General enquiries on this form should be made to:
Defra, Procurements and Contracts Division (Science R&D Team)
Telephone No. 0207 238 5734
E-mail: research.competitions@defra.gsi.gov.uk

SID 5 Research Project Final Report

- **Note**
  In line with the Freedom of Information Act 2000, Defra aims to place the results of its completed research projects in the public domain wherever possible. The SID 5 (Research Project Final Report) is designed to capture the information on the results and outputs of Defra-funded research in a format that is easily publishable through the Defra website. A SID 5 must be completed for all projects.
- This form is in Word format and the boxes may be expanded or reduced, as appropriate.
- **ACCESS TO INFORMATION**
  The information collected on this form will be stored electronically and may be sent to any part of Defra, or to individual researchers or organisations outside Defra for the purposes of reviewing the project. Defra may also disclose the information to any outside organisation acting as an agent authorised by Defra to process final research reports on its behalf. Defra intends to publish this form on its website, unless there are strong reasons not to, which fully comply with exemptions under the Environmental Information Regulations or the Freedom of Information Act 2000.
  Defra may be required to release information, including personal data and commercial information, on request under the Environmental Information Regulations or the Freedom of Information Act 2000. However, Defra will not permit any unwarranted breach of confidentiality or act in contravention of its obligations under the Data Protection Act 1998. Defra or its appointed agents may use the name, address or other details on your form to contact you in connection with occasional customer research aimed at improving the processes through which Defra works with its contractors.

Project identification

1. Defra Project code: PS2015
2. Project title: Additional Field Spray Drift Data for the Buffer Zone Review
3. Contractor organisation(s): Food and Environment Research Agency, Sand Hutton, York, YO411LZ
4. Total Defra project costs (agreed fixed price): £ 26309
5. Project: start date ..... 01 October 2007
   end date ..... 31 December 2010

6. It is Defra's intention to publish this form.
Please confirm your agreement to do so..... **YES** √ **NO** ☐

(a) When preparing SID 5s contractors should bear in mind that Defra intends that they be made public. They should be written in a clear and concise manner and represent a full account of the research project which someone not closely associated with the project can follow.
Defra recognises that in a small minority of cases there may be information, such as intellectual property or commercially confidential data, used in or generated by the research project, which should not be disclosed. In these cases, such information should be detailed in a separate annex (not to be published) so that the SID 5 can be placed in the public domain. Where it is impossible to complete the Final Report without including references to any sensitive or confidential data, the information should be included and section (b) completed. NB: only in exceptional circumstances will Defra expect contractors to give a "No" answer.
In all cases, reasons for withholding information must be fully in line with exemptions under the Environmental Information Regulations or the Freedom of Information Act 2000.

(b) If you have answered NO, please explain why the Final report should not be released into public domain

Executive Summary

7. The executive summary must not exceed 2 sides in total of A4 and should be understandable to the intelligent non-scientist. It should cover the main objectives, methods and findings of the research, together with any other significant events and options for new work.

During 2007 a review of spray drift data was undertaken by CRD, using examples of data from previous Fera (then CSL) field spray drift studies and data from wind tunnel experiments with nozzles and operating conditions where no field data exist.

It was recognised that further data reflecting modern application practices were required by in the review of the setting unsprayed buffer zones (UBZ) for arable sprayers. Therefore this project PS2015 has generated data for airborne and ground deposited spray drift arising from typical current spraying practices, particularly related to boom height and forward speed. These data are being used along with data from projects PS2017 and PS2022 to supplement the data generated with spraying practices involving forward speeds of 8 km/h and boom heights of 50cm above a short crop. As the modern practices for arable spraying involve spraying at tractor forward speeds of >10km/h and boom heights of 0.5 to 1.0m above the crop fields studies have generated data with the following conditions:

Tractor forward speed of 12 and 16 km/h;

Boom heights of 0.7, and 1.1m above a short crop; (24m boom width)

Three nozzle types: one standard flat fan nozzle used for LERAP (e.g. 03F110); one extended range flat fan nozzle (XR11003) and one A.I. nozzle with LERAP 3-star low drift status (size 025).

