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Insecticidal effect of some Moroccan plants extracts on *Macrosiphum rosae* and *Gynaikothrips ficorum*

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Abstract

Extracts from *Nicotiana glauca, Withania frutescens, Urtica urens, Ricinus communis, Rosmarinus officinalis* and *Oxalis pes-caprae* collected in the Oriental region were tested for their insecticidal effects on the adults of *Macrosiphum rosae* and *Gynaikothrips ficorum*, pests attacking Green spaces, under laboratory and field conditions. The insecticidal tests carried out revealed very important results; all the extracts of the plants used have an insecticidal effect, which is high in the concentration of 100%, this effect appeared as early as 24 hours after the treatment. At the laboratory, extracts of *Withania frutescens, Nicotiana glauca, Urtica urens and Ricins communis* have the highest mortality rates, from 93% to 100% on *Macrosiphum rosae and Gynaikothrips ficorum*, while *Oxalis pes-caprae, Rosmarinus officinalis* have the lowest mortality rates, from 53% to 77%. These results are confirmed by the field tests, noting that the extracts have a lethal repellent insecticidal effect; All extracts show a high insecticidal effect on *Macrosiphum rosae* exceeding 90% except *Rosmarinus officinalis* which has the lowest mortality rates (85%), whereas for the test against *Gynaikothrips ficorum* the extracts of *Nicotiana glauca* and *Urtica urens* have the highest insecticidal effect arriving at 100%, the others Extracts; *Ricinus communis, Rosmarinus officinalis, Withania frutescens*, and *Oxalis pes-caprae* have the lowest mortality rates from 67% to 81%.

Keywords: insecticidal effect, *Gynaikothrips ficorum, Macrosiphum rosae,* plant extracts

Introduction

Green spaces in the urban environment bring nature to the city and beautify it. The definition of urban green spaces which is agreed on by ecologists, economists, social scientists and planners is public and private open spaces in urban areas, primarily covered by vegetation, which are directly or indirectly available for the users [1].

Urban green spaces, as an important contributor, can be a significant part of sustainable development. They play a range of significant cultural, economic, social and environmental roles and have a positive influence on the quality of life in cities [2]. For the sustainability and development of these spaces, maintenance and permanent control are required. In fact, this environment remains a privileged place for insects where they find also shelter and food. This study focuses on *Macrosiphum rosae* (Hemiptera: Aphididae) and Gynaikothrips ficorum (Thysanoptera: Ploeothridae). This aphid is the most important pest of *Rosa* species [3]. As regards the thrip under study, it comprises approximately 40 species of dark brown to black thrips which induce galls on developing leaf tissues of *Ficus* species [4]. Aphids and thrips are important pests and vectors that transmit viruses to field crops, vegetables, ornamentals and greenhouse crops. They have shown a remarkable ability to develop resistance to most insecticides [5].

The need to protect urban spaces against these enemies makes phytosanitary interventions essential, which often do not take into account the fragility of the biological balances of the environment. However, chemical insecticide applications can be strictly limited to what is strictly necessary and replaced as often as possible by bio-pesticides [6].

The knowledge of medicinal plants, historically, was held by a few specialized herbalists in rural communities; thus, much of their use has been observed to be of first order of local interest [7]. In recent years, medicinal plants have been increasingly present in development policy. Their use and preservation constitute a cross-sectoral theme which compasses, in addition to health care, the protection of nature, biodiversity, biological control, as well as economic promotion, trade and various legal aspects [8]. Extracts of plants continue to be used as insecticides by humans before the time of the ancient Romans to the present day with many species of plants known to have insecticidal properties [9].

The objective of this work is to study the insecticidal activity of methanolic or ethanolic extracts of *Nicotiana glauca*, *Withania frutescens*, *Urtica urens*, *Ricinus communis*, *Rosmarinus officinalis* and *Oxalis pes-caprae* to determine the effects of each on adults of *Macrosiphum rosae* and *Gynaikothrips ficorum* in order to secure the sustainability of green spaces by reducing damage caused by these pests, and to reduce the use of conventional pesticides and, consequently, to limit their negative effects on the environment and human health. It is also to encourage and enhance the production of organic crops in Morocco.

Material and methods

Plant material

Six plant species were studied: *Nicotiana glauca*, *Withania frutescens*, *Urtica urens*, *Ricinus communis*, *Rosmarinus officinalis* and *Oxalis pes-caprae* (Table 1).

The plants were collected at the end of March 2020 in the green spaces of the Oriental region (eastern Morocco), then dried in an oven at 40 °C for 48 to 96 hours, protected from light and then crushed to a powder.

Table 1: Organs and solvent used for each plant

Species	Used parts	Solvent
Urtica urens	Leaves + stem	Ethanol
Withania frutescens	Leaves + stem	Ethanol
Oxalis pes-caprae	Leaves + stem + flowers	Methanol
Ricinus communis	Leaves + immature fruits	Methanol
Nicotiana glauca	Leaves + stem	Methanol
Rosmarinus officinalis	Leaves + stem	Methanol

Extraction and estimation of the quantities of the dry residue

The various extracts were prepared at a rate of 20 g of powder per 200 ml of methanol or ethanol. The powder was macerated for 48 hours in absolute solvent in the dark at room temperature in the laboratory (26 ± 2 °C). The resulted solution was filtered using blotting paper, and Whatman paper N° 1.

The solvent was evaporated to dryness under vacuum using a rotary evaporator (BUCHI R-114) at 40 °C. The residue was weighted, Yield results of the extracts were expressed in percentage (table 2).

Table 2: Yield results of the extracts of the plants used

Species	Yield (%)
Ricinus communis	15
Urtica urens	3.5
Withania frutescens	4.4
Nicotiana glauca	23
Oxalide pes-caprae	15
Rosmarinus officinalis	12.75

Insect material

Apterae adults of *Macrosiphum rosae* were collected from infested rose plants; whereas, the adults of *Gynaikothrips ficorum* were obtained from *ficus microcarpa*, a few minutes before start the experiment.

Biological tests

The test was carried out in two steps; the first one was performed at the Laboratory, the second was taken place in situ in the rose bushes and trees of *Ficus microcarpa* of the city.

For each plant, the doses were prepared by dissolving the dry extracts in the solvent and from this initial extract (100% = 46000 ppm), diluted concentrations of 50% (23000 ppm) and 25% (11500 ppm) were prepared. The control consists of solvent (methanol or ethanol).

In the laboratory, a rose or a *Ficus* leaf infested with ten adults of *Macrosiphum rosae* or *Gynaikothrips ficorum* was introduced into a plastic cup, the upper part of which is closed with an "Insect-proof" net to ensure the aeration. Insects were treated with a mini spray.

These bioassays were conducted under temperature conditions of 26 ± 2 °C, relative humidity ranging from 60 to 70% and a photoperiod of 16: 8.

Mortality rates were calculated after 24, 48 and 72 hours. Three replicates were set up for each treatment and control.

For the test carried out in situ, the same treatments were applied to *Macrosiphum rosae* and *Ficus microcarpa*. The insecticidal effect was estimated by the percentage of the mortality rate (Their behavior, i.e. whether the insects are dead or repelled by the drug). A label showing the type and the concentration of extract was affixed to each treated plant.

Data processing

The results of the experiment were subjected to a two-way analysis of variance (ANOVA). Post hoc testing was carried out using the Tukey test in case of significant difference between the treatments (at P <5%). All analyzes were performed using IBM SPSS statistical software.

Results and discussions

Extraction yield

The yield (Table 2), expressed as a percentage relative to the weight of the initial material, is determined by the following equation:

R (%) = dry extract weight (g) x 100 / initial dry weight (g).

The yield obtained varies according to the plants. It can be seen that the extract of *Nicotiana glauca* is the one with the best yield with 23%, while the lowest yield is observed in *Urtica urens* with 3.5% and *Withania frutescens* with 4.4%. This variation is certainly due to the richness of each species by secondary metabolites compatible with the solvent.

Effectiveness of plant extracts

After exposing adults of *Macrosiphum rosae* and *Gynaikothrips ficorum* to different concentrations of the six extracts for 24, 48 and 72 h under laboratory and field conditions, the mortality rates varied according to the concentrations.

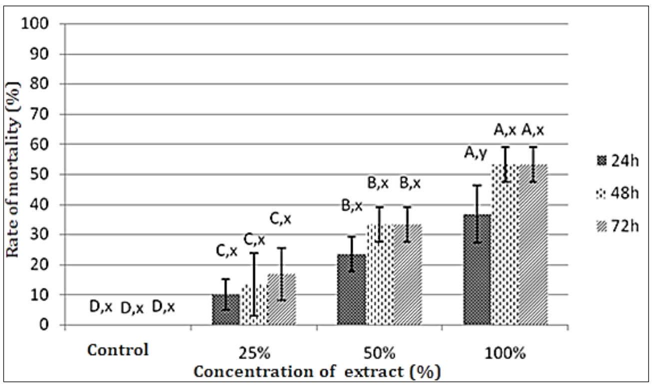

Fig 1: Evolution of the average mortality due to the extract of *R. officinalis* against adults of *M. rosae* in the laboratory.

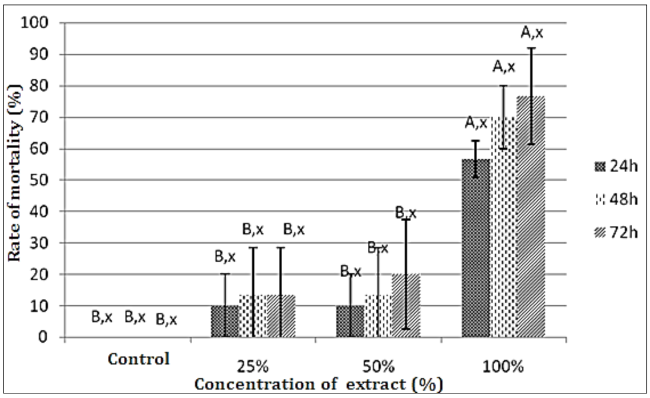

Fig 2: Evolution of the average mortality due to the extract of *Oxalis pes-caprae* against adults of *M. rosae* in the laboratory.

