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POULTRY LITTER AND COVER CROPS INFLUENCE THE AGRONOMIC PERFORMANCE AND GRAIN YIELD OF WHEAT

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Abstract

The use of poultry litter as a source of nitrogen (N) and the decomposition of ground cover plants can be an alternative and N management strategy in the wheat crop, in succession. Therefore, the objective of this study was to evaluate the effect of isolated and/or intercropped cultivation of ground cover plants in autumn/winter and the use of poultry litter on some plant parameters and on the final yield of wheat grains. The experimental design was randomized blocks, in split plots, with three replications. The treatments in the plots were composed of isolated coverings *Avena strigosa* Schreb., *Raphanus sativus* L. and intercropping of *A. strigosa* + *R. sativus* and fallow as a control. In the subplots, the N managements in the wheat crop with 100% of the N recommendation via poultry litter, 100% of the N via mineral (urea), 50% via poultry litter + 50% mineral and the control, without N application. The management of nitrogen fertilization and the cover crops altered the yield components of the wheat crop. The use of poultry litter increased the final grain yield, being an alternative as a partial replacement, when associated with urea, or total N. Isolated crops *R. sativus* and *A. strigosa* + *R. sativus* intercropping significantly influenced agronomic performance and final grain yield.

Keywords: Grain yield. Mineral nutrition. Organic fertilization. *Triticum aestivum* L.

1. Introduction

The wheat (*Triticum aestivum* L.) is the most important cereal in the world and meets about two thirds of the protein-energy demand of the world population (Cakman 2009). Nutritional management in the crop is a determining factor for the increase in grain yield. Of all the nutrients required by the wheat crop, nitrogen (N) is the one with the greatest response and increase in productivity (Rawal et al. 2022).

In most countries, agricultural systems are often unable to provide adequate nutrients to efficiently meet the requirements of their populations (Welch 2002). It is partially due to the increased demand for grain yield from farming systems in recent years. Therefore, to fill the gap between demand and suplly, the intensity of cultivation and the application of fertilizers increased, resulting in reduced soil fertility. Futhermore, excessive applications of chemical fertilizers increase production costs and can negatively affect surface water, groundwater, and the atmosphere through leachins, runoff, and N volatilization (Galloway et al. 2008).

Brazilian poultry farming has shown high growth rates in recent decades, conquering the most demanding markets. During this period, the country established itself as the second world producer and leader in exports, reaching 151 countries, mainly in Asia and the Middle East (ABPA 2022). The South region, according to IBGE data (2022), accounted for 60.2% of the national chicken slaughter and 78.8% of exports. In the first quarter of 2022, Brazilian exports of chicken meat increased by 8.6% compared to the same period of 2021 and had China (14.6%) as its main destination. Intensive poultry production generates waste that is poultry litter, formed by the mixture of excrement, feathers, feed remains and wood shavings (Thomazini et al. 2022). Poultry litter produced in bulk can negatively impact our environment. In this way, to meet the needs of the growing population, the dependence on fertilizers will consequently increase. The use of poultry litter as fertilizer is one of the options to reduce this dependency. The literature revealed that poultry litter is one of the vital sources of nutrients that enhance agricultural production (Basso et al. 2021; Khseem et al. 2015; Chaudry et al. 2013). Poultry litter is also considered the backbone of agriculture and plays a dynamic role in the agricultural sector (Bashir et al. 2022).

The N present in poultry litter is mostly found in organic form and must undergo a mineralization process to become available to plants (Rogeri et al. 2016), its dynamics being very complex in the soil, where the release can occur slowly and gradually throughout the crop cycle. In this scenario, the use of ground cover plants associated with the use of poultry litter as a strategy for total and/or partial replacement of mineral fertilization in the wheat crop can minimize production costs and contribute to the sustainability of agricultural systems, as an increase in the efficiency of N utilization by the crop.

In this context, the objective of this study was to evaluate the effect of isolated and/or intercropped cultivation of ground cover plants in autumn/winter and the use of poultry litter on some plant parameters and the final yield of wheat grains.

