Importance of Nettle on Crop Protection

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Abstract: Organic farming has an important place in agricultural economy. However few studies talk about biological control of many enemies groups. This study aims to illustrate nettle efficiency as preventive fight towards both insect’s outbreaks and disease infestation. It consists of verifying if nettle extract has curative properties towards gummosis citrus or stops development disease and we evaluated its efficiency on main insects’ pests of bean. Moreover nettle field of insects was tested if it can protect bean. Investigational device was realized during season crop 2017-2019 and took place in market gardens around the city Antananarivo (Madagascar). Nettle field of insects’ efficiency was compared with witness plots and field of insects which composed with various companions’ plants (maize, nettle, crucifers). Each companions’ specie grows on 1 m width and the length depends on plot size which needs protection. And nettle extract modalities were compared with witness untreated and reference treatment such as garlic extract for insecticides plants and Bordeaux mixture for mineral fungicide. Each bean plot has a surface of 20 m$^2$ spaced out at least 0.5 cm. Three repetitions were realized for each modality. For citrus disease evaluation was realized on 10 observed plants that each plant constitute s one modality. Evolution of pest number for bean and symptoms of gummosis (yellow leaf importance and phytosanitary situation after treatment) was observed as parameters. As results, nettle extract has a better efficiency to control bean aphids as reference treatment and restores citrus gumminess as much as treated with mineral fungicide. Similarly, nettle field of insects presented the same efficiency to allow diversifying pest as diversification field insects’. In sum use of nettle extract needs tracking on gummosis citrus if there was reverse disease. Nevertheless, nettle has appreciable protection properties on crops which can help farmers to produce in a sustainable and environmentally-friendly way.

Key words: Nettle extract, field of insects, major insects’ pest of bean, gummosis, citrus, efficiency, viability.

1. Introduction

Fruits and vegetables provide health benefits and are important for prevention of illnesses. Over last 10 years, global demand for fruits and vegetables has increased. In response, Madagascar can produce sustainable farming complying with organic and fair trade standards. Effectively, world citrus production increases year after year: in 2017, 110,000,000 t distributed on 7.5 million ha was harvested twice greater than product in 1980 [1] with 220 kg per tree for EU v/s 15-30 kg per tree for Malagasy. And bean world production turns around of 6,416,000 t with 10 t/ha [2] but 6-7 t for Malagasy bean [3]. The island offers ideal conditions to produce a wide range of tropical and temperate products bean and citrus represented these possibilities.

However, aphids applies greater pressure in fields as they can destroy a range of fruits and vegetables in a very short space of time [4] as well as gummosis can attack particularly citrus [5]. Pests and diseases in fruits and vegetables can have a negative economic impact on individual commercial producers and on the entire fruit and vegetable industry.

On one hand aphids *Aphis fabae* (Hymenoptera: Aphididae) and leafroller *Apoderus humeralis* (Coleoptera: Curculionidae) constitute major insect pest of bean. As direct effects aphids act to despoil sap causing weakens. As indirectly serious damages virus transmission by aphids conducted seed degeneration. In contrast leafroller was classified as shewing insect and lead mechanical damage [4]. To prevent loss product farmers use blind chemical control, whereas, agroecology stability offers a natural population pest regulation grace of auxiliary act. This action favored
in presence of flora diversity and needs to manage crop environment instead of maintain biodiversity [6]. On other hand *Phytophthora citriophthora*, *Phytophthora palmivora* or *Phytophthora cinamomi* (Chromista: Phycomycota) fungi remains present in almost all citrus orchards. An early symptom of gummosis was represented as sap oozing from small cracks in the infected bark giving bleeding tree appearance. Lesions spread around the circumference of the trunk slowly girdling the tree. Decline may occur rapidly within a year especially under favorable conditions for disease development. Late stages of gummosis intervention do not cure disease. Yet early detection and prompt management actions are essential for saving a tree. Under moist conditions the fungi produce large numbers of motile zoospores which are splashed onto the tree trunks. *Phytophthora* species causing gummosis develop rapidly under moist cool conditions [5]. Hot summer weather slows disease spread and helps drying and healing of the lesions. Management of *Phytophthora* gummosis focuses on preventing conditions favorable for infection and disease development. All scion cultivars are susceptible to infection under the right environmental conditions. Easy way out which is often proposed may be more economical consists to replace the tree than to try to control the infection but it will not solve the underlying problems.

