http://www.pjbs.org

PJBS

ISSN 1028-8880

Pakistan Journal of Biological Sciences

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Pakistan Journal of Biological Sciences 8 (4): 567-570, 2005
ISSN 1028-8880

Effect of Power on Droplet Size by Hand Held Spinning Disc Sprayer

[1]Muhammad Ishfaque, [2]Muhammad Ashfaq and [3]Ali H. Sayyed
[1]Department of Plant Protection, (Federal) Lahore, Pakistan
[2]Department of Agriculture Entomology, University of Agriculture Faisalabad, Pakistan
[3]Department of Biochemistry, School of Life Sciences, University of Sussex, Falmer, Brighton, BN1 9QG UK

Abstract: A comprehensive study was carried out on the effect of power (batteries) on the droplets with the objectives to minimise dose rate and maximise mortality, by avoiding the wastage of pesticides. Droplet distributions were obtained over a range of rotation speeds by using different nozzles. The data obtained using various batteries indicate that the speed was directly proportional to numbers of batteries used while the droplet size was inversely proportion to the speed of disc. With increasing problems in controlling some cotton pests, particularly those on the under-surface of leaves, these results indicate that it may now be worth re-exploring the issue of using charged sprays.

Key words: Spinning disc, ULV sprayer, droplet size, nozzle, cotton pests

INTRODUCTION

It was recognised that in any sprayer, droplet size is the most important controllable parameter. It influences the distribution of the spray downwind (small droplets are carried further and can therefore produce a wider swath), losses as fallout (large droplets sediments on to the soil) and the impaction efficiency on locusts and vegetation (very small droplets impact less efficiently). As a result, the size of droplets influences work rate and biological efficacy of the pesticide. It can also influence the environmental impact of the spraying operations. For example there may be negative impact if spray consisting of large droplets falls in overdosed stripes in the target area or alternatively spray consisting of very small droplets drifts out of the target area to deposit elsewhere.

If it is presumed that there is an optimal droplet size for each pest control situation then droplets larger or smaller than this size will be less effective. However, there are two problems with acting on this assumption: there is very little scientific data to indicate what the optimum droplet size is for each situation and even if there were, there are no commercial sprayers at the moment which can produce uniformly sized droplets[1].

Droplet size influences the distribution of the spray, for example downwind direction small droplets are carried further away and can therefore produce a wider swath, while large droplets sediments on to the soil. If it is presumed that there is an optimal droplet size for each insect pest control situation, the droplets larger or smaller compared with this size will be less effective. However, there is very little scientific data to indicate what the optimum droplet size is for each situation and secondly uniformly sized droplets producing sprayers are unavailable in the market[2].

Rotary atomisers have, to date, provided the most practical means of controlling droplet size. By using centrifugal energy it is possible, with a suitable atomiser design, to produce a very narrow range of spray droplet sizes. The range of droplet sizes can be selected by varying the rotational speed of the atomiser-increasing the speed decreases the droplet size and vice-versa. Rotary atomiser has long been used in aerial locust control operations and due to the unsuitability of the ENS for contact acting products are increasingly being used for ground control. A whole range of spray equipments using rotary atomiser is now available including hand-held spinning disc sprayers, motorized mist blower attachment and vehicle-mounted sprayers.

The most widely used sprayers utilize the rotary atomisation principle. Spray liquid is fed to a spinning disc attached to a miniature 12 volts DC motor powered by batteries and droplets are thrown off the edge of the disc. Cell life depend on the type of spinning disc sprayer in which it is used since the power consumption of the sprayer directly effects the life of the cells in a non-linear proportional relationship. However a serious disadvantage of most dry cells is the continuous reduction in cell voltage through out its working life,

Corresponding Author: Muhammad Ishfaque, 10.A, Plant Protection, Infantary Road, Dharam Pura, Lahore, Pakistan
Tel: 042 5300105/5310236 E-mail: ishfaque20@yahoo.com

normally resulting in a reduction in disc speed and consequent increase in droplet size. Rechargeable batteries are therefore important when spinning discs are used for ULV sprayers.

Conventional hydraulic pressure nozzles are unsuitable for ULV spraying, as they are incapable of producing controlled droplet spectra and emit a very wide range of droplet sizes[3]. By using centrifugal energy it is possible, with a suitable atomiser design, to produce a very narrow range of spray droplet sizes. The range of droplet sizes can be selected by varying the rotational speed of the atomiser-increasing the speed decreases the droplet size and vice-versa.

A comprehensive study was designed to investigate the effect of power (batteries) on the droplets with the objectives to minimize the dose rate and maximize mortality.

MATERIALS AND METHODS

All batteries were purchased as a new stock 1.5 V transistor D type and were tested with a MICRON ULVA+ spinning disc sprayer (Table 1). All experiments were conducted by using a set of 8 batteries at International Pesticide Application Research Centre, Imperial College London from March 2003 to February 2004.

