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TECHNIQUES FOR ENHANCED LIQUID PESTICIDE APPLICATION

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ABSTRACT

A portable batery operated spray table has been designed and constructed to quantify and demonstrate the effect of nozzle size, wear and damage, and of pump pressure on sprayer output. The effect of nozzle spacing, pattern, angle, height above ground, and of wind velocity can also be visually demonstrated. Utilizing proper pesticide application techniques can lead to enhanced plant protection and yields, and reduced phytotoxicity, environmental contamination, and monetary cost.

INTRODUCTION

There is a growing concern about protection of the environment and human health and safety as it relates to the use of chemical pesticides. The high cost of such chemicals is also a problem for many people. These issues can be addressed in part by their judicious and proper application. A spray table can be used as an excellent educational tool to demonstrate proper pesticide application techniques, equipment, and calibration. The advantage of a portable, battery-operated unit is that it can be used in the classroom or field without dependence upon electricity. The use of aluminum as the construction material provides strength while still having light weight for transport. In addition, aluminum does not rust when wet or under high humid conditions.

A spray table can be used to very effectively demonstrate sprayer calibration techniques (output/min.) and the effect of wind on spray drift. The importance of nozzle size, spacing, pattern, angle, wear, and height above ground can also be visually demonstrated. The design, construction specifications, and utility of a spray table are herewith presented.

MATERIALS AND METHODS

A spray table was designed and constructed for use in teaching pesticide applicators in industry and traditional college-level students the proper application techniques. The specifications for constructing the table are as follows:

Table dimensions are 182.9 cm in length by 106.7 cm in width by 121.9 cm (back) and 106.7 cm (front) in height (Figure 1).

The frame is made from 3.2 cm x 1.9 cm angle aluminum bars. The table has four legs and is supported by cross braces.

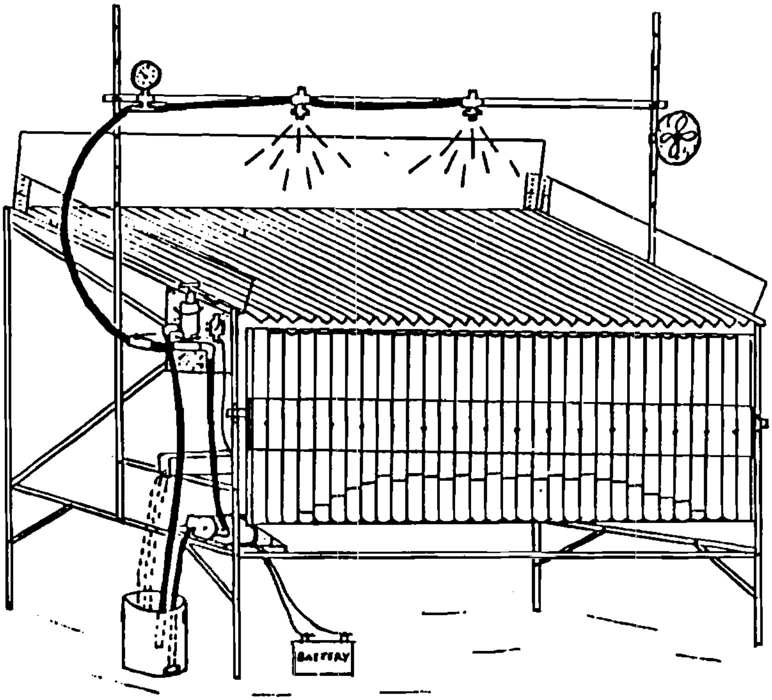

Figure 1. Spray table for demonstrating pesticide application techniques.

On each end of the table there is a vertical support bar for the spray boom which is 152.4 cm in length and extends 83.8 cm above the table surface. Each vertical end bar has holes every 7.6 cm to allow for up and down adjustment of the spray boom.

The spray boom is a steel pipe 193.0 cm in length by 2.5 cm in diameter. It extends across the top of the table from one vertical end bar to the other.

