Impact of Fall and Spring Fungicide Applications on Dollar Spot

Honor's Thesis

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ABSTRACT

Dollar spot, caused by *Sclerotinia homoeocarpa*, is one of the most widespread and chronic diseases of golf course turfgrass worldwide (Vargas, 1994). Cultural practices designed to minimize periods of leaf wetness and ample nitrogen fertility can decrease disease severity, but repeat applications of fungicides throughout the growing season are required to effectively manage dollar spot on intensively cultivated turfgrass. The objective of this research was to assess the impact of fall and/or early spring fungicide applications made to asymptomatic turfgrass on the development of dollar spot disease severity the following growing season. Replicated field studies at two locations with both contact and systemic fungicides were conducted in the fall and spring. Both fall and spring preventative fungicide treatments significantly delayed the onset of disease and the enduring severity of symptoms. Weather conditions in the fall significantly influenced the effectiveness of the treatments.

Dollar spot, caused by the fungus *Sclerotinia homoeocarpa* F.T. Bennett is one of the most prevalent and highly managed turfgrass diseases. More money is spent on the management of dollar spot than any other turfgrass disease (3,5,22). *S. homoeocarpa* infects most warm- and cool-season grasses, primarily affecting highly cultivated turfgrasses. If not managed, dollar spot can cause death of infected plants, resulting in thinned areas of the turf and unsightliness (5). Symptoms are small (2.5-5.0 cm diameter) straw-colored or necrotic spots on low-cut golf course turfgrass, but appear larger (15-30 cm diameter) and more diffuse on high-cut home lawns. Necrotic lesions on individual leaves are small and circular in the beginning but ultimately extend the width of the leaf blade, resulting in hourglass-shaped lesions (Figure 1,2,3).

Dollar spot was originally called small brown patch, *Rhizoctonia* spp., and thought to be caused by a different species of the organism that causes brown patch, *Rhizoctonia solani* Kuhn, L.P. (13,16). Bennett in England in 1937 (1) further investigated the fungus and renamed it in the Group Ascomycetes, Order Pezizales, Family Helotiaceae, Subfamily Helotiae, Section Hylaosporae and Genus *Sclerotinia*. Bennett chose the genus *Sclerotinia* because of the formation of aggregates of microsclerotia. Microsclerotia are darkened tissues with hard outer and soft inner cells. Bennett used isolates from Australia, The United States and Great Britain in his classification. All of the isolates he worked with showed different pigmentations, conidia and ascospore production and had different growth requirements. Since his studies, many mycologists have questioned the classification of *S. homoeocarpa* due to the lack of sclerotia production but rather the presence of stroma (10, 11, 12, 17). The North American isolate has produced apothecial initials in culture, but

mature ascospores nor conidia have ever developed (7, 8). Tests on the immature apothecia involving immunological and biochemical studies have also suggested an incorrect naming of the fungus (17, 12). Recent work by Powell and Vargas (18) analyzing the ribosomal DNA internal transcribed spacer (ITS) region has suggested the fungus is more closely related to the genus *Rutstroemia*. There has been no success in isolating the teleomorph of the fungus so reclassification is difficult.

Grown on potato dextrose agar (PDA), *S. homoeocarpa* produces fluffy white mycelia with extensive aerial mycelia, covering a standard petri dish in 3-5 days. Two to three weeks after initial growth on medium, be it PDA or millet seed, a sclerotized region or stroma, appears at the edges of the container and around the original source of innoculm. This area will continue to expand until the entire surface is covered. These blackened, hardened areas can be surface sterilized and used for long term storage, as well as for purification of isolates(1).

Management of dollar spot on golf courses is most often accomplished through the routine use of fungicides. Cultural practices such as nitrogen fertility management, dew and guttation water removal, and maintenance of adequate air circulation are also recommended practices for minimizing the development of dollar spot, however, fungicide applications are required to maintain disease-free turfgrass (5). Although many fungicides are available, three of the most commonly used classes of fungicides are benzimidazoles, dicarboximides and sterol inhibitors or demethlyase inhibitors (DMI's). Because of the frequent use of these chemicals resistance in *S. homoeocarpa* to each of these classes has been reported (23, 6, 9).