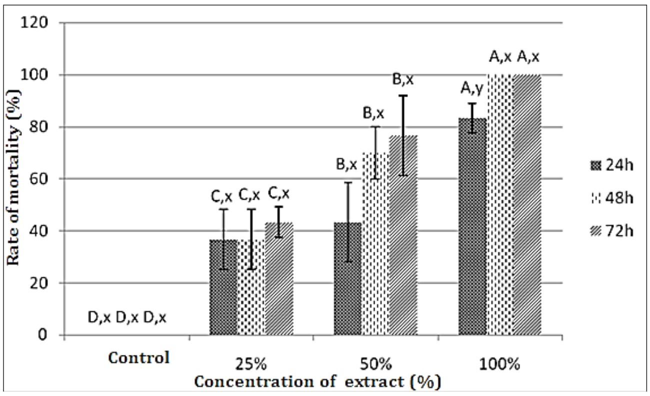

Fig 3: Evolution of the average mortality due to the extract of *Ricinus communis* against adults of *M. rosae* in the laboratory.

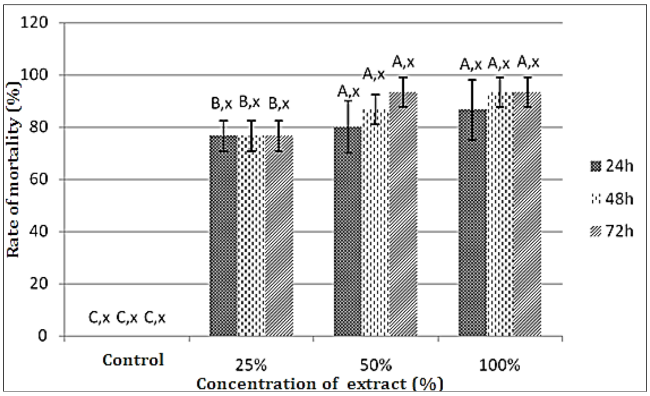

Fig 4: Evolution of the average mortality due to the extract of *Urtica urens* against adults of *M. rosae* in the laboratory.

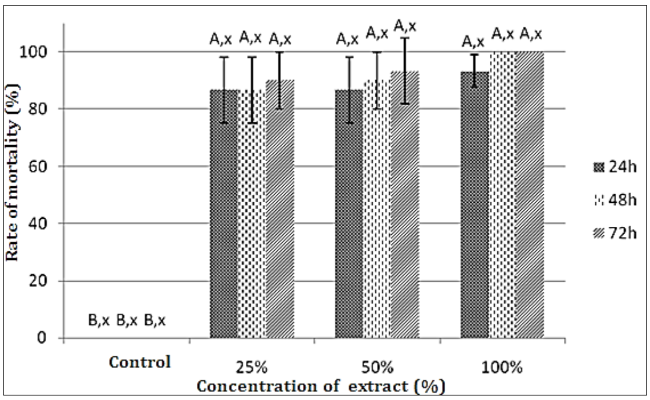

Fig 5: Evolution of the average mortality due to the extract of *Nicotiana glauca* against adults of *M. rosae* in the laboratory.

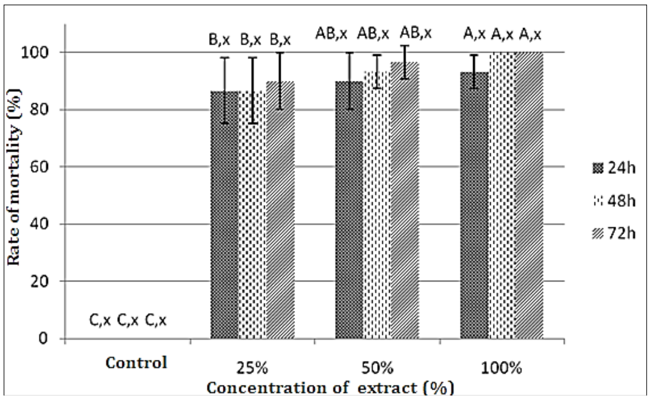

Fig 6: Evolution of the average mortality due to the extract of *Withania Frutescens* against adults of *M. rosae* in the laboratory.

