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Scientific Article

Tobacco stalk and poultry litter as nutrient sources for lettuce cultivation

Cama de frango e talos de tabaco como fontes de nutrientes no cultivo de alface

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ABSTRACT - The pursuit of sustainable agricultural practices has promoted the use of organic residues as alternative nutrient sources for vegetable crops. Lettuce, a short-cycle crop with high nutritional demand, shows potential to respond to such inputs. This study assessed the effects of tobacco stalk and poultry litter, applied at equivalent nitrogen rates, on soil fertility, plant nutrition, and lettuce yield. The experiment was conducted over two consecutive cycles in the experimental area of the Federal University of Paraná, Palotina, Paraná, Brazil, on a Typic Hapludox, using a randomized block design with four replications, in a double factorial arrangement, and a control treatment. Four nitrogen (N) rates were tested (50%, 100%, 150%, and 200% of the recommended rate). Soil fertility attributes, foliar nutrient accumulation, growth and yield. Soil organic matter, potassium and phosphorus contents, and foliar N accumulation were not affected. Plant diameter was 23.1 and 20.1 cm with poultry litter (124.8% N) and tobacco stalk (105.6% N), respectively. In the first cycle, yields was 10.58 Mg ha^{-1} (poultry litter) and 7.72 Mg ha^{-1} (tobacco stalk) at a dose of 113% N. In the second cycle, yields increased linearly for poultry litter, averaging 13.9 Mg ha^{-1} and reaching 13.2 Mg ha^{-1} with tobacco stalk at 114.8% N. Tobacco stalk demonstrates potential as an alternative N source, with performance comparable to poultry litter.

Keywords: Organic residues. *Lactuca sativa* L., Sustainable agriculture. Alternative nutrient sources. Nitrogen.

RESUMO - A busca por práticas agrícolas sustentáveis tem promovido o uso de resíduos orgânicos como fontes alternativas de nutrientes para o cultivo de hortaliças. A alface, cultura de ciclo curto e alta exigência nutricional, pode responder positivamente a esses insumos. Este estudo avaliou os efeitos da aplicação de talos de tabaco e cama de frango, aplicados em doses equivalentes de nitrogênio, na fertilidade do solo, nutrição das plantas e a produtividade da alface. O experimento foi conduzido durante dois ciclos consecutivos, na área experimental da Universidade Federal do Paraná, em Palotina, PR, sobre um Latossolo Vermelho Eutroférrico típico, utilizando delineamento em blocos ao acaso com quatro repetições, arranjo fatorial duplo e tratamento controle. Foram testadas quatro doses de nitrogênio (N) (50, 100, 150 e 200% da dose recomendada). Avaliaram-se atributos de fertilidade do solo, acúmulo de nutrientes foliares, crescimento e produtividade. A matéria orgânica, potássio e fósforo no solo, acúmulo de N foliar não foram influenciados. O diâmetro de planta foi de 23,1 e 20,1 cm com cama de frango (124,8%) e talo de fumo (105,6% N), respectivamente. No primeiro ciclo, as produtividades foram de 10,58 Mg ha^{-1} (cama de frango) e 7,72 Mg ha^{-1} (talo de tabaco), na dose de 113% N. No segundo ciclo, a produtividade aumentou linearmente para cama de frango, com média de 13,9 Mg ha^{-1} e atingiu 13,2 Mg ha^{-1} com talo de fumo a 114,8% N. O talo de tabaco possui potencial como fonte alternativa de N, com desempenho próximo ao da cama de frango.

Palavras-chaves: Resíduos orgânicos. *Lactuca sativa* L., Agricultura sustentável. Fontes alternativas de nutrients. Nitrogênio.

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INTRODUCTION

Lettuce (*Lactuca sativa* L.) is a significant vegetable in the Brazilian diet, serving as a rich source of vitamins and minerals. Its popularity stems not only from its pleasant flavor and nutritional quality but also from its affordability and accessibility, making it one of the most widely consumed vegetables in Brazil (RODRIGUES et al., 2016).

Lettuce exhibits a strong response to nitrogen (N) fertilization due to its short cycle, demonstrating high potential for utilizing organic nutrient sources. N is a critical nutrient for lettuce vegetative growth, and its deficiency can lead to stunted growth, poor head formation, chlorosis of older leaves, and potential leaf abscission (MOTTA, 2016; SANTOS et al., 2018a).

In lettuce cultivation, often practiced in small-scale systems, organic nutrient sources serve as effective nutritional supplements. The application of organic residues provides a sustainable approach for recycling waste generated on rural properties. Tobacco stalk and poultry litter are among residues recognized for their potential as soil conditioners, improving soil physical, chemical, and biological characteristics (ALGERI et al., 2018; BOHARA et al., 2019; ALGERI et al., 2021).

Poultry litter, a widely utilized agricultural residue, is generated during the replacement of bedding material in poultry houses after multiple chicken production cycles. Tobacco stalk, another significant residue in tobacco-producing regions, is generated during processing after the harvest and drying of tobacco plants. In Paraná, tobacco stalks are removed post-drying during the curing process, when leaves are manually separated from the stalks. In contrast, in Rio Grande do Sul, leaves are harvested based on their maturation stage, and the stalks remain in the field, later incorporated into the agricultural system (HIRSCH; LANDAU, 2020).

Although limited research exists on the use of tobacco stalk as an organic nutrient source, studies have investigated tobacco dust in tree seedling production and the nutritional quality of compost derived from tobacco residues (FENILLI; SCHORN; NASATO, 2010; PRIMO et al., 2010).

This study evaluated the effects of tobacco stalk on lettuce production, assessing its impact on soil fertility and crop yield compared to poultry litter, a widely used and studied organic nutrient source.

MATERIAL AND METHODS

The experiment was conducted at the Federal University of Paraná, Palotina, Paraná, Brazil (24°17'36"S and 53°50'27"W), across two curly lettuce crop cycles. The region's climate is classified as Cfa (humid subtropical mesothermic) according to Köppen and Geiger (1928), with mean temperatures ranging from 15 °C in winter to 37 °C in summer, annual rainfall of 1650 mm, and the predominant soil type is Typic Hapludox (Latossolo Vermelho Distroférrico; SANTOS et al., 2018b). Climate data for the experimental period are presented in Figure 1.