Two quick-snap spray nozzles are positioned on the spray boom 50.8 cm apart. However, these can be adjusted to different desired distances apart.

A pressure gauge is attached to the left end of the spray boom. It is a liquid-filled gauge (0-100 psi, model LFS 220).

Hose (2.5 cm i.d.) extends from the boom to a pressure regulator attached to a panel on the left end of the table. There is also a shut-off valve between the gauge and pressure regulator.

There is a small electric motor and pump positioned on a small platform on the left end of the table (FloJet, model 2100-652). It operates from a 12 volt battery with a 10 amp fuse in line between motor and batery.

A toggle switch is also located on the left end of the table to turn the motor on and off.

An aluminum panel (175.3 cm by 45.7 cm) with 29 glass tubes is positioned on the front side of the table. This panel is attached to a galvanized steel pipe 182.9 cm in length by 2.5 cm in diameter which thereby allows the panel to pivot inward to empty water collected in the tubes.

An aluminum trough (213.4 cm in length) is positioned under the table behind the panel into which water from the glass tubes is emptied. The water is thereby returned to the bucket from which it was pumped.

Glass tubes on the panel are 45.7 cm in length by 3.2 cm in diameter and are spaced about 2.5 cm apart.

The table top consists of two overlapping sheets of sharply corrugated aluminum approximately 111.8 cm square with corrugated valleys approximately 5.7 cm apart. These sheets rest on two (2.5 by 2.5 cm) channel aluminum bars extending from one end to the other on top of the table frame (one near the front and one near the back side).

A back splash-panel (177.8 cm by 30.5 cm) is hinged to two side splash-panels (106.7 cm by 15.2 cm) and rests on the tabletop. Panels are made from polycarbonate material with the Tuffak trade name.

A two-speed 12-volt fan is attached to the right vertical spray-boom support-bar to provide wind for demonstrating spray drift.

RESULTS AND DISCUSSION

A number of important spray application techniques and equipment components has been demonstrated by use of a spray table. These are as follows:

Sprayer Calibration.

The effect of change in pressure on volume output per minute was tested. For example, increasing pressure four times (from 15 to 60 psi) approximately doubles spray output. This can be shown by collecting spray from a nozzle for one minute (or for 30 seconds x 2). For the purpose of demonstration, water was collected from one nozzle for 30 seconds at 15, 40, and 60 psi. Ten consecutive samples were collected at each of these pressure settings. The average number of milliliters of water collected at each pressure setting is shown in Table 1. Slight

Table 1. Effect of pressure on volume output.

Pressure psi	Vol. (ml)* per 30 sec.	Vol. (ml)** per 60 sec.
15	352.2	704.4
40	588.2	1176.4
60	724.7	1449.4

*Based upon average of 10 samples collected at each pressure setting.
**Determined by calculating 30 second value x 2.

variations are due to a human error in timing and measuring. The nozzle used was a tapered flat-fan XR TeeJet 8003VS.

Another way to calibrate or change the output of a sprayer is to change nozzle size. The larger the nozzle opening, the greater the output at a given pressure. This can be demonstrated by collecting water from two nozzles of different sizes and measuring the difference in output per minute. This can also be visually demonstrated by the volume of water collected in the glass tubes on the front of the spray table. A typical pattern, for example, when comparing an LF2 with an LF3 nozzle is shown in Figure 2 (LF2, smaller nozzle, on right; and LF3, larger nozzle, on left).

Therefore, changing pressure and nozzle size are obviously two ways to change calibration of a sprayer. Changing nozzle size will allow for the largest change. The third way is to alter ground speed (which obviously cannot be demonstrated on a stationary spray table).

Worn and Damaged Nozzles.

A worn nozzle may have an uneven spray pattern and deliver more spray than when the nozzle was new. Two new nozzles were compared using tapered flat-fan XR TeeJet 8003VS nozzles. Output, as shown in Table 2, is very nearly the same.

