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Comparative Study of the Weed Flora in Sugar Cane (Sacharum Officinarum L.) Culvitation in the Area of the Sugar Refinery Complex of Ferkesedougou

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Summary: This study was carried out in the sugar-producing plants of Ferkessédougou, a city located north of the Ivory Coast, 580 km away from Abidjan, in the sub-Sudanese area. In the course of this work, a floristic inventory has been performed according to a stratified sampling method.
The surveys which, in each plot, consisted in noting the presence of the species therein, irrespective of the number of individuals during a cycle of the 2011 crop year, helped us to identify 129 weed species. Such species belonging to 83 genera can be broken down into 30 families. The varied floristic diversity indexes so identified show that there is a great diversity within this flora.
The similarity factor between the weed flora under this study and that of Boraud (2000), higher than 50 percent confirmed the homogeneity of both floras. Common species that are 72 in number constitute the core group of plant species of weeds as regards sugar cane cultivation.

Keywords: Weed – sugar cane- floristic diversity index - similarity factor- Ferkessédougou

INTRODUCTION

Sugar cane would be originating in the archipelago of New Guinea, from where it is said to have been spread by farmers across all the Pacific Islands, the Indian Ocean up to Malaysia and in the Indo-Chinese Peninsula. This crop has had for long a major economic impact. Before the discovery of beet sugar, sugar cane provided almost all of sugar volumes in Europe and worldwide. Back then it would play a major role as an economic weapon because both crop production areas and its means of transport were subject to wars of conquest. More than a hundred countries grow sugar cane over 130 000 km^2. The largest producers are Brazil, India and China (Fauconnier, 1991).

Sugar cane was first grown in Africa in the sixteenth century and was for long farmed empirically. In Ivory Coast, cultivation of sugar cane was started experimentally in Nieky, Oumé, Zuénoula, Bouaflé, Niakaramandougou and Ferkessédougou as of the year 1964.

Wherever it is practiced, sugar cane farming provides many numerous advantages in terms of multifunctionality in the context of rural development: generation of income and provision of services to other agro-outputs. However, sugar cane farming in Ivory Coast is experiencing a loss of significance and remains today the business of a few national and foreign private individuals. Despite this loss of importance, the sugar cane sector still plays a pivotal role in the farming industry and agroindustry.

However, it is important to note that, like other crops, the industrial sugar cane monoculture remains heavily dependent on the quaternary complex: varieties - pedology climate - cultivation practices, whose equilibrium depends on the local ecosystem which remains itself strongly dynamic under human pressure through deforestation and depletion of water resources. Under such conditions, support and stabilization of sugar production will be based on the search for an efficient and sustainable management of the micro ecosystem resources.

In terms of sugar cane cultivation, the management of grass seeding remains a major problem in the sense that the presence of weeds during the entire cycle of sugar cane could reduce aboveground biomass from 92 to 96.6 %, the leaf-area index from 84 to 87 %, the diameter of rods from 39 to 42 %, the number of rods than can be machined from 62 to 82% and, therefore, the yield ranging from 85 to 89% (Hammi, 1994; Raji, 1995). Sugar cane is less competitive than weed species. Thus, a 4-month maintenance time is

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required in order for canes to escape from a measurable loss in yield following the competition induced by weeds (Hammi, 1994; Raji, 1995). However, the success of any control of such weeds is dependent on the knowledge of the weed flora in support of the crop or at least of its most harmful components. Thus, this study aims to characterize the weed flora associated with sugar cane cultivation in Ferkessédougou and to identify the main troublesome species.

1. Material

1.1. Study Environment

Ferkessédougou is located in the northern part of Ivory Coast, 580 km away from Abidjan, in the sub-Sudanese area, between 9°24' and 9°27' north latitude and between 5°12' and 5°15' west longitude, at an altitude of 323 m. The area of Ferkessédougou enjoys a transition tropical sub-humid or sub-Sudanese climate (Guillaumet and Adjanohoun, 1971). According to Roose et al. (1981), this is a transition tropical climate lying between the equatorial transition type and the desert dry climate. Figure 1 shows a chart of Ferkessédougou based on the rainfall and temperature data collected over 10 years (2001 to 2011) from the weather stations of sugar-producing plants Ferké 1 and 2.

The climate is characterized by two seasons, a rainy one while the other is dry. The dry season starting from December to February is characterized by harmattan, a hot dry wind from the Northeast and of Saharan origin.

