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Weediness of the Cotton Crop in Cote D'Ivoire in 2014

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Abstract: During the year 2014, 619 floristic observations were made in cotton fields in Côte d'Ivoire. 80 % of cotton plots, wich average size was about 5.4 ha, were treated with a pre-emergence herbicide. Additional weeding occured when necessary (three times on average). This study identified the dominant weeds in cotton crop from sowing to harvest. *Rottboellia cochinchinensis* (Lour.) Clayton, *Euphorbia heterophylla L.*, *Ageratum conyzoides L.* and *Commelina benghalensis L.* were the most common species. The floristic composition evolved along the cropping season: at the beginning, *Euphorbia heterophylla* and *Commelina benghalensis* were the most frequent species, while *Ageratum conyzoides* grew especially late in the cycle. The species were also distributed according to the different climate areas. Weed infestation was correlated with control practices.

Keywords: Cotton, Weed, Herbicide, Hand Weeding, Climate Area

Introduction

In Côte d'Ivoire, cotton is grown in the north of the country from the sixth parallel. Following the privatisation in 2000 of the only textile ginning and farmer support company, CIDT (Compagnie Ivoirienne pour le Développement du Textile), other companies such as Ivoire Coton, COI-C (Compagnie Ivoirienne du Coton) and SECO (Société d'Exploitation du Coton) have been set up. Each of these companies offers the cotton farmers that it supervises the inputs of its choice. As a result, there is a wide range of crop inputs (cotton seeds, fertilisers, insecticides, herbicides) available to farmers. Chemical weeding of this crop is widely practiced in Côte d'Ivoire. Recurrent use of herbicides with various active ingredients requires monitoring of weediness in order to detect changes in the weed flora, to analyse the causes of these changes and to propose alternative solutions in the case of species selections.

Observations of the weed flora, carried out over four years (2002, 2004, 2005 and 2006) at the beginning of the cotton cycle, revealed the dominance of the following species : *Ageratum conyzoides* L. (43 %), *Digitaria horizontalis* Willd. (39 %), *Commelina benghalensis* L. (38 %), *Euphorbia heterophylla* L. (35 %), *Rottboellia cochinchinensis* (Lour.) W.Clayton (21 %) and *Ipomoea eriocarpa* R.Br. (15 %), (Téhia, 2013). The dominant weeds present in the fields from first weeding to harvest have not yet been studied. Are they the same as those that appeared before the first weeding or are other species able to emerge after the first maintenance work (weeding, ridging) to become invasive ?

Material and Method

The study was conducted in 2014 on farmers' plots cultivated with cotton in order to observe the weeds encountered throughout the crop cycle.

Weed Monitoring Sites And Methods For Sampling Areas And Farmers

The geographical area of cotton cultivation in the north of Côte d'Ivoire is subdivided into 36 administrative zones. Monitoring of weediness is carried out in 16 zones shown on the map in Figure 1. Floristic surveys are carried out by the technicians of the cotton companies. In each zone, about ten farmers were selected ; as far as possible, the farmers were located in different villages. The monitoring of weediness is carried out on one plot of each farmer.

Observed Variables

All surveys are georeferenced. In addition to the date of observation and the flora, the following variables are recorded : area of the field, date of ploughing, date of sowing, herbicides used, dates of weeding, rainfall.

The fertilisation practised by the majority of farmers and the insecticide treatments that are essential to obtain better production are not taken into account because they do not allow for differentiation between the records.

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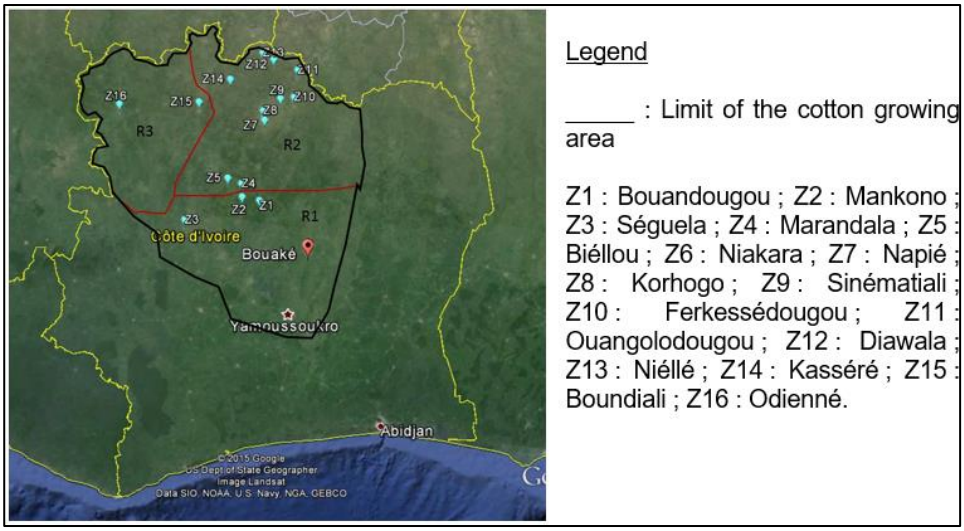

Figure 1 : Investigated areas (Z1 à Z16)

Method of Floristic Survey

The floristic survey is done monthly from June to October, if possible before each weeding.

