

Weed Diversity under Cover Crops *Arachis repens* (L.) and *Desmodium adscendens* (Sw.) in Banana Plantations in Southeastern Côte d'Ivoire

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Abstract

In industrial dessert banana cultivation, weed control involves the use of chemical herbicides that are harmful to human health and the environment. In this study, the introduction of cover crops as an alternative was considered in banana plantations in southeastern Côte d'Ivoire. The experimental design was a Fisher block with three replicates of three treatments consisting of the use of the species *Arachis repens* and *Desmodium adscendens*, as well as two synthetic herbicides (control). The specific diversity and biological spectrum of weeds were evaluated. The results identified 71 weed species divided into 50 genera and 25 families, with slightly greater diversity of species and biological spectrum in the *D. adscendens* and control plots compared to *A. repens*. This study therefore suggests that *A. repens* could be used as a cover crop for weed management in banana plantations, replacing herbicides such as glyphosate and glufosinate. This conclusion is supported by the lower weed diversity observed under *Arachis repens*, indicating its superior competitive ability and stronger weed-suppressive effect.

Keywords

Banana Plantations, Weed Diversity, Cover Crops, Côte d'Ivoire

1. Introduction

Dessert bananas from *Musa* spp., AAA, are an important crop in the economy of Côte d'Ivoire, which is Africa's leading exporter to the European market, with more than 350,000 tons of fruit sold during the 2018/19 season [1]. However, like all cultivated plants, banana trees face pressure from numerous pests, particularly weeds [2]. In addition to being potential reservoirs for predators or diseases, weeds very often compete directly with crops for water, nutrients, and space [3]. Crop losses are estimated at 9.7% worldwide and 25% in Côte d'Ivoire [4] [5]. The relatively excessive use of synthetic herbicides to control weeds on agricultural land in general, and in banana plantations in particular, often generates prohibitive costs. This practice also poses numerous risks to both health and the environment through various types of pollution [6]. With the aim of steering cropping and pest control systems towards practices that meet the challenges of sustainable agriculture [7], the use of cover crops that are capable of smothering weeds is presented as an alternative to the application of synthetic chemical herbicides [8] [9]. In banana cultivation, several studies have been conducted on the use of annual and perennial cover crops for weed control [10]-[12]. However, few studies are available that have been conducted in Côte d'Ivoire on weed control in banana plantations using cover crops. This study aims to contribute to the biological control of weed growth in banana plantations by utilising cover crops. It will compare the specific diversity and biological spectrum of weeds under the cover crops *Arachis repens* and *Desmodium adscendens*, native to the local flora.

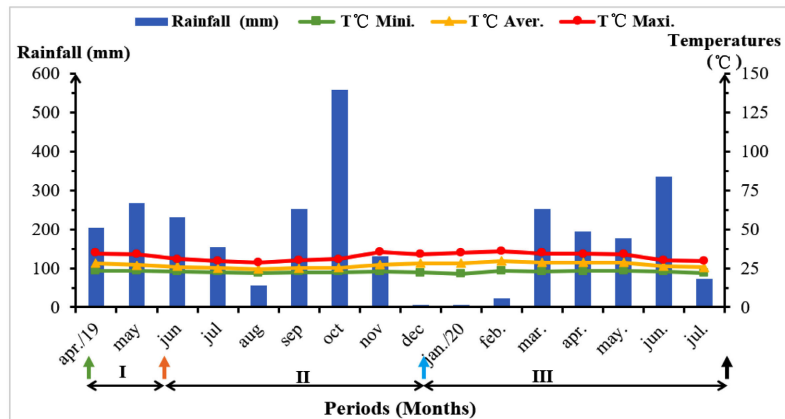
2. Materials and Methods

2.1. Experimental Site

The trial was conducted in an industrial banana plantation in Southeastern Côte d'Ivoire (5° 41'04.09" N, 3° 3'53.95" W, 100 m altitude). The climate, which is tropical and humid, is characterized by four seasons, two dry and two rainy [13]. The vegetation is diverse and includes coastal savannas, mangroves, swamp forests, riparian forests, and evergreen forests [14]. During the study (April 2019 to July 2020), the average temperature fluctuated around 27°C and rainfall was recorded at approximately 2915.11 mm (Figure 1).

2.2. Plant Material

Plants of *Arachis repens*, and *Desmodium adscendens* (non-food legumes), as well as banana trees (*Musa* sp., AAA, Cavendish, Grande Naine cultivar) were used as plant material. The individuals of the first two species mentioned, aged 84 days, were grown from cuttings taken in a nursery using coconut fiber. The nurseries were set up in the greenhouse at the experimental station. For the third species, the plants were obtained after 77 days of acclimatization in the nursery from imported vitroplants.



I: Latency time before the installation of cover crops in banana plots; **II:** 1st phase or period of banana plantation trials; **III:** 2nd phase or period of banana plantation trials and 2nd banana trees growing cycle; **I + II:** 1st banana trees growing cycle;
 ↑: Transplantation of banana trees in the field; ↑: Transplantation of cover crops in banana plots;
 ↑: Harvest of 1st bananas growing cycle; ↑: Harvest of 2nd bananas growing cycle

Figure 1. Rainfall and temperatures of the study site during the test period.

3. Methodology

3.1. Selection, Preparation of the Plot, and Transplanting of Cover Crops

For the trial, a banana plantation (3.6 ha), which had been left fallow for one year, was selected. At the time of plot preparation, the plantation contained banana trees aged 6 weeks. Within the plantation, three successive blocks, each with an area of 1080 m² (108 × 10 m), were selected. Fourteen days before the cover plants were installed, the weed flora was treated with glufosinate (SL 200 g/l) at a dose of 2 l/ha, using a backpack sprayer. Subsequently, weeding with a hoe was carried out to remove any weeds that were still alive. In addition, each block was subdivided into three elementary plots with an individual area of 360 m² (36 × 10 m) and identified with signs. The cover plants from the nursery were transplanted during the rainy season over the entire surface of the elementary plots. The plants, removed from the seedling trays, were transplanted at a spacing of 30 × 30 cm, a density of 111,111 individuals/ha. Before and after transplanting, the plot and the plants were watered.

3.2. Trial Maintenance

Trial maintenance consisted of manually pulling up resistant weeds and removing them from the banana plantation. For the control plots, weeding was done by applying glufosinate every 4 weeks during the first two months of the trials, then glyphosate (SL 360 g/l; 3 l/ha) every 8 weeks until the end of the experiment according to the standard local practice in banana cultivation. Glufosinate, a contact herbicide, acts rapidly on young broadleaved weeds and has low phytotoxicity for banana young plants, whereas glyphosate, a systemic herbicide, provides broader-spectrum control later in the cycle when weed communities are more established and has low phytotoxicity on banana old plants. These practices were carried out

when weeds began to dominate the cover crops or invade the control plots. Other maintenance activities were those commonly used in banana plantations. These included fertilization (NPK 12.5-04-28, urea 46, DAP 18-46, KCl 50, etc.), irrigation (2 hours per intervention every 2 days during the dry season), chemical and physical control of major pests and parasites (sigatoka, nematodes, black weevils), and care of banana trees and fruit.

3.3. Experimental Design

The trial was arranged in a Fisher block design with three replicates of three treatments. The factor studied was the method of weed management, with the treatments *A. repens*, *D. adscendens*, and herbicides (control). Each elementary plot or experimental unit was equivalent to one replicate of a treatment (factor treatment). Each replicate consisted of 60 banana plants planted at a density of 1820 plants/ha (2×2 staggered rows, with a spacing of 2.2 m between banana plants in the row and 1.7 m between double rows). For the elementary plots treated with cover crops, transplanting was carried out at a density of 111,111 plants/ha (spacing of $30 \text{ cm} \times 30 \text{ cm}$). For each cover crop, the number of plants transplanted per experimental unit was 4000. Within the same block, the experimental units were spaced 3 m apart. Two successive blocks were separated by a drain 1 m wide and 1 m deep.

