RECENT DEVELOPMENTS IN SPRAYING NOZZLES

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SUMMARY

THIS paper is being presented to point out to people engaged in agricultural spraying that manufacturers of spraying nozzles are playing their part in perfecting their products to a standard that enables both the experimentalist and the field user to make accurate and efficient applications of chemicals.

INTRODUCTION

During the development of weedkillers and insecticides in New Zealand particular importance has been placed on chemical rates of application to achieve desired results. It is a well known fact that many poor results due to inaccurate rates of application are caused by varying speed of travel, faulty boom height, incorrect pressure, or inconsistent capacities of nozzles. All but the last item can be attended to by the operator.

Nozzle manufacturers have spent and are still spending large sums of money both in manufacturing procedure and laboratory testing which involves besides spray angle and flow rate information on distribution, spray dimensions, particle size, velocity, impact, wear-life, corrosion resistance, and the effect of various liquid properties on spraying characteristics of nozzles. From their results nozzles which give patterns of even, regular design are being developed with an aim to eliminate all inconsistent performances. In the past particular importance has been placed on the flat or fan type nozzles, while brief mention has been made of the three other basic patterns, that is, hollow cone, full or solid cone, and last but by no means least the straight stream. Work has been carried out on all these types and some of the results together with new developments are now reviewed.

1. FLAT OR FAN TYPE

The converging stream principle has been refined through much development to give us this series of nozzles. Converging streams of liquid meet within the nozzle to form a flat spray and the V slot governs the width of the resulting pattern. By control of the inner shape of the orifice and the angle of the slot the capacity, angle of spray, and the distribution can be predetermined.

A. Taper edge pattern: Experiment has proved this pattern to be the most efficient for boom spraying work due to a more even over-all pattern being obtained under field conditions. Distribution has been perfected so that overlapping is not unduly upset when booms are tilted or swayed during spraying operations. In contrast nozzles having streaky patterns or ones having heavy overlap give irregular over-all results.

B. Off-centre pattern: A tip designed to spray to one side of the point of delivery only. These tips are ideally suited for fenceline spraying where danger of striking booms exists. Also the presence of poles supporting overhead wires presents no problem in roadside spraying. A further development of this type has been its incorporation in boomless jets, a method of spraying, providing wind conditions are reasonable, suitable for applications which do not require a great deal of accuracy or where obstructions such as tree stumps are encountered.

OFF-CENTRE SPRAY NOZZLE.

Typical set-up for pre-emergence spraying.

C. Even pattern: This tip gives an even spray distribution throughout its spraying area and is specially designed for pre-emergence row crop work where only the soil directly over the crop is desired to be sprayed.

D. Light-centre pattern: Again a tip designed for pre-emergence row crop spraying. The pattern formation allows for a light application of chemicals over the seedbed while adjacent strips are treated at higher rates.

2. HOLLOW CONE

This type of nozzle is formed by imparting a whirling action to the liquid before it leaves the orifice. By controlling the inlet hole and the orifice diameter it is possible to produce different spray characteristics. The liquid leaves the orifice as a thin sheet and atomisation takes place directly after exit. The degree of atomisation is dependent on pressure, surface tension, specific gravity, and other characteristics. Generally, the hollow cone nozzle will provide a finer break up than other orifices of equal capacities. A development of particular interest in the hollow cone field has been the disc and core combinations which are ideal for the spraying of wettable powders where large capacities and low or high pressures are required. The interchanging of discs and cores of various sizes gives a wide range of capacities and spray angles and manufacture in hardened stainless steel or tungsten carbide allows for the use of highly abrasive materials.

3. FULL OR SOLID CONE

The full cone spray pattern is produced by a whirling action of the liquid plus some means of filling in the centre of the pattern. This calls for the use of an inner core or twirler. In one type of core a turbulence is set up within the nozzle and control of this provides a full cone pattern with good distribution of liquid. In another design the core has a hole drilled in its centre for purposes of filling in the spray pattern. In both cases atomisation or liquid break up begins to take place within a whirl chamber or area before leaving the orifice. The particles are larger than those provided by a hollow cone nozzle of equal capacity. The full cone is used wherever a larger droplet with more drive or impact is required. The relative sizes of the core slots and the orifice diameter are important to the spray characteristics. A large core slot with a small orifice will provide a narrow full-cone spray, and, conversely, a small core slot with a large orifice will produce a wide angle full-cone spray.

