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Influence of Mint (Mentha Piperita) in The Control of *Adults of Bruchidius atrolineatus* (Coleoptera-Bruchinae), A Major Pest of Cowpea (*Vigna unguiculata* Walp.) in The Sahelian Zone

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Abstract **Original Research Article**

Bruchidius atrolineatus (Pic) is the main pest of cowpea in cultivation and at the start of storage. In this study, the effect of mint leaf persistence was investigated on adult mortality of *B. atrolineatus.* To do this, a variable number of after glow is tested on adults with a negative control for each experiment. Analysis of the results shows over 80% of adults die using only 3g of afterglow compared to only 5% in the control. By varying the amount of afterglow, all results showed that afterglow seemed to be more effective than during the first three days of the experiment. For the shelf life and when the same amount of the number of persistence is renewed every two days, the mortality of adults of *B. atrolineatus* seems to be greater and spread over time. These results are necessary indicators for the technical services with a view to implementing alternative control strategies.

Keywords: *Bruchidius atrolineatus*, cowpea, mint, biological parameters, adult mortality.

INTRODUCTION

Cowpea (*Vigna unguiculata* (L.) Walp (Fabaceae)) is a plant that occupies an important place in the diet of many populations (Onwubiko NIC *et al.*, 2011; Adeyemi SA *et al.*, 2012; Kudre TG *et al*.., 2012). In Niger, it is the main food legume cultivated for its nutritional and economic interest. In addition, its agronomic interest makes this legume a plant which improves the nitrogen content of the soil (Boubie V. B., 2002; Abdouramane *et al.,* 2020). However, abiotic and biotic constraints (FAO, 2004) limit cowpea production with yields of 334 kg / ha on average in peasant environments (Abdouramane *et al.,* 2020). Cowpea yield is currently low compared to the plant's potential estimated at two tonnes / ha (Singh B. B. *et al*., 1997; Abdouramane *et al*., 2020). This situation is confirmed by several studies recently conducted in Niger (Issoufou O. H. *et al*., 2017) in Burkina Faso (D. Bambara and J. Tiemtoré, 2008; Abdouramane *et al.,* 2020). Nevertheless, cowpea production, already affected by climatic hazards, is limited by the losses caused by Bruchinae beetles, which make it very difficult to keep it after harvest. In fact, the larval stages of these pest insects develop inside the seeds and consume them contained in the cotyledons. In the Sahelian context, the greatest damage is caused by two species of bruchinae beetles, *Bruchidius atrolineatus* P. and *Collosobrucus maculatus* F. (Coléoptera Bruchidae). Their attacks start in crop fields and continue in stocks if no adequate protective measures are taken (Moumouni *et al.,* 2013). Of these two species, *B. atrolineatus* is the one which causes the first damage in fields and in stocks. It therefore appears necessary to initiate a fight against pests of crops and cowpea seeds in stock (Moumouni *et al*., 2013). Several methods are thus developed. Some of them, (in particular, chemical control), although effective, present dangers for man and his environment because of the toxicity of the products used (Thiam and Ducom, 1933; F. Jhnson *et al*., 2006). On the other hand, natural substances are less toxic to humans than synthetic insects (Ostermam, 1993; F. Jhnson *et al*., 2006). For example, Foua-bi (1993) reported that African peasants used to use natural substances to protect their crops against insects. Some work on natural insecticides has been carried out in Niger (Alzouma ET Boubacar, 1987; F. Jhnson *et al*., 2006) and in Burkina-Faso (1995) and Seri-kouassi (2005) to successfully use extracts of plants to control insects and molds. This study follows the same logic and deals with the effect of mint on adults of *B. atrolineatus.*

METHODOLOGY

Adult mother strains used

The first strain of adults used in the various experiments comes from pods collected from producers in Tahoua. The cowpea pods once harvested were brought to the laboratory and incubated until the emergence of adults which will be used for mass rearing.

