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SINGLE AND FRACTIONED SUPPLY OF NITROGEN IN WHEAT PRODUCTIVITY

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ABSTRACT

Higher wheat productivitycan be obtained according tothe form of nitrogen supply. The objective of this study wasto increase the biomass and wheat grain productivitythroughthe forms of nitrogen supplyinconditions of favorable and unfavorable years,in corn/wheat and soybean/wheat succession systems. The study was conducted in 2014 and 2015, in randomized block design, with four replicates in a 4 x 3 factorial, for N-fertilizer doses 0, 30, 60, 120 kg ha^{-1} and nutrient supply forms [single dose 100% at the phenological stage V_3 third leaf expanded; fractioned 70 and 30% at the V_3/V_6 phenological stages third and sixth leaves expanded, respectively and; fractioned 70 and 30% at the V_3/R_1 phenological stages third leaf expanded and early grain filling], respectively, in soybean/wheat and corn/wheat succession systems. In general, the increase of biomass productivity in wheat can be obtainedthroughthe fractionation in the phenological stage V_3/V_6, but it is not always accompanied of the highestgrain productivity. Regardlessof the succession system, in favorable years of cultivation, the nitrogen supply in single dose increases grain productivity; in unfavorable years, the nutrient fractionation is more appropriate.

INTRODUCTION

Wheat is a cereal of worldwide cultivation aimed mainly at human nutrition Pietro-Souza *et al*., 2013;Silva *et al*., 2015. In Brazil, it is the winter culture of biggest economic importance Arenhardt *et al*., 2015; CONAB, 2016 and due to the great demand for the product, the country is still dependent on imports to supply the domestic market Costa *et al*., 2013;Silva *et al*., 2015. Therefore, the development of cultivars that are more productive and stable regarding the climatic variations, and efficient to the use of technologies,may leverage the productivity and the quality of the wheat, with direct reflexes in the international market Camponogara *et al*., 2016. In wheat, nitrogen is essential to ensure high productivity and grain quality Rodrigues *et al*., 2014; Arenhardt *et al*., 2015; however, the nutrient is of great complexity of action on the environment, being easily lost by leaching in rainy seasons or volatilized in drier conditions Teixeira Filho *et al*., 2011; Hawerroth *et al*., 2015. Thus, the efficiency of nitrogen use by wheat ends up being compromised, decreasing productivity, raising costs and generating environmental contamination Pietro-Souza *et al*., 2013, Mantai *et al*., 2016. The determination of the nitrogen fertilization dose in wheat is determined according to the content of the organic matter of the soil, the previous crop and the productivity expectation Siqueira Neto *et al*., 2010; Costa *et al*., 2013. In the definition of the fertilization season, the technical indications for wheat in Brazil recommend it to be performed between the beginning of tillering stage V_3 = third leaf expanded and the beginning of elongation stage V_6 = sixth leaf expanded, period ranging from 25 to 65 days after the emergence of the plant, comprising a 30-day interval between V_3 and V_6 stages Arenhardt *et al*., 2015; CBPTT, 2016. In this period, a single application under conditions of inadequate soil temperature and humidity may alter the efficiency of nitrogen use by wheat. Evidencesreport in favorof the fractionation of this nutrient for the crop Megda *et al*., 2009; Camponogara *et al*., 2016. However, other studies have been showing that the use of nitrogen fractionation in wheat does not affect grain productivity and increases production costs Espindula *et al*., 2010; Teixeira Filho *et al*., 2010. The proper use of the nitrogen dose and its supply in a single or fractional way may be determinant in the maximum productive efficiency of biomass and wheat grains. However, the responses of the crop to the forms of nitrogen availability

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may present distinct results when the cultivation conditions are altered. Therefore, the complex relations of plant, climate and management should be considered in the obtentionof a more efficient management. Thus, the objective of this study is the search for improved efficiencyof nitrogen use to the biomass and wheat grain productivity throughthe single and fractioned supply of N-fertilizer, in conditions of favorable and unfavorable years to cultivation in succession systems of high and reduced N-residual release.

