Mapping Spring Dead Spot Using Unmanned Aerial Vehicles to Further Explore Epidemiology and Management

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Rationale

- Bermudagrass (*Cynodon* spp.) and its hybrids are the most utilized turfgrass on golf courses in the U.S.
- Spring dead spot (SDS) limits successful management in marginal regions of adaptation
- Suppression strategies are often inconsistent
- Unmanned aerial vehicles (UAVs) allow for rapid data collection at relatively low costs, and may be useful for tracking disease epidemics
- Disease incidence maps could improve understanding of SDS epidemiology and management
- Efficacy may be improved using precision-guided applications of more effective fungicides, while also reducing overall costs

Research Objectives

1. Document a reliable method to effectively map SDS epidemics with UAVs
2. Investigate the use of map-based SDS quantification to guide site-specific fungicide applications

Methodology

Location: The Country Club of Virginia, Tuckahoe Creek Course, Richmond VA

- Aerial imagery and SDS ground-truth coordinates collected 26 May, 2016 (Fig. 1)
- Iris+ (3D Robotics, Inc.) multirotor UAV, fitted with a HERO 3 (GoPro, Inc.) digital camera and PixHawk Mini mission planner
- Images mosaicked using Agisoft PhotoScan 1.2.6 Professional
- Maps were validated by comparing predicted SDS locations to geo-referenced, ground-truth disease locations
- Grid was established with 80 individual 33.4 m^2 plots (Fig. 2) and 11.1 m^2 subplots to determine feasibility of SDS quantification
- SDS patches were quantified digitally and visibly for future precision-guided field research (Fig. 3)

Figure 1: Mosaicked aerial imagery collected with an UAV from a bermudagrass fairway to capture and further study SDS epidemics: Richmond, VA May 2016.

Figure 2: Geo-referenced field plots that cover 2,700 m^2 were layered over geo-rectified fairway mosaics across five test sites.

Figure 3: Individual geo-referenced subplots, measuring 11.1 m^2, overlaid across aerial imagery were used to digitally and visually quantify spring dead spot incidence and severity.

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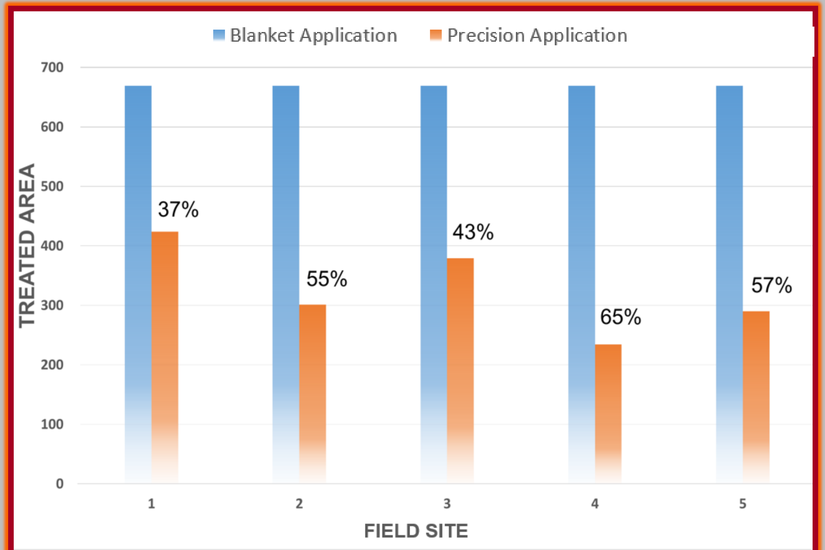


Figure 4: Reduction in treatable area using historical disease maps for precision-guided fungicide applications. Site-specific management based on treating only when SDS exceeds a threshold of two infection centers per plot.

Summary of Results

- Mosaicked UAV-captured imagery provided reliable and accurate disease epidemic maps (Figure 1)
- Maps were georectified with known ground points and individual plots georeferenced for field studies (Figure 2)
- Maps were used to quantify SDS incidence and severity for use in future precision management studies of SDS (Figure 3)
- Precision-guided fungicide applications, based on disease SDS epidemic mapping, reduced the total treatable area by an average of 51.4% over five sites (Figure 4)
- Disease suppression using site-specific management units is still unknown at this time.

Future Research

- Maps generated from this research will serve as the foundation for site-specific management and epidemiological exploration of SDS
- Fungicide efficacy studies are underway using this technique to treat site-specifically within mechanical limitations, only when deemed necessary by UAV-generated epidemic maps
- Combined research efforts with these projects will be considered successful if site-specific applications are able to reduce total fungicide usage and associated costs, without compromising efficacy
- Further investigation of spatial and temporal changes in SDS development using UAV-generated maps is possible using georectified imagery across multiple seasons

	Class				Site-specific units
Site	1	2	3	4	Plots exceeding threshold (>2)
1	0-5	5-9	9-16	17-32	43
2	0-1	1-6	6-12	12-39	27
3	0-3	4-8	8-16	16-32	34
4	0-2	2-4	4-8	9-24	21
5	0-3	3-6	6-9	9-23	26

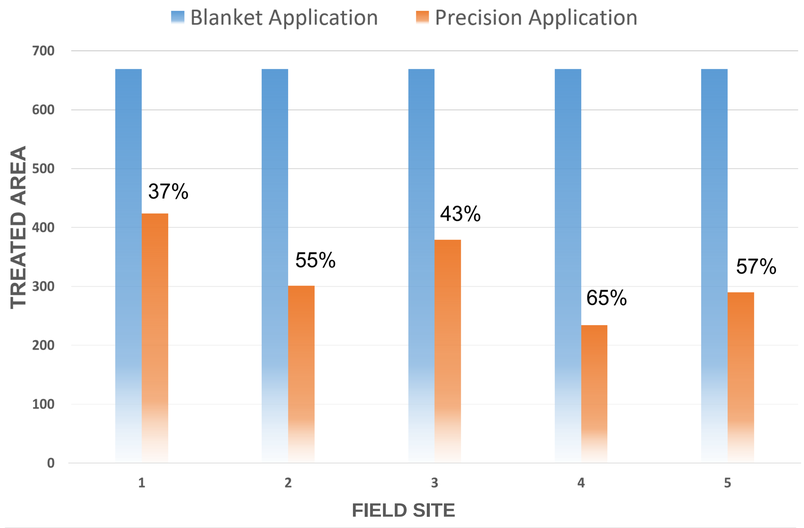
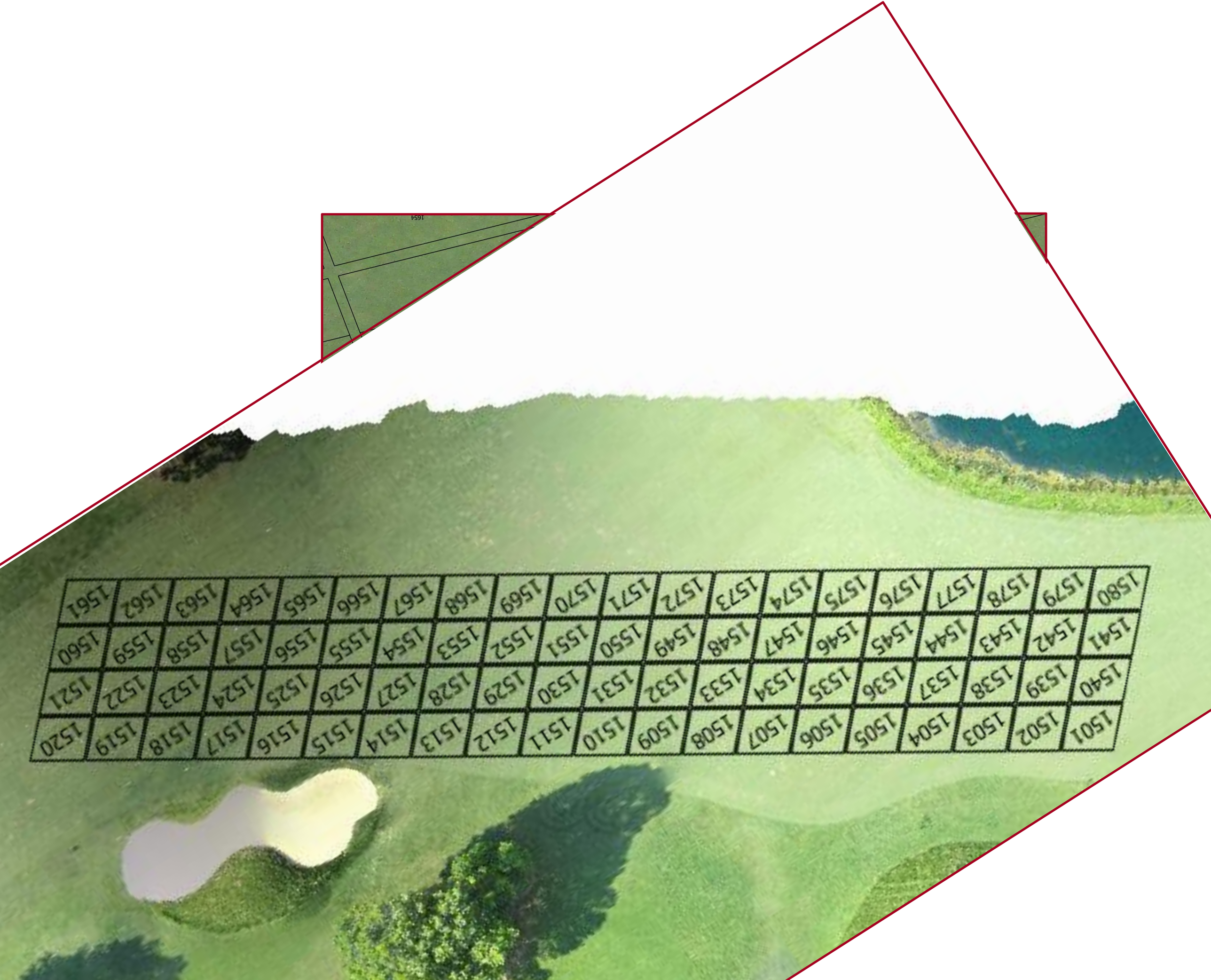


Figure 4: Reduction in treatable area using historical disease maps for precision-guided fungicide applications. Site-specific management based on treating only when SDS exceeds a threshold of two infection centers per plot.

Future Research

- Prescription maps for GPS guided chemical application are commonly used in agriculture. Application of SDS maps to all fairways may reduce overall fungicide requirements and enhance SDS control through the use of more effective active ingredients
- Anticipated fungicide savings using the marriage between SDS precision maps and GPS-guided spraying systems should be quantified
- The efficacy of fungicide applications based on UAV-generated epidemic maps for SDS suppression needs to be studied
- Further research needs to be performed on UAV-mounted imaging technology and its application for SDS incidence recognition
- Methods need to be developed to install mapping software into GPS-guided turf sprayers to control the precision-applications of plant protectants based on disease incidence
- Further research needs to explore how these strategies can be applied to other turfgrass pests and stresses such as volumetric water content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