

Cleaning Field Sprayers to Avoid Crop Injury

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Crop yield and quality depend on effective application of agricultural chemicals. Proper selection, use and maintenance of sprayers can save you money, improve the performance of the agrichemicals you use, and protect the environment.

With the increased emphasis on custom application of herbicides, postemergence weed control, and use of herbicides that are active at low application rates, proper cleaning and maintenance of sprayers will be increasingly necessary to avoid injury to non-target crop species. The issue will take on added importance as more producers use broad-spectrum herbicides such as Roundup and Liberty on their herbicide-tolerant crops. Postemergence applications sprayed directly on the crop foliage will generally have greater potential for crop injury than will soil applications. Serious crop injury can result from small amounts of herbicides remaining in the sprayer system.

In recent years there have been numerous occurrences of soybean crop damage with symptoms resembling injury from growth regulator herbicides (Figure 1). The injuries were attributed to various causes, including the use of other soybean herbicides and herbicide additives, but in many cases the spray tanks had not been cleaned properly before applying soybean herbicides. Crop injury from sprayer contamination can occur up to several months after using the sprayer if it has not been cleaned properly. Injury from sprayer contamination can affect crop growth and development for several weeks after application and in severe cases can reduce crop yields. Herbicide residues in the sprayer can be redissolved through later contact with herbicides, their solvents or spray adjuvants. The objective of this publication is to present the appropriate cleanup procedures for sprayer equipment following the use of various herbicides in corn, soybean, wheat and cotton production.



Figure 1. Leaf cupping (above) is a sign of sprayer contamination injury from growth regulator herbicides.

A crop with moderate damage (below) will suffer both delayed maturity and reduced yield.

General sprayer cleanup procedures

Pesticides can settle to the bottom or cause rapid corrosion in the spraying system and thus should be washed from the whole system immediately after use. One should always try to end the workday with an empty tank. If you will be using the same agricultural chemical the next day, thoroughly flushing the

sprayer tank and sprayer with clean water is sufficient and will help prevent drying and hardening of pesticide residues. If a different agrichemical will be used, then a more comprehensive procedure is recommended immediately after use.

When cleaning a sprayer, select a location where any spilled rinsate will not contaminate water supplies, streams, crops or other plants and where puddles will not be accessible to children, pets, livestock or wildlife. Preferably the area should be impervious to water and have a wash rack or cement apron with a sump to catch contaminated wash water and pesticides. If such a facility is not available, catch or contain the rinsate and spray the rinse water or the cleaning solution on a field in a manner consistent with the intended use of the agrichemical. Avoid discharging all the cleaning solution in a small area.

The quickest and easiest way to rinse a tank and spraying equipment and dispose of waste safely is to carry a 50- to 100-gallon drum of fresh water with the spraying equipment. When spraying is finished, flush the system in the field and spray the rinsate on the field in a manner consistent with the products intended use.

If spray material is spilled on the sprayer during loading or mixing, wash the outside of the sprayer immediately. As a general rule, plastic or polyethylene tanks and hoses tend to require more extensive cleaning than stainless steel tanks. Screens and strainers should also be cleaned or replaced frequently as they can be a major source of contamination.

Residues can also accumulate in checked or cracked hoses. Inspect the inside of hoses and replace if necessary. Pay special attention to the following areas that may be missed or difficult to clean:

- sprayer surfaces or components where buildup might occur due to repeated coats of spray followed by drying
- sprayer sumps and pumps
- inside the top of the spray tank and around baffles
- irregular surfaces inside tanks caused by baffles, plumbing fixtures, agitation units, etc.

When switching between crops, such as applying soybean herbicides after corn spraying is complete, follow the procedure described in the box below to clean out sprayers.

