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Effect of Different Nozzle Types on Drift and Efficacy of Roundup Ultra

Summary

Field and laboratory experiments were conducted to determine the effect of five types of spray nozzles at spray pressures from 20 to 70 pounds per square inch (psi) on spray droplet size, spray patterns, and efficacy of Roundup Ultra® herbicide. When Roundup Ultra was applied with the different types of nozzles at the rate of 1 pound of active ingredient (a.i.) in 10 gallons of water per acre (gpa), the percent volume of fine, highly driftable spray droplets (less than 105 microns in diameter) varied from 2% to 53%, and the volume median diameter of droplet sizes varied from 99 to 582 microns. The widths of the spray patterns with the various types of spray nozzles ranged from 35 to 50 inches. Weed control in the field treatments was similar (91% to 100%) with all five types of spray nozzles for each of three weedy species: nodding spurge, pitted morningglory, and southwestern cupgrass.

Results of this study indicate that spray nozzles are available that produce larger, less driftable spray droplets and smaller amounts of fine driftable spray droplets than the nozzle types most commonly used at this time without affecting the efficacy of the herbicide.

Introduction

Drift of agricultural chemicals is a major concern with many agricultural cropping systems *(3)*. Drift reduces efficacy, damages adjacent crops, and contaminates streams and rivers. Chemical placement from spray applications is affected by the size of spray droplets and the pattern of spray delivery, each of which is influenced by the configuration of the spray nozzles *(6)*. In 1990, the Environmental Protection Agency requested quantitative data to determine factors that affect chemical spray drift. In response, a consortium of 38 agricultural chemical companies formed the Spray Drift Task Force. Research by this organization determined that droplet size was the most important factor affecting the drift of agricultural chemicals, wherein the smaller droplets resulted in greater drift *(5)*. Using a laser measuring device, two methods have been used to characterize droplet size spectra. One was the volume median diameter (VMD), which is the droplet size at which half the spray volume is composed of smaller droplets and half of larger droplets *(4)*. The other, more useful value using the laser beam analyses for determining drift potential was the percentage of the spray volume resulting in droplets less than 105 microns (<105 µ) in diameter *(1)*.

Experiments were conducted to determine the effect of five types of spray nozzles at different spray pressures on spray droplet size and at one spray pressure on spray patterns. The study also assessed herbicidal efficacy using the five types of spray nozzles.

Materials and Methods

Roundup Ultra was applied at 1 pound of active ingredient in 10 gallons of water. Spray droplet size was determined at 20, 30, 40, 50, 60, and 70 psi. Spray nozzles used were the TeeJet® Air Induction 110015VS, TeeJet Turbo Flood VS2, TeeJet Turbo 110015, TeeJet Drift Guard 110015VS, and TeeJet Extended Range 110015VS (all nozzles are registered trademarks of Spraying Systems Company in Wheaton, Illinois). Droplet size distribution was determined with a Malvern laser particle size analyzer model 2600Lc (Malvern Instruments, Malvern, England). Measurements were made by traversing the entire spray pattern through the laser beam at a constant height and speed as described by Hanks and McWhorter *(2)*. Droplet size was determined as both the volume median diameter in microns and as the percentage of the spray volume less than 105 microns in diameter.

Spray patterns were determined for a single nozzle of each type by applying 600-milliliter volumes each of water alone and the Roundup Ultra solution at a flow rate of 5 ounces in 15 seconds. Applications were to a slanted sheet of corrugated metal with troughs spaced 2.5 inches apart, where the discharge flowed down the troughs into 100-milliliter graduated cylinders. The spray tip was placed in a stationary position at 13 inches above the surface. The average milliliter volumes (three replications) collected at each position from left to right were reversed right to left, added together, and averaged again to show a symmetrical spray pattern for each mixture.

Roundup Ultra was applied in the field to 6- to 8-inch-tall Roundup Ready® soybean (*Glycine max* L.) 'ASGROW 5901 RR' planted in plots of four 40-foot rows spaced 38 inches apart and interspersed with 4- to 5-inch-tall nodding spurge (*Euphorbia nutans* Lag.) and pitted morningglory (*Ipomoea lacunosa* L.), and 4- to 6-inch-tall southwestern cupgrass [*Eriochloa gracilis* (Fourn.) A.S. Hitchc.]. Roundup Ultra was applied to separate plots with the five different nozzle types as described previously. For most nozzle types, the spray solution was applied with a tractor-mounted spray boom with nine nozzles spaced 19 inches apart. For the Turbo Flood VS2 nozzle, the solution was sprayed with four nozzles spaced 38 inches apart. Each treatment was replicated four times in a randomized complete block design. Means were separated using Fisher's Protected LSD using a significance level of 0.05.