MATERIALS AND METHODS

The experiment was conducted in the field in Augusto Pestana, RS, Brazil 28 ° 26'30"S latitude and 54 ° 00' 58" longitude W in 2014 and 2015. The soil of the experimental area is classified as typical Red Dystrophic Latossoloand the climate of the region, according to Köeppen classification, is of Cfa type, with hot summer without dry season. In the study, ten days before sowing, soil analysis was performed and the following chemical characteristics of the place were averaged over the years: corn/wheat system pH = 6.5, P = 34.4 mg dm^{-3}, K = 262 mg dm^{-3}, MO = 3.5%, Al = 0.0 cmolc dm^{-3}, Ca = 6.6 cmolc dm^{-3} and Mg = 3.4 cmolc Dm^{-3} and; soybean/wheat system pH = 6.2, P = 33.9 mg dm^{-3}, K = 200 mg dm^{-3}, MO = 3.4%, Al = 0.0 cmolc dm^{-3}, Ca = 6.5 cmolc dm^{-3} and Mg = 2.5 cmolc dm^{-3}. Sowing was performed based on the technical indications for the species, with sowing-fertilizerfor plot composition, which had 5 lines of 5m in length and spaced by 0.20 m, forming the experimental unit of 5 m^2.At the sowing were applied 30 and 15 kg ha^{-1} of P_2O_5 and K_2O, respectively, based on the soil P and K contents for expected grain productivity of 3 t ha^{-1} and N at the base with 10 kg ha^{-1} except for the standard experimental unit in the form of urea, and the remainder aiming at contemplating the doses proposed in the study. The seeds were submitted to germination and vigor laboratory testsin order to correct the desired density of 300 viable seeds m^{-2}.

During the execution of the study, tebuconazole fungicide of commercial name FOLICUR®CE was applied at a dosage of 0.75 L ha^{-1}. In addition, weed control was performed with metsulfuron-methyl herbicide, commercially available under the name ALLY®, at a dose of 4g ha^{-1}, and additional weedings when necessary. The wheat cultivar BRS Guamirim low-growing, early-stage, resistant to lodging of commercial class type “bread” and high productive potential has been used. This cultivar represents the standard biotype commonly desired by the triticulturists of southern Brazil. In each cultivation condition of high and low N-residual release soybean/wheat and corn/wheat systems, two experiments were conducted, one to quantify the biomass productivity rate BP, kg ha^{-1} every 30 days until physiological maturity, and the other for the estimation of grain productivity GP, kg ha^{-1}. Therefore, in the four experiments, the design was randomized blocks with four replications in a 4 x 3 factorial scheme for N-fertilizer doses 0, 30, 60, 120 kg ha^{-1} and nutrient supply [Single condition 100% at phenological stage V_3 third leaf expanded; fractioned 70%/30% at the phenological stage V_3/V_6 third and sixth leaves expanded and; fractioned 70%/30%at the phenological stage V_3/E third leaf expanded and beginning of grain filling, respectively, totalizing 192 experimental units. The harvest of the experiments to estimate the productivity of biomass and grains occurred manually by cutting the three central lines of each plot, near the harvest point 125 days, with grain moisture of 15%.

The time of grain harvest was also defined as the last cut in the experiment directed to the analysis of biomass productivity. The plots directed to the grain crop were harvested with a stationary harvester and sent to the laboratory for correction of grain moisture to 13%, after weighing and estimation of grain productivity GP, kg ha^{-1}. The plots for biomass analysis were directed to a forced air ventilation greenhouse at 65ºC until they reached constant mass, with subsequent weighing and estimation of the biomass productivity BP, kg ha^{-1}. By following the assumptions of homogeneity and normality via Bartlett test, a variance analysis was performed to detect the main and interaction effects. Based on this information, a linear equation $BP = b_0 \pm b_1x$ was calculated for the estimation of biomass productivity rate ha^{-1} day^{-1} and average by Scott & Knott in the analysis of grain productivity, at each dose and supply condition of N-fertilizer. In each condition of single and fractioned supply of nitrogen to grain productivity, regression analysis was also performed according to nutrient doses. In the conditions where there was significant quadratic behavior $GP = b_0 \pm b_1x \pm b_2x^2$, an estimate of the maximum technical efficiency $MTE = -b_1 / 2b_2$ of nitrogen use was obtained for the grain elaboration. On the other hand, when there was significant linear behavior $GP = b_0 \pm b_1x$, the grain productivity was obtained by means of the N-fertilizer technical recommendation obeying the succession culture for the estimate of 3 t ha^{-1}. For these determinations, the computational program Genes Cruz, 2006 has been used.