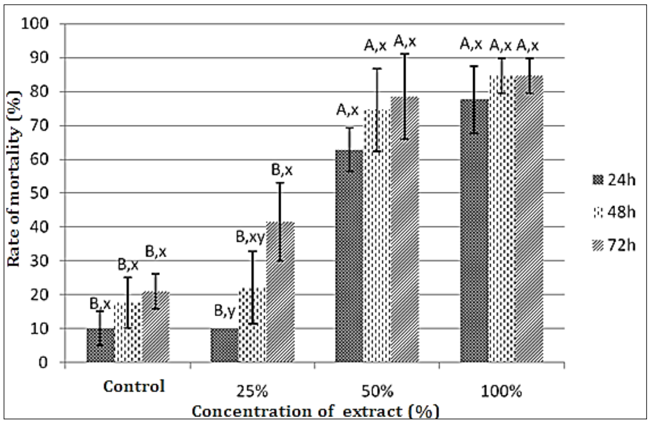

Fig 7: Evolution of mortality averages and repellent effect due to the extract of *R. officinalis* against adults of *M. rosae* in situ.

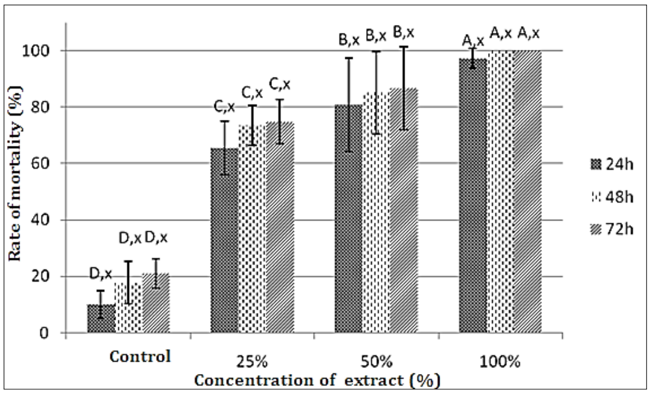

Fig 8: Evolution of average mortality and repellent effect due to the extract of *Oxalis pes-caprae* against adults of *M. rosae* in situ.

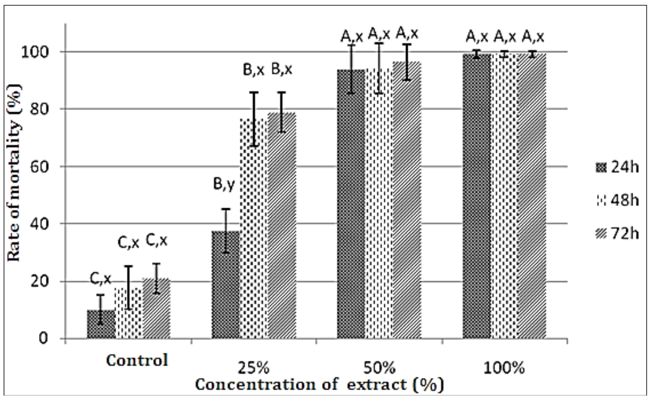

Fig 9: Evolution of mortality averages and repellent effect due to the extract of *Ricinus communis* against adults of *M. rosae* in situ.

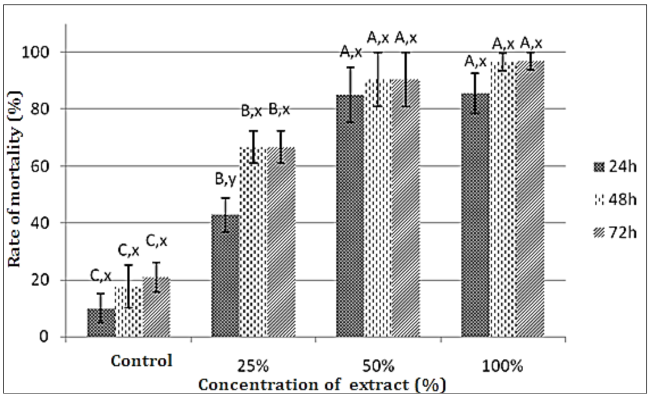

Fig 10: Evolution of the average mortality and repellent effect due to the extract of *Urtica urens* against adults of *M. rosae* in situ.

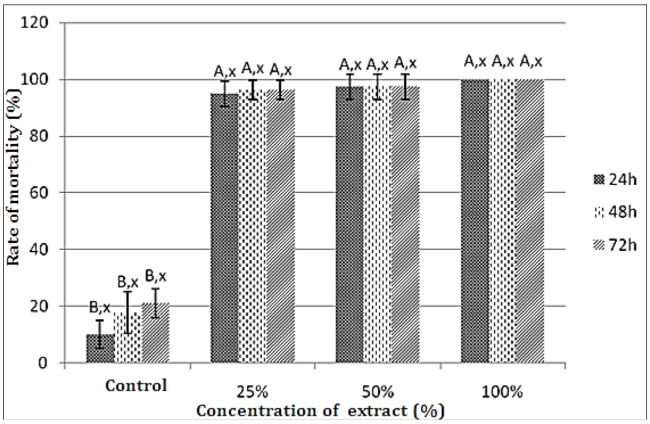

Fig 11: Evolution of the average mortality and repellent effect due to the extract of *Nicotiana glauca* against adults of *M. rosae* in situ.