A method to more effectively manage dollar spot either through cultural practices or fungicide efficacy is needed. A study done in 2001 by P.J. Landschoot et al., (13) looked at the non-target effects of pentachloronitrobenzene (PCNB) on putting green turf, and produced surprising results in respect to dollar spot incidence. Included in their study was an iprodione and chlorothalonil comparison treatment as well as their control. In the third year of their study, 2000, there was significantly less disease incidence in the spring on the fall chlorothalonil and iprodione plots than on the control and PCNB fall and spring applied plots. This study suggests the application of fungicides to asymptomatic turfgrass in the fall has an affect on dollar spot disease incidence in the spring.

The null hypothesis for this experiment is that fungicide applications to asymptomatic turfgrass affect dollar spot severity and incidence in the spring. The goals of this study were to (1) observe the affects of spring and fall applications of fungicides to asymptomatic turfgrass and to (2) determine if air temperature have an affect on fungicide efficacy in these treatments.

MATERIALS AND METHODS

Two replicated field trials were completed at Brookside Golf and Country Club and The Ohio Turfgrass Foundation Research and Education Center (The OTF Research Center). All fungicides were applied using a CO_2 backpack sprayer at 40 PSI and a spray volume of 3 gpm using 6503 TeeJet nozzles. A randomized complete block design was used, with 4 replications per location. Plots were a standard 3 by 5 foot size.

Study 1. To determine if fungicide applications made to asymptomatic turfgrass eliminates or delays dollar spot disease incidence, fall and spring applications were made. One third of the plots received a Banner MAXX 1.0 oz/1000 ft^2 and Daconil Ultrex, 3.2oz/1000ft^2 (Syngenta Professional Products, Greensboro, North Carolina) combination mix every 21 days in the fall on September 26, October 17, and November 11, 2003. The second third of the plots received one application of the combination mix in the fall. The second third of the plots received no treatment in the fall. Banner MAXX 1.0 oz/1000 ft^2, and Daconil Ultrex 3.2oz/1000ft^2, were applied to plots in each of the three treatment groups once on May 6, 2004. The remaining plots received no treatment in the spring.

Study 2. In order to asses if weather conditions impact fungicide efficacy in preventative applications, biweekly applications were made in the spring and fall. Banner MAXX 1.0 oz/1000 ft^2, Daconil Ultrex 3.2oz/1000ft^2, and a combination mix with the same rates were applied once every two weeks. Applications were made on September 26, October 10, October 24, November 7, November 21, 2003, and April 9, April 22, May 6 and May 20, 2004.

Disease rating. Visual assessments of the amount of diseased turfgrass within each plot were recorded at two week intervals after significant disease pressure was observed. Dollar spot infection centers (DSIC's), or necrotic spots were quantified in the center 2 by 4 foot area of the plots. A necrotic area of 5cm^2 was considered a single spot. In treatments where disease incidence was significantly lower than control treatments, the weather data from the dates of those applications was correlated providing the environmental condition when the applications were most effective. Differences in disease incidence among

treatments were assessed with a one-way analysis of variance (ANOVA) using PROC GLM of SAS. Differences among treatment means were determined using Fisher's protected least significance difference (LSD) at $P = 0.05$.

RESULTS

Study A. At The OTF Research Center and Brookside Golf and Country Club, three applications of fungicides in the fall significantly reduced dollar spot disease severity compared with the non-treated check. Single fungicide applications also significantly reduced disease but, not as much as treatments with three applications. Interestingly, spring treatments of Daconil Ultrexx, Banner MAXX and the combination mix on plots sprayed three times in the fall did not differ from those sprayed three times in the fall and not in the spring (Table 1).

All spring applications of Daconil Ultrexx, Banner MAXX and the combination mix applied on May 6th, 2004 significantly reduced disease as compared to the non-treated control. At Brookside Golf and Country Club, all three treatments were equally effective at reducing disease. This was not the trend at The OTF Research Center, where disease pressure was significantly greater (152 DSIC's in the non-treated check compared with 38.5 DSIC's at Brookside Golf and Country Club). At The OTF Research Center, Banner MAXX and the combination mix treatment in the spring were more effective at reducing disease than Daconil Ultrexx (Table 2). For example, the combination May 6th treatment had 0 DSIC's and Daconil Ultrexx had 41.8 DSIC's.

