A.I. CRESI CARYOCA

REPORT

Weeds of tropical rainfed cropping systems: are there patterns at a global level of perception?

Thomas Le Bourgeois[1,2], Pascal Marnotte[3,4], Benjamin Fayolle[3,4,5]

[1] CIRAD, UMR AMAP, F-34398 Montpellier, France
[2] AMAP, Univ Montpellier, CIRAD, CNRS, INRAE, IRD, Montpellier, France
[3] CIRAD, UPR AIDA, F-97400 Saint-Denis, La Réunion
[4] AIDA, Univ Montpellier, CIRAD, Montpellier, France
[5] Université Grenoble-Alpes, Grenoble, France

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Abstract

The objective of this study was to investigate the effect of general factors such as crop, regional climate or country on the weed flora and weed abundance in rainfed crops in tropical regions. For this purpose, we used 24 weed survey datasets from 4 climates, 11 crops and 11 countries in the tropics. These datasets are available in public access on the CIRAD Amatrop dataverse. This represents a set of 6 069 weed surveys, covering a total of 1 388 taxa. The data were analysed using different complementary approaches, including infestation diagrams, species correlation and co-occurrence matrices, corrected ecological profiles, and PCAIV. The results show that in the tropics there is a background of fairly common and ubiquitous species that are found in varying abundance in almost all situations. *Ageratum conyzoides* is the only Major general species, while *Rottboellia cochinchinensis, Digitaria horizontalis, Bidens pilosa, Cyperus rotundus, Commelina benghalensis, Euphorbia heterophylla, Eleusine indica, Euphorbia hirta* and *Tridax procumbens* are General species, present in more than 15% of the records. The climate factor, depending on rainfall and altitude, which influences temperature, selects certain indicator species for different situations. The crop factor does not have a particular selective effect and the country highlights local flora. Crops are themselves dependent on climate. It is nevertheless possible to know which species are most likely to be found in a plot of a crop, under a given climate and in a given country. However, it seems that it is the combination of the edaphic and climatic nature of the plot that most accurately determines the floristic composition of the weed flora, although we were unable to analyse this due to the lack of complete information on these factors for all the datasets used. Finally, out of the 1 388 taxa taken into account, only about 300 species constitute the core of the weeds of tropical rainfed crops, because of their frequency, their abundance or their character as indicators of particular agro-ecological conditions.

Résumé

Cette étude à pour objectif d'étudier l'effet de facteurs généraux comme la culture, le climat régional ou le pays sur la composition floristique des enherbements et l'abondance des adventices dans les cultures pluviales des régions tropicales. A cette fin, nous avons utilisé 24 jeux de données de relevés malherbologiques réalisés en abondance sous 4 climats, dans 11 cultures et 11 pays des régions tropicales. Ces jeux de données sont disponibles en accès public sur le dataverse Amatrop du Cirad. Cela représente un ensemble de 6 069 relevés, portant sur un total de 1 388 taxons. Les données ont été analysées selon différentes approches complémentaires, mettant en jeux des diagrammes d'infestation, des matrices de corrélation et de coocurrence des espèces, des profils écologiques corrigés, ainsi qu'une ACPVI. Les résultats montrent que dans les régions tropicales il existe un fond d'espèces assez communes et ubiquistes que l'on retrouve de façon plus ou moins abondante dans presque toutes les situations. *Ageratum conyzoides* est l'unique espèce Majeure générale, tandis que *Rottboellia cochinchinensis, Digitaria horizontalis, Bidens pilosa, Cyperus rotundus, Commelina benghalensis, Euphorbia heterophylla, Eleusine indica, Euphorbia hirta* et *Tridax procumbens* sont des espèces Générales, présentes dans plus de 15% des relevés. Le facteur climat en fonction de la pluviométrie et de l'altitude, qui influe sur la température, sélectionne certaines espèces indicatrices des différentes situations. Le facteur culture ne présente pas un effet sélectif particulier et le pays met en évidence des flores locales. La pratique des cultures est elle-même dépendante du climat. Il est malgrès tout possible de connaitre les espèces les plus susceptibles d'être rencontrées dans une parcelle d'une culture, sous un climat et dans un pays donnés.

Cependant, il semble que ce soit la combinaison de la nature édaphique et climatique de la parcelle qui détermine de façon la plus précise la composition floristique de l'enherbement d'une culture, bien que nous n'ayons pu l'analyser, faute d'une information complète sur ces facteurs pour l'ensemble des jeux de données utilisés. Finalement sur les 1 388 taxons pris en compte, seulement environ 300 espèces constituent le noyau dur des adventices des cultures pluviales tropicales, du fait de leur fréquence, de leur abondance ou de leur caractère indicateur de conditions agro-écologiques particulières.

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Introduction

Weeds are the most damageable pests to crops (Oerke, 2006), particularly in tropical areas where temperature and humidity allow them to develop and grow fast, and therefore to have a high potential harmfulness much higher than in temperate conditions (Marnotte and Le Bourgeois, 2018). In these tropical areas, different forms of agriculture coexist, from traditional farming with very few technical and economic means, to intensive farming systems, based on chemical inputs, mechanization, varietal improvement, etc. This situation results in a diversity of agroecosystems management practices linked to the diversity of crops, climate and soil conditions and socio-economic contexts encountered, which ultimately translates to a diversity of weed communities and weed constraints.

Functional approach is used in ecology to reduce the complexity of the diversity of organisms to combinations of characters (called functional traits), allowing by aggregation of individuals within communities, predicting the functioning of ecosystems (Violle et al., 2007). It is increasingly mobilized in agricultural systems, in particular to understand how weed communities affect crops and are likely to evolve according to changes in cultural practices, environments, and climate (Fried et al., 2012; Gaba et al., 2017).

Despite years of work and multiple studies, weeds of tropical agroecosystems are still not very well known.

Cropping systems in tropical areas can be splited into two main groups, that are flooded crops (e.g. irrigated or flooded lowland rice) and unflooded rainfed crops. These two groups correspond to two very different situations in terms of weed communities. The fact that weeds in flooded rice have to adapt to wet or aquatic conditions reduces drastically the biodiversity range in comparison to other arable crops and water management is the most selective factor on weed spectra (Kraemer et al., 2015; Rodenburg and Johnson, 2009).

In rainfed unflooded cultivation, local studies on weeds show that the composition of the weed flora is mainly dependent on the environmental conditions (soil type, temperature, rainfall) and finally quite little on the crop itself, especially for annual crops, except that the choice of crop is often correlated to edaphic conditions (Le Bourgeois, 1993; Randriamampianina, 2001). The impact of cultural practices (degree of intensification, fertilization, tillage, weeding) has little effect on the floristic spectra but has a strong influence on the abundance of species by reducing sensitive species and favouring tolerant species (Le Bourgeois 1993).

In this study, we would like to see if it is possible to highlight general features of the weed flora of rainfed crops, depending on general factors such as crop, or climate when changing the level of perception from the local to the global scale of the tropics.

Based on a set of phytoecological datasets of weed communities carried out in tropical rainfed crops over the last 30 years and available on the AMATROP dataverse (Le Bourgeois et al., submited; Le Bourgeois et al., 2020a), the objective of the present work is to analyse weed harmfulness and behavior at a global level (climate, cropping system, country), and classify weed species according to their frequency and abundance in different kind of situations in tropical areas. These first results could contribute in modeling weed communities' dynamics in tropical rainfed cropping systems.

1. Material and method

1.1. The datasets selection

The Amatrop Dataverse currently provides 30 datasets of phytoecological surveys of weeds in tropical crops. In this set, we have selected the datasets carried out in rainfed crops and taking into account the abundance of species. This subset provides 24 datasets of studies conducted in 11 countries and for 11 rainfed crops, in four different tropical climates (Table 1). Original datasets of tropical weed surveys were collected from studies conducted or supervised by Cirad weed scientists or partners from 1988 to 2020. The original floristical data were collected following three different types of protocols:

- Phytoecological surveys with weighted species records in farmer's fields : species were scored according to different scales such as 1-5 Braun-Blanquet (Braun Blanquet, 1932), 1-9 CEB score revised by Marnotte (Marnotte, 1984; Mathieu and Marnotte, 2000), or cover percentage;
- Weed surveys with weighted species records in experimental designs with replications and time series : species were scored according to percentage of coverage or 1-9 CEB score revised by Marnotte;
- Synthesis of control plots of experimental designs : In herbicide multilocal experimental designs, weeds species from control plots (untreated plots) were scored as the average abundance score (1-9 CEB score) of the control repetitions in each location.

The environmental factors were collected according to the objectives of each study. They could be very detailed (19 factors concerning country, location, year, environmental and agronomical factors) to very reduced (5 factors concerning location, year, crop, intensification, herbicide).

Datasets available in the Amatrop Dataverse have been standardized and homogeneized. In the floristic spreadsheets, the nomenclature of weed species has been fully updated and homogeneized following Plants Of The World Online (http://www.plantsoftheworldonline.org). In this spreadsheet, species scientific names were replaced by their 5 letter EPPO code from the EPPO Global Database (https://gd.eppo.int). Species abundance or species coverage scores were converted to 1-9 score. The "Reference Weed Flora of the tropical weeds studies datasets" lists all the taxa present in the different datasets with their EPPO code, their current scientific name, their family name and the most used synonyms (those mentioned in the original datasets). In the spreadsheet of study's factors, five of them are common to all datasets, they are, Author, Country, Crop, Irrigation and Climate (Le Bourgeois et al., submited).

Each dataset contains a different number of surveys, species considered and species occurrences. The quantification of floristic data of the 24 datasets is presented in Table 2.

Table 1: Details on the 24 datasets (country, author, year of study, file name, crops studied, reference of the dataset)

Country	Author	Year	File	Crops	Reference
Benin	Marnotte	2013	BEN-MAR-2013-DIV-AD	groundnut, tubers, food crop, fallow, rice	(Marnotte et al., 2020f)
Cameroon	Le Bourgeois	1988-1991	CAM-LEB-1988-DIV-AD	cotton, food crop, groundnut	(Le Bourgeois et al., 2020b)
Cameroon	Marnotte	1999	CAM-MAR-1999-MSK-AD	food crop	(Marnotte et al., 2020h)
Cameroon	Vall	2001	CAM-VAL-2001-COT-AD	cotton	(Huguenot et al., 2020)
Ivory Coast	Touré	2011-2014	CDI-AWA-2011-VIV-AD	food crop	(Touré et al., 2020)
Ivory Coast	Marnotte	1991-1992	CDI-MAR-1991-CAN-AD	sugarcane	(Marnotte et al., 2020d)
Ivory Coast	Kouamé	2015	CDI-SAB-2015-VIV-AD	tubers, food crop	(Kouamé et al., 2020)
Guadeloupe	Hatil	2006	GUA-HAT-2006-CAN-AD	sugarcane	(Hatil et al., 2020)
Guinea	Marnotte	1996-1997	GUI-MAR-1996-COT-AD	cotton	(Marnotte et al., 2020c)
French Guiana	Le Bourgeois	2 018	GUY-LEB-2018-DIV-AD	orchard, vegetable	(Le Bourgeois et al., 2020d)
Madagascar	Rafenomanjato	2017	MAD-ANT-2017-RIZ-AD	rice	(Rafenomanjato et al., 2020)
Madagascar	Randriamampianina	1998	MAD-JAR-1998-DIV-AD	cotton, groundnut, food crop	(Randriamampianina et al., 2020a)

Madagascar	Randriamampianina	1999	MAD-JA2-1999-DIV-AD	cotton, tubers, groundnut, food crop	(Randriamampianina et al., 2020b)
Madagascar	Rakotonirina	2015	MAD-RAK-2015-RIZ-AD	rice, tubers, groundnut, food crop	(Rakotonirina et al., 2020)
Mauritius	Marnotte	2019	MAU-MAR-2019-MAR-AD	vegetable	(Marnotte et al., 2020e)
Mauritius	Payet	2020	MAU-PAY-2020-MAR-AD	vegetable	(Payet et al., 2020)
Mayotte	Marnotte et al	2019-2020	MAY-MAR-2020-DIV-AD	orchard, vegetable, food crop, pasture, tubers, pineapple	(Marnotte et al., 2020i)
Reunion	Le Bourgeois	2003-2006	RUN-LEB-2003-DIV-AD	sugarcane, vegetable, pineapple, orchard, fallow, food crop, pasture	(Le Bourgeois et al., 2020c)
Reunion	Marnotte	2005-2016	RUN-MAR-2016-CAN-AD	sugarcane	(Marnotte et al., 2020a)
Reunion	Marnotte	2019	RUN-MA2-2019-CAN-AD	sugarcane	(Marnotte et al., 2020b)
Reunion	Marnotte	2019	RUN-MA3-2019-CAN-AD	sugarcane	(Marnotte et al., 2020g)
Reunion	Baillif	2017-2018	RUN-BAI-2017-CAN-AD	sugarcane	(Baillif et al., 2020a)
Reunion	Baillif	2019-2020	RUN-BA2-2020-CAN-AD	sugarcane	(Baillif et al., 2020b)
Viet Nam	Stevoux	1999	VIE-STE-1999-RIZ-AD	rice, food crop	(Stevoux et al., 2020)

Table 2: Quantification of the floristic data of the 24 datasets

File	Nb of surveys	Nb of Taxa	Nb of Occurrences
BEN-MAR-2013-DIV-AD	26	86	228
CAM-LEB-1988-DIV-AD	540	157	11437
CAM-MAR-1999-MSK-AD	52	64	573
CAM-VAL-2001-COT-AD	88	71	1666
CDI-AWA-2011-VIV-AD	240	389	8111
CDI-MAR-1991-CAN-AD	261	124	2094
CDI-SAB-2015-VIV-AD	200	324	7920
GUA-HAT-2006-CAN-AD	883	107	4593
GUI-MAR-1996-COT-AD	110	158	1633
GUY-LEB-2018-DIV-AD	61	138	735
MAD-ANT-2017-RIZ-AD	417	66	1340
MAD-JAR-1998-DIV-AD	198	120	3193
MAD-JA2-1999-DIV-AD	210	140	3839
MAD-RAK-2015-RIZ-AD	544	79	4983
MAU-MAR-2019-MAR-AD	82	206	1316
MAU-PAY-2020-MAR-AD	69	131	593
MAY-MAR-2020-DIV-AD	476	165	6936
RUN-LEB-2003-DIV-AD	566	278	13420
RUN-MAR-2016-CAN-AD	108	179	1666
RUN-MA2-2019-CAN-AD	121	62	1615
RUN-MA3-2019-CAN-AD	170	39	1606
RUN-BAI-2017-CAN-AD	219	73	2979
RUN-BA2-2020-CAN-AD	117	68	2172
VIE-STE-1999-RIZ-AD	363	113	5045
TOTAL	**6 121**	**1 366**	**89 693**

1.2. Data analysis

Of the 6121 floristic surveys in the complete dataset, the analysis was limited to the 6069 surveys carried out in the rainfed crop plots.

1.2.1. Weed flora characterization

The weed flora of the study was analysed from a taxonomic point of view to evaluate the biodiversity degree encountered in the tropical rainfed cropping systems.

1.2.2. Weed harmfulness and weed relationships

The analysis of weed harmfulness was conducted using infestation diagrams that relate the mean recovery of species calculated from the surveys where they are present and their relative frequency.

From the concatenation of the 24 floristic tabs, the relative frequency RFs of each species is calculated as the number of times the species appears in a survey divided by the total number of surveys.

$$RF_s = \frac{\sum_r \mathbf{1}_{(M_{s,r} \neq 0)}}{N_r}$$

By noting M as the species cover matrix for a set of floristic surveys, where the cell Ms,r is the cover value of species s in survey r, and Nr is the total number of surveys.

The mean cover AMs of each species is calculated as:

$$AM_s = \frac{\sum_r M_{s,r}}{\sum_r \mathbf{1}_{(M_{s,r} \neq 0)}}$$

The relative frequency and mean recovery of species within of the concatenate dataset can be related by considering these two quantities as coordinates. We thus obtain the infestation diagram. From this diagram and based on relative frequency and cover thresholds, it is then possible to define different groups of species according to their weediness evaluated according to the combination of cover and frequency (Le Bourgeois and Guillerm, 1995):

- the group of “*General major”* weeds that are very frequent and regularly abundant and that are responsible of the most problems to farmers in terms of production losses and management difficulties. Their relative frequency is greater than 15% and their mean cover is greater than 20%;
- the group of “*General*“ weeds present in a large number of situations but rarely abundant. These ubiquitous species are either more or less well controlled or are likely to become more abundant in the event of changes in environmental conditions (e.g. climate change or new cultural practices that would favour them). Their relative frequency is greater than 15% and their mean cover is less than 20%.

- The group of “*Local major”* weeds unfrequent and present only in particular situations (soil, climate …) but allways abundant and domageable to crops where they grow. Because of their reduced ecological niche, they also are very good ecological indicators. Their relative frequency is less than 15% and their mean cover is greater than 20%.
- The group of “*Minor”* weeds which are recorded occasionnaly and they are not a problem for farmers because never abundant and easy to control. Their relative frequency is less than 15% and their mean cover is less than 20%.

This kind of infestation diagram gives a good overview of the role of the species in the cropping systems of the area studied, and their harmfulness that is often due to the difficulty to control them efficiently in the crops concerned. However, the species are considered here independently to each other.

A complementary objective, is to better define the existing links between different species: for example, is one species necessarily accompanied by another? On the contrary, it can be very useful to know that a species cannot grow in the presence of another one. In this way, we have sought to highlight these links between species, taken in pairs. With the co-occurrence analysis, we are first attached to locate the species often present together: from the floristic tab, we calculated a matrix of co-occurrences of species, which we divided (term to term) by the total number of surveys, to obtain the proportion of surveys in which two species are present in the same place, at the same time. We then graphically represented this matrix in a co-occurrence graph. For reasons of better readability, we have limited the graph to the 50 most frequent species. The analysis of co-occurrences thus allows to identify species evolving together, or, on the contrary, species that are never together.

However, this co-occurrence does not take into account cover values of species: If two species are regularly found on the same plot, it is not known that their cover is comparable. In order to take these cover values into account, a Spearman's correlation coefficient (Spearman, 1987) was calculated between surveys of all species caught in pairs. If two species frequently together develop in a comparable manner in terms of coverage, the correlation coefficient will be positive. Conversely, if, for two species regularly occurring together, one occupies all the space and stifles the other, then the correlation coefficient will be negative. Of course, co-occurring species can be uncorrelated. It should be noted that Spearman's coefficient was preferred to Pearson's (Freedman et al., 2007), even though it is more widely used. This second coefficient makes the assumption of data normality (Schober et al., 2018), which is rarely verified in the present situation, while the former approach is non-parametric and thus completely independent of the data distribution. Indeed, after having systematically verified the normality of the distribution of the species abundance across the surveys, it turns out that only one species, within a single dataset, was distributed normally. The verification was done using Shapiro-Wilk tests, taking a decision threshold at 5%. A correlation matrix between species covers was calculated, and then graphically represented (we also limited the representation to the 50 most frequent species, for better readability). In addition, for each calculated correlation, a hypothesis test allowing to verify that the correlation is significantly different from 0 is set up. Finally, only the correlations for which the p-value of the underlying test is less than 5% were kept.

Once the different types of analyses were established, we decided to implement them at different levels.

1.2.3. Relationships between weeds and environmental factors

At a second level of perception, we have taken advantage of the common environmental factors between all the datasets in order to decide on relevant analysis filters. Thus, two sub-levels of analysis were conducted to produce infestation diagrams:

- Climate sub-level: the datasets were filtered and analysed according to climate types. Four types of climates were concerned: tropical (annual rainfall from 1000 to 2000 mm), dry-tropical (annual rainfall less than 1000 mm), wet-tropical (annual rainfall more than 2000 mm), altitude-tropical (location at more than 400 m of elevation).

- Crop sub-level: the datasets were filtered and analysed according to crop types. 11 rainfed crops were concerned: pineapple, groundnut, rainfed rice, food crops, orchard, fallow, vegetables, pasture, tuber, cotton, and sugarcane.

Since floristic surveys are linked to agro-ecological descriptors, a complementary approach is the analysis of the floristic surveys by corrected ecological profiles according to the Climate, Crop and Country factors. This approach is based on the calculation of the frequencies and cover of each species for each of the modalities of the considered factor, which makes it possible to estimate the influence of this factor (mutual information) on the overall weed community and on the behaviour of the species (Daget et al., 1970).

In order to be able to compare the behaviour of the different species, which do not have similar mean cover, a corrected cover was calculated, which corresponds to the mean cover in a factor state divided by the mean cover over all the surveys considered. This calculation is multiplied by 100, so the greater the deviation from 100, the more sensitive the species is to the factor under consideration. Table 3 explains the calculation of the corrected profile of a species for the different states of a factor.

	State 1	**…**	**State i**	**All surveys**
Number of surveys	N1	…	Ni	NT
Average recovery	Rc1 = $\sum note/state1$/N1	…	Rci = $\sum note/state\ i$/Ni	RcT = $\sum note\ total$/NT
Corrected average recovery	(Rc1/RcT) x 100	…	(Rci/RcT) x 100	100

Such a corrected ecological profile was calculated for the global set of data (24 concatenate datasets) to establish the situations favourable or unfavourable to the development of the species according to the different modalities of the three factors Country, Crop and Climate, but this approach do not take into account the possible correlations between factors.

Finally, we conducted a multivariate analysis to consider the possible interactions between factors and precise their contribution in the selection of weed communities and weed abundance. We decided to use a PCAIV (Principal Componant Analysis with respect to Instrumental Variables) (Lebreton et al., 1991; Sabatier et al., 1989)

This method makes it possible to relate a table of floristic surveys in abundance to a table of supposedly explanatory descriptors. The necessary notations are:

- *n*: the number of surveys
- *p*: the number of weed species
- *q*: the number of descriptors
- *X:* the matrix of factors in the surveys, dimension (*n, q*)
- *Y:* the matrix of species abundance in the surveys, dimension (*n, p*)

The PCAIV operates in several stages. The first step is to perform multiple linear regressions of the species covers according to the X matrix of descriptors (qualitative descriptors will be rendered binaries in the X matrix according to the principles of One Hot Encoding). The regressions are done in a D metric, i.e. that each observation is weighted. In the classical formulation of PCAIV, D = 1/nIn (where In is the identity matrix of order n). Each species Yi is thus expressed as a linear combination of the descriptors, plus a residual independent of them:

$$Y_i = \beta_{i,0} + \sum_{k=1}^{p} \beta_{i,k} X_k + \varepsilon_i,$$

Which means:

$$Y_i = \widehat{Y}_i + \varepsilon_i$$

A new $\widehat{Y}$ matrix can thus be constructed, composed of abundance estimates based on linear regressions on the descriptors. Thus, the $\widehat{Y}$ matrix can be interpreted as the strictly explained part of species abundances explained by descriptors.

Formally, we have:

$$\widehat{Y} = X(X^t D X)^{-1} X^t D Y$$

Once the $\widehat{Y}$ matrix has been calculated, the second step consists of performing and interpreting a simple Principal Components Analysis (PCA) on the latter. By the way, only the part of species abundances explained by the descriptors is projected in the factorial plane, since the factorial axes are linear combinations of species, themselves linear combinations of descriptors.

This method then allows access to a certain amount of information:

- The percentage of inertia explained by the descriptors, by making the ratio between the sum of the eigenvalues of the PCAIV and the sum of the eigenvalues of a simple PCA on Y . This gives us an idea of the interpretability of PCAIV's results: if it explains a very low percentage of total inertia, then the descriptors simply do not explain the abundances of species, and vice versa.

- The highlighting of species with high variance, therefore often with a high abundance index, in calculating the covariance between species and factorial axes.

- The highlighting of the most important descriptor(s) to explain species abundance, by calculating the correlation between each descriptor and the factorial axes. Indeed, the factorial axes summarize the structure of the $\hat{Y}$ matrix. The descriptors having a strong correlation with the factorial axes (in particular the first ones) are thus those having the most explanatory power on the structure of the $\hat{Y}$ matrix. If the percentage of inertia explained is sufficiently high, it is reasonable to generalize this to the scale the $\hat{Y}$ matrix, therefore species abundance.

- The highlighting of the species strongly related to a given descriptor, by comparing the correlation of the species/factorial axes to the one of descriptors/factorial axes: if, in the factorial plane formed by the first two axes of PCAIV, a species is located in the same region as a descriptor (coordinates given by the correlations), then the abundance of the species considered is probably related to the descriptor. Again, this interpretation should be put into perspective with the percentage of inertia explained by the PCAIV.

All data analysis of this study were performed under R Studio environment with the Amatrop R-package which was specifically developed for such studies under version 3.6.1 of R and is compatible with version 2.10 or later (R-Development-Core-Team, 2009). The package has been developed using the devtools and roxygen2 tools. At this time, the Amatrop R-package is not intended to be made public via CRAN, since the Amatrop project remains mainly internal to CIRAD (Fayolle, 2020; Fayolle et al., 2020).

2. Results

The 24 datasets used in this global study (Table 2) constitute a set of 6 069 surveys carried out in rainfed crop plots (Min. 27, Max. 883), with an average number of 119 taxa per dataset (Min. 89, Max. 389), an average number of 22 taxa per survey (Min. 3, Max. 71), and a total number of weed species occurrences of 89 693.

2.1. The weed flora of tropical rainfed crops

The weed flora encountered in tropical rainfed crops is composed of 1 388 taxa. Unfortunately, the full list of taxa can not be presented here, thus only the most representatives or interesting taxa shall be mentioned along the text. The complete scientific names, EPPO codes and family name of these 299 species are presented in Appendix 1. In the full list, 173 taxa were identified only at the genus level, because the complete identification of certain species is sometimes difficult when they are at an early stage of growth. The genera with the most numbered taxa partially identified are respectively *Cyperus* (10 sp. taxa), *Digitaria* (8 sp. taxa), *Indigofera* (5 sp. taxa), *Ipomoea* (6 sp. taxa), *Panicum* (7 sp. taxa) and *Vigna* (5 sp. taxa). Table 3 presents an overview of the distribution of this weed flora into several levels of the botanical systematics.

