STUDIES ON EFFICACY OF BOTANICAL OILS AND LEAF POWDERS AGAINST LESSER GRAIN BORER, RHYZOPERtha DOMINICA (F.) IN STORED WHEAT

SYED MOHAMED IBRAHIM S¹, PRITHIV RAJ V¹ and PRABAKARAN V²

Department of Agricultural Entomology, C P College of Agriculture, SDAU 385506, Gujarat, India
Department of Agricultural Entomology, B A College of Agriculture, AAU, Anand 388110, Gujarat, India
*Email: syedali.s1966@gmail.com (corresponding author): ORCID ID: 0000-0003-2304-1326

ABSTRACT

The experiment on biological activity of botanical oils and leaf powders against R. dominica was conducted under laboratory condition. The results revealed that among the botanical oils and leaf powder, the castor oil 2.0% and neem leaf powder 1% achieved maximum adult mortality at 72 hr after treatment (91.67% and 81.67%) and revealed as the best grain protectants with least seed damage (4.33% and 3.67%), weight loss (2.01% and 1.04%), F₁ adult emergence (3.67 and 4.33) and high inhibition rate (97.25% and 97.34%). This is due to their high viscosity of oils and asphyxiation effect by leaf powders. The finding also revealed that the botanical oils and leaf powders do not affect the germination of wheat seed.

Key words: Abrasion, asphyxiation, adult mortality, inhibition rate, efficacy, seed protectants, botanical oils, Rhyzopertha dominica, wheat, viscosity

Wheat is the strategic cereal crop for the majority of the world’s population. In India, it was the second most produced cereal with an estimated production of 107.18 mt and 3507 kg/ha during 2018-19 (Anonymous 2019). The postharvest losses of the stored product due to insects were 9% to 20% in developed countries and 2.0 to 4.2% in developing country such as India (Anonymous 2019). As in the case of India, 20-25% food grains were damaged by insect pest of stored grain (Rajashekar et al., 2010). Wheat is attacked by approximately 39 species of insect pests in field as well as storage condition. Among them lesser seed borer is a primary pest of wheat in storage (Mark et al., 2010), which causes heavy losses ranging from 15 to 66% per annum (Singh, 2010). To overcome this problem, farmers are using different synthetic insecticides and phosphine gas during storage in today’s practice for control of stored grain insect pests (Anwar et al., 2003). Moreover, the continuous use of chemicals has also resulted in the development of a high degree of resistance in insects to phosphine in India (Mau et al., 2012). Although insecticides are best, their repetitive usage leads to environmental pollution, residual toxicity and adverse effect on human food (Lu and Wu, 2010). These problems pave the way to develop an effective alternative pest control method. Among different methods, the researcher focused much effort on plant derived materials (Lengai et al., 2020). Hence, locally available different botanical oils and leaf powders showed strongest fumigation activity, repellent activity, antifeedant and ovicidal activity (Moses et al., 2020) which are considered to be cost-effective and environmentally safe alternative to synthetic insecticides and fumigants.

MATERIALS AND METHODS

The efficacy of different oils and plant leaf powder against the R. dominica were investigated under laboratory condition. The botanical oils were made into 1 and 2% concentration. The leaves of such plants were pulverized into fine powder (Ileke and Bulus, 2012) which were quantified at 2% concentration (20 g/ kg) and untreated as control. The culture of Rhyzopertha dominica was collected at Wheat Research Station, Vijapur. 200 g of dry seeds (GW 451) was mixed vigorously with required quantity of seed protectants. Twenty pairs of adults were released into each container having treated seeds. The observations on adult mortality were recorded at 24, 48 and 72 hours after release of adults. The death of beetles was confirmed by Adedire et al. (2011). The experimental set up was kept undisturbed for 60 days to allow adult emergence of F₁ generation. After excluding the frass from each treatment, the final weight of seed was measured (Khattak et al., 1987). The seed damage (%) of each treatment after 60 days and inhibition rate (%) of F₁ generation adult emerged was calculated the formula given by Kakade et al. (2014) and Tapondjou et al. (2002). The emergence of F₁, adult generation was assessed in from each treatment of oils and leaf
powder was counted started a week after oviposition. In order to determine the detrimental impact of plant products on seed viability, the germination test of the treated seed samples was conducted as per procedure followed by Kakade et al. (2014). The data were collected statistically by using the one way analysis of ANOVA and were analyzed by using the SPSS computer program (IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY: IBM Corp.).

RESULTS AND DISCUSSION

The results of botanical oils obtained are presented in Table 1. The % adult mortality of *R. dominica* was recorded in 24, 48 and 72 hrs after release in wheat, which was significantly superior over untreated control. In present study, the efficacy of different oils in 24, 48 and 72 hrs after treatment showed the maximum adult mortality of 55.00%, 73.33% and 91.67% were displayed in castor oil 2% and the groundnut oil 1% displayed least adult mortality of 11.67%, 16.67% and 25.00%. The study indicated that all the treatment have various adult mortality % and its efficacy also impairing the adult’s growth and development. The least weight loss (%) was noticed in castor oil 2% (2.01%) and maximum weight loss (%) in groundnut oil 1% (14.07%) before control (39.17%). Kumawat and Naga (2013) who evaluated three oils and observed that the least weight loss in castor oil 1% among them, which also positive relation with natural product concentration and weight loss. In oils treatment at different conc., there was no seed infestation or damages were recorded before the 60 days of treatment. After 60 days treatment, the minimum seed damage (%) was recorded in the castor oil 2% (4.33%) and maximum seed damage (%) was noticed in castor oil 1% (35.33%) before control (58.67%) (Table 1). Kumawat and Naga (2013) who revealed that lower seed damage and weight loss. In oils treatment at different conc., there

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Treatments (oils)</th>
<th>Dose (ml/kg)</th>
<th>Adult mortality (%)</th>
<th>Weight loss (%)</th>
<th>Seed damage (%)</th>
<th>F, adult emergence</th>
<th>Inhibition rate (%)</th>
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<tr>
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Table 1. Effect of botanical oils against of *R. dominica* in wheat

S. Em. ± CD (p=0.05) CV%
6.19 3.31 12.59
9.60 4.59 14.23
3.38 2.44 11.98
4.35 6.16 19.24
1.85 0.89 6.67
5.09 2.44 10.76
0.70 0.33 8.34
5.44 2.61 5.31

Notes: *Figures in parentheses retransformed values of arc sin transformation; **Figures in parentheses retransformed values of transformed values; Treatment mean with common superscript letter (s) not significant by DNMT (p=0.05)
control. The lowest F <sub>1</sub> adult emergence was observed in castor oil 2% (3.67 adults) 60 days after treatment, meanwhile maximum adult emergence in control (110.67 adults) followed by treatment of groundnut oil 1% (41.67 adults) (Table 1). Similar result was reported earlier by Kumawat and Naga (2013), the lower and higher adult emergence was noticed in 270 days after treatment of castor and eucalyptus oils at 0.10%. The castor oil 2% displayed huge (97.25%) inhibition rate (%) and minimum inhibition rate (%) was displayed in control followed by groundnut oil 1% (61.47%), but it performed significantly better over untreated control (Table 1). Pacheco et al. (1995) noticed castor oil 0.5% as best effective due to high adult inhibition upto 60 days. Chandel et al. (2019) evaluated the toxicity and repellent effect of eucalyptus oil which they confirmed as the concentration and exposure time increased the mortality and repellency also increased. Similarly, Mantzoukas et al. (2020) cleared pesticidal activity for neem and cannabidiol oils, which at high doses induced significant mortality. Devi et al. (2020) and Jayakumar et al. (2021) also evaluated the toxicity and repellent effect of essential oils which proved that the oils have potential to control R. dominica and T. castaneum; hence the essential oil may be used as an alternate for synthetic insecticide to control the test insect.

The data on adult mortality revealed that neem leaf powder was most effective seed protectants (Table 2). After 24, 48 and 72 hrs of treatment, the highest adult mortality of 28.33%, 53.33%, 81.67% was noted in neem leaf powder, while arani leaf powder caused the least adult mortality % of 5.00%, 6.67% and 16.67%. The rest of the treatments were significantly at par with each other. Kudachi and Balikai (2009) reported that seed powder 5% and leaf powder 5% of A. indica resulted 87 and 76% adult mortality of R. dominica. Many researchers were attributed the toxicity of neem to stored insects, which has the responsible chemical ingredients like triterpenoids and it includes meliantriol, azadiractin and salalin etc. (Mbailao et al., 2006).

Neem leaf powder (1.04%) had the lowest weight loss % and maximum % weight loss in arani leaf powder (9.67%) before control (45.89%) (Table 2). Kakde et al. (2014) reported a minimum weight loss in wheat seed treated with neem leaf powder 2%. After 60 days of

<table>
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<tr>
<th>Sr. No.</th>
<th>Treatments (leaf powders)</th>
<th>Dose (g/kg)</th>
<th>Adult mortality (%)</th>
<th>Weight loss (%)</th>
<th>Seed damage (%)</th>
<th>F&lt;sub&gt;1&lt;/sub&gt; adult emergence</th>
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Notes: *Figures in parentheses retransformed values of arc sin transformation; **Figures in parentheses retransformed values of √(X+1) transformed values; Treatment mean with common superscript letter (s) not significant by DNMRT (p= 0.05) level of significance.
treatment, the neem leaf powder considerably lowered
the infestation of adult _R. dominica_ recording lowest
seed damage (3.67%) (Table 2). The control had the
most seed damage (47.76%) followed by the treatment
of arani leaf powder (29.67%). According to Amin et al.
(2000), the neem leaf powder is an effective treatment
for reducing the seed damage in wheat by _R. dominica_.
The application with neem leaf powder resulted in the
lowest F1 adult emergence (4.33 adults) preceded by
lantana leaf powder (7.67 adults). The maximum F1
adult emergence was recorded in control (134.00 adults)
followed by arani leaf powder (24.00 adults) (Table 2).
Even the smallest dose (1.5%) of neem leaf powder
reduced the number of F1 adult emergence in wheat
(Samyal and Sharma, 2006). The maximum inhibition
rate (%) was recorded in neem leaf powder (97.34%),
while Minimum inhibition rate (%) was recorded in
arani leaf powder (80.07%) before control (Table 2).
Neem powder when admixture with wheat checked
the population growth in the resources resulting into
3.5 times less adult production compared to controls
(Ahmad et al., 2019). Germination % of botanical
oils and leaf powder after 60 days of treatments
ranged from 68.00 to 76.67 and 74.33 to 80.60, which
were statistically equivalent to one another (Fig. 1).
Therefore, it was determined that the treatments with
seed extract and oils did not harm the viability of the
seeds. The current results are consistent with those of
Verma et al. (1983) and Kakde et al. (2014), who found
that seeds treated with different oils, leaf extract and
powders had no negative effects on their seed viability.

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**AUTHOR CONTRIBUTION/ STATEMENT**

Syed Mohamed Ibrahim S carried out the screening
of bio-efficacy of different oils and powders the
manuscript. Prithiv Raj V also guides the culturing
of insects and technique to apply botanicals to wheat
grains. Prabhaharan V conceived the study and carefully
monitored the management work. All authors read and
approved the final manuscript.

**CONFLICT OF INTEREST**

The authors declare that they have no conflicts of
interests.

**REFERENCES**

of *Callosobruchus maculatus* (Coleoptera: Chrysomelidae) to
extracts of cashew kernels. Journal of Plant Disease Protection
11: 75-79.

Ahmad F, Iqbal N, Zaka S M, Qureshi M K, Saeed Q, Khan K A,
Comparative insecticidal activity of different plant materials
from six common plant species against *Tribolium castaneum*
(Herbst) (Coleoptera: Tenebrionidae). Saudi Journal of Biological
Sciences 26(7): 1804-1808.


