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INSECTICIDAL PROPERTIES OF SIX PLANT MATERIALS AGAINST *CARYEDON SERRATUS* (OL.) (COLEOPTERA: BRUCHIDAE)

A. DELOBEL and P. MALONGA
Centre ORSTOM/DGRST, B.P. No. 181, Brazzaville, Congo

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Abstract—An account is given of the effectiveness against *Caryedon serratus* of powders of *T. ephrosia vogelii* (a known source of rotenone) and of five other plants traditionally used in the Congo to protect groundnuts. At application rates of 1:40 w/w, *Chenopodium ambrosioides* and *T. vogelii* affected the survival of *C. serratus* adults, 90.0 and 98.8% of them dying within 13 days, respectively. No or very few eggs were laid. Other plant materials had little or no effect on the different stages of the insect.

INTRODUCTION

The protection of stored products by the use of plant materials is a common practice among smallholder farmers in Africa. Repellent, anti-feeding, and insecticidal substances have been identified in a large variety of plant species, long before the "industrial insecticide revolution" in the 1930's and 1940's, when compounds such as nicotine, derris and pyrethrum were the only effective insecticides (Green *et al.*, 1979). Azadirachtin, a component of *Azadirachta indica* A. Juss. and *Melia azedarach* L. (Meliaceae), is presently considered as a promising alternative to synthetic insecticides, and is currently under investigation in several developing countries (Jotwani and Srivastava, 1981; Ivbijaro, 1983; Jilani, 1983). Plants traditionally used in the tropics to protect stored products against various insect pests have been reviewed by Golob and Webley (1980).

In the Congo, *Lippia multiflora* Hochst, *Eupatorium odoratum* L., *Ocimum canum* L., *Nicotiana tabacum* L. and *Chenopodium ambrosioides* L. are used by farmers to protect beans against *Acanthoscelides obtectus* (Say) and *Callosobruchus maculatus* (F.), as well as groundnuts against *Caryedon serratus* (01.), but their efficiency, according to the farmers themselves, is extremely low. Some of these plants have known pharmacological properties. In particular, *C. ambrosioides*, known in the New World as "Mexican tea", is used in Africa as a cure for minor disorders and also as an anthelminthic. According to Kerharo (1974), it owes its therapeutic properties to ascaridole, a terpenic peroxide.

The present experiment was designed to investigate the toxicity of these plants to *Caryedon serratus*, which is the most serious pest of groundnuts in central Africa (Matokot *et al.*, 1987). *Tephrosia vogelii* Hook. f. was also included in the study because its leaves contain a rotenoid compound known as deguelin (Kerharo, 1974). Considerable work was done, before World War II, to assess the possibility of using extracts of *Tephrosia* spp. from Africa, southern Asia and Latin America as a source of insecticides with a low toxicity to mammals and a short persistence (Le Pelley and Sullivan, 1936; Anon., 1938; Hansberry and Clausen, 1945).

MATERIALS AND METHODS

Six plant species were tested:

Lippia multiflora Hochst. (Verbenaceae)
Eupatorium odoratum L. (Compositae)
Ocimum canum L. (Labiatae)
Chenopodium ambrosioides L. (Chenopodiaceae)
Nicotiana tabacum L. (Solanaceae)
Tephrosia vogelii Hook. f. (Leguminoseae)

Material for the experiments was collected during the early months of 1986 around Brazzaville and in the Bouenza region (Southern Congo). Plants were dried for 3–5 days in a wooden cabinet fitted with a 30 W bulb providing a temperature of 38°C and 20–25% r.h. Green parts were then ground in a mortar to pass a 0.4 mm screen.

One kilogram each of unshelled groundnuts, variety "Rose de Loudima", was placed in small bags (28 × 40 cm), made of woven polypropylene, of the type commonly used in the Congo for groundnut storage. Plant powder (25 g) was carefully mixed with each sample. This rate of application roughly corresponded with rates usually employed by peasant farmers; however, farmers use whole plants and not ground material, as was the case in the present experiment. Each sample was then infested with 10 pairs of newly emerged (less than 24 hr old) *C. serratus* adults from a colony maintained in the laboratory for six generations and originating from farmers' stores in the Bouenza region. Untreated bags (control) were similarly infested with 10 pairs. Each treatment, including control, was replicated four times at 24 hr intervals. Bags were randomly assigned to positions on the floor of a store; air temperature was 24.8 ± 2°C and the relative humidity ranged from 78 to 99%, with a natural photoperiod régime.

Adult mortality was assessed 5, 9 and 13 days after infestation; adults were considered as dead when no response was obtained after probing the abdomen with forceps. Dead adults were removed from the bags. Eggs were counted 13 and 30 days after infestation on randomly selected samples of 100 groundnuts per replicate. Infertile and dead eggs were also recorded. No egg was laid after the 30th day of the experiment. Observations on larval and pupal survival were made on 100 randomly selected groundnuts 50 days after infestation.

RESULTS

Adult survival

T. vogelii and *C. ambrosioides* powders were highly toxic to the groundnut bruchid (Table 1). After only 5 days, adults exhibited various degrees of intoxication, with uncoordinated movements or prostration. After 13 days, mortality was 90% in *C. ambrosioides*-treated bags, and 98.8% in *T. vogelii*-treated bags. Control mortality averaged 13.8%; there was no significant effect of any of the other plant materials.

Fecundity, fertility and egg development

No eggs were laid in bags treated with *T. vogelii* powder. On the 13th day after infestation, two eggs were recovered from *C. ambrosioides*-treated nuts (Table 2); these two eggs were hatched, which seems to indicate that the powder has no effect on egg development.

Egg-laying in *L. multiflora* and *E. odoratum*-treated bags was reduced by 24.9 and 23.8%, respectively, as compared with controls. Other plant materials had no significant effect on oviposition. Tobacco (*N. tabacum*) powder significantly affected egg development: 14% of fertile eggs were found dead 30 days after infestation, a proportion which is significantly higher than egg mortality observed in untreated controls ($\chi^2 = 7.17$; 1 d.f.; $P < 0.01$).

Table 1. Effect of plant powders on mortality of *C. serratus* adults

	C. serratus mortality		
	Sampling date		
Plant powder	I+5	I+9	I+13
T. vogelii	3.25	13.25	19.75a
C. ambrosioides	9.75	13.00	18.00a
L. multiflora	1.00	1.50	3.25b
E. odoratum	0.25	0.75	3.25b
O. canum	0.50	2.00	5.00b
N. tabacum	0.25	0.75	2.50b
Control	0	0.50	2.75b

Each value is the mean number of dead adults 5, 9 and 13 days after infestation out of 20 (four replicates). Values followed by the same letter are not significantly different at $P = 0.001$ according to Tukey's test.

Table 2. Effect of plant powders on oviposition by *C. serratus*

	Number of eggs				
	Sampling date				
		I + 30			
Plant powder	I + 13	Sterile	Dead	Hatched	Total
T. vogelii	0a	0	0	0	0a
C. ambrosioides	0.50a	0	0	0	0a
L. multiflora	50.25bc	3.75	3.75	44.75	52.00b
E. odoratum	40.00b	3.00	3.25	46.75	52.75b
O. canum	48.25bc	1.75	4.50	57.75	64.00c
N. tabacum	63.75d	4.00	9.50	58.50	72.00d
Control	56.25cd	5.75	2.50	61.00	69.25cd

Each value is the mean number of eggs per 100 groundnuts 13 and 30 days after infestation (4 replicates).
Values followed by the same letter are not significantly different at $P = 0.05$ according to Tukey's test.

