Journal of Agricultural Chemistry and Environment, 2022, 11, 132-142
https://www.scirp.org/journal/jacen
ISSN Online: 2325-744X
ISSN Print: 2325-7458

Ethnobotanical Investigation of Insecticidal Plants and Evaluation of the Insecticidal Activity of *Capsicum chinense* on *Sitophilus zeamaïs* of Maize and *Aphis craccivora* of Groundnuts: Case of Boffa, Boké Region (Republic of Guinea)

Aboubacar Diallo[1*], Adama Moussa Sakho[1,2], Namory Keita[3], Lansana Abou Bangoura[1], Amadou Youssouf Bah[1], Abdoulaye Keita[1]

[1]Department of Chemistry, Gamal Abdel Nasser University, Conakry, Republic of Guinea
[2]Department of Laboratory Techniques, Mamou Superior Institute of Technology, Mamou, Republic of Guinea
[3]Department of Biology, Kindia University, Kindia, Republic of Guinea
Email: *aboucar2009@yahoo.fr, keitanamory13@gmail.com, lansanaaboub@gmail.com, youssb2002@gmail.com, keita.dept.chimie.uc@gmail.com

How to cite this paper: Diallo, A., Sakho, A.M., Keita, N., Bangoura, L.A., Bah, A.Y. and Keita, A. (2022) Ethnobotanical Investigation of Insecticidal Plants and Evaluation of the Insecticidal Activity of *Capsicum chinense* on *Sitophilus zeamaïs* of Maize and *Aphis craccivora* of Groundnuts: Case of Boffa, Boké Region (Republic of Guinea). *Journal of Agricultural Chemistry and Environment*, **11**, 132-142.
https://doi.org/10.4236/jacen.2022.112009

Received: April 11, 2022
Accepted: May 22, 2022
Published: May 25, 2022

Abstract

The present study, which aims to contribute to the valorization of *Capsicum chinense*, focuses on ethnobotanical investigations and evaluation of insecticidal activity on *Sitophilus zeamaïs* and *Aphis craccivora*, as well as the germination power of infected maize and peanut grains treated and not treated with *Capsicum chinense* leaf powder. To do this, the moisture content of corn and peanuts was determined by the techniques: drying in the sun and in the oven. The insecticidal effect of the powder was tested on maize and peanut kernels infected by the AGRAR (2013) method, followed by a test of the germination potency of these treated grains. The average moisture values of corn and groundnut kernels are 14.51% and 12.25% respectively. The results show, a higher insecticidal efficacy of *Capsicum chinense* leaf powder on *Sitophilus zeamaïs* and *Aphis craccivora* with doses (2, 4 and 8 g). The average germination rates of maize and peanut kernels infected and treated with this powder are: (16.5%; 63%; 99.5%) and (21.25%; 96.5%; 99.75%), respectively. This study could be a bio-insecticide alternative for the peasant community in the conservation of cereal and legume products.

Keywords

Corn, Groundnut, Ethnobotany And Insecticidal Activity of *Capsicum chinense*

1. Introduction

The insects encountered in foodstuffs stored in warehouses, in this case maize and groundnuts, are many and varied. They can cause significant losses on the quality and quantity of products stored in the range of 5% to 10% in temperate regions and 20% to 30% in tropical regions [1] [2]. Maize and groundnuts are among the most important cereal crops in the world followed by the others (wheat and rice). In the Republic of Guinea, 30% of production is destroyed between harvest and consumption caused by insect pests [3]. In December 1988 in the prefecture of Pita, a vast research program on a majority of insect pests was initiated by the Guinean government to be able to reduce their damage. This program found that, the most destructive insects of these cereals were: *Sitophilus zeamaïs* and *Aphis craccivora* of the peanut [4]. Many aromatic plants such as *Lamiaceaes*, *Solanaceaes* have been used in traditional medecine, and instead of chemical insecticides for reasons of health poisoning of users caused by insecticides of chemical origin, or lack of means for populations to buy chemical insecticides as well as environmental pollution by these chemical insecticides [5]-[10]. Indeed, we recently published the insecticidal effect of two plants that are *Hyptis suaveolens* and *Hyptis spicigera* on corn kernels infected with *Sitophilus zeamaïs* [3]. As an extension of our studies, we report in this work, an ethnobotanical survey of some plants with insecticidal virtues was used by the farmers of Boffa and determined the insecticidal activity of *Capsicum chinense* on *Sitophilus zeamaïs* of corn and *Aphis craccivora* of peanuts followed by the determination of the germination rates of corn and peanut grains infected with *Sitophilus zeamaïs* and *Aphis craccivora* and treated with *Capsicum chinense* powder.

2. Material and Methods

2.1. Presentation of the Study Area

Boffa Prefecture is an administrative subdivision of the Republic of Guinea. Located in the west of the country on the Atlantic coast, in the natural region of Maritime Guinea, this prefecture is part of the administrative region of Boké with an area of 910,000 ha = 9100 km^2 (10˚11'03" north, 14˚02'38" west). Distant 150 kilometers from the Guinean capital, Conakry, Boffa has nearly 227,217 inhabitants and a density of 25 inhab./km^2 in 2016. Its capital is the city of Boffa. The prefecture is divided into eight sub-prefectures: Boffa-Centre; Kolia; Douprou; Koba; Lisso; Mankountan; Tamita; Tugnifili.

2.2. Framework of Studies

The Laboratory of Organic Chemistry of the Gamal Abdel Nasser University of Conakry, the laboratory of the National Office of Quality Control of Matoto Conakry, served as a framework for studies.

2.3. Ethnobotanical Investigations

Ethnobotanical surveys were carried out using a series of questionnaires pre-developed on a survey sheet designed for this purpose. This investigation was conducted in some localities of the prefecture of Boffa for 4 months. The collection of information covered respondents, pests and insecticidal and medicinal plants in selected Districts of Kolia and Tugnifili (Table 1). On the survey sheet used was distributed farmers, herbalists, breeders, option leaders according to Districts, method of acquisition, age group, by socio-professional category, modes of use of the parts used, citation frequencies, scientific and vernacular names, the list of plants (Tables 1-5). Among the most cited plants, *Capsicum chinense* was the most cited; it is for this reason that we have specifically chosen this plant in this study.

2.4. Collection of *Capsicum chinense* Fruit

The fruits of *Capsicum chinense* have been the cause of its frequency of citations. The fruits of *Capsicum chinense* were collected in Boffa and surrounding areas in January 2019. They were subjected to drying in the shade and in the open air for 30 days. Then they were pounded and sieved. The powders thus obtained were used as raw materials for the evaluation of their insecticidal activity.

2.5. Collection of Uninfected Corn Kernels and Peanuts

The corn and groundnut kernels) that were used for this test were purchased at the yenguema market in (Boffa) prefecture. These purchased grains were sorted to remove bad grains, foreign matter, and then washed and dried at room temperature in the laboratory for 72 hours. Then, a second drying at 40˚C in the oven for 15 minutes removed residual contaminants.

2.6. Breeding of *Sitophilus zeamaïs* and *Aphis craccivora* (Maize and Groundnuts)

The maize and groundnut kernels infected with *Sitophilus zeamaïs* and *Aphis craccivora* were purchased at the yenguema market (Boffa), and their farms continued under the ambient conditions of the Matoto natural and industrial products quality control laboratory (temperature 20˚C ± 40˚C) and humidity in the vicinity (81% ± 5%).

Procedure: Weigh 6 kg of corn kernels (or peanuts) already infested with *Sitophilus zeamaïs* or *Aphis craccivora* of peanuts and placed in glass jars then cover with a porous fabric for better aeration and prevent insects from escaping. Keep these jars at room temperature in the laboratory for 30 days away from foreign infestations. Then, sift to eliminate the adult *Sitophilus zeamaïs* and *Aphis craccivora* and continue rearing with the grains infested by the eggs for 29 days

to obtain new insects.

2.7. Experimental Methods

A total of 42 jars were used for this experiment; they were arranged in 02 batches of 21 and each bio-insecticide was repeated three times. Of these 02 lots, 01 was intended to study the insecticidal effect of *Capsicum chinense* powders, 01 others to assess the damage caused by *Sitophilus zeamaïs* (or Aphis craccivora) for 120 hours. The jars were kept in a well-ventilated room under laboratory conditions.

2.8. Infestation of Maize and Groundnut Kernels (AGRAR-2013 Method)

Procedure: According to the Food Africa Programme-African Research on agriculture, food, and nutrition method [11], 100 g of non-infested maize (or peanut) grains were weighed and then introduced into the jars previously marked as: T0 (control), Fch1, Fch2, Fch3 (the powder of the fruits of *Capsicum chinense*). Then weigh 2 g, 4 g, 8 g of powder, add to 100 g of homogenized corn or peanut in the jars. Control jars (T0) did not receive treatment [5]. Then introduce into each jar 20 adult insects and cover with a porous cloth for better aeration; sealed with elastic fronds to prevent external contamination.

2.9. Determination of Moisture Content of Uninfected Maize and Groundnuts

Procedure: The moisture levels of the corn and groundnut kernels were determined by the method of complete desiccation in the oven between 100˚C - 105˚C for 3 hours according to the (formula) [12] [13].

$$H\% = \frac{P_2 - P_1}{Pe} \times 100 \quad (1)$$

wherein "H%" represents Percentage of humidity; P_1; P_2 = Weight of capsule and sample before and after drying; Pe = Weight of the test portion.

2.10. Calculation of the Powder Toxicity of *Capsicum chinense* Fruits

The percentage of mortality was determined using W.S. Abbott's formula [13] after 5 days of observation of the contents of the jars taking into account the natural mortalities observed in the control jars according to (the formula):

$$Mc = \frac{Mo - Mt}{100 - Mt} \times 100 \quad (2)$$

Mc = Adjusted mortality; Mo = Mortality in treated boxes and Mt = Mortality in control boxes.

2.11. Germination Rate Test

The germination test was performed at the beginning of the experiment on infested grains that were in constant contact with capsicum chinense fruit powders

for 6 days [14] [15] [16]. The grains were spread in jars containing soil moistened with water at 26˚C and sealed at laboratory temperature. The germination rate was evaluated by counting sprouted grains versus seeded grains according to (the formula).

$$G\% = \frac{NGG}{NGE} \times 100 \quad (3)$$

$G\%$ = Percentage of germination; NGG = Number of sprouted grains; NGE = Number of seeded grains.

3. Results

3.1. Results of Ethnobotanical Surveys

Our ethnobotanical surveys in the (02) sub-prefectures allowed us to identify 71 people, including 20 women and 51 men (or 71.83%) (Table 1). Indeed, of the 71 respondents who use insecticides of plant origin and their methods of acquisition, 39 (54.93%) acquired on the basis of parental transmission (Table 2). It is also noted that the age of respondents varies from 30 to 70 years (Table 3). The age groups that practice effectively are around 41 - 50 years (39.44%) and 51 - 60 years (29.58%). On the other hand, the other age groups are less represented: 30 - 41 (18.31%) and 61 - 70 (12.67%). The results also show that only 18.31% of respondents were in school compared to 35.25% of farmers; 19.72% marabouts and sage; 15.49% merchants and 8% of traditional hunters (Table 4).

In this ethnobotanical survey, eight (8) native plants with insecticidal effects were identified and grouped into eight families which are: *Solanacea* (98%), *Liliacea* (10%), *Zingiberaceae* (10%), *Combretaceae* (15%), *Labiae* (15%), *Myrtaceae* (16%), *Chrysobalanaceae* (20%), *Lamiaceae* (20%) (Table 5). The results of the ethnobotanical survey showed that the plant species most used as an insecticide

Table 1. Distribution by districts by origin and sex in the Sub-Prefecture of Tugnifili and Kolia.

Locality (districts)	Sex		Totals	Percentage
	Male	Female		
Kakilet	6	3	9	12.68
Yoyah	5	2	7	9.86
Tagbé	4	2	6	8.45
Dabayah	8	4	12	16.90
Kolon	6	1	7	9.86
Yampony	4	3	7	9.86
Dansa	7	2	9	12.68
Bigory	5	1	6	8.45
Mokeifoton	6	2	8	11.26
Totals	51	20	71	100

Table 2. Distribution by mode of knowledge acquisition.

Mode of knowledge acquisition	Number	Percentage
Parental	39	54.93
Work experience	12	16.90
apprenticeship	20	28.17
Totals	71	100

Table 3. Distribution by age group and sex.

Age range	Sex		Totals	Percentage
	Male	Female		
30 - 41	8	5	13	18.31
41 - 50	21	7	28	39.44
51 - 60	16	5	21	29.58
61 - 70	6	3	9	12.67
Totals	51	20	71	100

Table 4. Distribution by socio-professional categories.

Occupation	Number	Percentage
Farmer	25	35.21
Marabou, wise	14	19.72
Seller	11	15.49
Agronomist, herbalist	13	18.31
hunter	8	11.27
Totals	71	100

Table 5. List of plants cited and their frequency of citation.

