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Agronomic evaluation and economic profitability of biopesticide derived a neem (*Azadirachta indica* A. Juss) seed in leafy onion and African eggplant production

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ABSTRACT

Leafy onion and African eggplant are two profitable crops whose yields are negatively impacted by insect pests, vectors and diseases. This study was undertaken to compare the agronomic efficacy and economic profitability of neem seed extract to the conventional vegetable crop in Louda village. A randomised complete block design with three replications including one treatment of Neem seed grain powder aqueous extract (TB); treatment of chemical pesticide of industrial synthesis (TP); and control treatment, without any phytosanitary treatment (TA) was implemented with farmers. The results showed that neem seed extracts had comparable effects to chemical pesticides in pest control. Indeed, compared to the TA treatment, the TP and TB treatments significantly reduced the number of perforated plants of Leafy onion and African eggplant. The number of diseased plants of African eggplant was significantly reduced by -239% under TB treatment compared to TA. The best yields were recorded with the TB and

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TP treatments significantly increases of 33 and 44% on leafy onion and 57 and 56% on African eggplant respectively compared to the TA treatment. Economically, the results showed that gross margins from production and marketing of leafy onion under TB and TP were 63% and 17% higher respectively; net margins 91% and 76%; and average labour productivity 91% and 80% higher than under TA. These results show that the use of biopesticides in leafy onion and African eggplant crops was relatively equal to and many times more agronomically and economically effective than industrial pesticide treatment. Thus, better pest management by vegetable growers and the production of healthy produce can be achieved by adopting organic production and by training garden farmers in the manufacture and use of biopesticides.

***Keywords*:** Biopesticides, *Azadirachta indica*, leafy onion, African EGGPLANT, Burkina Faso

1. INTRODUCTION

Vegetable cropping is an activity practiced in all regions of west Africa, and vegetables crop contribute greatly to the fight against poverty and to resolving the challenge related to food insecurity. Among vegetable gardening, leafy vegetables are better reported than fruit, root, bulb or tuber vegetables. Onion and eggplant crops are subject to many constraints such as diseases, insect pests and nematodes. Among these constraints, pests are undoubtedly the most formidable because in addition to being pests, they are vectors of diseases. They are causing considerable crop losses in vegetable crops. Indeed, they cause the destruction of leaves through the taking of their food and the transmission of virus affecting the growth and maturation of crops and this damage can lead to yield losses in vegetable crops of up to 60% (Sumit, *et al.*, 2021). To control these diseases and pests, producers use chemical inputs to obtain better yields. But their use is not without danger on ecosystems, but also human health (de Bon et al., 2014; Kumar and Singh, 2015).

In addition, long-term widespread use of these chemicals would lead to pesticide resistance and deteriorate the quality of cultivable land (Adigoun, 2002). In view of their negative effects, research programs on alternative methods that meet economic and toxicological requirements and have less ecological impact have been developed. Among these methods is the use of botanical pesticides or biopesticides, effective in the control of crop pests and diseases, having less damage on the ecological chain and environmental pollution (Leng *et al.*, 2011). Botanical insecticides are desirable alternatives to synthetic chemical insecticides for controlling pests because they are best suited for use in organic food production in industrialization countries but can play a much greater role in developing countries as a new class of ecofriendly products for controlling pests (Khater *et al.*, 2012; Unigwe, *et al.*, 2016).

For more than thirty years, the anti-parasitic effects of neem seed extracts have been the subject of numerous scientific studies throughout the world. These extracts have been shown to be effective in the control of more than 400 species of arthropod pests and certain plant diseases. Studies have shown that neem compounds in general, and seeds in particular, contain a high amount of azadirachtin, a compound that regulates the dynamics of insect pests and disease vectors of crops and stocks (Degri *et al*., 2013; Shannag *et al*., 2014).