The soils in the area of Ferkessédougou are mainly ferralitic and medium-desaturated soils originating in granites or in schists and of ferruginous type (Poilecot et al., 1991). The latter, derived from granites, are low in bases and indicative of characteristics of low and subgrade fertility. Tropical and eutrophic brown soils are more fertile and develop on materials derived from basic rocks and on a broken surface pattern. As to hydromorphic soils, they occupy the flats, small valleys and alluvial plains along the Bandama river and its main tributary: the Lokpho (Péné, 1999).

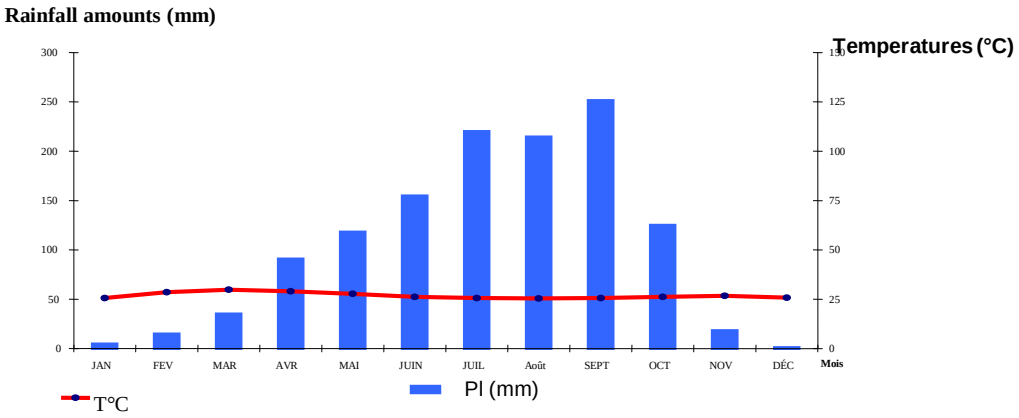

Figure 1: Temperature/Rainfall Chart from the town of Ferkessédougou

2.3. Vegetative material

1.2.1. Sugar cane

The term **sugar cane** refers to a set of species of plants of the Poaceae family and of the *Saccharum* genus*: Saccharum arundinaceum, Saccharum bengalense, Saccharum endeavored, Saccharum officinarum, Saccharum procerum, Saccharum ravennae, Saccharum robustum, Saccharum sinense, Saccharum spontaneum, Saccharum barberi*. The plant no longer exists in its natural form and in that of the various existing species; however, *Saccharum officinarum* has been domesticated. It was then crossbred with wildlife species *(Saccharum robustum, Saccharum barberi, Saccharum spontaneum and Saccharum sinense)* to improve its yield in sugar and its resistance to climates (Fauconnier, 1991).

1.2.2. Weeds

Any plant species other than sugar cane growing spontaneously in plots is called a weed.

2. Methods

2.1. Sampling Method

In this study, the floristic inventory has been performed according to stratified sampling. It is to classify the tilled plots in sub-sets more or less homogeneous, called strata (Mallet, 1981; Hoffmann, 1986; Fontanel, 1987). This stratification is done from properly chosen variables (Godron, 1971). The floristic inventory was conducted by considering the following factors: the age of plots, the mode of water supply for the plot, and the type of soil.

The surveys consisted, in each plot, to note the presence of the species therein, irrespective of the number of individuals during a cycle of the crop year 2011.

2.2. Floristic diversity Indexes

Different indexes help characterize a flora. In this work, the diversity of the flora has been defined by the two following indexes:

- The generic diversity index (Gdi) which is the ratio between the number of genera and that of families identified;
- The specific diversity index (Sdi), a ratio between the number of species and that of the genera identified.

2.4. Similarity factor (Sf)

It helps check the homogeneity of the sites of surveys taken two by two in the light of their floristic make-up. There are several formulas for calculating, but one of the most used formulae is the Sϕrensen (1948) factor:

$$Cs = 100.\ 2\ c\ /\ (a+b)$$

where a and b represent the numbers of species identified respectively in sampled sites A and B, c being the number of species common to both sites.

This factor varies from 0 to 100% whichever two sites are completely different floristic make-ups (c = 0) or identical ($a = b = c$). As regards a similarity factor greater than or equal to 50 %, the two sites concerned are considered as floristically homogeneous.

The floristic make-up of this study has been compared to that of Boraud (2000).

RESULTS

1. Floristic diversity

1.1. Floristic richness

During the floristic surveys performed in 41 plots, 129 weed species have been tallied. These species belong to 32 families, divided into 83 genera. The Class of Dicotyledons, with 59 genera and 27 families, account for 65% of the species while the Monocotyledons account for 35 % of the taxa, divided into 24 genera and into 5 families (figure 2).