The observation station corresponds to the whole field of the farmer if it is less than one hectare or to a portion equal to one hectare if the field is larger than one hectare. The station is surveyed along the two diagonals. After running the diagonals, the three dominant weed species with the highest soil cover are selected.

Data Processing

The data were entered, formatted and processed using Excel software.

Constitution of variable classes

The survey dates were grouped into four classes corresponding to each of the survey months : July (which also includes the end of June surveys), August, September and October.

The areas studied are grouped into three climatic regions defined below :

- Region 1 (Bouandougou, Mankono and Séguela), a transitional zone in central Côte d'Ivoire, with two rainy seasons and annual rainfall ranging from 900 to 1,600 mm;
- Region 2 (Biéllou, Marandala, Niakara, Diawala, Ferkessédougou, Kasséré, Korhogo, Napié, Niellé, Ouangolo and Sinématiali) in the north of the country, an area with one rainy season and an annual rainfall of 1,000 to 1,400 mm;
- Region 3 (Boundiali and Odienné), corresponding to the mountainous western part of the country, with a rainy season and annual rainfall of between 1,400 and 1,600 mm (Brou, 2005).

Relative frequency of a weed

The relative frequency is defined as the ratio of the number of records where the species is present to the total number of records considered; this ratio is expressed as a percentage

Corrected weed frequency index

For each species, relative frequencies are calculated for the different states (or classes) of the same factor to establish an ecological profile of the species in relation to the states of that factor. For the different species, these relative frequencies are not of the same order of importance. In order to compare the behaviour of different species for a given factor, its corrected frequency must be calculated. The corrected frequency or corrected frequency index is equal to the relative frequency for a factor condition divided by the relative frequency over all surveys. The more the corrected frequency deviates from unity (1), the more sensitive the species is to the state of the factor studied. According to Daget and Godron (1982), the corrected frequency (CF) of the species at the level of a descriptor class is written as :

$$FC = \frac{v1N}{e1n}$$

v1 = number of records in class k1 where species E is present
e1 = number of records in class k1
n = total number of records where species E is present
N = total number of records
This corrected frequency can be expressed as a percentage, as is the case in this paper.

Results

The 619 floristic surveys, carried out during the 2014 croppin son, covered 154 farmers' cotton plots, spread 95 villages and 16 administrative zones located in the northern half of Côte d'Ivoire. These plots vary in size from 0.5 to 25 hectares with an average of 5.4 hectares. Areas between 0.5 and 10 hectares represent 89 % of all plots. Of these, the most frequent (36 %) are between 2.1 and 5 hectares (Figure 2).

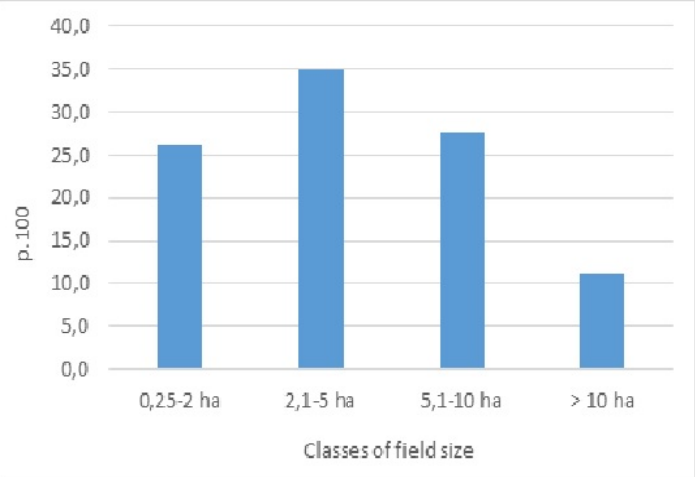

Figure 2 : Percentage of fields according to the classes of field size

The Conduct Of Cotton Cultivation

In the whole sample, a quarter of the plots are not ploughed. Among these plots, small plots (< 2 ha) are the most numerous (29%) while large plots are less represented (12%). Half of the plots in the sample were ploughed between 15 May and 30 May.

Sowing was mainly spread over the three decades of June, respectively 45 % (1-10 June), 38 % (11-20 June) and 17 % (21-30 June). The average time between ploughing and sowing is 11 days, 50 % of the plots are sown in the first week after ploughing : this proportion is 70 % for small plots (< 2 ha), while it is only 20 % for large plots.