Table 3: Systematic distribution of the weed flora of tropical rainfed crops

Class	Family	Genus	Taxon
5	137	666	1 388

The best represented class, families and genera in terms of number of taxa are presented in Table 4. The *Magnolopsida* (Dicotyledons) class is by far the most diversified with 978 taxa, followed by the *Liliopsida* (Monoctoyledons) class with 368 taxa. But, from this later class, the *Poaceae* family is the most represented with 208 taxa and *Cyperaceae* is also very well represented with 76 taxa. From the *Magnolopsida*, Fabaceae and *Asteraceae* appear the most represented with 87 and 77 taxa respectively. Other families like *Rubiaceae, Malvaceae, Convolvulaceae* appear less diverse but well represented with 52, 52 and 48 taxa respectively. At the genus level, the greatest specific diversity appears for the genera *Cyperus* (44 taxa), *Ipomoea* (27 taxa), *Digitaria* (18 taxa), *Indigofera* (16 taxa), *Phyllanthus* (15 taxa), *Commelina, Sida, Solanum* and *Urochloa* (14 taxa).

Table 4: Best represented class, families and genera (sp. corresponds to taxon identified only at the genus level)

Class	Nb. of taxa	Family	Nb. of taxa	Genus	Nb. of taxa
Magnoliopsida	978	*Poaceae*	208	*Cyperus*	34 + 10 sp.
Liliopsida	368	*Fabaceae*	87	*Ipomoea*	21 + 6 sp.
Polypodiopsida	18	*Asteraceae*	77	*Digitaria*	9 + 9 sp.
		Cyperaceae	76	*Indigofera*	11 + 5 sp.
		Rubiaceae	52	*Phyllanthus*	11 + 4 sp.
		Malvaceae	51	*Commelina*	10 + 4 sp.
		Convolvulaceae	47	*Sida*	12 + 2 sp.
		Euphorbiaceae	38	*Solanum*	13 + 1 sp.
		Lamiaceae	37	*Urochloa*	14
		Apocynaceae	28	*Eragrostis*	13
		Amaranthaceae	24	*Panicum*	6 + 7 sp.
		Solanaceae	24	*Dioscorea*	9 + 3 sp.
		Commelinaceae	20	*Spermacoce*	9 + 3 sp.

Class	Nb. of taxa	Family	Nb. of taxa	Genus	Nb. of taxa
		Cucurbitaceae	20	*Vigna*	7 + 5 sp.
		Phyllanthaceae	20	*Amaranthus*	11
		Acanthaceae	18	*Paspalum*	9 + 2 sp.
				Euphorbia	10
				Hibiscus	8 + 2 sp.
				Sesbania	7 + 3 sp.
				Tephrosia	8 + 2 sp.

2.2. Frequency and abundance of weed species

The infestation diagrams that relate the relative frequency and mean cover of species allow us to define groups of weeds according to their harmfulness. Figure 1 is the infestation diagram elaborated for the full dataset.

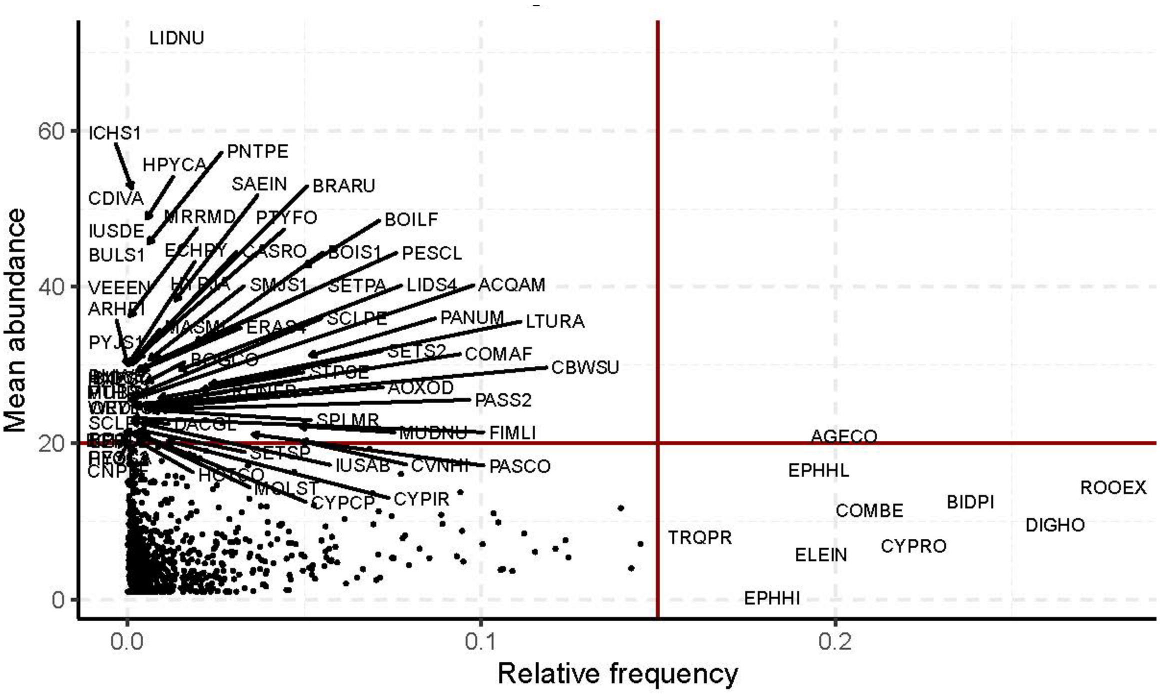

Figure 1: Infestation diagram of the full dataset of 6 069 surveys

In such a very big set of data coming from different tropical countries and recorded in several cropping systems, *Ageratum conyzoides* (AGECO) is the only one weed species which belongs to the group of *General major* weeds with a relative frequency of 0.21 and a mean cover of 23%.

The group of *General weeds* contains 9 species which are namely *Rottboellia cochinchinensis* (ROOEX), *Digitaria horizontalis* (DIGHO), *Bidens pilosa* (BIDPI), *Cyperus rotundus* (CYPRO), *Commelina benghalensis* (COMBE), *Euphorbia heterophylla* (EPHHL), *Eleusine indica* (ELEIN), *Euhorbia hirta* (EPHHI) and *Tridax procumbens* (TRQPR). These species are very common and time to time enough abundant to cause damages to the crops. They are ubiquitous species and can be observed in many different situations.

The group of *Local major* weeds contains 63 species that are infrequent, but often abundant or even very abundant when present. These species are characteristic to very specific agro-ecological conditions, poorly represented at the scale of the complete dataset. These weeds are locally responsible of huge damages and are very difficult to control, but they also are very good agro-ecological indicators. It is therefore important to understand the conditions that allow them to grow. Table 6 shows the species of this group that have been recorded in more than 50 or in at least 20 surveys (not frequent but not really rare species).

Table 6: *Local major* weeds* that are present in more than 50 or at least 20 surveys

More than 50 surveys		20 to 50 surveys	
PANUM	*Brachiaria umbellata*	CASRO	*Chamaecrista rotundifolia*
BOILF	*Spermacoce alata*	HOTCO	*Houttuynia cordata*
CVNHI	*Croton hirtus*	SETPA	*Setaria palmifolia*
MUDNU	*Murdannia nudiflora*	SCLPE	*Scleria pergracilis*
PASCO	*Paspalum conjugatum*	CBWSU	*Clibadium surinamense*
LTURA	*Leptothrium senegalense*	CYPCP	*Cyperus compressus*
SAEIN	*Sacciolepis indica*	MASMI	*Marsilea minuta*
HYPJA	*Hypericum japonicum*	FIMLI	*Fimbristylis littoralis*
CYPIR	*Cyperus iria*		
COMAF	*Commelina africana*		
STPSE	*Stenotaphrum dimidiatum*		
PESCL	*Cenchrus clandestinus*		
SPLMR	*Acmella caulirhiza*		
PNTPE	*Pentodon pentandrus*		
HPYCA	*Hyptis capitata*		
BOGCO	*Anredera cordifolia*		
AOXOD	*Anthoxanthum odoratum*		
DACGL	*Dactylis glomerata*		
IUSDE	*Ludwigia decurrens*		
MOLST	*Trigastrotheca stricta*		
LIDNU	*Craterostigma nummulariifolium*		
SETSP	*Setaria sphacelata*		

*6 taxa identified only at the genus level are not presented in this table.

The most frequent weed, *Rottboellia cochinchinensis* (ROOEX), is only present in 27.7% of the surveys, and the others *General* weeds are less frequent. This also means that the *General major* weeds and the *General* weeds of this study are absent in 73 to 84% of the surveys. This significates that there is no weed community or weed species that are truly common to all the rainfed crop fields all over the tropics.

The analysis of co-occurrence, and correlation between species is calculated for the 50 most frequent species and presented in Figure 2 and Figure 3. *Rottboellia cochinchinensis* (ROOEX) co-occures with quite few species like *Digitaria horizontalis* (DIGHO), *Commelina benghalensis* (COMBE), *Cyperus rotundus* (CYPRO), *Euphorbia heterophylla* (EPHHL), *Euphorbia hirta* (EPHHI) and *Tridax procumbens* (TRQPR) ; while *Digitaria horizontalis* (DIGHO) co-occurres very highly with a number of species like *Commelina benghalensis* (COMBE), *Eleusine indica* (ELEIN), *Euphorbia hirta* (EPHHI), *Tridax procumbens* (TRQPR), *Ipomoea eriocarpa* (IPOER), *Mitracarpus hirtus* (MTCVI), *Dactyloctenium aegyptium* (DTTAE), *Paramollugo nudicaulis* (MOLNU), *Boerhavia diffusa* (BOEDI) and *Acanthospermum hispidum* (ACNHI). *Bidens pilos*a (BIDPI) co-occurres highly with *Ageratum conyzoides* (AGECO), *Euphorbia heterophylla* (EPHHL), *Cardiospermum microcarpum* (CRIMI), and *Urochloa maxima* (PANMA).

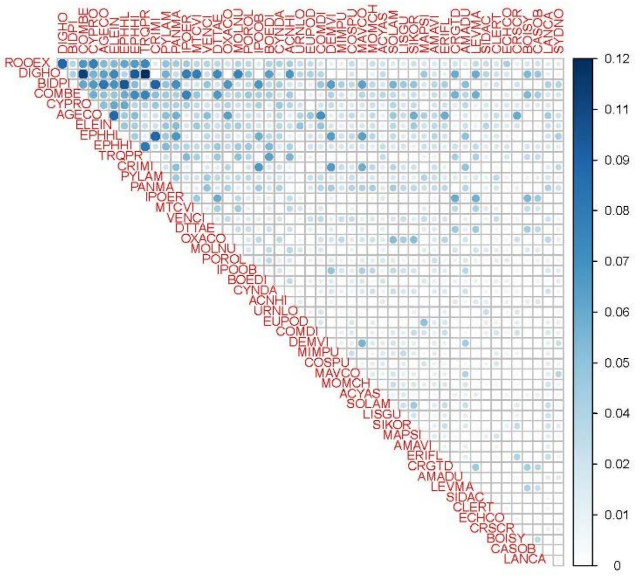

Figure 2: Co-occurrences between species

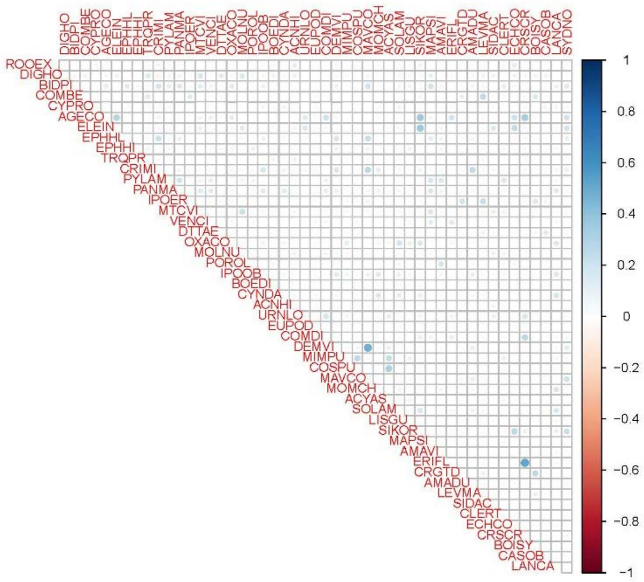

Figure 3: Correlations between species cover

The analysis of co-occurrences does not take into account abundance values. Thus, if two species regularly occur on the same plot, there is no evidence that their abundances are comparable. If two species frequently together develop in a comparable manner in terms of abundance, the correlation coefficient will be positive. Conversely, if, for two species regularly found together, one occupies all the space and suffocates the other, then the correlation coefficient will be negative. From the Figure 3 it appears that only a small number of species show a high positive correlation in abundance. These species are *Ageratum conyzoides* (AGECO) which cover is correlated to the one of *Eleusine indica* (ELEIN), *Sigesbeckia* *orientalis* (SIKOR) and *Crassocephalum crepidioides* (CRSCR); *Eleusine indica* (ELEIN) correlated to *Sigesbeckia orientalis* (SIKOR); *Desmanthus virgatus* (DEMVI) correlated to *Malvastrum coromandelianum* (MAVCO) and *Erigeron floribundus* (ERIFL) correlated to *Crassocephalum crepidioides* (CRSCR).

2.3. Relationships between weeds and environmental factors

The 24 datasets used in this study have five common descriptors that are, Author, Country, Irrigation, Climate and Crop. The Irrigation factor was used to select the 6069 surveys carried out on rainfed crops. We have analysed the potential effect of Climate, Crop and Country factors on the selection of the weed flora and the abundance of the species. Table 7 presents the distribution of surveys among the modalities of these three factors. The quality of sampling are respectively 0.91 for Climate, 0.76. for Crop and 0,84 for Country factor. Sampling among climates is fairly well balanced. Sampling among crops shows that Fallows, Pastures, and Pineapple are undersampled compared to other crops, while Sugarcane is oversampled. The oversampling of sugarcane fields is due to the number of studies conducted on this crop and also repetitions of observations over the year in certain studies. About the Country factor, Benin and French Guiana are undersampled while Reunion and Madagascar are oversampled and are likely to contribute strongly in the analysis. Infestation graphs have been produced for each of the four climates (Appendix 2) and 11 crops (Appendix 3). Corrected ecological profiles of species having a relative frequency greater than 3% have been calculated for the four climates (Appendix 4.1), the 11 crops (Appendix 4.2) and the 11 countries (Appendix 4.3). The results of the PCAIV are presented in Appendix 5. They show that the factors used in the analysis (Author, Country, Crop, Climate) explain only 21% of the inertia of the species cover matrix. This means that there are other factors that contribute to the composition of weed communities and the abundance of species in the plots but we could not take them into account because they were not recorded in all surveys nor datasets. The first three factorial axes of the PCAIV explain respectively 8.3%, 3% and 2% of the inertia, for a cumulative inertia of 13.3%.

Table 7: Distribution of factors modalities of the study

Climate	Nb. of surveys	Crop	Nb. of surveys	Country	Nb. of surveys
Tropical	2687	Cotton	628	Benin	11
Altitude-tropical	1400	Fallows	28	Cameroon	660
Wet-tropical	1364	Food crops	1160	Ivory Coast	705
Dry-tropical	618	Groundnut	203	Guadeloupe	862
		Orchards	117	Guinea	110
		Pastures	74	French Guiana	61
		Pineapple	68	Madagascar	1369
		Rice	909	Mauritius	151
		Sugarcane	2252	Mayotte	476
		Tubers	295	Reunion	1301
		Vegetables	335	Vietnam	363

Corrected ecological profiles give us an idea of the relation between each species and the factor (Mutual information) and the profile of the species among the different modalities of the factor. We have kept the species which mutual information with the factor was superior to 0.03. There are 124 taxa over this threshold for the Climate factor, while there are 180 for the Crop factor and 270 for the Country factor. This means that many more species are selected by the Country (e.g. geographical effect on the flora composition) than by the rainfed crops or by the tropical climates (see Appendix 4.1, 4.2 and 4.3).

2.3.1. Effect of the climate factor on the species

Infestation diagrams produced according to the four climates (Appendix 2) allowed us to define the harmfulness of weed species for the different climates and to classify them in the *General major*, *General* and *Local major* categories (tables 8, 9, 10 and 11). From the corrected ecological profiles of species with the climate factor (Appendix 4.1), we could select the species showing a high relationship with each climate. These species are mentioned in the three categories of the tables with a * symbol or added in the fourth column of the tables. From the results of the PCAIV (Appendix 5), the species showing a high relationship with a particular climate, are written in bold letters in the tables.

Table 8: Harmfulness and correlation of weeds with the Tropical climate

General major	General	Local major	Species correlated from Ecological profile
	Rottboellia cochinchinensis	*Brachiaria umbellata*	*Griffonia simplicifolia*
	Commelina benghalensis	*Leptothrium senegalense*	*Solanum erianthum*
	Euphorbia heterophylla	*Ipomoea triloba*	*Millettia zechiana*
	Digitaria horizontalis	*Anredera cordifolia*	*Combretum zenkeri*
	Euphorbia hirta	*Galinsoga parviflora*	*Cenchrus pedicellatus*
	Bidens pilosa	*Commelina africana*	*Leucas martinicensis*
	Urochloa maxima		*Rhynchosia minima*
	Ipomoea eriocarpa		*Physalis lagascae*
	Phyllanthus amarus		*Mallotus oppositifolius*
			Launaea cornuta

For the Tropical climate (Table 8) there is no *General major* weed, always present and abundant. There are few *General* weeds and few *Local major* weeds. From the two last groups, no species appears highly correlated with the Tropical climate in the corrected ecological profile that highlights 10 minor weeds. From the results of the PCAIV, the Tropical climate is correlated positively to the factorial Axis 1, in opposition to the Altitude–tropical climate, but no species appears clearly correlated to this Tropical climate. It seems that this Tropical climate represents a medium situation in tropical areas, not so cold, not so dry, and not so wet, and thus it is not a selective factor for weeds. In this situation, the weed community is composed of quite common species which abundance is due to other factors.

Table 9: Harmfulness and correlation of weeds with the Altitude-tropical climate

General major	General	Local major	Species correlated from Ecological profile
Ageratum conyzoides	***Eleusine indica****	***Spermacoca alata****	***Lygodium flexuosum***
Crassocephalum crepidioides*	***Urena lobata****	***Sigesbeckia orientalis***	*Neojeffreya decurrens*
	*Mitracarpus hirtus**	***Erigeron floribundus***	
	*Cleome hirta**	*Hyptis capitata*	

General major	General	Local major	Species correlated from Ecological profile
	Cyperus rotundus *Digitaria horizontalis* ***Commelina diffusa*** *Richardia scabra** *Rottboellia cochinchinensis* *Bidens pilosa* *Sida acuta* *Paramollugo nudicaulis* *Stylosanthes guianensis**	***Sacciolepis indica*** *Hypericum japonicum* *Paspalum conjugatum* *Cenchrus clandestinus* ***Paspalum scrobiculatum*** *Echinochloa colonum* ***Cyperus iria*** *Scleria pergracilis* *Anthoxanthum odoratum* *Murdannia nudiflora* *Chamaecrista rotundifolia*	***Centella asiatica*** ***Trema angustifolium*** ***Hypericum japonicum*** ***Adenosma indiana***

The most harmful weeds in Altitude-tropical climate, corresponding to tropical areas above 400 m of elevation (Table 9) are *Ageratum conyzoides* (AGECO) and *Crassocephalum crepidioides* (CRSCR). We also find in the *General* group many species that are common in every tropical situations. However, some species are preferentially present in regions above 400 m altitude and highlighted by the corrected ecological profile. In the PCAIV, the Altitude-tropical climate contribute positively to the factorial axes 1 and 2, together with Viet Nam, and Madagascar for their surveys in the highlands. The PCAIV results also allows us to refine the interpretation of the conditions under which these species are encountered. In the mountains of Northern Viet Nam where rainfed rice is cultivated, some important weeds are *Urena lobata* (URNLO), *Commelina diffusa* (COMDI), *Lygodium flexuosum* (LYFFL), *Sigesbeckia orientalis* (SIKOR), *Hypericum japonicum* (HYPJA), *Centella asiatica* (CLLAS), *Cyperus iria* (CYPIR), *Sacciolepis indica* (SAEIN), *Trema angustifolium* (TREAN), and *Spermacoce alata* (BOILF). This latter species is also very common in the highlands in Madagascar together with *Cleome hirta* (CLEHI), and *Stylosanthes guianensis* (STYGN) which has been used as cover crop in many places. Species like *Anthoxanthum odoratum* (AOXOD), *Cenchrus clandestinus* (PESCL) and *Paspalum conjugatum* are typical to altitudinal pastures in Reunion Island.

Table 10: Harmfulness and correlation of weeds with the Wet-tropical climate

General major	General	Local major	Species correlated from Ecological profile
Digitaria horizontalis	***Bidens pilosa**** *Ageratum conyzoides* *Cardiospermum microcarpum** ***Euphorbia heterophylla*** ***Urochloa maxima**** *Oxalis corniculata**	***Croton hirtus*** *Spermacoce alata** *Brachiaria umbellata* *Pentodon pentandrus* *Ludwigia decurrens* *Sphagneticola trilobata*	*Aspilia africana* *Leucas lavandulifolia* *Centrosema pubescens* *Litsea glutinosa* ***Cyperus tenuis***

General major	General	Local major	Species correlated from Ecological profile
	Cyperus rotundus *Eleusine indica* *Ipomoea obscura** *Cyanthillium cinereum** *Phyllanthus amarus** *Mimosa pudica** *Solanum americanum** *Amaranthus viridis** *Commelina benghalensis* *Commelina diffusa** *Cleome rutidosperma** *Passiflora foetida** ***Sigesbekia orientalis**** *Momordica charantia** *Euphorbia hirta* *Desmanthus virgatus**	*Craterostigma nummulariifolium* *Urochloa eminii* *Codiaeum variegatum* ***Mitracarpus hirtus*** *Imperata cylindrica* *Acmella caulirhiza* *Stenotaphrum dimidiatum* ***Pteridium aquilinum*** *Fimbristylis littoralis* *Polytrichastrum formosum*	*Emilia sonchifolia* *Hibiscus surattensis* *Lantana camara* ***Talinum fruticosum*** ***Telosma africana*** *Digitaria ciliaris* *Drymaria cordata* *Ipomoea involucrata* *Phyllanthus urinaria* *Phyllanthus tenellus* *Cyperus erectus* *Plantago lanceolata* *Amaranthus dubius*

In Wet-tropical climate places where annual rainfall is higher than 2 000 mm (Table 10), *Digitaria horizontalis* (DIGHO) appears to be the *Major general* weed, but this species is very common everywhere in tropical areas. In the PCAIV, the Wet-tropical climate is negatively correlated to the factorial axis 2 together with Ivory Coast. Many species are considered *General* weeds. They are very common in such a climate condition in Reunion Island, Ivory Coast, Mayotte and Guadeloupe. These species are *Bidens pilosa* (BIDPI), *Ageratum conyzoides* (AGECO), *Cardiospermum microcarpum* (CRIMI), *Urochloa maxima* (PANMA), *Oxalis corniculata* (OXACO), *Ipomoea obscura* (IPOOB), *Cyanthillium cinereum* (VENCI), *Phyllanthus amarus* (PYLAM), *Solanum americanum* (SOLAM), *Amarantus viridis* (AMAVI) *Commelina diffusa* (COMDI), *Passiflora foetida* (PAQFO), *Sigesbekia orientalis* (SIKOR), *Momordica charantia* (MOMCH), *Desmanthus virgatus* (DEMVI), *Cleome rutidosperma* (CLERT) and *Mimosa pudica* (MIMPU). In wet places of Ivory Coast some weeds are very common, such as *Digitaria horizontalis* (DIGHO), *Croton hirtus* (CVNHI), *Talinum africanum* (TALFR) and *Telosma africana* (TLMAF).

Table 11: Harmfulness and correlation of weeds with the Dry-tropical climate

General major	General	Local major	Species correlated from Ecological profile
*Murdannia nudiflora**	*Tridax procumbens** *Digitaria horizontalis** *Boerhavia diffusa** *Commelina benghalensis** *Euphorbia hirta**	*Setaria sphacelata* *Digitaria argillacea* *Echinochloa obtusiflora* *Oryza longistaminata* *Imperata cylindrica*	*Sesbania sesban subsp. punctata* *Sida rhombifolia* *Phyllanthus reticulatus* *Corchorus tridens*

General major	General	Local major	Species correlated from Ecological profile
	Rottboellia cochinchinensis *Acanthospermum hispidum** *Brachiaria nana** *Corchorus trilocularis** *Citrullus lanatus** *Dactyloctenium aegyptium** *Spermacoce stachydea** *Portulaca oleracea** *Echinochloa colonum* *Cleome viscosa** *Trichodesma zeylanicum** *Achyranthes aspera** *Tephrosia purpurea**	*Acroceras amplectens* *Rhamphicarpa fistulosa*	*Ocimum americanum* *Tribulus terrestris* *Commelina forskaolii* *Corchorus aestuans* *Urochloa deflexa* *Hibiscus coerulescens* *Paederia farinosa subsp. farinosa* *Aristolochia acuminata* *Scleromitrion diffusum* *Alyzicarpus vaginalis* *Eragrostis aspera* *Cenchrus biflorus* *Commelina subulata* *Senna obtusiflora* *Trianthema portulacastrum*

In Dry-tropical climate areas where the annual rainfall is less than 1000 mm (Table 11), *Murdannia nudiflora* (MUDNU) appears the only *Major-general* weed, recorded in almost 50% of the surveys and with a mean cover of 22%. In fact this species has been recorded mainly in Madagascar in surveys carried out in the dry-climate area (annual rainfall about 350 mm), in cotton and food crop plots grown on hydromorphic temporarily flooded soils, where it is present in 70% of the surveys. In the PCAIV, the Dry-tropical climate factor is negatively but weakly correlated with the factorial axis 3, together with Madagascar, for surveys carried out in the South West of the country, and the Northen part of Cameroon and Ivory Coast. The low number of surveys carried out in this climate makes also low its contribution to PCAIV, so the species concerned have little weight in the construction of the cloud and remain towards the center. These species are therefore difficult to distinguish. Very common weeds of the Dry-tropical climate areas are *Tridax procumbens* (TRQPR), *Digitaria horizontalis* (DIGHO), *Boerhavia diffusa* (BOEDI), *Euphorbia hirta* (EPHHI). These species are also recorded in other tropical climate situations. Some species are mainly recorded in places with Dry-tropical climate such as *Brachiaria nana* (BRANA), *Corchorus trilocularis* (CRGTR) and *C. tridens* (CRGTD), *Citrullus lanatus* (CITLA), *Spermacoce stachydea* (BOISY), *Achyranthes aspera* (ACYAS) and *Tephrosia purpurea* (TEPPU). *Tribulus terrestris* (TRBTE) is also typical of this context in Africa while *Tribulus cistoides* (TRBCI) is a similar species in Asia and Indian Ocean. Some particular species appear in the groups of *General* or *Local major* weeds of Dry-tropical conditions, they are *Rottboellia cochinchinensis* (ROOEX), *Echinochloa colonum* (ECHCO), *E. obtusiflora* (ECHOB), *Oryza longistaminata* (ORYLO), *Rhamphicarpa fistulosa* (RPCLO), Trianthema portulacastrum (TRTPO) or *Sesbania sesban* subsp. *punctata* (SEBSP). All these species are growing in Dry-tropical climate places but only on hydromorphic and/or temporarily flooded soils. They also are well known to be common species of lowland or irrigated rice (Le

Bourgeois et al., 2018; Rodenburg and Johnson, 2009), but the weed flora of inondated cropping systems is not studied here.

