



2010 **Weed Control**
Guidelines
for *Mississippi*

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2011 *Weed Control Guidelines for Mississippi*
c/o John D. Byrd, Jr., Weed Specialist
Dept. of Plant and Soil Sciences
Box 9555
Mississippi State, MS 39762-9555

Copies may not be available if not ordered in advance.

Please send me ____ copies (at \$9.00 each) of the publication, 2011 Weed Control Guidelines for Mississippi. Enclose check with order payable to Mississippi State University Extension Service and designate it 2011 Weed Control Guidelines.

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CONTRIBUTING GROUPS

This publication is the result of cooperative work by members of the Mississippi Weed Science Committee. This committee is composed of personnel from the following agencies:

1. Agricultural Research Service, U.S. Department of Agriculture
2. Bureau of Plant Industry, Mississippi Department of Agriculture and Commerce
3. Mississippi Agricultural and Forestry Experiment Station
4. Mississippi State University Extension Service
5. Mississippi State University Forest and Wildlife Research Center
6. U.S. Army Corps of Engineers, Waterways Experiment Station

This publication is for the direction and guidance of agricultural workers. Specific and less technical information for various crops may be obtained at county offices of the Mississippi State University Extension Service.

2010 Mississippi Weed Science Committee Assignments

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MISSISSIPPI WEED CONTROL GUIDELINES

Particular attention has been taken to ascertain that all herbicide treatments in this report are registered with the EPA for use in the manner described. Registrations for specific practices are frequently modified or deleted, often making it impossible for practices suggested in this report to remain current throughout the calendar year. Therefore, the manufacturer's label should be read and observed to prevent misuse of a herbicide. Some herbicide treatments or practices included herein are provided

for through Special Local Need Registrations, Section 24(c). Use directions may be in the form of supplemental labeling, which must be in possession of the user at the time of use. Supplemental labeling for these special uses may be obtained from the dealer or registrant. It is not intended or proposed that any practice suggested in this guide be in violation of existing registration or manufacturer's label.

Precautions

All agricultural chemicals should be handled with care. The manufacturer's label on the container includes precautions for safe handling, which should always be observed. When material is spilled on the body, it should be washed off immediately. In no case, should spray tips be placed to the lips to blow out trash. Many of the materials are flammable and should be handled accordingly.

Aerial application of dicamba, picloram, 2,4-D, and other phenoxy or hormone-type herbicides is regulated by law in Mississippi. 2,4-D, dicamba, and/or MCPA may not be applied by fixed-wing aircraft between April 1 and September 30. 2,4-D and/or MCPA shall not be applied in any form to rice by helicopter between April 1 and September 30, except with special spray equipment and under certain conditions. Before aerial applications of such materials are made, operators should contact the Bureau of Plant Industry, Mississippi Department of Agriculture and Commerce, Mississippi State, Mississippi, relative to compliance with this law and the regulations promulgated thereunder.

Clean spray tanks after the final application of a pesticide and before the application of another pesticide. Failure to clean the spray tank can result in severe crop injury or illegal residues in the harvested commodity. Most pesticide residues can be cleaned from the spray tank using household ammonia. Use clean water to rinse the inside of the spray tank. Use enough water to flush the spray boom hoses and spray tips.

Fill the spray tank with clean water; add enough ammonia to make a 1 percent solution (1 gallon ammonia per 100 gallons water). The ammonia used for cleaning should contain 3 percent active ingredient. Agitate the ammonia solution through the

spray equipment and flush the hoses, booms, and nozzles for at least 15 minutes. When possible, allow sprayer to sit with this solution overnight before draining. Fill the tanks with clean water, agitate the water, and flush the boom with clean water for 5 minutes. Whenever possible, locate mix-load sites and equipment clean-up sites at least 100 feet from any surface water or from direct links to groundwater.

It is best not to use the same spraying equipment for applying both phenoxy-type herbicides, (2,4-D, etc.) and other pesticides unless the crop has good tolerance. Herbicides such as 2,4-D can be satisfactorily cleaned out of sprayers, but some risk still exists when spraying sensitive broadleaf crops.

Injury to fish, birds, honey bees, and mammals may be avoided in these ways:

1. Prevent drift of herbicides to wooded areas occupied by wildlife, drift to land areas not intended for treatments, and drift to bodies of water.
2. Prevent runoff or washoff by rain from treated areas to bodies of water through judicious timing of application.
3. Do not make applications too often or in excessive dosages.
4. Do not apply highly toxic herbicides.
5. Prevent carelessness.
6. Avoid treating extensive areas of water with approved aquatic herbicides in one operation, since the decaying vegetation that would result might deplete oxygen content of the water to the point of causing fish kills.
7. Comply with all restrictions specified on the pesticide label in the Endangered Species Act.

Herbicide Safety

Herbicides should always be handled in such a way that the possibility of harm to nontarget organisms (including man), either through contamination of food and water or by contact, is kept to a minimum. All users should be trained in the proper handling of herbicides and in following the precautions below:

1. Know the material being applied; READ THE CONTAINER LABEL AND UNDERSTAND THE DIRECTIONS for preparing and applying the herbicide, and FOLLOW THE DIRECTIONS.
2. Wear protective clothing specified on the pesticide label and avoid prolonged exposure to herbicides. Special care should be exercised to prevent inhalation and contamination of the skin when handling concentrates (use respirators, goggles, impermeable aprons, and gloves as specified on the label).
3. Avoid contamination of foods or drinking water of man and animals.
4. When herbicide contamination of the body occurs, wash the affected area quickly and thoroughly with soap and water. Wash with soap routinely after each day of spraying.

5. Keep spray equipment clean and in good condition.
6. STORE HERBICIDES IN PROPERLY LABELED CONTAINERS OUT OF REACH OF CHILDREN AND ANIMALS.
7. Dispose of empty containers safely (See Container Disposal Section).
8. **KNOW THE EMERGENCY MEASURES FOR TREATING ACCIDENTAL POISONING.** When illness arises due to a possible overexposure to a herbicide, contact your local physician. **Physicians and other medical authorities may obtain information on the toxicity of herbicides from the Poison Control Center, University Medical Center, Jackson, MS, telephone 1-800-222-1222.**
9. If herbicides get into the eyes, flush the eyes with plenty of water for 15 minutes and call a physician.
10. If a herbicide is swallowed, apply the first-aid treatment printed on the label of the container and call a physician.

Mixing and Handling Herbicides

1. Mix and prepare herbicides in the open or in a well-ventilated place. When handled in close quarters, highly toxic herbicides may cause poisoning through inhalation. Certain volatile herbicides may cause fires or explosions.
2. Open herbicide containers carefully to prevent billowing of dusts or splashing of liquids.
3. Pour herbicides carefully to avoid spills. Triple or pressure rinse empty containers and use the rinse water to fill the spray tank.
4. Use special containers — drums or pails — for mixing herbicides; never use food or beverage containers.
5. Never use your mouth to siphon a herbicide from a container.
6. Do not mix herbicides in concentrations higher than those recommended and measure accurately. This will help ensure application of correct and safe dosages.
7. Avoid spilling concentrates on the skin or clothes, and keep them away from the eyes, mouth, and nose. If a herbicide is spilled, wash it off with soap and water and change contaminated clothing immediately. Launder contaminated clothing before wearing it again. Launder contaminated clothing separately. Do not launder with family wash.
8. Always wear rubber gloves when handling concentrates. Rinse the gloves with water before removing them; do not turn gloves inside out when removing.
9. To safely mix and prepare some herbicides, it is necessary to wear a respiratory device and protective clothing. The container label will indicate if these precautions are needed.
10. Do not smoke, eat, or drink when handling herbicides.

Applying Herbicides

1. Wear the protective clothing prescribed on the container label when applying a herbicide.
2. Do not apply dosages greater than those recommended on the container label.
3. Time your applications to prevent illegal herbicide residues on food, feed, or forage crops; allow the prescribed number of days' interval between the last herbicide application and harvest or grazing.
4. Guard against drift of herbicides onto nearby crops, pastures, or grazing livestock, or onto streams, ponds, lakes, other fish-bearing waters, or other sensitive areas. Do not spray when environmental conditions favor drift. Use of the correct nozzle size, which maximizes the largest droplet size, will aid in minimizing spray drift.
5. Guard against runoff of herbicides into water supply sources. Do not mix or/apply herbicides near dug wells, cisterns, or any other water sources into which they may run or be washed by rain. Do not clean application equipment, dump unwanted herbicides, or dispose of empty containers near these places.
6. When applying spray or dust, work into the breeze or at a right-angle to it; thus, the herbicide will be blown away from instead of onto you.
7. Do not smoke, eat, or drink while applying herbicides.
8. Be careful not to rub eyes or mouth with your hands during applications.
9. If you should feel ill while applying herbicides, stop work at once and get medical attention.
10. At the end of a day's work, bathe and change all clothing. Launder the clothing before wearing it again. Launder contaminated clothing separately, not with family wash.
11. Rubber shoes may be cleaned with soap and water. It is impossible to efficiently decontaminate leather shoes. If your shoes have become heavily contaminated with herbicide, do not wear them again. Dispose of contaminated footwear properly.

Worker Protection Standard

1. Agricultural, forestry, nursery, and greenhouse users are affected by the Worker Protection Standard.
2. Requirements for Worker Protection Standard must be followed when they appear on the pesticide label. This includes providing personal protective equipment, observing restricted-entry intervals (REI), and notifying workers about areas where applications are taking place or where REI's are in effect. Notification may be oral or with signs posted at field entrances or both if required by the label.
3. Generic provisions of providing a decontamination facility, worker training, monitoring of handlers, cleaning, inspection, and maintenance of personal protective equipment, and notification of applications are required.
4. Training for noncertified pesticide handlers and applicators can be provided by: (1) a currently certified restricted-use pesticide applicator, (2) a person currently designated as a trainer of certified applicators or handlers by State, Federal, or Tribal agency having jurisdiction, or (3) a person having completed a "Pesticide Safety Train-The-Trainer" program approved by the State, Federal, or Tribal agency having jurisdiction. Reinforcement training about the specific pesticide being used should be conducted at the time the pesticide is to be handled or applied.
5. The employer must display at a central location information about each application, the name, telephone number, and address of the nearest emergency medical facility, and a WPS pesticide safety poster developed by EPA or an equivalent poster. He must also provide transportation to an emergency medical facility for the employee thought to have been poisoned or injured and supply the treating medical personnel any requested information from the product label. A description of the way the pesticide was used and the circumstances of the worker's exposure to the pesticide must also be given.

Suggestions for Disposal of Excess Pesticides and Pesticide Containers

Owners of excess pesticides should first exhaust the two following avenues before undertaking final disposal:

1. Use the pesticide for the purposes originally intended at the prescribed rate, providing these uses are currently legal.
2. Return pesticide to the manufacturer or distributor.

Recommended Procedures for Disposal of Excess Pesticides

The best way to dispose of excess pesticides is to apply the pesticide according to the label. Cancelled or suspended pesticides are classified as hazardous waste and must be disposed of at a hazardous waste facility. For information on disposal, contact:

Suggestions for Disposal of Excess Pesticides and Pesticide Containers *(continued)*

Mississippi Department of Environmental Quality
 Bureau of Pollution Control
 Division of Hazardous Waste Management
 P. O. Box 10385
 Jackson, MS 39289
 Telephone (601) 961-5171

Recommended Procedures for Disposal of Pesticide Containers and Residues

Containers

Dispose of pesticide containers according to instructions on the pesticide label. As a general rule, (1) containers which held liquid pesticides should be triple or pressure rinsed and either offered for recycling or reconditioning, or disposed of in a permitted solid waste facility. (2) Containers which held dry materials should be completely emptied, triple or pressure rinsed if appropriate, and then either offered for recycling, reconditioning, or disposed of in a permitted solid waste facility.

For information on recycling pesticide containers contact your county Extension office.

Pesticide Residues

Rinsate from pesticide containers and spray equipment should be added to the spray or mix-tank as diluent and sprayed back on the field.

Open burning of pesticide containers is not permissible under Mississippi law.

Recommended Procedures and Criteria for Storage of Pesticides and Pesticide Containers

Temporary storage of highly toxic or moderately toxic pesticides for the period immediately prior to, and of the quantity required for a single application, may be undertaken by the user at isolated sites and facilities where flooding is unlikely, where provisions are made to prevent unauthorized entry, and where separation from water systems and buildings is sufficient to prevent contamination by runoff, percolation, or wind-blown particles or vapors.

General Instructions for Use of Abbreviated Guides

1. Preplant and preemergence herbicide rates are generally related to soil texture and organic matter content. Some herbicides are suggested in these guidelines for a wide range of soil types (sandy to clays); whereas, others are suggested for only a few soil types. The soil organic matter content further defines use rates. Some times low contents prevent use, but generally, rates increase with increasing organic matter content.
2. If a single rate is recommended for a herbicide, use the recommended rate for all soil types and weed conditions described.
3. If a range of rates (2 to 4 lb for example) is recommended, select a rate from within the range in accordance with the size and condition of crop and weeds. For example, the lowest recommended rate of diuron plus surfactant should be used to control a very scattered infestation of newly emerged crabgrass in 6-inch cotton. In cotton more than 10 inches tall, the highest rate should be used if the problem consists mainly of crabgrass 2-3 inches tall and thickly spaced in the row.
4. If a range of rates (2 to 3 to 4 lb for example) is recommended for soil-applied herbicides, the specific rate should be chosen in accordance with soil texture and organic matter content of the soil. First, use the lower range for soils in the sandy textural class and the higher range for loams, clay loams, or, where recommended, for clays. Second, within either the low or high range select the specific rate in accordance with the organic matter content of the soil. Use the lower side of the range where organic matter is low and the higher side of the range where organic matter is high. Although exact knowledge concerning the organic matter content of soils is generally not available, there are several rough guides that can be used. Soils high in organic matter tend to darker and more easily cultivated than similar soils low in organic matter. Plants grown in high organic soils suffer less from drought than plants grown in similar soils with low organic matter. Soils of the Midsouth with less than one percent organic matter should be considered low in organic matter while those with 1.5 percent should be considered high in organic matter for purposes of herbicide use.

FACTORS TO CONVERT BROADCAST RATE/A TO A BAND RATE AT VARIOUS BAND AND ROW WIDTHS.

Band width inches	Row Spacing — Inches							
	20	24	28	30	32	36	38	40
6	0.3	0.25	0.21	0.20	0.19	0.17	0.16	0.15
8	0.4	0.33	0.29	0.27	0.25	0.22	0.21	0.20
10	0.5	0.42	0.36	0.33	0.31	0.28	0.26	0.25
12	0.6	0.50	0.43	0.40	0.37	0.33	0.31	0.30
14	0.7	0.58	0.50	0.47	0.44	0.39	0.37	0.35
16	0.8	0.67	0.57	0.53	0.50	0.44	0.42	0.40
18	0.9	0.75	0.64	0.60	0.56	0.50	0.47	0.45
20	1.0	0.93	0.71	0.67	0.62	0.56	0.53	0.50

How to Convert: Find the factor for row spacing and band width and multiply this by the broadcast rate.

For Example: The broadcast rate is 1.0 lb/acre, row spacing is 30 inches and band width is 10 inches—multiply .33 by 1.0 to get 0.33 lb/acre on a 10-inch band.

Caution - Noxious Weeds

Mississippi Noxious Weeds being proposed by the Mississippi Department of Agriculture and Commerce (MDAC) (Rule 41: Regulation of Noxious Weeds Under Sections 69-25-1 through 69-25-47, Chapter 380, Laws of Mississippi 1974). Additional information on Mississippi Noxious Weeds will be available under Plant Pest Programs on the MDAC's Noxious Weed home page www.mdac.state.ms.us/Index.asp.

MISSISSIPPI NOXIOUS WEEDS

Common Name	Scientific Name	Habitat
Benghal dayflower	<i>Commelina benghalensis</i>	terrestrial
Brazilian satintail	<i>Imperata brasiliensis</i>	terrestrial
cogongrass	<i>Imperata cylindrica</i>	terrestrial
Chinese tallow tree	<i>Triadica sebifera</i>	terrestrial
giant salvinia	<i>Salvinia molesta</i>	aquatic
hydrilla	<i>Hydrilla verticillata</i>	aquatic
itchgrass	<i>Rotboellia exaltata</i>	terrestrial
tropical soda apple	<i>Solanum viarum</i>	terrestrial

Also, the MDAC has authority under the Mississippi Aquaculture Act of 1998 (Section 79-22-9) to regulate the cultivation and marketing of certain agricultural products. Under Public Notice of "Guidelines for Aquaculture Activities in Mississippi," the department further defined permitting requirements for the importation, selling, possessing, or transporting of species that are detrimental to the state's native resources. The Department of Wildlife, Fisheries, and Parks (DWFP) and the Department of Marine Resources may advise MDAC in issuing cultivation and marketing permits (Section 49-7-80). MDWFP determined the following species to be detrimental to the state's native resources. Sales and distribution of the following species are prohibited in Mississippi:

SALE AND DISTRIBUTION PROHIBITED IN MISSISSIPPI

Common Name	Scientific Name	Habitat
anchored waterhyacinth	<i>Eichhornia azurea</i>	aquatic
Brazilian Elodea	<i>Egeria densa</i>	aquatic
Eurasian watermilfoil	<i>Myriophyllum spicatum</i>	aquatic
hydrilla	<i>Hydrilla verticillata</i>	aquatic
melaleuca	<i>Melaleuca quinquenervia</i>	aquatic or wetlands
waterhyacinth	<i>Eichhornia crassipes</i>	aquatic
waterlettuce	<i>Pistia stratiotes</i>	aquatic

A list of federal noxious weeds is available on the APHIS home page www.aphis.usda.gov/. This list includes species or species groups that are not currently in the United States and present a real threat to agricultural, forest, urban, and natural areas. The list also includes species that are major weed problems elsewhere in the world and which currently have restricted distributions in the United States. **Movement of any Federal Noxious Weed, including seed and other propagules, into the United States and across state lines is prohibited.** See the Computer Aids section in this publication for additional web sites about non-native invasive weeds.

FEDERAL NOXIOUS WEEDS OCCURRING IN ADJACENT STATES

Common Name	Scientific Name	Habitat	States
cattail grass	<i>Setaria pallide-fusca</i>	terrestrial	Alabama, Louisiana
sessile joyweed	<i>Altheranthera sessilis</i>	terrestrial	Alabama
water lettuce	<i>Ottelia alismoides</i>	aquatic	Arkansas, Louisiana, Missouri

FORAGE CROPS

MSMA is **not** recommended nor labeled for application to bermudagrass or other forage grasses grown for livestock consumption.

