AGRONOMIC PERFORMANCE OF COVER CROPS AND UPLAND RICE CULTIVARS GROWN IN SUCESSION WITH DIFFERENT NITROGEN RATES IN NO-TILLAGE SYSTEM

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ABSTRACT: Rice is considered by FAO as one of the most important foods to world food security and nitrogen (N) is the nutrient that most often affects the productivity of this crop, with its dynamics in the soil-plant system changed by management used. With the objective of evaluating the yield and quantities of nutrients in the phytomass of cover crops; and to evaluate the influence of the isolated and combined use of cover crops and urea as N sources on the growth, productivity and grain quality of upland rice cultivars irrigated, in the implantation of the no-tillage system, was carried out a study in an Oxisol (Rhodic Haplustox), cerrado (savannah) phase at the Experimental Farm of UNESP/FEIS, in Selvíria-MS, Brazil. The experimental design was in randomized blocks, with four repetitions, in a 4x2x3 factorial scheme. The treatments were a combination of four cover crops: velvet bean (*Mucuna aterrima*), sunn hemp (*Crotalaria juncea*), millet (*Pennisetum glaucum*) and spontaneous vegetation (fallow in off-season); and two rice cultivars: Primavera and IAC 202; and three N rates: 0, 50 and 100 kg ha^{-1} as urea. The millet, followed by sunn hemp, produced the highest yield of dry phytomass and accumulation of nutrients. The succession sunn hemp-rice promoted higher grain yield, regardless of the N rate applied, while the cultivar IAC 202 was the most productive than Primavera. The increase of the N rate caused a drop in the number of spikelets seedless per panicle, with positive effects on grain yield. These results contribute with information about the cover plants and more efficient N rates to increase the quality and yield of rice crop.

Key words: *Oryza sativa*. Crop succession. Nutrient cycling. Oxisol. Cerrado.

DESEMPENHO AGRONÔMICO DE PLANTAS DE COBERTURA AND CULTIVARES DE ARROZ DE TERRAS ALTAS CULTIVADAS EM SUCESSÃO COM DIFERENTES DOSES DE NITROGÊNIO EM SISTEMA DE PLANTIO DIRETO

RESUMO: O arroz é considerado pela FAO como um dos alimentos mais importantes para a segurança alimentar mundial e o nitrogênio (N) é o nutriente que geralmente mais influencia na produtividade dessa cultura, com sua dinâmica no sistema solo-planta alterada pelo manejo utilizado. Com os objetivos de avaliar a produtividade e quantidades de nutrientes na fitomassa de plantas de cobertura; e avaliar o efeito do uso isolado e conjunto de plantas de cobertura e ureia como fontes de N para cultivares de arroz de terras altas irrigadas, na implantação do sistema de plantio direto, foi conduzido um experimento em um Latossolo Vermelho distroférrico, na Fazenda Experimental da UNESP/FEIS, em Selvíria-MS. O delineamento experimental foi o em blocos casualizados, com quatro repetições, em esquema fatorial 4x2x3. Os tratamentos foram a combinação de quatro cobertura de solo: mucuna-preta (*Mucuna aterrima*), crotalária (*Crotalaria juncea*), milheto (*Pennisetum glaucum*) e vegetação espontânea (pousio); dois cultivares de arroz: Primavera e IAC 202; e três doses de N: 0, 50 e 100 kg ha^{-1} N, na forma de ureia. O milheto, seguido pela crotalária, apresentaram maiores produtividades de fitomassa seca e acúmulo de nutrientes. A sucessão crotalária-arroz promoveu maior produtividade de grãos, independentemente da dose de N aplicada, enquanto o cultivar IAC 202 foi o mais produtivo do que o cultivar Primavera. O aumento das doses de N provocou queda no número de espiguetas chochas por panícula, com reflexos positivos na produtividade de grãos. Estes resultados contribuem com informações a respeito das plantas de coberturas e doses de N mais eficientes para aumento da qualidade e produtividade da cultura do arroz.

Palavras-chave: *Oryza sativa*. Sucessão de culturas. Reciclagem de nutrientes. Latossolo. Cerrado.

INTRODUCTION

The Food and Agriculture Organization of the United Nations (FAO) has shown great concern with the wastage levels and with the high of food in the world, which can aggravate the problem of hunger, mainly for the population that is close to the poverty line (FAO, 2015). The rice is considered by the FAO as one of the most important food to world food security, due to be essential food for about 2.4 billion people and, according to estimates, in 2050, there will be twice the demand. Brazil is the largest world producer of upland rice and the worldwide ninth producer of rice, considering the two cultivation systems: irrigated and high land, with an estimate of production of 16.5 million tons (husk base), for the season 2014/2015, for a consumption of the same order (CONAB, 2014).

