Research Journal of Agriculture and Forestry Sciences _____ISSN 2320 – 6063
Vol. **7(1),** 14-20, January **(2019)** *Res. J. Agriculture and Forestry Sci.*

A field study of vegetable farming environment, diseases and pests associated with lettuce and cabbage in Daloa (Côte d'Ivoire)

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Available online at: www.isca.in
Received 16th November 2018, revised 1st January 2019, accepted 6th January 2019

Abstract

Vegetable crops in Daloa occupy an important place in local and domestic food supply and security. However, diseases and pests significantly limit its development. The present study aims at figuring out the vegetable farming environment in Daloa and identifying pest and disease problems of main leafy vegetables so as to help producers make an effective diagnosis that can lead to a sustainable control approach. A questionnaire-based survey was conducted among 131 producers and pests and disease associated to lettuce and cabbage were studied. The results showed vegetables production in Daloa is practiced with traditional means by smallholders, with 44 % having little formal education. Vegetable production is conducted by as many women (49%) as men (51%) aged 17-40 and can be one of the responses to galloping unemployment rates in the city if it is better organized. Vegetables farmers are handicapped by a lack of supervision and training which causes a misuse of the technical itinerary of the different crops. All the respondents mentioned climate change and access to quality seeds adapted to local conditions as their major constraints in vegetables production while 91 % among them cited insects and diseases. The vegetables grown in the area of Daloa are diversified and consist of leafy vegetables mainly grown in the city, fruit vegetables mainly located in the outskirts and tuber vegetables grown mainly in the rural areas. Those diseases who damage lettuce and cabbage are seedling damping-off, collar rot, Fusarium wilt, downy mildew, leaf spot, bacterial rot, viroses and nematodes, while insects who attack these crops are Helicoverpa armigera, Plutella xylostella, Hellula undalis, Dysdercus sp, Lypaphis erysimi and Achatina sp. This study provides a trail from which further studies could be conducted for mapping the most significant diseases in the region so as to better monitor and protect vegetable crops.

Keywords: Vegetable crops, food security, pests, diseases, leafy vegetables and diseases mapping.

Introduction

According to the UN[1], "50% of the world's population lives in cities and such proportion could reach 70% by 2050''. In Côte d'Ivoire, the situation is no exception, as 51% of the population is in urban areas[2]. This arrangement has led to an increase of agriculture practice within the perimeter of large cities in order to meet the growing needs of populations in food and textile fibers[3]. In the urban agriculture model adopted in Côte d'Ivoire, Vegetable growing (truck farming) is an activity of choice because it is practiced on small areas to control the unpredictable effects of nature but also constitute sources of monetary income in a period of time[4].

Vegetable crops are vegetables and fruits grown around swamps, dams and lowlands. These include staple crops in Côte d'Ivoire, essential for food security because they are the main source of vitamins, dietary minerals and carbohydrates for populations[5]. Neglected over a long time for the profit of cash crops[6], vegetable crops have undergone recent development. They have diversified in response to market demand[3]. Thus, more yielding varieties selected from Europe were introduced in the activity in Côte d'Ivoire. In 2010, the domestic yield of vegetables was estimated at more than 850 000 t, including 400 000 t for European-type vegetables and 450 000 t for traditional vegetables[7].

Among vegetables growing, leafy vegetables are prominent because of their nutritional importance[8] and their short cycle, which is conducive to several crop cycles per year. However, the export market for these vegetables remains largely unexploited and the yield remains seasonal, although local and domestic demands for fresh and dry vegetables are considerably growing[9,10]. Thus, these vegetables are grown in the informal sector most of the time integrated into family farms in often insanitary lowlands[7].

Under such conditions, the cropping techniques and practices implemented for their yield are not sufficiently characterized so as to identify the constraints and propose sustainable solutions for improving the productivity of the varieties. In fact, poor cropping practices create a favorable environment for the development of diseases and pests[3]. However, it is known that such crops are subject to numerous microorganism attacks in every season that depreciate their market value and cause huge yield losses[11,12] thus creating desolation among farmers. Some

trials undertaken in the regions of Abidjan, Dabou and Dimbokro in Côte d'Ivoire were abandoned as a result of damage caused by pests whose significance made vegetable yield and quality too uncertain[13].

