Indian Journal of Weed Science (2023) **55**(1): 72–78
http://dx.doi.org/10.5958/0974-8164.2023.00013.8

RESEARCH ARTICLE

Cashew Orchards' weeds in high diseases and pests prevalence zone in Côte d'Ivoire

Latif Mory Konate*[1], Abdoul Rahim Falk Ky[2], Ali Mangara[3], François N'Guessan Kouame[4] and Daouda Kone[5]

Received: 10 October 2022 | Revised: 16 January 2023 | Accepted: 25 January 2023

ABSTRACT

The cashew orchards development and productivity faces several constraints, which include weeds. This study aims to assess the degree of infestation of weeds in cashew orchards by monitoring their density, richness and diversity in 108 cashew orchards in four regions of Côte d'Ivoire. In each plot of the 100 m² of each of the cashew orchards selected, weeds were identified and the individuals of herbaceous species were collected and counted whereas the trees and shrubs were counted without being up rooted. There were 295 weeds species belonging to 194 genera and 58 families of angiosperms. Regional data revealed 101 species and 50629 individuals in the Bounkani, 165 species and 70618 individuals in the Kabadougou, 156 species and 13597 individuals in the Gontougo and 164 species and 196257 individuals in Marahoué. A high negative relation was found between the orchards' age and the weeds infestation level in the cashew orchards.

Keywords: Cashew orchards, Cote D'Ivoire, Weeds survey, Weed diversity, Weed infestation

INTRODUCTION

Weeds have always been a major concern (Ipou 2005). Farmers maintain certain useful species for food, medicine, religious ceremonies, soil improvement (Ruthenberg 1976, Gliessman 1988) in association with the main crop in traditional agroecosystems (Altieri 1987; Konaté *et al.* 2021). Cashew is a tropical cash crop whose production in Africa increased very quickly during the current century (Bassett 2017, Firca 2018). Côte d'Ivoire became the leading African producer and exporter of raw cashew nuts (Diop 2016, Minagri 2016, Piperno 2011) with an estimated production of over 738,000 tons of raw cashew nuts in 2018 (Firca 2018). However, cashew nut yields in Ivorian orchards remain low, ranging from 350 to 500 kg/ha (Djaha *et al.* 2010), due to the climatic hazards, the agricultural techniques and the biotic factors (Link *et al.* 1984, Viana *et al.* 2007). Among these biotic factors, weeds are often cited to have a major impact on crop production and therefore cause a considerable decrease in yields (Mbaye 2013, Bassène *et al.* 2012, Noba 2002). This study aims to assess the weed flora, the floristic diversity and the degree of infestation of weeds in four cashew producing regions in Côte d'Ivoire.

[1] UFR Agriculture, Ressources Halieutic and Agro-industry University of San Pedro, BP V1800 San Pedro , Côte d'Ivoire

[2] Laboratory of Botany and valorisation of plant diversity, Sciences of Nature RFU, Nangui Abrogoua University, 02 BP 801 Abidjan 02, Côte d'Ivoire

[3] Laboratory of Botany and valorisation of plant diversity, Sciences of Nature RFU, Nangui Abrogoua University, 02 BP 801 Abidjan 02, Côte d'Ivoire

[4] Laboratory of Botany and valorisation of plant diversity, Sciences of Nature RFU, Nangui Abrogoua University, 31 BP 977 Abidjan 31, Côte d'Ivoire

[5] African Centre of Excellence on Climate Change, Biodiversity and Sustainable Agriculture, Félix Houphouët-Boigny University, 01 BP 34 Abidjan 01, Côte d'Ivoire

* Corresponding author email: kmorylatif@gmail.com

MATERIALS AND METHODS

All the weeds including the herbaceous species, the woody species and the climbing species were inventoried in the cashew orchards. During this study which was carried out in the four regions known as of the highest prevalence of cashew diseases (Soro *et al.* 2017) and pests' attacks (N'Dépo *et al.* 2017) in Côte d'Ivoire (**Figure 1**). The monitoring was done during the raining season (July to October 2020) when all the weeds especially herbaceous species were alive and could be easily identified botanically.

The Kabadougou and Bounkani regions are characterized by a Sudanese climate with an average temperature of 30 °C with a Sudanian savannah

vegetation (Monnier 1983). The annual rainfall of these regions ranged from 800 to 1 200 mm (Krogba *et al.* 2016). The Gontougo and Marahoué regions are in a forest-savannah mosaic vegetation (Monnier 1983) where the climatic regime was similar to the Guinean zone with an average annual rainfall between 1 200 and 1 500 mm; the annual average temperature is about 28.4 ° C (Krogba *et al.* 2016).

The survey was carried out in 108 cashew farms of age ranging from 5 to 48 years encompassing three villages in each region of Bounkani and Gontougo, and six villages in each region of Kabadougou and Marahoué (**Table 1**). Six cashew orchards were selected per village. Data was collected from 100 m^2 plot of 10 m x 10 m area. Weeds were recorded and assessed in 108 plots visited, *i.e.* one plot of 100 m^2 in each of the orchard. The herbaceous species that could have very high local densities and or be omitted when there are too short and rare, individuals were uprooted before being counted following methodology of Rew *et al.* (2000). But, the shrubs and trees individuals in plots except those of the cashew were counted without being uprooted. The observations were collected under three cashew tree crown configurations (Konaté *et al.* 2020).

The taxa were named in the field following methodology of Akobundu and Agyakwa (1989), Bourgeois and Merlier (1995), Arbonnier (2009) whereas the adopted nomenclature was the phylogenetic classification of APG (1998, 2003, 2009, 2016).

The floristical parameters were mainly the species richness (R), Simpson's diversity index (D), Shannon's diversity index (H), Piélou's equitability index (E) and Hill's equitability index (Na).

Simpson index (D) was calculated (Simpson 1949) by the following formula:

$$\boxed{D = \sum(\frac{ni}{N})} \textit{ Equation 1}$$

where ni = number of individuals/species and N = total number of individuals / survey; D varies from 0, for minimum diversity of taxa, to 1, for maximum diversity of taxa.

Shannon Index (H) was calculated according to Shannon (1948) as follows:

$$\boxed{H' = -\sum i\,(\frac{ni}{N})\,\log_2(\frac{ni}{N})} \textit{ Equation 2}$$

where ni = number of individuals/species and N = total number of individuals / survey; H' usually varies from 0, for dissimilar distribution of taxa, to $\log_2 S$, for similar distribution of all taxa.

Piélou equitability index (J') was calculated according to Pielou (1966) as follows:

$$\boxed{J' = H'/log_2 H'max} \textit{ Equation 3}$$

where H' = Shannon index and H'max = maximum diversity index. J' varies from 0, when the taxa show different abundances, to 1 when all taxa have the same abundance in the stand.

Hill's index was calculated according to Hill (1973) through the formula:

$$\boxed{Hill = (\frac{1}{\sum i(\frac{ni}{N})^2}) \times 1/e^{[H']}} \textit{ Equation 4}$$

where ni = number of individuals / species, N = total number of individuals/survey and H' = Shannon index. Hill varies from 1, for taxa single taxa stand, to ", for many taxa stand.

Density is always defined as the average of a taxa individuals' number on the sampled total area (Massenet 2010) and is expressed by the following formula:

$$\boxed{Density = N/S} \textit{ Equation 5}$$

with N = total number of individuals surveyed and S = total sampled area. The degree of infestation of the orchards by weeds was expressed according to the weeds density value to which this degree is positively correlated.

RESULTS AND DISCUSSION

A total of 295 species belonging to 194 genera and 58 families were recorded in 180 orchards. The dicotyledonous angiosperms were predominant (82%) than the monocotyledonous angiosperms (18%) (**Table 1**). The predominant families, to which recorded weeds belong, were Fabaceae (21%), Poaceae (10%), Rubiaceae (8%), Malvaceae (7%), Asteraceae (6%), Cyperaceae, Lamiaceae and Moraceae (4% each).

The total number of weeds species (weeds richness) recorded in each of the region was 101 species in Bounkani, 156 species / in Gontougo, 165 species in Kabadougou and 164 species in Marahoué. The majority (78-82%) of recorded species were dicots and 18-22% of them were monocots (**Table 1**).