Results and Discussion

Air Induction and Turbo Flood nozzles produced larger and less driftable droplets than the Turbo, Drift Guard, and Extended Range nozzles (Figures 1 and 2). For all nozzles, the droplet size volume median diameter (VMD) often decreased, and the percent of the spray volume in fine droplets (<105 μ) increased as spray pressure was increased from 20 to 70 psi. For many of the nozzle types and spray pressures, droplet measurements in the water-only treatments were different from measurements in the Roundup Ultra treatments.

The Air Induction 110015VS nozzle — which produced the least driftable droplet sizes in this study — produced smaller VMD and equal or greater percent volume of fine droplets with Roundup Ultra than with water alone as spray pressure was increased from 30 to 70 psi. The Air Induction nozzle did not form a uniform spray pattern below 30 psi spray pressure.

The Turbo Flood VS2 nozzle produced smaller VMD droplet sizes with Roundup Ultra than with water alone at 20 through 40 psi, showed no difference at 50 psi, and produced larger droplets with Roundup Ultra at 60 psi. There was no difference in the percent volume of fine droplets between sprays with water alone and Roundup Ultra at any spray pressure with the Turbo Flood VS2 nozzle.

The Turbo 110015 nozzle produced smaller VMD droplet sizes with Roundup Ultra than with water alone at 20 and 30 psi. Droplet size was not different between the sprays at 40 and 50 psi, and there were smaller droplets with water alone at 60 psi. Of the percent volume of fine droplets, the Turbo 110015 nozzle produced a greater percent with Roundup Ultra at 20 through 40 psi, but there was no difference at 50 and 60 psi.

