POTENTIAL BIOCIDE EFFECTS OF ALIEN INVASIVE PLANTS ON MORTALITY OF *RHYZOPERTA DOMINICA*

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Abstract. Lesser grain borer, *Rhyzoperta dominica* (Coleoptera: Bostrichidae) represent one of the most economically important primary storage pests on different commodities (wheat, peanuts, corn, legumes). As a consequence of developed *R. dominica* resistance to implemented insecticides ensue biocidal effect investigation of plant secondary metabolites. This is a possibility to identify an environmentally friendly and highly efficient a natural compound as insecticide. The aim of this study was to determine the potential biocidal effects of three widespread invasive species in area of the Čačak city *Ailantus altisima, Portulaca oleracea* and *Ambrosia artemisiofolia* on the *R. dominica* laboratory population. Experimental studies were performed in laboratories at the Faculty of Agronomy in Čačak, Serbia. The crude ethanolic extracts *A. altissima*, *P. olerace* and *A. artemisiofolia* were prepared in aqueous solution concentration 0.1%, 1% and 5%. The potential biocidal effects on *R. dominica* was tested by measuring the inhalation effect, contact and contact-digestive activity on adults in laboratory conditions. Biocidal effects of plant extracts estimated according to Abbot's formula. In investigation of inhalation effect of all three plant extracts on *R. dominica* adults the highest level of efficiency (17.66%) had showed 5% solution of *A. altisima*. In investigation of contact effect of all three plant extracts on *R. dominica* adults the highest level of efficiency (68.33%) had showed 5% solution of *P. oleracea.* In investigation of contact - digestive effect of all three plant extracts on *R. dominica* adults on whole corn kernel, the highest level of efficiency (13.33%) had showed 0.1% solution of *A. altissima.* In investigation of contact - digestive effect of all three plant extracts on *R. dominica* adults on broken corn kernel, the highest level of efficiency (17.66%) had showed 5% solution of *A. altissima* and on the wheat grain the highest level of efficiency (35.33%) had showed 5% solution *P. oleracea.*

Keywords*: Rhyzoperta dominica, Ailanthus altissima, Portulaca oleracea, Ambrosia artemisiofolia,* biocidal effect

INTRODUCTION

Stored pests according to the level of damage on primary or processed products represent economically the most important group of pests (ALMASI, 2008). The result of activity of different harmful organisms on storage products are more than 50% (STRBAC, 2002). Lesser grain borer, *Rhyzoperta dominica* (Coleoptera: Bostrichidae), represent primary pest of storage facilities all around world. *R. dominica* damaging many commodities with high level of starch as wheat, rice, corn (CHITTENDEN, 1911). This insect is first identified as a forest pest, but switch to another group of host plant specify (condition) it as one of most important storage pest (EDDE ET ALL., 2005). Hypothesize that India is country of origin for this species as well as for the most members of the family of Bostrichidae i.e. auger beetles (SCHWARDT, 1933; MARSKE AND IVIE, 2005). The first description of this pest under the name *Synodendrom dominicum* gave by Fabricius in 1972 on the basis of pests taken from nuts and roots imported from India (CHITTENDEN, 1911). LESNE (1896) described this pest and systematized under the name *R. dominica*. Registered host plants for *R. dominica* beside the starchy food include legumes (chickpeas, peanuts, beans) and also some pharmaceutical products, leather materials, plaster objects, wood, paper (POTTER, 1935; RILEY, 1882;

WINTERBOTTOM, 1922). Despite the large number of host plants this insect achieves a maximum oviposition on dry cereals especially on wheat grain (BASHIR, 2002; EDDE AND PHILLIPS, 2006). Compared with other stored pests *R. dominica* represent pest extremely difficult control or suppress by insecticide application (LORINI AND GALLEY, 1999; COLLINS, 2006). *R. dominica* has developed resistance to all organophosphorus insecticides (Phillips and Throne, 2010). Application of existing a.i. shows not satisfied efficiency against the *R. dominica*. It is hypostasised that the insect during the time has developed resistance (COLLINS, 2006). These phenomena resulted in the examination of secondary plant metabolites as potential biocide. The highly efficient natural compound innovation i.e. biocide which represents environmentally friendly insecticide and highly secure and healthy products represent high priority nowdays. Different plants produce primary and secondary metabolites and they have different biological activity measurable through allelopathic, herbicidal, toxic (human and animal) and insecticidal activity (JANJIC ET AL., 2008). The city of Čačak is highly compromised by the presence of alien invasive plant species (TANASKOVIC ET AL, 2013). Some species are wide spread, other is localized or spreads ranges as continuous growth.

