A FIXED SPRAY SYSTEM FOR FRUIT CROPS

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Summary

A fixed spraying system was developed to improve application timing, reduce drift and improve deposition in a high density orchard in New York State. Indications from three seasons of trials indicate biological control to be as good as airblast spraying without the associated disadvantages of drift and high visibility. This paper details the layout of a field trial along with the main engineering challenges such as pipe diameter, siting, sizes, emitters, flow rate and pressure changes. A novel direct injection technique using a water driven Dosmatic A-80 2.5% pump was used on a mobile pumping station. Netafim DNA 7000 emitters provided an inexpensive nozzle arrangement.

1. Introduction

Traditionally growers have used airblast sprayers to apply pesticides to apple trees, creating a vast plume of spray, a variable proportion of which hits the target. The result is often poor distribution within the canopy leading to ineffective disease or insect control, off-target drift leading to environmental pollution and economic inefficiency.

Many orchards now have a myriad of planting densities and tree canopies, ranging from dwarf trees on narrow row spacing through to large trees planted in wide rows. Large scale, modern, high density plantings entail many hours of travel, along many miles of tree rows, resulting in high labour and machinery costs and affecting timeliness of application.

Direct injection sprayers have been developed by many researchers for boom sprayers in conventional field crops, but only one paper has been published in their application to fruit crops where they used four direct injection pumps inside a trailed tunnel sprayer.

A fixed spraying system was devised at Cornell University and preliminary trials were conducted to measure its efficiency at applying pesticides and controlling insects and disease. Spraylines were fixed to metal conduit poles at three different heights and fitted with Netafim DAN 7000 sprinkler emitters. Preliminary trials were conducted in two blocks of Red Delicious and Empire apples on M.9 dwarfing stock located in a research orchard at Cornell University, Geneva, NY, Agnello et al (2004). Tracer solution, using micronutrients was used to monitor spray deposition and a conventional airblast sprayer was connected, via a hose, to the spraylines passing through the trees. The fixed line system orchard blocks were compared to blocks treated with a conventional airblast sprayer. The scope of the preliminary trials was small, but results showed control of plum curculio was equal to that obtained with a conventional airblast sprayer.

In order to develop the system further, a large scale, 1 acre block, of dwarf spindle apple trees, *var*. Gala, was used on a co-operating grower's orchard in Wolcott, New York.

2. Materials and methods

A pesticide application system was devised, similar to a fixed irrigation system, where two 0.75" plastic pipes (laterals) were positioned through the canopy of the apple trees, following the top wire at 6 ft and the bottom wire at 3ft above the ground. Small emitters, Netafim DAN 7000 series with an 8 mm orifice and flat pattern spreader (Netafim, Fresno, CA) were installed at 3 ft and 6ft intervals along the length of the pipe (depending on the trial block). A 2" main pipe was run along the junction of the rows to a central filling position. Pipe diameters were calculated based upon a hydraulic analysis computer program devised by Walid Shayya for irrigation purposes.

The preliminary trial used a traditional airblast sprayer with a pipe connected from the outlet of the pump to the inlet connector of the canopy pipeline. The challenges associated with this design were the quantity of material to be mixed in the tank, tank rinsing, rinsate application and filling/rinsing time.

Direct injection sprayers offer the operator many advantages, including reduced environmental pollution and operator contamination, Landers (1992) and (1997). Injection sprayers eliminate tank rinsing and allow rapid changes in dose rate. The main tank of the sprayer holds clean water only. Pesticide is injected into the water flow via a piston or a peristaltic pump and the resultant mix flows through the pipes to the nozzles. A manual or electronic controller adjusts the pesticide injection pump according to changes in operating requirements, e.g. changes in application rate and pesticide required.