4. SOLID STREAM PATTERN

The solid stream orifice is a round hole drilled into a thin plate or into the orifice tip. In the thin plate the edges at the inlet and outlet are kept sharp. This causes a contraction of the stream, but it assures a perfectly round pattern even at high pressures. In the orifice tip a tapered approach is normally used to ensure full flow capacity at lower liquid pressures. Capacity is controlled by the diameter and length of the orifice and the velocity of the liquid through the orifice. Atomisation is dependent on velocity differentials and air resistance. The tip is generally used for pest control work where a thin stream with minimum atomisation is required, and as a metering device for controlling flow of liquids. An example would be the application of liquid fertilisers and soil fumigants.

AERIAL NOZZLES

New developments have been made in this field with the introduction of the diaphragm check valve in place of the ball type. A further advance has been the adding of a manual shut-off device to the diaphragm check valve, which enables rates of application to be altered without changing nozzle sizes or by the fitting of blanks.

N°1 HEAVY EDGES GIVE
STREAKY PATTERN,

N°2 NOZZLES WITH EVEN
SPRAY PATTERN GIVE
HEAVY OVERLAP.

N°3 NOZZLES WITH
TAPERED EDGES GIVE
A PERFECT SPRAY
PATTERN. FURTHER-
MORE THIS PERFECTION
OF PATTERN IS
MAINTAINED OVER A
WIDE RANGE OF
BOOM HEIGHTS.

GENERAL

Under this section are listed observations made by the author and presented for general comment.

1. Where chemicals are to be applied with solutions which are of specific gravities and viscosities other than those of water chemical manufacturers should draw attention to the fact that calibration of spray rigs should be carried out before field spraying is commenced.

2. Manufacturers' charts should not be discounted before critics make due reference to such factors as temperature and details of the materials used for test purposes.

3. The variety and quality of nozzles available today warrants full-scale trials by the Department of Agriculture so that firm recommendations for nozzle spacing and boom heights can be made for New Zealand conditions.

4. The use of special nozzles developed in the flat spray range will become increasingly popular for pre-emergence and off-centre spraying.

5. Nozzles manufactured of the materials nylon, lucite, and delrin. Work is proceeding with these plastic materials for nozzle manufacture. Present

Cross section of spray pattern for pre-emergence spraying.

indications are that these materials generally lend themselves favourably to chemical resistance, but certain difficulties are obvious from a precision manufacturing point of view. However, until further field and manufacturing trials are carried out further comment cannot be made.

6. Other speakers at this conference will no doubt place emphasis on the importance of spraying pumps, but given perfect pumping conditions all is lost unless the point of delivery does its job effectively.

CONCLUSION

It will be realised that a spray nozzle is more than a spout for the discharge of liquid. It is a precision-made tool manufactured to meet the needs of the farmer and grower and it should be remembered that the final proof will be the results obtained in practice.

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DISCUSSION

Q.—How can we get over the poor results which occur when a tractor operator exceeds the recommended speed of application when boom spraying?

A.—If you try to counter this by increasing the pressure, you also affect the coverage. It is better to increase the rate of application by increasing the nozzle size.

Q.—Could not the manufacturers of nozzles tighten up the limits of tolerance for the percentages of coarse and fine droplets in the spray patterns?

A.—We are working on this problem in so far as it concerns spray drift. We find reducing pressure to 10 lb. gives a much bigger percentage of even-sized particles, which will make it possible for operators to work more safely and effectively in windy conditions.

Q.—Is every nozzle tested at the works, or only a sample of each batch?

A.—In my company, which is the biggest nozzle manufacturer in the world, every nozzle is tested. Their capacity is tested by putting through liquid, and their angle of spray tested against a key nozzle in the background.