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Quality of Vegetables and Pests Control in African Urban Cities

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1. Introduction

Urban farming or Urban gardening (Urban Agriculture) is the practice of farming in a city environment. This practice of food production takes place on rooftops, in backyards, in community gardens and in vacant public spaces in industrial countries (JOB S Ebenezer, 2010). In the industrialized world, urban farming largely disappeared in this century in spite of the recent development of the green roof movement, but in the developing world it has persisted and since the 1970's has shown signs of increase (Nelson., 1996). Today, in the developing world especially in African countries, more and more people are migrating from rural to urban settings adding to the increase in global population in urban cities. Such growing urbanization has increased the demand for quantity and quality food production and consumption in the cities. The contribution of urban agriculture to these cities has the potential to improve livelihoods and provide economic growth and stability to the population (Nugent, 1997; Garnett, 1996). Also, organic practices can be further promoted in urban agriculture by transforming nutrient rich waste from landfills into organic fertilizer and returning it to the land (Nancy Simovic, 1998).

In Côte d'Ivoire, migration from rural areas brings into the urban areas many persons with very little formal education. This may result in unemployment and under-employment of a sizable number of people. Urban agriculture may be a way to occupy the inner city youth, and new migrants.

Urban agriculture has the potential for creating micro-enterprises that can be owned and operated by the community members with little initial investment capital.

Horticulture is a vital economic sector for most African countries. Côte d'Ivoire fruits and vegetables export to EU (European Union) countries are estimated to over 360, 000 tons. In 2007, Burkina Faso exported more than 925, 000 tons of fresh green beans. In Mali tomatoes production was over 17,000 tons and okra reached 8,600 tons. Despite the economic potential, the horticultural sector including urban agriculture is confronted to pests' attacks and phytosanitary problems. It needs to comply with the pesticides regulations and the quality control (traceability) standards which are now required by most industrials and export countries. Hence, the importance of the present initiative to study the problematic of "The Quality of Vegetables and the Pests Control in African Urban Farming".

The main objective of this study is to assess the impact of pest on urban farming Lettuce, Spinach, and Turnip production, the application of agrochemicals for plant protection, and the quality of irrigation water. The specific objectives are (1) to evaluate the impact of agrochemicals application on plants' pests, (2) to determine their economic incidence, (3) to monitor irrigation water quality, and (4) to control some essential production factors which are indicators of a good standard quality production.

2. Materials and methods

The study was conducted near the “M’POUTO village “located around the lagoon Ebrié next to the district of Riviera-Golf of the city of Abidjan, the economic capital of Côte d’Ivoire.

Photo 1. M’ POUTO village; district of Riviera-Golf in Abidjan City. Côte d’Ivoire

The experimental zone is in full sub-equatorial climate with surrounding vegetation mostly composed of tall grasses and scattered bushes (Photo 1).
The area is characterized by hydromorphic and sandy soils (DUCHAUFOUR Ph, 1997). The climatic conditions of the study zone is characterized by four seasonal cycles:
A big or long rainy season from May to July and a small shorter rainy season from October to November followed by a long dry season from December to April and a short dry season from August to September. The average annual rainfall is about 2500 millimeters with a relative humidity of 80 to 90 %. The maximum and minimum average air temperatures are respectively 33°C and 21°C.

2.1 Plants

Subsistence crops are defined as crops that may be rich in proteins or carbohydrates grown by a farmer principally to feed his or her family, with little or nothing left over to sell while urban farming crops are considered as crops supplying luxury items intended for privileged people (MESSIAEN C.M., 1989);. Our study concerned three urban farming vegetable crops namely: Lettuce, Spinach and Turnip.

2.1.1 The Lettuce, *Lactuca sativa L*

The Lettuce, *Lactuca sativa* **L. (Asteraceae or Compositaceae)** is the more consumed vegetable in the world. There are approximately 149 varieties worldwide (CHAUX C et al., 1994). There are two main classes of lettuce: non-head forming lettuces such as the " celtuce " or " lettuce - asparagus " and the head-forming lettuces such as the " Batavia " or " curly " cabbage lettuce (Photo 2).
Seeds germination is normal between 0°C and 25°C, and sunlight plays a major role in the growth and the development process. Lettuce has a high water demand (E.J RYDER et al, 1976), and grows well in different types of soils presenting a steady structure with good water holding capacity. In general, lettuce is a moderately heavy consumer of nutrients. Seedlings of lettuce are planted at 2 to 4 leaf-stage in well-prepared seedbeds (trays of earth) ploughed at depth and mixed to manure. The application of fertilizer (NPKS) is often necessary and must be incorporated in the soil before planting. The growth cycle is very variable (45 to 100 days) depending on the variety. Agrochemicals applications (insecticides and fungicides) on the lettuce cultures against the pest attacks are often done in the middle and end of cultural cycle.

Photo 2. Lettuce salad: *Lactuca sativa (*Batavia)

2.1.2 The spinach, *Spinacia oleracea L*

The spinach, *Spinacia oleracea L.* **(Chénopodiaceae)**, is named " the prince of vegetables " (VERGNIAUD P. 1976). It is an annual plant generally cultivated as biennial in vegetable gardens (Photo 3). The plant develops initially, on a very short axis, a rosette constituted of fifteen (15) to twenty (20) leaves. These leaves are lengthily petiolate with full limb more or less blighted. Mineral fertilization (NPK) is often necessary according to expected yields. But the poultry's liquid manures and dejections abundantly brought are very largely sufficient to face exports of mineral elements. Watering must be sufficiently abundant to satisfy the water needs of the plant. The diseases and pest management of the plants must be carefully and frequently controlled (LAUMONNIER R., 1978). Also, weeding is very important and a thinning can be practiced in case of a very dense germination and seedlings. Spinach usually matures in 35 to 45 days. The plant may be harvested from the time there are 5-6 leaves on the plant right before the seed stalk develops (Photo 3). The phytosanitary protection of the plants intervenes in middle and end of cycle (FABIEN SEIGNOBOS et al., 2000).

