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Research Article

Management of rice weevil, *Sitophilus oryzae* (Coleoptera: Curculionidae) in stored rice grains using certain indigenous plant materials

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Abstract – Food grains are very essential in daily diet of population worldwide. There are huge qualitative and quantitative losses of rice grains in storages due to attack of rice weevil, *Sitophilus oryzea.* Safe alternatives to traditional chemicals/fumigants are a dire need to combat such losses. This pest regularly causes severe damage to stored products which may be 5 to 10 percent in temperate and 20 to 30 percent in tropical areas. Different indigenous plant extracts including *Cymbopogan citrate*, *Azadirachta indica*, *Eucalyptus grandis,* and *cannabis sativa* were used against this pest under laboratory conditions. Parameters of study were adult mortality rate, grains weight loss and F_1 adult emergence. The maximum mortality of pest was observed in grains treated with *A. indica* that is 66% and the minimum mortality was found in *Cannabis sativum* that is 55%. The maximum weight loss (47%) was recorded in grains treated with *A. indica* as compared to other plants extracts.

Keywords – Rice Weevil, Management, Plant Extracts, Mortality, Weight Loss

1. Introduction

Rice, *Oryza sativa* belongs to family poaeceae an annual monocot crop, it is widely grown cereal with high food value (Adeola et al. 2020). It has high nutritional value of 80% carbohydrates and easy to digest for humans. It contains low fats and cholesterol with high nutritional content (Mishra et al. 2016). About 6 million tons of rice is produced every year in Pakistan and this is 30% of total world rice production (Ashfaq et al. 2017). Rice is staple food of almost 1.6 billion people of the world especially in Asia, Latin America and some part of Africa (Govindharaj et al. 2018). Farmers want to produce more quantity of food and maintain their quality but they failed to produce because they loss most of rice during harvest and after storage the food being attacked by the stored insect pest specially rice weevil (Kumar & Kalita 2017). After the harvesting of crop the main problem facing by the farmers are stored insects that is why storage need much attention of the farmers to look after. In subcontinent the farmers used old method for storaging the crop and in most of the cases the crop are facing insects attack and moisture problem (Grover &Singh 2013).

Rice is very important and second staple food after wheat in Pakistan. The time period of crop is 8 month (Osaigbokan et al. 2017). While storing this crop, rice weevil (*Sitophilus oryzae*) damages 10 to 20 percent and it also affect the

country economy (Phillis et al. 2010). *Sitophilus oryzae* also damage the seed grain and can cause weight losses which also reduced the nutritional values for this purpose synthetic chemical insecticides have been widely used by the farmers but it has serious health hazards and not providing the eco-friendly environment (Aslam et al. 2002).

Under storage condition, different biotic and abiotic factors cause deterioration of stored grain products. Among biotic factors insect pest and rodent are important to crop. The insect pest caused quantitative and qualitative losses in storages ranging from 5 to 10 percent in the temperate and 20 to 30 percent in the tropical areas (Nakakita 2000). According of FAO the world wide losses have been estimated to be about 20 percent due to insects and rodents, however these 10 percent in Europe and North America and 30 percent in Africa and Asia. It is reported that rice is most common and suitable host for *S. oryzae* in respect of egg deposition and adult emergence and seed grain discoloration which lead to loss of yield (Arshad et al. 2009).

In stored products the rice weevil is major pest present all over the world. It is active throughout the year specifically it caused serious damage in July to November. This insect need moisture for their survival if it is suitable environment and moisture content available it can be multiple in large numbers (Ghosh & durbey 2003). Their larva and adult are the internal feeders of grain and female lay eggs inside the rice kernel where the larvae develop to adult stage and caused lower the quantity of grains and kernel are damage by rice weevil (*Sitophilus oryzae*).Their adult and grub caused serious damage to rice and other crops like wheat, maize, sorghum, lentil and barley. The larvae of *Sitophilus oryzae* consumed 14 mg grain per day and when it reaches to adult stage it can consume almost 0.4gm grain per day (Giolebiowska 1969). We also know as major destructive pest of stored grain commodities and cause huge losses.