Mass breeding

Adults of B. atrolineatus are obtained from samples of naturally infested seeds or pods and collected from producers' fields. These samples are first stored in the bags and brought back to the laboratory for emergence monitoring. After emergence, the seeds are sieved and the adults of B. atrolineatus obtained are placed in cylindrical and parallelepiped shaped boxes containing about 300 to 400 healthy seeds of cowpea variety KVX. A week later, the insects are removed and the contaminated seeds are left to incubate until the adults emerge. Upon emergence, the contents of the can are sieved to eliminate the adults. Twenty-four hours (24 hours) later, the contents of the box sifted the day before are sieved again in order to obtain adults aged at most 24 hours. It is these adults who are used for experimentation. Mass aging is carried out at an average temperature of 35 ° C and an average relative humidity of 15%.

Conduct of experiments

Persistence effect of mint leaf mash on adults of *B. atrolineatus*. A variable number of the amount of remanence (1g, 3g, 5g, 7g,) is placed in petri dishes of dimensions 4 x 6 cm each containing 20 healthy seeds and 5 pairs of *B. atrolineatus* and two (2) controls. negative. For each afterglow, four (4) repetitions are performed. The experiment is stopped on the fourth day. Every day the dead insects are counted.

Impact of the shelf life of mint on the activity of *B. atrolineatus* adults

The experiment consists of placing, in a single 4 x 6 cm petri dish, five pairs of *B. atrolineatus* containing 20 healthy seeds and 5 grams of persistence. The experiment is repeated four times and two (2) controls. Every two days the five remanence of the mint are renewed. Adult mortality is observed after 24 h. The experiment is stopped when no deaths are observed in the different boxes.

Effect of mint persistence activity on *B. atrolineatus* by sex

The experiment consists of placing in the same petri dish of dimensions 4 x 6 cm, five males or females plus 3g of the persistence of mint in the presence of 20 healthy seeds. The experiment is repeated 4 times in each case. The experiment was terminated when the insects used in the treated batches died.

Effect of increasing the number of seeds on the insecticidal activity of mint

A variable number of seeds (5, 10, 15, 20) is placed in five petri dishes of dimensions 4 x 6 cm each containing 3 g of the remanence and five pairs of Ba. The experiment is repeated four more times a witness. Every day, dead insects are counted. The experiment is stopped when all the insects introduced into the treated batches have died.

Parameters studied

Two parameters are studied. It is:

- Average daily mortality: This is the number of dead individuals per day compared to the total number of individuals introduced into the petri dishes;
- Mortality rate: This is the average daily mortality expressed as a percentage.

STATISTICAL ANALYSIS

For data analysis, STAT VIEW rar software, version 1999 was used. The factorial design analysis of variance was used to determine the daily means of adult mortality of B. atrolineatus for each experiment. The comparison of means was made by the smallest significant difference at the 5% level (Fisher test) in stat view.

RESULTS

Persistence effect of mint leaf mash on *B. atrolineatus*

Evolution of the adult mortality rate of *B. atrolineatus*

Figure 1 show the evolution of mortality in adults of *Bruchidius atrolineatus* in contact with the persistence of mints. The analysis shows that more than 80% of adults die in just three days when treated with the persistence of mint leaves compared to only 5% for the control. Statistical analysis shows a highly significant difference between the treated batches and the control (P = 0.0001).

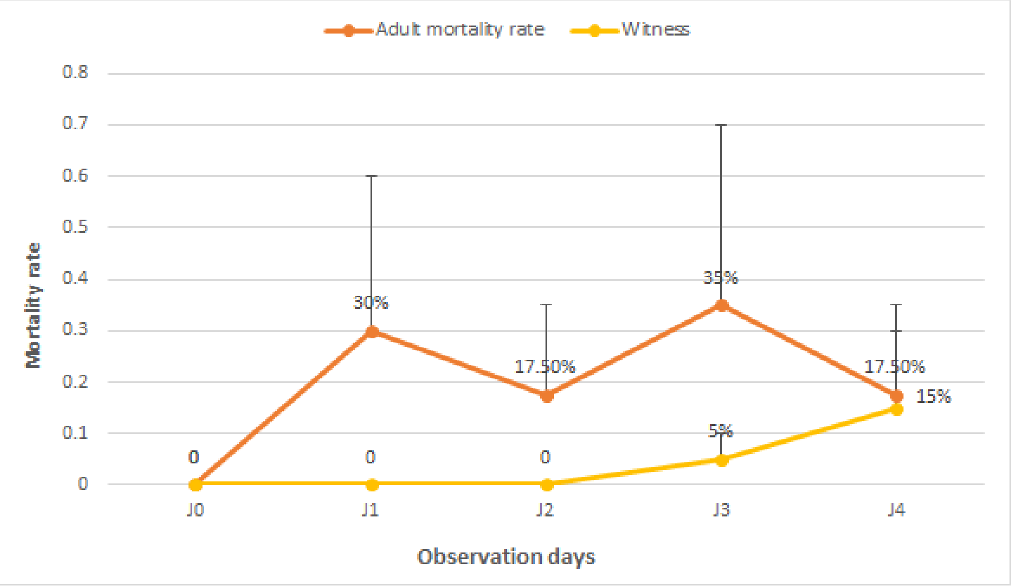

Fig-1: Curve of the evolution of the adult mortality rate of *B. atrolineatus*

Sex variation in adult mortality rate of *B. atrolineatus*

The analysis of the variation curve of the adult mortality rate of *B. atrolineatus* as a function of sex shows that in the mortality rate of adult male and female insects was recorded from the first day, i.e. respectively (18.12% and 15%) batches treated with the different doses of remanence. This rate progresses gradually until the 4th day when all adult males and females of *B. atrolineatus* have died. The mortality rate of *B. atrolineatus* males and females represents respectively (49.99% and 50%) four (4) days after treatment. In fact, it is observed that the males were more exposed to mortality than the females of *B. atrolineatus* between the 1st and 2nd day of treatment (Figure 2). Females of *B. atrolineatus* were somewhat more resistant than males. The average lifespan of males was somewhat shorter than that of *B. atrolineatus* females in the batches treated with Mint. While only 5% mortality is observed in the control on the 1st day. All the results obtained were very significantly different between the treated batches ($F = 9.32$; $P \leq 0.0001$) and the control.

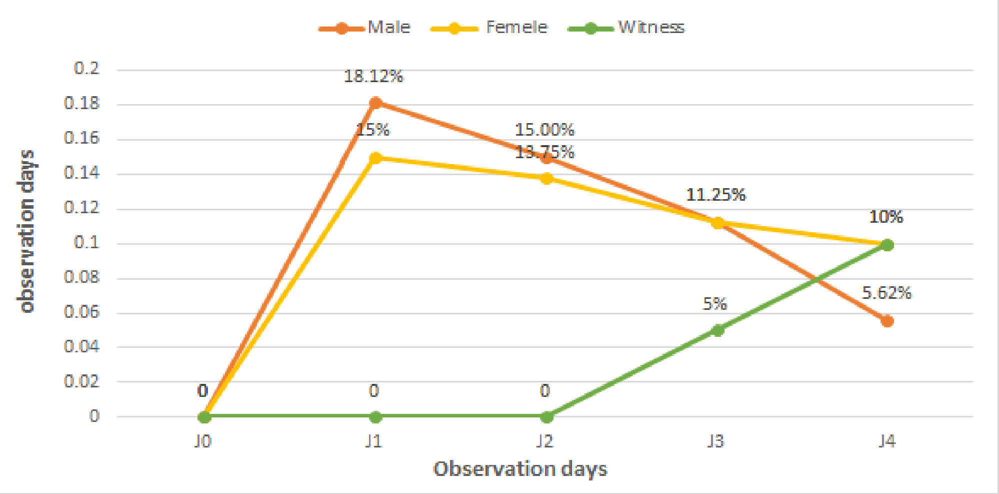

Fig-2: Evolution of mortality in adult mortality of *B. atrolineatus* according to sex

