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Efficacy of different medicinal plant extracts against *Rhyzopertha dominica* (Fabr.) (Bostrichidae: Coleoptera)

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Abstract
Rhyzopertha dominica (F.) is a very important and destructive pest of stored grains and cause serious ongoing problems in grain stocking. The main objective of this study was to evaluate the efficacy of four different plant extracts against *R. dominica*. The results of present study showed that among all medicinal plant extracts, maximum mortality was observed (67.81%) in case of *P. nigrum* after 120 hours of application. Similarly, the repellency percentage was also observed greater in treatment where *P. nigrum* applied. Percent weight loss and progeny development was also zero when *P. nigrum* was applied at 20% concentration. Overall, *P. nigrum* was observed effective against *R. dominica* and could be integrated into stored insects management system.

Keywords: Concentrations, plant extracts, *Rhyzopertha dominica*, toxicity

1. Introduction
Wheat, *Triticum aestivum* L. is the most important and chief cereal crop in Pakistan, occupying a prominent place in financial system. It is recognized as the staple food for the people of Pakistan and therefore, overcomes a critical position in forming agriculture policies and dominates all agronomic crops in term of acreage and production. It contributes14.4% to the value added in agriculture and 3.0% to gross domestic product (GDP) of Pakistan [6].
Insect pests cause substantial losses (running into millions of rupees) not only to field crops but also to stored grains, fruits, vegetables. About 39 species of insect pest attack the stored grains and grain products. Out of these, the lesser grain borer, *Rhyzopertha dominica* (F.) (Bostrichidae: Coleoptera) is more important insect as it is destructive at larval as well as adult stage [18]. The adults are migrating from one godown to another, causing a rigorous loss of quantity and quality of grain and its products [3]. It reduces the essential amino acid contents of wheat, maize and sorghum [10] and also reduces the germination ability and vigor of seeds [9]. Infested grain is then susceptible to promote the damage caused by secondary pests and fungi [11].
Due to this high rate of infestation, synthetic insecticides have been used to control it [16]. The excessive use of such chemical insecticides have critical effect on the stored grain insect pests including resistance [4], residual effects on grains, harmful effects on human health and toxic to beneficial insects [21]. However, due to the above constraints, there is a need to develop such materials which are more effective against the stored grain insect pests and have no negative aspects. The problems caused by pesticides and their residues demand for alternate, biodegradable and selective chemicals. Extracts produced by different plants genera have been reported to be biologically active and are capable with insecticidal, antimicrobial and bio regulatory properties [8]. Over 2000 species of plants are reported which contain the bioactive substances. The study was conducted to evaluate the bioactivities of different plant extracts against *Rhyzopertha dominica*.

2. Materials and Methods
The study was conducted in the Grain Research, Training and Storage Management Cell of the Department of Entomology, University of Agriculture, Faisalabad during the year 2010-2011.

2.1 Rearing of culture
The adults of tested insect were collected from grain markets and flour mills of Toba Tek Singh, Pakistan. Insect culture was reared on the whole wheat grains, sterilized at 60 °C for 60-90 minutes in sterilized glass jars and maintained at 28±2 °C temperature and 70±5% R.H. Each jar was filled with 2 kg of wheat grains and 50 pairs of *R. dominica* were released in each. The jars were covered with muslin cloths and tied with rubber bands to avoid the escape of insects.

2.2 Preparation of plant extracts
Seeds of black pepper (*Piper nigrum*), leaves of tobacco (*Nicotiana tabacum*), rhizomes of turmeric (*Curcuma longa*) and ginger (*Zingiber officinale)* were collected from the market located in Faisalabad District. These plant materials were shade-dried and grinded with the help of an electric grinder. The grinded materials were sieved with a 40-mesh sieve to obtain fine powders. Extractions were done using acetone as a solvent by adding 50 g of each powder in 100 ml of solvent (acetone). Mouth of each flask was closed with cotton plug to avoid the evaporation. The samples were loaded on a rotary shaker at 120 rpm for 24 hours. Filtration was done with the help of Whatman filter paper.