3.4. Data Collection and Analysis

The weediness of the experimental plots was assessed during the two trial phases in the banana plantation, starting on the 28th day after the cover plants were transplanted. Floristic surveys were conducted every two months using the systematic sampling method [15]. This method involves the use of observation squares measuring 1 m^2 each, randomly arranged at each assessment on the diagonals of the experimental units, at a rate of five per elementary plot [5]. The species observed were identified on site or collected and placed in a herbarium after being dried for three days at a temperature of 55°C , then sent to the National Floristic Center (CNF) for identification (Figure 2). The data collection focused on qualitative variables, namely the specific diversity of weed species and their biological spectrum. The weeds inventoried were classified according to species, genera, families, classes, and biological types based on the model developed by Ake-Assi [16] [17], adapted from that of Raunkiaer [18]. Verification and correction of species names were carried out using the CNF herbarium and the works of Lebrun and Stork [19]-[22] and Ake-Assi [16] [17]. The abbreviations of the biological types used are those defined by Ake-Assi [16] [17]. The percentage of a biological type was calculated from the ratio between the sum of the abundance-dominance indices of its weeds and that of all species, multiplied by 100, using the formula used by Tialou *et al.* [23]. The collected data were entered and processed using Excel 2021 spreadsheet software and its XLSTAT add-in, version 2016. Shapiro-Wilk's test for normality and Levene's test for homogeneity were performed before analysis of variance (ANOVA). These analyses aimed to compare the numbers of weed spe-

cies, genera, families, and biological types among treatments. In case of rejection of the hypothesis of equality between means, Duncan's test at the 5% significance level was performed to identify homogeneous groups ($p < 0.05$).

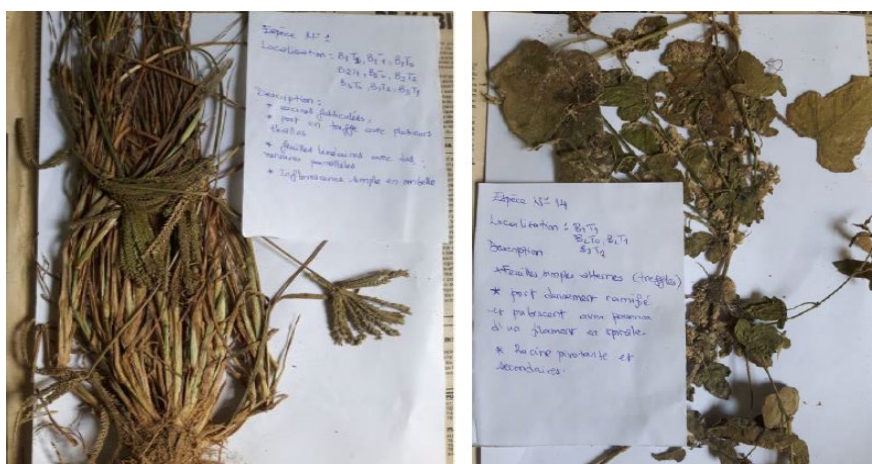


Figure 2. Weed species included in the herbarium.

4. Results

4.1. Floristic Diversity of Banana Plantations

A total of 315 floristic surveys were carried out across the entire experimental plot, at a rate of 105 per modality. Analysis of variance (ANOVA) showed statistically significant differences ($p < 0.05$) in the number of species and genera among treatments, but not for families and classes of weeds. The herbicide-treated plots and those associated with *Desmodium adscendens* exhibited higher richness of genera and families than the *Arachis repens* plots. For the entire study plot, three classes comprising 25 families, 50 genera, and 71 species were recorded (**Table 1** and **Table 2**). Dicotyledons were most dominant, accounting for at least 55% of the total, regardless of treatment. Monocotyledons contributed between 41% and 34% to the diversity of the flora, while pteridophytes were represented by only two species, accounting for less than 5% (**Table 3**). The families most represented in terms of species are grouped in **Table 4**. Overall, these were Poaceae (11.27% to 18.31%), Cyperaceae (11.27% to 15.49%), Euphorbiaceae (4.22% to 9.85%), Asteraceae (5.63% to 8.45%), Passifloraceae and Rubiaceae (2.82% to 4.22%), Amaranthaceae and Fabaceae (1.41% to 4.22%). In the Poaceae, Passifloraceae, Fabaceae and Rubiaceae families, the differences observed between *A. repens*, *D. adscendens*, and the control are not statistically significant ($p > 0.05$). For Cyperaceae, the highest values were recorded under *D. adscendens* and in the herbicide-treated plots, unlike *A. repens*, where the proportion is significantly lower. In the case of the Asteraceae and Euphorbiaceae, the control plots show higher proportions. Among Amaranthaceae, the proportion is significantly lower in plots under *A. repens* ($p < 0.05$). Overall, *A. repens* significantly reduced the species richness of several major weed families (Cyperaceae, Amaranthaceae, Asteraceae and Euphorbiaceae), while *D.*

adscendens is similar to the herbicide-treated plots for these families.

Table 1. Class, family, genus, and codes of all weed species inventoried during the study.

No.	Species	Genera	Families	Classes			
1	<i>N. biserrata</i> (Sw.) Schott.	Nephrolepis	Dennstaedtiaceae	Pteridophytes			
2	<i>P. aquilinum</i> (Linn.) Kuhn	Pteridium	Dryopteridaceae				
3	<i>C. alopecuroides</i> Rottb.	Cyperus	Cyperaceae	Monocotyledons			
4	<i>C. esculentus</i> L.						
5	<i>C. iria</i> L.						
6	<i>C. odoratus</i> L.						
7	<i>C. rotundus</i> L.						
8	<i>C. sphacelatus</i> Rottb.						
9	<i>C. strigosus</i> L.						
10	<i>F. dichotoma</i> (L.) Valh				Fimbristylis	Poaceae	Monocotyledons
11	<i>F. littoralis</i> Gaudich.						
12	<i>K. bulbosa</i> P. Beauv	Killingia	Poaceae	Monocotyledons			
13	<i>M. flabelliformis</i> Kunth	Mariscus					
14	<i>A. compressus</i> (Sw.) P. Beauv.	Axonopus					
15	<i>B. vulgaris</i> Shrad. Ex J.C. Wendl.	Bambusa					
16	<i>C. dactylon</i> (L.) Pers.	Cynodon					
17	<i>D. horizontalis</i> Willd.	Digitaria					
18	<i>D. sanguinalis</i> (L.) Scop.						
19	<i>E. colona</i> (L.) Link.	Echinochloa			Poaceae	Monocotyledons	
20	<i>E. obtusiflora</i> Stapf.						
21	<i>E. indica</i> (L.) Gaertn.						
22	<i>E. tremula</i> Hochst ex Steud.						
23	<i>P. laxum</i> Sw.						
24	<i>P. maximum</i> Jacq.						
25	<i>P. dilatatum</i> Poir.	Paspalum	Amaranthaceae	Dicotyledons			
26	<i>S. halepense</i> (L.) Pers.	Sorghum					
27	<i>A. sessilis</i> (L.) R. Br. ex DC.	Alternanthera					
28	<i>A. spinosus</i> L.	Amaranthus					
29	<i>A. viridis</i> L.						
30	<i>A. conyzoides</i> L.	Ageratum					
31	<i>B. pilosa</i> L.	Bidens			Asteraceae	Dicotyledons	
32	<i>C. odorata</i> (L.) R. King & H. Rob.	Chromolaena					
33	<i>E. praetermissa</i> Milne-Redh.	Emilia					
34	<i>E. floribundus</i> (H.B. & K.) Schultz	Erigeron					