Nowadays, the development of more sustainable agricultural systems, under economic and environmental aspects, has required great efforts of scientists and farmers. In this sense, the adoption of no-tillage system (NTS) in tropical and subtropical regions has made considerable improvements in the soil quality, due to greater biological cycle and conservation of nutrients, reduction of environmental degradation, in addition to economic returns to the farmers. However, in spite of technological innovations in the last three decades, there are many challenges in the Brazilian agronomic research in relation to the upland rice crop. Among the main challenges is the consolidation of crop, in a sustainable way, as a component of grain production systems, especially in the NTS and the management of nitrogen rates (NASCENTE et al., 2013a). The success of the NTS is dependent on the crop rotation and, mainly, of the straw production, which comprises a reservoir of nutrients released gradually by the action of microorganisms and contributes to the increase of structural stability and protection of the soil against erosion (CARVALHO et al., 2014).

The cultivation of upland rice has presented difficulties for using in the NTS, especially regarding to development and initial growth, which hinders their inclusion in rotation with soybean and maize (Pacheco et al., 2011). Because of the growing demand of this cereal and the difficulty in the expansion of irrigated crops in the south of the country, which concentrates approximately 75% of Brazilian production, it becomes necessary to study techniques that allow the introduction of the rice as option of crop rotation, once that can be used by large and small producers who do not use the irrigation system in most Brazilian states (NASCENTE et al., 2013a).

The use of cover crops in the NTS can be an important tool to enable cultivation the rice in this system (NASCENTE et al., 2013a). The cover crops can be used to break the compacted layers and their straw can reduce evaporation of water and conserving soil moisture for more time, increase the nutrient cycling and soil organic matter, change the balance ammonium and nitrate and therefore provide the conditions for the best development of rice plants (NASCENTE et al., 2013b).

Due to its potential for biological nitrogen fixation (BNF), the use of legumes as cover crops are considered promising alternatives to meet this demand (MURAOKA et al., 2002; CARVALHO et al., 2011). Muraoka et al. (2002), using the legumes sunn hemp and velvet bean as green manures, obtained an effect equivalent to the fertilization with 40 kg ha^{-1} N as urea, which indicates that these legumes constitute an important alternative as N source and other nutrients for the crops grown in succession. Silva et al. (2016), in Selvíria-MS, estimated that the cultivation of sunn hemp, pigeon pea, green velvet bean, cultivated in spring, preceding the upland rice grown, resulted in grain yield equivalent to the application of 60 kg ha^{-1} of N, as urea. Scivittaro et al. (2004), assessing the temporal pattern of release of N of velvet bean, verified an increase in the production of dry matter and N uptake by rice plants. However, although the prior cultivation of legumes can fully replace the mineral nitrogen fertilization, for some crops, often, its benefits are found in the long term.

In climatic conditions of the cerrado, the grasses have been rather used as cover crops, with emphasis to the millet and *brachiaria*, by reason of their greater tolerance to water deficit, the largest biomass production and the lower cost of the seed. Still, by high temperatures associated with the high humidity in summer promote rapid decomposition of plant residues of low C/N ratio (CARVALHO et al., 2011; PACHECO et al., 2011).

Several factors affect the rice yield, especially the nutritional factor, which varies according to the system of cultivation, being the N, among the macronutrients, the most limiting, the second most required by rice and the most exported with the harvested product (SILVA et al., 2016). In rice, the N has a fundamental role in the formation of the panicle and grain (HERNANDES et al., 2010). The nutrient also stimulates the growth of the root system of rice and consequently favors the tillering; increases the number of spikelets per panicle and the mass of grains as well as the number of panicles m^{-2} and the number of grains per panicle (HERNANDES et al., 2010).

In this context established the hypothesis that the previous cover crops grown can replace mineral nitrogen fertilizer for upland rice, with a positive impact on grain quality industrial. The objectives of this study were to evaluate the yield and quantities of nutrients in the phytomass of cover crops; and to evaluate the influence of the isolated and combined use of cover crops and urea as N sources on the growth, productivity and grain quality of upland rice cultivars irrigated, in the implantation of the no-tillage system in a cerrado Oxisol.

MATERIAL AND METHODS

Field study was carried out in the Selvíria-MS, Brazil (51º 22' W and 20º 22' S, 335 m of altitude), annual rainfall is 1,370 mm on average and temperature average annual of 24.5 ºC. The soil of the experimental area was classified as Dystropherric Typic Rhodic Haplustox soil (SOIL SURVEY STAFF, 2010) and *Latossolo Vermelho distroférrico*, loamy, cerrado (savanah) phase (Santos et al., 2013). The experimental area has a history of 22 years under conventional tillage with corn, soybean and bean, with the implantation of the no-tillage system in this harvested.

The experimental design was in randomized blocks, with 24 treatments and four repetitions. The treatments were arranged in a 4×2×3 factorial scheme, consisting of four cover crops: velvet bean (*Mucuna aterrima*), sunn hemp (*Crotalaria juncea*), millet (*Pennisetum glaucum*) and spontaneous vegetation (fallow in the off season); two rice cultivars: Primavera and IAC 202; and three doses of N: 0, 50 and 100 kg ha^{-1} as urea. The fallow, formed by spontaneous vegetation, also constituted a source of straw for the no-tillage seeding of rice. The experimental plots were constituted of eight lines of 6 m length, spaced 0.40 m between rows.

Before the cover crops seeding, samplings were done in layers of 0.00-0.10, 0.10-0.20 and 0.20-0.30 m, for the chemical characterization of soil, which were analyzed as Raij et al. (2001). The results of the chemical analysis (Table 1) were used for the calculation of the fertilization, according to Raij et al. (1996).

The initial preparation of the soil for the deployment of cover crops was performed by conventional system with moldboard plow and leveling disking, using velvet bean (10 seeds m^{-1} and spacing of 0.40 m between rows), sunn hemp (40 seed m^{-1} and spacing of 0.40 m between rows) and millet (20 kg ha^{-1} and spacing of 0.30 m between rows). The management of cover crops and the fallow area was performed by chemical desiccation, to

85 days after the emergency (DAE), using glyphosate and 2.4 D, at the doses of 1,080 and 670 g a.i. ha^{-1}, respectively.

Table 1. Results of chemical analysis for initial evaluation of the soil fertility.

Layer (m)	pH	O.M.	P (resin)	K	Ca	Mg	H+Al	SB	T	V
	($CaCl_2$)	(g dm^{-3})	(mg dm^{-3})	--------------- (mmol$_c$ dm^{-3}) -----------						(%)
0.00-0.10	5.1	26	51	4.0	23	15	31	42.0	73.0	58
0.10-0.20	4.7	22	26	1.0	15	9	31	25.0	56.0	45
0.20-0.30	5.0	17	8	0.7	12	8	31	20.7	51.7	40

(O.M.) organic matter; (SB) sum of bases; (V) base saturation.

The rice cultivars used were of short cycle and recommended for the cerrado region. Seeding was performed mechanically 20 days after desiccation of cover crops, adopting the spacing of 0.40 m between rows, and 150 viable seeds per m^2 (60 seeds m^{-1}). So that germination was homogeneous. There was a previous treatment of seeds for the control of insects (termites) and fungi, using benomyl at dose of 100 g p.c. for 20 kg of seed and Futur, at a dose of 400 ml p.c. for 40 kg of seed. The nitrogen fertilization was fragmented in three times, using urea as N source. At sowing, was applied to 20 kg ha^{-1} of N, in plots corresponding to the doses of 50 and 100 kg ha^{-1} of N. The first nitrogen fertilization of topdressing was performed at 35 days after emergence (DAE), at the beginning of the rice tillering, using 15 kg ha^{-1} of N for the treatment 50 kg ha^{-1} of N and 40 kg ha^{-1} of N, in the treatment 100 kg ha^{-1} of N. The second nitrogen fertilization of coverage was performed at the beginning of flowering, under the same N rates used in first topdressing.

For the control of weeds, were used the herbicides dichloride paraquat (Gramoxone), at a dose of 3 L ha^{-1}; oxadiazon (Ronstar), at a dose of 4 L ha^{-1}; and acid 2,4-D (2,4-D), at a dose of 1 L ha^{-1}. Supplementary irrigation was used, by sprinkling conventional, occurred when water deficiency capable of compromising the yield of crops. There weren't problems with pests and diseases.

The yield of dry phytomass of aerial part of millet, sunn hemp, velvet bean and spontaneous vegetation (fallow in off-season) were determined in four samples of 0.25 m^2, collected in the useful area of the each plot, one day before the mechanical handling of plants. Often, were dried in forced air convection ovens at 65 ºC, being that data were transformed at t ha^{-1} of dry phytomass. Were withdrawn samples, then passed in mill type Willey and done the determinations of the levels of N, P, K, Ca, Mg and S, according to the methodology described in Malavolta et al. (1997). To evaluate nutritional status rice plant, were collected 30 leaves in each plot, at the flowering stage, according to the method described by Raij et al. (1996). The procedures and analytical methods were similar to those described above for cover crops.