Photo 3. Spinach: *Spinacia oleracea L*

2.1.3 The turnip, *Brassica rapa L. var. rapa*

The turnip, *Brassica rapa L. var. rapa*, **(Brassicaceae)** is produced in specialized market gardening. The plant is normally bi-annual (photo 4). In its vegetative stage it is constituted of a basal rosette made of about fifteen leaves with real green limb and bristling with rough hairs (photo 4).

According to the varietal type, it has a tuberous root of flattened, conical or cylindrical form and of variable color (white (photo 4), yellow, black or two-tone) (LAURENCE S et al., 2009). One notes about thirty varieties but the range of the varieties currently cultivated is rather restricted (Tokyo hybridizes F1, Chinese turnip…). Turnips are primarily cultivated in full field by direct seeding on fertile well-prepared seedbeds.

The needs in mineral elements are important and sustained fertilization (NPK) is needed before planting and during the growth cycle. The application of manure must be done before planting and preferably on the previous crop in a rotation.

The growth cycle is 40 - 70 days dependent on climatic conditions and varieties. Turnips are harvested as young roots by successive thinnings. The diseases control and protection of turnips must be regular due to frequent pest attacks.

Photo 4. Turnip: Brassica rapa L. (White – Turnip)

2.2 Experimental plots

The used method is the visual trapping by colored traps to estimate the presence, the quantity and the quality of the individual species (RIBA et al., 1989; FISCHER et al., 1987). Two types of traps were put in every plot of land:

- An air trap at the level of the foliage (see Fig 1).
- A ground trap on the surface of the ground.

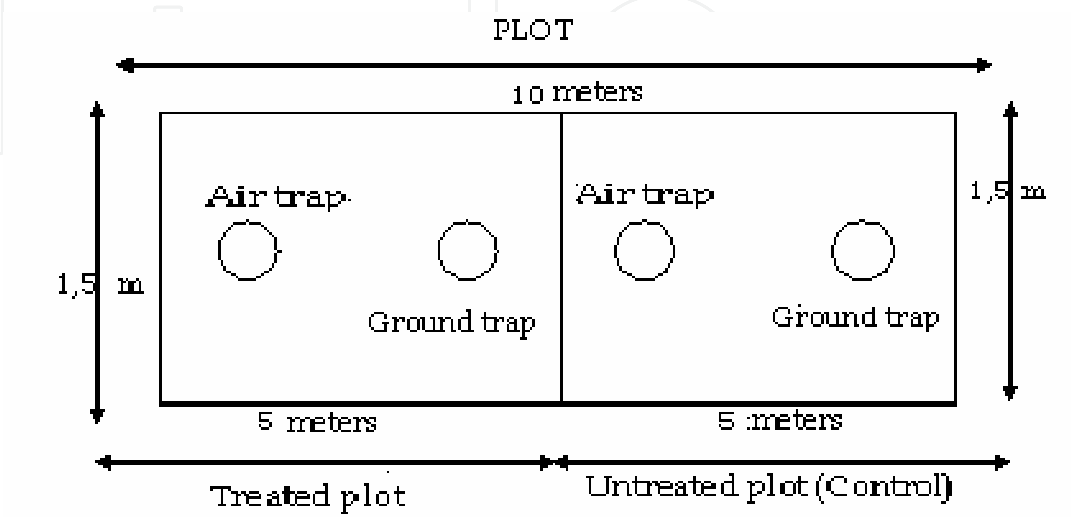


Fig. 1. Experimental Plots with air and ground traps

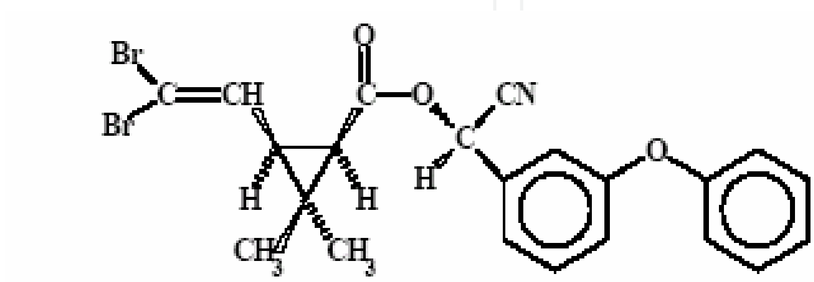
All these traps contain some soapy water which captures insects. The harvest of the grips is made every two days with change of the trapping liquid. Insects are kept in glass jars containing some alcohol (70 degrees) before being sent to the laboratory.
The ground is raised to form wide mounds or ground trays of 10 meters long by 1, 5 meters wide Blocks.
Every Block is formed by two plots of land or beds of 5 meters by 1, 5 meters each (see Fig1,). One of the plots of land is treated and the other one is untreated and constitutes the Control plot (blank). All in all, four Blocks and eight plots of land were realized: two Blocks for Lettuce, one Block for Spinach and one Block for Turnips. Every plot of land contains two traps.