The distribution of weeds' taxa varied amongst the regions and the cashew's crown types. Indeed, in Boukani region, weeds showed higher diversity and lower equitability under the juxtaposed cashew crown, and lower diversity and higher equitability under the separated cashew crown (**Table 2**). In Gontougo region, weeds showed higher diversity and lower equitability under the separated cashew crown,

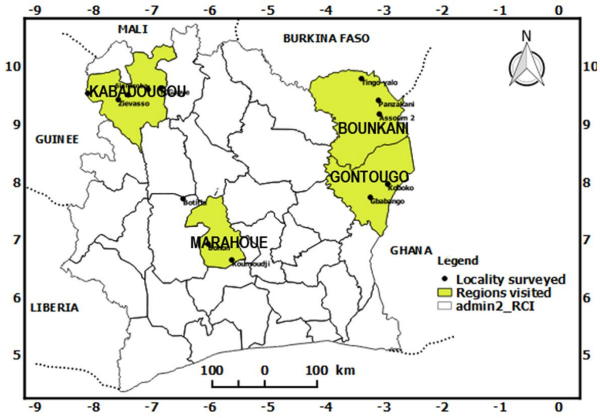

Figure 1. Map showing the studied regions in Côte d'Ivoire

Table 1. Weeds richness according to the regions

Regions	Plots number	Total number of weed species recorded	Dicots	Monocots
Bounkani	18	101	79 (78%)	22 (22%)
Gontougo	18	156	124 (79%)	32 (21%)
Kabadougou	36	164	135 (82%)	29 (18%)
Marahoué	36	165	134 (81%)	31 (19%)
Total	108	295	242 (82%)	53 (18%)

Values in (%) express the proportion of Angiosperm classes recorded by region

lower diversity under the closed cashew crown and higher equitability under the juxtaposed cashew crown (**Table 2**). In Kabadougou region, weeds showed higher diversity and lower equitability under the separated cashew crown, and lower diversity and higher equitability under the closed cashew crown (**Table 2**). In Marahoué region, weeds showed both higher diversity and equitability under the juxtaposed cashew crown, and both lower diversity and equitability under the separated cashew crown (**Table 2**). The overall highest weeds diversity was found under the juxtaposed cashew crown in Boukani region with 0.87 Simpson index, 1.06 Shannon-Weaver index and 53.13 Hill index while the lowest diversity was recorded under both separated cashew crown in Boukani region with 0.33 Simpson index, 1.46 Shannon-Weaver index and 10.26 Hill index, and closed cashew crown in Kabadougou region with 0.32 Simpson index, 1.46 Shannon-Weaver index and 10.13 Hill index (**Table 2**). The overall weeds' highest equitability was found under the juxtaposed cashew crown in Gontougo region with 0.62 Pielou index while the lowest equitability was experienced under the juxtaposed cashew crown in Boukani region with 0.31 Pielou index (**Table 2**).

The weeds flora of studied four regions is representative of the weeds national flora in cashew orchards of Côte d'Ivoire. It represents 67% of species, 70% of genera and 76% of families found in 261 cashew orchards spread in the production basin of cashew in Côte d'Ivoire (Konaté *et al.* 2020). However, it accounts for 54% of species, 58% of genera and 69% of families of the known cashew orchards weeds flora in the production basin of cashew in Côte d'Ivoire (Konaté 2021). It is far richer than the usual cashew orchards weeds flora in Côte d'Ivoire with 40,4% of species, 30,3% of genera and 17,6% of families (Konaté *et al.* 2021).

The highest value of dicotyledonous angiosperms and the predomination of Fabaceae family in the cashew orchards' floristic composition

Table 2. Variation in weeds' diversity indices in four study regions and under three cashew crown types

Study region	Diversity indices	Separated crowns**			Juxtaposed crowns***			Closed crowns****		
		Mini*	Max	Mean	Mini	Max	Mean	mini	Max	Mean
BOUNKANI	Simpson	0.17	0.69	0.33	0.17	0.87	0.87	0.09	0.65	0.45
	Shannon-Weaver	0.44	1.77	1.46	1.18	2.40	1.06	0.30	1.65	1.16
	Pielou	0.33	0.74	0.46	0.13	0.86	0.31	0.10	0.49	0.35
	Hill	1.52	17.08	10.26	1.75	82.86	53.13	1.48	15.01	6.12
GONTOUGO	Simpson	0.79	0.86	0.81	0.67	0.84	0.76	0.54	0.85	0.70
	Shannon-Weaver	1.01	1.42	1.36	1.49	2.28	1.90	2.39	2.50	2.90
	Pielou	0.43	0.71	0.39	0.46	0.76	0.62	0.43	0.79	0.58
	Hill	35.93	56.78	49.55	14.24	52.55	34.90	13.42	55.95	32.00
KABADOUGOU	Simpson	0.26	0.81	0.58	0.20	0.85	0.42	0.48	0.54	0.32
	Shannon-Weaver	0.71	1.94	1.35	0.51	2.09	1.03	0.94	1.72	1.46
	Pielou	0.24	0.63	0.33	0.17	0.66	0.47	0.36	0.58	0.49
	Hill	2.76	61.56	6.50	1.12	63.46	2.39	4.92	6.20	10.13
MARAHOUE	Simpson	0.52	0.81	0.37	0.03	0.73	0.55	0.34	0.63	0.49
	Shannon-Weaver	0.27	1.91	1.01	0.09	1.59	1.14	0.78	1.28	1.26
	Pielou	0.26	0.64	0.33	0.03	0.57	0.40	0.24	0.45	0.36
	Hill	12.1	36.05	3.57	1.12	20.94	12.37	3.28	19.68	7.11

