Identification of weeds in sweet potato crops (*Ipomoea batatas* L.) in the lowlands of Côte d'Ivoire

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Abstract

To ensure better management of weeds in sweet potato crops, in the lowlands of Anyama in Côte d'Ivoire, it is appropriate to first identify weeds, particularly the major species. To do this, 120 floristic surveys were carried out in four lowlands of pure sweet potato cultivation, i.e. 30 surveys in each lowland. This work has identified 110 species belonging to 79 genera distributed in 33 botanical families. The dominant families are represented by Cyperaceae (17.3%), Poaceae (16.4%), Asteraceae (10.0%), Fabaceae (5.4%) and Amaranthaceae (4.5%). Angiosperms are in the majority with 98.2% of the species recorded. Dicotyledons are the most represented with 60.0% of species against 38.2% for Monocotyledons. In terms of biological types, therophytes are the most represented with 39.0%, followed by nanophanerophytes, then hemicryptophytes with the same proportion (10.8%). The study area has a homogeneous floristic distribution. *Digitaria horizontalis, Eleusine indica, Alternanthera sessilis* and *Ageratum conyzoides* are the most damaging species to the crop in this area.

Keywords: Anyama, lowland, sweet potato, weed, floristic survey

INTRODUCTION

For decades, the lowlands in Ivorian cities, whatever their level of development, have always been used for farming (Konan, 2017). In most cases, this agriculture is used for self-consumption and is increasingly used to supply markets in and around the cities. Today, faced with the galloping demographic growth of Côte d'Ivoire, the state must take up the challenge of food and nutritional security. Thus, urban agriculture, such as that practised in the lowlands, can be seen as a solution to contemporary urban issues (Wegmuller and Duchemin, 2010).

In the commune of Anyama, the lowlands are an important element of the landscape and are used for market gardening, particularly sweet potatoes (*Ipomoea batatas* L.). Indeed, this crop accounts for 46% of the vegetable crop production in this area (Bosso *et al.*, 2020). In Africa, it ranks third among root and tuber crops after cassava and yam (FAOSTAT, 2020). It is cultivated throughout the country with an annual production and self-consumption of 57,983 tonnes (FAOSTAT, 2020). However, this crop faces several constraints that limit its production, including weeds. Spontaneous plants capable of causing a drop in yield due to their density, weeds are responsible for agricultural losses estimated at 2.2 million tonnes in Africa at an estimated cost of 700 billion CFA francs (Le bourgeois *et al.*, 2014).

The work of Vecchio *et al.* (1980) on the influence of weeds in crops, allowed to highlight several factors favouring their development such as the importance of the climate, the cultivation techniques, the type of crop and especially the period of emergence of the weeds. The knowledge of these weeds is a strategic factor of crucial importance, because from this knowledge comes the good control of these plants (Ipou Ipou, 2005). It is in this context that this study was initiated, with the general objective of knowing the weeds of sweet potato crops in the lowlands of Anyama, in order to ensure better management.

METHODOLOGY

Study site

The present study took place in Côte d'Ivoire, more precisely in the commune of Anyama with geographical coordinates 4° 03'W and 5° 29'N. In this area, four lowlands of pure sweet potato cultivation were selected because of their spatial representativeness. Indeed, they are far from each other, which allows a larger area to be covered. These lowlands are located in the villages of Ebimpé, Ahouabo, Yapokoi and Anyama-djamé.

Sampling

The floristic inventory was carried out using the random sampling method. This method consists of randomly selecting the sampling areas. It is recommended for large areas. The floristic surveys were carried out using areas of 4 m². These areas were chosen because the cultivation plots are not large. These surveys consisted of noting the presence of each weed species encountered and assigning them an abundance-dominance index (Table 1). This scoring was done according to the Le Bourgeois (1993) scale. The "tour de champs" technique was also used as a complement to the surface survey technique (Maillet, 1981; Chicouène, 2000). This technique (tour de champs) consists of walking the plot in different directions until a new species is found (Le Bourgeois, 1993). It thus makes it possible to identify species that may have been missed during the surveys in the delimited areas. Each of the four locations was surveyed 30 times, resulting in a total of 120 surveys.

