A SYSTEM TO ACCURATELY APPLY FINE POWDERS

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In order to pollinate kiwifruit (*Actinidia deliciosa*) flowers, a system was required that would accurately apply dry staminate pollen in the gas-solid aerosol state. The device must feed all the pollen from a reservoir into an airstream of known flow, yet be relatively cheap and practical. The agglomerate (shear) strength of the pollen particles or grains, has to be overcome to ensure that an even delivery rate is maintained.

Delivery or dispensing devices available include a rubber bulb puffer; various types of feeders e.g. screw, vibratory and rotary; and airstream pick-up and delivery of particles. Each has disadvantages which results in wide variations in dose rate. These disadvantages include: uneven particle entrainment, especially as the level of particles in the reservoir declines; working efficiently only at a specific agglomeration strength of the particles; incomplete discharge of all the particles; and the trapping of particles in the dead spaces of a machine which results in erratic dose rates.

Our device was adapted from a system designed to accurately dispense compacted powders of less than 10 microns for use in calibration of pollution measuring equipment (Zahradnick and Löffler 1976). The device (Fig. 1) consists of a cylinder which houses a tube, or cartridge, containing pollen. The top of the tube is open and, to prevent the creation of a dead space, is shaped to conform to the side of a round rotating brush feeder located at right angles to the cartridge. The brush feeder is covered with the hooked side of 'Velcro' which produces the required constant pick-up of particles. At the lower end of the tube a threaded rod winds up a piston which moves the pollen toward the brush. Therefore the particles are force-fed onto the brush with a consistent pressure in a manner similar to winding up lipstick. Pollen contact with the plastic cartridge generates electrostatic forces which cause the piston to stick in the cartridge but the resultant puffing can be overcome by lubrication of the piston with graphite powder. The brush separates the particles efficiently when its rotation velocity exceeds the piston feed rate by at least 100x. Both the brush and piston operate at low revolutions/minute: 230-250 and 2, respectively. The particles are then transferred to the delivery airstream by the brush which rotates against, and at right angles to, an airflow. The output dosage rate is the product of the particles' bulk density (about 0.63 g/cm³ for kiwifruit pollen) and the velocity and area of the feed piston. The rate can be further varied by changing the forward speed of the operator or tractor.

The applicator is constructed of aluminium and plastics with a motor to generate the airflow and to drive the brush and piston. It is light enough (0.57 kg) to be hand held with the short output nozzle aimed directly at the target. To allow the operator mobility when in the field, a 12 volt motorcycle battery held in a waist pouch is used as the power source. This machine can also be powered from the battery of a vehicle. Two further models are available. One has a motor on the operators back for maximum operator mobility and for the other, an 'extensive-use' model, the motor is carried on a tray behind a tractor. Each of the three models may be adapted to suit application, or injection, of powders from a stationary machine. Such situations are found in industrial production lines.

Pollen on the 'Velcro' brush is easily removed and therefore low flow rates of air are used. In the smaller machines, the velocity of the airflow common to both the brush feeder and particle delivery is about 30 litres/min. The larger backpack and tractor mounted models have a separate airflow of 8 litres/min to transfer the pollen from the

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Fig. 1: Side view of the brush feeder device.

brush into a separate delivery airflow of up to 11,280 litres/min. As a result of this increase in the delivery flow rate, the method of deposition onto the target changes from mainly drift, using the settling velocity of the particles, to impaction.

These machines were developed using pollens of *Lycopodium* spp., kiwifruit and *Pinus radiata*. Prototypes have been used for several seasons to successfully pollinate kiwifruit (Ferguson and Bradley unpub.) at rates from 26 g to 2 kg/ha. The machines have proved to be mechanically reliable. Other powders with a suitable agglomerate strength have been applied with this system. These include three fungicides, four insecticides, four herbicides and a commercial mixture of trace elements.

The result of this development is a lightweight yet robust machine which is of simple design and, hence, relatively inexpensive to manufacture. It offers a wide range of delivery airflows and dosage rates and is sufficiently flexible to be manufactured in small (hand held) or large (tractor-mounted) versions. Its major advantages are: an accurately metered consistent dose rate; no requirement for an inert carrier but one may be used if powder-solid or powder-liquid mixtures are essential; a delivery airflow rate that is independent of the powders agglomerate or compacted strength, and the complete use of the powder contained in the cartridge. The machines are relatively simple to operate and maintain and minimal staff training and supervision is required.

REFERENCES

- Zahradnicek, A. and Loffler, E., 1976. A new feeder for the production of aerosols from specific fine-grained powders. *Staub-Reinhalt. Luft Bd. 36 (11)*: 425-456.