Available online at www.elixirpublishers.com (Elixir International Journal)

Agriculture

Elixir Agriculture 132 (2019) 53430-53437

ISSN: 2229-712X

Effects of *Xanthosoma sagittifolium* (L.)Schott mother Bulb Characteristics on PIF Offspring Performance in Kisangani

Tshipamba, T.O[1], Mukandama, N.J-P[2], Pama, A.V[3] and Okungo, L.A.[4]

[1]Faculty of Agricultural Sciences, La Sapientia Catholic University, BP 50, Goma, Democratic Republic of Congo.
[2]Faculty of Renewable Natural Resource Management, University of Kisangani. B.P. 2012, Kisangani, Democratic Republic of Congo.
[3] Higher Institute of Agricultural Studies of Yatolema (ISEA / Yatolema).
[4]Institute Faculty of Agricultural Sciences, B.P. 1232, Yangambi, Democratic Republic of Congo.

ARTICLE INFO

Article history:
Received: 16 June 2019;
Received in revised form: 15 July 2019;
Accepted: 24 July 2019;

Keywords
Characteristics,
Mother Bulbs,
Xanthosoma Sagittifolium,
Performance of Rejectons and Plants from Stem Fragments.

ABSTRACT

Xanthosoma sagittifolium (L.) Schott can provide a solution to the problems of hunger, inadequacy and food insecurity facing many developing countries such as DR Congo, as it is adapted to humid tropical climates and is richer in nutrients than most root and tuber crops. However, its large-scale culture is confronted with the unavailability of propagation material related to its mode of multiplication and growth. In fact, the pronounced dominance imposed by the terminal bud inhibits bud burst and the development of lateral buds that can be used during planting. To try to solve this problem, a study was carried out by experimenting the PIF method in Kisangani. It consisted in evaluating the longevity of the bulbs in relation to their size, to estimate the production of the offspring with regard to the longevity of the mother bulbs and to evaluate the temporal evolution of the vigor of the obtained shoots. The observations made were based respectively on the diameter of the mother bulbs, the neck diameter of the weaned offspring, the lifespan of mother bulbs and the order of weaning. It was then established the relationship between the longevity of the mother bulbs and their size**,** the number of offspring formed and the lifespan of the mother bulbs and finally between the diameter of offspring formed and the order of weaning. The results obtained showed that: The longevity of the mother bulbs was independent of their size (P = 0,905);There is a positive correlation between the longevity of mother bulbs and the number of offspring formed. This relationship was translated by the equation: Number of offspring formed = 0,847 + 0,004X (X = longevity of mother bulbs). This equation indicates that the number of offspring formed increases moderately with the longevity of the mother bulbs (r = 0,346). The longevity of the bulb explains to 10,9% the increase in the number of the offspring formed (R^2 = 0,109);There were no significant differences between the tested substrates with respect to the longevity of the mother bulbs (P = 0,227);There is a close relationship between the weaning order and the vigor of trained and weaned offspring.

© 2019 Elixir All rights reserved.

Introduction

Root and tuber crops can help to address the global food deficit, particularly in developing countries. These plants are adapted to humid tropical climates and have a carbohydrate and protein content that can equal or exceed that of cereals (Messiaen, 1989). Among these plants, *Xanthosoma sagittifolium* (L.) Schott deserves a place of choice. Indeed, this plant has a good ecological adaptation and remarkable hardiness to diseases and other bio-aggressors (Cirad-Gret, 2006).In addition, the tuber of *Xanthosoma sagittifolium* (L.) Schott is richer in protein than sweet potato, cassava, potato and yam. It doses 2 to 4% of proteins and its carbohydrates are of good digestibility (Agueguia *et al*, 2007). In addition, the yield can reach 40-50 tons / ha.

Despite these advantages, the large scale cultivation of *Xanthosoma sagittifolium* (L.) Schott is limited by the lack of propagation material in sufficient quality and quantity. The pronounced apical dominance, imposed by the terminal bud, a general characteristic in the family Araceae, inhibits bud burst and the development of excess lateral buds on the bulb. Thus, each year the same number of cuttings is returned and the cultivated area remains the same (Van Den Put, 1981, Messiaen, 1989, Okungo, 2008).

PIF (Plants from Stem Fragments) has been developed to regenerate hard-to-propagate plants. It allows, in a propagator, to activate the latent buds and to produce ex situ a large amount of planting material. This method is currently used successfully for the regeneration of banana (Kwa Moïse, 1998, Meutchieye, 2009) and *Xanthosoma sagittifolium* (L.) Schott (Tshipamba *et al.*, 2019).

In *Xanthosoma sagittifolium* (L.) Schott, recent trials have shown that elimination of apical dominance allows rapid regeneration of new plants from lateral buds. Nevertheless, for a good production of propagation material, it is necessary

Tele: +243853960845
E-mail address: oliviertshipamba81@gmail.com

© 2019 Elixir All rights reserved

to master the factors that optimize the quantity and the quality of the offspring emitted by the bulbs. For example, Tshipamba *et al*. (2019) note the existence of a positive relationship between the diameter of mother bulbs and the vigor of the offspring formed. Also, it is expected that a bulb of a good diameter can survive for a long time in the propagator before rotting and can, therefore, emit more offspring. However, it is not known whether this vigor remains constant for all weaning waves. Thus, the present study has pursued the following objectives: 1) to evaluate the longevity of mother bulbs in relation to their dimensions; 2) estimate the production of the offspring with regard to the longevity of the mother bulbs and 3) evaluate the temporal evolution of the vigor of the offspring obtained. The hypotheses underlying this study are formulated as follows: 1) the size of the bulbs would not influence their longevity; 2) the longevity of the bulbs would lead to the increase of the offspring; and 3) there would be a decrease in the vigor of the offspring over time.

Material and Methods

Field of study

The present study was carried out in the parish of Saint Joseph Artisan parish of the Archdiocese of Kisangani (397 m altitude; 00 ° 31'52,4" North ; 25 ° 10'57,3" East). The climate of Kisangani is type *Af* of the Köppen classification. It is a hot and humid climate of the equatorial type. The average daytime temperature oscillates around 30 ° C and that of the night is 20 ° C. On average, there is 1885 mm of water per year. The rains are divided into two rainy seasons: the small one spreading from March to June and the big one from September to November. The annual insolation is 1972 hours and the relative air humidity varies between 80 and 90% (Van Wambeke and Libens, 1957, Litucha *et al*., 2015, Okungo *et al*., 2017). Figure 1 locates the study site.

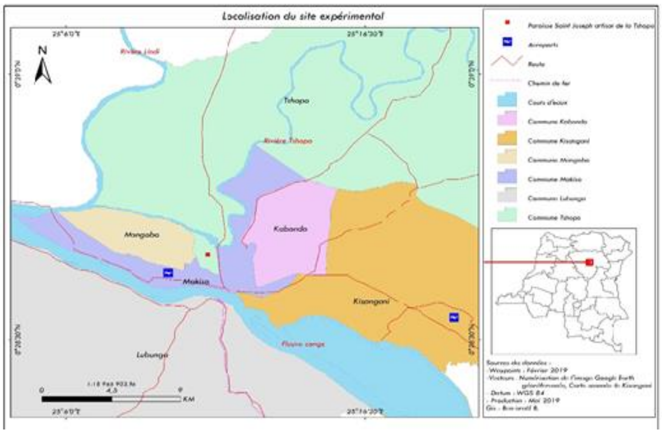

Figure 1. Location of the study site.

Equipment

During the course of this study, the *Xanthosoma sagittifolium* (L.) Schott bulbs were used as propagation material. The variety tested has the following morphological characteristics: green and edible leaves, petioles and purplish tubers, and resistant to cooking.

Methods

Propagator

The superstructure of the propagator was constructed from local materials including wooden sticks, bamboos and formwork boards. The dimensions of the propagator were 4 m long, 3 m wide and 2 m high. Then, this superstructure was covered with a transparent plastic sheeting to retain heat. To reduce the high brightness, a layer of palm leaves was spread over the tarpaulin.

Inside the propagator, three wooden regeneration compartments were built to dimensions of 2 m long, 1 m wide and 0,30 m deep. Each compartment was filled with one of three selected substrates (sawdust, rice husk and pounded charcoal). Thirty *Xanthosoma sagittifolium* (L.) Schott bulbs were placed in each of the compartments, for a total of 90 bulbs used for this study. The experimental set-up used was that of non-randomized trials.