Scientific names	Families	Vernacular names	Parts used	Citation frequency
	Nightshade	Gbengbè	Fruit	98
Allium cepa L	Liliacea	Yèbhègbeli (S)	Bulb	10
Zingiber officinale Rosc	Zingiberaceae	Nyokhomikunkuri	Bulb	10
Combretum micranthum G., Don	Combretaceae	Kankaliba	Leaves	15
Ocimum basilicum	Labiae	Khomio (S)	Leaves	15
Psidium guajava L.	Myrtaceae	Goyabè (P)	Leaves	16
Parinarima crophylla sabine	Chrysobalanaceae	Bansouma (S)	bark	20
Hyptis suaveolens (L.)	Lamiaceae	Yoguehirignahi (S)	Leaves	20

during the conservation of corn and groundnut grains is: *Solanacea* (98%), it is followed by the other species. The parts of the plants regularly used are: fruits, bulb, leaves and bark. Table 6 shows the average values of the moisture content

of maize and groundnut grains which are respectively: 14.51% and 12.25%. These values are at the limit of appreciation of the moisture content of drugs, which is 14% [12] [13].

3.2. Moisture Content of Maize and Groundnuts

Table 6. Moisture in corn and groundnut grains

Designation	P_2g	P_eg	P_1g	H%	H_M%
Corn	15.40	8.00	14.30	13.75	14.51
	16.50	8.10	15.30	14.81	
	17.00	8.01	15.80	14.98	
Peanuts	25.30	5.00	24.70	12.00	12.25
	27.15	5.10	26.50	12.75	
	25.70	5.01	25.10	12.00	

3.3. Insecticidal Effect of *Capsicum chinense* Powders

Table 7 shows the different doses used of *Capsicum chinense* powders on *Sitophilus zeamaïs* and *Aphis craccivora* as well as the standard deviations for assessing their insecticidal effects, and the photo of the experimental device of jars containing maize and groundnut grains. (Figure 1)

Table 7. Insecticidal effect (or toxicity) of *Capsicum chinense* powder.

Treatment	Doses (g/100g corn)	Average mortality rate (%) (standard deviation)
Fch	2	70 (0.81)
Fch	4	80 (0.81)
Fch	8	100 (0.8)
T0	0	
Fch	2	80 (0.81)
Fch	4	85 (0.81)
Fch	8	100
T0	0	2.8

Figure 1. Experimental device of jars containing corn kernels.

3.4. Impact of Capsicum Chinense Powder on Germination

Table 8 shows the different doses of *Capsicum chinense* powder used in the treatment of corn and peanut kernels infected with *Aphis Craccivora* and *Sitophilus zeamaïs* and the different germination rates, followed by the Figure 2 showing the stage of three (3) leaves after germination of corn and peanut grains treated with *Capsicum chinense* powder in the laboratory.

4. Discussion

For this study, 71 persons were identified 20 women and 51 men Table 1. This indicates a predominance of humans in agriculture and the use of plants in the preservation of harvest products. This is in contradiction with studies carried out in Republic of Mali by [17] which gave (71.83%) women who handle medicinal plants of all these forms.

Table 8. Impact of *Capsicum chinense* powder on germination.

Treatment	Doses (g/100g corn)	Germination percentage
Fch	2	6.5
Fch	4	63
Fch	8	99.5
Average rates (%)		53.33
T0	0	1.75
Fch	2	21.25
Fch	4	96.5
Fch	8	99.75
Average rates (%)		72.50
T0	0	1.75

Figure 2. Germination test.

Indeed, of the 71 respondents who use insecticides of plant origin and their methods of acquisition, 39 (54.93%) acquired on the basis of parental transmission **Table 2**.

The average moisture content values of corn and groundnut kernels are: 14.51% and 12.25% respectively which is the drug appreciation limit of 14% [13] which are presented in **Table 6**.

The different results in **Table 7**, show an effectiveness of *Capsicum chinense* powder on *Aphis Craccivora* and *Sitophilus zeamaïs* at the different doses used; a mortality rate of 80 ± 0.81; 85 ± 0.8. However, the results obtained for maize show a slight difference of ($P < 0.05$) compared to the results found for groundnuts. For the control, no mortality was recorded because he had not received treatment with *Capsicum chinense* powder. This indicates that the insecticidal activity of many plants is related to the presence of the essential oils they contain [18] [19].

