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Abstract

Significant yield losses can result from top dieback (TDB) in dent corn (*Zea mays*), which is caused by infection by the fungus causing anthracnose (*Colletotrichum graminicola*). Research is limited on the effectiveness of fungicide application because of the unpredictable nature of the disease. Two field studies were established to assess the timing of fungicide application on TDB, one in Illinois (2010) and the other in Kansas (2015). Fungicide applications at tasseling (VT) and later were effective in reducing the incidence of TDB 20 to 30% and increasing yield 15 to 19 bu/a, or up to 10%, while earlier applications (V5 to V8) did not reduce TDB nor increase yield compared to the untreated check.

Keywords

Top Dieback, corn, strobilurin, fungicide, Anthracnose

Timing of Strobilurin Fungicide for Control of Top Dieback in Corn

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Summary

Significant yield losses can result from top dieback (TDB) in dent corn *(Zea mays*), which is caused by infection by the fungus causing anthracnose (*Colletotrichum graminicola)*. Research is limited on the effectiveness of fungicide application because of the unpredictable nature of the disease. Two field studies were established to assess the timing of fungicide application on TDB, one in Illinois (2010) and the other in Kansas (2015). Fungicide applications at tasseling (VT) and later were effective in reducing the incidence of TDB 20 to 30% and increasing yield 15 to 19 bu/a, or up to 10%, while earlier applications (V5 to V8) did not reduce TDB nor increase yield compared to the untreated check.

Introduction

Top dieback (TDB) of dent corn *(Zea mays*) is caused by an infection of the upper part of the corn plant by the fungus causing anthracnose (*Colletotrichum graminicola)*. Anthracnose can infect the corn plant early in the season, causing foliar lesions and/or stay dormant in the plant until stress conditions cause the infection to result in stalk rot and/or TDB symptoms (Bergstrom and Nicholson, 1999). Yield losses to anthracnose TDB in 2012 in North America were estimated at 13% (Mueller and Wise, 2012). Infections later in the season, under the right environmental conditions, have been reported when the infection occurs in the pre-tassel whorl or on the leaf sheaths (Munkvold, 2002). Spores of the pathogen are dispersed by wind and rain and infection is favored by warm, humid, and overcast conditions (Bergstrom and Nicholson, 1999). The symptoms of TDB can be diagnosed when leaves in the top part of the plant, primarily the flag leaf, start to become reddish/purple, then yellow (Figure 1) and then necrotic, while the lower leaves around the ear remain green (Robertson, 2007) (Bergstrom and Nicholson, 1999). The formation of black lesions and fungal fruiting bodies on the stalk near and under the leaf sheath confirm the diagnosis and distinguish TDB from other causes of the top of the corn plant dying prematurely (Robertson, 2007) (Bergstrom and Nicholson, 1999).

Management practices to reduce losses to anthracnose in corn include hybrid selection, crop rotation, controlling insect damage, and reducing stress from low fertility and moisture as much as possible (Jirak-Peterson, 2011) (Bergstrom and Nicholson, 1999). Strobilurin fungicides are effective at controlling the leaf blight phase of anthracnose, primarily in the early growth stages (Wise, 2015). However, there is little information on the effectiveness of strobilurins against the TDB phase of anthracnose. Strobilurins applied at tasseling or later reduced TDB, but did not affect yield in a one-year fungicide study conducted by Robertson, et al. (2010). Furthermore, reproducing the conditions that result in TDB is difficult, hindering experimentation. Similarly, repeating the same study for controlling TDB at multiple locations or years has not been very effective. The authors have observed TDB in only 2 of 8 corn fungicide studies. The results presented in this paper are from these two fungicide-timing studies that became infected with anthracnose causing the TDB symptoms.

