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Research Paper

Effect of Rice (*Oryza sativa* L.) Sowing Times Between Raspberries (*Arachis hypogeae* L.) On Paddy Yield in Kisangani Hinterland (Tshopo, DRC).

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SUMMARY
This work sought to obtain a high paddy grain yield potential under the effect of rice sowing times between groundnut lines on paddy yield.To achieve this, a randomised complete block design with four replications and five treatments was set up in Kisangani, at PK9, the old Buta road. In the various plots, the rice was sown during the leaf-out, leaf-out, fruiting and ripening stages of the groundnut. These were respectively 60, 70, 80, 90 days after sowing, so that the leaves of the groundnut crop hid the rice crop from the ravages of granivorous birds at emergence, in order to increase paddy rice yields. The results obtained showed that this cropping practice (relay cropping of rice with groundnuts) increases paddy grain yields. It is an effective means of combating rice pests and has agricultural, technical and socio-economic benefits for farmers. The good paddy grain yield during the leafing stage (4.3kg/12.48 m²) in T1 was supported by the emergence rate (97.7%). Sowing rice during the peanut leafing stage gave a good paddy grain yield (4.3 t/ha over 12.48 km²) in T1 compared with (2.4 t/ha over 12.48 m²) in T0 and T4; 2.6 t/ha over 12.48 m² in T2 and T3. This cultivation practice solves the problem of guarding at emergence and increases the substantial yield potential by demonstrating a good symbiosis between the groundnut and rice crops.

Key words*: yield, groundnut, rice, relay cropping, paddy.*

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I. INTRODUCTION

Rice (Oryza sativa L.) is the staple food of more than half the world's population. In Africa, the rice-consuming population is increasing by 1.8% per year (Rabarison, 2006). In the DRC, rice is the second most consumed cereal after maize. Estimated consumption of white rice ranges from 7kg to 19.5kg/person/year (FAO, 2012; FAO, 2019; IFAD and WFP, 2019). In D.R. Congo, access to adapted, high-yielding varieties also remains a major problem (MINAGRI and CAID, 2013; MINAGRI, 2018).

Rice growing has long attracted the population and become their main activity (Behavana, 2008). According to Dabat (2000), in a study of the rice value chain, these authors showed that a large number of players work and live from rice (Bastian, 1955; Bodelmann, 1976). National studies on the rice sector also highlight its importance in terms of rural household income (Rendianarisoa, 2003; Roubaud, 1996). Rice production has a number of strengths, including the availability of agricultural labour and land in rural areas (Charreau, 1972).

It also has weaknesses: low production capacity in some provinces, too many intermediaries between production and consumption, inadequate transport infrastructure (Bolakonga, I., 2013), and a low price structure for producers (Rakotojaona R., 2007).

Given the importance of rice in agriculture and nutrition, rice yield is considered to be a key indicator of performance in this sector (Nguetta et al., 2016). Higher yields increase food security and reduce pressure on land (Robaud, 1977).

Rice cultivation combats poverty in rural areas (Rabarison, 2006). However, some biotic constraints limit its production. These include weeds, diseases such as blast disease and helminthosporiosis (Kouakou et al., 2006), insects (Paul et al., 2014) and, above all, birds, which cause damage during emergence and flowering (Liboga, 2019). The cropping practice used solves the problem of guarding the rice crop at emergence and, allows yield to increase by highlighting a good symbiosis between the two crops. With this in mind, this study proposes to sow rice at different times between rows of groundnuts in order to control the latter against the ravages of granivorous birds at emergence, in order to increase paddy grain yields.

II. ENVIRONMENT, MATERIALS AND METHOD

2.1. ENVIRONMENT

The experimental field was set up in Kisangani, at PK9, the old Buta road. The geographical coordinates of the experimental site are: 00°33'39.5" north latitude and 025°12'43.5" east longitude. Its average altitude is 393m. The climate at the experimental site is of the Af type according to Köppen's classification. It is a humid tropical climate with average temperatures of around 25°C. Rainfall is spread throughout the year in two seasons. One runs from January to June (season A) and the other (season B) runs from July to December. Relative humidity varies between 80 and 90% (Borek, 1987). The primitive natural vegetation of Kisangani is a rainforest, but the land on which the trial was set up was a grassy fallow for a few months, dominated by Panium-maximum and Pueraria-javanica. The previous crops were cassava and maize.

