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Floristic diversity of weeds in pineapple (Ananas comosus (L.) Merr.) crop in the locality of N'douci in Côte d'Ivoire

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ABSTRACT: This study was conducted to characterize weed flora in pineapple plantations in the locality of N'douci. Floristic inventory was carried out in plots of pineapple cultivation of SCB / SPADI Company of N'douci (Ivory Coast). An area estimated to 80 m², 8 m x 10 m, representing a minimum area was used to make floristic surveys in the plantations. The floristic survey has identified 100 species from 80 genera belonging to 36 families. The class of Dicotyledons is by far the most represented with 80.55% against 11.11% for monocots and 8.33% for Pteridophytes. Forty percent of all inventoried species belong to the 4 families of Poaceae, Asteraceae, Euphorbiaceae and Cyperaceae. The Asteraceae are the most diversified of the most abundant families in this locality. Among the biological types identified, the therophytes predominate with 32% of the whole. Thirty four percent of weeds participate for 82.95% in the vegetation in this locality. Among these, the most aggressive against the pineapple culture are Digitaria horizontalis and Cleome rutidosperma.
Keywords: Characterize; diversity; flora; harmfulness; inventory; plantation.

INTRODUCTION

World pineapple production was estimated by FAO at 22.7 million tons in 2011, that is double that of 1987. Asia accounts for about half of world production, the Philippines in the lead (15% of world production), followed by Thailand (13%), Indonesia (11%) and India (9%). In Latin America, the main producing countries are, Costa Rica (13%), Chile (10%), Brazil (10%), Mexico (5%) and Colombia (5%). In Africa, Nigeria, Kenya, Angola, Cameroon and Guinea are the main producing countries. In West Africa, Nigeria exports mainly to Niger. Ivory Coast (78,000 tons) and Ghana (56, 000 tons) were the main exporters to the European Union (Anonymous). The Ivorian production was down, following huge financial difficulties of farmers. It is now growing up. Indeed, with more than 137, 000 tons in 2005 (Mangara et al., 2008), the rate had dropped to 68,000 tons in 2010. But, with the recovery, production reached 78,000 tons in 2012.

Among the reasons behind the drop in production, we can cite the often expensive and inefficient management of natural enemies of the culture (weeds, diseases, pests, etc.). In addition, the renewal of orchards difficulties related to heavy investment costs, particularly in terms of agricultural inputs, forcing many small farmers to retraining for other industries and the abandonment of this sector to industrial.

Among the natural enemies of pineapple, weeds are a major problem for the stiff competition they engage in culture. They are home to many pathogens responsible for diseases of seedlings of this culture.

Weeds quickly invade cultures and make difficult cultural practices including regular monitoring of the growth of plants for the flower induction treatment (FIT), counting them when flowering and the regular supply of fertilizers to leaf axils, etc. (Py et al., 1984; Kobenan et al., 2005).

In pineapple crop, weeds have a very strong depressant action on the growth, the development, and thus the yield.

For effective weed management, which previously was almost a permanent and expensive action, identification of weeds is therefore essential. This is the subject of this study.

MATERIAL AND METHODS

Site selection

The work was carried out in industrial plantations of the company SCB (Société d'Etude et de Développement de la Culture Bananière) in the locality of N'douci, in 2006 (figure). The culture plots inventoried included all phenological level, from the planting of the pineapple until post-harvest stage.

Figure 1. Industrial plantation of pineapple in N'Douci (Mangara, 2006)

Realization of floristic

The inventory was conducted according to the stratified sampling method used by Godron (1971) Daget and Godron (1982). A surface representing the minimum area for readings is determined and defined on successive rows of pineapple. The determined minimum area was estimated at 80m² (8m x 10m). Twenty-one plantations were used for the realization of surveys in this study.

Within the minimum area representing the surface, roving statements were conducted and the following concepts were determined:

Presence of each weed species;
Biological types;
Body type.

Data analysis

Species diversity index (Ids)

This index reflects the state of diversity of the flora of the study environment. It is expressed as follows:

$$\mathrm{Ids} = \frac{E}{G}$$ with E = Number of species and G = number of genera

Biological spectrum

This parameter is determined by the percentage of the number of species for each biological type, relative to the total number of species. The model used in this work is that of Ake Assi (1984, 2001 and 2002), adapted from that of Raunkiaer (1905).

