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# Foliar fungicide (pyraclostrobin) application on corn and its effects on corn silage composition

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ABSTRACT

The objective of this study was to determine the effects of various applications of foliar fungicide on corn ensiled as corn silage. Treatments were replicated once and assigned to one of eight 0.4-ha plots of corn as follows: control (**CON**), plants receiving no foliar fungicide application; treatment 1 (**V5**), where plants received a mixture of pyraclotrobin and fluxapyroxad foliar fungicide (Priaxor, BASF Corp.) at corn vegetative stage 5 (V5); treatment 2 (**V5** + **R1**), where plants received two applications of foliar fungicide, a mixture of pyraclotrobin and fluxapyroxad at V5 and a mixture of pyraclostrobin + metconazole foliar fungicide (Headline AMP; BASF Corp.) at corn reproductive stage 1 (R1); treatment 3 (**R1**), in which plants received one application of pyraclostrobin + metconazole foliar fungicide at R1. Samples of corn for corn silage were collected at harvest, prepared as 0.9-kg mini-silos and vacuum sealed. These were ensiled for 0, 30, 90, and 150 d postharvest then frozen for later analysis. Applications of fungicide on corn, later ensiled as corn silage resulted in less ($P < 0.001$) DM content (319, 315, and 317 g/kg for V5, V5 + R1, and R1, respectively) compared with untreated corn silage (CON; 335 g/kg). Corn silage from R1 resulted in a lower ($P = 0.03$) concentration of lignin (20 g/kg DM) and greater ($P = 0.001$) concentration of lactic acid (55.0 g/kg DM) when compared with corn silage from other treatments (lignin: 24, 24, and 26 g/kg DM for CON, V5, and V5 + R1, respectively; and lactic acid: 46.5, 50.1, and 50.9 g/kg DM for CON, V5, and V5 + R1, respectively). Treatment R1 had a greater ($P = 0.03$) concentration of water soluble carbohydrates at 0 and 150 d postharvest (123 and 31.5 g/kg DM for 0 and 150 d, respectively; and an increased lactic acid concentration at 90 d (71.1 g/kg DM for R1 vs. 63.4, 68.4, and 69.2 g/kg DM for CON, V5, and V5 + R1, respectively) when compared to the other treatments. Results suggested that fungicide application on corn at V5 or R1 may enhance the nutritive and fermentative profile when ensiled for feeding ruminants.

## 1. Introduction

One of the most common silages fed to ruminants is corn silage. The USDA reported in 2014 that 89.4 farms/1000 farms of the

*Abbreviations:* ADF, acid detergent fiber; d, day; DON, deoxynivalenol (Vomitoxin); MT, metric ton; milk kg/MT of DM, milk yield per metric ton of dry matter; milk kg/proc MT of DM, milk yield per metric ton of processed dry matter; NDF, neutral detergent fiber; NFC, non-fibrous carbohydrates; R1, corn reproductive phase one; R3, corn reproductive phase three; V5, corn vegetative stage five; VFA, volatile fatty acid

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United States dairy operations included corn silage in the diet of lactating cows (USDA, 2014). Length of ensiling has shown to have significant effects on DM (Der Bedrosian et al., 2012; Weinberg and Chen, 2013), lactic acid (Ferraretto et al., 2015) acetic acid (Der Bedrosian et al., 2012; Weinberg and Chen, 2013; Ferraretto et al., 2015), NDF digestibility (Der Bedrosian et al., 2012; Weinberg and Chen, 2013), and concentration of crude protein (Der Bedrosian et al., 2012).

On a DM basis, corn silage is included in the dairy diet at 40–60 g/kg of the total mixed ration (NRC, 2001). Dry matter intake, milk yield, and fiber digestibility decreased while ADF, NDF, and lignin content increased (Oba and Allen, 2000). In a meta-analysis of 162 treatments, DMI and milk yield was 0.7 kg/d and 1.0 kg/d greater, respectively, for cows fed corn silage with high *in vitro* NDF digestibility compared with a dual-purpose corn silage (Ferraretto and Shaver, 2015). Therefore, improvements in the nutritive quality and digestibility of corn silage may yield a greater lactation performance.