Sprayer cleaning agents

Cleaning agents should be selected based on the herbicide and formulation to be cleaned (see Table 1). Cleaning agents should penetrate and dissolve pesticide residues and allow them to be removed when the rinsate is removed from the sprayer. The functions of cleaning agents are dilution, solubilization and deactivation. Commercial tank cleaning agents and detergents help remove both water- and oil-soluble herbicides and are recommended on many pesticide labels. The commercial tank cleaning agents usually perform better than household detergents and can deactivate some herbicides in addition to solubilizing them.

Sprayer cleanout procedure between crops

This procedure is recommended for all herbicides unless the label specifies a different cleanout procedure.

1. Add one-half tank of fresh water and flush tanks, lines, booms and nozzles for at least 5 minutes using a combination of agitation and spraying. Rinsate sprayed through the booms is best sprayed onto cropland to avoid accumulation of pesticide-contaminated rinsate. Thoroughly rinse the inside surfaces of the tank, paying particular attention to the surfaces around the tank fill access, baffles and tank plumbing fixtures. The use of a 360-degree nozzle, such as the TeeJet Model 27500E-TEF rinsing nozzle, permanently installed to the spray system can automate the thorough cleaning of tops and sides of the tanks. Several nozzles may need to be carefully positioned to clean tanks with baffles. Pressure sprayers are useful for removing caked on internal and external residues. Hot water can increase penetration of dried residues, but the addition of hot water rinsing may cause unacceptable health hazards due to the vapors produced. Carefully review labeled safety precautions for the agrichemicals and cleaning products used. See also MU publication G1917, *Personal Protective Equipment for Working With Pesticides*.

2. Fill the tank with fresh water and add one of the cleaning solutions listed below or a commercially available tank cleaner and agitate the solution for 15 minutes.

Add one of the following to each 50 gallons of water to make a cleaning solution:

- 2 quarts of household ammonia (let stand in sprayer overnight for growth regulator herbicides such as 2,4-D, Banvel, Clarity)
- 4 pounds of trisodium phosphate cleaner detergent.

Operate the spray booms long enough to ensure that all nozzles and boom lines are filled with the cleaning solution. Let the solution stand in the system for several hours, preferably overnight. Agitate and spray the solution onto an area suitable for the rinsate solution.

3. Add more water and rinse the system again by using a combination of agitation and spraying. Remove nozzles, screens, and strainers and clean separately in a bucket of cleaning agent and water.
4. Rinse and flush the system once again with clean water.

Some tank cleaning agents and ammonia solutions also raise the pH of the rinsate solution, making some products such as sulfonyleurea herbicides more water soluble and thus easier to remove from internal sprayer parts. Chlorine bleach solutions will accelerate decomposition of sulfonyleurea and some other herbicides into inactive compounds. **However, chlorine is less effective at dissolving and removing sulfonyleurea herbicide residues from spray tanks than ammonia solutions. Chlorine bleach should never be added to ammonia or liquid fertilizers containing ammonia because the two materials react to form toxic chlorine gas, which can cause eye, nose, throat and lung irritation.** Fuel oil or kerosene is effective for removing oil-soluble herbicides such as esters and emulsifiable concentrates. The fuel oil or kerosene should be followed by a detergent rinse to remove the oily residue.

Final note

All sprayer components, including the tank, pump, hoses and nozzles, must be thoroughly cleaned to avoid contamination. The lowest point of the spray system should have a drain, and all sprayer plumbing should gravity drain to that point. **If the system does not allow all of the solution to drain out, the effectiveness of cleaning agents is greatly reduced and may be useless.** Any contaminated solution remaining trapped in the sprayer system must be diluted and flushed out of the system with repeated rinses. Once the tank and all circulation lines have pure water, the spray valve to the nozzles should be opened and remain activated until all nozzles are spraying pure water. The sprayer must be thoroughly cleaned and flushed before the new herbicide mixture is added to the tank, or contamination will occur.

Cleanup procedures for specific herbicides

The following are specific cleanup procedures for selected herbicides if the spray equipment is to be used on a crop other than that for which the herbicide is labeled. These procedures were taken from the respective 1997 herbicide labels.

Banvel/Clarity, 2,4-D amine, Resolve SG

1. Thoroughly hose down the inside and outside surfaces of equipment while filling the tank half full of water. Flush by operating sprayer until all rinse water is removed from the system.
2. Fill tank with water while adding 1 quart of household ammonia for every 25 gallons of water. Operate the pump to circulate the ammonia solution through the sprayer system for 15 to 20 minutes and discharge a small amount of the ammonia through the boom and nozzles. Let the solution stand for several hours, preferably overnight.

3. Flush the solution out of the spray tank through the boom.
4. Remove the nozzles and screens and flush the system with two full tanks of water.

The steps listed below are suggested for thorough cleaning of spray equipment used to apply Resolve SG herbicide as a tank mix with wettable powders, emulsifiable concentrates, or other types of water-dispersible formulations. Resolve SG herbicide tank mixes with water-dispersible formulations require the use of a water detergent rinse.

5. Repeat step 1.
6. Fill tank with water while adding 2 pounds of detergent for every 40 gallons of water. Operate the pump to circulate the detergent solution through the sprayer system for 5 to 10 minutes and discharge a small amount of the solution through the boom and nozzles. Let the solution stand for several hours, preferably overnight.
7. Flush the detergent solution out of the spray tank through the boom.
8. Repeat step 1, and follow with steps 2, 3, and 4.

Amber, Beacon, Exceed/Spirit, Peak, Permit

1. Prepare a tank cleaning solution of 1 gallon of household ammonia per 50 gallons of water. Use sufficient cleaning solution to thoroughly rinse all surfaces. Do not use chlorine-based cleaners such as Clorox with Exceed and Peak.
2. When available, use a pressure rinser to clean the inside of the spray tank with this solution. Start agitation in the sprayer and thoroughly recirculate the cleaning solution for at least 15 minutes. All visible deposits must be removed from the spraying system.
3. Dispose of rinsate in an appropriate manner as described above.
4. Repeat steps 1–3.
5. Remove nozzles and screens and clean separately after completing above procedures.

Marksman, Optill

1. Thoroughly hose down the inside and outside surfaces of equipment while filling the tank half full of water. Preferably, inside surfaces should be rinsed using a multidirectional nozzle such as Spray Systems Tank Rinsing Nozzle 27500E-TF. Flush by operating sprayer until all rinse water is removed from the system.
2. Fill tank with water while adding a commercially available tank cleaning agent such as Nutra-Sol, Incide-out, or Loveland Industries Tank and Equipment Cleaner according to label instructions. Operate the pump to circulate the solution through the sprayer system for 15 to 20 minutes and discharge a small amount through the boom and nozzles. Let the solution stand for several hours, preferably overnight.
3. Completely flush the solution out of the spray tank through the boom.
4. Remove the nozzles and screens. Fill tank with clean water and circulate through the sprayer system for 15 to 20 minutes. Discharge a small amount through the boom lines.
5. Completely flush rinse water out of the spray tank.

Accent, Ally, Assure, Basis, Basis Gold, Finesse, Glean, Staple, FirstRate, Python

1. Drain the tank and thoroughly hose down the interior surfaces. Flush the tank, hoses, and boom with clean water for at least 5 minutes.
2. Partially fill the tank with clean water and add one gallon of household ammonia (3% active ingredient) for every 100 gallons of water. Finish filling the tank with water, then flush the cleaning solution through the hoses, boom and nozzles. Add more water to completely fill the tank and allow it to agitate and recirculate for at least 15 minutes. Again flush the hoses, boom and nozzles with cleaning solution, then drain the tank.
3. Repeat step 2.
4. Remove the nozzles and screens and clean separately in a bucket containing the cleaning agent and water.
5. Thoroughly rinse the tank with clean water for at least 5 minutes, flushing the water through the hoses and boom.

Stinger

1. Rinse and flush application equipment thoroughly after use at least three times with water and dispose of rinse water in noncropland areas away from water supplies.
2. During the second rinse, add 1 quart of household ammonia for every 25 gallons of water. Circulate the solution through the entire system so that all internal surfaces are contacted (15 to 20 minutes). Let the solution stand for several hours, preferably overnight.
3. Flush the solution out of the spray tank through the boom.
4. Rinse the system twice with clean water, recirculating and draining each time.
5. Nozzles and screens should be removed and cleaned separately.

Hornet, Scorpion III

1. Drain any remaining herbicide from the spray tank and dispose of it according to label instructions.
2. Hose down the interior surfaces of the tank. Flush tank, hoses, boom, and nozzles with clean water for 10 minutes. Fill the tank with water and recirculate for 15 minutes. Spray part of the mixture through the hoses, boom, and nozzles and drain the tank. All rinse water must be disposed of in compliance with local, state and federal guidelines.
3. Remove the nozzles and screens and clean separately.
4. If the spray equipment will be used on crops other than field corn, repeat steps 1 and 2, and thoroughly wash the spray mixture from the outside of the spray tank and boom.

Shotgun

1. Clean tank thoroughly immediately after use by flushing system with water and heavy-duty detergent such as Loveland Industries Tank and Equipment Cleaner.

Contour, Lightning, Tri-Scept, Squadron, Scepter

1. To avoid injury to sensitive crops, spray equipment used for the above-listed herbicide applications must be drained and thoroughly cleaned with water before being used to apply other products.

Canopy, Canopy XL/Authority Broadleaf, Cover, Harmony Extra, Pinnacle, Classic

1. Drain the tank and thoroughly hose down the interior surfaces. Flush the tank, hoses and boom with clean water for at least 5 minutes.
2. Partially fill the tank with clean water and add one of the cleaning agents listed below. Complete filling the tank with water, then flush the cleaning solution through the hoses, boom and nozzles. Add water to fill the tank and allow it to agitate or recirculate for at least 15 minutes. Again flush the hoses, boom and nozzles with cleaning solution, then drain the tank.
3. Remove the nozzles and screens and clean separately in a bucket containing the water and cleaning agent.
4. Repeat step 2.
5. Thoroughly rinse the tank with clean water for at least 5 minutes, flushing the boom and hoses.
Cleaning agents:
 1. One gallon of household ammonia (3% active ingredient) per 100 gallons of water.
 2. Nutra-Sol
 3. Loveland Industries Tank and Equipment Cleaner
 4. Protank Cleaner
 5. Chem-Tank Cleaner and Neutralizer
 6. Incide-Out
 7. Tank-Aid

Sencor/Lexone, Turbo

Drain any remaining spray solution from the spray tank and dispose of it according to label instructions. Rinse the spray tank and refill with water, adding a heavy-duty detergent at the rate of 1 cup per 20 gallons of water. Recycle this mixture through the equipment for 5 minutes and spray out. Repeat the procedure twice. Fill the spray tank with clean water, recycle for 5 minutes and spray out. Clean pump and nozzle screens thoroughly. Wash away any spray mixture from the outside of the spray tank, nozzles or spray rig.

Command

1. Drain any remaining spray solution from tank, pump, hoses and boom and discard in an approved manner.
2. Clean tank and fittings by the following procedure:
 - Thoroughly hose down the inside walls of the spray tank with a quantity of water equal to $\frac{1}{8}$ of the total tank capacity and operate the pump to circulate this solution through the sprayer system for 15 minutes.
 - Wash down the outside surfaces of equipment.
 - Remove nozzle tip and screen from end nozzle in each boom section and allow several gallons of rinsate to flush completely through the boom (collect rinsate while flushing).