RESULTS AND DISCUSSION

In Figure 1, the rainfall and maximum temperature data in the wheat crop cycle indicated in 2014 the absence of rainfall before and after nitrogen fertilization, fact that associated to the high temperatures at the beginning of the crop development may have caused the decrease of nutrient utilization due to volatilization losses,what promoted lower emission and development of tines and ears per area. In addition, shortly after the application of N-fertilizer in the V_6 phenological stage, there was a high volume of rainfall, causing a possible loss of the nutrient by leaching. These facts, along with the productivity averages obtained Table 1 and 2, qualify the year of 2014 as unfavorable UY to the cultivation of wheat.In 2015 Figure 1, rainfall was observed on days before the application of N-fertilizer, implying soil moisture favorable to nutrient management. Besides, with milder temperatures in the vegetative cycle, condition which favors the production of tillers and distribution of photoassimilates, implying greater productivity.

This fact, along with the highest averages of grain productivity in this year, characterizes 2015 as a favorable year FY for wheat cultivation. Cordeiro *et al*. 2015 state that climate is a factor of strong influence on wheat productivity. It requires a region with low temperatures and adequate distribution of low intensity rainfall. Excessive rainfall after fertilization causes damage to the plant due to the lack of oxygenation, as well as the loss of nutrients due to ammonia leaching Ercoli *et al*., 2013. Arenhardt *et al*. 2015, point out that wheat cultivation is mainly defined by the volume and distribution of rainfall. High temperatures also promote productivity decrease because of the loss of nitrogen by volatilization and reduction of the biomass accumulation due to the increase of respiration rate by the plant, a condition that causes environmental degradation, contributing to global warming events Mandal *et al*., 2016.