A damaged nozzle also likely will have greater output than a new one and the spray pattern may appear very erratic. An example of the pattern of a new LF8 nozzle (left) compared to a damaged LF8 nozzle (right) is shown in Figure 3.

Nozzle Types.

Nozzles are designed with different spray patterns and for differnet uses. For example, an even flat-fan fat nozzle (TeeJet 8002E) has very little taper at the edges of the spray pattern (Figure 4) and therefore may be a nozzle of choice for banding where nozzle spray patterns do not overlap. On the contrary, a tapered flat fan nozzle (XR TeeJet 8003VS) has gradually tapering edges and is designed for broadcast spraying where

Table 2. Comparison of output of two new nozzles.

Pressure psi	Vol. (ml)* Nozzle 1	Vol. (ml)* Nozzle 2
15	352.2	347.8
40	588.2	587.4
60	724.7	721.2

*Based upon the average of 5 samples collected for 30 seconds at each pressure setting.

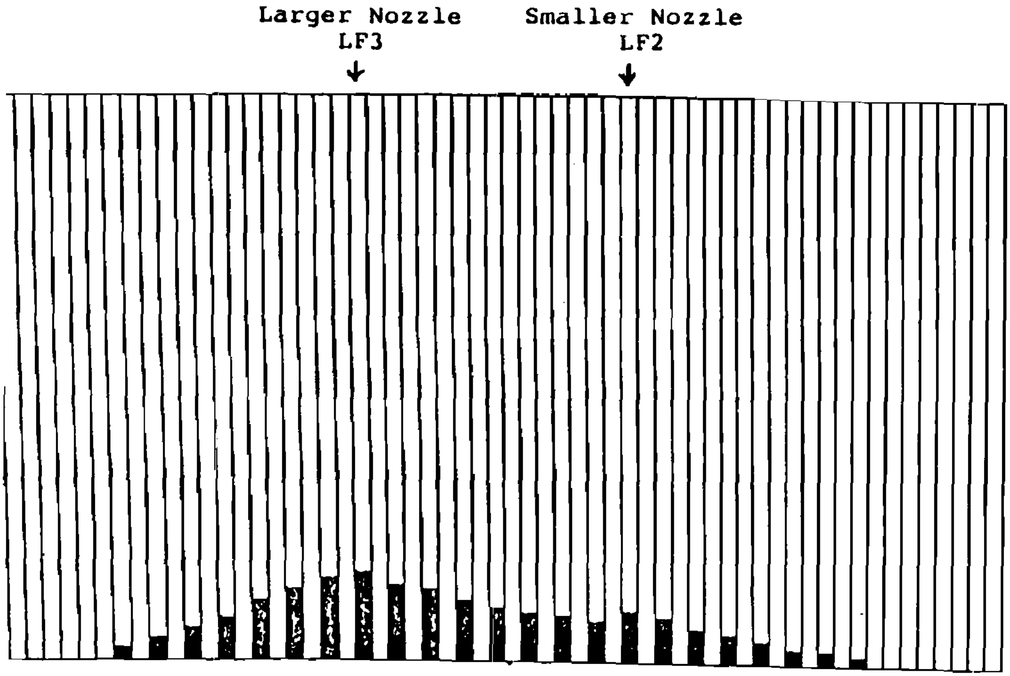

Figure 2. Comparison of nozzle sizes: LF3 on left, LF2 tapered flat fan on right.