*Mini: minimum, max: maximum indices' values; **Separate crowns: Cashew trees never touch each other; ***Juxtaposed crowns: All the cashew trees barely touch each other. all barely touch each other; ****Closed crowns: All the cashew trees overlap each other.

showed that these biotopes harbour a different flora in comparison to the local natural ecosystem which a Sudanian savannah or a Guinean savannah (Monnier 1983). Indeed, these savannahs were defined as a plant formation dominated by the Poaceae family (Trochain 1957). The higher weeds richness in Gontougo orchards than in Boukani orchards and the same weeds richness in both Kabadougou and Marahoué orchards, could be attributed to their savannah type and similar total plot area. In fact, the Guinean savannah in Gontougo region is naturally richer than Sudanian savannah in Boukani region due to the coexistence of wetter savannah and some islands of rainforests in Guinean savannah area while the Sudanian savannah is a mix of drier savannah and some islands of drier forests (Kouamé *et al.* 2021a, 2021b). This savannah type impact on the orchards' weed richness was more sighting in smaller total plot area of Boukani and Gontougo than in larger total plot area of Kabadougou and Marahoué.

The variation of the weeds' diversity according to both the region and the cashew crowns types could be attributed to the local farming practices. In all regions, cashew trees were planted at densities that varied from a farm to another and the clearing practices also vary from a farmer to another (Konaté *et al.* 2020, Konaté 2021, Ky 2021). And the variation in weed diversity according the cashew crowns type could be explained by the difference in the light availability for weeds under these crowns. Pioneer weeds that support full light intensity live and prosper under cashew separated crowns as in many crops lands like cotton (Aman e*t al.* 2004, Ipou 2005), rice (Kouamé *et al.* 2011, Konan *et al.* 2014, Touré 2014), pineapple (Mangara *et al.* 2010) and sugarcane (Traoré *et al.* 2019). Non-pioneer weeds hide under the cashew closed crowns like in some other crops lands such as rubber and cocoa (Kouamé and Koné 2021) while non-pioneer light-demanding weeds live as well under the cashew juxtaposed crowns as in some other crops like banana (Tano *et al.* 2016) and