Study B. In general, treatments made on October 10, 24, or October 10 and 24, had significantly less disease compared to the non-treated check with the exception of Daconil Ultrexx at The OTF Research Center on October 10, 2003. All applications made on September 26, November 7, and 21 were ineffective at reducing disease at both locations.

The timing of spring treatments did not impact fungicide efficacy. All spring treatments reduced dollar spot disease severity compared to the non-treated control with the exception of April 9 and 22, 2003 (early spring), Daconil Ultrexx treatments at The OTF Research Center. Consistent with Study A, disease pressure was less at Brookside Golf and Country Club and all spring treatments reduced dollar spot disease severity compared to the non-treated control.

DISCUSSION

Non-treated plots had high rates of disease at The OTF Research Ceneter and Brookside Golf and Country Club (152, 130, 145 DSIC's). All preventative treatments applied to asymptomatic turfgrass were effective at reducing dollar spot disease severity compared to the non-treated control the following season with the exception of the early spring Daconil Ultrexx treatments at The OTF Research Center. Three applications in the fall of Daconil Ultrexx and Banner MAXX combined were as equally effective as combined single fall and single spring treatments.

All spring applications (except for early spring Daconil Ultrexx at The OTF Research Center) reduced disease severity. At the time these applications were made, the turfgrass was actively growing. Active photosynthesis was occurring, leaf blades were extending and mowing was required. Based on weather data, *S. homoeocarpa* was most

likely in the same growth stage. Mycellium was pushing out of the over-wintering structures and actively invading plant tissue for infection. At this point in the life cycle of the fungus, *S. homoeocarpa* was susceptible to fungicides and thus decreased disease incidence was observed in these treatments. The early spring treatments catch the pathogen as it is beginning to come out of dormancy. The weather began to warm, and as the turfgrass de-winterized, so did the fungus (Figure 4). With delay in growth due to the early fungicide application, the pathogen needs more time to cause disease later in the spring. The late spring treatments had expected efficacy duration, 30 days.

Further evidence of this phenomenon of extreme vulnerability during the dormancy transition stage appears in the fall applications of 2003. The fall applications in October were the only treatments with significantly reduced disease in the spring. Again, *S. homoeocarpa* probably is entering dormancy coinciding with the host. Less mycellial growth occurs, it no longer causes disease, and the manufacturing of some type of over-wintering structure (stromata, or dormant mycellium) is underway. The weather during this time is indicative of winteriziation of the turfgrass and *S. homoeocarpa* (Figure 5). Applications made before the dormancy process began were ineffective due to the ability of *S. homoeocarpa* to recuperate lost growth before extreme cold temperatures began. Treatments made after this winterization process did not reduce disease severity in the spring, possibly because the pathogen had already stabilized in a dormant state for the winter and fungicides had no affect.

This hypothesis is supported by Landschoot et al. (14). Their study involved fall applications of fungicides then observation of dollar spot disease severity the following

season. The third year of their study in, 2000, fall chlorothalonil and iprodione applications were made during the previously described dormancy inducing weather pattern. These treatments had significantly reduced disease severity the following spring as compared to the non-treated control plots. A decrease in dollar spot incidence the following spring was also observed in the fall pentachloronitrobenzene (PCNB) treatments. The results of the PCNB treatments were more easily explained than the chlorothalonil and iprodione treatments, as the persistence of PCNB in soil is well documented (23). This possibly continued to affect the pathogen 5 and 6 months later. PCNB has also been shown to inhibit over-wintering structures such as sclerotia in various soil-borne pathogens, and may have prevented *S. homoeocarpa* from over- wintering (8). Chlorothalonil and iprodione however, are not known to interfere with sclerotia formation nor to persist for months in the soil. Therefore, weather playing a role in fungicide efficacy in fall applications is a better explanation.

