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Characterisation of the flora of major weeds in a cashew tree (*Anacardium occidental* L.) farm in Northern Côte d'Ivoire

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Abstract

This study was undertaken to characterize the major weed flora of cashew orchards. To do this, the cashew plantation of ANGELS'FARM, in the department of Ferkessédougou was chosen. Ten elementary plots measuring 10 m x 30 m, i.e. 300 m², were selected on the farm. The surface survey method and the itinerant survey method were used. In these plots, each species identified was evaluated according to its frequency, its abundance, dominance and its specific contribution. In total, 38 weed species distributed among 14 families and 31 genera have been inventoried. The most representative families are the Fabaceae, Poaceae and Euphorbiaceae. Four species have a centesimal frequency greater than or equal to 50%. These are, in descending order, *Hyptis suaveolens* (100%), *Spermacoce ruelliae* (90%), *Daniellia oliveri* (60%) and *Piliostigma thonningii* (50%). The most representative biological types are therophytes (34.21%) and nanophanerophytes (23.68%). The infestation diagram showed that the most aggressive species is *Hyptis suaveolens*. This species has dominance abundance greater than 1.5. Among the 38 inventoried species, five have a specific contribution greater than 4. These species provide a total specific contribution equal to 44.72% of the total rate of specific contribution of all the species inventoried, and are qualified as major or very representative weeds. However, for an improvement in productivity, control measures must be taken against these weeds.

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Introduction

In Côte d'Ivoire, cashew cultivation contributes to nearly 20% of GDP (Cirad, 2021). Become the leading african producer and exporter of raw cashew nuts (Piperno, 2016), Côte d'Ivoire began growing cashew trees around the 1960s (Salva, 2013). Annual production has estimated at 500,000 tonnes in 2013 and 700,00 tonnes in 2015 (Piperno, 2016). Thus, this export crop has become over the years an important source of secure income for producers and represents a factor in the fight against poverty, especially for the savannah zones of the north. In addition, the cutivation of the cashew tree and the processing of its nuts stems the rural exodus. In addition of these attributes, the cultivation of the cashew tree was introduced in areas with low rainfall (in the north) with the aim of solving environmental problems firstly and the secondly for socio-economic solutions (Yabi *et al.*, 2013). Indeed, it makes it possible to fight against soil erosion and also to very quickly reconstitute agricultural areas degraded by the extensive cultivation of other agricultural crops (Aîvodji and Anassidé, 2009). Unfortunately, cashew tree cultivation is subject to numerous biotic (parasites, weeds) and abiotic (climatic variations) constraints which contribute to lower yields. Among these, weeds constitute a limiting factor in good farm management. Indeed, it competes with cultivated species for water, mineral salts and space occupation (Akobundu, 1987). In addition, weeds can serve as reservoirs for other pests. In Côte d'Ivoire, little work has been carried out on weeds in cashew cultivation. However, any improvement in techniques for combating pests un general and in particular on the efficient management of weeds necessarily requires knowledge of the floristic procession present on cashew plots. In order to develop a grass cover management strategy, without intensive use of synthetic herbicides, this work was initiated. The general objective is to characterize the major weed flora in cashew farms in the north of Côte d'Ivoire. Specifically, this involves to identify the weeds present on the cashew farm of an agricultural company, establish the degree of harmfulness of each weed and to determine the biological and morphological types of weeds species ones through an analysis of qualitative and quantitative parameters.

Materials and methods

Angel's farm plantation served as the study site. It is located 30 Km from Ferkessedougou, in the north of Côte d'Ivoire. The land use of the Ferkessedougou natural areas is divided between light forest and wooded savannah; tree savannahs and shrub savannahs, grassy savannahs and armored or rocky outcrops (Kouakou, 2015). This site was acquired with aim of creating jobs for the local population. It has an area of 50 hectares distributed as follows; 35 hectares for the cultivation of cashew trees and 15 hectares for that of mango trees.

The study material consists of biological and technical material. The biological material contains the weeds encountered and the cashew plants present on the plantation. The technical material usually used by the botanist (GPS, 50 m decameter tape, data collection sheets, pruning shears, newsprint, etc.).

The floristic survey method adopte is that of the field tour (roving survey combined with the surface method). To do this, an elementary area of 300 m², i.e. 30 m long and 10 m wide was sampled. One each elementary plot, sampling was carried out along two diagonal lines of a rectangle (Fig. 1). In total, 10 elementary plots were sampled. For each weed, an abundance-dominance score assigned using the Braun-Blanquet index (Table 1) during the surveys. The identifacation of unknown species in the field was made based on the work of Johnson (1997). In this study, the floristic analysis of the species was based on two aspects : quantitative and qualitative.

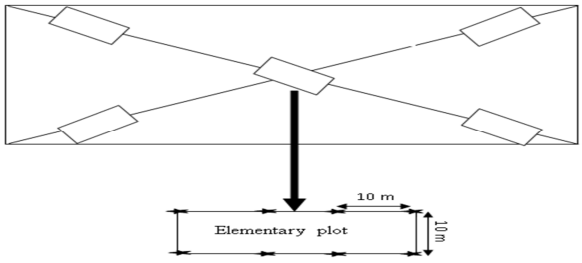

Fig. 1. Layout of sampling plots

Quantitative aspect

The quantitative analysis relates to the harmfulness of weeds. This was based on the frequency of weeds, then the specific contribution of weeds using several

formulas defined below, and finally the degree of infestation by constructing an infestation diagram.

Table 1. Abundance-dominance index (Braun-Blanquet, 1932)

Indices	Significance
1	Very rare, rare or fairly abundant, but low cover
2	Individuals very abundant or covering more than 1/20 of the surface
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

The relative frequency (Fr) of the species is the ratio of the absolute frequency (Fa) to the total number (N) of record determined by the formula below :

$Fr=Fa/N$

The centesimal frequency is the relative frequency (Fr) expressed as a percentage. It is defined as follows:

$Fc=(Fr/N)\times100$

The specific contribution due to the presence or frequency of a species (CsF(e)) is the expression of the contribution it can make to a given vegetation based on its specific frequency (Fs). It is determined by the formula proposed by Daget and Poisonet (1969).

$Csf(e)=\{FS(e)/\sum FS\}\times100$

Referring to Boraud (2000) and Ipou Ipou (2005), three groups of species can be distinguished : -minor weeds or weeds of more or less negligible representativeness, if their individual CsF is less than 1%; - potential weeds, if their individual CsF is between 1 and 4%; - major or very representative weeds, if their individual CsF is greater than 4%.

Infestation diagram

The degree of infestation includes both the frequency and the abundance-dominance index of each species. Harmfulness is assessed on the basis of an infestation diagram. This diagram is obtained by creating a scatter plot with centesimal frequencies on the abscissa and abundance-dominance indices on the ordinate. It can be used to differentiate between groups of species according to their degree of infestation, and therefore their agronomic importance (Ipou Ipou, 2005; Touré, 2009 ; Kouamé, 2014; Yapi, 2017; Bakayoko, 2018).

Qualitative aspect

The parameters of the qualitative analysis of the weed flora take into account the biological type and morphological type of all the species recorded on the various elementary plots.

Biological type

Determining the biological type of species is necessary because it allows us to characterise the flora of an environment. This parameter will guide the weed control method to be adopted. There are many systems for classifying the various forms of vegetation.

The biological type classification model adopted is that of Aké Assi (1984, 2001 and 2002). The percentage is calculated according to the following formula.

$\%TB=\{\sum AD\ moy.\ Species\ of\ the\ same\ (TB)\}/\{\sum AD\ moy.\ of\ all\ species\}$

TB = Biological type

AD moy = abundance dominance average.

The calculation of the percentages of biological types has used to construct the biological spectrum, which is a characteristic expression of the observation site.

Morphological type

Plant morphology is the part of botany that involves describing the shape and external structure of plants and their organs. This type of classification takes into account the habit of the species. These are trees (a), shrubs (b), herbs (h) and lianas (l) (Descoings, 1975).

Results

The weed flora recorded on the cashew plots comprises 38 species divided between 33 genera and 14 botanical families. The most dominant botanical families are Fabaceae (8 species), followed by Poaceae

(7 species) and Euphorbiaceae (4 species). The floristic surveys carried out on the elementary plots showed that four weed species had a centesimal frequency greater than or equal to 50%.

In descending order, these are *Hyptis suaveolens* (100%), *Spermacoce ruelliae* (90%), *Daniella oliveri* (60%) and *Piliostigma thonningii* (50%). Two weed classes are represented in the plots surveyed. These were the Dicotyledonous class with 28 species, i.e. 73.68%, and the Monocotyledonous class with 10 species, i.e. 26.32%.

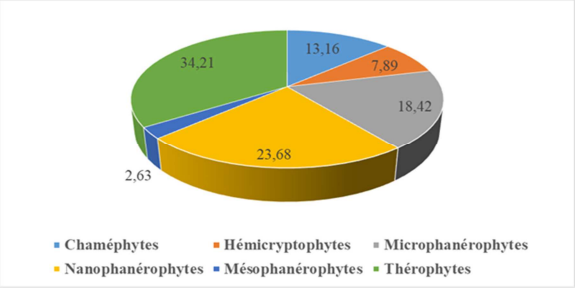

Fig. 2. Biological types of weeds based on the floristic inventory

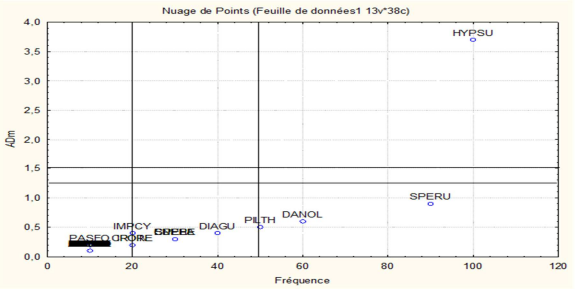

Fig. 3. Infestation diagram for elementary plots

Table 2. Number of species by morphological type

Morphological types	Number of species	Proportion (%)
Grass (G)	26	68,42
Shrub (s)	08	21,05
Liane (l)	04	10,53
Total	38	100

Four main biological types were identified. These were, in descending order, Phanerophytes (44.73%), Therophytes (34.21%), Chamephytes (13.16%) and Hemicryptophytes (7.89%). Within the Phanerophyte group, we found three subgroups, namely Nanophanerophytes, Microphanerophytes and Mesophanerophytes, with estimated proportions of 23.68%, 18.42% and 2.63% respectively (Fig. 2). Three morphological types were observed. Species of herbaceous morphological type (h) are the most representative with an estimated proportion of 68.42%, followed by shrubs (b) with 21.05% and lianas with 10.52% (Table 2).

The notion of specific contribution, which expresses the amplitude of the representativeness of a species in a phytocenosis, in direct relation to its absolute frequency, was determined for each species present on the elementary plots. Thus, on all the plots sampled, the specific contribution of weeds is divided into two groups (Table 3). These are species with a specific contribution of between 1% and 4% (group 1) and those with a specific contribution of over 4% (group 2). Group 1 species number 33 and represent 55.08% of the total specific contribution. These weed species are referred to as potential weeds. The second group contains five (5) weed species. In decreasing order of specific contribution, these are *Hyptis suaveolens* (13.16%), *Spermacoce ruelliae* (11.84%), *Daniellia oliveri* (7.89%), *Piliostigma thonningii* (6.68%) and *Detarium microcarpum* (5.26%). These five species make a total specific contribution equal to 44.72% of the total specific contribution of all the species recorded. This group of weeds are qualified as major or very representative weeds.

The combination of the frequency and dominant abundance of the species surveyed enabled us to better assess the degree of weed damage. Four (4) groups of weeds were found in the infestation diagram (Fig. 3). In decreasing order of harmfulness, these were major general weeds (G1), general weeds (G3), regional weeds (G6) and minor weeds (G9). Ranking them by decreasing degree of harmfulness we have *Hyptis Suaveolens*, with a centesimal frequency equal to 100 and an abundance-dominance equal to 3.7. This species is the most invasive and is present on all the plots sampled. It is the only group 1 species. Then there are the group 3 species, of which there are three. These include *Daniellia Oliveri, Spermacoce ruelliae* and *Piliostigma thonningii*.

Table 3. Classification of weeds according to their specific contribution

Species	Families	Specific contribution (%)
Ageratum conyzoides	Asteraceae	1,32
Axonopus compressus	Poaceae	1,32
Boerhavia diffusa	Nyctaginaceae	1,32
Brachiaria lata	Poaceae	1,32
Calopogonium mucunioides	Fabaceae	1,32
Chromoleana odorata	Asteraceae	1,32
Cnestis feruginea	Conaraceae	3,95
Commelina benghalensis	Commelinaceae	1,32
Crotalaria retusa	Fabaceae	2,63
Croton hirtus	Euphorbiaceae	1,32
Cyperus esculentus	Cyperaceae	1,32
Cyperus rotundus	Cyperaceae	1,32
Dactyloctenuim eagyptium	Poaceae	1,32
Daniellia oliveri	Fabaceae	7,89
Detarium microcarpum	Fabaceae	5,26
Digitaria cialiaris	Poaceae	1,32
Digitaria horizontalis	Poaceae	1,32
Euphorbia heterophylla	Euphorbiaceae	3,95
Euphorbia hirta	Euphorbiaceae	1,32
Hyptis suaveolens	Lamiaceae	13,16
Imperata cylindrica	Poaceae	2,63
Ipomoea Involucrata	Convolvulaceae	2,63
Ipomoea mauritiana	Convolvulaceae	1,32
Mariscus cylindristachyus	Cyperaceae	1,32
Mimosa pigra	Fabaceae	1,32
Mimosa pudica	Fabaceae	1,32
Oldenlandia corymbosa	Rubiaceae	1,32
Panicum laxum	Poaceae	1,32
Parkia biglobosa	Fabaceae	1,32
Passiflora foetida	Passifloraceae	1,32
Phyllanthus amarus	Euphorbiaceae	1,32
Piliostigma thonningii	Fabaceae	6,58
Sida acuta	Malvaceae	1,32
Spermacoce lactifolia	Rubiaceae	3,95
Spermacoce ruelliae	Rubiaceae	11,84
Spigelia anlthemia	Loganiaceae	1,32
Tridax procumbens	Asteraceae	1,32
Urena lobata	Malvaceae	1,32
Total		100

This group includes weeds with a frequency of more than 50% but an average dominance abundance of less than 1.25. Finally, the species in groups 6 and 9 are the most numerous of the four groups. Seven weed species are found in group 6. These are *Cnestis ferruginea, Detarium microcarpum, Euphorbia heterophylla, Spermacoce lactifolia, Crotalaria retusa, Imperata cylindrica* and *Ipomoea involucrata*. These species have a centesimal frequency of between 20% and 50% and a dominant abundance of less than 1.25%. These species are regularly found in crops in the savannah district of northern Côte d'Ivoire. The 27 species in group (9) have a centesimal frequency of less than 20% and a dominance abundance of less than 1.25. Examples include: *Ageratum conyzoides, Axonopus compressus, Spigelia anlthemia, Sida acuta*, etc.

Discussion

The study of the weed flora on the plots of ANGEL'S FARM's cashew farm yielded 38 species in 14 botanical families. Within this floristic diversity, 3 families are the most representative or remarkable by their number of species. These are the Fabaceae, Poaceae and Euphorbiaceae. The importance of these families could be explained by the ability of the species to proliferate, resist cultivation techniques and adapt to environmental conditions. These results are in agreement with those obtained by Konaté et al (2020) in cashew orchards in Côte d'Ivoire. In addition, several weed flora characterisation studies in Côte d'Ivoire have found these families to be in the majority during floristic surveys (Mangara, 2009 ; Kouamé, 2014 ; Yapi *et al.*, 2021).

The work of Akobundu (1987) also showed that these three families are on the list of families considered to be "major weeds worldwide". However, in terms of the number of species, our results disagree with those obtained in several studies (Kouamé 2014 ; Bakayoko, 2018 ; Konaté *et al.*, 2020).

The relatively small number of species in our work could be explained not only by the size of the plots sampled but also by the weed management technique, which is exclusively chemical. This technique advocates the total destruction of species (Vega, 1986). Therophytes (34.21%), Nanophanerophytes (23.68%) and Microphanerophytes (18.42%) are the most predominant biological types. The specific importance of these three biological types is due, on the one hand, to their ability to colonise the environment and their relatively short lifespan (Therophytes) and, on the other hand, their ability to prevent light reaching the ground (Nanophanerophytes and Microphanerophytes) to the detriment of other species. The predominance of this weed flora in the plots is contrary to the results of

Konaté *et al.*, 2020, who found that the weed flora was dominated by Microphanerophytes and Nanophanerophytes. This difference in results could be explained by the fact that the work of Konaté *et al.*, 2020 covers more than half of Côte d'Ivoire and therefore encompasses several ecosystems with different floristic assemblages. Grasses (h), with an estimated proportion of 68.42%, are the predominant morphological type. In the north of Côte d'Ivoire, the dominant vegetation type is savannah. Five (5) species stood out from the others by the high value of their specific contribution (greater than 4). These were *Hyptis suaveolens, Detarium microcarpum, Piliostigma thonningii, Daniellia oliveri* and *Spermacoce ruelliae*. These species are described as weeds with very high depressive effects. These weeds represent the major weeds on the farm.

The infestation diagram identified four groups of weeds according to their degree of harmfulness. These groups are major general weeds (G1), general weeds (G3), regional weeds (G6) and minor weeds (G9). Among the weeds making up these groups, Hyptis Suaveolens (major general weed) is the most aggressive major species on all cashew plots. The strong presence of this species can be explained by the fact that it may have allelochemical powers (Atta, 2020). This characteristic enables it to inhibit the germination of seeds of other species and the ability to prevent the growth and proliferation of other species in its vicinity. According to Atta (2020), *Hyptis suaveolens* has a remarkable inhibitory effect on the germination of the species around it.

Conclusion

This study on the characterisation of the main weeds on cashew farms was carried out on ANGEL'S Farm, in the sub-prefecture of Ferkessédougou, in the north of Côte d'Ivoire. The inventory of the weed flora in the 10 elementary plots of 300 m² identified 38 weed species divided into 14 families and 32 genera. The floristic inventory showed that this cashew tree farm is rich in Dicotyledons, with 73.68% of the weed flora. Therophytes and nanophanerophytes are the most predominant biological types, while herbaceous species dominate in terms of morphological types. Species such as Hyptis suaveolens, Detarium microcarpum, Piliostigma thonningii, Daniellia oliveri and Spermacoce ruelliae are the most frequent and aggressive weeds on this cashew farm. This study is a response to the implementation of an efficient weed management strategy on the cashew farm at ANGEL'S Farm.

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