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Research Paper

Effects of corn treated with foliar fungicide on in situ corn silage degradability in Holstein cows

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ABSTRACT

With increasing feed prices and decreasing profit margins livestock producers are constantly searching for ways to increase nutritive value of the feed in order to get more production per unit of feedstuff. The objective of this study was to assess the digestibility of corn silage made of corn plants treated with various foliar fungicide applications. Treatments were: control (CON), corn received no foliar fungicide application; 1X, corn received one application of pyraclostrobin foliar fungicide (PYR; Headline; BASF Corp.) at vegetative stage 5 (V5); 2X, corn received 2 applications of foliar fungicides, PYR at stage V5, and a mixture of pyraclostrobin and metconazole (PYR + MET; Headline AMP; BASF Corp.) at reproductive stage 1 (R1); and 3X, corn received 3 applications of foliar fungicides, PYR at stage V5, PYR + MET at stage R1, and PYR + MET at reproductive stage 3. Corn was harvested at the same time and ensiled for 7 months. Dried unground corn silage was put into 288 (3 per time points/treatment/cow) 10 × 20 cm bags and incubated for 8 different time points (0, 2, 4, 8, 12, 48, 72, and 96 h). A sample of unground dried corn silage was also placed into 20 × 40 cm bag and incubated for 48 h. Digestibility of corn silages was estimated using in situ procedure with 3 rumen-cannulated lactating multiparous Holstein cows. The degradable fraction of dry matter (DM) tended to be greater ($P = 0.08$) for corn silages treated with fungicide when compared with CON. There was no treatment effect ($P > 0.05$) on neutral detergent fiber (aNDF), acid detergent fiber (ADF), starch, and crude protein (CP). However, the soluble fraction of DM, aNDF, and ADF decreased ($P < 0.05$) as fungicide applications increased. Effective degradability (ED) was greater ($P < 0.05$) in CON than corn silages treated with fungicide mainly due to decreased ED in 3X compared with 1X and 2X. In situ digestibility for bigger and smaller bags was different. Degradability of DM, aNDF, and ADF was higher ($P < 0.05$), while starch and CP degradability was lower ($P < 0.01$) in the larger bags. Fungicide application to corn for silage lead to higher DM degradable fraction which seems to be the result of increased sugar and starch along with decreased aNDF and ADF.

Abbreviations: 1X, treatment 1; 2X, treatment 2; 3X, treatment 3; ADF, acid detergent fiber expressed inclusive of residual ash; aNDF, neutral detergent fiber assayed with a heat stable amylase and expressed inclusive of residual ash; ANOVA, analysis of variance; ATP, adenosine triphosphate; CON, control; CP, crude protein; DM, dry matter; ED, effective digestibility, k_d, fractional digestion rate; MET, metconazole; NDF, neutral detergent fiber; NRC, National Research Council; PYR, pyraclostrobin; R1, reproductive stage 1; V5, vegetative stage 5.

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1. Introduction

As prices of feed increase, particularly corn, and nutritional demands of milk production increase, it is important to evaluate potential ways of increasing feed efficiency in the dairy cow leading to increased profitability for dairy farmers. During the course of a growing season corn plants can be exposed to many environmental stressors including heat, cold, drought, and pathogens (Rivero et al., 2001). Plant stress may lead to decreased quality of the plant when used for animal feed, to decreased potential for digestibility, and altered digestibility characteristics (Fahey et al., 1994). Fungal colonization on the corn plant causes a competition between the plant and the fungus for nutrients. The plant has many mechanisms (e.g., lignification and leaf shedding) to attempt to hinder the growth of the fungal infestation. These mechanisms may potentially decrease the digestibility of the plant. The fungal infestation itself may also change the chemical composition of the plant in the process of competing for nutrients (Venancio et al., 2009). Research also has examined the different effects of the foliar fungicide on the plant at a chemical level (Köhle et al., 2002). The class of foliar fungicides known as strobulins have been studied for their possible increase in the greening effect of plants as well as their ability to handle stressors (Venancio et al., 2009). The aforementioned physiological changes elicited by the foliar fungicide have been shown to increase yield in plants that are not infected with disease, which may cause a possible increase in digestibility and nutritive content of the plant when used as feed for animals (Wise and Mueller, 2011). This increase in quality can be due to decreased lignification, increased grain fill and starch content, and increased nitrate assimilation and consequently increased protein content (Yates et al., 1997; Venancio et al., 2009).

