Impact of Fumigation Made with Crataeva religiosa Forts, Azadirachta Indica A. Juss. and Senna occidentalis L. on Callosobruchus Maculatus Fab.

Ablaye Faye,
Department of Animal Biology,
University Cheikh Anta Diop,
Faculty of Sciences and Technology,
Dakar, Senegal
E-mail: fablaye82@yahoo.fr

Toffene Diome
Department of Animal Biology,
University Cheikh Anta Diop,
Faculty of Sciences and Technology,
Dakar, Senegal

Mbacké Sembène
Department of Animal Biology,
University Cheikh Anta Diop,
Faculty of Sciences and Technology,
Dakar, Senegal

Abstract :- Comparing the effectiveness of certain plants fumigation (*Crataeva religiosa* Forts, *Azadirachta indica* L. and *Senna occidentalis* L.) on eggs and adults of *Callosobruchus maculatus* made us investigate in our study. The crushed leaves smoke substance of these plants have been applied to the external forms of this insect. For each of the plants we tested, the fumigation effect is gradual on the eggs. Thus, whatever the plant, the mortality of the eggs increases with the increase of the applied dose; But *A. indica* is found to be more effective on eggs than other plants. The adults of this species are more susceptible to the fumigation of crushed leaves of *C. religiosa* than to that of other plants. from 12 hours of impact all the doses (D_1 (0.00364g/cm^3), D_2 (0.00728g/cm^3), D_3 (0.01456g/cm^3) and D_4 (0.02912g/cm^3)) made of this plant, applied, induced 100% mortality whereas this effect was observed only on day 7 with *S. occidentalis* and day 11 of application with *A. indica*. The combined application of these plants fumigation would have a considerable impact on the protection of cowpea in the actual storage systems against the effect of *C. maculatus*.

Keywords: *fumigation, Callosobruchus maculatus, adults, eggs, Crataeva religiosa, Senna occidentalis, Azadirachta indica*.

*****

1. INTRODUCTION

Fumigation is one of the remarkable techniques used to control insect pests, particularly pests of stored food. Synthetic fumigants are the most commonly used by farmers, while they are often harmful for manipulators, as well as for the environment. In fact, several scientists have done searches to find active fumigants and control pests of food crops and rents. These ones, considered as harmfulness to man, and in general, to mammals and easily biodegradable, can be handled without major concerns. We associate ourselves with these researchers [4], [5], [7],[8], [11] to demonstrate the toxicity of smoke substances contained in the leaves of three plants (*A. Indica, C. religiosa* and *S. occidentalis*) opposite to the external forms of *C. maculatus*.

These plants have been the subject of several studies to find harmful substances against insect pests, but with drastic methods and not applicable by the farmers. For this reason we tested a methodology easily applicable by farmers.

2. MATERIAL AND METHODS:

This test is carried out to demonstrate a probable fumigant effect of *C. religiosa, A. indica* and *S. occidentalis* on adults and *C. maculatus* eggs.

Fresh leaves were harvested early in the morning before sunrise and in the evening before sunset to obtain a high concentration of secondary metabolites in these leaves. These leaves were then crushed with a mortar and a pestle. The shredder was automatically placed in small jars (8 cm in diameter and 5 cm in height) equipped with wire mesh cover. Each jar was then placed in a larger box (10 cm in diameter and 7 cm high) containing 12 non-sexuous *C. maculatus* adults. After introduction, each large jar was also early closed with a lid without screens and the closure was reinforced with an adhesive tape so that the smoke cannot escape. For each weight of leaves used, three replications were carried out and a blank control without ground leaves. Hermetically sealed jars were kept in the laboratory. Dead insects were daily counted. All insect lying on its back and making no movement of legs or antennas after agitation was considered to be dead. The weights of used leaves were 2 g, 4 g, 8 g and 16 g.

The ovicidal tests were also carried out with the same process as before, where the seeds carrying each an egg replace the insect adults. The same leaf weights were used and underwent the same manipulation as before (adulticide tests). The seeds, bearing each an egg, were obtained by the following process: healthy cowpea seeds were taken and placed in a jar containing pairs of cowpea beetles and 24 hours after introduction, the beetles were removed from the jar and infested seeds were observed under the microscope to ensure that there is only one egg present on each seed. If a seed bears more than one egg, the extra eggs will be peeled off with a soft clamp. As far as eggs are concerned, the

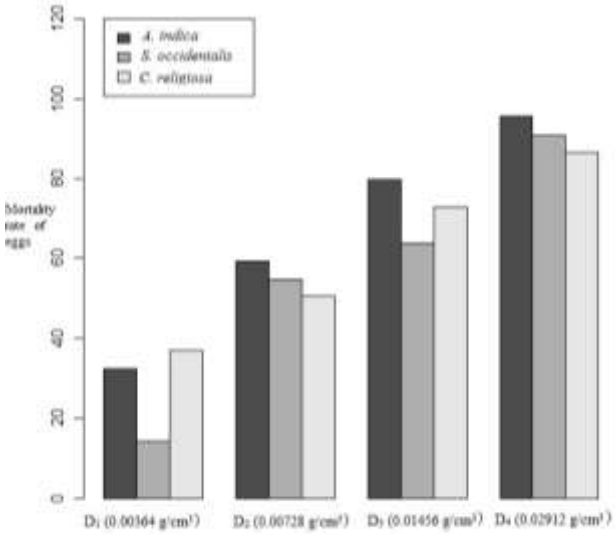
counting is done 15 days after introduction and we count hatching eggs and unhatched eggs. To make this happen, the jars were open and each seed was taken to remove the unhatched egg or the rest of the hatched egg. This allowed us to calculate the embryonic mortality rate by the Abbott formula.

Mortality rates are presented in tables or graphs. ANOVA tests were performed using the Statview 5 software.

3. RESULTS

3.1. Comparison of ovicidal effect:

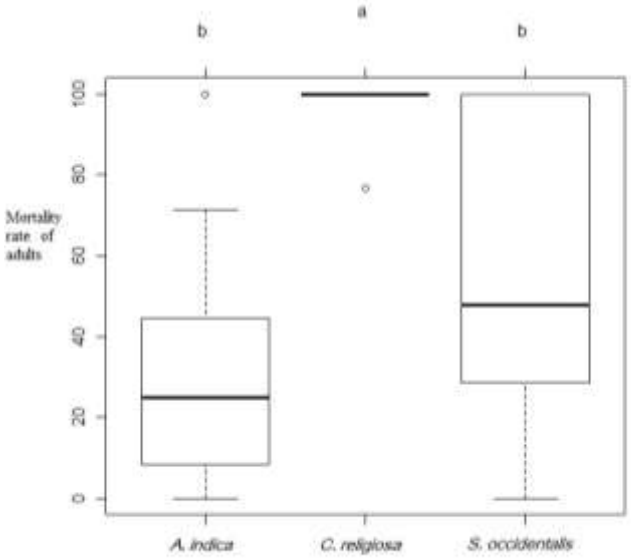
For all plants we note that the mortalities induced by the different doses are proportional to these ones. Thus the larger doses produced the highest mortalities. This comparison also shows that *A. indica* is more effective on eggs with higher doses (D_1 (0.00728g/cm^3), D_3 (0.01456g/cm^3) and D_4 (0.02912g/cm^3)), Whereas *C. religiosa* was found to be more toxic on the eggs of *C. maculatus* (36.94%) at the lower dose level globally *S. occidentalis* is less toxic on eggs. Statistical analysis show that mortality of eggs depends on applied doses ($p < 0.0001$).



Comparison of the ovicidal effects induced by the fumigation of fresh ground leaves of the different plants used

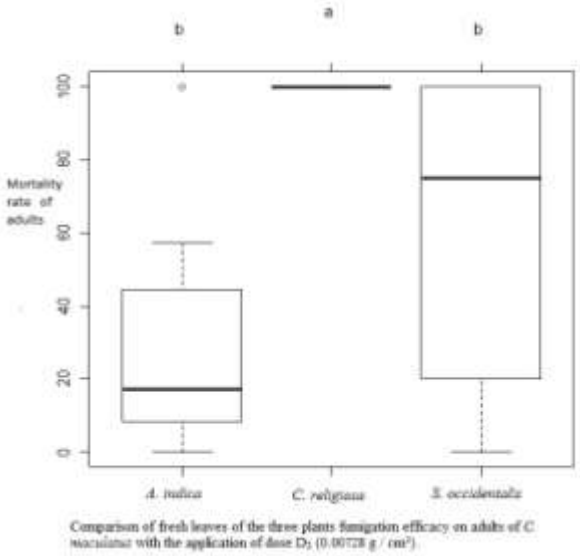
3.2. Comparison of the fumigation adulticidal effect per dose

A. indica and *S. occidentalis* showed adult mortality with D_1 (0.00364g/cm3) only at the end of the first day of application. Before that period, only *C. religiosa* gave a consistent mortality. Thus from 6 hours of exposure, mortalities recorded with the application of *C. religiosa* are close to 80% and reach 100% from 12 hours of application. Throughout the exposure, *A. indica* was found to be less effective than other plants (*S. occidentalis* and *C. religiosa*) by fumigation on *C. maculatus* adults. *A. indica* and *S. occidentalis* showed the same efficacy, which differs from that induced by *C. religiosa* on adults of *C. maculatus* at $p < 0.05$ with the impact of D_1.



Comparison of the fresh leaves of three plants fumigation efficacy on adults of *C. maculatus* with the application of dose D_1 (0.00364g/cm^3)

The following figure shows a greater efficacy on adults with *C. religiosa* (100%) applying the dose D_2 (0.00728 g / cm3) by fumigation. *C. religiosa* caused 100% mortality from the sixth hour of exposure, whereas the other plants, *S. occidentalis* and *A. indica* caused this adulticide effect only on the sixth and tenth day of application, respectively. Thus it is visual that *A. indica* is less effective than other plants with the application of this dose. As a result of the statistical analysis, the mortality of the eggs depends on the doses applied ($p < 0.0001$).

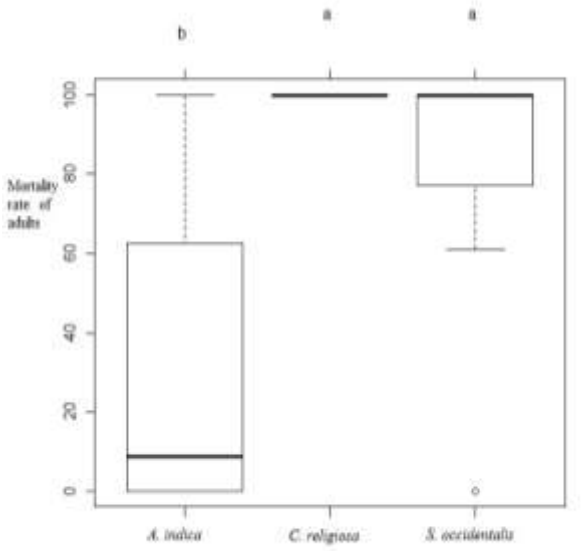


Comparison of fresh leaves of the three plants fumigation efficacy on adults of *C. maculatus* with the application of dose D_2 (0.00728 g / cm^3)

Comparing the mortality induced by different plants on adults of *C. maculatus* with application of dose D_3 (0.01456g/cm^3) highlights a greater efficacy of *C. religiosa*.