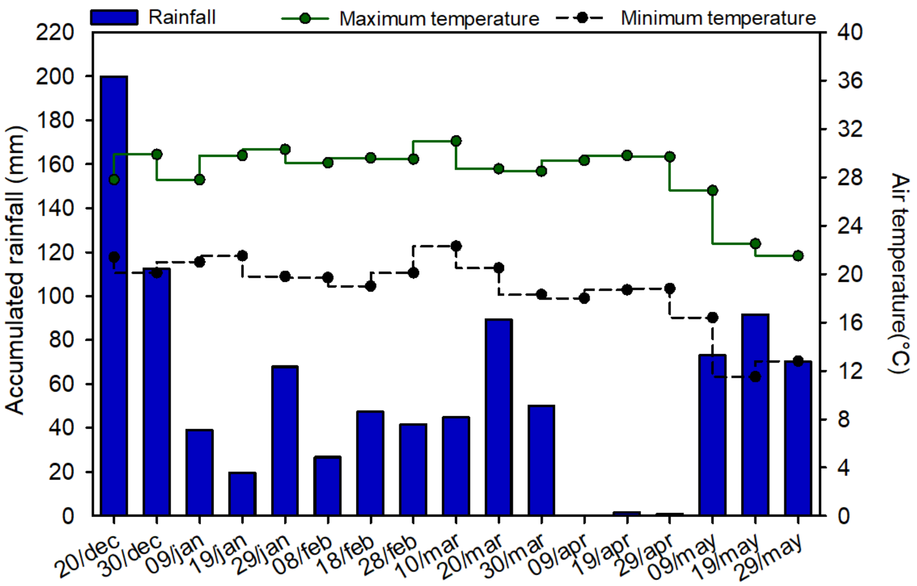

Figure 1. Rainfall (mm) and maximum and minimum temperatures (°C) during two curly lettuce crop cycles fertilized with organic nitrogen (N) sources. Palotina, PR, Brazil. Source: Agritempo (2024).

Soil fertility and granulometry in the 0.0–0.2 m layer was assessed prior to the start of the experiment, following the methodology of Raij et al. (2001), and the results are presented in Table 1.

Table 1. Chemical and physical characterization of soil in the experimental area prior to the first curly lettuce crop cycle under organic nitrogen fertilization.

pH	OM	C	P	Al^{3+}	$H+Al^{3+}$	K	Ca	Mg	Clay	Silt	Sand
$CaCl_2$	g dm^{-3}		mg dm^{-3}	------------------------ cmol$_c$ dm^{-3} ------------------------						%	
5.40	46.7	27.1	13.0	0.0	4.28	0.62	6.86	1.83	20.0	18.8	61.3

OM = organic matter. Methodology by Raij et al. (2001).

A randomized block experimental design with four replications (n = 36) was used, in a double factorial arrangement with an additional treatment (2×4+1), consisted of two N sources (tobacco stalk and poultry litter), four organic residue rates based on the percentage of the recommended N rate, and a control treatment without fertilizer application (Table 2). Each experimental unit consisted of a 1.0 × 1.30 m area (1.30 m^2), with 16 plants arranged in 4 rows and spaced at 25 cm between plants and 30 cm between rows. The treatments were evaluated in two crop cycles. The recommended N rate (40 kg ha^{-1}) was established based on regional studies using N-P-K formulations, as described in SBCS (2016). Other elements, such as phosphorus (P) and potassium (K), were present in the materials in variable amounts but were not used to determine application rates.

Table 2. Treatments, sources, and application rates of organic nutrient sources for curly lettuce crops.

Treatments	Source	Rate (%) *
T1	-	0
T2	Poultry litter	50
T3	Poultry litter	100
T4	Poultry litter	150
T5	Poultry litter	200
T6	Tobacco stalk	50
T7	Tobacco stalk	100
T8	Tobacco stalk	150
T9	Tobacco stalk	200

*Percentage of the recommended nitrogen rate (40 kg ha^{-1}) described by SBCS (2016).

Poultry litter and tobacco stalk were sourced from broiler poultry farming and tobacco cultivation activities on a rural property in Jesuítas, PR. The poultry litter was collected from a poultry house after 12 production cycles and subjected to a controlled fermentation process to ensure stabilization for application. The tobacco stalk was left to undergo natural decomposition near a tobacco drying shed, ready for safe and efficient use as a nutrient source for the crop. The nutrient contents of each material are detailed in Table 3.

Table 3. Chemical characterization of organic residues used as fertilizer sources for lettuce crops.

Residues	N	P	K	OM	C	DW-1	DW-2
	------------------- g kg^{-1} -------------------			----------------------------- % -----------------------------			
Poultry litter	25.70	54.00	36.00	25.72	14.92	70.00	78.12
Tobacco stalk	38.37	8.08	8.96	36.19	20.99	62.56	42.11

OM = organic matter; DW-1 and DW-2 = dry weight at the first and second cycles, respectively, according to the methodology of Silva (2009). N content was obtained by steam distillation, Kjeldahl; P and K contents were obtained by spectrophotometry with molybdenum blue and flame photometry, respectively.

The organic residue application rates were determined using Equation 1 (SBCS, 2016), with details provided in Table 4 for poultry litter and Table 5 for tobacco stalk:

$$AQ = \left(\left(\frac{AxB}{100}\right) \times \left(\frac{C}{100}\right) \times D\right) \qquad (1)$$

where:
AQ = available quantity (kg ha^{-1});
A = quantity of material applied (kg ha^{-1})
B = percentage of dry weight of the material;
C = percentage of the nutrient in the dry weight;
D = efficiency index of each nutrient, with N = 0.50, P = 0.70, and K = 1.00.

Table 4. Characterization of poultry litter residue quantities (kg ha^{-1}) as a function of nitrogen rates applied in lettuce cultivation during the first (FLC) and second (SLC) crop cycles.

Rate (%)	FLC	Nitrogen	Phosphorus	Potassium	SLC	N	P	K
0	-	-	-	-	-	-	-	-
50	2223	20	58.8	56.0	1655	20	52.8	50.3
100	4447	40	117.7	112.1	3309	40	105.6	100.6
150	6670	60	176.5	168.1	4964	60	158.4	150.9
200	8894	80	235.3	224.1	6619	80	211.2	201.1

Table 5. Characterization of tobacco stalk residue quantities (kg ha^{-1}) as a function of nitrogen rates applied in lettuce cultivation during the first (FLC) and second (SLC) crop cycles.

Rate (%)	FLC	Nitrogen	Phosphorus	Potassium	SLC	N	P	K
0	-	-	-	-	-	-	-	-
50	1655	20	6.6	10.4	3706	20	14.7	23.2
100	3309	40	87.6	83.4	7412	40	29.3	46.5
150	4964	60	131.4	125.1	11117	60	44.0	69.7
200	6619	80	175.1	166.8	14823	80	58.7	93.0

The applied treatments were incorporated in demarcated plot areas, and seedlings were transplanted 7 days after incorporation. Curly lettuce seedlings, obtained from a nursery in Cascavel, PR, approximately 28 days after sowing, were transplanted on January 25, 2018, for the first cycle, and April 17, 2018, for the second cycle.

Dependent variables were assessed in four central plants of each plot at harvest. Total plant height (cm) and diameter (cm) were measured, with height determined from the soil surface to the highest leaf tip and diameter measured at the widest point across the plant, using a ruler. Plants were harvested 35 days after seedling transplanting in the first cycle and 42 days in the second cycle, and the following variables were evaluated: total fresh weight (without roots) (g), marketable fresh weight (commercial leaves) (g), dry weight (g), and yield (Mg ha^{-1}).

After the harvest and initial assessments, plants were dried in a forced-air circulation oven at 60 °C for 72 hours. The samples were then reweighed to determine dry weight (g), ground in a knife mill with a 1-mm sieve, and submitted to laboratory analyses to quantify N and P contents in the plant tissue, using sulfuric digestion, following the methodology of Silva (2009). Soil K, P, and organic matter contents in the 0.00–0.10 m layer were also determined post-harvest for each lettuce crop cycle, using the methodology of Raij et al. (2001) and Embrapa (1997).

The data were subjected to analysis of variance (ANOVA) using the F-test ($p \leq 0.05$), followed by fitting to polynomial regression models ($p \leq 0.05$).

RESULTS AND DISCUSSION

The soil in the production area exhibited adequate acidity, base saturation > 60%, absence of exchangeable aluminum, and medium to high organic matter, phosphorus (P), and potassium (K) contents (Table 1) (SBCS, 2016; CANTARELLA et al., 2022). Soil K contents showed no significant differences after harvest, though reductions were observed compared to the initial analysis, decreasing from 0.62 cmolc dm^{-3} to 0.48 cmolc dm^{-3} (poultry litter) and 0.38 cmolc dm^{-3} (tobacco stalk) after the first cycle, and to 0.26 cmolc dm^{-3} (poultry litter) and 0.19 cmolc dm^{-3} (tobacco stalk) after the second crop (Figure 2).

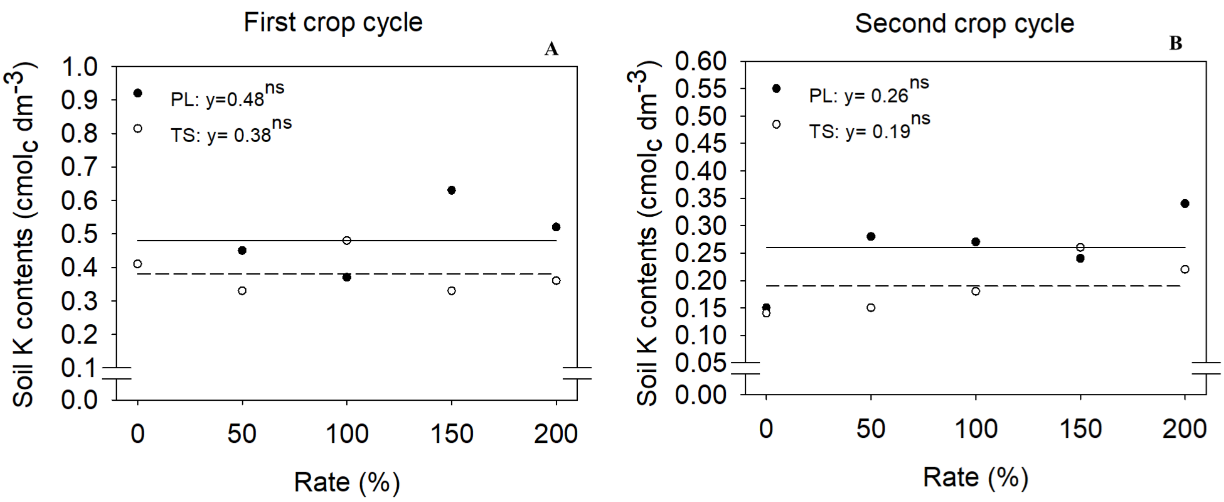

Figure 2. Soil potassium (K) contents as a function of treatments with poultry litter (PL) and tobacco stalk (TS) rates applied during the first (A) and second (B) lettuce crop cycles. Regression equations were not significant ($p \leq 0.05$). Rate (%) refers to the percentage of the recommended N rate of 40 kg ha^{-1} supplied by the residues.

Reductions in soil K contents are likely due to the crop's high K demand and the dynamics of K availability, as K is not integrated into plant molecules or functional structure (PITTA et al., 2012; SUBLETT; BARICKMAN; SAMS, 2018). The applied K rates at the rates of 150% and 200% were 160 and 213 kg ha^{-1} for poultry litter and 97 and 130 kg ha^{-1} for tobacco stalk, respectively. For soils with medium to high K contents, an application of approximately 70 kg ha^{-1} of K is recommended (PAULETTI, 2019). In this study, higher rates than recommended were applied; however, soil K availability was not maintained by the organic compounds due to their physical or chemical properties.