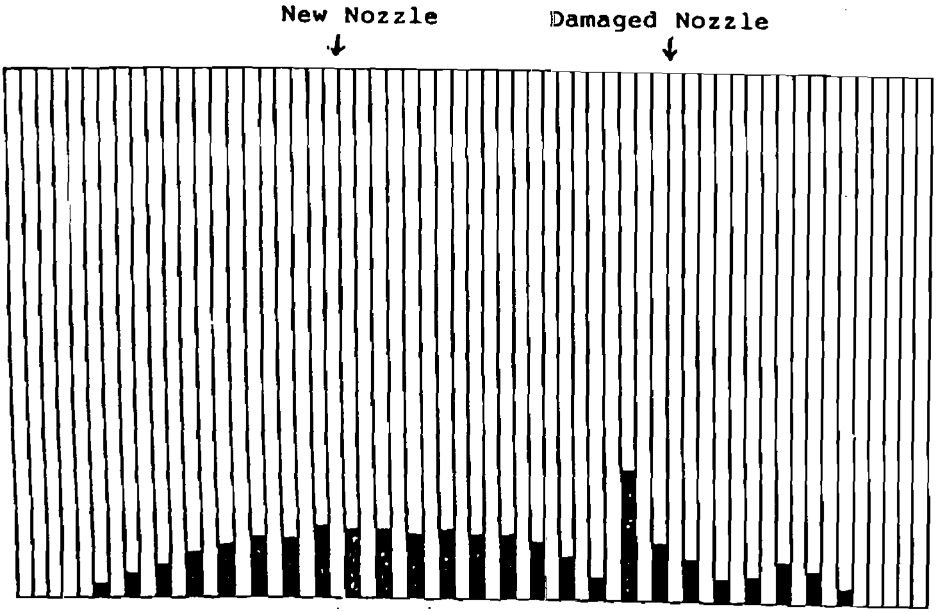

Figure 3. Comparison of new versus damaged LF8 tapered flat-fan nozzles.

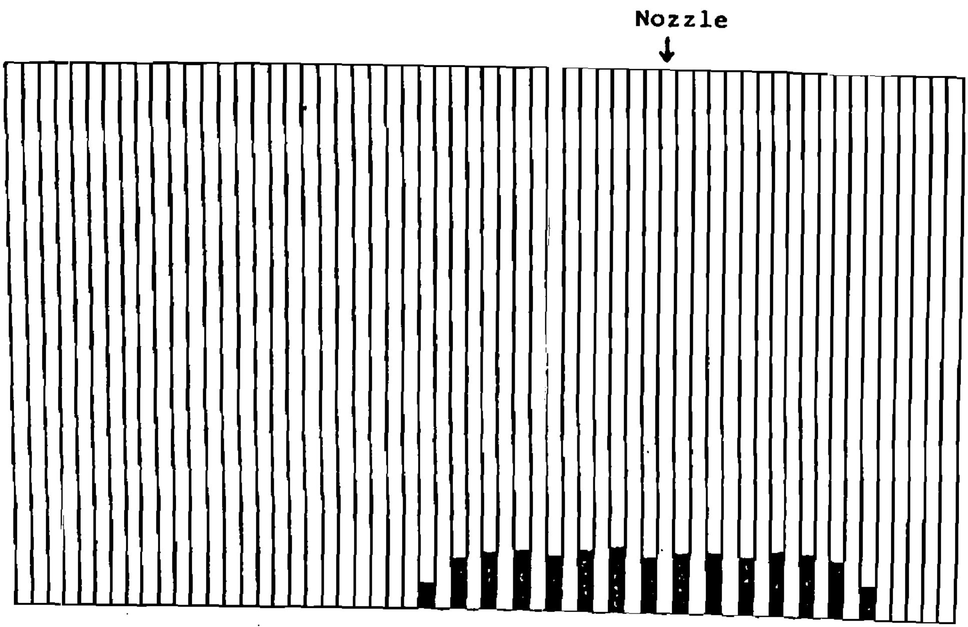

Figure 4. Spray pattern of an even flat fan nozzle (TeeJet 9002E).

spray nozzle patterns overlap. Generally, a 30% overlap is needed between nozzle spray patterns with this type of nozzle in order to provide for uniform application (Figure 5). Nozzles are also designed to yield different spray pattern angles or widths (i.e. 65º, 80º, 110º, etc.). This needs to be taken into consideration when determining proper spray-boom height and nozzle spacing.

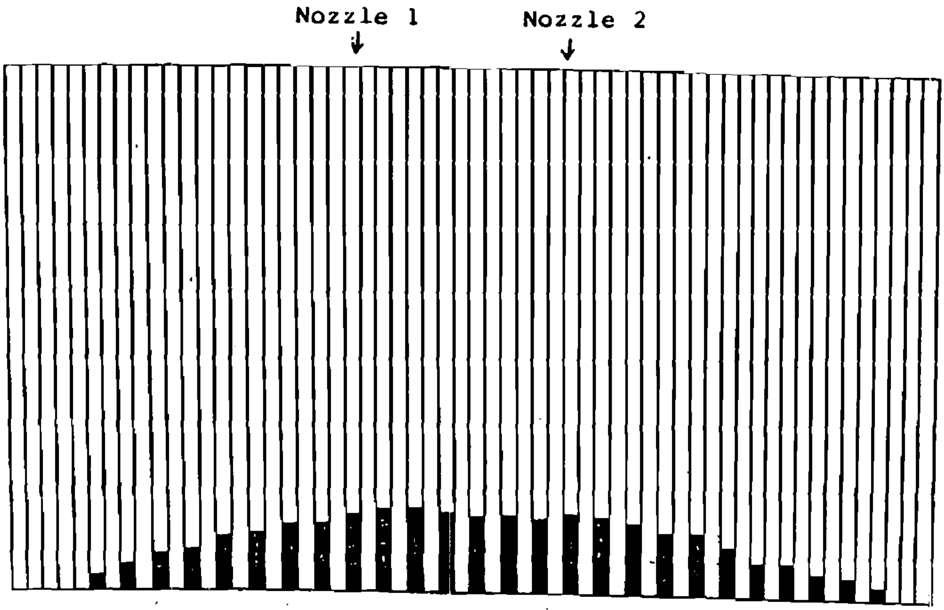

Figure 5. Spray pattern of two tapered flat-fan nozzles (XR TeeJet 8003VS) with appropriate overlap.

Boom Height and Nozzle Spacing.

The uniformity of spray application is greatly affected by boom height above the target surface and nozzle spacing. For example, if the nozzles (XR TeeJet 8003VS) are 47 cm above the table surface with a 50.8 cm spacing as was used to obtain the spray pattern shown in Figure 5, the point of overlap between the two nozzles is very uniform. If the boom is lowered to 32 cm above the table surface, and the same spacing, pressure, and nozzles are used, the spray pattern output may appear as shown in Figure 6. There is a decrease in volume of spray applied to the surface at the point of overlap between the two nozzles thereby giving the appearance of two hills with a valley between. An abnormal pattern will also be obtained if the boom is higher above the surface at one end than the other.