2.3 Agrochemicals

2.3.1 Deltamethrin: trade name DECIS (K -OTHRINE)

Molecular formula: $C_{22}H_{19}Br_2NO_3$ (WHO., 1990a, 1990b)

Structural formula:



(*S*)- α-cyano-3-phenoxybenzyl (1*R*,3*R*)-3-(2,2-dibromovinyl)-2,2-dimethylcyclopropane carboxylate (*IUPAC*)

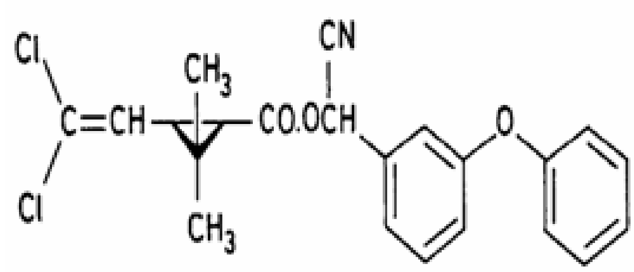
Decis 25 EC is an emulsifiable concentrate of formulation (25g/ l). It is approved for a wide variety of insects including acarina, thysanoptera and arthropods pests of the horticultural plants **(DEMBELE A.; 2000)**. We made a first application on the salad lettuce at the stage 27 days at a concentration of 0.042 g/ l (25 L of Decis in 15 l of water) for 400 m^2. The stage 39 days corresponds to the second treatment by Deltamethrin with the same concentration of 0,042 g/ l and by Maneb with the concentration of 5 g/ l representing 93,75 grams of CALLIMAN 80 WP for the sprayer of 15 liters for 400 m^2. The stage 45 days: corresponds to the third treatment by Maneb with the same concentration of 5 g/ l.

For turnip, at the stage 18 days we have done the first treatment by Deltamethrin with the concentration of 0,025 g/ l (15 milliliters of DECIS 25 EC in 15 liters of water) for 400 m^2. The Stage 30 days corresponds to the second treatment by Deltamethrin with the same concentration of 0,025 g/ l and by Maneb with the concentration of 5 g/ l representing 93,75 grams of CALLIMAN 80 WP for the sprayer of 15 liters. The Stage 38 days of turnips received the same treatment as the stage 30 days.

2.3.2 Cypermethrin: trade name Cypercal 50 EC

Molecular formula: $C_{22}H_{19}C1_2NO_3$ (WHO., 1979)

Structural formula:



***RS*)-I-cyano-3-phenoxybenzyl (1*RS*)-*cis-trans*-3- (2,2-dichlorovinyl)-2,2-dimethylcyclopropanecarboxylate (*IUPAC*).**

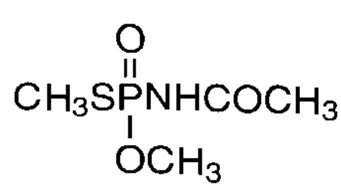
Cypermethrin 50 EC is an emulsifiable concentrate of formulation (50 g/ l). It is approved for a broad spectrum of harmful insects (Caterpillars, Thrips, Heliothis and white flies).

We carried out the first application on spinaches at the stage 18 days; the amount of application is of 0.133 g/ l (40 ml of CYPERCAL 50 EC. in 15l of water) for 400 m^2. At the stage 30 days the spinaches received an amount of treatment of 0,133 g/ l in addition to 5 g/ l of maneb (93.75g of CALLIMAN 80 WP in 15 l of water) for 400 m^2.

2.3.3 Acephate: trade name Orthen 75 SP

Molecular formula: $C_4H_{10}NO_3PS$ (WHO., 1976)

Structural formula:

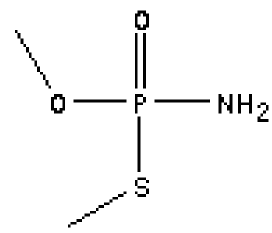


***O,S*-dimethyl acetylphosphoramidothioate (IUPAC)**

Orthen 75 SP is a water-soluble powder of formulation 75% acephate. It is a systemic pesticide. Methadomiphos (**$C_2H_8O_2NPS$**) is a metabolite of acephate and it is also systemic **(DEMBELE A.; 2000)**.

Molecular formula: $C_2H_8O_2NPS$

Structural formula:



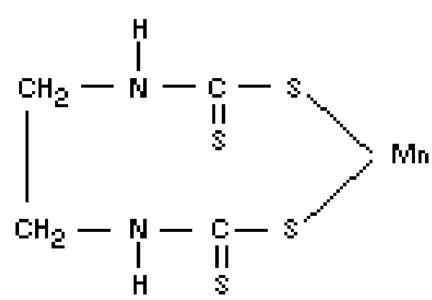
O,S,-**dimethyl phosphoramidothioate (IUPAC)**

These two organophosphorous pesticides are both effective against a broad range of insect pests (sucking, biting, and mining insects) on such vegetable and crops as cabbages, cotton, tobacco, sugar beet, head lettuce. It is used as a pre-harvest spray at 0.5-1.5 kg/ ha. With this amount, protection against the insects vermin is obtained from 7 to 21 days.
The first application on lettuce is done at at stage 27 days with the amount of 2 g/ l (40 g of Orthen 75 SP in 15 l of water) for 400m^2.
At the stage 39 days the amount of treatment of lettuce is 2 g/ l in addition to 5 g/ l of maneb for 400 m^2.

2.3.4 Maneb: trade name Calliman 80 WP

Molecular formula: $C_4H_6N_2S_4Mn$ (WHO-1993)

Structural formula:



Manganese ethylene-1,2-bisdithiocarbamate (IUPAC)

Calliman 80 WP is a wettable powder of formulation 80% of maneb (dithiocarbamate), an effective protective fungicide against the main foliar diseases (Anthracnose, Mildew, Alternaria, Rhizoctonia, cercospora, Sclerotinia and Septoria). It should be applied before and after seeding on all three vegetables at amount of 5 g/ l. Moreover the salad lettuce received a treatment at the stage of 45 days.

2.4 Plants phytopathology and pests monitoring

After each treatment, every two days we proceed:

- To the description of the general characteristics of the plants, especially the leaves, and we look out for visible signs of attacks and diseased plants.

- To the counting of the insects captured in the traps for follow-up of the dynamics of the recolonization following the various treatments.

The final identification of the fungus was made after observation of the samples under a microscope (enlarged to a size 400 times) and according to known keys of identification (BOTTON.B et al, 1990; KIFFER. E et al, 1997).

2.5 Irrigated water monitoring

We sowed under the fume hood raw water of boring in the Petri glass, on culture medium sterilized. The analysis consisted of identifying thermotolerant Coliform and fecal Streptococci and counting of the colonies of red or pink coloring of 2 to 3 millimeters (mm) in diameter. The criterion of assessment is fixed to $2x10^3$.

3. Results and discussion

3.1 Pests assessment on lettuces

The trapping on the level of lettuces allowed the identification of six (6) Orders grouping together in total forty two (42) families of insects. They are: 10 families of Beetles, 9 families of Hymenopterans, 10 families of Dipterans, 7 families of Hemiptera, 3 families of Lepidoptera and 3 families of Orthoptera. Seventy nine per cent (79 %) of these families are present on the untreated plot (blank) whereas 69 % meet on the treated plot with Deltaméthrin (Tabl 1, 2, 3) (Graphic 1).

We counted 79% of pests in the untreated lettuce plots against 69% in the deltamethrin treated plots with the Hemiptera representing the most important group of devastators pests. The pests recolonization of the field plots was done 12 days after the first application of acephate against 8 days with deltamethhrin. The agrochemicals application makes it possible to reduce by 50% the losses of production of the Lettuces salad (Graphic 1).

THE COLEOPTERA ORDER					
FAMILIES	RELATION	Treated Plots		Untreated Plots	
		Areas Traps	Grounds Traps	Areas Traps	Grounds Traps
Buprestidae	P	+	-	-	-
Carabidae	T	-	+	-	+
Chrysomelidae	P	-	+	+	+
Coccinellidae	T	+	-	+	+
Elateridae	P	+	-	-	-
Hydrophilidae	P	-	+	-	+
Scarabaeidae	P&T	+	+	+	+
Staphylinidae	T	+	-	+	-
Tenebrionidae	T	-	+	-	+
Cicindelidae	T	-	-	-	+

(-) = Absent (+) = Present P = Pest insects T = Non -Target Insects N = Neutrals

Table 1. Order and Insects families' identified on lettuces

FAMILIES	RELATION	Treated Plots		Untreated Plots	
		Areas Traps	Grounds Traps	Areas Traps	Grounds Traps
THE HYMENOPTERA ORDER					
Pompilidae	N	-	+	-	-
Ichneumonidae	T	+	-	-	-
Halictidae	T	+	-	-	-
Vespidae	T	+	-	-	-
Formicidae	T	+	-	-	+
Cynipidae	P	+	-	-	-
Cephidae	P	-	-	+	-
Crabronidae	T	-	-	+	-
Encyrtidae	T	-	-	+	-
THE DIPTERA ORDER					
Agromyzidae	P	+	+	+	-
Drosophilidae	N	+	+	+	-
Sarcophagidae	N	+	-	-	-
Muscidae	P&N	+	-	+	-
Dolichopodidae	T	+	-	+	-
Chironomidae	N	+	-	+	-
Diopsidae	P	-	-	+	-
Stratiomyidae	N	-	-	+	-
Tephritidae	P	-	-	+	-
Phoridae	N	-	-	+	-
THE HEMIPTERA ORDER					
Cicadellidae	P	+	+	+	+
Cicadidae	P	+	-	+	-
Miridae	P	+	-	+	+
Piesmidae	P	+	-	+	-
Coreidae	P	-	-	-	+
Membracidae	P	-	-	+	-
Lygaeidae	P	-	-	+	-
	P				

