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Availability of Herbicides Used in Market Gardening in the City of San Pedro (Côte d'Ivoire)

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Abstract | **Original Research Article**

Weeds represent a major constraint to agricultural production. This study aimed at identifying and documenting the herbicides used in market gardening in the city of San Pedro. To achieve this objective, surveys were conducted among 40 market gardeners and 20 agrochemical product retailers. The results revealed that at least 26 herbicides are used in local production. Except for diuron, all recorded herbicides contained glyphosate as their active ingredient. The most commonly used herbicides were Roundup (19%), T'asman (16%), Chapchap (14%), and Glyphocel, Bibana (11% each). The main formulations available were water-soluble granules (SG) at 34.62%, followed by soluble concentrates (SL) and water-dispersible granules (WG), each representing 30.84%. The findings highlight the potential risk of synthetic herbicide poisoning faced by market gardeners and consumers.

Keywords: Availability, Côte d'Ivoire, Gardener, Glyphosate, Herbicides.

INTRODUCTION

Market garden products contribute essential vitamins and micronutrients that are often lacking in staple foods. Vegetables are the main source of vitamins and trace elements for vulnerable rural populations in particular (Kouakou *et al*., 2019). Increasing and diversifying the consumption of vegetables especially fresh and raw ones helps improve food security by ensuring a more balanced diet, reducing nutritional deficiencies, and preventing certain diseases (Bancal and Tano, 2019). In Côte d'Ivoire, market gardening production is carried out by a wide range of male and female farmers, generally living in the peri-urban areas of major cities. Production usually takes place on very small plots, and most farmers sell their vegetables fresh on urban markets through intermediaries (AGRA, 2021). Market gardening thus represents an important income-generating activity for farmers, ensuring their financial autonomy (AGRA, 2021; Diomandé *et al*., 2019).

However, market gardening production is constrained by multiple abiotic and biotic factors that affect yields. In tropical regions, weeds are among the major limitations to crop development and productivity. They directly compete with cultivated plants for water, fertilizers, and sunlight (Merlier and Montegut, 1982). Weeds significantly reduce both crop yields and farm profitability (Machane, 2008). Gordon (1997) showed that under severe weed pressure, yield losses can reach 68% in cereals (maize, sorghum, and millet) and 63% in soybean. Similarly, yield reductions of 85%, 60%, and 63–88% were recorded for sorghum, maize, and groundnut respectively, in the absence of weeding compared to two weedings during the crop cycle (Déat, 1986a). Numerous studies have been conducted on weeds in industrial sugarcane plantations in Côte d'Ivoire (Tialou *et al*., 2021; Traoré *et al*., 2019). In cashew orchards, weed-related losses are also among the main causes of low yields (Konaté *et al*., 2020).

To minimize such losses, market gardeners increasingly rely on herbicides due to the scarcity of labor. However, the active ingredients of certain herbicides pose potential health and environmental risks. In San Pedro region, recent studies on herbicide use have focused mainly on lowland rice cultivation (Diomandé *et al*., 2024), while data on herbicide use in market

gardening production remain scarce. The objective of this study is therefore to identify and catalogue the herbicides currently used in market gardening in the city of San Pedro.

METHODOLOGY

Study Site

The study area is located in the region of Bas-Sassandra, specifically in San-Pedro department (Figure 1). The climate of this region is of the transitional equatorial type, characterized by a bimodal rainfall pattern alternating between rainy and dry seasons. Average temperatures range between 24°C and 27°C. Rainfall is frequent, and the average relative humidity is among the highest in the country, regularly exceeding 80% throughout the year (Pemedci, 2015). The soils are generally deep, highly developed, and ferralitic, moderately leached, with a relatively coarse texture. They often contain numerous silty-sandy alluvial deposits (Soro *et al*., 2015).

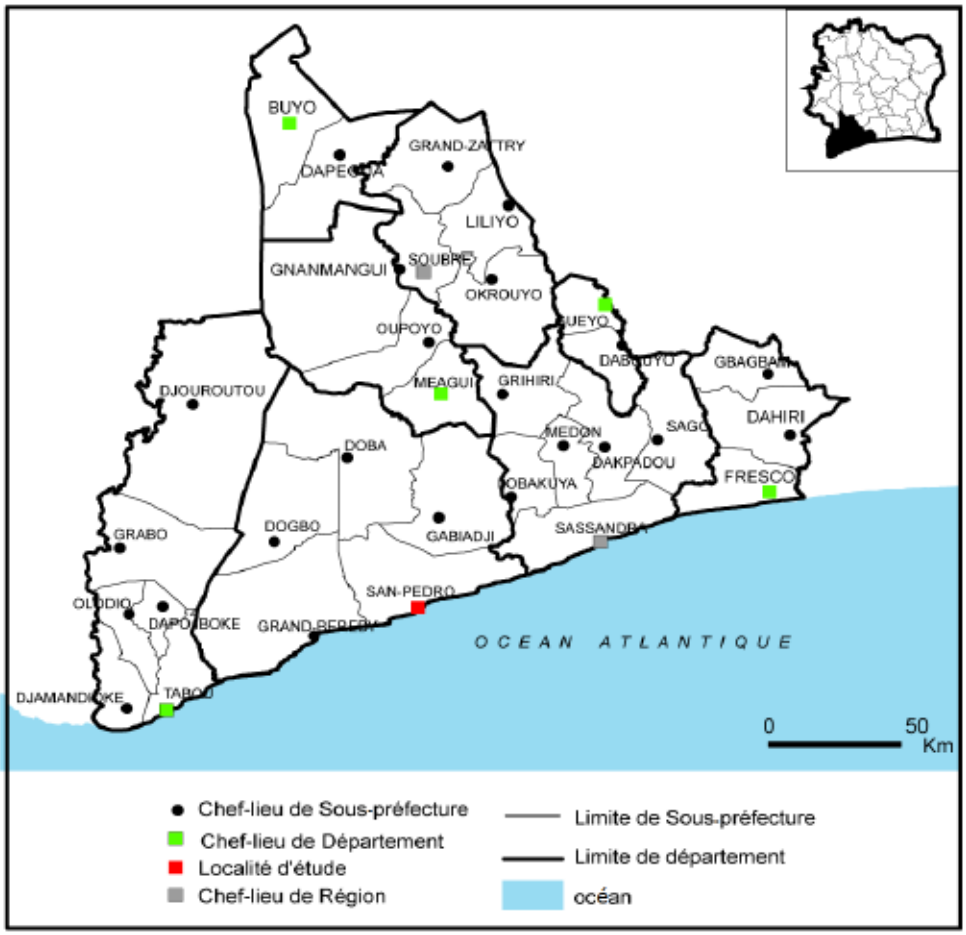

Figure 1: Location of the study area

METHODS

Field Data Collection

The total number of market gardeners and the production volume in the study area are not precisely known, due to the lack of reliable agricultural statistics in Côte d'Ivoire. Data were collected through individual surveys conducted with forty (40) market gardeners from the municipality and twenty (20) synthetic pesticide sellers over a three-month period, from March to May 2024.

Survey on the Availability of Herbicides With Herbicide Retailers

The information gathered from the survey of phytosanitary product sellers included, on one hand, social data such as gender, age, educational level, and place of origin, and on the other hand, agronomic data related to the various herbicides marketed and their respective active ingredients. The survey was carried out in locations where most market gardeners reported sourcing their herbicide products.

With Marker Gardeners

The selection of market gardeners was primarily based on their use of pesticides, their willingness to voluntarily participate in the survey, and the size of the areas devoted to vegetable crops. Using a structured questionnaire, individual interviews with the gardeners focused on two main aspects: (1) Social characteristics of the market gardeners (educational level, age, cultivated area, importance given to market gardening production, and types of crops grown); (2) Herbicides used in their gardening practices.

Data Processing and Analysis of Results

The survey sheets were manually analysed and the data collected were processed using appropriate tools. Microsoft Word and Excel were used for entering textual and numerical data, generating graphs and tables, and conducting preliminary interpretations. A one-way analysis of variance (ANOVA) was used to compare the availability of herbicide products on the market and their effectiveness on crops. This analysis was performed using R software (version 4.1.2).

RESULTS

Social Characteristics of the Interviewed Traders

The surveys reveal that 90% of the traders interviewed are men compared to 10% of women (Table I). Regarding age range, 70% of traders are between 15 and 30 years old, while 30% are between 31 and 50 years old. As for the levels of education, merchants with a secondary level are the most represented (70%) compared to 5% for the least educated

Table I : Social Characteristics of the Interviewed Traders

Variables	Categories	Number (n=20)	%
Sex	Men	18	90
	Women	2	10
Age range	15–30	14	70
	31–50	6	30
Level of education	Illiterate	1	5
	Primary	2	10
	Secondary	15	70
	Higher	3	15

Herbicides Inventoried on the Market

At the main market of San Pedro city, twenty (20) herbicide supply points were visited. The survey conducted among pesticide retailers identified twenty-six (26) herbicides used in market gardening production (Table II) within the city of San Pedro. Among these products, twenty-five (25) contain glyphosate as the active ingredient, while only one contains diuron as the active ingredient. According to FAO/WHO classifications, these herbicides are slightly hazardous.

Table II: List of Herbicidal Products Used in Market Gardening Identified During the survey

No.	Trade Name	Active Substances and Concentrations	FAO/WHO Class
1	Solution 480 SL	480g/L of glyphosate isopropylamine salt	III
2	Stop Herb 720 WG	720g/L ammonium salt of Glyphosate	III
3	Force Up 757SG	757g/kg glyphosate isopropylamine salt	III
4	Ridout 480 SL	480g/L of glyphosate isopropylaminer salt	III
5	Royasate 757 GF	757g/L ammonium salt of Glyphosate	III
6	Royasate 480SL	Glyphosate 480SL	III
7	Ko.herb 680SG	Glyphosate 680 g/kg	III
8	Kalash extra70 SG	700g/kg of glyphosate a.i.	III
9	Bibabna 480 SL	480g/L glyphosate isopropylamine salt	III
10	T'asman 757SG	Glyphosate ammonium salt 757 g/kg	III
11	Glyfonate 888WG	Glyphosate ammonium salt 888 g/kg	III
12	Ladaba 480SL	Glyphosate acid 360 g/L a.i.	III
13	Adjuman 780SG	780g/kg of glyphosate ammonium salt	III
14	Bibana extra 888WG	888g/kg of glyphosate	III
15	Waraba 888SG	Glyphosate ammonium salt 888 g/kg	III
16	Bin'kêrê 500WG	Glyphosate 500 g/kg	III
17	Bibana 680 SG	757g/kg of ammonium of Glyphosate	III
18	Rapidmax 750WG	Glyphosate 750 g/kg	III
19	Glyphader 75	680 g/kg Glyphosate a.i.	III
20	Baylayage 480SL	Glyphosate acid 360 g/L a.i.	III
21	Ridout xtra 888WG	888g/kg glyphosate isopropylamineer salt	III
22	Tempra 80WP	800g/kg diuron	III
23	Tête Rouge 500WG	500g/kg of glyphosate ammonium salt	III
24	Chap chap 480SL	Glyphosate 480SL	III
25	RoundupXL360 SL	Glyphosate acid 360 g/L	III
26	Glyphader unik 88SG	800 g/kg Glyphosate a.i.	III

SL: Soluble Concentrate; WG: Water-Dispersible Granules; GF: Water-Soluble Granule; WP: Wettable Powder; a.i.: active ingredient; Class III: Slightly Hazardous (according to FAO/WHO classification)

Herbicides Most Commonly Used by Market Gardeners

The results of the survey conducted among market gardeners revealed that, out of the 26 herbicides available, 10 are the most commonly used (Figure 2). These include the commercial products T'asman, Chapchap, Glyphocel, Tête rouge, Bibana, Lamachette, Roundup, Bin'fla, Ladaba, and Gramoxone. However, Roundup is the most frequently used (19%), followed by T'asman (16%), Chapchap (14%), and both Glyphocel and Bibana (11% each).

Figure 2. Proportion test (X-squared = 9.039, df = 9, p-value = 0.4337) (11% each).

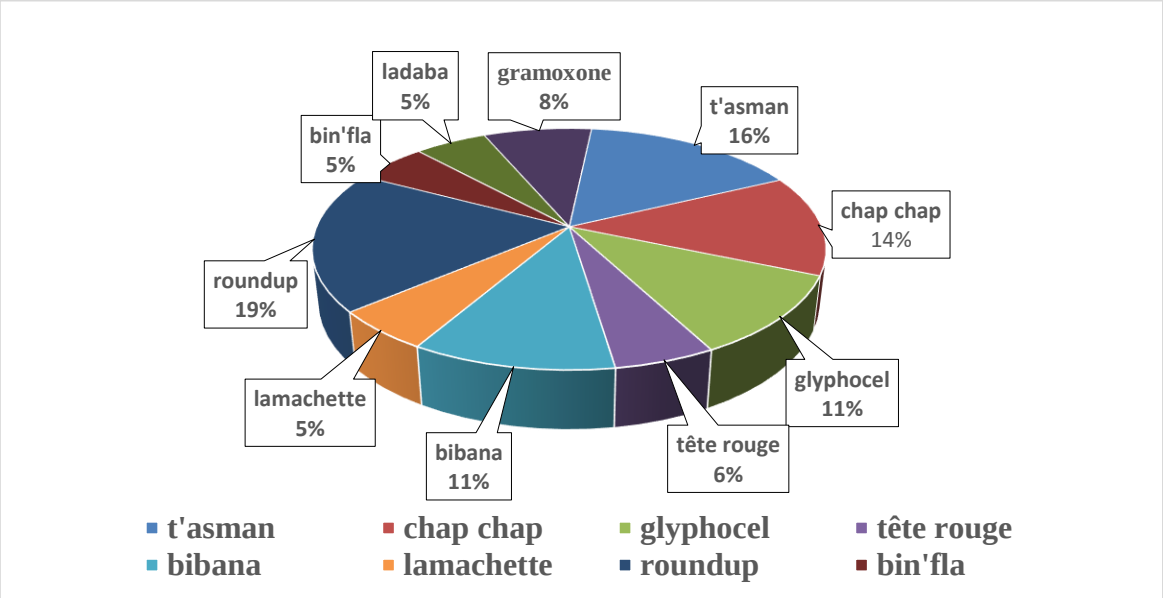

Figure 2: Proportion test (X-squared = 9.039, df = 9, p-value = 0.4337)

Mode of Formulation of Available Herbicides

The herbicides recorded exhibit various formulations, namely: soluble concentrate, water-soluble granule, and wettable powder (Figure 3). Among these formulations, the water-soluble granule (SG) was the most frequently found (34.62%), followed by the soluble concentrate (SL) and the water-dispersible granule (WG), which accounted for 30.84% each.

