Bio-pesticides are one of the best ways to completely exterminate these pests with least to no harmful effect on environment.

Bio-pesticides can be made by any plant part especially the secondary alkaloids obtained in the form of powders, crushed plant parts and essential oils. This research hereby proves that medicinal plants are capable of controlling the growth of different pests, without causing harm to the environment [6-10].

Bio-pesticides, therefore can be a great solution for this. Bio-pesticides are produced as the secondary metabolites that few medicinal plants produce for safety against nematodes, viruses, pests, and other plant diseases. These secondary metabolites can potentially be used as bio-pesticides.

OBJECTIVE: To have an analytical comparative study of various medicinal plants against *Prostephanus truncatus* on *Zea mays* var. *Azad kamal*. [The present study has used the extracts from the following medicinal plants i.e *Nigella sativa* (Kalonji)*, Piper nigrum* (Pepper)*, Illicium verum* (Star anise)*, Trigonella foenum-graecum* (Fenugreek) and *Curcuma longa* (Turmeric).]

2. MATERIALS AND METHODS

1. Collection of plant:

On the basis of insecticidal properties and availability, the specimens of *Illicium verum* , *Nigella sativa*, *Curcuma longa* and *Trigonella foenum-graecum* were collected along with *Zea mays var. Azad kamal (*grains collected from CSA University, Kanpur)*,* from different parts of Uttar Pradesh, India. *Illicium verum*, *Nigella sativa*, *Curcuma longa* and *Trigonella foenum-graecum* were then shed-dried. Ethyl acetate solution was used as a homogenous solution spray for making of 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 due to moisture or humidity in environment. Complete intact and un-infested grains were selected for the experiment.

Grain moisture content and its removal: Silva method was used to check the moisture of grain. 50grams of grain was taken and placed on previously weighed crucibles. It was then heat dried at 1O5^{o}C in hot air oven until the grain weight was constant. Moisture content was noted, which was the difference between the initial and dried weight.

Grain weight: Infestation can only be studied with the help of grain weight. So, 100 grams of fresh grans were taken, weighed and noted out. The process was repeated after every 7 days for 35 days.

Removal of hidden infestation: The infestation of fungi, insects and other organisms were eliminated by heat sterilization of the grain at 60-70^{o}C for 15-20 min.

3. Collection of insect: Eggs of *Prostephanus truncatus* were collected from CSA University Kanpur U.P. that infested *Zea mays var. Azad Uttam. Zea mays var. Azad Uttam* was used as inoculum.

***Rearing of pest*:** Eggs of *Prostephanus truncatus* were collected from the *Zea mays var. Azad Uttam* and then used as inoculums in *Zea mays var. Azad kamal* for further experiment and

observation. Rearing was done on *Zea mays var. Azad kamal*. Neonate larvae were kept individually in a jar with enough amount of food and proper aeration with controlled temperature of 32^{o}C with relative humidity of 60%. When larvae turned into adults they were kept in separate jars, for mating. The jars were covered with muslin cloth tied with rubber band for aeration. Examination was done periodically during whole experiment [11,12].

4. Treatments:

T1-*Illicium verum*, T2- *Nigella sativa*, T3- *Curcuma longa* and T4- *Trigonella foenum-graecum* T5-Control.

***Spray solution formation*:**

$$Amount\ of\ pesticidal\ formulation\ = \frac{Concentration\ required\ (\%)\ x\ Volume\ required\ (I)}{Concentration\ of\ toxicant\ in\ insecticid\ al\ formulation}$$

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

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

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

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

(c) Calculation of weight loss: These losses can ne estimated by=

$$\frac{\text{Total yield of maize (q ha}^{-1}\text{) –Yield of healthy maize (q ha}^{-1}\text{)}}{\text{Total yield of maize (q ha-}^{1}\text{)}}$$

Economic Injury Level (EIL):

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

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

(d) Duration; The extracts from these plants were used for 4 times at an interval of 7 days to check the efficacy of medicinal plants i.e *Nigella sativa* (Kalonji)*, Piper nigrum* (Pepper)*, Illicium verum* (Star anise)*, Trigonella foenum-graecum* (Fenugreek) and *Curcuma longa* (Turmeric) against *Prostephanus truncatus* on Azad Kamal, a variety of *Zea mays* [13-16].

