Project Title	Development and Evaluation of Aeolian Nozzles for spraying Bush Crops
Project number:	GSK 203
Project leader:	Keith Tridgell SFM Technology Ltd
Report:	Final : November 2006
Previous report	
Key staff:	Peter Cole SFM Technology Ltd Len Mathieson SFM Technology Ltd Keith Tridgell SFM Technology Ltd Neale Thomas FRED Ltd
Location of project:	SFM Technology manufacturing plant and Commercial blackcurrant crops Martock Somerset UK
Project coordinator:	Peter Cole Design Engineer SFM Technology Ltd
Date project commenced:	12th October 2005
Date completion due:	31 November 2006

Grower Summary

Development and Evaluation of Aeolian System Nozzles for spraying Bush Crops

Headline

- Project involves development of a set of Aeolian Nozzles that can be used in field trials on one side of a 2-row trailed blackcurrant sprayer, for visual evaluation against current SFM Technology spray nozzles.
- Evaluate penetration and drift characteristics of Aeolian Nozzle in commercially grown blackcurrants using water sensitive paper.

Background and expected deliverables

Aeolian system nozzles are the invention of Professor Neale Thomas and are the subject of and existing patent. Relative to conventional air assisted sprayers, they function with a relatively lower volume of air, albeit at higher pressure. The technology has yet to be evaluated in bush crops, but if successful, may offer several benefits.

The expected deliverables from this project are:

- Smaller, lighter booms may facilitate the construction of multi-row sprayers.
- It may be possible to reduce power requirements per row sprayed.
- Of major interest is the penetration and drift characteristics that the nozzle achieves

Further development work on the sprayer design and nozzle specification would be required before growers could adopt the result of this work.

Summary of the project and main conclusions

- The project designed and manufactured a 2-part air knife that was attached to a 150mm rigid air pipe that also acted as a plenum chamber. This allowed 6 nozzles to be installed onto one side of an existing 2 row trailed sprayer. The Aeolian system produced finer droplets than the SFM system.
- Aeolian system delivered smaller droplets homogenized throughout the airflow from ejector and high airspeed drag aided their transport into the bush whereas the SFM system that injected into low speed ducted airflow that moves the leaves more vigorously, exposing both sides of the leaf to be exposed to the spray.
- Both systems provided excellent penetration at the higher application rate of 650 litres/Ha, which mimicked the typical 'overdosing' application of sulphur,, but penetration at the lower rate of 260litres/Ha, more commonplace with insecticide and pesticide applications, was more thorough with the SFM system.
- Spray drift was more noticeable from the Aeolian system
- A single nozzle was used at each air knife, not a pair as normal set up, but it was agreed that 2 liquid nozzles per air knife would not compromise matched momentum.
- The practicality of incorporating Aeolian technology for bush spraying would provide a lighter assembly than the existing SFM system, use less energy and would facilitate the construction of multi-row sprayers.

- However, the Aeolian system developed for these trials would need to be modified for 2 main reasons. Firstly, the blower (Roots M407) was far too noisy and a quieter model needs to be found. Secondly, although not insurmountable, the Aeolian nozzle assembly would need to incorporate physical adjustability to provide flexibility of positioning nozzles to allow growers to adapt the sprayer to suit all situations throughout the season and life of the blackcurrant bush.

Financial benefits

- Lower energy requirements and therefore fuel savings
- Less wear and tear through using lightweight materials
- Potentially lower cost to manufacture

Science Section

Introduction

The opportunity to reduce environmental contamination is always uppermost in agronomists minds and GSK wanted to evaluate the use of existing Aeolian spray technology that had already been seen in arable crop research that Neale Thomas has developed and that has received awards, both environmental, (GB Inventions fair 1995) and commercial (DTi smart 92-94). The Aeolian system basically involves matching momentum at liquid fragmentation locus requiring velocity ratio at 30 or so. For example, liquid at 4 m/s at fragmentation point requires air at 120 m/s. This system has not been evaluated in bush crops so it was SFM's task to manufacture an air knife to the Aeolian specification and match this to an air delivery system.

Materials and Methods

The manufacture of the air knife was achieved by machining a 2-piece assembly using a CNC machining centre that could repeat the pattern accurately. The 2 pieces were then glued together and attached to a 150mm PVC pipe in the shape of an inverted 'u' that could be attached to the trailed sprayer. Air for the Aeolian system was provided by a Roots blower type M407 driven by a hydraulic motor that at 2900 rpm producing approximately 600m3/hour and an air pressure of 0.20 to 0.25 bar. All equipment was mounted on a special boom that replaced one side of the SFM trailed sprayer. In this way, the Aeolian system could be compared to the SFM airknife system simultaneously, ensuring similar field conditions. The Aeolian nozzles were bench tested and once a satisfactory spray formation was achieved, the equipment was operated in the field for visual assessment .

The water-sensitive paper trial was set up on a relatively calm day, (average wind speed 2m/s). The water pressure used was 2.5 bar and six 04F110 liquid nozzles used on the booms on each side of the sprayer. The air pressure in the Aeolian boom was 0.25 bar. For the first trial strips were placed approximately 1metre apart in 4 locations within the bush; one at each side' one at the top and one in the middle, (see diagram). The tractor was driven at 2 Kph which produced an application rate of 650 litres/Ha. The second set of strips were placed in the middle of the bush at approximately 2 metre intervals. The sprayer was driven at 5 Kph to produce an application rate of 250 litres/Ha. The water-sensitive strips were left to dry on the bush and then collected for evaluation. Air speed was also measured

Results and Discussion

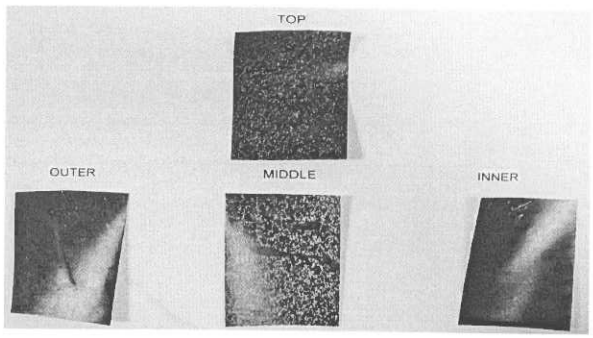
Visually, the Aeolian system nozzles created a curtain of fine droplets entrained in high velocity airflow that came together as a 'vortex' in the target area. In the field, the Aeolian boom output penetrated the bush and left most of the strips completely covered at the higher dose rate. This was the type of 'overdosing' that would be required for Sulpher applications. In the bush at the lower water volume of (250 l/HA) the Aeolian nozzles did not achieve as much penetration as the SFM nozzles, but still covered the strips at most locations with sufficient liquid.

There appeared to be more drift with the Aeolian nozzles, despite all nozzles being directed at the bush. This was not seen with the SFM nozzles, probably due to the larger droplet size and lower speed air flow at the air/liquid fragmentation locus.

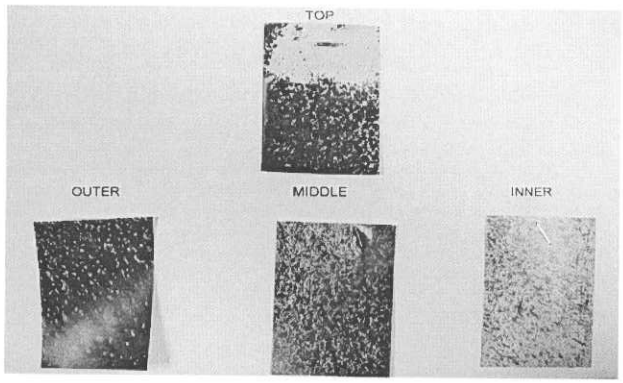
The equipment that was produced to trial the Aeolian system was of a rigid pipe construction to create a one piece plenum chamber and boom, but if commercialized, then greater flexibility of boom configuration would need to be devised. For the purpose of the trial, the SFM nozzle configuration was comparable to that of the Aeolian boom.

Appendices

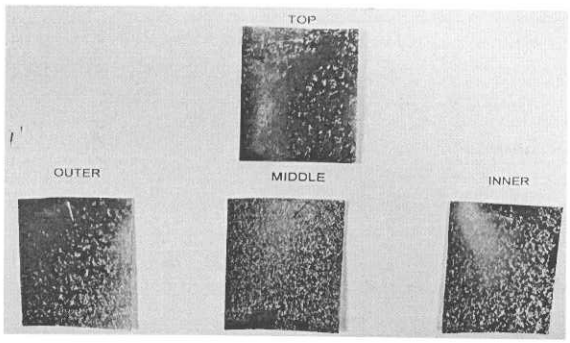
Water sensitive strips
Air speed recordings
Roots Blower specification
Aeolian nozzle pictures



AEOLIAN BUSH 1 AT 2 KP/H



SFM AIR KNIFE BUSH 1 AT 2 KP/H



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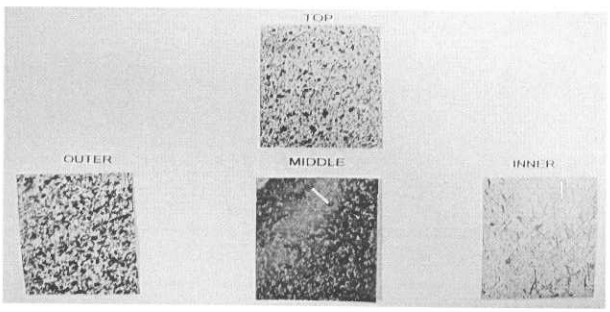

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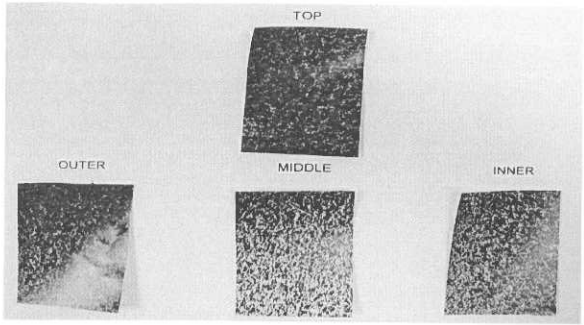

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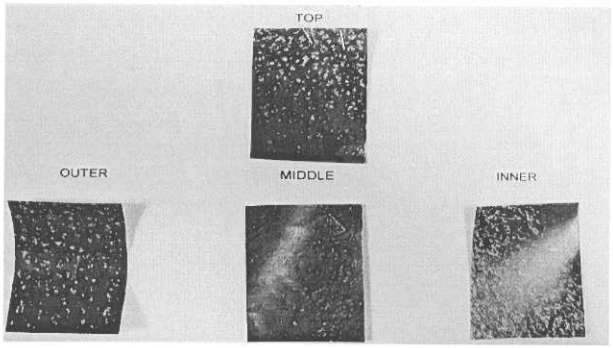

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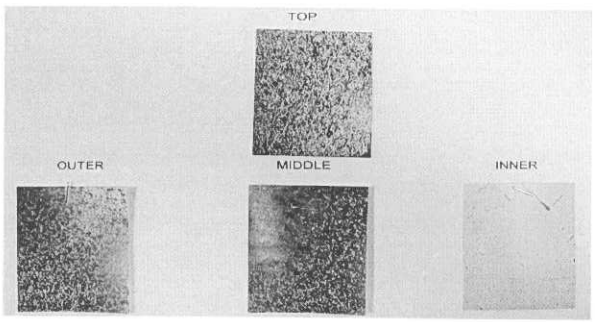

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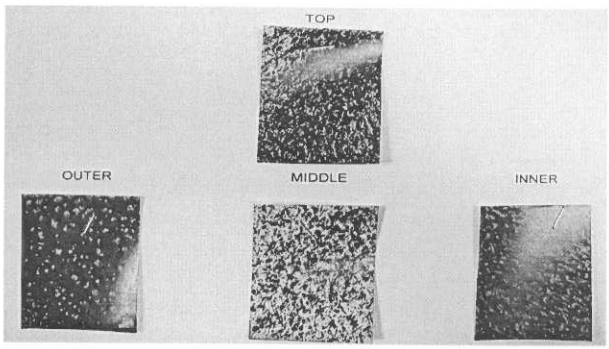
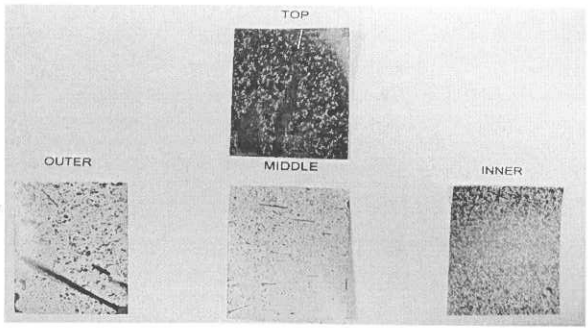


SFM AIR KNIFE BUSH 4 AT 2 KP/H



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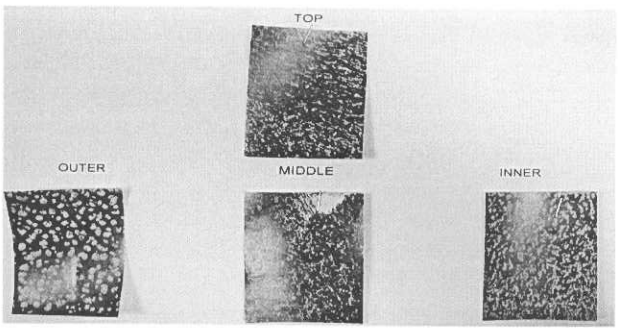

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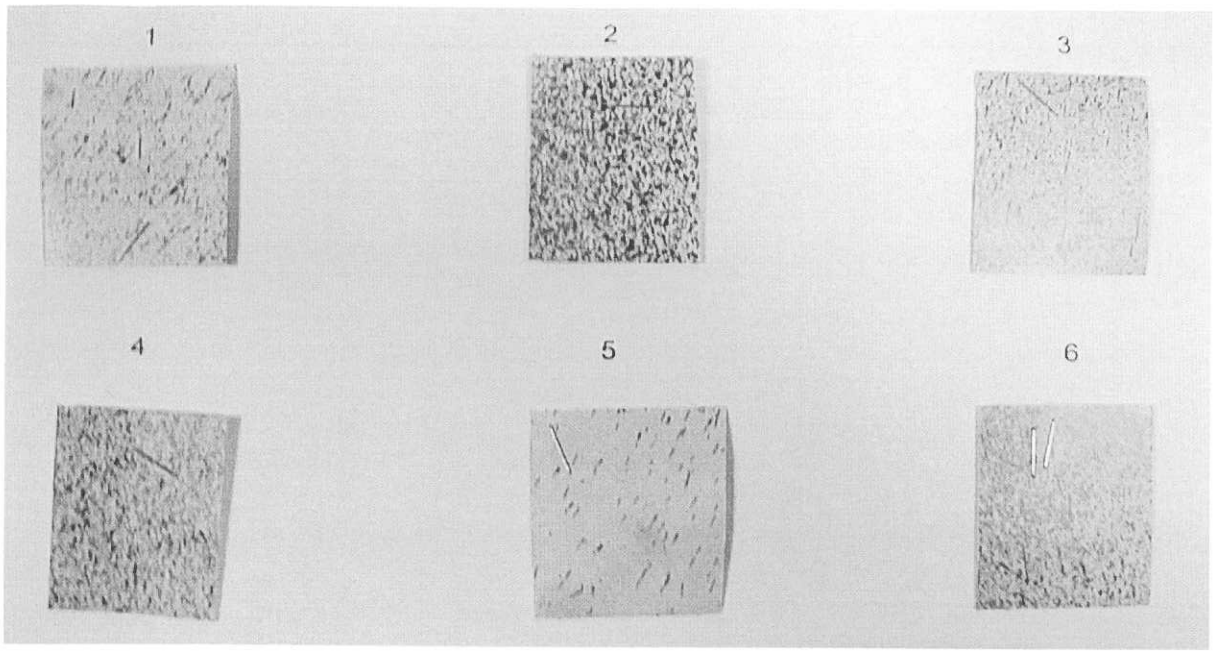
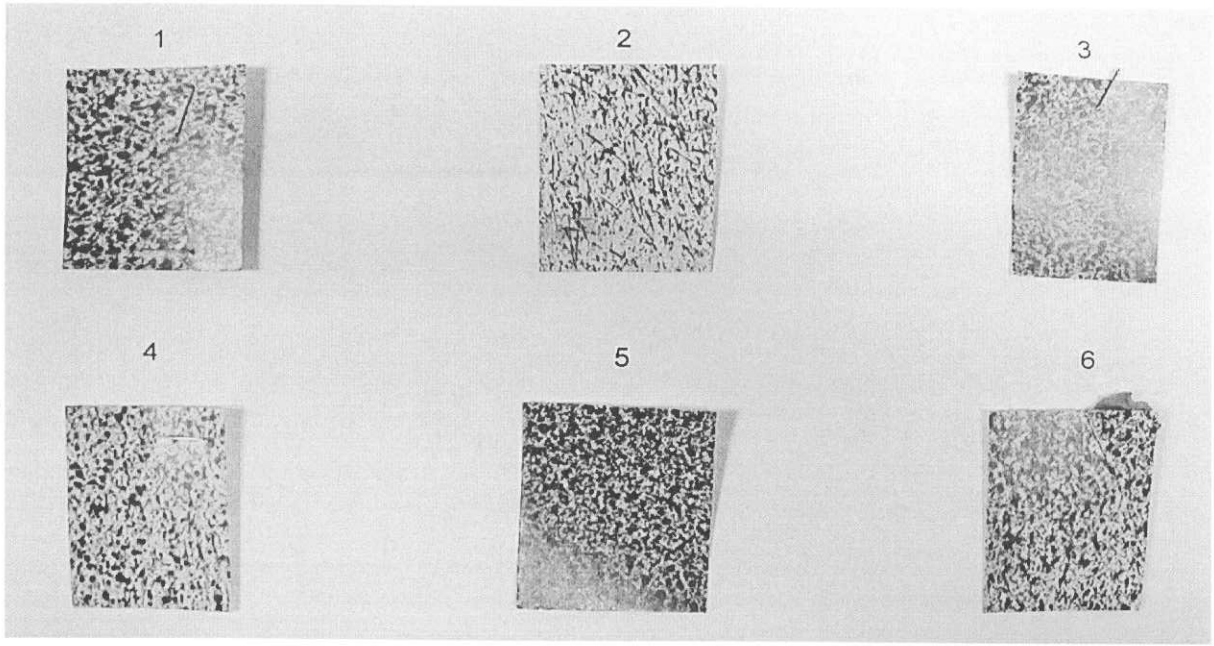
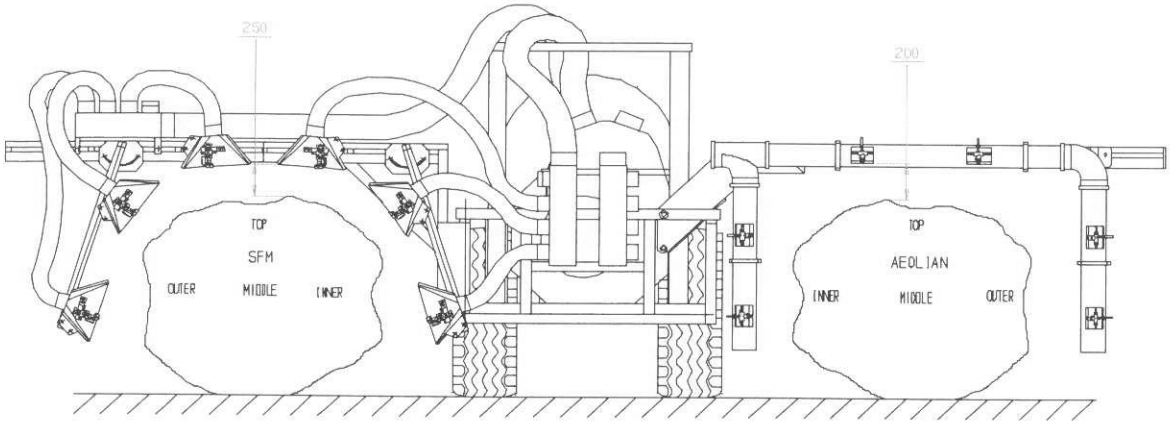


AEOLIAN TEST 2 AT 5 KP/H TOP OF BUSH TO AIR OUTLET 200 MM BUSH NUMBERS LISTED



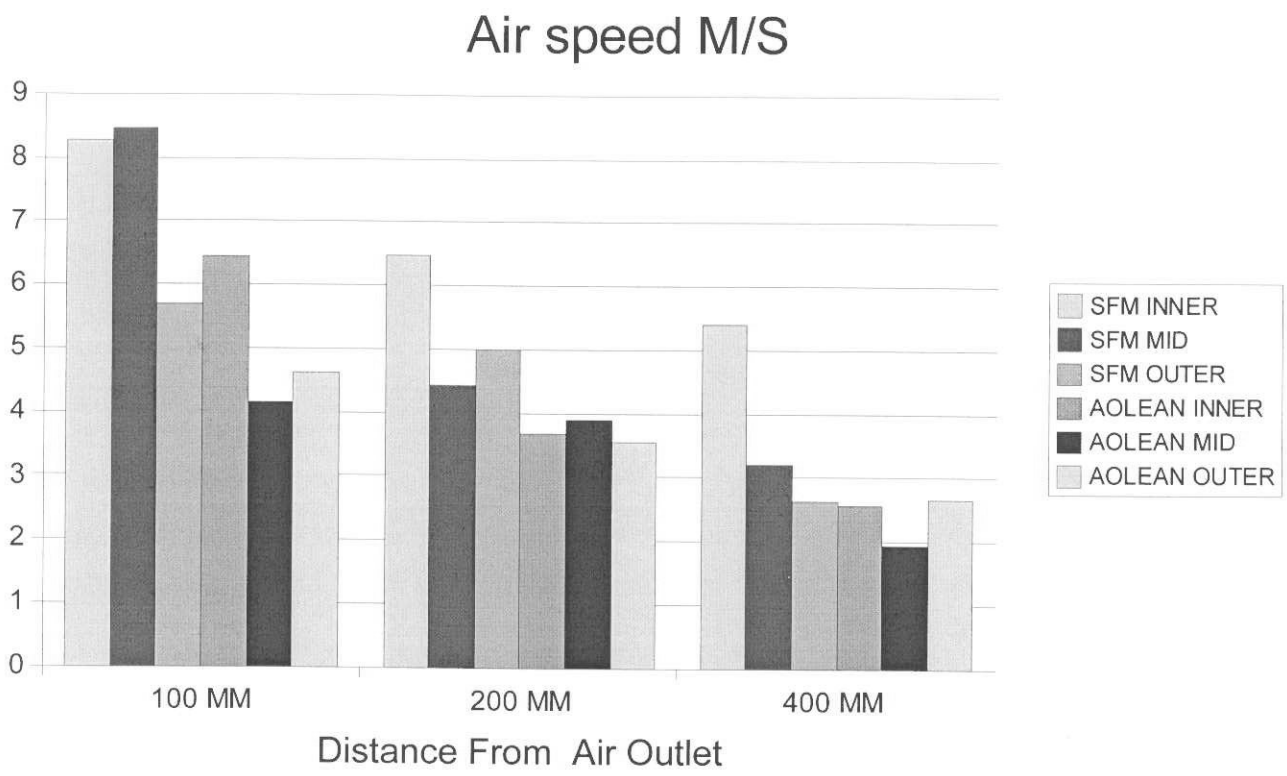
SFM AIR KNIFE TEST 2 AT 5 KP/H TOP OF BUSH TO AIR OUTLET 250 MM BUSH NUMBERS LISTED

2-ROW TRAILED SPRAYER



Air Speed Recordings

These were taken on an AIRFLOW LCA6000 VT Mk II



ROOTS BLOWER

TYPE	Roots blower M407
Operation speed	2900 rpm
Absorbed power at 2550 rpm	5.5kW
Air flow at 2550 rpm	500 m^3/hour
Air pressure	0.2-0.25 bar

Aeolian Nozzles