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Insecticidal Effects of Three Solanaceous Plants Against *Urentius hystricellus* (Richter) (Hemiptera: Tingidae)

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***Abstract* — Laboratory experiments were conducted to study the insecticidal actions of three solanaceous plants, viz. *Nicotiana tabacum* (leaves), *Solanum dubium* (fruits) and *Solanum incanum* (fruits), compared with that of the commonly known neem (*Azadirachta indica*) seed extract. Two concentrations (2.5% and 5% w/v) of aqueous extracts from the four plant species were screened in separate bioassay tests against adults and nymphs of the eggplant tingid bug (*Urentius hystricellus*), a major pest of eggplant in Sudan. All botanical treatments revealed potent insecticidal activities in combating the pest. Significant knockdown effects were achieved by almost all treatments 24 h post exposure, with activities increases progressively with concentration and exposure time. Such treatments gave higher mortality results on nymphs than on adults. Although, superior effects were manifested by *N. tabacum* and *A. indica* during early counts (24 and 48 h), comparable results were achieved by the two *Solanum* spp. during the third check (72 h). However, the better results obtained by *N. tabacum* against the nymphs, as compared with neem extract, needs further investigations. The latter two plants should be stressed for practical exploitation in management of the tingid bugs on eggplant. However, the promising insecticidal potentialities of the tested plants also encourage more research on indigenous solanaceous species as rich sources of active compounds that need to be checked on various biological aspects (repellent, antifeedant, hormonal etc.) of this pest and others.**

***Key Words* — Botanical extracts, Solanaceae, *Solanum* spp., *Nicotiana tabacum*, neem, bioassays.**

I. Introduction

Solanaceae, as one of the largest families in plant kingdom, comprises 95 genera and more than 3000 species distributed in variable climates ranging from tropical rainforests to deserts and snowy areas. The importance of Solanaceae also came from the fact that it comprises species which are said to be essential to life, including edible plants, ornamentals and medicinal or narcotic species. Several active compounds found in this plant family such as steroidal (includes a variety of compounds e.g., sapogenins, tomatidine, solasodine and neotigogenin) and tropane alkaloids are important in drug and pharmaceutical industry. Hence, the family is mainly known for possessing appreciable amounts of diverse alkaloid compounds, but other active principles like flavonoids and phenolic compounds were detected at variable levels in some species [1]-[2].

Besides the cultivated vegetable crops such as tomato (*Lycopersicon esculentum*), potato (*Solanum tuberosum*) and eggplant (*Solanum melongena*), there are several wild solanaceous plant species (e.g., *Solanum* spp. and *Datura* spp.) in Sudan, some of which are known to be used in folk medicine. On the other hand, a number of wild solanaceous species are known to act as alternative hosts for insect pests of cultivated plants of the same family [3]. Therefore, to understand whether these wild species are beneficial or harmful from plant protection point of view, comprehensive scientific research should be elaborated to cover their ecological interactions with major pests besides their possible consequent uses in this field.

Most of the plant derivatives detected in Solanaceae were also proved to be effective as natural insecticides, and the nicotine found in *Nicotiana* spp. is one of the famous insecticidal alkaloids [4]. Products of these plants were exploited since earlier times as the major tools for pests' control, before the discovery of synthetic pesticides. However, scientific research continuously adds new records of active solanaceous plants to the candidate flora of botanical pesticides [1].

Eggplant tingid bug [*Urentius hystricellus* (Richter)] is one of the important economic pests of eggplant in Sudan. It is distributed in all parts of the country causing considerable damage to this crop and other alternative wild plants, particularly *Solanum dubium* and *Solanum incanum* [3]-[5]-[6]. The pest generally shows its peak population on eggplant during autumn (August – November), while the lowest density occurs in winter (December - March) season [3]. Application of synthetic chemicals is the main tactic adopted for controlling this pest in Sudan [7]. However, the numerous side effects of such chemicals have led to think and search for effective and ecologically safe alternatives. Accordingly, some different botanical preparations were attempted, and the best results obtained yet were recorded from neem seed extracts, which showed better effects than several recommended synthetic insecticides [8].

In this study laboratory experiments were conducted to compare the insecticidal actions of three solanaceous plants (viz. *Nicotiana tabacum*, *Solanum dubium* and *Solanum incanum*) with that of the commonly known neem (*Azadirachta indica*) seed extract, against the eggplant tingid bug (*Urentius hystricellus*).

II. Materials And Methods

Laboratory studies were conducted at the Environment and Natural Resources Research Institute, National Centre for Research, Khartoum-Sudan, to evaluate the insecticidal activities of three solanaceous plants compared with the neem (*Azadirachta indica*), against the adults and nymphs

of eggplant tingid bug (*Urentius hystricellus*), in two separate experiments. The plant materials utilized included leaves of tobacco (*Nicotiana tabacum*), fruits of "Gubein", *Solanum dubium*, and "Gubein Elbagar", *Solanum incanum*, plus the neem seeds.