2.2. MATERIALS

The biological material used in this study came from the INERA Yangambi research centre in DR Congo and consisted of G17 groundnuts, a medium-growth cycle variety, and NERICA4 rice, also a short-growth cycle variety. The data sheet for 'G17' drawn up at the INERA Yangambi research centre is as follows: crop cycle of ± 90 days, light green leaf colour, sowing to flowering cycle of 21 - 30 days, average production per hectare of ± one tonne and the variety is tolerant of groundnut mosaic (rosette). It is an erect variety with a red tegument of the Spanish type. The rice cultivar is a short vegetative cycle variety with an average production per hectare of ±2-3 tonnes/ha. The vegetation period is 100-120 days, the average plant height is 98-100 cm, the average number of tillers is 14-16, the cultivar is resistant to lodging and disease, the panicle length is 24-26 cm and the sowing to heading cycle is 91-93 days.

2.3. METHOD

The experimental design used was a randomized complete block design with four replicates and five treatments each. The replicates were separated by one metre and the treatments by half a metre as recommended by INERA (2017). Each experimental plot measured 5m x 3m, i.e. 15m². The treatments were defined as follows:
To: pure rice sowing (before leafing stage)
T1: rice sowing 60 days after peanut (peanut leafing stage);
T2: rice sowing 70 days after peanut (peanut leafing stage);
T3: rice sowing 80 days after peanut (peanut fruiting stage)
T4: rice sowing 90 days after peanut (peanut ripening stage).
Cultivation during the experiment was limited to three weedings: two weedings during groundnut flowering and leafing before sowing rice. After the groundnut harvest, the rice crop was weeded once. Clearing the edges of the field and the paths was also part of the care provided and was done as needed. Data was collected in the 2.6 m x 4.8 m plot.

A. Vegetative parameters.

Emergence rate: this was conventionally determined from the following relationship:
Emergence rate = (1)
Tillering: This was determined by simple counting on five dishes taken at random from each useful plot. Incidence of damage at emergence: this is directly related to the emergence rate. For its evaluation, we used the standard rice evaluation system (evaluation system, 1988), based on a scale for evaluating the incidence of bird damage at emergence, as follows:
0: no rice stacks dug up by birds: no damage
1: 1-5% of rice stacks dug up by birds: light damage
5: 5.1 - 25% of rice stacks dug up by birds: heavy damage
9: 25.1 - 100% ofn rice stacks dug up by birds: very heavy damage.

B. Yield and its components

Number of grains per panicle: determined by simply counting paddy grains along the entire panicle on five samples taken at random from each useful plot.

Percentage fertility: calculated according to the following conventional formula:

% tillers fertility = number of tillers with panicles/total tallea (2)

Panicle length (PL): this was determined using a graduated slat from the panicle neck to the top of the panicle.

Percentage of panicle fertility: this was calculated using the relationship:

Panicle fertility rate =Number of panicles-filled grains/total number of grains (3)

Thousand-grain weight: this was determined by weighing, after sun-drying, a batch of thousand grains from the harvest of each useful plot.

Yield: after harvesting, threshing, drying and winnowing, the paddy rice yield of each plot was determined by weighing using a precision balance. The weight thus obtained was converted into tonnes per hectare.

STATISTICAL ANALYSIS OF THE DATA

The data obtained were subjected to analysis of variance (ANOVA) to test for differences between treatments overall. In the event of a significant difference, the means were compared using Tukey's multiple comparison test at the 5% significance level.

III. RESULTS AND DISCUSSION

3.1. Emergence rate, incidence of emergence damage and tillering/

The results relating to emergence rate, incidence of emergence damage and tillering are summarised in the table below.

N°	Treatments	Lift rate (%)	Incidence of damage at emergence	Number of talles	
1	Sowing pure rice T0	73,4d	5	5	14
2	Sowing rice 60 days after groundnuts T1	97,7 a	24,2	1	14
3	Sowing rice 70 days after groundnuts T2	90,2b	24,0	1	14
4	Sowing rice 80 days after groundnuts T3	90,2b	23,7	1	13
5	Sowing rice 80 days after groundnuts T4	77,7c	24,4	5	14
M.G.		85,8 a	24,0		14
C.V(%)		11,6	0,03		0,1
L.S.D. 0,5		$0,0000^{***}$	0,4039		0,6013

Legend: in the results tables, the values followed by the same letters in the same column are not significantly different for p=5%;

NS: not significant for p=5%;

*Significant difference for p = 5%;

**Highly significant difference for p = 1%;

***Very highly significant difference for p = 0.1%;

G.A.=general average

C.V (%): coefficient of variation, expressed as a %.

