Quest Journals
Journal of Research in Agriculture and Animal Science
Volume 12 ~ Issue 1 (2025) pp: 09-14
ISSN(Online) : 2321-9459
www.questjournals.org

Research Paper

Determining The Ideal Moment For Sowing Rice (Oriza Sativa L.) In The Interlines Of Arachide (Arachis-Hypogea) To Control The Attacks Of Granivorous Birds At Rising In The Kisangani Interland

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Summary
The objective of this study was to ascertain the optimal timing for the interplanting of rice with groundnuts, with the aim of minimising the damage caused by granivorous birds at the emergence stage, while simultaneously enhancing the yield of paddy rice.
To achieve this objective, two trials (seasons A and B) were conducted using a randomised block design with four replications, each with five treatments. The treatments correspond to the times when inserting rice between the groundnut rows, 60 days after sowing, ensures a higher emergence rate (97%) and significantly reduces the incidence of bird damage (3%) at emergence, compared with the other times tested.
The insertion of rice between the rows of groundnuts between 60 and 80 days after sowing resulted in a reduction in the incidence of bird damage at emergence, with an incidence of 1-5% of pods dug up by birds. Subsequently, at 90 days after sowing, damage reaches 6-25%, leading to a reduction in paddy rice production.
This technique provides farmers with a degree of flexibility in terms of guarding at emergence. It demonstrates a positive symbiotic relationship between the two crops. It reduces the cost of guarding the crop at emergence. It also makes it possible to have two cropping cycles per year.

Keywords: *granivorous birds, relay cropping, emergence rate, groundnut, rice.*

***R**eceived 29 Dec., 2024; **R**evised 07 Jan., 2025; **A**ccepted 09 Jan., 2025* © *The author(s) 2025.*
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I. INTRODUCTION

Rice is among the most widely cultivated cereals globally (Pandey and Shukla, 2015 ; Islam et al., 2018). In the D.R. Congo, rain-fed rice is the principal method of rice production. However, the country exhibits substantial potential for the development of irrigated rice agriculture (Bangata et *al*., 2018). It is notable that national production of this commodity remains low.

The low production levels observed can be attributed to a number of factors, including the quality of the seeds used, climate change, abiotic constraints (as evidenced by the findings of Momolu et *al*., (2016), Gnago et *al*. (2017), Samota et *al*., (2017) and Islam et *al*., (2018)) and biotic constraints. The latter include insects that ravage crops, weeds (Janil et *al*., 2012 ; Babiker et *al*., 2016), rodents, diseases (Baouet et *al*., 2010) and especially birds, which cause significant damage during the emergence and flowering stages. In rice cultivation, the damage caused by birds at the emergence stage has considerably more significant consequences than that caused at flowering.

The impact of birds on rice crops at the seedling stage results in irregular spacing between rows, which in turn leads to uneven emergence, reduced plant density and diminished yields.

In order to combat these pests, farmers employ a variety of techniques, including the use of guarding, crop combinations and relay cropping. The latter is more frequently employed by farmers who are accustomed to cultivating groundnuts and rice in the same field, in an effort to address the issue. The groundnut crop is sown at a distance of 40 cm by 20 cm, with rice introduced to the inter-rows prior to the harvest period.

Although this relay cropping technique is sometimes employed to safeguard rice plants at the emergence stage, the outcomes remain inconclusive, as there is currently no definitive data on the precise timing for introducing rice between the rows of groundnuts to enhance the resilience against avian predators. In light of the aforementioned considerations, the objective of this study is to ascertain the optimal timing for the introduction of rice cultivation between the rows of groundnuts, with the aim of safeguarding the rice plants from granivorous birds at emergence.

II. ENVIRONMENT, MATERIALS AND METHODS

2.1. ENVIRONMENT

The experimental field was set up in Kisangani at PK 9 on the old Buta road. The geographical coordinates of the experimental site are as follows 00° 33'39,5" north latitude and 025°12'43,5" east longitude. Its average altitude is 393 m. The climate at the experimental site belongs to the Af type according to the Köppen classification. It is a humid tropical climate with an average temperature of 25°C. Rainfall is abundant (1800 mm/year on average) and is distributed throughout the year according to two seasons: January to June (Season A) and July to December (Season B), according to Van WAMBEK and LIBENS (1957). The relative humidity varies between 80 and 90% (Borek, 1987). The original natural vegetation of Kisangani is rainforest. However, the land on which the trial was carried out was a grassy fallow for a few months, dominated by Panicum-maximum and Pueraria-javanica. The previous crops grown on the trial site were manioc and maize.

2.2 MATERIALS

2.2.1. Biological material: This consisted of peanut seed G17 and rice seed NERICA4 from the INERA Yangambi research centre in the Democratic Republic of Congo.