Figure 1: Inventory of weeds in a sweet potato plot

Analysis of the data

The following parameters were analysed:

- ***Floristic composition***: This is the total number of taxa recorded in an area. This floristic richness was obtained by counting all the species recorded during the surveys. Each species is assigned a five-letter code (first three letters of the genus name and first two letters of the species name), its family, its biological type and its class. The APG III classification was used to establish the botanical families of the different species.
- ***Biological spectrum:*** This is defined as the distribution of species within the biological types. The biological type represents the mode of conservation of the perennial organs during the period unfavourable to vegetative life (Raunkiaer, 1905 and 1934). The biological type classification adopted is the Raunkiaer (1905) model modified by Aké-Assi (2001).
- ***The generic diversity index***: It reflects the state of diversity of the flora of a study area. This index is obtained by taking the ratio of the number of species to the number of genera in a family (Nusbaumer, 2003).
- ***Coefficient of similarity (Cs)***: This concept reflects the degree of similarity between two floristic lists. It was used to compare two by two the floristic lists obtained in our different localities. The formula used is that of Sørensen (1948):

$$Cs = \frac{2c}{a + b} \times 100$$

With a and b, the number of species identified respectively in lists (A) and (B), and c the number of species common to both lists (A) and (B). The value of the similarity coefficient (Cs) is expressed as a percentage.

- ***The centesimal frequency (Fc)***: It reflects the rate of presence of a species during a sampling representing N surveys. Species with a value greater than or equal to 50% are the most frequently encountered. It is defined by the following formula:

$$Fc(\%) = \frac{Fa}{N} \times 100$$

Fa: absolute frequency, represents the number of observations (n) of a species during (N) surveys.

- ***The potential for harmfulness***: This reflects the extent of the weed problems posed by the different species (Ipou Ipou, 2005). The classification of these species according to their potential for harmfulness gives the infestation diagram. The established infestation diagram is inspired by that of Le Bourgeois (1993) which makes it possible to differentiate the groups of species according to their degree of infestation, and therefore their power of harmfulness (Guillerm *et al.*, 1989; Traoré and Maillet, 1992) (Table 1).

Table 1: Index of abundance/dominance according to Le Bourgeois (1993)

Rating index	Meaning
1	Rare, scarce or abundant individuals, but with low cover
2	Individuals very abundant or covering 1/20 of the sampled area
3	Individuals covering ¼ to ½ of the surface, any abundance
4	Individuals covering ½ to ¾ of the surface, any abundance
5	Individuals covering more than ¾ of the surface, any abundance

RESULTS

Floristic composition

The results show that the weed flora in sweet potato cultivation is composed of 110 species, including 52 species in Ahouabo, 78 species in Anyama-djamé, 61 species in Ebimpé and 58 species in Yapokoi. This flora is distributed in 79 genera and 33 families that belong to the Angiosperms and Pteridophytes. The study of the proportions of the different taxonomic groups (Table 2) shows that the whole flora is largely dominated by Angiosperms with 98.2% of the species against 1.82% for Pteridophytes. Within the Angiosperms, the Dicotyledonous class is more important with more than half of the species (60%) than the Monocotyledons which represent 38.2%. Table 3 gives the proportions of the 33 families recorded, of which 5 are predominant with 53.6% of all species and 48.1% of genera. These are, in decreasing order of their proportions in species: Cyperaceae (17.3%), Poaceae (16.4%), Asteraceae (10.0%), Fabaceae (5.45%) and Amaranthaceae (4.55%).

Biological spectrum

The biological spectrum of the weed flora in the study area is shown in figure 2. These results show that therophytes are the best represented with 39%, followed by nanophanerophytes and hemicryptophytes with the same proportion (18%). These 3 biological types are always the best represented with a contribution of at least 75% to the vegetation of each village studied (Ahouabo, Anyama-djamé, Ebimpé and Yapokoi), whose proportions of biological types are recorded in Table 4.

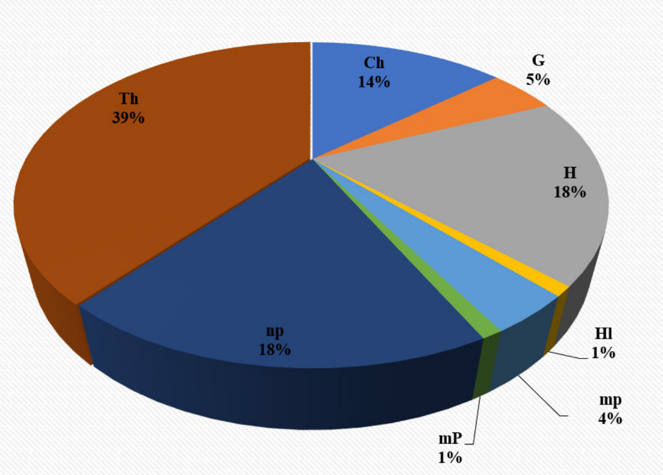

Figure 2: Biological spectrum of the lowland flora of Anyama

***mP:** Mesophanerophytes, **mp:** Microphanerophytes, **np:** Nanophanerophytes, **Ch:** Chamephytes, **H:** Hemicryptophytes, **G:** Geophytes, **Th:** Therophytes, **Hl:** Helophytes*

Generic diversity index

Among the 5 predominant families of the whole flora (Table 5), the Asteraceae with 11 species distributed in 10 genera, have the lowest diversity index (Idg=1.1). This family is therefore the most diverse in the whole area. The other families are, in decreasing order of diversification, the Fabaceae (Idg=1.2), the Amaranthaceae (Idg=1.25), the Poaceae (Idg=1.29) and the Cyperaceae (Idg=3.8).