In this study, one application made during the correct weather period in the fall was sufficient to decrease disease incidence, but not to eliminate it. This approach enables better fungicide efficacy during the spring, but does not lessen the number of applications made during one year. More research is needed regarding the biology of *S. homoeocarpa* . How the pathogen over-winters, if there is a dormancy process, what it involves, and at what stage the pathogen most vulnerable is much needed information. Correlation of *S. homoeocarpa* biology and turfgrass dormancy data to the weather will help increase fungicide efficacy in all applications.

In this field study a contact and systemic fungicide were used to test the null hypothesis. Work using chemicals with different modes of action and different brand names is underway to ascertain if all chemicals are equally effective. Research to determine if a single application of a systemic fungicide is as effective as two applications of a contact fungicide is in the planning stages.

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Table 3. Disease severity at The OTF Research Center on 6-5-2004, Study 2.

Trade name	Date of application	Dollar spot severity [a]
Non-treated		62 a-d
Banner MAXX[b]	9-26-2003	57.3 a-e
Daconil Ultrexx[c]	9-26-2003	17.2 ab
Banner MAXX, Daconil Ultrexx [d]	9-26-2003	40.3 c-h
Non-treated		60 a-d
Daconil Ultrexx	10-10-2003	50 b-g
Banner MAXX	10-10-2003	15 hij
Banner MAXX, Daconil Ultrexx	10-10, 10-24-2003	2.8 j
Daconil Ultrexx	10-24-2003	23 f-j
Banner MAXX	10-24-2003	27 e-j
Banner MAXX, Daconil Ultrexx	11-7-2003	71.3 abc
Daconil Ultrexx	11-7-2003	80.3 ab
Banner MAXX	11-7-2003	64 a-d
Non-treated		81.8 a
Daconil Ultrexx	11-21-2003	79 ab
Banner MAXX	11-21-2003	77.8 ab
Banner MAXX, Daconil Ultrexx	11-21-2003	82.5 a
Daconil Ultrexx	4-9-2004	39 d-i
Banner MAXX	4-9-2004	8.8 ij
Banner MAXX, Daconil Ultrexx	4-9-2004	.3 j
Daconil Ultrexx	4-22-2004	60.5 a-d
Banner MAXX	4-22-2004	6.5 j
Banner MAXX, Daconil Ultrexx	4-22-2004	.5 j
Banner MAXX	5-20-2004	3 j
Daconil Ultrexx	5-20-2004	4.3 j
Banner MAXX, Daconil Ultrexx	5-20-2004	.8 j
Daconil Ultrexx	5-20-2004	4.8 j
Banner MAXX	5-20-2004	5.3 j
Banner MAXX, Daconil Ultrexx	5-20-2004	1.3j
Non-treated		53.3 a-f
Non-treated		65.5 a-d
Banner MAXX, Daconil Ultrexx	5-6-2004	0 j
Daconil Ultrexx	5-6-2004	20.5 g-j
Banner MAXX	5-6-2004	.5 j

[a] Number of dollar spot infection centers (DSIC's) in the 2 by 4 foot center portion of each plot.
[b] Propiconazole, Banner MAXX, 1.0 oz/1000 ft^2
[c] Chlorothalonil, Daconil Ultrexx, 3.2 oz/1000 ft^2
[d] Banner MAXX, 1.0 oz/1000 ft^2, Daconil Ultrexx, 3.2 oz/1000 ft^2

Table 4. Disease severity at Brookside Golf and Country Club on 6-5-2004, Study 2.