Procedures

Descriptions of Sites

Fungicide timing application studies on corn that developed TDB symptoms were conducted in 2010 at the University of Illinois' Northwestern Illinois Agricultural Research and Demonstration Center (NWRC), near Monmouth, IL; and in 2015 at Kansas State University's Kansas River Valley Experiment Field (KRV), near Topeka, KS (Table 1). The dryland study at NWRC was in corn following soybeans, while the study at KRV was under sprinkler irrigation in second-year corn. Nitrogen fertilizer was applied at recommended levels at both locations (Table 1). Due to the sandy soils and 10 inches of rain in May at KRV, an additional 130 lb of N was sidedressed at V5 (five leaves with collars visible), which alleviated some of the N deficiency symptoms. In both studies, the corn was planted in 30-inch rows: hybrid DeKalb 61-69 (Monsanto, St, Louis, MO) at NWRC and Golden Harvest 11-U-58-3111 (Syngenta, Research Triangle, NC) at KRV. Both hybrids had Bt genes for resistance to European corn borer (*Ostrinia nubilalis*). The plots were 10 ft wide (4, 30-inch rows) by 100 ft long at NWRC and 40 ft long at KRV. The experimental design was randomized complete block with 4 replications for both studies. Additional crop management details are listed in Table 1. The irrigation scheduling at KRV was assisted by the KanSched2 irrigation scheduling program (Rogers and Alam, 2008).

Application of Fungicides

The fungicide treatments were applied with a CO_2 backpack sprayer equipped with Spraying Systems TJ 8002VS nozzles (Spraying Systems, Glendale Heights, IL) set on 15-inch spacing on a 5-ft wide boom at 30 psi, 20 gallons per acre to the middle two rows of a 4-row plot. The fungicide applied at the NWRC was Headline SC (BASF Corp., Research Triangle Park, NC) at 6 oz. per acre plus NIS (nonionic surfactant). At the KRV field, several different strobilurin fungicides in proprietary studies conducted for Bayer CropScience (Research Triangle Park, NC) and DuPont Crop Protection (Wilmington, DE) were used at labeled rates. At KRV, multiple fungicide treatments applied at the same time were grouped for analysis because there were no significant differences between strobilruin treatments applied at the same time (data not shown). The growth stages of the corn at treatment applications were: V5-8 (five to eight leaves with collars emerged), tasseling (VT), one week after tasseling (VT+1), and two weeks after tasseling (VT+2).

Data Collection

Foliar disease severity was quantified at R5 (dent), evaluating the severity of foliar disease from the ear leaf and above as a percent of the leaf area with symptoms on 30 to 40 plants. Gray leaf spot (GLS) (*Cercospora zeae-maydis*) was the predominant leaf disease at NWRC, and GLS and common rust (*Puccinia sorghi*) were present at KRV. Quantifying the incidence of TDB was accomplished by counting the number of plants exhibiting symptoms in the middle two rows of each plot and converting to a percentage of all plants. The middle two rows of the plots were harvested for yield with a Kincaid 8XP (Kincaid Mfg., Haven, KS) plot combine equipped with a HarvestMaster High Capacity Graingage System (Juniper Systems, Logan, UT) at NWRC; and a modified John Deere 3300 combine (Deere Company, Moline, IL) equipped with a HarvestMaster Classic Graingage system at the KRV field. Yields were calculated from plot weights adjusted to 15.5% grain moisture. Percent yield was calculated to reduce some of the variability between locations and replications, and was calculated by dividing each yield in a replication by the yield of the highest yielding treatment in the replication. Return on fungicide investment was calculated by multiplying the yield increase over the check treatment in each replication by $3.50 per bushel, then subtracting $28 for estimated cost of foliar fungicide application at VT.

Statistical Analysis

Statistical analysis was conducted using general linear models with PROC GLIMMIX (SAS Institute, Inc, Cray, NC). Data are presented for the combined locations as there was no interaction between location and treatment and the terms that were significant for location were due to quantitative differences, and not qualitative differences.

Results

Fungicide Application at V5 to V8

The early season fungicide application at the V5 to V8 growth stages did not reduce foliar disease of TDB or increase yield when compared with the untreated check (Table 2). As a result, fungicide application did not result in a positive economic return. The lack of effectiveness on TDB indicates the infection occurred after the V5 to V8 application and near VT, when the environmental conditions were very favorable for the disease.

Fungicide Application at VT

The foliar application of fungicides to corn at tasseling (VT) or up to two weeks after VT reduced the incidence of TDB and resulted in increased grain yield up to 10% (Table 2). Applying a strobilurin fungicide up to two weeks after VT also resulted in a positive return on investment of the foliar fungicide application. However, the benefits of foliar fungicide application may be diminishing when applications are later. The effect of the timing of strobilurin fungicides on TDB agrees with the results from a study conducted in Iowa (Robertson, et al., 2010), where the VT or later application of fungicides reduced TDB. The severity of foliar disease at the ear leaf and above was also lower with application of fungicides at VT and at one week later (Table 2), though the level of disease was very low.

