BIBLIOGRAPHIC DATA SHEET

1. CONTROL NUMBER: PN-AAH-730

2. SUBJECT CLASSIFICATION (695): AH20-0000-0000

3. TITLE AND SUBTITLE (240)

Knapsack sprayers

4. PERSONAL AUTHORS (100)

Fraser, Frank; Burrill, L. C.

5. CORPORATE AUTHORS (101)

Or. State Univ. Int. Plant Protection Ctr.

6. DOCUMENT DATE (110): 1979

7. NUMBER OF PAGES (120): 31p.

8. ARC NUMBER (170): 632.94.F841

9. REFERENCE ORGANIZATION (130)

Or. State

10. SUPPLEMENTARY NOTES (500)

11. ABSTRACT (950)

12. DESCRIPTORS (920)

Equipment
Pest control
Storage
Pesticides
Sprayers

13. PROJECT NUMBER (150)

931046300

14. CONTRACT NO.(140)

AID/ta-C-1295

15. CONTRACT TYPE (140)

16. TYPE OF DOCUMENT (160)

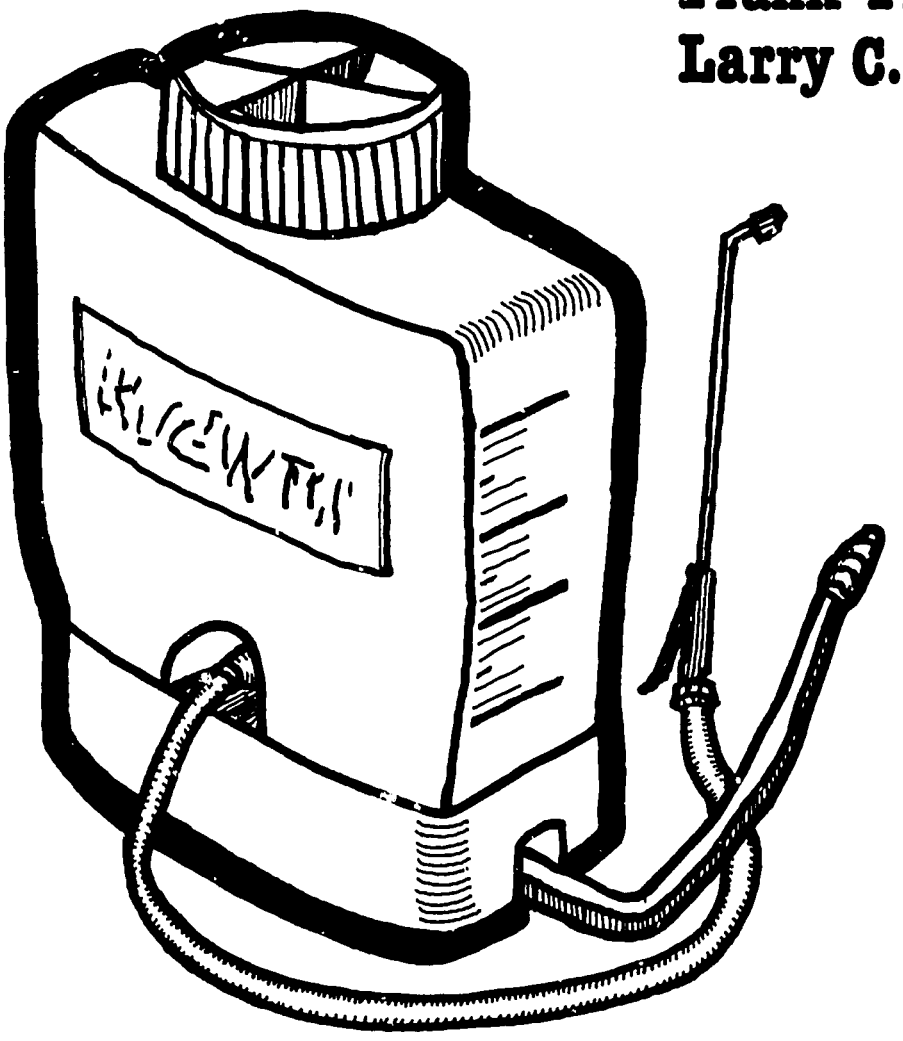
AID 590-7 (10-79)

632.94
F841

KNAPSACK SPRAYERS

* USE
* MAINTENANCE
* ACCESSORIES

Frank Fraser
Larry C. Burrill



PN-AAH-130

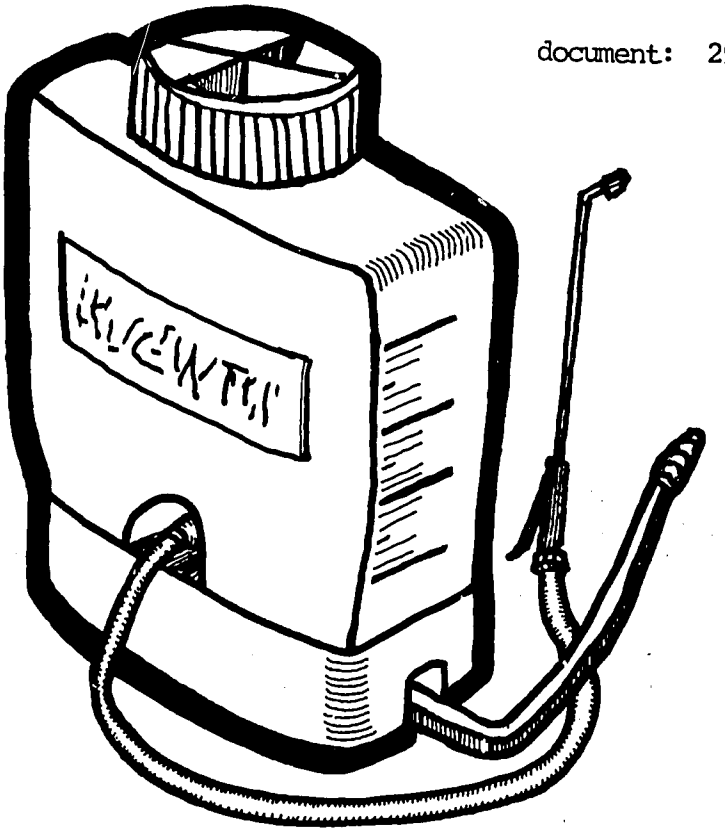
KNAPSACK SPRAYERS

* **USE**
* **MAINTENANCE**
* **ACCESSORIES**

by: Frank Fraser and Larry C. Burrill

published by: International Plant Protection Center, Oregon State University, Corvallis, Oregon 97331 / USA

document: 29-A-79



November 1979

US$3.00

3

Contents

Acknowledgement	2
Introduction	3
The Hand-Held Sprayer	3
The Knapsack Sprayer	4
Using the Knapsack Sprayer	5
Functions of the Nozzle	7
Types of Spray Nozzles	7
Booms	12
How to Calibrate a Sprayer	28
Pesticides and Safety	29
Pesticide Storage	30
Disposal	30
Application	30

Acknowledgement

The authors acknowledge their appreciation to the U.S. Agency for International Development for providing major financial support; to Dr. Stanley F. Miller, director of the International Plant Protection Center, for his encouragement and direction; to Patty Brown for the typing; and to Anne Michalski for the layout and design.

FF, LCB
October 1979

The views and interpretations in this publication are those of the authors and should not be attributed to the Agency for International Development or to any individual acting in their behalf.

INTRODUCTION

Knapsack sprayers have long been standard equipment for applying pesticides in developing countries. They are sturdy, reliable tools for many spraying needs.

Various models of knapsack sprayers are now being introduced into developed areas as a low cost alternative to larger motorized sprayers for such diverse uses as general spraying on small farms, spot treatment on larger farms, and spraying areas inaccessible to larger equipment. Even some homeowners with large lots or gardens are finding the knapsack sprayer suitable for their needs.

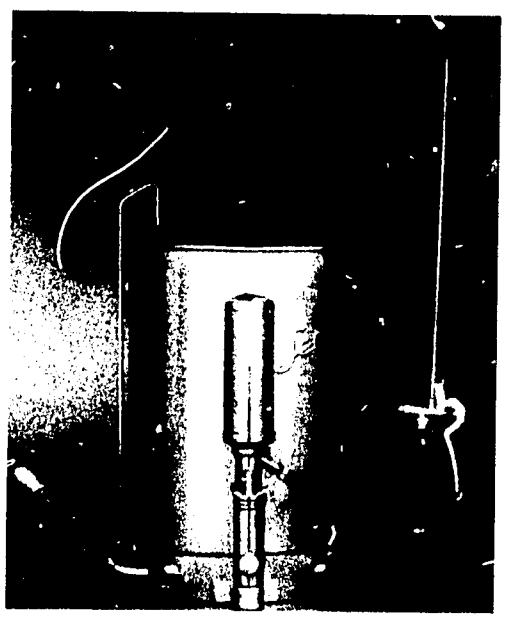


Figure 1.

But the knapsack sprayer is not the best for everyone. There are smaller, simpler, and less expensive manual sprayers which may be adequate for many needs.

It would be difficult to make recommendations as to one sprayer being better than the other but the following paragraphs may help one decide which type of sprayer best suits their needs.

Figure 2. Long, slender external pump serves as carrying handle

There is a combination of things to consider: size, availability of sprayer and spare parts, cost and personal preference. In the small hand held, pump-up, compression sprayers, most plastic models have small filler openings which can be awkward, especially when using wettable powders. Pumps vary in efficiency. Some can charge a sprayer to an acceptable pressure with fewer strokes than others.

THE HAND-HELD SPRAYER

Since many of the operational procedures and modifications to be suggested for the knapsack sprayer also apply to alternate types, we will first discuss various hand-held sprayers, then concentrate on the knapsack models.

Nearly all hand-held sprayers are the manually operated compression type.

There are different sizes, shapes, and materials available, but the principle is the same. An internal, or external, compression pump is an integral part of the sprayer. Spray can then be discharged onto the target for a short time before the pressure drops to where the operator must stop and pump it up again.

Most compression sprayers come equipped with a "dial a spray" or "multi spray" nozzle that delivers a cone spray pattern and adjusts from a fine spray, best for insecticides and fungicides, to a coarse spray, better for herbicides, to a nearly solid stream that will reach 3 to 5 meters.

Compression sprayers are suitable for most home gardeners as long as the limitations are understood. The steady pressure drop makes accurate spraying difficult, but in some situations this is not a serious drawback.

These sprayers can be modified within limits to allow more accurate spraying as will be discussed for the knapsack sprayer. Modificiation is usually not justified for the home gardener, but researchers may wish to get more accurate and uniform applications combined with the simple, inexpensive, and light weight compression sprayer.

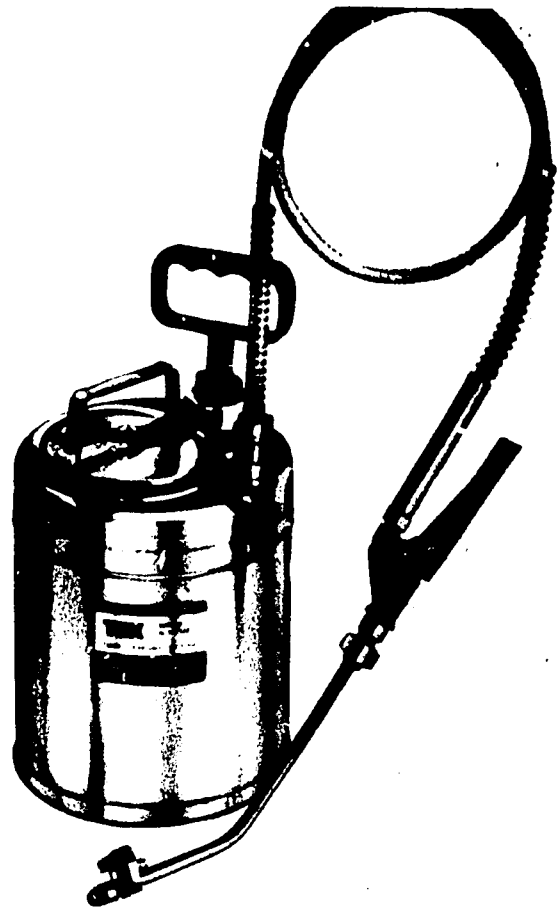
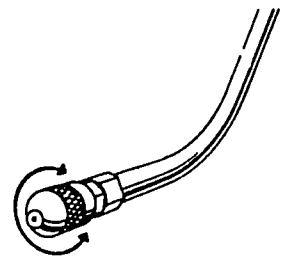


Figure 3.

Figure 4.



Dial A Spray

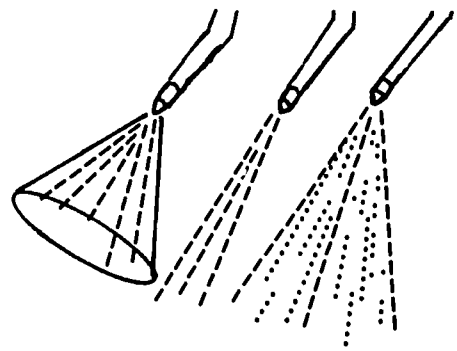


Figure 4A.

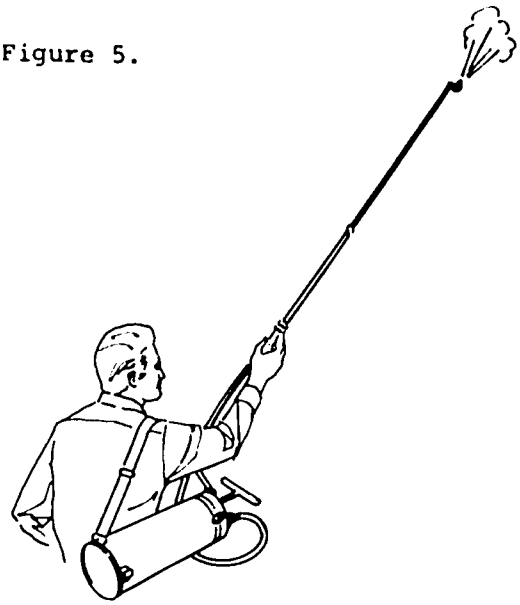
THE KNAPSACK SPRAYER

A typical knapsack sprayer can be described as having a capacity of 8 to 20 liters (approximately 2 to 5 gallons), being carried on the operator's back, and being operated by nearly continuous hand pumping. Knapsack sprayers are not prepressurized. The pumping action forces the liquid spray mixture out via a small surge chamber. Some of the pressure is retained in the surge chamber, but spray delivery rapidly diminishes when pumping stops.

By using a knapsack sprayer an operator can handle large quantities of spray liquid (up to 5 gallons) with

greater comfort and freedom of movement than with hand-held compression sprayers or those slung by a single shoulder strap (Figure 5). Thus knapsack sprayers are adapted for bigger jobs.

Figure 5.



While most knapsack sprayers are basically similar, there are differences between individual models that become apparent under actual use conditions. One of the most noticeable differences is in the ease of pumping. While this is not very significant when using a single nozzle wand, it becomes a telling factor when spraying with a three or four nozzle boom. With some models it is nearly impossible to keep up the vigorous pumping required to maintain proper pressure for uniform spray coverage.

On some makes the pump handle can easily be switched from one side of the sprayer to the other. When large areas are being sprayed this minor difference can turn into a major advantage.

Building Materials

Stainless steel, galvanized steel and brass have been the predominant materials used in sprayer construction. Plastic units are gaining popularity due to corrosion resistance and light weight. Being able to see the liquid level through the plastic sprayer body is an additional convenience.

Figure 6.

USING THE KNAPSACK SPRAYER

Knapsack sprayers are adequate for most field spraying, including research, if the operator understands and compensates for their limitations.

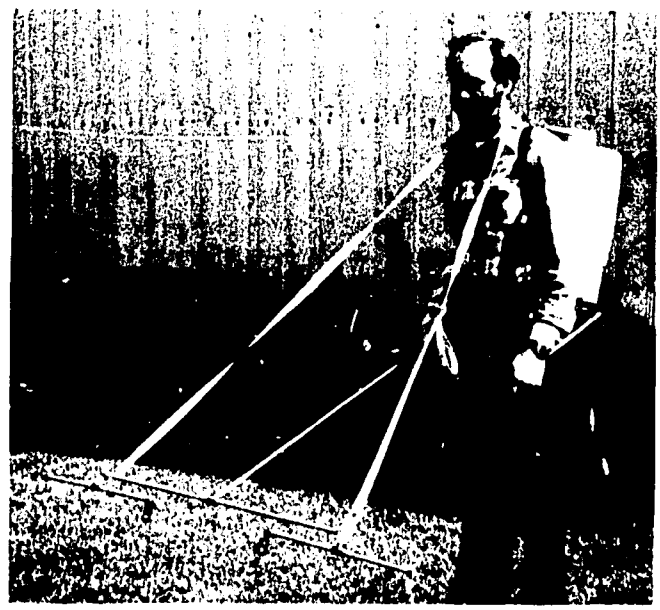


Figure 7.

Adjustable canvas support strap

Agitation

Some pesticides settle out rapidly when added to water. This can pose a problem with manual sprayers which have no mechanical or hydraulic agitation, though this feature is being introduced by some manufacturers. The small hand held sprayers can be shaken periodically to prevent settling (Figure 8).

With the knapsack sprayer agitation is often neglected. An effort is needed on the part of the applicator to stop at intervals and slosh the spray solution around (Figure 9).

Figure 8.

Pumping Air

When spraying, the normal pumping and walking action will cause a certain amount of liquid movement in the sprayer. This can be a problem when only a liter or less of spray mixture is left in the sprayer. There is still enough liquid to continue spraying, but air is introduced into the line. For the person spraying large areas, this is a signal to refill the sprayer. To the small-plot researcher it is more serious. When air is pumped into the line, uneven spray application results. An easy way for the researcher to avoid the problem is to prepare an amount of pesticide solution greater than that necessary to just cover the plots. A little trial and error with water in the sprayer and spraying the desired area will soon give one an indication of how much spray solution is needed to satisfactorily cover the plots and yet not have so much spray left over that it presents a disposal problem or is needlessly wasteful.

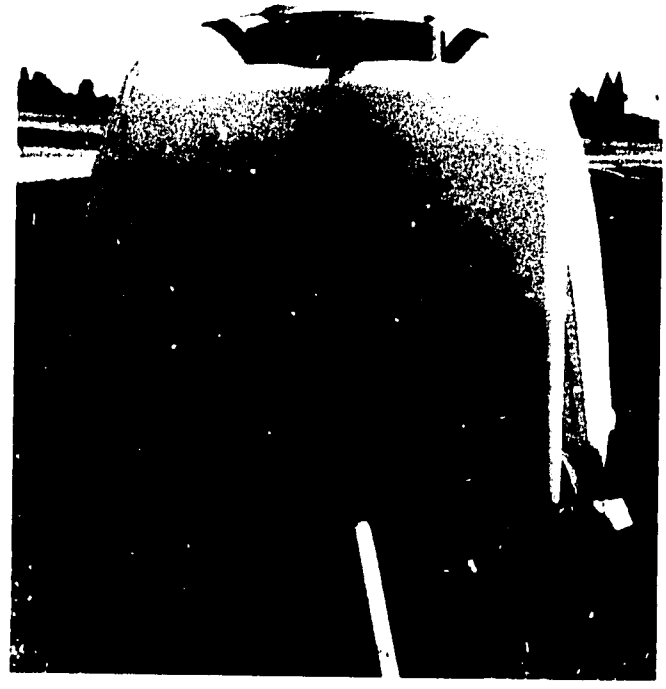


Figure 9.

Cleaning the Sprayer

Whether spraying research plots or large areas it is important that the sprayer be thoroughly cleaned when changing to another chemical. Sufficient chemical can be retained in the pump, hose, wand, boom or in the sprayer body to cause injury to sensitive plants. The sprayer should first be rinsed with fresh water to remove most of the chemical. This should be poured out and fresh water added. Then operate the pump for at least 10 strokes and pour out remaining water. This should be repeated two more times. When a very active hormonal herbicide such as 2,4-D, picloram, or dicamba is used extra precautions should be taken.

A household detergent can be added to the wash water or an organic solvent such as alcohol or acetone can be used to rinse with.

Large Area Spraying

Many owners of knapsack sprayers soon find that it is slow and difficult to accurately spray large areas with the single nozzle wand which is standard equipment on all models. One should then consider buying or building a two, three, or four nozzle boom which will allow not only faster but more accurate spraying. Much of the following is offered to assist those who wish to make a boom.

One should first decide what kind of nozzles will be used. The following discussion of various nozzles will help with this decision.

FUNCTIONS OF THE NOZZLE

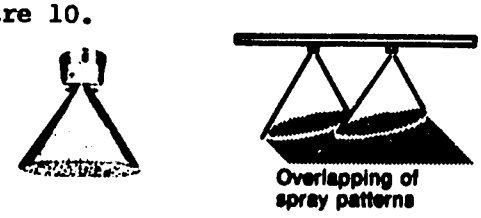
Though requirements of a nozzle differ from one application to another, the basic functions of nozzles are:

1. To meter liquids;
2. To atomize or break up liquids into droplets;
3. To disperse these droplets in specified patterns;
4. To provide hydraulic momentum or impact.

TYPES OF SPRAY NOZZLES

FLAT SPRAY OR FLAT FAN - Flat spray nozzles are designed to produce an elliptical spray pattern. Uniform distribution is achieved by overlapping the tapered edges of the individual spray pattern (Figure 10). This nozzle is specified for many types of herbicide, insecticide and fertilizer applications and was the one used in the boom fabrication presented in this article.

Figure 10.



EVEN SPRAY OR EVEN FAN - Designed primarily for the band application of preemergence chemicals as a planter attachment (Figure 11). Similar in design to the flat spray except there is no tapering of the spray pattern at the edges. May be used in a single nozzle wand for a very uniform application in a fairly narrow band.

Figure 11.

FLOODING OR FLOOD - Another type of flat spray pattern is produced by flood nozzles. They are characterized by a much wider spray angle than the nozzles discussed above and are designed to operate at lower pressures. Flood nozzles are well suited (broad coverage from a single nozzle) for the backpack sprayer in a forestry situation (postemergence herbicides) or in plantation crops where a multiple nozzle boom is an encumbrance. They are not as well suited for most research work as their spray pattern tends to show a narrow band at the outer edges receiving a higher application and this may not be acceptable to the research worker.

Figure 12.

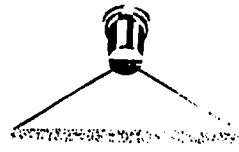
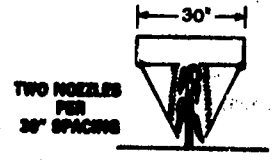


Figure 13.

HOLLOW CONE - These are usually operated with higher pressure than any of the foregoing. They produce a more finely atomized spray concentrated at the outer edge of a conical pattern. This gives better overall coverage of plant leaf surfaces, especially when used in multiples as in Figure 15. Frequently used to apply insecticides.

Figure 14.

Figure 15.



OTHER TYPES - Have been developed for applications requiring special spray patterns. A few of these will be mentioned but briefly as someone using a manual sprayer will not likely have use for them.

A simple metering orifice without swirl chamber or distributor producing a straight stream.

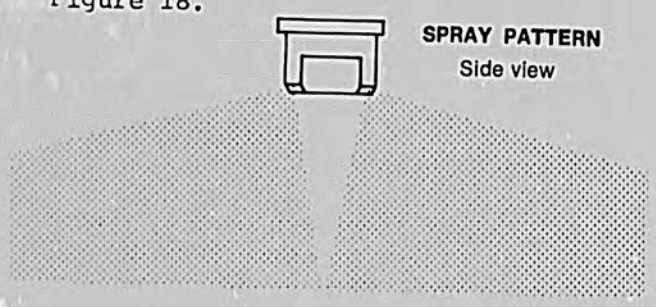
Figure 16.

Off set orifice, when spray is directed to one side.

Figure 17.

Double orifice for spraying row crops.

Figure 18.



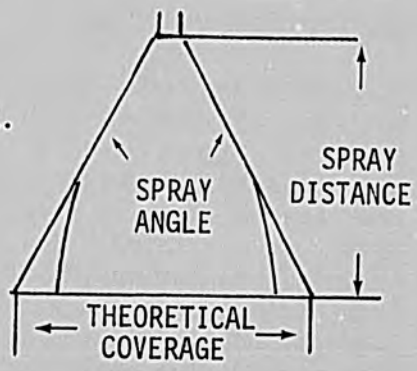
Flooding nozzle positioning.

Figure 19.

Backpack spraying with flood nozzle in horizontal position.

Figure 20.

Figure 21.



When a nozzle type is chosen the next step is to determine the proper spacing on the boom. Tables A and B on page 9 and 10 list theoretical coverage (Figure 21) of spray patterns as calculated from the spray angle and the distance from the nozzle orifice.

TABLE A

THEORETICAL SPRAY COVERAGE WIDTHS IN INCHES

Spray Angle	6"	8"	10"	12"	15"	18"	24"	30"	36"	48"
10°	1.1	1.4	1.8	2.1	2.6	3.1	4.2	5.2	6.3	8.4
15°	1.6	2.1	2.6	3.2	3.9	4.7	6.3	7.9	9.5	12.6
20°	2.1	2.8	3.5	4.2	5.3	6.4	8.5	10.6	12.7	16.9
25°	2.7	3.5	4.4	5.3	6.6	8.0	10.6	13.3	15.9	21.2
30°	3.2	4.3	5.4	6.4	8.1	9.7	12.8	16.1	19.3	25.7
35°	3.8	5.0	6.3	7.6	9.5	11.3	15.5	18.9	22.7	30.3
40°	4.4	5.8	7.3	8.7	10.9	13.1	17.5	21.8	26.2	34.9
45°	5.0	6.6	8.3	9.9	12.4	14.9	19.9	24.8	29.8	39.7
50°	5.6	7.5	9.3	11.2	14.0	16.8	22.4	28.0	33.6	44.8
55°	6.3	8.3	10.3	12.5	15.6	18.7	25.0	31.2	37.5	50.0
60°	6.9	9.2	11.5	13.8	17.3	20.6	27.7	34.6	41.6	55.4
65°	7.6	10.2	12.7	15.3	19.2	22.9	30.5	38.2	45.8	61.2
70°	8.4	11.2	14.0	16.8	21.0	25.2	33.6	42.0	50.4	67.2
75°	9.2	12.3	15.3	18.4	23.0	27.6	36.8	46.0	55.2	73.6
80°	10.1	13.4	16.8	20.2	25.2	30.3	40.3	50.4	60.4	80.6
85°	11.0	14.7	18.3	22.0	27.5	33.0	44.0	55.0	66.0	88.0
90°	12.0	16.0	20.0	24.0	30.0	36.0	48.0	60.0	72.0	96.0
95°	13.1	17.5	21.8	26.2	32.8	39.3	52.4	65.5	78.6	105.0
100°	14.3	19.1	23.8	28.6	35.8	43.0	57.2	71.6	85.9	114.0
110°	17.1	22.8	28.5	34.3	42.8	51.4	68.5	85.6	103.0	
120°	20.8	27.7	34.6	41.6	52.0	62.4	83.2	104.0		
130°	25.7	34.3	42.9	51.5	64.4	77.3	103.0			

DISTANCE FROM NOZZLE ORIFICE

TABLE B

THEORETICAL SPRAY COVERAGE WIDTHS IN CENTIMETERS

Spray Angle	10 CM	20 CM	30 CM	40 CM	50 CM	60 CM	70 CM	80 CM
10°	1.7	3.5	5.2	7.0	8.7	10.5	12.2	14.0
15°	2.6	5.3	7.8	10.5	13.1	15.7	18.4	21.0
20°	3.5	7.1	10.6	14.1	17.6	21.2	24.7	28.2
25°	4.4	8.8	13.2	17.7	22.1	26.5	31.0	35.4
30°	5.4	10.7	16.1	21.4	26.8	32.2	37.5	42.9
35°	6.3	12.6	18.9	25.2	31.5	37.8	44.1	50.4
40°	7.3	14.6	21.8	29.1	36.4	43.7	51.0	58.2
45°	8.2	16.5	24.8	33.1	41.4	49.6	57.9	66.2
50°	9.3	18.7	28.0	37.3	46.6	56.0	65.3	74.6
55°	10.4	20.8	31.2	41.6	52.0	62.4	72.8	83.2
60°	11.5	23.1	34.6	46.2	57.7	69.3	80.8	92.4
65°	12.7	25.4	38.2	50.9	63.7	76.4	89.1	101.9
70°	14.0	28.0	42.0	56.0	70.0	84.0	98.0	112.0
75°	15.3	30.7	46.0	61.4	76.7	92.1	107.4	122.8
80°	16.8	33.6	50.3	67.1	83.9	100.7	117.5	134.3
85°	18.3	36.6	54.9	73.3	91.6	109.9	128.3	146.6
90°	20.0	40.0	60.0	80.0	100.0	120.0	140.0	160.0
95°	21.8	43.6	65.4	87.2	109.1	130.9	152.7	174.5
100°	23.8	47.7	71.5	95.3	119.2	143.0	166.8	190.7
110°	28.6	57.1	85.7	114.3	142.8	171.4	199.4	228.5
120°	34.6	69.3	103.9	138.6	173.2	207.8	242.5	277.1
130°	42.9	85.8	128.7	171.6	214.5	257.3	300.2	343.1

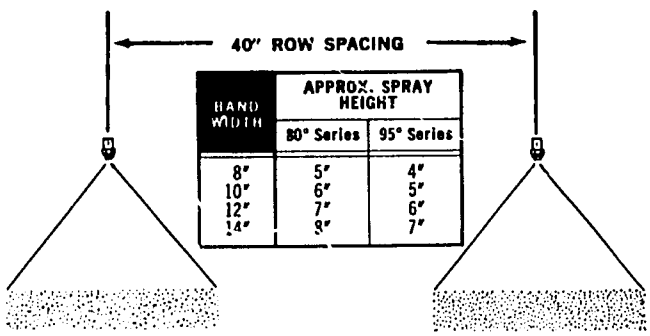
DISTANCE FROM NOZZLE ORIFICE

12

These values are based on the assumption that the spray angle remains the same throughout the entire spray distance between the nozzle and the target. In actual practice, the tabulated spray angle does not hold for long spray distances (Figure 21).

In spite of this slight drop off, one may, with a fair measure of accuracy, read directly from the table when using an even flat spray tip, as is the case at times with a single nozzle spray lance, or in band spraying (Figure 22).

Figure 22.



BAND WIDTH	APPROX. SPRAY HEIGHT	
	80° Series	95° Series
8"	5"	4"
10"	6"	5"
12"	7"	6"
14"	8"	7"

In the case of a multiple nozzle boom using flat fan tips which are designed to overlap (Figures 23 and 24) allowance must be made for this overlapping feature, plus, to a lesser extent, the tendency for the spray to fall away from the intended angle. This dictates that the boom be held 50% higher than the table would indicate.

Figure 23.

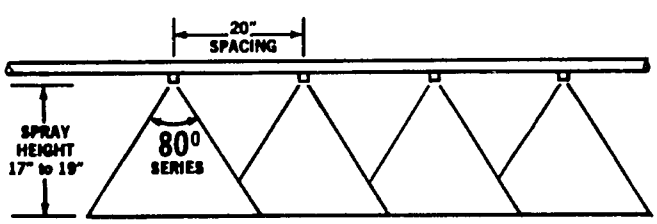


Figure 24.

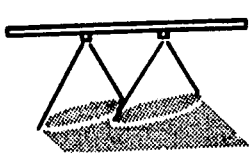
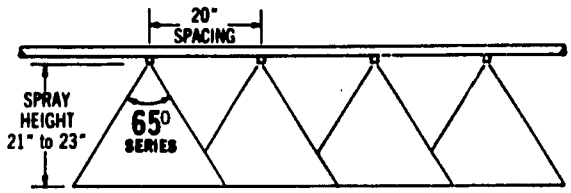


Figure 25.



EXAMPLE: If you wish to make a multiple nozzle boom to cover a given plot size or spray a predetermined swath width, of let us say, six feet and a four nozzle boom has been decided upon. Each nozzle would then have to cover 18 inches and would therefore be spaced 18 inches apart on the boom. By referring to the tables, one possibility would be to use 65° nozzle tips; read across from 65° (Table A) until you come to what would be a coverage of approximately 18 inches (just before the 19.2 inches shown on the chart) referring to distance line at the bottom of the table it would read about 14 inches. Add 7 inches (50% of 14) and you arrive at the approximate boom height, 21 inches.

Going metric and thinking of a two meter boom, one could again chart across from 65° (Table B this time) until coming to the desired coverage. In this case, the closest tabulation is 50.9 cm, at the bottom of the column the theoretical distance is 40 cm. Add 50% (20 cm.), this gives an approximate boom height of 60 cm. above spray target.

Twenty-one inches or 60 cm. may be too high for your needs. Boom height can be lowered by going to a wider angled nozzle tip, for instance 80°. As before, one would read across from 80° to the desired coverage, i.e. 18 inches (between 16.8 and 20.2 on the table) the tabulated distance shown is 11 inches. Add 50% of 11 and the actual boom height comes out to be approximately 16 inches. The same applies to the metric approach, in this case arriving at a boom height of 45 cm.

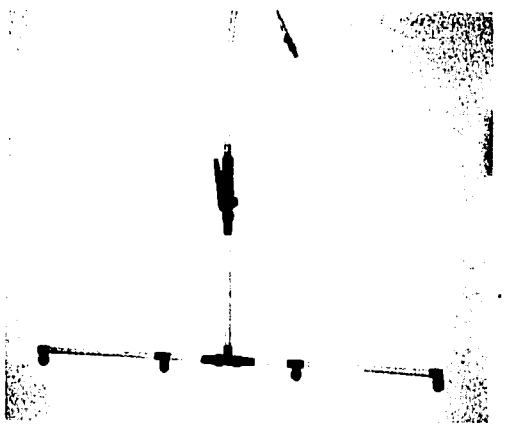
BOOMS

Now that you know how to arrive at a proper nozzle spacing, tip size and boom height for your desired spray swath we can combine this with available material for boom fabrication. The most common need seems to be for a take down type boom for ease of transporting. Here are some options covering this approach plus parts and material.

Buy A Boom

Some sprayer manufacturers have booms made entirely of plastic (Figure 26). These work reasonably well, are very inexpensive compared to metal, but are more vulnerable to breakage. Also, compared to metal booms, they are of fairly large diameter (to impart strength and stability) requiring more solution to fill the boom therefore

Figure 26.



increasing weight. The large plastic fittings are easy to assemble without tools and the trigger handle of some models is threaded and capped allowing for a pressure gauge to be screwed on after removing the blind cap (Figures 27 & 28).

Figure 27.

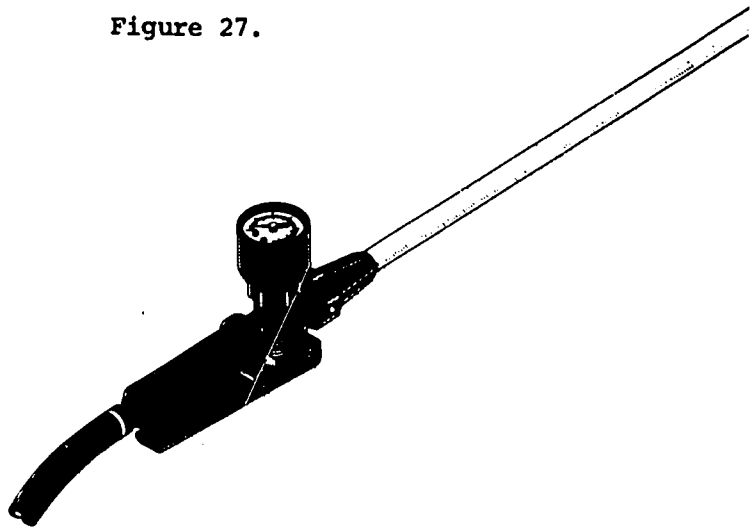
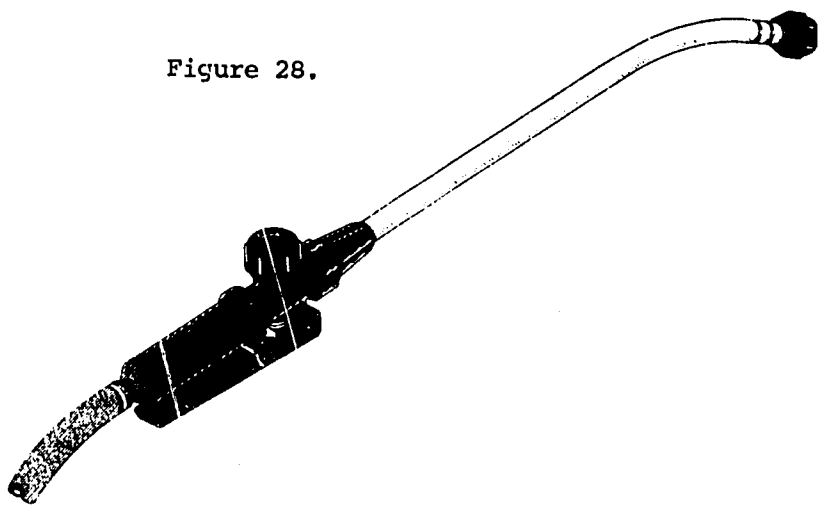


Figure 28.



14

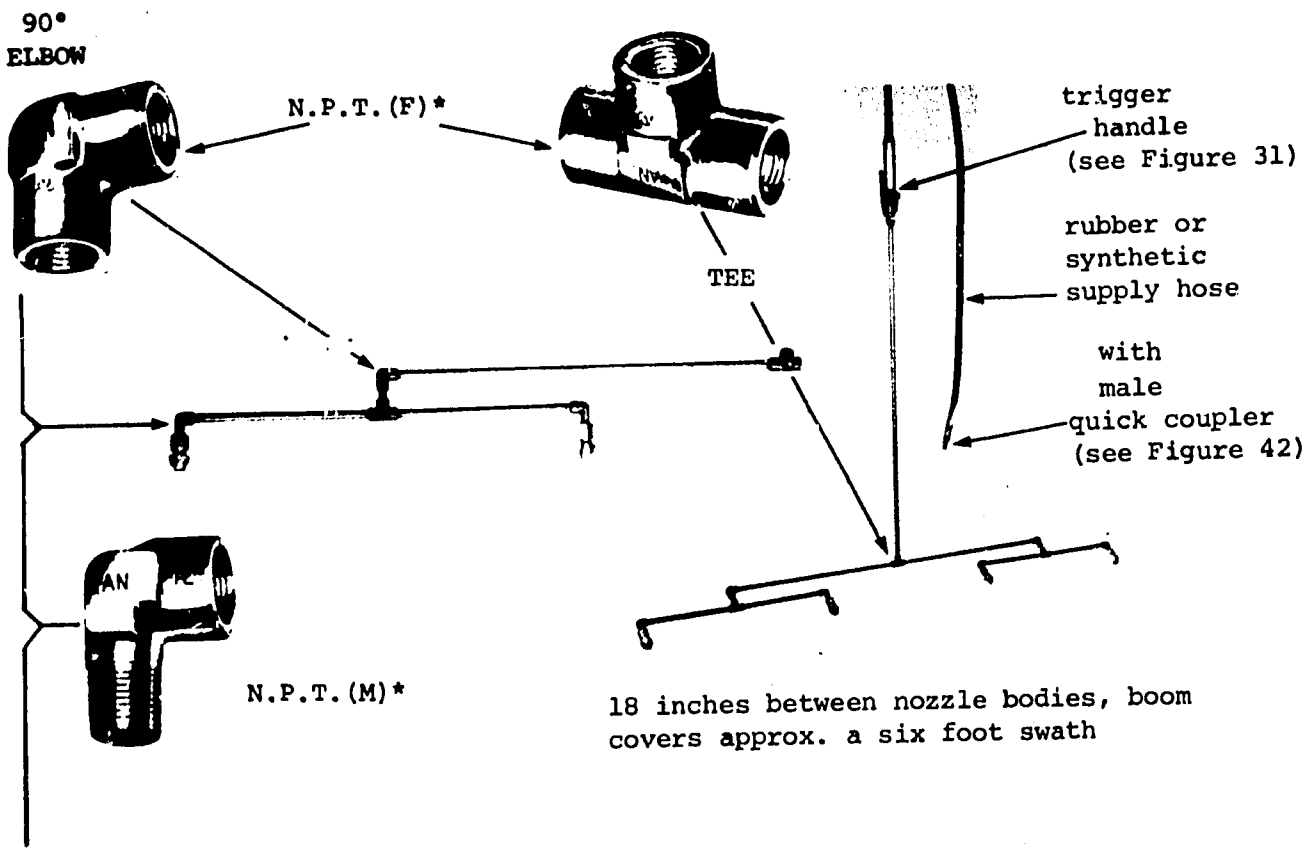
Another commercial boom which we have used is made from 1/8 inch aluminum pipe and all aluminum fittings.

This boom is light weight for the coverage it gives and is fairly easy to disassemble or partially take down. In doing so one must exercise care as 1/8 inch aluminum threads are somewhat delicate.

Make A Boom

For our own use we have relied primarily on stainless steel or aluminum pipe, with aluminum and brass fittings. There are occasions though where these pipe materials are extremely hard to obtain. Copper tubing, and to a lesser extent brass, are widely distributed and should be found wher-

Figure 29.



either elbow
may be used here, depending on whether one uses a male or female threaded nozzle body (for nozzle bodies see Figure 34A)

* N.P.T.(F) -- National Pipe Taper (Female) -- internal thread

N.P.T.(M) -- National Pipe Taper (Male) -- external thread

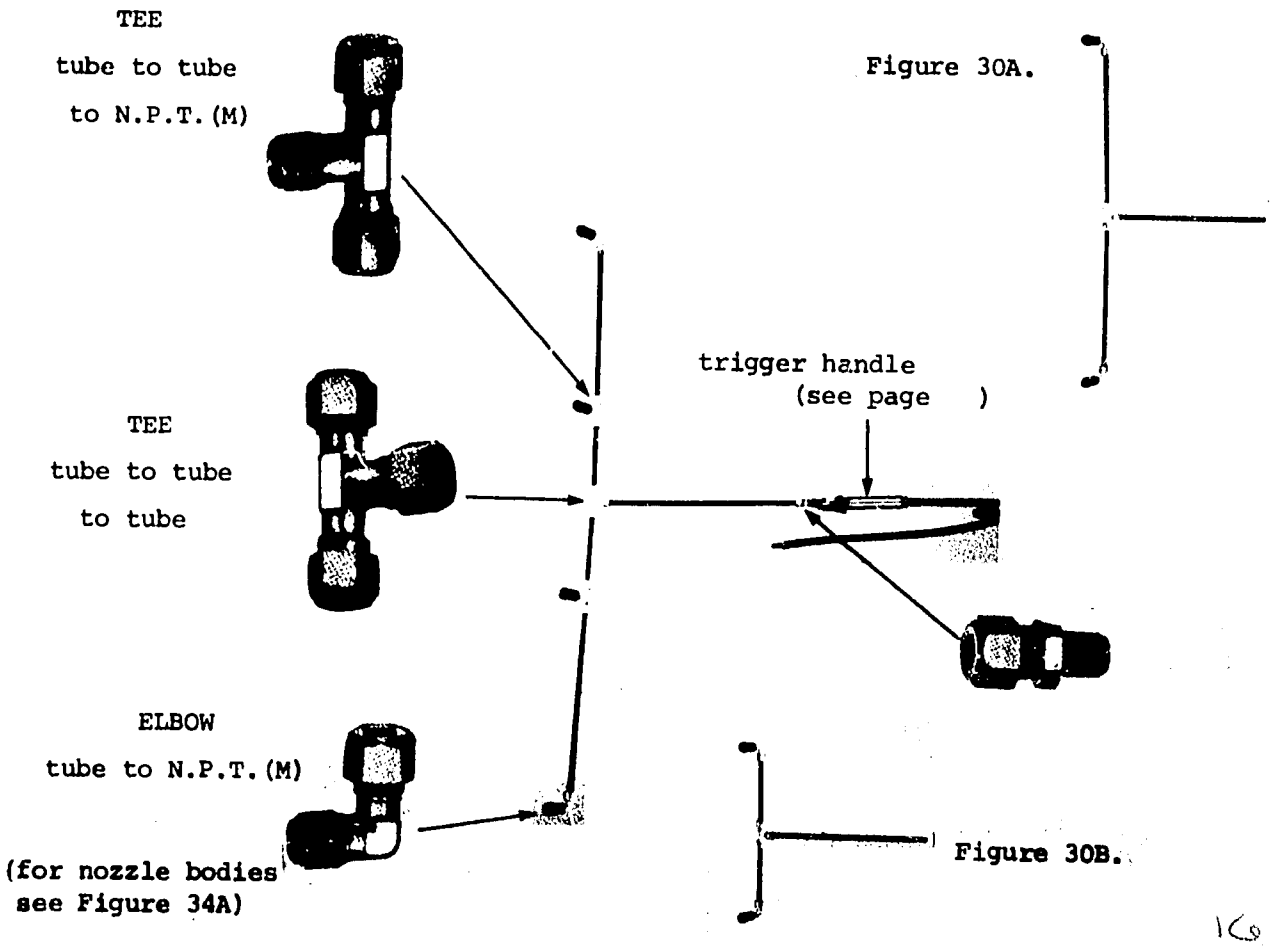
15

ever there is refrigeration. We have not used the soft tubing that comes in bulk coils but have made booms using hard drawn tubing that commonly comes in 12 ft. lengths. Figure 30 shows a boom made with copper tubing, using polypropylene fittings.

The tubing was cut to 12 inches (33 cm) giving a nozzle spacing of 14 inches or 35 cm. The shorter pieces of tubing in the middle are 6 1/4 inches (16 cm) long. The two insets show two-nozzle booms, using the same material. In this example (Figure 30A) the two longer end sections have been used, giving 28 inches (71 cm) between nozzles. If e.g. 95° tips are used then this boom would be held approximately 20 inches (52 cm) above target area to be sprayed.

With the smaller two-nozzle boom (Figure 30B) the middle sections of tubing have been used to make a boom to cover a narrower swath: the nozzles are 14 inches apart, as in the four-nozzle arrangement. If one chooses to use 80° tips then the boom will be held at approximately 13 inches. The plastic fittings used in Figure 30 have hexagonal nuts (ferrules) requiring no flaring or other preparation of the tubing other than a clean, straight cut. The tubing is inserted into the loosened fitting until it bottoms out, then the ferrule is tightened securely. Finger tight has been found satisfactory for the low pressures used in herbicide spraying. One failing noted was that the boom will rotate slightly on the delivery lance section from abrupt wrist movement at the trigger handle. Plastic fittings are cheaper than metal, display good reusability and ease of assembly and disassembly, but are not as sturdy.

Figure 30.



For convenience, Spraying Systems Trigger Tee Jet valve and strainer handle has been used throughout as a component part in manufacture of these booms, the following pictures show some options for this unit (Figures 31-33).

The four-nozzle boom in Figure 34 has been put together using the same tubing material as in Figure 30, but with all brass fittings. These are Intru-Lok , flareless fittings, designed to permit tube entry and fitting make-up without removal of the nut and ferrule. The tube, which should be cut off squarely, is simply inserted through the nut and ferrule until it bottoms on the seat within the fitting body. The nut should be screwed down finger tight, the boom parts properly aligned, then wrench tightened 1 turn. This should allow the boom to be disassembled and rebuilt a maximum number of times.

Figure 31.

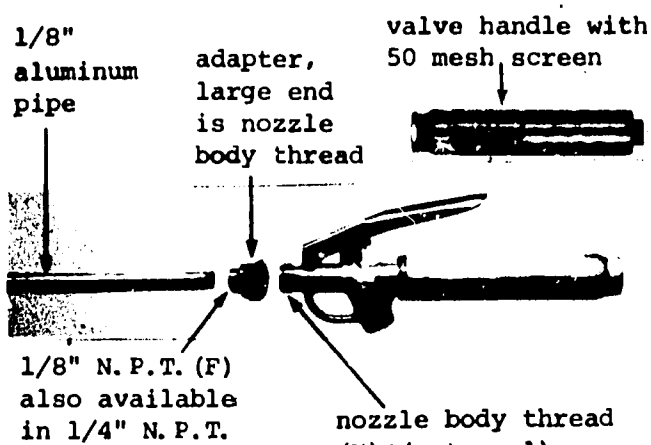


Figure 32.

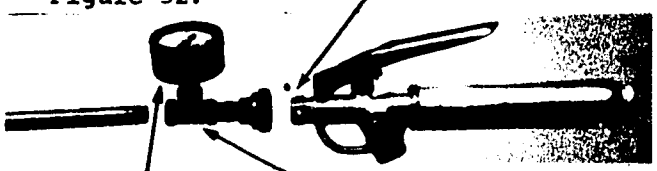
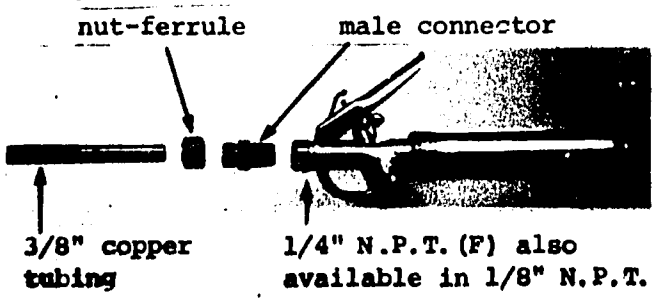


Figure 33.



The illustration below depicts half of a four-nozzle boom. For standardization of tubing and/or pipe lengths the delivery lance section can be the same length as the longest boom section, in this picture, 15 inches (38 cm). Though for a tall person, this could make the delivery lance too short for the boom to be comfortably held at the desired height.

Figure 34.

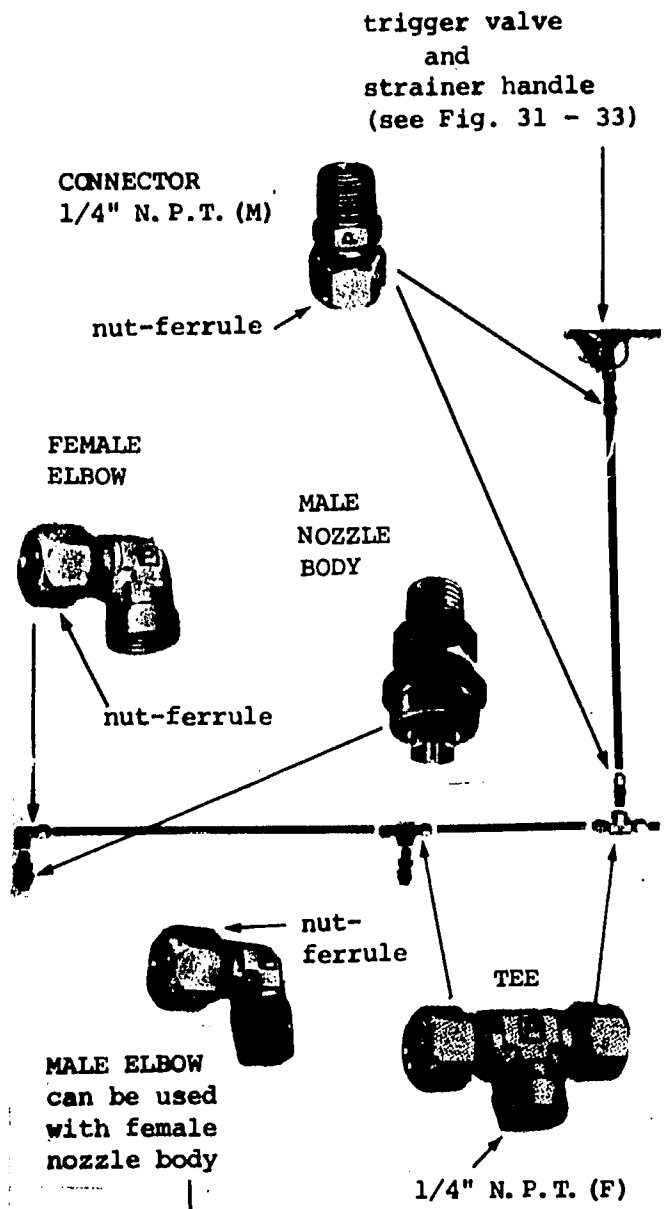
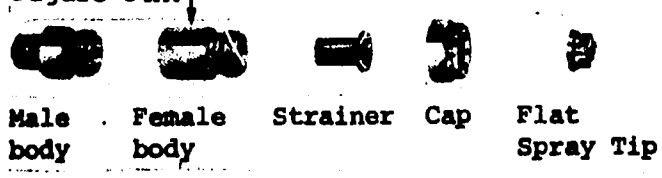


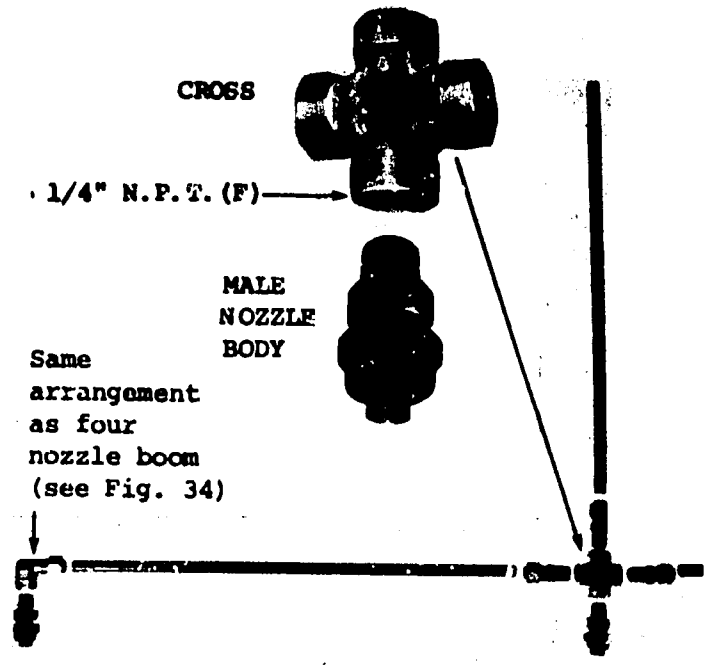
Figure 34A.



Using the same material as in the previous example (copper tubing 15 inches long) with the addition of a pipe cross, a three-nozzle boom may be constructed. Half of which is shown here.

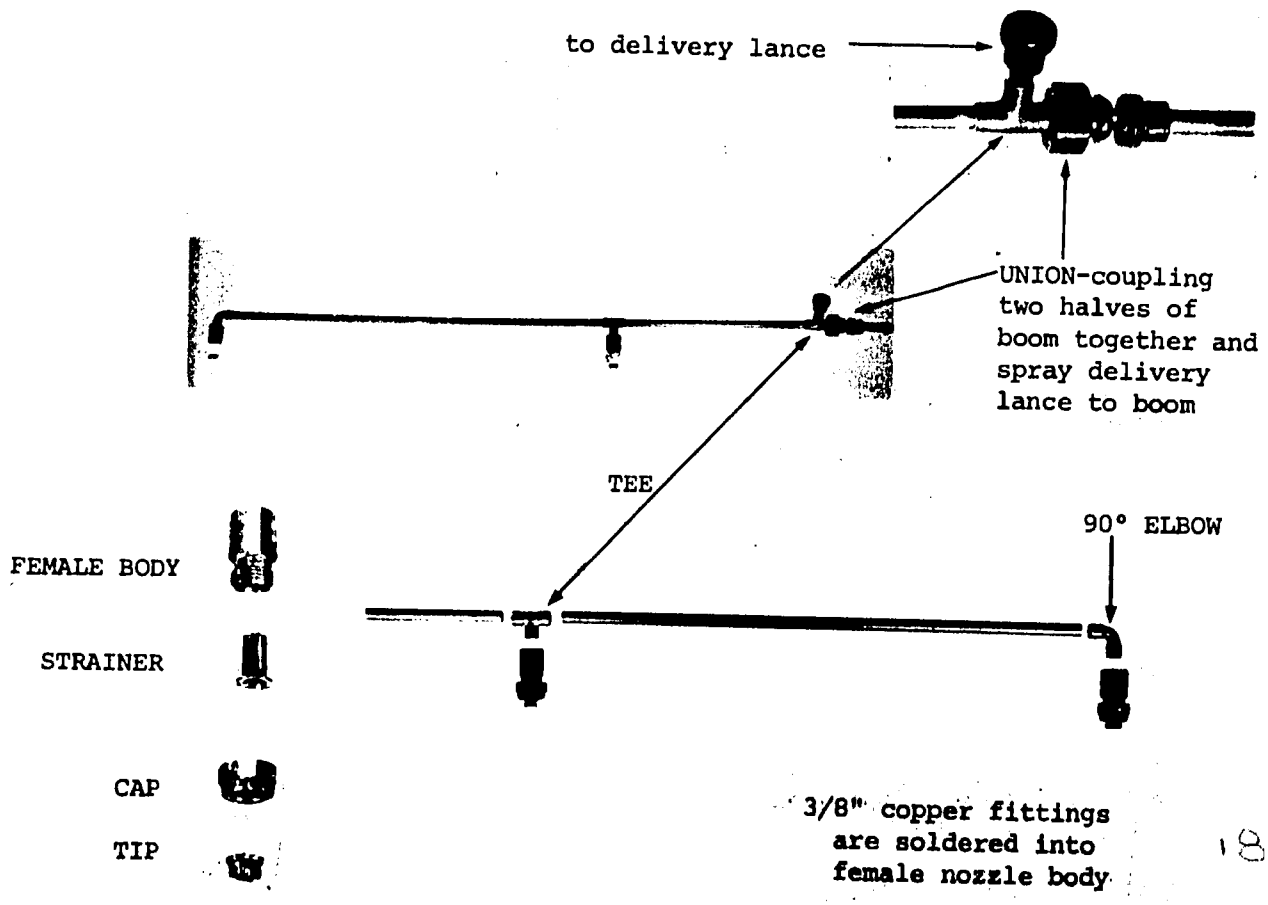
This boom will have 16 inches (41 cm) between nozzles for a total coverage of four feet or approximately 120 cm.

Figure 35.



Where threaded or ferrule type fittings are unavailable one may go to sweat soldered fittings as used in refrigeration lines. See Figure 36 showing half of a four-nozzle boom, again using 3/8" copper tubing.

Figure 36.



If a person has occasion to use several booms with the same sprayer; it is helpful if the booms can be quickly changed. A fast convenient way to facilitate this interchangeability is to cut the delivery hose approximately mid way, install proper size hose shanks (hose barbs) (Figure 37A) secured with hose clamps and attach quick couplings, or purchase as a complete unit (see Figures 40 and 41).

The female coupler* should be on the portion of the hose left attached to the sprayer. This will prevent leakage through the line when the union is uncoupled. Do not uncouple while there is pressure in the line as the spray liquid will momentarily spurt out. Male couplers* are affixed to hose ends of all boom options on hand. See Figures 40-42 for quick couplers.

Figure 37.

Figure 38.

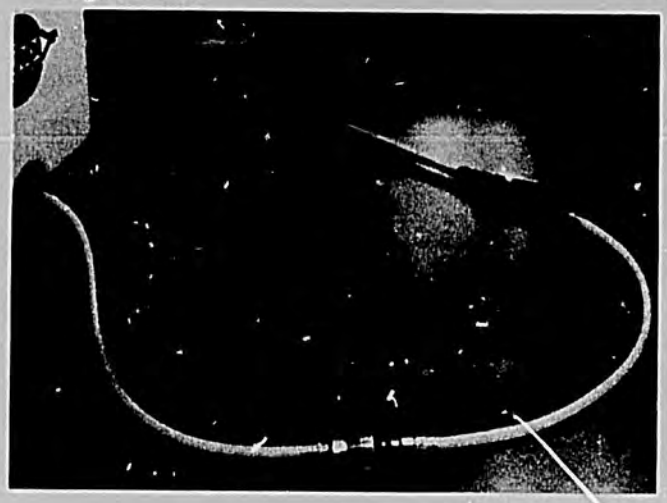
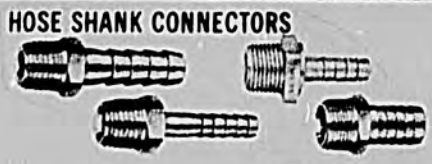


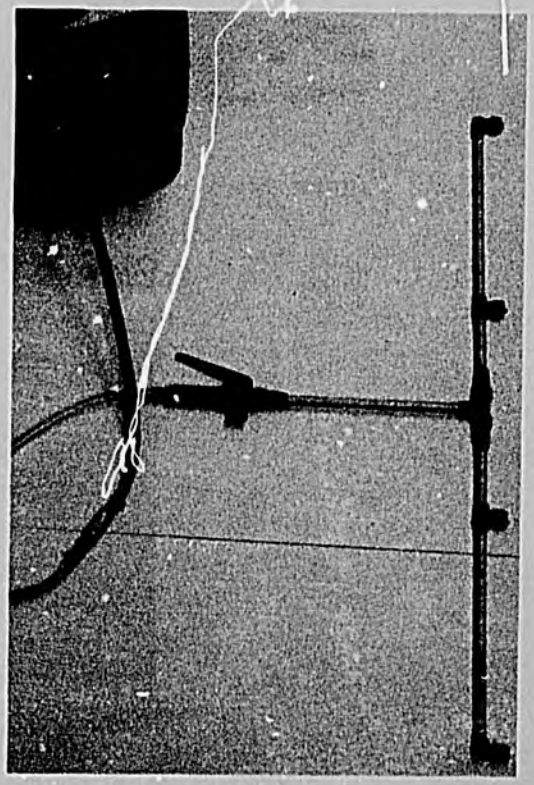
Figure 37A.



Swivel type hose shank

This type of hose shank is designed to be used with nozzle body cap

Figure 39.



*Designation of male and female couplers is in common use though professionally they are coupler and nipple.

19

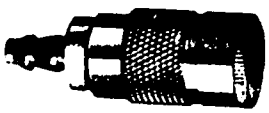
couplers

Female Pipe Thread

Male Pipe Thread

Standard Hose Barb

Push-Lok Hose Barb



Reusable Hose Fitting

Figure 40.

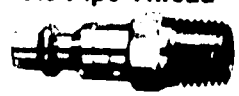
The primary function of a quick disconnect coupling is to allow quick and easy connection by hand of a flexible hose to another hose or to a rigid piping while sealing the media to prevent loss of fluid or energy.

Straight thru couplings are made without valves in either half. They are normally used in fluid systems where external valves are available such as the trigger valve on your spray lance (see Figures 31-33).

nipples

Female Pipe Thread

Male Pipe Thread



Standard Hose Barb

Push-Lok Hose Barb

Reusable Hose Fitting

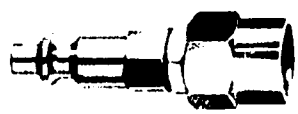


Figure 41.

Sleeve Type

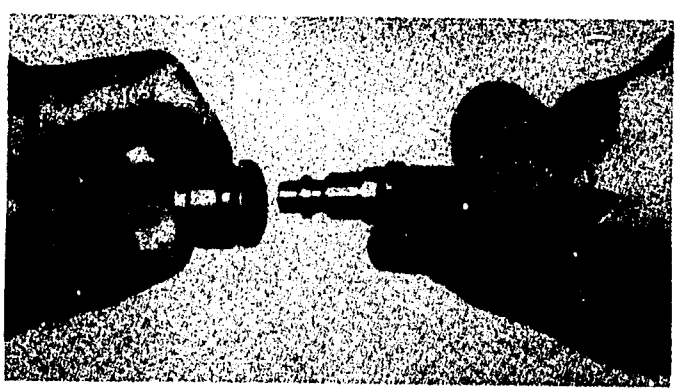
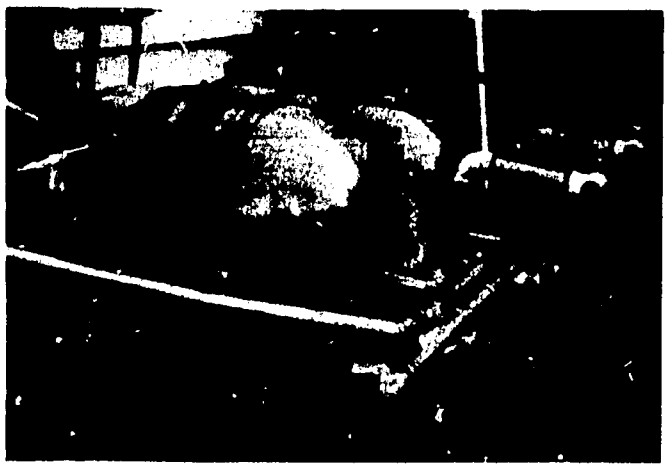


Figure 42.

20

Yet another style of boom we have made and used is the inline type with eyelet nozzle bodies on 1/4 inch stainless steel pipe. The one pictured below is mounted on a single wheel bicycle type plot sprayer, one of the many uses to which this boom has been put.

Figure 43. Ten inch spacing between nozzles to allow for low boom height used in small plot herbicide research.



PETCOCK

By inserting carrying handles made from 1/4" pipe, a long boom can be supported between two people as in Figure 44.

Eyelet nozzle body for 1/4" pipe (approx. 1/2" actual size, "tubing")

Figure 45.

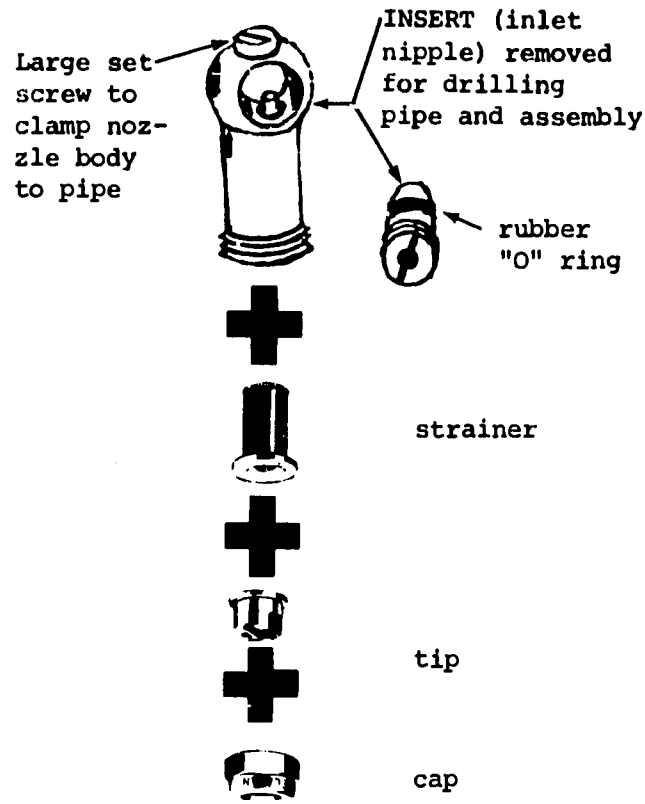
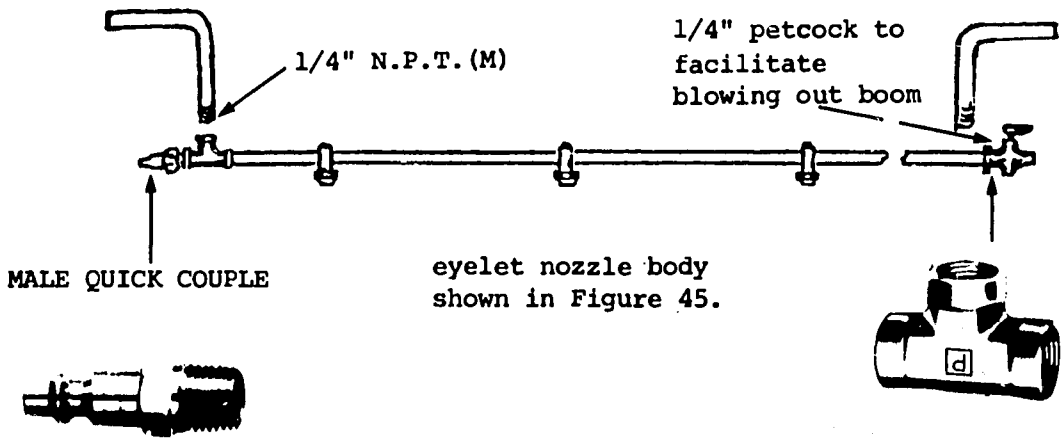


Figure 44.



(see Figure 41.)

addition of pipe TEE required to attach carrying handle

21

Drilling several holes in a perfect straight line on a hard, rounded surface, e.g. stainless steel pipe, can be a time consuming, expensive, and frustrating task.

We devised a simple, low-cost method for accurate drilling based on an inserted drill guide. Here's how it works:

1. remove the nozzle insert and "O" ring from inside the nozzle bodies;
2. slide the desired number of nozzle bodies onto the pipe (future boom);
3. space the bodies along the pipe at predetermined intervals;
4. lay the pipe out on a flat straight surface and allow the bodies to all rest on the surface, thereby placing them in a straight line;
5. tighten the set screw on each body---all the bodies should now be spaced, aligned, and firmly set on the pipe;
6. now clamp the boom assembly in a vise, slip the drill guide into the first body, insert the drill bit into the guide hole, and commence drilling, no need to use a center punch;
7. drill a hole for each body;
8. replace the insert with "O" ring in each nozzle body.

Key to the system is the drill guide, a short length of round mild steel stock which is placed in a lathe, center bored, and machined to an outside diameter that just fits inside the nozzle body (15/32"). The top collar of the guide has two "flats" in case the guide has to be held to keep it from rotating while drilling nozzle holes.

Figure 46.

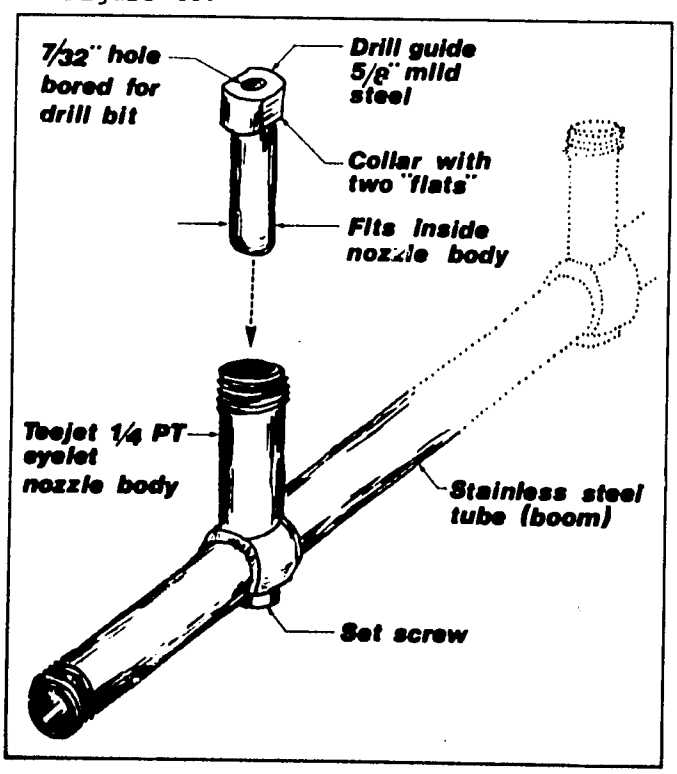


Figure 47.

Same boom as in Figures 43 and 44 being used to spray small experimental plots in rice with compressed air type sprayer, backpack could be used. Trigger handle is coupled directly to boom.

22

Figure 48.

Long boom with carrying handles. The nozzle tip orifice size (and consequently volume of spray) would have to be reduced for this size boom in order for backpack sprayer to keep up operating pressure.

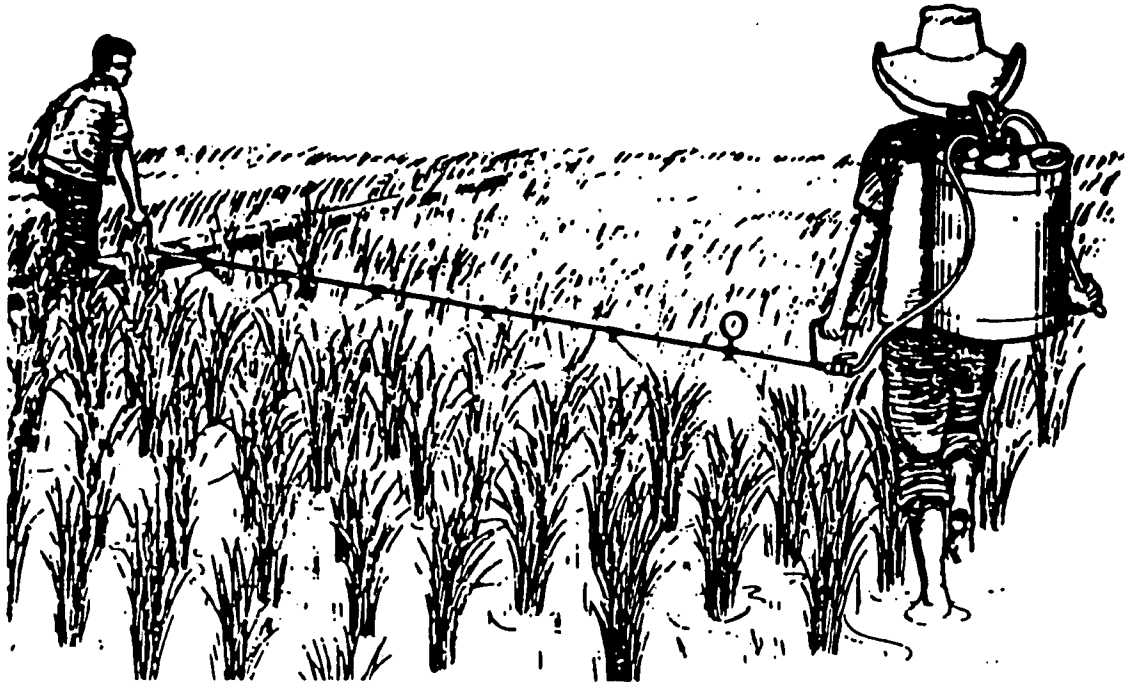


Figure 49.

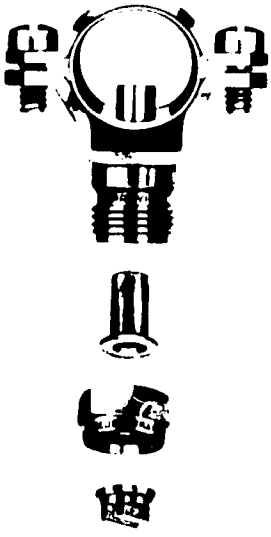


Figure 50.

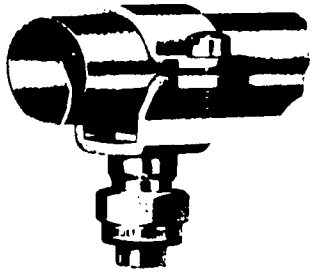


Figure 51.

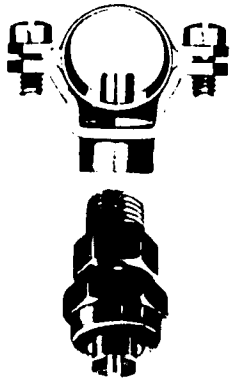


Figure 52.

Figure 53.

SPLIT-EYELETT nozzle bodies can be used on larger pipe, i.e. 1/2" (approx. 13/16" actual O.D.)

Material of this dimension is somewhat impractical because of the volume of fluid needed to fill the large I.D., pipe which would also contribute to its already excessive weight.

But this type of body is versatile, Figure 51 shows the split-eyelet with female outlet connection in a choice of 1/8" or 1/4" N.P.T.

This facilitates using male nozzle bodies or connecting a pressure gauge as in Figure 52.

This unit can also be used for attaching hose and drop pipes, though either of these uses would rarely be applicable to the small hand held boom.

Installing split-eyelet bodies on boom (1/2" pipe or 7/8" tubing) consists of drilling 9/32" diameter holes, appropriately spaced along boom material, inserting inlet nipple and clamping assembly in place. Boom drilling technique on page 20 cannot be used here as the inlet nipple in this unit cannot be removed.

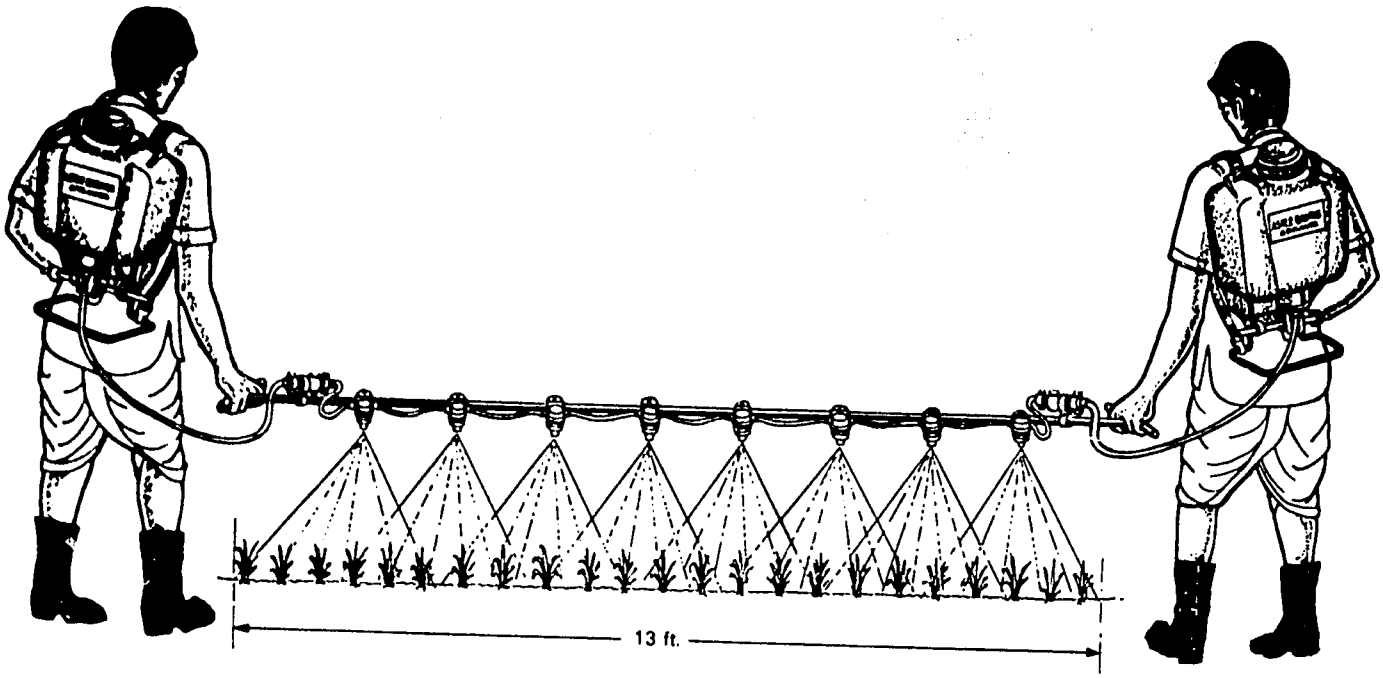


Figure 54.

Another type of nozzle body mounting that loses out in the light weight division but whose attributes deserve mentioning is the variable spacing body assembly. Figure 54 shows a two-man boom manufactured in India using this unit. Its main feature is, as the name implies, the option of readily changing the nozzle spacing as they are connected one to another with flexible hose. The clamps can be moved along the supporting boom to the desired spacing. They also allow using either pipe, round or square tubing as boom material (Figures 55-57).

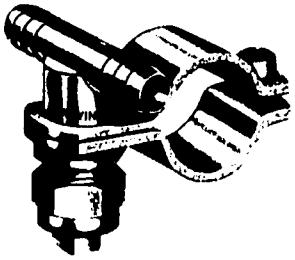


Figure 56.

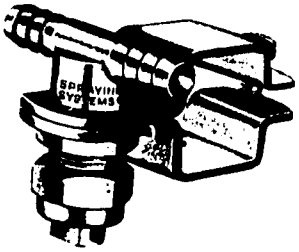


Figure 57.

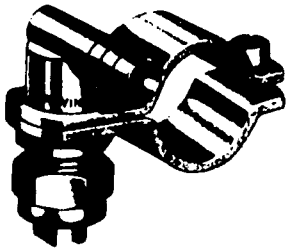


Figure 55.

end piece

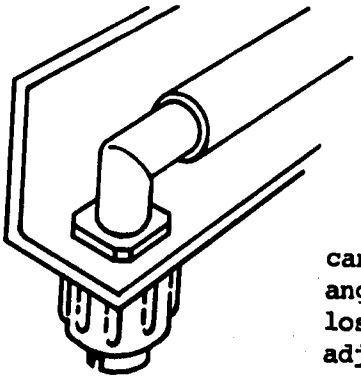
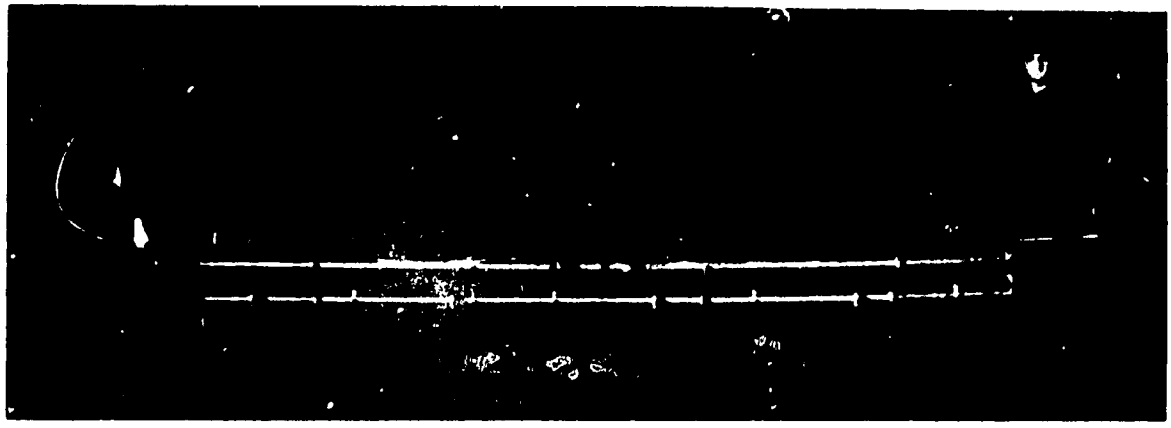


Figure 58.

can be mounted on angle iron, with loss of spacing adjustability

24



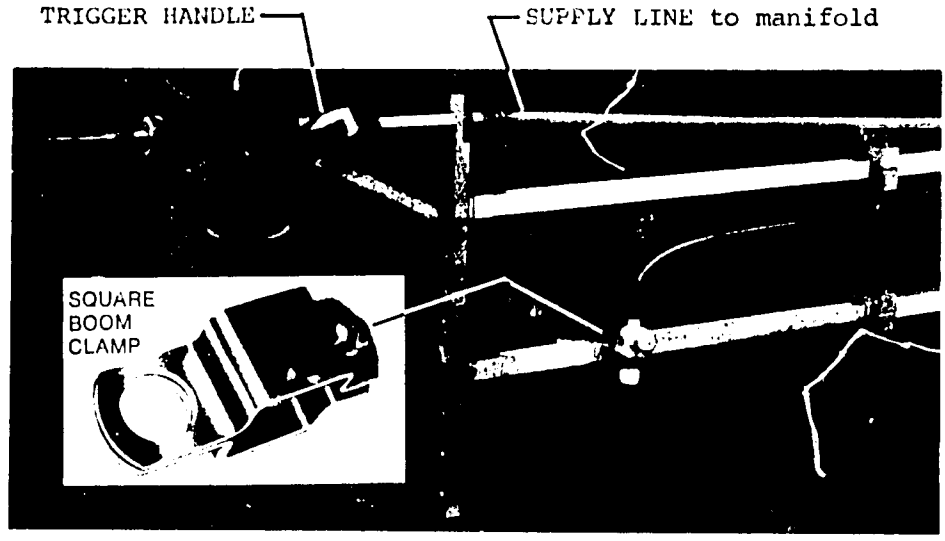


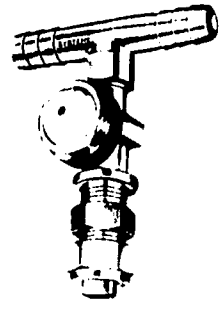
Figure 59.

Long boom requiring two people, constructed from square tubing with a centrally-located manifold using individual feeder lines to each nozzle. In this way all nozzles receive equal pressure and an equal volume of spray liquid. In an arrangement where the boom itself is the delivery line, pressure falls off due to friction of the fluid in the line. Therefore, the nozzle furthest from the point of spray solution entry will be operating at a slightly reduced pressure from the next one closer and so on down the line.

The type of nozzle body used here has a diaphragm check valve as an integral part of the nozzle assembly. Originally developed for use in aerial spraying. They give instant drip-free shut off when pressure drops to 7 p.s.i. There are more designs available than those shown here.

Figure 60.

Figure 61.



Some manufacturers offer extra equipment for their sprayers, such as rear mounted booms, Figures 62 and 63; and shielded spray attachments, Figures 64 and 65.

Figure 62.

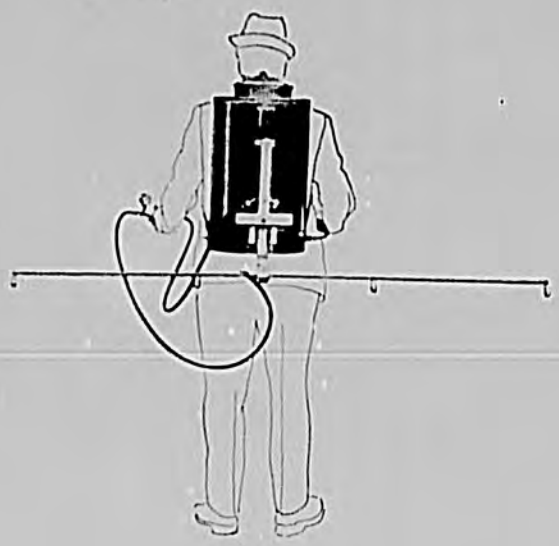


Figure 63.

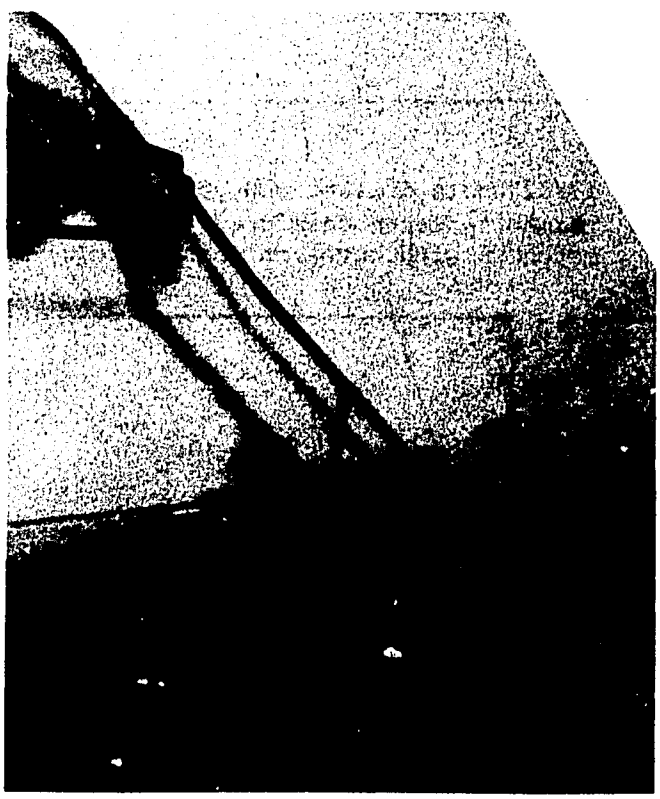
Figure 64.

Figure 65.

Figures 66 and 67 show a wheeled nozzle carrier, designed for directed postemergence herbicide application. The side wings shield the crop and are adjustable for varying row spacing.

Figure 66.

Figure 67.

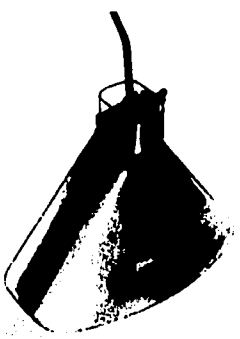


The trigger handle on the supply line from the knapsack is attached directly to the nozzle carrier handle, cum steering column, which acts as the supply line to the nozzle. The dual wheels tend to over respond to steering pressure, necessitating constant alert guidance.

Figure 68.

There are also small shields commercially available that attach directly to the hand held spray wand (Figures 68 and 69).

Figure 69.

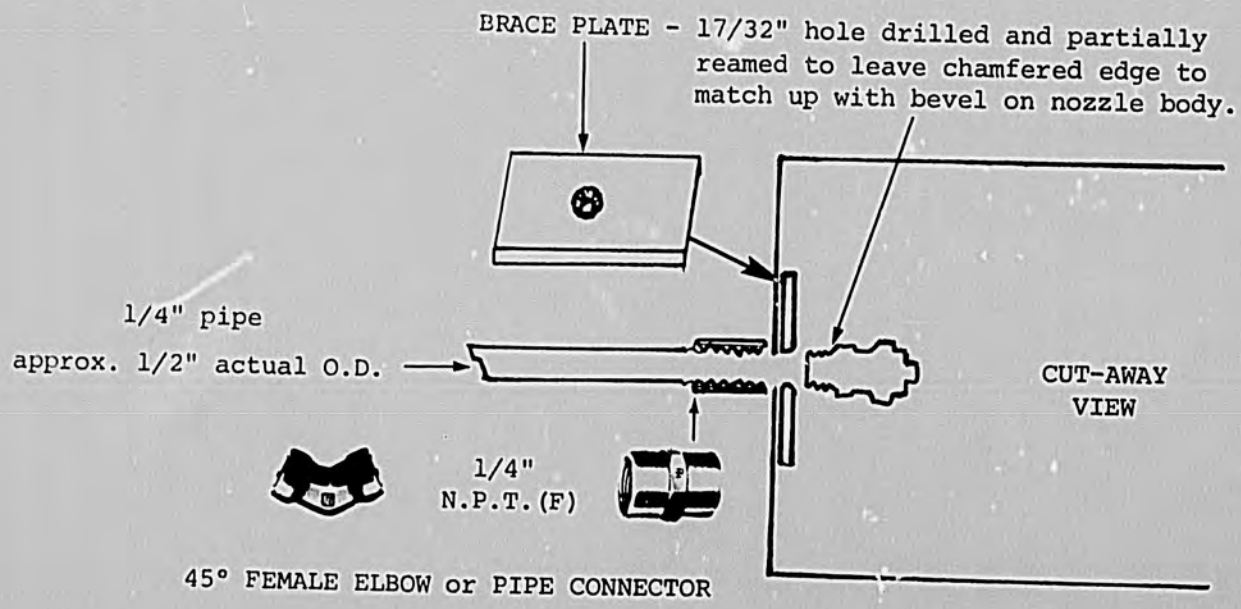


If commercially unavailable, a spray shield can be made from cardboard (short term use) or a large can, as depicted below. A 1/2" hole is drilled through the bottom of the can at center, through which a nozzle body is threaded into a short straight pipe coupling, as in the diagram, in which case the spray lance is bent to give a slight angle (Figure 70) or a 45° female elbow can be used. A reinforcing plate can be installed as shown. This shield worked well, is very durable, though rather weighty.

Figure 70.

Figure 71.

Figure 72.



Directed spray shields designed to protect young conifers. Used with knapsack sprayer.

Figure 73.

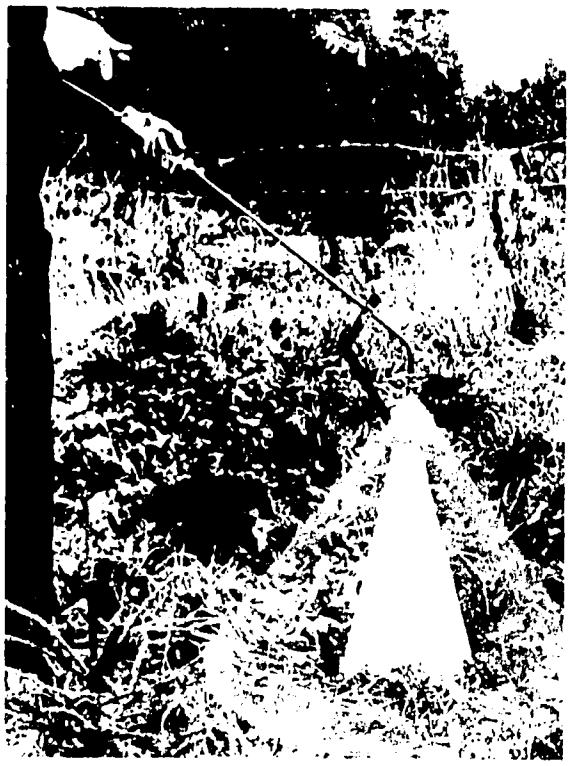


Figure 74.

As mentioned previously under TYPES OF SPRAYS - FLOODING, using a multiple nozzle boom for forestry spraying can be awkward at best. An Oregon State University, Douglas County extension agent designed and built a spray lance attachment mounted to the rear of a knapsack, featuring a single flood jet type nozzle. The prototype pictured in Figure 75 shows flood nozzle in vertical up position on 14 inch (35 cm) delivery lance (3/8" copper tubing, 1/8" aluminum pipe).

Figure 75.

In Figure 76 an extension has been added giving more clearance if higher brush is encountered. With the extension pipe bent to a slight angle the flood tip is set at a semi-horizontal or semi-vertical up position.

Figure 76.

Simulated spraying of broadleaf herbicide (water substituted) for conifer release, using knapsack sprayer equipped with one flood nozzle. During actual application operator would wear protective head gear.

Figure 77.

HOW TO CALIBRATE A SPRAYER

Proper calibration of a sprayer--finding out how much spray is pumped out in a given time and the area that can be covered (walked over) in this same time--can be a sore spot for even a professional applicator, though it is not all that complex. The average homeowner or backyard gardener needn't be too concerned; carefully following the recommended amounts spelled out on the pesticide container label should suffice. But for those who spray larger areas, calibration is important, both economically and environmentally.

Here is a well-tested technique for determining the amount of pesticide that will be applied per acre.

Step 1 - Make sure the sprayer is in good working order (no leaks, blocked nozzles, etc.). Also make sure it has been washed thoroughly and that it contains no pesticide. Fill it half full of clean water (only) and practice using it to get a feel for the best spray pattern, manner of spraying, coverage, etc.

Step 2 - Measure and mark out a square rod (16 1/2 X 16 1/2 ft). Calibration should be done on a surface similar to that to be sprayed.

Step 3 - Fill the sprayer half to two-thirds full of clean water. Put it on and time yourself (or have a helper do it) while spraying the entire square rod at a walking speed that is comfortable and which must be maintained throughout calibrating and, of course, during actual spraying operations. Note the time. Make a second or even third run to confirm (or average) the elapsed time.

Step 4 - Add more clean water to the sprayer and operate it in a similar manner to actual spraying, but in a stationary situation using a suitable measuring device to catch the spray

coming from the nozzle for the same amount of time needed to walk over the square rod. Measure the amount of water collected. Repeat this step a second time to confirm results.

Step 5 - Perform the calculations. Here's why a square rod was suggested: 160 square rods = 1 acre; and 16 cups = 1 gallon (1 cup = 1/2 pint or 8 ounces). Therefore the amount (in cups) sprayed out (in the same time it took to cover the square rod) times 10 equals gallons per acre, the application rate value used for most pesticides.

EXAMPLE: Time to cover a square rod = 50 seconds; Spray collected for 50 seconds = 24 oz. of water or 3 cups; Therefore, volume of spray the sprayer will apply is: 10 X 3 = 30 gal/acre.

You have just calibrated your sprayer.

Now, how is calibration used? Assume that the rate recommended on the label of the pesticide to be used calls for 1 quart/acre. The calculation would be:

Since 30 gallons are going to be applied per acre (as calibrated), an equal part of that quart is needed in each gallon, or 1/30 of a quart (1 quart/30 X 32 ounces/1 quart = 1.1 ounces). If the sprayer is to be filled with 2 gallons of water, then add 2.2 ounces of pesticide (2 X 1.1 ounces).

For those that prefer to operate metrically, the same procedure applies:

Step 1 - Same.
Step 2 - Substitute a 10 X 10 meter (or 100 square meter) area.
Step 3 - Same.
Step 4 - Same.
Step 5 - Perform the calculations. There are 10,000 square meters in a hectare, so the measured 100 square meters represents 1/100 of a hectare. Therefore, the amount of water sprayed out (in the same time it took to cover the 100 square meters) times 100 equals liters per hectare.

EXAMPLE: Time to cover 100 square meters = 180 seconds

Spray collected for 180 seconds = 2 liters

Therefore, volume of spray the sprayer will apply = 2 X 100 = 200 liters/hectare.

PESTICIDES AND SAFETY

Pesticides are chemicals and must be handled with caution.

Toxicity can be acute or chronic; attention often focuses only on the acute form. Less information is available on chronic toxicity; however, both forms should be kept in mind. For instance, researchers are more likely to suffer chronic toxicity from handling pesticides than acture toxicity from swallowing them. At home the greatest hazard is probably from accidental ingestion.

Pesticides can be hazardous when ingested, absorbed through the skin, splashed into the eyes, or inhaled as spray or dust. The general rule: for ingestion of noncaustic materials, induce vomiting; for caustic materials, vomiting should not be induced. In any event, material should not be allowed to get into the trachea and lungs (respiratory system). For skin contamination, the exposed area should be thoroughly rinsed with water followed by an extensive washing with soapy water and then a second thorough rinse. Eye contamination requires thorough multiple washings with clean water.

A person with the first suspicion of complications should be taken to a hospital for surveillance and medical care.

In some regions there are reference centers on poisoning that can be contacted for information, or in case of emergency. Researchers working in areas where this service is not available should keep a list for first aid

measures handy for the different types of pesticide toxication.

Labels of commercially available pesticides should contain indications as to toxicity, and some contain first aid measures. This information is usually not provided with experimental pesticides. Consequently the latter should be handled as dangerous materials.

PESTICIDE STORAGE

Pesticides should be stored in a specific room, shed, or area having a lockable entry with key(s) assigned only to authorized individuals.

The storage area should be maintained above freezing temperature and protected from excess heat; use a fan if necessary. Adequate ventilation is also essential and a washable floor (preferably concrete) desirable. Sunlight entering the area should be kept off glass containers to prevent light-caused degradation.

Store pesticides in an orderly system; they should be dated on receipt and discarded after two years if intended for research work (one year in the tropics). A periodic inventory helps to maintain fresh, adequate supplies.

It is imperative that there be no smoking around chemicals. Most solvents used to dissolve pesticides are flammable so the use of matches, flame, or cigarettes may cause a serious accident. Storage and mixing areas should be equipped with a chemical fire extinguisher.

DISPOSAL

Pesticide containers though appearing to be empty, may still hold traces of chemical. The recommended procedure is to rinse the container at least three times with clean water at the time it is emptied so rinse water can be put in the sprayer and sprayed on the target area. Never reuse containers to carry water etc. Local laws should be checked to determine if there is a prescribed place to dispose of empty containers. If not the containers should be perforated or broken and disposed of by burying in an area where there is no water management. Soil microorganisms are the best and safest decomposers of pesticides. Certain materials are not decomposed by burning; therefore, humans and animals should not be exposed to the smoke from burning containers.

Waste water from the preparation area needs to be carefully controlled. It should not be allowed to run into an area where it may be used by humans or animals; also, it should be kept away from crop irrigation systems.

Do not dump excess chemicals after spraying, except in a specific disposal pit or other area that will not result in land, crop, or other environmental contamination.

APPLICATION

Certain safety steps should be observed when spraying.

Wind

Avoid spray applications when blowing wind will cause spray to drift onto nearby persons, crops, or test plots. Spray can be applied during moderately breezy conditions provided application moves in the direction of the wind; spray will then be blown away from, not onto, the operator.

When wind is a problem, reduce drift by using nozzles that emit a coarse spray. Also operate a sprayer at the lowest possible pressure consistent with spraying needs and label recommendations. The sprayer has to be calibrated again for spraying under this changed condition.

Protective Gear

For safety, a person applying pesticides (an operator) should understand the potential hazards to himself and others and should be properly motivated to take necessary precautions. An operator should both change clothing (and have it washed) and bathe thoroughly with soap and water after each

day's spraying operations. Protective clothing should be worn (depending on the toxicity of the pesticide being applied) including a long-sleeved shirt or coat, hat, rubber gloves, respirator, and eye protector. In hot humid climates such clothing will not be comfortable, but should be used when indicated. Boots are needed to protect feet and ankles often applicators walk through the treated area.

Common sense and an accurate, cautious approach to research will prevent most problems. An operator must NOT drink, eat, or smoke while spraying or handling pesticides.

Inclusion in this publication of items, equipment or pieces thereof or information pertaining to, does not constitute endorsement of them or any firm or company nor does exclusion signify rejection or criticism.

If the reader has difficulties in obtaining building materials discussed in this publication, such as fittings, please write to:

The International Plant Protection Center
Oregon State University
Corvallis, Oregon 97331 / U.S.A.