A. *Preparation of Treatments*

Tobacco leaves were kindly provided by the Blue Nile Cigarette Co., Khartoum-Sudan, and "Gubein", *S. dubium*, fruits were collected from Shambat area, while fruits of "Gubein Elbagar", *S. incanum*, were brought from El-Gorair area in Northern State. On the other hand, neem seeds were collected from Shambat area, Khartoum North, so as to be used for comparison. After drying under shade conditions in the laboratory, the plant samples were ground into fine powders using an electric blender. The powders were extracted with water at the time of application, based on steps described in previous studies [9]-[10]. One day before the commencement of an experiment, the needed quantity of powder was weighed, soaked in water, agitated for five minutes and left to stand overnight. On the next day the mixture was filtrated, and 0.1% of Gum Arabic and liquid soap were added to improve the adherence property. The extract volume was completed with water to attain the two concentrations applied (2.5% and 5% w/v).

B. *Insect Rearing and Bioassays*

Early stages of tingid bug nymphal instars (1st and 2nd) were collected from unsprayed eggplant fields at Shambat and reared in the laboratory to get the 4th instar nymphs and adults needed for the two bioassay experiments. Upon treatments, fresh leaves of eggplant were dipped in the extract solution for one minute according to concentration, and dried for 5 minutes before introduction into the Petri dishes. The treatments were replicated three times, assigned in a Completely Randomized design. The experiment was investigated daily for counting dead insects and recording any observations until the 3rd day (i.e., 24, 48 and 72 h post treatments). The recorded data were statistically analyzed, and means separation was performed according to Duncan's Multiple Range test.

III. Results And Discussion

The first experiment evaluated two concentrations (2.5% and 5%) of water extracts prepared from the four mentioned plant parts against the adults of eggplant tingid bug (*Urentius hystricellus*). These plant parts included; *Nicotiana tabacum* (leaves), *Solanum dubium* (fruits), *Solanum incanum* (fruits) and *Azadirachta indica* (seeds). The mortality results of treatments were demonstrated in table 1. All solanaceous plant extracts showed variable mortality levels on adults since the first day (24 h) of treatments, but mostly without significant differences from the control. Here, neem extract induced significantly higher mortality levels than solanaceous plants. The mortality trend was gradually increased during the subsequent days (48 and 72 h). At these intervals, the two concentrations of neem seed extract showed the best mortalities, though *S. incanum* extract (5%) was gained comparable effect. In most cases the activity of each plant was almost positively proportional with concentration. However, the ranking of these plants according to the extracts used may put the neem on the top as the most effective plant against adults of tingid bugs, followed by *S. incanum*, *N. tabacum* and lastly *S. dubium*.

On the other hand, table 2 shows the mortality results regarding the effects of the same previous treatments on the 4th instar nymphs of *U. hystricellus*. After 24 h post exposure, both neem and tobacco treatments attained significant mortality results, as compared with that of control. 100% mortality was obtained by the highest concentration (5%) of the two plants. In the second day, the lowest rate (2.5%) of both plants also achieved 100% mortality, and even the other extracts of the two *Solanum* spp. almost gained comparable effects. Thenceforth, nearly the same trend was maintained during the third day. Moreover, it was observed in some treatments of *S. dubium*, that some nymphs were failed to moult properly and find difficulties to release themselves from their moulting skin until died. This might suggests the occurrence of certain growth regulatory active compounds in this plant.

However, the whole picture of the results indicated that all the tested plants extracts were more effective on nymphs than on adults. Another observation is that, different ranking of the four plants was achieved when considering their activities against nymphs. Thus, *N. tabacum* was the best, followed by *A. indica*, *S. dubium* and *S. incanum* in the last. In other words, *N. tabacum* may contain active ingredients with higher potency against nymphal stages than adult stage. Moreover, nicotine has the advantage of entering the insect body through the spiracles. It is an acetylcholine receptor antagonist. Since *U. hystricellus* generally breeds and buildup during late autumn season [3], hence, extracts of *N. tabacum* and *A. indica* can be attempted for the management of this pest to prevent its multiplication and subsequent crop damage in such period.

Very meager literature is found considering the insecticidal effects of the tested *Solanum* species. For instance, EL-Kamali (2009) reported moderate activities (LC_{50}= 100mg/ml after 72 h) of *Solanum dubium* ethanolic extract against *Tribolium castaneum*, which was attributed to presence of some secondary metabolites (e.g., alkaloids, flavonoids, and phenolic compounds) in this plant [11]. Mortality and contact effects of *S. incanum* were reported on some insects [12]. Contrarily, a voluminous literature is available worldwide on neem [13] and tobacco [4] insecticidal properties. High insecticidal activities were obtained against various agricultural pests as a result of spraying tobacco leaves extracts on different crops worldwide [14]-[15]-[16]. However, among botanical extracts attempted at field level in Sudan, neem ingredients proved to be the most effective in combating different pests as compared to other plant extracts. Neem seed water extract was recorded to show superior control with sharp reduction in population levels of the tingid bug

Table 1. Insecticidal effect of water extracts from four plant species on adults of *Urentius hystricellus*, at different intervals from treatments.