REPLANTING RESTRICTIONS FOR FORAGES *(See product labels for crops not listed.)*¹

Product	Legumes		Pasture Grasses			
	Alfalfa	Clover	Bahia	Bermuda	Fescue	Rye
Arsenal Powerline	12 m + bioassay	12 m + bioassay	12 m + bioassay	12 m + bioassay	12 m + bioassay	12 m + bioassay
Chaparral	bioassay	bioassay	ns	ns	fall	ns
Cimarron Max at 0.25 oz/A plus 1 pt/A	4 m	4 m	-	4 m	4 m	4 m
Cimarron Plus at 0.25 oz/A	4 m	4 m	-	4 m	4 m	4 m
Clarity/Banvel (per pint applied per acre)	120 d	120 d	30 d	30 d	30 d	30 d
Crossbow	3 w	3 w	3 w	3 w	3 w	3 w
Diuron	2 y	2 y	2 y	2 y	2 y	2 y
Glyphosate	1 w	1 w	1 w	1 w	1 w	1 w
Grazon Next	bioassay	bioassay	-	-	-	-
Grazon P+D	1 y	1 y	3 w	3 w	3 w	3 w
Lineage Clearstand	12 m + bioassay	12 m + bioassay	12 m + bioassay	12 m + bioassay	12 m + bioassay	12 m + bioassay
Metsulfuron	bioassay	bioassay	ns	ns	fall	fall
Milestone	bioassay	bioassay	-	-	-	-
Outrider	12 m + bioassay	12 m + bioassay	12 m + bioassay	12 m + bioassay	12 m + bioassay	12 m + bioassay
Overdrive	30 d	30 d	30 d	30 d	30 d	30 d
Paraquat	0 d	0 d	0 d	0 d	0 d	0 d
Pasturegard	1 m	1 m	3 w	3 w ²	3 w	3 w
Redeem R&P	bioassay	bioassay	14 d	14 d	14 d	14 d
Remedy	3 w	3 w	3 w	3 w	3 w	3 w
Surmount	bioassay	bioassay	12 m	12 m	12 m	12 m
Telar	bioassay	bioassay	bioassay	bioassay	bioassay	bioassay
Velpar	2 y	2 y	2 y	2 y	2 y	2 y

¹D, m, w, and y following numbers in this table indicate days, months, weeks, and years, respectively.

²Interval applies to seeded bermudagrass cultivars.

HAYING, GRAZING, AND SLAUGHTER RESTRICTIONS FOR LIVESTOCK

Product	Dairy Animals				Meat Animals		Slaughter
	Lactating		Nonlactating		Grazing	Haying	
	Grazing	Haying	Grazing	Haying			
	----- (days) -----						
2,4-D amine ³	7	30	7	30	0	30	3
2,4-D ester ³	7	30	7	30	7	30	3
Arsenal Powerline	0	7	0	7	0	7	-
Buctril							
spring treatment	30	30	30	30	30	30	-
fall/winter treatment	60	60	60	60	60	60	-
Butyrac							
established alfalfa	30	30	30	30	30	30	-
seedling alfalfa, clover	60	60	60	60	60	60	-
Chaparral	0	0	0	0	0	0	-
Cimmaron Max	7	37	0	37	0	37	30
Cimarron Plus	0	0	0	0	0	0	-
Clarity/Banvel							
1/2 qt/A or less	7	37	0	0	0	0	30
1-2 qt/A	40	70	0	0	0	0	30
Crossbow							
2 gal or less/A	14	NS ¹	0	7	0	7	3
2-4 gal/A	NS	NS	14 ²	14	14 ²	14	3
Diuron	70	70	70	70	70	70	-
Glyphosate							
legumes							
preplant, preemerge, at-plant <44 oz/A	0	0	0	0	0	0	-
>44 oz/A	56	56	56	56	56	56	-
alfalfa preharvest	1.5	1.5	1.5	1.5	1.5	1.5	-
spot treatment (<10% total acres)	14	14	14	14	14	14	-
renovation < 44 oz	1.5	1.5	1.5	1.5	1.5	1.5	-
renovation > 44 oz	56	56	56	56	56	56	-
grass pastures							
preplant, preemerge, renovation	56	56	56	56	56	56	-
spot or wiper treatment	14	14	14	14	14	14	-
Gramoxone							
alfalfa/clover							
dormant/clover	-	60	-	60	-	60	-
between cuttings	30	30	30	30	30	30	-
bermudagrass, dormant	-	40	-	40	-	40	-
Gramoxone							
alfalfa	-	30	-	30	-	30	-
dormant bermudagrass	-	40	-	40	-	40	-
Grazon Next	0	7	0	7	0	7	-
Grazon P+D	7	30	0	30	0	30	3
Journey	0	7	0	7	0	7	-
Lineage Clearstand	0	7	0	7	0	7	-
Metribuzin	28	28	28	28	28	28	-
Metsulfuron	0	0	0	0	0	0	-
Milestone	0	0	0	0	0	0	-
Outrider	0	14	0	14	0	14	-
Overdrive	0	0	0	0	0	0	-
PastureGard	NS	14	0	14	0	14	3
Poast	7	20	7	20	7	20	-
Redeem R+P	14	NS	0	7	0	7	3
Remedy							
2 qt or less/A	14	NS	0	7	0	7	3
2-4 qt/A	NS	NS	14 ²	14	14 ²	14	3
4-6 qt/A	NS	NS	14 ²	NS	14 ²	NS	3
Select	15	15	15	15	15	15	-
Surmount	14	7	0	7	0	7	3
Telar	0	0	0	0	0	0	-
Velpar	60	60	60	60	60	60	-
Weedmaster	7	37	0	37	0	37	30

¹NS indicates next season.

²If the area treated is less than 25 percent of grazing area, there is no restriction for nonlactating or meat animals.

³Restrictions vary among manufactured products. Refer to particular product label for specific restrictions.

Weed resistance to recommended use-rates of certain herbicides has been documented in Mississippi — SEE PAGE 9.

Consult labels for approved adjuvants.

Herbicide use may require some waiting period before haying or grazing — SEE ABOVE.

Forage Crops, Continued

Crop, weed, or situation and active chemical per treated land acre	Formulation needed for 1 acre treated broadcast	Time of application	Weeds controlled	Special instructions and remarks
Preplant				
<i>Alfalfa</i>				
benefin at 1.1 to 1.5 lb/A	1.5 lb/gal formulation Balan at 6 to 8 pt in 10 to 20 gal water.	Incorporate immediately after application fall or spring.	Certain annual grasses and broadleaves.	Do not use if grain or grass crop is to be planted with alfalfa. See label.
Preemergence				
<i>Bermudagrass, at planting</i>				
diuron at 0.8 to 2.4 lb/A	80 WP at 1 to 3 lb, or 4L at 1.6 to 4.8 pt/A in 25 gal water.	At sprigging.	Many annuals including signalgrass and some seedling perennials.	May temporarily burn emerged bermuda and permanently injure Alicia. For control of small emerged weeds, use low rate plus surfactant. SEE PAGE 88.
<i>Sorghum-sudan hybrids</i>				
atrazine at 1.6 lb/A	1.8 lb 90DF or 2 lb 80WP or 3.2 pt 4L in 25 gal water.	Sorghum should be completely germinated and emerged and weeds not more than 1.5 inches high.	Annual grass and broadleaf weeds.	Do not use on sand or loamy sand. May injure winter annuals that follow high rates.
Postemergence				
<i>Alfalfa seedling</i>				
bromoxynil at 0.25 to 0.37 lb/A	Buctril at 1 to 1.5 pt/A.	Fall or spring when majority of alfalfa has a minimum of 4 trifoliolate leaves.	Annual broadleaf weeds.	Do not add surfactant or crop oil unless specifically recommended. SEE PAGE 88.
<i>Alfalfa only</i>				
clethodim at 0.094 to 0.125 lb/A	Select 2EC at 6 to 8 oz/A in up to 20 gal water with 1 qt/A crop oil concentrate.	To actively growing annual or perennial grasses.	Most grasses.	Do not apply more than 32 ounces per acre to alfalfa. Do not apply a broadleaf herbicide within 1 day before or after application.
imazethapyr at 0.05-0.09 lb/A	Pursuit DG at 0.72 to 1.08 oz/A with 0.25% nonionic surfactant or 1 qt/A crop oil concentrate and 1-2 qt/A liquid N fertilizer or 2.5 lb/A spray grade ammonium sulfate.	Seedling alfalfa with at least 2 fully expanded trifoliolate leaves or established, dormant or semi-dormant alfalfa or between cuttings.	Broadleaf weeds and certain grasses.	Do not exceed 6 ounces per acre per year. Do not apply during the last year of the stand. Do not feed, graze, or harvest alfalfa within 30 days of application. In the event of stand failure, do not reseed alfalfa within 4 months after application.
<i>Alfalfa, Clover, seedling and established</i>				
2,4-DB at 0.5 to 1 lb/A	2 to 4 pt/A of 2 lb/gal material.	Where weeds are young and actively growing.	Most small annual broadleaf weeds.	Do not use on sweet clover nor on clover grown for seed. Apply before weeds are 3 inches high. SEE PAGE 88.
sethoxydim at 0.19 to 0.47 lb/A	Poast 1.5E at 1 to 2.5 pt in up to 20 gal water at 40-60 psi by ground. Add 2 pt/A oil concentrate.	To actively growing grasses.	Most grasses.	Apply no more than 5 pints per acre in one season. SEE PAGE 88.