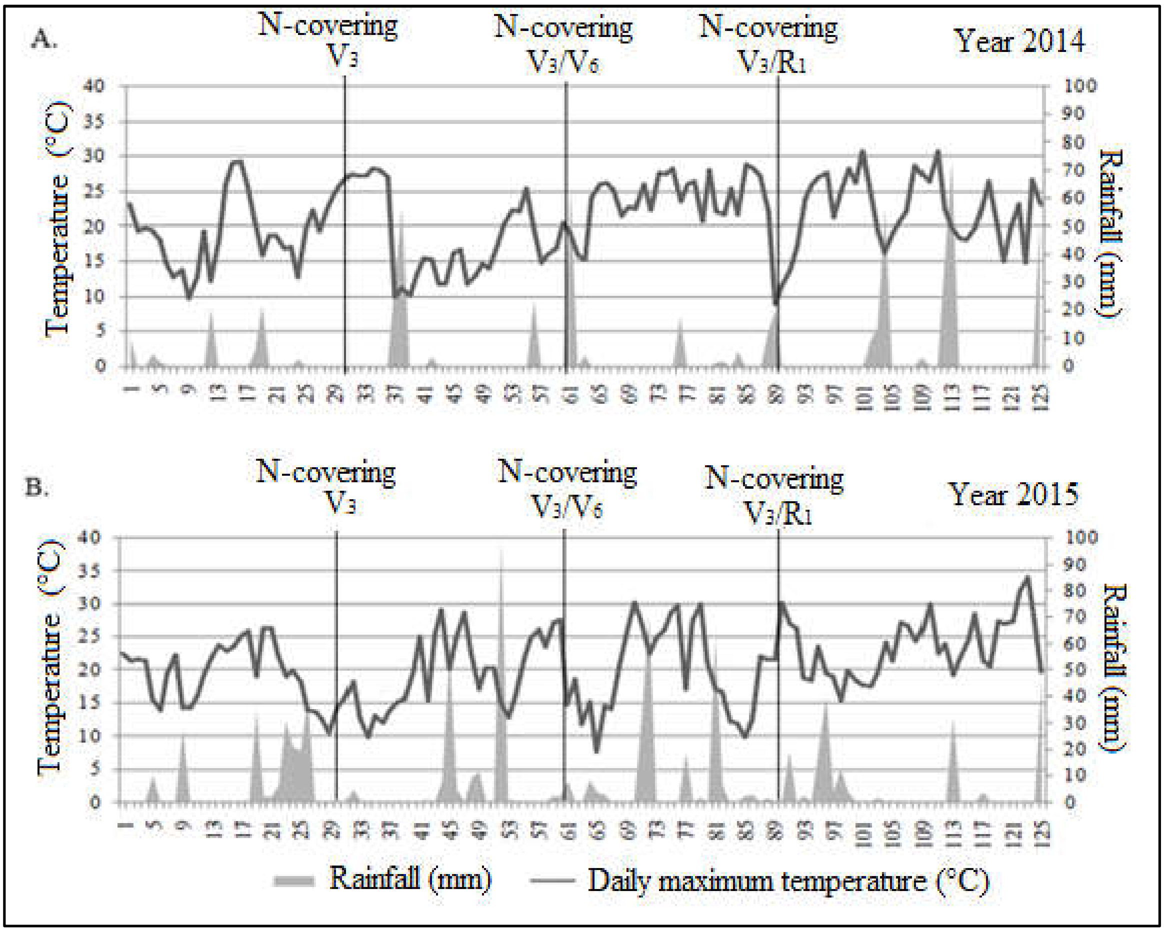

Figure 1. Rainfall and maximum temperature in the wheat cultivation cycle and days of nitrogen application. V_3 = dose of total nitrogen (100%) in the third expanded leaf. V_3/V_6 = fractional dose (70%/30%) of nitrogen in the third and sixth expanded leaf and V_3/E = fractionated dose (70%/30%) of nitrogen in the third expanded leaf and beginning of grain filling

Table 1. Linear equation of the biomass productivity rate and grain productivity averages per dose and nitrogen supply form in the soybean/wheat system

Dose N (kg ha^{-1})	N-fertilizer stadium/DAE	Equation BP = $b_0 \pm b_1x$	R^2 (%)	P (b_ix)	GP (kg ha^{-1})
		Year 2014 (UY)			
0	-	1604 + 72.6x	85	*	1685
30	V_3	1134 + 68.7x	75	*	2298 b
	V_3/V_6	1811 + 83.2x	83	*	2544 a
	V_3/R_1	1614 + 77.3x	61	*	2273 b
60	V_3	1570 + 78.9x	68	*	2144 b
	V_3/V_6	1307 + 74.5x	73	*	2460 b
	V_3/R_1	1763 + 82.1x	72	*	2611 a
120	V_3	1434 + 75.0x	74	*	2875 a
	V_3/V_6	1327 + 78.5x	75	*	2788 a
	V_3/R_1	2245 + 85.5x	83	*	2846 a
		Year 2015 (FY)			
0	-	2115 + 65.6x	97	*	1930
30	V_3	1823 +73.4x	99	*	3116 a
	V_3/V_6	3055 + 86.4x	95	*	3060 a
	V_3/R_1	2393 + 77.1x	86	*	2900 b
60	V_3	1908 + 84.2x	91	*	3952 a
	V_3/V_6	2179 + 84.9x	93	*	3628 b
	V_3/R_1	2019 + 75.6x	97	*	3223 c
120	V_3	877 + 73.0x	84	*	4988 a
	V_3/V_6	2754 + 108.1x	88	*	4874 a
	V_3/R_1	2351 + 88.7x	99	*	4636 a

BP = biomass productivity (kg ha^{-1}); GP = grain productivity (kg ha^{-1}); V_3 = 3rd expanded leaf of main stem; V_3/V_6 = Paste formed on the 6th leaf of the main stem; V_3/R_1 = Spike differentiation; R^2 = coefficient of determination; P (b_ix) = Line slope parameter; Averages followed by the same letters constitute a statistically homogeneous group per dose of nitrogen by the Skott & Knott test at 5% probability of error.

Table 2. Linear equation of the biomass productivity rate and grain productivity averages per dose and nitrogen supply form in the corn/wheat system

Dose N ($kg\ ha^{-1}$)	N-fertilizer stadium/DAE	Equation $BP = b_0 \pm b_1x$	R^2 (%)	P (b_ix)	GP ($kg\ ha^{-1}$)
		Year 2014 (UY)			
0	-	1028 + 44.7x	84	*	918
30	V_3	1734 + 74.5 x	69	*	1745 a
	V_3/V_6	2214 + 75.4 x	84	*	1912 a
	V_3/R_1	1765 + 67.4x	83	*	1764 a
60	V_3	2714 + 93.0x	86	*	2237 a
	V_3/V_6	2543 + 89.4x	88	*	2357 a
	V_3/R_1	1754 + 73.2x	77	*	2197 a
120	V_3	2288 + 87.0x	84	*	2782 b
	V_3/V_6	2220 + 85.6x	77	*	3211 a
	V_3/R_1	2167 + 83.2x	79	*	2795 b
		Year 2015 (FY)			
0	-	1350 + 43.8x	95	*	1265
30	V_3	2608 + 76.8x	97	*	2892 a
	V_3/V_6	2600 + 76.9x	93	*	2265 b
	V_3/R_1	2927 + 75.3x	94	*	2243 b
60	V_3	2432 + 75.1x	98	*	3083 a
	V_3/V_6	3449 + 97.2x	94	*	3077 a
	V_3/R_1	2573 + 73.9x	95	*	2392 b
120	V_3	2735 + 92.5x	88	*	3871 a
	V_3/V_6	3355 + 108.2x	96	*	3939 a
	V_3/R_1	3030 + 95.8x	94	*	3448 b

BP = biomass productivity ($kg\ ha^{-1}$); GP = grain productivity ($kg\ ha^{-1}$); V_3 = 3rd expanded leaf of main stem; V_3/V_6 = Paste formed on the 6th leaf of the main stem; V_3/R_1 = Spike differentiation; R^2 = coefficient of determination; P (b_ix) = Line slope parameter; Averages followed by the same letters constitute a statistically homogeneous group per dose of nitrogen by the Skott & Knott test at 5% probability of error.

Table 3. Regression variance analysis and parameters of the equation to the maximum technical efficiency of grain productivity of wheat by nitrogen under the conditions of supply

N-fertilizer stadium/DAE	SV	Equation $GP = b_0+b_1x+b_2x^2$	P (b_ix^n)	R^2 (%)	N_{MTE} ($kg\ ha^{-1}$)	GP_{MTE}	N ($3\ t\ ha^{-1}$)	GP($3\ t\ ha^{-1}$)
		soybean/wheat system (2014 - UY)						
V_3	L	1856+8.9x	*	92	-	-	60	2532
	Q	$1755+15.95x-0.05x^2$	ns	-	-	-		
V_3/V_6	L	1971+7.64x	*	69	-	-	60	2757
	Q	$1899+20.3x-0.10x^2$	*	85	100	2929		
V_3/R_1	L	1848 + 9.43x	*	85	-	-	60	2646
	Q	$1686+22.0x-0.10x^2$	*	99	110	2896		
		soybean/wheat system (2015 - FY)						
V_3	L	2278 + 23.9 x	*	97	-	-	60	3975
	Q	$2068+38.39x-0.11x^2$	ns	-	-	-		
V_3/V_6	L	2127 + 23.6 x	*	97	-	-	60	3753
	Q	$1970+34.52x-0.08x^2$	ns	-	-	-		
V_3/R_1	L	1938 +22.4 x	*	96			60	3324
	Q	$1902+24.90x-0.02x^2$	ns	-	-	-		
		corn/wheat system (2014 - UF)						
V_3	L	1109+15.2x	*	91	-	-	90	2667
	Q	$886+30.59x-0.12x^2$	ns	-	-	-		
V_3/V_6	L	1243 +14.4x	*	87	-	-	90	2854
	Q	$973+33.5x-0.14x^2$	*	99	120	2977		
V_3/R_1	L	1070+18.2x	*	98	-	-	90	2783
	Q	$981+24.43x-0.049x^2$	ns	-	-	-		
		corn/wheat system (2015 - FY)						
V_3	L	1700+20.0x	*	81	-	-	90	3852
	Q	$1204+48.3x-0.21x^2$	*	94	115	3983		
V_3/V_6	L	1471+21.9x	*	95	-	-	90	3626
	Q	$1235+38.27x-0.13x^2$	ns	-	-	-		
V_3/R_1	L	1520+16.1x	*	95	-	-	90	3049
	Q	$1460+20.36x-0.03x^2$	ns	-	-	-		

SV = Source of variation; V_3 = Necklace formed on the 3rd leaf of the main stem; V_3/V_6 = Paste formed on the 6th leaf of the main stem; V_3/R_1 = Spike differentiation; R^2 = coefficient of determination; P (b_ix^n) = probability of the slope significance of the line; L = linear equation; Q = quadratic equation; N_{MTE} = Nitrogen dose of maximum technical efficiency; GP_{MTE} = Grain productivity for maximum technical efficiency; N = Nitrogen dose for productivity expectation of $3\ t\ ha^{-1}$; GP = Grain productivity for expectation of $3\ t\ ha^{-1}$.