2. Materials and methods

i. Collection and Rearing of Rice Weevil:

Adults of rice weevil were collected from different gowdons and stores. *Sitophilus oryzae* were reared in Stored Product Laboratory of Entomology of the University. Insects were reared in incubator at controlled condition with 30^{o}C and 65% relative humidity. The rice weevil was reared for 2 months. After completion of rearing process, the infested grains having adults and pupae of *S. oryzae* were screened to separate the adults from jars.

ii. Insect Bioassays:

Plant leaves were collected from different parts of pothwar region of Punjab Province Pakistan and also from the university campus. Following plants i.e. *Cymbopogan citrate, Azadirachta indica, Eucalyptus grandis,,Cannabis sativum* were used in the current study. These plants were easily available in Punjab region and were used against *Sitophilus oryzae*. Leaves of the collected plants were washed in tap water. These were dried in the shade to become crispy dry. These dried leaves were made to powder form. The 50g of each powder were placed in 1 liter flask separately and 100ml ethanol was added in each flask. These flasks were placed in rotary shaker at 120rpm for 48 hours. After 48 hours, the solutions were filtered by Whatman's paper No. 1 for every flask. The filtrates were aqueous extracts, which were collected in beakers separately. Thin film rotary evaporators were used to evaporate the solvent. The obtained extracts were kept for bioassays in refrigerator at 0°C.

iii. Application of Extracts:

In each jar 50g of rice grains were treated with five concentrations of every plant extract. Each extracts has three replications along with a control. Ten pairS of adults of rice weevil were released in each jar. The jars were covered with muslin cloth tightened with rubber band and then placed in the incubator at 30°C.

3. Results and Discussion

1. Insect Mortality:

The highest adult mortality observed in grains treated with extract of *A. indica was* 24%, 50% and 66% after 24, 48 and 72hours respectively. In control the total adult mortality was 6%. Mortality graph shows that our result are

similar with Devi et al. (2014) who conduct the experiment on different six plants extract and observed 51% mortality after 24 hours and 47% after 48 hours when it treated with neem. This difference was due to environmental factor. The highest mortality showed with higher concentration after 72h the adult were dead with maximum number as compared to control which has minimum mortality.

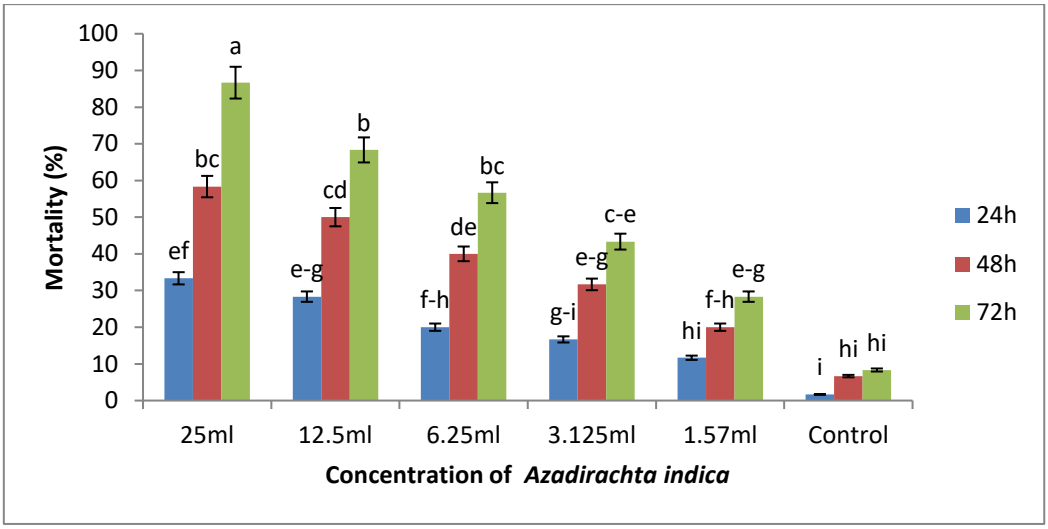

Figure 1. Adult mortality in stored rice grains treated with *Azadirachta indica*

The highest adult mortality observed in grains treated with extract of *Cannabis sativum* was about 25%, 42% and 55% and lowest mortality 10%, 13% and 17% after 24, 48 and 72 hours respectively. In control the total adult mortality was 5%. Mortality graph shows that our result are same with Devi et al. (2014) who conduct the experiment on different six plants extract and observed 51% mortality after 24 hours and 47% after 48 hours when it treated with neem. This difference was due to environmental factor. The highest mortality shows with higher concentration after 72h the adult were dead with maximum number but when the concentration was dropped to the minimum, the mortality was the minimum as far as control has concerned which showed minimum mortality with maximum losses.

