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No-tillage drilling of Italian ryegrass (*Lolium multiflorum* L.): Crop residue effects, yields and economic benefits

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Abstract

Variable practical results have been observed for no-till (NT) drilling of grasslands in Galicia, northwest Spain. One of the possible explanations to this erratic behaviour could be the influence of different types of stubble on drill performance and grassland emergence. Because the rotation of silage corn (*Zea mays* L.) with grassland is the most popular rotation in the Galician dairy farms at present, NT drilling of Italian ryegrass on corn stubble and ryegrass stubble was evaluated. Results were compared with NT drilling after shredded stubble and with conventional drilling (with tillage) for 5 years. Annual ryegrass establishment, biomass production, and forage production were measured each year. Treatments considered were: (1) NT on shredded ryegrass stubble; (2) NT on ryegrass stubble; (3) NT on corn stubble; (4) NT on shredded corn stubble; (5) conventional tillage (CT). Better plant stands and more forage production were obtained on the CT and NT-shredded treatments. Allelopathic effects were not observed, and the differences in plant stands among treatments could be caused by the physical effects of stubble and not by its physiological effects. The shredding operation improved plant stands and forage production of Italian ryegrass, which were not influenced by the type of stubble. Years with abundant rainfall negatively affected crop development, which was more evident in NT treatments. NT methods had advantages in terms of timeliness and low economic costs, as compared to CT.

Keywords: No-tillage; Grassland; Crop residue; Forage production; Shredder; Production costs

1. Introduction

In the last few years, dairy cattle farms in northwestern Spain have intensified forage production and tried to reduce the use of concentrates, which has resulted in higher net margins (Barbeyto, 1997). The rotation of annual Italian ryegrass with silage corn is considered an effective method to increase forage production on dairy cattle farms (Lloveras-Vilamanya, 1987). As compared to silage corn monoculture, this rotation shows further advantages such as decrease in N loss due to leaching (Baez et al., 2000), and increase in silage corn yield (Lubet et al., 1993; Zhou et al., 2000).

No-till (NT) drilling of grasslands can contribute to reducing production costs on farms. This system reduces the expenses of crop establishment because it requires fewer operations than conventional tillage (CT). Moreover, NT drilling reduces the time required for grassland establishment (which favours rotation with silage corn in intensive farms), and improves field trafficability (both for machinery and grazing cattle) (Bueno et al., 2006). However, little research deals with direct drilling of grasslands, which can be due to the fact

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that grasslands have been essentially used for grazing and haying until recently. Obtaining reliable measurements in a mixed crop-livestock system is not easy due to the difficulty of checking the amount of food consumed by animals, and of determining the amount of food assimilated by animals (Allen, 1981). In the United States, about 35% of NT corn in the northern dairy region is seeded after perennial forages. However, most information about NT drilling of corn in this region is based on research in corn–soybean (*Glycine max* L.) rotation, or on continuous corn (Smith et al., 1992).

Baker et al. (1996) stated that the main problem of NT establishment of grasslands lies in guaranteeing appropriate seeding depth and germination environment. In trials conducted in Aberdeen, Scotland, Marshall and Naylor (1984) observed that emergence with NT was poorer than emergence with CT. Cuomo et al. (1999) and Martínez (2000) reported similar conclusions. However, both authors verified that differences in the number of plants did not involve reductions in production. Because the results obtained are largely variable, some researchers do not recommend NT drilling of grassland after grassland, even in the case that the grassland is treated with non-selective herbicide (Piñeiro, 1997).

Erratic behaviour in stand establishment can be attributed to a physical effect of stubble, which hinders correct seed placement and appropriate row closure (Marshall and Naylor, 1984; Cuomo et al., 1999), or to a phytotoxic effect of stubble. Phytotoxic effect can be caused either by herbicide residues on the stubble, which is not very probable if glyphosate is applied (Klingman and Murray, 1976), or by the occurrence of allelopathic effects. Many authors have found different compounds obtained from decomposition of Italian ryegrass that act as inhibitors of germination and development of other crops or of ryegrass itself (Breland, 1996; Stirzaker and Bunn, 1996). However, the concentrations demanded for the occurrence of inhibition are usually high, and certain conditions (proximity to the residues, time passed after the residues are killed) are required for inhibition to become significantly apparent.

Not only ryegrass stubble can be detrimental for the emergence and development of ryegrass. Kato-Noguchi et al. (1998) isolated a compound, generated from decomposition of corn stubble (C1-MBOA), which inhibited the development of Italian ryegrass by more than 25% with a concentration of 40%. However, such a high concentration was obtained only in the laboratory.

Many studies have confirmed the economic advantages of various forms of conservation tillage. Bordegaray et al. (1996), in trials conducted in northern Spain for corn-Italian ryegrass rotation, observed savings of 64% in tillage time using direct drilling as compared to CT. In addition, these authors verified a substantial reduction in costs that would justify the use of CT only for yields at least 2.5 times higher than the yields obtained with NT.

We hypothesized that the type and state of stubble at the time of NT drilling could affect successful establishment of grasslands in northern Spain. This work aimed to: (1) compare crop establishment and final yield of Italian ryegrass with NT and CT; (2) analyse the effect of the type of stubble (corn or grassland) on crop establishment; (3) evaluate the effect of shredding before drilling on drill performance and crop emergence; (4) quantify the benefits of NT in terms of timeliness and economics.

2. Materials and methods

The experiment was carried out from 1998 to 2003 on the Gayoso-Castro farm (43°06′N, 7°27′W) in Castro de Ribeiras de Lea, 20 km north of Lugo, Spain. The soil was a gleyic Phaeozem (FAO, 1998) with sandy loam topsoil (35 cm depth), an average organic matter content of 8% and an average pH of 5.9. Site elevation was 420 m, with a level slope class (dominant slope <4%). Average annual temperature was 11.2 °C and average annual rainfall ranged from 1000 to 1300 mm, occurring mainly in the October to June period (Table 1). Due to the relevance of rainfall to the interpretation of the results obtained, Table 1 shows rainfall values for the trial period.

Annual Italian ryegrass (*Lolium multiflorum* L.) was sown at 40 kg ha^{-1} in all treatments. Sowing dates were 27 October 1998, 28 November 1999, 18 October 2000, 19/31(NT/CT) October 2001 and 28 October 2002. In 1999, the sowing date was delayed due to October rainfall, which caused failure in plant establishment. For this reason, there were no data available for the 1999–2000 growing season.

The following factors were considered: tillage system applied (NT or CT), type of stubble from the previous crop (corn or grassland), and performance or not of shredding operations before drilling. Many authors reported the occurrence of interactions among the various factors (Halsall et al., 1995; Stirzaker and Bunn, 1996; Shapiro et al., 2001), and the convenience of reducing the size of the experiment design. Therefore, a complete randomised block design with five treatments and four replications was used. Plots were 20 m long by 5 m wide. The five treatments were: