is up to 6 to 8%, O_2 is down to 10%, and there is a little ethylene. One of the benefits of the tight boxes, we feel, is the high CO_2, which should reduce respiration.

Tuesday Evening, December 11, 1984

Dave Beattie moderated the Educational Program. The following paper by Dave Williams was part of that program.

USE OF A SPRAY PATTERNATOR TO DEMONSTRATE LOW-PRESSURE PESTICIDE APPLICATION

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The selection of the proper pesticide to control a known pest is only the first step in implementing a spray program. It is essential that the pesticide be applied properly to insure that the desired pest control will occur in an efficient manner without waste or environmental contamination. More pesticides are applied with low-pressure sprayers than with any other kind of equipment. These sprayers apply chemicals to control weeds, insects, and diseases in field, nursery, vegetable and fruit crops, and turf. Tractor-mounted, pull-type, and self-propelled sprayers are available in many models; however, these may not be available to the classroom teacher or be too cumbersome to use for demonstration purposes. The use of a portable spray patternator allows the instructor to demonstrate the concepts of proper pesticide application in a limited area. The spray patternator, due to its portability, is also useful for extension meetings.

All low-pressure sprayers have several basic components: a pump, a tank, an agitation system, a flow-control assembly, and a distribution system. Spray pressures range from almost 0 to about 200 psi and application rates can vary from 10 to over 100 gal/A.

The spray patternator can be used to demonstrate the effects of pressure, boom height, nozzle placement, and nozzle type on spray patterns. The use of a strobe light behind the spray pattern illuminates the pattern so that it can be easily seen by the audience. Plans for the construction of a portable spray patternator are available from the author.

The spray patternator is an effective teaching tool for studying spray distribution systems. The following is a discussion of distribution systems that should prove useful to instructors and pesticide applicators.

All hoses and fittings should be of a suitable quality and strength to handle the chemicals at the selected operating pressure. They should be chosen on the basis of composition, construction, and size.

A good hose is flexible, durable, and resistant to sunlight, oil, chemicals, and general abuse, such as twisting and vibration. The hose must be resistant to the chemical action of spray materials. The outer coating of the hose should be chemically resistant because spray may occasionally contact it. Two widely used materials that are generally chemically resistant are ethylene vinyl acetate (EVA) and ethylene propylene dione monomer (EPDM). A special reinforced hose must be used for suction lines to prevent collapsing.

Peak pressures are often encountered that are much higher than average operating pressures. These peak pressures usually occur as the spray boom is shut off. For this reason, the sprayer hoses and fittings *must be in good condition* to prevent a possible break and the operator being covered with the spray chemical.

Spray lines and suction hoses must be the proper sizes for the system The suction hoses should be air-tight, noncollapsible, as short as possible, and as large as the pump intake. A collapsed suction hose can restrict flow and "starve" a pump, causing decreased flow and damage to the pump or pump seals. When you cannot maintain spray pressure, check the suction line to be sure that it not restricting flow.

Other lines, especially those between the pressure gage and the nozzles, should be as straight as possible, with a minimum of restrictions and fittings. The proper size of these lines varies with the size and capacity of the sprayer. A high, but not excessive, fluid velocity should be maintained throughout the system. If the lines are too large, the velocity will be so low that the pesticide will settle out and clog the system. If the lines are too small, an excessive drop in pressure will occur. A flow velocity of 5 to 6 ft/sec is recommended. The suggested hose sizes for various pump rates are listed in Table 1.

Boom stability is important in achieving uniform spray application. The boom should be relatively rigid in all directions. Swinging back and forth, or up and down, is undesirable. The breakaway hinge arrangement of the boom should be dampened so that the boom is rigid in the fore and aft direc-

Table 1. Suggested hose sizes for various pump sizes

Pump output (GPM)	Hose sizes Suction (inches)	Pressure
0-1	½	¼
1-3	½	⅜
3-6	¾	½
6-12	¾	⅝
12-25	1	¾
25-50	1¼	1
50-100	1½	1¼

ion. The boom should be constructed to permit folding for transport. Check for interference of the folded booms with tractor cabs and roll bars. The boom height should be adjustable from about 1 to 4 feet above the ground.

Certain commonly used chemicals will react with some plastic materials. Check with the sprayer manufacturer and the chemical manufacturer for compatibility.

NOZZLES

The proper selection of nozzle type and size is the most important part of pesticide application. The nozzle determines the amount of spray applied to a particular area, the uniformity of the applied spray, the coverage obtained on the sprayed surfaces, and the amount of drift. You can minimize the drift problem by selecting nozzles that give the largest drop size, while providing adequate coverage at the intended application rate and pressure. Although nozzles have been developed for practically every kind of spray application, only a few types are commonly used on low pressure sprayers. These types are described below.

Regular Flat-Fan Nozzles. Regular flat-fan nozzles are used for most broadcast spraying of herbicides and for certain insecticides when foliar penetration and coverage are not required. These nozzles produce a tapered-edge, flat-fan spray pattern, and are available in several selected spray-fan angles, although 80-degree spray-angle tips are most commonly used. The nozzles are usually on 20-in. centers at a boom height of 10 to 23 in. The boom heights for various spray-angles are shown in Table 2.

When applying herbicides with flat-fan nozzles, keep the operating pressure between 15 and 30 psi. At these pressures, flat-fan nozzles produce medium-to-coarse drops that are not as susceptible to drift as the fine drops produced at presssures of 40 psi and higher. Regular flat-fan nozzles are recommended for some foliar-applied herbicides at pressures from 40 to

Table 2. Boom heights for various spray angles

Spray angle (degrees)	Boom height, 20-in spacing (inches)
65	21-23
73	20-22
80	17-19
100	10-12

60 psi. These high pressures will generate fine drops for maximum coverage on the plant surface.

Because the outer edges of the spray pattern have tapered or reduced volumes, adjacent patterns along a boom must overlap in order to obtain uniform coverage. For maximum uniformity, this overlap should be about 40 to 50% of the nozzle spacing.

The LP or "low-pressure" flat-fan nozzle is available from the Spraying Systems Company. This nozzle develops a normal fan angle and distribution pattern at spray pressures from 10 to 25 psi. Operating at a lower pressure results in large drops and less drift than the regular flat-fan nozzle designed to operate at pressures of 15 to 30 psi.

Even flat-fan nozzles apply uniform coverage across the entire width of the spray pattern. They should be used only for banding pesticides over the row, and should be operated between 15 and 30 psi. Band width is determined by adjusting nozzle height. The band width for various nozzle heights are shown in Table 3.

Table 3. Band width for various even flat-fan nozzle heights

Band width (inches)	Nozzle height 80-degree series (inches)	Nozzle height 95-degree series (inches)
8	5	4
10	6	5
12	7	6
14	8	7

Flooding Flat-Fan Nozzles. Flooding flat-fan nozzles produce a wide-angle, flat-fan pattern, and are used for applying herbicides and mixtures of herbicides and liquid fertilizers. The nozzle spacing for applying herbicides should be 60 in. or less. These nozzles are most effective in reducing drift when they are operated within a pressure range of 8 to 25 psi. Pressure changes affect the width of spray pattern more with the flooding flat-fan nozzle than with the regular flat-fan nozzle In addition, the distribution pattern is usually not as uniform as that of the regular flat-fan tip. The best distribution is achieved when the nozzle is mounted at a height and angle to obtain at least double coverage or 100% overlap

Flooding nozzles can be mounted so that they spray straight down, straight back, or at any angle in between. Position is not critical as long as double coverage is obtained. You can determine nozzle position by rotating the nozzle to the angle required to obtain double coverage at a practicable nozzle height.

Hollow-Cone Nozzles (Disc and Core Type). Hollow-cone nozzles are used primarily when plant foliage penetration is essential for effective insect and disease control, and when drift is not a major concern. At pressures of 40 to 80 psi, hollow-cone nozzles produce small drops that penetrate plant canopies and cover the undersides of leaves more effectively than other nozzles. If penetration is not required, the pressure should be limited to 40 psi or less. The most commonly used hollow-cone is the two-piece, disc-core, hollow-cone spray tip. The core gives the fluid a swirling motion before it is metered through the orifice disc, resulting in a circular, hollow-cone spray pattern.

Whirl-Chamber Hollow-Cone Nozzles. Whirl-chamber nozzles have a whirl chamber above a conical outlet. These nozzles produce a hollow-cone pattern with fan angles up to 130 degrees, and are used primarily on herbicide incorporation kits. The recommended pressure range is 5 to 20 psi.

Raindrop° Hollow-Cone Nozzles.[1] Raindrop° nozzles have been designed by the Delavan Corporation to produce large drops in a hollow-cone pattern at pressures of 20 to 60 psi. The RD Raindrop nozzle consists of a conventional disc-core, hollow-cone nozzle to which a Raindrop can has been added. The RA Raindrop nozzle (a whirl-chamber nozzle with the Raindrop cap) is used for herbicide incorporation, and the RD Raindrop nozzle for foliar spraying. When used for broadcast application, these nozzles should be rotated 30 to 45 degrees from the horizontal to obtain uniform distribution.

Nozzle Tip Materials. Nozzle tips are available in a wide variety of materials, including hardened stainless steel, stainless steel, nylon, and brass. Hardened stainless steel is the most wear-resistant material, but it is also the most expensive. Stainless steel tips have excellent wear resistance with either corrosive or abrasive materials. Although nylon and other synthetic plastics are resistant to corrosion and abrasion, they are

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[1] Registered Trademark

subject to swelling when exposed to some solvents. Brass tips are the most common, but they wear rapidly when used to apply abrasive materials such as wettable powders, and are corroded by some liquid fertilizers. Brass tips are probably the most economical for limited use, but other types should be considered for more extensive use.

Thursday Morning, December 13, 1984

The Thursday morning session was convened at 8:00 a.m. with Ralph Shugert serving as moderator.

CUTTING PROPAGATION OF SOME SHADE AND FLOWERING TREES

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The specific objectives of this paper are to review: 1) reported shade and flowering trees that can be commercially propagated by softwood cuttings, and 2) the morphological characteristics of the growth stage at which these softwood cuttings are most likely to root.

One advantage of propagating trees by cuttage lies in the fact that ease of propagation would stimulate the introduction of regionally-oriented cultivars from superior trees. An important consideration in selecting regional cultivars is the provenance expression of these plants for characteristics such as winter hardiness. As one moves farther north, trees are more photoperiodic responsive. Photoperiod affects vegetative growth, carbohydrate storage, abscission, the onset of dormancy, and overall winter hardiness, to mention a few responses for northern temperate zone trees.

Other characteristics one is searching for when selecting cultivars include disease resistance, environmental tolerance (air pollutants, chlorides, and high water tables), and unique phenotypic expression (habit, flower color, and fruit color and size). Trees selected and propagated with identifiable desirable characteristics could lead to new cultivars for use in park, street, home, or commercial landscapes.

There are several morphological characteristics for *Acer*, *Malus*, *Aesculus*, and *Magnolia* which have consistently indicated the stage at which to take cuttings to be successful. Chapman and Hoover (6) reported that elongation of new