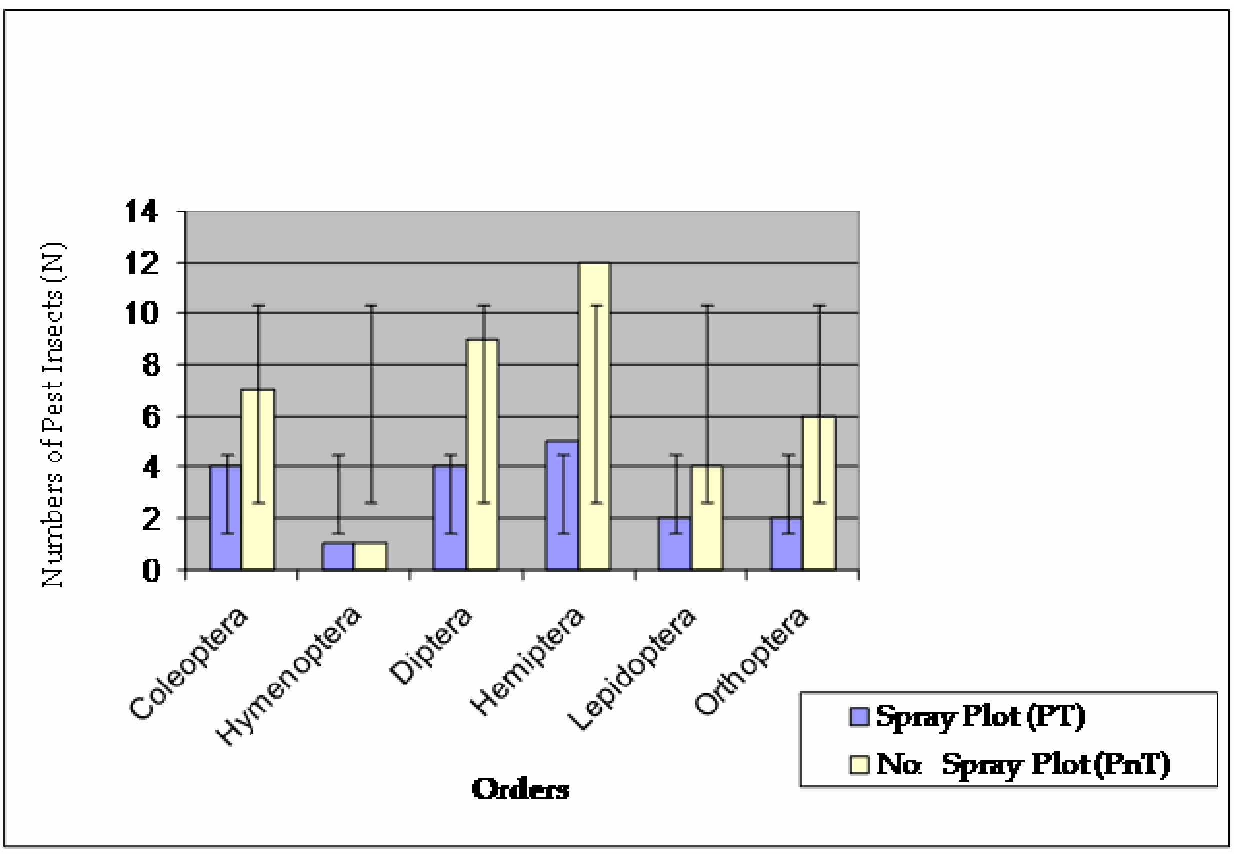
(-) = Absent (+) = Present P = Pest insects T = Non -Target Insects N = Neutrals

Table 2. Order and Insects families' identified on lettuces

THE LEPIDOPTERA ORDER					
FAMILIES	RELATION	Treated Plots		Untreated Plots	
		Areas Traps	Grounds Traps	Areas Traps	Grounds Traps
Pieridae	P	+	-	-	-
Noctuidae	P	+	-	+	-
Yponomeutidae	P	-	-	+	-
THE ORTHOPTERA ORDER					
FAMILIES	RELATION	Treated Plots		Untreated Plots	
		Areas Traps	Grounds Traps	Areas Traps	Grounds Traps
Gryllidae	P	-	+	-	+
Acrididae	P	+	-	+	-
Gryllotalpidae	P	-	-	-	+

(-) = Absent (+) = Present P = Pest insects T = Non -Target Insects N = Neutrals

Table 3. Order and Insects families' identified on lettuces



Graphic 1. Pests Control on Lettuces

3.2 Pests sssessment on spinaches

On the spinach Seven (7) Orders grouping together in total Thirty seven (37) families of insects were identified. They are: 9 families of Beetles, 9 families of Hymenoptera, 10 families of Diptera, 4 families of Hemiptera, 2 families of Lepidoptera, 2 families of Orthoptera, and 1 family of Isoptera.

84 % of these families were present on the Untreated against 57 % on the treated plot with Cypermethrin.

THE COLEOPTERA ORDER					
FAMILIES	RELATION	Treated Plots		Untreated Plots	
		Areas Traps	Grounds Traps	Areas Traps	Grounds Traps
Carabidae	T	-	+	-	+
Cicindelidae	T	-	+	-	+
Scarabaeidae	T	+	+	+	+
Hydrophilidae	P	+	+	+	+
Staphylinidae	T	+	-	+	-
Coccinellidae	T	+	-	+	-
Ténébrionidae	T	-	-	+	+
Chrysomélidae	P	-	-	+	-
Elateridae	P	-	-	+	-
THE HYMENOPTERA ORDER					
FAMILIES	RELATION	Treated Plots		Untreated Plots	
		Areas Traps	Grounds Traps	Areas Traps	Grounds Traps
Pompilidae	N	-	+	+	+
Ichneumonidae	T	-	+	-	-
Tenthrédinidae	P	+	-	-	-
Sphecidae	T	+	-	+	-
Crabronidae	T	+	-	+	-
Vespidae	T	-	-	-	+
Formicidae	T	-	-	+	+
Nyssonidae	T	-	-	+	-
Bethylidae	T	-	-	+	-