Table 3: Weed families identified in the study area

Families	Number of genus	P (%)	Number of species	P (%)
Acanthaceae	3	3.80	4	3.64
Amaranthaceae	4	5.06	5	4.55
Araceae	1	1.27	1	0.91
Araliaceae	1	1.27	1	0.91
Arecaceae	1	1.27	1	0.91
Asteraceae	10	12.7	11	10.0
Boraginaceae	1	1.27	1	0.91
Caryophyllaceae	1	1.27	1	0.91
Cleomaceae	1	1.27	2	1.82
Commelinaceae	1	1.27	2	1.82
Convolvulaceae	1	1.27	1	0.91
Cyperaceae	5	6.33	19	17.3
Euphorbiaceae	3	3.80	4	3.64
Fabaceae	5	6.33	6	5.45
Lamiaceae	2	2.53	2	1.82
Linderniaceae	1	1.27	1	0.91
Malvaceae	3	3.80	3	2.73
Marsileaceae	1	1.27	1	0.91
Melastomataceae	2	2.53	2	1.82
Onagraceae	1	1.27	4	3.64
Oxalidaceae	1	1.27	1	0.91
Passifloraceae	2	2.53	2	1.82
Phyllanthaceae	1	1.27	1	0.91
Piperaceae	1	1.27	1	0.91
Poaceae	14	17.7	18	16.36
Polygonaceae	1	1.27	1	0.91
Pontederiaceae	1	1.27	1	0.91
Portulacaceae	1	1.27	1	0.91
Rubiaceae	3	3.80	4	3.64
Scrophulariaceae	2	2.53	2	1.82
Solanaceae	2	2.53	3	2.73
Urticaceae	1	1.27	2	1.82
Woodsiaceae	1	1.27	1	0.91
Totals	79	100	110	100

Table 2: Taxonomic distribution of recorded weeds

		Ahouabo	Anyama-djamé	Ebimpé	Yapokoi	Study zone
Dicotyledons	N	26.0	46	37	38	66
	P (%)	50.0	59.0	60.7	65.5	60.0
Monocotyledons	N	25	31	23	19	42
	P (%)	48.1	39.7	37.7	32.8	38.2
Pteridophytes	N	1	1	1	1	2
	P (%)	1.92	1.28	1.64	1.72	1.82
Families	N	21	28	28	26	33
Genus	N	42	56	50	48	79
Species	N	52	78	61	58	110

Table 4: Proportion (%) of the biological types of the different localities

	Th	np	H	Ch	G	mp	Hl	mP
Ahouabo	46	18	20	6	6	4	0	0
Anyama-djamé	40	18	17	15	5	4	1	0
Ebimpé	44	20	16	10	3	3	0	2
Yapokoi	42	17	17	12	5	5	2	0

Table 5: Diversity index of the predominant families in the different villages

Families	Ahouabo			Anyama-djamé			Ebimpé			Yapokoi			Study zone		
	G	E	Idg	G	E	Idg	G	E	Idg	G	E	Idg	G	E	Idg
Cyperaceae	5	11	2.2	4	13	3.25	4	11	2.75	4	10	2.5	5	19	3.8
Poaceae	9	10	1.1	10	14	1.4	9	9	1	8	8	1	14	18	1.29
Asteraceae	6	6	1	7	8	1.14	6	6	1	7	7	1	10	11	1.1
Fabaceae	4	4	1	3	3	1	2	2	1	3	3	1	5	6	1.2
Amaranthaceae	2	2	1	2	3	1.5	4	5	1.25	2	3	1.5	4	5	1.25

Coefficient of similarity

The coefficients of similarity calculated by comparing two by two the floristic lists of the 4 villages inventoried (Table 6) show that all values are higher than 50%. Thus, the pairs of villages have a homogeneous floristic composition.

Weed frequency

Out of 110 species encountered, 8 are the most frequent in the whole area (Table 7). These are in decreasing order: *Alternanthera sessilis* (75.8%), *Ageratum conyzoides* (71.7%), *Eleusine indica* (70.8%), *Digitaria horizontalis* (61.7%), *Commelina benghalensis* (57.7%), *Ludwigia hyssopifolia* and *Phyllanthus amarus* (55.8% each), then *Ludwigia abyssinica* (51.7%). The three (3) species at the top of the list are always present among the most frequent species in each village (Table 7).

