Comparison of Leaf Reflectance of Sorghum Plants Infested by Sugarcane Aphids

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INTRODUCTION

Sugarcane aphid, *Melanaphis sacchari* (Homiptera: Aphididae; Fig. 1A), is a significant pest to sorghum, *Sorghum bicolor* (Fig. 1B). Sorghum fields are regularly surveyed to detect pest infestation. Remote sensing methods using satellite and aircraft data are expected to provide an efficient alternative to field surveys. However, spectral signature of sugarcane aphid infested sorghum plants is not well understood.

We evaluated reflectance spectra of sorghum leaves infested by sugarcane aphids. We used those spectral data to estimate indices that are related to photosynthetic pigments such as chlorophyll[1], anthocyanin[2], and carotenoids[3]. We also estimated an aphid index, damage sensitive spectral index (DSSI)[4].

We used these data to examine whether indices differ between pest infested and uninfested plants. We predicted that plants infested by aphid will have higher levels of anthocyanin, carotenoids, and DSSI indices compared to the control plants. In contrary, chlorophyll index will be greater for uninfested plants.

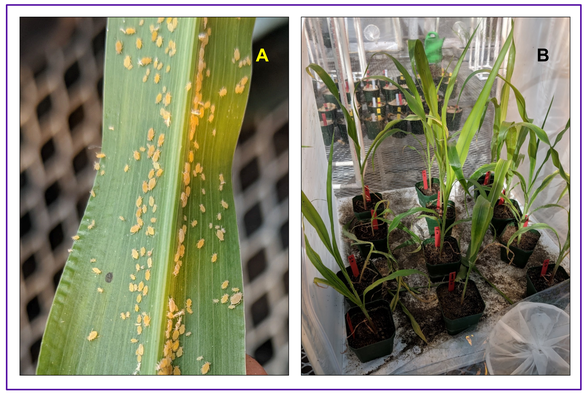

Fig. 1(A). Sugarcane aphid, (B) Sorghum plants infested by sugarcane aphids

METHODS

In a greenhouse experiment, we measured reflectance spectra of sorghum leaves. Twelve plants were infested with sugarcane aphids (number = 20 per plant), while the other 12 plants were left as control. In a week, infested plants appeared stressed and smaller in size then the control plants.

We used leaf spectrometer (CI-710, CID Bio-Science Inc.) to measure reflectance spectrum. Spectral reflectance was recorded on the upper surface of the second newest leaf of each plant. Using these reflectance data, we estimated indices for each plant (Table 1). Finally, variation on each index between control and infested plants was evaluated using t-test.

Table 1. Indices used in this study..

Index	Equation
Chlorophyll[1]	$(\lambda_{750} - \lambda_{705}) \times (\lambda_{750} + \lambda_{705})^{-1}$
Carotenoids[2]	$(\lambda_{800} - \lambda_{470}) \times (\lambda_{800} + \lambda_{470})^{-1}$
Anthocyanin[3]	$\lambda_{550}^{-1} - \lambda_{700}^{-1}$
DSSI[4]	$(\lambda_{719} - \lambda_{873} - \lambda_{509} - \lambda_{537}) \times (\lambda_{719} + \lambda_{873} + \lambda_{509} + \lambda_{537})^{-1}$

RESULTS

Reflectance spectra differed substantially between control and sugarcane aphid infested plants (Fig. 2).

Aphid infested plants showed 29% less chlorophyll (t_{22} = 4.725, P = 0.0001, Fig. 3A) and 34% higher anthocyanin (t_{22} = -2.832, P = 0.010, Fig. 3B) indices than the control plants. Carotenoid index did not differ between control and infested plants (t_{22} = -0.331, P = 0.744, Fig. 3C). Aphid index (DSSI) was 17% greater in the infested plants than the control plants (t_{22} = -2.671, P = 0.014, Fig. 3D).

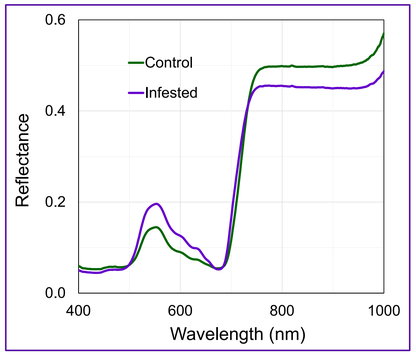

Fig. 2. Reflectance spectra of control and sugarcane aphid infested sorghum plants

CONCLUSIONS

Indices related to photosynthetic pigments and aphid infestation differed significantly between control and sugarcane aphid infested plants. These results indicate that leaf reflectance data can be used to detect sugarcane aphid infested sorghum plants in the field.

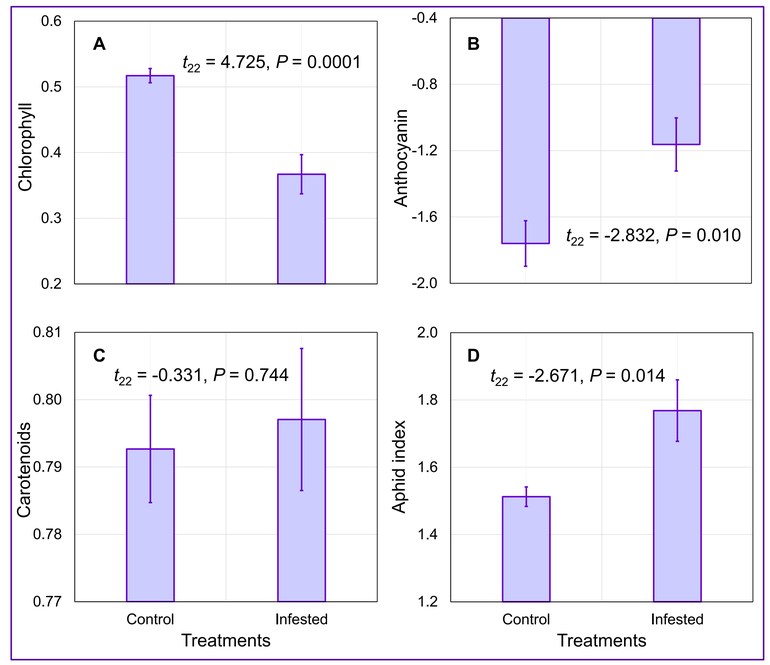

Fig. 3. Indices (mean ± SE) related to photosynthetic pigments and aphid infestation: (A) chlorophyll, (B) anthocyanin, (C) carotenoids, and (D) DSSI

FUTURE RESEARCH

Although the indices examined in this study differed significantly between control and aphid infested plants, the generality of these patterns are not examined in agricultural fields. Future studies should examine these patterns in the field. Furthermore, it is also important to compare the reflectance spectra of aphid infested plants to those subjected to various biotic and abiotic stresses to find out whether aphid infestation could be distinguished from other stresses.

REFERENCES

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