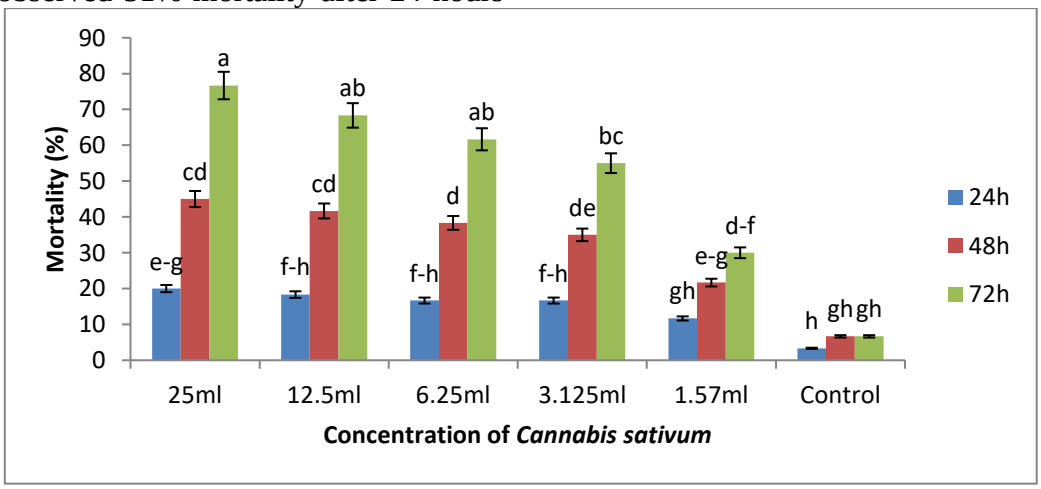

Figure 2. Adult total mortality in stored rice grains treated with *Cannabis sativum*

The highest adult mortality found in grains treated with extract of *Eucalyptus grandis* was 23%, 38% and 59% and lowest mortality 9%, 11% and 18% after 24, 48 and 72 hours respectively. In control the total adult mortality was 5%. Mortality graph shows that our result are similar with Gaje Singh et al. (2018) who conduct the experiment on efficacy of plant derived essential oils against *S. oryzae* and observed 25% mortality after 24 hours

and 36% after 48 hours and 61% after 72 hours when it treated with eucalyptus.