Impact of mint shelf life on adult mortality of *B. atrolineatus*

Mortality rate of adults of *B. atrolineatus*

Analysis of the adult mortality curve of B. atrolineatus than in controls, the adult mortality rate was observed from the 3rd day (5%) after the experiment. For the batches treated with mint at a dose of 5g of persistence, the mortality rate on the 1st and 3rd day, respectively (30% and 35%), was greater than that of the 2nd and 4th day (17.50%). The persistence of mint was found to be more effective overnight (Figure 3).

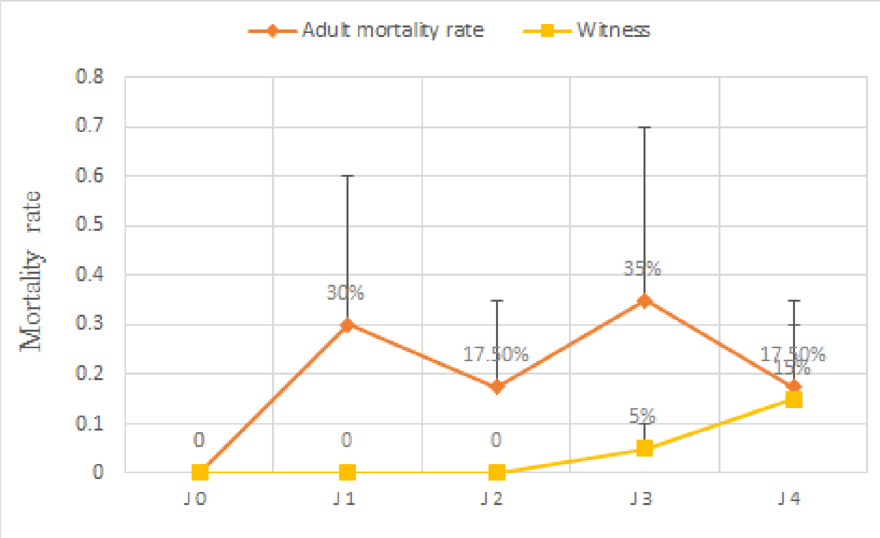

Fig-3: Evolution of adult mortality of *B. atrolineatus* using the same amount of 5g of remanence.

Sex variation in adult mortality rate of *B. atrolineatus* (5g of persistence)

Analysis of the curve of variation of the adult mortality rate according to sex shows that the control was negative from day 1 to day 2 and positive from day 3 (5%) of the experiment (Figure 4). For the batches treated with the persistence, the mortality rate of adult males between the 1st and 3rd day of exposure was respectively (17.50% and 20%) against that of females of *B. atrolineatus* which is respectively (12.50% and 15%) This is explained by the fact that the treatment was repeated again 2 days later. The green leaves of the mint used for treatment appear to be an adult-control alternative to *B. atrolineatus*, but its effectiveness wanes overnight. In fact, it can be seen that the males were more rapidly exposed to mortality than the females of *B. atrolineatus*.

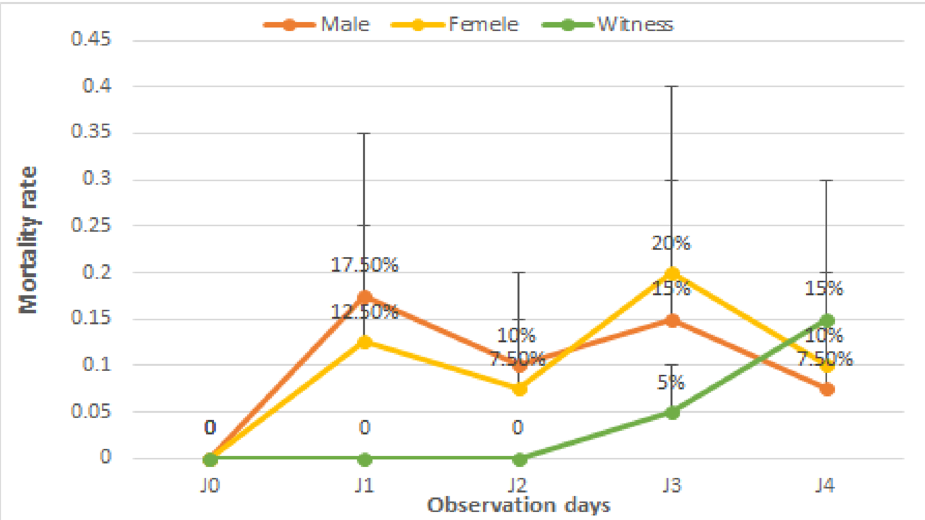

Fig-4: Curve of variation of the mortality rate of adults of *B. atrolineatus* according to sex

Treatment effect on *B. atrolineatus* by sex

Sex variation in adult *B. atrolineatus* mortality rate.

The analysis of the variation curve of the adult mortality rate of B. atrolineatus as a function of sex shows that whatever the experimental batch, a large number of males die on the first day, i.e. a mortality rate of (40%) against (10%) which is that of females on the 1st day. Indeed, we see that the curve of variation of the mortality rate of males has fallen while that of females increases gradually until the 4th day when all the males and females have died (Figure 5). The controls were negative between the 1st and the 2nd day then from the 3rd day the mortality of males and females was observed. The results of the experiment show that the males were more quickly sensitive to the treatment than the females of *B. atrolineatus*. The use of the green leaves of mint (Mentha x piperita) as a natural bio-pesticide appears to be effective in the control of *Bruchidius atrolineatus* (Coleoptera Bruchnae).

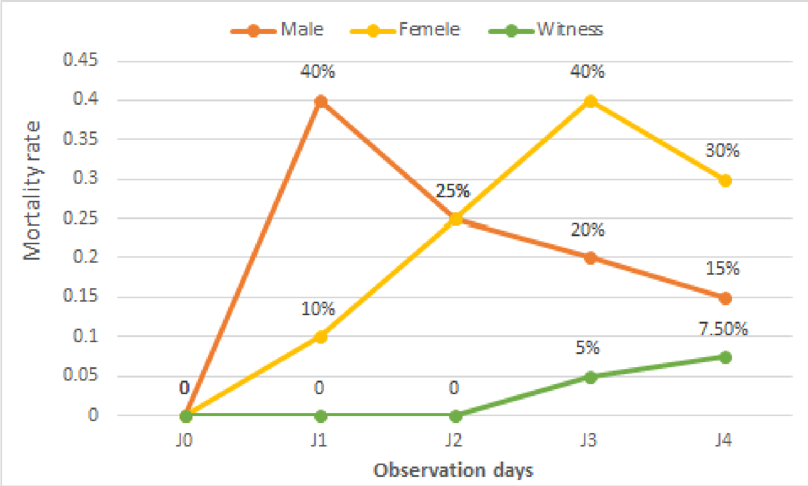

Fig-5: Curve of variation of the mortality rate of adults of *B. atrolineatus* according to sex