Treatments	Mortality means (X± S.E.) and percentages(%) after different intervals					
	24 h		48 h		72 h	
	X ± S.E.	%	X ± S.E.	%	X ± S.E.	%
Nicotiana tabacum at 2.5%	0.3 ± 0.3ab	4.8	1.7 ± 0.9bc	23.8	3.0 ± 0.6c	42.9
Nicotiana tabacum at 5%	1.0 ± 0.6ab	14.3	4.7 ± 1.3ab	66.7	5.7 ± 1.3ab	81.0
Solanum incanum at 2.5%	0.3 ± 0.3ab	4.8	2.3 ± 0.3abc	33.3	4.7 ± 0.7abc	66.7
Solanum incanum at 5%	0.7 ± 0.7ab	9.5	4.3 ± 1.5ab	61.9	6.0 ± 1.0a	85.7
Solanum dubium at 2.5%	1.0 ± 0.6ab	14.3	2.7 ± 0.7abc	38.1	4.3 ± 0.3abc	61.9
Solanum dubium at 5%	0.3 ± 0.3ab	4.8	2.2 ± 0.7abc	23.8	3.3 ± 0.9bc	47.6
Azadirachta indica at 2.5%	2.3 ± 0.9a	33.3	5.0 ± 1.2a	71.4	6.0 ± 0.6a	85.7
Azadirachta indica at 5%	2.0 ± 1.2ab	28.6	5.0 ± 1.0a	71.4	6.3 ± 0.3a	90.5
Control	0.0 ± 0.0b	0.0	0.0 ± 0.0c	0.0	0.0 ± 0.0d	0.0
C.V.%	122.6		53.8		29.2	

Means with the same letter(s), in each column, are not significantly different (at 5% level) based on DMR test.

Table 2. Insecticidal effect of water extracts from four plant species on 4th instar nymphs of *Urentius hystricellus*, at different intervals from treatments.

Treatments	Mortality means (X± S.E.) and percentages(%) after different intervals					
	24 h		48 h		72 h	
	X ± S.E.	%	X ± S.E.	%	X ± S.E.	%
Nicotiana tabacum at 2.5%	4.3 ± 0.3a	86.7	5.0 ± 0.0a	100.0	5.0 ± 0.0a	-
Nicotiana tabacum at 5%	5.0 ± 0.0a	100.0	5.0 ± 0.0a	-	5.0 ± 0.0a	-
Solanum incanum at 2.5%	0.3 ± 0.3cd	6.7	2.7 ± 1.2b	53.3	3.3 ± 0.9b	66.7
Solanum incanum at 5%	0.7 ± 0.3cd	13.3	3.3 ± 0.9ab	66.7	4.0 ± 0.6ab	80.0
Solanum dubium at 2.5%	0.3 ± 0.3cd	6.7	3.3 ± 0.3ab	66.7	3.3 ± 0.3b	66.7
Solanum dubium at 5%	1.3 ± 0.3c	26.7	3.3 ± 0.3ab	66.7	4.7 ± 0.3ab	93.3
Azadirachta indica at 2.5%	3.0 ± 0.6b	60.0	5.0 ± 0.0a	100.0	5.0 ± 0.0a	-
Azadirachta indica at 5%	5.0 ± 0.0a	100.0	5.0 ± 0.0a	-	5.0 ± 0.0a	-
Control	0.0 ± 0.0d	0.0	0.0 ± 0.0c	0.0	0.7 ± 0.7c	13.3
C.V.%	28.8		25.0		19.2	

Means with the same letter(s), in each column, are not significantly different (at 5% level) based on DMR test.

after one spray on eggplant crop, and even manifested better insecticidal performances than the applied standard chemicals, reflecting the high sensitivity of the pest to neem extracts [8].

Therefore, the superior activities obtained in the current research by tobacco extract against nymphal stage of *U. hystricellus*, as compared to neem and other plants, may need to be elucidated in imminent research studies, though no significant differences were obtained. Neem chemicals are known to act principally through stomach action with minor contact effect [13], but tobacco ingredients can readily enter the insect body through the respiratory system (spiracles) to interfere with the function of the nervous system, and may also taken via stomach route [17], hence this may be one of the reasons why the latter plant gave better knockdown effect than that of the neem extract against the tested insect nymphs. This aspect needs further investigations. Moreover, the effect of *S. dubium* on the insect moulting process may also need to be elaborated in search of growth regulatory active compounds from this plant. Based on the present results more research are also encouraged on indigenous active solanaceous plants to evaluate their future exploitation in pests' control.

IV. Conclusion

The current findings proved the occurrence of potential insecticidal effects in the tested three solanaceous plants against adult and nymphal stages of *Urentius hystricellus*. Since superior insecticidal effect was obtained by neem and tobacco water extracts on the nymphal stage of this pest, such extracts can be applied in the field coincided with the highest breeding period of the tingid bug,

particularly during late autumn season. This will help to prevent the high multiplication of the pest and its subsequent damage to the crop.

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