A study on the inventory of vegetable pathogens in Côte d'Ivoire showed the predominance of fungi in vegetable farming and fruit diseases[14]. Some workers studied the vegetable Capsicum spp. in the area of Abidjan in southern Côte d'Ivoire, have highlighted the presence of several insect pests on crops and their role in the transmission of diseases to plants[11]. In the fight against pests and diseases of vegetables under cultivation, chemical control remains the most effective means in the short term[15], which results in environmental and crop pollution. As a result, an approach for designing cropping systems less dependent on phytosanitary products must be based on an effective agronomic diagnosis integrating knowledge on bio-aggressors. In pursuing such goal, this study, located in the area of Daloa, one of the major granaries of food production in Côte d'Ivoire[16,17] aims at identifying pests and diseases of the major leafy vegetables cultivated. To this end, it was thus necessary to describe the environment of vegetable farming in this area.

Materials and methods

The study was conducted from December 2016 to February 2018 in the area of Daloa (6.8883°N, 6.4397°W) in west central Côte d'Ivoire. The average annual rainfall of the last ten years in the region was 1302.23mm with an average annual temperature of 27.75°C. The climate is tropical humid and the mean yearly humidity is about 86.01%. The vegetation of this region is forest. Soil in Daloa area is ferralitic with a pH ranging from weakly acidic to weakly basic. Many seasonal watercourses water the region, resulting in numerous lowlands.

The methodology initially consisted of the 3-month survey (December 2016, January and February 2017) of vegetable growers in the area of Daloa. The study started with purposive selection of the surveyed sites in consultation with the Ministry of Food and Agriculture in the region. The surveys were carried out in the city and outskirts of Daloa, in the vegetable production sites of Tazibouo, Gbeulville, Lobia Extension, Quartier Garage, Issia corridor, Man corridor, Huberson. The investigations also concerned rural areas that included Sikaboutou (18km north), Yaokro (12km east), Mahounou (15km east) and Gonaté (20km east). The survey consisted in interviewing producers directly from a previously established questionnaire focused on the identity of the producer, the cropping practices and the problems encountered in the practice of vegetable farming. A detailed information about pests and diseases associated with lettuce and cabbage were collected only in the city and outskirts of Daloa farms during 12 months (March 2017 to February 2018) corresponding to at least 3 crops cycles for cabbage and 10 for lettuce. Field survey was done weekly in the morning between 6:30 and 10:00. The technique of direct observations on the different parts of the plants was used according to methodology used by some authors[18]. For the formal identification of certain fungal pathogens associated with certain symptoms observed in the fields, diseased organs were transported to the laboratory of plant pathology of the University Jean Lorougnon Guédé of Daloa for their identification and characterizing. The Data collected were analyzed using Microsoft Excel package program. Descriptive statistics were used and means were presented using tables and graphs.

Results and discussion

Human and social characteristic of producers: The total number of farmers interviewed was 131. About 33% produced vegetables in rural areas (village) and 67% in the city and outskirts of Daloa. Respondents differed by age, sex, family status, and level of education (Table-1). Most of them farmers were household heads (79.1%) while 51% were men and 49 % were women. Vegetable farming was mainly practiced by non-native people (83.7%). Most of them were illiterate (44.2%) and had no training in the field. The activity is practiced on small surface areas because 55.8 % of producers had less than 1 ha. Only 18.6% of farms had surface areas greater than 2 ha. Overall, the plots were in lease mode (83.7%). The labor used by the producers was essentially family (100%).

Table-1: Characteristics of producers and vegetable farms in the area of Daloa.