2.3.2. Effect of the crop factor on the species

Infestation diagrams produced according to the 11 crops (Appendix 3) allowed us to define the harmfulness of weed species for the different crops (tables 12, 13, 14, 15, 16, 17, 18, 19, 20, 20, 21, 22). From the corrected ecological profiles of species with crop factor (Appendix 4.2), we could select the species showing a high relationship with each crop. These species are mentioned in the tables with a * or added in a fourth column. From the results of the PCAIV (Appendix 5), when species show a high relationship with a crop, its name is written in bold letters in the tables.

Table 12: Harmfulness and correlation of weeds with the Cotton crop

General major	General	Local major	Species correlated from Ecological profile
*Murdannia nudiflora**	*Digitaria horizontalis** *Tridax procumbens** *Commelina benghalensis* *Rottboellia cochinchinensis* *Ipomoea eriocarpa** *Spermacoce stachydea** *Boerhavia diffusa** *Euphorbia hirta* *Acanthospermum hispidum** *Dactyloctenium aegyptium** *Corchorus tridens** *Cantinoa americana ** *Brachiaria nana* *Cyperus rotundus* *Cenchrus setosus** *Cenchrus pedicellatus** *Mitracarpus hirtus* *Senna obtusifolia** *Leucas martinicensis* *Corchorus trilocularis** *Paramollugo nudicaulis* *Corchorus trilocularis* *Sida rhombifolia**		*Sesbania sesban* subsp. *punctata* *Ocimum americanum* *Hackelochloa granularis* *Amaranthus graecizans* *Commelina forskaolii* *Citrulus lanatus* *Phyllanthu reticulatus* *Bulbostylis barbata* *Vicoa indica* *Tribulus terrestris* *Cyperus squarrosus* *Spermacoce radiata* *Commelina subulata* *Aneilema lanceolata* *Cucumis melo* *Eragrostis aspera* *Corchorus aestuans* *Corchorus olitorius* *Eragrostis tremula* *Bulbostylis hispidula* *Chrysanthellum americanum* *Acalypha segetalis*

General major	General	Local major	Species correlated from Ecological profile
	Portulaca oleracea *Cleome viscosa** *Cyperus metzii**		

In Cotton crop (Table 2), *Murdannia nudiflora* (MUDNU) appears the only *Major-general* weed, recorded in almost 25% of the surveys and with a mean cover of 22%. In fact this species has been recorded mainly in Madagascar in surveys carried out in the dry-climate area (annual rainfall about 350 mm), in cotton and food crop plots grown on hydromorphic temporarily flooded soils. On the other hand, a very large number of species appear as *General* weeds. They are common and time to time abundant. The corrected ecological profile highlights also a large number of species as correlated to Cotton crop. The PCAIV do not mention the Cotton crop as an important selective factor contributing to the building of the factorial axes. In the factorial plans, Cotton is located near the center and close to the Dry-tropical climate. Thus we can conclude that at a global level of perception, Cotton crop do not select a true characteristic weed flora. In this crop, the spectrum of the weed flora is more dependent on local climate and edaphic conditions.

Table 13: Harmfulness and correlation of weeds with the Fallows

General major	General	Local major	Species correlated from Ecological profile
Chamaecrista rotundifolia *Bidens pilosa* *Commelina benghalensis* *Mimosa diplotricha* *Cleome rutidosperma** *Brachiaria umbellata** *Urochloa reptans* *Cynondon dactylon* *Urochloa maxima*	*Mimosa pudica** *Eleusine indica* *Solanum americanum** *Hibiscus surattensis** *Litsea glutinosa** *Ageratum conyzoides* *Cyanthillium cinereum** *Cyperus rotundus* *Phyllanthus amarus** *Euphorbia hirta* *Phyllanthus tenellus** *Setaria barbata* *Ipomoea obscura** *Teramnus labialis** *Portulaca oleracea** *Echinochloa colonum* *Momordica charantia** *Lantana camara** *Desmanthus virgatus** *Ipomoea nil** *Achyranthes aspera**	*Cyperus erectus* *Amaranthus spinosus* *Senna obtusifolia* *Setaria geminata* *Plectranthus amboinicus* *Heliotropium amplexicaule* *Operculina turpethum* *Stachytarpheta jamaicensis* *Melilotus albus* *Mirabilis jalapa* *Anredera cordifolia* *Echinochloa pyramidalis* *Phaulopsis verticillaris*	*Senna tora* *Vigna radiata* *Panicum trichocladum* *Panicum brevifolium* *Asystasia gangetica* *Leucas lavandulifolia* *Passiflora foetida* *Ipomoea hederifolia*

General major	General	Local major	Species correlated from Ecological profile
	Senna occidentalis *Argemone mexicana**		

Fallows are very poorly represented in the sampling of the dataset analysed here, with only 28 surveys collected in four countries namely Cameroon, French Guiana, Mayotte and Reunion Island. It is therefore not relevant to extract any valuable global results about the flora of such situations. In the PCAIV, Fallows do not contribute significatively to the building of factorial axes. Table 13 shows that *Urochloa maxima* (PANMA) appears a very common and abundant species and correlated to fallows while *Bidens pilosa* (BIDPI) also a *General major* weed is very common in most of the other crops. *Panicum* species are well represented in this kind of environment as well as vine plants such as *Ipomoea* spp., *Momordica charantia* (MOMCH), *Mimosa diplotricha* (MIMIN), *Anredera cordifolia* (BOGCO), *Teramnus labialis* (TERLA), *Operculina turpethum* (OPCTU), *Vigna radiata* (PHSAU) and *Passiflroa foetida* (PAGFO). Shrubs and subwoody species are also well represented such as *Chamaecrista rotundifolia* (CASRO), *Mimosa* spp., *Hibiscus surattensis* (HIBSU), *Lantana camara* (LANCA), *Litsea glutinosa* (LISGU), *Mirabilis jalapa* (MIBJA), and *Melilotus albus* (MEUAL).

Table 14: Harmfulness and correlation of weeds with the Food crops

General major	General	Local major	Species correlated from Ecological profile
Ageratum conyzoides	*Digitaria horizontalis* *Rottboellia cochinchinensis* *Eleusine indica* *Euphorbia hirta* *Commelina benghalensis* *Chromolaena odorata* *Tridax procumbens* *Bidens pilosa* *Ipomoea eriocarpa* *Urena lobata* *Solanum erianthum* *Griffonia simplicifolia* *Laportea aestuans* *Cyperus cyperoides*	*Sigesbeckia orientalis* *Brachiaria umbellata* *Echinochloa colonum* *Spermacoce alata* *Murdannia nudiflora* *Craterostigma nummularifolium* *Pentodon pentandrus* *Ludwigia decurrens* *Commelina africana* *Trianthema portulacastrum* *Acmella caulirhiza* *Ludwigia abyssinica*	*Griffonia simplicifolia* *Solanum erianthum* *Millettia zechiana* *Combretum zenkeri* *Motandra paniculata* *Mallotus oppositifolius* *Striga hermonthica* *Antiaris toxicaria* *Mezoneuron benthamianum* *Albizia zygia* *Spondias mombin* *Clerodendrum capitatum* *Fimbristylis scabrida* *Laportea aestuans* *Paullinia pinnata* *Steinchisma laxum* *Albizia adianthifolia* *Physalis lagascae* *Physalis angulata*

The Food crops do not select a particular weed flora (Table 14). *Ageratum conyzoides* (AGECO) appears to be the only *General major* weed. *General* weeds of this cropping system are common to most of the other cropping systems studied. In the PCAIV, the Food-crops factor is correlated negatively with the factorial axis 1 but located quite at the center of the factorial plan, which confirms that this factor is not selective to the flora. Most of the species correlated with the Food crops in the ecological profile are from Ivory Coast, where food crops were particularly surveyed.

. **Table 15: Harmfulness and correlation of weeds according to the Groundnut crop**

General major	General	Local major	Species correlated from Ecological profile
	*Digitaria horizontalis** *Tridax procumbens** *Commelina benghalensis* *Leucas martinicensis* *Ipomoea eriocarpa** *Cenchrus pedicellatus** *Dactyloctenium aegyptium** *Euphorbia hirta* *Mitracarpus hirtus** *Corchorus tridens** *Paramollugo nudicaulis* *Rottboellia cochinchinensis* *Commelina subulata** *Acanthospermum hispidum** *Commelina forskaolii** *Bulbostylis hispidula** *Senna obtusifolia** *Eragrostis ciliaris** *Melinis repens* *Oldenlandia corymbosa** *Eragrostis tremula**	*Ludwigia octovalvis*	*Spermacoce radiata* *Chrysantellum americanum* *Aneilema lanceolata* *Cyperus squarrosus* *Alysicarpus ovalifolius* *Vicoa indica* *Cyperus metzii* *Eragrostis aspera* *Hackelochloa granularis* *Acalypha segetalis* *Bulbostylis barbata* *Cleome viscosa* *Amaranthus graecizans* *Corchorus olitorius* *Cucumis melo* *Spermacoce stadydea* *Tribulus terrestris* *Ocimum americanum* *Citrulus lanatus* *Cantinoa americana*

The Groundnut crop (Table 15) is also a poorly selective crop on the weed flora. In the PCAIV, it is not significatively correlated to any factorial axis and it is located at the center of the factorial plan. All the species listed as correlated with Groundnut crop from the ecological profile (fourth column of the table) and those highlighted with a * in the *General* group are typical species to dry conditions (in terms of climate or soil) in which groundnut is preferentially grown.

Table 16: Harmfulness and correlation of weeds with the Orchards crop

General major	General	Local major	Species correlated from Ecological profile
Mimosa pudica* **Brachiaria umbellata*** **Leptothrium senegalense*** Asystasia gangetica* Centrosema pubescens* Stenotaphrum dimidiatum	**Flueggea virosa*** Oxalis corniculata* Achyranthes aspera* **Litsea glutinosa*** Senna tora Phaulopsis verticillaris* Bidens pilosa Ageratum conyzoides Hibiscus surattensis* Paspalum conjugatum Paspalum paniculatum* Oplismenus burmanii* Psidium guajava* Cyperus richardii Elephantopus mollis Panicum brevifolium Sida urens Panicum tricocladum*	Digitaria ciliaris Drymaria cordata Mimosa diplotricha Spermacoce verticillata Rolandra fruticosa Passovia pyrifolia Senna occidentalis Cyperus rotundus Indigofera hirsuta Urochloa eminii Phyllanthus niruri Digitaria horizontalis Galinsoga parviflora Steinchisma laxum Commelina erecta Scleria gaertneri	Phaulopsis verticillaris Leptothrium senegalense Cyperus richardii Spathodea campanulata Vigna radiata

Orchards crop (Table 16) determines a particular weed flora dominated by numerous Poaceae species and is characterised by a group of very common and hightly correlated species from both the ecological profile and the PCAIV, which are namely *Mimosa pudica* (MIMPU), *Brachiaria umbellata* (PANUM), *Leptothrium senegalense* (LTURA), *Flueggea virosa* (SEAVI), and *Litsea glutinosa* (LISGU). Most of the common weed species in orchards are also common species in fallows. Among the *Local major* species, some of them like *Digitaria ciliaris* (DIGAD), *Spermacoce verticillata* (BOIVE), *Rolandra fruticosa* (RONFR), *Passovia pyrifolia* (PTHPY), *Steinchisma laxum* (PANLX) and *Scleria gaertneri* (SCLPT) are typical weed species of orchards but specifically in French Guiana.

Table 17: Harmfulness and correlation of weeds with the Pastures crop

General major	General	Local major	Species correlated from Ecological profile
Anthoxanthum odoratum Cenchrus clandestinus Dactylis glomerata Brachiaria umbellata* Centrosema pubescens* Leptothrium senegalense*	Holcus lanatus* Juncus effusus Hypochaeris radicata* Flueggea virosa* Oxalis corniculata* Eragrostis macilenta Mimosa pudica* Litsea glutinosa* Agrostis capillaris Rumex crispus	Commelina africana Cleome rutidosmerma Paspalum paniculatum Cenchrus cafer Leucaena leucocephala Phyllanthus niruroides Acroceras hubbardii Rhynchosia viscosa	Vigna radiata Panicum trichocladum Spathodea campanulata Psidium guajava Panicum brevifolium Senna tora Phaulopsis verticillaris

General major	General	Local major	Species correlated from Ecological profile
	Solanum mauritianum *Erigeron karvinskianus* *Danthonia decumbens* *Achyranthes aspera** *Acacia mearnsii*		*Plantago lanceolata* *Teramnus labialis* *Hibiscus surattensis*

Pastures (Tale 17) are undersampled in this dataset (about 1% of the surveys) and most of the surveys occurred in Reunion Island at high elevation while a few of them occurred in Mayotte. It does not contribute significatively in the PCAIV, and it is located close to the center of the factorial plans together with Fallows. The main characteristic weeds of pastures from the highlands are *Anthoxanthum odoratum* (AOXOD), *Cenchrus clandestinus* (PESCL), *Dactylis glomerata* (DACGL), *Holcus lanatus* (HOLLA) *Juncus effusus* (IUNEF), and *Hypochaeris radicata* (HRYRE). Most of the common species of pastures are also common in Fallows and Orchards.

Table 18: Harmfulness and correlation of weeds with the Pineapple crop

General major	General	Local major	Species correlated from Ecological profile
*Asystasia gangetica** *Cleome rutidosperma** *Brachiaria umbellata** *Panicum trichocladum**	*Bidens pilosa** *Euphorbia hirta** ***Oxalis corniculata**** *Ipomoea obscura** *Ageratum conyzoides* *Urochloa maxima** *Cardiospermum microcarpum** *Paspalum paniculatum** *Flueggea virosa** *Cyperus erectus** *Mimosa pudica** *Phyllanthus amarus* *Cyanthillium cinereum* *Phyllanthus tenellus** *Solanum americanum** *Amaranthus dubius** *Teramnus labialis** ***Centrosema pubescens**** *Cyperus rotundus*	*Leptothrium senegalense* *Commelina africana* *Urochloa reptans* *Merremia medium* *Medicago polymorpha* *Distimake dissectus* *Arachis pintoi* *Cyperus esculentus*	*Psidium guajava* *Vigna radiata* *Phaulopsis verticillaris* *Spathodea campanulata* *Panicum brevifolium* ***Senna tora*** *Litsea glutinosa* *Lantana camara* *Hibiscus surattensis* *Cyclospermum leptophyllum*

Pineapple crop (Table 18) is also undersampled in this dataset and most of the surveys recorded for this crop were carried out in Reunion Island. In the PCAIV, Pineapple crop slightly contributes positively to the factorial axis 3 as well as Reunion country. *General major* weeds of the Pineapple crop are *Asystasia gangetica* (ASYCO), *Cleome rutidosperma* (CLERT), *Panicum trichocladum* (PANTC), and *Brachiaria umbellata* (PANUM) while *Oxalis corniculata* (OXACO), *Centrosema pubescens* (COSPU), and *Senna tora* (CASTO) appear hightly correlated to this crop.

Table 19: Harmfulness and correlation of weeds with the Rice crop

General major	General	Local major	Species correlated from Ecological profile
Ageratum conyzoides ***Crassocephalum crepidioides**** *Commelina diffusa*	*Eleusine indica* *Urena lobata** *Mitracapus hirtus** *Richardia scabra** *Cyperus rotundus* *Cleome hirta** *Paramollugo nudicaulis* ***Lygodium flexuosum****	*Erigeron floribundus* *Sacciolepis indica** *Hypericum japonicum** *Paspalum scrobiculatum* *Paspalum conjugatum* *Spermacoce alata* *Cyperus iria* *Hyptis capitata* *Setaria palmifolia* *Scleria pergracilis* *Trigastrotheca stricta*	*Trema angustifolium* *Stylosanthes guianensis* *Neojeffreya decurrens* *Oplismenus burmanii*

Rice crop (Table 19), corresponding to rainfed upland rice, is very well sampled in the dataset but most of the surveys were carried out in the highlands of Madagascar and Viet Nam. In the PCAIV Rice crop is significatively and positively correlated to Axis 2 together with Altitude-tropical climate. That is why the species correlated to rice are also those correlated to Altitude-tropical climate, with species like *Crassocephalum crepidioides* (CRSCR), *Lygodium flexuosum* (LYFFL), *Hypericum japonicum* (HYPJA), *Urena lobata* (URNLO) and *Trema angustifolium* (TREAN) in Northern Viet Nam while *Richardia scabra* (RCHSC), *Cleome hirta* (CLEHI), *Stylosanthes guianensis* (STYGN), and *Neojeffreya decurrens* (PTODE) are typical to rainfed upland rice in Madagascar. *Ageratum conyzoides* (AGECO) is a *Major general* weed of rainfed rice everywhere, as well as most of the other rainfed crops.

Table 20: Harmfulness and correlation of weeds with the Sugarcane crop

General major	General	Local major	Species correlated from Ecological profile
	*Euphorbia heterophylla** *Rottboellia cochinchinensis* *Cardiospermum micranthum** *Bidens pilosa* *Cyperus rotundus*	*Ipomoea triloba* *Anredera cordifolia* *Jacquemontia tamnifolia* *Panicum subalbidum*	*Distimake aegyptius* *Centrosema virginianum* *Ipomoea tiliacea* *Eleutheranthera ruderalis* *Desmodium tortuosum*

	Urochloa maxima *Desmanthus virgatus** *Ipomoea obscura** *Malvastrum coromandelianum** *Momordica charantia* *Cynodon dactylon* *Commelina benghalensis* *Cyanthillium cinereum* *Amaranthus dubius**		*Sorghum arundinaceum* *Chloris barbata* *Parthenium hysterophorus* *Ipomoea hederifolia* *Rhynchosia minima* *Argemone mexicana* *Euphorbia hypericifolia*

The Sugarcane crop (Table 20), in spite of the very large number of surveys, does not discriminate a very particular weed flora. This flora is globally common to the crops of the regions with tropical and humid tropical climate. Most characteristic species are *Euphorbia heterophylla* (EPHHL), *Cardiospermum micranthum* (CRIMI), *Desmanthus virgatus* (DEMVI), *Malvastrum coromandelianum* (MAVCO), and *Amaranthus dubius* (AMADU). In the PCAIV, this crop contributes positively but slightly to the factorial axis 1 and is situated very close to the center, without being significatively correlated with particular species.

Table 21: Harmfulness and correlation of weeds with the Tubers crop

General major	General	Local major	Species correlated from Ecological profile
*Digitaria horizontalis** *Croton hirtus** *Ageratum conyzoides* *Spermacoce alata** *Bidens pilosa* *Euphorbia heterophylla*	*Cyanthillium cinereum** *Eleusine indica** *Cyperus tenuis** *Cyperus cyperoides** *Urochloa maxima** *Commelina diffusa** *Talinum fruticosum** *Boerhavia diffusa** *Phyllanthus amarus* *Paramollugo nudicaulis** *Euphorbia hirta* *Telosma africana** *Mitracapus hirtus* *Oldenlandia corymbosa** *Tridax procumbens* *Cleome rutidosperma** *Ipomoea involucrata** *Emilia sonchifolia** *Centrosema pubescens** *Chromolaena odorata*	*Brachiaria umbellata* *Imperata cylindrica* *Pteridium aquilinum* *Mimosa diplotricha* *Blighia welwitschii* *Hexasepalum scandens* *Leptothrium senegalense* *Paspalum vaginatum* *Acalypha indica*	*Plectranthus monostachyus* *Euphorbia hyssopifolia* *Oldenlandia affinis* *Cryptolepis nigrescens* *Phyllanthus reticulatus* *Passiflora foetida* *Physalis angulata* *Steinchisma laxum* *Solanum nigrum* *Spigelia anthelmia*

General major	General	Local major	Species correlated from Ecological profile
	Rottboellia cochinchinensis *Eragrostis ciliaris** *Pueraria phaseoloides** *Sida acuta** *Aspilia africana** *Urena lobata* *Paspalum scrobiculatum* *Celosia trigyna**		

In the PCAIV, Tubers crop is significatively and negatively correlated to the three factorial axes and located in the same direction as Ivory-coast and Wet-tropical climate. This is why, despite some weed species common in quite every context, there are, in Table 21, many species growing preferentially in Wet climate and found in Ivory-coast, such as *Talinum fruticosum* (TALFR), *Telosma africana* (TLMAF), *Aspilia africana* (APIAR), *Pueraria phaseoloides* (PUEPH), *Plectranthus monostachyus* (SLSMO), *Oldenlandia affinis* (OLDAF), and *Cryptolepis nigrescens* (KWONI).

Table 22: Harmfulness and correlation of weeds with the Vegetables crop

General major	General	Local major	Species correlated from Ecological profile
	Bidens pilosa *Oxalis corniculata** *Ageratum conyzoides* *Eleusine indica* *Centrosema pubescens* *Portulaca oleracea** *Cyperus rotundus* *Sonchus asper** *Euphorbia hirta* *Solanum nigrum** *Amaranthus viridis** *Galinsoga parviflora** *Solanum americanum** *Phyllanthus amarus* *Oxalis latifolia** *Stellaria media** *Gamochaeta purpurea** *Cleome rutidosperma** *Cyanthillium cinereum*	*Verbesina encelioides* *Fimbristylis littoralis* *Clibadium surinamense* *Rugoloa pilosa* *Bidens cynapiifolia* *Stenotaphrum dimidiatum* *Codiaeum variegatum* *Anredera cordifolia* *Polytrichastrum formosum* *Cleome aculeata* *Paspalum conjugatum*	*Lepidium didymum* *Sonchus oleraceus* *Euphorbia hyssopifolia* *Phyllanthus tenellus* *Plantago lanceolata* *Argemone mexicana*

General major	General	Local major	Species correlated from Ecological profile
	Cardiospermum microcarpum *Cyclospermum leptophyllum**		

The Vegetables crop factor (Table 22) is not significatively correlated to any factorial axis of the PCAIV, and the infestation graph does not highlight any *Major general* weed for this cropping system. This is probably due to the fact that these crops, grown on small plots and with a high economic stake, are systematically and regularly weeded. Some common weeds are very frequent in vegetables plots (about 40% of surveys) such as *Bidens pilosa* (BIDPI), *Oxalis corniculata* (OXACO), *Ageratum conyzoides* (AGECO) and *Eleusine indica* (ELEIN). Some species appear highly correlated with this cropping system and are more scarce in other crops, such as *Sonchus asper* (SONAS) and *S. oleraceus* (SONOL), *Portulaca oleracea* (POROL), *Solanum nigrum* (SOLNI) and *S. americanum* (SOLAM), *Amaranthus viridis* (AMAVI), *Oxalis latifolia* (OXALA), *Stellaria media* (STEME), *Gamochaeta purpurea* (GNAPU), *Cleome rutidosperma* (CLERT), *Cyclospermum leptophyllum* (APULE) and *Lepidium didymum* (COPDI).

2.3.3. Effect of the country factor on the species

The results of the PCAIV show that certain countries are highly correlated to factorial axes so that they contribute to discriminate a particular weed flora. For example, Northern Viet Nam in opposition to Madagascar along Axis 1, while it is also in opposition with Ivory Coast along the Axis 2. Mayotte and Reunion are situated on the positive part of Axis 3, while Madagascar and Ivory Coast are on the negative part. From the Corrected ecological profile of the species in relation to the country factor we can select the most correlated species to these ountries.

The most correlated species to Viet Nam are *Lygodium flexuosum* (LYFFL), *Trema angustifolium* (TREAN), *Hypericum japonicum* (HYPJA), *Cyperus mindorensis* (CYPKH), *Ficus simplicissima* (FIUHT), *Adenosma indiana* (ADVIN), *Lycopodiella cernua* (LPOCE), *Sacciolepis indica* (SAEIN), *Cyperus iria* (CYPIR), *Torenia crustacea* (LIDCR), *Centella asiatica* (CLLAS), and *Crassocephalum crepidioides* (CRSCR). They are weeds of rainfed rice and food crops in Altitude-tropical climate areas.

The most correlated species to Madagascar are *Cleome hirta* (CLEHI), *Richardia scabra* (RCHSC), *Corchorus trilocularis* (CRGTR), *Stylosanthes guianensis* (STYGN), *Brachiaria nana* (BRANA), *Sesbania sesban* subsp. *punctata* (SEBSP), *Neojeffreya decurrens* (PTODE), and *Murdannia nudiflora* (MUDNU).

The most correlated species to Ivory-Coast are *Fimbristylis scabrida* (FIUEX), *Cyperus tenuis* (MAPFL), *Griffonia simplicifolia* (GRFSI), *Solanum erianthum* (SOLER), *Millettia zechiana* (MIJZE), *Combretum zenkeri* (COGZN), *Cryptolepis nigrescens* (KWONI), *Pouzolzia guineensis* (PZLGU), *Antiaris toxicaria* (AJSTO), *Albizia zygia* (ALBZY), *Mezoneuron benthamianum* (MZUBN), *Ipomoea involucrata* (IPOIV), *Paullinia pinnata* (PAXPI), *Pueraria phaseoloides* (PUEPH), *Telosma africana* (TLMAF), *Motandra paniculata* (MOWGU), *Albizia adianthifolia* (ALBAD), *Oldenlandia affinis* (OLDAF), *Clerodendrum* *capitatum* (CLZCA), *Spondia mombin* (SPXMO), *Aspila africana* (APIAR), *Plectranthus monostachyus* (SLSMO), *Cnestis ferruginea* (CXNFE). *Ipomoea mauritiana* (IPOMT), *Sporobolus pyramidalis* (SPZPY), *Newbouldia laevis* (NWBLA), *Cissus arguta* (CIBPR), *Cardiospermum grandiflorum* (CRIGR), *Sterculia tragacantha* (SRLTA), *Senegalia pentagona* (SLGPN), *Clerodendron silvanum* var. *silvanum* (SLZSI), *Talinum fruticosum* (TALFR), *Mallotus oppositifolius* (MLLOP), and *Commelina bracteosa* var. *lagosensis* (COMLA). They are mainly weeds of food crops in Wet-tropical climate area.

The most correlated species to Mayotte are *Leptothrium senegalense* (LTURA), *Panicum trichocladum* (PANTC), *Phaulopsis verticillaris* (PVPVE), *Vigna radiata* (PHSAU), *Albizia lebbeck* (ALBLE), *Spathodea campanulata* (SPOCA), *Psidium guajava* (PSIGU), *Flueggea virosa* (SEAVI), *Brachiaria umbellata* (PANUM), *Panicum brevifolium* (PANBR), *Senna tora* (CASTO), and *Sida urens* (SIDUR). Those species are mainly recorded in orchards fields and food crops fields cultivated in the so-called "creole gardens" in Mayotte.

The most correlated species with Reunion Island are *Amaranthus blitum* supsp. *emarginatus* (AMALP), *Paspalum dilatatum* (PASDI), *Fumaria muralis* (FUMMU), *Tephrosia noctiflora* (TEPNO), *Desmodium intortum* (DEDIN), *Ipomoea hederifolia* (IPOHF), *Nicandra physaloides* (NICPH), *Leucas lavandulifolia* (LEVLA), *Rubus alceifolius* (RUBAC), *Plantago lanceolata* (PLALA), *Amaranthus dubius* (AMADU), *Parthenium hysterophorus* (PTNHY), *Oxalis debilis* var. *corymbosa* (OXACB), *Solanum americanum* (SOLAM), and *Malvastrum coromandelianum* (MAVCO). Most of them are sugarcane weeds or species growing at high elevation.

3. Discussion

In this study, quite a large number of datasets were processed, but unfortunately without a perfect sampling balance across crops, countries and climates. In addition, some tropical regions are clearly under-represented, such as tropical America, and tropical Asia.

The PCAIV is finally little informative with a cumulative inertia of the first three factorial axes of only 11.96% and an inertia of the species abundance matrix explained by the given factors of only 18.35%. This shows that despite the correlations highlighted by the corrected ecological profiles with respect to crop, climate and country factors, there are other agro-environmental factors acting on species selection and abundance, which we have not been able to analyse here. Part of the weakness of the PCAIV is undoubtedly explained by the crop groupings that we had to do. For the Crop factor, it was necessary to make groupings to avoid multiplying the number of crops and diluting the information, as for food crops (sorghum, muskwari, millet, maize) and tubers (cassava, yam, taro). But all these crops do not necessarily have the same needs in terms of soil types or climate. For example, sorghum and millet accept light soils in dry climates, while muskwarri is a sorghum variety from the dry zone on heavy soil that is temporarily flooded and maize is preferentially grown on rich soil in tropical climates. It is the same for cassava which tolerates poor soils and dry climate while yam and tarot are rather cultivated in deep soil in wet climate areas. Thus, the weed floras of these different crops will be partially different due to the soil and climate conditions. In their analyses of the constraints of weeds in rainfed crops in Northern Cameroon or Madagascar, Le Bourgeois (1993) and Randriamampianina et al. (2001) clearly showed that in a given region, the nature of the soil combined with rainfall represent the main factors acting on flora selection. Secondly, cultural practices (tillage, fertilizers, weeding methods) intervene on the abundance of species by reducing sensitive species and favoring tolerant species.

Beyond these local processes, it is obvious that at the global scale of the tropical level of our study, the geographical factor makes a rather important contribution in the floristic composition. Although many tropical weeds are pan-tropical and occur in all tropical regions of the world (e.g. *Bidens pilosa*, *Ageratum conyzoides*, *Rottboellia cochinchinensis*, *Cyperus rotundus*...) some species remain inferred to particular regions such as tropical America, Africa, or Asia. The islands of the Indian Ocean are clearly placed at the interface of African and Asian flora and even American and European flora because of the numerous introductions made for about 400 years of human activities in these islands. Thus, the weed flora of Reunion Island, which combines a very strong rainfall and altitudinal gradients, represents a magnificent mixture of tropical and subtropical weed flora from the 4 continents. In some 400 years of human occupation more than 3000 plant species have been introduced there (Lavergne, 1978). And despite new regulations and controls, a new weed, native to tropical America *Porophyllum ruderale*, has recently naturalized on this island and was reported in 2019 (Marnotte and Le Bourgeois, 2019).

Globally, the weed flora of tropical rainfed crops is very diverse and includes a very large number of species. However, on a global scale the most frequent species are present in less than 30% of the plots, but there is a pool of species that are found very regularly in the plots. Rainfall and altitude (inducing cooler average temperatures) are selecting certain species or favor their abundance. The crops themselves are partly correlated to climate (cotton and food crops are more likely to be grown in tropical or dry tropical regions, while sugarcane and tubers are more related to wet-tropical climates, and pasture and rainfed rice are more likely to be grown at higher altitudes.

Some species that are very common in tropical regions can be found in different climates or crops such as *Digitaria horizontalis, Ageratum conyzoides*, or *Rottboellia cochinchinensis* but in a more or less abundant way. It is probably the local edaphic conditions that are conditioning their development and possibly weed management practices such as the use of herbicides that are favoring or disadvantaging them. Unfortunately, we could not analyse the effect of the soil factor and weed management practices, because they were not recorded in all the datasets. Thus, a number of species appear as good indicators of the agro-ecological situations. But, it is rather a combination of species according to their presence and respective abundance that seems to be representative of a given situation. *Local major* species in infestation graphs and species appearing highly correlated in the corrected ecological profiles are also good indictors of environmental conditions, but as they are not common, it is important to understand the local agro-ecological factor that allow their development.

It is interesting, for example, to look at the status of *Murdannia nudiflora* (MUDNU) which appears as a *General major* weed in Dry-tropical climate regions whereas it is a wetland species (WIKWIO Portal, n.d.). It is typically a species that grows on hydromorphic or temporarily flooded soils but it can be found in Dry-tropical climate areas as long as the soil remains wet for part of the cropping season. Other species correlated to dry climate appear as *Local major* weeds because they grow in very wet lowland environments, such as *Echinochloa colonum* (ECHCO), *E. obtusiflora* (ECHOB), *Rhamphicarpa fistulosa* (RPCLO), *Oryza longistaminata*, or *Sesbania sesban* subsp. *punctata* (SEBSP). These elements of understanding confirm that the presence of weeds is very strongly dependent on the combination of soil and climate conditions. Another interesting case is *Asystasia gangetica* (ASYCO), that appears to be the

Major general weed of pineapple, and is known to be the worst weed of this crop in Reunion Island (Lebreton and Le Bourgeois, 2005) but also in other places (P. Marnotte c.p.). The fruits of this species are capsules that burst by projecting the seeds, which accumulate at the base of the leaves of the pineapple offsets and are thus disseminated from one plot to another by the offsets used for planting.

Weeds in temperate crops are highly dependent on temperature and day length to germinate and develop, which clearly differentiates autumn, winter, spring and summer weed floras. On the other hand, in tropical regions the temperature is rarely limiting (except with altitude) and the day length varies little during the year. Thus, it is above all the rainfall in terms of quantity and distribution along the year that plays a major role in the selection of species, combined with the nature of the soil through its water retention capacity and fertility. Thus, the edaphic situation represents a major factor in the selection of the weed flora of a crop plot. Then, rotation and agricultural practices will favour or unfavour species according to their tolerance or resistance to these practices.

Conclusion

A number of very ubiquitous and pantropical weed species were found in almost all regions, in all climates and in all crops. This does not mean that they are present and/or abundant in all cultivated plots. Indeed, it is important to keep in mind that even the most frequent species such as *Rottboella cochinchinensis, Digitaria horizontalis* and *Bidens pilosa* are respectively present in only 28%, 25% and 23% of the total plots surveyed. It is then particularly interesting to understand in which situations these species are not present and not growing. Indeed, according to the corrected ecological profile on the crop factor, *R. cochinchinensis* develops in all climates, but it is a species growing in heavy and more or less hydromorphic soils, which is never present in pasture or vegetable crops. *D. horizontalis* is present in all climates but prefers dry climates. It is rare in sugarcane and orchards and is absent from fallow land, pastures and pineapple plots. As for *Bidens pilosa*, this species is present in all climates but prefers humid climates, and is rare in Cotton and groundnut.

This study shows that it is not possible to define a weed flora specific to each crop type, but that the composition of the weed flora depends mainly on the region, the climate and the soil (which will interfere with the climate). However, it is still possible to know which species are most likely to be found in each crop. At the level of species knowledge, the combined analysis of results from infestation diagrams, ecological profiles and global multivariate analysis allows us to refine our knowledge of their behavior. For example, for the most frequent species, it is possible to highlight situations where they are not encountered or where they are scarse. Thus, it is possible to consider the elements of these contexts that would prevent the species from developing (competition by other species, such as in pastures or grassy orchards, very regular weeding as in vegetable crops...). Conversely, for the species that are not frequent but abundant when present (*Major-local* weeds) it is necessary to understand the particular situation in which these species develop. As for example *Hypericum japonicum* a major weed of rainfed rice but only in Northern Viet Nam.

From this study, we did not find patterns of weeds strictly related to any crop, but crops are cultivated in environments that are more or less favorable to the development of weeds.

Despite the exhaustive flora of this study is very diverse and counts 1 388 species with 89 to 389 taxa per study and 3 to 71 taxa per survey, finally, the weed flora of interest at the level of tropical areas for rainfed crops can be reduced to about 300 species, comprising the common and harmful species and the ecological indicator species. Only a small number of species are truly damaging to tropical agricultural production and need to be managed effectively. Some species are relevant agro-ecological indicators, and their presence informs us about the conditions of the climate, environment or cropping system. It is therefore very useful to know how to decipher the ecological significance of these species.

In this study, we worked at the species level, but each species can be considered as a combination of morphological or behavioural functional traits that can interact with the crop. In this study we did not find strong patterns discriminating weed communities according to rainfed tropical crops or tropical climates. The question then arises as to whether the analysis of the same dataset but based on functional traits instead of species could highlights patterns of selection of traits communities according to crops and climates at the global scale of tropical rainfed crops. In another hand, it would be interesting to assess the extent to which functional traits are more sensitive to crop and climate factor than species and more relevant in characterising weed constraint of these cropping systems.

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Appendix 1: List of 299 species mentioned in this study, sorted by scientific name

EPPO code	Scientific species name	Family name
ACAMR	*Acacia mearnsii* De Wild.	Fabaceae
ACCIN	*Acalypha indica* L.	Euphorbiaceae
ACCSE	*Acalypha segetalis* Müll.Arg.	Euphorbiaceae
ACNHI	*Acanthospermum hispidum* DC.	Asteraceae
ACYAS	*Achyranthes aspera* L.	Amaranthaceae
SPLMR	*Acmella caulirhiza* Delile	Asteraceae
ACQAM	*Acroceras amplectens* Stapf	Poaceae
ACQHU	*Acroceras hubbardii* (A.Camus) Clayton	Poaceae
ADVIN	*Adenosma indiana* (Lour.) Merr.	Plantaginaceae
AGECO	*Ageratum conyzoides* L.	Asteraceae
AGSTE	*Agrostis capillaris* L.	Poaceae
ALBAD	*Albizia adianthifolia* (Schumach.) W.Wight	Fabaceae
ALBLE	*Albizia lebbeck* (L.) Benth.	Fabaceae
ALBZY	*Albizia zygia* (DC.) J.F.Macbr.	Fabaceae
ALZOV	*Alysicarpus ovalifolius* (Schumach.) J.Léonard	Fabaceae
ALZVA	*Alysicarpus vaginalis* (L.) DC.	Fabaceae
AMALP	*Amaranthus blitum* subsp. *emarginatus* (Salzm. ex Uline & Bray) Carretero, Muñoz Garm. & Pedrol	Amaranthaceae
AMADU	*Amaranthus dubius* H.Martius ex Thell.	Amaranthaceae
AMAGR	*Amaranthus graecizans* L.	Amaranthaceae
AMASP	*Amaranthus spinosus* L.	Amaranthaceae
AMAVI	*Amaranthus viridis* L.	Amaranthaceae
ANELA	*Aneilema lanceolatum* Benth.	Commelinaceae
BOGCO	*Anredera cordifolia* (Ten.) Steenis	Basellaceae
AOXOD	*Anthoxanthum odoratum* L.	Poaceae
AJSTO	*Antiaris toxicaria* (J.F.Gmel.) Lesch.	Moraceae
ARHPI	*Arachis pintoi* Krapov. & W.C.Greg.	Fabaceae
ARGME	*Argemone mexicana* L.	Papaveraceae
ARPAC	*Aristolochia acuminata* Lam.	Aristolochiaceeae
APIAR	*Aspilia africana* (Pers.) C.D.Adams	Asteraceae
ASYCO	*Asystasia gangetica* (L.) T.Anderson	Acanthaceae
BIDCY	*Bidens cynapiifolia* Kunth	Asteraceae
BIDPI	*Bidens pilosa* L.	Asteraceae
BLIWE	*Blighia welwitschii* (Hiern) Radlk.	Sapindaceae
BOEDI	*Boerhavia diffusa* L.	Nyctaginaceae
BRANA	*Brachiaria nana* Stapf	Poaceae
PANUM	*Brachiaria umbellata* (Trin.) Clayton	Poaceae
BULBA	*Bulbostylis barbata* (Rottb.) C.B.Clarke	Cyperaceae
FIMHS	*Bulbostylis hispidula* (Vahl) R.W.Haines	Cyperaceae
CRIGR	*Cardiospermum grandiflorum* Sw.	Sapindaceae

CRIMI	*Cardiospermum microcarpum* Kunth	Sapindaceae
CEOTR	*Celosia trigyna* L.	Amaranthaceae
CCHBI	*Cenchrus biflorus* Roxb.	Poaceae
PESCA	*Cenchrus cafer* (Bory) Veldkamp	Poaceae
PESCL	*Cenchrus clandestinus* (Hochst. ex Chiov.) Morrone	Poaceae
PESPE	*Cenchrus pedicellatus* (Trin.) Morrone	Poaceae
PESPO	*Cenchrus setosus* subsp. *setosus*	Poaceae
CLLAS	*Centella asiatica* (L.) Urb.	Apiaceae
COSPU	*Centrosema pubescens* Benth.	Fabaceae
COSVI	*Centrosema virginianum* (L.) Benth.	Fabaceae
CASRO	*Chamaecrista rotundifolia* (Pers.) Greene	Fabaceae
CHRBA	*Chloris barbata* Sw.	Poaceae
EUPOD	*Chromolaena odorata* (L.) R.M.King & H.Rob.	Asteraceae
CJLAM	*Chrysanthellum americanum* (L.) Vatke	Asteraceae
CIBPR	*Cissus arguta* Hook.f.	Vitaceae
CITLA	*Citrullus lanatus* (Thunb.) Matsum. & Nakai	Cucurbitaceae
CLEAC	*Cleome aculeata* L.	Cleomaceae
CLEHI	*Cleome hirta* (Klotzsch.) Oliv.	Cleomaceae
CLERT	*Cleome rutidosperma* DC.	Cleomaceae
CLEVI	*Cleome viscosa* L.	Cleomaceae
CLZCA	*Clerodendrum capitatum* (Willd.) Schumach.	Lamiaceae
CLZSI	*Clerodendrum silvanum* var. *silvanum*	Lamiaceae
CBWSU	*Clibadium surinamense* L.	Asteraceae
CXNFE	*Cnestis ferruginea* Vahl ex DC.	Connaraceae
CDIVA	*Codiaeum variegatum* (L.) Rumph. ex A.Juss.	Euphorbiaceae
COGZN	*Combretum zenkeri* Engl. & Diels	Combretaceae
COMAF	*Commelina africana* L.	Commelinaceae
COMBE	*Commelina benghalensis* L.	Commelinaceae
COMLA	*Commelina bracteosa* var. *lagosensis* (C.B.Clarke) Faden	Commelinaceae
COMDI	*Commelina diffusa* Burm.f.	Commelinaceae
COMER	*Commelina erecta* L.	Commelinaceae
COMFO	*Commelina forskaolii* Vahl	Commelinaceae
COMSU	*Commelina subulata* Roth	Commelinaceae
CRGAE	*Corchorus aestuans* L.	Malvaceae
CRGOL	*Corchorus olitorius* L.	Malvaceae
CRGTD	*Corchorus tridens* L.	Malvaceae
CRGTR	*Corchorus trilocularis* L.	Malvaceae
CRSCR	*Crassocephalum crepidioides* (Benth.) S.Moore	Asteraceae
LIDNU	*Craterostigma nummulariifolium* (D.Don) Eb.Fisch., Schäferh. & Kai Müll.	Linderniaceae
CVNHI	*Croton hirtus* L'Hér.	Euphorbiaceae
KWONI	*Cryptolepis nigrescens* (Wennberg) L.Joubert & Bruyns	Apocynaceae
CUMME	*Cucumis melo* L.	Cucurbitaceae
VENCI	*Cyanthillium cinereum* (L.) H.Rob.	Asteraceae
APULE	*Cyclospermum leptophyllum* (Pers.) Eichler	Apiaceae

CYNDA	*Cynodon dactylon* (L.) Pers.	Poaceae
CYPCP	*Cyperus compressus* L.	Cyperaceae
MAPSI	*Cyperus cyperoides* (L.) Kuntze	Cyperaceae
KYLER	*Cyperus erectus* (Schumach.) Mattf. & Kük.	Cyperaceae
CYPES	*Cyperus esculentus* L.	Cyperaceae
CYPIR	*Cyperus iria* L.	Cyperaceae
KYLSQ	*Cyperus metzii* (Hochst. ex Steud.) Mattf. & Kük.	Cyperaceae
CYPKH	*Cyperus mindorensis* (Steud.) Huygh	Cyperaceae
KYLBU	*Cyperus richardii* Steud.	Cyperaceae
CYPRO	*Cyperus rotundus* L.	Cyperaceae
MAPSQ	*Cyperus squarrosus* L.	Cyperaceae
MAPFL	*Cyperus tenuis* Sw.	Cyperaceae
DACGL	*Dactylis glomerata* L.	Poaceae
DTTAE	*Dactyloctenium aegyptium* (L.) Willd.	Poaceae
SIGDF	*Danthonia decumbens* (L.) DC.	Poaceae
DEMVI	*Desmanthus virgatus* (L.) Willd.	Fabaceae
DEDIN	*Desmodium intortum* (Mill.) Urb.	Fabaceae
DEDTO	*Desmodium tortuosum* (Sw.) DC.	Fabaceae
DIGAR	*Digitaria argillacea* (Hitchc. & Chase) Fernald	Poaceae
DIGAD	*Digitaria ciliaris* (Retz.) Koeler	Poaceae
DIGHO	*Digitaria horizontalis* Willd.	Poaceae
CONAE	*Distimake aegyptius* (L.) A.R.Simões & Staples	Convolvulaceae
MRRDI	*Distimake dissectus* (Jacq.) A.R.Simões & Staples	Convolvulaceae
DRYCO	*Drymaria cordata* (L.) Willd. ex Schult.	Caryophyllaceae
ECHCO	*Echinochloa colonum* (L.) Link	Poaceae
ECHOB	*Echinochloa obtusiflora* Stapf	Poaceae
ECHPY	*Echinochloa pyramidalis* (Lam.) Hitchc. & Chase	Poaceae
ELPMO	*Elephantopus mollis* Kunth	Asteraceae
ELEIN	*Eleusine indica* (L.) Gaertn.	Poaceae
ELURU	*Eleutheranthera ruderalis* (Sw.) Sch.Bip.	Asteraceae
EMISO	*Emilia sonchifolia* (L.) DC.	Asteraceae
ERAAS	*Eragrostis aspera* (Jacq.) Nees	Poaceae
ERACI	*Eragrostis ciliaris* (L.) R.Br.	Poaceae
ERAMC	*Eragrostis macilenta* (A.Rich.) Steud.	Poaceae
ERATM	*Eragrostis tremula* Hochst. ex Steud.	Poaceae
ERIFL	*Erigeron floribundus* (Kunth) Sch.Bip.	Asteraceae
ERIKA	*Erigeron karvinskianus* DC.	Asteraceae
EPHHL	*Euphorbia heterophylla* L.	Euphorbiaceae
EPHHI	*Euphorbia hirta* L.	Euphorbiaceae
EPHHY	*Euphorbia hypericifolia* L.	Euphorbiaceae
EPHHS	*Euphorbia hyssopifolia* L.	Euphorbiaceae
FIUHT	*Ficus simplicissima* Lour.	Moraceae
FIMFE	*Fimbristylis ferruginea* (L.) Vahl	Cyperaceae
FIMLI	*Fimbristylis littoralis* Gaud.	Cyperaceae
FIUEX	*Fimbristylis scabrida* Schumach.	Cyperaceae

SEAVI	*Flueggea virosa* (Roxb. ex Willd.) Royle	Phyllanthaceae
FUMMU	*Fumaria muralis* Sond. ex Koch	Fumariaceae
GASPA	*Galinsoga parviflora* Cav.	Asteraceae
GNAPU	Gamochaeta purpurea (L.) Cabrera	Asteraceae
GRFSI	Griffonia simplicifolia (Vahl ex DC.) Baill.	Fabaceae
HAKGR	*Hackelochloa granularis* (L.) Kuntze	Poaceae
HEOAM	*Heliotropium amplexicaule* Vahl	Boraginaceae
HXESC	*Hexasepalum scandens* (Sw.) J.H.Kirkbr. & Delprete	Rubiaceae
HIBCE	*Hibiscus caerulescens* Baill.	Malvaceae
HIBSU	*Hibiscus surattensis* L.	Malvaceae
HOLLA	*Holcus lanatus* L.	Poaceae
HOTCO	*Houttuynia cordata* Thunb.	Saururaceae
HYPJA	*Hypericum japonicum* Thunb.	Hypericaceae
HRYRA	*Hypochaeris radicata* L.	Asteraceae
HPYCA	*Hyptis capitata* Jacq.	Lamiaceae
HPYSP	*Cantinoa americana* (Aubl.) Harley &J.F.B.Pastore	Lamiaceae
IMPCY	*Imperata cylindrica* (L.) B.Beauv.	Poaceae
INDHI	*Indigofera hirsuta* L.	Fabaceae
IPOER	*Ipomoea eriocarpa* R.Br.	Convolvulaceae
IPOHF	*Ipomoea hederifolia* L.	Convolvulaceae
IPOIV	*Ipomoea involucrata* P. Beauv.	Convolvulaceae
IPOMT	*Ipomoea mauritiana* Jacq.	Convolvulaceae
IPONI	*Ipomoea nil* (L.) Roth	Convolvulaceae
IPOOB	*Ipomoea obscura* (L.) Ker-Gawler	Convolvulaceae
IPOFA	*Ipomoea tiliacea* (Willd.) Choisy	Convolvulaceae
IPOTR	*Ipomoea triloba* L.	Convolvulaceae
IAQTA	*Jacquemontia tamnifolia* (L.) Griseb.	Convolvulaceae
IUNEF	*Juncus effusus* L.	Juncaceae
LANCA	*Lantana camara* L.	Verbenaceae
LAOAE	*Laportea aestuans* (L.) Chew	Urticaceae
LNECO	*Launaea cornuta* (Hochst. ex Oliv. & Hiern) C.Jeffrey	Asteraceae
COPDI	*Lepidium didymum* L.	Brassicaceae
LTURA	*Leptothrium senegalense* (Kunth) W.D.Clayton	Poaceae
LUAGL	*Leucaena leucocephala* (Lam.) de Wit	Fabaceae
LEVLA	*Leucas lavandulifolia* Sm.	Lamiaceae
LEVMA	*Leucas martinicensis* (Jacq.) R.Br.	Lamiaceae
LISGU	*Litsea glutinosa* (Lour.) C.Rob.	Lauraceae
IUSAB	*Ludwigia abyssinica* A.Rich.	Onagraceae
IUSDE	*Ludwigia decurrens* Walter	Onagraceae
LUDOC	*Ludwigia octovalvis* (Jacq.) Raven	Onagraceae
LPOCE	*Lycopodiella cernua* (L.) Pic.Serm.	Lycopodiaceae
LYFFL	*Lygodium flexuosum* (L.) Sw.	Schizaeaceae
MLLOP	*Mallotus oppositifolius* (Geisel.) Müll.Arg.	Euphorbiaceae
MAVCO	*Malvastrum coromandelianum* (L.) Garcke	Malvaceae
MASMI	*Marsilea minuta* L.	Marsileaceae

MEDPO	*Medicago polymorpha* L.	Fabaceae
MEUAL	*Melilotus albus* Medik.	Fabaceae
RHYRE	*Melinis repens* (Willd.) Zizka	Poaceae
MRRMD	*Merremia medium* (L.) Hallier f.	Convolvulaceae
MZUBN	*Mezoneuron benthamianum* Baill.	Fabaceae
MIJZE	*Millettia zechiana* Harms	Fabaceae
MIMIN	*Mimosa diplotricha* C.Wright	Fabaceae
MIMPU	*Mimosa pudica* L.	Fabaceae
MIBJA	*Mirabilis jalapa* L.	Nyctaginaceae
MTCVI	*Mitracarpus hirtus* (L.) DC.	Rubiaceae
MOMCH	*Momordica charantia* L.	Cucurbitaceae
MOWGU	*Motandra paniculata* (Poir.) I.M.Turner	Apocynaceae
PTODE	*Neojeffreya decurrens* (L.) Cbrera	Asteraceae
NWBLA	*Newbouldia laevis* (P.Beauv.) Seem.	Bignoniaceae
NICPH	*Nicandra physalodes* (L.) Gaertn.	Solanaceae
OCICA	*Ocimum americanum* L.	Lamiaceae
OLDAF	*Oldenlandia affinis* (Roem. & Schult.) DC.	Rubiaceae
OLDCO	*Oldenlandia corymbosa* L.	Rubiaceae
OPCTU	*Operculina turpethum* (L.) Silva Manso	Convolvulaceae
OPLBU	*Oplismenus burmanni* (Retz.) B.Beauv.	Poaceae
ORYLO	*Oryza longistaminata* A.Chev. & Roehr.	Poaceae
OXACO	*Oxalis corniculata* L.	Oxalidaceae
OXACB	*Oxalis debilis* var. *corymbosa* (DC.) Lourteig	Oxalidaceae
OXALA	*Oxalis latifolia* Kunth	Oxalidaceae
PAEFF	*Paederia farinosa* subsp. *farinosa*	Rubiaceae
PANBR	*Panicum brevifolium* L.	Poaceae
PANRP	*Urochloa reptans* (L.) Stapf	Poaceae
PANGB	*Panicum subalbidum* Kunth	Poaceae
PANTC	*Panicum trichocladum* K.Schum.	Poaceae
MOLNU	*Paramollugo nudicaulis* (Lam.) Thulin	Molluginaceae
PTNHY	*Parthenium hysterophorus* L.	Asteraceae
PASCO	*Paspalum conjugatum* P.J.Bergius	Poaceae
PASDI	*Paspalum dilatatum* Poir.	Poaceae
PASPA	*Paspalum paniculatum* L.	Poaceae
PASSC	*Paspalum scrobiculatum* L.	Poaceae
PASVA	*Paspalum vaginatum* Sw.	Poaceae
PAQFO	*Passiflora foetida* L.	Passifloraceae
PTHPY	*Passovia pyrifolia* (Kunth) Tiegh.	Loranthaceae
PAXPI	*Paullinia pinnata* L.	Sapindaceae
PNTPE	*Pentodon pentandrus* (Schumach. & Thonn.) Vatke	Rubiaceae
PVPVE	*Phaulopsis verticillaris* (Nees) Mankt.	Acanthaceae
PYLAM	*Phyllanthus amarus* Schumach. & Thonn.	Phyllanthaceae
PYLNI	*Phyllanthus niruri* L.	Phyllanthaceae
PYLNO	*Phyllanthus niruroides* Müll.Arg.	Phyllanthaceae
PYLRE	*Phyllanthus reticulatus* Poir.	Phyllanthaceae

PYLUR	*Phyllanthus urinaria* L.	Phyllanthaceae
PHYAN	*Physalis angulata* L.	Solanaceae
PHYLG	*Physalis lagascae* Roem. & Schult.	Solanaceae
PLALA	*Plantago lanceolata* L.	Plantaginaceae
CXUAM	*Plectranthus amboinicus* (Lour.) Spreng.	Lamiaceae
SLSMO	*Plectranthus monostachyus* (P.Beauv.) B.J.Pollard	Lamiaceae
PTYFO	*Polytrichastrum formosum* G.L.Smith	Polytrichaceae
POROL	*Portulaca oleracea* L.	Portulacaceae
POQER	*Porophyllum ruderale* (Jacq.) Cass.	Asteraceae
PZLGU	*Pouzolzia guineensis* Benth.	Urticaceae
PSIGU	*Psidium guajava* L.	Myrtaceae
PTEAQ	*Pteridium aquilinum* (L.) Kuhn	Dennstaedtiaceae
PUEPH	*Pueraria phaseoloides* (Roxb.) Benth.	Fabaceae
RPCLO	*Rhamphicarpa fistulosa* (Hochst.) Benth.	Orobanchaceae
RHNMI	*Rhynchosia minima* (L.) DC.	Fabaceae
RHNVI	*Rhynchosia viscosa* DC.	Fabaceae
RCHSC	*Richardia scabra* L.	Rubiaceae
RONFR	*Rolandra fruticosa* (L.) Kuntze	Asteraceae
ROOEX	*Rottboellia cochinchinensis* (Lour.) Clayton	Poaceae
RUBAC	*Rubus alceifolius* Poir.	Rosaceae
PANPI	*Rugoloa pilosa* (Sw.) Zuloaga	Poaceae
RUMCR	*Rumex crispus* L.	Polygonaceae
SAEIN	*Sacciolepis indica* (L.) Chase	Poaceae
SCLPT	*Scleria gaertneri* Raddi	Cyperaceae
SCLPE	*Scleria pergracilis* (Nees) Kunth	Cyperaceae
OLDDI	*Scleromitrion diffusum* (Willd.) R.J.Wang	Rubiaceae
SZGPN	*Senegalia pentagona* (Schumach.) Kyal.	fabaceae
CASOB	*Senna obtusifolia* (L.) H.S.Irwin & Barneby	Fabaceae
CASOC	*Senna occidentalis* (L.) Link	Fabaceae
CASTO	*Senna tora* (L.) Roxb.	Fabaceae
SEBSP	*Sesbania sesban* subsp. *punctata* (DC.) J.B.Gillett	Fabaceae
SETBA	*Setaria barbata* (Lam.) Kunth	Poaceae
PANGE	*Setaria geminata* (Forssk.) Veldkamp	Poaceae
SETPA	*Setaria palmifolia* (J.Koenig) Stapf	Poaceae
SETSP	*Setaria sphacelata* (Schumach.) Stapf & C.E.Hubb. ex Moss	Poaceae
SIDAC	*Sida acuta* Burm f.	Malvaceae
SIDRH	*Sida rhombifolia* L.	Malvaceae
SIDUR	*Sida urens* L.	Malvaceae
SIKOR	*Sigesbeckia orientalis* L.	Asteraceae
SOLAM	*Solanum americanum* Mill.	Solanaceae
SOLER	*Solanum erianthum* D.Don	Solanaceae
SOLMR	*Solanum mauritianum* Scop.	Solanaceae
SOLNI	*Solanum nigrum* L.	Solanaceae
SONAS	*Sonchus asper* (L.) Hill.	Asteraceae
SONOL	*Sonchus oleraceus* L.	Asteraceae

SORAR	*Sorghum arundinaceum* (Desv.) Stapf	Poaceae
SPOCA	*Spathodea campanulata* P.Beauv.	Bignoniaceae
BOILF	*Spermacoce alata* Aubl.	Rubiaceae
SPCRA	*Spermacoce radiata* (DC.) Hiern	Rubiaceae
BOISY	*Spermacoce stachydea* DC.	Rubiaceae
BOIVE	*Spermacoce verticillata* L.	Rubiaceae
WEDTR	*Sphagneticola trilobata* (L.) Pruski	Asteraceae
SPKAN	*Spigelia anthelmia* L.	Loganiaceae
SPXMO	*Spondias mombin* L.	Anacardiaceae
SPZPY	*Sporobolus pyramidalis* P.Beauv.	Poaceae
STCJA	*Stachytarpheta jamaicensis* (L.) Vahl	Verbenaceae
PANLX	*Steinchisma laxum* (Sw.) Zuloaga	Poaceae
STEME	*Stellaria media* (L.)Vill.	Caryophyllaceae
STPSE	*Stenotaphrum dimidiatum* (L.) Brongn.	Poaceae
SRLTA	*Sterculia tragacantha* Lindl.	Malvaceae
STRHE	*Striga hermonthica* (Del.) Benth.	Orobanchaceae
STYGN	*Stylosanthes guianensis* (Aubl.) Sw.	Fabaceae
TALFR	*Talinum fruticosum* (L.) Juss.	Talinaceae
TLMAF	*Telosma africana* (N.E.Br.) N.E.Br.	Apocynaceae
TEPNO	*Tephrosia noctiflora* Bojer ex Baker	Fabaceae
TEPPU	*Tephrosia purpurea* (L.) Pers.	Fabaceae
TERLA	*Teramnus labialis* (L.f.) Spreng.	Fabaceae
LIDCR	*Torenia crustacea* (L.) Cham. & Schltdl.	Linderniaceae
TREAN	*Trema angustifolium* (Planch.) Blume	Cannabaceae
TRTPO	*Trianthema portulacastrum* L.	Aizoaceae
TRBTE	*Tribulus terrestris* L.	Zygophyllaceae
TRHZE	*Trichodesma zeylanicum* (Burm.f.) R.Br.	Boraginaceae
TRQPR	*Tridax procumbens* L.	Asteraceae
MOLST	*Trigastrotheca stricta* (L.) Thulin	Molluginaceae
URNLO	*Urena lobata* L.	Malvaceae
BRADE	*Urochloa deflexa* (Schumach.) H.Scholz	Poaceae
BRARU	*Urochloa eminii* (Mez) Davidse	Poaceae
PANMA	*Urochloa maxima* (Jacq.) R.D.Webster	Poaceae
VEEEN	*Verbesina encelioides* (Cav.) Benth. & Hook.f. ex A.Gray	Asteraceae
VCOLE	*Vicoa indica* (L.) DC.	Asteraceae
PHSAU	*Vigna radiata* (L.) R.Wilczek	Fabaceae

Appendix 2: Infestation diagrams according to climates

Figure Ap.2.1: Infestation diagram for Tropical climate (annual rainfall from 1000 to 2000 mm)

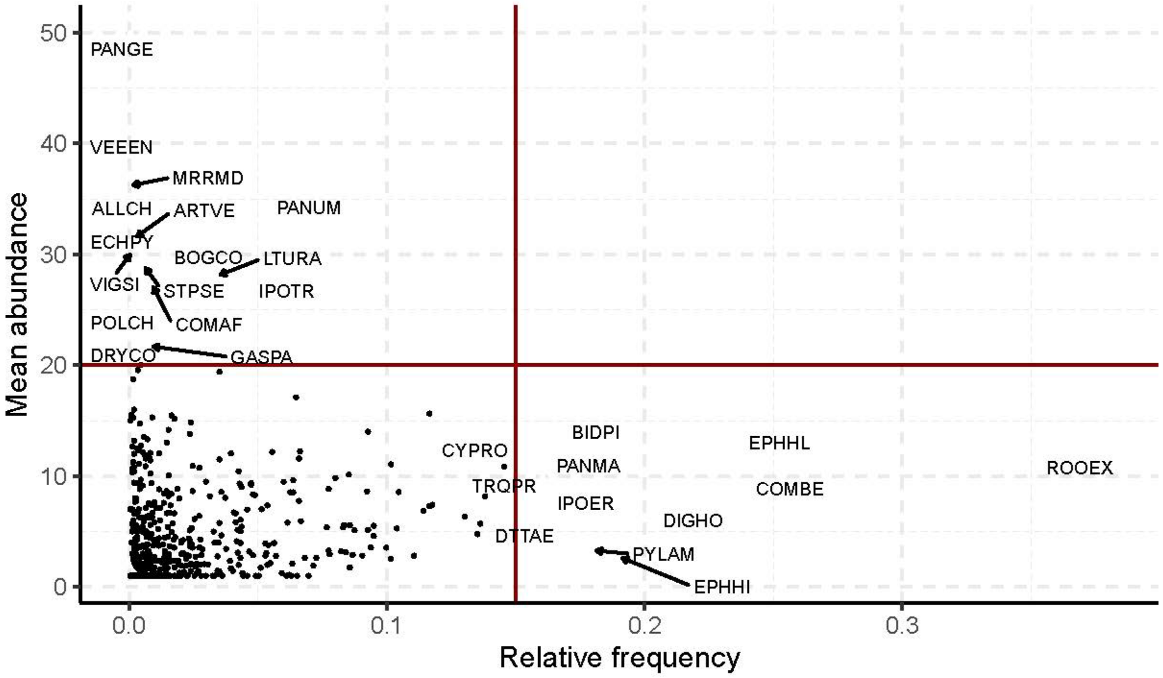


Figure Ap.2.2: Infestation diagram for Dry-Tropical climate (annual rainfall less than 1000 mm)

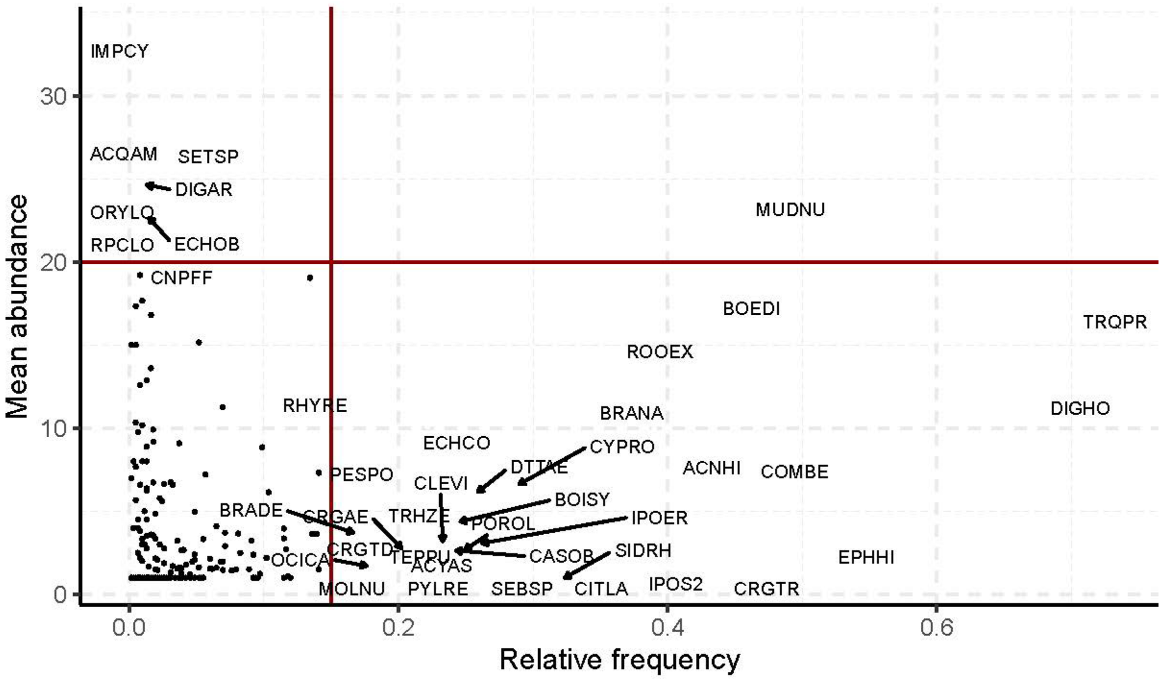


Figure Ap.2.3: Infestation diagram for Wet-Tropical climate (annual rainfall more than 2000 mm)

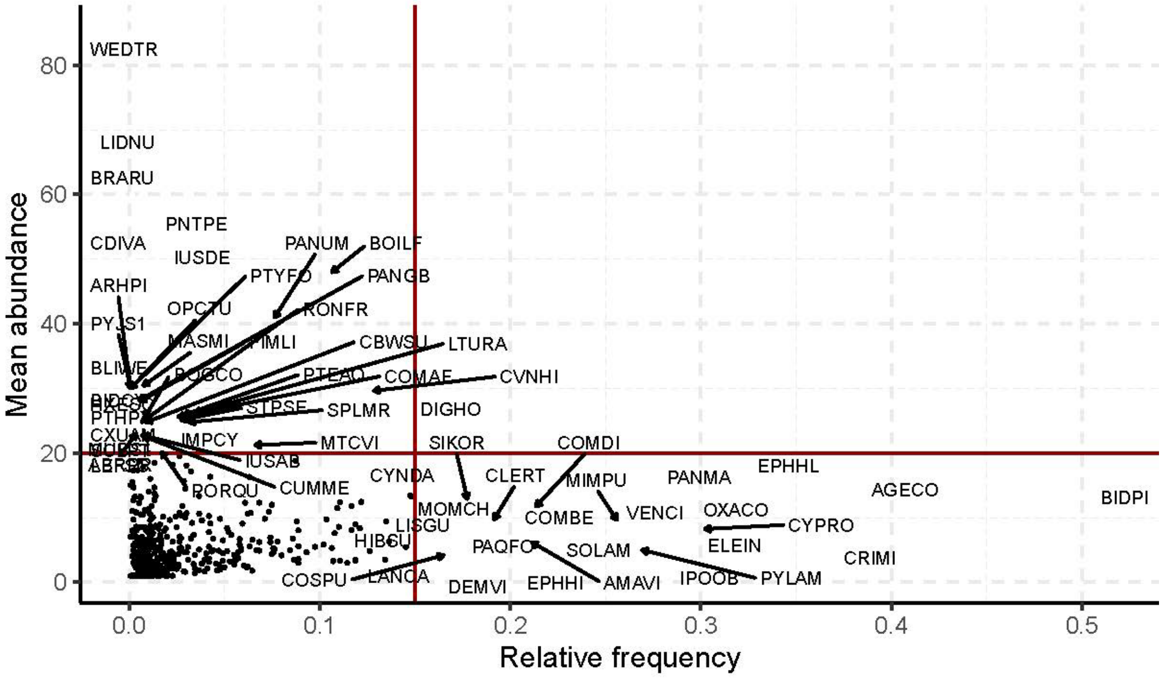
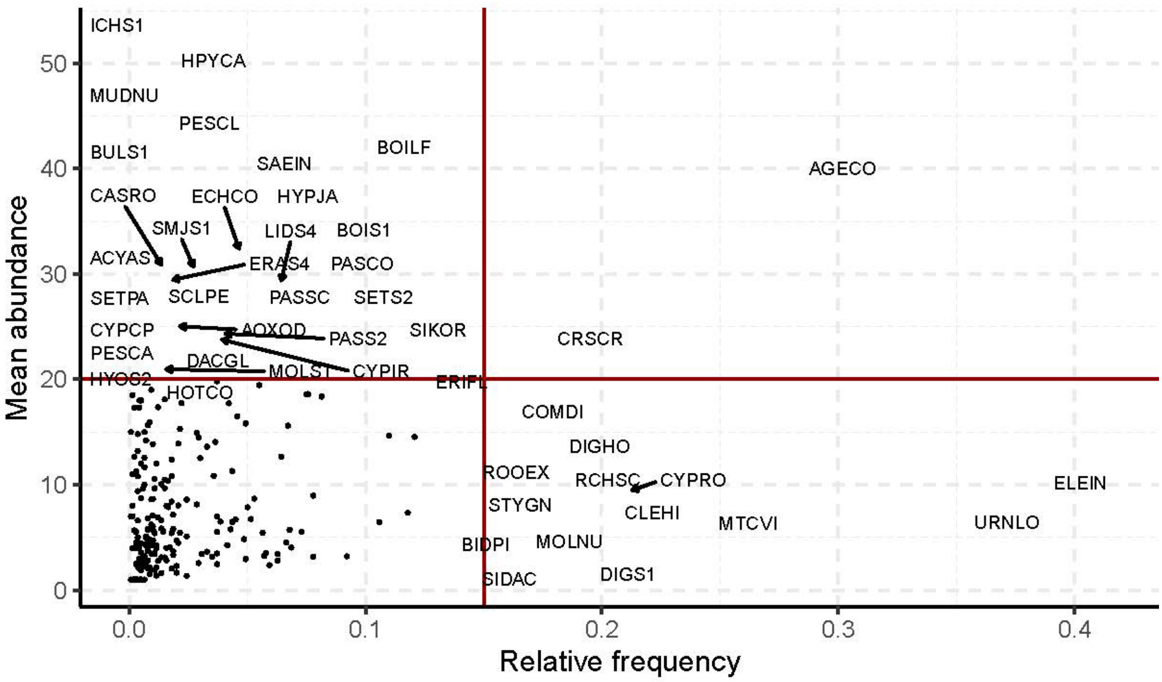


Figure Ap.2.4: Infestation diagram for Altitude-Tropical climate (location above 400 m of elevation)



Appendix 3: Infestation diagrams according to crops

Figure Ap.3.1: Infestation diagram for Cotton

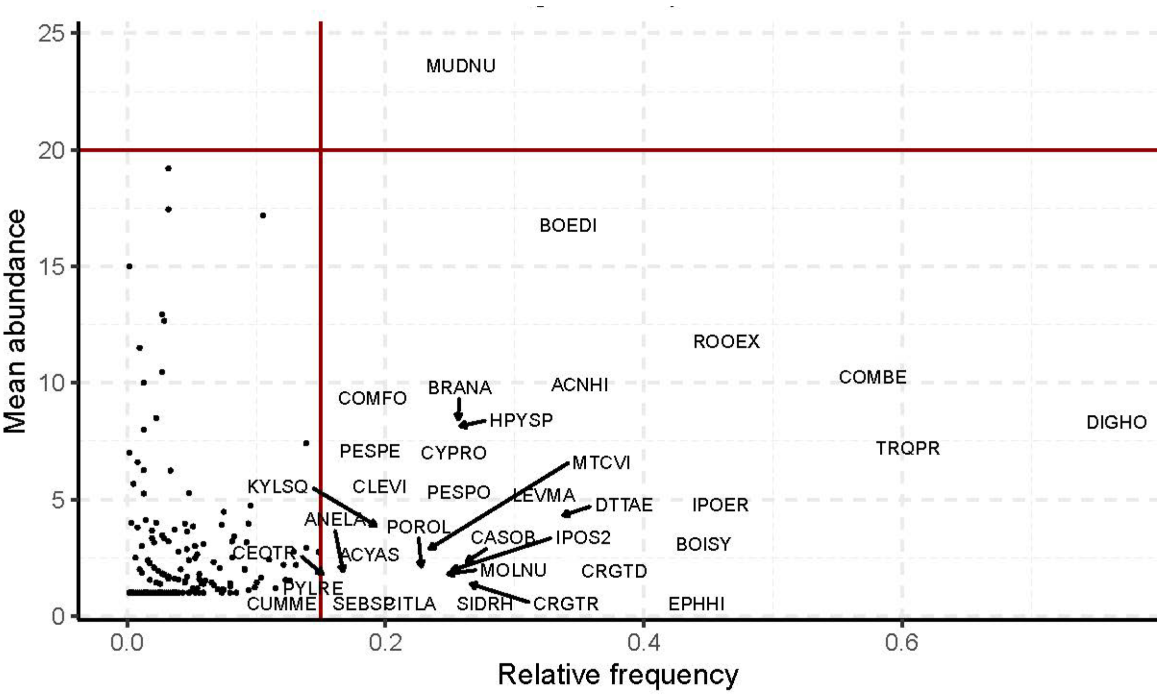


Figure Ap.3.2: Infestation diagram for Fallows

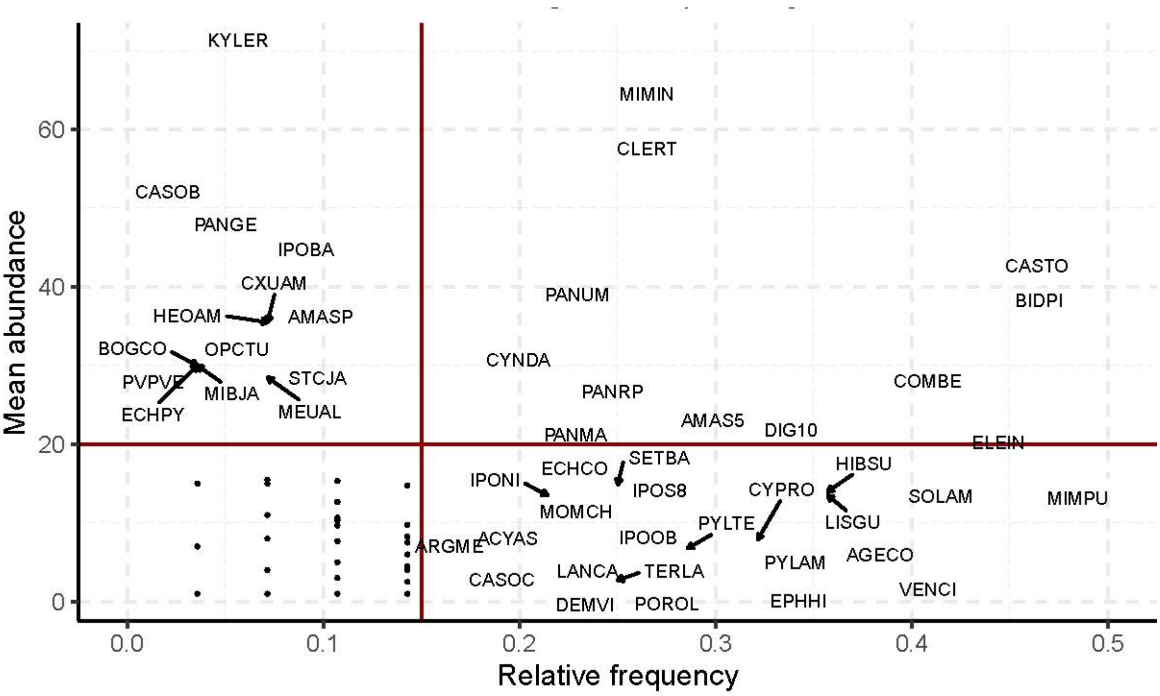


Figure Ap.3.3: Infestation diagram for Food crops (maize, sorghum, millet)

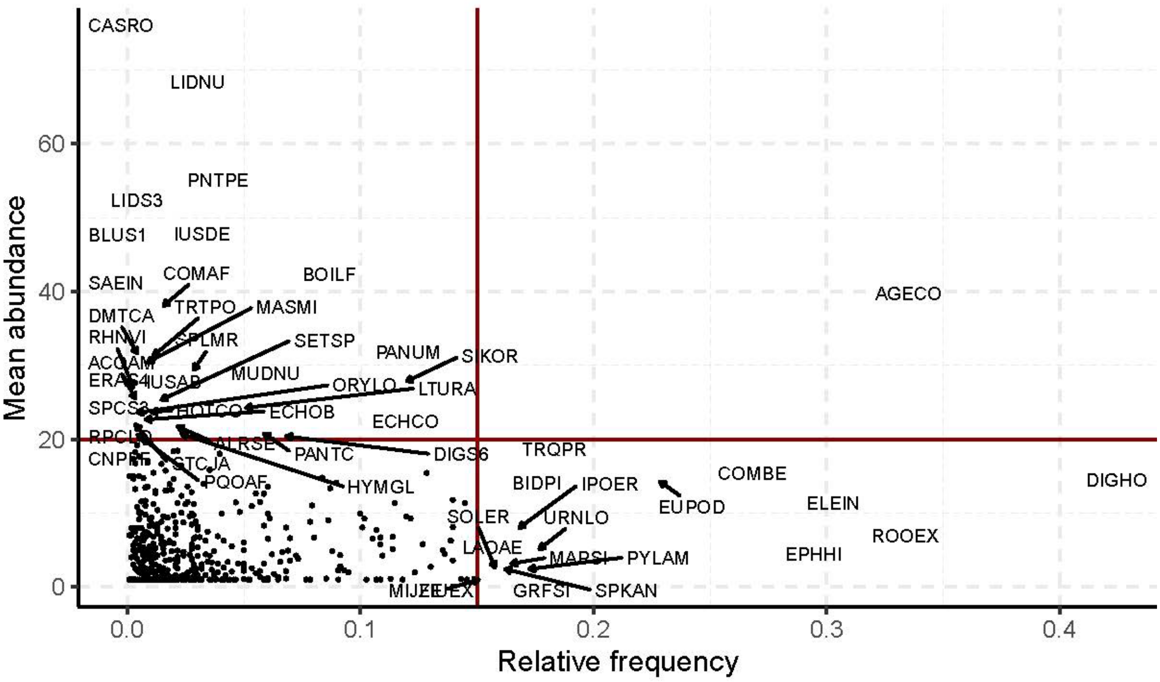


Figure Ap.3.4: Infestation diagram for Groundnut

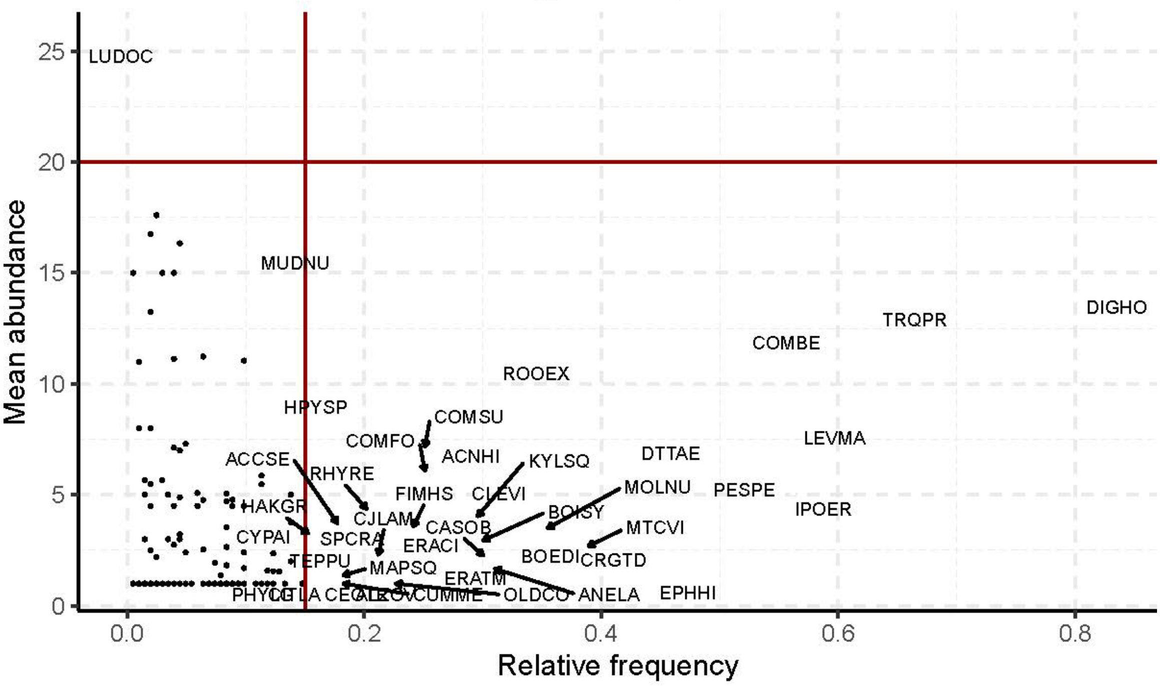


Figure Ap.3.5: Infestation diagram for Orchards

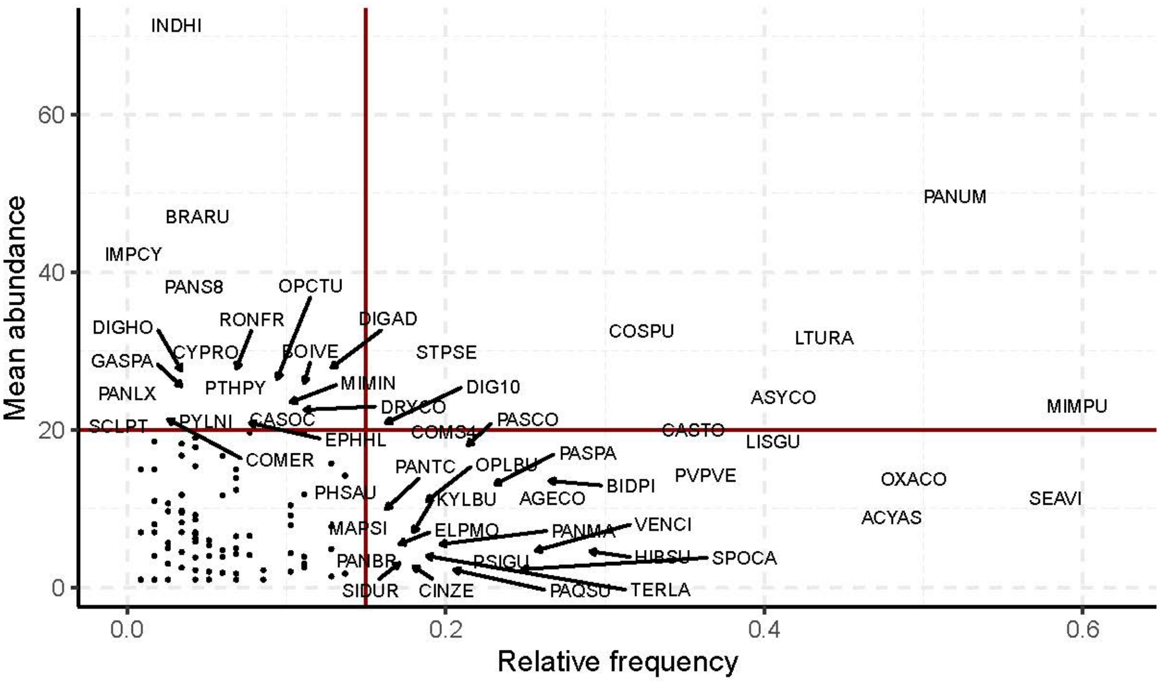


Figure Ap.3.6: Infestation diagram for Pastures

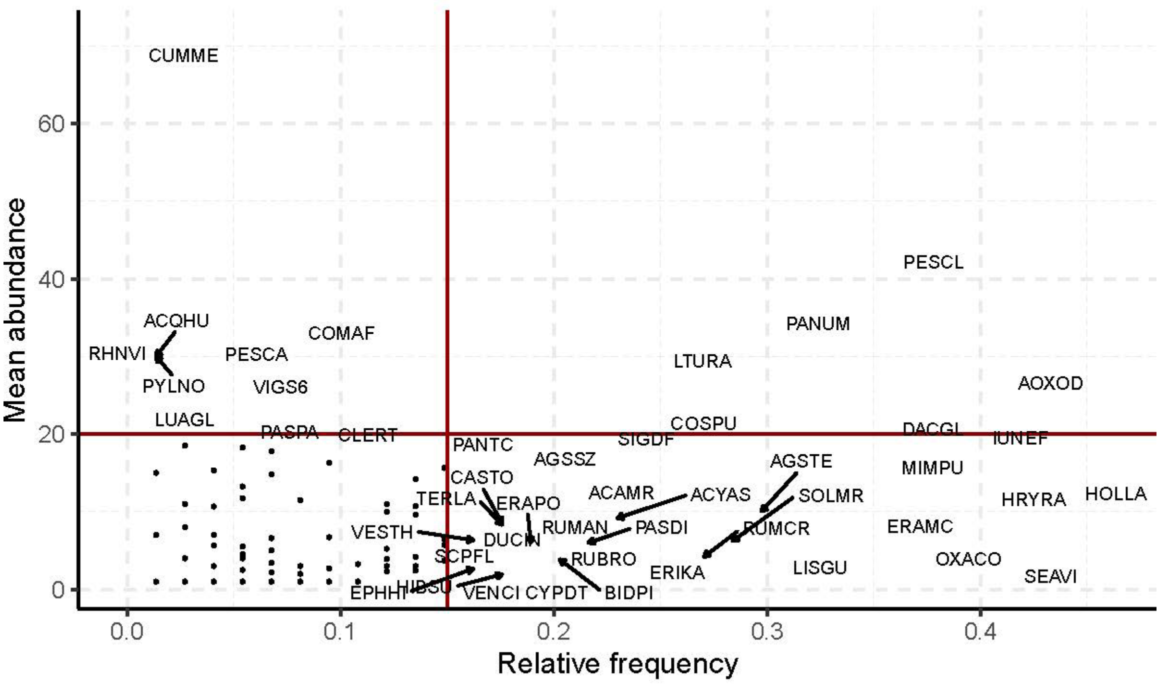


Figure Ap.3.7: Infestation diagram for Pineapple

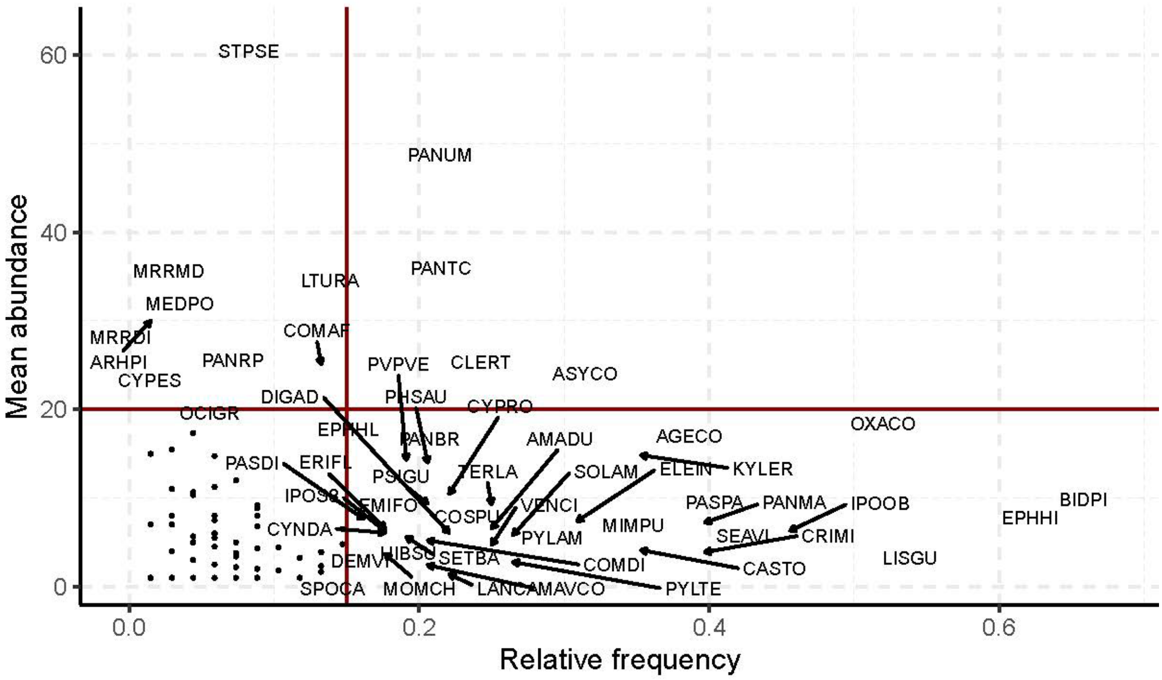


Figure Ap.3.8: Infestation diagram for Rice

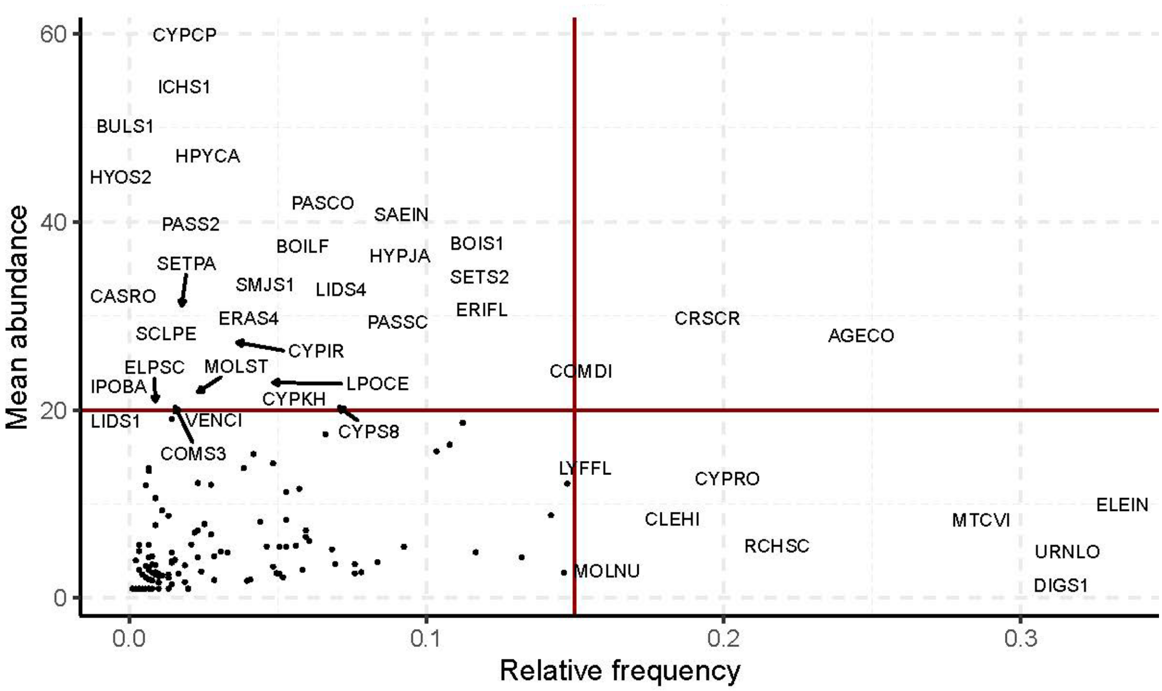


Figure Ap.3.9: Infestation diagram for Sugarcane

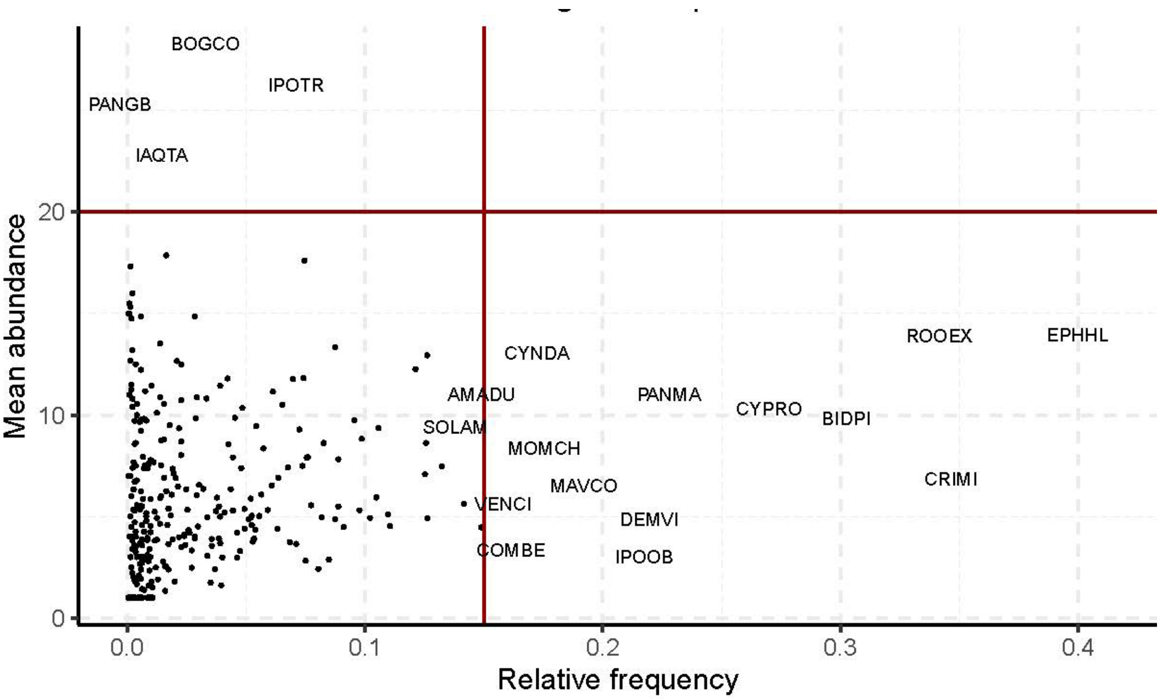


Figure Ap.3.10: Infestation diagram for Tubers

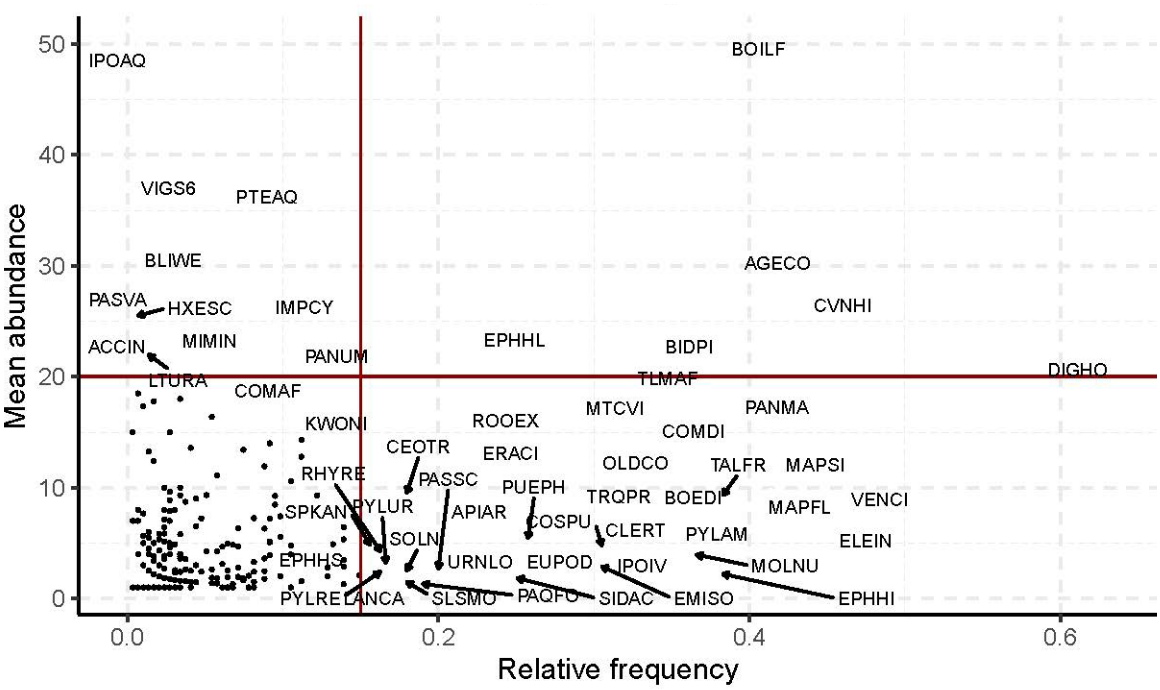
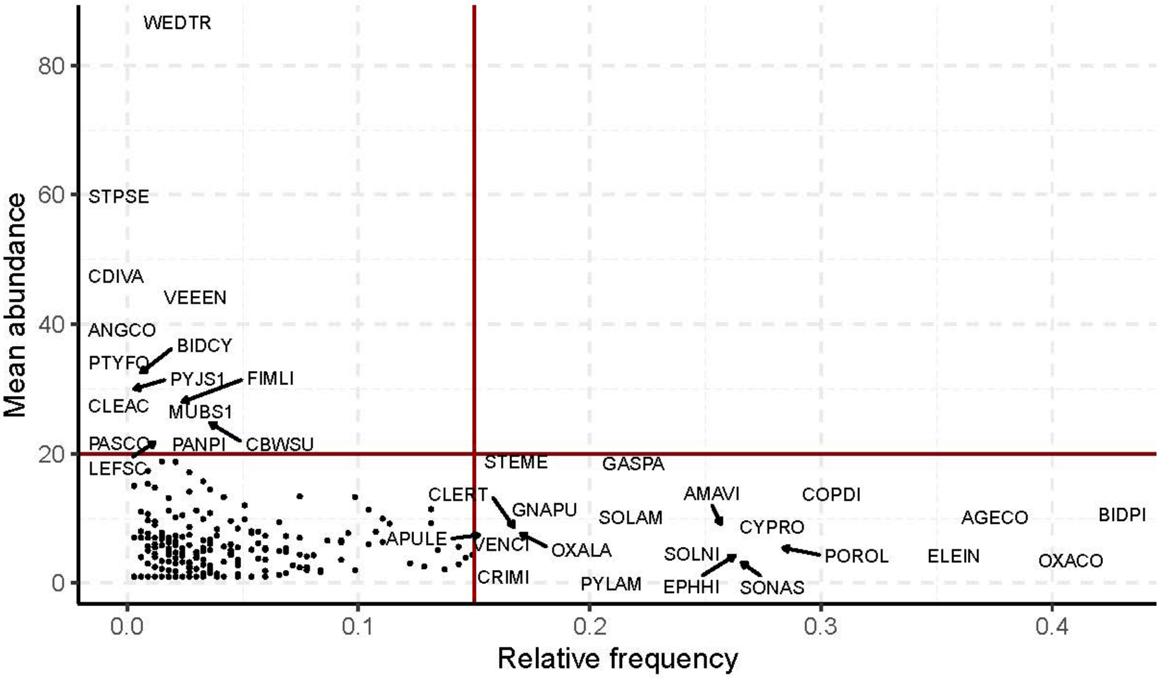


Figure Ap.3.11: Infestation diagram for Vegetables



Appendix 4: Ecological profiles

App.4.1 Corrected ecological profile of weeds according to the Climate factor

Variable entropy: 1.828; Maximum entropy: 2; Quality of sampling: 0.914

Mean species entropy: 0.193

Selection of species which mutual information with the Climate factor is more than 0.03 (124 taxa)

Species	Abs. frequency	Species. entropy	Mutual. info	Tropical	Altitude-tropical	Wet-tropical	Dry-tropical
MUDNU	296	0.281	0.169	0	4	5	962
CRGTR	273	0.265	0.164	0	0	0	982
TRQPR	1033	0.658	0.148	91	54	18	423
URNLO	576	0.453	0.148	15	378	27	0
BRANA	241	0.241	0.143	0	0	0	982
IPOS2	238	0.239	0.137	0	0	4	974
CRIMI	880	0.597	0.123	95	1	256	0
CITLA	277	0.268	0.115	38	0	0	819
CLEHI	282	0.271	0.104	0	434	0	0
BIDPI	1396	0.778	0.102	74	71	224	7
DIGS1	278	0.268	0.102	0	434	0	0
RCHSC	277	0.268	0.102	0	434	0	0
ELEIN	1240	0.73	0.097	42	203	145	17
PANMA	846	0.583	0.094	115	3	215	1
STYGN	257	0.253	0.094	0	434	0	0
BOEDI	636	0.484	0.093	91	0	76	420
AGECO	1283	0.744	0.09	54	149	185	2
SEBSP	155	0.172	0.089	0	0	0	982
DIGHO	1539	0.817	0.088	91	76	58	287
PYLAM	864	0.59	0.086	127	1	189	9
IPOOB	640	0.486	0.085	90	4	263	0
EPHHI	1157	0.703	0.081	100	16	106	276
EPHHL	1236	0.729	0.081	130	25	162	4
SIDRH	322	0.299	0.075	27	94	19	610
COMDI	572	0.45	0.075	19	177	226	0
CRSCR	415	0.36	0.074	11	304	112	0
BOISY	404	0.353	0.072	141	0	0	369
MIMPU	541	0.434	0.072	71	17	287	0
ACNHI	609	0.47	0.07	42	117	53	416
PYLRE	201	0.21	0.069	0	0	151	650
OXACO	681	0.507	0.069	56	69	264	0
VENCI	734	0.532	0.069	112	12	212	0
LEVLA	209	0.216	0.068	6	2	430	0

PAQFO	316	0.295	0.067	47	0	352	0
SOLAM	478	0.398	0.067	60	24	303	0
LEVMA	430	0.369	0.066	192	0	0	146
CRGTD	433	0.371	0.061	155	0	9	288
CLERT	422	0.364	0.061	86	0	275	0
DTTAE	699	0.515	0.058	140	1	66	225
ROOEX	1680	0.851	0.058	137	65	39	150
DEMVI	565	0.447	0.058	126	2	195	0
TEPPU	145	0.163	0.057	9	0	55	819
AMAVI	454	0.384	0.057	72	5	282	35
COSPU	538	0.432	0.057	131	0	186	0
MOMCH	501	0.411	0.056	112	2	222	0
PESPE	357	0.323	0.055	198	0	0	121
LYFFL	154	0.171	0.055	0	434	0	0
COMBE	1323	0.756	0.053	112	29	98	212
PTODE	148	0.165	0.053	0	434	0	0
OCICA	126	0.146	0.051	23	0	14	850
LISGU	472	0.394	0.051	110	4	225	0
CLLAS	229	0.232	0.049	1	320	115	0
MAPFL	190	0.201	0.048	30	0	386	0
EMISO	224	0.228	0.048	1	118	322	0
RHNMI	333	0.307	0.047	191	0	4	145
HIBSU	312	0.292	0.047	76	1	294	0
MAPSI	457	0.385	0.047	135	0	179	0
CLEVI	340	0.311	0.046	74	0	111	416
CASOB	394	0.347	0.046	120	23	16	374
SIKOR	470	0.393	0.046	35	143	229	0
ACYAS	483	0.401	0.045	108	1	93	307
BOILF	304	0.287	0.045	10	207	212	0
SETS2	127	0.147	0.045	0	434	0	0
COMFO	262	0.257	0.043	153	0	0	315
MAVCO	518	0.421	0.042	153	10	134	0
BOIS1	117	0.137	0.042	0	434	0	0
HIBCE	74	0.095	0.041	0	0	0	982
PAEFF	73	0.094	0.041	0	0	0	982
LANCA	375	0.335	0.041	83	18	263	0
DIGS6	114	0.135	0.041	0	434	0	0
ASYCO	239	0.239	0.04	69	0	309	0
CVNHI	298	0.283	0.04	93	0	261	0
ARPAC	71	0.092	0.039	0	0	0	982
ALZVA	74	0.095	0.039	0	0	12	955
TRHZE	318	0.296	0.039	82	3	94	411
TLMAF	124	0.144	0.039	9	0	427	0
PYLTE	192	0.203	0.039	48	0	350	0
ARKS1	109	0.13	0.039	0	434	0	0