The protocol for the field studies followed that used in previous field studies by Fera, using multiple passes spraying a visible tracer and adjuvant tank mixture. Downwind spray drift collection for ground deposited spray drift was carried out at 2, 4, 6, 8, 12, 15 and 20 metres downwind of the treated area. Airborne spray drift was collected up to a height of 2m at 2, 4, 8, 12 and 20 metres downwind of the treated area

The data presented in this report form part of a three-study field programme, which will be fully reported for the project PS2022. This report represents an executive summary for PS2015.

8. As a guide this report should be no longer than 20 sides of A4. This report is to provide Defra with details of the outputs of the research project for internal purposes; to meet the terms of the contract; and to allow Defra to publish details of the outputs to meet Environmental Information Regulation or Freedom of Information obligations. This short report to Defra does not preclude contractors from also seeking to publish a full, formal scientific report/paper in an appropriate scientific or other journal/publication. Indeed, Defra actively encourages such publications as part of the contract terms. The report to Defra should include:
   - the scientific objectives as set out in the contract;
   - the extent to which the objectives set out in the contract have been met;
   - details of methods used and the results obtained, including statistical analysis (if appropriate);
   - a discussion of the results and their reliability;
   - the main implications of the findings;
   - possible future work; and
   - any action resulting from the research (e.g. IP, Knowledge Transfer).

Specific objectives are:

1. Generate data for 3 nozzles types and 2 boom heights for ground deposited and airborne drift at distances up to 20m downwind of the treated area

2. Provide an evaluation of the data for use by CRD investigating the setting of buffer zones for the UK.

The objectives as set out have been met fully, and have provided data to show that the amount of spray drift generated is increased when using higher forward (operating) speeds of 12 and 16 km/h, and boom heights greater than 0.5m. The evaluation of the data for CRD is presented in the report for PS2022. Data from the field studies has been provided to CRD during the life of the project.

The results from study PS2015 will be discussed further in the SID5 for PS 2022. The results presented below in Tables 1 to 6 show volumes of spray drift for ground deposited and airborne spray drift at the downwind distances. The application volume rate has been included to allow the data to be normalised (i.e. taking into account the dilution of a pesticide when using these surrogate tracer data to compare spray drift).

Table 1. Spray drift fallout (ground) with nozzle XR11003 at 3 bar (1.18 L/min nozzle flow rate)

Table 2. Airborne spray deposits with nozzle XR11003 at 3 bar (1.18 L/min nozzle flow rate)

Table 3. Spray drift fallout (ground) with nozzle 03FF110 at 3 bar (1.20 L/min nozzle flow rate)

Table 4. Airborne spray deposits with nozzle 03FF110 at 3 bar (1.20 L/min nozzle flow rate)

Table 5. Spray drift fallout (ground) with nozzle ABJ025 at 3 bar (1.00 L/min nozzle flow rate)

Table 6. Airborne spray deposits with nozzle ABJ025 at 3 bar (1.00 L/min nozzle flow rate)

Table 1. Spray drift fallout (ground) with nozzle XR11003 at 3 bar (1.18 L/min nozzle flow rate)