The aim of this study was to investigate the potential biocidal effects of three wide spread invasive plant species *Ailantus athissima, Portulaca oleracea and Ambrosia artemisiofolia.* Biocidal effects were determined on laboratory population *R. dominica*.

MATERIAL AND METHODS

The crude plant extracts used in this experiment were obtained by the process of maceration with ethanol as the solvent. For the preparation of the extract 10 g of air dry plant material overflow with 100 mL of ethanol. After 24 hours the solvent was decanted. From initial extract concentration were prepared 0.1%, 1% and 5% dilution in distilled water and used in the experiment. As a nutrient are used corn kernel (whole and broken) and wheat grain.

Biocidal effects. Inhalation was tested according to STEFANAZZI ET ALL (2010). The experiment was set up in three repetitions, 12 vials per repetition. Extracts (0.1%, 1%, 5%) and distilled water were (12 μL) deposited on filter paper which was placed in the recess in the cover and trough it was put gauze clip so the insects would not have contact with extracts. In the glass vial was put 10 adults of *R. dominica* (10-15 days old). The glass vial with insects was incubated in a thermostat in the dark at a temperature 29 ºC. Effects was monitored by counting the live and immobile specimens 24, 48 and 72 hours after exposure.

Contact effects. The experiment was set up in three repetitions with 36 tubes. Before entering insects, tubes were washed with plant extracts and a control (untreated) tubes with distilled water. After washing the tubes were allowed to dray at room temperature. After drying tubes it has been entered 20 adults per tube, tubes were sealed with parafilm and left in horizontal position for the easiest insect's movement. The tubes with insects were incubated in a thermostat in the dark at a temperature 29 ºC . Effects was monitored by counting the live and immobile specimens 24, 48 and 72 hours after exposure.

Contact – digestive effects. Experiment set up according to Obeng – OFERI AND REICHMUTH (1997). Before setting the experiment insects were starved over a period of 24 hours. For this experiment were used whole and broken corn kernels and whole wheat grain. For all three variants (different plant extracts) of experiment was measured 10 g of kernels/grains per Petri dishes. Total of 108 Petri dishes was used for design of experiment. After placing the corn and wheat grains in Petri dishes, grains was treated with different concentration of all three plant extracts (0.1%, 1%, 5%) and distilled water as control (untreated). After that Petri dishes were placed on a stirrer for 1 hour, to the extracts evenly distribute on the medium and left to dray at room temperature. After drying in each Petri dishes

has been entered by 20 adults of *R. dominica*. The Petri dishes with insects were incubated in a thermostat in the dark at a temperature 29 ºC . Effects was monitored by counting the live and immobile specimens 24, 48 and 72 hours after exposure.

Biocidal effects of plant extracts estimated according to Abbot's formula (ABBOT 1925).

RESULTS AND DISCUSSIONS

1. Inhalation effect on mortality of *R.domica*

In investigation of inhalation effect of *A. altissima* on *R.dominica* adults after 24 ^{h} effect had been showed only 5% extract with level of efficiency of 1.66%. During the second inspection after 48 ^{h} it was established the efficacy of 1.66% in a exposure of 5% extract of *A. altissima.* Plant extracts of *A. altissima* at a concenracion of 0.1% and 1% are exhibited the highest efficiency after 48 ^{h} with efficiency of 3.33% (Graph 1.a).