However, the use of biopesticides derived from neem is less popular with producers due to the time required to produce the extracts, which is considered too long, the number of treatments required too high, and the specificity of these extracts. In addition, there is a lack of sensitization and information on the effectiveness of these products, as well as the level of education of garden farmers on good pest management practices. Thus, the objective of this study is to evaluate the efficacy of neem seed extracts on the production of leafy onion and African eggplant in garden farmers' school fields in Burkina Faso.

2. MATERIAL AND METHODS

2. 1. Experimental site

The study was conducted in the village of Louda located in the rural commune of Boussouma in the North Central region of Burkina Faso, with geographic coordinates of 13°01′ 27″ N latitude and 1°03′ 46″ W longitude. The study was conducted at the Centre de Formation Agropastoral et Artisanal (CFFA), a learning and production setting set up by the non-governmental organization Technical Alliance for Development Assistance (ATAD) with support from its partner " Other Earth ". The site is certified by the Burkina Faso National Council for Organic Agriculture (CNABIO) and about 50 women are practicing vegetable gardening. The climate of the site is of the Sudano-Sahelian type, characterized by two seasons: a dry season that lasts 8 months between October and June, and a rainy season that lasts 4 months from June to September. According to the data from the meteorological station of the North Central region where our study site is located, the average temperatures vary between 17 °C recorded during the months of December and January and 40 °C during the months of March and April. The year 2011 recorded the smallest amount of rainfall (567.35 mm) and the year 2020 the largest (878.5 mm) in the last ten years (2011-2021) with an average of 698.91 mm/year. October as the month with the lowest rainfall (6.13 mm) and July as the month with the highest (171.89 mm) during the year 2021 with an average of 78.94 mm/month.

The major soils in the study site can be grouped following the World reference base for soil resources (2015): *leptic* or *lithic Leptosols*; *epiphytic Plinthosols*; *endopetroplinthic Lixisols*; *haplic* or *Vertic Cambisols*; *epiphytic Fluvisols*; *umbric (eutric)* or *haplic Gleysols*; and *hypereous* or *mazic Vertisols*.

2. 2. Evaluation of the agronomic efficiency of leafy onion and African eggplant

2. 2. 1. Plant material

The plant material was composed of 2 crops: The first one is the MEKETAN variety of African eggplant which presents plants with smooth leaves. These fruits are of big calibre with an average weight of 200 g, of elongated and slightly bitter form and of white-ivory colour. It has a sowing-maturity cycle of 50 to 60 days from transplanting to harvest with a potential yield of 30 to 40 t/ha. The second one is a local variety of leafy onion with a sowing-maturity cycle of 45 to 50 days after transplanting. It is a variety produced and appreciated by the population of Louda.

2. 2. 2. Fertilizers and pesticides

The organic fertilizer used was compost. It was composed of green and dead leaves of *Vitellaria paradoxa*, small ruminant faeces, cow dung and poultry droppings obtained through an anaerobic fermentation process for 2 months. The biopesticide used was a macerated solution of neem seed powder. Indeed, dry powder of neem seeds was obtained after grinding with a mortar. One (01) kg of powder was mixed with a little water until oil was felt to be beaded between the fingers at the end of mixing. Seventeen liters (17) of water were added and left to macerate for 24 hours. After maceration, the solution obtained by filtration through a 0.5 mm mesh sieve constituting the biopesticide, was transferred to a pulverizer with a capacity of sixteen (16) liters without adding water. This process is repeated each time there is a need. Bomec (200 g/l Tefluthrin) and Attack (Abamectin 18G/L EC) were the chemical pesticides of industrial synthesis proposed and used by the garden farmers because of its effectiveness according to them.