The plant height was determined by measuring, with a graduate ruler, the distance from the soil to the highest panicle in 20 rice plants per each plot, in the stage nine in the vegetative cycle (IRRI, 2002). The data were expressed in cm, using only whole numbers.

The number of panicles m^{-2} was determined by direct count of panicles harvested in four subsamples of 0.25 m^2 demarcated in the useful area of each plot.

The number of fertile stems was determined at the time of harvest, in each plot, through the relation between the number of panicles m^{-2} by the number of fertile stems m^{-2}, multiplied by 100. The number of stalks m^{-2} was obtained by counting the number of stalks contained in 1.0 m row of each plot, calculated per m^{-2}, at the time of harvesting.

The total number of spikelets per panicle was obtained by means of the average number of spikelets 20 panicles sampled for the determination of the number of panicles m^{-2}; the number of full spikelets and seedless spikelets per panicle were obtained, respectively, by the average of the number of full spikelets and seedless spikelets, of 20 panicles used to assess the number of panicles m^{-2}.

The spikelet fertility was determined from the relation between the numbers of spikelets per panicle grenades by total number of spikelets per panicle, multiplied by 100. The mass of 1000 grains was determined by the average of the masses, in grams, of the four lots of 1000 grain, of groups of 10 panicles randomly taken of the subsamples of 0.25 m^2.

The harvest of rice was performed manually in the useful area of plot, through the collection of panicles 4 m of four rows in the center of each plot, when the grain of 2/3 superiors of 50 % of panicles were hard and those of the lower third, medium-hard. The following was performed the trail manual, drying in the shade and the cleaning material, separating the straw and grain percentage with the aid of a sieve, through manual cleaning, and the data processed in kg ha^{-1} of paddy grains, the 13 % humidity.

Grain yield was obtained 60 days after storage, from each plot, one sample of 100 g of hulled rice grains was collected, and a proof mill model MT (SUZUKI) was used for 1 min; then the polished grains were weighed and the found values were considered the milling yield percentage. Later, the polished grains were placed in a "trieur" 2 and the grains separated for 30 s. The grains that remained in the "trieur" were weighed to determine the percentage of undamaged grains and broken grains rice.

The data obtained were submitted to analysis of variance, with application of F test and average comparison by the Tukey test, at 5 % probability and regression analysis. Statistical analyzes were performed with the statistical software program SAS 8.02 (SAS Institute, 2001).

RESULTS AND DISCUSSION

Yield of dry matter and accumulation of nutrients by cover plants

At 85 days after seeding, time that has proceeded to harvest, the yield of dry phytomass of shoot of cover crops, as well as the quantities of macronutrients accumulated, varied with the species (Table 2). The millet, in addition to the higher yield of dry phytomass (13.9 Mg ha^{-1}), showed a greater accumulation of phosphorus (P), potassium (K) and magnesium (Mg), in addition to the quantities of nitrogen and sulfur (S) content similar to the sunn hemp, which does it a viable alternative as culture supplier of straw for the no-tillage system in Brazilian cerrado. Yield of dry phytomass by millet was superior to yield rates reported in studies conducted with this crop in the cerrado, the example of 5.5 and 9.0 Mg ha^{-1} obtained by Salton et al. (1993), in experiments performed in Maracaju-MS, and similar to that obtained by Guimarães et al. (2003), in Selvíria-MS, approximately 13.5 Mg ha^{-1}. For a yield of 12.0 Mg ha^{-1} of dry phytomass by millet, Scalea (1994) found that the return of nutrients to the soil was of the order of 206, 26, 292, 33 and 32 kg ha^{-1}, respectively, for N, P, K, Ca and Mg.

Table 2. Productivity of dry phytomass (DS) and quantity of macronutrients (N, P, K, Ca, Mg and S) accumulated in the shoot part of the sunn hemp, millet, velvet bean and spontaneous vegetation (fallow in off-season), to 85 days after sowing, Selvíria-MS.

Cover crops	DS	N	P	K	Ca	Mg	S
	(Mg ha^{-1})	------------------------------		(kg ha^{-1})	------------------------------------		
Millet	13.9 a [1]	151.3 a	19.5 a	361.1 a	56.9 b	41.2 a	6.3 a
Sunn hemp	7.0 b	156.7 a	13.4 b	134.5 b	65.0 a	23.6 b	6.5 a
Velvet bean	5.4 c	105.4 b	9.3 c	81.2 c	52.8 b	8.9 c	4.2 b
Fallow	5.0 c	53.9 c	7.0 c	96.4 c	20.4 c	14.6 c	2.2 c

[1] Values followed by different letters, in columns, indicate significant differences (Tukey test, $p < 0.05$).