Harmfulness potential

The analysis of the infestation diagram of the study area (Figure 3) allowed to identify 8 groups of weeds. Group 1 (G1), consisting of the general major weeds, represents the most damaging species in the area. They have a very high invasion potential and represent a strong agronomic constraint. These species are: *Digitaria horizontalis, Eleusine indica, Alternanthera sessilis* and *Ageratum conyzoides*. In the village of Ahouabo, the general major weeds are *Eleusine indica* and *Alternanthera sessilis*. In Anyama-djamé, this group is represented by *Digitaria horizontalis, Eleusine indica* and *Ageratum conyzoides*. In Ebimpé, *Eleusine indica* and *Ageratum conyzoides* represent this group. In Yapokoi, they are: *Commelina benghalensis, Digitaria horizontalis, Alternanthera sessilis* and *Ageratum conyzoides*. It can be seen that the degree of harmfulness varies with the locality.

Table 7: Most frequent weeds in the study area

Species	Fc (%)
Alternanthera sessilis	75.8
Ageratum conyzoides	71.7
Eleusine indica	70.8
Digitaria horizontalis	61.7
Commelina benghalensis	57.7
Ludwigia hyssopifolia	55.8
Phyllanthus amarus	55.8
Ludwigia abyssinica	51.7

Table 6: Coefficients of similarity of the flora of the different villages

Village couple	a	b	c	Cs (%)
Anyama-djamé et Ahouabo	78	52	44	67.7
Ahouabo et Ebimpé	52	61	33	58.4
Ahouabo et Yapokoi	52	58	28	50.9
Anyama-djamé et Ebimpé	78	61	41	59.0
Anyama-djamé et Yapokoi	78	58	43	63.2
Ebimpé et Yapokoi	61	58	42	70.6

***a:** number of species in the first village; **b:** number of species in the second village; **c:** number of species common to both villages; **Cs:** coefficient of similarity.*

Table 8: Most frequent weeds in the lowlands of the different villages

Species	Ahouabo	Anyama-djamé	Ebimpe	Yapokoi
	Fc (%)	Fc (%)	Fc (%)	Fc (%)
Acmella uliginosa	53.3			76.7
Ageratum conyzoides	50	60	93.3	83.3
Alternanthera sessilis	53.3	80	86.7	83.3
Amaranthus hybridus	80			
Amaranthus spinosus		60		
Commelina benghalensis	50	80		60
Cyanthillium cinereum			60	
Cyperus distans		63.3		
Digitaria horizontalis		56.7		100
Eleusine indica	83.3	73.3	70	56.7
Kyllinga erecta			60	
Ludwigia abyssinica	53.3	76.7		66.7
Ludwigia hyssopifolia		76.7		83.3
Oldenlandia corymbosa		66.7	53.3	
Peperomia pellucida				80
Phyllanthus amarus			66.67	70
Synedrella nodiflora		50		

DISCUSSION

The weed flora surveyed is floristically homogeneous. This result can be explained by the fact that the study was carried out in the same type of environment (lowlands), on the same type of soil, in the presence of the same crop (sweet potato) and possibly using the same cultivation techniques. Indeed, weeds are characteristic of ecological parameters (edapho-climatic) and agronomic factors as observed by Déat (1976). The results of this study show that the flora is composed of 110 species distributed in 79 genera and 33 families. These results, compared to the weed flora in sweet potato cultivation obtained by Diallo (2020), during his work on vegetable crops in the same area, show a specific difference. Indeed, he inventoried 70 species, distributed in 59 genera and 26 families in sweet potato cultivation. This specific difference could be explained by the diversity of the sites and the number of surveys. Diallo (2020), conducted 25 surveys in sweet potato cultivation in these lowlands, which is much lower than the number of surveys in the present study (120 surveys). The present study also took place in 4 localities, while Diallo (2020) conducted his surveys in only one locality. This analysis is supported by the work of Kokou *et al.* (2005), who showed that the species richness of an area can vary according to the area exploited. The weed flora of 110 species recorded in this study is close to the 105 species identified by Koffi (2014) in the market gardens of the Adiopodoumé lowlands. This quantitative similarity could be explained by the fact that our study and that of Koffi (2014) took place in relatively close areas of southern Côte d'Ivoire and in the same type of environment (lowland). However, the number of species recorded is lower than that of Ipou Ipou (2005) in cotton cultivation in northern Côte d'Ivoire with 284 species. Mangara *et al.* (2010) recorded 239 species in pineapple cultivation in the localities of Bonoua and N'douci in lower Côte d'Ivoire. These results can be explained mainly by the size of the study area. Moreover, the said work was carried out in dryland cultivation where a wide variety of species can develop, whereas in the lowlands, priority is given to species that thrive in wet conditions.

