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Market Availability of Selective Post-emergence Herbicides for Major Food Crops in the Haut-Sassandra Region, Central-western Côte d'Ivoire

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Weed control in crops is increasingly done by the chemical method in the Haut-Sassandra region. However, farmers in this region often struggle to obtain selective post-emergence herbicides for certain food crops. The purpose of this study was therefore to assess the availability of selective post-emergence herbicides of the main food crops of this region markets with a view to providing necessary information to effective weed management and ensure food security. In this context, a survey was conducted among 104 managers of phytosanitary product stores in the region. At the

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end of the investigations, 41, 34, 2, 5 and 4 trade names of selective post-emergence herbicides of rice, maize, cassava, yam and plantain were observed, respectively. The relative frequencies of these main food crops selective post-emergene were 92,00 %, 92,00 %, 5,00 %, 3,75 % and 1,75 %, respectively, on the regional market. They were divided into 9, 3, 2, 3 and 2 active ingredients, respectively. Selective post-emergence herbicides for rice and maize have been observed on the markets of the four departments of the region and the selective cassava herbicides in Daloa only. As for the selective post-mergence herbicides of yam and plantain, they were noted in Vavoua and Daloa. To effectively manage weeds in their crops, yam, cassava and plantain producers in the departments of Issia and Zoukougbeu and cassava growers in Vavoua can stock up on selective post-emergence herbicides in Daloa. They can also use selective pre-emergence herbicides for their crops or adopt stale seed bed.

Keywords: Food crops; chemical weeding; selective post-emergence herbicides; Haut-Sassandra; central-western Côte d'Ivoire.

1. INTRODUCTION

As a result of population growth and the expansion of cash crops, we are currently witnessing the scarcity of agricultural land in the Haut-Sassandra region (Demont & Jouve, 1999; N'Cho, 2001). To cope with this situation, farmers are increasingly opting for crop intensification using agricultural inputs (Dally, 2016). In terms of weed management, they use herbicides (N'Guessan et al., 2016).

Several types of herbicides exist on the market (De La Taille, 1987). Depending on their timing of application, pre-plant, pre-emergence and post-emergence herbicides are available (Singh, 2012). Indeed, when the crop has already emerged and the farmers observe the presence of weeds in their fields, they use selective post-emergence herbicides for the crop. These herbicides kill weeds in a germinating or growing crop without harming the crop beyond the point of recovery (Singh, 2012). Consequently, herbicides are crucial for farmers in the Haut-Sassandra area since they save time that would have been spent on weeding, as chemical weeding is quick and efficient. The gained time allows them to perform other agricultural tasks during the growing seasons (De La Taille, 1987).

However, in practice, producers in the Haut-Sassandra region often have difficulty to obtain selective post-emergence herbicides for certain food crops grown in their region. This reality can clearly be seen in the study by N'Guessan et al. (2016) on the use of herbicides by farmers in Issia, a department in the Haut-Sassandra region where the use of selective post-emergence herbicides was noted on only two main crops (rice and maize) out of the five in the region (plantain, cassava, yams, rice and maize). The purpose of this study is to inventory the selective post-emergence herbicides of Haut-Sassandra's primary food crops that are available on the local market (CropLife International,2021). This will help to increase food production by offering farmers recommendations for weed control.

2. MATERIALS AND METHODS

In order to carry out this study, a survey was conducted among 104 managers of phytosanitary product stores in the four (4) departments (Daloa, Issia, Vavoua and Zoukougbeu) of the Haut-Sassandra region (Fig. 1). The survey was carried out from July 2020 to March 2021 in the Haut-Sassandra region in Central-Western Côte d'Ivoire. Stores selling phytosanitary products in each department of Haut-Sassandra were taken into account. Thus, for the departments of Daloa, Vavoua, Issia and Zoukougbeu, 50, 22, 20 and 12 stores were visited, respectively. In each visited store, the trade names of the selective post-emergence herbicides of major food crops and their active ingredients were identified.

The collected data were analysed using descriptive statistics method (Dong, 2023). The relative frequencies (Spiegel & Stephens, 2018) of the selective post-emergence herbicides for each considered major food crop or their active ingredients were calculated. Microsoft Excel 2016 spreadsheet was used for this purpose.

The relative frequency is given by the following formula:

$$Fr = N/N_T \times 100$$

N : Number of stores where a selective post-emergence herbicide of a given main food crop or its active ingredient is sold in the Haut-Sassandra region.

