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RESEARCH ARTICLE

POULTRY LITTER AS AN ALTERNATIVE SOURCE FOR NITROGEN IN WHEAT

[1]Gustavo Henrique Demari, *[,1]Ivan Ricardo Carvalho, [1]Maicon Nardino, [1]Vinícius Jardel Szareski, [2]Andrêssa Cristina Datsch Demari, [1]Alan Junior de Pelegrin, [1]Tamires da Silva Martins, [1]Nathan Lobler dos Santos, [3]Francine Lautenchleger, [1]Tiago Pedó, [4]Velci Queiróz de Souza, [1]Tiago Zanatta Aumonde, [3]Claudir José Basso and [1]Paulo Dejalma Zimmer

[1]Federal University of Pelotas, Brazil
[2]Development Institute of High Uruguay, Brazil
[3]Federal University of Santa Maria, Brazil
[4]Federal University of Pampa, Brazil

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ABSTRACT

Wheat grains have excelente bromatological quality, having high protein concentration. The increasing consumption of poultry meat is important for the economy, mainly in the states of Santa Catarina, Paraná and Rio Grande do Sul. The poultry industry generates high amount of waste, which can be used as fertilizer due to the concentration of nutrients and emerge as an alternative organic fertilizer for crops. The poultry litter can be characterized as waste composed by sawdust, wood shavings, rice hulls, poultry waste, feathers, ration residues, among others. However, the nitrogen must be supplied in optimum quantity and timing to ensure that the plant can express its maximum yield potential. Thus, the phenological stage that the plant is located is the indicator of the moment of nitrogen application. It is known that the various sources used to supply the nutritional demand of culture, express high added value, thus the use of poultry litter becomes an economic and environmentally sustainable alternative. The most practical definition for poultry litter is the material used to form the warehouse floor of the farms, composed of rice straw, grass hay, corn cobs, sawdust, wood shavings, feathers and ration residues. Among the nutrients, nitrogen is essential for wheat, because it increases the growth and development of the culture, having direct influence on the quality and quantity of grain. The use of poultry litter becomes an alternative to the producer, due to the need for material disposal, as well as the utilization of nutrient concentrations of compounds, that provide nutrients necessary for plant development.

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INTRODUCTION

Wheat (Triticum aestivum L.) originated from Southeast Asia, belongs to the Poaceae family and stands out as the most important cereal in the world economy, with an annual production of 600 million tons. The main worldwide producers and exporters are: European Union, United States and China, and importers: Brazil, China, India. In Brazil, the southern region stands out in cereal production in the winter period, producing 45.5% of the total Brazilian production (Conab, 2016). In recent years new sustainable strategies have been sought in the agricultural sector, especially regarding the fate of livestock productive systems waste, like the poultry litter, which is produced in large quantities in aviaries. The proper use of these wastes for fertilization can bring significant increase in productivity and significantly reduce the negative effects to the environment. The absence of symbiosis with micro-organisms causes grasses, such as wheat, respond positively to the increase of nitrogen in the soil solution. The fertilization with poultry litter as nutrient source may totally or partially replace the use of chemical fertilizers (Menezes, 2004). Wheat grains have excelente bromatological quality, having high protein concentration. It is considered a crop with medium investment and high risk during its development period, caused mainly by frost, hail and excessive rainfall (Wendt, 2007). Nitrogen fertilization is necessary for this crop. According to Frank & Bauer (1996) the availability of nitrogen in the cellular differentiation period, is strongly related to grain yield, because in this period occurs the development of the spike and spikelets. The same was seen for the other winter cereals, where the application of nitrogen in coverage at tillering stage provides increase in grain yield (Peruzzo, 2000). However, the high need of this nutrient by the plant reflects in high cost in production. According to Ragagnim (2013) most of the fertilizers used in Brazil are imported, which promotes an increase in cost. The increasing consumption of poultry meat is important for the economy, mainly in the states of Santa Catarina, Paraná and Rio Grande do Sul. The poultry

Corresponding author: Ivan Ricardo Carvalho
Federal University of Pelotas, Brazil.

industry generates high amount of waste, which can be used as fertilizer due to the concentration of nutrients and emerge as an alternative organic fertilizer for crops. Studies by Blum (2003) in cucurbits, demonstrate the potential use of poultry litter as an alternative to fertilization. According to Avila *et al*., (2007) The poultry litter can be used as a nutrient source for fertilizing crops. Silva *et al*., (2011), using poultry litter as a nitrogen source, observed increase in morphological parameters of corn plants. The poultry litter can be characterized as waste composed by sawdust, wood shavings, rice hulls, poultry waste, feathers, ration residues, among others. This organic waste is rich in nutrients, in which nitrogen highlights, that shows itself mostly in organic form, requiring a period of mineralization to be available for absorption (SANGOY *et al*., 2008). For that, this work aims to evaluate the possibility of using poultry litter as an alternative fertilizer in the fertilization of the wheat crop.