2. 2. 3. Experimental design and treatments

Experiment was carried out in a farming environment. The crops of leafy onion and African eggplant were installed in collaboration with the garden farmers. The design was arranged in randomized complete blocks and included 3 treatments repeated 3 times for each crop. The treatments were composed of one treatment with the extract of neem seed powder biopesticide (TB) and one treatment with a chemical pesticide of industrial synthesis (TP) and a control without any input (TA). A total of eighteen (18) elementary plots were made on July 13, 2021. Each elementary plot was 5 m long and 1 m large, i.e., an area of 5 m^2. The distance between the plots was 1 m. In order to avoid the effect of industrial chemical pesticides, two conventional growers were rigorously selected to conduct the TP treatment on the two crops. A distance of 50 m was left between the plots treated with biopesticides and those with any phytosanitary treatment (TA) and industrial synthetic chemical pesticides (TP).

2. 2. 4. Crop management

The soil of the trial is clayey-sandy and well drained on which the leafy onion and the African eggplant adapt quite easily.

The preparation of the soil began with the delimitation of the trial which consisted in the materialization of the experimental device. A digging followed by a levelling was then carried out. Onion and eggplant seedlings obtained from the women's cooperative of the study center producing only organic crops were used for transplanting. The transplanting of the leafy onion plants was carried out on July 15, 2021 on 6 beds with a spacing of 15 cm between the lines and pockets. Per onion bed, there were 33 lines and seven plants per line for a total of 231 plants. After transplanting, 15 liters of water were added per bed using a watering can.

The transplanting of the African eggplant plants was carried out on July 16, 2021 after a mudding of the beds. The spacing was 50 cm between the rows and the plants on each row. A total of 22 African eggplant plants per bed, i.e., 11 lines and 2 plants per line, were planted.

Compost was applied 10 days, 50 days and 71 days after transplanting at a rate of 9 t/ha per bed. The compost was broadcast on the leafy onions and applied locally under each plant for eggplant followed by burial. Also, thirteen (13) manual weeding's were carried out on the crops at a rate of one weeding per week. As the rains were not regular, additional irrigation was sometimes necessary at a rate of 3 times per week, i.e., 60 liters of water per bed and per irrigation.

Biopesticide treatments were applied to three African eggplant beds and three leafy onion beds. The beds were treated twice a week. The doses applied per bed were 11.4 liters, for a total of 22,848 l/ha. The biopesticide was applied by spraying with a sprayer.

The phytosanitary treatment with the industrial synthetic pesticide (TP) of curative order, was used by spraying for two treatments spaced of 20 days. For this purpose, Bomec and Attack were mixed in a volume ratio of 2/1. The dose of 1 liter of the product (Bomecx+Attack) per ha was then applied. All treatments were carried out according to the practices of the vegetable growers of the experiment site.

2. 2. 5. Evaluation of phytopathological parameters and yields

The evaluation of phytopathological parameters consisted of enumerating per crop and per treatment (bed) the total number of plants containing at least one perforated leaf, the number of diseased plants and their ratios to the total number of plants. These observations were made at time intervals of three days until harvest.

Leafy onion and eggplant were harvested progressively in a staggered fashion. The first eggplant harvest was at 49 days after transplanting, and the next harvests at 07-day intervals. In total, seven harvests were made. The first harvest of leafy onion was done at 62 days after transplanting and the second at 28 days after the first harvest. A total of two harvests were conducted. All harvests were weighed on each day of collection. Yields in t/ha of leafy onion and African eggplant fruit were calculated based on the treatments.

2. 3. Evaluation of economic profitability of leafy onion and African eggplant

2. 3. 1. Data collection

Data on the economic profitability of leafy onions and African eggplant under the different treatments were carefully collected during a detailed field survey through a form linked to the expenses and revenues of each production. Fixed and variable costs were collected. Data on the doses, methods of application and costs of inputs (seed, organic fertilizer, NPK, Urea, phytosanitary treatments) used during cropping activities were collected. In addition, the labour force by activity, distributed by gender, the quantity produced and the selling price of the harvested products were also collected.