Characteristics		%
Gender	Male	51.2
	Female	48.8
Producers' age group (Year)	17-40	60.5
	41-60	20.9
	61 et 65	18.6
Origin	Native	83.7
	Non-native	16.3
Level of education	Illiterate	44.2
	Primary education	16.3
	Secondary education	39.5
Training in vegetable farming	Yes	00,0
	No	100,0
Main activity	Yes	79.1
	No	20.9
Experience in the activity	1-5	9.3
	6-14	27.9
	15 and over	62.8
Surface area (ha)	<1 ha	55.8
	1 ha-2 ha	25.6
	> 2 ha	18.6
Tenure	Leasing	83.7
	Family property	16.3
Labor	Family	100.0
	Temporary	27.90
	Salaried	9.3
Water source	Open wells	88.4
	River /lowland	11.6

Diversity of vegetables produced in the area of Daloa: The vegetables cultivated in the locality of Daloa consisted of leafy vegetables (Amaranth, Lettuce, Cabbage, Parsley, Mint and green onion), root vegetables (Carrot), fruit vegetables (tomato, eggplant, cucumber, bell pepper, chilli, okra, Guinea sorrel, zucchini) and tuber vegetables (sweet potato) (Figure-1). Leafy vegetables were mainly grown in the city of Daloa, while fruit and tuber vegetables were mainly produced in the peri-urban and villages areas of Daloa. The selection of cultivated vegetables depended on market demand and plant cycle.

Constraints in vegetable production practices in Daloa: During our survey, producers expressed constraints encountered in carrying out their activities (Figure-2). All respondents mentioned the difficulty of accessing credit, the high cost of inputs, the difficult access to quality seeds and the use of rudimentary equipment. More than 80% highlighted difficulties related to water supply of plants, parasitic attacks that make the yield uncertain and depreciate the commercial quality of the vegetables and the lack of supervision for the total success of this crop. Added to this was the continuing decline in soil fertility and the problem of vegetable preservation.

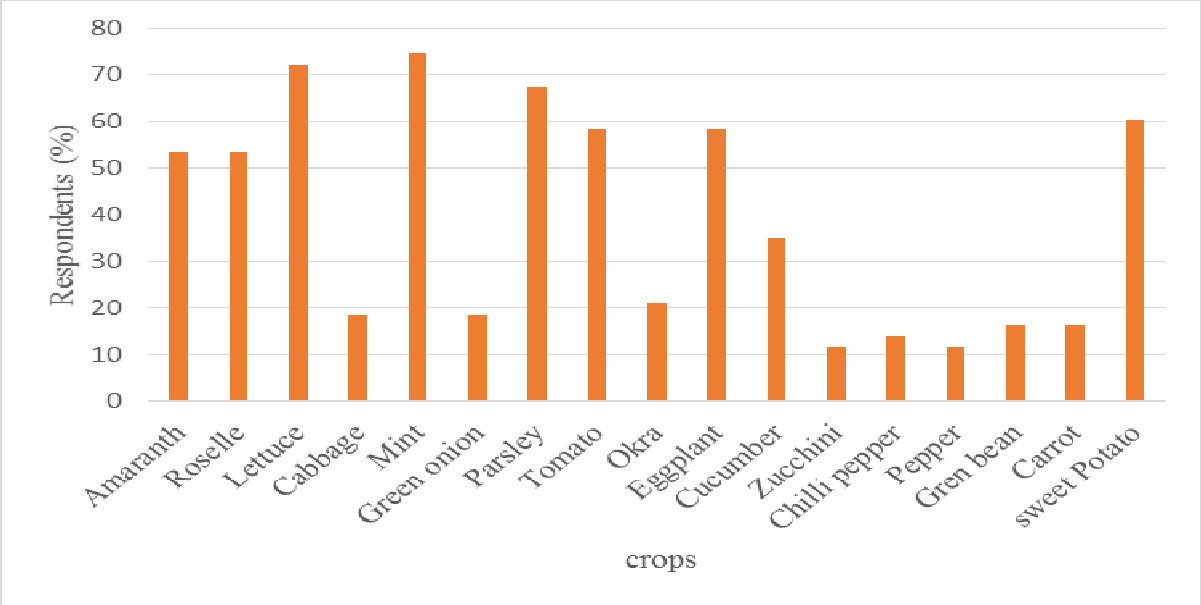

Figure-1: Diversity of vegetables cultivated in Daloa.