(-) = Absent (+) = Present P = Pest insects T = Non- Target Insects N = Neutrals

Table 4. Order and Insects families' identified on Spinach

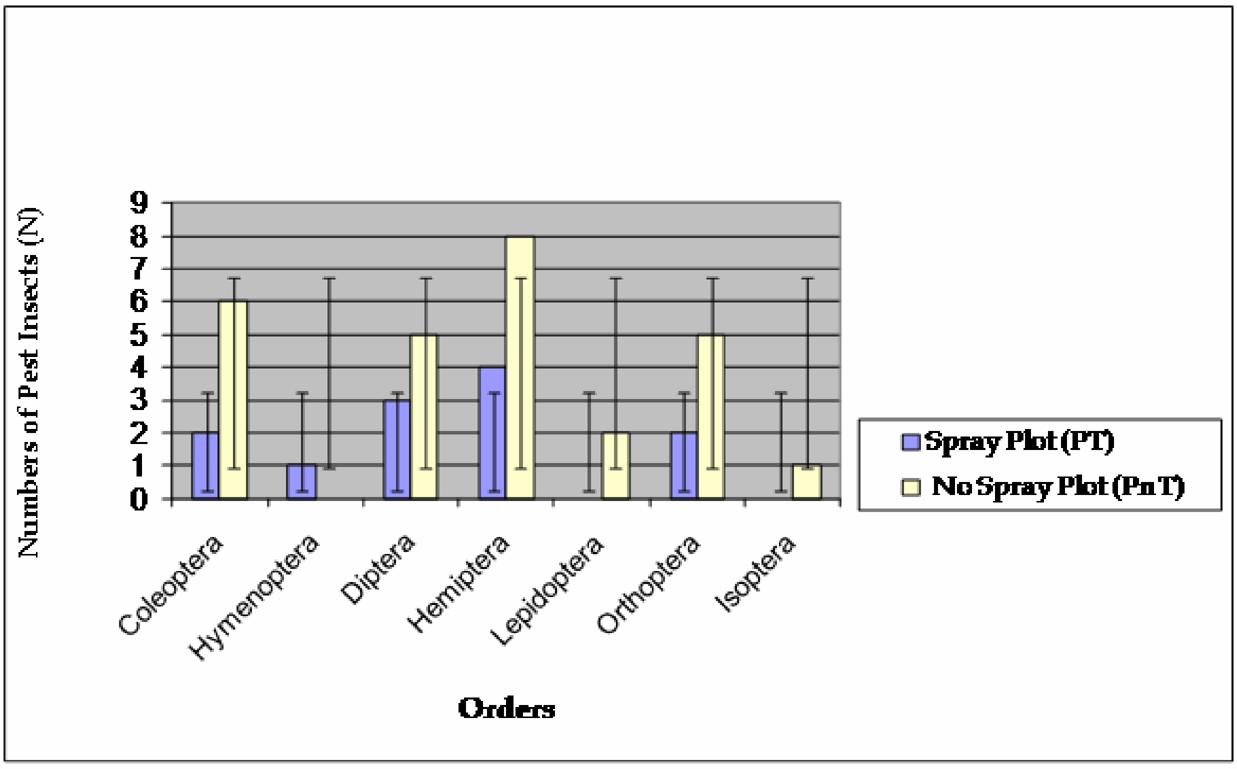
THE DIPTERA ORDER					
FAMILIES	RELATION	Treated Plots		Untreated Plots	
		Areas Traps	Grounds Traps	Areas Traps	Grounds Traps
Tachinidae	T	-	+	-	-
Agromyzidae	P	+	+	+	-
Dolichopodidae	T	+	-	-	-
Diopsidae	P	+	-	-	-
Stratiomyidae	N	+	-	+	-
Muscidae	P&N	+	-	-	-
Sarcophagidae	N	-	-	+	-
Anthomyiidae	P	-	-	+	-
Calliphoridae	N	-	-	+	-
Phoridae	N	-	-	+	-
THE HEMIPTERA ORDER					
FAMILIES	RELATION	Treated Plots		Untreated Plots	
		Areas Traps	Grounds Traps	Areas Traps	Grounds Traps
Cicadellidae	P	+	+	+	+
Piesmidae	P	+	-	+	+
Cicadidae	P	+	-	+	-
Tingidae	P	-	-	-	+

(-) = Absent (+) = Present P = Pest insects T = Non- Target Insects N = Neutrals

Table 5. Order and Insects families' identified on Spinach

We obseved 84% of pests in untreated plots against 57% in plots treated with the cypermethrin, with the Hemiptera representing the most important group. The recolonization by the pests was done 10 days after the first application of cypermethrin or Lambdacyhalothrin. Agrochemicals application makes it possible to reduce by 25% the losses of production of the spinaches (Graphic 2, photo 5).

Photo 5. Application of pesticides doesn't respected GAP



Graphic 2. Pests Control on Spinaches

3.3 Pests assessment on turnips

On the turnips we identified six (6) Orders making a total of 34 insect's families. They are: 7 families of Beetles, 9 families of Hymenopterans, 8 families of Dipterans, 4 families of Hemiptera, 4 families of Lepidoptera and 2 families of Orthoptera.

91 % of these families were present on the untreated plots whereas 62 % were on the treated plot (spray plot) with Deltamethrin (Tabl 6, 7, 8,).