Site Differences

The yield potential was very different in these two studies, averaging 238 and 132 bu/a at NWRC and KRV, respectively. Excessive rainfall in May caused a loss of N in the KRV soil for which sidedressed N could not fully compensate. Additionally, the incidence of TDB in the check treatment was 65% at NWRC compared to 37% at KRV. However, the response of TDB to the fungicide applications was very similar at both locations (data not shown). The common factor at both locations was a period of several days of rain and/or irrigation just prior to or at VT (Figures 2 and 3).

Additional Treatments

At NWRC, an additional fungicide treatment applied one week before tasseling (VT-1) was not used in the combined analysis. The VT-1 treatment at NWRC did reduce the percent of foliar disease to the level of the VT and VT+1 week treatments, but the TDB with VT-1 was less than those treatments and not different from the check and V5 treatments. Also the yield of the VT-1 treatment was less than the VT and VT+1 week treatments (data not shown). At KRV, an additional treatment was a double application of fungicide at V8 and VT. The percent foliar disease and TDB were similar to the VT and VT+1 and 2 week treatments, though the yield was not different from the check and V8 treatments or the VT, VT+1, and VT+2 treatments (data not shown). These additional treatments suggest that the infections causing TDB at both locations occurred very close to or at tasseling.

Weather Factors

The onset of TDB in these studies is probably attributed to several days of rain and/or irrigation prior to or at tasseling. Anthracnose is favored by warm, wet, and overcast conditions (Figures 2 and 3) (Bergstrom and Nicholson, 1999). At KRV, corn reached VT in the period of July 6 to 10 under overcast conditions, which resulted in below average solar radiation recorded. For that period, average solar radiation was 299 langleys compared to a monthly average of 478, with several days over 600 (Weather Data Library, 2015). No anthracnose lesions were observed at either location at the V5 to V8 growth stages (data not shown).

Cultural Factors

Additional factors that favored TDB development at KRV were crop rotation, tillage and possible N stress (Jirak-Peterson, 2011; Bergstrom and Nicholson, 1999). The study at KRV was planted into cornstalks that had been vertical tilled with a TurboMax tool (Great Plains Mfg., Salina, KS) in the fall, leaving ample corn residue on the soil surface to serve as an inoculum source. Additionally, the N deficiency experienced early in the season and into the growing season could have been an additional stress factor that could have made the corn more susceptible to TDB.

The conditions at NWRC were favorable for high yield potential, and there were no other factors other than the warm and humid weather conditions that increased the risk of TDB.

Practical Applications

The possible diminishing benefit of applying foliar fungicide after VT can be attributed to at least two factors. First, applying fungicide just prior to or after an infection event will be the most effective at reducing the impact of a fungal disease on plant health. A wider window for the fungus to infect the plant can result in reduced photosynthetic capacity, and subsequently, yield potential. Additionally, grain fill is progressing rapidly after VT (Abendroth et al., 2011), and delays in fungicide application reduce the amount of time the plant can benefit from grain fill. Defoliation of the corn plant at R5 or later has little effect on yield because much of the grain yield potential has already been determined (Adee et al., 2005; Abendroth et al., 2011).

Relative to TDB, the positive benefit to fungicide application for up to two weeks after VT demonstrates a relatively wide window of application time that will still result in a positive return on investment for fungicide application. Delays to fungicide application at VT could be attributed to the weather or scheduling a commercial applicator. A two-week window gives growers some flexibility when faced with potential delays.

Confirming that strobilurin fungicides are effective in reducing TDB and increasing yield of corn could be a significant factor in reducing losses to TDB. The difficulty will be in predicting when the environmental conditions are most conducive for TDB. If other foliar fungal diseases are at the threshold to apply a fungicide at VT, then there could be the added benefit of control of TDB. However, if the foliar disease level is below the threshold at VT, it may be more difficult to guarantee a positive return for the investment in the fungicide application. Much more attention should be paid to the timing of rainfall/irrigation events in coordination with VT. Additionally, better understanding of the hybrid, crop rotation, and/or tillage interaction with rainfall at VT will help improve the success rate of a fungicide application in improving yield in the event that TDB is expressed.

References

Abendroth, L.J., Elmore R.W., Boyer, M.J, Marlay, S.K. 2011. Corn growth and development. Iowa State Extension. Publication PMR 1009.

Adee, E.A., Paul, L.E., Nafziger, E.N., and Bollero, G. 2005. Yield loss to corn hybrids to incremental defoliation. Online. Crop Management doi.10.1094/CM-2005-0427-01-RS.

Bergstrom, G. C., and Nicholson, R. L. 1999. The biology of corn anthracnose. Plant Dis. 83:596-608.

Jirak-Peterson, J. C., and Esker, P. D. 2011. Tillage, crop rotation, and hybrid effects on residue and corn anthracnose occurrence in Wisconsin. Plant Dis. 95:601-610.

Mueller, D. and Wise, K. 2012. Corn disease loss estimates from the United States and Ontario, Canada - 2012. Purdue Extension. Publication BP-96-12—W. http://fyi.uwex.edu/fieldcroppathology/files/2014/01/BP-96-12-W.pdf.

Munkvold, Gary P., "Anthracnose top dieback is back" (2002). *Integrated Crop Management News.* Paper 1699. http://lib.dr.iastate.edu/cropnews/1699.

National Climate Data Center. 2016. http://www1.ncdc.noaa.gov/pub/orders/IPS/

Robertson, A. 2007. Top dieback in corn: is anthracnose the cause? *Integrated Crop Management News.* IC-498. http://www.ipm.iastate.edu/ipm/icm/2007/9-10/topdieback.html.

Robertson, A.E., Peckinovsky, K., and Liu, L. 2010. Effect of foliar fungicides on anthracnose top dieback, and frost injury of corn in Iowa, 2009. Plant Disease Management Report, 4:FC087.

Rogers, D.H. and Alam, M. March 2008. KanSched2: An ET-based irrigation scheduling tool. Kansas State University. Electronic Only Publication. EP-129 revised.

Weather Data Library. Kansas State University. http://mesonet.k-state.edu/weather/historical/

Wise, K. 2015. Fungicide efficacy for control of corn diseases. *Purdue Extension • The Education Store www.edustore.purdue.edu. BP-160-W.*

Table 1. Study details for corn fungicide studies with TDB

	NWRC 2010	KRV 2015
Soil type	Muscatune silt loam	Eudora sandy loam
Previous crop	Soybeans	Corn
Tillage	Chisel in fall, field cultivate in spring	Vertical tillage in fall
Nitrogen fertilizer	160 lbs	200 lbs followed by 130 lbs side-dressed
Planting date	20-Apr	16-Apr
Hybrid	DK 61-69	GH 11-U-58-3111
Seeding rate	37.8 K	32 K
V5-8 application	1-Jun	8-Jun
VT application	8-Jul	8-Jul
VT+1 application	15-Jul	15-Jul
VT+2 application	22-Jul	22-Jul
Foliar Dis rate 1	23-Aug	6-Aug
Foliar Dis rate 2		14-Aug
TDB rating	23-Aug	14-Aug
Harvested	8-Sep	14-Sep

Table 2. Effect of timing of fungicide application to corn on top dieback (TDB) at Northwestern Research Center (NWRC), Illinois, in 2010, and Kansas River Valley (KRV), KS, in 2015

Timing of fungicide application	Yield	Percent yield†‡	Top Die Back†	Foliar disease severity†	Return on fungicide investment§†
	bu/a	pct	% of plants	% ear leaf and above	$
Check	179.5 b	81.7 b	51.3 a	5.3 a	-
V5-8	180.9 b	81.9 b	48.7 a	3.9 b	-19.23 b
VT	198.3 a	91.2 a	22.5 b	1.8 c	42.74 a
VT+1	196.4 ab	89.5 ab	20.2 b	1.9 c	33.82 ab
VT+2	195.3 ab	89.5 ab	25.7 b	2.7 bc	30.20 ab
Pr > F	0.016	0.027	0.004	0.014	0.05

† Means followed by the same letter within a column are not significantly different at Pr > 0.05.
‡ Percent yield is calculated as a percent of the highest yielding plot in each replication.
§ Increase in yield over check × $3.50/bu less $28 for fungicide application.

Figure 1. Top dieback in dent corn *(Zea mays*), which is caused by infection by the fungus causing anthracnose (*Colletotrichum graminicola).* Eric Adee, Kansas River Valley Experiment Field-Topeka, 2015.