Trade name	Date of application	Dollar spot severity[a]
Non-treated		40.5 a-d
Banner MAX[b]	9-26-2003	13.3 e-h
Daconil Ultrexx[c]	9-26-2003	17.8 d-h
Banner MAXX, Daconil Ultrexx [d]	9-26-2003	19 d-h
Non-treated		11.5 g-h
Daconil Ultrexx	10-10-2003	14.8 e-h
Banner MAXX	10-10-2003	13.8 e-h
Banner MAXX, Daconil Ultrexx	10-10, 10-24-2003	6 gh
Daconil Ultrexx	10-24-2003	12.5 fgh
Banner MAXX	10-24-2003	18 d-h
Banner MAXX, Daconil Ultrexx	11-7-2003	23 c-h
Daconil Ultrexx	11-7-2003	55.3 a
Banner MAXX	11-7-2003	21.3 c-h
Non-treated		50 ab
Daconil Ultrexx	11-21-2003	35.8 a-f
Banner MAXX	11-21-2003	15.5 e-h
Banner MAXX, Daconil Ultrexx	11-21-2003	44.8 abc
Daconil Ultrexx	4-9-2004	21.8 c-h
Banner MAXX	4-9-2004	21.5 c-h
Banner MAXX, Daconil Ultrexx	4-9-2004	12.5 fgh
Daconil Ultrexx	4-22-2004	5.8 gh
Banner MAXX	4-22-2004	4.8 gh
Banner MAXX, Daconil Ultrexx	4-22-2004	1.3 h
Banner MAXX	5-20-2004	16.5 d-h
Daconil Ultrexx	5-20-2004	6.5 gh
Banner MAXX, Daconil Ultrexx	5-20-2004	3 h
Daconil Ultrexx	5-20-2004	8.5 gh
Banner MAXX	5-20-2004	3.3 h
Banner MAXX, Daconil Ultrexx	5-20-2004	.8 h
Non-treated		28.8 b-g
Non-treated		36.8 a-e
Banner MAXX Daconil Ultrexx	5-6-2004	0 h
Daconil Ultrexx	5-6-2004	9.8 gh
Banner MAXX	5-6-2004	3 h

[a] Number of dollar spot infection centers (DSIC's) in the 2 by 4 foot center portion of each plot.
[b] Propiconazole, Banner MAXX, 1.0 oz/1000 ft^2
[c] Chlorothalonil, Daconil Ultrexx, 3.2 oz/1000 ft^2
[d] Banner MAXX, 1.0 oz/1000 ft^2, Daconil Ultrexx, 3.2 oz/1000 ft^2

Table 1. Disease severity at The OTF Research Center on 6-5-2004, Study 1.

Treatment	Date of application	Treatment	Date of application	Dollar spot severity [a]
Non-treated				152.5 a
Banner MAXX[b]	5/6/2004			2 d
Non-treated				130.25 a
Daconil Ultrex[c]	5/6/2004			41.75 c
Non-treated				145.75 a
Banner MAXX Daconil Ultrex [d]	5/6/2004			0 d
None		Banner MAXX Daconil Ultrex	9/26, 10/17, 11/7/2003	.75 d
Banner MAXX	5/6/2004	Banner MAXX and Daconil Ultrex	9/26, 10/17, 11/7/2003	0 d
None		Banner MAXX Daconil Ultrex	9/26, 10/17, 11/7/2003	5.25 d
Daconil Ultrex	5/6/2004	Banner MAXX Daconil Ultrex	9/26, 10/17, 11/7/2003	0.5 d
None		Banner MAXX Daconil Ultrex	9/26, 10/17, 11/7/2003	2.25 d
Banner MAXX Daconil Ultrex	5/6/2004	Banner MAXX Daconil Ultrex	9/26, 10/17, 11/7/2003	0 d
None		Banner MAXX Daconil Ultrex	9/26/2003	86 b
Banner MAXX	5/6/2004	Banner MAXX Daconil Ultrex	9/26/2003	1.25 d
None		Banner MAXX Daconil Ultrex	9/26/2003	97.5 b
Daconil Ultrex	5/6/2004	Banner MAXX Daconil Ultrex	9/26/2003	10.75 cd
None		Banner MAXX Daconil Ultrex	9/26/2003	91 b
Banner MAXX Daconil Ultrex	5/6/2004	Banner MAXX Daconil Ultrex	9/26/2003	.25 d

[a] Number of dollar spot infection centers (DSIC's) in the 2 by 4 foot center portion of each plot.
[b] Propiconazole, Banner MAXX, 1.0 oz/1000 ft^2
[c] Chlorothalonil, Daconil Ultrexx, 3.2 oz/1000 ft^2
[d] Banner MAXX, 1.0 oz/1000 ft^2, Daconil Ultrexx, 3.2 oz/1000 ft^2

Table 2. Disease severity at Brookside Golf and Country Club on 6-5-2004, Study 1.