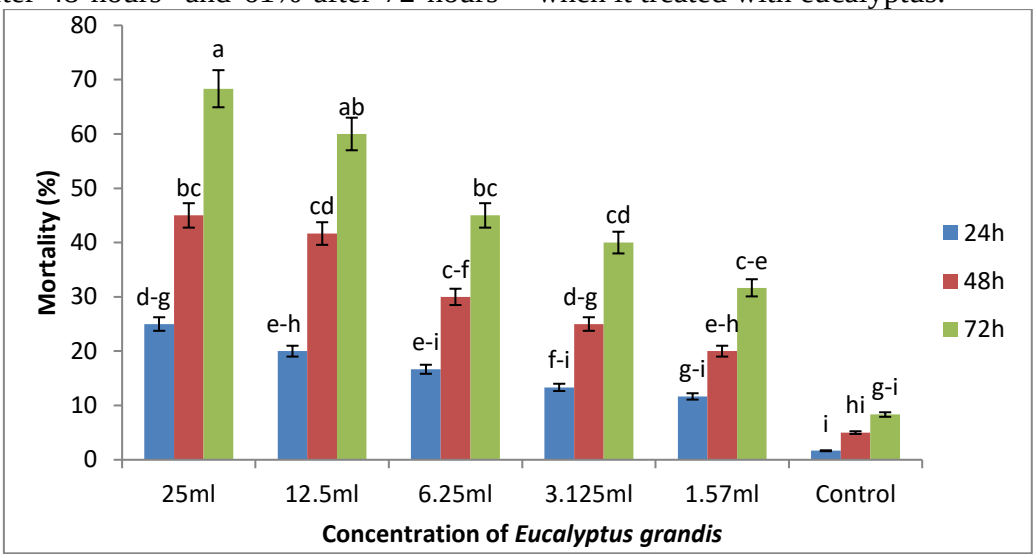

Figure 3. Adult mortality in stored rice grains treated with *Eucalyptus grandis*

The highest adult mortality found in grains treated with extract of *Cymbopogan citrate* was about 30%, 50% and 61% and lowest mortality 5%, 10% and 13% after 24, 48 and 72 hours respectively. In control the total adult mortality was 7%. Mortality graph shows that our result are same with Gaje Singh et al. (2018) who conduct the experiment on efficacy of plant derived essential oils against *Sitophilus oryzae* in stored wheat grains and observed 35% mortality after 24 hours and 51% after 48 hours and 66% after 72 hours when it treated with eucalyptus.

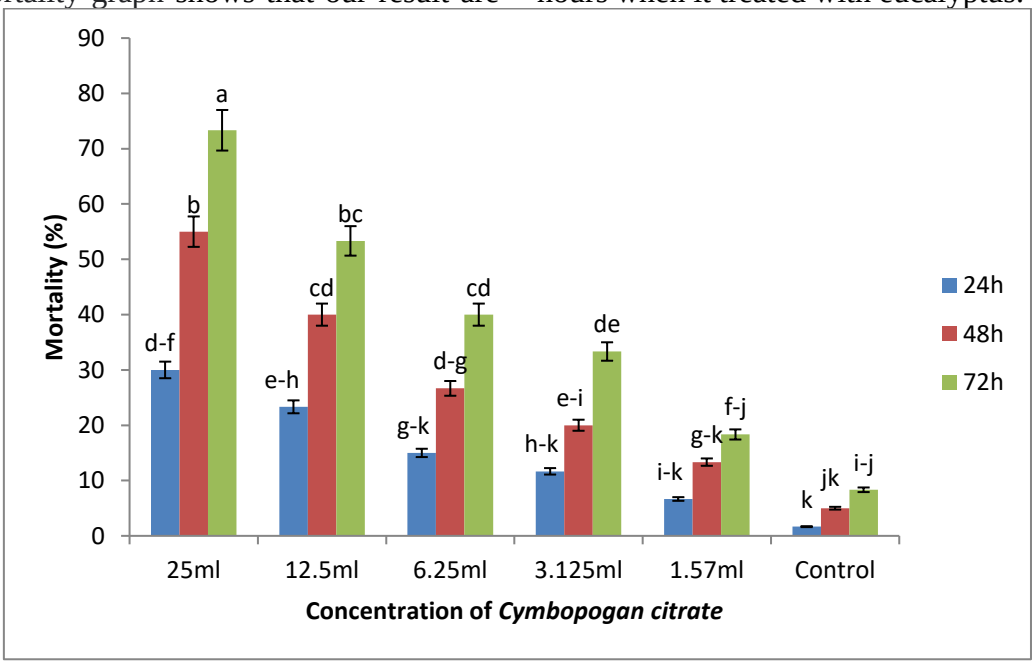

Figure 4. Adult mortality in stored rice grains treated with *Cymbopogan citrate*

2. Weight loss:

After infestation of S. *oryzae*, the effect of plant extracts on grains was dose dependent and showed that treated grains weight loss was low as compared to control, which provide maximum weight loss of 47% in *Azadirachta indica* in stored rice grains. The minimum weight (26%) loss was recorded at higher concentration which was statistically different from all other plant extract. Our result are similar with Zahir rayhan et al. (2014) was conducted experiment on bio-efficiency of neem, mahogoni and their mixture to protect seed damage and seed weight loss by rice weevil in storage. In this experiment the minimum

weight loss is 19% the remaining difference was due to environmental factors.

