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**Factors affecting spray deposits
and their biological effects on
New Zealand apple canopies**

*A thesis presented in fulfillment of the requirements
for the degree of Doctor of Philosophy in
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by

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by *David W.L Manktelow*

Abstract

A series of apple tree spraying experiments was conducted to identify factors affecting agrichemical deposits from airblast sprayers and to relate deposit observations to biological responses in selected pest, disease and physiological systems. Factors addressed included tree canopy form, application volume, travel speed and sprayer type.

Several tracers were evaluated and deposits quantified by wash-off removal from bulked leaf or fruit samples drawn from 10-15 spatially consistent 1.5 m³ zones per tree. Deposit data were expressed on a tissue area basis and/or as a proportion of the spray emitted (retention).

Spray deposits were compared across 11 canopy forms to identify interactions with tree size, leaf area and canopy density and volume. A two-fold difference in deposits between canopies occurred when sprays were applied at a constant chemical rate per hectare. This variability was approximately halved when chemical rates per hectare were adjusted on the basis of the canopy Tree-Row-Volume (TRV). The best TRV measurement system identified used across-row canopy spread measurements at half metre height intervals, rather than just a single measurement of canopy spread. Deposits were better correlated with TRV data than with any of the other canopy descriptors used. Canopy density was identified as an important covariate, but light penetration proved an unsuitable indicator of canopy density as it was strongly correlated with TRV. Deposit variations between zones within trees were consistent between all but the smallest canopy sprayed. Increasing the distance from the sprayer and/or increasing canopy penetration requirements reduced spray deposits.

Spray retention across these canopies in full leaf ranged from 25-90%, but tended to increase with decreased application volume. There was a ca. 10-15% increase in deposits when spray volumes were reduced 4-5 times below those used in typical dilute spray volumes (ca. 2,000 l ha⁻¹). At high volumes with significant run-off, retention could ca. 50% of that at lower volumes. Run-off losses could be related to TRV, with significant run-off occurring once application volumes exceeded one litre per 7.5-11 m³ of TRV.

Surprisingly, average deposits on 5m tall slender pyramid trees increased with increased travel speed over the range 1.9-8.8 km h⁻¹. Within-tree spray deposit distributions were not markedly affected by the travel speeds tested with air assistance volumes of ca. 30,000 or 44,000 m³ h⁻¹.

High, but relatively consistent within-tree deposit variability was a feature of deposits from axial fan, airblast sprayers, especially when used in intensive 4-6 m

tall, single leader tree plantings. Within-tree deposit variability decreased with increased application volumes. Tower sprayers provided a more even vertical distribution of spray emission points and achieved different, but not necessarily more even, within-tree deposit distributions than airblast machines.

Experiments on chemical thinning, mealybug (*Pseudococcus viburni*) and black spot (*Venturia inaequalis*) control, showed the biological responses could not have been predicted from the spray deposit measurements. However, combined assessment of spray deposits and biological effects greatly facilitated interpretation of both sets of data.

KEYWORDS: spray application, deposit, retention, spray volume, tracer, spray distribution, tree-row-volume, canopy, light penetration, apple, *Malus domestica*, *Venturia inaequalis*, *Pseudococcus virbuni*., chemical thinning, sprayer.

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Well maybe slightly differently next time.....

Table of Contents

ABSTRACT	II
ACKNOWLEDGEMENTS	IV
LIST OF FIGURES	X
LIST OF TABLES	XII
BACKGROUND AND STUDY OBJECTIVES	1
CHAPTER 1	4
1 SPRAY DEPOSITS: MEASUREMENT, ASSESSMENT AND SAMPLING	4
1.1 Introduction	5
1.1.1 Chapter objectives	5
1.1.2 Spray deposit measurement parameters and requirements	5
1.1.3 Quantifying spray deposits and describing deposit distributions	6
1.1.3.1 Quantitative recovery of visible dyes and fluorescent tracers.	6
1.1.3.2 Chemical residue analysis	8
1.1.3.3 Techniques to describe deposit distributions	9
1.1.4 Presenting spray deposit data	10
1.1.5 Experimental design and sampling methods	12
1.2 Materials and Methods	14
1.2.1 Deposit assessment techniques	14
1.2.1.1 Food dye tracers: Sample preparation, recovery efficiency, sample units and deposit assessments.	14
1.2.1.2 Spray coverage estimation	17
1.2.2 Sampling methods	19
1.2.2.1 Establishment of a stratified zoning system for tree deposit assessments	19
1.2.2.2 Sample size requirements	20
1.3 Results	20
1.3.1 Deposit assessment techniques	20
1.3.1.1 Food dye tracers: Sample preparation, recovery efficiency, sample units and deposit assessments	20
1.3.1.2 Spray coverage estimation	23
1.3.2 Sampling methods	24
1.4 Discussion	25
1.4.1 Deposit assessment techniques	25
1.4.1.1 Food dye tracers: Sample preparation, recovery efficiency, sample units and deposit assessments.	25
1.4.1.2 Spray coverage estimation	27
1.4.2 Sampling methods	28
1.5 Conclusions	30
1.6 References	31

CHAPTER 2	35
2 APPLE CANOPIES AS SPRAY TARGETS AND THEIR INFLUENCE ON SPRAY DEPOSITS	35
2.1 Introduction	36
2.1.1 Influence of apple canopy on spray deposits	36
2.1.1.1 Canopy structure and seasonal development	36
2.1.1.2 Apple tree forms under different training systems and their effects on spray deposits	40
2.1.2 Influence of apple canopy on spray retention	48
2.1.3 Spray volume requirements in different canopies: Tree-Row-Volume spraying	48
2.2 Materials and Methods	50
2.2.1 Canopy form in Gala apples on seven training systems and in five cultivars trained as slender pyramids	50
2.2.1.1 Row-end profiles, Tree-Row-Volumes and Along-Row Continuity	51
2.2.1.2 LAI and Density assessments	51
2.2.1.3 Physical spray-throw requirements	51
2.2.1.4 Comparison of Tree-Row-Volume measurement systems	52
2.2.2 Canopy and application volume influences on spray deposits and retention	52
2.2.2.1 Spray deposits	52
2.2.2.2 Canopy influences on spray retention	53
2.2.2.3 Tree-Row-Volume spraying to manage spray deposits	54
2.2.2.4 Canopy influences on spray deposit variability	54
2.3 Results	54
2.3.1 Canopy form in Gala apples on seven training systems and in five cultivars trained as slender pyramids	54
2.3.1.1 Row end profiles and along-row continuity	55
2.3.1.2 LAI and Density assessments	55
2.3.1.3 Physical spray-throw requirements	57
2.3.1.4 Comparison of Tree-Row-Volume measurement systems	57
2.3.2 Canopy and application volume influences on spray deposits and retention	59
2.3.2.1 Spray deposits	59
2.3.2.2 Canopy influences on spray retention	60
2.3.2.3 Tree-Row-Volume spraying to manage spray deposits	62
2.3.3 Canopy influences on spray deposit variability	65
2.4 Discussion	68
2.4.1 Canopy form in Gala apples on seven training systems and in five cultivars trained as slender pyramids	68
2.4.1.1 Comparison of Tree-Row-Volume measurement systems	69
2.4.2 Canopy and application volume influences on spray deposits and retention	69
2.4.2.1 Spray deposits and retention	69
2.4.2.2 Tree-Row-Volume spraying to manage spray deposits	71
2.4.3 Canopy influences on spray deposit variability	73
2.5 Conclusions	74
2.6 References	75
CHAPTER 3	78
3 EFFECTS OF SPRAY MACHINERY AND OPERATION ON SPRAY DEPOSITS	78
3.1 Introduction	79

3.1.1	Spray volume, droplet size and nozzle distribution effects on spray deposits	79
3.1.2	Travel speed and air assistance effects on spray deposits	81
3.1.3	Sprayer effects on deposits	84
3.1.4	Experimental Objectives	85
3.2	Materials and Methods	85
3.2.1	Effect of application volume on deposits	85
3.2.2	Travel speed and air assistance effects on spray deposits	86
3.2.3	Tower sprayer effects on deposits	87
3.2.4	Nozzle distribution and drop size effects on spray deposits	90
3.3	Results	90
3.3.1	Effect of application volume on deposits	90
3.3.2	Travel speed and air assistance effects on spray deposits	90
3.3.3	Tower sprayer effects on deposits	92
3.3.4	Nozzle distribution and drop size effects on spray deposits	95
3.4	Discussion	95
3.4.1	Effect of application volume on deposits	95
3.4.2	Travel speed and air assistance effects on spray deposits	96
3.4.3	Tower sprayer effects on deposits	97
3.4.4	Nozzle distribution and drop size effects on spray deposits	97
3.5	Conclusions	98
3.6	References	99
CHAPTER 4		102
4	SPRAY DEPOSIT REQUIREMENTS FROM SINGLE SPRAY APPLICATIONS FOR CHEMICAL THINNING OR MEALYBUG CONTROL	102
4.1	Introduction	103
4.1.1	Chemical thinning with carbaryl	104
4.1.2	Mealybug control	105
4.1.3	Experimental Objectives	106
4.2	Materials and Methods	106
4.2.1	Chemical thinning trial	106
4.2.1.1	Experimental design and treatments	106
4.2.1.2	Spray deposit assessments	107
4.2.1.3	Thinning assessments	108
4.2.2	Mealybug control trial	108
4.2.2.1	Experimental design and treatments	108
4.2.2.2	Spray deposit assessments	112
4.2.2.3	Mealybug distribution analysis	113
4.3	Results	113
4.3.1	Chemical thinning trial	113
4.3.2	Mealybug control trial	116
4.3.2.1	Spray Coverage and spray deposit assessments	116
4.3.2.2	Fruit Assessment	118
4.4	Discussion	118
4.4.1	Chemical thinning trial	118
4.4.2	Mealybug control trial	120
4.4.3	General discussion	123

4.5	Conclusions	123
4.6	References	124
CHAPTER 5		127
5	SPRAY DEPOSIT REQUIREMENTS FROM MULTIPLE SPRAY APPLICATIONS FOR BLACK SPOT DISEASE CONTROL	127
5.1	Introduction	128
5.1.1	Black spot disease control	128
5.1.2	Fungicide deposit and residue level requirements for black spot control	129
5.1.3	Spray application scheduling and spraying patterns	130
5.1.4	Objectives	131
5.2	Methods	131
5.2.1	Experimental site	131
5.2.2	Seasonal canopy development	131
5.2.3	Treatments	132
5.2.4	Spray Deposits	133
5.2.5	Residue Maintenance	134
5.2.6	Disease Control	136
5.3	Results	136
5.3.1	Seasonal canopy development	136
5.3.2	Spray deposits	138
5.3.2.1	Whole tree spray deposit comparisons	138
5.3.2.2	Spray deposit comparisons for different tree zones	138
5.3.2.3	Comparisons of spray deposit data from different sampling techniques	139
5.3.3	Residue maintenance	142
5.3.3.1	Mancozeb decay profile following different application methods	142
5.3.3.2	Residue maintenance under different application methods	142
5.3.4	Disease control	145
5.4	Discussion	146
5.4.1	Seasonal canopy development	146
5.4.2	Spray deposits	148
5.4.2.1	Whole tree spray deposit comparisons	148
5.4.2.2	Spray deposit comparisons for different tree zones	149
5.4.2.3	Spray deposits from zoned samples compared with residue samples	150
5.4.3	Residue maintenance	150
5.4.4	Disease control	151
5.5	Conclusions	152
5.6	References	153
CHAPTER 6		155
6	CONCLUSIONS	155
6.1	Spray deposit assessment	155
6.2	Canopy effects on spray deposits	156
6.3	Sprayer effects on spray deposits	157

6.4	Biological implications of observed spray deposits	158
6.5	Future studies	159
6.6	References	160
7	APPENDICES	161
7.1	Canopy row-end profiles and along-row continuity estimates	161
7.1.1	Multi-leader	162
7.1.2	McKenzie centre leader	163
7.1.3	Old slender pyramid	164
7.1.4	Ideal slender pyramid	165
7.1.5	Hedgerow	166
7.1.6	Slender spindle	167
7.1.7	Ebro espalier	168
7.2	Photographs of Gala apple canopies	169
7.3	Sprayer setup and calibration details for tree-row-volume spraying experiments	171
7.4	Sprayer-type comparisons	174
7.4.1	Airblast and tower sprayer air output orientations	174
7.4.2	Photographs of airblast and tower sprayers	175
7.5	Sprayer setup and calibration details for thinning spray applications	178
7.6	Sprayer setup and calibration details for mealy bug spray applications	179
7.7	Photograph of spray application for mealybug work	179
7.8	Seasonal canopy development data	180
7.9	Fruit surface area calculation assumptions	182
7.10	Sprayer setup and calibration details for black spot control experiments	183