Treatment	**Date of application**	**Fall Application**	**Date of application**	**Dollar spot severity[a]**
Non-treated				38.5 ab
Banner MAXX[b]	5/6/2004			19.5 cde
Non-treated				31.75 bc
Daconil Ultrex[c]	5/6/2004			6 ef
Non-treated				32.75 bc
Banner MAXX Daconil Ultrex [d]	5/6/2004			7.5 ef
None		Banner MAXX Daconil Ultrex	9/26, 10/17, 11/7/2003	11 def
Banner MAXX	5/6/2004	Banner MAXX Daconil Ultrex	9/26, 10/17, 11/7/2003	.5 f
None		Banner MAXX Daconil Ultrex	9/26, 10/17, 11/7/2003	11.75 def
Daconil Ultrex	5/6/2004	Banner MAXX Daconil Ultrex	9/26, 10/17, 11/7/2003	3 ef
None		Banner MAXX a Daconil Ultrex	9/26, 10/17, 11/7/2003	10 def
Banner MAXX Daconil Ultrex	5/6/2004	Banner MAXX Daconil Ultrex	9/26, 10/17, 11/7/2003	.75 f
None		Banner MAXX Daconil Ultrex	9/26/2003	53.5 a
Banner MAXX	5/6/2004	Banner MAXX Daconil Ultrex	9/26/2003	7 ef
None		Banner MAXX Daconil Ultrex	9/26/2003	37.75 ab
Daconil Ultrex	5/6/2004	Banner MAXX Daconil Ultrex	9/26/2003	16.75 cdef
None		Banner MAXX Daconil Ultrex	9/26/2003	25.75 bcd
Banner MAXX Daconil Ultrex	5/6/2004	Banner MAXX Daconil Ultrex	9/26/2003	14.25 def

[a] Number of dollar spot infection centers (DSIC's) in the 2 by 4 foot center portion of each plot.
[b] Propiconazole, Banner MAXX, 1.0 oz/1000 ft^2
[c] Chlorothalonil, Daconil Ultrexx, 3.2 oz/1000 ft^2
[d] Banner MAXX, 1.0 oz/1000 ft^2, Daconil Ultrexx, 3.2 oz/1000 ft^2

Figure 1. Dollar spot lesion

Figure 2. Dollar spot infection centers (DSIC's)

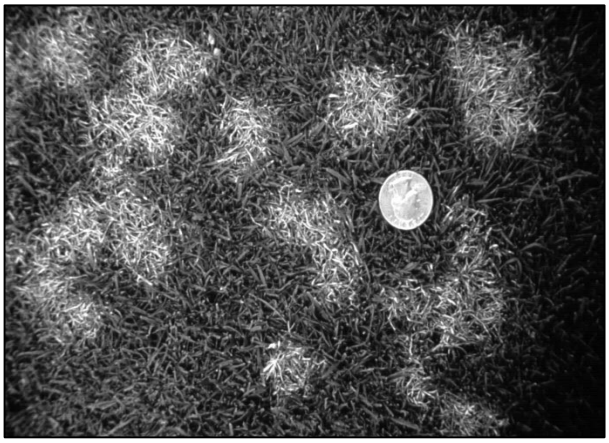

Figure 3. Example of high disease pressure

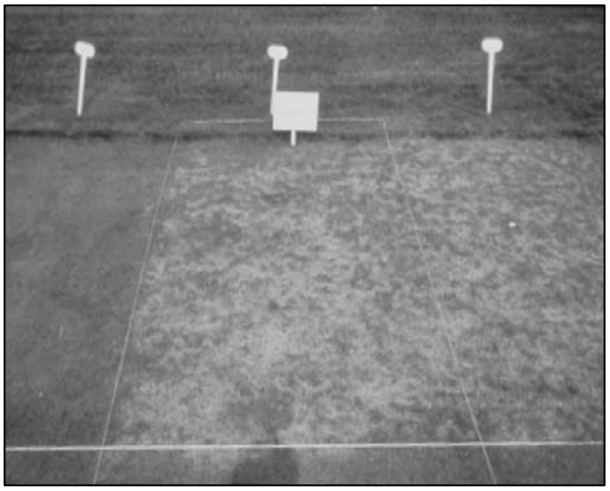

Figure 4. Mean daily high and low temperatures in Columbus, Ohio (Sept-Nov 2003)

