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Research Article

Dynamics and Depths of Emergence of *Croton hirtus* Herit (Euphorbiaceae) Seedlings in the Central Western Côte d'Ivoire

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ABSTRACT

Croton hirtus is a major weed of food crops in the Central Western Côte d'Ivoire. The present research aimed to study its seedlings emergence dynamics and depth in order to conceive effective management strategies and increase food production in Central Western Côte d'Ivoire. To carry out the investigations on the emergence dynamics of *Croton hirtus* seedlings, 12 quadrats distributed along three (3) transects were installed on plots previously occupied by maize cultivation and heavily infested by *Croton hirtus* in 2012 and 2013 and observations were made on a weekly basis. For the emergence depth of *Croton hirtus* seedlings, four (4) repetitions of 100 seeds of the species were sown at depths of 0, 1, 2.5, 5 and 10 cm from the soil surface in nursery bags (dimensions: 9.5 cm in diameter and 25 cm deep). Four (4) cohorts of *Croton hirtus* were observed during each of the two years of investigation. In the absence of drought, the highest emergence densities of seedlings of the studied species were observed at the start of the growing seasons. The high emergence rates of *Croton hirtus* seedlings were noted at 2.5 cm from the soil surface and the lowest at 10 cm. This study suggests that special attention should be paid to cohorts of *Croton hirtus* that emerge early in the growing seasons. In addition, the adoption of deep plowing (more than 10 cm from the soil surface) could reduce the emergence of *Croton hirtus* seedlings.

Key words: Food crops, Weeds, *Croton hirtus*, Seedling emergence dynamics, Seedling emergence depth, Central Western Côte d'Ivoire

INTRODUCTION

The Central Western Côte d'Ivoire is an area of high food production (Douka 2011). The main food crops in this part of Côte d'Ivoire are rice, maize, plantains, cassava, and yams (Koffie-Bikpo and Kra 2013). Their production faces several biotic constraints and the most important of them are weeds (Becker and Johnson 2001).

Traditionally, weed management was not a problem in the Central Western Côte d'Ivoire due to the cropping system adopted by farmers (Becker and Johnson 2001; Cuero 2006). In fact, in the past, food producers practiced shifting agriculture with long fallow periods (Gbakatchetche *et al.*, 2012). The long duration of fallows was intended to restore soil fertility and control weeds (Le Roy 1995). Today, with the reduction of agricultural land, the duration of fallow is shorter and shorter, around three (3) years (Gbakatchetche *et al.*, 2012; Konaté *et al.*, 2012). This led to an increase in the level of weed infestation of crop food plots in the area (Becker and Johnson 2001; Cuero 2006) with the consequence of reducing food production.

To control weeds in Central Western Côte d'Ivoire, growers are increasingly using herbicides (N'Guessan *et al.*, 2016). However, a sustainable and efficient management of weeds requires an identification of the major weeds of food crops in the Central Western Côte d'Ivoire as well as a thorough study of their biology and ecology (Bhowmik 1997; Campbell and Grice 2000; Basu *et al.*, 2004). In this context, numerous inventories of food

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crop weeds have been carried out in the locality (Becker and Johnson 2001; Kouadio, 2003; Cuero 2006; Boraud *et al.*, 2010). They identified the major weeds of food crops in the area. If these inventories were supported by biological and ecological studies of these major weeds, effective strategies for managing weeds in food crops could be conceived in the area. It is in this context that the present study on the dynamics and depth of emergence of seedlings of *Croton hirtus*, a major weed of food crops in the Central Western Côte d'Ivoire (Gué 2017), took place.

The general objective of this work was to propose weeding methods that could lead to the design of effective management strategies for *Croton hirtus* in food crops in the Central Western Côte d'Ivoire. Specifically, we determined the annual frequency and density of emergence of *Croton hirtus* and identified the ideal depths of emergence of seedlings of this weed. Our study was guided by the hypothesis that *Croton hirtus* seedlings emerge at high density at different soil depths throughout the cropping cycles in Central Western Côte d'Ivoire.

MATERIALS AND METHODS

Study Sites

The study of the emergence dynamics of *Croton hirtus* seedlings was carried out in a farming environment in the village of Dadéguhé, 20 km from the town of Issia (latitude 6°29'00"N and longitude 6°35'00"W) in the Haut-Sassandra region. As for the study of the depth of emergence of the seedlings of this weed, it took place on the experimental plot of the National Floristic Center (CNF) at the Félix Houphouët-Boigny University in Abidjan (latitude 5°20'11"N and longitude 4°01'36"W), Côte d'Ivoire.

Emergence Dynamics of *Croton hirtus* Seedlings

The experiments were carried out during the years 2012 and 2013. They were held on a plot with a sandy clay soil texture, previously occupied by the cultivation of maize after three (3) years of fallow and naturally infested by *Croton hirtus*. This weed was rated at level 5 on Le Bourgeois (1993) abundance-dominance scale. On the experimental plot, clearing followed by burning was carried out just before the installation of the experimental design. The purpose of this was to respect the conditions for establishing crops in our study area, which generally begins with these two processes.