List of figures

- Figure 1-1: Diagrammatic representation of the 1.5 m³ sampling zones used to take spatially consistent leaf and/or fruit samples for spray deposit assessments from a range of apple canopy forms. _____ 19
- Figure 1-2 Absorbance levels of Brilliant Blue and Tartrazine tracers over a range of wave lengths. Vertical lines indicate absorbance wavelengths selected for sample analysis when the tracers were to be used in combination. _____ 21
- Figure 1-3 Absorbance:concentration relationships for laboratory prepared stock solutions of Brilliant Blue (BB) and Tartrazine (T) food dye tracers (combined data from different stock solutions prepared over a three year period). _____ 21
- Figure 1-4 Row end profile view of the sampling zones established by Travis (1981) for spray deposit assessments on "small" and "medium" apple trees. _____ 29
- Figure 2-1 Apple row-end profiles and typical air blast sprayer location relative to each canopy for: slender spindle (left), NZ Slender pyramid (mid, shown in background) and American Standard (right) canopies at 3.6, 5.0 and 11 metre row spacings respectively. Crosses indicate tree centres at 1.5 m height intervals. Vertical and horizontal distances are given in metres. _____ 43
- Figure 2-2 Measurements used in estimates of American Tree-Row-Volume (US-TRV)(left), Half-Crown Tree-Row-Volume (HC-TRV)(centre) and Height-Stratified Tree-Row-Volume (HS-TRV) (right). _____ 49
- Figure 2-3 Height-Stratified-Tree-Row-Volume (HS-TRV) measurements compared with measurements made on the same trees using the American Tree-Row-Volume (US-TRV) and European Half-Crown-Tree-Row-Volume (HC-TRV) systems _____ 58
- Figure 2-4 Comparison of dilute spray volumes used by growers on 31 canopies in New Zealand orchards with spray volume requirements calculated from HS-TRV data, with a coverage assumption of 10.7 m³ TRV per litre of dilute spray. _____ 58
- Figure 2-5 Combined data from seven Gala apple canopy forms showing spray volumes applied and retained on foliage. (Combined canopies regression data: Deposit = 0.45x + 101.6 r²=0.63; Retention = -0.005x + 62.2 r²=0.08) _____ 61
- Figure 2-6 Spray volume applied and retained on foliage of seven Gala apple training systems (Combined canopies regression data: log[volume retained] = 0.89x + 0.03 r² = 0.84) _____ 61
- Figure 2-7 Deposits when chemical application rates were held constant per hectare or simulated on the basis of HS-TRV's. Linear regression lines are for combined concentrate and dilute application data (Table 2-11). Unfilled points show deposits on Ebro espalier trees and were not included in the regressions. _____ 64
- Figure 2-8 Deposits in relation to canopy density (measured as light penetration) when chemical application rates were either held constant per hectare or simulated on the basis of HS-TRV's. Linear regression lines are for combined concentrate and dilute application data (Table 2-11). Unfilled points show deposits on Ebro espalier trees and were not included in the regressions. _____ 64
- Figure 2-9 Spray deposit variations in different canopy zones in three selected Gala apple canopy forms, with zonal variations expressed as a percentage difference from the canopy mean deposit. See Figure 1.1 for details of the canopy zoning system. _____ 66

