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Evaluation of the Use of Organic and Mineral Fertilisers on Amaranth Productivity in the Locality of Kombé, Republic of Congo

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Authors' contributions

This work was carried out in collaboration among all authors. Author JM designed the research project, executed the project and edited the manuscript. Author HRG conducted the field activities of the project and analysed the data associated with Author GJEO. Author DLOM wrote the manuscript and supervised the associated field work with Author AM. Author ATTIBAYEBA is the head of the laboratory. All authors read and approved the final manuscript.

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ABSTRACT

The use and high cost of chemical fertilisers, as well as the dangers associated with their misuse, are leading growers to look for an alternative, sustainable form of fertilisation. A survey was carried out in the Kombé area of Brazzaville to assess the effectiveness and use of organic and mineral fertilisers on amaranth growth and yield. During the survey, 50 market gardeners growing amaranth were randomly selected and interviewed using a semi-structured questionnaire. The results obtained from our survey were analysed statistically, revealing significant differences between the different types of fertiliser used at Agricongo de Kombé ($p<0.05$). The variance analysis revealed five (5) heterogeneous groups (a, b, c, d, cd), the most significant being poultry manure (group d) and NPK (group cd). The results of the survey revealed that amaranth (32.31%) was the dominant previous crop, poultry manure (34%) was the main and least expensive fertiliser, so it is capable of improving the growth and yield of amaranth, compared with other manures. Poultry droppings could be recommended for amaranth production.

Keywords: Amaranth; organic fertilizer; mineral fertilizer; NPK; Agricongo de Kombé.

1. INTRODUCTION

Market gardening is characterised by the cultivation of leafy vegetables, fruit, roots and tubers for food use. Among the great diversity of vegetables in Africa are leafy vegetables of which amaranth is the most widely grown and the most important. Amaranth is one of the world's oldest food crops, having been cultivated in Mexico for 6,000 years Srivastava (2011). Some species of amaranth are leafy vegetables that are essentially needed to maintain health, especially in preventing human diseases, as they are a good source of vitamins, mineral nutrients and antioxidants Prasad et al. (2014) and Wouyou et al. (2017).

However, the yield of amaranth production can be improved by the use of chemical fertilisers, but the use of chemical fertilisers can lead to high toxicity, environmental pollution and possible side-effects on human health when they end up in foodstuffs. In addition, most vegetable growers in tropical Africa are smallholders who cannot afford the high cost of inorganic fertilisers Makinde et al. (2008). This is why new alternatives have been explored to reduce the use of chemical fertilisers. One solution is to use organic and mineral fertilisers to feed the soil and improve amaranth production by providing the necessary nutrients. Organic fertiliser sources with a C/N ratio below 20 contain a high concentration of nutrients Chaves et al. (2007); Tognetti et al. (2008). Mineral fertilisers provide nutrients that can be directly assimilated by plants. They are easy to use and act quickly on plants Graines Hubert (2024). These fertilisers are inexpensive rather than chemical fertilisers, because they are easy to mass-produce.

Several studies have focused on the chemical characterisation of organic and mineral fertilisers and their contribution to plant nutrition in vegetable crops Larounga et al. (2020) and Ballot et al. (2016). All these studies confirm the importance of nitrogen in the growth and production of market garden crops. Although organic and mineral fertilisers are used on market gardening sites in the Republic of Congo in general and in the city of Brazzaville in particular, very little work has been done on guiding market gardeners in their choice of fertilisers for amaranth production.

The aim of the study is to assess the effectiveness and use of organic and mineral fertilisers on amaranth growth and yield in Brazzaville, in order to recommend the choice of fertiliser types for optimum amaranth growth and development in the Kombé area.

2. MATERIALS AND METHODS

2.1 Study Area

The choice of the Agricongo centre in Kombé as the survey site was based on the level of vegetable production and the fact that it is one of the major vegetable production areas in Brazzaville Massengo et al. (2004).

The Agricongo center in Kombé was set up on 16 January 1986 on the initiative of the Congolese government and with the support of the Agri-sud international group, after the failure of the pre-cooperative groups set up in earlier years (70-80). It is located seventeen kilometres (17 km) south of the city of Brazzaville, in district 8 Madibou. The centre lies at latitude 4°19'34

South, longitude 15°9'49 East, at an altitude of 295 metres (Kombé agrometeorological station).

2.2 Plant Materials and Fertilising

The plant material used by market gardeners consists of *Amaranthus hybridus* seeds.

Fertilising materiel include organic and mineral fertilizers.

2.3 Survey

Aware of the need to master techniques for using fertilisers on amaranth production, we conducted a survey of growers from August to October 2022. The aim was to assess the type of fertiliser used for amaranth production in the Kombé area. Fifty (50) market gardeners were interviewed as a sample using a pre-established questionnaire consisting of individual forms (Table 2).

2.4 Statistical Analysis

The data collected in the field were analysed with the aid of computer-assisted statistical tools, using SPSS (Statistical Package for Social Science) version 22.0 and R version 4.1.3. The statistical methods used are linked to the sampling methods and experimental set-up adopted. The normality of the residuals and the homogeneity of the variances were verified. These methods included: two-factor ANOVA and linear correlations. Means were separated using the Student Newman and Keuls test and the Kruskal-Wallis test at the 5% probability threshold.

Table 1. List of fertilizers used

Type of fertiliser	Commercial name
Organics	Straw (dried *Echinochloa stagnina*)
	Poultry manure
	Pig manure
	Wheat waste
Minerals	NPK
	Urea

Table 2. Individual survey forms

Date……
Locality…….
Proprietor …… ……
Agricongo Kombé Site

1. **Characterisation of the operation**

1.1 Variety (s) ……

1.2 Age of culture	☐	month (date of plantation: ……)				
1.3 Cultural profil	☐	plat	☐	butte	☐	ridges
1.4 Plantation density strong	☐	medium low	☐		☐	
1.5 Siol Type light	☐	heavy	☐	other	☐	
1.6 cultural system	☐	pure	☐	mixed with……		
1.7 Cultivation Precedent (4 years ago)	2022…… 2021…… 2020…… 2019……..					
1.8 Agricultural input	☐	fertilizer	☐	herbicide	☐	insecticide fungicide

nature…… …… ……..
and dosage…… …… ……..

3. RESULTS

A field survey was carried out in the locality of Kombé in Brazzaville to evaluate the different types of fertilizer used on amaranth production.

Statistical analysis reveals significant differences between the different speculations of the Kombé center ($p<0.05$). The analysis of variance revealed six (6) homogeneous groups (a, b, c, bc, ab, d), the most significant of which are amaranth (group d) and lettuce (group c).

Table 3 represents the average percentage of crop precedents (PC) obtained after a survey of the respondents. There is a high occurrence of amaranth (32.31%) in the site compared to other speculations. It is followed by lettuce (23.08%) and spinach (13.84%), spring onion (7.69%), black nightshade (6.15%), baselle (4.62%), endive (4.62%), tomato (3.08%), eggplant (1.54%), cabbage (1.54%) and okra leaf (1.54%).

Fig. 1 shows the percentage use of fertilisers obtained from the survey. The results show that the most commonly used fertiliser is poultry manure, with the highest percentage (34%). In contrast, wheat waste has the lowest percentage of use. The percentage of other fertilisers used shows that: NPK (25.5%) > pig manure (12.8%) > straw (10.6%) > urea (8.6%) (Fig. 1).

Table 3. Average percentage of market garden crops per farmer in the Kombé Agricongo

Speculation	*N*	Percentage (%)
Amaranth	21	32,31d
Aubergine	1	1,54a
Baselle	3	4,62a
Cabbage	1	1,54a
Chives	5	7,69b
Endive	3	4,62a
Spinach	9	13,85bc
Okra leaf	1	1,54a
Lettuce	15	23,08c
Black nightshade	4	6,15ab
Tomato	2	3,08a

N= number of patients per culture. Figures preceded by different are statistically different at the threshold of P<0.05 according to the Student Newmann and Keul test

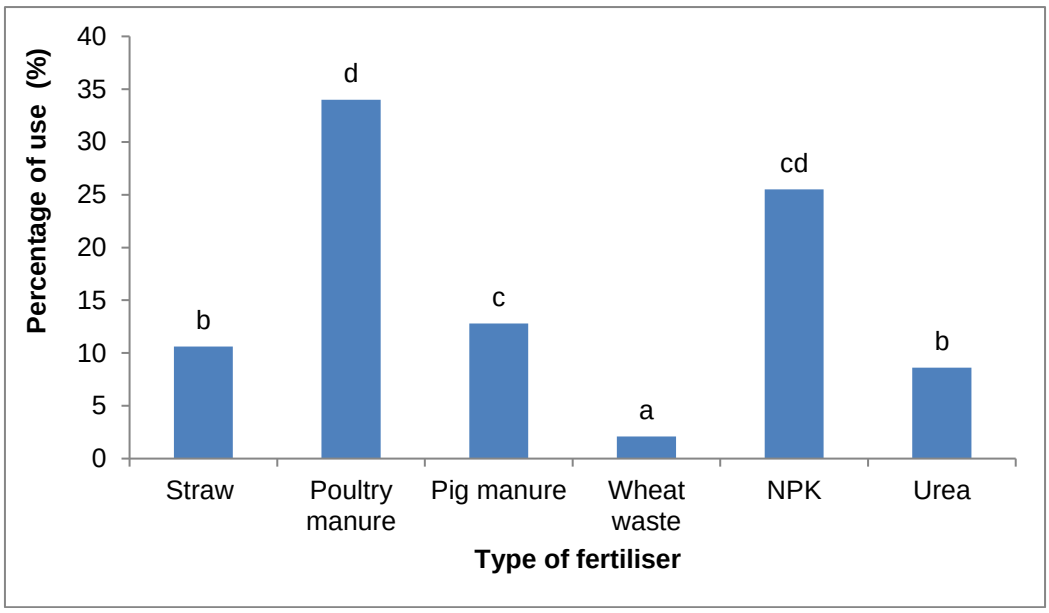

Fig. 1. Fertiliser use of organic and mineral in the Agricongo centre

The straw was made from the dried waste of Echinochloa stagnina

Méthode de Student Newmann et Keul : Les différences sont statistiquement différentes au seuil de P<0,05

The results obtained from the statistical analysis reveal significant differences between the different types of fertiliser used at Agricongo de Kombé ($p<0.05$). The analysis of variance revealed five (5) heterogeneous groups (a, b, c, d, cd), the most significant being poultry manure (group d) and NPK (group cd).

