

Detection of White Grub Damage in Turfgrass Using Remote Sensing

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Objectives

The specific objectives of this preliminary study were: (1) to determine if three levels of white grub infestation in greenhouse turfgrass can be discriminated using a non-imaging spectrometer and (2) to determine specific wavelengths or vegetative indices that are more sensitive to damage resulting from white grub injury in turfgrass.

Rationale

White grubs (e.g. larvae of Japanese beetles or masked chafers) are the most destructive and economically injurious pests of turfgrasses in the Midwest and eastern United States. Developing grubs feed on turfgrass roots at the soil/thatch interface or in the first few centimeters of soil. Visual evidence of an infestation includes thinning, wilting in the presence of adequate irrigation, and yellowing or browning of the grass. Grub infestations typically occur in sporadic patches affecting only a relatively small fraction of the turfgrass in an area. The patchy nature of white grub infestations is rarely taken into account when managing these pests because of the difficulty of pinpointing the location and extent of infestation using traditional sampling techniques.

Repeated blanket-type pesticide applications without knowledge of the actual infestation are not in harmony with IPM philosophy and may lead to environmental pollution and/or decreased pesticide efficacy. Adopting a site-specific management program could greatly reduce the amount of pesticide released into the environment. The purpose of this study is to investigate the use of remote sensing as a sampling tool to detect early white grub damage in turfgrass in a site-specific fashion. This would facilitate site-specific treatment of infested areas and would eliminate traditional prophylactic pesticide applications for grubs.

Remote sensing in this context refers to measuring discrete wavelengths or wavelength ranges (bands) of visible and infrared light reflected from turfgrass. The amount of light reflected from the grass is dependent upon the chemical and structural properties of the turfgrass and is wavelength dependent. Researchers have shown that plant stresses can be identified using remote sensing since the structure and chemical composition of plant cells change in response to environmental pressures (e.g. disease, water stress, nutrient stress).

How It Was Done

Kentucky bluegrass sod was planted on sandy loam topsoil in 11-gallon containers and maintained in a greenhouse at Purdue University between 30 June and 14 Nov-00. The grass was trimmed weekly to approximately 3 in. and was watered and fertilized regularly. On 29 Sep, the containers of grass were arranged in a randomized complete block design (five replicate blocks of three treatments). On 3 Oct, third-instar masked chafer grubs were field collected and transplanted into the containers by making equally spaced slits in the grass with a butcher knife and gently inserting a grub into each slit at the thatch/soil interface. The thatch was then closed over the grub. Treatment 1 (control) received no grubs. Treatments 2 and 3 were infested with 10 and 31 grubs/ft² respectively. Although treatment 1 had no grubs introduced, slits were made in the sod using the grid pattern used for treatment 3. On 10 Oct, 19 Oct, and 3 Nov, all containers were moved outside and spectrometer measurements were taken over each container using a Geophysical & Environmental Research Corporation GER 1500 field spectrometer. The spectrometer was held by hand approximately 70 cm above the top of each container (18 cm field of view). Every 15 minutes the instrument was recalibrated.

On the first date, two measurements per container were taken. On subsequent dates, three measurements per container were taken. Analysis of variance was used to analyze the spectrometer data (percent reflectance factor) for each day for wavelengths known to be sensitive to plant stresses (661, 670, 707, 814, 871, and 938 nm) as well as for two 10-nm bands (667-678 nm and 811-821 nm). Three growth/stress indices were calculated as follows: (1) normalized difference vegetation index ($NDVI_1 = (R_{936} - R_{661}) / (R_{936} + R_{661})$), (2) $NDVI_2 = (R_{Avg\ 811-812} - R_{Avg\ 667-678}) / (R_{Avg\ 811-821} + R_{Avg\ 667-678})$, and (3) $Stress = R_{707} / R_{814}$. Analysis of variance was also used to analyze the growth and stress indices data for each day. Fisher's protected LSD was used to compare treatment means.

Results to Date

- No significant differences among treatment means were found seven days after grub introduction (10 Oct) for any of the wavelengths or indices tested.
- Sixteen days after infestation (19 Oct), the treatment 3 stress index mean was significantly different from the treatment 2 mean (Table 1).
- Thirty-one days after infestation (3 Nov), treatment 3 was significantly different from treatments 1 and 2 for all wavelengths tested in the 650-700 nm range and for all growth and stress indices (Table 2).

Conclusions to Date

- High level grub damage can be clearly distinguished from zero and intermediate damage four weeks after infestation, using wavelengths in the 650-700 nm range and using growth and stress indices.
- Growth indices such as NDVI, and stress indices appear to be more sensitive to grub-induced damage in turfgrass than do individual wavelengths or bands.
- Differences between treatments could not be separated using near infrared wavelengths (800-950 nm) on any of the sampling dates.
- An index of stress may be more effective at differentiating early grub damage than other indices.
- Field studies with additional levels of grub infestation are needed and will be conducted during the summer of 2001.

Table 1. Mean stress index values for 19 Oct spectrometer data.

Treatment	Stress Index
1	0.40 ab ^a
2	0.39 b
3	0.44 a

^a Means followed by the same letter are not significantly different ($P>0.05$; Fisher's protected LSD)

Table 2. Mean percent reflectance factor values for 3 Nov statistically significant wavelengths and indices.

Treatment	Wavelength or Growth/Stress Index					
	661 nm	670 nm	Avg. 667-678 nm	NDVI1	NDVI2	Stress
1	5.84b ^a	5.83b	5.89b	0.74a	0.71a	0.38b
2	6.68b	6.63b	6.73b	0.71a	0.67a	0.40b
3	8.55a	8.43a	8.63a	0.63b	0.58b	0.47a

^a Means followed by the same letter in each column are not significantly different ($P>0.025$; Fisher's protected LSD)