Tips for Ground Application of Fungicides for 'Asian Rust' Control

Robert E. Wolf, Assistant Professor & Extension Specialist, Biological & Agricultural Engineering Department, Kansas State University, Manhattan, KS
Dennis R. Gardisser, Professor & Assoc. Dept. Head, Biological and Agricultural Engineering Department, University of Arkansas Division of Agriculture – Cooperative Extension Service, 2301 University Drive, Little Rock, AR
Scott Bretthauer, Extension Specialist – Pesticide Safety Education, Department of Agricultural and Biological Engineering, University of Illinois, Urbana, IL

Asian soybean rust, a pest first identified in the United States during the late fall of 2004, has potential to cause severe damage to the soybean crop across a wide area of the United States. In areas were the pathogen has been present losses have been near 80 percent without treatment. Because of the size of the U.S. soybean crop a large rippling affect through the industry may result, including an estimated $1.5-2 billion in losses. Soybean rust can appear and spread quickly over a large area from the plant's early vegetative stages through its later stages. If the disease goes untreated, the plant may become entirely defoliated in 10 to 14 days.

The challenging aspect of combating this disease is with the lack of practical experience in making fungicide applications to a soybean crop during the growth stages when this disease may strike. The most critical stages for the disease to affect the yield and quality of the soybean plant are from the start of flowering, R1, through pod formation, R4, and fill, R5. During these stages the canopy density is increasing, making it more difficult to achieve adequate placement of the fungicide. Many questions remain to be answered regarding specific application techniques. Some questions that applicators will need to ask are:

- What fungicide or combination of fungicides should be used?
- At what stage of the disease should the application(s) occur?
- Will multiple applications be necessary?
- What application volume (GPA) will be needed?
- What spray nozzle type, orifice size, and pressure will be necessary for good coverage?
- Will a specific droplet size be necessary?
- Can fungicide applications be combined with herbicides or insecticides as a tank mix application?
- Would the addition of tank mix deposition aids benefit canopy penetration?
- What application system would work best – aerial, ground, chemigation?
- Are there any spray system technologies that may be better than using conventional systems?
- What other application time conditions should be considered – environmental, time of day, field conditions, or others?

Critical information regarding the answers to many of these questions will be available through several sources. But strict attention to the label directions for the product(s) of choice will be essential. Any spray system (aerial or ground) should be able to make efficient and efficacious applications for rust control. This document addresses ground applications only. Several general application practices would be appropriate which include selecting the proper fungicide or combination, applying it at the proper time, and setting the application parameters to give ample coverage into the soybean canopy.

Past experience with disease control in heavy canopies would tell us that getting the spray droplets to penetrate into the canopy would be beneficial to achieve the best coverage and improved efficacy. Past experience would also tell us that when using conventional spray systems it can be very difficult to achieve adequate coverage into the lower parts of heavy crop canopies, which is necessary for maximizing product performance. A key to successful prevention or control of soybean rust is in knowing what amount of actual fungicide will be needed in the lower parts of the canopy and then getting it there.

The following is a set of guidelines that can be used to help applicators in selecting the proper application parameters for making fungicide applications with conventional boom sprayers.

- Application timing will be critical and multiple applications may be needed to fully minimize the impact from a disease outbreak.
- All applications must be made uniformly over the crop.
- Regardless of the mode of action of the fungicide of choice an application providing excellent coverage throughout the canopy will be essential. Achieving good coverage will be influenced by growth stage during the application time.
- Selecting the proper application volume will be a good starting point. Currently many labels are suggesting a minimum of 10 and preferably 15 gallons per acre (GPA). Data would support improved droplet penetration into the canopy as application volumes increase. Calibrating the sprayer to achieve the selected GPA using the intended operating speed and pressure will be essential.
- Application speed will be based on several factors including field conditions, nozzle type, and orifice size selected, as well as operating pressure requirements. Travel speed considerations are important for maximizing efficacy of fungicide applications. Relatively high speeds common to herbicide applications may not be appropriate. Higher speeds may result in less penetration into the canopy.
- The nozzle type, orifice size, and operating pressure selected will be influenced by the need to achieve the optimum spray droplet size for maximum coverage in the canopy. Research indicates droplet size requirements in the upper fine to lower medium range (200-300 microns — Volume Median Diameter — VMD) based on current standards (ASAE S-572). Nozzle manufacturer charts will guide you through this determination. Manufacturer Web site addresses are provided for your reference[1]. With a specific droplet size in mind, selecting the nozzle type best suited for the job will be influenced by speed of travel, pressure, and orifice size needed to deliver the desired GPA. Again, proper calibration is essential; field operations must adhere to these selected parameters.
- There are several options available for selecting a nozzle type to use. There are also some limitations to consider. The first and main concern is to select a nozzle type that will deliver the desired droplet spectra for fungicide applications.
- A limitation with wide-angle flat spray nozzle types is not to use them at excessively high pressures, creating a droplet spectrum in the low end of the fine to the very fine category