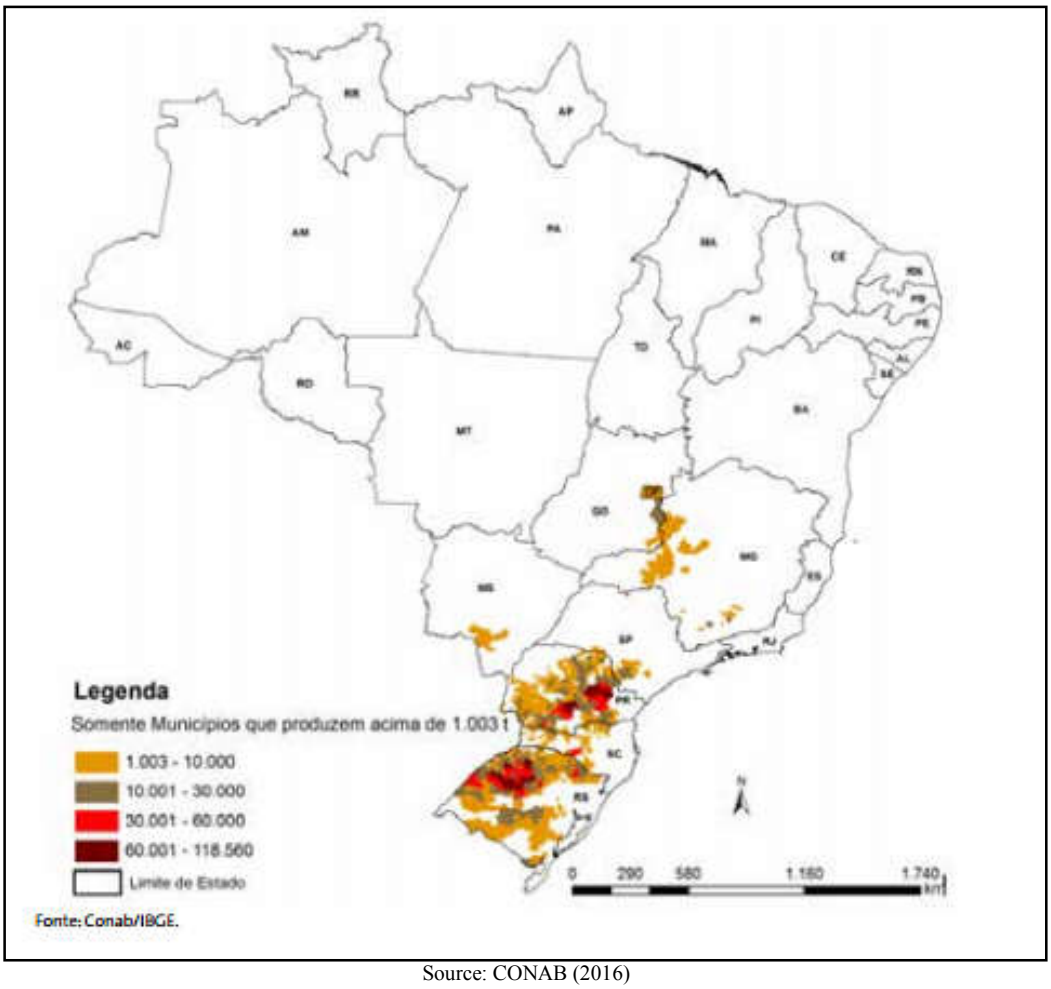
Characterization and origin of wheat

Wheat belongs to the *Poaceae* family, *Triticum* genus, which contains about 30 species. This genus presents seven chromosomes in its genome. The best known species are diploid, tetraploid and hexaploid wheats, and *Triticum monococcum* with 14 chromosomes, *Triticum durum* with 28 chromosomes, and *Triticum aestivum*, called common wheat, with 42 chromosomes. It is considered the species of greater commercial interest (Brammer, 2001).

The complexity of its genome is what provides the wide adaptation of wheat cultivars, and possible cultivation of this cereal in diverse environments (Walter *et al*., 2009). This culture is among the first crops domesticated by man between 7000-9000 BC in Southeast Asia, later introduced in India, China and Europe. In Brazil, it was introduced by the colonizers in the eleventh century, being the first agricultural activity in Brazil. The first Brazilian crops were in the state of São Paulo, and later in Rio Grande do Sul, where, along with Paraná, have the largest Brazilian production nowadays (Figure 1). Advances in research provided new genotypes to the market, more adapted to the regions, making its cultivation a lower risk activity, with greater adaptation and stability cultivars. Thus it became the main southern winter cereal being exported to different countries. Worldwide, wheat ranks first in volume of production. In our country, the annual production varies from 5 to 6 million tonnes, and on the other hand, the consumption remains at 10 million tons (CONAB, 2016). Factors like production incentive, high dependence on meteorological factors and low profit limit the growth of Brazilian wheat production.

Nitrogen fertilization in wheat

Studies conducted by Viana *et al*. (2007) show that wheat needs, for maximum grain yield, to choose the genotype with better adaptability and stability as well as high soil fertility. Among the nutrients needed for plant growth, nitrogen stands out. According to Scalco *et al*. (2002), the use of this element



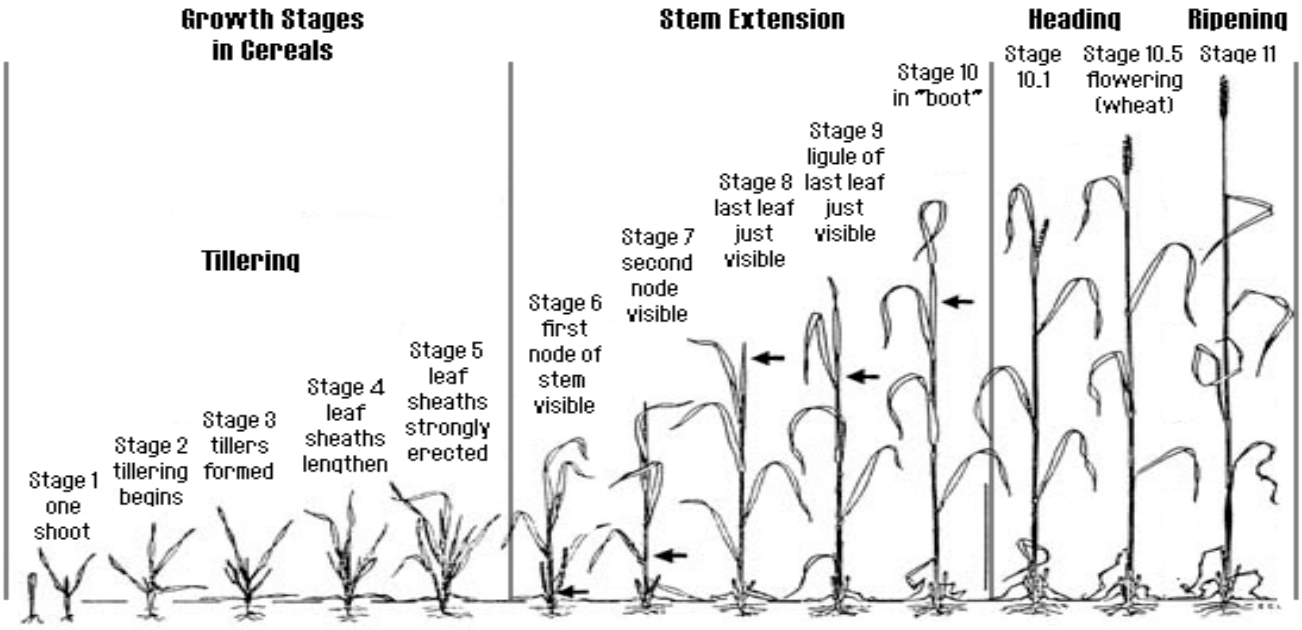
Source: CONAB (2016)

Figure 1. Map of wheat production in Brazil

in mineral form is necessary because the amount required by the plant exceeds the concentration available in the soil (Souza; Fernandes, 2006). Proper plant nutrition is essential for obtaining high yields of wheat crop. According to studies by Pettinelli Neto *et al*., (2002) nitrogen is one of the most required nutrients by the cereal. Nitrogen fertilization tends to be balanced, where the excess may harm the environment by nitrate leaching into groundwater, and to the producer by raising the cost of production. Nitrogen fertilizer shortage leads to a direct impact on the yield, being the most important nutrient in wheat production (Lamothe, 1998; Sylvester-Bradley *et al*., 2001).

In addition to the quantitative importance, studies by Coelho *et al*. (2001) show that the content and quality of proteins are affected by climate and soil conditions, and nutrient availability to the plant. The concentration and quality of protein without wheat determine the quality of the grain, and nitrogen becomes essential for quality increase in wheat (Soares Nephew, 1999).