The sunn hemp, in addition propitiated higher yield of dry phytomass, similar to those obtained by Silva et al. (2006) that presented great cumulative quantities of nutrients, with emphasis to the nitrogen (Table 2). Usually, the sunn hemp has potential for incorporation from 150 to 165 kg ha^{-1} yr^{-1} of N from BNF, which may reach 450 kg ha^{-1} yr^{-1}, and produce 10 to 15 Mg ha^{-1} of dry phytomass (WUTKE, 1993). The results obtained in the present study, as well as those obtained by Carvalho et al. (1996), of 5.98 and 6.92 Mg ha^{-1} of dry phytomass, in the cerrado, have reinforced the great potential of the sunn hemp as green manure and indicated it as an alternative for coverage of the soil under no-tillage, especially concerning the supply of N for crops of economic importance, such as upland rice grown in cerrado. In addition, as emphasized Calegari (2004), the system of after sunn hemp crop must be recommended, not only because of the greater inflow of N, but also by promoting the use of crop rotation, breaking cycles of pests and diseases, suppression of weeds, among other benefits.

With regard to the velvet bean showed lower dry phytomass productivity with those obtained by other studies (Table 2), such as those performed by Arf et al. (1999a, 1999b), in experiments conducted in Selvíria-MS, usually with superior results to 8 Mg ha^{-1}, which shows high production capacity of dry phytomass of this species in the cerrado, when managed at flowering. Thus, in this study, it was demonstrated that the lower productivity by velvet bean was due to the short period of time between the sowing and the burndown time, given that it would be necessary a longer period for the crop to achieve its productive potential, usually at the beginning of the flowering. Similar results were obtained by Silva et al. (2006), in Selvíria-MS, with yield of dry phytomass next to 5.0 Mg ha^{-1}, with burndown time of culture before the flowering.

The spontaneous vegetation, formed in areas fallow in off-season, presented lower dry phytomass income than millet and sunn hemp and equal to the velvet bean (Table 2). This income of dry phytomass of species present in the fallow land areas was similar to that obtained by Carvalho (1996), also in the climatic cerrado conditions, which verified yields ranging from 2.15 to 5.94 Mg ha^{-1} in two years of evaluation. The production of dry phytomass of fallow area is dependent on the type of vegetation present. In this study, the predominant species in the area were *Bidens pilosa*, *Ipomoea period exceeded* and *Panicum maximum.*

Performance of the rice crop

For macronutrient content obtained in foliar diagnosis of rice, there was a significant effect only for the N contents in rice cultivars, being that the cultivar IAC 202 showed higher N content than the cultivar Primavera (Table 3). For the remaining nutrients, the treatments had no significant influence and the levels were within the range considered adequate for the culture (RAIJ et al., 1996), with the exception for the K, which presented levels below this age.

Table 3. Content of macronutrients (N, P, K, Ca, Mg and S) in leaves of upland rice cultivars grown under different nitrogen rates in succession to cover crops, Selvíria-MS.

Treatments	N	P	K	Ca	Mg	S
			(g kg^{-1})			
Cover crops						
Fallow	29.9	4.1	10.8	2.8	3.8	2.4
Millet	30.2	4.1	10.8	2.9	3.9	2.4
Sunn hemp	30.9	4.4	11.2	3.3	4.0	2.9
Velvet bean	30.3	4.1	10.8	3.2	3.9	2.5
CV (%)	4.25	12.53	21.33	27.14	20.12	18.03
Rice cultivars						
IAC 202	31.7 a [(1)]	4.2	12.4	2.9	3.9	2.6
Primavera	28.5 b	3.8	11.5	3.2	4.1	2.5
CV (%)	3.30	18.26	23.42	22.10	24.20	15.26
N rates (kg ha^{-1})						
0	29.9	4.1	10.5	2.8	3.8	2.4
50	30.3	4.2	10.6	3.1	4.0	2.5
100	30.3	4.3	10.8	3.2	4.1	2.6
CV (%)	3.19	10.06	15.10	23.42	16.04	12.71
Adequate[(2)]	27-35	1.8-3.0	13-30	2.5-10.0	1.5-5.0	1.5-3.0

[1] Values followed by different letters, in columns, indicate significant differences (Tukey test, $p < 0.05$).
[2] Sufficiency range for nutrient concentration considered adequate (g kg^{-1}), according Raij et al. (1996).