Table 3. Total densities of the most invasive weeds in orchards by region

Taxa	Famillies	Total weed density (number/100 m²)			
		Bounkani	Gontougo	Kabadougou	Marahoue
Ageratum conyzoides L.	Asteraceae	102	614	6653	74070
Loudetia arundinacea (A. Rich) Hochst.	Poaceae	342	310	6276	6319
Mitracarpus scaber Urb.	Rubiaceae	17	35	24	1675
Croton hirtus L'Hér.	Euphorbiaceae	13914	439	2731	15221
Setaria barbata (Lam.) Kunth	Poaceae	6100	288	555	1201
Euphorbia heterophylla L.	Euphorbiaceae	27	501	429	24545
Desmodium triflorum (DC) L.	Fabaceae	3917	265	47	745
Talinum triangulare (Jacq.) Willd	Portulacaceae	234	356	46	4372
Imperata cylindrica (L.) Raeusch.	Poaceae	4912	74	9291	1016
Panicum brevifolium L.	Poaceae	816	45	172	4633
Indigofera hirsuta L.	Fabaceae	3	5	1232	345
Panicum laxum Sw	Poaceae	6356	1021	416	30
Phyllanthus amarus Schumach.	Phyllanthaceae	144	15	267	4069
Commelina diffusa Burm.f	Commelinaceae	14	4	45	5106
Synedrella nodiflora (L.) Gaertn.	Asteraceae	467	170	663	3814
Pouzolzia guineensis Benth.	Urticaceae	4	162	4	8704
Adenostemma perrottetii DC	Asteraceae	83	12	6276	2
Oplismenus burmannii (Retz.) P.Beauv	Poaceae	76	4945	1611	1610
Laportea aestuans (L.) Chew	Urticaceae	4	7	5	4888
Brachiaria lata (Schumach.)	Poaceae	6	2	1933	785
Pennisetum polystachion (L.) Schult	Poaceae	543	1	7159	5
Sida rhombifolia L.	Malvaceae	16	5	4074	3
Croton lobatus L.	Euphorbiaceae	10	2	1	2384
Hyptis suaveolens (L.) Poit	Lamiaceae	5103	3	3642	12
Mitracarpus villosus (Sw.) DC.	Rubiaceae	5074	3	100	45
Indigofera dendroides Jacq.	Fabaceae	2101	2	17	23
Spermacoce stachydea DC.	Rubiaceae	30	5	204	8829
Spigelia anthelmia L.	Loganiaceae	54	11	73	3440
Fimbristylis ferruginea (L.) Vahl	Cyperaceae	148	2	25	1234
Setaria pumila (Poir.) Roem.	Poaceae	342	3	5403	34
Aerva lanata (L.) Juss.	Amaranthaceae	3	1	3	534
Tridax procumbens L.	Asteraceae	745	10	276	3410
Paspalum conjugatum P.J.Bergius	Poaceae	77	6	1232	97
Justicia flava Forssk.) Vahl	Acanthaceae	12	2	1	1451
Cyperus rotundus L.	Cyperaceae	342	7	727	12

palm oil (Traoré *et al.* 2010). The dominance of the weeds depends on the cultural practices (Barralis *et al.* 1996) but also on the soil weed seedbank and the regrowth (Kouamé and Koné 2021).

Weeds density

The total weeds assessed in this study was about 333'377./10'800m² cashew orchards whereas the regional total density was respectively 50'629./1800m² in Bounkani, 13'597./1800m² in Gontougo, 70'618/3600m² in Kabadougou, and 196'257/3600m² in Marahoué.

Weeds with a total density higher than 100/100 m² in at least three regions belonged to the families Asteraceae (3 species), Poaceaes (6 species), Euphorbiaceae (2 species), and Fabaceae, Portulacaceae, Phyllanthaceae (1 species each) (**Table 3**). The less abundant species in the Boundani, Gontougo and Marahous regions are: *Mitracarpus* scaber, *Commelina diffusa, Laportea aestuans, Croton lobatus, Croton lobatus, Aerva lanata* and *Justicia flava* (**Table 3**). Of the four regions, Marahoué is the most weedy. Species such as *Ageratum conyzoides, Loudetia arundinacea, Croton hirtus, Euphorbia heterophylla, Panicum brevifolium, Phyllanthus amarus, Commelina diffusa, Pouzolzia guineensis, Laportea aestuans* and *Spermacoce stachydea* are abundant with more than 4000 individuals in the Marahoué plots while in the Gontaougo region they are less abundant with 100 individuals in the plots (**Table 3**). Weed density decreased with increasing orchard age (**Figure 2**).

The higher total weed density in the Bounkani region compared to the Gontougo region and those in the Marahoué region compared to the Kabadougou region, showed the absence of a link between local weed richness and local weed density in cashew orchards. Weed density depends mainly on their own ability to compete for nutrient resources (Delissio and Primack, 2003), spatial occupancy (Boyden *et al.* 2005; Brûmelis *et al.* 2009) and available sunlight (Poorter 2001, Baraloto 2003, Yedmel 2014) in the orchards.

A strong negative impact was found between orchard age and weed infestation level in cashew orchards (**Figure 2**). The impact of age on weed density found in this study is a combination of spatial occupancy and sunlight availability under cashew tree crowns. Indeed, these ecological parameters decrease from young to older cashew orchards. In this sense, Fenni (2003) and Traoré *et al.* (2019) evoked a progressive or regressive evolution of weed

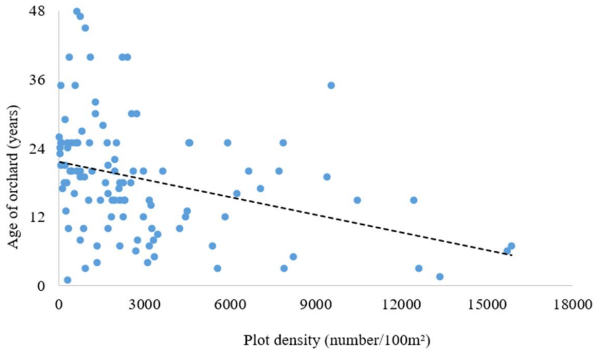

Figure 2. Evolution of weed density in the cashew orchards according to the orchards' age

density through a series of successive stages in cultivated lands during their evolution and according to the capacity of the weeds to withstand or not the light intensity.

Most often, the youngest cashew orchards were colonised by highly invasive weeds corresponding to weeds with a density of 4000/100m² for each taxon and led by *Ageratum conyzoides* Sieber ex Steud. Orchards with a density higher than 16'000/100 m² are more observed in young orchards with separate cashew tree crowns and mostly hosting few but very invasive weed species such as *A. conyzoides, Loudetia arundinacea* Hochst. ex Steud. etc. between cashew trees. Over time, the open crowns of these cashew orchards successively juxtapose and close, while at the same time the density of pioneer and invasive weeds decreases to the benefit of non-pioneer and non-invasive weeds, which also increase slightly.

ACKNOWLEDGEMENT

The cotton and cashew Council, the inter-professional fund for research and agricultural Council and the national research programme on cashew within the framework of the project of promoting the competitiveness of the value chain of the cashew (PPCA) funded this study. The Crop Protection team of this programme is thanked for their contribution to the collection of field data.

REFERENCES

Akobundu IO and Agyakwa CW. 1989. *Guide des mauvaises herbes d'Afrique de l'Ouest. IITA*. 522 p.

Aman KG, Ipou IJ and Touré Y. 2004. La flore des mauvaises herbes des cultures cotonnières de la région du Worodougou, au nord-ouest de la Côte d'Ivoire. *Agronomie Africaine* **16**(1): 1–14.

APG. 1998. An ordinal classification for the families of flowering plants. APG I. *Annals of the Missouri Botanical Garden* **85**(4): 531–553.

APG. 2003. An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG II. *Botanical Journal of the Linnean Society* **141**: 399–436.

APG. 2009. An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG III. *Botanical Journal of the Linnean Society* **161**: 105–121.

APG. 2016. An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants. APG IV. *Botanical Journal of the Linnean Society* **181**: 1–20.

Arbonnier M. 2009. *Arbres, arbustes et lianes des zones sèches d'Afrique de l'Ouest*. Quae, 3e édition, 576 p.

Baraloto C. 2003. Régénération forestière naturelle: de la graine à la jeune tige. *Revue Forestière de France LV (numéro spécial)* : 179–187.

Barralis G, Dessaint F and Chadeuf R. 1996. Relation flore potentielle – flore réelle de sol agricoles de Côte d'Or. *Agronomie* **16**: 453–463.

Bassène C, Mbaye MS, Kane A, Diangar S and Noba K. 2012. Flore adventice du maïs (*Zea mays* L.) dans le sud du Bassin arachidier (Sénégal) : structure et nuisibilité des espèces. *Journal of Applied Biosciences* **59**: 4307–4320.

Bassett T. 2017. Le boom de l'anacarde dans le bassin cotonnier du nord Ivoirien. Structures de marché et prix à la production**.** *Afrique Contemporaine* **263/264**: 59–83.

Bourgeois LT and Merlier H. 1995. *Adventrop. Les adventices d'Afrique soudano-sahélienne*. CIRAD, 637 p.

Boyden S, Binkle D and Shepperd W. 2005. Spatial and temporal patterns in structure, regeneration, and mortality of an old-growth ponderosa pine a forest in the Colorado Front Range. *Forest Ecology and Management* **219**: 43–55.

Brûmelis G, Strazds M and Eglava Z. 2009. *Stand structure and spatial pattern of regeneration of Pinus sylvestris in a natural treed mire in Latvia*. Silva Fennica **43**(5) : 767–781.

CIRAD-GRET. 2002. *Memento de l'Agronome*. Jouve, Paris, 1691 p.

Delissio LJ and Primack RB. 2003. The impact of drought on the population dynamics of canopy tree seed-lings in an aseasonal Malaysian rain forest. *Journal of Tropical Ecology* **19**: 489–500.

Djaha JBA, N'Guessan AK, Ballo CK and Aké S. 2010. Germination des semences de deux variétés d'anacardier (*Anacardium* L.) élites destinées à servir de porte-greffe en Côte d'Ivoire. *Journal of Applied Biosciences* **32***:* 1995–2001.

Fenni M. 2003. *Etude des mauvaises herbes des céréales d'hiver des hautes plaines*

constantinoises. Ecologie, dynamique, phénologie et biologie des bromes, Université de Sétif, 165 p.

Firca. 2018. La filière anacarde. firca.ci/wpcontent/uploads/2019/05/LaFiliereDuProgres20.pdf

Hill MO. 1973. Diversity and evenness: a unifying notation and its consequences. *Ecology* **54**: 427–432.

Ipou IJ. 2005**.** *Biologie et écologie* d'*Euphorbia heterophylla* L. (Euphorbiaceae) *en culture cotonnière. au nord de la Côte d'Ivoire*, l'Université de Cocody-Abidjan. UFR Biosciences 195 pp.

Konan Y, Akanvou L, N'Cho S, Arouna A, Eddy B and Kouakou CK. 2014. Analyse de l'éfficacité technique des riziculteurs face à l'infestation des cultures par les espèces parasites Striga en Côte d'Ivoire. *Revue Ivoirienne des Sciences et Technologie* **23**: 212–223.

Konaté ML, Kouamé FN, Abo K, Ipou Ipou J, Soro S, Traoré K and Koné D. 2020. Mauvaises herbes des vergers de l'anacardier en Côte d'Ivoire. *Agronomie Africaine* **32**(3): 277–295.

Konaté ML, Ouattara DN, Kouamé FN and Bakayoko A. 2021. Diversity and uses by farmers of cashew (*Anacardium occidentale* L.) orchards weeds in Côte d'Ivoire. *Ethnobotany Research and Applications* **21**(1): 1–14.

Konaté ML. 2021. *Caractérisation des adventices dans les vergers de l'anacardier (Anacardium occidentale L., Anacardiaceae) dans le bassin Anacardier de Côte d'Ivoire.*, Université Nangui Abrogoua, 201p.

Kouamé FN, Bakayoko A, Bah-Kouamé C, Téré HG and Dougouné Bi G. 2021a. Composition floristique des forêts denses en Côte d'Ivoire. *Afrique Science* **19**(4): 147–158.

Kouamé FN and Koné MLA. 2021. The effects of anthropogenic activities on the regeneration of flora in Duekoué and Scio forests in Southwestern Côte d'Ivoire. International Journal of Biodiversity and Conservation. **13**(1): 22–34.

Kouamé FN, Kouakou G, Bah-Kouamé C and Kouassi FL. 2021b. Structure et diversité floristique en forêt dense de la Côte d'Ivoire. *Afrique Science* **18**(6): 159–176.

Kouamé KF, Ipou IJ, Toure A and N'Guessan KE. 2011. Major weeds of rice agroecosystems in Côte d'Ivoire. *Agriculture and Biology Journal of North America* **2**(9): 1317–1325.

Krogba YN, Kouakou YKN, Gohi BZF, Rusu E and Yao KA. 2016. Distribution et comportement des éléments traces métalliques dans les cambisols manganésifères des sites volcano-sédimentaires de Côte d'Ivoire, *Lucrãrile Seminarului Geografic "Dimitrie Cantemir"* Nr. 43.

Ky ARF. 2021. *Pratiques paysannes de gestion des mauvaises herbes en culture de l'anacarde dans trois Régions en Côte d'Ivoire : Haut-Sassandra, Indénié-Djuablin et Poro*, Université Nangui Abrogoua, 33 p.

Link RJ and Mouch M. 1984. Contributions à la biologie, à la propagation et à la lutte contre les adventices au Maroc. *Deutsche Gesellschaft für Technische Zusammenarbeit.*

Mangara A, N'da AAA, Traoré K, Kéhé M, Soro K and Touré M. 2010. Etude phytoécologique des mauvaises herbes 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.

Massenet JY. 2010. Caractérisation et mesure des peuplements reguliers. 25 p.

Mbaye MS. 2013. *Association mil [Pennisetum glaucum (L.) R. Br] et niébé [Vigna unguiculata (L.) Walp.]: arrangement spatiotemporel des cultures. Structure, dynamique et concurrence de la ûore adventice et proposition d'un itinéraire technique*, UCAD (Sénégal), 236 p.

