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How pressure and travel speed affect sprayer application rate

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The rate of application, gallons per acre (GPA) obtained with either a boom or air blast hydraulic sprayer, is dependent on the following factors.

1. The effective sprayed width, measured in feet or inches (FT or IN)
2. The flow rate from the nozzles, measured in gallons per minute (GPM)
3. The travel speed, measured in miles per hour (MPH)

The following formulas show how these factors are combined to find GPA, GPM or MPH when the other factors are known.

	If sprayed width is in feet:		If sprayed width is in inches:
$GPA = \frac{GPM \times 495}{MPH \times FT}$		or	$\frac{GPM \times 5940}{MPH \times IN}$
$GPM = \frac{GPA \times MPH \times FT}{495}$		or	$\frac{GPA \times MPH \times IN}{5940}$
$MPH = \frac{GPM \times 495}{GPA \times FT}$		or	$\frac{GPM \times 5940}{GPA \times IN}$

Once the flow rate at the specified nozzle pressure has been determined for a particular travel speed and application rate, the application rate will be correct only if the specified nozzle pressure and sprayer travel speed are accurately maintained.

Pressure

The application rate is directly proportional to the flow rate of the nozzle. If the flow rate increases 10% then the application rate increases 10%. Changes in operating pressure will change nozzle flow rate. This change is expressed by the following relationship.

$$\text{NEW GPM} = \sqrt{\frac{NEW - PRESS}{ORIG - PRESS}}\ .$$

The new flow rate, caused by the change to a new pressure, is equal to the original flow rate times the square root of the ratio of the new pressure to the original pressure. For example if the flow rate from a sprayer is 20 GPM at 40 PSI a decrease in pressure to 30 PSI will produce a new GPM of 17.32 GPM.

$$\text{NEW GPM} = 20\ \text{GPM}\ \sqrt{\frac{30}{40}} = 17.32\ \text{GPM}.$$

Table 1 shows the percent increase or decrease in nozzle flow rate or application rate with various percent changes in nozzle operating pressure.

Pressure should always be measured at the spray nozzles with an accurate pressure-measuring unit. Pressure at the nozzles will usually be lower than the pressure at the pump or pressure regulator.

% Increase in Noz. PSI		% Increase in GPM or GPA	% Decrease in Noz. PSI		% Decrease in GPM or GPA
10	-	4.9	10	-	5.1
20	-	9.5	20	-	10.6
30	-	14.0	30	-	16.3
40	-	18.3	40	-	22.5
50	-	22.5	50	-	29.3
60	-	26.5	60	-	36.8
70	-	30.4	70	-	45.2
80	-	34.2	80	-	55.3
90	-	37.8	90	-	68.4
100	-	41.4			

Travel Speed

The application rate is indirectly proportional to the travel speed. As travel speed increases the rate of application decreases and vice versa. How much the application rate changes with changes in travel speed depends on the travel speed. The graphs below show the changes in application rate at changes in travel speed from 0 to 0.5 MPH. Each line on the graphs represents a travel speed for a correct application rate. One graph shows the percent decrease in GPA as travel speed increases from the correct value. The other graph shows the increase in GPA as travel speed decreases from the correct value. The change in application rate can be determined from the graphs by selecting the change in speed on the horizontal axis and proceeding vertically to the correct travel speed line. Then, from that point, proceed horizontally to the vertical axis for the percent change in application rate. The dashed lines show how this is done.

Note that changes in travel speed of plus or minus one-half MPH from a correct speed of 3 MPH will cause application rate to vary from -14.3% to +20%. Variations of one-half MPH from a correct speed of 8 MPH causes GPA to vary from -5.9% to +6.7%. If the application rate is to be correct, travel speed must be accurately controlled. A speed indicator that will show speed changes of 0.1 MPH or less is necessary to keep the error in application rate at a low level.