Digestion techniques are often used in evaluations of the nutritive value of corn silage (Nocek, 1988). The in vitro technique involves drying and fine grinding of whole plant corn silage for analysis. Grinding may minimize quality differences among whole plant corn silage samples related to physical form such as grain hardness and particle size (Bal et al., 2000). A macro in situ technique using undried, unground whole plant corn silage has been used to evaluate ruminal nutrient disappearance (Doggett et al., 1998). This procedure may provide better estimates of differences in ruminal starch disappearance as it is more influenced by maturity and hybrid than standard in vitro procedures. However, because of the occurrence of particle size reduction during eating and rumination it may tend to overestimate the magnitude of mechanical processing effects on ruminal starch disappearance and likely underestimates ruminal neutral detergent fiber (NDF) disappearance (Bal et al., 2000).

In situ studies have been used in ruminant animals for many decades to estimate the potential digestibility of feedstuffs as well as to attempt to understand the complex interactions of the rumen ecology on feedstuffs. Much research has been conducted to create a standard procedure for rumen in situ techniques, which will not only allow research to be sufficiently compared across laboratories but provides the best estimate of what actually happens in the rumen and is most biologically relevant (Vanzant et al., 1998). It is well known that sample size to bag surface area ratio is very important to obtain correct results. From various studies it has been agreed that an appropriate sample size to surface area ratio is 10–30 mg/cm^2 (Varga and Hoover, 1983; Vanzant et al., 1998). The objectives of this study were: (1) to evaluate in situ degradability of corn plant treated at various times with foliar fungicide on corn harvested as whole plant silage for lactating Holstein cows and (2) to determine if there were differences in 48 h in situ degradability between samples ruminally incubated in 10 × 20 cm bags when compared with samples in 20 × 40 cm bags.

2. Materials and methods

2.1. Treatments

Corn was grown for silage on fields owned by the University of Illinois (Urbana, IL, USA) located at 40.08 latitude, and − 88.22 longitude. The four silages evaluated in this experiment were: control (CON), corn received no foliar fungicide application; treatment 1 (1X), in which corn received 1 application of pyraclostrobin (PYR) foliar fungicide (Headline; BASF Corp., Florham Park, New Jersey, USA) at a rate of 0.11 kg of active ingredient (a.i.)/ha at corn vegetative stage 5 (V5; when 5 visible leaf collars can be seen; Mueller and Pope, 2009); treatment 2 (2X), in which corn received 2 applications of foliar fungicides, PYR at 0.11 kg of a.i./ha at corn stage V5, and a mixture of PYR + metconazole (MET; Headline AMP; BASF Corp., Florham Park, New Jersey, USA) at 0.11 + 0.04 kg of a.i./ha at corn reproductive stage 1 (R1; when silks are visible outside the husks; Mueller and Pope, 2009); and treatment 3 (3X), in which corn received 3 applications of foliar fungicide, PYR at 0.11 kg of a.i./ha at corn stage V5, PYR + MET at 0.11 + 0.04 kg of a.i./ha at corn stage R1, and PYR + MET at 0.11 + 0.04 kg of a.i./ha at corn reproductive stage 3 (when kernel is yellow outside, whereas the inner fluid is now milky white due to accumulating starch; Mueller and Pope, 2009). The dates for fungicide application for first, second, and third applications were: July 7, 2013; July 26, 2013; and August 13, 2013. The corn hybrid planted was 'LG2636 VT3P RIB' (LG Seeds; Elmhurst, IL, USA), which is a dual purpose hybrid used for either grain or silage. The hybrid is advertised as 114-day maturity, with high yield potential, strong stalks, and high vigor. This hybrid also is advertised as having a high level of resistance against northern corn leaf blight (caused by the fungus *Exserohilum turcicum*), southern corn leaf blight (caused by the fungus *Bipolaris maydis*), and gray leaf spot (caused by the fungus *Cercospora zeae-maydis*). This hybrid contains transgenic traits that provide protection against corn earworm (*Helicoverpa zea*). All corn was planted on June 5, 2013 and harvested on September 27, 2013 at a dry matter (DM) of 330, 300, 300, and 325 g/kg for CON, 1X, 2X, and 3X, respectively. Harvester included kernel processing to have the same theoretical length of chop, set at 1.9 cm. Inoculant (Silo-King WS; 1.5×10^5 cfu/g of *L. plantarum*, *P. pentosaceus*, and