Monnier Y. 1983. Carte de la végétation de la Côte d'Ivoire. Pp. ***72.*** In: Vennetier P. & LaclavèreG. (eds) : Atlas de Côte d'Ivoire. 2e éd., *Jeune Afrique, Paris.*

N'Dépo OR, Chérif M, Johnson F, Kassi KFJM, N'Guessan AC, Silué N and N'Goran O.M. 2017. Inventaire des insectes ravageurs du verger anacardier dans les régions de Bounkani, Gontougo et Indénie-Djablun au Nord-Est en Côte d'Ivoire. *Afrique Science* ***13***(2): 333–343.

Noba K. 2002. *La ûore adventice dans le sud du bassin arachidier (Sénégal): Structure, dynamique et impact sur la production du mil et de l'arachide*, UCAD (Sénégal), 126p.

Pielou EC. 1966. The measurement of diversity in different types of biological collections. *Journal of theoretical Biology* **13**: 131–144.

Piperno DR. 2011. The Origins of plant cultivation and domestication in the New World Tropics patterns. Process and new developments. *Current Anthropology* **52**(4):ý S453–S470.

Poorter L. 2001. Growth responses of 15 rain-forest tree species to a light gradient: the relative importance of morphological and physiological traits. *Functional Ecology* **13**: 396–410.

Rew LJ, Alston CL, Harden S and Felton WL. 2000**.** Counts versus categories: Choosing the more appropriate weed scoring method. *Australian Journal of Experimental Agriculture* **40**: 1121–1129.

Shannon CE. 1948. The mathematical theory of communication. *The Bell System Technical Journal* **27**: 379–423 and 623–656.

Simpson EH. 1949. Measurement of diversity. Nature **163**: 688.

Soro S, Silué N, Ouattara GM, Chérif M, Camara B, Sorho F, Abo K, Koné M, Kouadio YJ and Koné D. 2017. Suivi effcient du verger anacardier à travers la veille sanitaire en Côte d'Ivoire. État sanitaire du verger anacardier ivoirien. *Colloque International d'Échanges Scientifques sur l'Anacarde* **2017**: 137–142.

Tano EJ, Kouadio YP, Gnonhouy GP and N'guessan KE. 2016. Inventaire floristique et effet de la densité de culture sur l'enherbement en bananeraie de type plantain (*Musa paradisiaca* L.) dans deux zones de production (Azaguié-abbè, région de l'Agnéby-tiassa et Éboissué, region de l'Indenié-djuablin) de la Côte d'Ivoire. *Agronomie africaine* **28**(3): 53–67.

Touré A, Adou LM, Kouamé FK and Ipou IJ. 2016. Dynamique d'infestation de la forêt classée de Sanaimbo par les mauvaises herbes à partir des agroécosystèmes environnants. *Tropicultura* **34**(4): 361–374.

Touré A. 2014. *Gestion agronomique et dynamique des mauvaises herbes dans les systèmes de riz de bas fond en Afrique de l'Ouest*, Université d'Abomey-Calavi, Bénin, 180 p.

Traoré K, Ouattara K, Sylla M and Coulibaly S. 2019**.** Dynamique des Mauvaises herbes dans la Culture de Canne À Sucre : Cas de l'Unité Agricole Intégrée de Zuénoula (Centre-Ouest de la Côte d'Ivoire). *European Scientific Journal* **15**(21): 1857–7881

Traoré K, Soro D, Péné CB and Aké S. 2010. Flore adventice sous palmeraie, dans la zone de savane incluse a dabou, basse Côte d'Ivoire. *Agronomie Africaine* **22**(1): 21–32

Trochain JL. 1957. Accord interafricain sur la définition des types de végétation de l'Afrique Tropicale. *Bulletin Institut Études Centrafricaines. Nouv. Sér*. **13**/**14**: 55–93.

Viana FMP, Cardoso JE and Suraiva HAO. 2007. First report of a bacterial leaf and fruit spot of cashew nut (*Anacardium occidentale* L.) caused by *Xanthomonas campestris* pv. *Mangiferae indicae* in Brazil. *The American Phytopatholo gical Society.* https://doi.org/10.1094/PDIS- 91-10-1361C.

Yedmel MSC. 2014. *Effets à long terme du feu en interaction avec les modalités sylvicoles dans le dispositif permanent de la forêt classée de la Téné (Côte d'Ivoire)*, Université Félix Houphouët-Boigny, 152 p.