In 79 % of cases, a pre-emergence herbicide is applied on the plots : these are mainly products based on metolachlor (51 %), diuron (19 %) or pendimethalin (9 %). Except these uses, the surveys reveal very rare applications of post-emergence herbicides, as well as only two cases of treatments with glyphosate for cleaning the plots before ploughing.

All plots are cleaned manually or mechanically. 46 % of the plots are butted during the cycle : this sarclo-butting must be included in the weed control practices. Figure 3 shows the distribution of the number of weeding operations : three weeding are carried out in the majority of cases (46 %).

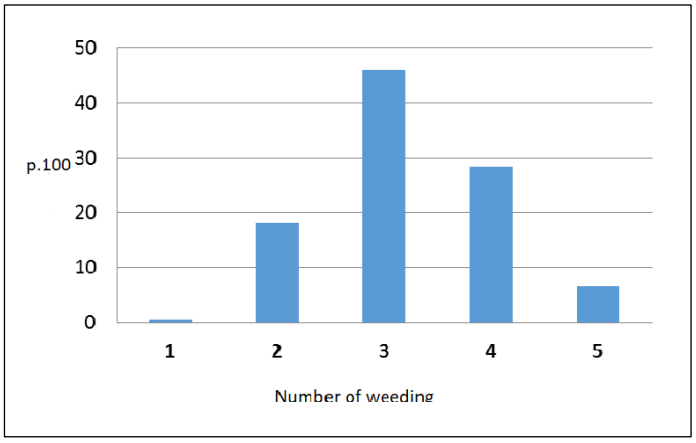

Figure 3: Distribution of the number of weeding

The Dominant Weed Flora Of The Cotton Crop In 2014

The analysis of the surveys shows 67 dominant weed species. The most frequent are *R. cochinchinensis* (47 %), *E. heterophylla* (45 %), *A. conyzoides* (45 %) and *C. benghalensis* (44 %). In Table I, dominant weeds with a relative frequency greater than or equal to 10 % are selected for all surveys or for the states of the variables studied.

Three less frequent species are worth mentioning : two Poaceae, *Brachiaria lata* (Schum.) C.E.Hubb (8 %) and *Paspalum scrobiculatum* L. (6 %), as well as a Rubiaceae, *Spermacoce ruelliae* DC (6 %) because of their high local dominance.

Table I : The most frequent weeds in cotton field

Specie	Family	Relative frequency
R. cochinchinensis (Lour.) W.Clayton	Poaceae	47,0 %
E. heterophylla L.	Euphorbiaceae	45,4 %
A. conyzoides L.	Asteraceae	44,7 %
C. benghalensis L.	Commelinaceae	43,9 %
Hyptis suaveolens (L.) Poit.	Lamiaceae	19,5 %
I. eriocarpa R.Br.	Convolvulaceae	12,4 %
D. horizontalis Willd.	Poaceae	10,8 %

Frequencies Of Dominant Weeds At Observation Dates

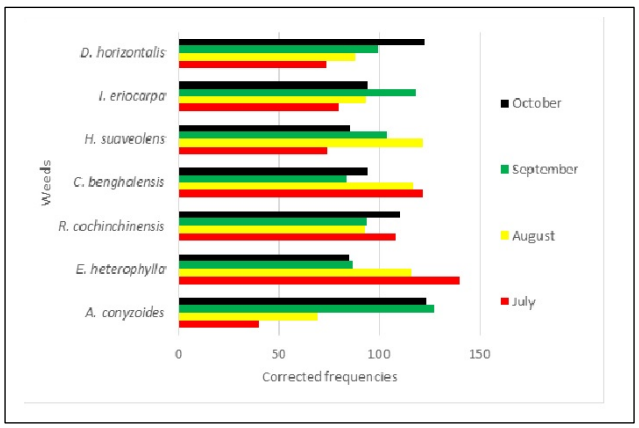

Figure 4 shows the distribution of the most frequent species during the crop cycle, according to their frequency corrected on this factor. Three species are more frequent at the beginning of the cycle (*H. suaveolens*, *E. heterophylla* and *C. benghalensis*), while *I. eriocarpa* has its maximum presence in September. *R. cochinchinensis* is well represented throughout the growing season. *D. horizontalis* seems to be more present at the end of the crop cycle, but this is especially the case for *A. conyzoides* which behaves preferentially as a late crop weed.