Prior to placement, the *Xanthosoma sagittifolium* (L.) Schott bulbs were stripped and decapitated. The decapitation of the bulbs eliminates the dominance of the apical bud, which removes the dormancy of the lateral buds. Then, the bulbs were left to dry in a shady place for a week to promote recovery.

Thirty days after the installation of the bulbs, the first offspring formed were weaned. Weaning continued at a weekly frequency to avoid re-establishment of dominant bud dominance. To wean, a sharp and sharp knife was used. It was enough to exert a slight pressure on the offspring and it is separated from the mother bulb.

The observations made during this study concerned the diameter of mother bulbs, the neck diameter of weaned offspring (vigor), the lifespan of mother bulbs and the order of weaning. (This study covered a 24-week period from 02 October 2018 to 02 April 2019. The data collected was analyzed by regression and the graphical method using SPSS 20.0 software (IBM SPSS Statistic, 2011). was set at 0,05.

Results

Effect of the size of mother bulbs on their longevity

The raw data on the size of mother bulbs and their longevity under different treatments are given in Annex 1.1. The results obtained on the regression calculations are as follows:

- Coefficient of correlation (r): 0, 013
- Coefficient of Determination ®: 0,000
- Adjusted coefficient of determination: - 0,011
- Std. Error of the Estimate: 17,138
- Regression equation: longevity of mother bulbs = 0,163 + 0,008 X (X = size of mother bulbs)

This equation indicates that the longevity of mother bulbs increases unmoderately with their size (r = 0, 013). This dimension of the mother bulb explains to -1, 1% their longevity (R^2 = -0,011).

Table 1 illustrates the results of the regression analysis

Table 1. Analysis of the regression of longevity of mother bulbs according to their size.

Modèle	SCE	DF	MS	F	P-Value
Regression	4,248	1	4,248	0,014	0,905
Residual	25845,975	88	293,704		
Total	**25850,222**	**89**			

***Legend*:** SCE: Sum of Square of the gaps; DF: Degree of freedom; MS: Middle Square and F: F calculated The results obtained indicate that the longevity of the mother bulbs was independent of their size (P = 0.905).

Effect of longevity of mother bulbs on the number of offspring formed

The raw data on the longevity of mother bulbs and the number of weaned offspring in the various treatments are given in Annex 1.1. The results obtained on the regression calculations are as follows:

- Coefficient of correlation (r): 0,346
- Coefficient of Determination ®: 0,119
- Adjusted coefficient of determination: 0,109
- Std. Error of the Estimate: 0.17633

- Regression equation: Number of offspring = 0,847 + 0,004 X (X = longevity of mother bulbs).

This equation indicates that the number of offspring formed increases moderately with the longevity of the mother bulbs (r = 0,346). The longevity of the bulb explains to 10,9% the increase in the number of the offspring formed (R^2 = 0.109).

Table 2 illustrates the results of the regression analysis.

Table 2. Regression of the longevity of bulbs and the number of offspring formed

	Model	SCE	DF	MS	F	P-Value
1	Regression	0,371	1	0,371	11,934	0,001
	Residual error	2,736	88	0,031		
	Total	3,107	89			

The results obtained indicate that there is a positive relationship between these two parameters (*P* = 0.001).

Effect of the substrate on the longevity of mother bulbs

Table 3 gives the results of the analysis of the variance, while the raw data relating to the longevity of mother bulbs under various treatments are given in Annex 1.1.

Table 3. Comparison of the longevity of bulbs on three different substrates

	SCE	DF	MS	F	P-Value
Between groups	866,756	2	433,378	1,509	0,227
Within groups	24983,467	87	287,166		
Total	25850,222	89			

The results obtained showed that there was no significant difference between the substrates tested with regard to the longevity of the mother bulbs.

Effect of weaning order on vigor of trained offspring

Figure 2 presents the results of changes in the vigor of weaning offspring, while the corresponding raw data are reported in Annex 1.2.

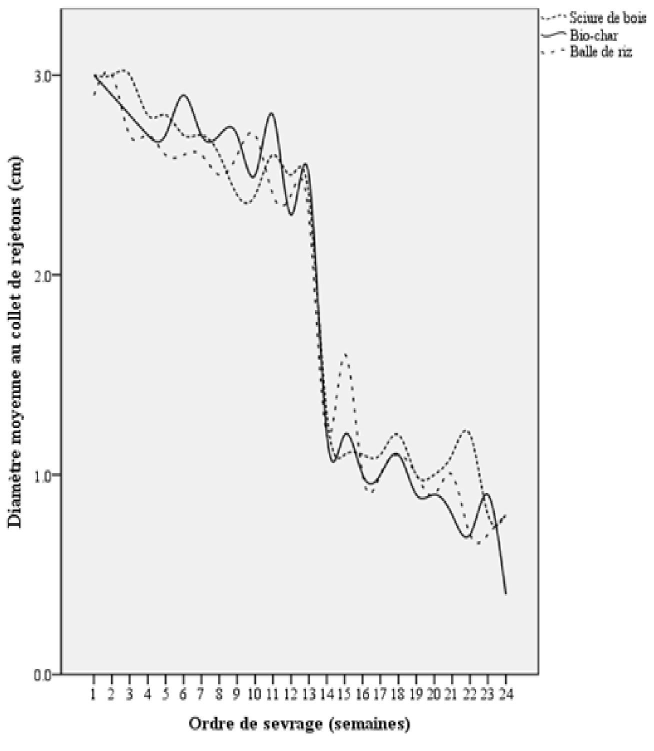

Figure 2. Evolution of strength of offspring formed by weaning order

These results indicate that the vigor of formed offspring decreases with weaning. However, there are two distinct groups. The decrease in vigor is observed for all offspring weaned until the 12th week. Then, there is a sharp decrease from the 13th week and continues until the 24th week.

Discussion

The results obtained on the effect of the size of mother bulbs on their longevity showed that the size of bulbs used did not influence their longevity. Indeed, Mazliak (1982) asserts that the reaction of a plant to any physiological phenomenon is both controlled by endogenous (genetic and hormonal) and exogenous (temperature, light, soil reaction, moisture) factors.

The study of the correlation between the longevity of mother bulbs and the number of offspring formed revealed a positive relationship between the two parameters (*P* = 0,001). These results indicate that the number of offspring formed increases moderately with the longevity of the mother bulbs (r = 0,346). This can be explained by a beginning of decomposition of the experienced substrates, especially sawdust and rice husk, allowing them to release a certain amount of nutrients to the bulbs, thus promoting their nutrition and longevity.

With respect to the relationship between the weaning order and the vigor of the offspring formed, the results obtained indicated that the vigor of offspring decreased with weaning. These results showed that the strength of trained offspring decreased sharply after the 12th week of weaning. These results can be explained by the depletion of organic substances (carbohydrates) contained in the bulbs (Okungo, 2012). Nevertheless, we do not know if this decrease in vigor can affect the productivity of the plants derived from these offspring.

The results obtained made it possible to verify our initial hypotheses. Indeed, the longevity of mother bulbs and the PIF method (Plants derived from stem fragments) experimented in this investigation make it possible to improve the multiplication rate of *Xanthosoma sagittifolium* (L.) Schott with a view to the extension of the culture. , as reported by Mayeki *et al*., 2010 and Ongagna *et al*., 2016 that the use of a suitable banana cultivar in the PIF technique yields several plants that are both healthy, moderately uniform and only three or four months.

The regression line obtained between the longevity of the mother bulbs and the number of formed and weaned offspring indicates that there is a low intensity link (r = 0,346 and R^2 = 0,109) between these two parameters.

We have also noticed that the longevity of mother bulbs is independent of their size and the nature of the substrate.

Comparing our results with those of the literature, we find that the longevity of mother bulbs and the PIF (Plants derived from Stem Fragments) method significantly improve the production of offspring in *Xanthosoma sagittifolium* (L.) Schott. However, it is important to note that the vigor of the offspring produced decreases with weaning, following the depletion of the nutrient reserves contained in each bulb.

Conclusion

The purpose of this study was to investigate the effects of *Xanthosoma sagittifolium* (L.) Schott mother bulb characteristics on PIF offspring performance in Kisangani. The experiment carried out consisted of evaluating the longevity of the bulbs in relation to their dimensions, to estimate the production of the offspring with regard to the longevity of the mother bulbs and to evaluate the temporal evolution of the vigor of the obtained shoots.

The main observations made during this investigation concerned the diameter of the mother bulbs, the neck diameter of weaned offspring, the lifespan of mother bulbs and the weaning order. It has been, then establishes the relationship between the number of offspring formed and the longevity of bulbs, and the vigor of formed offspring and weaning order.

All these results indicate that the longevity of the bulbs and the PIF method significantly improve the multiplication rate in *Xanthosoma sagittifolium* (L.) Schott and constitute solutions to the thorny problem of unavailability of propagation material in this culture. Indeed, *Xanthosoma sagittifolium* (L.) Schott would contribute to the food security of populations living in tropical zones given its productivity and nutritional value. It should also be noted that the PIF method is simple and adapted to the living conditions of the rural population, since it generally uses local materials.

Bibliographies

1.Agueguia, A., Fontem, DA, Bikomo Mbonomo, R., Mboua, JC, Mouen, M., Ndzana, X., Chuyanyo, M. and Zok, S., 2007. Taro and Macabo: two tubers like no other http/ wwwfao.org / inpho / content / documents / library / move rep / 5.

2. Carburet, A., Lebot, V., Ravaillac, P. and Vernier, P., 2007. Other starchy plants. In: Memento of the agronomist. CIRAD / GRET. Jouve. Paris. La France. Pp.831-864

3.Cirad-Gret, 2006.*Memento of the Agronomist*. Rural Technical Collection in Africa.Ministry of French Cooperation. 4th edition.Paris. 1680p.

Diploma of Rural Development Engineer.June 2009.

4. Janssens, M., 2001.The Taro (*Colocasia* and *Xanthosoma*) in Reamaekers. H.R. (Ed). Agriculture in tropical Africa. DGCL.Ministry of Foreign Affairs. trade and international cooperation. Brussels pp254-290.

5. Kwa, M., 1998.Study of propagation techniques of plant material in vivo. in: Technical Report 1996-1997. Doc. Internal. CRBP. Njombe. Cameroon. Pp.96-100.

6. Litucha, BM, Kombele, BMF, Dhed'a, DB and Baboy, L., 2015. Yield of cassava leaves (Mbongo cultivar) in relation to the secondary infection level of African cassava mosaic culture (MAM).Annals of the Institute Faculty of Agricultural Sciences of Yangambi, vol. 4 (2), 2015 pp 100-108, RD. Congo.

7. Mayeki JP, Ndong Biyo'o M, Ngnigone Ella C, Molouba F, Demikoyo D, Mibemu S, Effa B, 2010.Influence of substrate composition on weaning of plantain vivoplants (Musa sp),

Laboratory of Biotechnology Vegetables, IRAFCENAREST in Sciences Sud, 3: 1-16.

8. Mazliak, P., 1982.Plant Physiology II. Growth and Development, Herman, rue la Bourse, Paris.

9. Messiaen, C.M., 1989.*The tropical vegetable garden*. Collection "living techniques" ACCT and CILF. 2nd ed. Remelted. 580P.

10. Meutchieye, F., 2009.Factsheet on banana multiplication using the PIF method. plants derived from stem fragments. Training manual for rural communities.Cameroon. 15p.

11. Okungo, AL, Ramazani, A., Solia, E., Mwamba, K. and Dhed'a, D., 2017.Study of the methods of withdrawal and weaning as methods of rapid multiplication of propagation material at Macabo (*Xanthosoma sagittifolium* (L.) Schott) in Kisangani. Annals of IFA-YANGAMBI, No. 1 (1).

12. Okungo, L., 2008.A study of the methods of harvesting and weaning as a method of rapid multiplication of propagating material in the Taro Macabo (*Xanthosoma sagittifolium* (L.) Schott, Memory of unpublished DES IFA-YANGAMBI 63p.

13. Okungo, L., 2012.Methods of rapid multiplication of Mahole (*Xanthosoma sagittifolium* (L.)Schott) and evaluation of propagation material obtained under the agro-ecological conditions of Kisangani. Unpublished doctoral thesis, IFA-Yangambi, 182p.

14. Ongagna, A., Mialoundama, F., Bakouetila, MGF, 2016. Study of the production of banana and plantain plants (Musa spp.) By the technique of BIPs in Congo: Effects of substrates on growth and development nursery seedlings, International Journal of Neglected and Underutilized Species (IJNUS) 2: 42-56.

15. Tshipamba, T.O., Kankonda, M.O., Mukandama, N.N.J. and Okungo, L.A., 2019. Influence of Bulb Size on Macabo (*Xanthosoma sagittifolium* (L.)Schott) Propagation by the Kisangani PIF Method. Elixir Agriculture 132 (2019) 53298-53302 / ISSN 2229-712x. Pp53298-53302.

16. Van Den Put, R., 1981.*Main crops in Central Africa*. Ed LASAFFRE. Tournai. Belgium. 1552p.

17. Van Wambeke, A. and Libens, L., 1957. *Map of soils and vegetation of Belgian Congo and Ruanda-Urundi*. Brussels: Publ. INEAC, 32p.

ANNEX 1

Annex 1.1: Diameter of mother bulbs; Life expectancy of mother bulbs and total number of trained offsprings

N° Bulb	Sawdust			Bio-char			Rice Balls		
	Diameter of mother bulbs	Longevity of mother bulbs	Number of trained offspring	Diameter of mother bulbs	Longevity of mother bulbs	Number of trained offspring	Diameter of mother bulbs	Longevity of mother bulbs	Number of trained offspring
1	10	180	26	11,8	173	30	11,1	180	56
2	9,3	166	28	9,8	166	39	8,9	166	26
3	8,8	180	21	7,9	131	25	9,6	145	24
4	8,2	173	20	10,6	173	24	8,4	173	19
5	11,6	180	39	8,8	166	30	12	152	35
6	8,7	166	23	9,7	180	33	9,2	159	25
7	8,5	180	33	9,7	180	27	8,5	152	45
8	10	180	52	8,2	145	27	9,0	166	40
9	10,9	131	18	9,9	131	20	10,9	180	94
10	7,4	138	12	8,2	138	28	6,9	180	38
11	10	180	31	8,6	166	34	11,1	159	44
12	9,7	124	16	9,4	166	31	9,0	138	32
13	8,8	166	8,0	8,5	173	22	9,5	159	24
14	9,5	180	41	10,2	173	27	7,6	173	32
15	9,5	180	34	8,9	180	47	7,7	145	15
16	9,5	180	29	8,6	173	13	9,8	166	33
17	10,1	173	31	11,5	180	94	7,6	166	25
18	10,7	173	64	9,3	173	41	9	173	43
19	8,3	173	28	8,2	173	19	7,4	173	36
20	8,7	180	41	9,7	173	47	7,7	180	20
21	11,2	166	37	12,8	173	98	8,2	173	31
22	9,7	138	22	9,6	131	17	6,9	173	21

23	9,7	173	30	9,3	131	18	8,8	159	19
24	10,1	152	25	11,8	131	64	8,2	180	25
25	10,1	173	59	9,9	117	32	9,0	131	17
26	11,3	180	34	9,8	173	36	8,2	145	25
27	10,4	180	47	10,7	180	18	7,9	166	19
28	8	173	36	9,5	159	35	8,0	173	26
29	9,2	173	34	8,2	180	22	8,5	173	41
30	9,6	173	31	8,8	166	22	8,4	124	22
Sum	287,5	5064	950	287,9	4854	1020	263	4882	952
Average	9,6	169	32	9,6	162	34	8,8	163	32
Stardard Deviation	1,0	15,88	12,66	1,2	19,42	19,93	1,2	15,24	15,36
C.V	10,6	9,40	39,56	12,6	11,99	58,62	14,2	9,35	48,00

Annex 1.2: Average neck diameter of formed and weaned offspring

Order of Weaning	Sawdust	Bio-char	Rice Balls
1	3,0	3,0	2,9
2	3,0	2,9	3,0
3	3,0	2,8	2,7
4	2,8	2,7	2,7
5	2,8	2,7	2,6
6	2,7	2,9	2,6
7	2,7	2,7	2,6
8	2,6	2,7	2,5
9	2,4	2,7	2,6
10	2,4	2,5	2,7
11	2,6	2,8	2,4
12	2,5	2,3	2,4
13	2,4	2,5	2,3
14	1,3	1,2	1,2
15	1,1	1,2	1,6

16	1,1	1,0	1,0
17	1,1	1,0	1,0
18	1,2	1,1	1,1
19	1,0	0,9	1,0
20	1	0,9	0,9
21	1,1	0,8	1,0
22	1,2	0,7	0,7
23	0,8	0,9	0,7
24	0,8	0,4	0,8
Sum	**46,6**	**45,3**	**45**
Average	**1,94**	**1,89**	**1,88**
Standard deviation	**0,85**	**0,93**	**0,85**
C.V	**43,81**	**49,21**	**45,21**