2. Material and Methods

The experiment was carried out during the 2019 and 2020 growing years in the experimental area of the Department of Agronomic and Environmental Sciences at the Federal University of Santa Maria, campus Frederico Westphalen, RS. The soil in the area is classified as Distroferric Red Latosol (Santos et al. 2018), with the following chemical and physical attributes quantified in the 0.00-0.20 m layer: 610 g kg^{-1} of clay; 320 g kg^{-1} of silt; 70 g kg^{-1} of sand; 35 g dm^{-3} of organic matter; 5.7 pH (H_2O); 5.7 mg dm^{-3} of P (Mehlich); 165 mg dm^{-3} of K^+; 8.2 $cmol_c$ dm^{-3} of Ca^{2+}; 4.2 $cmol_c$ dm^{-3} of Mg^{2+}; H + Al of 4.4 $cmol_c$ dm^{-3}; CTC of 14.1 $cmol_c$ dm^{-3}.

The region's climate is classified as Cfa (humid subtropical), with an average annual temperature of 19.1 ºC and a maximum and minimum temperature of 38 ºC and 0 ºC respectively (Alvares et al. 2013).

The experimental area had a history of no-tillage since 2016 with crop rotation (corn, beans, corn, soybeans, wheat, soybeans and wheat), using cover crops in autumn/winter (black oats, forage turnip, black oat + forage turnip intercropping and fallow as control treatment) and poultry litter as a source of N. The experimental design was randomized blocks, in a factorial scheme (4x4) with split plots and three replications. The treatments, in the plots, constituted the cover crops in autumn/winter: *Avena strigosa* Schreb., *Raphanus sativus* L., *A. strigosa* + *R. sativus* intercropping and fallow (without any vegetation cover). In the subplots, the treatments consisted of four N management strategies in the wheat crop: 100% of the N recommendation via mineral source (urea), 100% of the N via poultry litter, 50% of the N via poultry litter + 50% of N via mineral and the control (without application of N). The cultivar used was Certero, sowings were carried out on June 18 and July 7, in the years 2019 and 2020, respectively. Sowing took place ten days after desiccation of cover crops, with the aid of a seeder, in rows spaced at 0.17 m and with a seed density of 419 $m^{-2.}$ The desiccation of cover crops was performed with the herbicide of the active ingredient glyphosate at a dose of 2 L ha^{-1} of the commercial product.

The cover crops that preceded the implantation of wheat were sown on March 29, 2019 (1st year) and April 16, 2020 (2nd year). For isolated cultivation, 100 kg ha^{-1} of seed was used for *A. strigosa*, 20 kg ha^{-1} for *R. sativus* and intercropping, 40 + 12 kg ha^{-1} respectively for *A. strigosa* and *R. sativus*. In fallow, the area was kept without vegetation during the entire period of fall through manual weeding. The plant material to determine the dry matter of the covers was collected about 60 DAE (days after emergence), when the cultures were in full flowering stage. The aerial part of the plants was removed in three rows of 0.17 m x 0.5 m (0.51 m^2) in two replications.

Fertilization followed the recommendation of the Fertilization and Liming Manual for the states of Rio Grande do Sul and Santa Catarina (CQFS, 2016) and regardless of the source, the total dose of N applied to the wheat crop was 87.5 kg ha^{-1}. For treatments with mineral fertilization, the source of N used was urea (45% of N), which was applied by broadcast in two moments: at wheat sowing, with application of 20 kg ha^{-1} of N and in cover, in the end of tillering and beginning of wheat elongation (40 to 45 days after emergency DAE), with the remainder of the dose 67.5 kg ha^{-1} of N. With regard to poultry litter, all of it was distributed by broadcast, right after sowing at a dose of 3182 kg ha^{-1} in 2019 and at a dose of 2423 kg ha^{-1} in 2020. In the 50% N via poultry litter + 50% N via mineral treatment, the entire poultry litter was applied right after sowing (1591 kg ha^{-1} in 2019 and 1212 kg ha^{-1} in 2020) which is equivalent to half the recommended dose of N (43.75 kg ha^{-1} of N). Also soon after sowing, the mineral source (20 kg ha^{-1} of N) was applied, with the remaining N (23.75 kg ha^{-1} of N) applied in coverage.