Soil P contents showed no significant differences, though contents tended to increase with the addition of organic residues (Figure 3) compared to the initial content (Table 1). Poultry litter resulted in mean P contents of 67.2 and 66.9 mg dm^{-3}, whereas tobacco stalk resulted in 63.0 and 52.7 mg dm^{-3} for the first and second crop cycles, respectively. As fertilization management was based on the N rate, poultry litter supplied excess P, leading to P accumulation in the soil. Moreover, when applied to acidic soils such as Typic Hapludox, poultry litter may enhance P solubility from the residue (SOUZA et al., 2012).

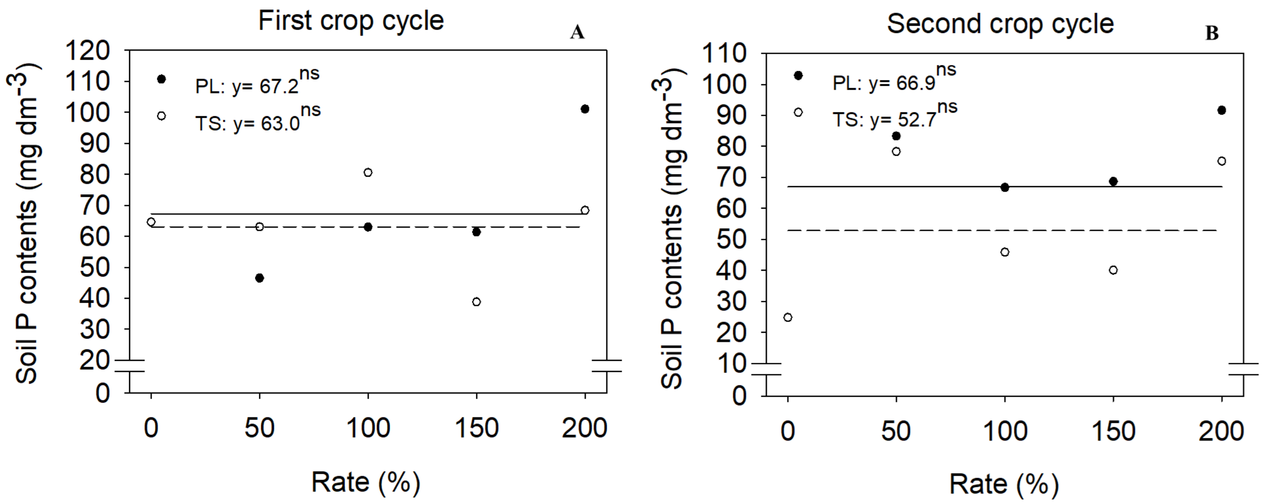

Figure 3. Soil phosphorus (P) contents as a function of treatments with poultry litter (PL) and tobacco stalk (TS) rates applied during the first (A) and second (B) lettuce crop cycles. Regression equations were not significant ($p \leq 0.05$). Rate (%) refers to the percentage of the recommended N rate of 40 kg ha^{-1} supplied by the residues.

No significant effects were observed for soil organic matter contents (Figure 4). Similar to the trends for K and P, soil organic matter contents decreased compared to the initial levels, with means of 32.41 and 30.18 g dm^{-3} for poultry litter, and 33.15 and 29.23 g dm^{-3} for tobacco stalk in the first and second cycles, respectively.

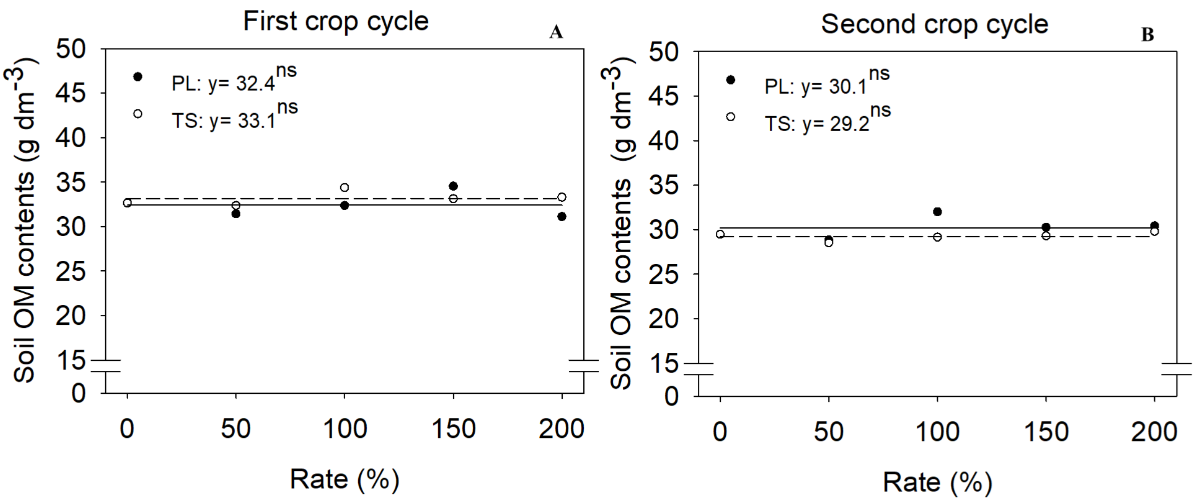

Figure 4. Organic matter (OM) contents as a function of treatments with poultry litter (PL) and tobacco stalk (TS) rates applied during the first (A) and second (B) lettuce crop cycles. Regression equations were not significant ($p \leq 0.05$). Rate (%) refers to the percentage of the recommended N rate of 40 kg ha^{-1} supplied by the residues.