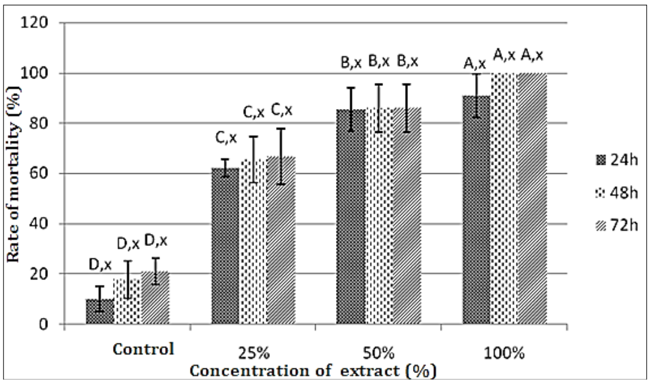

Fig 12: Evolution of the average mortality and repellent effect due to the extract of *Withania frutescens* against adults of *M. rosae* in situ.

Insecticidal tests against *Macrosyphum* in the laboratory showed that *Ricinus communis*, *Nicotiana glauca* and *Withania frutescens* have a very high mortality rate which reached 100% 72 hours after treatment for *Nicotiana glauca* and only 48 hours after treatment for the other two extracts at the concentration of 100%.

The extract of *Urtica urens* caused a mortality of 93% after 72h and 48h, respectively, for concentrations of 50% and 100%.

Extracts of *Rosmarinus officinalis* and *Oxalis pes-caprae*s showed the lowest mortality, it is 53% within 48 hours after treatment for *Rosmarinus officinalis* and 77% within 72 hours after treatment for *Oxalis pes-caprae*.

Field tests deduced that the insecticidal effect (mortality rate and repellent effect) exceeds 90% starting from the concentration of 25% for *Nicotiana glauca* and from the concentration of 50% for *Withania frutescens*, *Urtica urens* and *Ricinus communis*. *Oxalis pes-caprae* reached this rate at the concentration of 100%. The extract of *Rosmarinus officinalis* showed the lowest insecticidal effect (85%) 48 hours after treatment for the concentration of 100%.

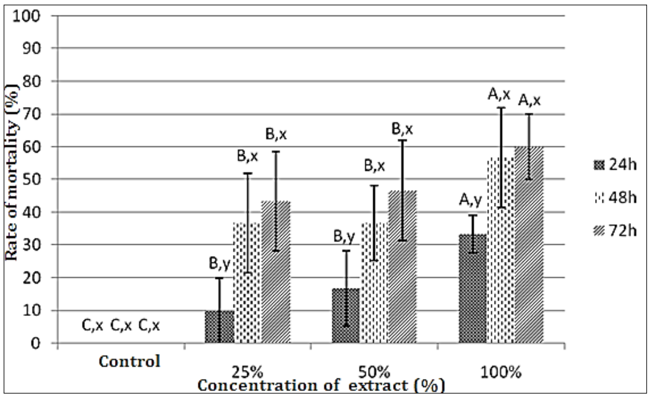

Fig 13: Evolution of the average mortality due to the extract of *R. officinalis* against adults of *G. ficorum*in in the laboratory.

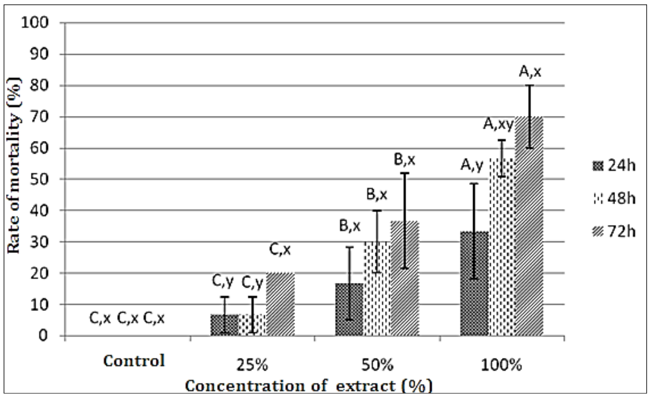

Fig 14: Evolution of the average mortality due to the extract of *O. pes-caprae* against adults of *G. ficorum*in in the laboratory.

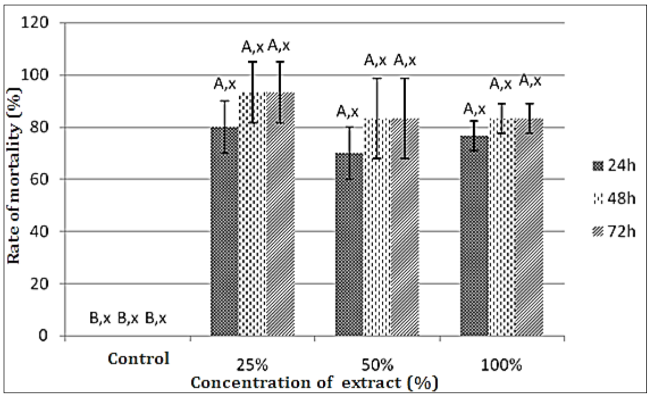

Fig 15: Evolution of the average mortality due to the extract of *R. communis* against adults of *G. ficorum*in in the laboratory.

