Detecting Boll Rot of Cotton with an Electronic Nose

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Introduction

Early detection of diseased cotton bolls is often complicated by the absence of external symptoms on infected green bolls. We examined the potential of using electronic nose (E-nose) technology to detect volatiles emitted from bolls infected with the opportunistic bacterial strain of *Pantoea agglomerans*, a causative agent of South Carolina Boll Rot (Medrano and Bell 2007). Unlike gas chromatography, E-nose technology was designed to characterize the odor profile or "smell print" of volatile organic compounds (VOCs) rather than quantify the individual components. Instruments are typically equipped with an array of chemical sensors that act as odor receptors. Each sensor generates an electrical signal when exposed to an odor, and the overall composition of individual signals is regarded as the "smell print" or "signature" for that odor. Presented herein are results from a preliminary trial conducted in 2009 with a commercially-available E-nose.

Materials and Methods

E-nose Model:

- Cyranose 320 equipped with 32 sensors (Smiths Technology, Watford, UK)

Treatments:

- *P. agglomerans* rifampicin (Rif)-resistant mutant (Sc 1-R) at a final concentration of 10^3 colony forming units (CFU) per injection (two injections per boll)
- Control – 10 µl of sterile water per injection (two injections per boll)

Experimental procedures:

- Bolls on greenhouse-grown plants (Fibermax 966) were inoculated 13-15 d postanthesis (6 bolls per treatment).
- Treatments were injected (≈ 5mm depth) into the center of the suture of two opposing locules that were previously surface-sterilized with 95% EtOH.
- Two weeks after inoculation, each boll was encased in a 4-oz Whirl-Pak bag (Nasco, Ft. Atkins, WI) for 1 h to collect released volatiles.
- One boll from each treatment was used to "exercise" the E-nose and the remaining bolls were used to train the E-nose to recognize the smell print of volatiles released into the headspace of bags (Fig. 1).
- Once trained, bolls were re-sampled to test the accuracy of the E-nose in discriminating between *P. agglomerans*-infected and control bolls.

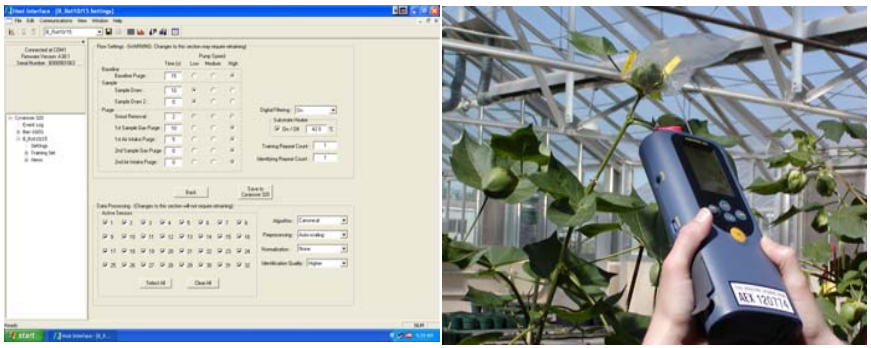

Figure 1. Detection and processing settings (left image) used on the Cyranose 320 while training the E-nose to recognize the smell print of volatiles released into the headspace of bags (right image).

Results & Discussion

- Canonical and principle component analysis projection plots showed distinct separation between the smell prints of *P. agglomerans*-infected and control bolls (Fig. 2).
- Cross-validation of the training data also indicated the E-nose would be 90% accurate in discriminating between the smell prints of infected and non-infected bolls.
- However, upon testing the same bolls used to exercise and train the E-nose, five of the six *P. agglomerans*-infected bolls were correctly identified, while only three of the six control bolls were correctly identified as "non-infected".
- This lower than expected accuracy may have been attributed to the fact that bolls were tested immediately after the training session. Consequently, sufficient time may not have been allowed for volatiles to build up in the headspace of bags prior to testing. Furthermore, we anticipate a higher level of accuracy could be achieved with minor adjustments to the training procedures as well as to the E-nose detection and/or processing settings.

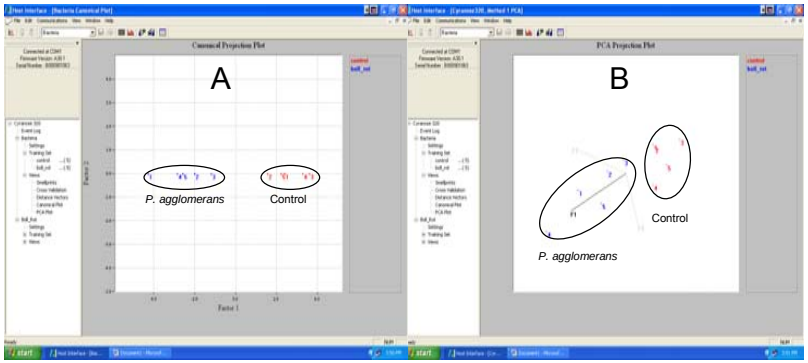

Figure 2. Canonical (A) and principle component analysis (B) projection plots of the smell prints for *P. agglomerans*-infected and control bolls.

Summary

Although the volatiles emitted from *P. agglomerans*-infected and control bolls were not identified in this study, our results suggest infected and non-infected bolls emit distinctly different odors. More importantly, our findings indicate the Cyranose 320 can be trained to detect and discriminate these odors with some degree of accuracy. Based on these promising but preliminary results, continued investigation of this technology is warranted.

Acknowledgments

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References

Medrano, E. G. and A. A. Bell. 2007. Role of *Pantoea agglomerans* in opportunistic bacterial seed and boll rot of cotton (*Gossypium hirsutum*) growth in the field. J. Appl. Microbiol. 102: 134-143.