Forage Crops, Continued

Crop, weed, or situation and active chemical per treated land acre	Formulation needed for 1 acre treated broadcast	Time of application	Weeds controlled	Special instructions and remarks
<i>Alfalfa, established</i>				
metribuzin at 0.38 to 0.75 lb/A	Sencor/Lexone 75DF at 0.5 to 1 lb or 4L at 0.8 to 1.5 pt in 20 to 40 gal water.	Winter dormant established	Chickweed, henbit and other winter annuals.	Apply only to winter dormant alfalfa no earlier than 12 months after seedling. SEE PAGE 88.
paraquat at 0.28 lb/A	Gramoxone Max (3 lb/gal) 0.75 pt/A or Boa (2.5 lb/gal) 0.78 pt/A in 20 gal water.	After cuttings.	Annual grasses and broadleaf weeds.	Apply to stands at least 1 year old and within 5 days after cutting. Add 1 quart of non-ionic surfactant per 100 gallons of spray solution. SEE PAGE 88.
<i>Grass pastures, established</i>				
2,4-D at 0.5 to 1 lb/A	1 to 2 pt/A (4 lb/gal formulation) in 10 to 20 gal water.	To actively growing weeds.	Buttercup, bitter weed, woolly croton, and others, except dogfennel, horsenettle, and smartweed.	Do not treat during long droughts and to annual legumes until after seed production. SEE PAGE 88.
2,4-D LV ester at 0.5 to 1 lb/A	1 to 2 pt/A (4 lb/gal formulation) in 10 to 20 gal water.	November to March when crop is well established, weeds are young, but before flowering of weeds.	Mustard, turnips, dock, buttercup, and others.	Apply during a clear, warm, sunny period when weeds are young and tender. May injure young, tender ryegrass. Add 0.5 to 1 quart of surfactant per 100 gallons of spray solution for improved control especially when applied during cool weather. SEE PAGE 88.
2,4-D at 0.38 to 1.4 lb/A plus dicamba at 0.12 to 0.5 lb/A	Weedmaster at 1 to 4 pt/A.	When weeds are young and actively growing.	Most broadleaf weeds and some hard-to-control weeds, such as dogfennel and smartweed.	Weeds should be less than 10 inches tall for lower rates. Same precautions as for dicamba alone. Clipping large weeds not dead in 2 to 3 weeks will improve control. SEE PAGE 88.
2,4-D at 0.24 to 2 lb/A plus picloram at 0.06 to 0.54 lb/A	Grazon P+D at 1 to 8 pt/A or 1 to 2% solution.	When weeds are actively growing and not stressed.	Most broadleaf weeds and some hard-to-control weeds, such as dogfennel, horsenettle, and woody brush.	Use lower rates early in the season when weeds are very small. Use higher rates for larger annual weeds or established perennials or woody brush. SEE PAGE 88.
aminopyralid at 0.06 to 0.11 lb/A	Milestone at 4 to 7 oz/A in 20 gal water with 0.25% v/v nonionic surfactant.	To actively growing broadleaf weeds.	Tropical soda apple, others.	Milestone will severely damage legumes. Do not plant legumes until successful field bioassay proves concentrations will not damage crop. Manure and urine from animals grazed on treated sites or fed treated hay within the last 3 days will injure legume or broadleaf plants. Manure should not be used in areas where sensitive broadleaf plants will be placed.
aminopyralid at 0.06 to 0.11 lb/A + 2,4-D at 0.5 to 0.9 lb/A	Grazon Next at 1.5 to 2.6 pt/A in 20 gal water with 0.25% v/v nonionic surfactant.	To actively growing weeds.	Broadleaf weeds.	Forefront will severely damage legumes. Do not plant legumes in treated areas until field bioassay proves herbicide residues will not damage crop. Manure and urine from animals grazed on treated sites or fed treated hay within the last 3 days will injure legumes or damage broadleaf plants. Manure should not be used in areas sensitive broadleaf plants will be placed.

Forage Crops, Continued

Crop, weed, or situation and active chemical per treated land acre	Formulation needed for 1 acre treated broadcast	Time of application	Weeds controlled	Special instructions and remarks
aminopyralid at 0.04 to 0.13 lb/A plus Metsulfuron at 0.006 to 0.02 lb/A	Chaparral at 1 to 3.3 oz/A for broadcast or 2.5 to 3.3 oz/100 gal for spot treatments	Use lower rate for young, annual weeds and higher rate for older or perennial weeds.	Broadleaf weeds.	Treatments will severely injure legumes, bahiagrass, or fescue. Use nonionic surfactant at 1 quart per 100 gallons of spray; however, applications to tall fescue should not exceed 1 pint per 100 gallons. Do not rotate to any crop within 1 year after treatment. Do not plant forage legumes until bioassay verifies residues will not injure crop. Do not seed ryegrass within 4 months after application. Do not use treated plants or manure around desirable broadleaf plants. Do not move animals from treated fields onto fields with legumes without first moving into untreated field for 3 days.
chlorsulfuron at 0.01 to 0.06 lb/A	Telar at 0.25 to 1.33 oz/A.	Apply to young, actively growing annual weeds and while biennial or perennial weeds are still in rosette.	Annual and some biennial and perennials.	Make only one application per season. Do not exceed 1.3 ounces per acre per season. Add 1 to 2 quarts nonionic surfactant per 100 gallons of spray.
dicamba at 0.25 to 2 lb/A	Clarity at 0.5 to 2 pt/A in 20 to 40 gal water for broadcast treatments or 25 to 50% solution with oil for individual stem or cut surface treatments.	When weeds are actively growing for foliar treatments or prior to active spring growth for stem applications with oil.	Most broadleaf weeds and small brush.	Do not broadcast spray more than 1 quart per acre in one season. Do not exceed 1 pint per acre on small grains grown for pasture. SEE PAGE 88.
diflufenzopyr at 0.005 to 0.01 lb/A plus dicamba at 0.015 to 0.03 lb/A	Overdrive at 4 to 8 fl oz/A.	Apply to young, actively growing weeds.	Annual and perennial broadleaf weeds.	Use low rate for annuals, high rate for biennials and perennials. Add 1 quart of nonionic surfactant per 100 gallons of spray or 1.5 to 2 pints per acre of methylated seed oil. Do not exceed 8 ounces per acre per season. Do not plant any rotational crop within 30 days of application. Do not apply to small grains grown for grazing. SEE PAGE 88.
imazapyr at 0.03 to 0.75 lb/A	Arsenal Powerline at 2 to 48 oz per treated acre spot broadcast or 0.5 to 5% solution for handgun spot treatment with 0.25% nonionic surfactant (v/v).	To actively growing weeds and woody species as foliar spray or to dormant trees and brush as injection, hack and squirt, or cut stump treatment.	Several annual and perennial grasses and broadleaf weeds plus vines and undesirable woody plants.	Do not treat more than 10% of the area grazed or cut for hay. Treatments will damage desirable forage species. Do not apply more than 48 ounces per acre per year.
imazapyr + metsulfuron at 0.03 to 0.4 + 0.005 to 0.06 lb/A	Lineage Clearstand at 0.8 to 10 oz in 20 gal water plus 0.25% nonionic surfactant (v/v).	To actively growing weeds and brush as foliar spray or to dormant trees and brush as injection, hack and squirt, or cut stump treatment.	Annual and perennial grasses and broadleaf weeds and brush.	Do not exceed 10 ounces per acre per year. Do not treat more than 10% of the area grazed or cut for hay. Treatments will damage desirable forage species.
picloram at 0.44 to 0.89 lb/A plus fluroxypyr at 0.36 to 0.72 lb/A	Surmount at 3 to 6 pt/A or 0.5 to 2% solution for spot treatment.	Apply to actively growing weeds.	Many broadleaf weeds and hard-to-control perennial weeds and woody plants.	Use lower rate for small annual weeds, higher rates for larger annuals or established perennials. Add 1 to 2 quarts of nonionic surfactant per 100 gallons of spray. SEE PAGE 88.

Forage Crops, Continued

Crop, weed, or situation and active chemical per treated land acre	Formulation needed for 1 acre treated broadcast	Time of application	Weeds controlled	Special instructions and remarks
triclopyr at 0.25 to 2 lb/A	Remedy at 1 to 4 pt/A for broadcast treatments or 1 to 1.5% solution with water for spot spraying perennial weeds or 20 to 33% solution with oil for dormant woody stem treatments.	When weeds are actively growing for broadcast or spot sprays or before bud break for applications with oils to woody stems.	Broadleaf weeds and woody vines, shrubs, and trees.	Add 1 to 2 quarts nonionic surfactant per 100 gallons with broadcast sprays. SEE PAGE 88.
triclopyr at 0.42 to 1.1 lb/A + clopyralid at 0.14 to 0.38 lb/A	Redeem R&P at 1.5 to 4 pt/A	To actively growing grasses.	Broadleaf weeds.	Use lower rates for weeds such as bitter sneezeweed, ragweed, thistle, marshelder, and croton; higher rates for spiny pigweed, horsenettle, and dogfennel.
triclopyr at 0.38 to 1.5 lb/A plus fluroxypyr at 0.125 to 0.5 lb/A	PastureGard at 2 to 8 pt/A for broadcast applications, or 1 to 2% solution for spot treatment, or 50:50 mix with oil and 10% penetrant for individual woody stem or cut stump treatment.	Apply foliar treatments to weeds that are actively growing and not stressed, and mixtures with oils to dormant stems.	Broadleaf annual and perennial weeds, including tropical soda apple, or woody perennials, such as vines, brambles, shrubs, and trees.	Use low rates for small annual weeds, higher rates for large annuals or perennials. Add 1 to 2 quarts of nonionic surfactant per 100 gallons of spray for applications. SEE PAGE 88.
triclopyr at 0.25 to 1 lb/A + 2,4-D at 0.5 to 2 lb/A	Crossbow at 1 to 4 qt/A or 1 to 1.5% solution for broadcast treatments, or 1 to 4% solution with oil for dormant woody stem treatments.	When weeds are actively growing for broadcast applications or just before breaking dormancy for woody stem treatments.	Annual and perennial broadleaf weeds and some woody vines and shrubs.	Adding 1 to 2 quarts of nonionic surfactant per 100 gallons of spray may enhance control. Do not reseed pastures within 3 weeks after treatment. Do not exceed 4 quarts per acre per season. Do not apply to newly seeded grasses until after tillering. SEE PAGE 88.
<i>Bermuda and Bahiagrass, established</i>				
hexazinone 0.69 to 1.13 lb/A	Velpar L 2.75 to 4.5 pt/A.	To actively growing smutgrass from May to October 15.	Smutgrass and many broadleaf weeds.	Do not apply near the root system of desirable woody plants such as oak trees. Apply with 1 quart of surfactant per 100 gallons of water. SEE PAGE 88.
sulfosulfuron at 0.06 to 0.09 lb/A	Outrider at 1.3 to 2 oz in 20 gal water with 0.25% nonionic surfactant (v/v).	To actively growing weeds.	Johnsongrass, sedges, ryegrass, mustards, and buttercup.	Sequential applications can be made no sooner than 40 days after the previous treatment. Do not exceed 2.66 ounces per acre per year.
<i>Bermudagrass, established</i>				
imazapic + glyphosate at 0.06 to 0.19 + 0.1 to 0.4 lb/A	Journey at 10 to 32 oz/A broadcast or as 0.625 to 13% solution for spot treatments.	To actively growing weeds	Vaseygrass, Johnsongrass, crabgrass, signalgrass, barnyardgrass, sandbur, and nutsedge	Methylated seed oil is preferred over nonionic surfactant. Use 1.5 to 2 pints per acre for broadcast or 1% for spot applications. Do not apply during transition from dormant to active growth. Do not apply to 'World Feeder,' Tifton 85, or hybrid bermudagrass. Do not exceed 21 ounces per acre on Coastal bermudagrass. Do not apply within 30 days of aeration. Bermudagrass growth will likely be suppressed 30 days.

Forage Crops, Continued

Crop, weed, or situation and active chemical per treated land acre	Formulation needed for 1 acre treated broadcast	Time of application	Weeds controlled	Special instructions and remarks
metsulfuron methyl 0.0038 to 0.015 lb/A	Metsulfuron at 0.1 to 0.4 oz/A in a minimum of 10 gal/A or 1 oz/100 gal for spot applications.	To actively growing weeds. For bahiagrass control, use 0.3 oz after green-up and before seed-head formation.	Pensacola bahia, wild garlic, buttercup, bitter sneezeweed, pigweed, and woolly croton.	Add 0.5 to 1 quart of nonionic per 100 gallons of spray solution surfactant. Will not control Argentine bahiagrass. Do not apply to Bahiagrass pastures. Following Cimarron applications at 0.1 to 0.3 ounce per acre, red, white, or sweet clover, bermudagrass, ryegrass, or tall fescue can be planted after 4 months; wheat after 1 month; barley or oats after 10 months. Do not apply more than 1.67 ounce per acre per season. Do not use on soils with pH above 7.9.
metsulfuron + 2,4-D + dicamba 0.004 to 0.011 + 0.36 to 0.72 to 1.4 + 0.125 to 0.25 to 0.5	Cimarron Max 0.1 to 0.3 oz/A Part A + 1 to 2 to 4 pt/A Part B	To actively growing weeds	Bahiagrass, woolly croton, bitter sneezeweed, vetch, dock, garlic dogfennel, marestail, blackberry, multiflora rose, and many other annual and perennial weeds	Add 1 quart of nonionic surfactant per 100 gallons of finished spray solution. Does not control 'Argentine' bahiagrass. Do not apply more than 1.67 ounces of Part A per acre per season.
metsulfuron + chlorsulfuron at 0.004 to 0.04 + 0.001 to 0.01 lb/A	Cimarron Plus at 0.125 to 1.25 oz in 20 gal water with 0.25% non-ionic surfactant (v/v).	To actively growing weeds.	Bahiagrass and many other broadleaf weeds less than 4 inches tall.	Do not apply to bermudagrass established less than 2 months or fescue established less than 24 months. Do not apply to carpetgrass or Pensacola bahiagrass.
<i>Bermudagrass, dormant</i>				
paraquat at 0.25 to 0.5 lb/A	Gramoxone Inteon at 1 to 2 pt in 20 gal of water.	Mid-March.	Emerged annual broadleaf weeds and grasses in dormant bermuda.	Add 1 quart of nonionic surfactant per 100 gallons of spray solution. Must be applied prior to seed head emergence for satisfactory control of little barley. SEE PAGE 88.
<i>Bermudagrass and Bahiagrass, sod suppression</i>				
paraquat at 0.25 to 0.5 lb/A	Gramoxone Inteon at 1 to 2 pt in 20 gal of water. Add 0.25% surfactant (v/v).	Early fall to sods not exceeding 3 inches in height.	Supresses summer grass while winter annuals establish.	Add 1 quart of nonionic surfactant per 100 gallons of spray. SEE PAGE 88.
<i>Endophyte-Infested Tall Fescue Destruction</i>				
paraquat 0.25 to 0.5 lb/A	Gramoxone Inteon at 1 to 2 pt in 20 gal of water followed by second application 10 to 21 days later at the same formulation.	When fescue is actively growing.	Endophyte-infected fescue and annuals.	Add 0.5 or 1 quart of nonionic surfactant per 100 gallons of spray solution. If new growth appears within 10-14 days, make a second application. Do not exceed 3 pints per acre. SEE PAGE 88.
glyphosate at 0.75 lb/A	Glyphosate 4/5 lb/gal at 2/1.2 pt in 3 to 10 gal water plus 0.5 to 1% surfactant	When fescue is actively growing in the fall and plants are 6 to 12 inches tall.	Endophyte-infected fescue and other annual plants.	A sequential application of 1 pint plus surfactant will improve long-term control. SEE PAGE 88.

EQUIPMENT AND CALIBRATION

Tank-Mixing Precautions

- Read product labels carefully and follow all applicable directions, precautions, and limitations.
- Do not exceed recommended application rates for respective products or maximum allowable application rates for any active ingredient in the tank mix.
- For products packaged in water-soluble packaging, do not tank mix with products containing boron. Also, do not mix in equipment previously used to apply a product mixture containing boron unless the tank and spray equipment have been adequately cleaned. (See Equipment Clean-Out Procedures.)
- Always perform a jar test to ensure the compatibility of products to be tank mixed before mixing a full tank.

Sprayer Agitation

Agitation is an essential design and operational component of the agricultural spray system. Agitation is the hydraulic stirring movement of spray solution. Agitation is necessary to maintain the homogeneous mixture required for uniform performance of the pesticide being applied. Poor agitation usually results in nonuniformity of the pesticide application. This may be most visible as crop injury caused by an excess rate of herbicide when the tank is full or recently refilled. As the tank becomes empty, you may see less control of weeds. The amount of agitation needed for the spray system depends upon the type of agitation being used, the size of the spray tanks, the configuration of the spray tanks, and the type of spray solution being applied. The most common type of agitation system is by-pass agitation where part of the spray pump capacity is used to create agitation inside the spray tanks to maintain a homogenous spray solution.

Spray tank agitation requirements are based on the total size of the spray tanks, the configuration of the spray tanks, and the type of pesticide formulation being applied. The volume of the spray tank agitation also depends on the type of tank agitation system being used. A rule of thumb suggests that about 10 percent of the total tank capacity is needed for sufficient agitation. For example, if the total capacity of two tanks is 300 gallons, then 30 gallons per minute (15 gallons per minute per tank) are needed for adequate agitation when conventional by-pass agitation is used. If the by-pass agitation system has induction jets attached, the total volume required for adequate agitation can be reduced.

In some of the new, very large and irregularly shaped spray tanks, it is more difficult to provide adequate agitation because of the way they are made. These tanks were made to more easily fit the tractor configuration than for spray agitation. More traditional EC, EW and flowable liquid pesticide formulations tend to have lower agitation requirements to maintain a homogenous spray mixture. Some formulation types may be prone to settling, especially if the agitation is inadequate or is stopped. In some situations, you may need to add spray adjuvants. Most agitation problems can be easily corrected with careful design and operation of the agitation system.

Where two or more tanks are used, the agitation system should be designed so that all tanks are agitated continuously once the pesticide is added. The operator must then decide whether to use from both tanks simultaneously or from one tank only. When operating from one tank with a full second tank, two separate pump/control/agitation systems are required to agitate both.

Spray tank agitation systems should include a high-volume spray pump and agitators that are carefully designed and installed. Agitators should be placed in the bottom of the spray tank with jets sweeping towards the ends of the tank so that the tank contents are rolled completely.

Total pump capacity is determined by the agitation requirement and the total nozzle requirement. The pump must have adequate capacity for both needs. If the pump is not large enough, it should be either replaced or a separate pump must be added so that one pump would be delivering the spray boom needs, and one pump would be delivering the agitation system needs.

Sprayer Operation

Agricultural sprayers should be operated so that the required rate of pesticide is delivered to the target site. Do not make applications when conditions are conducive to spray drift, poor spray deposition, or poor target coverage.

- Turn off the spraying system when turning or when booms must be raised to clear obstacles or folded for transport.
- Use check valves in individual nozzle bodies to prevent dripping during turns, transport, or when the sprayer is parked.
- Properly clean the sprayer before transporting, storing, or working in other crops or with other pesticides.

Minimize Drift from Ground Applications

Many variables influence drift from agricultural chemical applications. Focusing on the most important variables provides the applicator the greatest opportunity to minimize off-target movement. Research at Mississippi State University measured the relative importance of variables that influence drift from ground and aerial applications. The tips below are listed in order of importance in reducing drift as found in "Predicting ground boom spray drift" by, D. B. Smith, L. E. Bode and P. D. Gerard, Trans of ASAE 43(3):547-553, 2000.

- Maintain the maximum distance possible from the application to sensitive crops or areas downwind of the application by using buffer zones and by choosing times to spray when wind direction is away from sensitive crops and areas.
- Keep the spray release height and the nozzle to the target distance as low as possible to maintain a uniform application pattern from the nozzle for minimum influence of wind and evaporation. Select the proper nozzle type for the application and the nozzle pattern angle. Set the nozzle tip back or forward at approximately 45 degrees to horizontal to minimize height from boom to target.
- Make applications when wind speed is low (3 to 5 mph, but not dead calm indicating an inversion) and direction is away from sensitive crops and areas.

Applicators may benefit from spraying when temperature is low and humidity is high and with pressures no greater than 40 psi when using pattern-producing nozzles. Shielded and hooded sprayers may be used to minimize exposure of the spray to wind; however, one drift study found greater drift due to wind turbulence around a shield.

Aerial Drift Reduction

The tips below for reducing drift from aerial applications are listed in order of importance as found in Guidelines for Aerial Atomization and Spray Drift Reduction for Mississippi Applicators, MAFES Information Bulletin 251, by D. B. Smith, M. H. Willcutt, D. L. Valcore, J. W. Barry and M.E. Teske, Nov. 1993).

- Use the largest droplet size compatible with proper coverage required for the mode-of-action of the pesticide being used. The Department of Agriculture and Commerce Bureau of Plant Industry now requires a minimum of 300 micron vmd spray for glyphosate applications by air.

- Maintain the maximum distance possible from the application to sensitive crops or areas downwind of the application by using buffer zones and by choosing times to spray when wind direction is away from sensitive crops and areas.
- Make applications when wind speed is low (3 to 5 mph, but not dead calm indicating an inversion) and direction is away from sensitive crops and areas.

Mississippi regulations require that the outboard nozzles be no more than 70 percent of the wingspan or rotor span. Nozzles placed beyond this boom position contribute to vortex-influenced drift and non-uniform deposition, and they do not increase the effective swath width of the aircraft.

Oklahoma State University Publication E-948, Aerial Pesticide Drift Management, Ron T. Noyes, Dennis Gardisser and Dennis K. Kuhlman, makes this suggestion: "Make applications at a height of 25 to 50 percent of the aircraft wingspan, measured from the top of the canopy to the boom. This will generally equate to a minimum height of 9 to 10 feet to the gear or 10 to 15 feet from boom to target canopy. Flying too low can lead to narrow swaths, non-uniform distribution, and streaking. It may also lead to increased drift potential due to the excessive control surface movements generally associated with 'wheels in the crop' flying. Achieve level flight before spraying and turn off the spray system before pulling up. Do not use excessive aircraft speeds. As air speed increases, the amount of particle breakup and 'rooster tailing' potential increases. Higher airspeeds also increase the hazards of low altitude flying due to reduced pilot reaction time. Equip the spray boom for immediate/positive shut-off through properly installed bleed lines and well-maintained equipment. Attend educational meetings frequently and read all published information possible to increase your knowledge about factors that contribute to drift."

Sprayer Clean-Up

Thoroughly clean the sprayer after completion of the application, before repairs and maintenance, and before equipment storage or making other applications. Thorough cleaning will reduce the potential for product residues being dislodged during subsequent applications or worker exposure to pesticide residues and fumes from welding during repairs and maintenance.

At the End of the Day

At the end of each day of spraying, rinse the interior of the tank with clean water and then partially fill the tank. Flush the boom and hoses. This will reduce the buildup of dried pesticide deposits that may accumulate in the application equipment.

Upon Completion of the Application

Follow pesticide label directions for cleaning the sprayer. If no specific cleaning compound or procedure is recommended on the pesticide label, follow the procedure below:

- Drain the mixing and loading system, placing any remaining pesticide solution into the sprayer tank. Thoroughly rinse the mix vat, transfer pump, holding tank, and hoses. Clean this equipment with an appropriate spray tank cleaner. Remove and thoroughly clean all filters and screens on the mixing and loading system. Add all rinse water to the sprayer tank, washing the inside of the tank in the process. Apply rinse water to the application area.
- Fill the sprayer tank half full with clean water, washing the inside of the tank in the process; then apply the rinse water to the application area. Flush the boom with clean water. Loosen and physically remove any visible deposits.
- Fill the tank with clean water and 1 gallon of household ammonia (contains 3 percent active). Anhydrous ammonia may also be used at the same or stronger concentrations for every 100 gallons of water. Flush the hoses, boom, and nozzles with the cleaning solution. Then add more water to fill the tank completely. Circulate the cleaning solution through the tank and hoses for at least 15 minutes. Allowing the cleaning solution to sit 12 to 24 hours will result in better neutralization of pesticide residues. Apply the rinse solution to the application area or labeled cropland for the pesticide used.
- Remove the nozzles and screens and clean separately in a bucket containing cleaning agent and water using a soft-bristle brush.
- Repeat step 2 without the nozzles and strainers installed.
- Rinse the tank, boom, and hoses with clean water.
- Thoroughly clean exterior surfaces of spray equipment with a pressure washer or steam cleaner and with cleaning solutions recommended on the pesticide label.
- If the sprayer will be stored for long periods or during freezing weather, add about 2 to 5 gallons of a 50 percent antifreeze solution, allow it to circulate with the pump, and leave it in the sprayer to reduce damage caused by rust, corrosion, and freezing.
- Store the sprayer in a secure area away from frequent human and animal traffic patterns. Always lower raised components, place transmission in park, lock brakes, remove any keys, and lock cab and storage shed doors when leaving any equipment.

***Note:** If other cleaners are used, consult the cleaner label for rinse water disposal instructions. If no instructions are given, dispose of the rinse water on site or at an approved waste disposal facility.

Carefully read and follow the individual cleaner instructions. Consult your ag dealer, applicator, or pesticide manufacturer's representative for a list of approved cleaners.

- CAUTION: Do not use chlorine bleach with ammonia solutions as dangerous gases will form. Do not clean equipment in an enclosed area. Rinse all metal sprayer components thoroughly after using chlorine or ammonia cleaning solutions to prevent rusting.
- Steam clean aerial spray tanks to remove any caked deposits before performing the above cleanout procedure.
- When a tank mix with other pesticides has been applied, examine all cleanout procedures and follow the most rigorous procedure.
- In addition to this cleanout procedure, follow all pre-cleanout guidelines on subsequently applied products, as per the individual labels.
- Properly dispose of all empty pesticide containers, cleaning solutions, and rinse water in accordance with federal, state, and local regulations and guidelines. Triple or pressure rinse all empty pesticide containers and then render them unusable by puncturing the container.
- One accepted method of cleaning solution and rinse water disposal is to apply the rinse water to the field area previously treated. Do not exceed pesticide label recommendations for application rate when applying rinse water.
- Always wear the proper personal protective equipment while filling, cleaning, or working on sprayers.

Spray Tips for Successful Applications

The success of a crop chemical depends on its proper application as recommended by the chemical manufacturer. Proper selection and operation of spray nozzles are very important steps in accurate chemical application. The volume of spray passing through each nozzle plus the droplet size and spray distribution on the target influence weed control.

There is evidence that spray tips may be the most neglected component in today's farming; yet they are among the most critical of items in proper application of agricultural chemicals. For example, a 10 percent over-application of chemical on a twice-sprayed 1,000-acre farm could represent a loss of \$2,000-\$10,000 based on today's chemical investment of \$10-\$50 per acre. This does not take into account potential crop damage.

Careful cleaning of a clogged spray tip can mean the difference between a clean field and one with weed streaks. Flat spray tips have finely machined openings to control the spray. Damage from improper cleaning can cause both an increased flow rate and poor spray distribution. Be sure to use recommended strainers in your spray system to minimize clogging. If a tip clogs, use a soft-bristled brush or toothpick to clean it—**never** use a metal object. Use extreme care with soft spray tip materials such as plastic.

A wide selection of equipment is available for application of herbicides for weed control. Follow the manufacturer's guidelines for each specific type of equipment. Selection of the proper nozzle for the desired end-use is critical for proper calibration and application. Available nozzle types, spray patterns, and uses are presented in Table 3.

Precalibration check

Be sure that all sprayer components are free of foreign material and function properly. Inspect nozzle tips and internal parts for obvious wear, defects, proper size and type. Check the flow rate of each nozzle using water. Establish the desired operating pressure and check for uniform output, equal fan angle, and uniform appearance of spray pattern. Replace any nozzle tips having 5 percent more or less than the average flow rate of the other nozzles and/or having obviously different fan angles or patterns. If the average flow rate of the old nozzle tips differs from the flow rate of new nozzle tips or catalog flow rates for new nozzle tips by 10 percent or more, consider replacing with new nozzle tips. Check the flow rate of new nozzle tips before spraying.

Nozzle Height and Uniformity

Type and size of nozzle tip, operating pressure, spray formulation, tip spacing along the boom, tip-to-target distance, fan angle, and angle of nozzle tips in relation to vertical can greatly influence the spray swath uniformity. You can see extreme nonuniformity by spraying onto a prepared surface such as concrete or a dust-covered surface. Rotate fan-type tips approximately 5 degrees from being parallel to the boom so that adjacent spray fans do not interfere with each other. Suggested spray tip heights found in catalogs are a good starting point; however, these tip operating heights may or may not produce the maximum uniformity of application. For a more detailed discussion of spray uniformity and height and recommendations for specific nozzle tips, see Extension Publication 1697 *Improving the Uniformity of Ground Applied Broadcast Sprays* by D.B. Smith and M. H. Willcutt. (Specific recommendations for reducing aerial spray drift can be found in MAFES Information Bulletin 251 *Guidelines for Aerial Atomization and Spray Drift Reduction for Mississippi Applicators* by D.B. Smith, M.H. Willcutt, D.L. Valcore, J.W. Barry, and M.E. Teske.)