Specific contribution due to the frequency of each species Csf (e)

It is the expression of the contribution that a species can bring to a vegetation from its absolute frequency; it is calculated by the formula proposed by Daget and Poissonet (1969).

$$C_S F(e) = \frac{FS(e)}{\sum_{1}^{n} FS} \times 100$$

where FS (e) is the absolute frequency of the species (e) and,

$\sum_{1}^{n} FS$ the sum of absolute frequencies of all species recorded (n).

Referring to the two authors above and Aman Kadio (1978 a and b)

when : $C_S F(e) < 1$ %, weeds are more or less significant depressive effect;

for 1% < $C_S F(e)$ < 4 %, weeds are high depressive effect;

when $C_S F(e)$ > 4 %, weeds are very high depressive effect.

RESULTS AND DISCUSSION

RESULTS

Floristic diversity

The analysis of Table I provides the following interpretation.

The 76 surveys conducted have identified 100 species from 80 genera belonging to 36 families. The flora identified in this study indicates that the class of Dicotyledons is by far the most represented with 80.55% against 11.11% for monocotyledons and 8.33% for Pteridophytes.

From all the families identified, four are predominant: These are Poaceae, Asteraceae, Euphorbiaceae and Cyperaceae which represent nearly 40% of all species.

Table 1. Taxonomic distribution of weeds

Number of records	Dicotyledons		Monocotyledons		Pteridophytes		Number of Families	Number of Genera	Number of species	Ids
76	29	80,55 %	4	11,11 %	3	8,33 %	36	80	100	1,25

Plot floristic richness

The average number of species obtained by sample is 23.04 and the value ‘’ number of species by sample ’’ goes from 12 to 34 with the peak readings amounts to 21 species, reflecting a balanced distribution of species in all surveys (Table 2).

Table 2. Plot floristic richness in the locality of N'douci

Number of species	Number of records	Number of species	Number of records	Number of species	Number of records
34	1	25	7	16	4
33	2	24	2	15	3
32	1	23	6	14	1
31	3	22	2	13	3
30	3	21	8	12	1
29	1	20	5		
28	6	19	3		
27	5	18	2		
26	5	17	2		

Species diversity index (Ids)

A low species diversity index was observed in the most abundant families (Table 3). Asteraceae, after Poaceae well represented, have the lowest index of species diversity (Ids = 1.00), with 9 genera for 9 species. Asteraceae constitute the most diverse of the six most abundant families of this locality. In decreasing order of diversity, are the families of Amaranthaceae (1.25), Poaceae (1.25), Rubiaceae (1.25), Cyperaceae (1.75) and Euphorbiaceae (2.67). The diversity index of the study area is 1.25.

DISCUSSION

Floristic diversity

The average of the floristic plot richness is estimated at 23.04 species / sample. This value is high, compared to those obtained by Hoffmann (1986) in corn at the edge forest-savanna in Côte d'Ivoire (20 species / sample) and Le Bourgeois (1993) in cropping systems based on cotton in Sudano-Sahelian zone in Cameroon (22 species / sample). For Hoffmann (1986) and Traoré (1991), the plot floristic richness is greater in savannah woodland area than open forest area. This would be due to a more open savannah environments which promotes the spread and mix of flora. Taking into account this analysis, the values obtained should be below those of the authors, because our work was done in the Guinean area in the forest area, more accurately, in the transition area between the rain area in the south and mesophilic sector in the north. The high average floristic richness from the expected threshold is explained by the fact that the pineapple crops are grown on vast open areas, which are favorable conditions for the spread of flora.

The high representation of Dicotyledons (80.55%) followed by Monocotyledons (11.11%), at all stages of this work, was also observed by Boraud (2000), Le Bourgeois (1993), Traore et al., (2005) and Mangara et al., (2008), who observed the trend of about 2/3 of Dicotyledons and 1/3 of Monocotyledons. This strong presence of Dicotyledons is also recognized in Morocco by Bouhache et al., (1994), Taleb and Maillet (1994), Tanji and Boulet (1986), with 82.3%, 87% and 84% of their flora. These results reflect and confirm consistency at the level of representativeness of weeds taxonomically considered in Africa. According Deat (1976), there is no specific weed flora in a given culture, but rather to ecological parameters and agronomic factors.