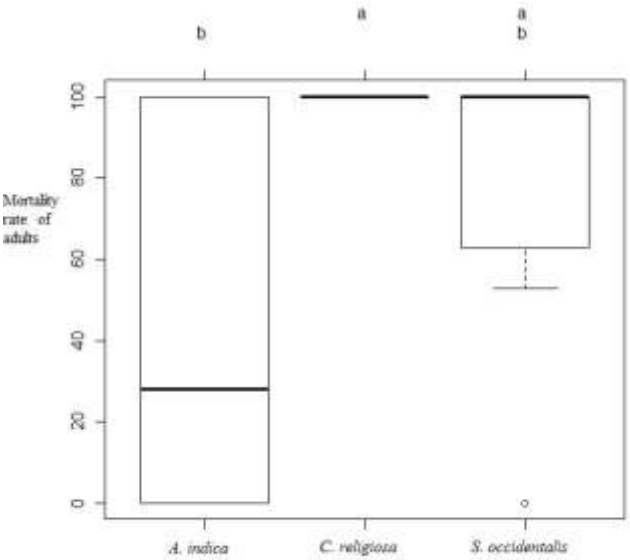
 ISSN: 2321-8169
475 – 479

The leaves of this plant's fumigation allowed to kill all the insects from the 6th hour of exposure. *A. indica* is also the least effective plant on these insects. We observed 100% mortality from the fifth day of application with *S. occidentalis*, whereas they are observable only on the tenth day with *A. indica*. Globally, *C. religiosa* and *S. occidentalis* have the same effects, which differ from those induced by *A. indica* at $p < 0.05$, with the application of D_3.



Comparison of the efficacy of fresh ground leaves fumigation of the three plants on adults of *C. maculatus* with the application of the dose D_3 (0.01456g / cm^3)

The same trends as above are observed with D_4 (0.02912 g / cm^3). Here the fumigation of the fresh ground leaves of *C. religiosa* is always more effective on the adults of this insect than that of the other plants. We observe respectively 100% of mortalities for the plants *C. religiosa*, *S. occidentalis* and *A. indica* at the sixth hour, on the fifth day and on the seventh day of the exposure.



Comparison of the efficacy of fresh ground leaves fumigation of the three plants on the adults of *C. maculatus* with the application of the dose D_4 (0.02912g / cm^3)

4. Discussion

In the laboratory, the fresh leaves fumigation of several plants (*A. indica*, *S. occidentalis* and *C. religiosa*) was tested on the external forms of *C. maculatus*.

The action of fresh ground leaves fumigation of *C. religiosa* has given very interesting results. The observed mortalities respectively grade between 36.94 to 86.49% for eggs and 10.29% to 100% for adults for 6 hours exposure with D_1 (0.00364g/cm^3), D_2 (0.00728g/cm^3), D_3 (0.01456g/cm^3) and D_4 (0.02913g/cm^3). It's showed that the fumigation with this plant is more effective on adults than on eggs.

Fumigation with freshly ground leaves of *S. occidentalis* was found to be ineffective on *C. maculatus* eggs with the lowest dose, while higher doses were very effective with mortalities greater than 50%. We also note that the observed mortalities are proportional to the applied doses. For adults, fumigation gives differential mortality according to the spread dose over time. In this way, we note a greater effect on adults than on eggs.

Neem fumigation is very effective on eggs of *C. maculatus*, with mortalities ranging between 32.44% and 95.73% with the application of all doses. Its effectiveness on adults is increases over time and depends on the applied doses; with higher observed mortality with the highest dose in the last days of application.

C. religiosa was found to be the most active of these plants on the adults of this insect by fumigation; so with the eggs, *A. indica* was more effective.

Several plants fumigation effect has been demonstrated by many other authors. Our work has confirmed those of some scientists. For example: Kébé [6] found 100% mortality of *C. serratus* adults after 24 hours of exposure with 1g of *Boscia senegalensis* ground fruit, while 1 to 2g of crushed leaves respectively indicated only 3 and 17% mortality of the exposed population. Camara [2] had very interesting results with crushed leaves of *B. senegalensis* with the concentration of 1.33g / l on adults of *C. serratus*. Baulard [1] also obtained the same results (100% mortality) using 4g / l of *B. angustifolia* leaves on adults of *C. maculatus*. Kéita *et al*. [7] obtained 80% adult mortality of *C. maculatus* with the application of 25µl / g of *Ocimum basilicum* essential oil after 12 hours of fumigation. The studies by Ketoh *et al*. [8] found mortalities of 90% of adults of *C. maculatus*. The ovicidal effect of certain plants fumigation has also been the subject of several studies. Ketoh *et al*. [8] argue that the oil extracted essential oil 33.3µ / l concentration from *Cymbopogon schoenanthus* is very toxic to the neonate eggs and larvae of *C. maculatus*. Whereas the acetone extract of *S. hermontica* used at a rate of 0.5% w / w causes

48% ovicidal effect and thus a reduction in the rate of adults emerging from the seeds [9].