Table 3. Effect of plant powders on preimaginal mortality in *C. serratus*

	Number of larvae and pupae		
Plant powder	Alive	Dead	Total
T. vogelii	0	0	0a
C. ambrosioides	0.50	0	0.50a
L. multiflora	41.75	0.50	42.25b
E. odoratum	41.50	0.25	41.75b
O. canum	47.75	1.50	49.25c
N. tabacum	54.75	0.25	55.00d
Control	50.25	1.00	51.25cd

Each value is the mean number of larvae and pupae in 100 groundnuts 50 days after infestation (four replicates).
Values followed by the same letter are not significantly different at $P = 0.05$ according to Tukey's test.

Larval survival

A very small number of larvae (first and second instars only) were found dead in the seeds 50 days after infestation (Table 3), and there was no significant effect of any of the powders. The difference between the number of hatched eggs after 30 days in each treatment (Table 2) and the number of larvae and pupae 50 days after infestation (Table 3) ranged from 5 (for *L. multiflora* and *N. tabacum*) to 16% in untreated controls. This variation is caused by newly hatched larvae which could not enter the seeds and died in the space between seed and shell (Matokot *et al.*, 1987). There was no significant effect of plant powders on this type of mortality.

The number of living larvae and pupae 50 days after infestation was highest (220 insects from 400 groundnuts) in *N. tabacum*-treated samples. It was reduced by 3.9, 17.6 and 18.5% in bags treated with *O. canum, L. multiflora* and *E. odoratum*, respectively, as compared with controls. Only two insects were recovered in *C. ambrosioides*-treated bags, while *T. vogelii* powder gave complete protection against *C. serratus*.

DISCUSSION

Of the five plants used by farmers in the Congo for the protection of stored groundnuts, only *C. ambrosioides* had a distinct effect on the survival of *C. serratus* adults. The reason why these plants are used in spite of their lack of effectiveness is not clear. Their common feature is a strong smell, which is believed to repel or kill insects, but this is obviously not always the case. The practice of mixing plants or parts of plants to stored grain appears to be more a token of allegiance to tradition than an effective control measure.

The longevity of *C. serratus* adults varies, according to Prevett (Davey, 1958) from 10 to 35 days at 25°C and 60% r.h. The present study has shown that *T. vogelii* and *C. ambrosioides* powders at an admixture rate of 25 g/kg groundnuts significantly reduced adult longevity, 98.8 and 90.0% of adults respectively, dying within 13 days. The most striking effect of these two plants is a reduction in fecundity, resulting in a complete (in the case of *T. vogelii*) or almost complete (in the case of *C. ambrosioides*) protection of groundnuts.

Powders or extracts of different *Tephrosia* spp. have been shown in the past to be toxic to insects, for example to *Epilachna varivestis* Muls. (Hansberry and Clausen, 1945), *Musca domestica* L. (Le Pelley and Sullivan, 1936), *Antestia* sp. (Lefèvre, 1942) and *Amphis rumicis* L. (Martin, 1936). It was considered at that time that *T. vogelii* itself had a potential as an economic source of rotenone (Anon., 1938). However, the rapid development of the chemical industry interrupted the spread of insecticides of vegetable origin.

C. ambrosioides is a promising control agent against stored products insects, at least in farmers' storage systems. The application rate of 1:40 w/w is low, as compared with dosages usually recommended for similar materials: 1:8 w/w of citrus peel powder for the protection of cowpea against *C. maculatus* (Don-Pedro, 1985), and 1:3.3 w/w of wood ash, tobacco dust and sand for the protection of maize against *Sitophilus zeamais* Motsch. and *Sitotroga cerealella* (01.) (Golob *et al.*, 1982).

The nature of the active compound of *C. ambrosioides*, which could possibly be the one responsible for its anthelmintic properties, will be the subject of further investigation by the authors. Its mode of action, persistence and spectrum of activity against other stored products insects, as well as the optimal size of particles and level of application necessary to afford complete protection of stored grain, will also be determined.

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