Unwanted fungal pathogens on corn may hinder the desired decreases in fiber and increases in digestibility of the plant content pursued by producers and nutritionists. Fungi attack plant cells and release toxins killing the plant tissue to provide nutrients for their growth (Sexton and Howlett, 2006). Lignification of the cell wall is a defense response of plants to both resist and defend against fungal enzymes (Vance et al., 1980). Physical damage to corn altered the NDF and ADF chemical composition of corn silage ensiled for 95 d (Teller et al., 2012). Furthermore, corn infected with Southern Rust resulted in increased NDF and ADF concentrations, and decreased *in vitro* NDF digestibility when ensiled as corn silage (Queiroz et al., 2012). Moreover, corn plants inoculated with *Exserohilum turcicum,* the fungus causing Northern Leaf Blight, resulted in increased NDF and ADF concentrations when corn silage, but did not decrease true digestibility of NDF when fed to sheep (Wang et al., 2010).

Management practices, such as tillage and crop rotation, may not be enough to effectively manage fungal disease. Therefore, fungicide application may protect corn from fungi, limiting increases in fiber content and decreased corn yields. When fungal disease pressure in the field was severe, fungicide application on corn decreased the severity of diseased foliage compared with untreated corn (Bradley and Ames, 2010). A meta-analysis reported applications of pyraclostobin foliar fungicide on corn increased mean corn yield by 256 kg/ha (Paul et al., 2011). Moreover, applications of foliar fungicide are more likely to consistently increase yield and decrease stalk rot of corn plant, as well as, provide a positive economic return for producers when disease in the field is severe (Wise and Mueller, 2011).

Few studies have examined the effects of foliar fungicide on corn ensiled as corn silage and its effects on the nutritive and fermentation quality of corn silage. Cows fed corn silage differing in foliar fungicide application showed a linear decrease in DMI as the number of applications increased, but constant milk production among treatments (Haerr et al., 2015). Cows fed corn silage treated with foliar fungicide tended to have better feed conversion values than those fed untreated corn silage (Haerr et al., 2015).

Therefore, the objective of this study was to determine the effects of foliar fungicide applications on corn at various times, then ensiled as corn silage for varying times post-harvest on the nutritive and fermentative quality of the feedstuff. We hypothesized that fungicide application on corn at R1 may positively affect the nutritive and fermentation profile the most compared to other application timings.

## 2. Materials and methods

### 2.1. Field preparation

Before winter 2014, manure was applied to the field where corn would be planted in the spring. Land was tilled conservatively using a Case IH Tiger Mate II (CNH Industrial, London, UK), making just one pass. Seven soil samples were collected from various places in the field and sent to a commercial laboratory (Rock River Lab, Watertown, WI) for soil analysis. Soil samples were analyzed for pH, buffer pH, organic matter, phosphorus, potassium, calcium, magnesium, boron, manganese, zinc, and cation exchange capacity. Data for mean environmental temperature for Champaign-Urbana, IL and total rainfall were collected daily from planting until harvest from the state climatologist office for Illinois (Illinois State Water Survey, Prairie Research Institute, Champaign, IL).

### 2.2. Corn

The corn hybrid planted was a silage variety (Pioneer 1417AMXRR 2015, Johnston, IA). Comparative relative maturity for this hybrid is reached at 114 d. The hybrid of corn is marketed for having an outstanding yield, whole plant digestibility, and crude protein values. The variety is resistant to Gray Leaf Spot (caused by the disease *Cercospora zeae-maydis*) and Northern Leaf Blight (caused by the fungus *Exserohilum turcicum)*. Corn seeds were planted on 30 April 2015 using a John Deere 7200 tractor (Moline, IL.). Eight 0.40-ha plots of corn were planted (40°04′58.8”N 88°13′08.4”W) at a planting density of 16,000 corn plants/ha.

### 2.3. Foliar fungicide application

Treatments were replicated once and randomly assigned to 1 of 8 0.4-ha plots of corn. Treatments were as follows: control (**CON**), corn receiving no foliar fungicide application; treatment 1 **(V5)**, where corn received a mixture of pyraclotrobin ($C_{19}H_{18}ClN_3O_4$) and fluxapyroxad ($C_{18}H_{12}F_5N_3O$) (**PYR** + **FLUX**), foliar fungicide (Priaxor, BASF Corp.) at a rate of 0.15 kg of active ingredient (**a.i.**)/ha at corn vegetative stage 5 (V5) where the emergence of the fifth leaf is visible (Mueller and Pope, 2009); treatment 2 (**V5** + **R1**), where corn received two applications of foliar fungicide, a mixture of PYR + FLUX at 0.15 kg of a.i./ha at corn vegetative stage five, and a mixture of pyraclostrobin ($C_{19}H_{18}ClN_3O_4$) + metconazole ($C_{17}H_{22}ClN_3O$) foliar fungicide (**PYR** + **MET**; Headline AMP; BASF Corp.) at 0.15 kg of a.i./ha at corn reproductive stage 1 (R1) or when the silks are fully extended (Mueller and Pope, 2009), treatment