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Effects of Pig Manure-Based Compost on the Productivity of *Xanthosoma Sagittifolia* (L.) Schott Under Goma Conditions

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ABSTRACT

In an attempt to evaluate the productivity of two varieties of cabbage-caraïbe: *Xanthosoma sagittifolia* (L.) Schott (violet and green), using compost from pig manure as fertilizer, a trial was conducted in Goma using a pairwise experimental design, with two blocks of three plots each, representing the two varieties tested. The planting was done at a distance of 50 x 50 cm. A total of 48 plants were planted for each of the varieties studied, at a rate of 16 plants per 4 m^2 plot, for a total of 96 plants for the entire experiment. The observations made during this study were related to the number of tubers per plant, the diameter of the tubers obtained, the weight of tubers per plot and the yield in tons per hectare. The correlation between the different yield parameters observed was calculated. The effects of the pig dung compost on the production parameters were assessed using the one-criteria analysis of variance classification with SPSS 20 Software (IBM SPSS Statistic, 2015). The significance level was set at 0.05%.The results obtained showed that:

1. The violet variety produced a greater number of tubers per plant than the green variety with an average of 10.66 ± 1.15 versus 6.66 ± 0.57. The difference observed from a statistical point of view is significant (χ^2 = 96.000 ; P < 0.000). These results indicate that the number of tubers produced per plant does depend on the variety tested;
2. The size of the tubers obtained does not depend on the variety tested (χ^2 = 263.537 ; P < 0.045) ;
3. The violet variety produced heavier tubers (15.03 kg) compared with those of the green variety (8.76 kg). The difference observed statistically was significant (χ^2 = 60.134 ; P < 0.000). These results indicate that tuber weight does depend on the variety tested. In addition, the violet variety gave a better yield (37.58 t/ha) compared to the green variety (21.90 t/ha) in terms of cultivated area ;
4. There is a positive correlation between the weight and the number of tubers produced on the one hand (r = 0.917 and R^2 = 0.840) and on the other hand between the weight and the size of tubers (r = 0.872 and R^2 = 0.760).

The overall results obtained reveal that the violet variety performed better in terms of the parameters studied and is more adapted to organic fertilization compared to the green variety.

Introduction

Food shortage is a scourge that affects several developing countries such as the DR Congo. The performance of the agricultural sector in the DRC remains very weak, with less than 10% of the country's land area actually under cultivation. In addition, agricultural production is declining, even though agriculture represents about 45% of the country's GDP and is the main source of income and employment for more than half of the population (CIRAD-GRET, 2008). One of the solutions would be the promotion and development of crops adapted to the ecological conditions of the environment, having a high production potential and posing fewer phytosanitary problems (Okungo, 2008).

To help the country achieve food security, it would be appropriate to offer producers food varieties with high nutritional and productive value. This study therefore proposes to evaluate some food crops, including *Xanthosoma sagittifolia* (L.) Schott to determine its agronomic potential.

X. sagittifolia is one of the major root and tuber plants that can play several roles in the human diet. It is consumed by over 400 million people worldwide (Bown, 2000). According to Onwueme (1999) cited by Gorgon (2021), *X. sagittifolia* is preferred as a food due to the energy value of its corms and the nutritional value of its leaves. Corms are richer

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in protein than sweet potato, cassava, potato and yam. They contain 2 to 4% protein and its carbohydrates are of good digestibility due to the small size of the starch seeds (Agueguia *et al*., 2007). In addition, *X. sagittifolia* is adapted to the agro-ecological conditions of the humid tropics where it can give an acceptable yield even in soils unsuitable for other crops (Van Den Put, 1981 ; Messiaen, 1989 ; Janssens, 2001 ; Carburet *et al*., 2007). Tubers are also rich in vitamins (A, B, C, etc.) and minerals, including calcium and iron, necessary for the maintenance of good health (Amagloh and Nyarko, 2012 ; Traoré, 2016). The survey funded by Word Vision (Jenga Jamaa II) showed that *X. sagittifolia* had replaced banana and plantain trees up to 10% of production of 485,320 inhabitants of Kalehe territory as a source of income (Njingulula *et al*., 2013).

Given the agronomic potential and socio-economic importance of *X. sagittifolia* (Birame, 2016), the promotion of improved varieties that are highly productive and hardy to biotic and abiotic conditions would contribute to the security and diversification of food resources in the Democratic Republic of Congo.