The data sheet for 'G17', produced at the INERA Yangambi research centre, is as follows: crop cycle ± 90 days, light green leaf colour, sowing to flowering cycle ± 21-30 days, average production per hectare ± one tonne, and the variety tolerates peanut mosaic (rosette). It is an upright variety with a Spanish type red legume. The other biological material sown between the peanut rows was NERICA4 rice. This is a variety with a short vegetative cycle and an average production of ± 2-3 tonnes per hectare.

The vegetation period is 100-120 days. The average plant height is 98-100 cm. The average number of tillers is 14-16. The variety is resistant to lodging and diseases. The panicle length is 24-26 cm. The cycle from sowing to heading is 91-93 days.

The strategy was to first sow the groundnut crop at 40cm x 20cm spacing in the different plots. During the different vegetative stages of peanut, rice is sown in the peanut rows at the same spacing. Knowing the vegetative cycle of peanuts, the ideal was to try to have a good time to sow rice in relay with peanuts to reduce the damage caused by granivorous birds at emergence.

The experimental design used was a randomised complete block. There were four replications and five treatments. The blocks were separated by one metre, while the experimental units were separated by half a metre, as recommended by INERA (2017). Each experimental plot was (5x3) m or 15 m2. The treatments were defined as follows:

T_0: pure rice cultivation (before foliation),
T_1: rice sown 60 days after peanut (leafing stage);
T_2: rice sown 70 days after peanut (leaf-out stage):
T_3: rice sown 80 days after peanut (fruiting stage);
T_4: rice sown 90 days after peanut (peanut maturity stage).

The sowing distances used were 40 cm x 20 cm, i.e. nine rows of twenty-six clusters each. Six grains were sown per cluster for rice and two grains per cluster for peanuts.

Cultivation during the experiment was limited to three weedings: two weedings during the flowering and leafing of the peanut before the rice was sown.

The rice crop was weeded once after the peanut harvest. The cleaning of the edges of the field and of the paths was also part of the maintenance work and was carried out according to need. The 2.6 m x 4.8 m plot was used for data collection.

Observations were made on * vegetative parameters, yield and its components.

a. Vegetative parameters

1**) Emergence rate**: this was determined conventionally using the following relationship
% emergence=(number of pots in which emergence occurred)/(total number of pots in which sowing occurred) X 100

2) Incidence of damage at the emergence stage:
This is positively related to the emergence rate. According to the standard rice grading system, a scale is given to evaluate the incidence of bird damage at emergence as follows
0: Number of pods dug by birds almost zero: (no damage).
1: number of pods dug up by birds between 1-5%: (slight damage).
5: Number of bunches dug up by birds between 6-25% (heavy damage).
9: number of clusters dug up by birds between 26-100% (very heavy damage).

3) Tallage:
This was determined by a simple count of five samples taken at random from each of the useful plots of land.
b.Yield and its components.
1. Number of grains per panicle :
This was determined by simple counting of paddy grains from a sample of five panicles taken at random from each plot. Grains are counted from the neck of the panicle to the top of the panicle.
2) Percentage of tillers fertility: this was calculated using the following conventional formula
% tillers fertility = (number of tillers with panicles)/(total number of tillers) X 100
3) Panicle length (PL): this was determined using a graduated bar, from the panicle neck to the top of the panicle.
4) Percentage of panicle fertility: this was calculated using the relationship
% panicle fertility = (number of filled grains per panicle)/(total number of grains) x 100
5) Thousand kernel weight: this was determined by weighing a thousand kernel batch selected from the harvest of each useful plot after sun drying.
6) Yield: after harvesting, threshing, drying and winnowing, the paddy yield of each plot was determined by weighing with a precision balance. Tonnes per hectare were extrapolated from the weight obtained.

DATA PROCESSING

Analysis of variance (ANOVA) was used to compare the means. We then applied Tukey's multiple comparison test at the 5% significance level in order to detect significant differences between treatments.

III. PARTIAL RESULTS

3.1. The average results for emergence rate, incidence of damage at emergence and tillering are presented in Table 1.

Table 1: Emergence rate, incidence of damage at emergence, tillering.

N°	Treatments	Lift rate	Incidence of damage at emergence	Tallage
01	Pure sowing of rice T_0	64,2 d	5	13a
02	Sowing of rice 90 days after groundnuts T_1	97,0 a	1	13a
03	Sowing of rice 90 days after groundnuts T_2	95,6 a	1	13a
04	Sowing of rice 90 days after groundnuts T_3	95,0 ab	1	12a
05	Sowing of rice 90 days after groundnuts T4	72,7 c	5	12a
MG		85,0		12,6
CV %		1,01	0	3,4
L.S.D	0,05	0,0000***		3,0764 ^{NS}

Legend:
In all tables of results,
At p = 5%, values followed by the same letter in the same column are not significantly different,
NS: not significant difference at p = 5%;
* Significant difference at p = 5%;
** Significant difference at p = 1%;
*** Significant difference at p = 0.1%.
MG= overall mean;
C.V= coefficient of variation
RISE RATE.