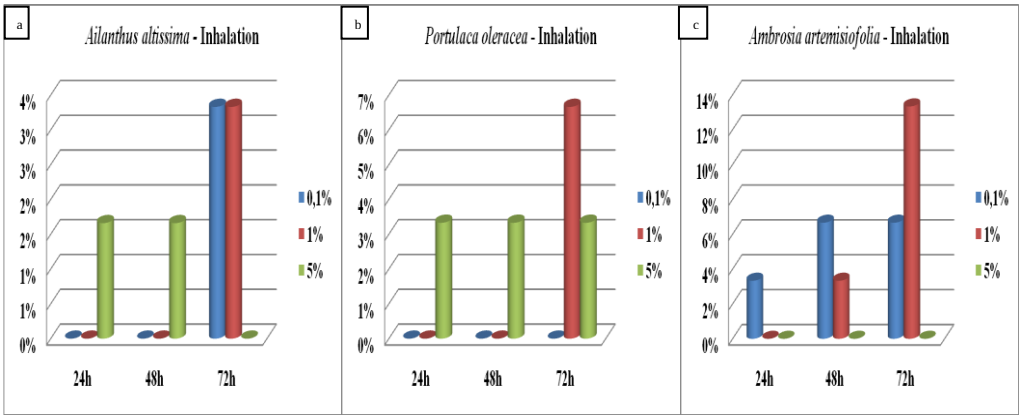

Figure 1. Calculate inhalation efficiency of plants extract on adult's *R. dominica* mortality according to Abbot

In investigation of inhalation effects of *P. olreacea* on mortality of *R. dominica* adults the highest level of efficiency 6.66% was recorded after 72 ^{h} in exposure of 1% extract. After 24 and 48 hours was recorded level of efficiency 3.33% in exposure 5% extract of *P. olreacea.* Plant extract 0.1% and 1% during first and second inspection showed no effect on mortality of *R. dominica*. During third inspection registered mortality of 1% extract with efficiency of 6.66% and 5% extract with eficiency level 3.33%. Plant extract *P. oleracea* of 0.1% concentration did not showed inhalation effect on *R. dominica* adults (Graph 1.b)

The highest level of efficiency 13.33% was recorded after 72 ^{h} in exposure to 1% extract of *A. artemisiofilia.* After 24 ^{h} effect of inhalation was recorded only in exposure of 0.1% with efficiency of 3.33%. Plant extract *A. artemisiofilia* after 48 and 72 hours showed level of efficiency of 6.66%. Plant extract *A. artemisiofilia* concentration of 5% did not showed inhalation effect on mortality of *R. dominica* (Graph 1.c)

2. Contact effect on mortality of *R.dominica*

In investigation of contact effects of *A. altissima* on mortality of *R. dominica* adults the highest level of efficiency 66.66% was recorded after 24 ^{h} in exposure of 1% extract. The lowest level of efficiency 1.66% was recorded after 72 ^{h} in exposure of 0.1% extract. During

secondinspection, after 48 ^{h}, the effect of contact have demonstrated a 1% extract with efficiency of 48.33% and 5% extract with 1.66% efficiency (Graph 2.a)

In investigation of contact efects of *P. oleracea* on mortality of *R. dominica* adults the lowest level of efficiency 1.66%, during all three observations, showed 0.1% plant extract. After 24 ^{h} beside 0.1% extract, also was recorded level of efficiency 36.66% in exposure of 1% extract and 66.66% in exposure of 5% extract. In second inspections was recorded increase efficiency of 53.33% and 68.33% in the exposure of 1% and 5% extract respectively. After 72 ^{h} are not registered changes in the efficiency of the mentioned extracts (Graph2.b).

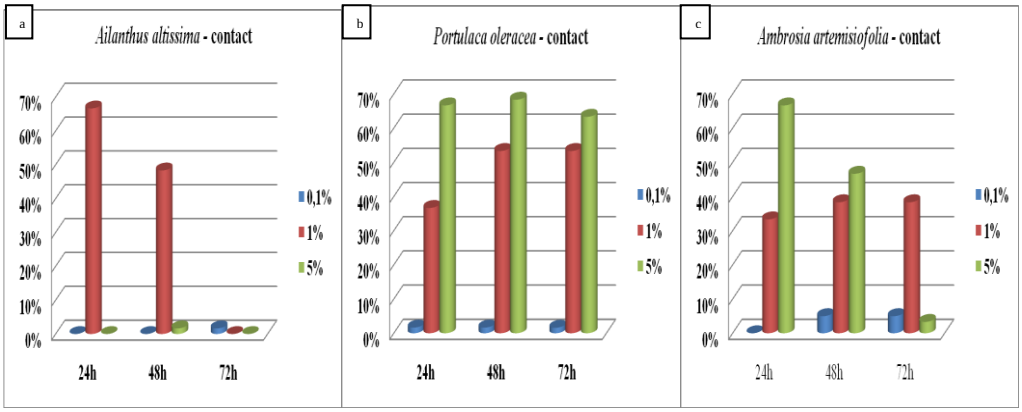

Figure 2. Calculate contact efficiency of plants extract on adult's *R. dominica* mortality according to Abbot

