Chapter

8

Chemical Applications

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Rice production efficiency and profitability are enhanced through the use of agricultural chemicals, including pesticides and fertilizers. Factors such as chemical selection and the timing and accuracy of applications can enhance the value and increase the economic return of these inputs. A variety of application techniques are used to apply chemicals to rice. Early-season chemical applications, prior to flooding of rice fields, are generally split between ground-based and aerial platforms. However, once fields are flooded, the primary application tool is the agricultural aircraft.

Global positioning systems (GPS) or satellites have been in widespread use for a number of years to provide guidance for chemical applicators. GPS is a very accurate method to follow a prescribed path in the field for each pass. Thus, flaggers are no longer needed, and the GPS provides a logistical value to applicators. Chemical applications can be made to fields at any time without having to coordinate the exact application time. GPS also has the ability to track the application operation, which provides an excellent record of the many application variables.

Soil Applications of Pesticides

Ground-Based Applications

Many growers use ground equipment to apply pesticides before planting and flooding. The focus of most chemical applications centers on application dosage accuracy, swath uniformity and drift minimization. Almost all nozzle manufacturers offer a table-based guide to assist applicators with the correct nozzle selection for each type of chemical used. These should be studied carefully to determine which nozzle type and setup will provide the best performance. Many nozzle manufacturers offer excellent web sites with selection and calibration information. Examples include www.teejet.com, www.greenleaftech.com and www.sprayparts.com.

Photo 8-1. Ground-based burndown herbicide application.

Many manufacturers are using an air induction-type nozzle to help control droplet size – particularly to reduce the number of fine or small droplets that are produced. Proper selection of air induction-type nozzles helps keep the droplet size within the desired range. Most ground-based pesticide applications should perform well with droplet spectrums that provide a VMD (volumetric mean diameter) in the range of 300 to 600 microns (µm). One micrometer, or micron, is 1/25,000 of an inch – the diameter of a human hair is approximately 100 µm. ASABE (American Society of Agricultural and Biological Engineers) has developed standards, ASABE S572, to describe names for droplet spectrums such as fine, medium and coarse. These names fully define the spectrum for fine, average and large droplets in the spectrum. Most rice applications utilize the medium droplet spectrum. Utilization of these names is very common as restrictions or guidelines on chemical labels.

Larger droplets (500 to 1,000 µm) are typically used for ground contact applications because coverage may not be as critical. Applications on leaf surfaces should be targeted for droplet spectrums in the 150 to 400 µm range. Nozzles on large floater trucks that are used for liquid fertilizer applications typically make a droplet size too large for adequate performance when applying to plant surfaces. Fertilizer-type flood nozzles may even produce droplets that are too large for soil-applied pesticides and should be used with caution. Carefully study the data available and select the best suited nozzles. Manufacturers typically offer bar graphs that help with selection based on chemical mode of action.

Aerial Applications

When early-season rainfall prevents ground-based burndown applications, many pesticide applications are done by agricultural aircraft. Development of new nozzle technology and performance evaluation techniques has allowed pilots to customize the aircraft to increase application efficiencies, making aircraft an excellent spray platform.

Photo 8-2. Aerial application of postemergence herbicide.

Spray pattern uniformity, droplet size and application dosage should be carefully evaluated with all types of sprayers. New GPS feed rate controllers allow applicators to maintain application spray rates within ±1 percent of the target rate. This technology is becoming more common. Estimates are that at least 10 percent of the Arkansas aircraft fleet has rate controllers.

Table 8-1. Spray tip classification by droplet size.

Classification Category	Color Code	Droplet Size	Approximate VMD (µm)†	Coverage	Used for	Drift Potential
Extremely Fine	Purple	Small	<50	Excellent	Exceptions	High
Very Fine	Red	↓	51-150	Excellent	Exceptions	↓
Fine	Orange		151-230	Very Good	Good Cover	
Medium	Yellow		231-340	Good	Most Products	
Coarse	Blue		341-405	Moderate	Systemic Herbicides	
Very Coarse	Green		405-505	Poor	Soil Herbicides	
Extremely Coarse	White		506-665	Very Poor	Liquid Fertilizer	
Ultra Coarse	Black	Large	>665	Very Poor	Liquid Fertilizer	Low†

† Estimated from sample reference graph in ASABE/ANSI/ASAE Standard S572.1 2009. Spray Nozzle Classification by Droplet Spectra. American Society of Agricultural and Biological Engineers.

Postemergence Applications of Pesticides

Ground-Based Applications

Ground-based postemergence pesticide applications to flooded rice fields can be difficult. These applications work best when specialized equipment is used or on applications made to precision-leveled fields with straight levees or on zero-grade fields with no levees. Typical ground-based application equipment may have problems with traction in the flooded fields and can damage levees to the point that using the equipment is impractical.

Aerial Applications

Most postemergence pesticide applications, especially those applied to flooded fields, are made using agricultural aircraft. Some postemergence pesticides are applied in a granular form (i.e., Facet®). These materials are generally applied at rates of 15 to 30 pounds per acre. Agricultural aircraft spreaders are typically designed to make applications at rates of 100 pounds per acre or higher. Spreaders can be set to make these lower application rates, but attention to setup details is more critical. These materials can be distributed quite accurately when aircraft are properly adjusted.

Photo 8-3. Aircraft spreader

Foliar insecticide applications are commonly needed for control of rice insect pests. When insecticide applications are needed to control insects there are several considerations that should be made:

1. **Time of day.** Many insects are more active early in the morning or late in the evening, and applications should be made to coincide with when insects are up on the plant where they can be reached with the application.
2. **Environmental conditions.** Mobile insects, such as rice stink bug adults, may move out of the field on hot, sunny days, and applications made in the middle of the day may occur when insect populations have temporarily moved out of the field. When temperatures are high, increasing spray volume (GPA) and the use of an adjuvant may improve deposition and coverage of insecticides.
3. **Insecticide selection.** Some insecticides have longer residual than others. Some are more appropriate for the pests that you are trying to control. Select the correct insecticide based on pest pressure. Refer to Chapter 12, Insect Management in Rice, or MP144, *Insecticide Recommendations for Arkansas* (http://www.uaex.edu/Other_Areas/publications/PDF/MP144/MP-144.asp) for additional information on insecticide ratings and selection.

Pesticide Drift

EPA, http://www.epa.gov/PR_Notices/prdraft-spraydrift801.htm, defines pesticide drift as:

"Spray or dust drift is the physical movement of pesticide droplets or particles through the air at the time of pesticide application or soon thereafter from the target site to any non- or off-target site. Spray drift shall not include movement of pesticides to non- or off-target sites caused by erosion, migration, volatility, or windblown soil particles that occurs after application or application of fumigants unless specifically addressed on the product label with respect to drift control requirements."

Buffer or no spray zones are also defined by:

"A no-spray zone is an area in which direct application of the pesticide is prohibited; this area is specified in distance between the closest point of direct pesticide application and the nearest boundary of a site to be protected, unless otherwise specified on a product label."

Pesticide drift refers to the movement of a pesticide away from the target application site. Pesticide drift occurs when pesticide applications are made in high winds or when conditions exist for temperature inversions. Under these conditions, rice herbicides can cause damage to susceptible crops. This damage can range from cosmetic to complete loss of the susceptible crop. The level of damage caused by pesticide drift depends on the sensitivity of the nontarget crop to the pesticide and upon the amount of the pesticide drifted. Table 8-2 lists several common rice herbicides and the relative sensitivity of nontarget crops. It can often be difficult to determine the exact economic loss caused by pesticide drift. Many factors including weather and overall growing conditions can influence the ability of nontarget plants to recover from drift. The information below is meant only to provide general guidelines.

Flag the Technology

Flag the technology is a program designed to help prevent herbicide drift issues. Many herbicide-tolerant crops are now available that allow certain broad-spectrum herbicides to be applied without causing crop injury. While multiple herbicide tolerance technologies are available, only one such technology, Clearfield, exists for rice. The use of colored marker flags (Figure 8-1) is intended to prevent application errors and herbicide drift issues with nearby crops. In rice, fields planted with Clearfield technology should be

Table 8-2. **Relative sensitivity† of major Arkansas field crops to commonly used rice herbicides.**

Herbicide (trade name)	Herbicide (common name)	Soybean	Corn	Cotton	Milo	Rice
Numerous	glyphosate	T*	T*/VS	T*/S	VS	VS
Newpath	imazethapyr	T	S	S	S	T*/VS
Facet	quinclorac	M	M	S	T	T
Prowl	pendimethalin	T	T	T	M	T
Command	clomazone	T	M	M	M	T
Numerous	propanil	S	S	S	S	T
Regiment	bispyribac	M*/VS	S	S	S	T
Permit	halosulfuron	T*/VS	T	S	T	T
Grasp	penoxsulam	M*/VS	S	S	S	T
Londax	bensulfuron methyl	M*/VS	S	S	S	T
Strada	orthosulfamuron	M*/VS	S	S	S	T
Ricestar	fenoxaprop	T	VS	T	VS	T
Clincher	cyhalofop	T	VS	T	VS	T
Blazer/Storm	acifluorfen	T	M/S	M	M/S	T
Numerous	2,4-D	S	T	VS	T	T
Grandstand	triclopyr	S	M	S	M	T
Aim	carfentrazone	M	M/S	M/S	M/S	

† T =Tolerant, M = Moderately Tolerant, S = Sensitive, VS = Very Sensitive.
T* = Some crops are available with herbicide tolerance to these herbicides.
M* = Some crops are available with moderate herbicide tolerance to these herbicides.

Color Codes:

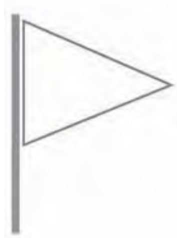
RED
signifies conventional varieties with no herbicide technology traits. *Extreme caution.*

[1] PMS 1797
R-201, G-40, B-45
C-15, M-98, Y-93, K-4

BRIGHT GREEN
indicates the Liberty Link® technology. This technology is tolerant to glufosinate (Ignite®) herbicide.

PMS 354
R-0, G-174, B-66
C-95, M-0, Y-100, K-0

WHITE
represents the Roundup Ready® technology that is tolerant to glyphosate herbicide.



BRIGHT YELLOW
is the color chosen for Clearfield® rice technology and STS® soybeans.[2]

PMS 102
R-251, G-231, B-0
C-5, M-3, Y-100, K-0

[1] Technical descriptions of the colors for use by printers and other manufacturers of flags.
[2] Although these herbicides are in the ALS family of herbicides, crops with this technology are not tolerant to all ALS herbicides.

Figure 8-1. **Key to Flag the Technology marker flag colors.**

marked with bright yellow flags while all others (with no herbicide tolerance) should be marked with red flags. Yellow flags marking soybean fields in and around rice indicate that those fields are STS soybeans. STS soybeans can tolerate rice herbicides such as Permit. Although injured less than conventional soybeans, STS soybeans may still be injured by drift from certain rice herbicides such as Regiment.

Fertilizers

Ground Applied

Spinner Units

Many applications are done prior to flooding using trucks and/or buggies with rotating spinner applicators. These units may do an excellent job of spreading, but they need to be adjusted carefully for the various application rates and material types used. There is no one setting that will provide a uniform distribution of all materials and application rates.

Photo 8-4. Spinner truck applying fertilizer.

Spinners should be carefully calibrated and the distribution pattern tested during the off-season to determine gate openings, spinner speeds, blade angle settings and feed point adjustments that will provide the best field uniformity. Optimum swath widths will also vary – so they should be noted as well during the calibration process.

Swath calibrations are typically done with a set of 11 to 25 pans that are about 6 inches tall and about 15 inches square. A fabric or grid is used in each pan to avoid "bounce out." These pans are spread out evenly and the unit operated over them normally. The material is collected from each pan, weighed or measured, and then graphed to determine swath width, uniformity, and application rate. This same technique is used for all types of granular distributors.

Air-Flow Spreaders

Air-flow spreaders have the potential to make very uniform applications. The distribution points are typically every 3 to 5 feet. If every point is properly adjusted, these units should be less susceptible than spinner units to variations in distribution pattern due to wind and topography. Care should be taken to keep the metering mechanism clean and in good repair.

Photo 8-5. Air-flow spreader.

Faulty or plugged feed delivery systems can adversely affect the dosage that is delivered to each distribution point. A thorough daily cleaning will help avoid this. Units should be operated statically long enough to completely dry all air passageways after cleaning.

Aerially Applied

Most nitrogen fertilizer is applied to rice aerially. Aircraft spreaders can do an excellent job but need to be carefully calibrated to ensure swath uniformity and that the correct swath width is being used. Workshops are held in Arkansas annually to help aerial applicators test and calibrate these spreaders. Measurement techniques very similar to those used on ground equipment are used. The major difference is the size and shape of the collectors. Generally, collectors are constructed on a steel skeleton with a cone-shaped fabric cover. The fabric absorbs the energy from the falling particles – helping to avoid bounce out.

Almost all state agencies and major forestry contracts now require aerial applicators to be tested and provide documentation on performance. This practice is becoming more common with farmer customers as well – to provide some assurance of quality prior to the job.

Aircraft equipment has improved dramatically in recent years. The most common swath width for prilled urea is about 78 to 85 feet when using an application rate of 100 pounds per acre. Swath widths typically narrow about 3 feet for each 25 pounds per acre increase in application rate. This is because there is an increased flow rate of material through a fixed air flow in the spreader. Each spreader has a maximum practical limit of material that can be transported with the available air – the intake area of the spreader is generally fixed.

Many spreaders reach a practical limit at application rates greater than 250 pounds per acre. Several new spreaders, with larger capacity, are beginning to show up in the Delta. These are capable of applying up to 350 pounds per acre in a single pass. Increasing flow rates above the practical limit of the spreader generally results in poor pattern uniformity. Applicators typically cut the swath width in half when the spreader limit is reached. This cuts the flow rate in half and provides a second coating of material. Two coats of fertilizer are very similar to two coats of paint – the overall application is more uniform.

Material Property Effects

Ground and aerial applicators do a much more uniform job of spreading seed than fertilizer. This is because seeds are all about the same size and shape – with almost no fine particles. The most important variable with seed applications, particularly with spinner and aerial spreaders, is use of the correct swath width. The swath width for seed varies with seed shape, density and size. Optimum swath widths differ very little for aerially-seeded rice. These are typically between 48 and 60 feet, with higher application rates and smaller equipment being on the low end.

Buying cheap fertilizer may not be a good way to reduce input costs if the fertilizer is not a uniform size. No application platform can uniformly spread materials with particles of many different sizes. The more fine particles or dust in a fertilizer mix, the poorer the spread pattern one can expect.

Segregation of sizes becomes a major problem with blended fertilizers. Segregation in the hopper may be avoided, or significantly reduced, if proper blending is done and the material is not allowed to cone during a transfer operation. Differences in spread widths of the blended materials will still occur if the individual components vary in size, shape and density.

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General Recommendations

Chemical applications represent a large component of rice production costs. Work with your equipment or your applicator to ensure that the most accurate application possible is obtained. Improper application or off-target movement can turn an economical treatment into an expensive one. Always read and follow labels directions. Additional information on proper mixing of chemicals can be found here: http://www.uaex.edu/Other_Areas/publications/PDF/FSA-2166.pdf