The chemical composition of the poultry litter used in the experiment for the year 2019 was 2.75% nitrogen and for the year 2020 was 3.61% nitrogen, 1.18% phosphorus, 5.62% potassium, 4.94% calcium, 2.02% magnesium and a pH of 8.40. The treatments with cover crops were allocated in plots of 60 m^2 (20.0 m x 3.0 m) and in the subplots, the N managements, in 15 m^2 (5.0 m x 3.0 m), with a useful area of 2.55 m^2, occupying the five central lines.

All plots received the same dose for phosphorus (P) and potassium (K). At the time of sowing, the fertilizer used as a source of P_2O_5 was triple super phosphate distributed in the sowing furrow, at a dose of 190 kg ha^{-1}. As for K_2O, the source used was potassium chloride applied by broadcast at a dose of 75 kg ha^{-1}, right after sowing, in both years.

Plant tissue for determination of N accumulated in the aerial part of the plant was collected at the full flowering stage, within an area of three rows measuring 0.17 m x 0.50 m, in two repetitions per plot (0.510 m^2). After determination of the dry matter of the samples, obtained through drying in an oven with forced air circulation at 65º C until constant mass, the samples were processed to carry out laboratory analyzes of N, following the methodology described by Tedesco et al. (1995). The accumulation of N found in the tissue was expressed in kg ha^{-1} obtained by the product of dry matter mass and N concentration (Nascimento et al. 2014).

Harvests were performed manually on October 22, 2019 and October 28, 2020, shortly after the plants reached physiological maturity. The variables plant height (PH), performed on ten plants per experimental unit, thousand-grain mass (TGM), determined according to the methodology proposed by Brasil (2009), and final grain yield (FGY) from the harvest of all plants in the useful area of the experimental unit, which are threshed and corrected for 13% humidity, the value being extrapolated to kilograms per hectare (kg ha-1).

The data were submitted to analysis of variance and when a significant difference was observed between treatments, the Tukey mean comparison test was performed at 5% probability of error, with the R language version 3.6.1 (R Core Team 2019).

3. Results

The DM production of cover crops for the year 2019 was 1926.07, 2574.86, 2848.85 kg ha^{-1} for *A. strigosa* single crop, *A. strigosa* + *R. sativus* intercropping and *R. sativus* single crop, respectively. In the year 2020, the DM obtained was 2542.84, 2609.67 e 2888.66 kg ha^{-1} for *A. strigosa, A. strigosa* + *R. sativus* and single *R. sativus* cultivation, respectively. Superiority was observed with the use of *R. sativus* as a cover crop, in both years, wich provided greater accumulation of DM and, consequently, greater straw under the soil and nutrient cycling for the subsequent crop, in this case, wheat.

There was interaction between cover crops x N managements in plant height (PH) (Table 1), thousand grain mass (TGM) (Table 2), final grain yield (FGY) (Table 3) and tissue nitrogen (TN) (Table 4), for the two years of study. As for shoot dry matter (DM), this difference only occurred for the year 2020 (Table

5). In 2019, DM variable showed a significant difference only in the single effect for cover crops and N management (Table 6).

Table 1. Effect of cover crops and nitrogen sources on plant height (PH) (cm) in wheat, Frederico Westphalen, Rio Grande do Sul, Brazil, 2019, 2020.

Cover crops	2019							
	PL		MI		PL+MI		WN	
A. strigosa	94.00	ABa	93.10	Ba	96.30	Aa	87.00	Ca
A. strigosa + R. sativus	95.70	Aa	91.80	Ba	96.00	Aa	87.20	Ca
R. sativus	95.70	Aa	89.60	Ba	95.30	Aa	89.50	Ba
Fallow	96.70	Aa	92.70	BCa	95.40	ABa	90.70	Ca
CV[1] (%)	2.98							
CV[2] (%)	1.49							
Cover crops	2020							
	PL		MI		PL+MI		WN	
A. strigosa	78.70	Bb	86.90	Aa	86.20	Aa	87.60	Aa
A. strigosa + R. sativus	86.60	Aa	84.20	Aab	86.90	Aa	85.70	Aa
R. sativus	89.60	Aa	87.40	Aa	88.10	Aa	79.50	Bb
Fallow	79.80	Ab	79.70	Ab	84.80	Aa	82.70	Aab
CV[1] (%)	1.76							
CV[2] (%)	3.54							

Means followed by the same uppercase letter in the row and lowercase letter in the column do not differ by Tukey's test ($p < 0.05$). CV[1]: coefficient of variation for the cover crops factor, CV[2]: coefficient of variation for the nitrogen fertilization factor. PL: poultry litter, MI: mineral, PL+MI: 50% poultry litter + 50% mineral, WN: without nitrogen fertilization.

Regardless of the cover plant, in 2019 a positive effect was observed on PH, in treatments with application of 100% of N via poultry litter and in the mixture of poultry litter (50%) and mineral (50%), (Table 1).

Table 2. Effect of cover crops and nitrogen sources on thousand-grain mass (TGM) (g) in wheat, Frederico Westphalen, Rio Grande do Sul, Brazil, 2019, 2020.

Cover crops	2019							
	PL		MI		PL+MI		WN	
A. strigosa	35.30	Aa	35.10	Ba	35.30	Aa	36.00	Aab
A. strigosa + R. sativus	35.30	BCa	35.60	Ba	34.30	Ca	36.90	Aa
R. sativus	35.20	Ba	34.90	Bab	34.70	Ba	36.60	Aa
Fallow	33.30	Cb	33.90	BCb	34.60	Aba	35.20	Ab
CV[1] (%)	1.40							
CV[2] (%)	1.46							
Cover crops	2020							
	PL		MI		PL+MI		WN	
A. strigosa	31.50	Ba	33.90	Aa	31.80	Ba	32.50	ABab
A. strigosa + R. sativus	33.20	Aa	30.70	Bb	32.50	ABa	32.10	ABa
R. sativus	33.20	ABa	31.90	BCb	30.90	Ca	34.20	Aa
Fallow	32.40	Aa	31.30	Ab	28.90	Bb	32.60	Aab
CV[1] (%)	1.86							
CV[2] (%)	2.85							

Means followed by the same uppercase letter in the row and lowercase letter in the column do not differ by Tukey's test ($p < 0.05$). CV[1]: coefficient of variation for the cover crops factor, CV[2]: coefficient of variation for the nitrogen fertilization factor. PL: poultry litter, MI: mineral, PL+MI: 50% poultry litter + 50% mineral, WN: without nitrogen fertilization.

As for TGM, for the year 2019, it was evidenced that the intercropping coverage of *A. strigosa + R. sativus* in the fertilization 100% via poultry litter and 50% via poultry litter + 50% via mineral fertilization resulted in the lowest averages. For the year 2020, superiority was observed between the coverage of black oats in relation to the others for 100% mineral fertilization (Table 2).

For the FGY, it is observed that the treatments with N application, regardless of the source, were superior to the control (without N) that presented the lowest productivity. In 2019, the highest grain yield was observed in the treatment with the application of 50% poultry litter + 50% mineral, in succession to the *A. strigosa* cover (5059.74 kg ha^{-1}). On average, treatments with partial replacement of N via poultry litter increased productive by 5.8% in relation to total N fertilization via mineral. In the year 2020, the treatment with 100% of N via poultry litter, in succession to the intercropping of *A. strigosa* + *R. sativus* presented higher productivity than the others (3552.68 kg ha^{-1}), showing a productive increase of 5.6% compared to treatment with 100% N via mineral (Table 3).

Table 3. Effect of cover crops and nitrogen sources on final grain yield (FGY) (kg ha^{-1}) in wheat, Frederico Westphalen, Rio Grande do Sul, Brazil, 2019, 2020.

Cover crops	2019							
	PL		MI		PL+MI		WN	
A. strigosa	4505.92	Aab*	4357.10	Aa	5059.74	Aa	3028.57	Ba
A. strigosa + *R. sativus*	4215.75	Ab	4127.83	Aa	4608.09	Aa	3356.71	Ba
R. sativus	5008.97	Aa	4723.46	Aa	4761.28	Aa	3083.92	Ba
Fallow	3025.10	Bc	4643.28	Aa	4469.18	Aa	3628.53	Ba
CV¹ (%)	6.10							
CV² (%)	7.62							
Cover crops	2020							
	PL		MI		PL+MI		WN	
A. strigosa	2573.59	Ac	2734.77	Ab	2333.46	Ab	1778.03	Bb
A. strigosa + *R. sativus*	3552.68	Aa	2638.30	Bb	3012.15	Ba	2726.53	Ba
R. sativus	3011.50	Bb	3472.81	Aa	3126.92	ABa	2437.90	Ca
Fallow	3125.62	Ab	2768.36	ABb	2529.41	Bb	2722.48	ABa
CV¹ (%)	4.02							
CV² (%)	7.02							

Means followed by the same uppercase letter in the row and lowercase letter in the column do not differ by Tukey's test ($p < 0.05$). CV¹: coefficient of variation for the cover crops factor, CV²: coefficient of variation for the nitrogen fertilization factor. PL: poultry litter, MI: mineral, PL+MI: 50% poultry litter + 50% mineral, WN: without nitrogen fertilization.

The accumulated amount of N in the wheat tissue on the different coverages was higher in the treatments with N addition, regardless of the source, compared to the WN, in the two years of cultivation (Table 4).

Table 4. Effect of cover crops and nitrogen sources on shoot tissue nitrogen (kg ha^{-1}) in wheat, Frederico Westphalen, Rio Grande do Sul, Brazil, 2019, 2020.

Cover crops	2019							
	PL		MI		PL+MI		WN	
A. strigosa	109.36	Ab*	111.80	Aa	130.16	Aab	65.13	Bb
A. strigosa + *R. sativus*	141.76	Aa	119.53	Aa	120.23	Ab	89.20	Ba
R. sativus	119.00	Ab	117.26	Aa	114.20	Ab	105.76	Aa
Fallow	150.40	Aa	113.83	Ba	145.23	Aa	98.90	Ba
CV¹ (%)	7.20							
CV² (%)	8.56							
Cover crops	2020							
	PL		MI		PL+MI		WN	
A. strigosa	88.58	ABb	95.47	Aa	85.81	Bb	32.88	Cd
A. strigosa + *R. sativus*	83.68	Cb	100.14	Aa	92.09	Bb	48.62	Dc
R. sativus	63.93	Cc	101.34	Aa	86.34	Bb	58.05	Cb
Fallow	105.98	Aa	95.58	Aa	102.71	Aa	74.27	Ca
CV¹ (%)	3.85							
CV² (%)	3.79							

Means followed by the same uppercase letter in the row and lowercase letter in the column do not differ by Tukey's test ($p < 0.05$). CV¹: coefficient of variation for the cover crops factor, CV²: coefficient of variation for the nitrogen fertilization factor. PL: poultry litter, MI: mineral, PL+MI: 50% poultry litter + 50% mineral, WN: without nitrogen fertilization.

The DM variable showed a significant difference in the interaction of the cover plant x nitrogen management factors, only for the year 2020. It is observed that the treatments with N addition, regardless of the source, were superior for the variables analyzes, demonstrating that poultry litter can be a viable alternative as a source of N. In addition, wheat grown in succession to cover crops of *A. strigosa* and the consortium *A. strigosa* + *R. sativus* had superior performance with 100% fertilization via PL in relation to the isolated culture of R. *sativus* proved to be more efficient in the accumulation of DM when fertilization via mineral or 50% via PL + 50% via MI. (Table 5).

Table 5. Effect of cover crops and nitrogen sources on shoot dry matter (DM) (kg ha^{-1}) in wheat, Frederico Westphalen, Rio Grande do Sul, Brazil, 2020.