Insecticidal effect of mint depending on the number of seeds

Average mortality of adults of B. atrolineatus according to number of seeds

Analysis of the variation curve of the adult mortality rate of *B. atrolineatus* shows that in the controls the mortality rate was constant (4.75%) regardless of the number (5, 10, 15, 20) of seeds of variety TN-88 contained in the petri dishes. For the experimental lots, the adult mortality rate of *B. atrolineatus* as a function of the number of seeds was (98.98%) after four (4) days of exposure (Figure 16). Indeed, the greatest value of this rate was (26.12%) for the boxes of kneads containing 5 seeds against (23.62%) which is that of boxes with 15 seeds, i.e. a decrease of (2.50 %). In addition, we notice that there is a small reduction of (0.50%) for the values of the mortality rate of adults of *B. atrolineus* recorded between the kneading dishes containing 10 and 20 seeds (respectively represent 24 , 87% and 24.37%). We can say about these results that there is the effectiveness of mint which decreases over time. Experience (generally) shows that despite the increase in the number of seeds in the experimental lots, adult insects of *B. atrolineatus* were exposed to mortality. It is the insecticidal effect of mint that keeps killing these insects. But the mortality of adults of *B. atrolineatus* seems to be wiped out by increasing an enormous quantity of seeds.

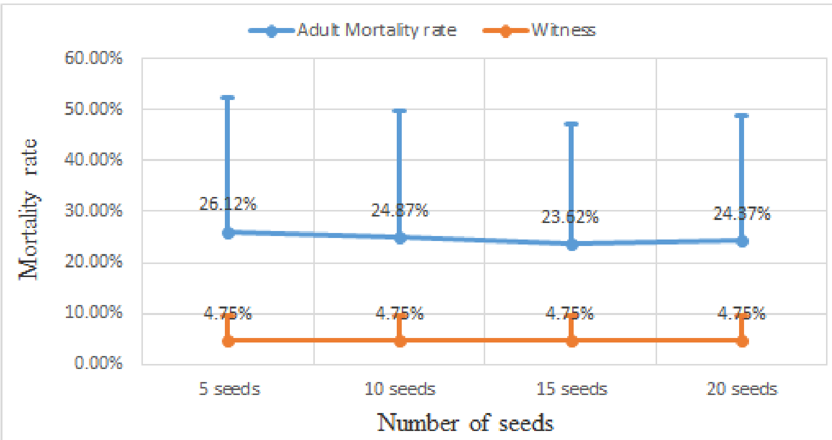

Fig-6: Evolution of the adult mortality rate of *B. atrolineatus* as a function of the number of seeds

DISCUSSION

Several alternative control methods against cowpea weevils are being developed in West Africa. Indeed, the scientific literature shows that many plants of the West African flora have an enormous biocidal potential on a wide range of pests and diseases (Boni *et al*., 2017). Most of these plants are not cultivated, such as A. indica, arguably the most widely used species as a pesticide plant. Thus, with regard to this study, the biological activity of the green leaves of mint (Mentha x piperita) was evaluated by measuring the fumigant effect of the plant on adults of *B. atrolineatus* whose adult mortality rate has been observed. The contact toxicity of the treatment on insects was quantified by counting the number of adults who died after 24 hours. Observation of the results obtained shows that for any treatment, mint has a marked action on insect mortality. Indeed, the results recorded were comparable to those of Dabire

