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RESEARCH ARTICLE

FORMATION OF PANICLE PRODUCTIVITY IN RICE VARIETIES ON DIFFERENT BACKGROUND OF MINERAL NUTRITION

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ABSTRACT

Summary: In Congo, rice yields remain low. To better determine the productivity of the panicle in rice varieties, following the different treatments of the mineral nutrition background, it was established that there is a considerable influence of the contributions of nitrogen and carbon compounds coming from the vegetative organs of the plant. ***Methodology and results:*** Three treatments were applied (N12 P6 K6), (N24 P12 K12) and (N 36P 18K18) on the two (2) varieties Nerica 14 and Nerica 12. Sowing was carried out according to stencils with the creation of the same density plants 250-300 grains/m2. The results show that the varieties studied react differently to a high level of mineral nutrition (N36 P18 K18). Increased photosynthesis productivity can be seen in the upper leaves, which transmit more light deeper into the crop. ***Conclusion and application of results:*** The most favorable nutrition of a developing panicle, balanced in terms of carbon and nitrogen, is observed when the ratio of carbon to non-protein nitrogen in its tissues is equal to 30 - 40 units.

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INTRODUCTION

Rice is undoubtedly the most remarkable plastic of cultivated plants. Although it can be grown dry like wheat, it thrives in swampy areas and irrigated land (MAYER et al 1973). Moreover, rice is the most important food in the world; it constitutes the basis of human nutrition in Asia, part of Latin America, and Madagascar. Its consumption is growing rapidly in Africa. Despite the fact that rice has high productivity, its harvest in Congo remains considerably lower than potential (Makoundou, 2005). Finally, when irrigated, in Asia and Madagascar, it has produced crops, one or more per year, for centuries without exhausting the soil. In these regions, human civilization was partly organized around the cultivation of rice and we could speak of a rice civilization (MAYER et al 1973). Most rice is still produced under traditional cultivation conditions, often careful but routine, relying primarily on human labor as a factor of production. One of the main components of the yield structure of rice is panicle productivity, which, depending on the variety, the level of mineral nutrition of plants and temperature conditions of the year, varies significantly. Which considerably affects the yield of this variety. The physiological mechanisms behind these fluctuations have not been sufficiently studied. Which negatively affects rice breeding in the development of new high-yielding and adaptive varieties and the development of efficient technology for their cultivation (Tour, 1989). Experimental data accumulated over recent years (Vorobyov et al, 1988 and 2001) show that the formation of panicle productivity elements is determined by the level of supply of nitrogen and carbon compounds from the vegetative organs of the plant. Therefore, determine the content of non-structural carbohydrates and nitrogenous substances in stems and panicles and establish their relationship with the number of fertile and sterile spikelets per panicle, depending on the variety and level of mineral nutrition of plants, is of great scientific interest (Alechine E.P, 1986).

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MATERIAL AND METHODS

The plant material consisted of grains of two varieties of rice (Nerica 12 and Nerica 14) of light yellow color, with ovoid grains.

- The Nerica 12 variety has a stem of medium thickness, and quite resistant to lying (This variety does not fall). Plant height is 80 to 90 cm. The leaf is long, narrow and light green. The panicle is moderately curved.
- The Nerica 14 variety is of medium thickness and more resistant to coating. Plant height is 90 to 100 cm. The leaf, of medium thickness, is short, medium green. The progressive rise of panicle organs, formation of floral elements, heading and flowering, formation and filling of caryopsis occurs during nine stages of organogenesis and covers the period of full maturity of rice (Figure 1)

Experiment site: The experiment was conducted at the Agricongo Professional Research Center in Kombé. The locality of Kombé is located in the East-South (00 and 20 South latitude and 150 and 160 East longitude), 17 km from Brazzaville (Congo).

Figure 1. Nerica Cultivar

The climate of the study area is humid tropical low Congolese, with 2 seasons:

- a rainy season, the months of December and April are the rainiest of the year in the study area; and a dry season. There are two dry periods, a large one is observed from June to September and a small one in January-February, marked by the decrease in precipitation (Anonymous, 1989)

The average annual temperature is 25.50 C. The average minimums are 19.90 C, reached in July and the average maximums are 31.90 C in March. The average annual rainfall is around 1200 to 1400 mm, unevenly distributed. The maximum precipitation is recorded in April. The annual average relative humidity is always high (98%). The soils are predominantly sandy clay, highly desaturated, poor in bases and very permeable. These soils occupy very large areas in the central part of the study area. The sum of exchangeable bases is less than 1 mg (Anonymous, 1989). The vegetation of the study area is dominated by a herbaceous stratum with Hyparrhenia diplandra (Hack) stapf, a shrub stratum based on acidophilic shrubs of the genus Hymenocardia acida Tull (Anonymous, 1989).

Setting up the test: The studies were carried out under semi-controlled conditions in lysimeters on three mineral nutrition funds (three variants):

1- N12P6K6 (medium background);
2- N24P12K12 (background close to optimal);
3- N36P18K18 (high bottom) per m2.

For the study, two zoned rice varieties were chosen: Nerica 12 and Nerica 14, which differ in yield and response to NPK funds. Before sowing, the seeds were kept in a bag and regularly exposed to the sun to avoid insect attacks.

Sowing was carried out in rows, according to stencils with the creation of the same density of plants: 250-300 seeds/m2. Two weeks after sowing, thinning was carried out to leave only one plant per hole.

RESULTS

The panicle formation process in rice is fairly well described (Erygine1989). The development of the panicle begins with the intensive growth of the growth cone, with the restructuring of metabolism in its tissues, in which the synthesis of nucleic acids, nucleotides, enzymatic proteins and other important compounds is activated. These processes are preceded by a little-studied preparatory stage of panicle formation. The generative state in rice does not occur at the beginning of its formation, but much earlier, in the middle of the tillering phase of the plants when they develop 5-6 leaves. The preparatory phase is partly associated with the accumulation of non-structural carbohydrates in the leaf sheaths, which, with the growth of the growth cone, with the development of the panicle and stem, move to these organs, contributing to the formation of a productive fruit plant. This is evidenced by our observations of the carbohydrate content of rice stalks at different phases of plant vegetation and their close relationship with the number of completed grains and the proportion of sterile flowers per panicle (Table 1). As can be seen, during the period from mid-tillering to mid-budding of plants, the basis for the high productivity of the panicle is laid by a greater accumulation of easily mobile carbohydrates in the leaf sheaths, which, together with the assimilates of current photosynthesis, cause the formation of a high number of fertile spikelets and, consequently, a smaller number of sterile spikelets. With increasing the level of mineral nutrition of plants, the content of carbohydrates in these organs significantly decreases with their simultaneous accumulation

Table 1. The content of non-structural carbohydrates in the stems of plants in the phases of tillering, budding and flowering of rice on different backgrounds of mineral nutrition and their relationship with the number of grains on the panicle and the proportion of sterile spikelets on this one (2020 -2021)

Variety	Variant	Carbons in stems*, %		Non-protein nitrogen*, %		Number of grains per panicle	Proportion of sterile spikelets per panicle, %
		5 leaf tillage	Budding 10 sheets	Tallage	Bud-ment		
Nerica 12	1	19,8	24,4	0,47	0,30	85,8	8,7
	2	13,7	16,8	1,21	0,43	75,9	13,5
	3	11,3	14,5	1,39	0,72	70,8	20,6
Nerica 14	1	19,3	26,5	0,42	0,31	87,1	7,3
	2	13,8	18,9	1,07	0,45	78,2	17,3
	3	10,9	11,3	1,55	0,90	61,0	30,2
HCP_{05}		0,68	0,54	0,075	0,060	3,6	
Correlation coefficient with the number of grains per panicle		0,93±0,18	0,96±0,14	-0,94±0,17	-0,96±0,14		
Correlation coefficient of the proportion of sterile spikelets on the panicle		0,89±0,23	-0,93±0,19	0,90±0,22	0,97±0,13		

Table 2. Coefficients of total plant tillering in rice varieties on different backgrounds of mineral nutrition and their relationship with the content of carbohydrates in leaf petioles, with the number of grains per panicle and the proportion of sterile spikelets on them (2020-2021)

Variety	Variant	Total tillering coefficient	Carbons in leaf petioles during tillering	Number of grains per panicle	Proportion of sterile spikelets per panicle, %
Nerica 12	1	1,6	19,8	85,8	8,7
	2	2,4	13,7	75,9	13,5
	3	2,8	11,3	70,8	20,6
Nerica 14	1	1,9	19,3	87,1	7,3
	2	2,7	13,8	78,2	17,3
	3	3,4	10,9	61,0	30,2
HCP_{05}		0,18	0,54	3,6	
Correlation coefficient with total plant tillering coefficient			-0,95±0,16	-0,95±0,16	-0,96± 0,14