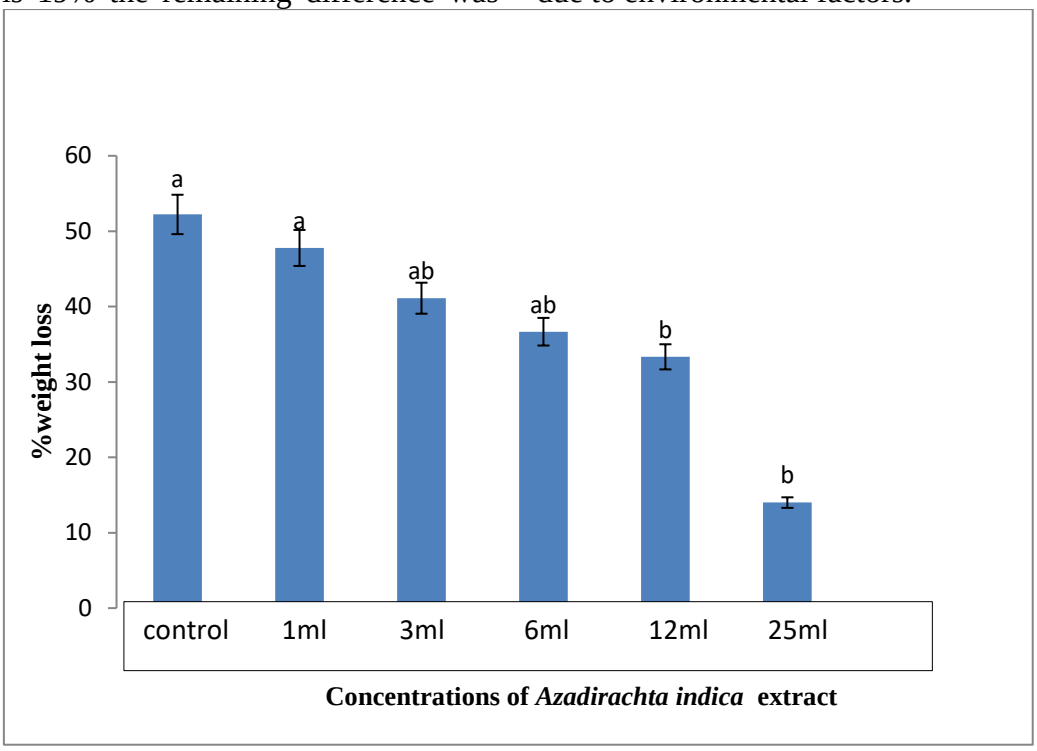

Figure 5. Aptness of *Azadirachta indica* on percentage weight loss of grains due to rice weevil

After infestation of *S. oryzae* the effect of plant extracts on grains was dose dependent and showed that treated grains weight loss was low as compared to control, which provide maximum weight loss of 49% in *Cannabis sativum* in stored rice grains. The minimum weight loss (19%) was recorded at higher concentration that was which was statistically different from all other plant extracts.