Although several studies have been conducted in the DRC and other African countries, including rapid propagation methods of Mahole (*Xanthosoma sagittifolium*) and evaluation of propagation material obtained under the agro-ecological conditions of Kisangani (Okungo, 2012), agro-morphological characterization (Acquaah, 2012 and Dede, 2017), on-farm agricultural practices and food biotechnology (Panyoo *et al*., 2012), comparative study of growth and productivity in Taro (Colocassia esculenta L.) and Macabo (*Xanthosoma Sagittifolium* and *X. Anthosoma* Sp) grown under the pedoclimatic conditions of Mbaïki town (Lobaye) in CAR (Gorgon *et al*., 2021) and the rejection capacity of two varieties of *Xanthosoma sagittifolia* (L.) Schott subjected to the PIF method under Goma conditions (Tshipamba *et al*., 2021), the valorization of this important crop by the population is still a problem.

Thus, the main objective of the present study was to evaluate the productivity of two varieties of *Xanthosoma sagittifolia* (L.) Schott (purple and green) under Goma conditions using pig manure-based compost as fertilizer. Specifically, the aim is to evaluate the yield parameters and the yield of each cultivar tested.

This study is based on the fact that the response to fertilization of any crop is, among other things, related to the variety and other environmental factors. Thus, the productivity of karibbean cabbage would be a function of the varieties.

Material and Methods

Study environment

This case study was carried out in Goma town, on the grounds of the Catholic University La Sapientia. The geographical coordinates of the experimental site taken with the GPS are as follows: 74 ° 11' 16" S ; 98 ° 17' 28,1" E ; 1474 m altitude (Figure 1).

The city of Goma is located in eastern DR Congo, at an altitude of approximately 1,500 meters in the Rift Valley. It covers an area of 66.45 km^2 covered by volcanic rocks with undulating relief at the foot of the Nyiragongo volcano. The city of Goma enjoys a tropical climate of altitude type Cf of the Köppen classification. The annual rainfall is 1250 mm and the average monthly temperatures vary between 20 and 25°C. Its vegetation is a grassy savanna covering the rocky expanses of volcanic origin and a few trees serving as shade within some plots throughout the city. The soils in the city of Goma are derived from magmatic rocks and are highly fertile volcanic (Kulimushi, 2011; Gashekero and Ntamabyaliro, 2012 and OVG, 2015).

Materials

The biological material used in this study consisted of *X. sagittifolia* plants produced in the propagator by the PIF method. These plants were obtained from bulbs collected from farmers in the agro-ecological zone of Mahanga in Masisi territory and Minova in Kalehe territory and were then grown in the nursery for a period of six months.

The morphological characteristics identifying the tested varieties are as follows: green leaves, green petioles and white tubers for the green variety and green leaves, violet petioles and violet tubers for the purple variety. In addition to the two varieties, one type of fertilizer was used, namely compost made from pig manure.

Methods

The preparation of the experimental field consisted in the delimitation of the land, the clearing, the ploughing, the levelling and the digging in order to provide the plants with a good planting bed. The trial was conducted according to a special case of randomized blocks, the pairing method, with two blocks (replicates) of three plots each, representing the two varieties tested.

The blocks as well as the plots were separated by 1 m alleys to facilitate the circulation of people and the maintenance work. A 1 m border was placed around the experimental field. Each plot was 2 m long and 2 m wide, i.e. an area of 4 m^2 and the plants were placed on the same day for the whole experiment at a spacing of 50 cm x 50 cm. A total of 96 plants were planted, with 16 plants per plot.

The observations made during this study were related to the number of tubers per plant, the diameter of the tubers obtained, the weight of the tubers per plot and the yield. Then, some correlations were established between these different yield parameters observed. This study covered the period from 01 October 2020 to 01 January 2022. The effects of pig manure-based compost on the production parameters were assessed using a one-criteria analysis of variance classification with SPSS 20 software (IBM SPSS Statistic, 2015). The significance level was set at 0.05%.

Results

Number of tubers per plant

Results for the average number of tubers per plant of *X. sagittifolia* according to the varieties tested are reported in Table 1.

Analysis of the results in this table shows that the violet variety produced a greater average number of tubers per plant than the green variety with an average of 10.66 ± 1.15 versus 6.66 ± 0.57. The difference observed statistically was significant (χ^2 = 96.000 ; P < 0.000). These results indicate that the number of tubers produced per plant does depend on the variety tested.

Tuber diameter (cm)

The results relating to the average size of tubers obtained from *X. sagittifolia* according to the varieties tested are presented in Table 2.

Examination of the results in this table indicates that the average size of tubers obtained does not depend on the variety experimented with (χ^2 = 263.537 ; P < 0.045).

Tuber weight per plot (plot production) (kg) and yield in (t/Ha)

The results for tuber weight of *X. sagittifolia* according to the varieties tested are presented in Table 3.