To respond to these challenges, organic farming has an important place in agricultural economy. Biological control responds to sustainable solution because it uses what happens in nature. This is evident through protection conferred by field insects. And use of plant extract instead of protecting field constitutes a main practice for major small farmers. However few studies talk about biological control of many enemies groups. Stinging nettle *Urtica dioica* L. (Urticaceae) grows in the wild form in Asia, Europe, North America and North Africa in Madagascar obviously. Plant has a very strong fiber and high fixed carbon. Nettle perennial plants are covered with fine hairs especially in the leaves and stems. Stinging nettle is also a widespread ruderal plant found in many mainlands. It is considered one of the most important plants used in phytotherapy as a plant rich in biologically active compounds and many studies explore virtue on phytosanitary in different countries such as Gembloux (Belgium) [6]. This study aims to test nettle efficiency as preventive fight towards both insect’s outbreaks and disease infestation.

2. Material and Methods

Investigational device realized during season crop 2017-2019 and takes place in market gardens around the city Antananarivo, Madagascar.

As principle of this study, it consists to verify if nettle extract has curative properties towards gummosis citrus or stops development disease and we evaluated its efficiency on main insects’ pests of bean. Moreover nettle field of insects was tested if it can protect bean.

Plants tested were bean *Phaseoulus vulgaris* (Fabacea) and citrus (Rutaceae) disease during these vegetative stages and another groups during fruiting forming. All trees received some scratching around the collar that farmers realized as alternative solution to attenuate gummosis attack. And nettle is collected on wild around countryside Antananarivo.

Nettle field of insects’ efficiency was compared with wetness plots and field of insects which composed with various companions’ plants (maize, nettle, crucifers). Choice of companion plants depends on these capacities to assist in the growth of others by attracting beneficial insects repelling pests and providing nutrients shade or support [7-9]. This case uses the capacity to attract beneficial insects in order to control insect’s pest. Each species’ companions grows on 1 m width and the length depends on plot size which needs protection.

As insecticide preparation 1 kg of leaf and steam cutting dilutes in 8 L of water for 1 acre during two weeks for extracting all its active ingredients. This
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The treatment was repeated at weekly intervals during three months for citrus and treatments were started two weeks after seedling and were repeated at weekly intervals till harvest for bean.

About preparation of the potion as biological fungicide nettle extract consists of macerating in 5 L of water. One (1) kg of leaf and steam cutting was accelerated for fermentation during six nights for extracting all its active ingredients. After that sieve extract more water was added to adjust solution to 5 L. Solution 0.5 L is smeared on collar trees particularly the scratch parts treatments.

Nettle extract modalities were compared with witness untreated and reference treatment such as garlic extract for insecticides dispositive and Bordeaux mixture for fungicide dispositive. Application rate of Bordeaux mixture for mineral fungicide (copper sulphate 80% and lime 20%) was using powder 20 g diluted with 1 L of water for 10 m².

Each bean plot has a surface of 20 m² spaced out at least 0.5 cm. Three repetitions were realized for each bean modality. For disease citrus each plant constitutes modalities and each treatment contains 10 observations plants.

Observation frequency in each modality reflects level of pest attack or disease infestation and is weekly held. Plant health characteristics are evaluated: aphid and leafroller for bean and evolution of symptom gummosis. Observations of bean enemies such as aphid’s count were immediately realized before treatment and 2 days after treatment and then weekly repeated which permitted to estimate the importance. Evaluation was realized on 10 plants of bean for each plot.

About gummosis citrus, symptoms evolution was weekly evaluated before treatment. Symptoms of gummosis such as importance of yellow leaf and phytosanitary situation after treatment were observed as parameters.