Observation:

Table 1. Grain damage and loss of weight due to *Prostephanus truncatus* in *Zea mays* along with grain hardness and moisture percentage

Prostephanus truncatus	**Grain damage**	**Loss of weight (%)**	**Grain hardness (kg/grain)**	**Grain moisture (%)**
R1	42.35	33.76	5.23	12.72
R2	45.68	36.45	7.01	9.06
R3	39.89	27.85	6.89	10.43
R4	48.67	38.95	5.83	11.21
R5	40.75	45.32	6.56	15.36

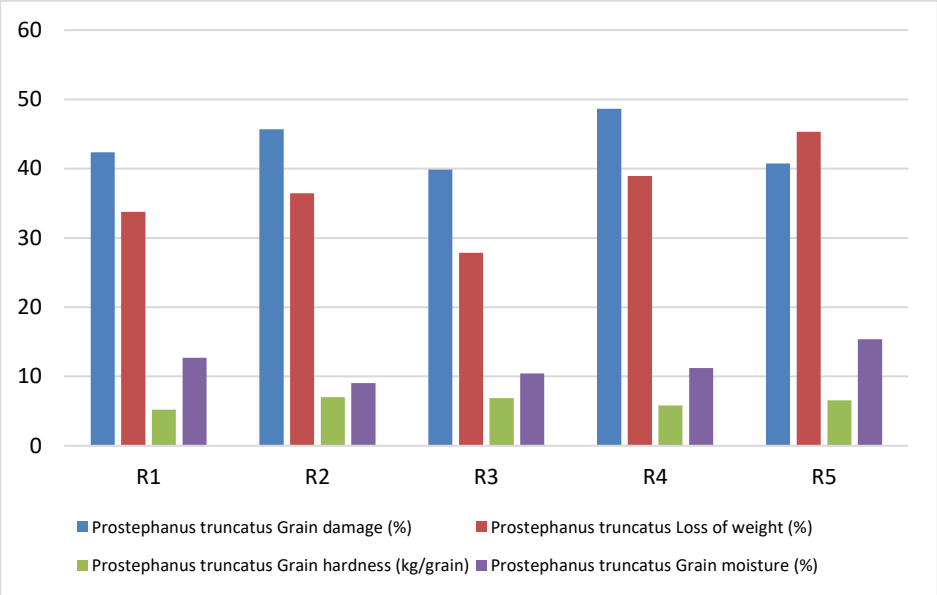

Chart 1. Percentage of grain damage and loss of weight due to *Prostephanus truncatus* in *Zea mays* along with grain hardness and moisture percentage

Table 2. % damage in *Zea mays* after multiple rounds of treatment

Plants	After 1st treatment	After 2nd treatment	After 3rd treatment	After 4th treatment
Illicium verum	4.25	4.73	5.02	5.11
Nigella sativa	6.05	7.01	7.87	8.66
Curcuma longa	5.85	7.17	8.64	9.16
Trigonella foenum-graecum	6.53	8.10	9.42	10.63
Control	10.45	13.65	15.32	17.83

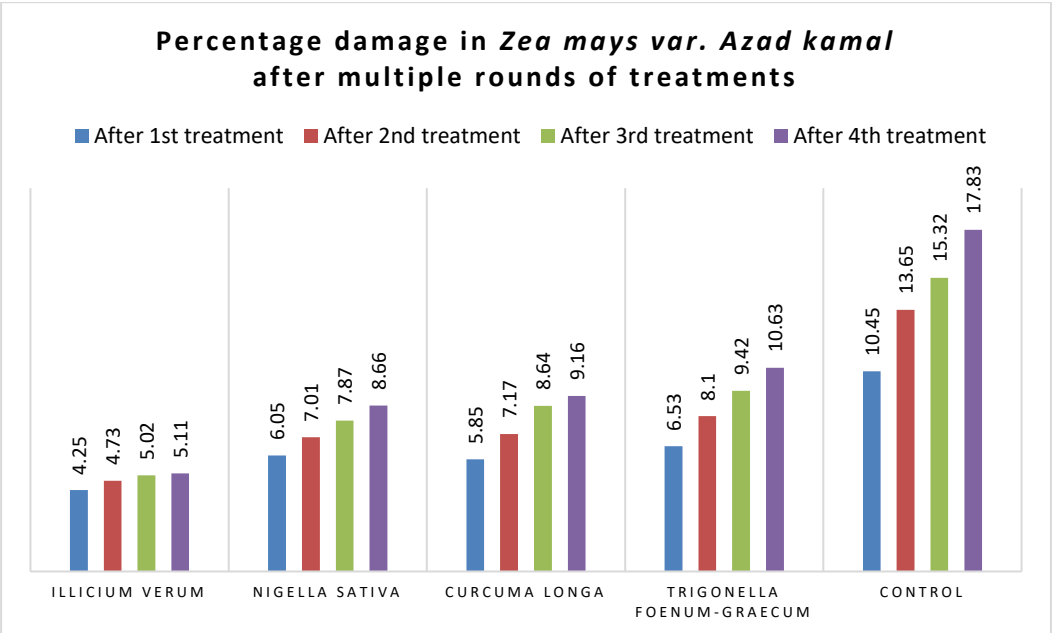

Chart 2. % damage in *Zea mays var. Azad kamal* after multiple rounds of treatments