TRBTE	118	0.138	0.038	59	0	0	724
CRGAE	216	0.222	0.038	50	46	41	568
TREAN	106	0.127	0.038	0	434	0	0
KYLSQ	251	0.248	0.037	187	0	0	168
IPOIV	127	0.147	0.037	16	0	413	0
PYLUR	131	0.15	0.037	17	0	411	0
DIGAD	209	0.216	0.037	49	10	338	0
CYPS8	105	0.126	0.037	0	433	0	0
GRFSI	187	0.198	0.037	226	0	0	0
AMADU	431	0.37	0.036	113	15	208	0
SOLER	183	0.195	0.036	226	0	0	0
BRADE	215	0.221	0.035	99	0	37	470
POROL	644	0.488	0.035	94	16	137	235
ANELA	234	0.236	0.035	185	0	0	176
KYLER	175	0.189	0.035	40	7	358	0
SEAVI	350	0.318	0.035	152	0	146	0
MIJZE	175	0.189	0.035	226	0	0	0
PLALA	198	0.207	0.034	32	42	339	0
TALFR	246	0.245	0.034	88	0	271	0
HYRS1	95	0.116	0.034	0	434	0	0
CRGS1	60	0.08	0.033	0	0	0	982
OLDDI	59	0.079	0.033	0	0	0	982
CCHBI	211	0.218	0.033	124	0	17	405
ERIFL	455	0.384	0.033	46	171	179	0
MESS1	94	0.115	0.033	0	434	0	0
COGZN	169	0.183	0.033	226	0	0	0
ERAS2	57	0.077	0.032	0	0	0	982
COMSU	180	0.193	0.032	137	0	0	387
PHYLG	280	0.27	0.032	196	0	35	53
APIAR	88	0.109	0.032	0	0	445	0
LIDS4	90	0.111	0.032	0	434	0	0
MTCVI	751	0.54	0.031	68	201	53	112
EPHHY	360	0.325	0.031	175	0	70	65
LNECO	187	0.198	0.031	214	0	0	53
DRYCO	103	0.124	0.031	13	0	419	0
SORAR	342	0.313	0.031	136	4	173	0
SPKAN	301	0.285	0.031	166	0	118	0
TERLA	304	0.287	0.031	166	0	117	0
MLLOP	170	0.184	0.031	222	0	8	0
ERAAS	122	0.142	0.03	94	0	0	572
TRTPO	286	0.274	0.03	137	0	45	285
IPOER	756	0.542	0.03	129	48	46	210
SIDAC	427	0.367	0.03	61	247	58	28
PUEPH	124	0.144	0.03	33	0	380	0
PASPA	266	0.26	0.03	80	16	271	0

App.4.2 Corrected ecological profile of weeds according to the Crop factor

Variable entropy: 2.638; Maximum entropy: 3.459; Quality of sampling: 0.763 Mean species entropy: 0.193

Selection of species which mutual information with the Crop factor is more than 0.03 (180 taxa)

Species	Abs. frequency	Species. entropy	Mutual. info	Cotton	Fallows	Food crops	Groundnut	Orchards	Pastures	Pineapple	Rice	Sugarcane	Tubers	Vegatables
DIGHO	1539	0.817	0.298	300	0	166	326	13	0	0	58	12	249	18
TRQPR	1033	0.658	0.179	369	21	115	405	0	0	17	45	29	167	9
CRIMI	880	0.597	0.165	0	74	11	0	88	56	274	0	230	9	113
BOISY	404	0.353	0.154	636	0	100	451	0	0	0	0	0	0	0
LEVMA	430	0.369	0.15	423	0	153	807	0	0	0	0	0	0	0
EPHHL	1236	0.729	0.144	6	35	60	7	38	0	79	11	203	131	48
CRGTD	433	0.371	0.142	482	0	153	594	0	0	0	0	0	19	0
MTCVI	751	0.54	0.139	189	0	117	314	0	0	0	240	0	238	0
DIGS1	278	0.268	0.132	0	0	4	0	0	0	0	663	0	0	0
PESPE	357	0.323	0.118	363	0	182	829	0	0	0	0	0	0	0
IPOER	756	0.542	0.115	350	29	135	451	0	0	24	33	42	16	24
COMBE	1323	0.756	0.114	275	180	125	267	31	25	67	15	76	40	67
URNLO	576	0.453	0.112	0	0	186	47	63	14	93	318	7	204	9
MOLNU	660	0.496	0.109	228	33	125	326	0	0	41	152	1	337	25
IPOOB	640	0.486	0.105	0	237	26	0	97	64	432	0	218	10	93
EPHHI	1157	0.703	0.104	215	187	148	225	58	85	316	10	44	201	138
CVNHI	298	0.283	0.103	0	0	262	0	70	0	0	0	11	897	18
PANMA	846	0.583	0.102	0	179	62	4	141	39	285	1	172	282	54
TALFR	246	0.245	0.099	0	0	281	12	0	0	0	0	0	945	0

OXACO	681	0.507	0.098	0	127	89	0	457	361	446	7	112	21	375
SEAVI	350	0.318	0.093	28	186	235	0	978	726	688	0	15	112	93
MAVCO	518	0.421	0.093	0	126	11	0	20	0	241	0	230	16	143
DEMVI	565	0.447	0.093	0	230	19	0	37	73	174	0	222	7	160
MAPFL	190	0.201	0.092	0	0	187	0	0	0	0	0	0	1321	0
MUDNU	296	0.281	0.092	578	0	95	343	18	0	0	0	0	195	12
BOEDI	636	0.484	0.091	304	0	97	320	0	0	0	0	58	336	26
CRGTR	273	0.265	0.088	591	0	96	274	0	0	0	0	0	234	0
COMFO	262	0.257	0.087	520	0	140	582	0	0	0	0	0	0	0
KYLSQ	251	0.248	0.083	466	0	146	715	0	0	0	0	0	0	0
PANUM	313	0.293	0.083	0	415	192	38	1044	655	456	53	0	223	145
OLDCO	346	0.315	0.082	193	125	177	397	60	0	0	0	1	547	79
SOLAM	478	0.398	0.082	0	499	15	0	54	17	336	0	197	13	288
AMADU	431	0.37	0.081	0	201	10	0	12	0	352	0	228	0	156
ERACI	299	0.283	0.08	246	0	147	530	35	0	30	0	0	550	18
VENCI	734	0.532	0.08	0	325	56	0	212	145	207	16	138	381	133
BRANA	241	0.241	0.08	646	0	100	161	0	0	0	0	0	179	0
IPOS2	238	0.239	0.08	642	0	73	314	0	0	0	0	2	173	0
HPYSP	351	0.319	0.079	446	0	149	315	0	0	0	87	0	35	0
DTTAE	699	0.515	0.078	293	62	99	381	0	0	13	0	77	121	57
ANELA	234	0.236	0.078	434	0	148	805	0	0	0	0	0	0	0
ROOEX	1680	0.851	0.078	159	26	117	116	15	0	32	30	128	88	5
BOILF	304	0.287	0.078	0	0	198	0	0	0	0	136	12	771	0
GRFSI	187	0.198	0.077	0	0	523	0	0	0	0	0	0	0	0
MAPSI	457	0.385	0.077	42	0	219	0	216	36	98	0	53	554	28
CITLA	277	0.268	0.075	513	0	142	345	0	0	0	0	5	134	0
SOLER	183	0.195	0.075	0	0	523	0	0	0	0	0	0	0	0
RCHSC	277	0.268	0.075	0	0	117	97	0	0	0	456	0	126	0
MIMPU	541	0.434	0.074	0	561	90	0	690	440	412	7	118	68	161

BIDPI	1396	0.778	0.074	10	202	69	19	115	88	294	57	137	165	184
FIUEX	216	0.222	0.074	0	0	438	0	0	0	0	0	2	314	0
CASTO	260	0.255	0.074	0	1084	245	0	798	410	824	31	0	103	160
ACNHI	609	0.47	0.073	327	0	138	314	0	0	0	92	29	88	6
MIJZE	175	0.189	0.072	0	0	523	0	0	0	0	0	0	0	0
CASOB	394	0.347	0.071	405	55	139	463	26	21	23	22	25	31	9
ELEIN	1240	0.73	0.069	29	210	141	55	33	0	151	162	54	221	181
COGZN	169	0.183	0.069	0	0	523	0	0	0	0	0	0	0	0
LAOAE	228	0.231	0.068	0	0	429	0	0	0	0	0	14	253	8
SORAR	342	0.313	0.067	0	190	9	0	15	0	52	0	251	6	53
COSPU	538	0.432	0.067	0	161	135	0	386	320	282	0	108	344	40
CLEHI	282	0.271	0.067	0	0	169	85	0	0	0	372	0	190	0
MLLOP	170	0.184	0.066	0	0	511	18	0	0	0	0	0	36	0
PESPO	236	0.237	0.066	618	0	60	38	0	0	0	124	1	87	0
TLMAF	124	0.144	0.066	0	0	131	0	0	0	0	0	0	1543	0
IPOIV	127	0.147	0.065	0	0	148	0	0	0	0	0	0	1474	0
LISGU	472	0.394	0.065	0	459	147	0	495	400	719	0	96	96	123
LYFFL	154	0.171	0.065	0	0	24	0	0	0	0	637	0	0	0
LTURA	142	0.16	0.063	0	153	217	0	1790	1213	503	0	0	58	0
PYLRE	201	0.21	0.062	505	0	112	74	0	0	0	0	0	491	0
COMSU	180	0.193	0.061	440	0	137	847	0	0	0	0	0	0	0
SIDRH	322	0.299	0.061	444	0	166	130	129	0	0	21	13	153	0
SEBSP	155	0.172	0.061	767	0	74	19	0	0	0	0	0	119	0
CLERT	422	0.364	0.06	0	360	89	7	160	136	317	0	94	507	240
PANLX	181	0.194	0.06	0	0	425	0	86	0	0	0	0	330	20
EUPOD	574	0.452	0.06	0	0	242	0	18	0	0	73	75	272	25
MOMCH	501	0.411	0.06	0	260	79	0	10	0	214	0	196	111	51
AGECO	1283	0.744	0.059	25	169	153	47	113	6	188	121	63	207	184
STYGN	257	0.253	0.059	0	0	165	93	0	0	0	335	0	312	0

SPKAN	301	0.285	0.058	0	0	327	0	86	0	0	0	50	314	36
CLEVI	340	0.311	0.057	404	64	49	484	0	0	0	0	70	67	59
PZLGU	158	0.174	0.057	0	0	500	0	0	0	0	0	7	39	0
COPDI	229	0.232	0.057	0	0	16	0	45	0	156	0	140	0	767
CEOTR	317	0.296	0.056	290	0	178	302	0	0	0	0	25	344	0
PUEPH	124	0.144	0.056	0	0	203	0	0	0	0	0	0	1261	0
RHNMI	333	0.307	0.055	119	0	13	0	0	0	0	0	229	6	0
PTNHY	320	0.298	0.055	3	0	13	0	32	0	112	0	239	19	102
PYLAM	864	0.59	0.054	81	251	121	104	30	38	186	0	104	276	155
ACYAS	483	0.401	0.054	242	269	136	173	580	289	18	0	58	60	45
ERATM	152	0.169	0.054	362	0	138	1082	0	0	0	0	0	0	0
FIMHS	166	0.181	0.054	361	0	173	882	0	0	0	0	0	0	0
AJSTO	143	0.161	0.054	0	0	501	0	0	0	0	0	0	86	0
PHYLG	280	0.27	0.053	173	0	303	331	0	0	0	0	20	118	0
CUMME	232	0.234	0.053	425	0	158	477	134	106	0	0	15	0	8
HAKGR	150	0.167	0.053	599	0	87	618	0	0	0	0	2	0	0
COMDI	572	0.45	0.052	7	76	148	21	109	29	218	151	47	414	89
KWONI	167	0.182	0.052	0	0	345	0	0	0	0	0	11	616	0
PANBR	181	0.194	0.051	0	479	269	0	545	453	690	0	0	273	170
EMISO	224	0.228	0.051	0	0	82	0	208	0	0	155	18	827	186
SONAS	239	0.239	0.051	0	91	24	0	87	206	261	0	136	0	675
IPOHF	241	0.241	0.05	0	270	0	0	0	0	148	0	248	0	90
ALBZY	133	0.152	0.049	0	0	488	0	0	0	0	0	0	139	0
MOWGU	119	0.139	0.048	0	0	523	0	0	0	0	0	0	0	0
SIDAC	427	0.367	0.048	14	0	175	35	36	0	42	208	37	357	13
CJLAM	153	0.17	0.047	328	0	198	840	0	0	0	0	0	0	0
ASYCO	239	0.239	0.047	0	363	149	0	998	172	747	0	58	267	106
MZUBN	132	0.151	0.047	0	0	499	0	0	0	0	0	12	0	0
EPHHY	360	0.325	0.047	59	0	19	0	72	0	74	0	213	11	156

ARGME	273	0.265	0.047	25	397	4	0	19	0	98	0	217	0	232
SIKOR	470	0.393	0.046	0	46	155	0	22	0	190	11	157	0	143
CRSCR	415	0.36	0.046	0	52	122	0	37	59	215	299	60	0	100
PVPVE	102	0.123	0.046	0	212	195	0	2085	402	1138	0	0	40	36
BULBA	153	0.17	0.045	486	0	109	547	0	0	0	0	0	215	0
MAPSQ	141	0.159	0.045	404	0	167	785	0	0	0	0	0	0	0
PAXPI	128	0.148	0.045	0	0	429	0	0	0	0	0	0	370	0
APIAR	88	0.109	0.045	0	0	143	0	0	0	0	0	0	1496	0
CONAE	186	0.198	0.045	0	0	0	0	0	0	0	0	269	0	0
LEVLA	209	0.216	0.045	0	311	0	0	0	0	128	0	254	0	52
TREAN	106	0.127	0.045	0	0	20	0	0	0	0	642	0	0	0
SPCRA	127	0.147	0.044	449	0	119	918	0	0	0	0	0	0	0
PANTC	135	0.154	0.043	0	482	264	0	730	790	1058	0	0	122	107
MESS1	94	0.115	0.043	0	0	0	0	0	0	0	668	0	0	0
AMAVI	454	0.384	0.041	38	95	67	40	34	0	138	0	137	199	343
SYIS2	147	0.165	0.041	329	0	260	488	0	0	0	0	0	0	0
SOLNI	339	0.311	0.041	0	0	140	0	0	73	105	24	78	322	417
CYNDA	628	0.48	0.041	18	207	43	24	41	118	171	38	179	88	138
PASPA	266	0.26	0.041	0	163	45	0	527	154	872	0	165	54	89
PTODE	148	0.165	0.041	0	0	117	40	0	0	0	478	0	97	0
ALBAD	115	0.135	0.04	0	0	414	0	0	0	0	0	0	429	0
CRGAE	216	0.222	0.04	389	201	194	14	72	152	83	6	7	190	75
PAQFO	316	0.295	0.04	0	274	79	0	0	0	0	0	168	365	63
OCICA	126	0.146	0.039	606	0	100	356	0	0	0	0	0	114	14
CLZCA	108	0.129	0.039	0	0	480	0	0	0	0	0	0	171	0
OLDAF	109	0.13	0.039	0	0	365	0	0	0	0	0	0	623	0
PLALA	198	0.207	0.039	0	0	0	0	105	373	135	0	188	0	403
BOIS1	117	0.137	0.039	0	0	98	0	0	0	0	542	0	0	0
SETS2	127	0.147	0.039	0	0	132	0	0	0	0	499	0	0	0

POROL	644	0.488	0.038	215	236	86	93	48	0	125	12	86	131	267
HIBSU	312	0.292	0.038	0	695	132	0	565	342	343	0	108	171	75
SLSMO	81	0.102	0.038	0	0	181	0	0	0	0	0	0	1346	0
COSVI	157	0.173	0.038	0	0	0	0	0	0	0	0	269	0	0
TERLA	304	0.287	0.038	0	499	77	0	375	351	499	0	163	47	54
OXALA	178	0.191	0.038	0	0	9	0	29	0	301	0	168	0	580
AMAGR	115	0.135	0.037	529	0	146	520	0	0	0	0	0	0	0
SPOCA	98	0.119	0.037	0	221	208	0	1535	669	1093	0	0	84	92
IPOFA	152	0.169	0.037	0	0	0	0	0	0	0	0	269	0	0
APULE	162	0.178	0.037	0	0	0	0	32	0	331	0	173	0	570
DIG10	110	0.131	0.037	0	1970	157	0	896	746	730	0	0	187	313
PHYAN	236	0.237	0.036	82	0	290	51	22	0	0	3	33	357	69
ALZOV	139	0.157	0.036	292	0	196	774	0	0	0	43	0	0	0
LANCA	375	0.335	0.036	0	347	92	0	221	197	357	4	130	285	135
SPXMO	96	0.117	0.035	0	0	485	0	0	0	0	0	0	150	0
IPOS8	108	0.129	0.035	0	1405	237	0	720	759	992	0	0	133	134
HOLLA	77	0.098	0.035	0	0	7	0	135	3621	232	0	77	0	376
HYPJA	82	0.103	0.035	0	0	13	0	0	0	0	651	0	0	0
CRGOL	167	0.182	0.034	376	130	157	501	0	0	0	24	6	148	11
ACCSE	181	0.194	0.034	320	0	168	595	0	0	0	0	40	0	0
ERAAS	122	0.142	0.034	404	0	167	637	0	0	0	0	0	101	0
EPHHS	79	0.1	0.034	0	0	93	0	0	0	0	0	0	1172	459
SYDNO	372	0.333	0.034	0	0	146	0	0	0	24	23	172	61	24
IPONI	203	0.211	0.034	0	641	15	0	0	0	132	0	227	51	107
DEDTO	177	0.19	0.033	5	0	9	17	0	0	0	0	253	35	31
PSIGU	81	0.102	0.033	0	268	181	0	1665	506	1543	8	0	76	67
CHRBA	154	0.171	0.033	0	0	0	0	0	0	0	0	250	0	129
SAEIN	82	0.103	0.033	0	0	19	0	63	0	0	627	0	0	22
GASPA	149	0.166	0.033	0	0	74	0	139	0	299	13	85	0	839

PYLTE	192	0.203	0.033	0	903	46	0	351	43	837	0	124	43	406
PHSAU	88	0.109	0.033	0	985	202	0	1061	932	1420	0	0	117	62
TRBTE	118	0.138	0.032	467	0	164	431	0	0	0	0	0	122	0
VCOLE	97	0.118	0.032	468	0	135	771	0	0	0	0	0	0	0
SONOL	139	0.157	0.032	0	156	0	0	37	0	128	0	173	0	600
HRYRA	45	0.063	0.032	0	0	12	0	115	5650	198	0	24	0	282
KYLER	175	0.189	0.031	0	124	27	0	445	187	1224	0	157	59	155
OPLBU	147	0.165	0.031	0	0	206	81	776	223	182	209	0	140	0
ELURU	129	0.148	0.031	0	0	0	0	0	0	0	0	269	0	0
MEOPY	349	0.317	0.031	0	124	54	0	0	0	0	101	191	24	36
TRHZE	318	0.296	0.031	246	68	41	226	0	0	28	0	147	52	23
DIGS6	114	0.135	0.031	0	0	363	0	0	0	0	205	0	0	0
TRTPO	286	0.274	0.03	223	152	24	0	0	0	62	0	158	65	165
DIGAD	209	0.216	0.03	0	311	35	0	372	0	641	0	152	89	303
GNAPU	153	0.17	0.03	0	142	44	0	170	0	117	0	134	0	663

App.4.3 Corrected ecological profile of weeds according to the Country factor

Variable entropy: 2.921; Maximum entropy: 3.459; Quality of sampling: 0.844 Mean species entropy: 0.193

Selection of species which mutual information with the Country factor is more than 0.03 (270 taxa)

Species	Abs. frequency	Species. entropy	Mutual. info	Benin	Cameroon	Ivory Coast	Guadeloupe	Guinea	French Guiana	Madagascar	Mauritius	Mayotte	Reunion	Vietnam
DIGHO	1539	0.817	0.352	215	307	197	0	287	84	161	16	0	3	0
CRIMI	880	0.597	0.32	0	0	0	0	0	0	0	119	117	410	0
EUPOD	574	0.452	0.292	0	0	726	0	0	35	0	56	0	0	233
IPOER	756	0.542	0.257	0	622	14	0	234	0	49	32	0	69	0
LEVMA	430	0.369	0.247	0	847	0	0	436	0	0	0	0	0	0
CRGTD	433	0.371	0.233	0	843	38	0	217	0	0	0	0	0	0
BOISY	404	0.353	0.227	0	758	0	0	970	0	0	0	0	0	0
BIDPI	1396	0.778	0.218	0	22	72	1	0	7	52	181	147	272	49
MAPSI	457	0.385	0.216	0	0	720	0	241	22	0	0	151	0	0
PESPE	357	0.323	0.215	0	920	0	0	0	0	0	0	0	0	0
EPHHL	1236	0.729	0.214	179	4	134	125	13	137	23	16	0	274	0
IPOOB	640	0.486	0.211	0	0	0	7	0	0	0	75	133	405	0
CRSCR	415	0.36	0.21	0	0	0	0	0	0	0	58	0	142	1140
SEAVI	350	0.318	0.202	0	0	91	0	158	0	0	0	1104	0	0
AGECO	1283	0.744	0.198	0	34	211	3	77	0	36	216	74	122	410
TRQPR	1033	0.658	0.194	107	312	85	0	101	0	216	16	9	20	0
DEMVI	565	0.447	0.193	0	0	0	0	0	0	0	149	90	416	0
COMBE	1323	0.756	0.188	42	341	52	0	209	0	58	36	58	146	52
DTTAE	699	0.515	0.187	79	509	181	0	126	0	9	63	0	82	0
MAVCO	518	0.421	0.184	0	0	0	4	0	0	0	101	39	438	0
LISGU	472	0.394	0.179	0	0	0	0	0	0	0	68	727	193	0

OXACO	681	0.507	0.179	0	0	0	0	0	0	0	271	333	264	174
SOLAM	478	0.398	0.167	0	0	4	4	0	21	0	0	61	438	0
MTCVI	751	0.54	0.163	0	345	103	0	220	0	202	0	0	0	13
PANUM	313	0.293	0.163	0	0	0	0	0	0	74	0	1063	0	0
CVNHI	298	0.283	0.162	0	0	838	2	0	234	0	0	0	0	0
AMADU	431	0.37	0.154	0	0	0	28	0	92	0	0	0	444	0
PANMA	846	0.583	0.146	65	0	185	91	0	35	1	33	104	261	2
SIKOR	470	0.393	0.146	0	0	0	0	0	0	8	34	0	325	466
MIMPU	541	0.434	0.142	102	0	0	83	0	331	0	30	584	162	56
COMFO	262	0.257	0.142	0	863	0	0	337	0	0	0	0	0	0
CASTO	260	0.255	0.139	0	0	0	0	0	0	0	0	966	0	405
TALFR	246	0.245	0.136	224	0	857	0	0	0	0	0	0	0	0
ANELA	234	0.236	0.134	0	920	0	0	0	0	0	0	0	0	0
KYLSQ	251	0.248	0.133	0	773	0	0	879	0	0	0	0	0	0
URNLO	576	0.453	0.131	0	0	43	10	0	0	279	0	69	5	406
ROOEX	1680	0.851	0.13	0	117	109	238	112	6	109	0	15	43	61
SPKAN	301	0.285	0.128	0	0	704	103	0	364	0	0	0	0	0
BOILF	304	0.287	0.127	0	0	413	30	0	0	0	0	0	0	797
ERIFL	455	0.384	0.126	0	0	153	0	0	0	0	0	0	224	573
MOLNU	660	0.496	0.123	167	254	134	0	109	0	231	0	31	0	0
HPYSP	351	0.319	0.123	0	608	7	0	566	0	101	0	0	0	0
LAOAE	228	0.231	0.12	0	0	846	9	0	44	0	0	0	0	0
FIUEX	216	0.222	0.118	0	0	861	0	0	0	0	0	0	0	0
CASOB	394	0.347	0.115	0	642	39	61	112	0	52	0	36	2	0
ACNHI	609	0.47	0.113	0	216	8	0	181	0	270	0	0	53	0
LYFFL	154	0.171	0.112	0	0	0	0	0	0	0	0	0	0	1672
CLERT	422	0.364	0.11	131	0	306	245	0	472	0	57	296	0	0
CLLAS	229	0.232	0.11	0	0	0	0	0	0	0	53	0	126	1197
PTNHY	320	0.298	0.109	0	0	0	0	0	0	17	50	0	443	0

MOMCH	501	0.411	0.108	0	0	201	79	0	20	0	24	0	302	0
VENCI	734	0.532	0.107	0	0	250	163	0	271	0	104	241	99	41
ERACI	299	0.283	0.106	0	560	291	0	185	67	0	0	0	6	0
MUDNU	296	0.281	0.106	0	0	0	0	0	101	434	0	0	0	17
CLEHI	282	0.271	0.106	0	0	0	0	0	0	443	0	0	0	0
DIGS1	278	0.268	0.104	0	0	0	0	0	0	443	0	0	0	0
RCHSC	277	0.268	0.104	0	0	0	0	0	0	443	0	0	0	0
MAPFL	190	0.201	0.103	0	0	861	0	0	0	0	0	0	0	0
CEOTR	317	0.296	0.103	174	348	399	0	661	0	15	0	0	0	0
OLDCO	346	0.315	0.103	638	420	351	0	96	460	23	35	0	0	0
GRFSI	187	0.198	0.102	0	0	861	0	0	0	0	0	0	0	0
CRGTR	273	0.265	0.102	0	0	0	0	0	0	443	0	0	0	0
PHYLG	280	0.27	0.101	197	328	517	0	197	0	0	0	5	0	0
HIBSU	312	0.292	0.101	0	0	44	0	0	0	0	0	682	193	0
COMSU	180	0.193	0.101	0	920	0	0	0	0	0	0	0	0	0
COSPU	538	0.432	0.1	0	0	261	139	0	0	0	0	355	103	0
SOLER	183	0.195	0.099	0	0	861	0	0	0	0	0	0	0	0
CUMME	232	0.234	0.098	0	741	45	0	452	0	0	0	71	2	0
STYGN	257	0.253	0.096	0	0	0	0	0	0	443	0	0	0	0
MIJZE	175	0.189	0.095	0	0	861	0	0	0	0	0	0	0	0
PANLX	181	0.194	0.095	0	0	837	0	0	275	0	0	0	0	0
AMAVI	454	0.384	0.092	0	45	284	0	0	175	15	567	0	199	4
PANBR	181	0.194	0.092	0	0	157	0	0	0	0	0	1043	0	0
SYDNO	372	0.333	0.092	0	0	139	0	0	0	0	11	0	297	333
FIMHS	166	0.181	0.092	0	920	0	0	0	0	0	0	0	0	0
ARGME	273	0.265	0.092	0	0	0	0	0	0	11	177	0	434	0
IPOHF	241	0.241	0.092	0	0	0	0	0	0	0	17	0	465	0
COGZN	169	0.183	0.091	0	0	861	0	0	0	0	0	0	0	0
MLLOP	170	0.184	0.091	325	0	856	0	0	0	0	0	0	0	0

LTURA	142	0.16	0.091	0	0	0	0	0	0	0	0	1275	0	0
SETS2	127	0.147	0.091	0	0	0	0	0	0	0	0	0	0	1672
KWONI	167	0.182	0.09	0	0	861	0	0	0	0	0	0	0	0
SORAR	342	0.313	0.09	484	0	8	136	0	0	0	47	0	363	0
BRANA	241	0.241	0.09	0	0	0	0	0	0	443	0	0	0	0
PHYAN	236	0.237	0.087	468	47	671	9	351	253	0	68	0	16	14
SOLNI	339	0.311	0.087	0	0	394	0	0	0	12	676	0	153	35
PYLAM	864	0.59	0.087	319	134	245	114	134	150	1	163	124	104	0
HAKGR	150	0.167	0.087	0	527	6	0	2317	0	0	0	0	0	0
IPOS2	238	0.239	0.086	0	0	0	0	0	0	440	0	0	4	0
PANTC	135	0.154	0.086	0	0	0	0	0	0	0	0	1275	0	0
PZLGU	158	0.174	0.085	0	0	861	0	0	0	0	0	0	0	0
CJLAM	153	0.17	0.085	0	920	0	0	0	0	0	0	0	0	0
COPDI	229	0.232	0.084	0	0	0	0	0	0	0	772	0	377	0
SONAS	239	0.239	0.083	0	0	0	6	0	0	0	555	0	398	0
BOIS1	117	0.137	0.083	0	0	0	0	0	0	0	0	0	0	1672
TERLA	304	0.287	0.082	0	0	0	42	0	0	0	13	470	265	0
ACCSE	181	0.194	0.081	0	782	128	0	0	0	0	0	0	0	0
SYIS2	147	0.165	0.081	0	920	0	0	0	0	0	0	0	0	0
DIGS6	114	0.135	0.081	0	0	0	0	0	0	0	0	0	0	1672
LANCA	375	0.335	0.08	0	0	211	0	0	0	5	32	146	290	0
PASCO	215	0.221	0.08	0	0	4	167	0	278	0	0	261	0	879
PESPO	236	0.237	0.079	0	257	40	0	1683	0	163	0	0	0	0
ERATM	152	0.169	0.079	0	859	0	0	363	0	0	0	0	0	0
CITLA	277	0.268	0.078	0	495	0	13	0	0	197	0	0	0	0
MAPSQ	141	0.159	0.078	0	920	0	0	0	0	0	0	0	0	0
BRALA	209	0.216	0.077	0	330	544	0	53	0	0	0	0	0	0
EMISO	224	0.228	0.077	0	0	446	3	0	1066	0	144	0	29	455
COMDI	572	0.45	0.077	0	16	250	4	0	0	63	7	76	110	415

LEVLA	209	0.216	0.077	0	0	0	0	0	0	0	96	0	455	0
AJSTO	143	0.161	0.076	0	0	861	0	0	0	0	0	0	0	0
COSVI	157	0.173	0.076	0	0	0	704	0	0	0	0	0	0	0
PASPA	266	0.26	0.075	0	0	0	13	0	37	0	0	321	338	0
TREAN	106	0.127	0.075	0	0	0	0	0	0	0	0	0	0	1672
CYPS8	105	0.126	0.074	0	0	0	0	0	0	0	0	0	0	1672
LNECO	187	0.198	0.073	0	266	612	0	0	0	0	0	0	0	0
IPOFA	152	0.169	0.073	0	0	0	704	0	0	0	0	0	0	0
EPHHI	1157	0.703	0.072	0	181	136	10	91	69	122	118	176	77	0
PLALA	198	0.207	0.072	0	0	0	0	0	0	0	142	0	450	0
ALBZY	133	0.152	0.071	0	0	861	0	0	0	0	0	0	0	0
MZUBN	132	0.151	0.07	0	0	861	0	0	0	0	0	0	0	0
DIGAD	209	0.216	0.07	0	0	78	0	0	1381	0	0	0	359	0
ACYAS	483	0.401	0.07	0	200	0	3	0	0	115	17	377	102	0
DIG10	110	0.131	0.07	0	0	0	0	0	0	0	0	1275	0	0
SIDAC	427	0.367	0.069	0	0	208	73	13	93	265	0	9	19	0
IPOIV	127	0.147	0.068	0	0	861	0	0	0	0	0	0	0	0
PAXPI	128	0.148	0.068	0	0	861	0	0	0	0	0	0	0	0
IPOS8	108	0.129	0.068	0	0	0	0	0	0	0	0	1275	0	0
PAQFO	316	0.295	0.067	0	0	251	13	0	31	0	64	69	288	0
PUEPH	124	0.144	0.066	0	0	861	0	0	0	0	0	0	0	0
TLMAF	124	0.144	0.066	0	0	861	0	0	0	0	0	0	0	0
BULBA	153	0.17	0.066	0	769	101	0	252	0	0	0	0	0	0
MESS1	94	0.115	0.066	0	0	0	0	0	0	0	0	0	0	1672
BOEDI	636	0.484	0.065	0	145	166	0	43	0	187	57	0	96	0
ELEIN	1240	0.73	0.065	44	47	123	20	71	136	164	175	20	108	150
CYNDA	628	0.48	0.065	0	0	29	213	0	32	74	115	43	200	5
SPCRA	127	0.147	0.065	0	840	0	0	478	0	0	0	0	0	0
ALZOV	139	0.157	0.064	0	840	0	0	119	0	29	0	0	0	0

PVPVE	102	0.123	0.064	0	0	0	0	0	0	0	0	1275	0	0
MOWGU	119	0.139	0.063	0	0	861	0	0	0	0	0	0	0	0
SIDRH	322	0.299	0.063	0	29	21	31	206	31	279	0	28	0	348
AMAGR	115	0.135	0.063	0	920	0	0	0	0	0	0	0	0	0
MEOPY	349	0.317	0.063	0	0	0	40	0	0	118	81	0	306	0
OXALA	178	0.191	0.063	0	0	0	0	0	0	0	384	0	422	0
LIDS4	90	0.111	0.063	0	0	0	0	0	0	0	0	0	0	1672
TRHZE	318	0.296	0.062	0	0	0	0	0	0	185	13	12	266	0
ALBAD	115	0.135	0.061	0	0	861	0	0	0	0	0	0	0	0
CYPRO	1299	0.749	0.061	0	105	17	150	17	31	106	139	20	152	55
BRADE	215	0.221	0.06	257	0	444	0	0	0	212	0	0	0	0
CRGOL	167	0.182	0.06	330	683	113	0	396	0	16	0	0	6	0
PAQSU	148	0.165	0.059	0	0	0	0	0	0	0	136	896	123	0
OLDAF	109	0.13	0.058	0	0	861	0	0	0	0	0	0	0	0
ASYCO	239	0.239	0.058	0	0	249	0	0	624	0	50	448	133	0
APULE	162	0.178	0.058	0	0	0	0	0	0	0	695	0	386	0
CLZCA	108	0.129	0.057	0	0	861	0	0	0	0	0	0	0	0
PASSC	340	0.311	0.057	811	105	241	0	503	0	9	0	19	119	349
DEDTO	177	0.19	0.057	312	0	15	0	0	0	10	68	0	437	0
RHNMI	333	0.307	0.057	0	14	3	338	0	0	59	0	0	172	0
SEBSP	155	0.172	0.057	0	0	0	0	0	0	443	0	0	0	0
NICPH	153	0.17	0.057	0	0	0	0	0	0	0	26	0	463	0
HYPJA	82	0.103	0.057	0	0	0	0	0	0	0	0	0	0	1672
SAEIN	82	0.103	0.056	0	0	0	0	0	243	0	0	0	0	1631
OXACB	164	0.179	0.056	0	0	0	0	0	0	0	98	0	441	51
PYLTE	192	0.203	0.056	0	0	0	0	0	0	0	481	452	245	0
CLEVI	340	0.311	0.055	0	462	5	33	16	0	82	95	22	100	0
PHSAU	88	0.109	0.055	0	0	0	0	0	0	0	0	1275	0	0
SPOCA	98	0.119	0.054	0	0	70	0	0	0	0	0	1171	0	0

PTODE	148	0.165	0.054	0	0	0	0	0	0	443	0	0	0	0
GNAPU	153	0.17	0.054	0	0	0	0	0	0	0	473	0	412	0
PYLRE	201	0.21	0.053	0	0	291	0	0	0	293	0	0	0	0
IPONI	203	0.211	0.053	0	0	30	76	0	0	0	99	0	388	0
SONOL	139	0.157	0.052	0	0	0	0	0	0	0	1041	0	346	0
AMALP	139	0.157	0.052	0	0	0	0	0	0	0	0	0	466	0
SPXMO	96	0.117	0.051	0	0	861	0	0	0	0	0	0	0	0
IPOTR	207	0.215	0.05	0	0	258	0	0	96	0	233	6	293	0
TEPBR	100	0.121	0.05	0	855	9	0	331	0	0	0	0	0	0
CYHPR	128	0.148	0.049	0	0	706	0	0	0	0	0	10	80	0
SEBPA	92	0.113	0.049	0	910	0	0	60	0	0	0	0	0	0
VCOLE	97	0.118	0.049	0	720	0	0	1194	0	0	0	0	0	0
LACIN	230	0.233	0.049	0	0	0	0	0	0	13	262	200	260	320
CASOC	347	0.316	0.048	0	29	67	0	0	0	78	81	85	293	0
LIDCR	83	0.104	0.048	0	0	62	0	0	1558	0	0	0	0	1289
EPHHY	360	0.325	0.048	0	0	26	221	0	332	30	223	60	211	0
CONAE	186	0.198	0.048	0	0	0	356	0	0	0	0	0	231	0
LIDS2	69	0.09	0.048	0	0	0	0	0	0	0	0	0	0	1672
SOLMR	135	0.154	0.047	0	0	0	0	0	0	0	506	0	408	0
APIAR	88	0.109	0.046	0	0	861	0	0	0	0	0	0	0	0
SOLTO	140	0.158	0.046	0	0	609	0	0	71	0	431	73	57	0
CHRRA	165	0.18	0.046	0	0	5	68	0	0	0	365	0	376	0
PASDI	123	0.143	0.046	0	0	0	0	0	0	0	0	0	466	0
MUCPR	185	0.197	0.045	0	0	489	213	0	0	5	0	41	40	0
ELURU	129	0.148	0.045	0	0	220	524	0	0	0	0	0	0	0
POROL	644	0.488	0.044	0	120	179	0	26	247	103	193	91	131	0
RHYRE	282	0.271	0.044	0	78	40	0	0	0	288	0	0	103	0
GASPA	149	0.166	0.044	0	0	0	0	0	0	27	351	0	398	0
TRTPO	286	0.274	0.043	0	0	292	0	19	0	129	337	0	132	0

SIDUR	97	0.118	0.043	0	0	195	0	57	0	5	0	960	0	0
KYLER	175	0.189	0.043	0	0	49	0	0	0	0	115	248	336	0
PANPU	101	0.122	0.043	0	0	43	669	0	0	0	0	0	0	0
PANRP	190	0.201	0.043	0	0	0	245	0	0	119	63	470	0	0
SLSMO	81	0.102	0.042	0	0	861	0	0	0	0	0	0	0	0
PSIGU	81	0.102	0.042	0	0	53	0	0	0	5	149	1133	0	0
SETBA	289	0.276	0.042	0	16	27	85	0	0	0	125	194	258	156
ALZRU	98	0.119	0.042	0	788	0	0	281	0	41	0	0	0	0
CHRBA	154	0.171	0.042	0	0	0	91	0	0	0	287	0	373	0
CXNFE	78	0.099	0.041	0	0	861	0	0	0	0	0	0	0	0
SCFDU	105	0.126	0.041	0	175	115	0	53	758	0	0	12	0	971
AMAS5	66	0.087	0.041	0	0	0	0	0	0	0	0	1275	0	0
FUMMU	109	0.13	0.041	0	0	0	0	0	0	0	0	0	466	0
CYPKH	59	0.079	0.041	0	0	0	0	0	0	0	0	0	0	1672
CRGAE	216	0.222	0.04	0	0	155	0	0	0	257	0	171	0	178
COMS4	65	0.085	0.04	0	0	0	0	0	0	0	0	1275	0	0
ALBLE	65	0.085	0.04	0	0	0	0	0	0	0	0	1275	0	0
TEPNO	108	0.129	0.04	0	0	0	0	0	0	0	0	0	466	0
PYLS3	58	0.078	0.04	0	0	0	0	0	0	0	0	0	0	1672
IPOMT	75	0.096	0.039	0	0	861	0	0	0	0	0	0	0	0
TIUBA	111	0.132	0.039	0	0	450	0	0	0	0	0	517	4	105
HIBAS	161	0.177	0.039	0	400	27	0	411	0	204	0	0	0	0
BOEER	167	0.182	0.039	330	182	0	0	429	0	3	193	15	304	0
BOICH	72	0.093	0.039	0	920	0	0	0	0	0	0	0	0	0
ARKS1	109	0.13	0.039	0	0	0	0	0	0	443	0	0	0	0
MEUAL	111	0.132	0.039	0	0	0	0	0	0	0	253	0	437	0
PASS2	57	0.077	0.039	0	0	0	0	0	0	0	0	0	0	1672
EPHHS	79	0.1	0.038	0	0	643	0	0	0	0	1018	0	0	0
CCHBI	211	0.218	0.038	0	0	20	0	52	0	183	0	0	259	0

ECHCO	420	0.363	0.038	131	83	14	243	0	0	119	48	82	22	255
UOUJA	110	0.131	0.038	0	0	0	0	0	0	0	329	0	428	0
PYLUR	131	0.15	0.037	0	0	559	0	0	0	0	92	88	121	0
ECLAL	96	0.117	0.037	1724	0	269	0	0	311	0	167	0	19	906
CVTGO	75	0.096	0.037	0	871	11	0	221	0	0	0	0	0	0
SETPU	277	0.268	0.037	0	159	3	0	239	0	149	0	5	205	0
CYPAI	97	0.118	0.037	0	702	0	0	455	0	69	0	0	0	0
TEPPU	145	0.163	0.037	0	0	0	0	0	0	370	0	0	77	0
SPZPY	69	0.09	0.036	0	0	861	0	0	0	0	0	0	0	0
CASHS	81	0.102	0.036	0	0	744	0	0	0	0	0	173	0	0
CLOMU	104	0.125	0.036	0	0	530	271	0	0	0	0	0	0	0
STRHE	66	0.087	0.036	0	920	0	0	0	0	0	0	0	0	0
LPOCE	53	0.072	0.036	0	0	0	0	0	188	0	0	0	0	1640
FIUHT	52	0.071	0.036	0	0	0	0	0	0	0	0	0	0	1672
TREOR	73	0.094	0.035	0	0	802	0	302	0	0	0	0	6	0
CHRPI	121	0.141	0.035	0	623	128	0	46	0	59	0	0	0	55
OPLBU	147	0.165	0.035	0	0	88	0	0	0	265	0	382	0	0
CYPIR	69	0.09	0.035	0	0	62	0	0	721	0	0	0	27	1333
OCICA	126	0.146	0.034	0	102	20	0	0	0	380	32	0	0	0
SYILA	58	0.078	0.034	0	476	0	0	2664	0	0	0	0	0	0
EMIFO	121	0.141	0.034	0	0	0	175	0	1398	0	0	0	285	0
HYRS1	95	0.116	0.034	0	0	0	0	0	0	443	0	0	0	0
STCUR	114	0.135	0.034	0	0	0	0	0	0	0	71	537	262	0
ADVIN	50	0.069	0.034	0	0	0	0	0	0	0	0	0	0	1672
NWBLA	63	0.083	0.033	0	0	861	0	0	0	0	0	0	0	0
COMLA	65	0.085	0.033	0	0	848	0	85	0	0	0	0	0	0
HPYSU	81	0.102	0.033	0	795	53	0	136	0	22	0	0	0	0
CUGPI	65	0.085	0.033	0	764	0	0	934	0	0	0	0	0	0
PYLMP	62	0.082	0.033	0	920	0	0	0	0	0	0	0	0	0

RUBAC	96	0.117	0.033	0	0	0	0	0	0	0	0	53	447	0
CIBPR	61	0.081	0.032	0	0	861	0	0	0	0	0	0	0	0
MIMIN	119	0.139	0.032	0	0	51	0	0	0	0	0	514	251	0
CNNIN	103	0.124	0.032	0	0	50	0	0	0	0	195	0	417	0
ERAAS	122	0.142	0.032	0	377	0	0	181	0	247	0	0	0	0
TRBTE	118	0.138	0.032	0	421	0	0	0	0	240	0	0	0	0
CRIGR	59	0.079	0.031	0	0	861	0	0	0	0	0	0	0	0
SRLTA	59	0.079	0.031	0	0	861	0	0	0	0	0	0	0	0
SZGPN	60	0.08	0.031	0	0	861	0	0	0	0	0	0	0	0
CVNLO	115	0.135	0.031	1919	112	269	373	0	0	0	0	0	0	0
CASMI	109	0.13	0.031	0	616	39	0	506	0	61	0	0	26	0
DRYCO	103	0.124	0.031	0	0	17	0	0	97	0	1093	161	267	0
CLZSI	57	0.077	0.03	0	0	861	0	0	0	0	0	0	0	0
LUDOC	85	0.106	0.03	3245	379	152	33	0	2107	0	236	0	16	0
DIHCA	64	0.084	0.03	0	0	0	704	0	0	0	0	0	0	0
DEDIN	81	0.102	0.03	0	0	0	0	0	0	0	0	0	466	0

Appendix 5: Results of the Principal Componant Analysis with Instrumental Variables (PCAIV)

Inertia of the abundance matrix explained by given factors (%): 18.35

Inertia per axis (%):	Axis 1	Axis 2	Axis 3
	7.65	2.48	1.84

Cumulative inertia (%):	Axis 1:1	Axis 1:2	Axis 1:3
	7.65	10.12	11.96

10 most correlated descriptors with each factorial axes:

	Axis 1	Axis 2	Axis 3
1	Pays.Vietnam 0.896 ***	Pays.Vietnam -0.744 ***	Pays.Mayotte -0.814 ***
2	Climat.tropical-altitude 0.350 ***	Climat.tropical-altitude -0.622 ***	Type_culture.arboriculture -0.572 ***
3	Climat.tropical -0.319 ***	Type_culture.riz -0.549 ***	Climat.tropical-sec 0.340 ***
4	Type_culture.canne -0.246 ***	Type_culture.tubercule 0.443 ***	Pays.Côte d'Ivoire 0.289 ***
5	Type_culture.tubercule 0.232 ***	Climat.tropical-humide 0.324 ***	Pays.Madagascar 0.283 ***
6	Type_culture.vivrier 0.224 ***	Pays.Côte d'Ivoire 0.262 ***	Type_culture.cotonnier 0.236 ***
7	Pays.Madagascar -0.203 ***	Climat.tropical-sec 0.248 ***	Type_culture.tubercule 0.231 ***
8	Pays.Guadeloupe -0.165 ***	Pays.Mayotte 0.216 ***	Type_culture.Ananas -0.211 ***
9	Pays.Côte d'Ivoire 0.162 ***	Type_culture.arboriculture 0.186 ***	Type_culture.prairie -0.200 ***
10	Type_culture.riz 0.143 ***	Pays.Réunion 0.164 ***	Pays.Cameroun 0.197 ***

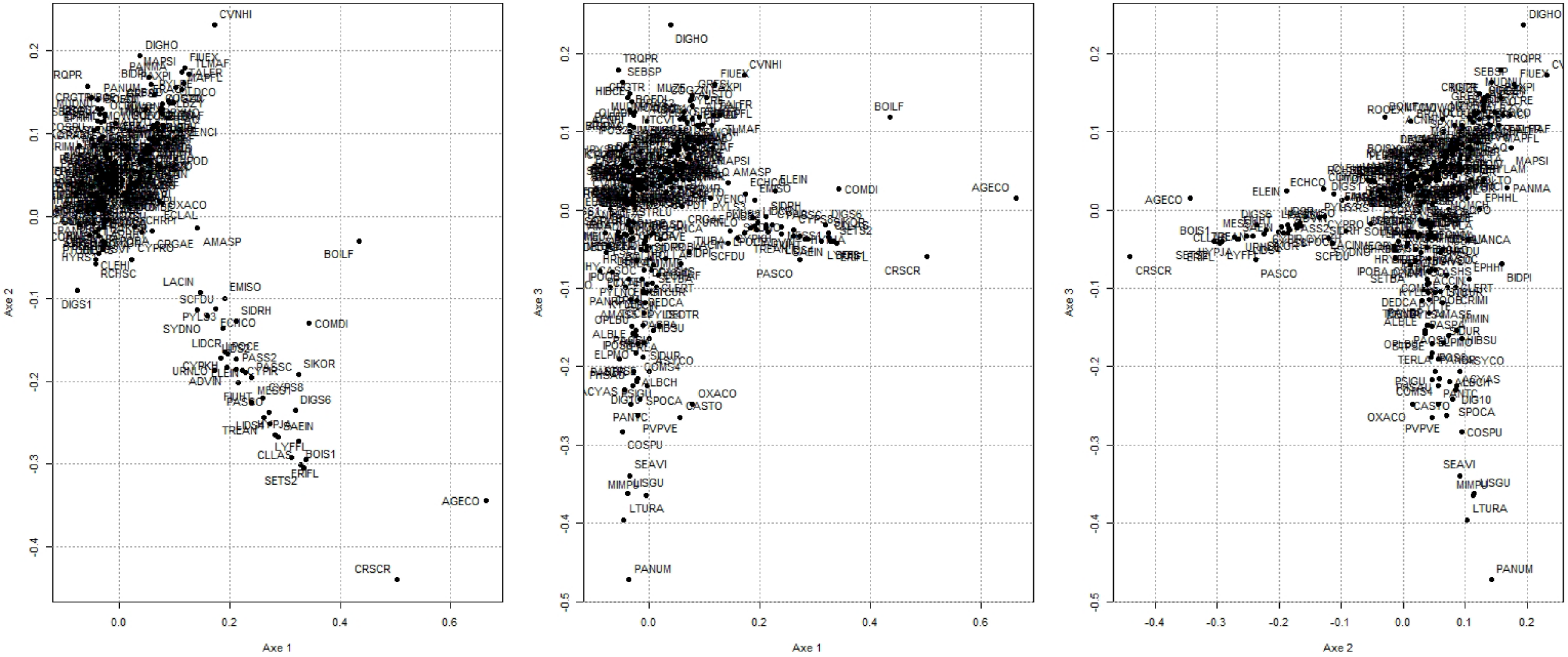
Signification of codes for correlation test's p values: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

10 most correlated species with each factorial axes:

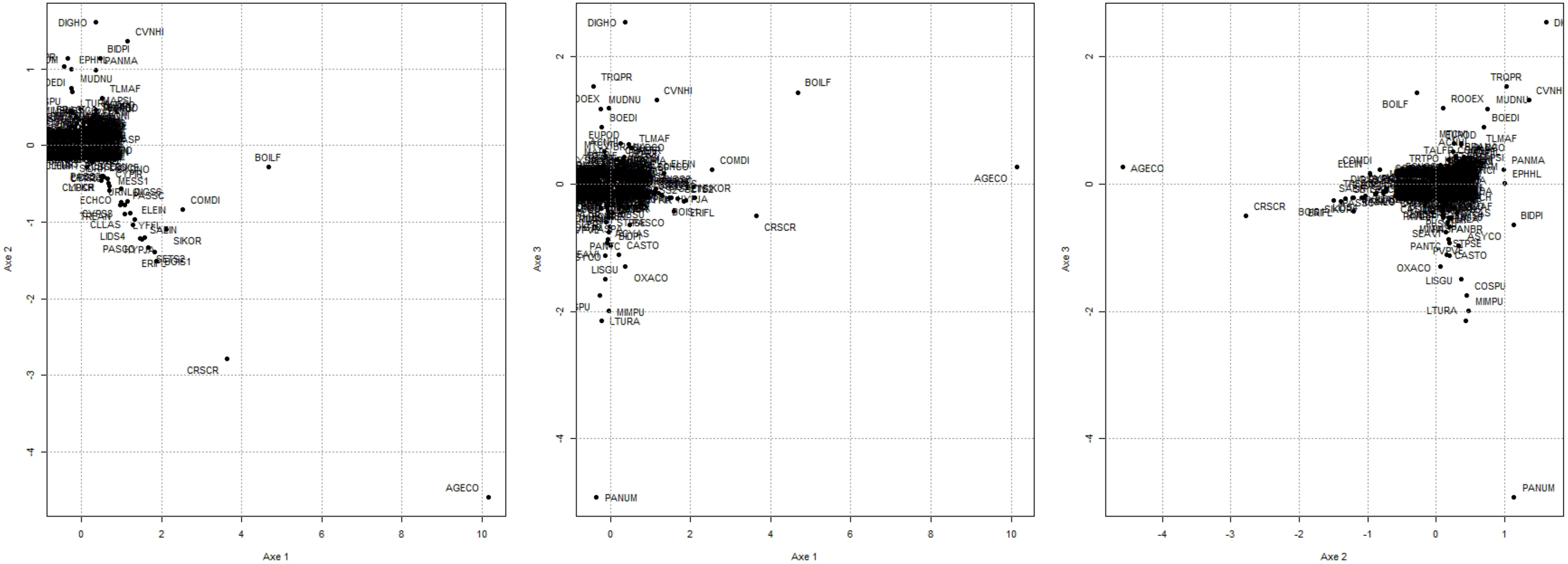
	Axis 1	Axis 2	Axis 3
1	AGECO 0.664 ***	CRSCR -0.440 ***	PANUM -0.472 ***
2	CRSCR 0.503 ***	AGECO -0.344 ***	LTURA -0.395 ***
3	BOILF 0.435 ***	SETS2 -0.305 ***	MIMPU -0.365 ***
4	COMDI 0.344 ***	BOIS1 -0.301 ***	LISGU -0.362 ***
5	ERIFL 0.338 ***	ERIFL -0.295 ***	SEAVI -0.339 ***
6	SETS2 0.334 ***	LYFFL -0.292 ***	COSPU -0.283 ***
7	BOIS1 0.328 ***	CLLAS -0.273 ***	CASTO -0.264 ***
8	CLLAS 0.325 ***	SAEIN -0.267 ***	PVPVE -0.262 ***
9	SIKOR 0.324 ***	HYPJA -0.265 ***	OXACO -0.248 ***
10	DIGS6 0.319 ***	LIDS4 -0.252 ***	PANTC -0.248 ***

Signification of codes for correlation test's p values: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Correlation of species with factoriel axis



Covariance of species with factorial axis



Correlation of factors with factorial axis