- Figure 2-10 Spray deposit sample zones (Figure 2-9) grouped by height (top graph) or proximity to the sprayer (lower graph) to show patterns of within-tree spray deposit variation in seven Gala apple canopy forms following application at dilute (HS-TRV) or concentrate spray volumes. Deposit variations are presented as percentage differences between the average deposit for the zone grouping and the average deposit for the whole canopy. _____ 67
- Figure 3-1 Within-tree spray deposit variations following applications at four travel speeds from axial fan, airblast sprayers with 30,000 (small sprayer) and 44,000 (large sprayer) $m^3 h^{-1}$ air assistance volumes. Deposit variations are expressed as the percentage difference between the average deposit in the zone grouping and the average deposit for the whole canopy. Zones were grouped by height (top graph) or ease of spray penetration/proximity to the sprayer (bottom graph). _____ 92
- Figure 3-2 Within-tree spray deposit variations at three heights following applications with four types of sprayer at 3.8 $km hr^{-1}$ (top graph) or 7.1 $km hr^{-1}$ (bottom graph). Deposit variations are expressed as the percentage difference between the average deposit measured at each height and the average deposit for the whole canopy. _____ 94
- Figure 4-1 Spray tracer deposit data by height for different thinning application volume treatments. The single triangular data point is the average tree deposit for treatment 7, which contained an organo-silicone surfactant. _____ 114
- Figure 4-2 Change in flower cluster density (FCD), fruit set density (FSD) and fruit numbers per cluster (FNC), 29 days after thinning treatment applications. Data points off the lines at the 500 $l ha^{-1}$ volume relate to treatment 7, which included an organo-silicone surfactant. _____ 115
- Figure 4-3 Change in fruit set density (FSD) at three heights, 29 days after thinning treatment applications. _____ 116
- Figure 5-1 Royal Gala shoot, flower and fruit development data. Graph a) shows average total leaf area per shoot (weighted for different shoot types) and the proportion of susceptible tissue. Closed arrows indicate the start and end of residue maintenance tests; the open arrow indicates the start of the residue decay test. Graph b) shows flower and fruit surface area development. _____ 137
- Figure 5-2 Within-tree spray deposit variations expressed as proportional differences between individual sample zones and whole-tree average deposits for three spray application treatments (Table 5-1). Graphs show; leaf deposits following applications using spring (a) or summer (b) sprayer calibrations, and fruit deposits (c) following application using the summer calibration. _____ 140
- Figure 5-3 Cumulative frequency distribution plots of zonal deposits from three spraying treatments (combined replicate*zone data). Graphs show; leaf deposits following applications using spring (a) or summer (b) sprayer calibrations, and fruit deposits (c) following application using the summer calibration. Each line was derived from 36 (replicate*zone) values. _____ 141
- Figure 5-4 Mancozeb residue decay on fruit (top) and expanded leaves (bottom) following single spray applications by three spray application methods. Day 0 = 15 December 1995. _____ 143
- Figure 5-5 Mancozeb residue maintenance over a 24 day period on different apple tissues under three spray application strategies, whereby chemical application rates in treatments 2 and 3 were half that of treatment 1, but applications were made twice as often. _____ 144
- Figure 5-6 Estimates of seasonal changes in Royal Gala leaf and fruit area index based on monitored shoot and fruit development and values at harvest of 3.4 and 0.4 respectively. _____ 148