For analysis methods, we use analysis of variance compared with importance of aphid number and virus infestation between plots treated and witness.

Application of Abbott’s formula (1925) [10] evaluated treatment efficiency for uniform population. Efficacy percent (EP) is calculated as follows by Eq. (1):

\[
EP = \left(1 - \frac{n_{\text{T after treatment}}}{n_{\text{Co after treatment}}} \right) \times 100 \quad (1)
\]

where: \( n \) = insect population; \( T = \) treated; \( Co = \) witness.

3. Results and Discussion

3.1 Nettle Extract Efficiency on Aphid’s Bean

Aphid low rate attack cannot permit to determine efficiency of extract before 46 days after seedling. After second and third treatment, nettle extract presented higher level efficiency than garlic extract (Table 1, Fig. 1). After each treatment, the number of aphid concentration decreases as we show on 36, 46, 53 days after seedling. Nettle extract remains efficiency during 6 days.

Application of Abbott’s formula permits to show that treatment repetition increases its efficiency (Fig. 2). Plant extract characterize as there is any resistance, it cannot realize a high selection pressure. Nettle presented an action acceptable on aphid pullulating.

As a result, nettle extract has a better efficiency to control bean aphids as reference treatment and witness. It must applicate as preventive action with low treatment thresholds and need to replicate each week. In comparison with others plants insecticides such as male fern (efficiency about 50%-80%) [11] and pepper extract (efficiency rate about 70%-90%) to control the aphids [12] with 10 g pepper extract dilute on water 5 L which permits to decrease 50% of aphids. Other studies show that the same extract can control neonate larvae [13].
### Table 1  ANOVA results for efficiency treatment on aphid rate concentration (DAS: Day after seedling).

| DAS | 15  | 18  | 22  | 25  | 29  | 32  | 36  | 39  | 42  | 43  | 46  | 49  | 50  | 53  | 56  | 57  | 60  |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| F   | 0.68| 1.47| 1.26| 1.56| 0.86| 0.74| 0.3 | 0.09| 0.29| 0.27| 5.08| 9.54| 1.95| 32.73| 43.97| 30.81|     |
| p   | 0.60| 0.31| 0.37| 0.46| 0.29| 0.51| 0.56| 0.82| 0.97| 0.83| 0.84| 0.04| 0.01| 0.22| 0.0004| 0.0002| 0.0005|

#### 3.2 Nettle Field of Insects to Fight Aphid’s Bean

Several insects’ beneficial and pest are observed on bean plots and they depend on field insects. Coccinellidae: Coleoptera constitutes benefit mainly with its diversity (*Cheilomenes sulphurea* (Olivier), *Cheilomenes simulans* (Olivier), *Elpis dolens* (Mulsant)) and was dominated by numbers (Fig. 3,
Table 2) and constitutes as predator safeguards pest attacks in fields. However Syrphidae: Diptera involves as soon as pest outbreak particularly aphids, they act as cleaning predator.

Fig. 3 and Table 2 show that pests on witness remain more important than plot protected by field insects.

Among these pests, leafroller *Apoderus humeralis* gnawing leaf and homoptera (*Aphis craccivora, Bemisia tabaci*) which weakens plant combined to limit bean production (Table 3).

Any significant difference about pest species is observed between bean plots protected by diversifying field insects nor nettle field insects. As early as emergence, leafroller begged to attack bean plots. Nettle field of insects has the same efficiency with diversification species of field of insects and remains viable (Figs. 4-6).

These studies presented importance of field insects as effective action to protect crop as other authors realize [7, 14]. And in this case, use of only nettle as field insects remains more sufficient than others.