THE COLEOPTERA ORDER					
FAMILIES	RELATION	Treated Plots		Untreated Plots	
		Areas Traps	Grounds Traps	Areas Traps	Grounds Traps
Coccinellidae	T	+	-	+	+
Buprestidae	P	+	-	-	-
Carabidae	T	-	+	-	+
Hydrophilidae	P	-	+	-	+
Staphylinidae	T	+	-	+	-
Cicindelidae	T	-	+	-	+
Chrysomelidae	P	-	-	+	+

(-) = Absent (+) = Present P = Pest insects T = Non -Target Insects N = Neutrals

Table 6. Order and Insects families' identified on the turnips

THE HYMENOPTERA ORDER					
FAMILIES	RELATION	Treated Plots		Untreated Plots	
		Areas Traps	Grounds Traps	Areas Traps	Grounds Traps
Pompilidae	N	-	+	+	+
Ichneumonidae	T	-	+	-	-
Sphecidae	T	+	-	+	-
Crabronidae	T	+	-	+	-
Vespidae	T	+	-	-	-
Nyssonidae	T	-	-	+	+
Bethylidae	T	-	-	+	-
Cephidae	P	-	-	+	-
Chalcididae	T	-	-	+	-
THE DIPTERA ORDER					
FAMILIES	RELATION	Treated Plots		Untreated Plots	
		Areas Traps	Grounds Traps	Areas Traps	Grounds Traps
Sarcophagidae	N	+	-	+	+
Muscidae	P&N	+	-	+	-
Agromyzidae	P	+	+	+	+
Drosophilidae	N	+	-	+	+
Stratiomyidae	N	-	+	+	-
Lonchaeidae	P	-	-	+	-
Cecidomyiidae	P	-	-	-	+
Mycetophilidae	T	-	-	-	+
THE HEMIPTERA ORDER					
FAMILIES	RELATION	Treated Plots		Untreated Plots	
		Areas Traps	Grounds Traps	Areas Traps	Grounds Traps
Cicadellidae	P	+	+	+	+
Cicadidae	P	+	-	+	-
Miridae	P	-	+	-	+
Aphididae	P	-	-	+	+

(-) = Absent (+) = Present P = Pest insects T = Non -Target Insects N = Neutrals

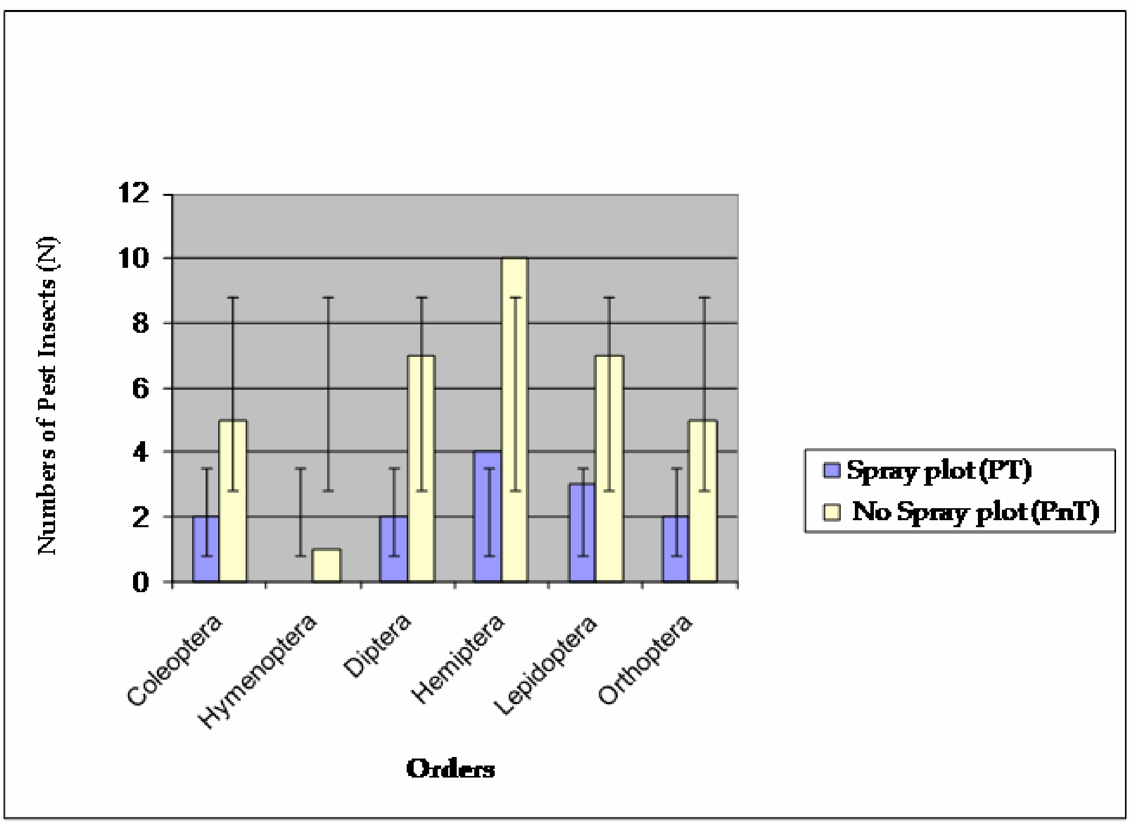
Table 7. Order and Insects families' identified on the turnips

THE LEPIDOPTERA ORDER					
FAMILIES	RELATION	Treated Plots		Untreated Plots	
		Areas Traps	Grounds Traps	Areas Traps	Grounds Traps
Noctuidae	R	+	+	+	+
Pieridae	R	-	-	+	-
Lycaenidae	R	-	-	+	-
Yponomeutidae	R	-	-	+	-
THE ORTHOPTERA ORDER					
FAMILIES	RELATION	Treated Plots		Untreated Plots	
		Areas Traps	Grounds Traps	Areas Traps	Grounds Traps
Acrididae	R	+	+	+	+
Gryllotalpidae	R	-	-	-	+

(-) = Absent (+) = Present P = Pest insects T = Non -Target Insects N = Neutrals

Table 8. Order and Insects families' identified on the turnips

We observed 91% of pests in untreated plots against 62% on the plots treated with deltarmethrin, and the Hemiptera also set up the most important group of pests. The pests recolonisation was done 8 days after the first application of deltarmethrin (Graphic 3). The first application of agrochemicals makes it possible to reduce by 42% the losses of turnip production.