Use this formula to determine nozzle size:
$$\text{GPM} = \frac{\text{GPA} \times \text{MPH} \times \text{Width}}{5,940}$$

The following web sites may be helpful in selecting nozzles, set-up and calibration of spray equipment:

www.agchem.com	Ag.Chem Equipment Co., Minnetonka, MN55343, 800-760-8800
www.teejet.com	Spraying Systems Co., Wheaton, IL, 770-552-9292
www.delavanagspray.com	Delavan AgSpray Products, Lexington, TN, 800-621-9357
www.sprayers.com	Sprayer Specialties, Inc. Grimes, IA, 800-351-1587

Always be sure to check the rated operating pressure of nozzles when comparing desired flow to rated flow.

1/128th Acre Calibration for Row- and Boom-Nozzle Sprayers

Calibration of sprayers involves selection of the proper nozzle, spraying pressure, and sprayer speed. See Table 3 for selection of nozzles. There are many ways to determine the right combination of these elements. One practical calibration method is given. For a more in-depth discussion of calibration procedures, see Extension Publication 1006 *Calibration of Ground Spray Equipment*.

The 1/128th acre, baby bottle, and 100-foot methods of calibration are based on spraying 1/128th acre. There are 128 ounces per gallon; therefore, ounces sprayed per 1/128th acre equal gallons sprayed per acre. This procedure results in a treated acre calibration. Broadcast herbicide rates should be added to the volume of water calibrated per treated acre.

1. Determine nozzle spacing or swath width. (Note: if you are making **band** applications and use nozzle spacings, you will figure the gallons of spray per **planted** acre.)
2. Refer to Table 1 on next page for length of calibration course and mark calibration course in the field or 340 ft²/nozzle swath width (feet) course length.
3. Record time required to drive length of calibration course at gear, engine rpm, and implement settings to be used while spraying.
4. Park sprayer, maintain engine rpm used to drive course, and turn on sprayer.
5. Collect all spray from one nozzle for time equal to that required to drive the calibration course.
6. Measure the **ounces** caught. Ounces caught equal gallons per acre of spray applied.
7. Repeat Steps 5 and 6 for several other nozzles.

* **NOTE:** If multiple nozzles are used per row (Figure 4) use the width of area treated by **all nozzles** as the swath width for step 1 and catch the flow from **all nozzles** directed to the row in step 5.

TABLE 1. DISTANCE FOR EACH NOZZLE TO SPRAY 1/128 ACRE.

Effective Swath Width (in)	Course Distance (feet)
6	681
8	510
10	408
12	340
14	292
16	255
18	227
20	204
22	186
24	170
30	136
36	113
38	107
40	102
42	97
48	85

TABLE 2. CALIBRATION LENGTHS FOR BOOMLESS SPRAYERS.

Effective Swath Width (feet)	Course Distance (feet)
15	363
18	302
20	272
22	248
24	227
26	209
28	194
30	182
32	170
34	160
40	136
47	116
50	109
52	105
56	97
60	91

1/8th Acre Calibration for Boomless Sprayers

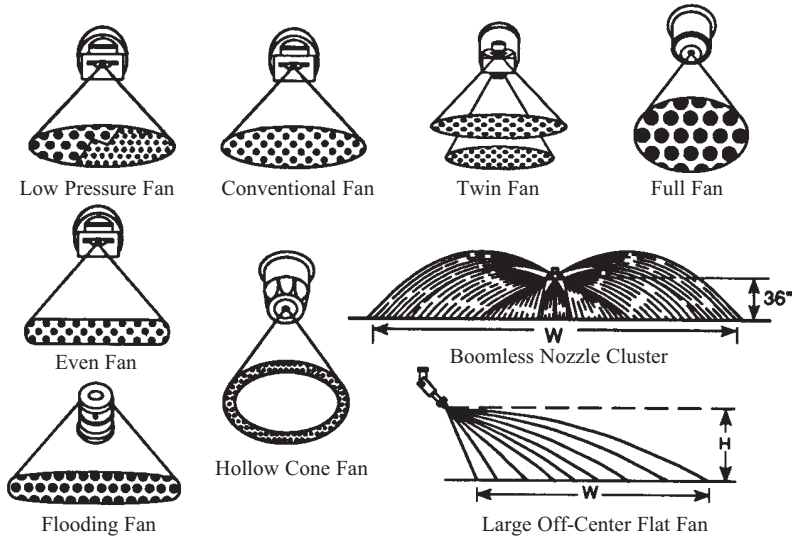
1. Turn on sprayer and measure effective swath width (feet). Note: swath width should be visually assessed when the vehicle is moving at 5 mph with very low wind speed and wind direction is parallel to the direction of travel of the spray vehicle.
2. Refer to Table 2 to determine length of calibration course and mark the calibration course in the field.
3. Record time required to drive course at gear, engine rpm, and implement settings to be used while spraying.
4. Park sprayer, maintain same rpm used to drive course, and turn on sprayer.
5. Catch water in plastic garbage bag for time equal to drive the calibration course.
6. Measure the pints caught. Pints collected equal gallons per acre.

TABLE 3. NOZZLE TYPES, SPRAY PATTERNS AND SUGGESTED USES¹.

Type	Spray Pattern	Pressure (psi)	Suggested Use/Comments
Flat Fan	Fan-like pattern of medium droplets. Not uniform across width.	20-40 (15-40 psi for LP nozzle)	Pre- and postemergence, broadcast booms. Available in low pressure tips that reduce clogging and drift potential. Requires 30% overlap for uniform distribution.
Even Fan	Fan-like pattern. Uniform volume across entire width.	20-40	Pre- and postemergence. Good for banding.
Flooding Fan	Wide, flat pattern of coarse droplet.	10-30	Broadcast booms, chemical-fertilizer mixture, layby. Requires 100% overlap for uniform distribution.
Off-Center Flat Fan (up to OCO8)	Flat-fan pattern. Directed to one side of tip. Swath width 20-144 inches.	20-40	Post-directed, low-profile spraying. Larger drops and increased volume deposited on the toe of pattern. Reasonably uniform deposits are not expected.
Large off-Center Flat Fan	Swath directed to one side from 12 to 33 feet width.	30-40	Herbicide application to ditches and roadsides. Reasonably uniform deposits are not expected.
Cone	Circular, with heavy concentration on outside. Small droplets.	40-60	Complete coverage of foliage. Insecticide, fungicide, and growth regulator applications, and Basagran rigs. Use where slight drifting is not hazardous.
Whirl Chamber (Raindrop™)	Hollow cone pattern.	5-20	Used on incorporation equipment.
Rotary Atomizers	Flat plane similar to hollow cone. More nearly uniform droplet size.	Device dependent	Low-volume application of herbicides and insecticides.
Boomless Nozzle Cluster	Wide swath (up to 60 feet). Pattern easily distorted by wind. High spray trajectory.	20-40	Pastures and broadcast spraying where obstructions to booms exist. High drift potential. Not suitable for orchard spraying. Reasonably uniform deposits are not expected.

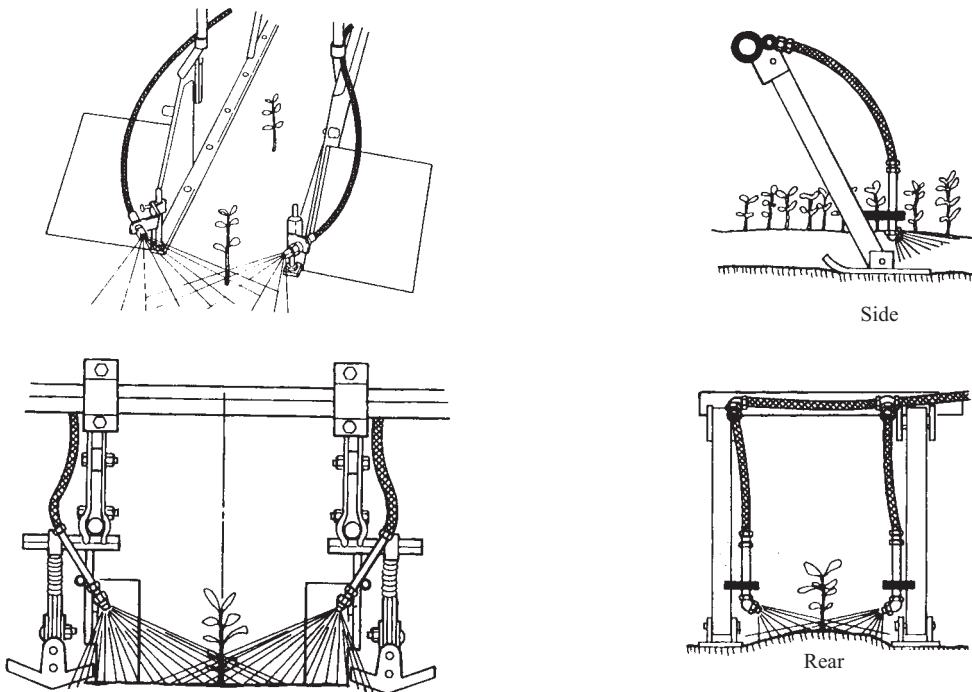
¹Suggested uses are a composite of recommendations from the manufacturer, research, and Extension. Always follow equipment and chemical label.

Nozzle Patterns



Typical Nozzle Settings

Typical nozzle arrangements for weed control applications are shown in Figures 1-5.



Figures 1 and 2. Flat-fan nozzles for post-direct spraying. Mount nozzle on row shield and direct spray down and back to provide desired overlap and band width.