Among the 31 families, 5 alone contain more than half of the species listed that is 52.7 percent of the species with 43 genera. Poaceae and Cyperaceae include species characteristics of savannas which dominate this weed flora with 35 different species that is 27.12 %.

1.2. **Diversity Indexes**

The various indexes of floristic diversity so identified are relatively low; in the region of 2.59 and 1.55 respectively in terms of generic diversity and specific diversity. This shows that there is a great diversity within this flora.

In considering the five best represented families, the Asteraceae family which ranks 2nd in terms of number of species is the most diversified, with a specific index of diversity of approximately 1. It is followed by the Poaceae family which in addition to being the richest one in species, has a large number of genera (table 1)

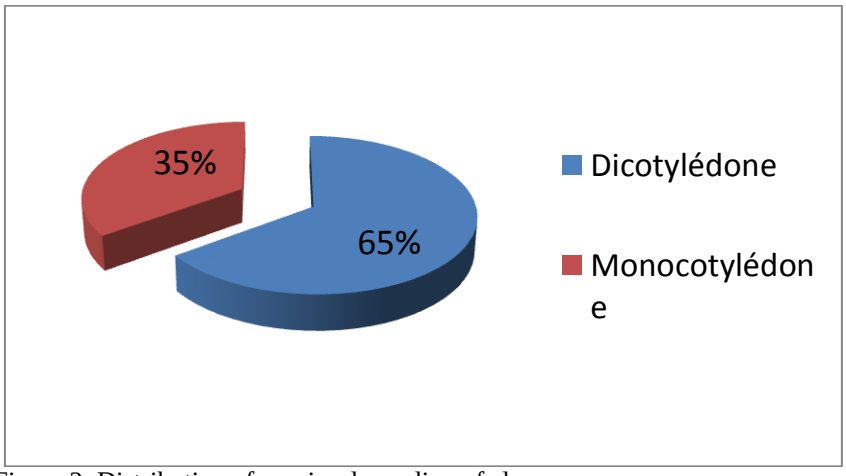

Figure 2: Distribution of species depending of classes

Table 1: Best represented families with their specific diversity indexes

Family	Number of genera	Number of species	Di_s
Poaceae	18	25	1.39
Asteraceae	11	12	1.1
Fabaceae	8	12	1. 5
Cyperaceae	3	10	3.33
Euphorbiaceae	3	9	3

2. Biological Types

The main biological types found out in this study are comprised of chamaephytes (Ch), Geophytes (G), Hemicryptophytes (He), Microphanerophytes (mp), Nanophanerophytes (np) and Therophytes (th). Figure 3 shows the relative importance of each of the biological types within the weed flora for the plots of the sugar-producing plant of Ferkessédougou. The Therophytes are the most represented therein by 59 %, followed by Nanophanerophytes and Chamaephytes (10.85 %).

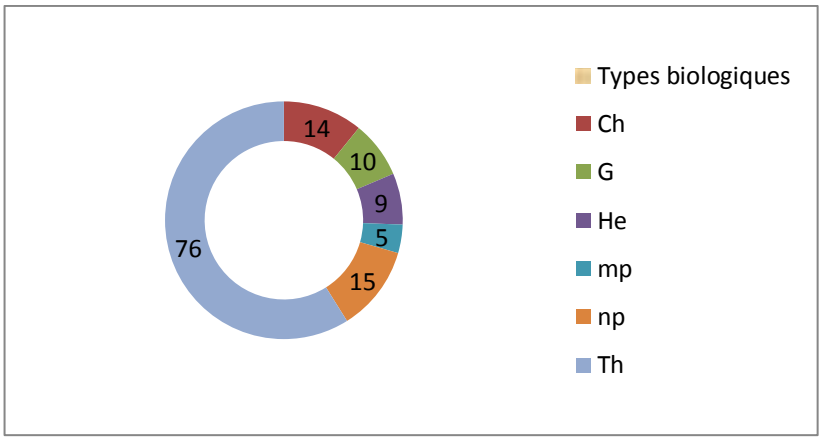

Figure 3: Distribution of the number of species according to the main biological types

3. Similarity of the weed flora

Table 2 shows the comparison between the floristic diversity of this study and that of Boraud 2000. These two floras are characterized by a relative quantitative homogeneity. This uniformity is also apparent when one considers the identity of the taxa identified. In fact the similarity factor which is higher than 50 percent indicated that there is a common floristic series between both works. The common species recorded in table 3 are the floristic core of weeds in terms of sugar cane cultivation.

