fresh NOTES
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SURVEY AND INVESTIGATION OF FUNGICIDE APPLICATION METHODS AND TECHNOLOGIES IN PLUM PACKING LINES

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Introduction

Successful control of plum decay by fungicides relies on accurate fungicide dosages and application methods. As yet, the methods and technologies of fungicide application in the South African plum industry have not been investigated and best practises are not known. The aim of this study was to conduct a survey of plum packing lines to determine and review the specifications at which fungicide application technologies are used.

17 Plum packing lines near Franschhoek, Wellington, Montague, Paarl and Robertson in the Western Cape were investigated. The two main fungicide atomising systems identified were either operated by:

- Nozzles, which were used by 70% of packing lines and
- Spinning disks, which were used by 30% of packing lines

Most of the atomiser systems were custom built (88%), and the design of systems was similar. Main components included a tank with fungicide solution which was pumped to a boom fitted with either nozzles or spinning disks for delivery of product.

The data collated identified five critical points for accurate product application (Figure 1).

1) The condition of the pump and connecting pipes carrying fungicide solution for atomisation
2) The mixing or agitation of product solution in the tank
3) The suitability of pipes transporting the product
4) The concentration of the fungicide solution and
5) The deposition of product on the fruit by the nozzles.

1) The condition of the pump and connecting pipes carrying fungicide solution for atomisation

Pumps and connecting pipes were not continuously maintained. In some instances fungicide leaking from pipes was observed and in one packing line total failure of a pump was noted. Maintenance plans should thus be dedicated to pumps and connections to ensure malfunctions are detected and subsequent responses are timeous.

2) The mixing or agitation of product solution in the tank

Two fungicides are registered for control of post-harvest decay in plums. Both fungicides contain Fludioxonil as single active ingredient, which is formulated into a suspension concentrate. Thus certain particles in the product are water insoluble and will settle if the product solution is not agitated frequently. Sufficient agitation of the fungicide solution

was not seen in 11 (of 17) packing lines and product sedimentation was likely. Ideally, automatic stirrers should be installed in tanks to agitate the product and notably the product should be agitated in the mornings, as particles may settle during the night, before the first spray application of the day.