2.3 Contact toxicity bioassay
From 100% stock solution, four dilutions of each extract (5%, 10%, 15% and 20%) were prepared in acetone. The experiments were conducted using completely randomized design (CRD) and each treatment was replicated three times. Aliquots of each dilution were applied on 40 g of wheat with the help of a pipette, while the control was treated only with acetone. Each jar was shaken mechanically for two minutes to achieve homogeneous distribution of extract. After acetone evaporation for an hour, twenty unsexed adults of *R. dominica* were introduced in each jar. Jars were placed in incubator at 32 °C temperature with 65% R.H. Mortality data was recorded at 24, 48, 72, 96 and 120 hours after application. Mortality was corrected and calculated according to the Abbott's formula [1].

$$\% \text{ corrected mortality} = \frac{\%Mo - \%Mc}{\%Mc} x100$$

M_o = observed mortality, M_c = corrected mortality

2.4 Repellency
Repellency experiment was carried out in 80 mm glass Petri dishes. The filter paper was cut into two equal pieces and each concentration was applied at half portion of filter paper as uniform as possible by using micro pipette. The other half of the filter paper was left untreated. Control was treated with acetone alone. The treated halves were air-dried to evaporate the solvent completely. Treated and untreated halves were attached with cellophane tape and placed in each Petri dish. Twenty adults of *R. dominica* were released at the center of the filter paper disc in each Petri dish and then sealed firmly. Each treatment was replicated thrice. The number of insects present on both the treated and untreated halves was recorded after 24 hours of application.

2.5 Percent weight loss
Percent weight loss was measured by counting and weighing of damaged and undamaged fractions in a sample of 100 grains after 35 days of treatment [15].

2.6 Population build-up
The survived individuals from the contact toxicity were transferred into the new clean jars, containing 40 g of sterilized wheat and the data of population build-up of F1 generation of *R. dominica* was recorded after 35 days. Progeny produced by a pair of *R. dominica* was also determined [17].

2.7 Data analysis
All the data obtained were subjected to one-way analysis of variance at 5% significance level and means were separated by Tukey HSD all pairwise comparison test using Minitab 16.1 software.

3. Results
The results of present study showed that among all the medicinal plant extracts, maximum mortality (67.81%) was observed in case of *P. nigrum* after 120 hours of application. *Z. officinale* was proved least toxic (4.58%) after 120 hours of application. The percent mortality increased with the passage of time (Table 1). The mortality percentage was observed greater (55.66%) in case of *P. nigrum* when applied with 20% concentration. So, the percent mortality was greater by the application of higher concentration of plant extracts (Fig. 1). Similarly, the percent weight loss was observed 0.00% in case of *P. nigrum* at both 15% and 20% concentrations. Overall, the percentage weight loss was greater in control as compared to treated insects (Fig. 2). Although, the percent repellency of *R. dominica* was maximum (90%, 83.33%) in *P. nigrum* and *C. longa* respectively (Fig. 3). Furthermore, the percentage progeny development of *R. dominica* was observed 0.00% in *P. nigrum* and *N. tabacum*. Percent progeny development was greater (6.29%) in case of *C. longa* (Fig. 4).

Table 1: Percent mortality ± SE of *R. dominica* after application of different plant extracts at different time intervals

Treatments	24HAT	48HAT	72HAT	96HAT	120HAT
C. longa	1.67±0.013	2.92±0.462	5.42±0.897	8.75±0.936	13.33±1.037
P. nigrum	5.46±1.373	14.17±0.896	36.25±1.894	55.42±2.894	67.89±2.964
Z. officinale	0±0.00	1.25±0.236	2.92±1.124	4.17±1.126	4.58±1.643
N. tabaccum	2.92±0.253	6.67±0.936	15.83±1.254	28.75±1.754	43.32±2.153

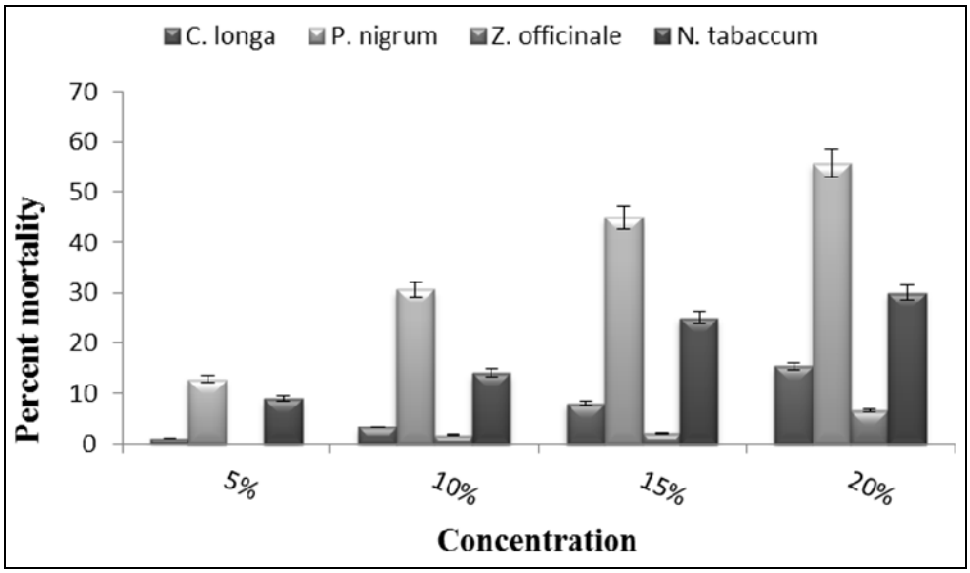

Fig 1: Percent mortality ± SE of *R. dominica* after application of different plant extracts at different concentrations