The highest level of efficiency 66.66% in exposure 5% extract of *A. artemisiofila* was recorded in first 24 ^{h}. During first inspection 1% extract showed an efficiency of 33.33%. After 48 ^{h} all three concentracion of *A. artemisiofila* extract showed efficiency (5%, 38.33% and 46.66%) in suppress adults of *R.dominica* (Graph 2.c).

3. Contact – digestive effect on whole corn kernels on mortality of *R. dominica*

During investigation of contact – digestive effect *A. altissima* on whole grain corn on moratlity of *R. dominica* is recorded only in exposure of 0.1% extract. Plant extract 0.1% concentracion during observations after 24, 48 and 72 hours, exhibited the mortality rate to be mesuared with efficiency of 8.33%, 10% and 13.33%. Extracts 1% and 5% concentracion did not showe lethal effect on insect (Graph 3.a).

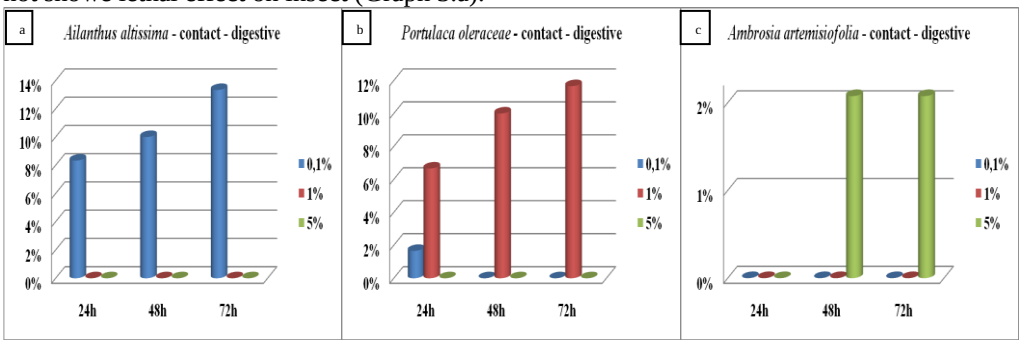

Figure 3. Calculate contact - digestive efficiency of plants extract on adult's *R. dominica* mortality according to Abbot on whole corn kernels

Exposure to 1% of the *P. oleracea* extract caused a linear increase in the mortality rate of 6.60% in the first 24 to 11.66% after 72 hours. The mortality rate in the control variants recorded an increase of 1.66% in the first to 7.27% in the second inspection. Plant extract 5% concentration did not exhibit lethal effects on *R. dominica* adults (Graph 3.b).

4. Contact – digestive effect on broken corn kernels on moratlity of *R. dominica*

In investigation of effect of *A. artemisiofolia* on mortality of *R. dominica* from all three used concentracion efficiency showed only 5% extract with a efficieny of 1.66% after 48 and 72 hours. The extracts 0.1% and 1% concentracion did not show the lethal effect (Graph 3.c).

During investigation of contact – digestive effect *A. altissima* on broken corn kernels on moratlity of *R. dominica* the highest efficiency 17.66% was registered in the first inspection after 24 hours in exposure to 5% extract. Also in first inspection the efficiency of 3% was registered in exposure to 0.1% extract. In the last two observations has not been recorded biocidal effect, it is not recorded lethality in any concentracion as well in the control (untreated) variant (Graph 4.a).

The effect of 5% *P.oleracea* extract caused a linear increase in the mortality rate of 3.33% in the first 24 to 13.33% after 72 hours. Effect of extract 1% concentracion also caused a linear increase in the mortality rate of 5% after the first review to 8.33% after 72 hours. Applied 0.1% extract caused a mortality rate of 11% only in the first 24 hours (Graph 4.b).

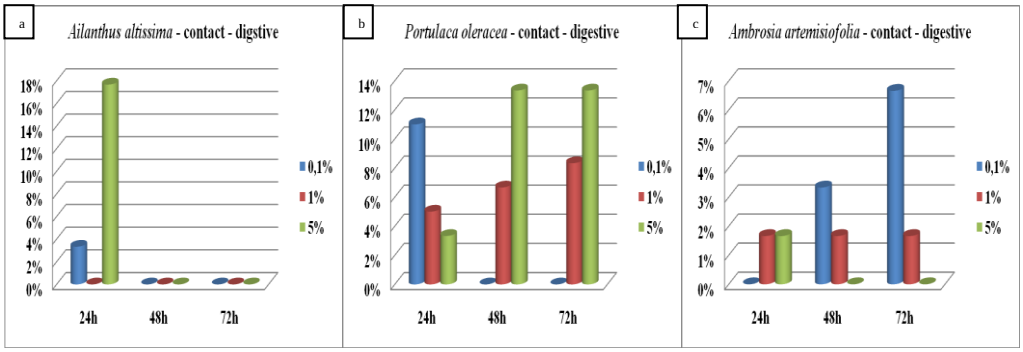

Figure 4. Calculate contact - digestive efficiency of plants extract on adult's *R. dominica* mortality according to Abbot on broken corn kernels

In the first 24 hours was observed an efficiency of 1.66% in an exposure of 1% and 5% of extract of *A. artemisifolia.* During the second observation it was registered efficiency of 3.33% and 1.66% in exposure of 0.1% and 1% extract. After 72 hours the efficiency of the same concentration was 6.66% and 1.66%. Plant extract 5% concentration did not showed insecticidal effects (Graph 4.c).

5. Contact – digestive effect on wheat grain on moratlity of *R. dominica*

The contact - digestive effect of *A. altissima* extract on wheat grain has not registered the death on *R. dominica* during the experiment (Graph 5.a).

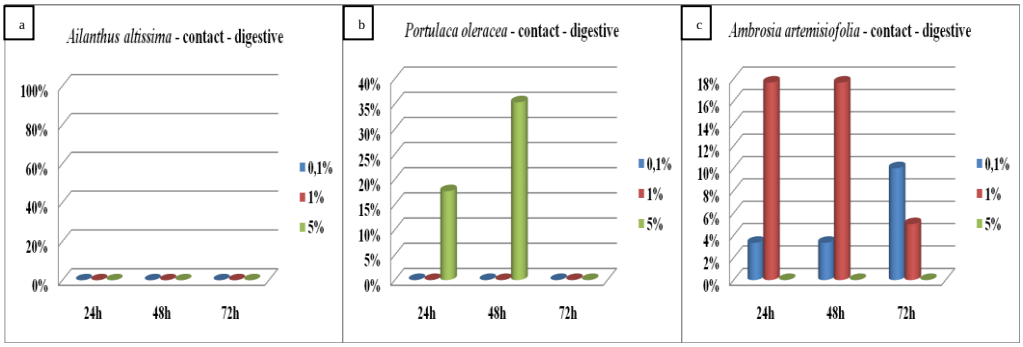

Figure 5. Calculate contact - digestive efficiency of plants extract on adult's *R. dominica* mortality according to Abbot on wheat grain

During all three inspection in investigation of contact – digestive effect *P. oleracea* on wheat grain on moratlity of *R. dominica* has been recorded efficiency of 17.66% in the first 24 hours and 35.33% in the next 48 hours only in exposure of 5% extract (Graph 5.b).

In investigation of effect of *A. artemisiofilia* maximum efficiency of 17.66% is determined under the influence of 1% extract after 24 and 48 hours. Plant extract 0.1% concentration is been caused a linear increase efficiency by 3% in the first 24 to 10% in the last 72 hours. Extract 5% concentration did not cause lethality of *R. dominica* on wheat grain (Graph 5.c).

CONCLUSIONS

According to obtained results it could be concluded that biocidal effects on inhalation and contact-digestive effects on whole, broken corn kernel and whet grain are unsatisfied. But, further research will be focus to investigate contact effects of *A. altissima* and *P. oleracea* extracts as a consequence of obtained preliminary results i.e. registered efficiency of 70 %. It will be focus also on the extracts influnce of techlological properties of flour in baker's industry.

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