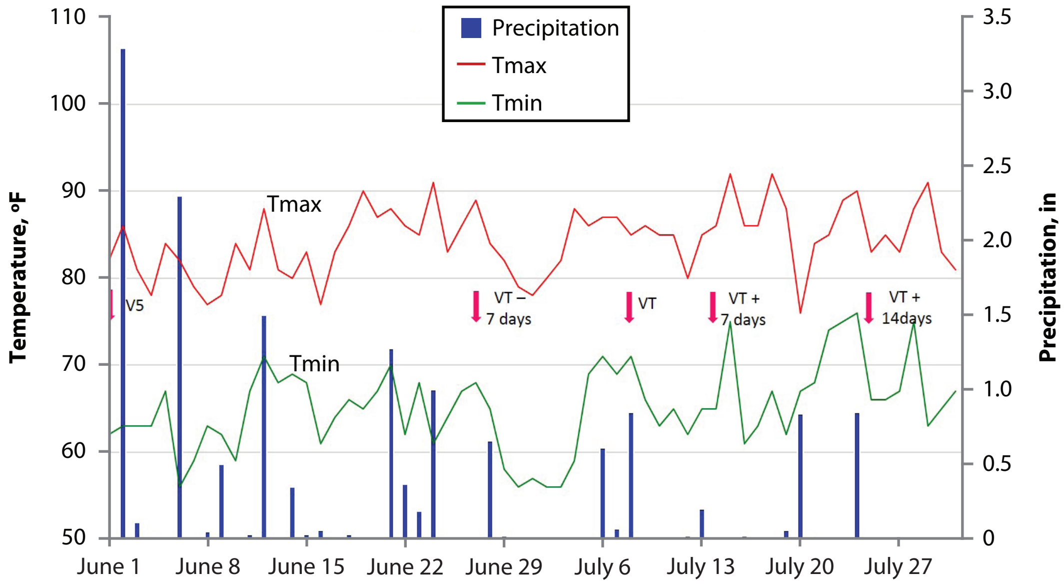

Figure 2. Rainfall and temperature data from University of Illinois' Northwestern Illinois Agricultural Research and Demonstration Research Center, Monmouth, IL, for June and July 2010. National Climate Data Center (2016).

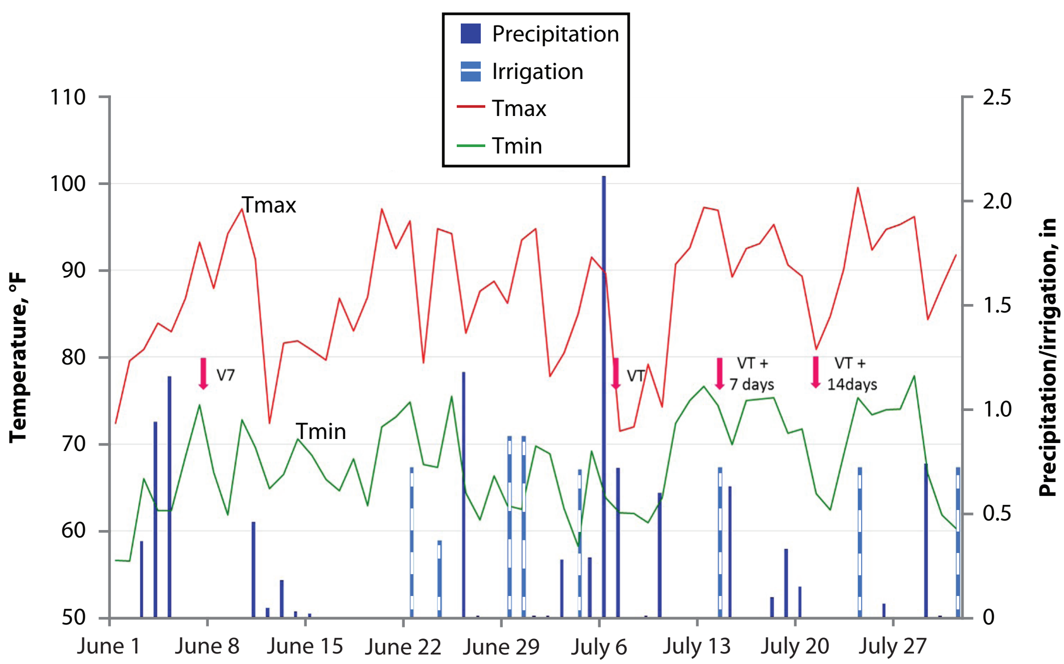

Figure 3. Rainfall, irrigation and temperature data from Kansas State University's Kansas River Valley Experiment Field, Topeka, KS, for June and July 2015. Weather Data Library. Kansas State University. 2016.