The results in the table show that the rate of lift varied from one treatment to another. It ranged from 64.2% (T0) to 97% (T1). The average for all treatments tested was 85%. This indicates the good quality of the seeds used (good conditioning, good conservation). The different times at which the rice was introduced between the peanut rows were very different in terms of emergence.

INCIDENCE OF DAMAGE AT EMERGENCE.

With regard to the incidence of damage at emergence, the data in the table generally show that it was higher in the plots with pure rice (T0) and in the plot where it was intercropped with peanuts 90 days after sowing (ripening period). At the other times, when rice was sown 60, 70 and 80 days after peanuts, the rice seedlings were well protected at emergence. For this parameter, however, there was no significant difference between the different treatments.

TILER NUMBER.

The analysis of variance for the number of cultivators is not significant at the 5% threshold, as shown in Table 2. This number varies from 12 to 13, with a general average of 13.
Although the number of tillers of a variety is a function of the variety, it is also a function of cultural and soil conditions (Anonymous, 2004). The number of tillers per interstalk (10 to 20 tillers) is good because high tillering: more than 20 tillers determines uneven ripening (Walangululu et al; 2003 cited by AMULI, 2015).

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

N°	Treatments	Number of grains	Per panicle	Percentage fertility of tillers Panicle length (in cm)
01	Pure sowing of rice T_0	178,5a	96,25 ab	25,1 a
02	Sowing rice 60 days after groundnuts T_1	178,25a	96,0 a	24,6 a
03	Sowing rice 70 days after groundnuts T_2	178,0a	96,5 a	25,6 a
04	Sowing rice 80 days after groundnuts T_3	183,25a	96,0 a	25,5 a
05	Sowing rice 90 days after groundnuts T_4	181,25a	96,25 a	25,3 a
MG		179,8	96,2	25,2
CV /%		1,58	0,46	1,62
L.S.D	0,05	$0,6383^{NS}$	$0,9288^{NS}$	$0,4372^{NS}$

NUMBER OF GRAINS PER PANICLE.

It varied slightly between treatments, ranging from 178 (T_1, T_2) to 183 (T_3). The mean for the whole trial was 179.8 (= 180). The treatments compared did not differ significantly in the number of grains per panicle.

The results recorded in our trial fall within the range of 150 to 360 grains per panicle. Our overall average is within this range and still higher than the average of 100 to 150 grains per panicle reported by Walangolulu (2003).
Our results show that the cultivar used is a productive cultivar. It produces about 178 grains more than the average reported by our predecessor mentioned above.

PERCENTAGE OF TILLERING FERTILITY.

The results in Table 2 show that the percentage of tillers fertility did not change between treatments. It varied from 96% (T1 and T3) to 96.5% (T2). The overall average was 96.2. No significant differences were observed between treatments. These observations clearly show that the majority of tillers of our rice variety can produce panicles. Our results are in good agreement with those of NIYONDAGARA (1984), who states that "The number of productive tillers plays a determining role in varietal production. It varies from one variety to another, depending on cultural and edaphic conditions. However, the variation was more influenced by the expression of the varietal genotype. The other parameters were homogeneous (Schalbroeck, 2001). The number of fertile tillers is the first indication of potential production capacity. Yield depends mainly on the number of fertile tillers per rice plant. This should give a general idea of the possible level of yield. As a result, it provides interesting information on the stimulating or limiting effect of each variable in the tillering process and, by the same token, on the fertility of the tillers (Adrao, 2014).

PANICLE LENGTH. According to the technical data sheet of the NERICA 4 variety from the INERA Yangambi Research Centre, the panicle length of this variety varies between 24-26 cm; the average values observed in our trial varied from 24.6 cm (T1) to 25.6 cm (T2), with an overall average of 25.2 cm.

This suggests that these values are within the relative range established by INERA. The average numerical values found are almost identical. They do not show any variability between them. No significant differences were found between the different treatments for this parameter. These results could be explained by the fact that these treatments did not have an impact on this parameter because it is a fixed parameter. It is linked to varietal characteristics.

Table 3: Percentage of fertility per panicle, thousand grain weight, yields

N°	Treatments	Percentage of panicle fertility	Weight of 1000 grains (in g)	Yields	
				in kg/12.48m2	in T/ha
01	Sowing pure rice T_0	83,25 a	25,3 a	1,551d	1,242
02	Sowing rice 60 days after groundnuts T_1	83,1 a	24,7 a	3,998 a	3,203
03	Sowing rice 70 days after groundnut T_2	84,6 a	24,7 a	2,622 ab	2,100
04	Sowing rice 80 days after groundnuts T_3	84,9 a	26,0 a	2,473 ab	1,981
05	Sowing rice 90 days after groundnuts T_4	847 a	24,5 a	1,742 c	1,396
MG		84,1	25,04	2,477	1,984
C.V(%)		1,51	1,89	4,87	
L.S.D. 0, 05		0,8107 ^{NS}	0,2224 ^{NS}	0,0000***	

PERCENTAGE OF PANICLE FERTILITY.

There is no variation in the percentage of fertility per panicle when this treatment is taken into account. They are almost identical. The mean values varied from 83.3% (T_0) to 84.9% (T_3). The mean value was 84.1%. The analysis of variance showed no significant difference between the treatments. Our results are in line with those of CIRAD-GRET (2010). According to the latter, "a rice variety is fertile if the sterility rate is between 25 and 10%, and very fertile if the sterility rate is less than 10%". These results are in line with those obtained by SCHALBROECK (2001) : these results can be explained by varietal differences.

THOUSAND KERNEL WEIGHT.

The thousand kernel weight values varied from 24.5g (T_0) to 26.0g (T_3). The overall mean value was 25.04 g. For this parameter, no significant differences were observed between the different treatments. Our results confirm those of BENITO (1992). According to this author, "a rice variety is considered normal if its thousand grain weight is greater than 25g. In most cases, a rice variety is considered to be normal if its thousand grain weight is greater than 25 g and a little less than 25 g (Schalbroeck 2001). He went on to say that the thousand grain weight is generally between 21 and 37g. It has been shown that rice varieties with short, narrow, erect leaves make efficient use of solar radiation and respond better to nitrogen supply, and therefore have good photosynthetic capacity and good carbohydrate accumulation for grain filling (Arraudeau, 1998).

EXTRAPOLE YIELD IN t/ha.

Yield values at different times of rice sowing between the peanut rows varied from 1.551 kg (T0) to 3.997 kg (T1). The overall mean was 2.447 kg. The post hoc test shows that only the yields obtained with T2 and T3 are almost similar, but they are significantly different from the yields of the other treatments (T0, T1, T4). The treatment of sowing rice 60 days after peanuts in T1, i.e. sowing rice when peanuts are in leaf, is therefore of interest for rice production in the soil conditions of Kisangani city and the surrounding area. This treatment was superior to the other treatments, with a highly significant difference at the 0.1% significance level.

The superiority of this treatment over the others can be explained by the fact that at this stage the groundnut crop still contains a large quantity of leaves, which can help it to hide the rice pods well from granivorous birds when they emerge. These results can be explained by the fact that the yield of rice varies according to the variety, the cultivation method and the cultivation and soil conditions. In this case, it is influenced by the number of fertile tillers, number of panicles per cluster, number of grains per panicle, low apical sterility and 1000 grain weight (SCHALBROECK, 2001).

IV. CONCLUSIONS

The aim of the present study was to determine, under conditions of relay planting of rice with peanuts, the ideal time for planting rice between the peanut rows that would minimise the damage caused by granivorous birds at emergence and, in addition, possibly have a positive effect on the yield of paddy rice.

To achieve this, two trials (seasons A and B) were carried out using a randomised design with four replications, each with five treatments, corresponding to the times when intercropping rice between groundnut rows at 60 days (leafing stage) ensures a higher emergence rate (97%) and significantly reduces the incidence of bird damage at emergence (3%) compared to the other times tested.

Intercropping rice with peanut rows between 60 and 80 days after sowing resulted in better control of bird damage at emergence, with an incidence of 1-5% of pods dug up by birds. After this time, i.e. from 90 days after sowing, damage reaches 6-25% and paddy production is reduced.

This technique frees farmers to some extent from the shackles of emergence protection. It shows a good symbiosis in this association. It reduces the cost of guarding the crop at emergence. It also makes it possible to have two cropping cycles per ye

Acknowledgements
This research was facilitated by the contributions of the following people:
1. Litucha-Bakokola Joseph: Professor at I.F.A/ Yangambi.
2. Mukandama- Ndolandola Jean Pierre: Professor at the University of Kisangani.
3. Liboga Oenabaiso Bienvenu: Associate Professor at I.F.A/ Yangambi.
4. Mambokolo Molongo Charles : Assistant Ir Msc at I.F.A/ Yangambi.

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