The cultivar IAC 202 showed greater plant height (98 cm), being statistically superior to the cultivar Primavera (82 cm) (Table 4). However, both presented medium size for the conditions of cultivation practices, not occurring lodging. In general, rice cultivars in the midsize offer greater resistance to lodging of that higher and greater competitive ability against weeds, as also noted Morais et al. (1983). Successions sunn hemp-rice and millet rice allowed more plants. Already in the fallow-rice successions, there was a lower height of plants. The height of plants is a variable of extreme importance in the culture of rice, seen that directly influences the degree of lodging. An ideal plant of rice for cultivation in irrigated with supplementary irrigation must have resistance to lodging, early cycle, high productive capacity, resistance to leaf blast disease and the brown spot, degree of numbness and grain long thin and translucent (SANT'ANA, 1982). Almost all of these characteristics are found in the cultivars used in this study, which makes evident the wide possibility of indication of both cultivars for grown under no-tillage system and may be option choices for the rice producer under edaphic and climatic cerrado conditions.

Table 4. Plant height, number of panicle m^{-2} and percentage of fertile stems of upland rice cultivars grown under different nitrogen rates in succession to cover crops, Selvíria-MS.

Treatments	Plant height (cm)	Number of panicles (m^{-2})	Fertile stems (%)
Cover crops			
Fallow	84 c [(1)]	184 b	92.6 b
Millet	92 ab	207 a	94.4 a
Sunn hemp	95 a	206 ab	95.0 a
Velvet bean	89 b	192 ab	94.4 a
Test F	23.45**	3.55*	18.35**
LSD	3.78	21,47	0.92
Rice cultivars			
Primavera	82 b	238 a	94.6 a
IAC 202	98 a	156 b	93.6 b
Test F	220.67**	204.08**	14.49**
LSD	2.02	11.50	0.49
N rates (kg ha^{-1})			
0	87 [(2)]	172 [(3)]	91.5 [(4)]
50	92	208	94.7
100	91	211	96.2
Test F	10.21**	19.52**	125.62**
CV (%)	5.53	14.34	1.28

[(1)] Values followed by the same letter did not differ by the Tukey test, at 5% level of probability. * and ** significant at 5 and 1% by the F test, respectively.
[(2)] $Y = 86.88 + 0.1760x - 0.0014x^2$, $R^2 = 1$; [(3)] $Y = 171.69 + 1.074x - 0.0068x^2$, $R^2 = 1$;
[(4)] $Y = 91.50 + 0.079x - 0.0003x^2$, $R^2 = 1$.

As to the effect of the N rates studied about the height of plants, it was found that the adjustment of data to a quadratic equation (Table 4). There was no effect of increasing doses of N on plant height, obtaining maximum height of the plants when the level of applied N was around 70 kg ha^{-1}, decreasing from this point.

The number of panicles m^{-2} was influenced by cover crops and cultivars, where the highest value was observed for the cultivar Primavera, which evidences the its greater capacity of tillering, when compared to the cultivar IAC 202 (Table 4). Regarding the influence of cover crops on the number of panicles m^{-2}, there was no statistical difference between the inheritances millet-rice, sunn hemp-rice and velvet bean-rice. However, these crops successions were superior to the fallow-rice, taking this last result in production of smaller number of panicles and treatment with the worst performance. The N has a fundamental role in the formation of the panicle and grains of rice (HERNANDES et al., 2010). Also stimulates the growth of the root system of rice and therefore favors the tillering; increases the number of spikelets per panicle and the mass of grains as well as the number of panicles m^{-2} and the number of grains per panicle (HERNANDES et al., 2010).

As regards the percentage of fertile stalks (Table 4), the total number of spikelets per panicle and full spikelet per panicle (Table 5), lower values were observed for the succession fallow land-rice, differing from the other successions, which did not differ among themselves. The cultivar Primavera showed per panicle, on average, a total of 273 spikelets, being 208 fulls, resulting in 75.2 % of fertility spikelet, while the cultivar IAC 202, despite the smaller number of spikelets per panicle (184 total and 143 fulls), presented a higher percentage of fertile spikelets (77.1 %).

Some research results are contradictory regarding the influence of nitrogen fertilization on the agronomic characteristics and productive of upland rice cultivars. Arf et al. (2003) did not observe significant differences of N rate for number of panicles m^{-2}, % of the sterile spikelets, number of spikelets floods per panicle and mass of 1,000 grain. In three growing season (harvests), Arf et al. (2015) also observed no effect of season of application of N in these variables. These results allow us to infer that these variables are more influenced by the characteristics of the plant genetic load, with little influence of nitrogen fertilization. In contrast, Hernandes et al. (2010) observed that N rate increased the N content of leaf area, plant height, number of panicles m^{-2} and the number and mass of spikelets grenades panicle, with positive effects on grain yield.