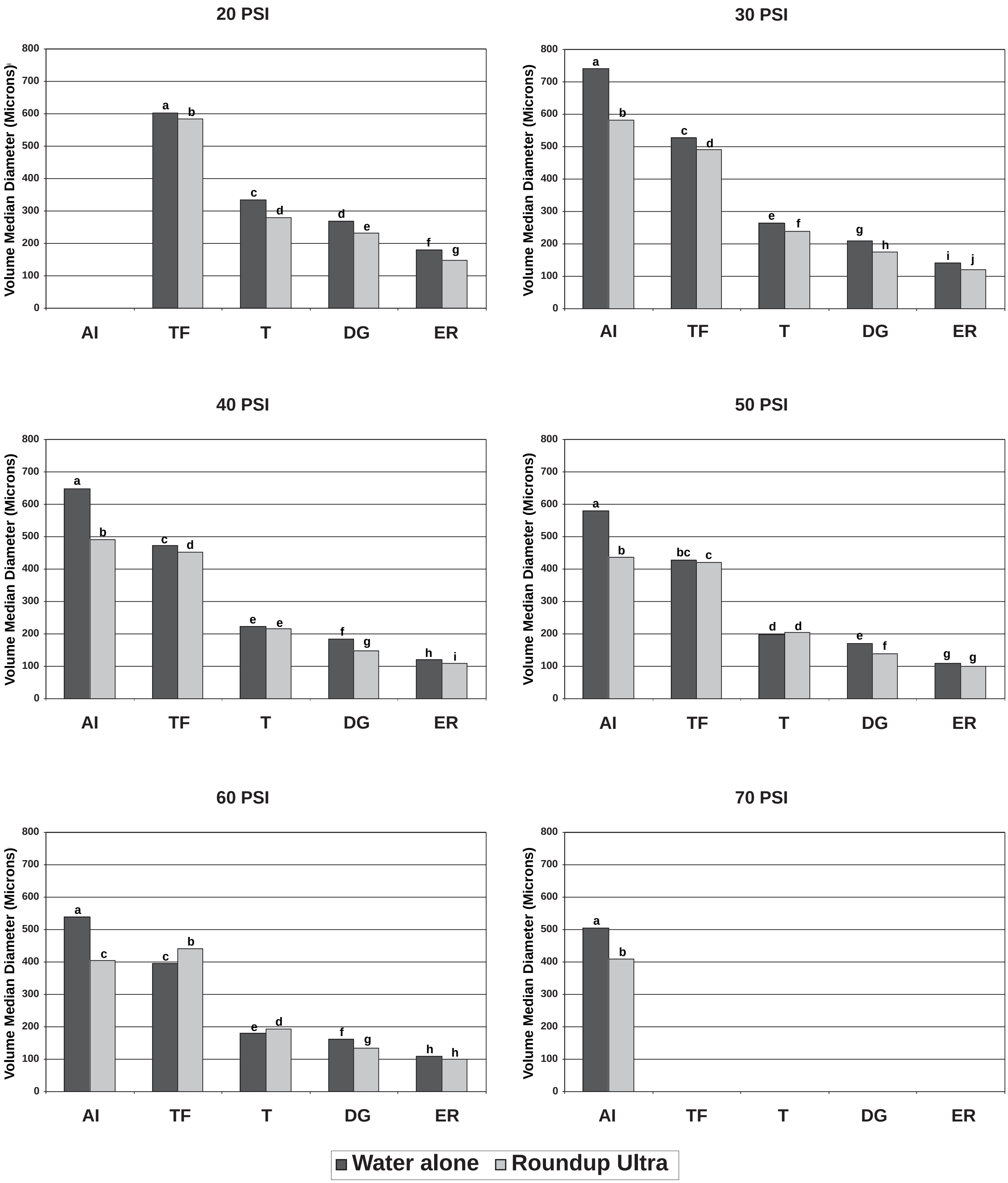

Figure 1. Droplet size as volume median diameter (measured in microns) of water alone and Roundup Ultra using different nozzle types and different pressures. Nozzle types: AI = Air Induction 110015VS; TF = Turbo Flood VS2; T = Turbo 110015; DG = Drift Guard 110015VS; and ER = Extended Range 110015VS. Roundup Ultra applied at the rate of 1 pound of active ingredient per 10 gallons of water.

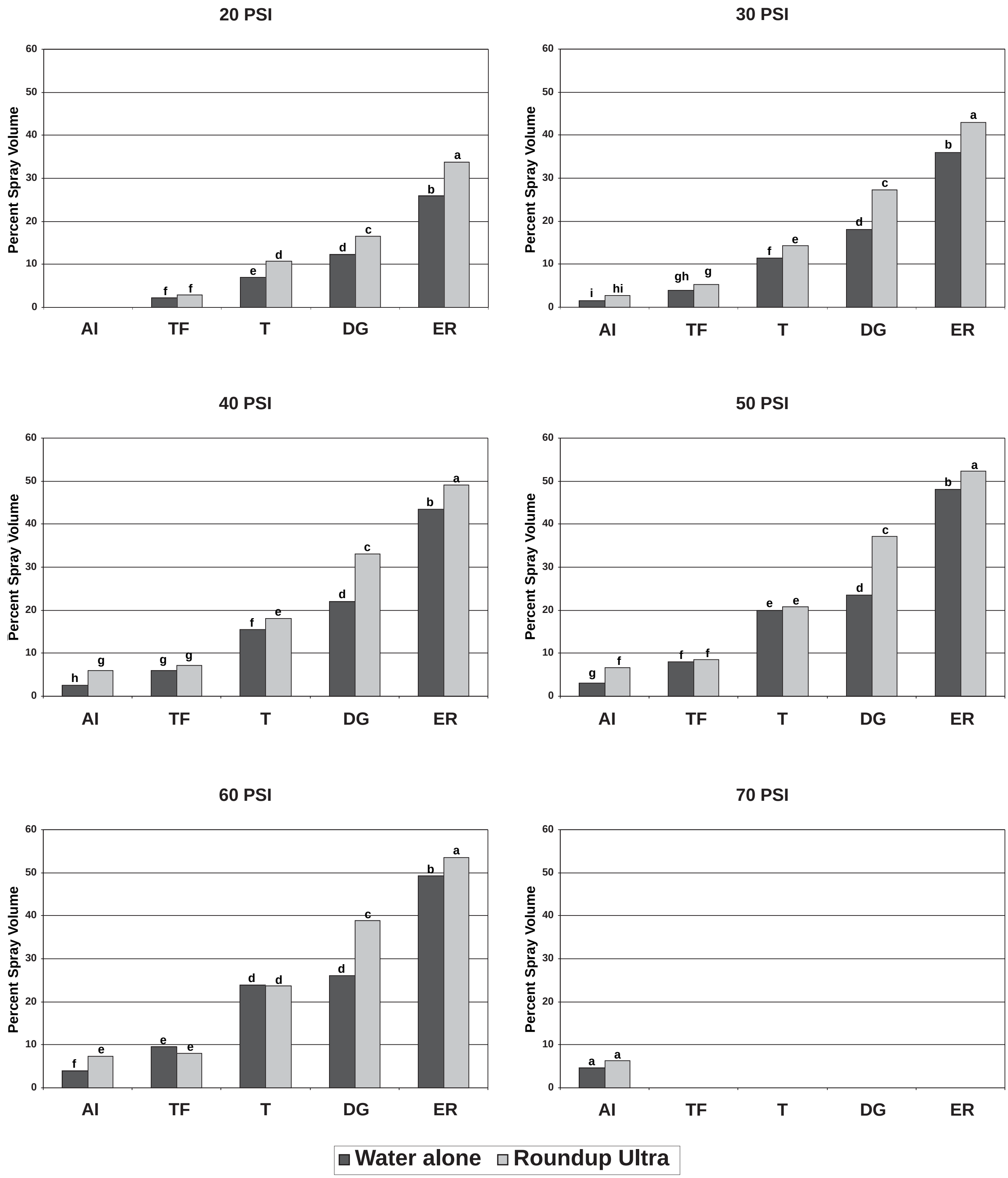

Figure 2. Percentage of spray volume in droplets smaller than 105 microns of water alone and Roundup Ultra using different nozzle types and different pressures. Nozzle types: AI = Air Induction 110015VS; TF = Turbo Flood VS2; T = Turbo 110015; DG = Drift Guard 110015VS; and ER = Extended Range 110015VS. Roundup Ultra applied at the rate of 1 pound of active ingredient per 10 gallons of water.

The Drift Guard 110015VS nozzle produced smaller VMD droplet sizes and a larger percent volume of fine droplets with Roundup Ultra than with water alone at each spray pressure from 20 through 60 psi.

The Extended Range 110015VS nozzle produced smaller VMD droplet sizes with Roundup Ultra than with water at 20 through 40 psi, but it demonstrated no difference at 50 and 60 psi. There was a greater percent volume of fine droplets with Roundup Ultra at each pressure from 20 through 60 psi.

Figure 3 shows the spray patterns of the different nozzle types used in this study. Generally, the spray patterns were similar for water-alone and Roundup Ultra treatments. However, there was a higher concentration in the center of the pattern when Roundup Ultra was applied with the Turbo Flood VS2 spray nozzle. The spray width was most narrow (35 inches) using the Air Induction 110015VS nozzle, medium (40 to 45 inches) with the Drift Guard 110015VS and the Turbo Flood VS2, and widest (50 inches or more) with the Turbo 110015 and the Extended Range 110015VS spray nozzle. Each of these nozzle types, when placed along the spray boom at the spacing recommended by Spraying Systems Company, provide adequate spray coverage over the entire spray swath.

Results of the field study at 2 weeks after treatment are shown in Table 1. Weed control was similar with all five nozzle types for each weedy species. Control of nodding spurge was 95% to 100%; pitted morningglory, 91% to 95%; and southwestern cupgrass, 100%. Roundup Ready soybean showed no effect from any treatment.