Table 2: Comparison between the floristic diversity of this study and that of Boraud 2000

	Floristic richness in this work	Floristic richness in the work of Boraud (2000)
Number of species	129	125
Number of genera	83	75
Number of families	32	30

Table 3: List of common species
(on Next Page)

Number	Names of species	Family	Class
1	Acanthospermum hispidum DC.	*Asteraceae*	Dicotyledon
2	*Ageratum conyzoides* Linn.	*Asteraceae*	Dicotyledon
3	*Amaranthus viridis* L.	*Amaranthaceae*	Dicotyledon
4	*Andropogon gayanus* Kunth	*Poaceae*	Monocotyledon
5	*Bidens pilosa* Linn.	*Asteraceae*	Dicotyledon
6	*Boerhavia diffusa* L.	*Nyctaginaceae*	Dicotyledon
7	*Boerhavia erecta* Linn.	*Nyctaginaceae*	Dicotyledon
8	*Brachiaria deflexa* (Schumach.) C.E. Hubbard ex Robyns	*Poaceae*	Monocotyledon
9	Brachiaria distichophylla	*Poaceae*	Monocotyledon
10	*Brachiaria lata* (Schumach.) C.E. Hubbard	*Poaceae*	Monocotyledon
11	*Cassia mimosoides* L.	*Caesalpiniaceae*	Dicotyledon
12	*Cassia obtusifolia* L.	*Caesalpiniaceae*	Dicotyledon
13	*Celosia trygina* L.	*Amaranthaceae*	Dicotyledon
14	*Cleome viscosa* L.	*Capparidaceae*	Dicotyledon
15	*Commelina benghalensis* L.	*Commelinaceae*	Monocotyledon
16	Commelina diffusa	*Commelinaceae*	Monocotyledon
17	*Corchorus olitorius* L.	*Malvaceae*	Dicotyledon
18	*Crotalaria retusa* Linn.	*Fabaceae*	Dicotyledon
19	*Cynodon dactylon* (Linn.) Pers.	*Poaceae*	Monocotyledon
20	Cyperus difformis	Cyperaceae	Monocotyledon
21	*Dactyloctenium aegyptium* (Linn.) P. Beauv.	*Poaceae*	Monocotyledon
22	*Desmodium scorpiurus* (Sw.) Desv.	*Fabaceae*	Dicotyledon
23	*Desmodium tortuosum* (Sw.) DC.	*Fabaceae*	Dicotyledon
24	Desmodium triflorum	*Fabaceae*	Dicotyledon
25	*Desmodium velutinum* (Willd.) DC.	*Fabaceae*	Dicotyledon
26	*Digitaria horizontalis* Willd.	*Poaceae*	Monocotyledon
27	*Dioscorea lecardi* De Wild	*Dioscoreaceae*	Monocotyledon
28	*Dioscorea praehensilis* (Benth) A. Chev.	*Dioscoreaceae*	Monocotyledon
29	*Eclipta prostrata* (Linn.) L.	*Asteraceae*	Dicotyledon
30	*Eleusine indica* Gaertn.	*Poaceae*	Monocotyledon
31	*Eragrostis tenella* (Linn.) P. Beauv.ex Roem & Schult.	*Poaceae*	Monocotyledon
32	*Erigeron floribundus* (H.B. & K.) Sch. Bip.	Asteraceae	Dicotyledon
33	*Euphorbia heterophylla* Linn.	*Euphorbiaceae*	Dicotyledon
34	*Euphorbia hirta* Linn.	*Euphorbiaceae*	Dicotyledon
35	*Euphorbia hyssopifolia* Linn.	*Euphorbiaceae*	Dicotyledon