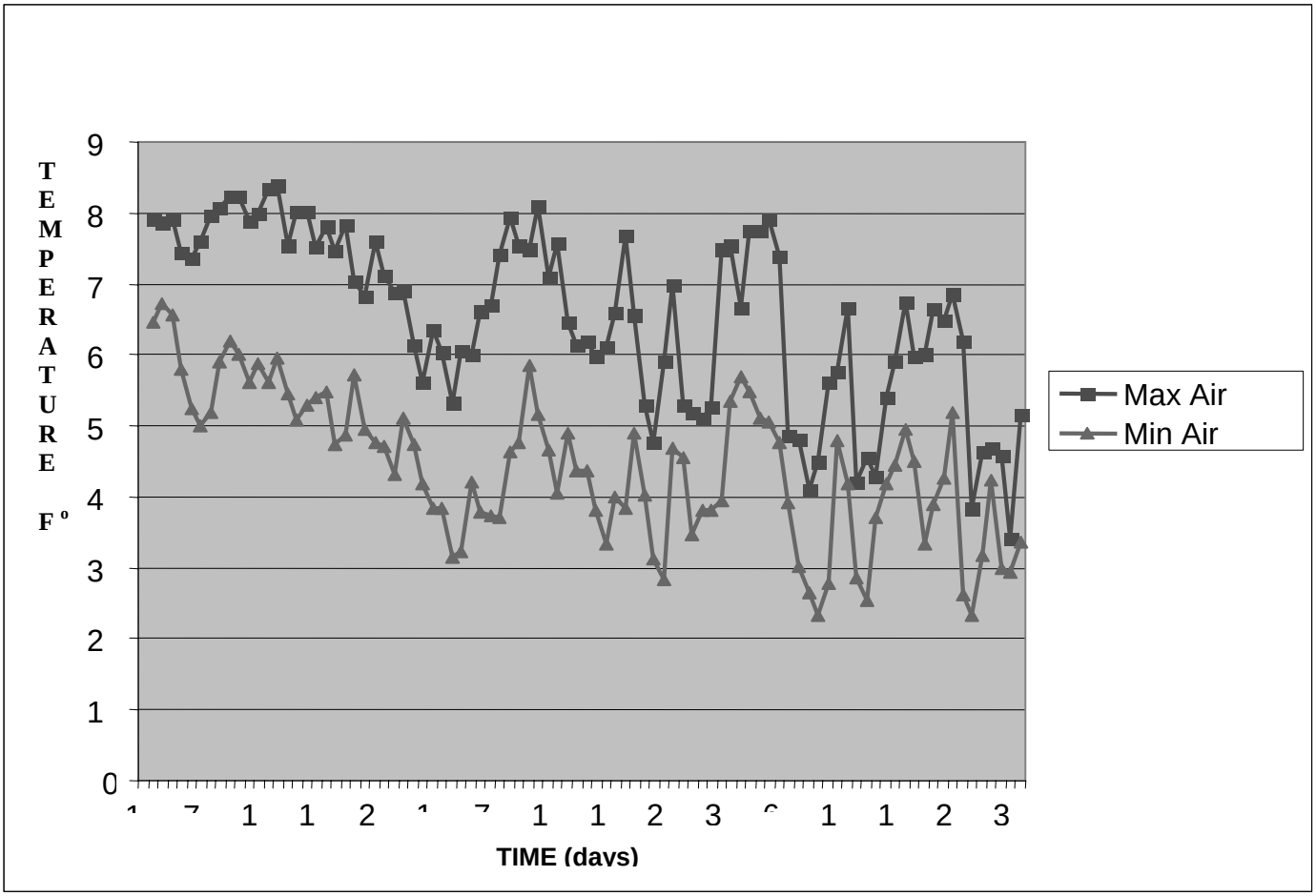

Figure 5. Mean daily high and low temperatures in Columbus, Ohio (April-May 2003).