However, the nitrogen must be supplied in optimum quantity and timing to ensure that the plant can express its maximum yield potential. Thus, the phenological stage that the plant is located is the indicator of the moment of nitrogen application. According to Feekes Scale (1954) wheat cycle is divided into five phases and within these, other sub-phases are included. In tillering period nitrogen levels should be adequate, because the lack of the nutrient causes significant losses in productivity (Benett *et al*., 2011). In addition to productivity, the appropriate moment of fertilization can reduce the risk of groundwater pollution caused by nitrate accumulation (Mahler *et al*., 1994). An alternative, in order to reduce the effect of nitrate leaching of nutrients is to split fertilizer application, because it provides greater nutrient uptake by the plant (Mundstock, 1999). The fertilization splitting can also bring benefits to industrial grain quality because the availability of nitrogen in the period of grain formation and filling contributes to the formation of protein in the grain (Rosa Filho, 2010).



Source: LARGE (1954)

Figure 2. Feekes Scale of wheat development stages

Nutrientes da cama de aviário

Nutriente	Kg/m³	Kg/ano
N	28	3.640
P_2O_5	21	2.730
K_2O	24	3.120

Fertilizantes minerais

Fertilizantes	Kg/ano
Ureia	8.090
ST	6.060
KCl	5.100

Source: Menezes (2004)

Figure 3. Comparison of poultry litter nutrient (kg) X mineral fertilizers (kg)

Poultry litter as an alternative source of nitrogen

The increase in the global consumption of poultry meat boosted the production growth of it in Brazil, consequently there was an increase in the waste production. One way to avoid exposure to the to the environment would be the use of these organic wastes in agriculture as a source of nutrients and organic matter. Concomitantly, with the high cost used in chemical fertilizers, the use of organic manure becomes economical and environmental alternative. Also, as shown in previous studies, using this residue enhances the chemical and physical properties of the soil, increasing fertility and consequently productivity gains (Souto *et al*., 2005). According to studies conducted by Felini (2011) using poultry litter as fertilizer in soybean and corn, it was shown an increase in productivity when applied doses up to eight tons per hectare. When comparing the nutrients from poultry litter with mineral fertilizers (Figure 3) it can be seen that as the poultry litter has a higher content of nitrogen, phosphorus and potassium, it is necessary less quantity in kilograms of fertilizer application per year, while with chemical fertilizer, it would be needed 8090 kg of urea (nitrogen). This is the equivalent amount of this urea in the poultry litter, being necessary only 3640 kg per year of manure, thereby reducing the cost of fertilizers. It is known that the various sources used to supply the nutritional demand of culture, express high added value, thus the use of poultry litter becomes an economic and environmentally sustainable alternative. The most practical definition for poultry litter is the material used to form the warehouse floor of the farms, composed of rice straw, grass hay, corn cobs, sawdust, wood shavings, feathers and ration residues. Studies are carried out in order to understand the use of animal manures for soil fertilization purposes, focusing on knowledge of its composition to its effect on chemical, physical and biological soil and plant productivity. The economic aspect of the use of these manures has also been studied, although with less intensity, particularly about the logistics of transporting the manure (economically viable distance) and the partial or total substitution of mineral fertilizer by organic fertilizer (Pandolfo, 2005). According to Prá (2005) the nitrogen from the solid fraction of the waste is under mineralization process, which includes the amination and ammonification processes, thereby transforming this organic nitrogen in mineral form, eventually being available to the plant. This process is regulated by the use of soil management and, as observed in studies carried out with the use of pig slurry, the transformation of nitrogen demonstrates efficiency, however, it is an extremely slow process (Sherer *et al*., 1994). Among the determinants factors for mineralization time of these residues, the soil influences directly, because its constituents change in the adsorption of these elements, which in many cases cause microbial activity limitations, retarding the process (Saggar *et al*., 1996). So that these resources can be used, it is recommended to follow the requirements of Fertilization and Liming Recommendation Manual for the states of Rio Grande do Sul and Santa Catarina (CQFS RS/SC, 2004), which displays the following parameters for recommendation of organic fertilization: dry matter content, nutrient release efficiency ratio (IELN) for organic fertilizer, nitrogen concentration, phosphorus and potassium.

Final considerations

Among the nutrients, nitrogen is essential for wheat, because it increases the growth and development of the culture, having direct influence on the quality and quantity of grain. The use of poultry litter becomes an alternative to the producer, due to the need for material disposal, as well as the utilization of nutrient concentrations of compounds, that provide nutrients necessary for plant development.

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