NT: Total number of the visited stores selling phytosanitary products**.**

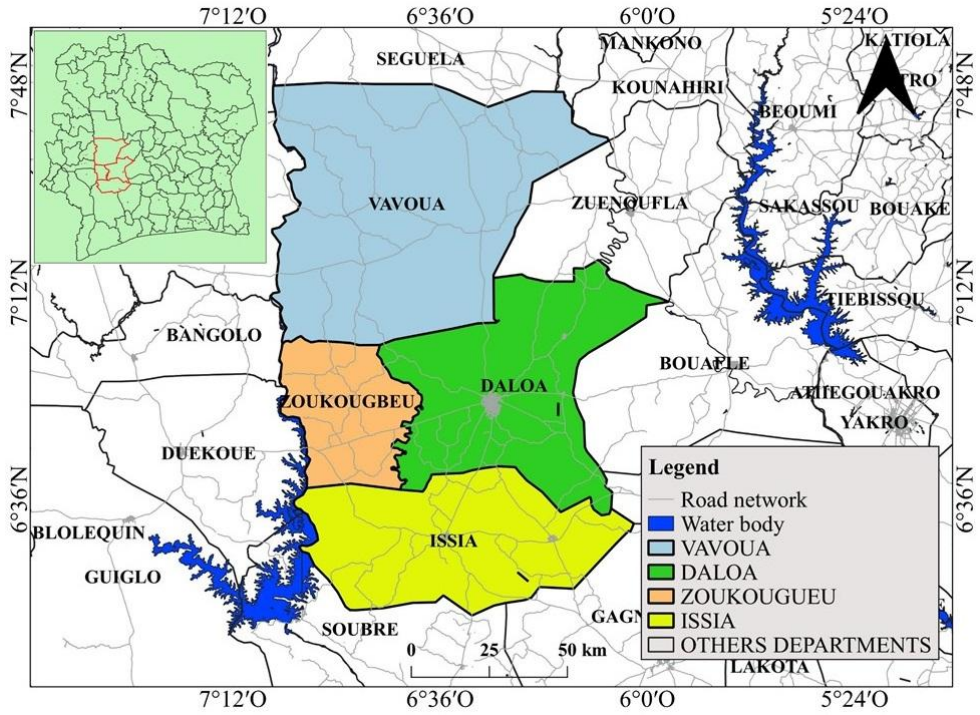

Fig. 1. Haut-Sassandra map

3. RESULTS

3.1 Selective Post-emergence Herbicides of the Main Food Crops of the Haut-Sassandra Region

The results of the survey reveal that in the entire market in the Haut-Sassandra region, selective post-emergence herbicides for rice and maize are the most numerous (Fig. 2). There are 41 and 34, respectively. As for selective post-emergence herbicides for cassava, plantain and yam, there are 2, 4 and 5, respectively on the market.

The relative frequencies of the selective post-emergence herbicides for rice, maize, plantain, yam and cassava in the Haut-Sassandra markets were respectively 92,00%, 92,00%, 5,00%, 3,75% and 1,75% (Fig. 3).

At the departmental level, the presence of selective post-emergence herbicides for rice and maize was noted in the markets of the four departments of the Haut-Sassandra region and the selective cassava herbicides only in Daloa (Table 1). On the other hand, selective post-emergence herbicide of yam and plantain were noted in the markets of Vavoua and Daloa.

In addition, the highest numbers of selective post-emergence herbicides of the main food crops in the study area were noted in the department of Daloa and the lowest in Zoukougbeu (Tables 2 and 3).

3.2 Active Ingredients of Selective Post-emergence Herbicides of the Main Food Crops of the Haut-Sassandra Region

Active ingredients of the selective post-emergence herbicides in rice, maize, yam, cassava and plantain crops are 9, 3, 3, 2 and 2, respectively on the market in the Haut-Sassandra region (Fig. 4). The most common active ingredients of selective rice post-emergence herbicides on the market are 2,4-D amine salt (84.62%), propanil and tryclopyr (44.23%) and metsulfuron methyl (26.92%). At maize level, active ingredients of the selective post-emergence herbicides of this crop are 2,4-D amine salt, nicosulfuron and atrazine with respective frequencies of 84.62%, 63.46% and 0,96% on the market. The active ingredients of the selective post-emergence herbicides of yam are atrazine (0.96%), bentazole (0.96%) and haloxyfop-R-methyl (4.81%). Those of selective post-emergence herbicides in cassava are atrazine (0.96%) and bentazone (0.96%). For plantain crop, haloxyfop-R-methyl and atrazine were observed on the market with the respective frequencies of 4.81% and 0.96%.

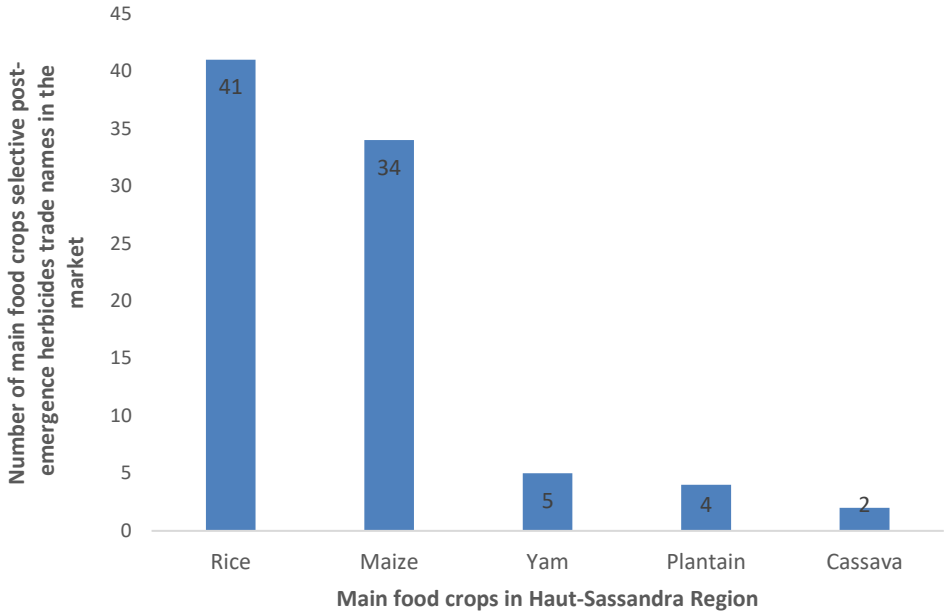

Fig. 2. Selective post-emergence herbicides trade names of major food crops on the market in the Haut-Sassandra region

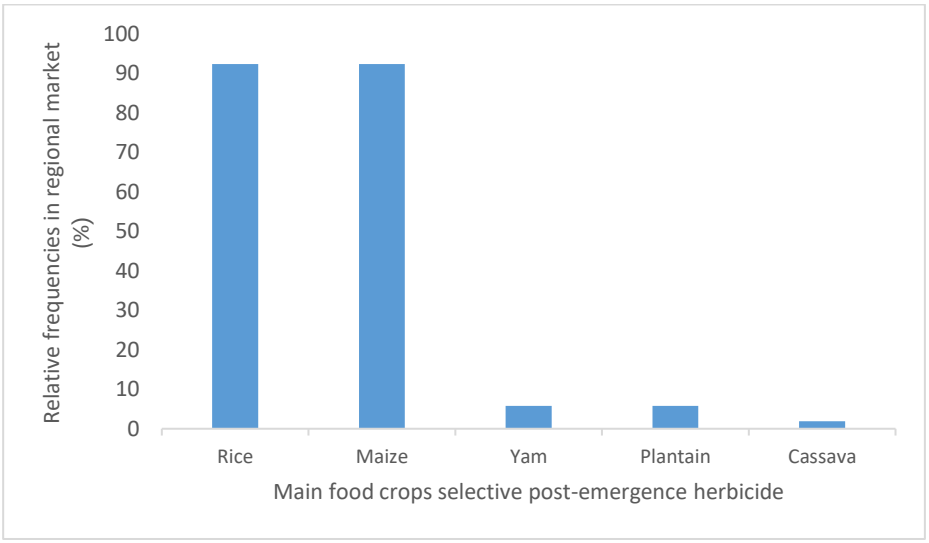

Fig. 3. Main food crops selective post-emergence herbicides frequencies in the Haut-Sassandra market

Table 1. Market availability of selective post-emergence herbicides trade names of the main food crops encountered in the Haut-Sassandra departments

Main food crops selective post-emergence herbicides trade names	Numbers			
	Haut Sassandra Departments			
	Daloa	Vavoua	Issia	Zoukougbeu
Rice herbicides	33	18	17	7
Maize herbicides	21	14	15	5
Yam herbicides	4	2	0	0
Plantain herbicides	2	2	0	0
Yam herbicides	2	0	0	0