In order to follow the emergence of each cohort (group of seedlings that emerge at the same time) of *Croton hirtus* during each of the two years of investigation, 12 permanent quadrats of 0.25 m^2 each and distributed along three (3) lines or transects at 2 m intervals were placed. This experimental design was the same as that used by Gallart *et al*. (2010) to study the demography of *Digitaria sanguinalis* (L.) Scop. (Poaceae).

After the detection of the first emergence of seedlings during each cropping season, the experimental plots were visited once a week. At each observation, the new seedlings were counted. In 2012, the first cohort was named A12, the second B12, the third C12, the fourth D12 and the fifth E12. In 2013, the first cohort of *Croton hirtus* was called A13, the second B13, the third C13, the fourth D13 and the fifth E13.

The density of the seedlings was expressed in number of seedlings per square meter (seedlings / m^2). The formula for the calculations is as follows:

$$D = Nes / S$$

D is the density and Nes is the number of seedlings observed on the surface S.

Influence of the Sowing Depths of *Croton hirtus* Seeds on the Emergence of Seedlings

The seeds of *Croton hirtus* used in this study were collected in 2013, directly from the plants, after their maturation in the village of Dadéguhé, 20 km from Issia (latitude 6°29'00"N and longitude 6°35'00"W), in the Haut-Sassandra region, in the Central Western Côte d'Ivoire. These seeds were stored for one year at room temperature prior to the study. The category of seeds used is that which gives the best germination rates. Indeed, the seeds of *Croton hirtus* have an initial dormancy (Pauwels and Breyne 1978).

The seedling emergence tests were carried out in 2014 at sowing depths of 0 cm, 0.5 cm, 2.5 cm, 5 cm and 10 cm. Four (4) repetitions of 100 seeds were used for each seeding depth. The tests were carried out in nursery bags (dimensions: 9.5 cm in diameter and 25 cm in depth) filled with sandy-clay soil without *Croton hirtus* seeds. The experimental design used to observe the influence of the sowing depth of the seeds of the studied weed on the emergence of seedlings was a completely random design.

Watering of the seedlings was done once a day (early in the morning) during the observation period to allow normal germination of the seeds. The counting of emerged seedlings was done daily for two months from the date of sowing.

The rate of seedlings emerged is the ratio of the number of emerged seedlings to the number of seeds initially sown, the whole multiplied by 100. The formula for the calculations is as follows:

$$Res = (Nes / Ns) \times 100$$

In the previous formula, Res is the rate of the emerged seedlings, Nes, the number of the emerged seedlings and Ns, the number of sown seeds.

Statistical analysis

All statistical analyses were performed with SPSS Statistical software version 20. The data on *Croton hirtus* cohorts, as well as data on its seeds sowing depth, underwent variance analysis and comparison of means was performed by the Duncan's test at a threshold of 5%.

RESULTS

Frequency and Density of Emergence of *Croton hirtus* Seedlings

Four (4) cohorts of *Croton hirtus* A12, B12, C12 and C12 were observed in 2012 with the respective densities of 379 ± 41; 275 ± 103; 372 ± 144 and 37 ± 20 seedlings/m^2. The first was observed on May 6, the second on May 13, the third on May 24 and the fourth on October 7. The analysis of variance shows a significant difference between the different generations of *Croton hirtus* seedlings from the year 2012 ($F = 11.928$; $P = 0.003$). Duncan's test reveals two homogeneous groups of cohorts: on the one hand, there

Table 1: Rates of emerged seedlings of *Croton hirtus* with respect to sowing depth

Rate of seedlings emergence (%)				
Depths of sown seeds (cm)				
0	1	2,5	5	10
44,00 ± 3,65 [b]	41,75 ± 7,50 [b]	49,75 ± 2,99 [a]	29,50 ± 4,44 [c]	7,25 ± 3,40 [d]

At the level of the independent variable, factors with the same letters are statistically identical.

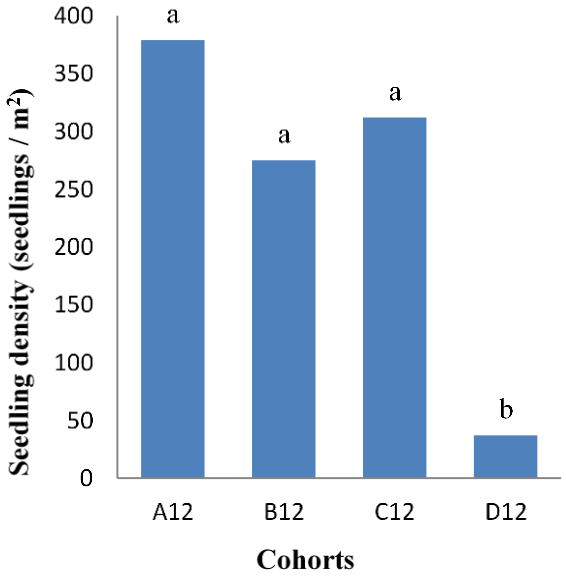

Fig. 1: *Croton hirtus* cohort densities in 2012 Bars that do not have the same letters are significantly different