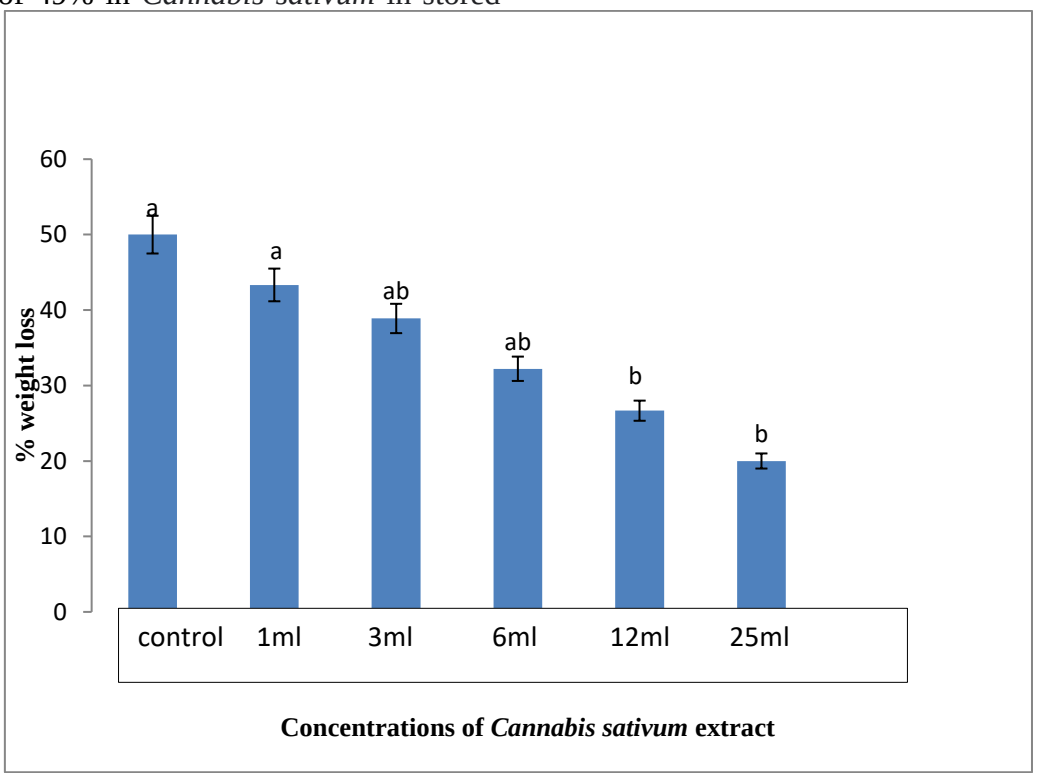

Figure 6. Aptness of *Cannabis sativum* on percentage weight loss of grains due to rice weevil

After infestation of *S. oryzae* the effect of plant extracts on grains was dose dependent and showed that treated grains weight loss was low as compared to control, which provide maximum weight loss of 50% in *Eucalyptus grandis*in stored rice grains. The minimum weight loss (17%) was recorded at higher concentration that was which was statistically different from all other plant extract. Our results are align with Gaje singh et al. (2018) he conducted the experiment on Efficacy of plant derived essential oils against *Sitophilus oryzae* in stored wheat grains. In this the weight loss is about 10%. The minor difference was about to environmental factors

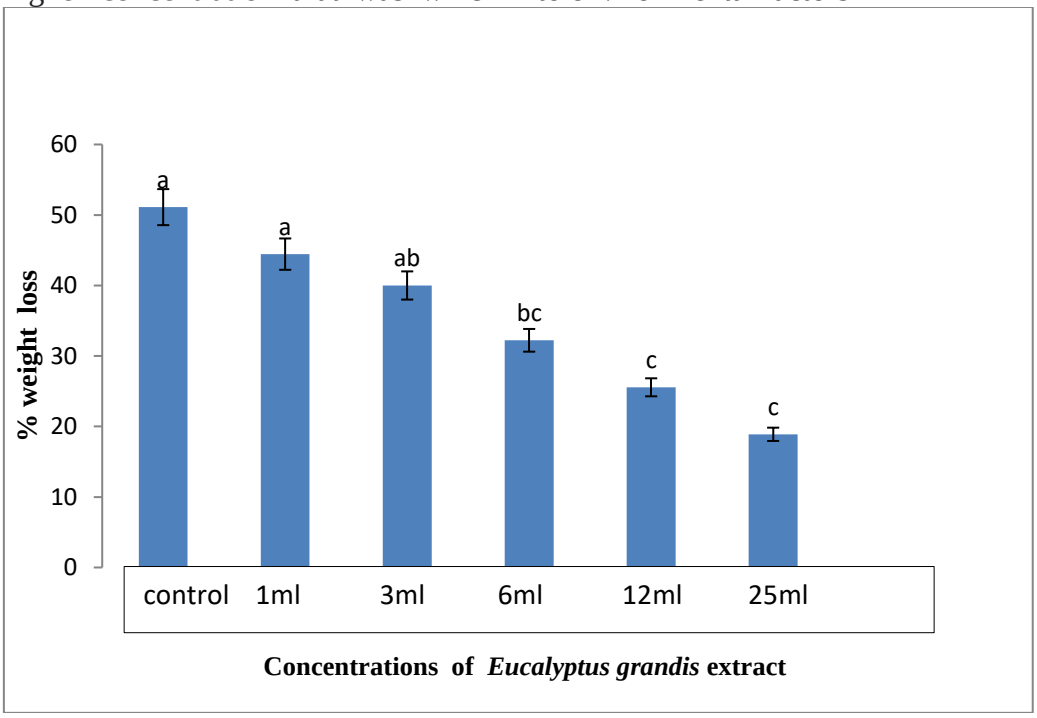

Figure 7. Aptness of *Eucalyptus grandis* on percentage weight loss of grains due to rice weevil

After infestation of *S. oryzae* the effect of plant extracts on grains was dose dependent and showed that treated grains weight loss was low as compared to control, which provide maximum weight loss of 43% in *Cymbopogan citrate* in stored rice grains. The minimum weight loss (18%) was recorded at higher concentration that was which was statistically different from all other plant extracts. Our result is similar with Aboelhadid M. et al. (2021) conducted an experiment about Control of red flour beetle (*Tribolium castaneum*) in feeds and commercial poultry diets via using a blend of clove and lemongrass extracts. Their weight loss percentage was 12%.

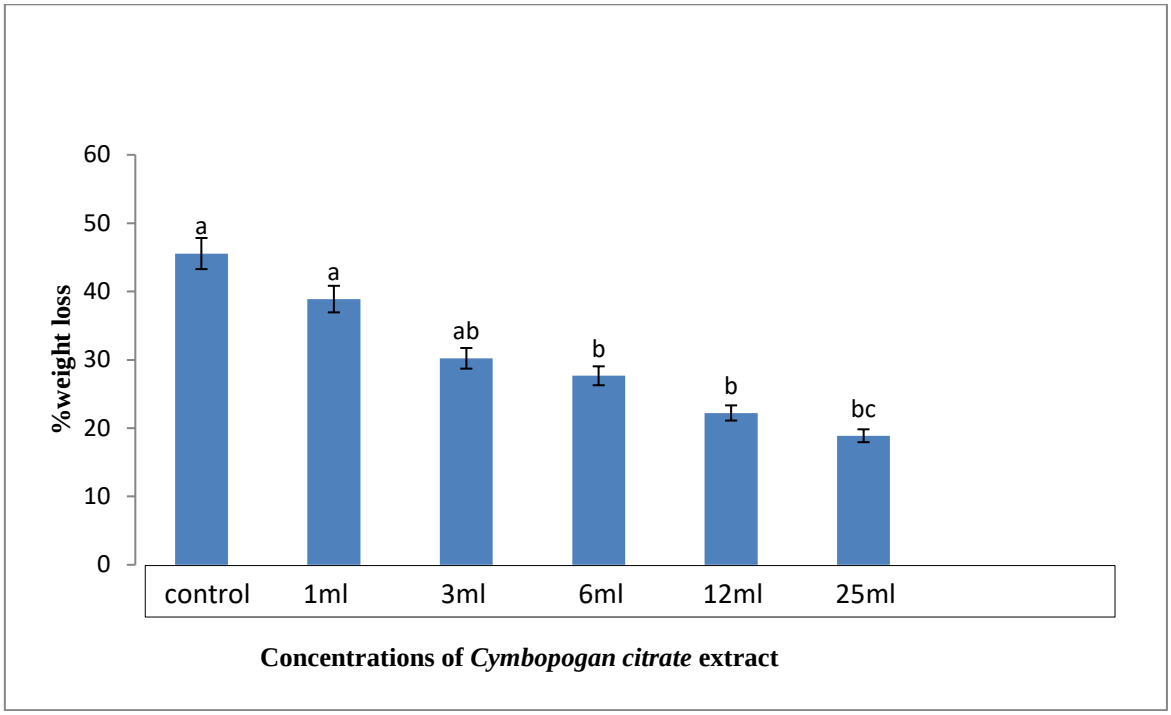

Figure 8. Aptness of *Cymbopogan citrate* on percentage weight loss of grains due to rice weevil

3. F_1 Adult Emergence:

All plants extract show significantly reduced adult emergence in rice grains as compared to untreated grains. The highest number of adult emerged was 24 in grains treated with *Cymbopogan citrate.* The minimum number of adult emerged 23 treated with *Cannabis sativum.* However among the untreated grains the highest number of adults emerged 30 in *Eucalyptus grandis* in stored rice grains. The minimum number of adult emerged were 26 in *Cannabis sativum* treated grains. The *Azadirachta indica* showed statistically different result from other three plant extracts and providing the best result in reduced number of F_1 adult in stored rice grains. The maximum number of adults in lemon grass was about 47.82% among the treated ones and the minimum number of newly emerged 43.75 in *Cymbopogan citrate.* In *Azadirachta indica* the highest newly emerged was 48.93 with treated ones and the lowest adult emerged 41.37 percent which is almost similar to extract of *Cymbopogan citrate.* In *Eucalyptus grandis* the maximum number of adult was 48.88% and lowest adults emerged was 44.11%. As far as *Cannabis sativum* is concerned the maximum number of newly emerged was 44.89 percent and the lowest number 37.50 percent that was almost lowest among all the extracts which treated ones.

Table 1. F_1 adult emerged of *Sitophilus oryzae* in stored rice grains, treated with different concentrations of *Cymbopogan citrate* extract

Concentrations	Mean±S.E
25ml	37.82±4.41a
12.5ml	43.75±4.41ab
6.25ml	45.00±2.89ab
3.1ml	44.44±4.41ab
1.5ml	47.05±5.77bc
Control	48.21±8.66b

Table 2. F_1 adult emerged of *Sitophilus oryzae* in stored rice grains, treated with different concentrations of *Azadirachta indica* extract

Concentrations	Mean±S.E
25ml	35.61±4.41a
12.5ml	41.37±7.64ab
6.25ml	46.87±7.64ab
3.1ml	43.58±4.41bc
1.5ml	48.93±4.41b
Control	50.87±6.01b

Table 3. F_1 adult emerged of *Sitophilus oryzae* in stored rice grains, treated with different concentrations of *Eucalyptus grandis* extract

Concentrations	Mean±S.E
25ml	34.83±3.33a
12.5ml	44.11±2.89ab
6.25ml	46.15±5.77ab
3.1ml	48.88±4.41bc
1.5ml	46.93±1.67bc
Control	52.63±2.89c

Table 4. F_1 adult emerged of *Sitophilus oryzae* in stored rice grains, treated with different concentrations of *Cannabis sativum* extract

Concentrations	Mean±S.E
25ml	37.44±5.00a
12.5ml	37.5±7.64b
6.25ml	43.58±6.01bc
3.1ml	41.86±8.66ab
1.5ml	44.89±6.01b
Control	45.61±3.33c

CONCLUSION

In this study, the use of ethanol extracts of leaves of four different indigenous plants extract like *Cymbopogan citrate, Eucalyptus grandis, Cannabis sativum, Azadirachta indica* were tested against *Sitophilus oryzae*. Results revealed that all plants extract effective against rice grains. The highest mortality was recorded in *A. indica* that was 65 percent in treated grains while lowest mortality was recorded in *C. sativum* that was about 55 percent as compared to control. The highest F_1 adult emerged in neem 49 percent with treated grains. The lowest adult emerged was 37 percent in *C. sativum* as compared to control. The maximum weight loss was recorded in *A. indica* 47 percent as compared to other three plants extract. The minimum weight loss was 16 percent in *E. grandis* in treated grains. The treated grains were minimum weight loss as compared to control. All plants extract show significantly reduced adult emergence in rice grains as compared to untreated grains. The highest number of adult emerged 24 treated with *C. citrate.* The minimum number of adult emerged 23 treated with *C. sativum.* The results of this study will lead to determination of effective formulations of different plant extracts against rice weevil, which will lead to development of bio-pesticides against stored grain insect pests.

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