Draft

Statements regarding treatments:

Nozzle studies were conducted to determine differences in ability to penetrate spray droplets down into a soybean canopy using a conventional ground sprayer. For these evaluations four GPA and speed combinations were evaluated. They were:

20 GPA @ 10 MPH
20 GPA @ 15 MPH
15 GPA @ 10 MPH
15 GPA @ 15 MPH

The 20 & 15 GPA application volumes were selected to match labeled recommendations that are being recommended for ground sprayer applications of many fungicides.

Researcher thought: Would expect to have increased canopy penetration with more GPA.

The 10 & 15 MPH application speeds were selected to match what is expected to be used especially with commercial spray systems. Farmer operated pull-type or 3-point mounted sprayers may travel slower. These trials will not reflect speeds under 10 MPH. However, the principles used for selection are the same at the lower speeds.

Researcher thought: Common thinking would be that slower speeds would increase canopy penetration. However, many are resisting the ‘spraying slower’ option due to the potential need to cover a lot of acres in a short amount of time.

A special spray machine was built to simulate an operating sprayer. See link to images of spray tester on my webpage. Tests were conducted in a laboratory setting at the above mentioned speeds. Several soybean plants were arranged under the test sprayer boom to simulate a dense canopy much like drilled or narrow row plantings (see picture). Water sensitive paper (wsp) placed in the canopy was used to collect the droplets and DropletScan® software was used to measure and evaluate droplet characteristics. WSP’s were placed at the canopy top, middle, and bottom for the purpose of comparing all treatments. The bottom and some middle collectors are reported at this time.

The soybean plants were grown in 6-inch pots in a greenhouse for use in the laboratory evaluation. The basic reason for the early preseason trials was to provide applicators information on how to configure sprayers with nozzles to improve canopy penetration. Applicators are being bombarded with options (sometimes confusing) from nozzle manufacturers as well as others (fungicide companies, pathologist, others). In fact, many new approaches are being suggested, some that require a complete change in nozzles currently being used to apply herbicides.

Many nozzle configurations are possible for the application of fungicides in dense soybean canopies for the control of ASR. However, many applicators have little experience in applying fungicides to soybeans. The following section will describe the researcher's rationale for determining the various nozzle treatments to meet the volume, speed, pressure, and droplet size requirements for fungicide applications in soybean.

Reasoning for nozzle choices and operating pressures:

1. A major question needs answered to better understand fully. How is applying a fungicide to a dense SB canopy different than applying a herbicide? Most are very familiar with applying herbicides.
   - Herbicides typically applied with less GPA 5 or 10 compared to 15 to 20
   - Basically, herbicides are applied uniformly over the canopy top
   - Fungicides will need same uniformity over top plus will need uniform and adequate coverage into the bottom of canopy.
   - Herbicides (with Glyphosate leading the way in popularity) will typically work with a larger droplet size. Efficacy is good while drift is minimized.
   - Fungicides will need more coverage which translates to smaller drops covering a higher percentage of the plant's leaves throughout the canopy.
   - Therefore, a different droplet spectrum is expected to be necessary for a fungicide to work effectively compared to most herbicides (glyphosate in particular). Mode of action of the chemical is critical to understand at this point.
   - The smaller droplets needed for coverage is important remembering that when droplets get too small they will be drift prone. Even though drifting fungicides may not cause serious problems, the smaller droplets will not effectively penetrate the canopy, thus, wasting expensive chemicals.
   - For the reasons stated about droplet spectrum differences, combining glyphosate and a fungicide are not recommended.

2. Calibration is very important when making the shift from herbicide to fungicides. Why?
   - Requires increasing the carrier volume. For some it will double (from 10 to 20 GPA) what sprayers are typically calibrated to deliver.
   - The simplest way to increase the application volume this much is to increase the orifice size. Other options but not as practical would be to slow down and/or increase pressure. Doubling the application volume (10-20 GPA) requires doubling nozzle orifice size. Reducing travel speed by one-half achieves the same result. This option is not popular when increased acres and "hurry up and get it sprayed" is the driving force. Raising the pressure 'four times' will also get you there – but think about what happens to the droplet size and drift potential.
   - Thus, at a minimum applicators will need to increase orifice size. For example, using an "03" orifice at 10 GPA would mean using an "06" orifice to get 20 GPA if speed and pressure are not adjusted. This is a simple fact of calibration and nothing new to an application strategy.
   - Caution here is……doubling the orifice size dramatically increased the droplet size. This is not what we want from droplet size perspective. See earlier comments.

- Thus, increasing pressure will be necessary to reduce droplet size but, remember, this will also increase flow rate from the orifice, thus increasing GPA.

THEREFORE: An extra step is involved – calibrating for 'DROPLET SIZE'.

Calibration to determine needed flow rate or orifice size must be done in conjunction with matching pressure, nozzle type, orifice size, and speed to the desired droplet size. This last step (matching the droplet size) is not something familiar to most applicators today. It will be necessary to add this step to the set-up of the sprayer to optimize the fungicide application for increased lower canopy coverage and minimized drift.

Consulting the nozzle manufacture droplet sizing charts is ESSENTIAL. Also, websites and manufactures literature is available to help. Example charts can be viewed on the following links.

http://www.teejet.com/MS/TeeJet/documents/Soybean%20Rust/LI-MS115%20Rust%20Bulletin%20(letter%20size).pdf

One of the main challenges for setting up this study was to determine the nozzle options available to apply fungicides achieving optimum lower canopy coverage. Each nozzle type and size chosen was selected first to meet the flow rate requirements for the GPA and MPH and then the pressure was selected to qualify for the droplet spectra desired. The following formula should be used to accomplish this:

$$\text{Nozzle Flow Rate (GPM)} = \frac{\text{GPA} * \text{MPH} * \text{Nozzle Spacing - inches}}{5940}$$

Using this scenario – 20 GPA at 10 MPH and 20 inch spacing - the flow rate required would be 0.67 GPM.

Website for example flow rate chart:

http://www.teejet.com/MS/TeeJet/documents/Catalog%2049A%20U.S.%20English/CAT49A_USA_9-26%20Broadcast%20Nozzles_lo.pdf

In reviewing the nozzle manufacture flow rate charts one possible nozzle to accomplish this flow rate would be the XR11006 at 50 PSI. Several other options would be possible, such as the XR 11005 at 58 PSI or the XR11004 at around 95 PSI. The last option would be too high a pressure for the XR. The Turbo flat-fan (TT) could also be considered. To determine which to use it is necessary to fit the orifice and pressure to accomplish the specified droplet size. Thus, consulting the droplet spectra charts will be necessary.

At this point the consensus for making fungicide applications is to select a droplet spectrum ranging from 200-300 VMD microns. Thus, the 200 – 300 micron parameter was selected for these studies and all the nozzle treatments were selected to fit this range.

This range is based on the ASABE Droplet Standard S-572 and would be classified as a high-fine to mid-medium sized droplet. This is compared to a typical glyphosate recommendation of 300-500 microns, or mid-medium through course to low end-very coarse (see chart).

In the above example the XR11006 at 50 would deliver a medium sized droplet. The XR 11005 at 58 PSI would be borderline medium – fine. Both would be possible choices. The TT11006 at 50 PSI would make droplets borderline coarse – very coarse. This would not be a good option. The TT11005 at 58 PSI would still be coarse. Using the TT 11004 at 95 PSI would produce medium droplets and is a possible selection provided the spray system can achieve and maintain operation at the higher pressures. For this study I left the TT11006 in the treatments to see what outcomes would occur.

In summary, all the nozzle types and orifice sizes used in these studies were determined based on achieving the calibrated flow rate and speed (see earlier mentioned rates and speeds) with the pressure adjusted to meet the 200-300 micron size requirement and then maintaining the calibrated nozzle flow rate (GPM). That is why different orifice sizes and pressures are shown through out the study (as mentioned the TT11006 is an exception). The nozzles with the highest pressures in the study were the induction, injector, or venturi style nozzles that required the higher pressures to meet droplet size specifications (115 PSI).

Researcher comment: Even though some of the venturi nozzle types did reasonably well in these studies, it is my opinion that not many applicators will be able or even willing to spray at such high pressures. This would contribute to sprayer component wear and possible malfunction. Operating at the higher pressures is not something I would recommend for all applicators.

The studies included single as well as double or twin nozzle configurations. When calibrating for a double nozzle arrangement (not TwinJet), you must remember to add the sum of the two nozzle flow rates to obtain the calculated rate. TwinJets are designed with two orifices and rated at flow. From the above example requiring the 0.06 flow rate, selecting two 0.03 orifices will provide the desired flow or 0.06. In that scenario, two XR11003 or two TT11003 nozzles used at 50 PSI would suffice. Again, after calibrating for the twin nozzles at flow rate and speed, the pressure to achieve the droplet spectra goal will need to be considered. In this example, the XR would provide a fine droplet spectrum and the TT would be borderline coarse – medium. In this example the XR8003 might have the best droplet spectrum (low medium). Using the two nozzle approach actually provides better options in matching the flow rate requirements to the droplet size at more reasonable pressures.

POINT TO REMEMBER:

End result of the calibration process regardless of speed or GPA:

Achieve 200-300 (hi-fine to mid-med) size droplets
Larger droplets – less potential for getting the droplets into the canopy.

Smaller droplets (less than 200) may result in increased drift potential and less coverage into bottom of canopy.

USING THE DROPLET SIZING CHARTS A MUST!!

Interpreting the results:

The number of nozzles used in each comparison and reported represents the possible setups for each application scenario. In some cases, nozzles were eliminated due to poor performance in earlier trials. In other cases there were not many options that met all the previously mentioned prerequisites of GPA, speed, pressure, and droplet size. In some cases not all possible combinations were available to the researcher.

The results reported represent an analysis of water sensitive paper (WSP) using DropletScan® software. One statistic useful for measuring canopy penetration is percent area coverage on the collectors. Results for all the nozzles studied are shown in graphical form (4 application scenarios from earlier). The amount of coverage measured represents a composite of 6 WSP's and a summation of two replications (12 WSP's per location). Only the results of the bottom canopy collector (WSP) location are reported here. The basis for this study was to determine which nozzle could get the most coverage into the bottom of the canopy.

Or is coverage the best indicator? Another important statistic reported is number of droplets per centimeter squared on the surface of the WSP. Note, in this study, the WSP were similar in size and orientation to the soybean leaves in the canopy and even though not a perfect simulation of the leaf, provides a basis for comparison within the parameters of this study. Number of droplets may be a better indicator of amount of fungicide distributed into the canopy.