Cover crops	PL		MI		PL+MI		WN	
A. strigosa	5849.67	Ab	5352.94	Bc	5339.86	Bb	2627.45	Cd
A. strigosa + *R. sativus*	5745.09	Ab	5581.69	ABbc	5254.90	Bb	3888.88	Cc
R. sativus	5816.99	Bb	6666.66	Aa	6640.52	Aa	4666.66	Cb
Fallow	6869.28	Aa	5960.78	Bb	6529.41	Aa	5300.65	Ca
CV^1 (%)			3.18					
CV^2 (%)			3.32					

Means followed by the same uppercase letter in the row and lowercase letter in the column do not differ by Tukey's test ($p < 0.05$). CV^1: coefficient of variation for the cover crops factor, CV^2: coefficient of variation for the nitrogen fertilization factor. PL: poultry litter, MI: mineral, PL+MI: 50% poultry litter + 50% mineral, WN: without nitrogen fertilization.

The DM wheat production and the averages for the different N managements were lower on *A. strigosa* straw compared to that observed on fallow, not differing from the other soil cover crops (Table 6). This shows the N immobilization potential of this *A. strigosa* straw with high C/N ratio. With regard to the treatments that used some source of N, the data show that there was no significant difference, all of which were superior to the control (without fertilization).

Table 6. Simple effect of cover crops and nitrogen sources on shoot dry matter (DM) (kg ha^{-1}) in wheat, Frederico Westphalen, Rio Grande do Sul, Brazil, 2019.

Cover crops	DM	NS	DM
A. strigosa	5300.10 b	PL	6188.66 a
A. strigosa + *R. sativus*	5733.33 ab	MI	5853.33 a
R. sativus	5750.00 ab	PL+MI	6193.33 a
Fallow	6216.66 a	WN	4776.66 b
CV (%)	7.96	CV (%)	8.79

Means followed by the same letter do not differ by Tukey's test ($p < 0.05$). CV: coefficient of variation for the cover crops factor. DM: dry matter, NS: nitrogen sources, PL: poultry litter, MI: mineral, PL+MI: 50% poultry litter + 50% mineral, WN: without nitrogen fertilization.

4. Discussion

For the PH variable, the best response occurred when poultry litter was used, regardless of whether it was applied alone with a single source of N or associated with mineral fertilization. This positive response in relation to poultry litter may be associated with the slow and gradual release of N throughout the crop cycle, resulting in greater utilization by the plants. These results are in line with those observed by Ribeiro et al. (2018) and Basso et al. (2021), where they show a higher plant height in treatments with N sources compared to the control without fertilization. As for 2020, it is observed that for coverage with *A. strigosa* in fertilization with poultry litter, there was the lowest mean height of wheat plant as well as in coverage with *R. sativus* without fertilization (Table 1).

The results obtained for TGM showed an advantage in the treatment using poultry litter plus mineral fertilizer compared to fallow, for the year 2020 (Table 2). This shows that this mixture can be an alternative for managing N in the wheat crop due to of a better synchronism between availability and demand for the plants throughout the crop cycle. When comparing the effect of soil cover as a source of N for wheat in succession compared to the control, there is no significant difference between these covers, this TGM was slightly higher in treatments with the presence of *R. sativus* mainly in the year 2020 in soil cover with *R. sativus* cultivated in isolation. These results corroborate those obtained by Nunes et al. (2011) who found a significant effect of different predecessor crops on wheat TGM, compared to fallow. According to Vesohoski et al. (2011) TGM has a great influence on wheat yield, as the greater the increment in grain weight, the greater the final yield.

For the FGY, it was observed that the result may be associated with a better synchronism between the demand and the availability of mineral N in the soil solution, due to the slower and more gradual release of poultry litter during the crop cycle. Similar results were also observed by Demari et al. (2016) where, when evaluating the use of poultry litter associated with mineral fertilizer (urea) in wheat, they concluded that the partial replacement of mineral nitrogen fertilizer by poultry litter increases productivity rates. Regarding the cover crops and still in 2019, regardless of the N source applied, *R. sativus* and *A. strigosa* provided an increase in wheat productivity of 11.5 and 7.5% respectively, compared to fallow, unlike what was observed by Neto and Campos (2017) where, when studying *R. sativus* before wheat, they observed that wheat yield did not differ from fallow without vegetation cover.

Mohammed et al. (2023) evaluating the effect of organic and chemical fertilizer on wheat growth, they reported that treatments with poultry litter and chemical fertilizer when mixed and poultry litter individually were the most effective, obtaining the highest grain yield and therefore having an impact positive effect on wheat growth and yield.

Briedis et al. (2011) demonstrated that the use of organic waste from poultry and swine slaughterhouses as a total or partial replacement of mineral fertilizer provided an increase in wheat productivity. A trend was observed in the two years of the study, that successive applications of organic waste can promote beneficial residual effect, contributing to better use by crops. With regard to cover crops, *R. sativus* and *A. strigosa* + *R. sativus* intercropping stood out. The treatment that provided the lowest productivity was *A. strigosa* coverage (1778.03 kg ha^{-1}), this result may be associated with the high C/N ratio of the straw, which may result in greater N immobilization (Aita and Giacomini 2003). In this context, it is essential that the cover crops that precede the wheat crop produce dry matter with a C/N ratio that promote a balance between mineralization and N immobilization, especially in the stages of greater demand for N by the crop (Viola et al. 2013).

Similar results of the amount of N accumulated in the tissue were observed by Basso et al. (2021), where when evaluating N sources, they observed that there was no significant difference between the 100% N-organic and 50% N-mineral + 50% N-organic treatments compared to the 100% N-mineral treatment. This greater accumulation of total N in the shoots of wheat is directly related to the higher dry matter production of the shoots of wheat (Table 4).

The DM variable showed that the high C/N ratio of *A. strigosa* straw can lead to greater immobilization of N, which implies less availability of this nutrient during the decomposition process of plant residues (Viola et al. 2013). This issue of N immobilization becomes clear when comparing the dry matter production of wheat in the fallow and on the *R. sativus* in the control (Table 5).

The production of DM observed in the treatments with N management shows a positive trend in the use of poultry litter as a source of N, among the treatments that received all or part of the organic residue, an average of 1949.34 and 1820.26 kg ha^{-1} was observed more compared to the control (without N). In addition, among the treatments that received 100% of N via poultry litter and 100% of N via mineral, there is a tendency to gain in the first fertilization system, demonstrating that the use of organic waste alone or combined with mineral fertilization, provides residual effect and gain in dry matter production.

The treatments with total and partial replacement of poultry litter obtained a increase of 335 and 340 kg ha^{-1} respectively, compared to the 100% N mineral treatment (Table 6). Although there is no statistical difference, it can be demonstrated that replacing mineral fertilizer with poultry litter is advantageous, much more so, especially in areas cultivated with dual purpose wheat whose objective is the production of biomass (Demari et al. 2016).

In the condition of this study carried out 5 years ago in the same area, the continuous applications of poultry litter may have favored the increase of organic matter in the soil, resulting in benefits for agricultural production, such as the increase in the capacity of retention and infiltration of water and water content in the soil, in addition to greater cation exchange capacity and structural stability. In general, the response to nitrogen fertilization by the wheat crop, in succession to cover crops, depends on the microbial processes of mineralization and immobilization that occur during the decomposition of crop residues (Weiler et al. 2019).

The decision to use poultry litter over mineral fertilizer depends on its chemical quality and nutrient content, in addition to the availability of this residue. In addition, the residual effect that it promotes on the soil must be considered, which may enable a reduction in input costs and, consequently, greater profitability for the producer.

5. Conclusions

Nitrogen fertilization management and soil cover crops alter wheat crop yield components. The use of poultry litter as a source of N, in the wheat crop, increases the final grain yield, being an alternative for partial replacement, when associated with urea, or total N. Wheat grown in succession to *R. sativus* and *A. strigosa + R. sativus* intercropping showed better agronomic performance and final grain yield.

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