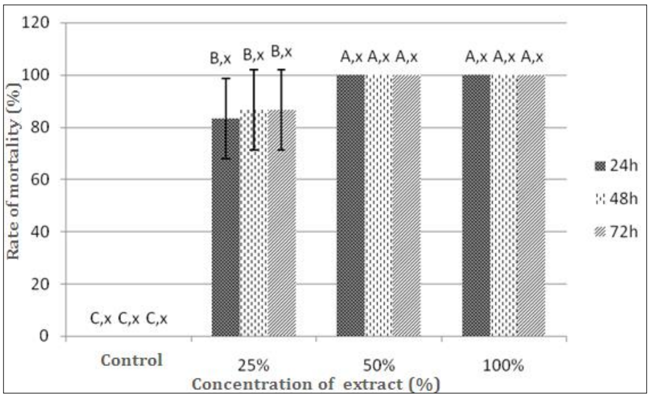

Fig 16: Evolution of the average mortality due to *Urtica urens* extract against adults of *G. ficorum*in the laboratory.

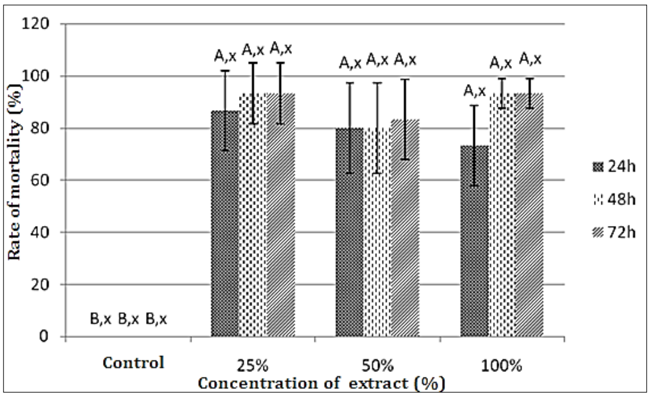

Fig 17: Evolution of the average mortality due to the extract of *Nicotiana glauca* against adults of *G. ficorum*in the laboratory.

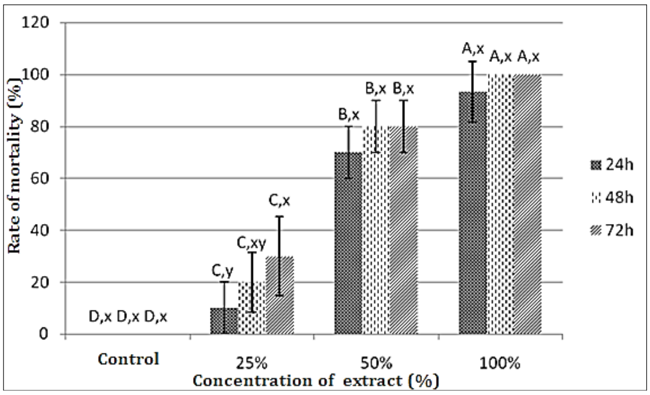

Fig 18: Evolution of the average mortality due to the extract of *Withania frutescens* against adults of *G. ficorum* in the laboratory.

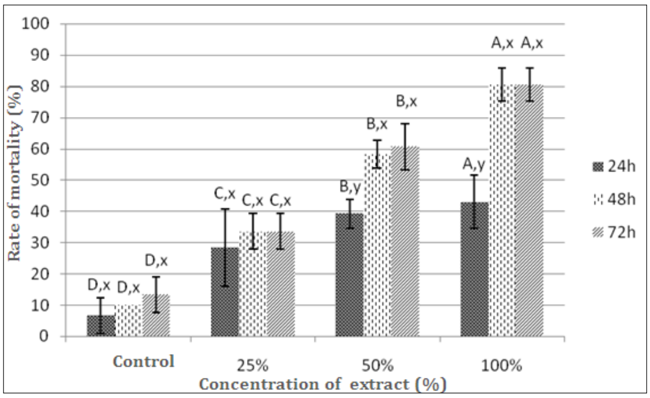

Fig 19: Evolution of mortality averages and repellent effect due to the extract of *R. officinalis* against adults of *G. ficorum* in situ.