Table 1 shows that the emergence rate obtained was very good, being above 85%. Considering the 100% of paddocks in which the rice grains were sown at emergence, the treatments compared were ranked in descending order according to the damage caused to the rice crop by granivorous birds, as follows: T0 (26.6%) > T4 (22.3%) > T3 = T2 (9.8%) > T1 (2.3%). Analysis of variance revealed very highly significant differences in average emergence rates obtained under different rice sowing times between groundnut lines (p = 0.0001). This could have a positive impact on paddy rice yields. From the above, we support these results based on the good protection of rice pockets by groundnut crop leaves. These results also show that the rice seed used was of good quality. Similar results were observed by SCHALBROECK (2001) who noted that the rice emergence rate depends on the good physiological maturity of the biological material used, good drying and winnowing of the plant material, good soil and climatic conditions and the establishment of a good root structure.

The work of ONWUEME and HAVERKORT (1991) also shows that the emergence rate depends more on the richness of the soil and the quality and physiological age of the plant material. In fact, according to CHAUDHARY et al (2003), poor germination leads to a low stand in the case of direct sowing.

With regard to the incidence of damage at emergence, the results indicate that it ranged from slight (1) to severe (5). The pure rice crop (T0) and the sowing of rice 90 days after groundnuts caused gaps with damage ranging from slight (1-5%) to severe (6-25%).

The other treatments, sowing rice 60, 70 and 80 days after groundnuts, maintained a good density. This is the right time to combine groundnuts and rice to obtain an interesting yield in terms of paddy grains. These results are justified by the fact that the rate of granivorous bird damage at emergence is a function of the degree of ravaging by these bio-aggressors, all other things being equal.

The number of tillers per clump was relatively the same whatever the treatment or time of introduction of rice between the rows of groundnuts. Considering that the tillering of a variety is linked to the genetic potential of the cultivar used, it shows little variation within a given interval. Nevertheless, it may be slightly influenced by cultural and edaphic conditions (CIRAD-GRET, 2004). A number of tillers per bunch ranging from 10 to 20 is considered good, while a number greater than 20 indicates uneven ripening (AMULI, 2015). During our study, the number of tillers varied from 13-14; values within the range of 10 to 20 tillers established by AMULI (op cit).

3.2. Number of grains per panicle, percentage of tillers fertility and panicle length.

The results relating to the number of grains per panicle, the percentage of fertility of the tillers and the length of the panicles are recorded in the table below:

Table 2: Number of grains per panicle, percentage of tillers fertility and panicle length.

N°	Treatments	Nuber of grains per panicule	Tiller fertility rate(%)	Panicle length (in cm)
1	Pure sowing of rice T0	190 a	97 a	24,2 a
2	Sowing rice 60 days after groundnuts T1	191 a	97 a	24,2 a
3	Sowing rice 70 days after groundnuts T2	191 a	96 a	23,7 a
4	Sowing rice 80 days after groundnuts T3	190 a	97 a	23,8 a
5	Sowing rice 80 days after groundnuts T4	193 a	97 a	24,4 a
C.V(%)		191	97	24, 0
L.S.D.0,5		0,1	0,02	0,03
		$0,8061^{NS}$	$0,2959^{NS}$	$0,4039^{NS}$

As far as the number of grains per panicle is concerned, there was little variation between the mean values for the different treatments. Their ranges of variation are very close: from 190 (T0,T3) to 193 (T4.) there is hardly any significant difference between the different treatments for this parameter (p>0.05).

In line with the results observed, the number of grains per panicle did not vary between treatments. In fact, the number of grains per panicle generally varied from 150 to 360, with an average of 100 to 150 grains for the productive varieties. The test cultivar used produced 190 to 193 grains per panicle. These values are higher than the average of 100 to 150 grains per panicle reported by WALANGULULU (2003) and suggest that the NERICA4 used is also productive. Our results are close to the averages already established for rice (Oryza sativa L.) in general by MIGABO (2009).

The percentage of tillers fertility varied little between treatments. It ranged from 96.0% to 97.0%, with an average of 96.5%. No significant differences were observed between the different treatments (P>0.05). Overall, our observations provide sufficient evidence that the majority of tillers of our rice variety are fertile. Our results indicated that the fertility rate was 96 to 97%. This parameter remained a varietal characteristic and was less influenced by the treatments tested. This finding is in line with that of SCHALBROECK (2001), who showed that the variation in fertility rate is more influenced by the expression of the varietal genotype, the other parameters being homogeneous.

Examination of the results in the table above shows that the average panicle length of the test variety varied slightly from 23.7 cm (T2) to 24.4 cm (T4), with an average of 24.0 cm. Analysis of variance revealed no significant difference between the treatments tested in terms of panicle length (p value > 0.05).

Our results also indicate that the number of grains per panicle is not linked to panicle length. Indeed, the results of the study show, for example, that a panicle 24.2cm long produced 191 grains more than one 23.8cm long produced 190 grains. All the values in our study are lower than those ranging from 26.9cm for the LIOTO variety to 31.0cm for the KITOMBE cultivar found by LIBOGA (2020). Our results and the values reported by our predecessors show that canicular length is a varietal characteristic that varies very little according to environmental conditions.

Panicular fertility, weight of 1000 grains, paddy rice yield.
The results relating to the percentage of panicular fertility, 1000-grain weight and paddy rice yield are presented in the table below.

Table 3: Fertility per panicle, 1000-grain weight, paddy rice yield.

N°	Treatments	Panicle fertility rate (%)	Weight of 1000 seeds (in g)	production	
				Parcel(Kg)	Yield(t/ha)
1	Sowing pure rice T0	87,5 a	24,2	3,1 c	2,4
2	Sowing rice 60 days after groundnuts T1	88,2 a	24,2	4,3 c	3,4
3	Sowing rice 70 days after groundnuts T2	88,3 a	24,0	3,3 b	2,6
4	Sowing rice 80 days after groundnuts T3	88,6 a	23,7	3,3 b	2,6
5	Sowing rice 80 days after groundnuts T4	89,0 a	24,4	3,1 c	2,4
M.G.		88,3 a	24,0	3,4	2,7
C.V(%)		0,03	0,03	0,7	
L.S.D.0,5		0,4392	0,4039	$0,0311^{***}$	

Considering the results in Table 3 above, there was very little variation in the percentage of panicular fertility according to the time of rice insertion between the groundnut lines. Mean values ranged from 87.5% (T0) to 89.0% (T4). Analysis of variance did not reveal a significant difference between treatments for P>0.05. Our results are similar to those of CIRAD-GRET (2010). According to the latter: "a rice variety is fertile if the sterility rate is between 10 and 25%; and very fertile if the sterility rate is less than 10%. With regard to this parameter, LIBOGA (2020) found values ranging from 98 to 100% for the KITOMBE, LIENGE and NERICA7 varieties, which are higher than those recorded in our study, thus confirming the assertion that panicular fertility is a varietal characteristic.

The table shows that the thousand kernel weight varies from 23.7g (T3) to 24.4g (T4). Taking into account the different values presented in the table above, the analysis of variance shows that there are no significant differences between the various treatments for this parameter (P>0.05). LIBOGA (2020) reported a thousand kernel weight of between 16.9 and 28.4g in its trial comparing the varieties Lioto, Lienge, Nerica7 and Kitombe. Only the Lienge cultivar gave a higher thousand-kernel weight than our Nerica4 cultivar. It is generally known that the thousand kernel weight is between 21 and 37g. Our results corroborate those found by BENITO (1992). According to the latter: "a rice variety is said to be normal if its thousand grain weight is greater than 25g. For the most part, a rice variety is considered normal if its thousand grain weight is greater than 25g or slightly less than 25g (SCHALBROECK, 2001).

This classification shows that the test cultivar NERICA4 is a normal variety because its thousand grain weight varied within the range of 24 to 25.2g. Our results show, in comparison with those of our predecessors, that thousand kernel weight is a varietal characteristic that varies little within a given range depending on the environmental or cultivation conditions in which the cultivar is placed.

With regard to the paddy rice yield recorded during the study, it varied from one treatment to another. In terms of induced paddy rice yield, the treatments were ranked in ascending order as follows: T0 = T4 (2.4t/ha)<T2 = T3 (2.6t/ha) < T1 (3.4 t/ha). Statistically, there were very highly significant differences between treatments in terms of yield (P=0.0001). The superiority of the treatment consisting of sowing rice between the groundnut rows at 60 days after sowing in terms of paddy rice production is apparent. This performance is linked to the fact that this treatment was more positively influenced by the number of fertile tillers, the number of grains per panicle and stabilised the thousand grain weight compared with the other treatments. Compared with pure rice cultivation, the agricultural practice of inserting rice between the peanut rows at times ranging from 60 to 80 days after peanut sowing increased paddy rice yields. Providing an average yield of at least 2.2 t/ha, this is slightly higher than the average yield in Africa, estimated at 2 t/ha (Schalbroeck, 2001). The rice sowing 60 days after the groundnut sowing resulted in a yield of 3.4 t/ha. This yield is slightly higher than the upper yield limit (3t/ha) reported in the technical data sheet for the Nerica4 variety.

The average yield recorded (3.4 t/ha) exceeds those of the test cultivars and varieties used in our predecessor trials: the Kitombe cultivar (2.1 t/ha), NERICA7 (2.6 t/ha) and Lioto (2.9 t/ha). However, the average yield of NERICA4 is lower than that of the Lienge cultivar (3.5 t/ha) and the Liboga variety (3.8 t/ha) found by Liboga (2020) in his study evaluating a number of rainfed rice varieties under the agro-ecological conditions of Kisangani (D.R. Congo).

IV. CONCLUSION AND APPLICATION OF RESULTS.

This study of the effect of groundnut-rice association under relay cropping conditions on paddy grain yield was carried out at PK9 in Kisangani on the old Buta road. The trial was conducted using a casualised block design with four replications and five treatments each. The combination consisted of sowing rice between the rows of groundnuts during the foliage, leaf-out, fruiting and ripening phases of the latter. The pure crop was used as the control or reference treatment. The treatments were compared on the basis of vegetative parameters (emergence rate, tillering), incidence of bird attacks, paddy rice yield and its components. The results are summarised below:

combination of groundnuts and rice, with the latter sown 60, 70 and 80 days after the groundnuts, provides good control of attacks by granivorous birds at emergence, reducing the level of attacks from 6 to 25% (heavy damage) to 1-5% (light damage) compared with pure cultivation and sowing rice at the groundnut ripening stage. These times ensure high paddy rice yields. Inserting rice between the groundnut rows 60 days after sowing gave a higher yield of around 3.4 t/ha than the other treatments (T0, T2, T3, T4), a highly significant difference (P=0.0001).

The results obtained in this study show the agricultural, socio-economic and technico-economic benefits. The adoption of this agricultural practice will enable Congolese rice growers to increase paddy grain yields and income, and consequently improve their well-being.

Thus, it gives us the latitude to recommend this agricultural practice to the farmers of the town of Kisangani and its surroundings in particular, and then of the D.R. Congo in general for its application in the field.