3. Thoroughly drain remaining rinsate solution from tank, pump and hoses. Combine with boom flushing and dispose of all rinsates from this first rinsing in an approved manner.
 - When switching from water dilutions to applications using crop oil or liquid fertilizer as a carrier, a small volume of crop oil or liquid fertilizer should be flushed through the tank, pump, hoses and boom before the next use.
4. Remove the remaining nozzle tips and screens and line filter and wash in a pail of warm soapy water, thoroughly rinse and replace.
5. Hose down the inside walls of the spray tank a second time and circulate this solution using the same procedure as noted in step 2 above.
6. If the next use of the sprayer will be for applying a preemergent or preplant incorporated pesticide on any crop for which Command is registered, rinsate from this second rinsing may be used by diluting with the water for the next pesticide load. **However**, if the next use of the sprayer will be a postemergence applied pesticide on any crop, drain rinsate solution from this second rinsing. Retain rinsate solution for use only with a soil incorporated pesticide to be applied on a crop for which Command is registered. Refill tank (after draining second rinsate solution) in accordance with postemergence product label directions.

Liberty

Thoroughly triple rinse sprayer and use a commercial tank cleaner before using on crops not labeled LIBERTY LINK. Make sure any rinsate or foam is thoroughly removed from spray tank and boom. Rinsate may be disposed of in noncrop areas that do not contain desirable vegetation.

Poast/Poast Plus/Prestige

1. Thoroughly hose down the inside and outside of equipment while filling the spray tank half full of water. Flush the system by operating sprayer until the rinse water has been purged.
2. Refill the tank with water while adding 1 gallon of household ammonia, 1 pint of household detergent, or commercial tank cleaning agent according to the manufacturer's instructions. Operate the pump to circulate the solution through the sprayer system for 5 to 10 minutes and discharge a small amount of solution through the boom and nozzles. Let the solution stand for 24 hours.
3. Flush the detergent solution out of the spray tank through the boom.
4. Remove the nozzles and screens and flush the system with two tankfuls of water.

Roundup Ultra

Clean sprayer parts immediately after use by thoroughly flushing with water.

Table 1. Recommended cleaning agents for corn, soybean, and cotton herbicides.

Herbicide	Recommended cleaning solution	Sensitive crops
2,4-D amine	ammonia + water	all broadleaf crops
2,4-D ester	kerosene or diesel fuel followed by ammonia + water	all broadleaf crops
Accent	ammonia + water	sorghum, sunflower, canola
Action	ammonia or commercial tank cleaner + water	—
Ally	ammonia + water	soybean, sunflower, corn, canola, cotton
Amber	ammonia + water	soybean, sunflower, corn, sorghum, canola, cotton
Assure II	ammonia + water	corn, sorghum, wheat, other grasses
Atrazine	detergent + water	wheat, sunflower, soybean, cotton
Authority	ammonia or commercial tank cleaner + water	corn, sorghum, cotton, canola
Banvel/Clarity	ammonia + water	all broadleaf crops
Basagran	ammonia or commercial tank cleaner + water	cotton
Basis Gold	ammonia + water	wheat, sunflower, soybean, cotton, canola
Basis	ammonia + water	cotton, soybean, canola
Beacon	ammonia + water	sorghum, sunflower, soybean, canola, cotton
Bladex	ammonia or commercial tank cleaner + water	soybean
Blazer/Status	ammonia or commercial tank cleaner + water	corn, sorghum
Buctril+Atrazine	ammonia or commercial tank cleaner + water	wheat, sunflower, soybean, cotton
Buctril/Moxy/Moxynil	ammonia or commercial tank cleaner + water	cotton
Canopy	ammonia or commercial tank cleaner + water	corn, sorghum, sunflower, sorghum, cotton, canola
Canopy XL	ammonia or commercial tank cleaner + water	corn, sorghum, sunflower, sorghum, cotton, canola
Caparol	ammonia or commercial tank cleaner + water	—
Classic	ammonia or commercial tank cleaner + water	corn, sorghum, sunflower, sorghum, cotton, canola
Cobra	ammonia or commercial tank cleaner + water	corn, sorghum
Command	water	corn, sorghum, wheat, oats

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Table 1 *continued*. Recommended cleaning agents for corn, soybean, and cotton herbicides.