The number of spikelets seedless per panicle showed little variation as a function of the treatments (Table 5); however, the amount of seedless spikelets was relatively high. The high percentages of spikelets seedless obtained in experiment could be related with the inadequate supply of water, fact not occurred, which would result in a decrease in the translocation of assimilated, resulting in a high percentage of grain pallets (MUELLER, 1980). When the rice was preceded by sunn hemp, millet or fallow, there was a greater number of spikelets seedless. Among the cultivars, the highest value was observed in cultivar Primavera (65), differing from IAC-202 (42), a fact that may have influenced the cultivar IAC 202 in higher grain yield, in relation to the cultivar Primavera. It was observed that the number of spikelets seedless decreased with the increase of the N rates, according to a linear equation (Table 5). The increase of the N rates applied caused a reduction in the number of spikelets seedless, in a similar way to increase the yield of grains in the light of increasing doses of N used in composting.

Table 5. Number of spikelets per panicle: total, full and seedless; and spikelet fertility of upland rice cultivars in the implantation of no-tillage system, under the influence of nitrogen fertilization and cover crop, Selvíria-MS.

Treatments	Number of spikelets per panicle			Spikelet fertility
	Total	Grenades	seedless	
Cover crops				(%)
Fallow	193 b [1]	141 b	52 ab	72.2 b
Millet	240 a	188 a	53 ab	78.0 a
Sunn hemp	245 a	186 a	59 a	75.8 a
Velvet bean	237 a	186 a	50 b	78.4 a
Test F	37.52**	35.45**	3.47*	12.67**
LSD	14.58	14.40	7.20	2.98
Rice cultivars				
Primavera	273 a	208 a	65 a	75.2 b
IAC 202	184 b	143 b	42 b	77.1 a
Test F	513.75**	287.86**	146.37**	5.48*
LSD	7.81	7.71	3.86	1.60
N rates (kg ha^{-1})				
0	210 [2]	154 [3]	57 [4]	72,4 [5]
50	232	180	53	77,2
100	243	192	51	78,9
Test F	23.88**	34.95**	3.32*	22.88**
CV (%)	8.40	10.81	17.70	5.15

[1] Values followed by the same letter did not differ by the Tukey test, at 5 % level of probability; * and ** significant at 5 and 1 % by the F test, respectively.
[2] $Y = 212.33 + 0.324x$, $R^2 = 0.96$ **; [3] $Y = 155.97 + 0387x$, $R^2 = 0.95$ **; [4] $Y = 56.61 + 0.061x$, $R^2 = 0.99$ *; [5] $Y = 72.94 + 0.064x$, $R^2 = 0.92$ **.

In Table 6, it is observed that the cover crops did not influence the income of whole grains and broken grain; however, showed significant effect on the mass of 1.000 grain, grain yield and income of grain in the benefit. The succession sunn hemp-rice resulted in higher grain yield, which was significantly superior to the other successions of cultures. The better performance of succession sunn hemp-rice on the yield of grains and mass of 1,000 grain, possibly due to the fact of this legume possess plant mass richer in N by BNF and other elements mineral nutrients, the example of that observed in other studies (SILVA et al., 2016).

The N rates employed if adjusted to ascending linear function for the yield of grains of rice (Table 6). The general average for grain yield was relatively high (5,140 kg ha^{-1}), if compared to the Brazilian averages (3,600 kg ha^{-1}) and the region of cerrado (1,800 kg ha^{-1}) (EMBRAPA, 2008), which demonstrates the viability of these cultivars in the implantation of no-tillage system in Brazilian cerrado.

Table 6. Grain yield; mass of 1000 grains; hulling grain yield undamaged and broken, rice cultivars in the implantation of no-tillage system, under the influence of nitrogen fertilization and cover crops, in Selvíria-MS.

Treatments	Grain yield	Mass 1.000 grains	Grain income		
			Hulling	Undamaged	Broken
	(kg ha^{-1})	(g)		(%)	
Cover crops					
Fallow	4348 c [1]	21.4 c	72.4 ab	65.1	7.0
Millet	5456 b	22.2 b	70.2 b	63.3	6.7
Sunn hemp	6469 a	22.7 a	73.6 a	66.1	6.9
Velvet bean	4287 c	22.2 b	72.4 ab	65.1	7.1
Test F	21.06**	91.99**	5.31**	2.08 ^{ns}	0.47 ^{ns}
LSD	840.00	0.22	2.31	2.70	0.79
Rice cultivars					
IAC 202	5367 a	22.0 b	71.0 b	65.3	5.4 b
Primavera	4913 b	22.2 a	73.3 a	64.7	8.5 a
Test F	4.04*	22.84**	13.32**	0.67 ^{ns}	207.95**
LSD	449.92	0.12	1.24	1.44	0.42
N rates (kg ha^{-1})					
0	4576 [2]	21.1 [3]	72.6 [4]	65.1 [5]	7.8 [6]
50	5355	22.1	72.6	66.1	6.4
100	5489	23.1	71.2	64.7	6.6
Test F	3.36**	387.56**	2.33 ^{ns}	2.59 ^{ns}	16.60**
CV (%)	21.52	1.30	4.22	5.47	15.01

(1) Values followed by the same letter did not differ by the Tukey test, at 5 % level of probability; * and ** significant at 5 and 1 % by the F test, respectively.

(2) $Y = 4683.39 + 9.131x$, $R^2 = 0.86$ **; (3) $Y = 21.10 + 0.020x$, $R^2 = 0.99$ **; (4) $Y = 72.85 - 0.014x$, $R^2 = 0.73$ ^{ns}; (5) $Y = 64.\ 13 + 0.073x - 0.0007x^2$, $R^2 = 1$; (6) $Y = 7.78 - 0.043x + 0.0003x^2$, $R^2 = 1$.

Between the cultivars studied, the highest average grains yield was achieved by the cultivar IAC 202 (5,367 kg ha^{-1}), significantly differing from the cultivar Primavera (4,913 kg ha^{-1}). As to the effect of the N doses studied on the yield of grains, there was a linear adjustment growing (Table 6). Is valid emphasize the possibility of yield increase of cultivars tested, in doses of N exceeding 100 kg ha^{-1}, once the linear model used indicated this trend, which suggests more studies which involve increasing doses of nitrogen, above this limit.

It was found significant influence of cover crops on the grain mass of 1.000 (Table 6). Several studies show that the number of panicles by area and the mass of 1.000 grain is positively correlated with the grains yield in the rice crop (HERNANDES et al., 2010). Lopes et al. (1996) found, in study in the Southern Brazil, response to nitrogen for rice yield with doses of up to 120 kg ha^{-1} of N, while Patel et al. (1986) found a significant increase in yield with increase of the doses of up to 180 kg ha^{-1} of N. However, Stone and Silva (1998) verified that the dose of 40 kg ha^{-1} of N was sufficient for the upland rice, with no significant difference between the yield obtained with this dose and 80 kg ha^{-1} of N. Already Mauad et al. (2003) found that application of high doses have not reflected in an increase in yield of grains, but in the reduction. According to these results and the well-known dynamics of nitrogen, there is no single recommendation for application this nutrient because should consider other factors, such as farming, production system, growing region, among others.

Although the rice cultivars were evaluated in this study are the short cycle, which varies from 96 days (cultivar Primavera) to 108 days (cultivar IAC 202), it is likely that in the period of greater demand to N, corresponding to the vegetative phase and the beginning of reproductive phase, the decomposition of phytomass of sunn hemp, millet and velvet bean has supplied the demand of the rice as to this nutrient. The high levels of N in the phytomass of these cover crops, in addition to the large amount of phytomass produced, represented a potential availability of N for rice in the order of 157, 152 and 106 kg ha^{-1}, respectively, from of sunn hemp, millet and velvet bean, as shown in Table 2. However, it is likely that a large portion of N of phytomass of cover crops has not been mineralized during the cycle of rice, and/or that the large amount of N applied has been immobilized by the heterotrophic microorganisms.

In this context, the cover crops grown become important management practices, since it promotes several benefits to the soil-plant system, in particular the nutrients recycling and the production of straw, which besides protecting the soil of the erosive agents, provides more maintenance of humidity and lower thermal amplitude, with reflexes positively in some physical, chemical and biological properties of the soil, which is desirable for the maintenance of the productive potential of the soil in long term.

CONCLUSION

The millet, followed by sunn hemp, produced the highest yield of dry phytomass and accumulation of nutrients.

The succession sunn hemp-rice promoted higher grain yield, regardless of the N rate applied, while the cultivar IAC 202 was the most productive than Primavera.

The increase of the N rate caused a drop in the number of spikelets seedless per panicle, with positive effects on grain yield.

The cover crops did not influence the income of whole grains and broken grain; however, showed significant effect on the mass of 1.000 grain, grain yield and income of grain in the benefit.

These results contribute with information about the cover plants and more efficient N rates to increase the quality and yield of rice crop.

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