Table 3. Mortality % of 3rd instar larva of *Prostephanus truncatus* after treatment

Treatments	Mortality % of 3rd instar larva of *Prostephanus truncatus* after treatment
Illicium verum	97.00
Nigella sativa	92.32
Curcuma longa	87.54
Trigonella foenum-graecum	76.33
Control	34.25

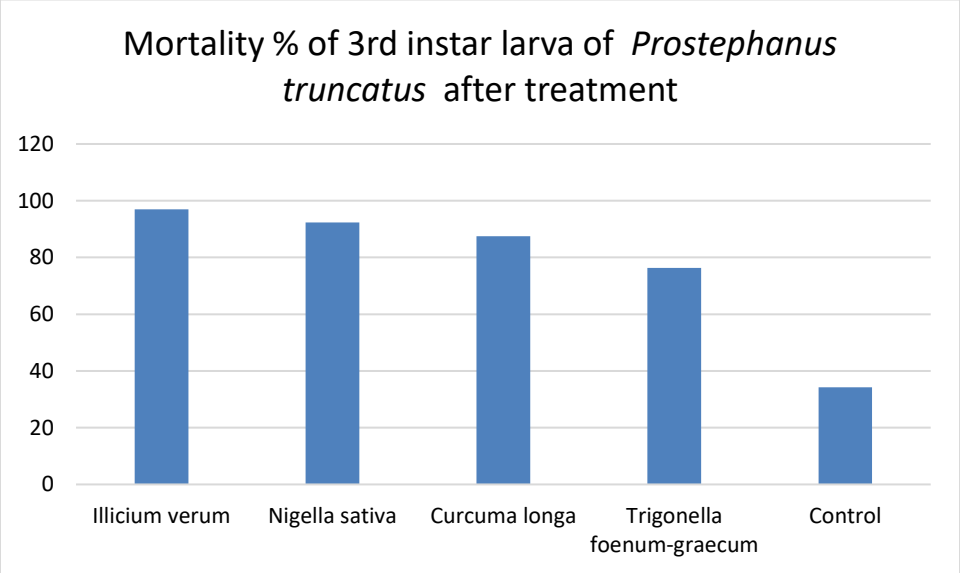

Chart 3. % of 3rd instar larva of *Prostephanus truncatus* after treatment

3. RESULTS AND DISCUSSION

As Hannah Quellhorst et al. (2021) stated that 40% of the stored maize is destroyed by this pest. Hermetic storage is efficient to control this pest. The control of *Prostephanus truncatus* was done by bio-pesticides, i.e. extracts of *Illicium verum*, *Nigella sativa*, *Curcuma longa* and *Trigonella foenum-graecum*. The results confirmed that *Prostephanus truncatus* is a serious pest of *Zea mays*. The bio-pesticide screening is practicable because of the comparison of the unprocessed plot with the treated one. However, Yunus Emre Altunç et al. explained in their research that there is a significant effect on the progeny production and damage of *P. truncatus* is dependent on different hybrid and cropping location [17-19]. *Prostephanus truncatus* has competitive advantage as an invasive species even in the presence of *S. oryzae* with stored maize. *When* results were observed it showed that among four of these *Illicium verum* was most effective with highest mortality of about 97.00% and *Trigonella foenum-graecum* was least effective with only 76.33% of mortality. However *Nigella sativa* and *Curcuma longa* showed 92.32% and 87.54% of mortality. However C.G. Athanassiou et al. (2017) showed that this pest was able to thrive on amylaceous maize only. Its failed to develop in other grains or non-amylaceous commodities. Its survival and spread is negligible to marginal by the utilisation of non-host commodities.

4. CONCLUSION

However all five botanical extracts performed exceptionally well in the experiment but *Prostephanus truncatus* could be best controlled by *Illicium verum*. However, a combination of different secondary metabolites of various medicinal plants may result into a very effective bio-pesticide. *Illicium verum*, *Nigella sativa*, *Curcuma longa* and *Trigonella foenum-graecum* together showed remarkable results in controlling the pest.

Bio-pesticides are not a threat to environment as they are formed by the secondary metabolites produced by the plant itself. Therefore, bio-

pesticides are the most effective way of destroying the targeted pest and bio-pesticides are also environment-friendly.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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