List of tables

Table 1-1	Some tracers evaluated for use in spraying experiments _____	15
Table 1-2	The effect of sample filtering and other treatments on background sample absorbance levels at two wavelengths. _____	22
Table 1-3	Average ratios of deposits estimated from Brilliant Blue and Tartrazine tracers recovered from apple leaves sprayed at low or high volumes, with the tracers either tank mixed or overlaid by separate spray applications _____	23
Table 1-4:	Deposit data from whole leaf versus leaf punch samples from different positions within leaves for high volume spray application. _____	23
Table 1-5	Mean deposit levels and visual deposit assessment scores on leaf top and bottom surfaces for leaf samples from four spraying treatments _____	24
Table 1-6	Linear regression parameters from comparison of spray deposits measured on individual leaves (independent) with summed visual spray deposit rankings for combined top and bottom leaf surfaces _____	24
Table 1-7	Sample number requirements calculated to estimate leaf spray deposits to within a desired percentage of the population mean. _____	24
Table 2-1	Relative surface areas of apple tree wood and leaf tissues at two growth stages. ^v _	37
Table 2-2	Tree spacings and gross dimensions in selected apple canopy planting and training systems _____	42
Table 2-3	Linear regression data comparing HS-TRV with five canopy parameters _____	55
Table 2-4	Canopy volume, tree-row-volume, along-row continuity, leaf area and canopy density for seven Gala apple canopy forms and five apple cultivars trained to the slender pyramid tree form. _____	56
Table 2-5	Distances from the closest nozzle on an axial fan sprayer to first canopy and tree centres on trajectories to 1.5, 3.0, 4.5 metre heights in seven Gala apple canopy forms. _____	57
Table 2-6	Mean leaf deposits following tracer application at 1 kg ha ⁻¹ in different water volumes on seven Gala apple tree canopy forms _____	59
Table 2-7	Mean leaf deposits following spray application at 500 l ha ⁻¹ (ca. 4X concentrate) on five apple cultivars trained as slender pyramids _____	60
Table 2-8	Spray retention (volume of spray deposited per hectare of leaf surface area) as a percentage of the spray volume applied per hectare on seven Gala apple canopy forms _____	60
Table 2-9	The influence of various canopy parameters on spray retention. Linear regressions were conducted using the combined canopies data set (n = 19). _____	62
Table 2-10	Tracer deposits from applications at 1 kg ha ⁻¹ in different water volumes, or simulated for TRV spraying with tracer rates determined by application volume _____	63
Table 2-11	The influence of various canopy parameters on spray deposits following applications with fixed chemical rates per hectare or where chemical rates were simulated according to HS-TRV calculations _____	63
Table 3-1	Theoretical sprayer air output volumes required (per side) per metre of travel in order to fill different apple canopies with spray laden air _____	82
Table 3-2	Theoretical sprayer air outputs in relation to distance travelled (m ³ m ⁻¹) for five air output levels at 11 travel speeds. _____	83

<i>Table 3-3</i>	<i>Data from Travis et al. (1987) reworked to show the effect of travel speed on spray deposits in apple trees of two different sizes.</i>	84
<i>Table 3-4</i>	<i>Specifications of the axial fan and tower sprayers used in experiments²</i>	89
<i>Table 3-5</i>	<i>Average whole tree spray deposits and CV's following spray applications at four speeds with two different sprayers</i>	91
<i>Table 3-6</i>	<i>Coefficients of variation for spray deposits from four types of sprayer following applications at two travel speeds to slender pyramid apple trees.</i>	93
<i>Table 3-7</i>	<i>Spray deposits at three heights in slender pyramid apple trees following applications from pairs of fine or coarse nozzles located in five positions on an axial fan, airblast sprayer.</i>	95
<i>Table 4-1:</i>	<i>Tree training, size, spacing, tree-row-volume and stage of growth data.</i>	106
<i>Table 4-2:</i>	<i>Tree training, size, spacing TRV and stage of growth data.</i>	109
<i>Table 4-3</i>	<i>Mealybug spray application treatments</i>	112
<i>Table 4-4</i>	<i>Whole tree average leaf deposit data from thinning spray applications at different spray volumes.</i>	114
<i>Table 4-5</i>	<i>Spray volumes deposited on artificial spray targets, with deposit volumes standardised between treatments to an application volume of 2,500 litres per hectare.</i>	117
<i>Table 4-6</i>	<i>Spray deposit ratios for six height zone and branch surface combinations.</i>	117
<i>Table 4-7</i>	<i>The influences of application technique and spray adjuvants on the incidence^x and severity^y of mealybug infestation on 'Royal Gala' apples.</i>	118
<i>Table 5-1</i>	<i>Experiment treatment details</i>	132
<i>Table 5-2</i>	<i>Fungicide application rate details for the low rate spraying treatments</i>	133
<i>Table 5-3</i>	<i>Fungicide treatments, residue sample dates, spray deposit sample dates and treatment.</i>	135
<i>Table 5-4:</i>	<i>Average leaf and fruit spray deposits from three different fungicide application methods. Deposit data were standardised to a tracer application rate of 1 kg ai ha⁻¹.</i>	138
<i>Table 5-5</i>	<i>Spray deposits ($\mu\text{g cm}^{-1}$) observed with two sampling techniques on three tissue types, with two different tracers. Data were standardised to equivalent application rates of 1 kg ai ha⁻¹.</i>	139
<i>Table 5-6</i>	<i>Black spot infection period (IP) occurrence relative to fungicide timing.</i>	145
<i>Table 5-7</i>	<i>Disease assessment data</i>	146