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# EC70-166 A Hand Sprayer for Herbicides

C. Fenster

L. Robison

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# A HAND SPRAYER for Herbicides

EC 70-166

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# A Hand Sprayer for Herbicides

By C. R. Fenster and L. R. Robison

Extension Agronomists

A hand sprayer can be effective in controlling weeds. When weeds such as Canada thistle or bindweed are in small patches a few minutes with a good hand sprayer may prevent their spread.

Here's how to make and use a good sprayer for small areas around buildings, lawns or in hard-to-get-at places.

The sprayer must apply chemicals at a given rate uniformly over an area. It must be easy to operate, easy to clean, and safe to use. You can buy sprayer tanks with removable lids. Plastic liners in the tank aid in cleaning if you use the sprayer for several chemicals. They are particularly helpful if you use hormone type herbicides such as 2,4-D. Hand sprayer tanks vary in size, but two to four gallon tanks are popular.

Uniform application of a chemical requires constant pressure. Most hand sprayers do not have pressure gauges or a regulator. You can buy gauges at hardware stores and regulators at supply houses.

Hand sprayers frequently have a single nozzle. A multiple nozzle boom is needed to spray an area uniformly and to save time. Boom widths of 20 and 60 inches give effective spray widths of 40 and 80 inches respectively, with nozzles spaced 20 inches apart.

Most hand sprayers have no accurate control of tank pressure or herbicide delivery rate. Considering the many herbicides being used, their cost, and the various application rates recommended, a good sprayer with controls is a cheap investment in weed control. Use two pressure gauges, one on the tank for tank pressure and one in the delivery line above the boom for delivery pressure. A pressure regulator mounted on the tank in the delivery line allows you to control uniform pressure at the nozzles.

## Materials for a Two-nozzle Hand Sprayer Boom

One 1/8-inch black steel pipe 21 inches long
One 1/8-inch black steel pipe 20 inches long
Three 1/4-inch pipe couplings
One 12-inch sash chain
Two 11002 nozzles
Two 1/4-inch male spray nozzle bodies
Two nozzle caps
Two 50-mesh screens
One shut-off valve
Two 1/4 x 1/8-inch bushings
Two 60-pound pressure gauges
Two 1/8-inch pipe caps
3 feet of 1/4-inch I.D. flexible tubing
Two 1/4-inch hose clamps
One 1/4-inch nipple

## Building the Boom

Thread both ends of the 20-inch length of 1/8-inch black pipe and attach the pipe caps. One-half inch from each end of the pipe weld one half of a 1/4-inch coupling. Be sure the couplings are lined up. In the center, perpendicular to the pipe, and at a 45° angle to the other couplings, weld another half of a 1/4-inch coupling. Drill a 1/4-inch hole in the boom in the center of the 1/4-inch couplings. Attach the male spray nozzle bodies to the end couplings. Install the 50-mesh screens, 11002 nozzles, and caps to the male bodies. Be sure the nozzles are parallel to the boom. Pipe caps attached to each end of the boom can be removed for easy cleaning of the boom.

Thread both ends of the 21-inch length of 1/8-inch pipe and attach a 1/4 x 1/8-inch bushing to each end. Weld one half of a 1/4-inch coupling 5 inches from one end of the 20-inch pipe and bore a 1/4-inch hole in the center of the coupling. This coupling will be used for mounting an in-line pressure gauge behind the boom.

Attach the end of the pipe that is closest to the coupling to the shut off valve, and attach the other end to the sprayer boom. A 3-foot length of 1/4-inch plastic hose connects the shut off valve to the sprayer tank. Connect a 12-inch sash chain to the center of the sprayer boom as a guide to operate the sprayer the recommended 9 to 11 inches above the ground.

## Attaching Pressure Gauges and Regulator

Mount one pressure gauge on the tank and one in the coupling previously welded to the delivery line behind the boom. Mount the

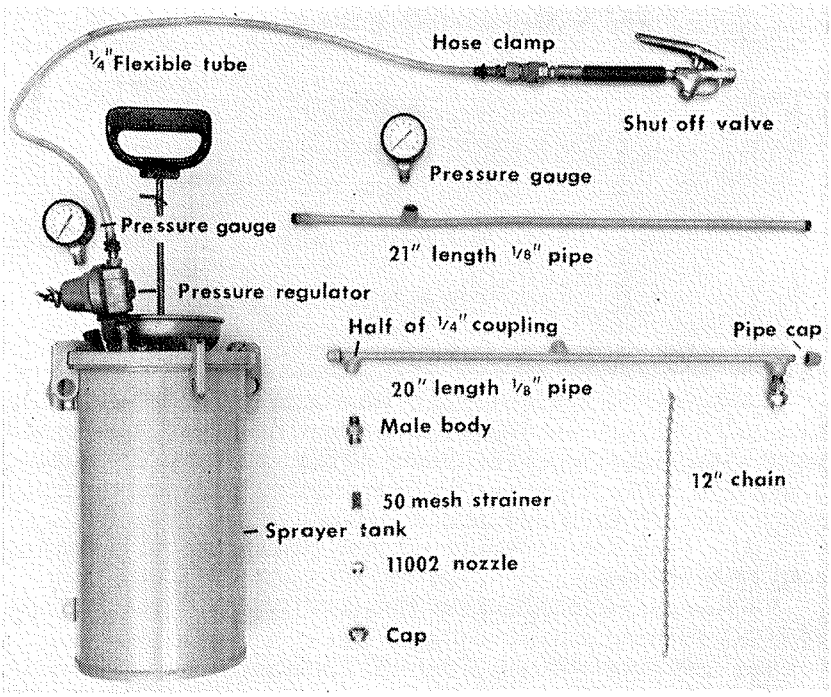


**Figure 1. Parts of the hand sprayer.**

tank gauge by welding half of a ¼-inch coupling to the tank, boring a hole through the coupling into the tank and screwing the gauge into the coupling. Mount the pressure regulator in a ¼-inch nipple welded on the tank delivery opening (Fig. 1).

## Calibrating the Sprayer

Since most chemicals are applied in water, and at a recommended rate, you must know how much water the sprayer will deliver. Application rates vary with nozzle size, tank pressure, and walking speed. Sprayers are usually calibrated for a small area and the water discharged is calculated on a per acre basis.

To calibrate a sprayer having a boom with 20-inch nozzle spacing:

1. Measure and stake 50 feet in a straight line.
2. Fasten containers on at least two nozzles to catch spray.
3. Fill the tank with water and spray the 50 feet using the same pressure (25 pounds per sq. in.) and speed used for spraying weeds.

**Table 1. Calibrating boom with 20-inch nozzle spacing.**

| Water collected in ounces | Delivery rate gallons per acre |
|---|---|
| 1 | 4.1 |
| 2 | 8.2 |
| 3 | 12.2 |
| 4 | 16.3 |
| 5 | 20.4 |
| 6 | 24.5 |
| 7 | 28.6 |
| 8 | 32.6 |
| 9 | 36.7 |
| 10 | 40.8 |
| 11 | 44.9 |
| 12 | 49.0 |

4. Measure the water collected from each nozzle. The amounts collected from each nozzle should be about the same. Then average together the ounces of water collected from each nozzle. (If you collect 4 ounces from one nozzle and 3 ounces from the other add the figures together and divide by 2 to get the average.)

5. Use Table 1 to determine the amount of water (in gallons per acre) being delivered.

A minimum of 20 gallons per acre is advisable for most herbicide applications.

## Herbicide for the Tank

Herbicide labels usually give recommended application rates in pounds per acre. Herbicides applied through a sprayer are formulated as liquids or wettable powders. Liquid formulations show on the label the percent active ingredient per gallon. For instance, a label on 2,4-D may read:

**Alkanolamine salts of 2,4-Dichlorophenoxyacetic acid.....65%**
**2,4-Dichlorophenoxyacetic acid .....39%**
**Inert ingredients .....35%**
**2,4-D acid equivalent 4 pounds per gallon.**

Some herbicides are formulated in several weights. *Be sure of the weight of active material per gallon being used.*

Wettable powders are finely divided solid particles. A label on a wettable powder (Simazine 80 W) gives the percentage of active ingredient followed by a "W," indicating the formulation is a wettable powder. Since wettable powders occur in various percentages of active ingredient, correct amounts of commercial product to apply must be calculated.

Applying the correct amount of herbicide is important for weed control. "Pouring until it looks like enough" or assuming that doubling the recommended rate will be doubly effective often gives disappointing results. Calculate correct amounts of herbicide to apply on

the basis of amounts added to a gallon of water or total amount added to a given sprayer tank volume.

Mix wettable powders with water as a carrier and agitate constantly by shaking the sprayer to keep them in suspension. Mix these formulations with a small quantity of water before putting them in the sprayer tank.

## To Get Correct Amounts of Herbicide

*Read the label.*

Use recommended application rate.

**Liquid Herbicides**

1. Divide the number of gallons the tank will hold by the previously calibrated gallons per acre of water the sprayer will apply to get the fraction of an acre 1 tankful will spray.

*Example: Your tank holds 3 gallons. After calibrating your sprayer you find it will apply water at the rate of 25 gallons per acre. Divide 3 gallons by 25 gallons: $^{3}/_{25}$ = .12. You now know that one tankful will spray .12 of an acre.*

2. Multiply this figure (.12) by the recommended rate per acre to get the amount of herbicide to mix with each tankful of water.

*Example: The recommended application rate on the label of the herbicide you plan to use is 1 pound of active ingredient per acre. The herbicide is formulated to have 4 pounds of active ingredient per gallon.*

*Go to Table 2 and under the heading "Pounds of active ingredient per gallon of commercial product" find 4. You want to apply 1 pound of active material so read across the line opposite 4 until you come to the column "1 pound application rate" and find 32 ounces.*

*Multiply 32 ounces x .12 to get the ounces of herbicide to put in the sprayer tank: 32 x .12 = 3.84 ounces herbicide to each tankful of water.*

**Powder Herbicides**

The label on an 80% wettable powder recommends an application rate of 2 pounds per acre of active ingredient. Find the amount of commercial product to apply.

*Example: Go to Table 3 and under the column "Percent active ingredient of commercial product" find 80. Read across the line from 80 until you get to the column headed by the "two pound recommended application rate" and find 2.50. To get 2 pounds active material per acre you must apply 2.50 pounds of commercial product.*

*2. Multiply 2.50 pounds x .12 to get pounds of commercial product to apply in each tankful of water: 2.50 x .12 = .3000 pounds. There are 16 ounces in a pound. 16 ounces x .3000 = 4.8 ounces of commercial product per tankful of water.*

## Table 2. Conversion table for liquids (acre basis).

| Lbs. of active ingredient per gal. of commercial product | Recommended application rate per acre | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | ¼ lb. | | ½ lb. | | 1 lb. | | 1½ lb. | | 2 lb. | | 4 lb. |
| | Amount of commercial product needed per acre | | | | | | | | | | |
| | pts. | oz. | pts. | oz. | pts. | oz. | pts. | oz. | pts. | oz. | pts. |
| 1.50 | 1⅓ | 21.3 | 2⅔ | 42.6 | 5⅓ | 85.3 | 8 | 128.0 | 10⅔ | 170.5 | 21⅓ |
| 2.00 | 1 | 16 | 2 | 32.0 | 4 | 64.0 | 6 | 96 | 8 | 128.0 | 16 |
| 2.64 | ¾ | 12 | 1½ | 24.0 | 3 | 48.0 | 4½ | 72.0 | 6 | 96.0 | 12 |
| 3.00 | ⅔ | 10.6 | 1⅓ | 21.2 | 2⅔ | 42.4 | 4 | 63.6 | 5⅓ | 84.8 | 10⅔ |
| 3.34 | ⅗ | 9.6 | 1⅕ | 19.2 | 2⅖ | 38.4 | 3⅗ | 57.6 | 4⅕ | 76.8 | 9⅗ |
| 4.00 | ½ | 8.0 | 1 | 16.0 | 2 | 32.0 | 3 | 48.0 | 4 | 64.0 | 8 |
| 6.00 | ⅓ | 5.3 | ⅔ | 10.6 | 1⅓ | 21.2 | 2 | 31.8 | 2⅔ | 42.4 | 5⅓ |

## Table 3. Conversion table for wettable powders and granules (acre basis).

| Percent active ingredient of commercial product | Recommended application rate per acre | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | ¼ lb. | ½ lb. | 1 lb. | 2 lb. | 4 lb. | 6 lb. | 8 lb. | 10 lb. | 12 lb. |
| | Pounds of commercial product needed per acre | | | | | | | | |
| 2 | 12.50 | 25.0 | 50.0 | 100.0 | 200.0 | 300.0 | 400.0 | 500.0 | 600.0 |
| 5 | 5.0 | 10.0 | 20.0 | 40.0 | 80.0 | 120.0 | 160.0 | 200.0 | 240.0 |
| 10 | 2.50 | 5.0 | 10.0 | 20.0 | 40.0 | 60.0 | 80.0 | 100.0 | 120.0 |
| 20 | 1.25 | 2.50 | 5.0 | 10.0 | 20.0 | 30.0 | 40.0 | 50.0 | 60.0 |
| 50 | .50 | 1.0 | 2.0 | 4.0 | 8.0 | 12.0 | 16.0 | 20.0 | 24.0 |
| 75 | .33 | .66 | 1.33 | 2.66 | 5.33 | 8.0 | 10.6 | 13.3 | 16.0 |
| 80 | .31 | .62 | 1.25 | 2.50 | 5.0 | 7.5 | 10.0 | 12.5 | 15.0 |

Amount of commercial product needed for various application rates may be calculated for the different commercial formulation.

*Wettable powder or granule.* Assume you buy a herbicide with 80% (.80) active ingredient, such as Simazine, you want to apply 2.0 pounds of active ingredient per acre; therefore, $\frac{2.0}{.80} = 2.5$ pounds of commercial product needed to apply.

*Liquid Formulations.* Assume you buy 2,4-D as a 2-pound per gallon acid equivalent formulation and the recommended rate to apply is ¼ pound active material per acre; using ratio and proportion (cross multiply and divide):

$$\frac{128 \text{ oz. or } 8 \text{ pts./gal.}}{2 \text{ lb. active material per gallon}} \qquad \frac{X \text{ (unknown oz. or pts.)}}{.25\ (1/4) \text{ lb. active material/Acre recommended rate}} = 16 \text{ oz. or } 1 \text{ pt. of commercial product needed to apply } 1/4 \text{ lb./Acre}$$

**Table 4. Conversion table for liquids (per 1000 square feet).**

| Lbs. of active ingredient per gal. of commercial product | Recommended application rate per acre | | | | | |
|---|---|---|---|---|---|---|
| | ¼ lb. | ½ lb. | 1 lb. | 1½ lb. | 2 lb. | 4 lb. |
| | Amount of commercial product needed per 1000 square feet | | | | | |
| | teaspoons | teaspoons | teaspoons | tablespoons | tablespoons | tablespoons |
| 1.50 | 3 | 6 | 12 | 6 | 8 | 16 |
| 2.00 | 2½ | 4½ | 9 | 4½ | 6 | 12 |
| 2.64 | 2 | 3½ | 7 | 3 | 4½ | 6½ |
| 3.00 | 1½ | 3 | 6 | 3 | 4 | 8 |
| 3.34 | 1½ | 2½ | 5 | 2½ | 3½ | 7 |
| 4.00 | 1 | 2 | 4 | 2 | 3 | 6 |
| 6.00 | 1 | 1½ | 3 | 1½ | 2 | 4 |

**Table 5. Conversion table for wettable powders and granules (per 100 square feet).**

| Percent active ingredient of commercial product | Recommended application rate per acre | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | ¼ lb. | ½ lb. | 1 lb. | 2 lb. | 4 lb. | 6 lb. | 8 lb. | 10 lb. | 12 lb. |
| | Ounces of commercial product needed per 1000 square feet | | | | | | | | |
| 2 | 4⅔ | 9⅙ | 18 | 37 | 74 | 110 | 147 | 184 | 220 |
| 5 | 1⅚ | 3⅔ | 7⅓ | 15 | 29 | 44 | 59 | 74 | 88 |
| 10 | 1 | 1⅚ | 3⅔ | 7 | 15 | 22 | 29 | 37 | 44 |
| 20 | ½ | 1 | 1⅚ | 3⅔ | 7 | 11 | 15 | 18 | 22 |
| 50 | ⅙ | ⅓ | 1⅔ | 1½ | 3 | 4½ | 6 | 7 | 9 |
| 75 | ⅙ | ⅓ | 1½ | 1 | 2 | 3 | 4 | 5 | 6 |
| 80 | ⅙ | ⅓ | ½ | 1 | 1⅚ | 2⅚ | 3⅔ | 4⅔ | 5½ |

Tables 4 and 5 convert the information on the herbicide label into teaspoons and ounces per 1000 sq. ft. The appropriate amount of herbicide should be put in sufficient water (e.g. 1 gal. water per 1000 sq. ft.) to give good coverage.

Remember that whether you apply herbicide on a thousand square feet or on an acre, you still have to calibrate the sprayer.

## Using the Sprayer

Spray when the air is still. In general, there is less air movement just before sunrise and after sunset. Wind movement causes spray drift. When applying herbicides to gardens or lawns be careful to avoid drift onto susceptible plants. To check air movement, toss a handful of dust into the air. If some of the dust moves several feet it probably is too windy to spray. Reduce drift hazard and obtain proper coverage of vegetation by operating the sprayer at the correct height (Table 4).

Increasing nozzle opening and/or reducing pressure will also avoid drift. Temperature, kind of vegetation, and age of vegetation determine effectiveness of chemicals. *Read the labels* to determine what and when to spray.

## Cleaning the Sprayer

Clean the sprayer thoroughly before storage. Empty the tank and rinse it with water. This may be sufficient for short-time storage. Rinsing the tank inside and out with kerosene or fuel oil will protect most parts from corrosion.

Thoroughly cleaning the sprayer after herbicide application will avoid injuring or killing sensitive plants the next time you use the sprayer. 2,4-D and related products are difficult to get out of sprayers. It may be advisable to use a separate sprayer for hormone type herbicides such as 2,4-D.

To clean the sprayer first rinse with a material which acts as a solvent for the herbicide. Kerosene and fuel oils carry away oil-soluble herbicides. Chemicals which form emulsions when mixed with water are oil-soluble. After the oil rinse, a rinse with water containing deter-

**Table 6. Relationship between nozzle spacing, spray angle and nozzle height.**

| Nozzle spacing inches | Nozzle spray angle | | | |
|---|---|---|---|---|
| | Operating height in inches from vegetation | | | |
| | 60° | 80° | 90° | 110° |
| 12 | 16 | 11 | 9 | 6 |
| 16 | 21 | 14 | 12 | 8 |
| 18 | 23 | 16 | 14 | 9 |
| 20 | 26 | 18 | 15 | 11 |
| 24 | 31 | 22 | 18 | 13 |

gent soap will help remove the oil. Oil-soluble herbicides, such as 2,4-D esters, are usually the most difficult to remove. 2,4-D amine salts are water-soluble.

For most water-soluble herbicides repeated rinsing with water is usually enough. 2,4-D requires extra precaution. If the ester form of 2,4-D was used, fill the tank with water and ammonia. Add household ammonia at the rate of 1 quart of household ammonia to 25 gallons of water. Pump enough solution through the hose and nozzles to fill these parts completely. Then fill the tank, close, and leave for 24 hours before rinsing thoroughly with water.

One day before using the sprayer again fill the tank with clean water. Drain before using.

Use activated charcoal after the preliminary rinsing to decontaminate the sprayer. A 3% suspension immediately absorbs the 2,4-D. Agitate the suspension for 2 to 3 minutes and drain, then rinse thoroughly with clear water.

For wettable powder herbicides, see that none of the powder remains in the tank. A thorough rinsing with water is usually sufficient.

Be sure the sprayer is cleaned thoroughly. Minute quantities of 2,4-D or other hormone type herbicides will injure such sensitive plants as beans, tomatoes, and most flowers.

## Safety Precautions

1. *Always read the label* before using herbicides. Note warning and cautions each time before opening the container.

2. Never put more than 50 pounds per square inch of pressure in tank.

3. Keep herbicides out of the reach of children, pets, and irresponsible people. They should be stored outside the home, away from food and feed, and under lock and key.

4. Always store in original containers and keep them tightly closed.

5. Never smoke while spraying.

6. Avoid inhaling spray. Wear protective clothing and mask whenever indicated.

7. Do not spill herbicides on the skin or clothing. Remove contaminated clothing *immediately* and wash thoroughly.

8. Wash hands and face and change to clean clothing after spraying. Wash contaminated clothing before reuse.

9. Cover food and water containers when applying around livestock or pet areas.

10. Use separate equipment or use special care in cleaning sprayers after applying hormone-type herbicides to avoid accidental injury to susceptible plants.

11. Always dispose of empty containers so they pose no hazard to humans, animals or valuable plants.

12. Observe label directions and cautions to keep residues on edible portions of plants within the limits permitted by law.

13. If symptoms of illness occur during or shortly after spraying, call a physician or get the patient to the hospital immediately.

*Weights and Measures*

| | Teaspoons | Tablespoons | Fl. Ounces | Cu. Cms. or Ml. |
|---|---|---|---|---|
| 1 teaspoon | 1 | ⅓ | ⅙ | 4.9 |
| 1 tablespoon | 3 | 1 | ½ | 14.8 |
| 1 Fl. ounce | 6 | 2 | 1 | 29.6 |
| ¼ cupful | 12 | 4 | 2 | 59.1 |
| ½ cupful | 24 | 8 | 4 | 118.3 |
| ¾ cupful | 36 | 12 | 6 | 177.3 |
| 1 cupful | 48 | 16 | 8 | 236.6 |
| 1 liquid pint | 96 | 32 | 16 | 473.2 |
| 1 liquid quart | 192 | 64 | 32 | 946.4 |
| 1 liter | 203 | 67.6 | 33.8 | 1000.0 |
| 1 gallon | 768 | 256.0 | 128.0 | 3785.4 |

*Rules for Computing Circumference, Areas, and Volumes*

Area of rectangle: length x width
Circumference of circle: 3.1416 x diameter
Capacity of rectangular container: length x width x depth
Volume of cylinder: 0.7854 x diameter x diameter x height

*Avoirdupois Weight*

1 dram = 27 11/32 grains
1 ounce = 16 drams
28.35 grams
437½ grains
1 pound = 16 ounces
7000 grains
453.59 grams
0.45 kilogram

*Volume Measure*

1 pint = 2 cups
1 quart = 2 pints
1 gallon = 4 quarts
8 pints
1 peck = 8 quarts
1 bushel = 4 pecks

*Linear Measure*

1 inch = 2.54 centimeters
1 foot = 12 inches
30.48 centimeters
1 yard = 3 feet
0.91 meter
1 rod = 5½ yards
16½ feet
1 mile = 320 rods
1,760 yards
5,280 feet

*Area Measure*

1 square foot = 144 square inches
1 square yard = 9 square feet
1 square rod = 30¼ square yards
272¼ square feet
1 acre = 160 square rods
4,840 square yards
43,560 square feet
1 square mile = 640 acres
1 section = 1 mile square