Figure 4 : Corrected frequency of the dominant weeds by month

Distribution Of Dominant Weeds According To Climatic Regions

The results show in figure 5 that there are :

- Dominant and very frequent species in region 3, the most rainy, *R. cochinchinensis*, *E. heterophylla*, *I. eriocarpa* and *B. lata* with corrected frequencies of 154, 126, 227 and 161 respectively;
- A dominant and very frequent species in Region 1 with two rainy seasons, *H. suaveolens*, with a corrected frequency of 158 ; this species is very rarely dominant in Region 3 with high rainfall where its corrected frequency is 20 ;
- And species that are more or less indifferent to the three climatic regions, namely *A. conyzoides*, *C. benghalensis* and *D. horizontalis*, with corrected frequencies of around 100.

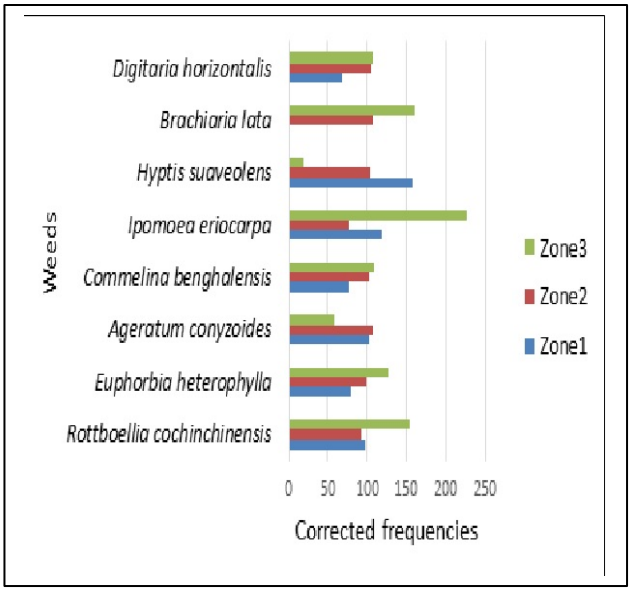

Figure 5: Corrected frequency of weeds according to climatic areas

Discussion

Considering only the three dominant weed species per survey, without measuring their importance by means of a rating scale, does not allow a comparison of the same species in two different surveys. If it is ranked as the first dominant weed in the two surveys, its cover rate may be different. The impossibility of carrying out this type of survey by technicians specialised in weed science limits us to such a survey method practicable by technicians of cotton companies.

The weed flora is dominated by four species (*R. cochinchinensis*, *E. heterophylla*, *A. conyzoides* and *C. benghalensis*), which confirms the results of 1,500 surveys carried out from 2002 to 2006 (Tehia, 2006). This study helps to understand the high frequencies of dominant species such as *S. ruelliae* and especially *H. suaveolens* in cotton plots. The availability of inexpensive generic herbicides on the market encourages their massive use. Some herbicides, based on diuron and pendimethalin, are inefficient against these weeds and have favoured their development.

The abundance of *I. eriocarpa* on plots treated with herbicides of the metolachlor class is explained both by the ineffectiveness of these herbicides and the possibility for this weed to regrow from roots sectioned after weeding.

According to Le Bourgeois (1993), Niéré (1981) and Strahan et al. (2000), *C. benghalensis*, *D. horizontalis*, *E. heterophylla*, *I. eriocarpa* and *R. cochinchinensis* are very long emergenced species that start to germinate from the beginning of the rainy season until October when the rains stop. The emergence of *A. conyzoides*, like that of other Asteraceae, is more important in the middle of the rainy season, this

species becoming dominant at the end of the cycle. These staggered or late emergences explain the presence of these weeds on the plots after each weeding.
These different weedings favour the emergence of *A. conyzoides* and *D. horizontalis*, whose frequency increases from June to October. Inversely, *E. heterophylla* and *P. scrobiculatum*, which are sensitive to weeding, see their frequency decrease during the cycle.

R. cochinchinensis appeared to be very frequent in region 3, which receives the highest rainfall : this behaviour is similar in Bolivia, where it has been shown that increasing rainfall has a positive effect on the emergence of this species (NAPPO, 2003).

Conclusion

Cultural practices influence weed behaviour according to their effectiveness in controlling the different species. Repeated use of certain herbicides favoured the development of *Spermacoce ruelliae*, *Hyptis suaveolens* and *Ipomoea eriocarpa*; this confirms the need to widen the choice of available herbicides in order to be able to change them from one crop cycle to another.

Successive weeding has a positive effect on the reduction of *Euphorbia heterophyll*a and *Paspalum scrobiculatum* populations, whose frequencies become progressively lower during the cotton crop cycle. On the other hand, they favour the proliferation of *Ageratum conyzoides* and *Digitaria horizontalis*. In this case, directed chemical weed control in the inter-rows could limit their development.

The same method or a second sarclo-butting can be considered to control *R. cochinchinensis*, *E. heterophylla*, *I. eriocarpa* and *B. lata*, which are frequently dominant in the most watered areas.

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