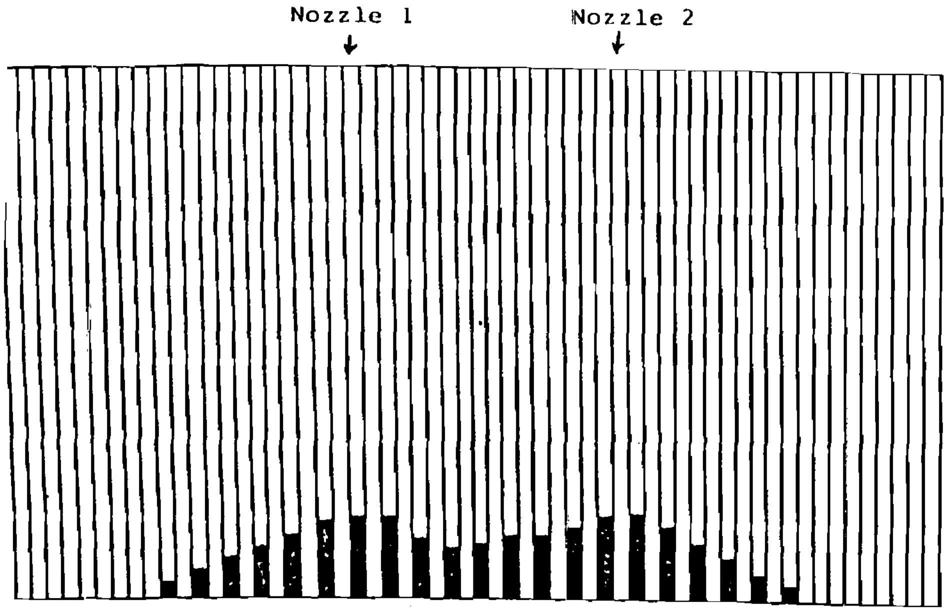

Figure 6. Spray pattern of two tapered flat-fan nozzles (XR TeeJet 8003VS) with inadequate overlap.

Spray Drift.

Spray droplets which are very small in size are especially susceptible to drift caused by wind. The spray table was designed to demonstrate this phenomena. A two-speed fan is positioned on the right vertical boom support bar. The effect of wind on spray patterns can be demonstrated by closing the left nozzle opening and inserting a hollow cone TXVS-1 ConeJet in the right nozzle opening. The effect of wind on the spray pattern can visually be seen as the spray leaves the nozzle and is collected in the glass tubes on the front of the table (Figure 7). The pattern of spray collected is shifted to the left of the nozzle and has a long decreasing tail effect to the left.

The back splash-panel on the spray table is painted black to increase the vissibility of the spray as it leaves the nozzles. This allows one to visually see the difference in spray patterns of TwinJet nozzles, FloodJet nozzles, ConeJet nozzles, TeeJet flat fan nozzles, etc. Such nozzles are designed for different uses and it is important that they be used accordingly.

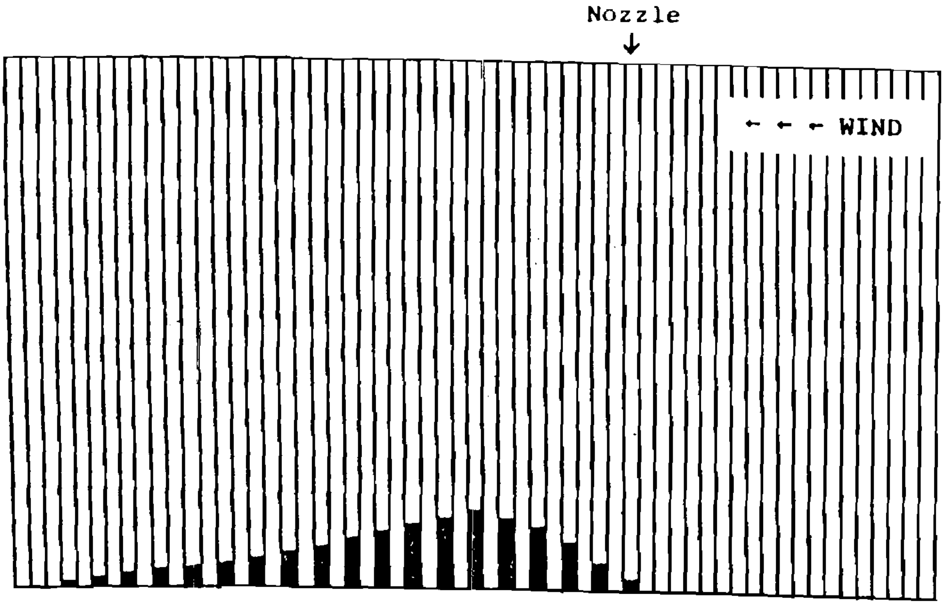

Figure 7. Effect of wind on spray drift.

Proper spray application can maximize efficacy and reduce potential phyto-toxicity, overdosing, environmental contamination and monetary costs.

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