Therefore, temperature and rainfall in the cereal crop cycle may be used to classify years of cultivation as favorable or unfavorable Arenhardt *et al*., 2015;Mantai *et al*., 2016. In Table 1 of the soybean/wheat system in 2014, a year classified as unfavorable to cultivation, the linear equation indicated a higher rate of biomass productivity day^{-1} b_1x next to the highest grain productivity average at doses 30 and 60 kg ha^{-1} of nitrogen in the fractionation condition V_3/V_6 and V_3/R_1, respectively. The highest nutrient dose 120 kg ha^{-1} showed no change in grain productivity at single or fractional dose delivery. Therefore, in high doses, the V_3 stage was more indicated, mainly in the reduction of costs by a single application, less soil compaction due to avoiding the entrance of machines and reduction of the time and labor spent in the application. In the year 2015 Table 1, a favorable year for cultivation, the doses of 30 and 60 kg ha^{-1} of nitrogen indicated the highest biomass productivity rate of day^{-1} with grain productivity averages when the nitrogen was supplied in a single dose V_3. The higher dose of nitrogen showed similar behavior to 2014, not altering grain productivity as a function of nutrient supply. It should be emphasized that the biomass productivity rate of day^{-1} in the year 2015 was higher in comparison to 2014, according to the results of the most favorable meteorological conditions in this crop season Figure 1. These results raise the hypothesis that under unfavorable year conditions the nitrogen fractionation is adequate, but in favorable years the application in a single dose is more efficient.

In Table 2, of the more restrictive condition of N-residual availability by the corn/wheat system, the unfavorable crop year 2014 indicated a higher productivity rate of biomass day^{-1} with 60 kg ha^{-1} of nitrogen in a single application. In the grain productivity analysis, the 30 and 60 kg N ha^{-1} doses did not show differences as a function of supply form. Therefore, the application in a single dose in this succession system is more indicated, unlike what occurred in this same year in the soybean/wheat system. This fact raises the hypothesis that the lower release of N-residual in this system promotes the need for the singlenitrogen dose when using lower doses in the V_3 phenological stage, moment that initiates the differential of the floral primordium and the production and development of tines, component directly linked to the productivity. It is worth noting that in the higher dose of nitrogen 120 kg ha^{-1}, the highest grain productivity was obtained with the fractionation in the V_3/V_6 stages. Therefore, although it is a system of lower N-residual release, high doses of nitrogen may not be fully utilized in a single application, mainly because there is a limiting capacity of the absorption rate of the nutrient by plants. In the favorable year of cultivation 2015 in the corn/wheat system Table 2, the highest rate of biomass productivity was obtained with nitrogen fractionation in the V_3/V_6 stage, regardless of the nutrient dose. On the other hand, the highest expression of grain productivity was obtained when nitrogen was supplied in a single application. Thus, in a more restrictive condition of N-residual in a favorable crop year, the highest grain productivity efficiency is given by the use of nitrogen in a single application. In the unfavorable year, the use of single dose in reduced doses of the nutrient is also suggested, however, in high dose, the nitrogen supply in the fractioned form is more beneficial. The favorable effect of nitrogen on wheat productivity is reported by several researchers Teixeira Filho *et al*., 2011;Nunes *et al*., 2015;Camponogara *et al*., 2016. As wheat has C_3 metabolism, its demand for nitrogen is high and extremely important for CO_2 assimilation, interfering with the formation of biomass Taiz and Zeiger, 2009; Barcelos *et al*., 2016. Teixeira Filho *et al*. 2010 found that the increase in the nitrogen dose up to the application of 120 kg ha^{-1} increases the biomass and wheat grain productivity, regardless of the application time and nitrogen source. However, high doses do not guarantee higher productivity, mainly due to nutrient loss due to unfavorable weather conditions. Thus, the nitrogen fertilization scheme may provide a greater efficiency in nutrient assimilation by wheat, reducing loss by leaching in rainy years and volatilization in dry years Costa *et al*., 2013; Silva *et al*., 2015. In this aspect Costa *et al*. 2013 discuss that the low response of the cultivars to the nitrogen splitting can be explained by the strong occurrence of rainfall after the application of N-fertilizer, limiting the use of the nutrient by the plant. Sangoi *et al*. 2007, verified that the nitrogen fertilization scheme implies a greater recovery of the nutrient by the plant and higher productivity when compared to a single application. However, Espindula *et al*. 2010 did not observe benefits to wheat grain productivity by nitrogen splitting. According to Braz, *et al*. 2006, wheat productivity is also influenced by the type of successor crop, and under legume cultural residue reaches its productivity efficiency with a quantity of nitrogen significantly lower than in succession with grasses. Brezolin *et al*. 2016 obtained higher wheat productivity in a high N-residual system soybean/wheat system, indicating the single dose in the V_3 stage as the most efficient. On the other hand, under conditions of low N-residual release corn/wheat system, nitrogen fractionation was more indicated in the V_3/V_6 stage.