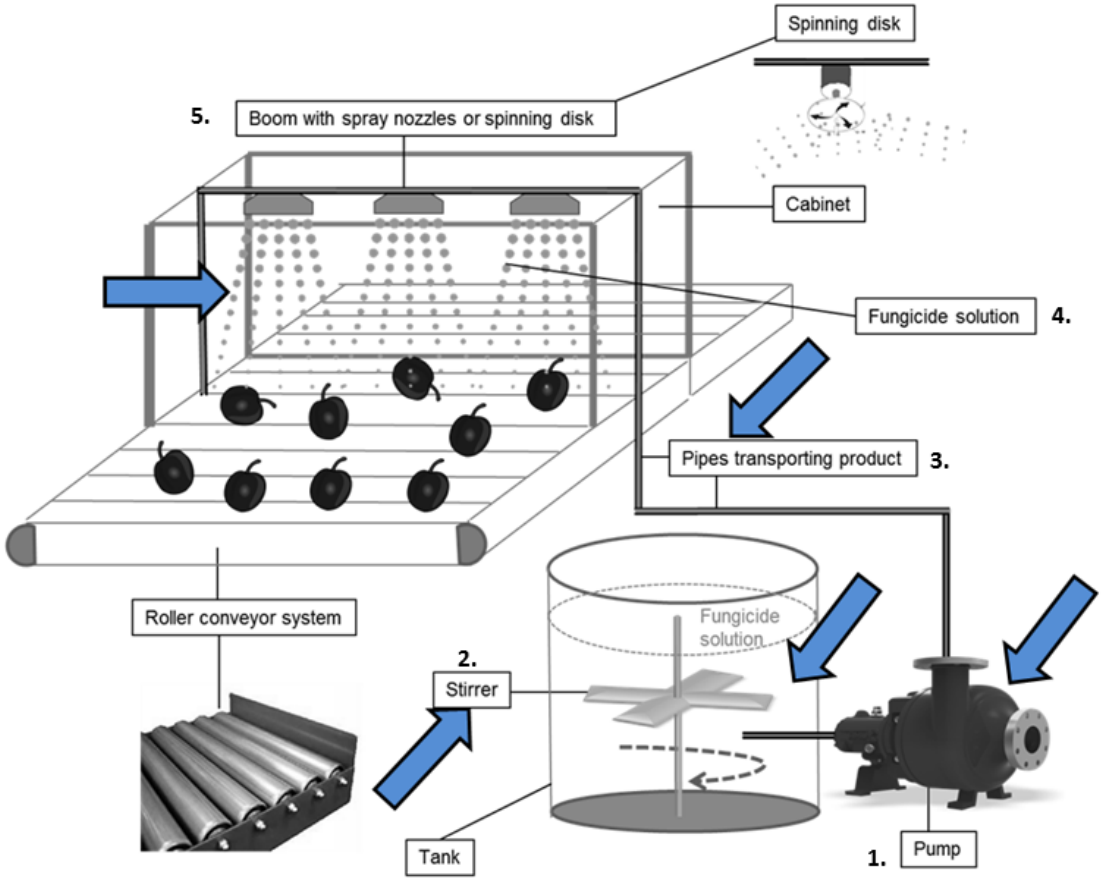


Figure 1: The general design of the atomiser systems that were surveyed in this study, indicating critical points for intervention to ensure accurate placement of the fungicide

3) The suitability of pipes transporting the product

The product that is generally used, since it is a suspension concentrate, tends to deposit particles inside pipes which may lead to clogging. However pipe diameters of ≥10mm were sufficient to overcome build up of particles and subsequent obstruction of the flow of fungicide solution. Flushing the system with warm water also efficiently cleared product sediment. In one instance a filter was placed between the pump and connecting pipes to capture particles, and the filter was cleaned at regular intervals. Clogging of pipes can thus be overcome by preventative measures.

4) The concentration of the fungicide solution

Inaccurate fungicide dosages were applied at all but one of the packing lines studied (94%). At ten packing lines the solution was made up at higher concentrations than the label recommendation, whilst at six of the packing lines the product was below the recommended dosage on the label. Over dosing with fungicide will have implications for the Maximum Residue Levels measured on fruit, whilst under dosing holds implications for decay control. Product solutions should be prepared with care to ensure that they keep to the registered dosage.

5) The deposition of product by the nozzles

Spray *coverage* of fungicide on target areas is a measure of spray application *success*. Spray deposition of fungicide solutions can be visually assessed by using water-sensitive paper cards. These cards make spray coverage immediately obvious when the bright yellow substance that the cards are covered with turns blue on contact with water droplets (Figure 2).

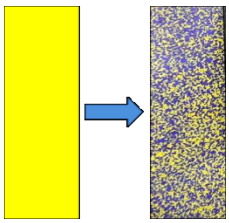


Figure 2: The yellow surface of water-sensitive paper cards turns blue when in contact with water

To evaluate the spray deposition of the nozzles or spinning disks from packing line atomiser systems, the abovementioned water-sensitive cards were used to examine the droplet pattern of the spray application. Cards were placed in three positions, representing the two sides, and the middle of the spray area over the roller conveyor system. Exposure of the fungicide to the paper cards was at the same height and for the same duration at which it would have been applied to fruit, which varied between 8-13 seconds depending on the packing lines (Figure 3).

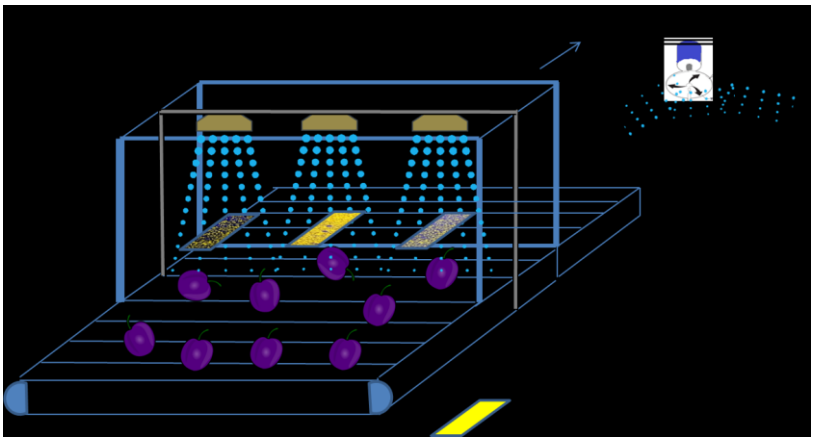
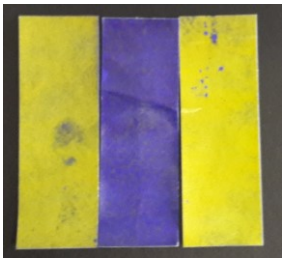


Figure 3: A schematic representation of the evaluation of spray deposition of the fungicide solution by water-sensitive paper cards. Paper cards were placed at three localities under the spray boom to get an indication of the spray deposition of fungicide delivered by either the nozzles or the spinning disk

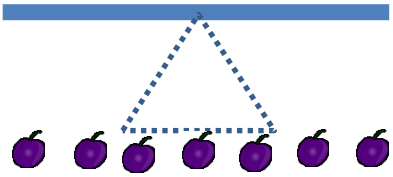
5.1) ***Spray deposition using compressed air nozzles***

Number of nozzles used

One nozzle on the spray boom was not sufficient to ensure adequate coverage of fruit on the conveyor belt. Fruit rolling on the sides of the roller conveyor system did not receive product. Residues on fruit clearly differed between sections receiving too much fungicide (blue card- 1.36 mg / kg) and sections receiving too little fungicide (yellow card -0.56 mg / kg).

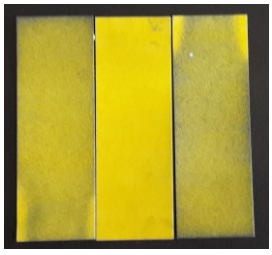


1.35 mg / kg 0.56 mg / kg

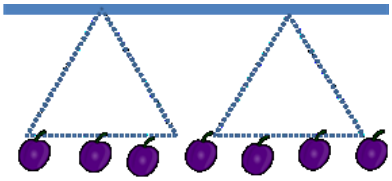


Spacing of the nozzles on the spray boom

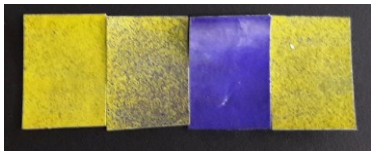
When two nozzles were too widely spaced over the spray boom, the middle of the conveyor belt did not receive product. In addition, in this instance the spray deposition of the droplets was fine and not much product was being delivered. Product residue on fruit taken from a mixed sample over the conveyor belt was 0.18 mg / kg.



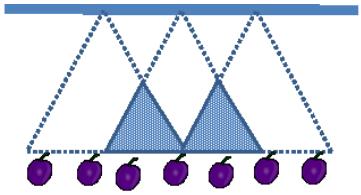
0.18 mg / kg

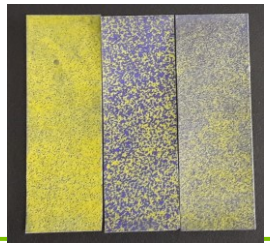


Overlap of spray deposition by nozzles on the conveyor belt resulted in greater product placement on some parts of the conveyor belt than in others. Product residue for one line is indicated.

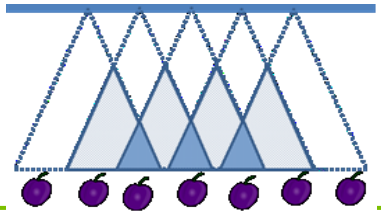


0.16 mg / kg



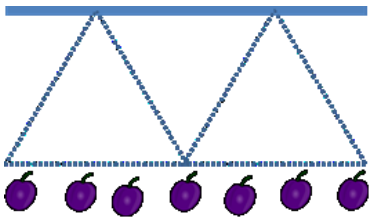


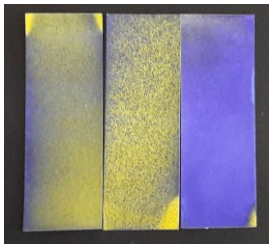
No residue data



The flow rate of the nozzles

In some instances nozzles were adequately spaced, but the flow rate of nozzles varied between nozzles on the same boom. Pack-house staff were observed to randomly adjust nozzles that seemed to be blocked. This hinders accurate nozzle calibration. The varied flow rates of the different nozzles can be seen on the water-sensitive cards. Product residue on fruit from mixed samples was 0.20 mg / kg.

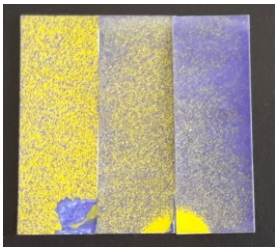




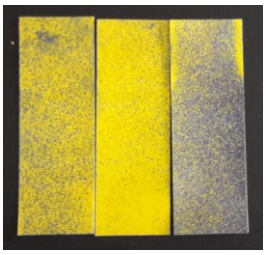
0.20 mg / kg

5.2) ***Spray deposition using hydraulic pressure nozzles***

In the two lines that made use of hydraulic nozzles for atomisation, varied spray deposition with under and over delivery of product, was noticed.



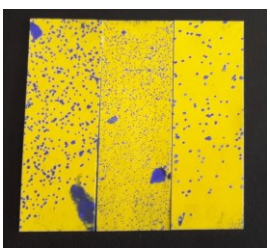
1.97 mg / kg



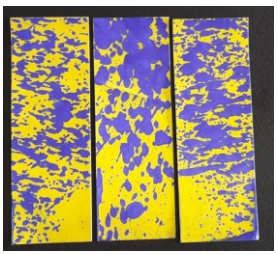
No residue data

5.3) ***Spray deposition with spinning disks***

Fungicide droplet sizes originating from spinning disks tended either to be too small and varied, or too big and uneven and spray deposition was never homogenous. With such spray deposition, parts of the fruit surfaces would be left untreated.



1.10 mg / kg



0.89 mg / kg

The default maximum residue levels on plums destined for export is five parts per million (mg/kg). This MRL on fruit was not exceeded in any of the pack-lines evaluated.

Discussion

The majority of pack-houses surveyed atomised fungicide with compressed air or hydraulic nozzles, and a minority used spinning disks. Systems were mostly custom built. These systems were all similar in major components, consisting of a pump with pipes to lead the fungicide solution to a boom with nozzles or a spinning disk. Shortcomings were noticed in the spacing of the nozzles. Nozzles too close to each other result in product overlap, whilst nozzles spaced too far apart resulted in product not being delivered to parts of the conveyor belt. Additionally, nozzles were sometimes blocked with product sediment and were used at inaccurate flow rates. Generally, fungicide spray deposition was highly variable and seldom homogenous. In the worst instances the product was delivered abundantly on one part of the rotary conveyor belt whilst no product was delivered on the other parts of the belt.

It is important that the product, a suspension concentrate, is continuously agitated, but in most cases this was not adhered to. Without agitation product particles settles and forms sediment. In the majority (65%) of pack-lines settling of the product was likely due to lack of agitation. Moreover, the fungicide *dosage* was higher (in 60% of packing lines) or lower (in 35% of packing lines) than label recommendations. Only one line (5%) adhered to the dosage as recommended on the label.

The knowledge gained from this study emphasises the importance of appropriate design, installation and maintenance of several components within atomising systems in the placement of fungicide on plums. Accurate placement of fungicides may result in better decay control, whilst possibly saving costs. Notably fungicide product performance and cost cannot be seen as the primary consideration in decay control strategies, when application methods are faulty. A fungicide can only be fully effective if it is applied accurately.