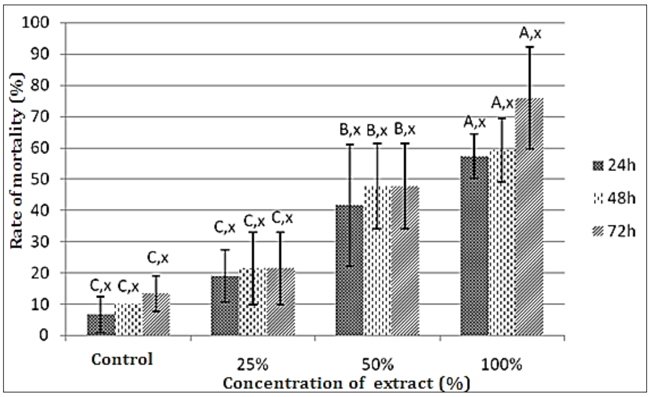

Fig 20: Evolution of mortality averages and repellent effect due to the extract of *Oxalis pes-caprae* against adults of *G. ficorum* in situ.

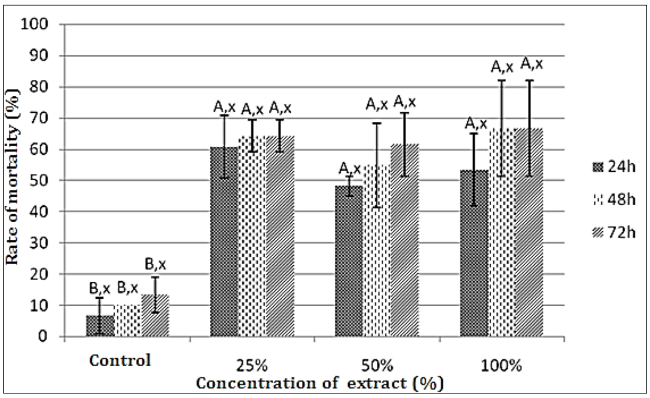

Fig 21: Evolution of average mortality and repellent effect due to the extract of *Ricinus communis* against adults of *G. ficorum* in situ.

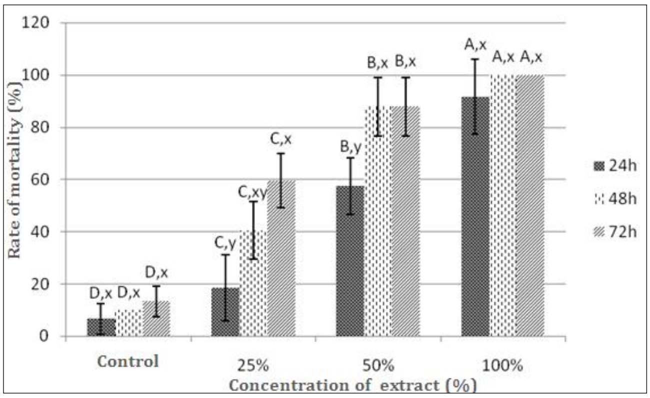

Fig 22: Evolution of the average mortality and repellent effect due to the extract of *Urtica urens* against adults of *G. ficorum* in situ.

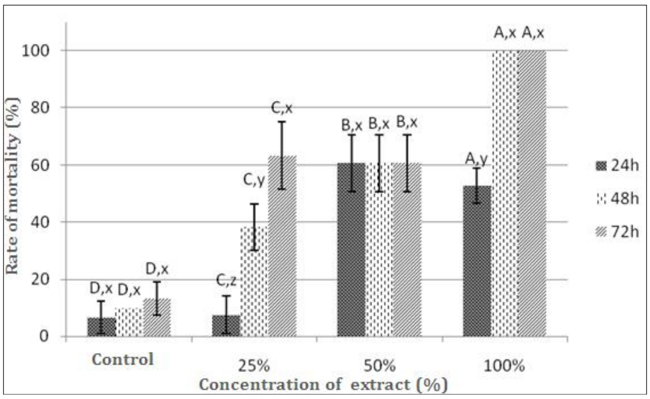

Fig 23: Evolution of the average mortality and repellent effect due to the extract of *Nicotiana glauca* against adults of *G. ficorum* in situ.

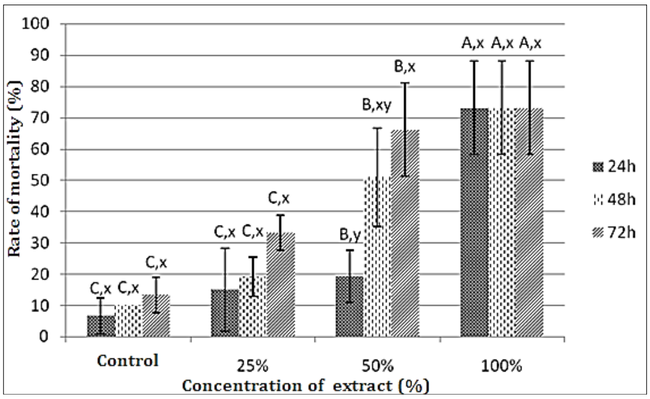

Fig 24: Evolution of average mortality and repellent effect due to the extract of *Withania frutescens* against adults of *G. ficorum* in situ.

Laboratory tests showed that the mortality rate of *Gynaikothrips ficorum* reached 100% for the extracts of *Withania frutescens* at the 100% concentration; 48 hours after the treatment, and only 24 hours after the treatment for *Urtica urens* at concentrations of 50% and 100%.