Table 3 shows the regression equations for the maximum technical efficiency of wheat grain productivity by nitrogen and the required nutrient dose for grain productivity expectation of 3 t ha^{-1} in the supply forms. In the unfavorable crop year 2014 in soybean/wheat system, grain productivity was linear in the single dose supply. Under conditions V_3/V_6 and V_3/R_1 the quadratic equation was confirmed, indicating in these conditions a tendency to reach productivity stability. Although grain productivity linearity was confirmed $GP = 1856 + 8.9x$, the use of 120 kg ha^{-1} of nitrogen evidences an expectation of 2920 kg ha^{-1}. The values of productivity close to this one, obtained in V_3/V_6 2818 kg ha^{-1} and V_3/R_1 2943 kg ha^{-1} with 100 and 115 kg ha^{-1} of nitrogen, respectively, are noteworthy. Therefore, it is verified that the lowest dose of nutrient use and with grain productivity similar to the other supply conditions was obtained in V_3/V_6 condition. In the use of nitrogen in the dose of 60 kg ha^{-1} for productivity expectation of 3 t ha^{-1} in the soybean/wheat system, the fractionation in the V_3/V_6 condition is indicated to the elaboration of grain productivity. In the favorable crop year 2015, grain productivity showed a linear behavior in the use of nitrogen, regardless of the chemical element supply condition. It is worth noting that the use of 60 kg ha^{-1} of nitrogen for expectation of grain productivity of 3 t ha^{-1} in the soybean/wheat system obtained the highest efficiency in grain elaboration with nutrient supply in a single dose.In the corn/wheat system Table 3, in the unfavorable year condition 2014, the linear tendency for grain productivity through the use of nitrogen was obtained in a single dose, but with higher productivity when applied by V_3/V_6 fractionation. Also, in favorable year conditions, the linear trend is observed, however, the highest productivity is achieved by the single application of nitrogen, coinciding with the application that shows the highest biomass rate Table 2, a fact also observed in the soybean/wheat.

In addition, for both succession systems, under climatic conditions suitable for wheat 2015, the use of 60 and 90 kg N ha^{-1} nitrogen rates recommended by the technical indication provided a grain productivity higher than the expectation of 3 tons, fact not observed in unfavorable crop year 2014. According to Arenhardt *et al*. 2015, regardless of the year of cultivation and succession system of high or low N-residual release, nitrogen fertilization 30 days after emergence of wheat shows high averages and greater stability in grain productivity. Espindula *et al*. 2010 do not recommend the fractional application of nitrogen, especially when temperatures are high, implying the advance of the wheat crop cycle. Silva *et al*. 2005 point out that the correct application time of N-fertilizer is essential to increase grain productivity, since early or late applications may influence nutrient utilization by the plant. However, from the economic point of view, the dose and the ways of making the nitrogen available often do not correspond to the greater economic efficiency, and therefore, are longer adequate for technical indication Teixeira Filho *et al*., 2010. According to Tian *et al*. 2011, the use of management practices that optimize applied inputs, especially of fertilizers, can contribute to increase productivity in wheat crops and reduce production costs. It is worth noting that the results obtained in this study highlight the possibility of optimizing the use of N-fertilizer, improving the current technical recommendations in the wheat crop.

Conclusion

In general, the increase of biomass productivity in wheat can be obtained by fractionation in the phenological stage V_3/V_6, but it is not always accompanied by the highest grain productivity. Regardless of the succession system, in favorable years of cultivation, nitrogen supply in a single dose increases grain productivity; in unfavorable years, nutrient fractionation is more appropriate.

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