Seck *et al*. (1993) determined the toxicity of leaves and fruit of *B. senegalensis* on three stored beetle pests. Seck [12] demonstrated the fumigating effect of the bark of *SecuridacaIongepedunculata* roots on *C. maculatus*, *Sitophilus zeamais* Motsch. And *Tribolium castaneum* Herbst., With an LC50 which, depending on the species, ranges from 1.6 to 47.1 g/L. The recorded LC50 range from 1 to 4.23 g/L for fresh ground leaves and from 0.42 to 1.75g/L. These same authors obtained with the fruits 73.8% mortality for the species *C. maculatus* against 8% mortality with the crushed fresh leaves for the same concentration. All these authors have demonstrated that the bioactive molecule causing the death of these insects in *B. senegalensis* is methyl isothiocyanate. This molecule would be derived from the enzymatic degradation of a glucosinolate, the methyl glucosinolate commonly called glucocapparin. This compound has ovicidal, larvicidal and adulticidal effects on beehives and whose toxicity has been the object in several studies [3][13]. Working on *C. religiosa*, a plant of the same family as *B. senegalensis*, one might think that they have the same bioactive molecule on insects. When we compare our results with those of these authors, it is observed that the crushed leaves of *C. religiosa* are more effective than those of *B. senegalensis* on insects. These differences can be explained by a higher bioactive molecule content in *C. religiosa* than *B. senegalensis*. These results may also lead us to believe that bioactive molecules of these two plants are different. This hypothesis leads us to look for these molecules in the chemical composition of the leaves of this plant or in the products of recombination or degradation of many of them. The toxicity of *Aeorus ealamus* HE vapors on *Callosobruchus chinensis* L eggs was reported by Schmidt *et al*. (1991), who reported that essential oils had a sterilizing action on eggs. The essential oils of *Cymbopogon giganteus* and *Cymbopogon nardus*, tested on the immature stages of *C. maculatus* F. and *C. subinnotatus* Pic. Were revealed to have efficacy these lasts [11]. These authors demonstrate that embryogenesis is inhibited at 10 µL/L with *C. nardus* oil and 30 µL/L with *C. giganteus*, whereas the neonate larvae of both species are killed with the 40 µL/L dose regardless of the oil. They also show that the susceptibility of this insect's larvae to the two plants essential oils is different according to their age. Thus, 5-day-old larvae are as sensitive as neonatal larvae, whereas 10- to 15-day-old larvae are more tolerant regardless of the tested essential oil [11].

5.CONCLUSION

The biocidal impact of fresh leaves of three plants fumigation (*A. indica*, *C. religiosa* and *S. occidentalis*) served as an evaluation in our study. From this assessment, *C. religiosa* is far from being the most effective plant on reducing the number of living adults of this beetle, than the other plants. It should also be noted that *S. occidentalis* is the least effective plant on adult mortality of *C. maculatus*. Globally, whatever the impacted plant, the adulticidal effects are proportional to the applied doses. The eggs of this insect are more sensitive to *A. indica* than to other plants, whereas *S. occidentalis* was less sensitive with the application of the three lowest doses. On the other hand, with the highest dose, this plant becomes the first before *C. religiosa* on the reduction of the number of eggs having hatched. This formulation is very effective on the external forms of this beetle in the laboratory. This formulation is readily applicable and could be used by farmers to cope with insect pests of pulses and cereals. The extrapolation of this formulation effectiveness on the actual storage systems will be an evaluation in our subsequent studies.

REFERENCES

[1] Baulard, C., 1999.Contribution à l'étude de plantes insecticides. Mémoire de fin d'étude pour l'obtention du grade d'ingénieur chimiste et de bio-industries, *Faculté Universitaire des Sciences Agronomiques de Gembloux Belgique*, 67 p.

[2] Camara M., 1997.Recherche sur les nouvelles substances biocides végétales, application au contrôle des bruches du niébé *Callosobruchus maculatus* F. et de l'arachide *Caryedon serratus* OL, p. 78

[3] Ducom V., 1994.Méthyl isothiocyanate used as a grain fumigant. *In* Highley E., Wright E. J., Banks H. J. & Cham B. R. Proc. 5th Int. Work. *Conf. On Stored Prod. Prot.* 3: 1671-1678.

[4] Faye A., Thiaw C., Ndiaye A. G., Sembène M., 2012. First investigation of different *Crateava religiosa* Forst formulations on the cowpea (*Vigna unguiculata* Walp.) seed-beetle, *Callosobruchus maculatus* Fabricius. *International Journal of Science and Advanced Technology* Volume 2 No 8 August 2012, p. 56-65

[5] Faye A., Thiaw C., Sarr M., Sembène M., 2014.Effectiveness of different formulations leaves of *Senna occidentalis* on the external stages of *Callosobruchus maculatus* Fabricius main pest of cowpea (*Vigna unguiculata* Walp) stored.*Vol. 4, No. 9, p. 246-253, 2014*

[6] Kébé S. B., 2004.Etude de l'activité biologique de produits bruts et d'extraits de *Boscia senegalensis* (PERS.) LAM ex POIR. Sur *Caryedon serratus* (OL), ravageurs des stocks d'arachide. *Mémoire de DEA de Chimie et Biochimie des Produits Naturels*.

[7] Kiendrebeogo M., Ouedraogo A. P., Nacoulma O. G., 2006. Activités insecticides de Striga hermonthica (Del) Benth (Scrophulariaceae) sur *Callosobruchus maculatus* (Fab) (Coléoptera : Bruchidae). Biotectnol. Agron. Soc. Environ 10(1) : 17-23.

[8] Kéita M., Vincent C., Schmit J. P., Arnason J. T.,& Bélanger A., 2001. Efficacity of essential oil of *Ocimum*

basalicum L. and *Ocimum gratissimum* L. applied as an insecticidal fumigant and powder to control *Callosobruchus maculatus* (Fab.) (Coleoptera: Bruchidea), *Journal of Stored Products Research*, 37 (4) 339-349.

[9] Ketoh G. K., Koumaglo H. K., & Glitho., 2005.Inhibition of *Callosobruchus maculatus* (F.) (Coleoptera : Bruchidea) development with essential oilextrated from *Cymbopogon Schoenanthus*L. Spreng. (Poaceae), and the wasp *Dinarmus basalis* (Rondani) (Hymenoptera: Pteromalidae), *Journal of StoredProductsResearch*, 41 (2005) 363-371.

[10] Mbaye N. N., Sarr M., Ndiaye A. G., Samb A, Sembène M., (2014).Repulsive and biocide activities of leaves powder of *Crataeva religiosa* (Forst) on *Dermestes spp.* associated with the salty smoked-dried fish. *International Journal of Biosciences* 4 (1): 306-312.

[11] Nyamador S. W., Ketoh G. K., Koumaglo H. K., Satu Paukku I. A. etKotiaho J. S., 2008.Female Oviposition decisions and their Impact on progeny life-history traits.*J Insect Behav* 21:505–520

[12] Seck D., 1994.Développement de méthodes alternatives de contrôle des insectes ravageurs au Sénégal par l'utilisation de plantes indigènes. Thèse de Doctorat, Faculté des Sciences Agronomiques de Gembloux, p.192

[13] Seck D., Lognay G., Hambrudge E., Marlier M., Gaspar C. et Severein M., 1993.Biolocal activity of the shurb *Boscia senegalensis* Lam. (Capparidaceae) on stored grain insects. *J. Chem. Ecology*, 29 : 377-389.