NEBRASKA TECHNICAL NOTE

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

June 1986

AGRONOMY TECHNICAL NOTE NO. 101
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APPLYING PESTICIDES ACCURATELY

The enclosed information is an excellent reference for your use in working with cooperators in applying pesticides accurately.

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HOW TO APPLY PESTICIDES ACCURATELY

By W.F. Millier

Accurate application of pesticides with a constant pressure system is not difficult to accomplish. Basically it is done by knowing and controlling the factors that affect the application rate. They are:

1. Nozzle condition and output.
2. Sprayer travel speed.
3. Mixing the chemical in the sprayer tank.
4. Operating pressure
5. Maintaining a uniform mixture during application.
6. Providing proper delivery of the chemical to the target.

Application rate (gallons per acre-GPA) is dependant on the sprayer output (gallons per minute-GPM), sprayer travel speed (miles per hour-MPH) and the width of the field covered by a nozzle or the spray boom. The following formulas combine these factors:

$$GPA = \frac{GPM \times 495}{MPH \times FT \text{ (width)}} \quad \text{or} \quad \frac{GPM \times 5940}{MPH \times IN \text{ (width)}}$$

The gallons per minute in each of the equations must correspond to width covered. If the width is the boom, then use the GPM for the boom and the boom coverage, FT, in the first equation. If the width is one nozzle, then use the average GPM for the nozzles and the nozzle coverage, IN, in the second equation. The numbers 495 and 5940 account for the width factors of FT and IN.

NOZZLE CONDITION AND OUTPUT

The capacity and the delivery characteristics of a spray nozzle are affected by the amount of wear that has occured. The capacity increases as the nozzle is used. The amount of wear, indicated by an increase in capacity, depends on the nozzle material, the abrasiveness of the spray mixture, the number of hours of use and the operating pressure. As the nozzle wears, the delivery characteristics deteriorate resulting in poor delivery of the pesticide to the target. In general it is advisable to equip the sprayer with nozzles that are resistant to wear. This reduces the frequency of checking nozzle capacity and the adjustments to maintain correct application. The additional initial cost will be a savings in the long run. It is recommended that nozzles, worn to cause an increase of 10% in capacity, be replaced.

Nozzle capacity, GPM, must be accurately determined to calculate the application rate. One needs a stop watch, a collection container that will hold at least one liter, a one liter graduated cylinder, a level surface to set the graduated cylinder on when making measurements and a calculator for solving the simple equations. A short piece of hose slipped over the nozzle eliminates the foaming and splashing during collection of water from the nozzle.

Do it this way:

1. Clean all strainers and nozzles on the sprayer. A tooth brush is a good tool for cleaning nozzles. Never use anything harder than a wooden tooth pick to clean nozzle tips.

2. Put clean water in the sprayer tank.

3. Operate the sprayer and adjust the pressure control device to the operating pressure.You will need a dampened accurate pressure gauge on the sprayer at all times to be able to adjust to the desired operating pressure.

4. Time the collection of approximately a liter of water from each nozzle on the boom. Carefully measure the amount collected with the graduated cylinder. Read the amount to the nearest 5 ml. For example, if the level of water in the cylinder is about halfway between 840 and 850 ml. list the amount for that nozzle as 845 ml. If the level is closer to the 840 mark than halfway between, list the amount as 840 ml. Record the time (SEC) and the amount (ML) below. Calculate the capacity (GPM) and record below.

GPM = MLS X 0.01585 / SEC

Ex. GPM = 845 ML X 0.01585 / 57.25 SEC = 0.273 GPM

NOZ #	TIME SEC	AMT ML	CAP GPM
1			
2			
3			
4			
5			
6			
7			
8			

NOZ #	TIME SEC	AMT ML	CAP GPM
9			
10			
11			
12			
13			
14			
15			
16			

TOTAL GPM _____ / NO. OF NOZZLES_____ = AVE GPM _____

Small errors in nozzle capacity are costly. In this case, if chemical cost is $25 per acre, a 0.004 gpm increase,0.277 gpm, will cost $5.00 per hour for a sprayer with a 25 foot boom traveling 4.5 mph.

