

Best spraying strategies to fight against **Soybean Rust**

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Asian Soybean Rust (*Phakopsora pachyrhizi*) has officially arrived in the U.S. in the fall of 2004. It was first found on soybean leaf samples collected from Research Plots near Baton Rouge, LA. The number of confirmed cases in the U.S. stood at 29 with the discovery of fungus in a total of 9 states: Louisiana, Alabama, Georgia, Florida, Mississippi, Arkansas, Tennessee, South Carolina and Missouri.

There are no soybean varieties currently available that have high levels of resistance to soybean rust. Researchers will find such varieties some day, but according to the most optimistic predictions, this may not happen for another 5 years. This leaves us with only one alternative option: be prepared to do as good a job as possible applying fungicides that are registered for protecting against or controlling this disease. So what is the best spray equipment set up to do an effective job?

Before listing a number of specific spraying recommendations for Soybean Rust, I would like to remind applicators the 5 major general spraying principles that result in satisfactory and economic control of the problem, regardless of whatever it is that we are trying to control: 1) positive identification of the disease; 2) using the right pesticide; 3) selecting the right equipment, and particularly the right type and size of nozzle for the job; 4) applying the pesticide at the right time; and 5) checking the accuracy of equipment periodically to make sure that we are applying the amount recommended on the label.

Fungicides manufactured to control soybean rust are effective. However, success will largely depend on proper application. Proper application starts with selecting the right equipment, specifically nozzles, and spraying the right amount of fungicide uniformly across the field before the disease is detected. Pesticide manufacturers have invested heavily to determine the most effective as well as economical application rate for the fungicides labeled for soybean rust. However, it is up to the applicator to make sure the recommended amount is applied.

Spraying the right amount of fungicide on each acre of soybean is not enough to achieve effective pest control. How uniformly the fungicide is deposited on the spray target is as important as the amount deposited. Each nozzle produces a unique spray pattern. Some nozzles require precise overlapping of patterns from adjacent nozzles. Setting the proper boom height for a given nozzle spacing is extremely important in achieving proper overlapping. A low boom does not allow proper overlap while a boom set too high causes overdosed areas. Other situations that cause improper overlapping and poor uniformity include: clogged nozzles, misaligned nozzles spraying at different directions, and mixing nozzles with different spray angles. All these common errors contribute to non-uniform coverage.

The single most important factor affecting the control of this disease is to get a **thorough coverage of soybeans with the fungicide**, which is much different and more challenging than spraying for weeds and insects. How do we get the most effective coverage on soybean leaves? The answer to this question is much easier when we are dealing with a problem that is visible, and on the top part of the canopy, as it is usually the case with weed control. In such situations we will be fairly satisfied if we can achieve a good uniformity of coverage on the

horizontal plane. Unfortunately, with the soybean rust, we are going to be concerned with both the horizontal, as well as vertical distribution of the fungicide on soybean leaves. Soybean rust first shows its symptoms usually in the lower parts of the plant and works itself up towards the top of the plant. So, by the time we notice the problem in the mid-to upper canopy, it may be too late to spray any fungicide. Complete coverage of the disease could be even more challenging if the symptoms of the disease are found at later stages of plant growth when the plant is close to having the full canopy. Penetrating droplets inside the canopy of a fully grown plant is a much bigger challenge for us. Detecting the disease early and using the most effective control mechanism are keys to controlling this disease.

So, which spray equipment set up is likely to provide the best defense against soybean rust? Unfortunately, we DO NOT have efficacy data for soybean rust with different equipment yet. However, we DO have spray coverage data from several research projects dealing with other soybean diseases such as Sclerotinia Stem Rot that require probably the same type of equipment set up for effective control. Does good coverage correlate with efficacy? Yes, at least most of the time. Findings from some of our research on fungicide applications on vegetables indicate that the control was equally good regardless of the nozzle arrangement used, in spite of the fact that there were differences in coverage on the plant among these nozzle arrangements. But in most cases, there is a very strong correlation between coverage and efficacy.

How to achieve the best coverage?

There are basically two ways to increase coverage: 1) reduce droplet size; and 2) increase carrier volume (application rate). Large droplets don't provide a good coverage and result in waste of chemical. Increasing the application rate may be equally undesirable. It requires frequent refilling of the sprayer tank. This wastes time that may be extremely valuable when there is a short window of opportunity to spray. Ideally, we want to have as many small droplets on the target as possible. However, extremely small droplets have a tendency to drift. Research has shown that there is a rapid decrease in the drift potential of droplets whose diameters are greater than approximately 200 microns. When small droplets are released from the nozzle, they quickly lose the momentum that is needed to push the droplets into the canopy. Also, these extremely small droplets do not last long after they are released from the nozzle. Most of them evaporate within a few seconds.

However, there is a way to utilize most of the droplets that may normally drift: using the air-assist technology. Air flow carries these small droplets into the canopy where they can have a chance to deposit, rather than drift away. In all the spray coverage tests using different sprayers we conducted in Ohio, **air-assisted sprayers** consistently provided the best coverage on targets placed well inside the canopy. This advantage was even more noticeable when we compared the spray deposits on underside of plant leaves.

For example, we conducted research on determining which equipment set up would provide the best coverage on a soybean plant to control Sclerotinia Stem Rot (cooperators on this research project: Anne Dorrance, Plant Pathologist, OSUE; and Richard Derksen, Agricultural Engineer, USDA-ARS). Because flower petals are the sites of primary colonization of this disease, the application of fungicides must be directed at soybean flower petals, especially in the lower portions of the crop canopy. Once established, infections can spread to leaves, petioles, internodes, and also adjacent plants through contact with diseased plants. Flower petals are very close to the stem of the plant and about at two-thirds of the height of the plant. The challenge to reach the flower petals is similar to the challenge to reach Soybean Rust spores well hidden in lower parts of the plant canopy.

We compared coverage from 4 different nozzle/equipment setups: XR8002 conventional flat-fan, TT110015 low-drift flat-fan, D-2-23 Disc-core hollow cone, and an air-assisted sprayer fitted with XR110015 flat-fan nozzles. A pair of 1/4" map tacks were used as simulated soybean flower buds at two elevations: 20 inches (representing middle elevation), and 12 inch (representing lower elevation) above the ground. Upper elevation on plant was not evaluated because it was assumed that all sprayers could treat this area effectively well and it was assumed that disease incidence would be greater deeper in the canopy. Map tack targets were placed on the soybean stem in the area of flower buds. The plant height ranged from 30-34 inches at the time of spraying. The travel speed was 3 mph, and the application rate was 20 gpa. Target map tacks were removed after spraying, washed and the wash solution was evaluated to determine the amount of deposit on the target. Coverage Results from this research are shown in the table below.

Table 1. Mean target deposits by treatment and elevation

Sprayer Treatment	Nozzle Pressure (psi)	Middle Elevation Mean Deposit ($\mu\text{g}/\text{cm}^2$)	Lower Elevation Mean Deposit ($\mu\text{g}/\text{cm}^2$)
Myers Air-Assist**	28	725.6	397.0
TT110015 (flat fan; low-drift)	71	283.0	199.0
XR8002 (flat fan)	43	267.3	188.6
D2-23 (hollow cone)	240	232.7	158.0

** The sprayer was equipped with XR110015 flat-fan nozzles

The key conclusions from this research are as follows:

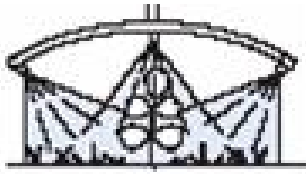
- Myers air-assisted sprayer produced significantly higher deposits than all the other sprayers.
- No significant differences among conventional broadcast sprayers but the low-drift Turbo TeeJet nozzle (TT110015) did produce the highest deposits and the cone nozzle (D2-23) produced the lowest deposits.
- The Myers air-assist produced significantly higher deposits at both elevations.
- The Myers Air produced higher deposits in the lower elevation than any of the other sprayers produced in the middle elevation

All the results mentioned above could be applicable to spraying for soybean rust. So, it is very clear that an air-assisted sprayer is the best equipment option we have if our goal is to achieve the best coverage of soybeans with the fungicide. Unfortunately, a commercial-scale sprayer with the air assistance may add from \$10,000 to \$15,000 to the price tag of the equipment. However, this one-time cost may well outweigh the income lost due to Soybean Rust in one growing season.

If an air-assisted sprayer is not an option, which nozzle should be chosen?

If beans are planted in 30" rows, and if there is sufficient open space between the rows at the time of spraying, take advantage of directed spraying to cover the plant with more than one nozzle from different angles (from top and both sides). This can be accomplished by using drop pipes between soybean rows, and attaching a double swivel nozzle to the ends of these pipes. The spray from each nozzle should be directed toward a row of soybeans. An additional nozzle can be placed on the boom directly above the row. Unfortunately, in most cases, the directed

spraying with drop pipes will be impractical because the disease may usually occur when the canopy is well established, and there is not enough clearance between the rows for the pipes to go through.