Thus, soil K and organic matter contents were not significantly altered by the application and rates of the residues, showing reductions across both crop cycles. This is likely attributable to the greater nutrient extraction by the crop to meet its nutritional demands compared to the amounts supplied by the residue, despite their potential as alternative nutrient sources (SALDANHA; RIBEIRO, 2021).

Variations in plant development were observed through measurements of plant height and plant diameter. Lettuce plants exhibited reduced plant height and diameter in the first cycle, but showed normal development in the second cycle. Originating from a temperate climate, lettuce generally exhibits inferior quality attributes when grown in summer, such as poor head formation and reduced fresh weight. These quality attributes are influenced by both cultivar characteristics and seasonal factors. Lettuce crops under stress conditions, such as high temperatures and long photoperiods, have limited growth, which shortens its development cycle and compromises product quality (BLAT et al., 2011; BENTO, 2017).

The results revealed significant effects of soil fertilization with organic residues on plant diameter, height, yield, total fresh weight (without roots), marketable fresh weight, dry weight, and leaf P content. However, no significant effects were observed for leaf N content. Regarding quality, this indicates that organic residue application positively influenced plant structural development (diameter and height) and yield, and leaf P content, an essential nutrient for energy metabolism and plant growth (COSTA et al., 2024). The lack of significant effect on leaf N content may suggest that the N availability in the residues was insufficient to affect N accumulation.

In the first cycle, plant diameter was influenced by the application of the organic residues, with both showing similar effects, fitting to a quadratic model (Figure 5A). Poultry litter at the rate of 124.8% was the most efficient rate, resulting in a plant diameter of 23.11 cm, while tobacco stalk at the rate of 105.6% achieved the highest mean diameter of 20.10 cm.

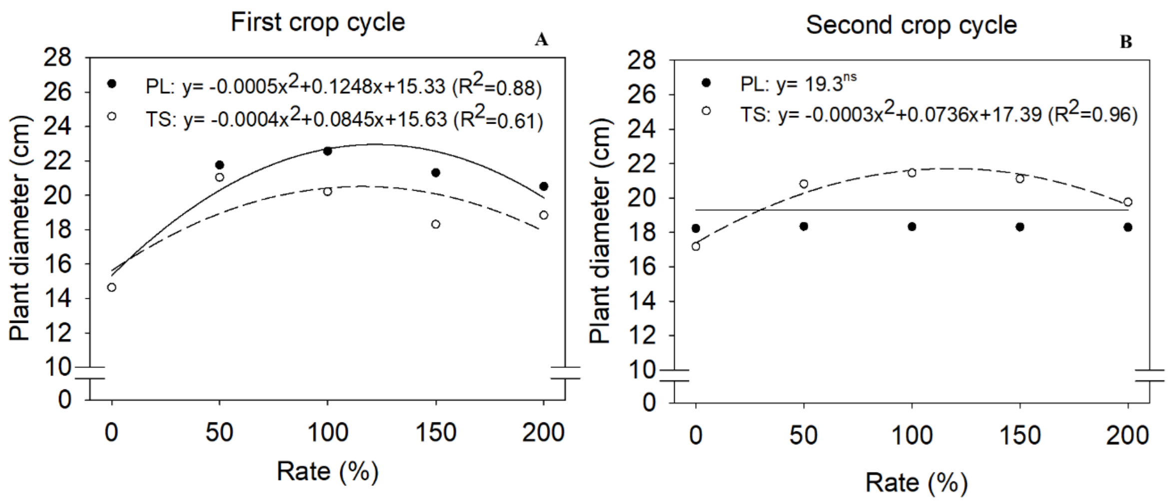

Figure 5. Diameter (cm) of curly lettuce plants as a function of treatments with poultry litter (PL) and tobacco stalk (TS) rates applied during the first (A) and second (B) lettuce crop cycles. Regression equations are shown for significant models ($p \leq 0.05$). Rate (%) refers to the percentage of the recommended N rate of 40 kg ha^{-1} supplied by the residues.

In the second cycle, the effects of the residues diverged (Figure 5B). Plant diameter data for tobacco stalk fitted a quadratic model, indicating that the rate of 123% was the most efficient, resulting in a diameter of 21.9 cm. In contrast, the application of poultry litter rates showed no significant effect, resulting in a mean diameter of 19.3 cm. These results are contrary to those reported by Marchi (2006), who observed that poultry litter increased plant diameter.

Plant height was significantly influenced by the residues in the first cycle (Figure 6A). Poultry litter exhibited the most efficient rate at 125.5%, resulting in a mean plant height of 15.26 cm, whereas tobacco stalk showed no significant effect, with a mean of 12.30 cm obtained across treatments. In the second cycle (Figure 6B), poultry litter achieved a mean plant height of 13.17 cm, while tobacco stalk showed a significant effect, with the rate of 161.5% resulting in the highest response (13.37 cm). Algeri et al. (2018) reported a mean plant height of 20.20 cm for poultry litter, which is higher than the values observed in this study.

The results indicate that the application of organic residues influenced plant diameter and height. This effect is primarily attributable to the improved nutritional conditions provided by the organic residues. The addition of residues likely enhanced the availability of essential nutrients, which are critical for the vegetative growth of lettuce.

The rates of organic residues exhibited varying effects on plant yield, total fresh weight (without roots), marketable fresh weight, and dry weight. In the first cycle, yield was influenced solely by the N rates supplied by poultry litter, achieving a yield of 10.58 Mg ha^{-1} at the most efficient rate of 113.1%. The mean yield of plants treated with tobacco stalk was 7.72 Mg ha^{-1} (Figure 7A).

In the second cycle, crop yield increased linearly with poultry litter application rates, achieving a mean yield of 13.9 Mg ha^{-1}, while tobacco stalk at a rate of 114.8% resulted in a mean yield of 13.2 Mg ha^{-1} (Figure 7B). Marchi (2006) observed an increase in yield with poultry manure, attributing it to its greater susceptibility to mineralization and the availability of nutrients within the residue. Similarly, Queiroz, Cruvinel and Figueiredo (2017) reported a yield increase with poultry litter application.

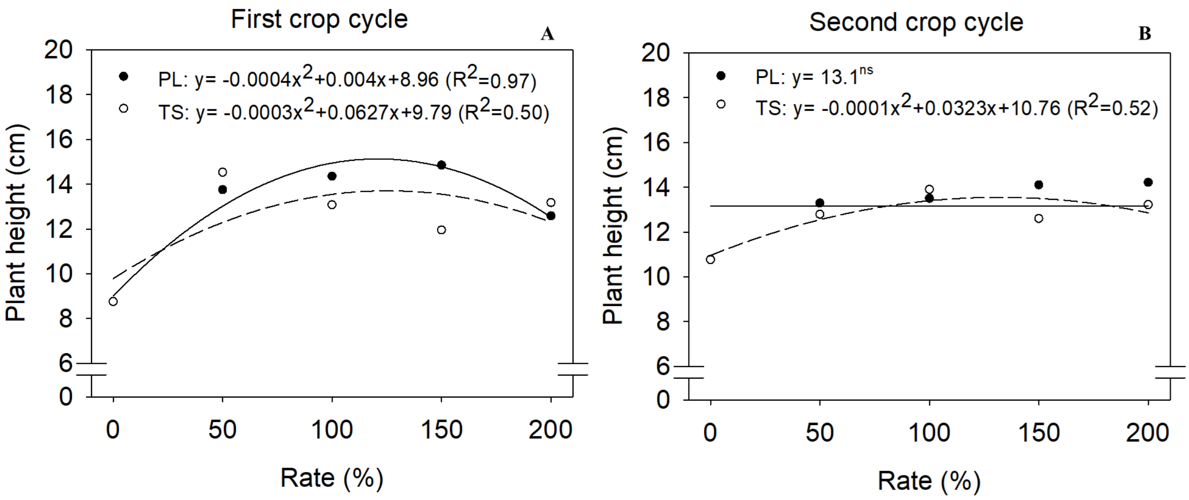

Figure 6. Plant height (cm) of curly lettuce plants as a function of treatments with poultry litter (PL) and tobacco stalk (TS) rates applied during the first (A) and second (B) lettuce crop cycles. Regression equations are shown for significant models ($p \leq 0.05$). Rate (%) refers to the percentage of the recommended N rate of 40 kg ha^{-1} supplied by the residues.

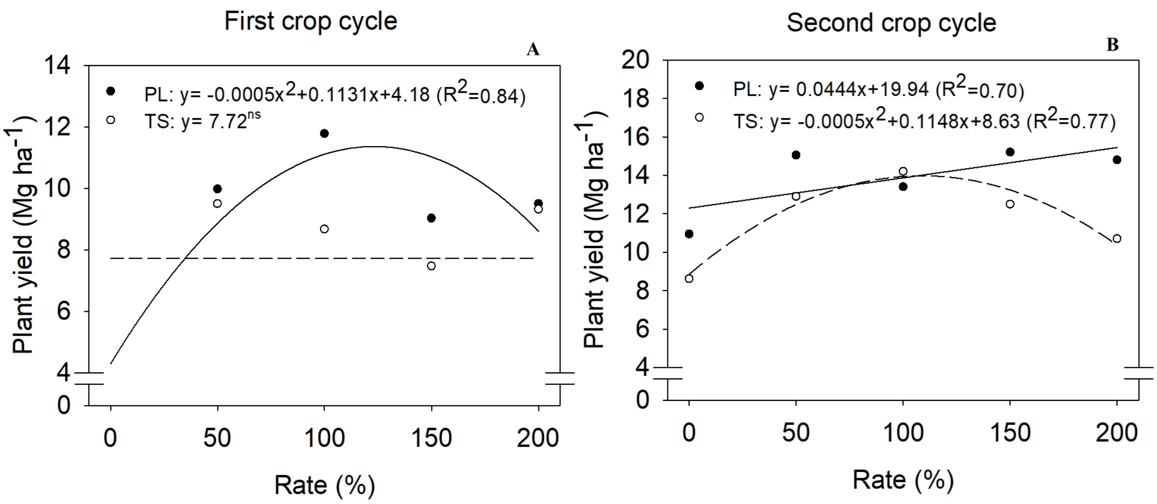

Figure 7. Yield of curly lettuce plants as a function of treatments with poultry litter (PL) and tobacco stalk (TS) rates applied for the first (A) and second (B) lettuce crop cycles. Regression equations are shown for significant models ($p \leq 0.05$). Rate (%) refers to the percentage of the recommended N rate of 40 kg ha^{-1} supplied by the residues.

Thus, the lettuce plant yield, total fresh weight (without roots), marketable fresh weight, and dry weight exhibited similar trends. Significant effects were observed for poultry litter, with the most efficient rates being 124.7%, 125.1%, and 112.5%, respectively, whereas no significant effects were observed for tobacco stalk, with mean values of 57.84, 51.2, and 3.38 g plant^{-1}, respectively, in the first cycle (Figure 8A, 8C, and 8E). In the second cycle, an opposite trend was observed for total fresh weight (without roots), marketable fresh weight, and dry weight (Figure 8B, 8D, and 8F). These parameters showed similar patterns in treatments with poultry litter, with data fitting to linear models, achieving 146.7, 140.6, and 7.9 g plant^{-1}, respectively, whereas tobacco stalk rates exhibited significant effects, with the highest efficiency at 120.2%, 124%, and 136.8%, resulting in mean values of 119.5, 101.4, and 7.7 g plant^{-1}, respectively.

Santos et al. (2014) reported that increasing poultry litter rates led to a linear increase in dry weight and N accumulation, which was attributed to the quantity of nutrients applied through the organic residue and their availability in the soil. The absorption of these nutrients contributed to plant development, subsequently increasing fresh and dry weights. Similar results were reported by Marchi (2006) and Peixoto Filho et al. (2013), who found that chicken manure treatment produced the highest values for fresh weight, dry weight, and yield.

Leaf N accumulation was not significantly affected by the treatments (Figure 9), differing from results observed by Abreu et al. (2010), who reported that the use of poultry manure increased nutrient contents, achieving high N concentrations.

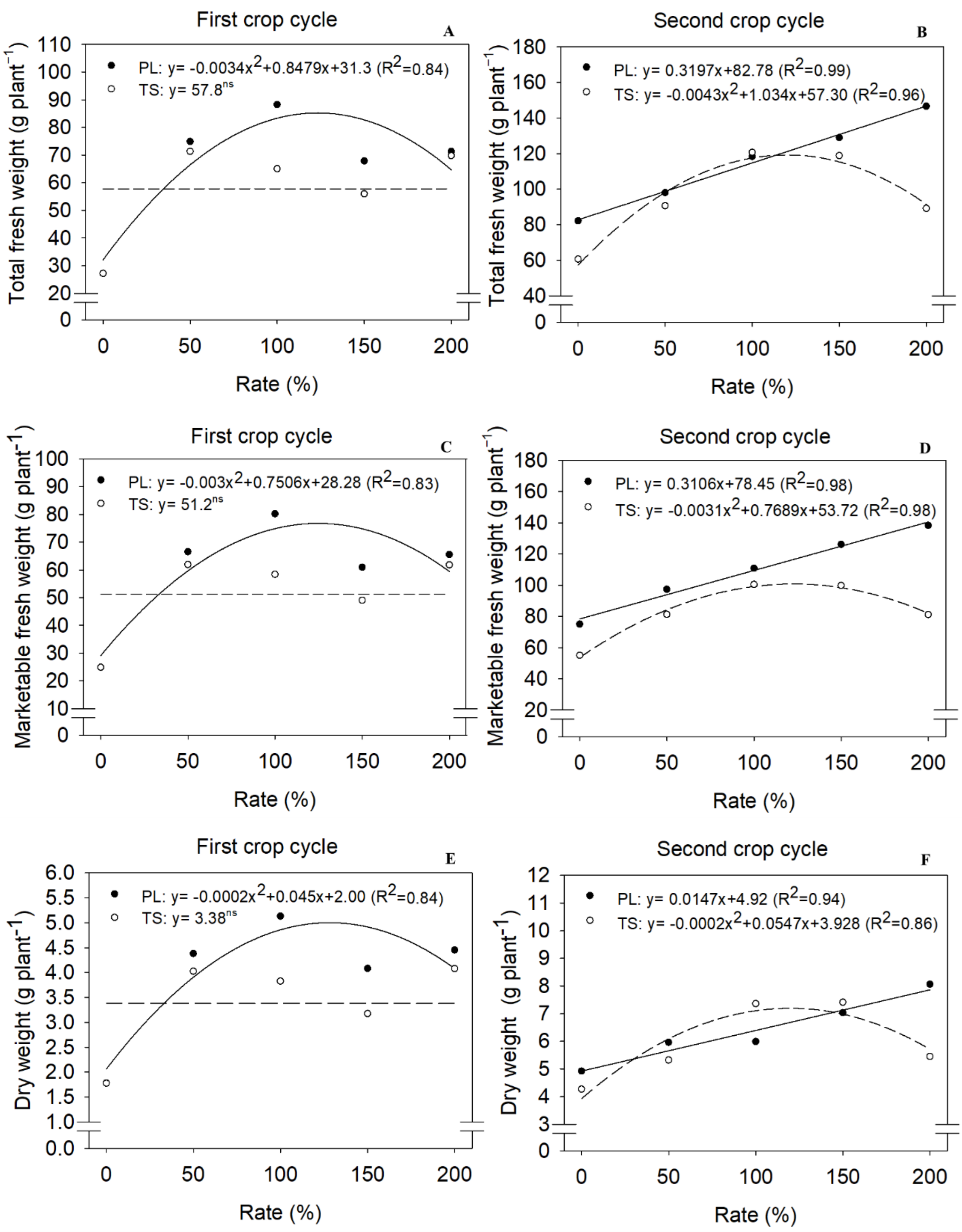

Figure 8. Total fresh weight (A and B), marketable fresh weight (C and D), and dry weight (E and F) of curly lettuce plants as a function of treatments with poultry litter (PL) and tobacco stalk (TS) rates applied for the first and second lettuce crop cycles. Regression equations are shown for significant models ($p \leq 0.05$). Rate (%) refers to the percentage of the recommended N rate of 40 kg ha^{-1} supplied by the residues.

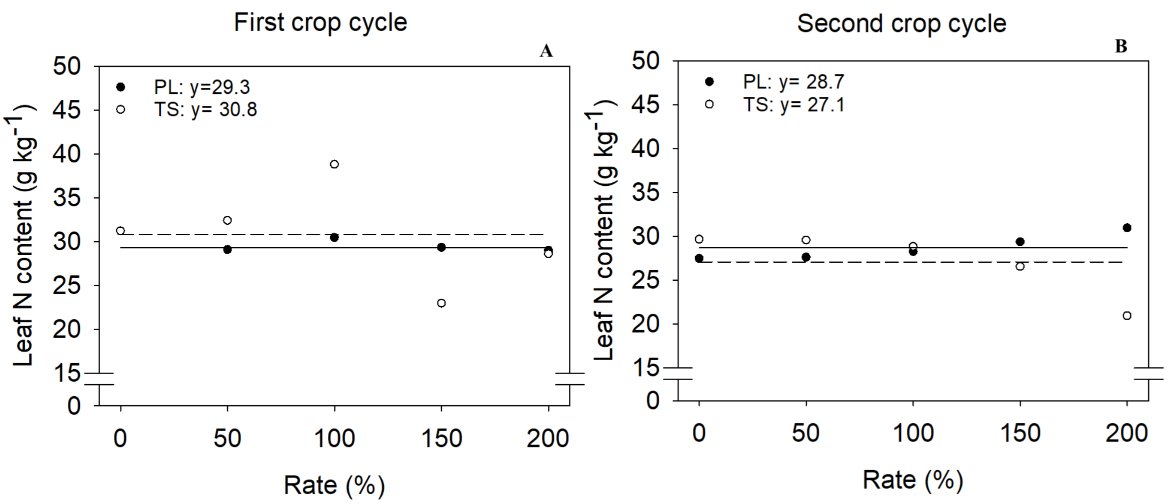

Figure 9. Leaf nitrogen (N) contents in curly lettuce plants as a function of treatments with poultry litter (PL) and tobacco stalk (TS) rates applied for the first (A) and second (B) lettuce crop cycles. Regression equations were not significant ($p \leq 0.05$). Rate (%) refers to the percentage of the recommended N rate of 40 kg ha^{-1} supplied by the residues.

The first and second lettuce crop cycles were comparable, with all evaluated characteristics influenced by the applied organic residue rates, except for leaf N content. The primary difference between the cycles was that, in the second cycle, all analyzed variables were numerically higher, except for leaf N accumulation, likely due to cultivation during a more favorable season.

In the first cycle, leaf P accumulation increased as the residue rates increased; however, rates exceeding 100% reduced leaf P accumulation (Figure 10A). In the second cycle, poultry litter resulted in the highest foliar P accumulation, of 6.6 g kg^{-1}. In contrast, tobacco stalk application showed significant effects, reaching its highest efficiency, 129.4%, with a corresponding foliar P concentration of 6.1 g kg^{-1}.

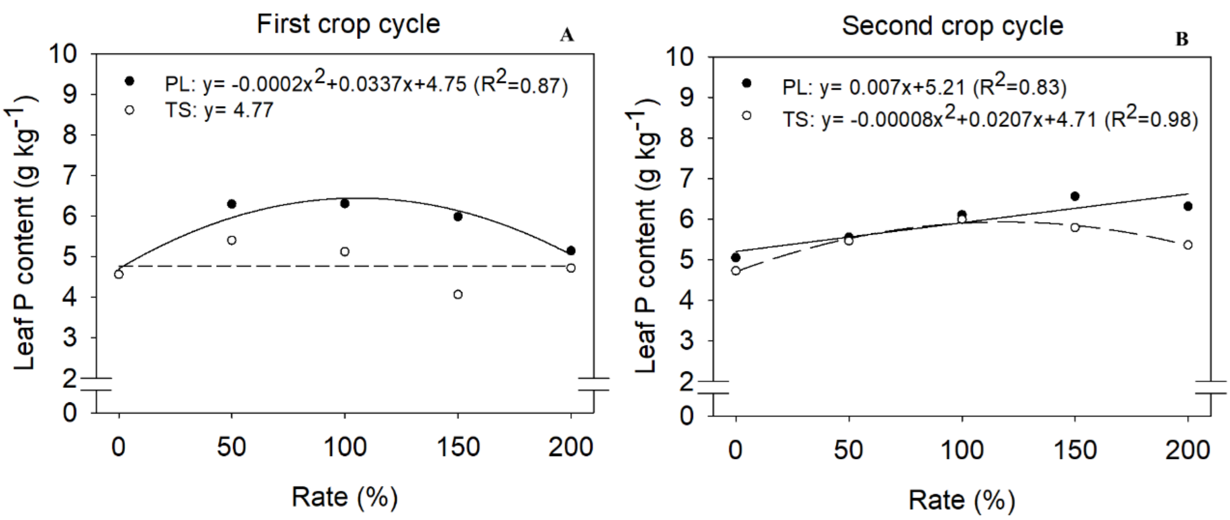

Figure 10. Leaf phosphorus (P) content in curly lettuce plants as a function of treatments with poultry litter (PL) and tobacco stalk (TS) rates applied for the first (A) and second (B) lettuce crop cycles. Regression equations shown for significant models ($p \leq 0.05$). Rate (%) refers to the percentage of the recommended N rate of 40 kg ha^{-1} supplied by the residues.

In the first cycle, poultry litter demonstrated stronger effects on the analyzed variables, likely due to its C-to-N ratio (C:N), which facilitates rapid N mineralization. As a result, organic matter mineralization was slower in treatments with tobacco stalk compared to poultry litter, potentially contributing to higher yields with poultry litter in the first cycle and comparable plant diameter, yield, and leaf P content in the second cycle. The C:N of poultry litter was 40% lower than that of tobacco stalk, supporting the hypothesis of faster poultry litter mineralization.

Tuzzin et al. (2015) reported that tobacco stalk contains high levels of cellulose and lignin, whereas poultry litter has undergone an extended decomposition period. Lignin resists decomposition, persisting longer in the system compared to cellulose and, consequently, has a residual rather than immediate effect.

Although the residues showed numerical differences between crop cycles, they were not significantly different, indicating that the use of these alternative nutrient sources for fertilization holds promising potential. According to Peixoto

Filho et al. (2013), organic and mineral fertilization have similar effects in the first cycle, but organic compounds tend to produce more consistent and higher results across subsequent crop cycles due to slow nutrient release and improvements in soil structuring. Thus, the improved crop performance during the second cycle can be attributed to the greater availability of mineralized nutrients from residues due to the prolonged contact with the soil.

The use of organic residues for soil fertilization in vegetable cultivation has increased in recent years, driven by the demand for alternative nutrient sources that replace or complement synthetic fertilizers and the growing demand for organic products.

CONCLUSION

Tobacco stalk and poultry litter are viable alternative nutrient sources for soil fertilization in curly lettuce cultivation, providing comparable performance in plant growth and yield. The application of both organic residues positively influenced plant diameter, height, and yield across two crop cycles, with poultry litter exhibiting higher effectiveness in the first cycle and tobacco stalk achieving comparable results in the second cycle. Thus, tobacco stalk is confirmed as a potential alternative nutrient source for lettuce crops, particularly when applied at approximately 100% of the recommended nitrogen rate. However, no significant effect on leaf nitrogen content was observed, indicating that the nitrogen released from both organic residues may be insufficient to immediate nitrogen accumulation. These findings underscore the potential of organic residues as nutrient sources.

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