Insecticidal and repellent activities of five plant extracts against stored grain pest Tribolium confusum (Jacquelin du duval) , 1868 (Coleoptera: Tenebrionidae)

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Abstract. The present research was carried out at the laboratory of plant pathology, Directorate of Diyala Agriculture during 2017 to evaluate the bioactivity of plant extracts Moringa oleifera, Origanum majorana, Artemisia vulgaris, Trigonella foenum and Syzygium aromaticum with three concentrations 10, 20, and 30 % against adults of Tribolium confusum under laboratory conditions. Two bioassays were conducted, the first to evaluate percentage of mortality and second to evaluate repellency percentage. S. aromaticum was recorded higher percentage of mortality 22.2% at 30% concentration after 3 and 4 days, maximum mortality was observed in A. vulgaris 46.6% and 60% at 10% concentration after 7 and 8 days respectively, whereas the average of mortality for plant extracts was higher in A. vulgaris 37.7% followed by S. aromaticum and T. foenum 33.3% with significant differences from control 0% after 8 days. O. majorana was recorded higher average of repellency percentage 46.6% after 10 minute, maximum of repellency percentage was in S. aromaticum 66.6% at concentration10% whereas average of repellency percentage was higher in S. aromaticum 48.8% and M. oleifera 37.7% after 20 minute, while after 30 minute M. oleifera and O. majorana were recorded heights repellency percentage 73.3% and 66.6% at concentration30% respectively and M. oleifera was superior in the average of repellency percentage reached 51.1%.

Keywords: Tribolium confusum; Moringa oleifera; Origanum majorana; Artemisia vulgaris; Trigonella foenum and Syzygium aromaticum

1. Introduction

Tribolium confusum is the most widely distributed and destructive insect pest of stored cereals throughout the world [1]. The adults are long-lived and produce eggs continuously over a long period [2,3]. It is a polyphagous species and a significant pest in flours, adults and larvae feed on various products such as dried fruits, oil plants, corn, coffee, nuts, cocoa and causes decreases the quality of products and led to enormous economic losses each year, adults and larvae feed on flour and cause unpleasant smell in the flour and deteriorate of its properties [4], the protection of stored grain against pests has been a major problem from the development of agriculture [1]. The widespread use of synthetic pesticides has led to several effects such as contamination of food, toxic residues, side effects on non-target insects [5]. The continual use of these synthetic insecticides has led to the development of pest strain resistance [6]. To overcome these problems, it is necessary to seek on
alternative methods, safe, convenient and environmental for pest control. Botanical extracts have several uses in insect control. These products have been studied for its antifeedant, repellent, attractant, and fumigant effects, as well as inhibiting reproduction of many pests. The present study was initiated to find the most effective plant extracts such as *Moringa oleifera*, *Origanum majorana*, *Artemisia vulgaris*, *Trigonella foenum* and *Syzygium aromaticum* in different concentrations 10, 20 and 30 % against *T. confusum*.

2. Materials and Methods

2.1. Collection and preparation of plant extracts

In this study five powders of plants such as *Moringa oleifera*, *Origanum majorana*, *Artemisia vulgaris*, *Trigonella foenum* and *Syzygium aromaticum* were purchased from a local market in Baqubah, One hundred grams of plants powders were mixed separately with 500 ml water in an electric grinder then filtered through muslin cloth for three times and these extracts were diluted to make 10, 20 and 30 %.

2.2. Culture of Tribolium confusum

The adults *T. confusum* were collected from infested flour purchased from the local market and brought to the laboratory then sieving the culture to separate the adult insects (figure 1 and 2).

2.3. Bioassays

2.3.1. Mortality Testing

Petri dishes of 9 cm diameter and a height of 2 cm were treated by added 2 ml from each concentration by rubbing in a cotton piece and another 2ml of ethanol 99% was used as a control and air-dried, five adults of *T. confusum* were introduced into each petri dish, each treatment was replicated three times [9], Dead beetles in each replicate were recorded daily for 8 days and adult mortality was assessed as.

\[
\text{\% Mortality} = \frac{\text{Number of Dead Weevils}}{\text{Total Number of Weevils}} \times 100
\]

2.3.2. Repellent activity of Plant extracts against Tribolium confusum

Petri dishes of 9 cm diameter and a height of 2 cm were divided into two equal halves and drawn a circle of 2 cm diameter in the center, one of the halves was treated by added 1 ml from each concentration by rubbing in a cotton piece and the other half treated with water only and left to dry in the air. Ten adults of *T. confusum* were introduced into each petri dish in the circle, each treatment was replicated three times, percentage of adults in untreated part was recorded for 10, 20 and 30 minutes [10]. Percentage repellency (PR) values were computed using the formula:

\[
\text{PR} = 2(C - 50 \%) \\
\text{Where; PR = percentage repellency} \\
C= \text{percentage of adults in untreated part}
\]

2.3.3. Statistical Analysis

The factorial experiment was conducted and the data was analyzed by one way Analysis of Variance (ANOVA) [11].
3. Results and Discussion

The results in Table 1 and 2 revealed that Percentage of mortality was increased according to the increase of the days, after 1 and 2 days no significant differences in mortality was noted , the higher percentage of mortality was reached 22.2% at 30% concentration of S. aromaticum after 3 and 4 days, maximum mortality was observed in A. vulgaris 46.6% at 10% concentration and S. aromaticum 33.3% at 30% concentration with significant differences from control 0% while the average of mortality for plant extracts was highest in A. vulgaris and T. foenum were reached 26.6% and 22.2 % respectively after 7 days, also A. vulgaris caused the highest mortality of adults reached 60% at 10% concentration followed by S. aromaticum 44.4% at 30% concentration and T. foenum 40% at (20 and 30 % concentrations) whereas the average of mortality for plant extracts was higher in A. vulgaris 37.7% followed by S. aromaticum and T. foenum 33.3% with significant differences from control 0% after 8 days.

The results indicates variation among the plant extracts in repellency percentage against the selected insect in (Table 3), O. majorana was recorded higher average of repellency percentage 46.6% after 10 minute ,maximum of repellency percentage was in S. aromaticum 66.6% at concentration10% followed by A. vulgaris 66.6% at concentration20% and M. oleifera 53.3% at concentration30% whereas average of repellency percentage was higher in S. aromaticum 48.8% and M. oleifera 37.7% after 20 minute, while after 30 minute M. oleifera and O. majorana were recorded heights repellency percentage 73.3% and 66.6% at concentration30% respectively and M. oleifera was superior in the average of repellency percentage reached 51.1%.

Through results of the present study, it was found that S. aromaticum, T. foenum and A. vulgaris were effective in increase mortality percentage of T. confusum while M. oleifera and O. majorana were effective in increase repellency percentage of T. confusum.

[12] reported that the essential oil of S. aromaticum was found to be effective against larvae and adults of Tribolium castaneum, [13] reported that S. aromaticum essential oil has more insecticidal activity against Sitophilus oryzae than the other essential oils, it was found that eugenol was the major component of the oil S. aromaticum and it may be responsible for inhibition of adult development, fumigant toxicity and oviposition deterrent of test insect [14]. The extracts of Trigonella foenum showed repellant activity against adult beetles of Tribolium castaneum [15], extract of Artemisia vulgaris showed higher insecticidal activity against Tribolium castaneum and may be due to the potential compounds was present in hexane extract of the A. vulgaris [16], Origanum majorana oil showed insecticidal activity, repellent and effective in reducing Callosobruchus chinensis infestation in cowpea and wheat , so it can be used as a protective agent to prevent infestation of stored grains by insect pests [17], [18,19] reported that Moringa oleifera can be used as biopesticide and moringa leaves are safe for consumption and have no known toxic elements or negative side effect. Tribolium castaneum was more killed by the extract of Moringa oleifera as compared by other two plant extracts [20].

4. Conclusion

Results of this study point out that some plant extracts might be useful as potent insect-control agents. S. aromaticum, T. foenum and A. vulgaris were found to have potent insecticidal activity toward T. confusum through increase mortality percentage . while M. oleifera and O. majorana were effective in increase repellency percentage of T. confusum, the study demonstrated that these plant extracts can play an important role in the protection of flour from T. confusum.
Table 1: Effect of different concentrations from plants extracts on mortality percentage to adult of *Tribolium confusum* after 1, 2 and 3 days

| Treatment             | (A)          | 1 day | 2 day | 3 day |
|-----------------------|--------------|-------|-------|-------|
|                       | 10% 20% 30% | 10% 20% 30% | 10% 20% 30% | 10% 20% 30% |
| *Moringa oleifera*    | 0.0 0.0 0.0 | 0.0 0.0 0.0 | 0.0 0.0 0.0 | 0.0 0.0 0.0 |
| *Origanum majorana*   | 0.0 0.0 0.0 | 0.0 0.0 0.0 | 0.0 0.0 0.0 | 0.0 0.0 0.0 |
| *Artemisia vulgaris*  | 6.6 0.0 6.6 | 6.6 0.0 6.6 | 6.6 0.0 6.6 | 6.6 0.0 6.6 |
| *Trigonella foenum*   | 0.0 6.6 6.6 | 0.0 6.6 6.4 | 0.0 6.6 6.4 | 0.0 6.6 6.4 |
| *Syzygium aromaticum* | 0.0 0.0 0.0 | 0.0 0.0 0.0 | 0.0 0.0 0.0 | 0.0 0.0 0.0 |
| control               | 0.0 0.0 0.0 | 0.0 0.0 0.0 | 0.0 0.0 0.0 | 0.0 0.0 0.0 |
| Average               | 1.1 1.1 2.2 | 1.1 1.1 2.2 | 1.1 1.1 2.2 | 1.1 1.1 2.2 |
| CD 5% A               | 5.09         | 5.09  | 10.2  |        |
| B                     | 3.6          | 3.6   | 7.2   |        |
| A×B                   | 8.8          | 8.8   | 17.7  |        |

Table 2: Effect of different concentrations from plants extracts on mortality percentage to adult of *Tribolium confusum* after 4, 7 and 8 days

| Treatment             | (A)          | 4 day | 7 day | 8 day |
|-----------------------|--------------|-------|-------|-------|
|                       | 10% 20% 30% | 10% 20% 30% | 10% 20% 30% | 10% 20% 30% |
| *Moringa oleifera*    | 0.0 0.0 0.0 | 0.0 6.6 13.3 | 6.6 13.3 6.6 | 6.6 13.3 11.1 |
| *Origanum majorana*   | 0.0 0.0 0.0 | 0.0 6.6 26.6 | 6.6 26.6 6.6 | 6.6 26.6 33.3 |
| *Artemisia vulgaris*  | 6.6 0.0 6.6 | 46.6 13.3 20 | 26.6 22.2 20 | 20 40 40 |
| *Trigonella foenum*   | 0.0 6.6 6.4 | 20 26.6 20 20 | 20 40 40 20 | 20 40 40 |
| *Syzygium aromaticum* | 0.0 0.0 22.2 | 0 0 33.3 11.1 | 22.2 33.3 44.4 | 33.3 44.4 33.3 |
| control               | 0.0 0.0 0.0 | 0.0 0.0 0.0 | 0.0 0.0 0.0 | 3.6 3.6 3.6 |
| Average               | 1.1 1.1 5.9 | 11.1 8.8 18.8 | 20.9 21.7 26.9 |        |
| CD 5% A               | 10.2         | 17.4  | 19.7  |        |
| B                     | 7.2          | 12.3  | 13.9  |        |
| A×B                   | 17.7         | 30.2  | 34.2  |        |

Table 3: Effect of different concentrations from plants extracts on repellency percentage to adults of *Tribolium confusum* after 10, 20, 30 Minute

| Treatment            | (A)          | 10 Minute | 20 Minute | 30 Minute |
|----------------------|--------------|-----------|-----------|-----------|
|                      | 10% 20% 30% | 10% 20% 30% | 10% 20% 30% | 10% 20% 30% |
| *Moringa oleifera*   | 6.6 46.6 40 | 20 40 53.3 37.7 | 26.6 53.3 73.3 | 51.1 |
| *Origanum majorana*  | 40 53.3 46.6 | 20 46.6 40 35.5 | 20 46.6 66.6 44.4 |        |
| *Artemisia vulgaris* | -13.3 13.3 6.6 | 20 46.6 40 35.5 | 20 46.6 66.6 44.4 |        |
| *Trigonella foenum*  | 6.6 13.3 20 | 13.3 66.6 20 33.3 | 20 26.6 13.3 20 |        |
| *Syzygium aromaticum*| 40 66.6 -6.6 | 66.6 46.6 33.3 48.8 | 33.3 33.3 53.3 40 |        |
| control              | 16 38.6 21.3 | 29 41.3 28 | 29.3 36 42.6 |        |
| Average              | 37.4         | 27.9      | 27.6      | 40       |
| CD 5% A              | 37.4         | 27.9      | 27.6      | 40       |
| B                    | 29           | 21.6      | 21.4      | 37.4     |
| A×B                  | 64.9         | 48.3      | 47.9      | 51.1     |
Figure 1: Adult beetles (Tribolium confusum)

Figure 2: Close-up image of adult beetle (Tribolium confusum)

5. References

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