

Aerial Application of Fungicide for the Suppression of Fusarium Head Blight in Small Grains



Vern Hofman

Retired Extension Agricultural Engineer,
North Dakota State University, Fargo

Scott Halley

Crop Protection Scientist,
North Dakota State University,
Langdon Research Extension Center,
Langdon, N.D.

Gary Van Ee

Agricultural Engineer, Biosystems and
Agricultural Engineering, Michigan
State University, East Lansing

Charla Hollingsworth

Extension Plant Pathologist,
University of Minnesota,
Northwest Research and Outreach
Center, Crookston and
Department of Plant Pathology

Marcia McMullen

Extension Plant Pathologist,
North Dakota State University, Fargo

Brad Ruden

Plant Science Department,
South Dakota State University,
Brookings

NDSU
Extension Service

North Dakota State University
Fargo, North Dakota 58105

MAY 2007

Introduction

Fusarium head blight (FHB) has caused considerable damage to small grains during the past 14 years. Crop losses to growers in North Dakota, Minnesota and South Dakota have been significant. Serious yield and quality losses from FHB occur whenever wet weather coincides with the heading and flowering growth stages of the crop. Inoculum of the *Fusarium* disease organism is in nearly every wheat production field in the northern Plains or comes from a nearby source, so potential risk nearly always is present.

One of the management strategies to control FHB is to use fungicides. A traditional method of aerial fungicide application for leaf disease control often has provided less than adequate control of FHB. The flowering grain head (wheat) or fully emerged grain head (barley) is the most important site of infection of the *Fusarium* fungus and economically the most important growth stage to implement control strategies. If fungicides are applied with very fine spray drops, much of the fungicide is deposited on the leaves or awns and does not deposit on the spikelets of the grain head. Fungicides used for FHB control will move only upward and outward within plant tissues from the point at which they are applied, so crops need thorough coverage for adequate fungicide performance.

The most effective FHB control occurs when fungicide is applied to the spikelets on all sides of the grain head. A certain amount of fungicide may move into unsprayed spikelets (locally systemic) if the fungicide reaches the inner portions of the wheat head (rachis) and is allowed to move upward through the wheat head. Full coverage to all spikelets is very difficult to do, so the challenge is to find the most effective and efficient aerial technique to achieve maximum fungicide deposition.

Fungicide application for best control of FHB should be done at the proper stage of growth, typically during a four- to five-day period. Aerial application offers three distinct advantages over ground application: Aerial applicators can apply fungicide when fields are very wet, they can spray large acreages in a short period of time and they eliminate the wheel tracks in a field.

Aerial Studies

Aerial studies have been completed during the past five years on both wheat and barley. The research trials included measuring disease incidence and severity, grain yield, applied spray drop size, the quantity of tracer dye deposited on the grain head and the percent of the head that is covered with spray.

The spray trials included various spray application methods: varying water volumes from 3 to 10 gallons per acre and varying drop size with a volume median diameter (VMD) drop size ranging from 200 to more than 400 microns. Volume median diameter characterizes the drop size where one-half of the spray volume is in drops smaller than this value and one-half of the spray volume is in drops larger than this value.

A typical fungicide application method has been to apply fungicide with fine drops (200 microns). To apply the finest drops with an aircraft, the orifice or nozzle deflector must be set to disperse the spray vertically or at a 90-degree angle downward to the flying direction. This produces the maximum wind shear across the nozzle, which will produce the smallest spray drops. Changing the orifice spray angle so it is parallel to air flow will increase drop size. Adjusting the orifice angle between vertical and horizontal will provide gradual changes in drop size. The drop size also can be modified by changing flying speed and operating pressure.

Increasing flying speed produces finer drop sizes

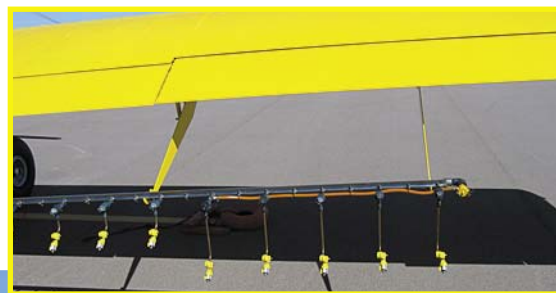
and increasing operating pressure will increase drop size until the spray pattern is directed down about 60 degrees to the flying direction.