A trailed application unit was constructed using a 300 gallon water tank and a petrol driven centrifugal pump producing a flow of 90 gallons/minute at 36 psi. Two DOSMATIC A80-2.5% proportional injection pumps (Dosmatic USA, Carrollton, TX) were fitted into the water flow line after the pump. The water driven pumps were fitted with super corrosive transfer (SCT) kits to avoid damage to the pump seals from solvents in the pesticides. The pumps dispense pesticide at a known rate into the water stream in the spray pipeline, the injection rate being adjustable from 0.2 -2.5% or 1:500 to 1:40. The resultant mix is then pumped along the main pipe to the laterals within the tree canopy.

Specific objectives of the trial in comparing the fixed sprayline with an airblast sprayer are:

1. the biological effectiveness in controlling diseases and insect activity
2. the economics of a fixed sprayline system
3. the reliability of the components of fixed sprayline system over a number of seasons
4. the deposition characteristics of the sprinklers
5. the uniformity of pesticide concentrations from nozzle to nozzle
6. the uniformity of pesticide concentrations with changes in dose level
7. the system response time during filling and application of products
8. the use of a purge mode to rinse the sprayline pipes
9. the injection pump characteristics
10. further improvements to the system leading to grower acceptance

3. Results and discussion

The engineering challenges in this project have been numerous, but not insurmountable. The original lateral design used 0.3” risers between the laterals and the nozzles, this would cause excessive pressure loss, with subsequent changes in flow rate on such a large scale trial. Minimising pipe runs, branch points and using a high and low lateral and careful analysis of the hydraulic flows with an irrigation engineer overcame these problems.

As so many nozzles are required, traditional sprayer nozzles, nozzle bodies and anti-drip check valves would be prohibitively expensive. Micro-emitters are used in greenhouse irrigation systems and produce small droplets. Droplet size was of concern, the micro-emitters were tested at OARDC, Wooster, Ohio using an Aerometrics PDPA 1-D laser system. The VMD at 60psi was 310 micron. This is larger than we might choose, but is the smallest emitter available. Initial field trials over two seasons have shown extremely good biological control with these emitters.

Spacing, size and position of emitters were studied over the seasons, would emitters positioned outside the canopy be more effective? The longevity of the plastic irrigation pipe was also studied over a number of seasons.

Another hydraulic concern was overcome by using a mobile pumping unit. Originally we had hoped to use a central pumping station, but hydraulic flows, and costs were a major concern. The mobile unit can be transported from one block of trees to another.

A conventional airblast sprayer, used as the pumping station, suffers from a tank of mixed pesticide and water, plus operating at a high pressure. To overcome tank rinsing and pump pressures, we chose a direct injection unit. A water driven injection pump and petrol driven centrifugal water pump allows the system to be independent of tractors and PTO drive lines. The unit could, if desired, be pulled and operated with a pick up truck. A 12 volt electricity supply is required for the pesticide mixing unit fitted below the intake of the injection pump.

The large internal volume of a mains/lateral pipeline system through a block of apple trees presents many problems, such a filling and emptying the pipe. The direct injection pump allows us to fill the pipes with clean water for one minute, then inject pesticides for one minute and then push the pesticide laden water out with a clean water for a further minute.

Biological trials were conducted to measure the effectiveness of the spraying system at controlling insects and diseases, see webpage details below. Engineering trials investigated mixing efficiency, deposition and coverage and residue in the pipes. The efficiency of mobile sprayer at pumping and mixing pesticides with water was also investigated. The running costs and timeliness was also considered.

A future system may include a pump house and a sprayline system being incorporated within the trellis design, as the orchard is being laid out. The system could also be used for frost protection and for irrigation. Large blocks could be sprayed via an automated control system. Quietness and low visibility are hallmarks of this system.

Further information on this system, including results on biological efficacy is available on the internet at:-
http://www.nysaes.cornell.edu/ent/faculty/agnello/pdf/Agnello%20Fixed%20Spray%2007.pdf

Acknowledgements

We would like to acknowledge the kindness of the cooperating grower, John Fowler of Fowler Farms, Woolcott, NY. Also technical assistance from Bruce Wadhams and Eric van Hemel. Financial assistance was provided by USDA Federal Formula Funs (Hatch) and North Eastern IPM Centre.

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