Advances in Pattern Testing Equipment

By

Dr. Randy R. Price
LSU AgCenter
Dean Lee, Alexandria, LA
Summary

- Newer “wet” analysis methods:
  - Vision based fluorescence on pattern test strings
  - Single pixel TSC3200 color chip used to detect fluorescent dye on pattern test strings
  - Fishing reel tensioner

- New “dry” material evaluation systems
  - Optical, Impact, and Depth
Current “Wet” and “Dry” Systems

- Allow quantitative analysis of spray pattern for testing

“Wet” system:
- For liquid applications
- Typical equipment needed:
  - WRK string door mounted to a Turner fluorometers

- Advantages:
  - Software great at determining swath width

- Disadvantages:
  - Fluorometers has reached end-of-life
  - Base line zero not always easy to achieve
    - Multiple light and filter adjustments needed

“Dry” Analysis system:
- Time consuming to weight individual vials, but very precise method
Vision Based Fluorescence:

- Regular USB camera used with LabVIEW Vision:
- Green laser pointed
- Rhodamine filter (yellow)
- HD USB Camera

Analysis software written to:
- Obtain image
- Color threshold image at 127
- Record area of fluorescent spot in image
Individual Droplets on String:

No Droplets

Droplets

Droplets
Program:

- Color threshold image and count pixels in analysis area of image:
Comparison of Vision System – 10 GPA:

- **CP09 Straight Stream / AT502 Airplane**

Run A  
Run B  
Run C
Vision System Comparison – 3 GPA:

- Penetrator and Drift Guard Test - CP09 Straight Stream

Run C

Run B

Run A

Maybe Real Baseline ???
Currently Testing on Normalized Data:

* Mowata, La / Pass C
Advantage of System:

- Can see string during analysis
- No changes in shutter parameters or light levels
  - Very few changes available (laser is output controlled / only spot size window can be changed)
- Uses a standard USB (HD quality) camera
- Maybe applicable to a cell phones and tablets that contain a camera
Alternate Vision TCS3200 Sensor:

- Want something that will interface “easily” to WRK string door
- Single spot image sensor (TCS3200)
  - Very sensitive
  - Low cost ($40)
  - Interfaces easily with low cost micro-controllers (Arduino, Basic Stamp, etc.)
  - These chips can easily output 0 to 1 volt output to interface with WRK string door
Completed System:

- TCS3100 mounted in Turner fluorometers case
- Two white LED’s replaced with 535 nm Green Led’s
- Rhodamine filter added to front of TCS3100 (Yellow pass)
- Arduino UNO board used to operate TCS3200 and output readings in a serial terminal screen
- Led pulsed to prevent output changes with temp.
Comparisons to Actual Strings:

- **10 GPA / AT502 / Rhodamine Dye**: (Red lens / 20 pt. moving averaged, flipped and zeroed):

Run A

Run B

Run C
String Tensioner Modifications:

- Current String Tensioner:

- Older string winder system good, but can be a "pickle" to re-thread get working when airplane is in the air
Fishing Reel Winder:

- **Fishing reels tensioners**
  - Key to making units work:
    - Multiple O-rings on spools
    - Single wrap of string, so some pretension needed
    - Initially thought two reels were needed (to “pre-tension” string), but “pre-tension” achieved through feed tube and string tub

- **Removable clear plastic lid to allow quick adjustments of tensioner**

- **Results:**
  - Used for 1 year and works good
  - Re-feeding of string still takes time to get through the string tube
Dry Analysis Systems

- Development of automated systems to measure dry material falling from the airplane:

- Two systems tested:
  - Impact plate
  - Optical system

- Material and rate tested:
  - Rice (20 to 100 lbs/acre)
  - Urea (20 to 400 lbs/acre)
Impact Plate System:

- Pseudo-linear relationship, but variances high:
  - 20 to 40 lbs./acre
Optical System for Measuring Material Flow

- Linear Relationship:
- Variance in reading:
  - 2 to 4 lbs./acre
- Building complete system for both

![Optical System / Rice](image1)

Optical System / Rice
10 usec delay in loop / four weight vib motor

![Fertilizer Estimate from Sensor Readings](image2)

Fertilizer Estimate from Sensor Readings

\[
y = 0.00014946x + 0.63853794 \\
R^2 = 0.99592317
\]
Material Depth Measurement:

- Measure material depth in the vial tube after settling
- **Results:** 4 lbs/acre standard deviation on rice
- System will need automatic dumping system
- Shaker motor necessary for settling
- Moy not work on our bags because of limited ground clearance

![Rice Seed - Calibration Curve](image)

\[ y = -0.0098x^2 + 3.8804x - 187.29 \]

\[ R^2 = 0.987 \]
Field Tests:

- System tested in the field:
  - Too much noise from vibrational motors
    - Need to change wiring harness communications system
  - Patterns were recorded very quickly
    - while plane still in the air:
    - approx. 45 seconds

![Comparison of Output and Equation to Transform Data](image)
Conclusions:

- **Tested two wet analysis methods:**
  - **Vision System**
    - Worked well on both high (10 GPA) and low (3 GPA) rates
    - Method seems sensitive enough for pattern testing work.
    - Very easy to see what was on string during analysis
    - Future work will compare actual numbers
    - Maybe be able to detect droplet size
  - **TSC3100 Optical chip:**
    - Works good also
    - Will be very easy to interface with current WRK string door
    - More testing on lower rates

- **Dry pattern testing equipment:**
  - Two system developed:
    - Impact Plate and Optical Flow
  - Both system work, but optical flow seems the best
  - Further development into both systems
The End

Questions?
Test on Single Nozzles:

- Yellow Flat Fan A.I. Nozzle (TT0011 - Course droplets: mean 470 um)

- Herbi Disk Sprayer (ULV - mean 270 um):
TCS3200 Spectrum

- With NIR blocking lens:

- Without lens: