SPRAYER CALIBRATION

Calibration of your spraying equipment is very important. It should be done daily or whenever you change chemicals to insure application of the proper dosages. Applying incorrect amounts may do more damage than good.

Adjustable factors which determine calibration and affect application rate are: speed, pressure, and nozzle size and type, or a combination of the three. Speed is the easiest and most common adjustment.

THREE CALIBRATION METHODS

Method I:

A. Measure nozzle flow rate:

$$\text{gal/nozzle/min} = \frac{\text{Ounces collected for 1 min from 1 nozzle}}{128}$$

B. Calculate:

$$\text{gallons per acre} = \frac{\text{gal/nozzle/min} \times 12 \times 43{,}560}{\text{nozzle spacing} \times \text{speed}}$$

- Where nozzle spacing = inches between nozzles and speed = MPH x 88
- Test several nozzles to ensure uniformity and replace any that have > 10% variation from the average of all nozzles

Method II:

A. Spray 660 feet at the desired speed and pressure

B. Determine the amount of spray discharge (water) traveling this distance

C. Use this formula:

$$\text{gallons/acre} = \frac{\text{gallons used in 660 feet} \times 66}{\text{swath width in feet}}$$

Method III:

A. Fill spray tank and spray a specified number of feet.

B. After spraying refill tank measuring the quantity of material needed for refilling.

C. Use this formula:

$$\text{gallons/acre} = \frac{43{,}560 \times \text{gallons sprayed}}{\text{distance sprayed} \times \text{swath width (ft)}}$$

USEFUL FORMULAS

- To determine the **amount of active ingredient (ai)** needed:

$$\text{Gallons or pounds} = \frac{\text{Acres to spray x lb ai/A}}{\text{lb ai/gal or ai/lb}}$$

- To determine the **size of pump** needed to apply gallons/acre desired:

$$\text{Pump capacity} = \frac{\text{gal/A desired x boom width (ft) x MPH}}{495}$$

- To determine the **nozzle capacity** in gallons/minute at a given rate/acre and MPH:

$$\text{Nozzle Capacity} = \frac{\text{gal/A x nozzle spacing (in) x MPH}}{5940}$$

- To determine the **acres / hour** sprayed

$$\text{Acres/hour} = \frac{\text{swath width (in) x speed (MPH)}}{100}$$

- To determine the **amount of purchased material** to use:

$$\text{liquids (gallons product required/A)} = \frac{\text{lb ai/A}}{\text{lb ai/gal}}$$

$$\text{wettable powders (lb product required/A)} = \frac{\text{lb ai/A}}{\text{\% ai in formulation}}$$

- To determine the **rate of speed** in MPH:
  Measure the seconds it takes the tractor to go a distance of 300 to 500 feet

$$\text{MPH} = \frac{\text{distance traveled (ft)}}{1.47 \times \text{time (seconds)}}$$

- To determine the **nozzle flow rate**:
  Time the seconds necessary to fill a pint jar from a nozzle. Divide the number of seconds into 7.5

$$\text{gallons/minute/nozzle} = \frac{7.5}{\text{seconds}}$$

- To determine the **acreage sprayed per hour:**

$$\text{acres sprayed/hour} = \frac{\text{boom width (ft) x MPH}}{12}$$

- **Sprayer Tank Capacity**

1. Cylindrical Tanks:

   gallons = length x diameter^2 x 0.0034

2. Elliptical Tanks:

   gallons = length x short diameter x long diameter x 0.0034

3. Rectangular Tanks:

   gallons = length x width x depth x 0.004329

   *__Note__: all tank measurements in inches

PROPORTIONATE AMOUNTS OF DRY MATERIALS

Water	**Quantity of Material**				
100 gallons	1 lb	2 lb	3 lb	4 lb	5 lb
50 gallons	8 oz	1 lb	24 oz	2 lb	2.5 lb
5 gallons	4 oa.	1.5 oz	2.5 oz	3.2 oz	4 oz
1 gallon	0.16 oz	0.3 oz	0.5 oz	0.64 oz	0.80 oz

PROPORTIONATE AMOUNTS OF LIQUID MATERIALS

Water	**Quantity of Material**		
100 gallons	1 qt	1 pt	1 cup
50 gallons	1 pt	1 cup	0.5 cup
5 gallons	3 tbs	5 tsp	2.5 tsp
1 gallon	2 tsp	1 tsp	0.5 tsp

MILES PER HOUR (MPH) CONVERTED TO FEET PER MINUTE (FPM)

MPH	**FPM**
1	88
2	176
3	264
4	352

Use this table to calculate rows/acre from row length and spacing

Row Length	----------Row Spacing----------			
	12”	30”	36”	40”
	----------Rows/Acre----------			
5280	8	3	2.7	2.5
3960	11	4	4	3.3
2600	17	7	6	5
1300	33	13	11	10
600	73	29	24	22
300	145	58	48	44
100	436	174	145	131

- To find rows/acre with other spacings or lengths use this formula

$$\text{Rows/acre} = \frac{43{,}560}{\text{row spacing (ft) x row length (ft)}}$$

USEFUL CONVERSION FACTORS:

1 acre	=	43,560 ft^2
1 gallon	=	128 fluid ounces = 3785 ml
1 gallon	=	4 quarts = 8 pints
1 gallon	=	16 cups
1 gallon	=	8.35 pounds of water
1 quart	=	32 ounces = 946 ml
1 quart	=	= 2 pints
1 pint	=	16 fluid ounces
1 ounce	=	28.35 grams
1 ounce	=	29.57 ml
1 pound	=	16 fluid ounces of water
1 acre inch	=	27,154 gallons
1 cubic foot	=	7.48 gallons
1 cubic foot	=	6.24 pounds of water
1 cubic meter	=	1,000 liters
1 cubic meter	=	264.2 gallons

Use this table to calculate acreage from swath width and distance traveled

Distance Traveled (feet)	----------Swath Width (feet)----------					
	10	20	30	40	50	60
	----------Acres Covered----------					
100	0.02	0.05	0.07	0.09	0.12	0.14
150	0.03	0.07	0.10	0.14	0.17	0.21
200	0.05	0.09	0.14	0.18	0.23	0.28
250	0.06	0.12	0.17	0.23	0.29	0.35
300	0.07	0.14	0.21	0.28	0.35	0.41
350	0.08	0.16	0.24	0.32	0.40	0.48
400	0.09	0.18	0.28	0.37	0.46	0.55
450	0.10	0.21	0.31	0.41	0.52	0.62
500	0.12	0.23	0.35	0.46	0.58	0.69
600	0.14	0.28	0.41	0.55	0.69	0.83
700	0.16	0.32	0.48	0.64	0.81	0.97
800	0.18	0.37	0.55	0.74	0.92	1.10
900	0.21	0.41	0.62	0.83	1.04	1.24
1000	0.23	0.46	0.69	0.92	1.15	1.38
1200	0.28	0.55	0.83	1.10	1.38	1.66
1300	0.30	0.60	0.90	1.20	1.50	1.79
2600	0.60	1.20	1.79	2.39	2.99	3.59
3960	0.91	1.82	2.73	3.64	4.55	5.46
5280	1.21	2.43	3.64	4.86	6.07	7.29

- To determine the acres in a given area:

  Acres = distance traveled x swath width (feet) x 0.000023

USEFUL CONVERSIONS

U.S. TO METRIC

U.S. to	Metric	Multiply by
acre	hectare	0.4047
mile	km	1.609
yard	meter	0.9144
foot	meter	0.3048
inch	cm	2.54
mile2	km2	2.59
foot2	meter2	0.0929
foot3	meter3	0.0283
gallon	liter	3.785
quart	liter	0.9463
pint	liter	0.4732
oz (fl)	ml	29.57
ton	metric ton	0.9078
pound	kilogram	0.4536
pound	gram	454.5924
ounce	gram	28.3495
lb/A	kg/ha	1.1209
gal/A	L/ha	9.3538
oz(dry)/gal	g/L	7.4892
oz(dry)/A	g/ha	70.054
oz(fl)/gal	ml/L	7.8125
oz(fl)/A	ml/ha	73.079

METRIC TO U.S.

Metric to	U.S.	Multiply by
hectare	acre	2.471
km	mile	0.6214
meter	yard	1.094
meter	foot	3.281
cm	inch	0.3937
km2	mile2	0.3861
meter2	foot2	10.76
meter3	foot3	35.31
liter	gallon	0.2642
liter	quart	1.057
liter	pint	2.113
ml	oz (fl)	0.0338
metric ton	ton	2.205
kilogram	pound	2.205
gram	pound	0.0022
gram	ounce	0.0353
kg/ha	lb/A	0.2048
L/ha	gal/A	0.1069
g/L	oz(dry)/gal	0.1335
g/ha	oz(dry)/A	0.0143
ml/L	oz(fl)/gal	0.128
ml/ha	oz(fl)/A	0.0137

CALIBRATION FOR CENTER PIVOT CHEMIGATION

Only products that are **specifically labeled** for chemigation may be applied through center pivot irrigation systems. The label may also contain specific chemigation requirements that must be followed. The following calculations will help you determine the injection pump setting for the proper application rate.

a. **Acres to be treated**

$$\text{Acres} = \frac{(\pi R^2)}{43{,}560} \qquad (\pi = 3.1416)$$

R = System Length including the reach of the end gun

b. **Acres treated per hour or per minute**

$$\text{Acres/hour} = \frac{\text{acres to be treated}}{\text{revolution time (hr) @ desired inches of water}} \qquad \text{Acres/min} = \frac{\text{acres/hour}}{60}$$

c. **Pump setting**

Depending upon the manufacturer of your injection pump you will initially need to set the pump in either gallons per hour (gal/hr) or %. The following calculations will help you make the correct setting.

gal/hr = Acres treated per hour (from b.) x gallons per acre*

*Labeled rate of product to be applied

$$\text{\% Dial setting on pump} = \frac{\text{gallons per hour}}{\text{Max injection pump rating (GPH)}}$$

d. **Pump output**

After initially setting the pump, it is a good idea to fine-tune your pump output. Systems should have a calibration tube (graduated in ounces or milliliters) located in-line between the nurse tank and the pump. Adjust the pump while monitoring the site tube until the proper rate is achieved. The following conversions are included to allow you to convert gallons per hour to ounces or milliliters per minute.

Ounces (oz) per minute = (gallons per hour) x 2.13

Milliliters (ml) per minute = (gallons per hour) x 63.1

The **Colorado Chemigation Act** requires a chemigation permit and the appropriate anti-siphoning devices to be used when applying pesticides and fertilizers in closed irrigation systems. Contact the Colorado Department of Agriculture at (303) 239-4149 for updated information on these requirements.