Measurement of disc speed: A Disc rotation speed was determined using a TM-3011 Hand Tachometer (range 30.0 to 30, 000.0 rpm) with accuracy 0.01±1% digit. Readings of rotation speed were taken five times for a single set of batteries without load.

Measurement of flow rates: The flow rates were measured for each nozzle using Edelex oil 50% + kerosene oil 50%. Atomiser disc was removed and let the liquid flow until it become steady and then the liquid was allowed to flow for one minute in an appropriate container and the volume dispensed was measured. The experiment was replicated three time and the data was pooled to calculate the mean value.

Table 1: Droplet size characteristics of ULVA sprayer

No. of batteries	Speed (rev/min)	Type of nozzle	Flow rate (mL/min)	*VMD (μm)	*NMD (μm)	Ratio (vmd/nmd)
5	6000	Black	125	97.46	69.67	1.39
5	6000	Orange	54	75.39	47.02	1.60
6	7000	Black	125	80.16	49.59	1.61
6	7000	Orange	54	65.51	43.93	1.49
7	8400	Black	125	70.03	30.32	2.31
7	8400	Orange	54	59.35	28.32	2.10
8	9300	Black	125	65.92	30.42	2.16
8	9300	Orange	54	60.11	28.85	2.08

*VMD: Volume Median Diameter, *NMD: Number Median Diameter

Measurement of droplet size: A Malvern particle size analyser series (2600 c) was used to measure the droplet spectra, which can measure droplets ranging from 0.5 to 1880 μm. It uses a light diffraction technique to measure the droplet spectra and the light detector is connected to a computer. The information of the angular light intensity forward scattering is used to establish the droplet spectrum. Different droplet sizes produce different diffraction patterns, for example small droplets produce diffraction patterns with a large angle of scatter; large droplets produce a function of the droplet concentration by volume[4].

The position of a partially shrouded ULVA+ spinning disc was adjusted to emit a sector of the spray 20 cm to lens. Voltage was supplied with a stabilizer and Edelex oil 50% + kerosene oil 50% used for droplet size sampling. The alignment of the Malvern laser beam was maintained by adjusting the position of the sensor. A lens of focal length of 800 mm was used and room light were switched off before taking the readings. The exhaust fan was turn on to avoid the droplets from crossing the laser beam more than once. Each sample was measured with five replicate.

RESULTS AND DISCUSSION

Droplet distributions were obtained over a range of rotation speeds by using different nozzles. These nozzles were given different flow rates from 30 to 125 mL min^{-1}. The data obtained using various batteries indicate that the speed was directly proportional to numbers of batteries used (Fig. 1). The droplet size obtained was inversely proportion to the speed of disc. For example with 5 batteries, the speed was 6000 rpm, 0.4% spray was in size <30 μm. The results obtained are in broad agreement with Cooper and Johnstone[5] where they showed that by increasing the number of batteries the

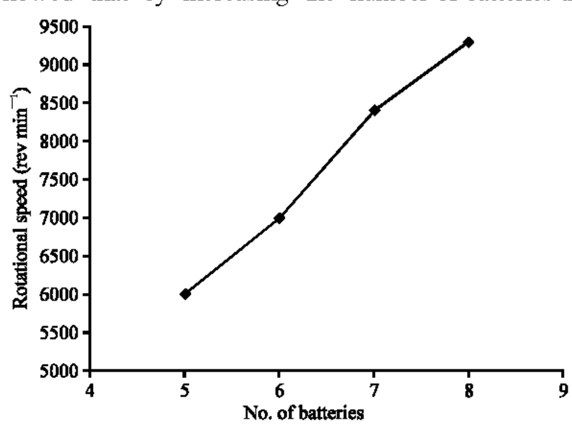

Fig. 1: Effect of power on disc speed

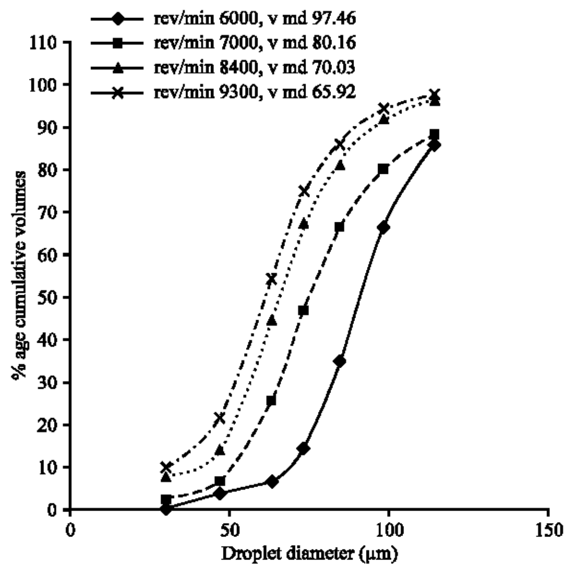

Fig. 2: Effect of disc speed on droplet size distribution using black nozzle (125 mL min^{-1}) flow rate