(1993) whose work showed that certain plant species reduce the lifespan of adults and the fecundity of *C. maculatus.* They also join those of Gakuru and Foua-bi (1995) who report that plant essences are very effective and reduce the lifespan of C. maculatus and sitophilus orizae. Thus, the mortality of *B. atrolineatus* insects is thought to be due to respiratory intoxication linked to the volatile compounds contained in the remnants of the green leaves of mint (personal communication). The green leaves of the mint seem to have an ovicidal effect. Also, the effect of the treatment persisted so that the insects died from 24 hours. Indeed, certain chemical compounds present in mint including menthol are responsible for the insecticidal activity. This argument is in agreement with that of SERI-Kouassi (2004) whose treatments have shown that the ovicidal and larvicidal activities of essential oils extracted from certain plants are linked to their terpene content. Thus, the effectiveness of Mentha would be due to its richness in Menthol (majority compound) while the majority compound of Ocinum is thymol. These terpene compound would play a repellent role at low concentration and lethal at high concentration. They act both on the nervous system and on protein synthesis in insects (Picimbon, 2002). In addition, statistical analysis of the data has always shown significant differences between the treated batches compared to the controls. These results show the high sensitivity of adult *B. atrolineatus* insects. According to TOUNOU *et al*. (2011) reported by Boni *et al*. (2017) demonstrated that aqueous extracts of the plant of *Ricinus communis* L. (Euphorbiaceae) on *P. xylostella* larvae cause mortality (54 to 71%), deformation (wings and legs) of adults at emergence and reduces oviposition. Similar work has revealed that an extract from the leaves of *A. indica* has a strong insecticidal activity (mortality> 95%) and considerably reduces the fertility of *M. persicae* (Mondédji *et al*., 2014; Frédéric *et al*., 2017). According to the same authors, the application of this extract (*A. indica)* on plants would considerably modify the feeding behavior of this aphid (probing by the stylets, penetration of the phloem, salivation and ingestion). On *Tetranychus urticae* Koch, it has also been reported that extracts of *Leonotis nepetifolia* (L.) R.Br. and *Ocimum gratissimum* L. (Lamiaceae) can not only inhibit oviposition of this mite, but also cause high mortality (90%) (Ogayo *et al*., 2015). Other work comparing plant extracts with conventional insecticides has shown that certain extracts can have the same efficacy as synthetic insecticides. Thus, extracts of *N. tabacum*, *Cassia sophera* L. (Fabaceae), *Jatropha curcas* L., *R. communis*, *Ageratum conyzoides* (L.) L. (Asteraceae), *C. odorata* and *Synedrella nodiflora* (L.) Gaertn. (Asteraceae) would be as effective as emamectin benzoate and lambda-cyhalothrin for the control of *P. xylostella* and *B. brassicae* in cabbage crops (Amoabeng *et al.*, 2013; Boni *et al*., 2017). The same observation was made with extracts of *Allium sativum* L. (Liliaceae), *C. frutescens* and *A. indica* compared to emamectin and a binary pesticide (cypermethrin + dimethoate) on pests of cabbage and green beans (Fening *et al*., 2014; Mondédji *et al*., 2014). Similar observations were also reported with the J. curcas extract compared to pyrethroids (deltamethrin, cypermethrin) for tomato pest control (DIABATE *et al.*, 2014) and between a product based on *A. indica* and dimethoate to control *P. xylostella* on cabbage (SOW *et al*., 2015). A laboratory experiment on *P. xylostella* mentions that at low doses (5%), the oil of *R. communis* induces a deformation and delays the emergence of adults from treated larvae (Tounou *et al*., 2011). The results of this study are also close to those of Alexis Malou (1999) where he shows that the oil of *A. indica* causes a mortality of 59% after 72 hours at a dose of 50 ml / kg. At the concentration of 100 ml / kg, it induces a mortality of 74% after 72 hours, while under the same conditions, acetone, at a dose of 100 ml / kg, respectively causes 0 and 44% after 72 hours. Studies carried out (Alzouma *et al*., 1985; Rabiou *et al*., 2020) have shown that *B. senegalensis* has extraordinary potential in terms of protecting stored foodstuffs. Several authors have reported its lethal action on adult insects of *B. atrolineatus* and *C. maculatus* in stocks which results in the immediate death of one part and irreversible state of agony in the others. The potency of its insecticidal effect is also reflected in the inhibition of egg hatching, thus blocking the emergence of the future F1 generation (Alzouma & Boubacar, 1985; Rabiou *et al*., 2020). From all the results of this study, it emerges that the green leaves of mint (Menthaxpiperita) prove to be toxic on *Bruchidius atrolineatus* (Coleoptera Bruchinae), and that the treatment based on them was effective for the control adults of *B. atrolineatus*. This control on this cowpea weevil can be explained by the fact that the smell of remnants of green mint leaves can asphyxiate or block the respiratory pores which reduces the mobility of the insect and causes their mortality to more than (98%) after 96 hours of exposure.

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