Continued

35	<i>S. sparganophora</i> (L.) Kuntze	Struchium	
36	<i>C. obtusifolia</i> L.	Cassia	Caesalpiaceae
37	<i>C. ciliata</i> Schum. & Thonn.	Cleome	Cleomaceae
38	<i>C. rutidosperma</i> DC.		
39	<i>C. diffusa</i> Burm.	Commelina	Commelinaceae
40	<i>C. erecta</i> L.		
41	<i>I. triloba</i> L.	Ipomoea	Convolvulaceae
42	<i>A. cordifolia</i> Schum. & Thonn.	Alchornea	
43	<i>E. heterophylla</i> L.		
44	<i>E. hirta</i> (L.) Millsp.	Euphorbia	Euphorbiaceae
45	<i>E. hyssopifolia</i> L.		
46	<i>E. prostrata</i> Ait.		
47	<i>H. brasiliensis</i> Müll	Hevea	
48	<i>P. amarus</i> Schum. & Thonn.	Phyllanthus	
49	<i>C. mucunoides</i> Desv.	Calopogonium	
50	<i>D. dichotomum</i> (Willd.) DC.	Desmodium	Fabaceae
51	<i>I. hirsuta</i> L.	Indigofera	
52	<i>H. rotundifolia</i> (Sm.) Jacq.	Heterotis	Melastomataceae
53	<i>M. pudica</i> L.	Mimosa	Mimosaceae
54	<i>F. exasperata</i> Vahl	Ficus	Moraceae
55	<i>L. hyssopifolia</i> G. Don	Ludwigia	Onagraceae
56	<i>L. octovalvis</i> Jacq. PH Raven		
57	<i>P. edulis</i> Sims		
58	<i>P. foetida</i> L.	Passiflora	Passifloraceae
59	<i>P. trifasciata</i> Lem.		
60	<i>P. pellucida</i> (L.) Kunth.	Peperomia	Piperaceae
61	<i>B. crenata</i> (P. Beauv.) Hepper	Bacopa	Plantaginaceae
62	<i>T. triangulare</i> (Jacq.) Willd.	Talinum	Portulacaceae
63	<i>B. latifolia</i> (Aublet.) K. Schum.	Borreria	
64	<i>O. corymbosa</i> L.	Oldenlandia	Rubiaceae
65	<i>O. lancifolia</i> (Schum.) DC.		
66	<i>S. melongena</i> L.	Solanum	Solanaceae
67	<i>S. torvum</i> Sw.		
68	<i>S. zeylanica</i> Gaertn	Sphenoclea	Sphenocleaceae
69	<i>U. urens</i> L.	Urtica	Urticaceae
70	<i>C. splendens</i> G. Don	Clerodendrum	Verbenaceae
71	<i>L. camara</i> L.	Lantana	

Table 2. Number of classes, families, genera, species, and proportions of weed flora according to banana plantation weed management treatment.

Weed management treatments	Classes		Families		Genera		Species	
	Number	P (%)	Number	P (%)	Number	P (%)	Number	P (%)
<i>A. repens</i>	3 a	100 a	19 a	76 a	34 b	68 b	44 b	61.97 b
<i>D. adscendens</i>	3 a	100 a	20 a	80 a	39 a	78 a	49 a	69.01 a
Herbicides	3 a	100 a	21 a	84 a	37 ab	74 ab	51 a	71.83 a
All treatments	3	100	25	100	50	100	71	100

P: proportions; In the same column, values followed by the same letter are not significantly different at the 5% level according to the Duncan test.

Table 3. Number and proportion of weed species by class according to weed management treatments in banana plantations.

Weed management treatments	Classes	Weed species	
		Number	Proportion (%)
<i>A. repens</i>	Dicotyledons	27 a	61.36 a
	Monocotyledons	16 b	36.36 b
	Pteridophytes	1 c	2.27 c
	Total	44	100
<i>D. adscendens</i>	Dicotyledons	27 a	55.10 a
	Monocotyledons	20 a	40.82 a
	Pteridophytes	2 b	4.08 b
	Total	49	100
Herbicides	Dicotyledons	31 a	60.78 a
	Monocotyledons	19 b	37.25 b
	Pteridophytes	1 c	1.96 c
	Total	51	100
All treatments	Dicotyledons	45 a	63.38 a
	Monocotyledons	24 b	33.80 b
	Pteridophytes	2 c	2.82 c
	Total	71	100

For a treatment within the same column, values followed by the same letter are not significantly different at the 5% level according to the Duncan test.

4.2. Biological Spectrum of Weeds

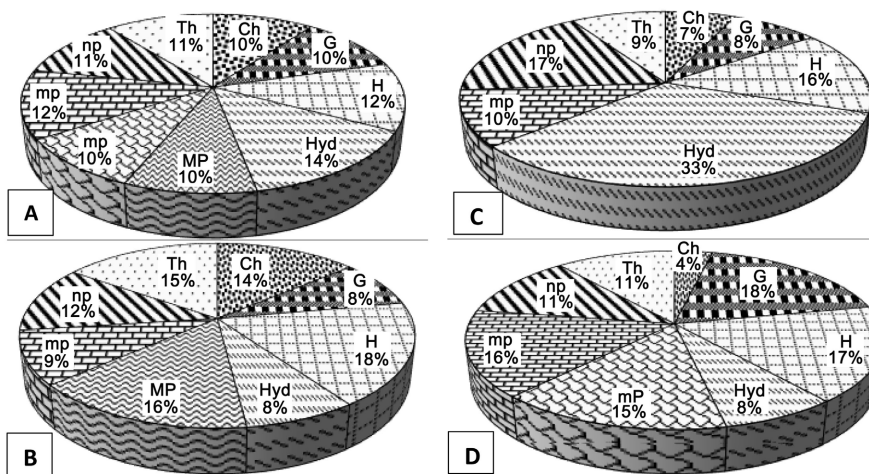
All biological types were present in the adventitious vegetation inventoried on the experimental site. These include megaphanerophytes (MP), mesophanerophytes (mP), microphanerophytes (mp), nanophanerophytes (np), geophytes (G), hydrophytes (Hyd), chamaephytes (Ch), hemicryptophytes (H), and therophytes (Th). However, mesophanerophytes were absent from plots treated with herbicides and megaphanerophytes from those associated with *D. adscendens*. Chamaephytes contributed the least, proportionally, to the weed flora inventoried in plots

associated with cover crops. Hydrophytes were predominant in the *A. repens* plots and geophytes in the *D. adscendens* plots. In the control experimental units, hemikryptophytes were dominant (Figure 3).

Table 4. Numbers and proportions of species from the weed families most commonly found in banana plantations, according to weed management treatments.

N°	Families	Number of species				Proportion of species (%)			
		Weed management treatments				Weed management treatments			
		<i>A. r</i>	<i>D. a</i>	Hb	E. P	<i>A. r</i>	<i>D. a</i>	Hb	E. P
1	Poaceae	8 a	9 a	9 a	13	11.27 a	12.68 a	12.68 a	18.31
2	Cyperaceae	8 b	11 a	10 a	11	11.27 b	15.49 a	14.08 a	15.49
3	Asteraceae	4 b	5 ab	6 a	6	5.63 b	7.04 ab	8.45 a	8.45
4	Euphorbiaceae	3 b	3 b	5 a	7	4.22 b	4.22 b	7.04 a	9.85
5	Passifloraceae	3 a	2 a	2 a	3	4.22 a	2.82 a	2.82 a	4.22
6	Amaranthaceae	1 b	3 a	1 b	3	1.41 b	4.22 a	1.41 b	4.22
7	Fabaceae	2 a	2 a	1 a	3	2.82 a	2.82 a	1.41 a	4.22
8	Rubiaceae	2 a	2 a	3 a	3	2.82 a	2.82 a	4.22 a	4.22

A. r: Banana plantations associated with *A. repens*; *D. a*: Banana plantations associated with *D. adscendens*; Hb: Control banana plantations treated with herbicides; E. P: Entire experimental plot; For a family within the same variable, values followed by the same letter are not significantly different at the 5% level according to the Duncan test.



A: entire experimental site; B: control; C and D: plots associated with *A. repens* and *D. adscendens*, respectively. MP = Megaphanerophyte (tree over 30 m tall), mP = Mesophanerophyte (tree between 8 m and 30 m tall), mp = Microphanerophyte (shrub between 2 m and 8 m tall), np = Nanophanerophyte (shrub between 25 cm and 2 m tall), Ch = Chamaephyte (species whose perennial buds are located less than 25 cm above the ground), H = Hemikryptophyte (species whose buds are located on the ground or very close above it), G = Geophyte (species whose buds are hidden in the ground), Th = Therophyte (annual species that spends the unfavorable season in the form of dormant embryos, protected inside seeds); Hyd = Hydrophyte (species whose buds are located in water).

Figure 3. Biological spectra of weeds identified in banana plots.

5. Discussion

Floristic surveys carried out in banana plots identified 71 weed species, with little difference in specific and biological diversity between weed management treatments. This situation is thought to be due to the homogeneity of the experimental plot due to its small size (0.4 ha), as pointed out by Le Bourgeois [24] in cultivated environments. This observation may also be attributable to the type of soil, climatic conditions, technical itinerary, and previous crop, which were identical for the entire experimental plot [25] [26]. Indeed, the shade cast by banana trees on the soil in the established plots and the absence of tillage undoubtedly gave rise to weed flora distributed independently of the treatments tested. In addition, soil moisture availability was ensured throughout virtually the entire study period by heavy rainfall and regular irrigation, which may have reduced weed differentiation depending on the conditions [27]. The small plot size is a clear limitation of the study, as it may have contributed to the limited floristic differentiation between treatments. Larger, multisite, and multiseason trials would be necessary and are being considered to validate these findings under broader production conditions. However, the lower number of weed species observed in the *A. repens* plots shows that this cover crop controls some of these plants. According to De Raissac *et al.* [28] and Noba *et al.* [29], the introduction of one species into an environment could favor the presence or absence of another. Indeed, the rapid and uniform establishment of *Arachis repens* in banana plantations reinforces its role as a competitive ground cover, capable of limiting the resources available to weeds and reducing their proliferation by smothering or inhibiting germination [30]. An allelopathic effect of root exudates (benzoxazinoids, glucosinolates, flavonoids, phenolic acids, saponins), as evidenced in several Poaceae, Brassicaceae, and Leguminosae, could also be involved [2] [31]. The low frequency of weeds in plots associated with *A. repens* would obviously imply a significant reduction in the number of weeding operations and the time spent on these operations, improving overall plot management and the sustainability of the cropping system. The overall floristic composition observed is more diverse than that obtained in the work of Kouadio *et al.* [32], but less rich than the vegetation recorded in the studies of Kouadio *et al.* [33] carried out in banana plantations in Dabou, in southern Côte d'Ivoire. These differences can be explained by the size and number of observation squares and surveys carried out, as well as the type and length of the sampling period [34]. Dicotyls were in the majority, regardless of treatment. This finding has been reported in several previous studies, including those by Mangara *et al.* [35] and Faye *et al.* [36], who reported proportions of two-thirds dicotyledons. Poaceae, Cyperaceae, Euphorbiaceae, Passifloraceae, Asteraceae, Amaranthaceae, Fabaceae, and Rubiaceae were the most commonly observed families in all modalities. Most of these taxa have also been reported in several studies [37] [38] and are among the 10 families comprising the most species considered to be major weeds in cropping systems [39]. Poaceae was the most abundant family in all treatments, indicating a higher presence of grasses in banana cultivation plots. For Cy-

peraceae and Amaranthaceae, the low proportion under *A. repens* suggests that it exerts greater competitive pressure on this family. These results confirm the greater ability of *A. repens* to limit certain dominant weed families in industrial banana plantations. The high proportion of Asteraceae and Euphorbiaceae in the control plots implies that the absence of cover favors the establishment of these pioneer families, which are generally associated with disturbed environments. For the other families, the results reflect their lower sensitivity to the weed management practices tested in this study. Megaphanerophytes or mesophanerophytes were absent from the experimental conditions, which clearly reflects the predominance of herbaceous or liana species, as shown by Vroh *et al.* [40] in cultivated plots. The low dominance of chamephytes and the low proportions of therophytes, nanophanerophytes, and microphanerophytes in all treatments can be explained by the shade provided by banana trees, as these types of weeds are generally heliophilic [41]. Hydrophytes, which were predominant in the *A. repens* plots, are thought to be the result of the soil moisture clearly maintained by this cover plant due to its dense cover, which would have created a pedoclimate that is very important for these plants [42] [43]. From a practical standpoint, the use of *Arachis repens* as a cover crop could help banana farmers reduce herbicide applications, lower long-term weed-management costs, and improve ecological sustainability by limiting chemical inputs.

6. Conclusion

The weed study conducted in the various banana plots identified 71 weed species divided into 50 genera and 25 families, with slightly greater diversity in the *Desmodium adscendens* and control plots. However, the floristic composition is dominated by dicotyledons, while monocotyledons and pteridophytes occupy only a secondary place. In terms of biological types, geophytes were found to predominate in associations with *D. adscendens*, hydrophytes in associations with *Arachis repens*, and hemicryptophytes in the control plots. This study highlights the sensitivity of adventitious flora to cultivation practices. It confirms the regulatory role of the cover crop *A. repens* in the dynamics of weed proliferation in industrial banana plantations. Future studies should examine, in large banana plot size, the long-term effects of *A. repens* on banana yield, soil health, and pest dynamics to strengthen recommendations for large-scale implementation.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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