Analysis of the results in this table shows variability between the tuber weights of the different varieties tested. The violet variety produced heavier tubers (15.03 kg) compared to the green variety (8.76 kg). The difference observed statistically was significant (χ^2 = 60.134 ; P < 0.000). These results indicate that tuber weight does depend on the variety tested. The violet variety gave a better yield (37.58 t/ha) compared to the green variety (21.90 t/ha) in terms of cultivated area.

Correlations between the different yield parameters observed

By establishing the correlation between the weight and number of tubers produced on the one hand, and between the weight and size of the tubers on the other hand, the results obtained indicate that there is a positive relationship of moderate intensity (r = 0.917 and R^2 = 0.840) between the weight and number of tubers produced on the one hand, and between the weight and size of the tubers on the other hand (r = 0.872 and R^2 = 0.760).

Discussion

The results obtained on the number of tubers per plant showed that the violet variety produced a higher average number of tubers (10.66) compared to the green variety (6.66) (Table 1). These results indicate that the number of tubers produced per foot does depend on the variety tested (χ^2 = 96.000 ; P < 0.000). This superiority of the violet variety can be explained by the genetic potential of the varieties studied. Indeed, Mazliak (1972) states that the response of a plant to any physiological phenomenon is under the control of both endogenous (genetic and hormonal) and exogenous (temperature, light, soil reaction, moisture) factors. Comparing our results with those obtained by Okungo (2012) who found an average of 9 tubers/foot when experimenting with the same variety and fertilizer as our trial (purple variety and pig droppings), it emerges that the results obtained in this trial are slightly superior. We believe that the soil and climatic conditions of the environment influenced and explained this difference. Indeed, Goma and Kisangani do not benefit from the same soil and climatic conditions.

However, when comparing our results with those of Gorgon *et al*. (2016) (6.16) and (5.16) testing the same varieties of *X. sagittifolia* as we do, it is observed that our results are superior. This important difference can be due on the one hand to the cultivation systems practiced and on the other hand to the pedoclimatic conditions of the experimental site. Indeed, this trial used organic fertilizer, notably pig manure, whereas Gorgon *et al*. (2016) did not. In addition, Goma and the Central African Republic do not have the same soil and climatic conditions.

As for tuber diameter, the results obtained indicated that the size of tubers obtained did not depend on the variety experimented with (χ^2 = 263.537 ; P < 0.045) (Table 2). This result may be due to the individual abilities of the varieties tested.

With respect to tuber weight (plot production) and yield in tons per hectare, it is noticeable that the violet variety produced heavier tubers than the green variety. These results show that tuber weight does depend on the variety tested (χ^2 = 60.134 ; P < 0.000) (Table 3). Indeed, according to Garnier (2004), tuber weights of *X. sagittifolia* are influenced by crop density.

In addition, the violet variety gave a better yield (37.58 t/ha) compared to the green variety (21.90 t/ha) in terms of cultivated area. These yields are within the range recommended by Van Den Put (1981) and Janssens (2001) under tropical conditions, estimated at 20-30 t/ha (green variety). However, for the violet variety, they are much higher than this estimate. Comparing the results of this trial with those obtained by Gorgon *et al*. (2016), it is found that their results are largely lower than ours (11.42 t/ha and 5.30 t/ha). These results can be explained by the fact that *X. sagittifolia* responds well to organic manure (Messiaen, 1989 and Janssens, 2001). In addition, as the varieties studied were different from a morphological and agronomic point of view, this variability would be due to genetic diversity (Ouedraogo *et al*., 2018). In Kisangani with the violet variety, Okungo (2012) obtained variable yields with an upper limit of 41.6 t/ha close to 50 t/ha as indicated by Carburet *et al*. (2007). These differences are related to the experimental conditions (climate and soil) on the one hand and on the other hand to the genetic potential of each variety tested.

A positive correlation was established between the weight and number of tubers produced (r = 0.917 and R^2 = 0.840) and between the weight and size of the tubers (r = 0.872 and R^2 = 0.760). These results demonstrate that tuber weight of *X. sagittifolia* depends on the number and size of tubers. Indeed, Carburet *et al*. (2007) state that there is a direct positive correlation between propagule weight and final yield.

Conclusion

The purpose of this investigation was to evaluate the productivity of two varieties of *Xanthosoma sagittifolia* (L.) Schott (violet and green) under Goma conditions using pig dung compost as fertilizer. The hypothesis underlying this investigation is that the productivity of *X. sagittifolia* varies according to the variety experimented with, given that each variety has its own genetic heritage.