Graphic 3. Pests Control on Turnips

Overall the application of Agrochemicals significantly reduced the number and the species of pests on the treated plots. The Coleoptera and the Hymenoptera contain the main species of the predatory and natural enemies thus auxiliary (no target insect) of plants protection, having a significant impact on the dynamics of the populations of pests. The preservation of these different auxiliaries is necessary for a sustainable management of natural resources. Deltamethrin has a good level of selectivity with a superior advantage for the management of pests and the environment over the Acephate which, has a low selectivity but a wide range of effectiveness against insect pest and good residual activity. The preservation of the auxiliaries of culture in spite of the chemical treatment is essential considering the important role that they play in the maintenance of agro-ecological balances.

The Lepidoptera (larva), Orthoptera and Hemiptera represent the most important group of insect pests, which attack and cause the highest damage in vegetable gardening of lettuce, spinach and turnip. However, the considerable differences in number of captured insects and pests found between the treated and untreated field plots show that a targeted application of agrochemicals against these groups of pests is efficient.

The majority of the groups of pests which attach and cause important damage on turnip, spinach and lettuce can be controlled by the application of agrochemical products applying good agricultural practices (GAP) compatible with the protection of the environment and the preservation of non-target organisms.

Photo 6. Pesticides Plastic container on the plot (Maneb)

However, one of the biggest problems encountered by vegetable producers is their lack of sufficient knowledge about how to use safely the agrochemicals. Very large numbers of empty pesticide containers are left lying in the fields because of the lack of collection and disposal facilities and constitute acute potential hazards for the environment and the fauna due to the left-over of toxic pesticides in the containers (Photo6).

The producers are not sufficiently aware of the risks of pesticides accumulation in vegetables, and the possible health problems for consumers being exposed to these risks. They are also often confronted with the problems of accessibility to agricultural credits.

3.4 Plants phytopathology and water monitoring

We identified only one pathogenic fungus on the lettuce (9 % of production). It is Cladosporium *sp of The* Amastigomycota *Divion*; *Group of Deuteromycete;* Hyphomycetes' Class and *Gender of Cladosporium.* This fungus is the agent responsible of Cladosporium gray mold, but the preventive spraying of Maneb (photo 6) gives efficient protection on the lettuce.
The irrigation water is characterized by the presence of micro-organisms such as Thermotolerant Coliform and the fecal Streptococci. Their numbers areas respectively one hundred fifty (150) times and one thousand (1000) times higher than the criteria for international standard allowed for irrigation water quality in agricultural fields (Table 9 and Photo 7).

BACTERIA	RESULTATS	CRITERIA
Thermotolerant Coliform/g	3.10^5	2.10^3
Faecal Streptococci/ g	10^6	10^3

Table 9. Microbiology Monitoring of Irrigated Water

Photo 7. Irrigated water quality is doubtful

The microbiological analysis of the irrigation water highlighted an overload of thermotolerant Coliforms and fecal Streptococci. These bacteria which are not normally pathogenic are usually used to indicate the possible presence of pathogenic microfauna organisms. Thus their very high number compared to the threshold recommended shows a low water quality (Photo 7).
The strong presence of these indicator bacteria suggests a probable presence in the irrigation water of very dangerous pathogenic parasites that could develop and cause very important damages to the plants, farmers and the consumers.
The contaminated vegetables can cause a certain number of diseases. Particularly, the contaminated salads are sources of bacterial diseases such as the typhoid and paratyphoid

fevers (Salmonella typhi/ paratyphi) whose origin comes from the excrements of the patients or healthy carriers (MESSIAEN C.M, 1989). Other bacteria of the Salmonella species can also cause collective intoxications. The periodically endemic Cholera in the tropical countries, maybe transmitted by soiled salads. Also the bacterial dysenteria (Shigella dysenteriae) can be transmitted by soiled vegetables believed contaminated by the excrements. The preventive protection against these diseases is often done by vaccination. But the use of hygienic measures like disinfections with chloramphenicol, bleach into the water or the potassium permanganate ($KMnO_4$) is of primary importance.

4. Conclusion

The insecticides of biological origin represent an asset but their major disadvantage in addition to their high costs, is their instability with storage. They quickly lose their effectiveness and consequently any competitiveness. But the need for both safe and natural food products while respecting nature and maintaining a healthy environment is a very important concept to be considered in Integrated Pest Management (IPM). IPM can be defined as a combination and the reasoned use of all the methods which makes it possible to control or to maintain the populations of pests to a threshold economically bearable. And if the consumers estimate that the products are of the first rate quality, they will not hesitate to pay for the full price. Finally, one can reach a great effectiveness in the improvement of plants protection by associating the conservation of auxiliary insects with the application of agrochemicals and biotechnology. Our developing countries will be able certainly to benefit from this progress.

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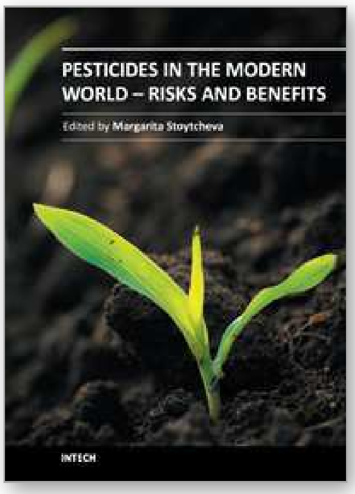

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