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BIBLIOGRAPHICAL REFERENCES

[1]. Adrao,G.,2014. The NERICA rice variety as a source of life in West Africa Bouaké, cote d'Ivoire: 64 PP.
[2]. Amuli, S., 2015. Comparaison de deux techniques de gestion intermittented'eau sur le rendement des cinq variétés de rizirrigué à Kiringye dans la plaine de la Ruzizi, unpublished dissertation, UCB
[3]. Anonymous, 2004. Mementodel'agronome, Ministry of Foreign Affairs, Centre de coopération international en recherche agronomique pour le développement (C.I.R.A.D.) 1698 PP
[4]. Anonymous, 2010. Projetriz. Le leader, BRALIMA company review number 50 :34PP
[5]. Anonymous, 2014. Note technique sur la filièreriz dans la zone CMA/AOC. Arradeau, 1998
[6]. Bastian, G., 1955. "Madagascar, géographie physique, humaineéconomique. p1-105
[7]. Behavana I.M.J., 2008. Viral and fungal diseases of rice in the Mahajanga region. Mémoire Master I, option Science biologiegénérale. Faculty of Science, University of Mahajanga. Academic year 2007/2008. 33p.
[8]. Benito, S., 1992. Le manuel de la riziculture, 2éd, Manila, philipines: 219PP.
[9]. Bolakonga, I., 2013. Influence de l'enclavement sur le développement rural (cas du territoired'opala, district de la Tshopo, R.D.Congo). PhD thesis.
[10]. Boreks, s.,1987. Climatologie, coursuniversitaireinéditfaculté des sciences université de Kisangani 25P.
[11]. Chareau, C., 1972. Problèmesposés par l'utilisationagricole des sols tropicaux des cultures annuelles. Afrique tropicale, sérieagron. Générale, études techniques n° 9-IRAI,Paris.
[12]. Dabat M.H.P., 2000. Diagnostic et perspectives de la filièreriz à Madagascar. Ministry of Agriculture, Rural Development Policy Unit.
[13]. Dobelmann J.P., 1976. Riziculture pratique-2, riz pluvial " presses universitaires de France.
[14]. F.A.O, 2012. World agriculture towards 2030/2050. Interim report, Rome, www.fao.org/economic/esa.p55
[15]. F.A.O, 2019. Overview of rice development in Côte d'Ivoire.
[16]. www.fao.org/economic/esa.
[17]. FIDA AND PAM, 2019. Analysis of food losses: causes and solutions. Case studies on maize and rice in the Democratic Republic of Congo.P2.FEWS NET.
[18]. Kouakou et al., 2016. Agronomic performance of four NERICA upland rice varieties sown at different dates in the Sudano-Sahelian zone of Senegal.
[19]. Liboga O.B, 2019. Study of the physico-chemical and technological quality of a local variety (kitombe) and four improved rainfed rice varieties (Lioto,liboga,lienge and NERICA7) grown in and around Kisangani, D.R.Congo.
[20]. Migabo, K, 2009. Essaid'introduction de six variétés de rizirrigué dans les conditions édaphoclimatiques de la plaine de Ruzizi. Unpublished UCB dissertation: 51pp.
[21]. MINAGRI ET CAID, 2013. Rapport annuel des activités de l'inspection provinciale de l'agriculture et élevage. Province de bandundu. P16. Faolex.fao.org.
[22]. Nagata k, TakitaT.yoshinanga S.,Terashimak.,Fukuda A.2004.effect of air temperature during te early grain-filling stage on grain fissuring in rice.
[23]. Japanese J-of crop. Sc. 73:336.-342
[24]. Nguetta et al. 2016. Selection of high-performance varieties of rainfed rice (0ryza-sp) in the sub-equatorial region of Congo Brazzaville. Afrique science.

[25]. Niyondagara T, 1984. Contribution à la sélection du riz pour un environnement pluvial. Dissertation, FACAGRO, U.B, Bujumbura: 112PP.
[26]. Paul O.O., Thaddée G., Daniel O.M., Drice M.K. and Claire K. 2014. Study of insect population dynamics on NERICA rice crop under Masuku conditions, South-East Gabon (Franceville). P20. http//ajol.infolindex.php/ijbcs.
[27]. Raharison H.Z.C.G., 2006. Filièreriz et luttecontre la pauvreté dans le monde rural à Madagascar. Faculty of Law, Economics, Management and Sociology. University of Antananarivo.
[28]. Rakotojaona R., 2007. Le rizproduitstratégique pour Madagascar :"analyse swot ". Master's thesis, Faculty of Law, Economics, Management and Sociology. Université d'Antananarivo.
[29]. Randrianarisoa, J.C., 2003. Analysespéciale de la production rizicolemalgache.
[30]. Agriculture et pauvreté" conference, Centre national de recherche appliquée au développement rural. Programme ILO.P :1-8
[31]. Robaud,F., 1997. La question rizicole à Madagascar: les résultatsd'unedécennie de libéralisation".
[32]. Robaud,F., 1996. La question rizicole à Madagascar : les résultatsd'unedécennie de libéralisation", MADIO Project (Madagascar dial Instorstom) n° 9653/EP :1-22.
[33]. Schalbroeck, 2001. Agriculture in tropical Africa. D.G.C.I. Rue de petits carmes, Bruxelles, Belgique :1634PP
[34]. Systèmed'évaluation standard de riz : 3e éditionjuin 1988 P.28.
[35]. Takahashiw, ojima T., Nomura M., Nabeshima M., 2002. Development of a model for producing cracked rice Kernel of rice-cultuvar"Koshihikari" The Kokuriko crop sci., 37:48-51.
[36]. Usui et al. 2015. Rice grain yield and quality responses to free.air Co2 enrichment combined with soil and water waming.
[37]. Walangululu, 2003. Study of the behaviour and performance of eight hybrid lines of medium-cycle upland rice selected at YANGAMBI. Tropicultura, 21 (3), 112 - 116.