![Comparison of important beneficial insects on plot protected.](image)

**Fig. 3** Comparison of important beneficial insects on plot protected.

| Species Order: Family | F       | p         |
|-----------------------|---------|-----------|
| Cheilomenes sulphurea | 98.72   | < 0.0001  |
| Cheilomenes simulans  | 946.75  | < 0.0001  |
| Elpis dolens          | 235.50  | < 0.0001  |
| Ischiodon aegyptus    | 73.71   | < 0.0001  |
| Mantis religiosa      | 46.43   | 0.0002    |
| Aphidius              | 69.73   | < 0.0001  |
| Encarsia formosa      | 8.49    | 0.0178    |

**Table 2** Statistical analysis of field insect’s effects on beneficial importance on bean plots.

| Species Order: Family | F       | p         |
|-----------------------|---------|-----------|
| Melanagromyza phaseoli| 1.75    | 0.25      |
| Nezara viridula       | 24.143  | 0.001     |
| Apoderus humeralis    | 73.72   | < 0.0001  |
| Lagria villosa        | 147.00  | < 0.0001  |
| Aphis craccivora      | 467.15  | < 0.0001  |
| Bemisia tabaci        | 14.07   | 0.005     |

**Table 3** Statistical analysis of field insect’s effects on pest importance on bean plots.
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Fig. 4  Comparison importance pest insects on plot protected.

Fig. 5  Effect of protection types on aphids evolution, *Aphis craccivora*.
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Fig. 6  Effect of protection types on leafroller evolution, *Apoderus humeralis*.

Fig. 7  Treatment effect on evolution of leaf yellow importance.
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Table 4  Statistical analysis of treatment effect on evolution of leaf yellow importance.

|                | Vegetative stage | Fruiting forming |
|----------------|------------------|------------------|
|                | p    | F   | p    | F   |
| WAT0           | 0.41 | 0.67 | 3.19 | 0.2 |
| WAT1           | 0.83 | 0.36 | 2.87 | 0.2 |
| WAT2           | 0.02 | 4.79 | 0.74 | 0.69|
| WAT3           | 0.02 | 4.79 | 1.27 | 0.53|
| WAT4           | 0.02 | 4.39 | 5.7  | 0.06|
| WAT5           | 15.14| < 0.0001 | 11.83 | 0.002|
| WAT6           | 17.55| < 0.0001 | 11.83 | 0.003|
| WAT7           | 18.05| < 0.0001 | 11.83 | 0.003|
| WAT8           | 11.75| < 0.0002 | 19.64 | < 0.0001|
| WAT9           | 223.22| < 0.0001 | 19.99 | < 0.0001|
| WAT10          | 717.24| < 0.0001 | 25.91 | < 0.0001|

Fig. 8  Trees state of health after one week’s treatment.

3.3 Nettle Efficiency on Citrus Gumminess

As a result nettle extract has a better efficiency to restore citrus gumminess which can lay to moderate severity disease for all trees stage which presented different symptom level. For vegetative stage and after 5th treatment, nettle has a high performance so speed restorations of phytosanitary compared to mineral fungicide. These two fungicides presented the same action for fruiting forming trees which can need more time (Fig. 7, Table 4).

Phytosanitary situation shows that nettle can restore citrus gumminess as much as treated with mineral fungicide. Witness presented low degradation during evaluation. Nettle constitutes yet one solution which can cure trees in addition to others control methods as resistance rootstock [15] and sore scratching currently farmers’ practice. Many authors confirmed its fungicide properties [16, 17]. Phytotoxines constitutes major nettle extract substance active and inhibits fungal growth of plant disease powdery mildew, downy mildew, damping-off, grey mould.

Concretely, nettle extract activates bacterial soil flora regeneration and stimulates phytosanitary auto defensive. It permits to activate growth, accelerates plant immunity and delays apparition of downy mildew.
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Seed soaked avoids earth disease assault such as dumping-off. To avoid resistance creation, its application shall be limited accordingly (maximum twice or threefold in garden) but it depends probably on symptom severity as Fig. 7.

4. Conclusion

Nettle field insects provide permanent protection to crop and nettle extract needs application perseverance. Field insects can ensure a larger crop surface than extract treatment which occurs as repellent action on insects through aphids, coleopteran, lepidopteran. Furthermore, anyone has solution for gummosis but now nettle solves this problem it can cure disease. In sum nettle has an appreciable protection property on crops which can help farmers to produce in a sustainable and environmentally-friendly way.

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