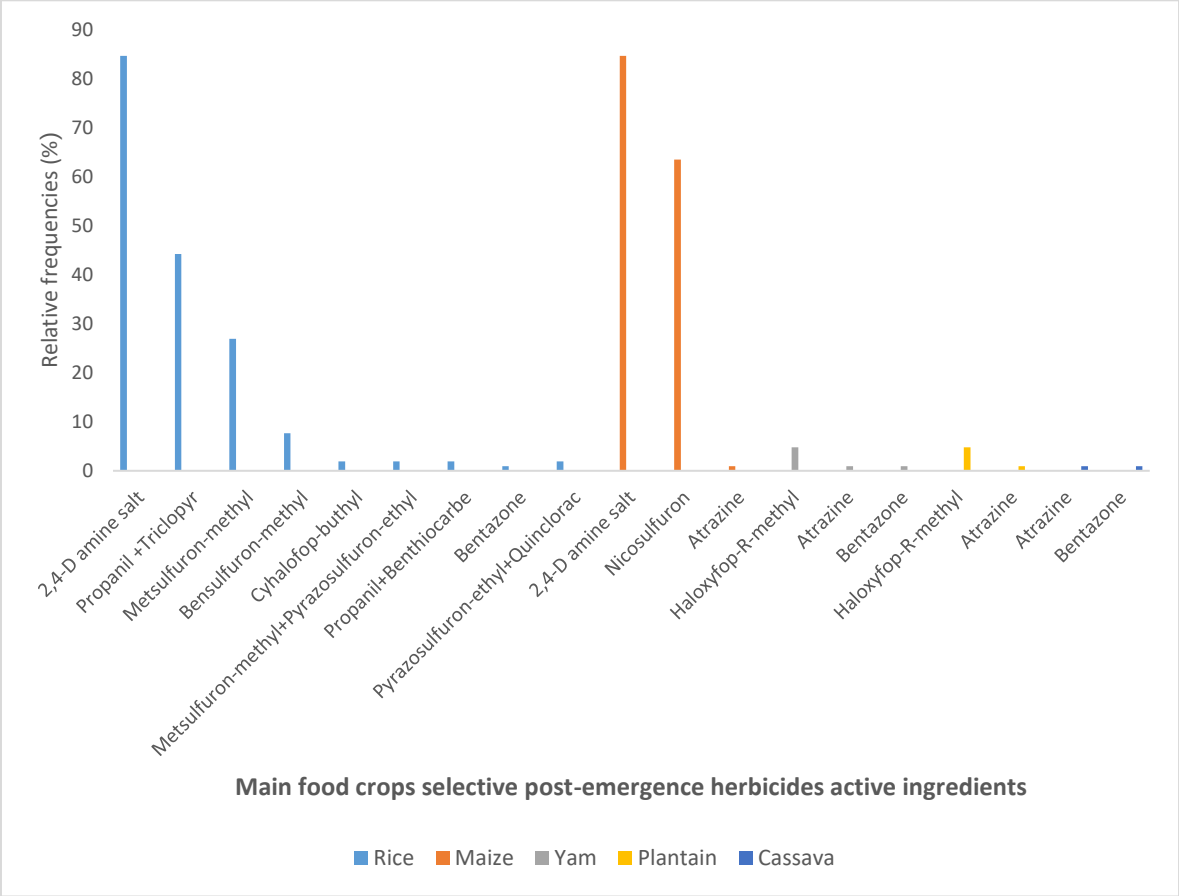

Fig. 4. Main food crops selective post-emergence herbicides active ingredients frequencies in the Haut-Sassandra region

The nine (9) active ingredients of the selective post-emergence herbicides of rice identified in the Haut-Sassandra region are all found in the department of Daloa, while 4, 3 and 2 are observed respectively in the markets of Vavoua, Issia and Zoukougbeu (Table 3). For maize, the 3 active ingredients of the selective post-emergence herbicides of this crop identified in the study area are present in the departments of Daloa, Issia and Vavoua compared to 2 in the department of Zoukougbeu. The active ingredients of selective post-emergence herbicides for yam, plantain and cassava were 3, 2 and 2, respectively in the department of Daloa compared to 2, 1 and 0 respectively for the department of Vavoua. In the departments of Issia and Zoukougbeu, no active ingredient of selective post-emergence herbicide for yams, plantains and cassava has been observed on the market.