of non-protein nitrogen Which leads to a decrease in the number of completed grains and an increase in the proportion of sterile spikelets per panicle. A direct and close relationship was found between the carbohydrate content in the stem and the number of grains per panicle (r = 0.93 ± 0.18 ÷ 0.96 ± 0.14) and an inverse relationship between the carbohydrate content non-protein nitrogen and the second indicator (r = - 0.94 ±0.17 ÷ 0.96±0.14). A high but inverse relationship was established between the content of carbohydrates, non-protein nitrogen in the stems and the proportion (%) of sterile spikelets on the panicles. The manifestation of these dependencies is due to the fact that the supply of panicles during their growth with carbon and nitrogen metabolites is closely linked to their accumulation in the stems. Between the concentration of these substances in stems in the middle of the budding phase (10 leaves) and in panicles, a fairly high direct relationship was found (r = 0.88 ± 0.24). Unbalanced carbon and nitrogen nutrition of developing rice panicles leads to a significant increase in their proportion of sterile spikelets and a decrease in their productivity. This was observed when the ratio of carbohydrates to non-protein nitrogen (U/Knebel) in panicle tissues was 20 units or less. Determination of the content of carbohydrates and non-protein nitrogen in the stems and panicles of rice and establishing the value of their ratio during the development of these organs is of great importance in the study of physiological state of plants, the level of their nitrogen supply. The studies carried out show that the varieties studied react differently to a high level of mineral nutrition (N36P18K18). The Nerica 14 variety, in comparison with Nerica 12, clearly lacks assimilates for the metabolization of ammoniacal nitrogen absorbed by the root system from the soil, which leads to excessive accumulation of non-protein forms of nitrogen in the stems and panicles, leading to a decrease in the grain content of the latter and resulting in lower crop yields. The identification of the physiological causes of this phenomenon is of great practical scientific interest. Increased photosynthesis productivity can be seen in the upper leaves which transmit more light deeper into the crop. However, the varieties studied differ little in their morphotype. We noted that these varieties differ, particularly in a context of high mineral nutrition, by the intensity of general tillering (Table 2). The correlation coefficient is much higher in the Nerica 14 variety than in Nerica 12. It is known that lateral shoots at the beginning of their development consume assimilates from the maternal shoot, gradually switching to independent feeding through photosynthesis. With abundant tillering, unproductive lateral shoots obscure the productive ones and consume part of their assimilates. This causes a deficiency of the latter which results in a reduction in the carbohydrate reserve funds of the stems, insufficient metabolism of absorbed nitrogen, by the accumulation of non-protein forms of it in rice panicles. Between the value of the total tillering coefficient of plants and the number of grains on the panicle a high negative relationship was established (r = -0.95±0.16) and a positive relationship between the value of the first indicator and the proportion of sterile spikelets on it (r = - 0.96 ± 0.14).

DISCUSSION

The observations carried out during this study made it possible to highlight the effects of different mineral funds on the parameters of the average production of the panicle of two (2) varieties of rice. The formation of panicle productivity elements of the main stem gives better results on the Nerica 14 variety, for the v1 and v2 variants, followed by the proportion of sterile spikelets per panicle for the v2 and v3 variants of the Nerica 14 variety. Our results obtained are similar to those recorded by Alechine et al (1971) and Zelensky (1994). The average number of grains per panicle observed is 3.6. The observation is that the varieties studied react differently to a high level of mineral nutrition (N36P18K18). We observed that these varieties differ, particularly in a context of high mineral nutrition, by the intensity of general tillering. This can be one of the important indicators in evaluating rice varieties for productivity and nitrogen responsiveness. Our results are similar to those of Cheoudjen et al 1995 who showed the effectiveness of nitrogen substances in rice cultivation. Our investigations relating to mineral fertilization showed that the addition of nitrogen improved not only the productivity of the Nerica 14 variety, but also that of the Nerica 12 variety. This proves the determining role of nitrogen in the grain formation, hence its contribution to improving rice yield. Similar results were observed with the addition of nitrogen to cassava (Umeh et al 2012; Ukaoma and Ogdbonnaya, 2013). On this plant, high nitrogen supplies excessively increase the weight of the foliage and reduce the weight of its roots.

CONCLUSION

The studies carried out have shown that the formation of panicle productivity elements depends on its supply of carbon and nitrogen metabolites from the vegetative organs. The most favorable nutrition, balanced in terms of carbon and nitrogen, of a developing panicle is observed when the ratio of non-protein carbons to nitrogen in its tissues is 30-40 units. With the decrease in this indicator to 20 units and less, the number of sterile spikelets on the panicle increases sharply and, as a result, the number of fertile spikelets decreases. The greater sensitivity of the Nerica 14 variety, compared to Nerica 12, to the increased supply of rice with nitrogen is determined by the lack of assimilates associated with intensive tillering of plants. The level of their general tillering in a high nitrogen nutrition context can be one of the important indicators in evaluating rice varieties for productivity and nitrogen responsiveness.

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