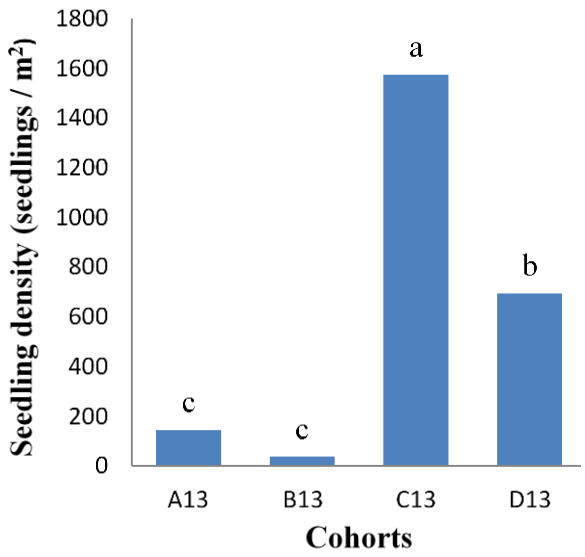

Fig. 2: *Croton hirtus* cohort densities in 2013 Bars that do not have the same letters are significantly different

are the A12, B12 and C12 cohorts with the highest densities of *Croton hirtus* seedlings and on the other hand, the D12 cohort which has the smallest density of *Croton hirtus* seedlings (Fig. 1).

Four generations of *Croton hirtus* were also seen during the year 2013. The emergence densities of these successive generations of *Croton hirtus* A13, B13, C13 and D13 were respectively 143 ± 137; 39 ± 10; 1574 ± 203 and 693 ± 83 seedlings/m^2. The first generation of seedlings was observed on May 8, the second on May 15, the third on September 22 and the fourth on September 29. Analysis of variance reveals a significant difference between these different generations of seedlings (F = 88.395; P = 0.000). Duncan's test shows three homogeneous groups of seedling generations (Fig. 2). Generation C13 has the highest emergence density of *Croton hirtus*. Next comes the D13 generation with an intermediate density of *Croton hirtus* seedlings. Finally, we have the A13 and B13 generations which have the lowest seedling densities.

The strongest emergence densities of *Croton hirtus* were observed at the start of the growing season (early May and mid-September).

Croton hirtus Seedling Emergence as a Function of Sowing Depths

The sowing depths 0 cm, 0.5 cm, 2.5 cm, 5 cm and 10 cm resulted respectively in the average seedling emergence rates of 44.00 ± 3.65%, 41.75 ± 7.50%, 49.75 ± 2.99%, 29.50 ± 4.44% and 7.25 ± 3.40%. Analysis of variance shows a significant difference between the different sowing depths examined for emergence of *Croton hirtus* seedlings (F = 52.069; P = 0.000). Duncan's test at the threshold of 0.05 detects four homogeneous groups of seedling emergence depths (Table 1). The highest emergence rates of *Croton hirtus* seedlings were obtained at 2.5 cm. Then came in descending order the rates of emergence of seedlings from sowing depths 0; 0.5; 5 and 10 cm.

DISCUSSION

The number of *Croton hirtus* cohorts in 2012 is equal to that of 2013 though the year 2013 was marked by drought in the department of Issia. During the drought period observed during the year 2013, there was therefore at the sowing depths required for the germination of *Croton hirtus* seeds (0.5; 2.5 and 5 cm), humidity necessary for the germination of the seeds of this weed.

During the two years of investigation (2012 and 2013), the highest densities of *Croton hirtus* seedlings emergence were generally observed at the start of the growing seasons (early May and mid-September) in the absence of a deficit of rain. These results are consistent with those of Ipou Ipou (2005) who noted the highest densities of *Euphorbia heterophylla* at the start of the crop cycle in cotton crops in the North of Côte d'Ivoire. In fact, at the start of the growing season, a large quantity of weed seeds are on the soil surface or close to the soil surface. Therefore, as soon as the favorable conditions for germination are met, they germinate and the seedlings establish themselves on the soil surface.

The highest emergence rates of *Croton hirtus* seedlings are observed at the sowing depth of 2.5 cm. This weed therefore emerges more deeply than *Ageratum conyzoides* and *Panicum laxum*, also major weeds of food crops in the Central Western Côte d'Ivoire (Gué 2017). This is because the seeds of *Croton hirtus* are relatively larger in size than those of *Ageratum conyzoides* and *Panicum laxum*. They therefore have sufficient reserves to ensure the heterotrophic growth of the seedlings before they establish themselves on the soil surface.

Conclusion

The present study focused on the dynamics and depth of emergence of seedlings of *Croton hirtus*, a major weed of food crops in the Central Western Côte d'Ivoire in order to put in place its effective management strategies and increase food production in the area. It showed that in the absence of drought, the highest densities of *Croton hirtus* seedlings emergence were observed at the start of the growing seasons. The highest emergence rates for this weed were observed at 2.5 cm from the soil surface and the lowest at 10 cm. This study suggests that special attention should be paid to cohorts of *Croton hirtus* that emerge at the start of the growing seasons. In addition, the adoption of deep plowing (more than 10 cm from the soil surface) could reduce the emergence of *Croton hirtus* seedlings.

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