The Cyperaceae, Poaceae, Asteraceae, Fabaceae, and Amaranthaceae are the best represented, accounting for 53.6% of the species in the total flora. Among these families, Cyperaceae, Poaceae and Asteraceae are the best represented in each locality and in the whole flora of the present study. Indeed, Mbarga-Mbindzi *et al.* (2014) in their studies on the ecological diversity of Cyperaceae in Yaoundé (Cameroon), showed that humidity is a main factor explaining the distribution of species in this family. Several studies, including those of Cremers and Hoff (1993) and Rejmánek (2000), have also highlighted the numerical importance of Cyperaceae in humid areas. The cultural biotope of market gardening being generally the open environment, this may explain the proliferation of Poaceae and Asteraceae in these crops, as these families are largely anemochorous (Kouakou *et al.*, 2016). Indeed, anemochory is very easy in open environments.

Our results at the level of the biological spectrum show that therophytes are the best represented with 39%, followed by nanophanerophytes and hemicryptophytes with the same proportion (18%). These three (3) biological types appeared dominant in the weed flora of a fallow land on a previous sweet potato crop in Adiopodoumé locality (Mangara *et al.*, 2017). The high presence of therophytes in our study can be explained by the tilling of the soil through ploughing that is regularly done in market gardening (Maillet, 1992). This leads to the redistribution of the seed stock of therophytes, which end

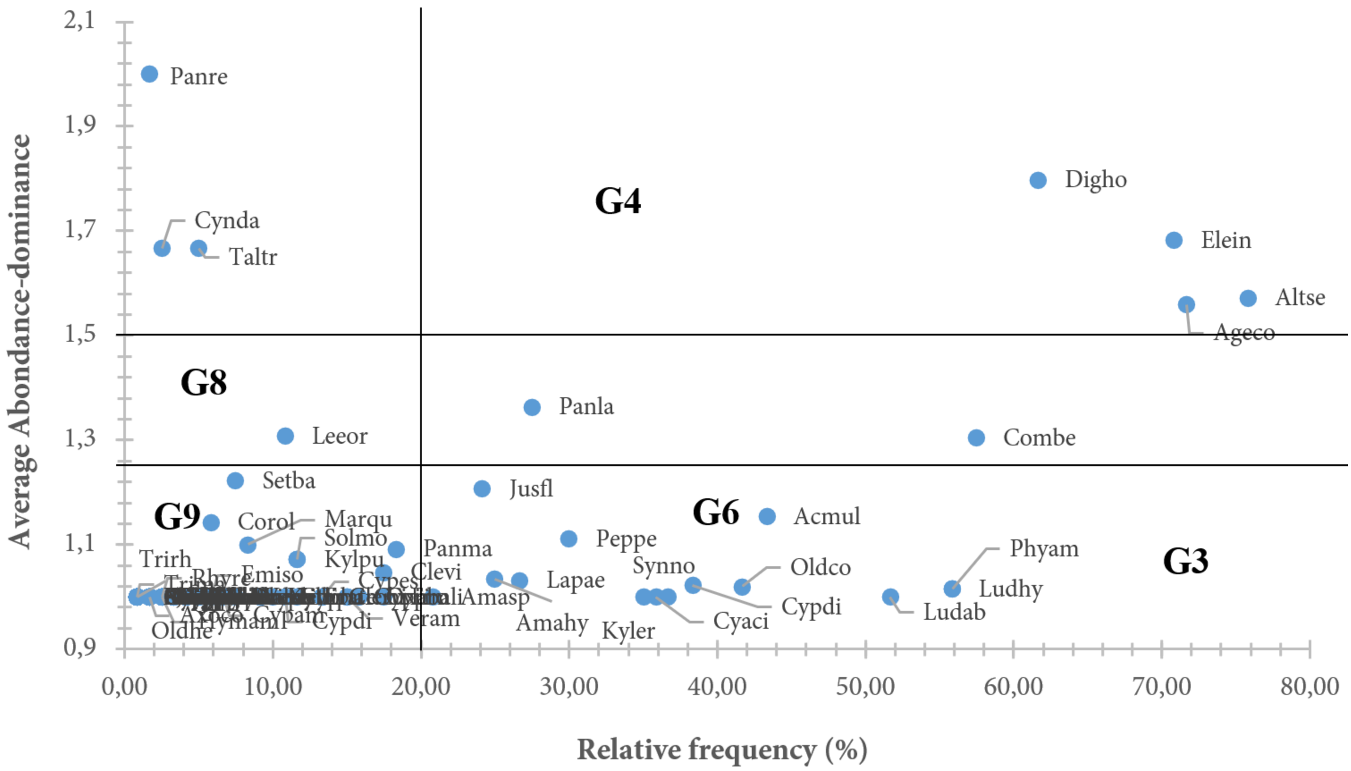

Figure 3: Infestation diagram of the lowlands of Anyama commune under sweet potato cultivation

up colonising the environment. In addition, since most therophytes are heliophilic plants, light penetration in the plots facilitates their adaptation. As the sweet potato is also heliophilic, its cultivation requires the destruction of the plant cover, an action that favours the development of therophytes through the intensity of light reaching the soil. This predominance of therophytes is also favoured by the development of the sweet potato's leaves, which cover the soil, thus reducing the light flux on the soil. In addition, once the leaves are mature and used as leafy vegetables, they are largely removed from the crop area, which could contribute to the proliferation of therophytes. Indeed, the seeds of these plants, being exposed, will germinate and proliferate. Several authors have also noted the high representation of therophytes in their studies (Ipou Ipou, 2005; Boraud, 2000; Le Bourgeois, 1993; Traoré, 1991).

The phanerophytes found in this flora (nanophanerophytes, microphanerophytes and mesophanerophytes) are derived from stump sprouts. Indeed, the clearing carried out before the establishment of the crop generates the dissemination of stump sprouts throughout the plot. When these shoots are not eliminated from the plot, they develop new individuals under favourable conditions. Shallow tillage in market gardening is a practice that cannot affect the viability of these stumps. This explains the persistence of these biological types in market gardens.

The analysis of the infestation diagram shows that *Digitaria horizontalis, Eleusine indica, Alternanthera sessilis* and *Ageratum conyzoides* are the most damaging species in sweetpotato cultivation in the lowlands of Anyama commune. Their inclusion in the group of general major weeds can be explained by their biological and ecological characteristics. Indeed, most of these species have a high seed production rate and some of them (*Digitaria horizontalis* and *Alternanthera sessilis*) have the ability to spread by vegetative propagation.

Digitaria horizontalis is a species with a very wide ecological range. Le Bourgeois and Merlier (1995), explain their strong presence in crops by their capacity to develop on almost all types of soil. In addition to this ubiquity, it has a seed potential estimated at 12,000 seeds per plant (Akobundu, 1987). Its seeds germinate preferably on the soil surface and ploughing or weeding can trigger their germination. This seed potential, combined with its ability to multiply vegetatively and its wide ecological spectrum, makes it a very damaging species in cultivation. It is one of the most damaging species in the work of Mangara *et al.* (2008) in pineapple cultivation in lower Côte d'Ivoire.

Concerning *Eleusine indica*, it is a widespread weed in many agricultural systems (Shekoofa *et al.*, 2020). It is one of the worst weed species in the world (Holm *et al.*, 1977). This species has a high seed potential, with an individual producing up to 40,000 seeds on average (Holm *et al.*, 1977). In addition, its germination rate is over 90% under optimal conditions (Yang *et al.*, 2009). It is one of the harmful species in vegetable and fruit crops in Guyana in South America (Le Bourgeois, 2018).

Alternanthera sessilis is a plant capable of growing both in extremely dry areas and in seasonally flooded areas (Holm *et al.*, 1977). It has been reported in sorghum, millet, maize, cotton, cassava fields, pastures and vegetable farms (Gupta, 2014). Seeds and fruits are dispersed by myrmechory (Pancho, 1986; Soerjani *et al.*, 1987). The average number of seeds produced per plant is around 2000.

Finally, the species *Ageratum conyzoides*, owes its strong presence in cultivation to its high seed potential estimated at 40,000 seeds per individual (Holm *et al.*, 1977). The dispersal of its seeds is facilitated by water and wind, and half of them are able to germinate just after dissemination (Le Bourgeois and Merlier, 1995). This species also constitutes with *Digitaria horizontalis*, the main harmful species of the work of Mangara *et al.* (2008) in pineapple cultivation in lower Ivory Coast.

CONCLUSION

The present work has made it possible to record 110 species belonging to 79 genera distributed in 33 families in the lowlands of Anyama. The best represented families are, in decreasing order: Cyperaceae (17.3%), Poaceae (16.4%), Asteraceae (10%), Fabaceae (5.45%) and Amaranthaceae (4.55%). Of the 110 species recorded, 4 were the most damaging. These are, in decreasing order of harmfulness: *Digitaria horizontalis, Eleusine indica, Alternanthera sessilis* and *Ageratum conyzoides*.

However, this study will only be complete if these results are used to set up effective control methods against the major weeds of the sweet potato crops in this area. In this sense, further research should be conducted on the infestation mode of these weeds, the influence of cultural practices on the dynamics of these weeds and the evaluation of the soil seed stock. This additional research will make it possible to anticipate the infestation of plots, which would avoid excessive weediness that is difficult to control.

REFERENCES

Aké Assi L. (2001). Flore de la Côte d'Ivoire: catalogue systématique, biogéographie et écologie. Volume 1: Mémoire de Botanique systématique. Conservatoire et Jardin Botanique de Genève; Boisseria 57; 396 p.

Akobundu I. O. (1987). Weed science in the Tropics. Principles and practices. Chichester, J. Wiley & Sons Editions. 522 p.

Boraud N. K. M. (2000). Etude floristique et phytoécologique des adventices des complexes sucriers de Ferké 1 et 2, de Borotou-Koro et de Zuénoula, en Côte d'Ivoire. Thèse de Doctorat, Université d'Abidjan-Cocody (Côte d'Ivoire), 157 p.

Bosso A.V., Sika N. A., Kwadjo K. E., Pokou K. P. (2020). Caractérisation des systèmes de cultures maraîchères dans deux localités du district d'Abidjan (Anyama et Port-bouët) au Sud de la Côte d'Ivoire. *Reb-pasres*, 5: 41-50.

Chicouène D. (2000). Stratégies de lutte contre les mauvaises herbes: préventives ou curatives. Aperçu des bases de raisonnement, *Phytoma – La défense des végétaux*, 532: 12-16.

Cremers G., Hoff M. (1993). Inventaire taxonomique des plantes de la Guyane française. Les Cyperaceae et les Poaceae. Paris. 216 p.

Déat M. (1976). Les adventices des cultures cotonnières en Côte d'Ivoire. *Coton et fibres tropicales*, 31: 419-427.

Diallo Y. (2020). Inventaire et caractérisation des adventices des cultures maraîchères de la commune d'Anyama (Côte d'Ivoire). Mémoire de Master 2, Protection des végétaux et de l'environnement, malherbologie. Université Nangui Abrogoua, 66 p.

FAOSTAT (2020). Base de données FAO, https://www.fao.org/faostat/fr/#data/QV, consulté le 30/06/2021.

Guillerm J. L., Maillet J., Sanon M., Barbier J. M. (1989). Variabilité des communautés d'adventices des rizières en Camargue (France). Proc. 4e EWRS Mediterranean Symp., Valencia, Espagne: 312-320.

Gupta A. K. (2014). *Alternanthera sessilis*. The IUCN Red List of Threatened Species. Version 2014. http://www.iucnredlist.org. Consulté le 25/12/2021.

Holm L. R. G., Plucknett D. L., Pancho J. V., Herberger J. P. (1977). The world's worst weeds-distribution and biology. East-west Center, university Press of Hawaii, Honollulu, Hawaii, 609 p.

Ipou Ipou J. (2005). Biologie et écologie de *Euphorbia heterophylla* L. (Euphorbiaceae) en culture cotonnière, au nord de la Côte d'Ivoire. Thèse de doctorat, Université de Cocody-Abidjan, 200 p.

Koffi K. A. (2014). Techniques culturales dans les maraîchers des bas-fonds d'Adiopodoumé en basse Côte d'Ivoire: cas des cultures de chou et de laitue. Rapport de fin de cycle de Brevet Technicien Supérieur, filière Agriculture Tropicale option, Production Végétale à Est Loko. 55 p.

Kokou K., Adjossou K., Hamberger K. (2005). Les forêts sacrées de l'aire Ouatchi au sud-est du Togo et les contraintes actuelles des modes de gestion locale des ressources forestières. *VertigO - la revue électronique en sciences de l'environnement*, 6: 1-10.

Konan J. K. A. (2017). Compétition entre bâti et agriculture dans la conquête des bas-fonds de la ville de Bouaké: le savoir-faire ou les actions stratégiques des citadins-agriculteurs pour préserver les espaces agricoles. *VertigO - la revue électronique en sciences de l'environnement*. Hors-série 28.

Kouakou J. N., Kouamé F. K., Ipou Ipou J., Gue A. (2016). Relative importance of weeds in maize cultivation in the M'Bahiakro department. *International Journal of Innovation and Applied Studies*, 17: 768-778.

Le Bourgeois T., Merlier H. (1995). Adventrop. Les adventices d'Afrique soudano sahélienne. Montpellier, France, Cirad-CA éditeur, 640 p.

Le Bourgeois T. (1993). Les mauvaises herbes dans la rotation cotonnière au Nord-Cameroun (Afrique): Amplitude d'habitat - Degré d'infestation - Phénologie. Thèse de doctorat, université de Montpellier II, Sciences et techniques du Languédoc, 249 p.

Le Bourgeois T. (2018). Analyse des enherbements des cultures maraîchères et fruitières de Guyane, 23 septembre - 5 octobre 2018. Montpellier, France, Cirad, 56 p.

Le Bourgeois T., Grard P., Marnotte P., Rodenburg J. (2014). Amélioration de la gestion de l'enherbement des rizières en Afrique par le partage de l'information et l'aide à l'identification des adventices: le potentiel de la plateforme collaborative AFRO Weeds. htpp ://www.africarice.org, consulté le 12 décembre 2020.

Maillet J. (1981). Evolution de la flore adventice dans le Montpelliérais sous la pression des techniques culturales. Thèse de doctorat, USTL, Montepellier (France), 200 p.

Maillet J. (1992). Constitution et dynamique des communautés de mauvaises herbes des vignes de France et des rizières de Camargue. Thèse d'état, USTL, Montpellier, 179 p.

Mangara A., Aza R., Kouame N. M. (2017). Dynamics of reconstitution of weeds on a young fallow with a sweet potato crop antecedent after a herbicide treatment in Adiopodoumé (Côte d'Ivoire). *Agriculture and biology journal of North America*, 8: 214-226.

Mangara A., N'da adopo A. A., Traore K., Kehe M., Soro K., Toure M. (2010). Etude phytoécologique des adventices en cultures d'ananas (*Ananas comosus* (L.) Merr.) dans les localités de Bonoua et N'douci en Basse Côte d'Ivoire. *Journal of Applied Biosciences*, 36: 2367-2382.

Mangara A., N'Da Adopo A. A., Boraud N. K. M., Kobenan K., Lejoly J., Traoré D. (2008). Inventaire de la flore adventice en culture d'ananas (*Ananas comosus* L. MERR.) dans la localité de Bonoua en basse Côte d'Ivoire. *Agronomie africaine*, 20: 23-35.

Mbarga-Bindzi M. A., Kono L. D., Biyé E. H., Angoni H., Endanga H. G. (2014). Diversité et écologie des Cyperaceae rudérales de la ville de Yaoundé et ses environs. *Cameroon Journal of Biological and Biochemical Sciences*, 22: 01-09.

Nusbaumer L. (2003). Structure et composition floristique de la forêt classée de Scio (Côte d'Ivoire). Etude descriptive et comparative, 153 p.

Pancho J. V. (1986). Weeds of vegetable farms in La Trinidad, Benguet, Philippines. Weed control in tropical crops. *Weed Science Society of the Philippines*, 2: 1-8.

Raunkiaer C. (1905). Types biologiques pour la géographie botanique. *Kongelige Danske Videnskabernes Selskabs forhandlinger*, 5: 347-437.

Raunkiaer C. (1934). The life forms of plants and statistical plant geography. Clarendon Press. Oxford, 623 p.

Rejmánek M. (2000). Invasive plants : approaches and predictions. *Austral Ecology*, 25: 497- 506.

Shekoofa A., Brosnan J. T., Vargas J. J., Tuck D. P., Elmore M. T. (2020). Environmental effects on efficacy of herbicides for postemergence goosegrass (*Eleusine indica*) control. *Scientific Report*, 10 : 20579.

Soerjani M., Kostermans A. J. G. H., Tjitrosoepomo G. (1987). Weeds of Indonesia. Jakarta, Indonesia: Balai Pustaka, 716 p.

Sørensen T. (1948). A method of establishing groups of equal amplitude in plant sociology based on similarity of species content. *Det Kongelige Danske Videnskabernes Selskabs Kopenhague, Biologiske Skrifter*, 5: 1-34.

Traoré H., Maillet J. (1992). Flore adventice des cultures céréalières annuelles du Burkina Faso. *Weed research*, 32: 279-293.

Traoré H. (1991). Influence des facteurs agro-écologiques sur la constitution des communautés adventices des principales cultures céréalières (Sorgho, mil, maïs) du Burkina Faso. Thèse de Doctorat, Université de Montpellier II, 180 p.

Vecchio V., Vazzana C., Crosta G. (1980). Relations entre plantes adventices à différents niveaux d'infestation et le développement et rendement du blé. In : Actes du Vie Colloque International sur l'Ecologie, la Biologie et la Systématique des mauvaises herbes (Tome 2), Montpellier, 7 - 8 mai 1980. Montpellier, Columa/EWRS: 421-433.

Wegmuller F., Duchemin E. (2010). Multifonctionnalité de l'agriculture urbaine à Montréal: étude des discours sur la base du programme des jardins communautaires. *VertigO – la revue électronique en sciences de l'environnement*, 10 : 1-24.

Yang C. H., Feng L., Yue M. F., Tian X. S. (2009). Study on Seed Germination Characteristics of Goosegrass (*Eleusine indica*) (in Chinese). *Weed Science*, 9: 21-24.