2. 3. 2. Calculation of gross and net margins

Fixed costs, which are the expenses of a business that do not depend on its production, were calculated. In this study, the total salaries received by the farm's workers were considered as fixed costs. Next, the variable costs, being costs that change according to the activity of the enterprise, were calculated. The costs of seeds, fertilizers, pesticides, compost and family labour were considered as variable expenses.

The gross margin or gross profit was then obtained by subtracting the variable costs from the value of gross product for a production cycle (Paraïso *et al*., 2011). It was expressed by the following formula:

$$\text{Gross margin} = \text{Value of Gross product} - \text{Variable costs.}$$

If the gross margin was positive, then it is concluded that the product manages to cover all variable costs and that the production is economically profitable (without deducting fixed costs). On the other hand, if the gross margin is negative, then the product does not manage to cover all variable costs. In this case, the product has not been economically profitable. This situation usually occurs when variable costs have been too high and the gross revenue has been so low that it cannot cover them (Touré *et al*., 2021). According to Touré *et al.* (2021), the net margin of production is obtained by deducting fixed costs from the gross margin. It is expressed according to the following formula:

$$\text{Net margin} = \text{Goss margin} - \text{Fixed costs.}$$

If the net margin, also known as net profit, is positive, then the gross product covers all the total costs (variable + fixed) and the production is financially profitable. On the other hand, if the net margin is negative, then the gross product does not cover all the total costs. In this case, the product is not economically profitable.

2. 3. 3. Calculation of average labor productivity

Average labor productivity or average labor compensation rate was given by the following formula proposed by Touré *et al*. (2021):

$$\text{Average labor productivity} = \frac{\text{Net margin or profit margin}}{\text{Family labor}},$$

with net margin is a profit margin of the production activity, and family labor, the total number of workers.

2. 4. Statistical analysis

A Levene normality test at the 5% threshold was applied to the different data. For each of the evaluated parameters, a comparison of the means according to the treatments by analysis of variance (ANOVA) and a Tukey HSD test of separation of means were performed at the 5% threshold. XLSTAT 4.1, 2021 (ADDINSOFT, 2021) software was used for this analysis. On the economic aspect, comparisons in percentage (%) were made on gross and net margins, average labor productivity according to treatments and crop.

3. RESULTS

3. 1. Effect of treatments on phytopathological parameters of crops

3. 1. 1. Effect on the number of perforated plants of leafy onion

The mean values of the numbers of perforated plants per bed and the ratios of perforated plants to the total number of plants of leafy onion according to the treatments are represented in Table 1. According to ANOVA, significant differences (P = 0.04) were observed between the numbers of perforated plants per bed and the ratios of perforated plants to the total number of plants of leafy onion according to treatments.

The TP treatment significantly reduced the number of perforated plants and the ratio by -60% compared to TA following the TukeyHSD test of separation of means at the 5% threshold. The TB treatment reduced the number of perforated plants and the ratio by -59% compared to the TA treatment and by -6% compared to TP treatment but not significantly. No diseased plants were observed in the onion crop.

Table 1. Effect of treatments on numbers and ratio of perforated plants in leafy onion.

Treatments	Total number of Plants per bed	Number of plants perforated per bed	Number of plants perforated / total number of plants
TA	194.50±0.53[a]	6.83±1.31[a]	0.04±0.007[a]
TB	194.17±0.26[a]	2.83±0.77[ab]	0.02±0.004[ab]
TP	192.17±0.48[b]	2.67±0.66[b]	0.01±0.003[b]
P	0.02	0.04	0.04
Significance	S	S	S

TA: Absolute control without any phytosanitary treatment; **TB**: Neem seed grain powder aqueous extract treatment; **TP**: Chemical pesticide of industrial synthesis treatment. The values in the table are the means ± standard errors of each parameter according to the treatments. **P** = Probability according to ANOVA at the 5% threshold. Means in the same column with the same letter do not differ significantly according to the TukeyHSD test at the 5% threshold. **P < 0.05**: significant (**S**); **P ≤ 0.01**: very significant (**VS**); **P ≤ 0.001** (**HS**): highly significant; **P ≥ 0.05**: Not significant (**NS**).

