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: do as good a job as we can with spraying fungicides that are registered to control this disease. So what is the best spray equipment set up to do an effective job?

The single most important factor affecting the outcome of the fight against this disease is to get a **thorough coverage of the plant with the fungicide.** Fortunately, we have the technology, but, it may come with a higher equipment cost. For many reasons, including economic, some farmers have been reluctant to adopt the latest spray innovations. However, the threat of poor control of Asian Soybean Rust may change their thinking. Using the right equipment may mean the difference between profit and loss.

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.

Pesticide manufacturers spent large amounts of time and money to determine the most effective as well as economical application rate for the fungicides labeled for Soybean Rust. And of course these products are not cheap. Our soybean producers and custom applicators should be highly encouraged to do everything possible, including calibrating sprayers frequently, to make sure we are applying the amount recommended on the label. Too little fungicide results in poor control and reduced yields, while too much wastes dollars, and increases the risk of polluting the environment.

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. As I mentioned earlier, the single most important factor affecting the outcome of fight against Soybean Rust is to get a thorough coverage of the plant.

How do we get the most effective coverage on the target? 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 product on the target. 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. Detecting the disease early and using the most effective control mechanism are keys to controlling this disease. 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.

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. Ideally, we want to have as many small droplets on the target as possible. But is it a realistic goal today when spray drift is an issue? Also the nozzles we use currently produce droplets that vary greatly in size, some more, some less. Large droplets don't provide a good coverage and result in waste of chemical. So, for Soybean Rust control, we have to do everything possible to utilize the small-to-medium size droplets, approximately 200-300 micron in size. To achieve this, we have to choose and operate nozzles that will provide a relatively high number of droplets in this range, and fewer of the drift-prone droplets (those smaller than 100 micron), because they do not have any momentum pushing them into the canopy, and they do not last long after they are released from the nozzle. Most of them evaporate within a few seconds. So, if drift is a concern, some low-drift flat fan nozzles (excluding air-induction nozzles) may be used as long as the final droplet size is classified as fine to medium. This mean that these nozzles may have to be operated at slightly higher pressures (60-70 psi) than usual. These nozzles allow you to operate the sprayer at higher pressures without increasing the spray volume contained in extremely small, drift-prone droplets.

However, there is a way to utilize the droplets even smaller than 100 micron: utilizing the air-assist technology. In all the spray coverage tests 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, intenodes, 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 ($\mu g/cm^2$)	Lower Elevation Mean Deposit ($\mu g/cm^2$)
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

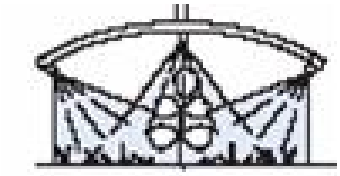
The key conclusions from this research are as follows:

- 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 maximum efficacy from a 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?

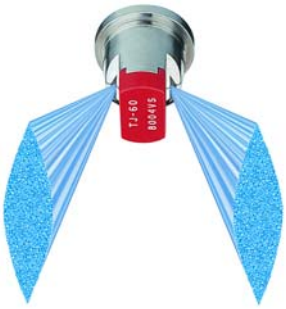
If beans are planted in 30” rows, and if there is sufficient open space between the rows at the time of spraying, take advantage of directed spraying to cover the plant with more than one nozzle from different angles (from top and both sides). This can be accomplished by using drop pipes between soybean 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.



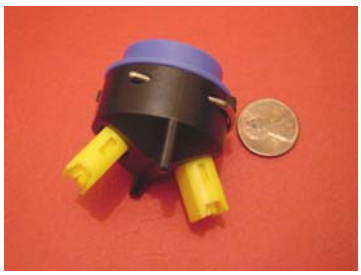
This next paragraph applies to both row beans and solid seeded beans.

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, 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 (200 to 300 micron). Check the nozzle catalog to find out at what pressure the nozzle you picked should be operated for it to produce fine to medium quality spray. 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 TwinJet nozzles.



(TwinJet)



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 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 size droplets.
- 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.
- If spray drift is a concern, you may use some of the “low-drift” nozzles (other than air induction nozzles) as long as the spray quality is defined as fine or medium. Operate these nozzles at slightly higher pressures (60-70 psi) than usual.
- 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.