[1]Spraying Systems – TeeJet; http://www.teejet.com/ms/teejet/
Greenleaf Technologies; http://www.turbodrop.com/
Hypro Pumps; http://www.hypropumps.com/
Billericay Farm Services; http://www.bfs.uk.com/bubblejet.htm
Wilger Industries; http://www.wilger.net/products.html

— below 200 microns. These smaller droplets will be highly drift prone and lack sufficient velocity to get adequate canopy penetration. They may also move off target, creating undesirable environmental concerns.

Figure 1. Total Range, Extended Range (left), TurboTeeJet flat-fan (center), TwinJet (right)

- When considering high pressure limitations for some spray systems, wide-angle Extended Range (XR)®[2] or Total Range (TR)®[2] (figure 1), Turbo TeeJet®[2] flat-fan (figure 1), and certain venturi design nozzles may provide the best options for achieving the droplet spectra needs. The Spraying Systems TwinJet®[2] nozzle is also a possibility (figure 1).
- The use of some venturi or air induction type nozzles with excellent drift reducing tendencies will have severe limitations based on flow rate and pressure requirements to obtain 200-300 micron droplets. Achieving a proper droplet size can be accomplished but may require pressures higher than 80 PSI. Higher pressure requirements may be more than your spray equipment is capable of delivering. However, the AirMix®[2] from Greenleaf (figure 2) and the Air BubbleJet®[2] from Billericay Farms (figure 2) have the ability to produce the desired droplet spectra at somewhat lower pressures. A close review of the manufacturer's droplet selection charts will resolve this issue.

Figure 2. Greenleaf Air Mix (left), Billericay Air bubble Jet (center), Hypro Twin-cap with Lurmark® adapter utilizing two extended range flat-fan nozzles.

- Hollow-cone nozzles have also been suggested but often are used at high pressures (by design) resulting in the creation of fine droplets that will have higher potential for drift and will have very low trajectory speeds, making canopy penetration difficult. Hollow-cone nozzles may be an excellent choice when used with two- and three-nozzle clusters directed over each — especially prior to full canopy closure.
- The Wilger COMBO-JET® - COMBO-RATE®[2] nozzle system also has possibilities for improved crop canopy coverage (figure 3). This system allows applicators the flexibility to meet higher flow rate requirements by combining multiple nozzles at one location (nozzle bank) while maintaining the correct droplet size, rather than using a single larger orifice resulting in a droplet spectra too big for adequate crop canopy coverage.

Figure 3. Wilger combination nozzle bank (left) and Twin Cap adapter with MR nozzles.