The extracts of *Ricinus communis* caused, 48 hours after treatment for all the concentrations, an average mortality between 83% and 93%, *Nicotiana glauca* showed this mortality rate, during the same period at the concentration of 100%.

For *Rosmarinus officinalis* and *Oxalis pes-caprae* the mortality rate reached 60% and 70% for the 100% concentration and 72 hours after treatment.

Field tests showed that the extracts of *Urtica urens* and *Nicotiana glauca* showed an insecticidal effect of 100% at the concentration of 100%, 48 hours after treatment. For the concentration of 100% and 24 hours after treatment, *Rosmarinus officinalis* reached 81% mortality and repellent effect. While *Oxalis pes-caprae*, *Withania frutescens* and *Ricinus communis* caused, at the same concentration, an insecticidal effect of 76%, 73% and 67% respectively, 72 hours after treatment.

These results testify to the good insecticidal activity of the plant extracts tested. Those of *Nicotiana glauca*, *Withania frutescens*, *Urtica urens* and *Ricinus communis* constitute promising insecticides for the control of *Macrosiphum rosae* and *Gynaikothrips ficorum* whose mortality rate of these insects exceeds 90%, except for the *in-situ* test against *G. ficorum* whose mortality and repellent effect were about 70% for *W. frutescens* and *R. communis*. Extracts of *Rosmarinus officinalis* and *Oxalis pes-caprae*are are also effective in controlling the insects tested causing a moderate to high mortality.

Plant extracts as a natural alternative to synthetic insecticides, have a good potential for safe insect control on diverse array of agricultural products. Natural organic compounds extracted from plants include repellents, growth inhibitors, and toxins that form an extensive chemical defense against plant pests [10].

The insecticidal effect of *Nicotiana glauca* is very marked in this study, this may be due to its richness in Nicotine which is a toxic alkaloid used as an insecticide. But it also contains anabasine, another alkaloid close to nicotine (pyridine alkaloid), particularly effective against aphids [11]. Zammit *et al*. have proven the efficacy of *Nicotiana glauca* extract against local *Pieris rapae* and can be used in minute concentrations in insect traps as a natural insecticide [12]. A recent study showed that this plant extracts have a remarkable potentiality as insecticidal substances that can be used as an ecofriendly integrated approach for the management of *Rhynchophorus ferrugineus* [13].

Our results generally show that the extract of *Withania frutescens* also has a significant insecticidal effect, which can be explained by its richness in Alkaloids, Saponins, Terpenes / Sterols and Tannins [14]. Studies have shown that *Withania somnifera* extracts have insecticidal effect against *Trogoderma granarium* (everts) (Coleoptera: Dermestidae) [15], *Tribolium castenum* [16], Lepidopteran and Hemipteran Pest [17]. No past work was found in the literature where the same type of plant extract, which was use in the present study.

A study carried out on *Urtica urens* showed that the ethanolic extract of this plant contains several metabolites; phenolic compounds, flavonoids, tannins, ortho-diphenols and flavonol [18]. This species shows insecticidal activities against pests of stored cereals (*Tribolium castaneum*) [19], Bruchinae coleoptera pest [20].

Ricinus communis on its part has a strong effect on treated insects; This species contains Ricin which is a toxic glycoprotein substance [21]. Also, it appears that *Ricinus communis* is effective against the beetle *Callosobruchus chinensis* (Coleoptera) [22]. Other results showed that the hexanic extracts of *R. communis* and their fatty acids may be an alternative for the development of new insecticides against *Melanaphis sacchari* Zehntner (Hemiptera: Aphididae) [23].

The effect of *Rosmarinus officinalis* (L.) (Hemiptera: Aphididae) on the survival of the red rose aphid *Macrosiphum rosae* (L.) on the cut flower rose *Rosa hybrida* L. was confirmed under laboratory conditions, with a maximum mortality recorded at 86.12 ± 1.02% [24]. Other studies have shown that at all the different doses tested, the volatile substances emitted by the rosemary plants showed repellent effects on *Myzus persicae*. These results provide new information on the interactions between *Rosarinus officinalis* and *Myzus persicae*, which will contribute to the development of new management strategies for the biological control of insect pests [25].

There is no literature available on the insecticidal activity of Oxalis pes-caprae to compare with the present results. But there are studies on *Oxalis corniculata* who have shown a high mortality rate against *Tribolium castaneum* and *Ephestia cautella*.

Conclusion

The results of laboratory and in situ experiments revealed that the extracts of *Nicotiana glauca, Withania frutescens, Urtica urens, Ricinus communis, Rosmarinus officinalis* and *Oxalis pes-caprae* have insecicidal effects against *Macrosiphum rosae* and *Gynaikothrips ficorum.* These biopesticides can be an alternative to chemicals although they are often reputed to be less effective, their ecological benefits cannot be ignored.

Acknowledgments

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