Objective to germinate corn and peanut grains treated with *Capsicum chinense* powder, (**Figure 2**) under laboratory conditions was, to evaluate the possibility of germination of these infected grains and treated with *Capsicum chinense* powder. During this period, we actually observed their germinations, and the different germination rates varied according to the doses administered. The average germination rates are: 53.33% for infected maize grains treated with *Capsicum chinense* powder and 72.50% for infected peanut grains and processed *Capsicum chinense* powder. The grains in the control jars (T0) **Table 6** gave identical rates of 1.75%. According to some scientific publication on the germination power of grains show that the decrease in the germination power of seeds can probably be related to many parameters that are in one way or another their heterogeneities, color, weight, size as well as their chemical compositions, ligth [1] [18] [19] [20].

5. Conclusion

This ethnobotanical survey in two sub-prefectures of Boffa identified 71 people, including 20 women and 51 men who grow maize and groundnuts. The age range is: 41 to 61 years. The majority use the parts of the plants to preserve their harvest grains. Eight (8) plants with insecticidal properties frequently mentioned are: *Solanacea*, *Liliacea*, *Zingiberaceae*, *Combretaceae*, *Labiae*, *Myrtaceae*, *Chrysobalanaceae*, *Lamiaceae*. And the one most cited as an insecticide in the conservation of corn and groundnut grains is: *Solanacea* (*Capsicum chinense*). The insecticide efficacy test of *Solanacea* powder (*Capsicum chinense*) was performed on corn and peanut kernels infected with *Aphis craccivora* and *Sitophilus zeamaïs*. The average germination rates of these infected maize and peanut grains treated with *Capsicum chinense* powder are: 53.33%; 72.50% respectively. Untreated corn and peanut kernels significantly lost their germination powers with a rate of 1.75%. The moisture content of corn kernels and groundnuts gave: 14.51%, 12.25% respectively.

Conflicts of Interest

We the authors, declare that there is no conflict of interest regarding the publication of this paper.

References

[1] Hassan, K., Nasser, A.A., Sabiha, S., Nesa, N., Khan, M. and Islam, N. (2018) Control Potentials et *Hyptis sauveolens* L. (Pait) Extracts against *Artamia salima* L. Nauplil and *Tribalium castaneum* (HBST) Adults. *Journal of Entamology and Zoology Studies*, **6**, 785-789.

[2] Bounechada, M.M. and Arab, R. (2011) Effet insecticide des plantes *Melia azedarach* L. et *Peganumharmala* L. sur *Triboliumcastaneum* Herbst. (Coleoptera: Tenebrionidae). *Agronomie*, **1**, 1-6

[3] Sakho, A. M., Diallo, A., Traoré, K., Condé, F., Keita, A. et Kourouma, M. (2021) Evaluation de l'activité insecticide des feuilles Hyptis suaveolens et de Hyptis spicigera sur le taux de germination des grains de maïs infectés par Sitophilus zeamais. *Afrique Science*, **18**, 31-40.

[4] Camara, S. (2017) Institut de rechercheagronomique de Guinée, Kindia, République de GuinéeProduction et utilisation du maïsen Guinée. https://www.fao.org

[5] Gueye, M.T., Cissoko, P.S., George, G., Wathel, J.P. and Lognay, G. (2012) Efficacy of Powdere Maize Cobs against the Maize Weevil *Sittophilus zeamais* (Coleoptera: Curculionidae) in Stored Maize in Senegal. *International Journal of Tropical Insect Science*, **32**, 94-100. https://doi.org/10.1017/S1742758412000148

[6] Yolide, I., Keita, D.A., Moussa, I., Toumane, A., Bakasso, S., Saley, K., Much, T., Pirat, J. and Ouamba, J.M. (2020) Enquête ethnobotanique sur les plantes utilisées traditionnellement au Niger dans la lute contre les moustiques vecteurs des maladies parasitaires. *International Journal of Biological and Chemical Sciences*, **14**, 570-579. https://doi.org/10.4314/ijbcs.v14i2.21

[7] Ngamo, T.S.L., Ngatanko, I., Ngassoum, M.B., Mapongmestsem, P.M. and Hance, T. (2007) Insecticidal Efficiency of Essential Oils of 5 Aromatic Plants Tested Both alone and in Combination towards *Sitophilusoryzae* (L.) (Coleoptera: Curculionidae). *Research Journal of Biological Science*, **2**, 75-80.

[8] Bossou, A.D., Ahoussi, E., Ruysbergh, E., Adams, A., Smagghe, G.N.D., Kimpe, Avlessi, F., Sohounhlou, D.C.K. and Mangelinckx, S. (2015) Characterization of Volatile Compounds from Three *Cymbopogon* Species and *Eucalyptus citriodora* from Benin and Their Insecticidal Activities against *Tribolium costaneum*. *Industrial Crops and Products*, **76**, 306-317. https://doi.org/10.1016/j.indcrop.2015.06.031

[9] Athanassiou, C.D., Kavallieratos, N.G. and Meletitsis, C.M. (2007) Insecticidal Effect of Three Diatomaceous Earth Formulations, Applied alone or in Combination, against Stored-Product Beetle Species on Wheat and Maize. *Journal of Stored Products Research*, **43**, 330-334. https://doi.org/10.1016/j.jspr.2006.08.004

[10] Pierre, V.K.S., Beaudelaire, K.P., Borice, T., Tsafack., Jonas, K., Roland, T.T., Rémy, B.T., Jean, P.D., Till, O. and Léon, A.T. (2021) Ethnobotany, Pharmacology and Phytochemical Investigations of the Seeds of *Pentaclethra macrophylla* Benth (Mimosaceae). *Advances in Biological Chemistry*, **11**, 126-141. https://doi.org/10.4236/abc.2021.113009

[11] Fok, M., Ndoy, O., Koné, S. and AGRAR (2013) Proceedings of AGRAR 1st Conference of African Research on Agriculture, Food and Nutrition. Yamoussoukro, June 4-6.

[12] Détermination de la teneur en humidité dans les aliments pour animaux et les pains. Agence Fédérale pour la Sécurité de la Chaine alimentaire, Laboratoire de Liège (2013, Février).

[13] Deffen, K.P., Akanvou, L., Nemlin, G.J. and Kouame, P.L. (2015) Evaluation morphologique et nutritionnelle de variétés locales et améliorées de maïs (*Zea mays* I.) produites en Côte d'Ivoire. *Afrique Science*, **133**, 181-196.

[14] Aminata, K.A., Gueye, M.T., Diop, S.M., Cissokho, P.S. and Gueye, A.N. (2018) Etude de l'efficacité de la poudre et des cendres de balle de riz contre deux insectes ravageurs du riz stocké au Sénégal, *Sitophilus zeamais* (Matsch) et *Tribalium castanneum* (Harbst). *International Journal of Biological and Chemical Sciences*, **12**, 1731-1739. https://doi.org/10.4314/ijbcs.v12i4.17

[15] Conti, B., Benelli, G., Flamini, P.L., Cioni, R., Profeti, L., Cedcarini, M., Macchia, A. and Canale, A. (2012) Larvicidal Repellent Activity of *Hyptis suaveolens* (Lamiaceae) Essential Oil against the Mosquito *Aedes albopictus* Skuse (Diptera: Culicidae). *Parasitology Research*, **110**, 2013-2021. https://doi.org/10.1007/s00436-011-2730-8

[16] Ri, A.A., Irie, B., Kouame, P.L. and Zoro, B.I.A. (2011) Base génétiques et biochimiques de la capacité germinative des graines: Implications pour les systèmes semences et la production alimentaire. *Sciences & Nature*, **8**, 119-137.

[17] Denou, A., Koudouvo, K., Togola, A., Haidara, M., Dembele, S.M., Ballo, F.N., Sanogo, R., Diallo, D. and Gbeassor, M. (2017) Savoir traditionnel sur les plantes antipaludiques à propriétés analgésiques, utilisées dans le district de Bamako (Mali). *Journal of Applied Biosciences*, **112**, 10985-10995. https://doi.org/10.4314/jab.v112i1.3

[18] Conti, B., Canale, A., Cioni, P.L. and Flamini, G. (2010) Repellence et Essential Oils from Tropical and *Mediterranean* Lamiaceae against *Stophilus zeamais*. *Bulletin of Insectology*, **62**, 197-202.

[19] Dedi, J. and Allou, K. (2015) Etude du pouvoir germinatif de quatre variétés de riz que sont GIZA 178, WAB 56-50, LOHININI, DANANE et identification des champions présents sur les grains en germination. *Afrique Science*, **11**, 161-171.

[20] Xue, W. , Guo, Q. , Zhu, J. , Wu, J. , Huang, Y. and Deng, L. (2022) Research on the Effects of Light Intensity and Seeding Density on the Seed Germination and Seeding Growth of *Liriodendron chinense*. *Journal Agricultural Chemistry and Environment*, **11**, 24-41. https://doi.org/10.4236/jacen.2022.111003