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**Management Strategies of a *Sclerotinia homoeocarpa* Population with Multiple Fungicide Resistance and Multidrug Resistance**

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Objectives:
1. To assess field efficacy of dicarboximide, DMI and SDHI fungicides in a dicarboximide-resistant *S. homoeocarpa* population.
2. To develop the best fungicide options for controlling a *S. homoeocarpa* population with multiple fungicide resistance.
3. To understand how many applications of non-dicarboximides are required in order to revert a dicarboximide-resistant population into sensitive by monitoring the population shift.
4. To determine how persistent the reverted dicarboximide-sensitive population will be after reversion.

Dollar spot, caused by *Sclerotinia homoeocarpa* F.T. Bennett, is one of the most significant diseases of cool-season turfgrass on golf courses. Resistance to the benzimidazole and dicarboximide classes and reduced sensitivity to the sterol demethylation inhibitor (DMI) fungicide class in *S. homoeocarpa* populations has been reported, moreover, a select number of golf courses also contain *S. homoeocarpa* populations with high levels of reduced dicarboximide (iprodione and vinclozolin) sensitivity. In order to better understand the practical implications of dicarboximide fungicide resistance, we conducted a field trial in 2015 and 2016 on a golf course fairway with a dicarboximide-resistant *S. homoeocarpa* population to develop fungicide options for dollar spot control.

During the 2015 and 2016 field season, fungicide efficacy was tested on two different fairway locations at Wethersfield Country Club (WCC) in Connecticut and the population exhibited a combination of four different isolate genotypes with differing resistance profiles to the benzimidazole, dicarboximide and DMI fungicide classes. Field efficacy data in 2015 and 2016 showed a fairly similar trend. Reduced field efficacy was observed using the following fungicides: iprodione (Chipco 26GT), vinclozolin (Curalan), and low rate of propiconazole (Banner MAXX II). On the other hand, good control was observed with high rate of boscalid (Emerald), fluxapyroxad (Xzemplar), fluazinam (Secure), and Enclave (Fig. 1).

*In vitro* fungicide sensitivity assays of *S. homoeocarpa* isolates sampled before and after fungicide applications were conducted to monitor changes of dicarboximide-resistant isolates in the population. All *S. homoeocarpa* isolates in the population were insensitive to the DMI fungicide, propiconazole. Increased number of dicarboximide-resistant isolates was observed in plots treated with propiconazole and iprodione in 2015 and 2016 (Fig. 2A and 2B). Number of dicarboximide-resistant isolates was decreased 21 days after fungicide application in 2015 (Final sampling) and in the 2016 overwintered sampling. However, number of dicarboximide-resistant isolates was still high for iprodione and propiconazole applied plots in 2016 Final sampling (Fig. 2A and 2B). The higher application rate of boscalid displayed excellent control of the dicarboximide-resistant population in 2015, however, the dicarboximide-resistant population increased 20% after overwintering. In 2016, boscalid provided good control of the dicarboximide-resistant population (Fig. 2A and 2B). Propiconazole and iprodione applications reduced the percentage of thiophanate-methyl (TM; benzimidazole fungicide) resistant isolates following sampling 7 days after treatment in 2015 and 2016. Due to the high level of control with applications of boscalid, the TM-resistant population was not detected 7 days after treatment in 2015, but the resistant population increased at the Final sampling and decreased after overwintering (Fig. 3A and 3B). The 4$^{th}$ application of boscalid increased the percentage of TM-resistant population by 2-fold in 2016 (Fig. 3A and 3B). In 2017, we will continue to monitor dicarboximide-resistant population by collecting *S. homoeocarpa* from infected turfgrass after overwintering and test the sensitivity of isolates to different fungicides to validate the previous year's results are repeatable.

## Summary

- Non-DMI and non-dicarboximide fungicides (Xzemplar, Emerald, Secure), and Enclave provided better control of the multiple-fungicide resistant *S. homoeocarpa* population than Banner MAXX, Chipco 26GT, or Curalan.
- Dicarboximide-resistant isolates in the population was increased by applications of propiconazole and iprodione, however, they decreased after fungicide applications ended in 2015.
- 2-4 applications of boscalid are required to shift a bimodal dicarboximide-resistant/sensitive population to a unimodal dicarboximide-sensitive population. However, the reverted sensitive population shifted back to bimodal population after overwintering in 2015 and 21 days after treatment in 2016.
- Propiconazole and iprodione provided good control of the thiophanate-methyl-resistant population.

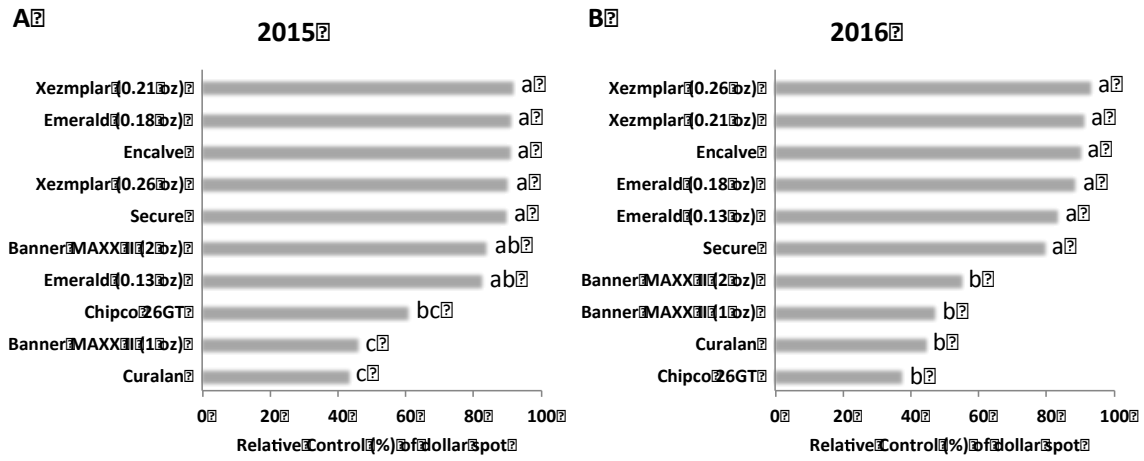


Fig. 1. Relative control percent (%) of dollar spot of fungicide treatments on two different fairway locations at Wethersfield Country Club, CT in 2015 (A) and 2016 (B). Relative control percentage (RC%) data were collected by counting number of individual infection centers and calculating area under (AUDPC) values for all rating dates among all treatments. Rating began on the first date of the first fungicide application and concluded 21 days after the final application. RC% was calculated with the following formula: [(untreated-fungicide treated)/untreated] × 100 = RC%. Different letters on top of bar indicated significantly different ($p$<0.05) according to Fisher's protected least significant difference.

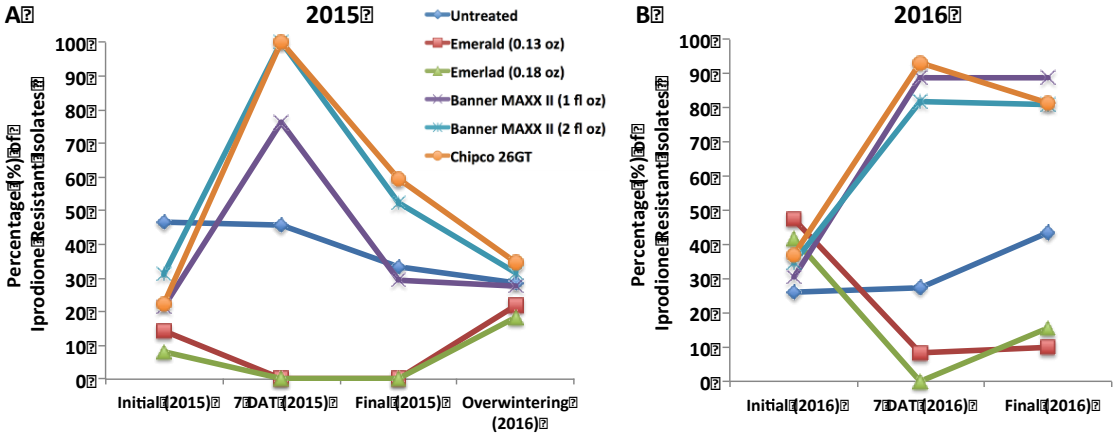


Fig. 2. Percentage of dicarboximide-resistant isolates on untreated and different fungicides treated plots in 2015 (A) and in 2016 (B). Initial, 7-DAT, Final, and Overwinter indicate initial sampling before fungicide application, 7 days after treatment of fungicide, 21 days after final treatment of fungicide, and after overwintering, respectively.

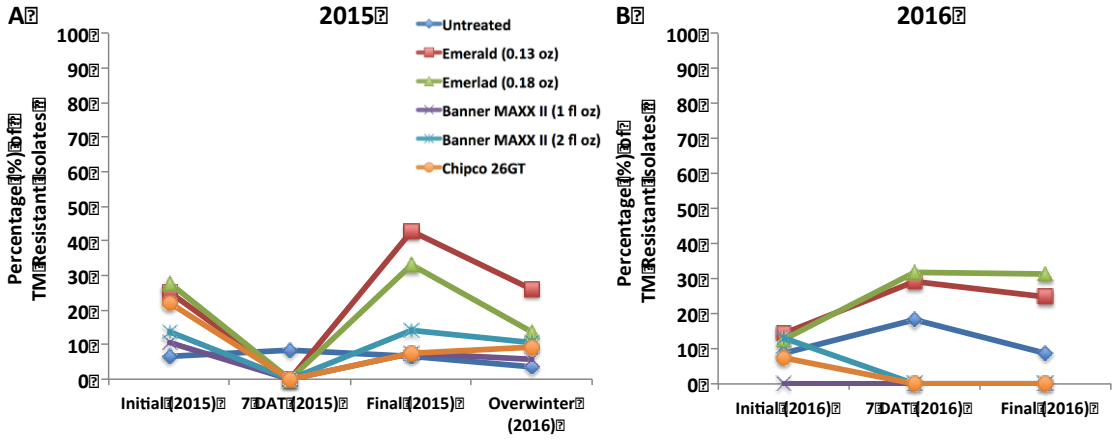


Fig. 3. Percentage of benzimidazole-(TM: thiophanate-methyl) resistant isolates on untreated and different fungicides treated plots in 2015 (A) and in 2016 (B). Initial, 7-DAT, Final, and Overwinter indicate initial sampling before fungicide application, 7 days after treatment of fungicide, 21 days after final treatment of fungicide, and after overwintering, respectively.