3. 1. 2. Effect of treatments on the number of perforated and diseased plants of African eggplan

Table 2. Effect of treatments on the number of perforated and diseased plants of African eggplan.

Treatments	Total number of Plants per bed	Number of plants perforated per bed	Number of plants diseased plants per bed	Number of plants perforated / total number of plants	Number of plants diseased plants per bed/ total number of plants
TA	20.29±0,10[a]	16.80±0,45[a]	1.39±0.33[a]	0.83±0.03[a]	0.07±0.02[a]
TB	20.55±0,18[a]	12.94±0,69[b]	0.41±0.16[b]	0.63±0.04[b]	0.02±0.01[b]
TP	20.18±0.11[a]	12.35±48[b]	1.61±0.27[a]	0.62±0.03[b]	0.08±0.01[a]
P	0.158	0.0001	0.005	0.0001	0.006
Significance	NS	HS	TS	HS	TS

TA: Absolute control without any phytosanitary treatment; **TB**: Neem seed grain powder aqueous extract treatment; **TP**: Chemical pesticide of industrial synthesis treatment. The values in the table are the means ± standard errors of each parameter according to the treatments. **P** = Probability according to ANOVA at the 5% threshold. Means in the same column with the same letter do not differ significantly according to the TukeyHSD test at the 5% threshold. **P < 0.05**: significant (**S**); **P ≤ 0.01**: very significant (**VS**); **P ≤ 0.001** (**HS**): highly significant; **P ≥ 0.05**: Not significant (**NS**).

Table 2 shows the mean values of the numbers of perforated and diseased plants to total number of plants of African eggplant according to treatments. A highly significant difference was observed between treatments and the number of perforated and diseased plants, the ratios of perforated and diseased plants to total number of plants according to ANOVA at the 5% threshold. Compared to TA treatment, the TP and TB treatments significantly (P = 0.0001) reduced the number of perforated plants by -36 and -30%, respectively, and TB treatment significantly (P = 0.005) reduced the number of diseased plants by -239% according to Tukey HSD test at the 5% threshold.

TB and TP treatments significantly (P = 0.0001) reduced the ratio of perforated eggplant plants to total plants compared to the TA control by -31% and -35%, respectively. As for the ratio of diseased plants to the total number of plants of African eggplant a significant difference (P = 0.006) was also recorded. For this parameter, TB treatment significantly reduced them by -71% and -74% in comparison respectively to TA and TP treatments.

3. 1. 3. Effect of treatments on yields of leafy onion and African eggplant

The effects of treatments on average yields of leafy onion and African eggplant by treatment was showed in table 3. Leafy onion yields as a function of treatments varied from 2.23 t/ha with the TA treatment to 3.96 t/ha with the TP. ANOVA and the TukeyHSD test of separation of means at the 5% threshold showed that the TB and TP treatments significantly (P = 0.0001) improved the yields of leafy onion compared to the TA treatment with 33 and 44% respectively.

Yields of African eggplant as a function of treatments ranged from 1.34t/ha under TA treatment to 3.14 t/ha under TB (Table 3). TB and TP treatments significantly (P = 0.0001) improved the yields of African eggplant compared to the TA treatment, with rates of 57 and 56% respectively (ANOVA and tTukeyHSD test at the 5% threshold).