The lowest operating pressure for an agricultural spray plane should not be less than 30 pounds per square inch (psi). Operating at this pressure or higher will help assure that all nozzles will discharge an equal amount of spray. Lower pressures may reduce flow to the end of the boom and produce a poor spray pattern.

Aerial applications should produce a spray pattern that is as uniform as possible over about 75 percent of the swath width and then taper off on both edges (shaped like a trapezoid). This allows the next spray swath to add to the sloping edges of the adjacent swath and produce a uniform spray pattern with multiple passes across the field. Use a pattern test to determine whether you have a uniform spray pattern.

All spray applications by aircraft should be completed at a boom height of 8 to 10 feet above the sprayed surface for slower/smaller aircraft and 10 to 12 feet for faster/larger planes (due to heavier wing loading). Lower heights are not recommended as the spray pattern may not develop properly. As a result, an uneven spray pattern will occur plus produce a narrow spray swath. Spray heights above 12 feet are not recommended as spray potentially can drift and any wind may distort the spray pattern.

Agricultural spray planes should have the nozzles mounted as far as possible below the wing (12 inches or more). This helps disperse the spray into air that has the least amount of turbulence. Turbulence causes



Spray nozzles must be mounted as low as possible below the wing to produce a 300- to 350-micron drop size while applying 5 gallons/acre.

Inset photo shows a closeup of drop nozzles mounted at the end of a spray boom. This helps reduce fine drops in the vortex.





Aerial application is an effective method to apply FHB suppression fungicide to large acreages of small grains in a timely manner.

spray drops to shatter, which produces fine drops that potentially can drift off target.

Spray nozzles on booms should not extend over more than 70 percent of the wing span. Nozzle distribution of 65 percent or less of the wing span is preferred. If the end nozzles are beyond these limits, spray drops may be caught in the wing tip vortex and be carried away as spray drift. Proper boom length, nozzle placement, operating pressure, flying height and speed will help manage these issues. Nozzles mounted over 65 percent or less of the wing span may reduce the swath width.

Most spray planes usually have a uniform spacing between nozzles except for the center of the aircraft. Nozzles placed in the center of the aircraft should be spaced at least two times as far apart as those mounted on the wings because of the high airflow from the propeller and fuselage. Many spray planes will be completely void of nozzles in the center of the aircraft or have a maximum of only one or two nozzles. A pattern test is the best way to determine nozzle spacing and placement on an aircraft.

Spray Drop Size

The American Society of Agricultural and Biological Engineers (ASABE) developed a drop size classification system (ASABE standard S-572). It contains six categories that range from very fine to extremely coarse-sized drops. A fine spray drop is about 150 to 300 microns in size and a medium drop is about 300 to 430 microns.

Spray application studies show the best FHB control is achieved when drop size VMDs are between 300 and 350 microns, a size considered to be a large fine to a small medium-sized drop. This drop size range has been found to maximize the spray deposition on the grain

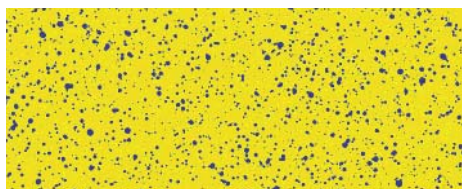
head and to be the best for getting the fungicide to penetrate beyond small-grain awns and depositing it on the spikelets. The fungicides used to control FHB have a localized systemic-type activity as it is transferred up and away from the point of deposition. Smaller drops (200 microns) deposit on the awns extremely well but fungicide on awns does little to control FHB. Larger drops, 400 microns or larger, produce poor control of FHB as they provide poor head coverage.

Low wind velocities (3 to 10 mph) while spraying have shown to produce increased fungicide coverage on the upwind side of the head. At the same time, the downwind side of the head receives much less spray. Spraying one side of the head well has been found to produce good control of FHB.