SPRAYER TRAVEL SPEED

Sprayer travel speed is another factor that must be known and controlled to obtain an accurate application rate. The tractor tachometer doesnot indicate true travel speed because wheel slippage will vary with ground contitions, slope and load. A speed indicator, separate from the tractor drive wheels, capable of indicating speeds of 0.1 miles per hour and calibrated for the particular field conditions, is essential to maintain correct spraying speed. Sprayers with PTO driven pumps must be operated at a PTO speed that will provide the pump capacity to supply the boom, the agitation system and enough reserve to control pressure.Travel speed will be dependent on gear selected and this PTO speed. The following procedure can be used to determine the speed of the sprayer.

1. Half fill the sprayer tank. This will be the average load for the tractor while spraying.

2. Carefully measure and mark the ends of a 300 ft. speed test course where ground conditions and terrain are the same as where the sprayer will be operate.

3. Select the tractor gear and adjust throttle to obtain the desired PTO speed.

4. With the tractor operating as adjusted above before the start mark of the test course, measure the time required to traverse the course. Record the time. Repeat the timing over the test course in the opposite direction. Record and add this to the previous time.

TOTAL FEET _____ , TIME 1ST TRIP_____SEC., RETURN_____SEC

MPH = TOTAL DIST TRAVELED (FT) X 0.682 / TOTAL TIME (SECS)

Ex. MPH = 600 FT X 0.682 /90.76 SEC = 4.509 or 4.5 MPH

Small errors in travel speed are costly. If chemical cost is $25 per acre, a 0.1mph reduction in speed, 4.4 mph, will cost $7.58 per hour for a sprayer with a 25 ft. boom.

APPLICATION RATE

Once the nozzle capacities and travel speed have been determined, it is a simple calculation to determine the application rate. The formulas for calculating gallons per acre (GPA) are on the first page. Assume you have determined the average nozzle capacity to be 0.273 GPM, the travel speed to be 4.5 MPH and the nozzles are spaced 20 inches apart on the boom.

The application rate will be:

$$\text{GPA} = \frac{\text{GPM X 5940}}{\text{MPH X IN}} = \frac{0.273 \text{ X } 5940}{4.5 \text{ X } 20} = 18.02 \text{ GPA}$$

If the total boom capacity, consisting of 15 nozzles to make a 25 ft. boom length, is 4.10 GPM at a travel speed of 4.5 MPH the application rate will be:

$$\text{GPA} = \frac{\text{GPM X 495}}{\text{MPH X FT}} = \frac{4.10 \text{ X } 495}{4.5 \text{ X } 25} = 18.02 \text{ GPA}$$

This is the rate of application of water. The application of the pesticide per acre will depend on the mixing of the pesticide with the water.

MIXING THE PESTICIDE

The final step in obtaining an accurate application of the pesticide is the measurement and mixing of the chemical in the sprayer tank. The procedure to this point has established the amount of water applied per acre by the sprayer. If the recommended amount of pesticide per acre is added to this amount of water the correct application will be obtained.

It is mistakenly assumed that a tank holds exactly the advertised number of gallons. Such a tank could vary considerably from this nominal capacity. Tank capacity must be known to mix the chemical correctly. A hose end meter measures the flow from a hose into a tank. It is an excellent type of meter for measuring the capacity of sprayer tanks. Other methods tend to give erroneous result even when carefully done.

The amount of pesticide per tank filling is calculated as follows:

$$\text{PESTICIDE PER TANK} = \frac{\text{PESTICIDE PER ACRE X TANK CAPACITY (GALLONS)}}{\text{APPLICATION RATE (GPA)}}$$

If tank capacity is 285 gallons(a nominal 300 gallon tank) and the recommended pesticide per acre is one quart, the amount per tank fill is:

$$\text{PESTICIDE PER TANK} = \frac{1 \text{ qt. X } 285}{18.02} = 15.82 \text{ qts.}$$

Since it might be difficult to measure 0.82 qts. Convert it to ozs. by multiplying by 32 oz. per qt. The amount per tank then becomes 15 qts.- 26 oz. **Always measure the chemicals very carefully.** Small mixing errors can be costly. If chemical costs are $25 per acre, 1 cup or 8 oz. too much chemical in this tank will increase costs $5.39 per hour for a sprayer with a 25 ft. boom traveling at 4.5 miles per hour.