The two varieties of *X. sagittifolia* grown showed variability in the yield parameters tested. In the violet variety, the production was better, with an average number of tubers per plant (10.66) and an average yield of 37.58 t/ha compared to 6.66 and 21.90 t/ha for the green variety. Although a variability is observed between the various parameters of production, the two tested varieties present interesting returns adapted to the pedoclimatic conditions of the site of study.

However, it should be noted that the results obtained as a whole show that the violet variety performed better in terms of the parameters studied and is better adapted to organic fertilization than the green variety.

Table 1. Average number of tubers per plant according to the varieties tested

Variety	Average	Confidence Interval (95%)		Hypothesis test		
		Inferior	Superior	χ^2	dl	*P*
Violet	10,66 ± 1,15	6,400	9,600	96,000	1	0,000
Green	6,66 ± 0,57	1,935	18,603			

Table 2. Average size of tubers according to the varieties tested

Variety	Average	Confidence Interval (95%)		Hypothesis test		
		Inferior	Superior	χ^2	dl	*P*
Violet	4,48 ± 0,50	3,348	4,268	263,537	1	0,045
Green	3,47 ± 0,32	0,160	1,535			

Table 3. Tuber weight according to the varieties tested

Variety	Average	Confidence Interval (95%)		Hypothesis test		
		Inferior	Superior	χ^2	dl	*P*
Violet	15,03 ± 0,80	8,112	13,599	60,134	1	0,000
Green	8,76 ± 2,54	5,688	54,685			

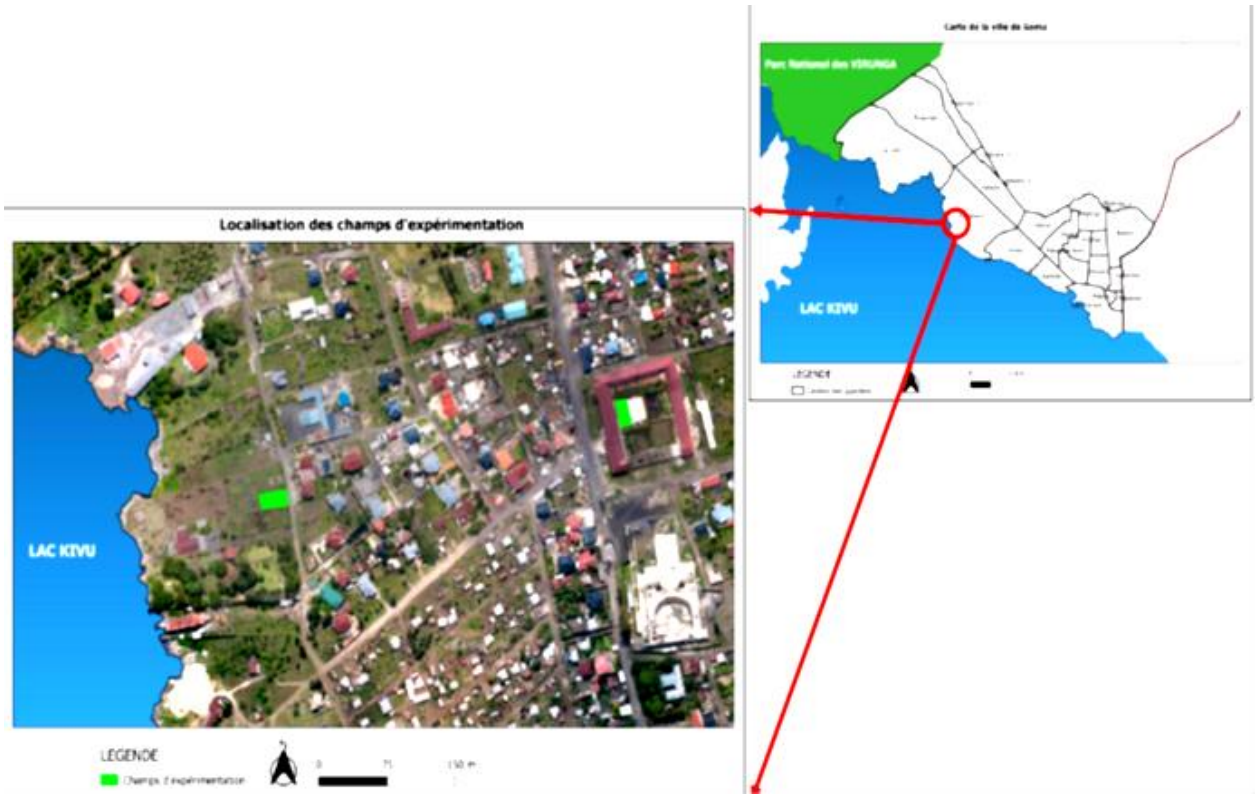

Figure 1. Location of the study site

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