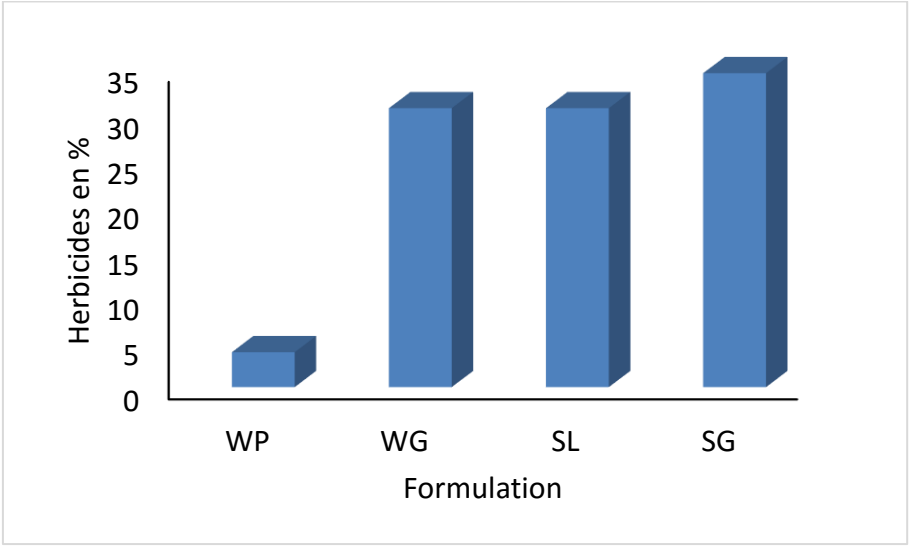

Figure 3: Formulation of Herbicide

DISCUSSION

Market gardening is a sector of agriculture mainly practiced in cities and on the outskirts of urban areas in Côte d'Ivoire. A list of 26 herbicides was obtained. This indicates that there is a wide variety of registered herbicide products available in Côte d'Ivoire, particularly in the city of San-Pedro. This could be explained by the large number of locations where phytosanitary products are supplied. These results are consistent with those of Dosso *et al*. (2023), who listed a wide range of synthetic pesticides (herbicides, insecticides, fungicides, and others) registered in Côte

d'Ivoire and used in the market gardening sector, as part of a functional analysis of peri-urban market gardening production in the country. The study by Le Bars *et al.* (2022) identified 49 herbicides and 11 insecticides. Cotton cultivation uses the largest number of these products, 25, followed by market gardening production with 24. Based on trade names, Ouedraogo *et al*. (2009) inventoried 12 synthetic chemical pesticides, including herbicides and insecticides. However, this list appears to be larger than that reported by Diomandé *et al*. (2024), who identified 16 herbicides used by rice farmers for field maintenance. Among these herbicides, 13 contained glyphosate as the active ingredient. In our study, we identified 25 herbicides, most of which also had glyphosate as the active substance. The results revealed that in market gardening, herbicides are mainly total herbicides, used during the post-emergence phase of the crop. Indeed, market gardeners commonly apply them during land preparation to control weeds. In rice cultivation in Burkina Faso, the active ingredients of herbicides used were glyphosate, paraquat, bensulfuron-methyl, and bispyribac-sodium, in proportions of 50%, 30%, and 10%, respectively (Ouedraogo *et al*., 2009).

The formulations commonly used in the study area include, for solid formulations: soluble granules (SG), water-dispersible granules (WG), and wettable powders (WP); and for liquid formulations: soluble concentrates (SL). According to CIRAD (2000), the type of formulation plays an important role in the handling of these products. Therefore, it appears necessary to strengthen farmers' knowledge regarding the proper use of these herbicide formulations.

CONCLUSION

Market gardening products are an important part of human consumption. They help to provide vitamins and micronutrients not provided by basic foods. At the end of this study, it appears that a large number of herbicide products used in market gardening production are available in the city of San-Pedro. All the market gardeners surveyed said that herbicides are necessary, especially for the establishment and maintenance of cultivated plots. These results reveal the potential risk of poisoning from synthetic herbicides for market gardeners and vegetable consumers.

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