The nozzles we use currently produce droplets that vary greatly in size, some more, some less. The range of droplets from a nozzle is also affected by liquid flow rate (size of nozzle orifice), liquid pressure, and physical changes to nozzle geometry and operation. To help applicators select nozzles and use them at the most optimum droplet size range for a given situation, ASAE (American Society of Agricultural Engineers) has developed a classification system. According to this system, spray quality from a nozzle can be classified as: Very Fine, Fine, Medium, Course, Very Course, and Extremely Course.

**ASAE Standard S-572
Droplet Spectrum Categories**

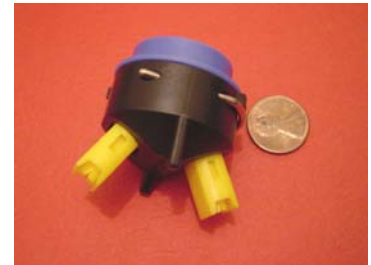
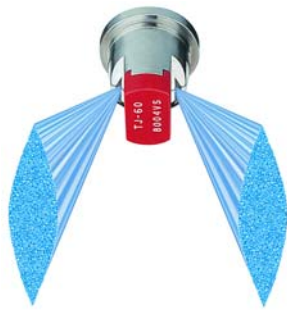
Category	Color
Very Fine (VF)	
Fine (F)	
Medium (M)	
Course (C)	
Very Course (VC)	
Extremely Course (XC)	

Fine-to-medium spray quality (approximately 200-300 micron in size) is recommended by nozzle manufacturers for application of fungicides for soybean rust. To achieve this, choose the right type and size of nozzles and operate them at the appropriate pressure. Nozzle catalogs have charts, as shown below, to help you find out at what pressure the nozzle you picked will produce Fine to Medium quality spray. When drift is a concern, or you have to choose between Fine and Medium spray quality, choose the Medium quality.

	PSI										
	15	20	25	30	35	40	50	60	70	80	90
TT11001	C	M	M	M	M	M	F	F	F	F	F
TT110015	C	C	M	M	M	M	M	M	F	F	F
TT11002	C	C	C	M	M	M	M	M	M	M	F
TT11003	VC	VC	C	C	C	C	M	M	M	M	M
TT11004	XC	VC	VC	C	C	C	C	C	M	M	M
TT11005	XC	VC	VC	VC	VC	C	C	C	C	M	M
TT11006	XC	XC	VC	VC	VC	C	C	C	C	C	M
TT11008	XC	XC	VC	VC	VC	VC	C	C	C	C	M

Nozzles producing a cone pattern may work for soybean rust, but since they produce a higher portion of extremely small (less than 100 micron) droplets than flat-fan nozzles at any given pressure, the flat-fan pattern nozzles are still the best choice as long as the spray quality from these nozzles are categorized as Fine to Medium. In the coverage study for Sclerotinia Stem Rot mentioned above, the cone nozzle gave the least amount of deposits on targets hidden in both the middle and lower elevation of soybean plants.

A flat-fan nozzle set up with two spray patterns (see pictures below) seems to provide a better coverage of plants with fully developed canopies. Research has shown that hitting the target from two different angles, with one forward and one backward spray pattern, provides a more effective coverage than spraying with just one spray pattern shooting down. Several nozzle manufacturers have either the nozzles that provide a twin spray pattern from one tip (picture on the left), or special fittings/caps that allow the producers to place two nozzles in the same cap, one pointed forward, and the other one pointed backward. If the two nozzle set-up is used, the nozzles should be size 2 (0.2 gpm at 40 psi) or higher to avoid generating a high number of extremely small droplets. Choose size 4 or above when using nozzles as shown on the left below.



Summary

Soybean Rust is a serious disease. But it can be controlled if the right fungicide is applied with the most effective equipment at the right time. Here are the key recommendations discussed above:

- Choose the appropriate size and type of nozzles and operate them at a pressure that will allow them to produce small to medium spray quality.
- Keep spray volume (application rate) above 15 gpa for best results.
- Try running the sprayer at slightly higher pressures than usual. Higher spray pressures usually help the droplets penetrate into the canopy better.
- To improve coverage, if applicable, use directed spraying.
- Use twin nozzle/pattern technology. Two nozzles (or spray patterns) angled (one forward one backward) work better than single nozzles spraying down.
- Air-assisted spraying usually provides the best coverage and droplet penetration into canopy when beans reach their full or near-full growth stage.