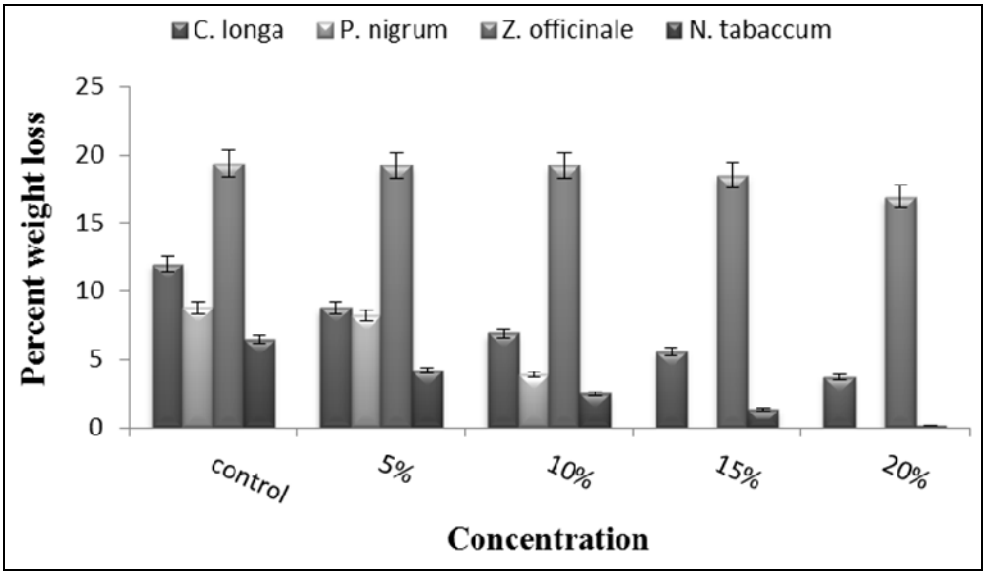

Fig 2: Percent weight loss ± SE of *R. dominica* after application of different plant extracts at different concentrations

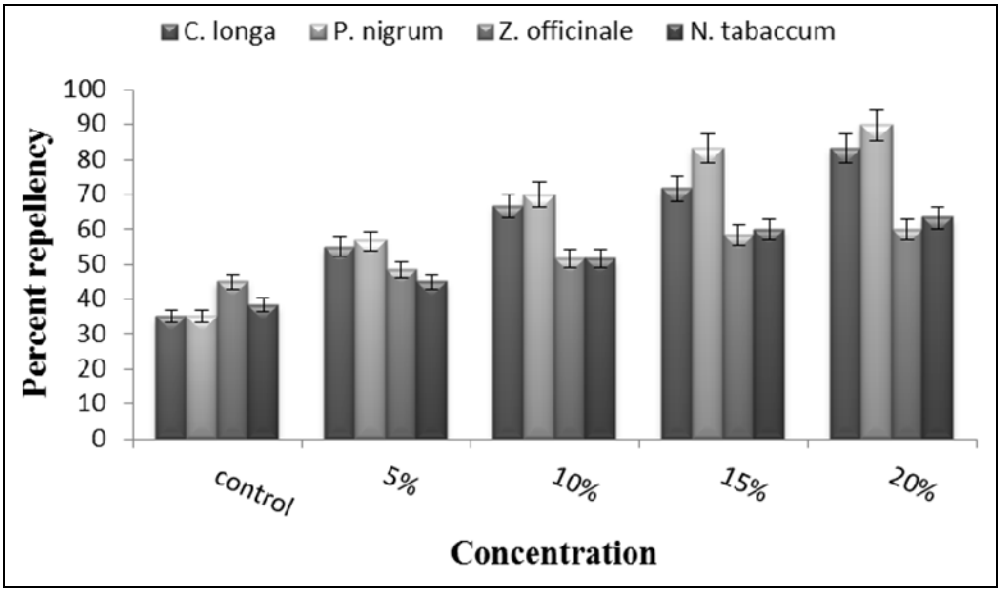

Fig 3: Percent repellency ± SE of *R. dominica* after application of different plant extracts at different concentrations

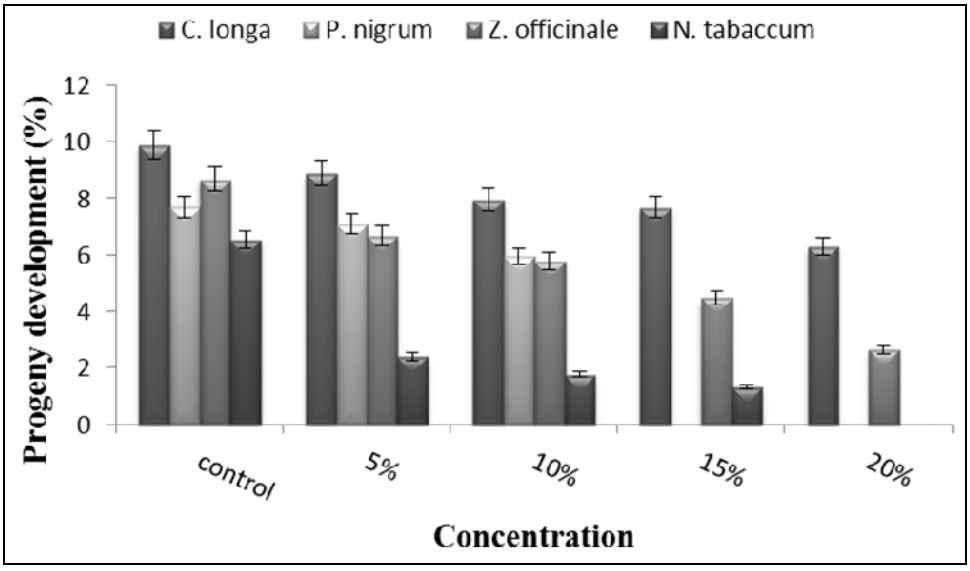

Fig 4: Percent progeny development ± SE of *R. dominica* after application of different plant extracts at different concentrations

4. Discussion

The present research work has been carried out for evaluation of appropriate concentration for *Curcuma longa*, *Piper nigrum*, *Zingiber officinale* and *Nicotiana tabacum* against *R. dominica* to find out some safe alternatives of highly toxic chemicals for the control of insect pests of stored grains. The results revealed that different concentrations of tested plant extracts against the *R. dominica* varied greatly with regard to insect mortality, percent weight loss, their repellent action and population build-up. Acetone extract of *P. nigrum* was most effective as compared to *N. tabacum*, *C. longa* and *Z. officinale* and showed more mortality to *R. dominica*. Botanical source insecticides may serve as alternatives to commercially used synthetic chemical insecticides and many of them have often been used against a number of species of stored product insect pests including Coleoptera and Lepidoptera [12]. They are believed to be easily biodegradable and not toxic to non-targeted organisms. Moreover, prior to the discovery of the organochlorine and organophosphate insecticides in the late 1930s and early 1940s, botanical insecticides have remained an important weapon in the farmer's armory in managing insect pests of their farm produce [7]. Many Nigerian plant species are medicinal and they are proved to be effective against a wide range of insect pests [2].

In case of *R. dominica,* no weight loss was observed at 20% and 15% concentration of *Piper nigrum* while minimum weight loss was observed at 10% concentration. Ousman *et al.* [14] reported that *P. nigrum* leaf oil was the most toxic to stored insect pests and concluded that it can be used as a substitute of synthetic insecticides by small scale farmer. Upadhyay and Jaiswal [19] reported that *P. nigrum* oil significantly suppressed the progeny development of *Tribolium castaneum*. Chaubey [5], reported that *P. nigrum* oil reduced the progeny development of *Callosobruchus chinensis.* The inability of these insects to emerge may be due to the death of the insect's larvae, which may occur due to inability of the larvae to fully cast off their exoskeleton, which remained linked to the posterior part of their abdomen. This is in agreement with the observation by Oigiangbe *et al*. [13], who worked on insecticidal properties of an alkaloid from *Alstonia boonei*. The different chemical compositions of these plants, as mentioned earlier, could be responsible for the inability of the adult insects to emerge, as they are found to disrupt growth and reduce larvae survival as well as disruption of life cycle of insects [20].

5. Conclusion

This study suggests that *P. nigrum* extract may be a potential grain protectant due to its toxicity and antifeedant activity against *R. dominica*. The results of this study highlight the potential benefit of further research on this extract against different insect pest of stored grains.

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