- Another option with promise is a special nozzle design that incorporates a double flat-fan spray set up. Double cap or twin cap nozzle holders are available from manufactures to adapt standard nozzle bodies. This design has two cap openings or two independent caps allowing for two flat-fan nozzles to be mounted on the typical nozzle body (figure 2). One nozzle will be oriented forward and one backward from the direction of travel, ranging from 60-120 degrees between. This arrangement should not be confused with twin-orifice nozzles. A double cap set up could accommodate either extended range or turbo flat-fan designs (figure 4) or a combination as long as flow rate and droplet size needs were fulfilled. It is also possible to use this 'TwinFan' arrangement in combination with the Greenleaf AirMix® and TurboDrop® Venturi (TDTF)[2] (figure 4). Greenleaf is recommending a smaller orifice with wider angle to produce smaller droplets for coverage in the upper part of the crop canopy on the forward nozzle and a narrow angle with larger orifice on the rearward nozzle producing larger droplets to penetrate deeper into the crop canopy. Doing this in combination with a venturi system will allow for higher pressures (80-150 PSI) to achieve the fine to medium droplet, thus the potential for increased droplet velocity into the crop canopy.
- Other nozzle designs may be appropriate for fungicide applications as well. Again, this would only be true if you properly match the application parameters to provide the desired droplet spectra.
- It is also possible to consider lower boom settings for fungicide applications. This would only be advised when using the wider angle (110+ degree fan) spray patterns. Nozzle set-up charts indicate 14-15 inches above the target on 20-inch spacing will provide adequate overlap to avoid streaking with wider angled spray nozzles.
- It is best to utilize different travel directions when more than one application is necessary. This may not be as important when nozzles with multiple spray or canopy entry angles are used — such as the twin fans.

Figure 4. Double nozzle body adapter TeeJet Duo (left), Greenleaf TwinFan AirMix (center), and Greenleaf TurboDrop Venturi TwinFan (right). Twin fan uses the Hypro Twin-cap.

- In canopy applications, increasing nozzle overlap from the typical 50-60 percent to 80 - 85 percent may improve deposition potential. This can be achieved by raising the boom

height above target to 21-23 inches or tilting the boom approximately 15 degrees rearward, an angle that already exists with the turbo flat-fan. Raising the boom for applications requiring canopy penetration, however, is not advised due to losses in droplet trajectory speeds and increased drift potential.

- Higher temperatures and lower humidity may deter good penetration through evaporation of water from the droplets, thus decreasing their size. Heat energy absorbed into the canopy may also make it more difficult to move the smaller droplets through the strong micro-inversion layer that forms in the top of the crop.
- The use of adjuvants and surfactants may be very beneficial as spreaders and stickers. Research also supports improved canopy penetration with the addition of spray deposition aids. Care should be taken to avoid major droplet spectra changes, particularly increases in the overall droplet spectrum, when these products are added to the tank. Remember to always check the fungicide label for adjuvant compatibility issues.
- The combination of a tank mix of herbicide (Glyphosate) and fungicide is not recommended. The main reason is because of the different droplet spectra requirements for each pesticide. Herbicide applications are commonly made with lower application volumes (5-12 GPA) and with a droplet spectra recommendation in the higher medium to coarse classification (300-450 microns). This is not what is being recommended for fungicides in the soybean rust scenario. When using the lower droplet spectrum with herbicides the drift potential increases.
- Utilizing air-assist, air shroud, spray technology may provide an advantage for increasing droplet penetration in the soybean canopy. There is evidence that air-assist may also improve coverage on the under side of the plant leaves. However, spray systems with air-assist technology are considerably more costly. More information about air-assist technology is available by doing a Web search with the key words “air-assist sprayers.”
- Research does not support the use of electrostatic spray systems to increase canopy penetration in heavy crop canopies such as soybeans. To learn more about the electrostatic spray process do a Web search using the key words “electrostatic sprayers.”

Fungicide recommendations for controlling Asian soybean rust are based on observations and experiences in other countries where conditions, rates, and other parameters may differ. Research will continue and recommendations are likely to adjust as our understanding of Asian soybean rust improves. One thing that is known for sure is it will be essential to select the application parameters to achieve thorough canopy coverage while minimizing drift. It can not be stressed enough to make sure the application system chosen for the job is properly calibrated to deliver the proper amount of fungicide in a uniform manner over the soybean crop. Follow label directions and be alert for any new strategies that may be forthcoming.

For more information on specific management strategies for controlling Asian soybean rust refer to the following web sites or others that you may be aware of.

www.aphis.usda.gov/lpa/issues/sbr/sbr.html
www.apsnet.org/online/feature/rustadvice
www.apsnet.org/online/feature/rust
www.aphis.usda.gov/ppq/ep/soybean_rust/
www.gpdn.org

A general search with “Asian soybean rust” as the keyword will also provide a large amount of information.