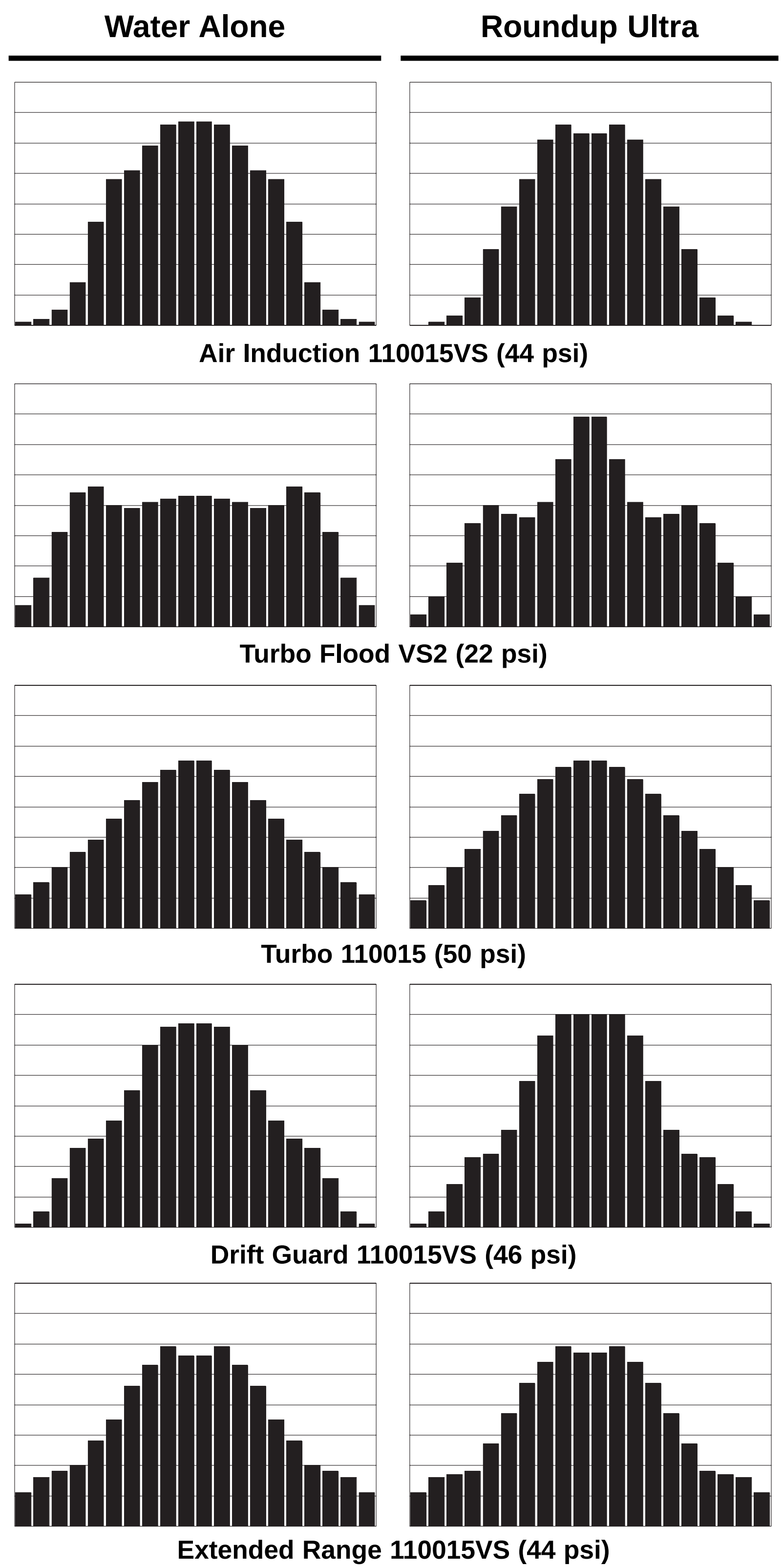

Figure 3. Spray patterns using different nozzles for applying either water alone or Roundup Ultra at the rate of 1 pound of active ingredient in 10 gallons per acre (GPA) where 1.5 pints of spray solution were collected at 2.5-inch intervals as applied at 10 GPA with a flow rate of 5 ounces in 15 seconds from each nozzle positioned at 13 inches above the surface.

Table 1. Effect of different spray nozzle types on the efficacy of Roundup Ultra applied to control three weedy species in soybean plots.[1]

Nozzle type	Percent control		
	Nodding spurge	Pitted morningglory	Southwestern cupgrass
TeeJet Air Induction 110015VS (38 psi)	95	91	100
TeeJet Turbo Flood VS2 (19.5 psi)	98	94	100
TeeJet Turbo 110015 (42 psi)	98	93	100
TeeJet Drift Guard 110015VS (40.5 psi)	96	95	100
TeeJet Extended Range 110015VS (38 psi)	100	95	100
Untreated control	0	0	0
LSD (0.05) [2]	3	3	1

[1]Roundup Ultra was applied at the rate of 1 pound of active ingredient in 10 gallons of water per acre over-the-top to three-trifoliolate-stage Roundup Ready® soybean, 4- to 5-inch-tall nodding spurge and pitted morningglory, and 4- to 6-inch-tall southwestern cupgrass at 2 weeks after treatment. Soybeans showed no affect from any treatment. Data are the average of four replications.

[2]Means within a column are not different at $P \leq 0.05$ according to Fisher's Protected LSD test.

Figure 4. Application to bare ground showing greater drift from Extended Range 110015VS spray (right) than from Air Induction 110015VS spray nozzles (left).

Figure 5. Effect of herbicide drift using Extended Range 110015VS spray nozzles (above) and Air Induction 110015VS spray nozzles (below) applying at 10 gallons per acre in wind moving from left to right at 7 to 10 mph.

Conclusion

Results using five different nozzle types with Roundup Ultra herbicide indicate that herbicide drift can best be reduced by using the Air Induction nozzle type, which produced the largest average droplet size and the smallest volume of very fine spray droplets while maintaining adequate herbicidal activity. In this study, greater than 90% weed control was obtained with each of the five different types of spray nozzles. However, Air Induction and Turbo Flood nozzles produced less driftable, larger average droplet sizes and smaller volumes of very fine, highly driftable spray droplets than Turbo, Drift Guard, and Extended Range spray nozzles (in order of preference for controlling spray drift).

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