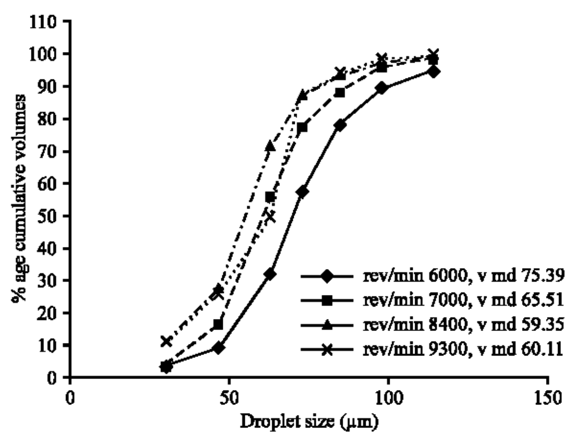

Fig. 3: Effect of disc speed on droplet size distribution using orange nozzle (125 mL min^{-1}) flow rate

speed of rotation was increased which reduced the droplet size. This shows a tendency to a bimodal distribution indicative of direct droplet formation at the lower rotation speeds, while the log-normal tendency at the highest rotation speed conforms to ligamentary atomization. An increase in flow rate would be expected to produce ligamentary atomization at the lower rotation speeds. Similarly, droplet size distribution produced by a spinning disc sprayer could also depend upon the voltage supply to the motor[6]. In contrasts the results obtained in our experiments showed no influence of droplet size distribution with increase in batteries. Cumulative volume of 3.9% at 6000 rpm and 3.7% at 7000 rpm was distributed in sizes < 30.1 µm (Fig. 2 and 3). The important factor in ULV spray is that with reduced applied volume, the droplet size must be reduced in order to obtain a sufficient density of droplets to maintain spray coverage and retain control of the pest[3].

It is generally accepted that the way control agents are applied greatly affects the chance of contact with the pest[7]. The charged spray can greatly enhance under-leaf cover, which has a great advantage[8]. As many sucking pests tend to found on under-surface of leaves which usually receives little spray and enhanced under-leaf cover would surely improve control of many pests, such as jassid and whiteflies which are becoming increasingly important and difficult to control, partly because of control regimes involving pyrethroids and other insecticides have promoted their development[9] and partly because they are becoming resistant to insecticides[10].

In this study the electrostatic charge was demonstrated to have potential pest management benefits in terms of efficient distribution. The combination of rotary atomisation with a charge system has advantages compared with some other systems because it can utilize commonly available products without special formulation. In the past the limited success of the electrodyn electrostatic sprayer due to formulation constraints may have discouraged further development of charged spray application equipment for small farmer crops. With increasing problems controlling some cotton pests, particularly those on the under-surface of leaves, these results indicate that it may now be worth re-exploring the issue of using charged sprays.

REFERENCES

1. Dobson, H.M., 2002. Draft of workshop on spray equipment used in Desert Locust control, 23-25 September, 2002, Cairo, Egypt. Commission for Controlling the Desert Locust in the Central Region and the FAO EMPRES/C.
2. Dobson, H., 1999. Advances in locust spraying technology. Insect Science and its Application, 19: 355-368.
3. Cooper, J.F., K.A. Jones and G. Moawad, 1998. Low volume spraying on cotton: A comparison between spray distribution using charged and uncharged droplets applied by two spinning disc sprayers. Crop Protec., 17: 711-715.
4. Swithenbank, J., J.M. Beer, D.S. Taylor, D. Abbott and G.C. McCreaton, 1976. A laser diagnostic technique for the measurement of the droplets and particle size distribution. American Institute of Aeronautics and Astronautics, 5: 76-79.

5. Cooper, J.F. and D.R. Johnstone, 1979. The new Mini-ULVA. A hand-held,battery-operated ultra-low-volume sprayer. Miscellaneous Report No. 49. Ministry of Overseas Development, London, pp: 9.
6. Nyirenda, G.K.C., 1986. Studies of the effects of insecticide application on cotton in Malawi. Ph.D Thesis, University of London.
7. Dittrich, V., S. Uk. and G. H. Ernst, 1990. Chemical Control and Insecticide Resistance of Whiteflies. In: Whiteflies: Their Bionomics, Pest Status and Management. Ed. Gerling, D., Intercept andover, UK., pp: 263-285.
8. AbdelBagi, H.A. and A.J. Adams, 1987. Influence of droplet size, air assistance and electrostatic charge upon the distribution of ULV sprays on tomatoes. Crop Protec., 6: 226-233.
9. David, B.V. and R.W.A. Jesudasan, 1986. Status of whitefly, *Bemisia tabaci* (Gennadius) excluding its vector biology. Pesticides, 20: 42-47.
10. Denholm, I. and L.C. Birnie, 1990. Prospects for managing resistance to insecticides in the whitefly. In: Cotton Production Research from a Farming System Perspective, with Special Emphasis on Stickiness. 49th Plenary Meeting, International Cotton Advisory Committee, ICAC, Washington, pp: 37-41.