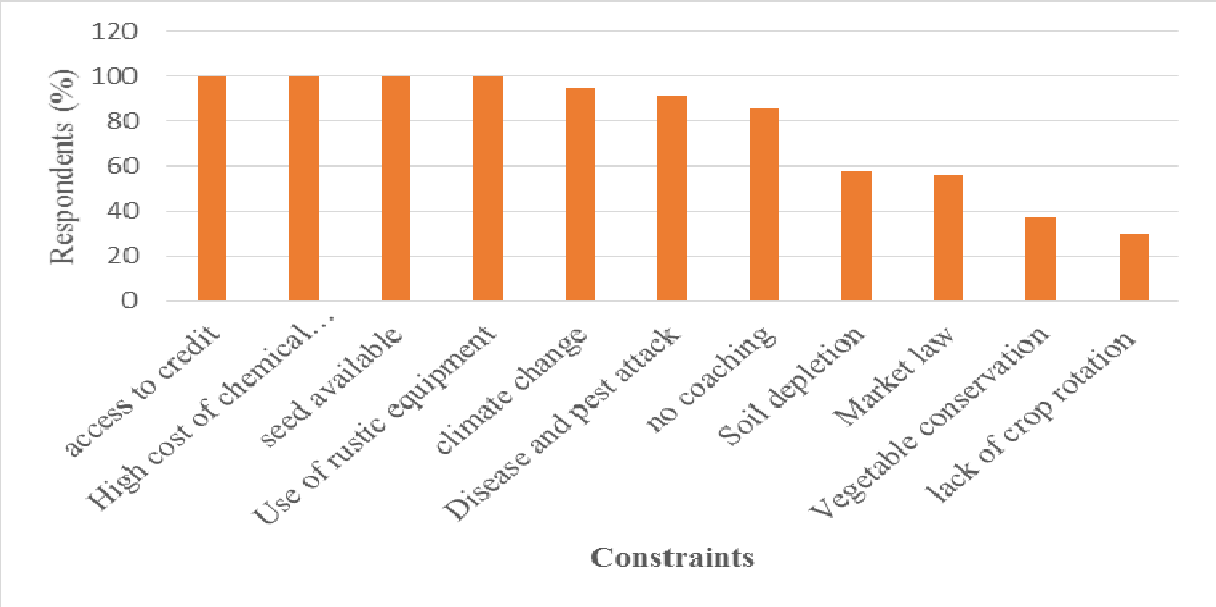

Figure-2: Constraints in vegetable production in Daloa.

Main diseases and pests associated of cabbage and lettuce cultivated in Daloa: Leafy vegetables cultivated in the area of Daloa were the subject of several diseases and pest attacks. These pests cause many changes in vegetable plants and affect their production. However, the most significant diseases were those found on cabbage and lettuce. Thus, in nurseries, on young lettuce seedlings, stem wilting was observed. Seedlings became filiform and collapse, leaving empty spaces (Figure-3). This seedling damping off was caused by telluric fungi (pythium sp, Rhizoctonia solani and Fusarium sp. On-farm, the most economically significant diseases occurred either in the form of leaf rot or fusarium wilt, in the form of color anomalies, foliar deformation or tiny spots. Sometimes deformations of the whole plant followed by dwarfing were observed due in part to nematodes. With regard to pests the most significant economically belonged to 3 orders (Figure-4). These included Lepidoptera (*Helicoverpa armigera, Plutella xylostella, Hellula undalis*), Hemiptera (*Dysdercus sp* and *Lypaphis erysimi*) and Stylommatophora (*Achatina sp*.).