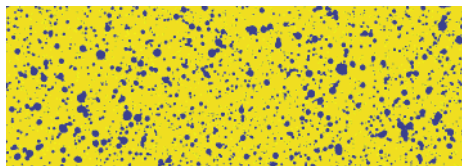
Determining Drop Size

A laser droplet analyzer is the best way to determine drop sizes from aircraft. These units are very expensive and few are available. The drop size of several nozzles with individual aircraft spray parameters can be determined from the Web site at the U.S. Department of Agriculture-Agricultural Research Service (USDA-ARS) station at College Station, Texas. It can be found at www.ars.usda.gov/Main/site_main.htm?modecode=62-02-40-05

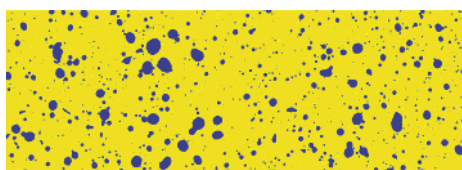
Click on “downloads” on the left side of the page. A screen (spreadsheets or nozzle tables) will provide the opportunity to select the nozzle type, a range of airspeeds, operating pressures and the nozzle deflector angle to use to obtain the desired drop size. The drop size to select should be between 300 and 350 microns. The spreadsheets provide information on the ASABE drop size classification system and should be in the large fine to small medium category. This is indicated in the tables.



**235
microns**



**340
microns**



**410
microns**

These are examples of spot cards measured by WRK Droplet Scan. The application rate was 5 gallons/acre.

Drop size can be estimated with water-sensitive cards available from spray equipment suppliers. They are 1 inch by 3 inches and come in packs of 50 cards. Spread several cards across your spray swath and label the location. Be sure to fasten them so they don't blow away. Calibrate your aircraft and make one pass with water across the cards at your normal flying height, speed, operating pressure and nozzle orientation and then compare the exposed papers to the example spot cards in this publication. Then make adjustments to the nozzle or deflector to orient the spray angle to produce a 300- to 350-micron drop. The example cards were measured with the WRK Droplet Scan measuring system. Let the cards dry for a few minutes and be sure to handle the cards by the edges because the moisture on your fingers will contaminate the cards (they'll turn blue like the spray drops on the cards). They are extremely sensitive to moisture.

For more information on this and other topics, see: www.ag.ndsu.edu

County commissions, North Dakota State University and U.S. Department of Agriculture cooperating. Duane Hauck, director, Fargo, N.D. Distributed in furtherance of the acts of Congress of May 8 and June 30, 1914. We offer our programs and facilities to all people regardless of race, color, national origin, religion, gender, disability, age, veteran's status or sexual orientation; and are an equal opportunity institution. This publication will be made available in alternative formats for people with disabilities upon request, (701) 231-7881. 2M-5-07

Acknowledgement

This information is based upon work supported by the U.S. Department of Agriculture under agreement No. 59-0790-3-079. This is a cooperative project with the U.S. Wheat and Barley Scab Initiative.

Recommended Fungicide Application Techniques for FHB Suppression in Small Grains with Aerial Application

- Produce a "large fine" to "small medium" sized spray drop (300 to 350 microns). Use the USDA-ARS Web site as a starting point and water-sensitive paper to determine drop size.
- Minimum spray operating pressure should be 30 psi.
- Operate smaller and slower aircraft at a height of 8 to 10 feet above the sprayed surface and heavier aircraft at 10 to 12 feet.
- Apply the fungicide at 5 gallons per acre.
- Mount spray nozzles so they do not exceed more than 70 percent of the wing span. Nozzles mounted over 65 percent of the wing span are preferred. This will reduce the quantity of fines at the wing tip vortices and reduce drift.
- Produce a uniform spray pattern with tapered edges. A pattern test will show abnormal variations in your spray pattern.
- Most aircraft use a uniform nozzle spacing except in the center. Nozzles in the center of the aircraft should have a spacing at least double to those mounted on the wings. A pattern test is the best way to determine the exact nozzle spacing and placement.
- Mount the spray nozzles as low as possible below the wing. This helps discharge spray into air with the least amount of turbulence. Turbulence causes spray drop breakup and spray drift.