OPERATING PRESSURE

The capacity of the nozzle varies with the pressure. The gauge tells the operator the pressure in the system. Most sprayers have the gauge located at the regulator to be used in adjusting the pressure.

Since there will always be some pressure loss in the system the gauge at the pressure regulator doesn't indicate the pressure at the nozzle. A gauge, tapped into the center of one of the boom sections, would more accurately show pressure at the nozzles. A gauge, dampened by a liquid filling or a restrictor is necessary to accurately adjust the operating pressure. **The extra cost of a reliable gauge will be saved many times during a season's use.**

The pressure must always be adjusted to the value used when nozzle capacities were measured. It is advisable to select a pressure that is right on a mark on the gauge dial so it can easily be reset. If chemical costs are $25 per acre, a 1psi increase over 30 psi will cost $5.63 per hour for a sprayer with a 25 ft. boom traveling at 4.5 miles per hour.

AGITATION

Adding the correct amount of the pesticide to the spray tank, setting the correct pressure and driving at the correct speed does not provide a correct uniform application if the chemical is not thoroughly mixed with the water in the tank. Both wettable powders and oil emulsions require continuous agitation after initial mixing to maintain the uniform mixture. Mechanical or hydraulic agitation systems are used for this purpose. The hydraulic agitation system capacity for initial mixing is dependent on: 1) the concentration of wettable powder or emulsion, 2) the time available for mixing, 3) the size of the sprayer tank and 4) the pressure at the agitation system nozzles.To mix a 300 gallon tank containing 1 pound of wettable powder per each 10 gallons of water, in 5 minutes, would require 13 gallons per minute at 40 psi. The system capacity to maintain the mix after initial mixing is often more critical because the proportion of pump capacity available for agitation is reduced by the boom requirement and pressure might be lower. Maintenance capacity is dependent on many of the same factors as for initial mixing. In the case above, it would require 6.9 gallons per minute at an operating pressure of 30 psi to maintain a uniform mixture during application. Bypass flow from the pressure regulator returns to the tank at low pressure and contributes very little to the mixing action. The agitation system must be separate from the pressure control circuit and should include a valve to adjust agitation flow where foaming is a problem.

DELIVERY TO THE TARGET

The final step in applying pesticides is delivering the uniform mixture to the target. Nozzle selection, operating pressure and nozzle position are the factors controlling the delivery of the pesticide to the target. Carefully follow the recommendations from the nozzle manufacturers, the pesticide suppliers and the cooperative extension service.

If pesticide drift is a problem do not spray when windy, maintain recommended operating pressure and boom height and select nozzles that produce a minimum of drift sensitive droplets. If pressure reduction is used to reduce drift be sure to recheck nozzle capacity at the reduced pressure and adjust the tank mixing to compensate for the reduced application rate.

EFFICIENT PEST CONTROL IS YOURS ONLY WHEN YOU KNOW WHAT THE SPRAYER IS DOING

Small errors in nozzle capacity, travel speed, operating pressure and measuring the pesticide added to the sprayer tank can significantly increase operating costs. If all the errors used as examples in these instructions all occurred at the same time, the excess chemical cost would be $23.60 each hour the sprayer is operated. It is well worth the time it takes to to determine what the sprayer is doing and to make the adjustments necessary for accurate application.

SPRAYER FORMULAS

$$GPA = \frac{GPM \times 495}{MPH \times FT} \quad (1)$$

$$GPM = \frac{GPA \times MPH \times FT}{495} \quad (2)$$

$$MPH = \frac{GPM \times 495}{GPA \times FT} \quad (3)$$

$$GPM = \frac{OZ}{SEC} \times 0.469 \quad (4)$$

$$= \frac{LBS}{SEC} \times 7.194 \quad (5)$$

$$= \frac{LITERS}{SEC} \times 15.85 \quad (6)$$

$$MPH = \frac{FT}{SEC} \times 0.682 \quad (7)$$

over

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over

Formulas 1, 2 & 3 find GPA or GPM or MPH when the other two variables are known. FT in the formulas is the width sprayed. If sprayed width is in inches, change 495 to 5940. **Formulas 4, 5 & 6** are used to determine nozzle flow rates by timing the collection of liquid. Use the formula that corresponds to units collected. **Formula 7** is used to determine sprayer travel speed by timing travel over a measured course.

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