Figure 3. Off-center nozzle for post-direct spraying. Nozzle can be positioned further from the crop than regular flat-fan nozzle.

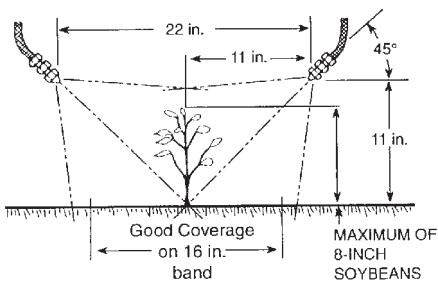


Figure 4. Two-nozzle arrangement for over-the-top applications.

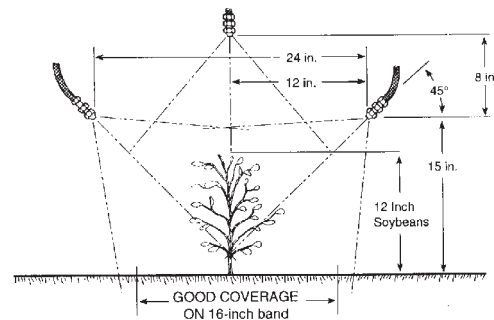


Figure 5. Three-nozzle arrangement for over-the-top applications.

Shielded Sprayers

Shielded sprayers offer a potential to apply herbicides for preplant burn down and in crop post direct with reduced drift and little or no injury to surrounding crops. However, use precautions to prevent drift and resulting crop injury. The shield alone is not enough to permit safe herbicide application when weather conditions are unfavorable. Abide by the normal recommendations for applying herbicides in a manner to reduce drift. Select a nozzle that will produce as large a drop as practical for coverage, spray volume, and control. Lower pressure or extended range nozzles (15 to 20 psi) should be given preference over more conventional nozzles (40 psi) since fine droplet production will be reduced. Set the hood and the nozzles for the lowest position to give adequate coverage of the weeds to be controlled. Angling the nozzles to the rear will usually give better coverage at a lower height as in any post-direct spraying. Never allow a nozzle to spray against the shield or curtain and accumulate to run-off.



Figure 6. Broadcast shielded sprayer operating in "burn-down"



Figure 7. Shielded sprayer in soybeans

Hooded and Shielded Sprayers

Hooded and shielded sprayers offer a potential to apply herbicides for preplant burn down (figure 6 above) and in crop post direct with little or no injury to surrounding crops. A sprayer hood with multiple nozzle configurations is shown in Figure 8. Use precautions to prevent drift and injury to nontarget crops. Do not use when weather conditions are unfavorable for a safe application. During each application, exercise the following precautions:

Set hood and nozzles for the lowest position to give adequate coverage of weeds to be controlled.

Never allow a nozzle to spray against the shield or curtain and accumulate to run-off.

The hood should be operated in contact with the ground and not bounce when using nonselective herbicide in susceptible crops.

Make sure flaps or curtains extend into the furrow for maximum protection when spraying crops in raised beds.

Avoid operating a hooded sprayer on sloping ground.

Maximum operating speed of the tractor and hoods should not be greater than 5 mph with slower speeds preferred for rough or uneven surfaces.

Leave a minimum of an 8-inch band centered over the drill row untreated when using nonselective herbicides.

Avoid spraying weeds that are in direct contact with the crop.

Select low drift, flat fan type nozzles with a 95-degree included spray fan angle that produce medium to large drops suitable for the desired coverage, application, volume, and control.

Always read and follow herbicide label directions.

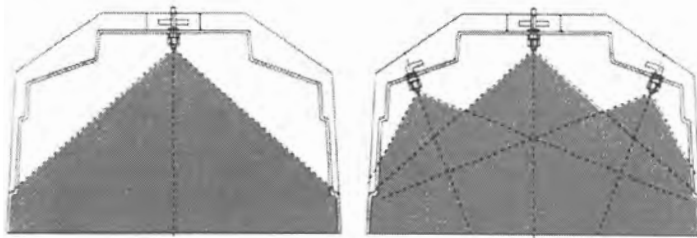


Figure 8. Sprayer hoods with one and three nozzles

Converting Liquid Formulations

$$\text{Volumetric Application Rate (pt/A)} = \frac{8 \text{ pt}}{\text{gal}} \times \frac{\text{Rate (lb ai/A)}}{\text{Concentration (lb ai/gal)}}$$

Example: To apply 1 lb/A active rate of a 4 lb/gal material

$$\frac{8 \text{ pt}}{\text{gal}} \times \frac{1 \text{ lb ai/A}}{4 \text{ lb ai/gal}} = 2 \text{ pt/A}$$

Similar conversion to liquid ounces/acre (oz/A) may be accomplished by:

$$\frac{\text{oz}}{\text{A}} = \frac{128 \text{ oz}}{\text{gal}} \times \frac{\text{Rate (lb ai/A)}}{\text{Concentration (lb ai/gal)}}$$

Converting Dry Material Formulation

$$\text{Amount of product (lb/A)} = \frac{\text{Technical material rate (lb ai/A)}}{\text{Percent active ingredient (\% ai)}}$$

$$\text{Volumetric Application Rate (oz/A)} = \frac{\text{lb ai/A}}{\% \text{ Active}} \times \frac{16 \text{ oz}}{\text{lb}}$$

Factors to Convert Broadcast Rate/Acre Banding Applications

$$\% \text{ area treated with band} = \frac{\text{Total band width sprayed per pass of implement}}{\text{Total row width covered per pass of implement}} \times 100\%$$

This allows computations for skip-row patterns:

Example: A field planted to 8-40-inch row pattern is 50% treated when a 20-inch band is applied to each row:

$$\frac{8 \times 20}{8 \times 40} \times 100\% = 50\%$$

Conversion Factors

Area Measure

1 square mile (mi ²)	= 640 acres
1/4 mi x 1/4 mi	= 40 acres
1,320 ft x 1,320 ft	= 40 acres
1 acre	= 43,560 ft ²
1 acre	= 208.7 ft x 208.7 ft
1 acre	= 13,068 ft of 40-in. rows
	13,756 ft of 38-in. rows
	14,520 ft of 36-in. rows
	16,335 ft of 32-in. rows
	17,424 ft of 30-in. rows
1 acre	= 0.405 hectare
1 hectare	= 2.47 acres
1 hectare	= 10,000 m ²
1 yd ²	= 9 ft ² = 0.836 m ²
1 ft ²	= 144 in ² = 0.09 m ²
1 cm ²	= 0.155 in ²

Linear Measure

1 in	= 2.54 cm
1 ft	= 12 in = 30.48 cm
1 yd	= 3 ft = 36 in = 91.44 cm
1 rod	= 16.5 ft
1 mi	= 5,280 ft = 1.6093 km

Conversion Factors (continued)

Volume and Liquid Measure

1 yd³ = 27 ft³ = 0.76 m³
1 ft³ = 1,728 in³ = 0.028 m³ = 7.48 gal
1 bu = 1.25 ft³
1 gal = 231 in³ = 4 qt = 8 pt = 16 cups
1 gal = 128 fl oz = 3.785 L = 3,785 ml = 3,785 cm³
1 qt = 2 pt = 4 cups = 32 oz = 0.946 L = 946 ml
1 pt = 2 cups = 16 oz = 0.473 L = 473 ml
1 cup = 8 oz = 0.24 L = 240 ml
1 fl oz = 2 tbsp = 6 tsp = 1.8 in³ = 0.02957 L = 29.57 ml
1 tbsp = 3 tsp = 0.5 oz = 14.78 ml
1 tsp = 0.166 oz = 4.92 ml
1 ml = 0.0338 fl oz

Mass (Weights)

1 U.S. ton = 2,000 lb = 0.907 metric ton
1 metric ton = 2,205 lb (avoir)
1 lb = 16 oz = 453.6 g = 0.4536 kg
1 oz = 28.35 g

Velocity Measure

1 mph = 5,280 ft/hr = 88 ft/min = 1.467 ft/sec
1 m/sec = 196.85 ft/min = 2.24 mph
1 m/sec = 1.942 knots

Pressure Measure

1 atm = 14.7 psi = 406.8 inches H₂O @ 40 °F
1 atm = 29.92 inches Hg @ 40 °F = 760 mm Hg @ 4 °C
1 atm = 1.01325 bar
1 psi = 27.68 inches H₂O @ 40 °F = 144 lb/ft² = 703.06 kg/m² @ 4 °C
1 psi = 6.8948 x 10³ pascals = 6.895 Kpa = 2.036 inches Hg
1 psi = 70.3 g per cm²
1 pascal = 10 dynes/cm² = 1.45 x 10⁻⁴ psi

Temperature

°C = 5/9 (°F - 32)
°F = (9/5 °C) + 32
°K = °C + 273.16
°R = °F + 459.69

* For additional conversions see <http://www.abe.msstate.edu/tools.htm>

Abbreviations

A = acres	in = inches	pt = pints
ai = active ingredient	in ² = square inches	qt = quarts
atm = atmospheres	in ³ = cubic inches	tbsp = tablespoons
bu = bushels	kg = kilograms	tsp = teaspoons
cm = centimeters	km = kilometers	yd = yards
cm ² = square centimeters	L = liters	°C = Degrees Celsius
fl oz = fluid ounces	mi = miles	°F = Degrees Fahrenheit
ft = feet	ml = milliliters	°R = Degrees Rankin
ft ² = square feet	m = meters	°K = Degrees Kelvin
ft ³ = cubic feet	m ² = square meters	
g = grams	mm = millimeters	
gal = gallons	mph = miles per hour	
H ₂ O = water	oz = ounces	
Hg = mercury	psi = pounds per square inch	