Table 3. List of families with number of genus, number of species and species diversity index (Ids)

Taxonomic group	Families	Number of Genera	Number of species	Ids
	Acanthaceae	3	3	1
	Aizoaceae	2	2	1
	Amaranthaceae	4	5	1,25
	Asclepiadaceae	2	2	1
	Asteraceae	9	9	1
	Bombacaceae	1	1	1
	Caesalpiniaceae	1	1	1
	Capparaceae	1	1	1
	Convolvulaceae	1	2	2
	Euphorbiaceae	3	8	2,67
	Fabaceae	2	2	1
	Lamiaceae	1	1	1
	Loganiaceae	2	2	1
	Lythraceae	1	2	2
Dicotyledons	Malvaceae	1	1	1
	Melastomataceae	1	1	1
	Mimosaceae	2	2	1
	Moraceae	3	3	1
	Onagraceae	1	3	3
	Passifloraceae	2	2	1
	Periplocaceae	1	1	1
	Piperaceae	1	1	1
	Portulacaceae	2	3	1,5
	Rubiaceae	4	5	1,25
	Scrophulariaceae	3	3	1
	Solanaceae	2	3	1,5
	Sterculiaceae	1	1	1
	Urticaceae	1	1	1
	Verbenaceae	1	1	1
Total	29	59	72	1,22
	Commelinaceae	1	1	1
Monocotyledons	Cyperaceae	4	7	1,75
	Dioscoreaceae	1	1	1
	Poaceae	12	15	1,25
Total	4	18	24	1,33
	Davalliaceae	1	1	1
Pteridophytes	Pteridaceae	1	1	1
	Thelypteridaceae	1	2	2
Total	3	3	4	1,33
General total	36	80	100	1,25

Biological Types

All the species inventoried belong to eight biological types (Table 4). These are the therophytes predominating with 32 species (32% of biological types), divided among 28 genera and 16 families. Coming in their wake, in decreasing order, the nanophanérophytes (18%), the chamaephytes (17%), hemicryptophytes (16%), the microphanerophytes (12%).

Table 4. Distribution of number of species according to their biological types

	Biological types									
	MP	mP	mp	np	Ch	G	H	Th	Hyd	Total
Number of species	2	0	12	18	17	2	16	32	1	100
%	2	0	12	18	17	2	16	32	1	100

MP : megaphanerophyte mP : mesophanerophyte mp : microphanerophyte np : nanophanerophyte Ch : chamephyte G : geophyte H : hemicryptophyte Th : therophyte Hyd : hydrophyte

Morphological types

The weed flora of this study is composed of four morphological types that are shown in Table 5. The herbaceous plants are the most abundant, followed by shrubs, lianas and trees.

Specific contribution due to the frequency of each species (Csf)

This notion that expresses the magnitude of the dynamics and aggressiveness of a species in a plant community, in direct relation to its absolute frequency was calculated for each species (table VI). It allowed us to identify aggressive species against which action should be taken in the fight against weeds in pineapple cultivation. These aggressive species have a Csf greater than 1.

Thirty-four species inventoried, have Csf greater than 1. That is that those weeds participate for 82.95% in the vegetation of weeds in this locality (Table 6). The most aggressive species are Digitaria horizontalis and Cleome rutidosperma. They are even described as very aggressive because their Csf> 4.

Table 5. Distribution of number of species according to morphological types

Morphological types	Trees	Shrubs	Grasses	Lianas	Total
Number of species	2	20	68	10	100
%	2,00	20,00	68,00	10,00	100,00

Table 6. Classification of weed from pineapple crops, depending on their specific contribution (Csf)

N°	SPECIES	fq/ab	Csf
1	Cleome rutidosperma	76	4,34
2	Digitaria horizontalis	72	4,11
3	Phyllanthus amarus	62	3,54
4	Brachiaria lata	61	3,48
5	Trianthema portulacastrum	59	3,37
6	Amaranthus viridis	58	3,31
7	Portulaca oleracea	57	3,26
8	Mariscus cylindristachyus	56	3,2
9	Pentodon pentandrus	51	2,91
10	Oldenlandia corymbosa	50	2,86
11	Portulaca quadrifida	50	2,86
12	Cyperus rotundus	49	2,8
13	Eleusine indica	48	2,74
14	Chromoleana odorata	44	2,51
15	Cyperus sphacelatus	44	2,51
16	Eragrostis ciliaris	44	2,51
17	Phyllanthus niruroides	41	2,34
18	Talinum triangulare	41	2,34
19	Celosia trigyna	40	2,28
20	Kyllinga pumila	40	2,28
21	Echinochloa colona	39	2,23
22	Cyperus distans	38	2,17
23	Dactyloctenium aegyptium	36	2,06
24	Euphorbia forskalii	36	2,06
25	Fimbristylis littoralis	35	2
26	Mariscus flabelliformis	33	1,88
27	Brachiaria distachyoides	32	1,83
28	Panicum laxum	32	1,83
29	Laportea aestuans	25	1,43
30	Eragrostis tenella	22	1,26
31	Vernonia cinerea	22	1,26
32	Euphorbia hirta	21	1,2
33	Physalis angulata	21	1,2
34	Spigelia anthelmia	20	1,14
	TOTAL		83,10

fq/ab : absolute frequency

Species diversity

The most diverse family in this study is that of the Asteraceae. Most species of this family are characterized by their dissemination by wind (anemochory), which allows it to quickly colonize cultivated circles (Mangara et al., 2008). The Pineapple crop circles are open areas so that anemochory is very developed. This explains the strong presence of that family into the study area.

Biological Types

In this study, therophytes are the most represented, followed by nanophanerophytes. The great abundance of therophytes, was also observed in the work of Hoffmann (1986) and Traoré (1987) in the forest-savanna edge in Côte d'Ivoire with more than 75%; Traoré (1991) in Burkina Faso with 84%; Le Bourgeois (1993) in Sudano Sahelian climate in Cameroon with 93%; Boraud (2000) with over 70% in the Sudan sector in Côte d'Ivoire and Aman Kadio et al., (2004) in northern Côte d'Ivoire with more than 30%. The work of these authors mentioned above took place in areas of Sudanese tropical climate, Sudano-Sahelian climate and forest-savanna edge, which are favorable conditions for the proliferation of therophytes. According to Le Bourgeois (1993), the predominance of therophytes is related to the great duration and high intensity of the dry season which characterizes the climate of Sudanese zones. In our case, the dominance of therophytes is related to the openness of the culture areas. These are recognized as herbaceous plants that take advantage of any opening in the forest or lower clearings to install, which is consistent with the mode of creation of pineapple plantations. That is why Sillans (1958) considers therophytes as ephemeral elements to fill the gaps.

Harmfulness of weeds

Cleome rutidosperma and Digitaria horizontalis appear the most aggressive species on pineapple cultivation. Aman Kadio et al., (2004) found Digitaria horizontalis significantly present in the cotton plantations

of the Worodougou region in the north of Côte d'Ivoire. This species is in this area, with Euphorbia heterophylla, the two most harmful species. The ubiquity of Digitaria horizontalis is linked to its ability to grow on almost all soil types, and is also favored by crop intensification (Le Bourgeois and Merlier, 1995). we can also mention his great potential seed. Indeed, Digitaria horizontalis is an annual species that reproduces by seed, but also has the ability to multiply by cuttings during rainy season. It has a seed potential estimated at 12 000 seeds per plant (Akobundu, 1987), sleeping during the dispersion and germinating preferably in surface (Le Bourgeois and Merlier, 1995).

CONCLUSION

The inventory of weeds in pineapple plantations in N'douci revealed the presence of 100 species distributed among 80 genera and 36 families. Taxonomically, Dicotyledons predominate, followed by monocotyledons and pteridophytes. The most represented families in number of species are Poaceae, Astereaceae, Euphorbiaceae and Cyperaceae. Therophytes biological types are predominant. The study of the specific contribution revealed the aggressiveness of two species against the pineapple culture. They are Cleome rutidosperma and Digitaria horizontalis.

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