Figure-3: Main diseases of cabbage and lettuce cultivated in Daloa.
a) Damping-off (*Rhizoctonia solani, phytium sp*.), b) Cabbage leaf curl virus, c) Fusarium wilt on cabbage, d) Cabbage head affected by bacterial soft rot, e) Powdery mildew, f) browning effect on lettuce caused by bacterial, g) Botrytis gray mold on lettuce, h) Leaf Spot (*Cercospora lactucae*) on lettuce, i-a&b) Cabbage roots damaged by root-knot nematodes.

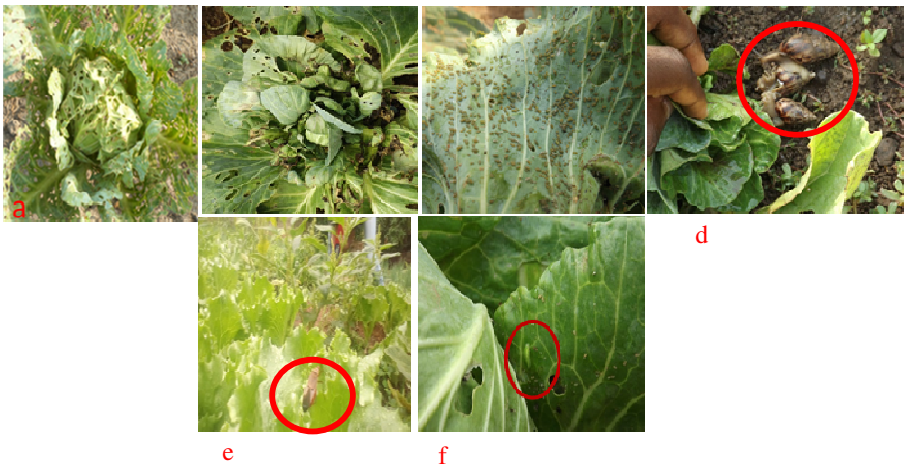

Figure-4: The main pests of cabbage and lettuce in the region of Daloa.
a) Cabbage leaf destroyed by cabbage moth larvae, Plutella xylostella, b) Multiple cabbage heads caused by cabbage borer Hellula undalis, c) Aphid Lipaphis erysimi colony on the underside of a cabbage leaf, d) Achatina sp on Cabbage leaf, e) Dysdercus sp on salad leaf, f) Helicoverpa armigera on the upper side of a cabbage leaf.

Discussion: Vegetables production in Daloa was done by farmers with rustic tools due to a serious lack of means and a virtual lack of supervision. This condition explains the fact that most of the farms are smaller than 1 ha. This result confirms the works of some authors who have shown that vegetable production in West Africa is in the hands of smallholders[19]. However, it is worth noting an increase in the surface areas occupied by vegetables as we moved away from the city. This is justified by the fact that within the cities the availability of cultivable lands would be limited and would belong to the public domain when available[10].

Another characteristic of vegetable farming in Daloa is the strong presence of women in this business which represent their main activities. These results are similar to those achieved by many researchers[20], which confirm that vegetable production is a main business that employs more women and contradicts finding according to which in developing countries, men are those who manage income-generating activities[21]. However, under the conditions of our study, the presence of women is much noticed in the production of vegetables inside the city rather than in the countryside and in the outskirts of the city. Indeed, this business is for women living in cities, who do not have access to formal employment because of their low education or training and other limited opportunities as a salaried job[21]. The dominant age range in this business is between 17 and 40 years old and constituted 60% of the respondents. These young people said they learned this activity from their parents and remained in it while some were there because of job insecurity or school failure. For them, vegetable production is the main business and source of income. This leads us to conclude that this income-generating activity[10,22] can therefore be an alternative to the increasing unemployment rates in large African cities if it is organized and better supervised.

The vegetables grown in the region of Daloa were diversified however it was observed a predominance of leafy vegetables mainly in the city and fruit and root vegetables in the countryside. Indeed, leaves such as lettuce and cabbage are prized for their fresh condition and are difficult to preserve. Thus, they are the subject of a strong demand in the big cities because there are many African households which are increasingly adopting European-style diets made from raw vegetables. Producers are aware of this, and the surveys made it clear that the cultivation of one species at the expense of another is guided by local demand. Moreover, the marketing of leafy vegetables is immediate after physiological maturation of the plant product and is done either as direct sale or by the intervention of a single intermediary[22]. This fact justifies that such types of vegetables are grown close to the consumers to be available.

The constraints that limit the production of vegetables in the area of Daloa are numerous and producers have widely expressed it in this study. While some of the constraints are climate and policy-related, diseases and pests are considered to be the main biotic factors limiting the quality and yield of vegetables in tropical countries[23,24]. The most significant diseases faced by vegetables farmers in the area of Daloa in lettuce and cabbage nursery were damping off caused by telluric fungi of the *pythium, Rhizoctonia* and *Fusarium* genera. These fungi survive in the soil as oospores that germinate and attack the seedling root hairs and root tips, resulting in a gradual deterioration of the root system. The plant wilts before surface lesions become visible[25].

In some cases the seeds may not germinate because they rot into the soil. This disease is amplified because of poor cropping practices used by farmers mainly due to a lack of training correlated to a lack of technical supervision. Indeed, the conditions conducive to the development of this disease are high soil moisture, poor aeration and especially seeds closely sown[26]. Furthermore, on-farm, the main fungal diseases of leafy vegetables are mildew, rot (Botrytis sp.), necrotic spots on lettuce leaf (*Cercospora lactucae, colletotrichum sp*.,) and fusarium wilt. These diseases cause economically significant losses on vegetables[27,28]. Several selected varieties introduced in Côte d'Ivoire are sensitive thereto[29]. In addition to fungal diseases, bacterial rot is an obsessive fear for farmers because it is difficult to manage. Bacterial diseases are frequently associated with the Xanthomonas and Erwinia genera[10,30]. With regard to nematode-related damage, several genera might be associated with vegetable crops visited in the area of Daloa. But the Meloidogyne genus might be the most common and the most widespread. This genus is responsible for overall crop losses in tropical regions[31]. With regard to pests, the most feared by farmers are *Plutella xylostella, Helicoverpa armigera, Hellula undalis*. These pests were responsible for losses of up to 100% on cabbage in some farms visited. These insects have also been reported in several countries of the sub-region, particularly in Senegal and Benin where these insects cause considerable damage to vegetables[32,10]. Furthermore, these polyphagous insects are the main vectors of plant viral diseases such as leaf wilting or leaf curl[33,34].

For the management of vegetable diseases and pests, producers use chemical control. However, because of the high rate of illiteracy, we have noticed a bad use of some of these products causing the phenomenon of phytotoxicity in several smallholder farms. According to several authors, phytotoxicity and even chemical intoxication would be common among vegetable producers in Africa[35,31]. Among the pesticides commonly used by producers against vegetable pests, the pyrethroid family occupies a prominent place. This intensive use might favor the development of resistant pest strains and might explain the resistance of several insects to the chemical family of pyrethroids[36,37]. Indeed, chemical control requires an alternation between the families of products used in order to limit the risks of appearance of resistant strains. Also, vegetable leaves being consumed in fresh condition, it is desirable to have a healthy product without pesticide residues. Thus, genetic control remains the best protection.

Conclusion

At the end of our study, we note that ruck farming in the area of Daloa is a business that provides an occupation to a large segment of young people and women and deserves to be better organized and supervised so as to meet the challenge of food security. Although a variety of vegetables are cultivated in the area of Daloa, leafy vegetables are cultivated mainly in the city because of local demand and proximity constraints with consumers. Truck farming is an income-generating activity that requires more attention from public authorities and research. Indeed, vegetables are prone to disease and pest attacks that degrade their quality and reduce yield. The sanitary status of the crops highlights the omnipresence of root-knot nematodes and their damage on all sites visited, bacterial, viral diseases as well as an abundance of fungal diseases. The main pests observed are *Lypaphis erysimi, Plutella xylostella, Hellula undalis* and *Helicoverpa armigera*, which have a strong impact on cabbage cultivation.

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