Table 3. Effect of treatments on yields of leafy onion and African eggplant

Treatments	Yields (t/ha)	
	Leafy onion	**African eggplant**
TA	$2.23±0.16^a$	$1.34±0.25^a$
TB	$3.34±0.18^b$	$3.14±0.22^b$
TP	$3.96±0.16^b$	$3.08±0.28^b$

P	0.0001	0.0001
Significance	HS	HS

TA: Absolute control without any phytosanitary treatment; **TB**: Neem seed grain powder aqueous extract treatment; **TP**: Chemical pesticide of industrial synthesis treatment. The values in the table are the means ± standard errors of each parameter according to the treatments. **P** = Probability according to ANOVA at the 5% threshold. Means in the same column with the same letter do not differ significantly according to the TukeyHSD test at the 5% threshold. **P < 0.05**: significant (**S**); **P ≤ 0.01**: very significant (**VS**); **P ≤ 0.001** (**HS**): highly significant; **P ≥ 0.05**: Not significant (**NS**).

3. 2. Economic profitability of leafy onion and African eggplant according to treatments

Table 4 presents the economic profitability indicators for onion and eggplant under the different treatments. The results showed that gross margins from the production and marketing of leafy onion with the TB and TP treatments were 63% and 17% higher, respectively; net margins were 91% and 76% higher; and average labor productivity was 91% and 80% higher than with TA. The TB treatment increased gross margin by 55%, net margin by 65%, and average labor productivity by 58% compared to TP treatment.

African eggplant gross margins were affected by 63% with TB and -2% with TP; net margins by 91% with TB and 77% with TP; average labor productivity by 91% under TB and 84% under TP compared to TA. The TB treatment increased gross margin by 63%, net margin by 63% and labor productivity by 46% compared to the TP treatment.

Table 4. Economic profitability of leafy onion and African eggplant according to treatments.

Treatments	**Variables costs**	**Value of Gross Product**	**Gross margins**	**Fixed costs**	**Net margins**	**Average labor productivity**
			FCFA			
			Leafy onion			
TA	976702	3350000	2373299	2004286	369013	33547
TB	1192702	7537500	6344799	2004286	4340513	394592
TP	1791891	4641000	2849109	1316713	1532396	166049
			African eggplant			
TA	976702	3350000	2373299	2004286	369013	33547
TB	1192702	7537500	6344799	2004286	4340513	394592
TP	1599031	3860122	2332827	717624	1615203	213215

TA: Absolute control without any phytosanitary treatment; **TB**: Neem seed grain powder aqueous extract treatment; **TP**: Chemical pesticide of industrial synthesis treatment. FCFA: African Financial Community franc.

4. DISCUSSION

The results showed that treatments with biopesticides and industrial synthetic chemical pesticides significantly reduced the number of perforated plants in leafy onion, in contrast to the control treatment, where damage was more severe. This tendency was also observed in African eggplant where the biopesticide and industrial synthetic pesticide treatments significantly reduced the number of diseased and perforated plants compared to the control. These results could be explained in part by the fact that biopesticides, although not very persistent, are able to maintain the pest population below the threshold of harmfulness. These observations are in agreement with those of Amoabeng *et al.* (2014) who reported that under certain conditions, plant extracts can have comparable efficacy to conventional insecticides. While this efficacy is not complete, it can still keep the pest population below the harmful threshold and reduce the use of industrial synthetic pesticides used on vegetables. The neem-based biopesticides used in this study would therefore contain substances that give them this effectiveness comparable to chemical pesticides.

The action of these substances would be at the origin of the better yields observed in these treatments. In addition, Isman (2006) also reported that the level of Azadirachtin and its derivates are higher in the filtrate obtained from directly ground neem seeds, hence their perceived effectiveness on pests in this study. Several authors have instead put forward the hypothesis that neem extracts have an inhibitory effect on the development of pests, preventing them from feeding and eventually killing them (Schlenk *et al.*, 2001). Neem extract compounds have regulatory effects (antibiosis and/or anticenosis) on insect pest populations (Mondédji *et al*., 2014). Amtul (2014) reported that *Azadirachta indica* contains compounds acting as inhibitors of the digestive enzyme alpha-amylase in the insect pest *Tribolium castaneum* (Coleoptera: Tenebrionidae). In addition to these regulatory effects, neem extracts are selective and less toxic to natural enemies of insect pests that play a role in reducing pest populations (Charleston *et al*., 2005). At the same time, the application of biopesticides would help reduce the severity of diseases.