Herbicide	Recommended cleaning solution	Sensitive crops
Contour	ammonia or commercial tank cleaner + water	soybean, canola, sorghum, wheat, cotton, sunflower
Cotoran	ammonia or commercial tank cleaner + water	soybean
Dual/Dual Magnum	ammonia or commercial tank cleaner + water	—
Exceed/Spirit	ammonia + water	sorghum, soybean, wheat, cotton, sunflower
Expert	ammonia + water	sorghum, cotton, canola, sunflower
Finesse	ammonia + water	soybean, sunflower, corn, sorghum, canola, cotton
FirstRate	ammonia + water	sunflower, sorghum, canola, corn, cotton
Frontier	ammonia or commercial tank cleaner + water	—
Fusilade/Fusion	ammonia or commercial tank cleaner + water	corn, sorghum, wheat, other grasses
Glean	ammonia + water	soybean, sunflower, corn, sorghum, canola, cotton
Gramoxone	ammonia or commercial tank cleaner + water	all crops
Harmony Extra	ammonia or commercial tank cleaner + water	canola, corn, soybean, sorghum, sunflower
Harness/Surpass	ammonia or commercial tank cleaner + water	—
Hornet	ammonia or commercial tank cleaner + water	soybean, sunflower, cotton
Karmex	ammonia or commercial tank cleaner + water	—
Laddok	ammonia or commercial tank cleaner + water	wheat, sunflower, soybean, cotton
Lasso/Partner/Microtech	ammonia or commercial tank cleaner + water	—
Liberty	commercial tank cleaner + water	all sensitive crops
Lightning	ammonia or commercial tank cleaner + water	soybean, sorghum, wheat, cotton, sunflower, canola
Marksman	commercial tank cleaner + water	all broadleaf crops
MSMA/DSMA	ammonia or commercial tank cleaner + water	—
Optill	commercial tank cleaner + water	all broadleaf crops
Option II	ammonia or commercial tank cleaner + water	corn, sorghum, wheat, other grasses
Peak	ammonia + water	soybean, cotton, sunflower, canola
Permit	ammonia + water	soybean, canola, sunflower
Pinnacle	ammonia + water	sunflower, canola
Poast/Poast Plus/Prestige	ammonia, commercial tank cleaner, or detergent + water	corn, sorghum, wheat, other grasses
Python	ammonia + water	sunflower, sorghum, canola, cotton
Prowl	ammonia or commercial tank cleaner + water	—
Pursuit Plus	ammonia or commercial tank cleaner + water	sunflower, canola, sorghum, cotton
Pursuit	ammonia or commercial tank cleaner + water	sunflower, canola, sorghum, cotton
Reflex/Flexstar	ammonia or commercial tank cleaner + water	sorghum
Resource	ammonia or commercial tank cleaner + water	—
Resolve	ammonia + water	sorghum + all broadleaf crops
Roundup Ultra	water	all sensitive crops
Scepter	ammonia or commercial tank cleaner + water	sunflower, canola, corn, cotton
Scorpion III	ammonia or commercial tank cleaner + water	soybean, sunflower, cotton
Select	ammonia or commercial tank cleaner + water	corn, sorghum, wheat, other grasses
Sencor/Lexone	detergent + water	—
Shotgun	commercial tank cleaner + water	all broadleaf crops
Squadron	ammonia or commercial tank cleaner + water	sunflower, canola, corn, cotton
Staple	ammonia + water	sorghum, corn, canola, sunflower
Steel	ammonia or commercial tank cleaner + water	sunflower, canola, corn, cotton
Stinger	ammonia + water	sunflower, soybean, cotton
Touchdown	commercial tank cleaner + water	all sensitive crops
Treflan	ammonia or commercial tank cleaner + water	—
Tri-Scept	ammonia or commercial tank cleaner + water	sunflower, canola, corn, cotton
Turbo	detergent or commercial tank cleaner + water	cotton
Zorial/Rapid 80	ammonia or commercial tank cleaner + water	corn, wheat