36	*Evolvulus alsinoides* (Linn.) Linn.	*Euphorbiaceae*	Dicotyledon
37	*Fimbristylis littoralis* Gaudet	*Cyperaceae*	Monocotyledon
38	*Gomphrena celosioides* Mart.	*Amaranthaceae*	Dicotyledon
39	*Hyptis suaveolens* Poit.	*Lamiaceae*	Dicotyledon
40	*Imperata cylindrica* (Anderss.) C.E. Hubbard	*Poaceae*	Monocotyledon
41	*Indigofera hirsuta* Linn.	*Fabaceae*	Dicotyledon
42	*Ipomoea heterotricha* Dird.	*Convolvulaceae*	Dicotyledon
43	*Ipomoea involucrata* P. Beauv.	*Convolvulaceae*	Dicotyledon
44	*Laportea aestuans* (L.) Chew	*Urticaceae*	Dicotyledon
45	*Mariscus alternifolius* Vahl	*Cyperaceae*	Monocotyledon
46	*Mollugo nudicaulis* Lam	*Aizoaceae*	Dicotyledon
47	*Oldenlandia corymbosa* Linn.	*Rubiaceae*	Dicotyledon
48	*Oldenlandia herbacea* (Linn.) Roxb.	*Rubiaceae*	Dicotyledon
49	*Panicum maximum* Jacq.	*Poaceae*	Monocotyledon
50	*Paspalum conjugatum* Berg.	*Poaceae*	Monocotyledon
51	*Passiflora foetide* L.	*Passifloraceae*	Dicotyledon
52	*Pennisetum alopecuroides*	*Poaceae*	Monocotyledon
53	*Pennisetum pedicellatum* Trin.	*Poaceae*	Monocotyledon
54	*Phyllanthus amarus* Schum. et Thonn.	*Euphorbiaceae*	Dicotyledon
55	*Physalis angulata* Linn.	*Solanaceae*	Dicotyledon
56	*Physalis micrantha* Link.	*Solanaceae*	Dicotyledon
57	*Platostoma africanum* P. Beauv.	*Lamiaceae*	Dicotyledon
58	*Portulaca oleracea* Linn.	*Portulacaceae*	Dicotyledon
59	*Rottboellia cochinchinensis* (Lour.) Clayton	*Poaceae*	Monocotyledon
60	*Setaria barbata* (Lam.) Kunth	*Poaceae*	Monocotyledon
61	*Sida acuta* Burm. f.	*Malvaceae*	Dicotyledon
62	*Sida linifolia* Juss ex Cav.	*Malvaceae*	Dicotyledon
63	*Sida rhombifolia* L.	*Malvaceae*	Dicotyledon
64	*Solenostemon monostachyus* (P. Beauv.) Brig.	*Lamiaceae*	Dicotyledon
65	*Spermacoce verticillata* Linn.	*Rubiaceae*	Dicotyledon
66	*Spigelia anthelmia* Linn.	*Loganiaceae*	Dicotyledon
67	*Spilanthes filicaulis* (Schum. & Thonn.) C.D. Adams	Asteraceae	Dicotyledon
68	*Sporobolus pyramidalis* P. Beauv	Poaceae	Monocotyledon
69	*Tridax procumbens* Linn.	Asteraceae	Dicotyledon
70	*Uraria picta*	Fabaceae	Dicotyledon
71	*Vernonia cinerea* (Linn.) Less.	*Asteraceae*	Dicotyledon
72	*Vernonia perrottetii* Sch. Bip.	*Asteraceae*	Dicotyledon

DISCUSSION

The homogeneity between the weed flora considered under this work and that of Boraud 2000 as well as the prioritization of families show some monotony in the floristic diversity within the weeds in tropical Africa (Marnotte 2000). Weed flora is specific to environmental (soil and climatic) parameters and agronomic factors as has been observed by Deat (1976). In a general way, from 2000 to 2011, the soil and climate factors and culture methods did not vary in the sugar-producing plants of Ferkessédougou, some selected weeds therefore adapted to these conditions.

The best represented five families (Euphorbiaceae, Asteraceae, Poaceae, Cyperaceae and Fabaceae) under this study are part of the 10 families who according to the work of Akobundu (1987) contain the most species regarded as "global major weeds". These are Euphorbiaceae, Malvaceae, Asteraceae, Poaceae, Cyperaceae, Convolvulaceae, Fabaceae, Polygonaceae, Amaranthaceae and Solanaceae. These results are also consistent with those of Traoré (2007), Le Bourgeois (1993), Le Bourgeois and Guillerm (1995), Boraud (2000), M'boma (2001), Aman Kadio *et al.* (2004), who observed the relative dominance of these 5 families within the weed flora of cultivated plants..

The dominance of therophytes in this work is consistent with the studies carried out by several writers in tropical environments (Hoffmann, 1986; Traore, 1991; Le Bourgeois, 1993; Boraud, 2000) and this could be explained by the climate of the areas under consideration by these studies. Indeed, this biological type is characteristic of marked dry season areas, 5 to 8 months (tropical climate). In addition, these studies were all conducted under annual crops or the soil is tilled at least once a year, does not promote the development of micro and nanophanerophytes.

Conclusion

As a whole, 129 weed species have been tallied with 83 genera and 30 families. The different indexes of floristic diversity which are relatively low show a large diversity within this flora. The weed flora referred to in this study is homogeneous as compared to that of Boraud (2000) with a similarity factor higher than 50 %. The 72 common species are the floristic core of weeds as part of sugar cane cultivation.

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