This reduction would be due to the fact that biopesticides would have natural organic molecules with antimicrobial activities. The most used plant-based biopesticide is neem oil extracted from the seeds (Asogwa *et al*., 2010; Pandey *et al*., 2014) which contains azadirachtin, a mixture of seven tetranortritarpinoid isomers. This principal active ingredient in this neem oil has the property of disrupting insect morphogenesis and embryonic development (Correia *et al*., 2013). Also, In the United States, the biological effects of a neem-based biopesticide, containing 4.5% azadirachtin, were assessed against the Asian citrus psyllid, Diaphorina citri Kuwayama, a recently introduced insect pest and potential disease vector of citrus and this at a concentration of 10 ppm azadirachtin (Weathersbee and McKenzie, 2005). In addition, in Ghana, Shaiba *et al*. (2019) showed that application of neem biopesticides is also considered in terms of practicality, effectiveness, cost, and environmental and health issues and concluded with a discussion of the importance of farmer education for effective fall army worm monitoring and neem biopesticide use.

Natural products from plants can also significantly increase yields comparable to those of industrially synthesized chemical pesticides. In this sense, the results obtained on the yields of leafy onion and African eggplant showed that they were significantly higher under the treatments with biopesticides and chemical pesticides of industrial synthesis compared to the control. This would be due to the use of organic fertilizer but also to the effectiveness of aqueous extracts of neem seed powder for reducing the pathogen population below the threshold of harmfulness, thus significantly increasing the yield potential of leafy onion and African eggplant. Lesur-Dumoulin *et al.* (2017) indicated that there is a 20% chance of higher yields in organic farming compared to conventional systems for horticultural crops production. After testing different biopesticides such as Neem seed extract, Neem oil, Asafoetida (Hing) and Tobacco leaf extract on cotton insect, concluded that among all bio-pesticides, the highest percent reduction of thrip was recorded in Neem seed extract (Noonari *et al*., 2016).

The economic profitability of leafy onion and African eggplant under the neem seed powder aqueous extract treatment compared to conventional pest management practices showed that there is a difference between gross and net margins with the highest margins resulting from organic production (using neem extract). Pacini *et al*. (2003) showed that when comparing biological, integrated, and conventional systems in different agro-ecosystems in Italy, the biological systems have the highest gross margins compared to the other two systems.

This is explained by the fact that organic crops are generally sold at higher prices than conventionally grown products. In this sense, Brumfield *et al.* (2000) and Dobbs (1997) found that in some cases, organic systems are more profitable than conventional systems when the organic premium is taken into account, and the reverse is true when the organic premium is not. Also, results had shown that the use of neem seed extracts increases yields with a cost/benefit ratio that is comparable to that of chemical pesticides or even higher regardless of the crop produced.

Furthermore, some analyses of this economic profitability couldn't show a significant difference between the expenses of the conventional production system and those of the organic production. Indeed, chemical inputs (mineral fertilizers, pesticides) are the main expense items of the conventional production. In contrast, the organic system depends more on natural ingredients and resources such as organic fertilizer, plants with insect repellent or insecticide effects, mobilized locally at lower cost. This paradox is due to the fact that organic production requires more tillage (more surface work due to the non-use of herbicides) and therefore more labor, thus increasing costs.

5. CONCLUSION

The agronomic evaluation and the economic profitability allowed a comparative analysis between the organic productions based on neem extract and the conventional ones using industrial synthetic pesticides. It was found that agronomically, neem seed extract-based treatments have a significant effect on pests.

Moreover, the yields of leafy onion and African eggplant in organic treatment were statistically similar to those of chemical pesticides of industrial synthesis. It should also be noted that the results obtained in the present study showed that the economic profitability of the organic production was superior to that of the production based on chemical pesticides of industrial synthesis.

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