4. DISCUSSION

The average percentage of previous crops (PC) obtained after surveying the respondents showed that amaranth was the dominant previous crop before the crops planted. This is because amaranth produces higher yields than other seed plants. It is a short-cycle plant. It requires less money and time to grow because it grows in poor soil, is resistant to disease and pests, resists water shortages and can be cultivated all year round. Its seeds are readily available on the market and from market gardeners. On local markets, it is the most common leafy vegetable to be found on stalls, because of its low price and the fact that the quantity sold per bunch is sufficient. Amaranth is a widely grown vegetable on market gardens. In fact, amaranth is a widely grown vegetable on market gardening farms. These results are quite similar to the results of work carried out by Marandet (2016) in market gardening in the city of Brazzaville: the dominant leafy vegetables include amaranth (*Amaranthus hybridus. L*), baselle (*Basella alba L.*), black nightshade (*Solanum nigrum L.*), bitter nightshade *(Solanum aethiopicum*), etc. According to the results of a study by Mialoundama (2021) on strategies for managing bioaggressors in urban market gardening in Brazzaville (Congo), the most widely grown vegetables are tomatoes, spring onions, amaranth and chillies.

The results of our survey revealed that poultry manure is the main fertiliser used at Agricongo's Kombé site. Organic matter feeds and shelters a large number of useful soil organisms, such as earthworms and micro-organisms, which work continuously to improve soil fertility and structure Ouédraogo et al. (2008), hence the attachment of the market gardeners of Kombé to the use of poultry manure, they understood that organic manure improves the physical properties of the soil and feeds the plant by providing the nutrients it needs. Their preference for poultry manure is due to the fact that it is affordable and more accessible than other manures. Poultry manure is a very economical fertiliser, because market gardeners harvest it from poultry farms for the most part, and spend only on the purchase of the shavings. Onana (2006), for example, shows that a 35-40 kg bag of poultry manure is sold for 2200 CFA francs in the villages, compared with 17500 CFA francs for a 50 kg bag of compound mineral fertiliser on the Yaoundé market. At Agricongo in Kombé, market gardeners use poultry manure in nurseries and open fields to reduce the use of chemical fertilisers and pesticides. These results are similar to those obtained by Ruf et al. (2016), who conducted a survey on the use of poultry manure in the Duékoué region of Côte d'Ivoire. According to their results, poultry manure is widely used by cocoa farmers. In the Duékoué region as a whole, 90% of farmers use poultry manure. Another reason why market gardeners in Kombé prefer to use poultry manure is to improve the productivity of amaranth. This corroborates the observations made by Tchaniley et al. (2020), who showed that treatment T2 with poultry manure increased lettuce yield with a product surplus of 134.00%. The same results were obtained by Biaou et al. in (2017) after using compost enriched with poultry droppings for carrot production. In addition, the results of our survey show poor results on the use of pig manure. This is because pork is sold at high prices and is difficult to access. Ognika et al. (2016) pointed out that pork production in the city of Brazzaville and its outskirts is not yet able to satisfy domestic demand and guarantee the sustainability of the activity.

According to data collected in 2011 on fertiliser consumption and nutrient balances, nitrogen fertilisers accounted for the vast majority (77.4%) of nutrients consumed. Consumption is estimated at 59 kg per hectare in the European Union (EU), ranging from 19 kg per hectare in Portugal to 125 kg per hectare in the Netherlands (Statistics Explained, 2015). These data differ from our results. Our results collaborate with the experimental results of Kahu et al. (2019) have shown that poultry manure had higher growth performance on the two varieties of Amaranth when compared NPK compound fertilizer. The poor results on the use of NPK by market gardeners in Kombé is due to the low productivity of amaranth. Ognalaga et al. (2015) noted the poor growth of amaranth plants on plots fertilised with NPK. This means that the mineral elements alone are not sufficient for good amaranth growth.

5. CONCLUSION

The aim of this study was to assess the effectiveness and use of organic and mineral

fertilisers on the growth and yield of amaranth in the Kombé area of Brazzaville. The results of the survey revealed that amaranth (32.31%) was the dominant previous crop, poultry manure (34%) was the main fertiliser and was able to improve amaranth growth and yield compared with other manures. As a result, organic fertilisers such as poultry manure could well be substituted, even partially, for synthetic chemical fertilisers.

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.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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