Table 2. Main food crops selective post-emergence herbicides frequencies for each Haut-Sassandra department

Main food crops selective post-emergence herbicides	Relative frequencies (%)			
	Haut-Sassandra Departments			
	Daloa	Vavoua	Issia	Zoukougbeu
Rice herbicides	48,08	24,04	12,50	7,69
Maize herbicides	48,08	24,04	12,50	7,69
Yam herbicides	3,85	1,92	0	0
Plantain herbicides	3,85	1,92	0	0
Cassava herbicides	1,92	0	0	0

Table 3. Market availability of Active Ingredients of Selective Post-emergence Herbicides of the Main Food Crops Encountered in the Haut-Sassandra Departments

Food crops selective post-emergence herbicides active ingredients	Relative frequencies (%)			
	Haut-Sassandra Departments			
	Daloa	Vavoua	Issia	Zoukougbeu
Rice herbicides				
2,4-D amine salt	40,38	24,04	12,50	7,69
Propanil+Triclopyr	23,08	9,62	7,69	3,85
Metsulfuron-methyl	14,42	8,65	3,85	0
Bensulfuron-methyl	5,77	1,92	0	0
Cyhalofop-buthyl	1,92	0	0	0
Metsulfuron-methyl+Pyrazosulfuron-ethyl	1,92	0	0	0
Propanil+Benthiocarbe	1,92	0	0	0
Bentazone	0,96	0	0	0
Pyrazosulfuron-ethyl+Quinclorac	1,92	0	0	0
Maize herbicides				
2,4-D amine salt	40,38	24,04	12,50	7,69
Nicosulfuron	0,77	19,23	9,62	3,85
Atrazine	0,96	0	0	0
Yam herbicides				
Haloxyfop-R-methyl	1,92	1,92	0	0
Atrazine	0,96	0	0	0
Bentazone	0,96	0	0	0
Plantain herbicides				
Haloxyfop-R-methyl	1,92	1,92	0	0
Atrazine	0,96	0	0	0
Cassava herbicides				
Atrazine	0,96	0	0	0
Bentazone	0,96	0	0	0

4. DISCUSSION

Unlike, other selective post-emergence herbicides of the main food crops found on the market in the Haut-Sassandra region, atrazine is a both pre- and post-emergence (Bhuva & Detroja, 2018). Moreover, this herbicide is not registered in Côte d'Ivoire (MEMINADER, 2021). It was therefore fraudulently ended up on the market in this region.

Selective post-emergence herbicides for rice and maize, including 2,4-D amine salt, propanil and triclopyr and, nicosulfuron are the most numerous on the market in the various departments of the Haut-Sassandra region. This abundance is linked to the fact that these herbicides are highly sought after by farmers in the region due to their effectiveness and relatively low costs. Indeed, the cost of agricultural inputs is a limiting factor in the appropriation of these inputs by farmers in the Haut-Sassandra region (Sounkolé, 2024).

Apart from rice, food producers in Haut-Sassandra do not have enough selective post-emergence herbicides for other food crops to effectively rotate herbicides on their plots. There is therefore a risk of resistance of weeds in cassava, yam, plantain and maize crops to the herbicides available in the Haut-Sassandra region. Indeed, according to CropLife International (2012), rotation of herbicides that have different modes of actions can reduce the risk of weed resistance to herbicides. However, for cassava, yams, plantains and maize, there are fewer than three herbicide active ingredients registered on the market. To effectively manage weeds in these crops and prevent weed resistance to herbicides, growers can practice crop rotation, stale seed bed; and integrated weed management.

In plantains, they can also use glyphosate, which is a non-selective post-emergence herbicide tolerated by this crop (Liu & Rodriguez-Garcia, 1988).

As far as cassava is concerned, phytosanitary companies can place lactofen, clethodim and trifloysulfuron-sodium on the market in the region, which are selective post-emergence herbicides of this crop (Hauser & Ekeleme, 2017).

5. CONCLUSION

Chemical weed control is a method of weed management that is currently widespread in the Haut-Sassandra region. The purpose of this study was to assess the market availability of selective post-emergence herbicides for major food crops in this region. As a result, there are sufficient selective post-emergence herbicides for rice and maize in the markets of the region. On the other hand, cassava herbicides are only present on the Daloa market and those of yam and plantain are only found in Daloa and Vavoua. In addition, for the region as a whole, it is only for rice that there are sufficient active ingredients to provide the herbicide rotation necessary to avoid the phenomenon of weed resistance. To effectively manage weeds in their crops, cassava, yam and plantain producers in the departments of Issia and Zoukougbeu and cassava producers in Vavoua can get their supplies in Daloa, the capital of the region, either using selective pre-emergence herbicides from their crops or adopting stale seed bed. In order to avoid the phenomenon of herbicide resistance in their fields in the long term, maize, yam, plantain and cassava producers throughout the Haut-Sassandra region can practice crop rotation and /or integrated weed management.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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