Forward speed	Boom height		Wind Speed	Ground deposit of spray drift at downwind distances (ml spray per square metre)						
km/h	m		ms^{-1}	2m	4m	6m	8m	12m	15m	20m
12	0.7		3.6	2.11	0.81	0.41	0.23	0.08	0.05	0.03
			1.3	1.52	0.53	0.24	0.16	0.08	0.04	0.02
			2.2	2.93	0.26	0.14	0.08	0.03	0.02	0.01
		Mean	2.4	2.18	0.53	0.26	0.16	0.06	0.03	0.02
		SD		0.71	0.28	0.14	0.07	0.03	0.02	0.01
12	1.1		4.1	5.78	2.99	2.06	0.86	0.28	0.17	0.11
			0.6	0.26	0.05	0.01	0.004	0.003	0.003	0.003
			1.7	0.42	0.23	0.12	0.04	0.02	0.01	0.01
		Mean	2.2	2.15	1.09	0.73	0.30	0.10	0.06	0.04
		SD		3.14	1.65	1.15	0.48	0.16	0.09	0.06
16	0.7		2.6	1.56	0.42	0.35	0.19	0.07	0.04	0.03
			4.6	0.89	0.50	0.27	0.25	0.16	0.14	0.07
			1.2	0.80	0.29	0.17	0.10	0.04	0.02	0.04
		Mean	2.8	1.08	0.40	0.26	0.18	0.09	0.07	0.05
		SD		0.41	0.11	0.09	0.08	0.06	0.06	0.03
16	1.1		0.9	2.59	0.89	0.35	0.19	0.08	0.05	0.03
			4.6	4.79	1.89	1.06	0.54	0.24	0.14	0.09
			4.3	4.69	2.57	1.02	0.54	0.40	0.24	0.19
		Mean	3.3	4.02	1.79	0.81	0.43	0.24	0.14	0.10
		SD		1.24	0.85	0.40	0.20	0.16	0.09	0.08

Application volume rates
At 12 km/h = 118 L/ha
At 16 km/h = 88.5 L/ha
Wind speed at 2m above ground level

Table 2. Airborne spray deposits with nozzle XR11003 at 3 bar (1.18 L/min nozzle flow rate)

Forward speed	Boom height		Wind Speed	Total airborne spray drift in sampling frame (0.5m x 2m) at downwind distances (ml spray per square metre)				
km/h	m		ms^{-1}	2m	4m	8m	12m	20m
12	0.7		3.6	3.53	2.53	1.67	1.11	0.69
			1.3	2.03	1.04	0.62	0.36	0.18
			2.2	2.25	1.68	1.22	0.36	0.17
		Mean	2.4	2.60	1.75	1.17	0.61	0.35
		SD		0.81	0.75	0.53	0.43	0.30
12	1.1		4.1	10.03	6.30	3.53	2.67	1.66
			0.6	0.11	0.04	0.007	0.006	0.001
			1.7	0.95	0.63	0.49	0.21	0.10
		Mean	2.2	3.70	2.33	1.34	0.96	0.59
		SD		5.50	3.46	1.91	1.48	0.93
16	0.7		2.6	4.88	3.01	1.62	1.16	0.81
			4.6	6.00	4.76	2.71	1.45	1.15
			1.2	1.23	1.01	0.44	0.25	0.16
		Mean	2.8	4.04	2.92	1.59	0.95	0.70
		SD		2.50	1.88	1.14	0.63	0.50
16	1.1		0.9	2.45	1.35	0.63	0.42	0.21
			4.6	11.60	8.02	3.91	3.01	1.97
			4.3	9.51	6.88	5.82	4.13	2.14
		Mean	3.3	7.85	5.42	3.45	2.52	1.44
		SD		4.80	3.57	2.63	1.90	1.07

Application volume rates
At 12 km/h = 118 L/ha
At 16 km/h = 88.5 L/ha
Wind speed at 2m above ground level

Table 3. Spray drift fallout (ground) with nozzle 03F110 at 3 bar (1.20 L/min nozzle flow rate)

Forward speed	Boom height		Wind Speed	Ground deposit of spray drift at downwind distances (ml spray per square metre)						
km/h	m		ms^{-1}	2m	4m	6m	8m	12m	15m	20m
12	0.7		4.1	0.61	0.26	0.17	0.11	0.04	0.02	0.01
			2.3	0.75	0.42	0.21	0.11	0.05	0.03	0.01
			1.8	1.44	0.35	0.19	0.08	0.05	0.03	0.02
		Mean	2.7	0.93	0.34	0.19	0.10	0.05	0.02	0.01
		SD		0.45	0.08	0.02	0.02	0.01	0.00	0.00
12	1.1		3.4	1.53	1.14	0.65	0.50	0.17	0.14	0.09
			2.0	1.52	0.37	0.30	0.25	0.05	0.03	0.02
			3.7	2.18	0.68	0.45	0.23	0.09	0.04	0.02
		Mean	3.1	1.74	0.73	0.47	0.33	0.11	0.07	0.05
		SD		0.38	0.39	0.18	0.15	0.06	0.06	0.04
16	0.7		2.7	1.46	0.36	0.20	0.11	0.04	0.04	0.02
			2.8	0.79	0.23	0.18	0.09	0.03	0.02	0.02
			1.9	0.83	0.22	0.10	0.05	0.02	0.01	0.01
		Mean	2.5	1.03	0.27	0.16	0.08	0.03	0.02	0.02
		SD		0.38	0.07	0.05	0.03	0.01	0.01	0.01
16	1.1		3.6	2.33	0.49	0.41	0.32	0.16	0.11	0.06
			2.3	2.61	1.28	0.56	0.28	0.09	0.06	0.04
			3.1	3.22	2.06	0.93	0.54	0.25	0.18	0.08
		Mean	3.0	2.72	1.28	0.63	0.38	0.17	0.12	0.06
		SD		0.45	0.78	0.27	0.14	0.08	0.06	0.02

Application volume rates
At 12 km/h = 120 L/ha
At 16 km/h = 90 L/ha
Wind speed at 2m above ground level

Table 4. Airborne spray deposits with nozzle 03F110 at 3 bar (1.20 L/min nozzle flow rate)

Forward speed	Boom height		Wind Speed	Total airborne spray drift in sampling frame (0.5m x 2m) at downwind distances (ml spray per square metre)				
km/h	m		ms^{-1}	2m	4m	8m	12m	20m
12	0.7		4.1	3.45	1.90	1.06	0.64	0.28
			2.3	3.02	1.45	0.69	0.62	0.26
			1.8	2.36	1.02	0.41	0.50	0.21
		Mean	2.7	2.94	1.46	0.72	0.59	0.25
		SD		0.55	0.44	0.33	0.08	0.03
12	1.1		3.4	4.98	2.84	1.89	1.71	0.84
			2.0	3.69	2.07	1.27	0.95	0.33
			3.7	4.12	2.62	1.61	1.00	0.39
		Mean	3.1	4.26	2.51	1.59	1.22	0.52
		SD		0.66	0.40	0.31	0.43	0.28
16	0.7		2.7	2.25	1.44	0.65	0.44	0.28
			2.8	1.80	1.18	0.63	0.50	0.27
			1.9	0.00	0.00	0.00	0.00	0.00
		Mean	2.5	1.35	0.87	0.43	0.31	0.18
		SD		1.19	0.77	0.37	0.27	0.16
16	1.1		3.6	7.52	4.83	2.99	1.88	1.34
			2.3	4.37	2.33	1.42	0.95	0.68
			3.1	7.07	4.69	2.64	1.64	1.01
		Mean	3.0	6.32	3.95	2.35	1.49	1.01
		SD		1.70	1.41	0.82	0.48	0.33

Application volume rates
At 12 km/h = 120 L/ha
At 16 km/h = 90 L/ha
Wind speed at 2m above ground level

Table 5. Spray drift fallout (ground) with nozzle ABJ025 at 3 bar (1.00 L/min nozzle flow rate)

Forward speed	Boom height		Wind Speed	Ground deposit of spray drift at downwind distances (ml spray per square metre)						
km/h	m		ms^{-1}	2m	4m	6m	8m	12m	15m	20m
12	0.7		3.1	0.56	0.22	0.06	0.05	0.02	0.02	0.014
			2.7	0.19	0.09	0.05	0.03	0.015	0.012	0.000
			2.2	0.36	0.07	0.02	0.01	0.007	0.005	0.005
		Mean	2.7	0.37	0.13	0.04	0.03	0.014	0.013	0.006
		SD		0.19	0.08	0.02	0.02	0.008	0.007	0.007
12	1.1		2.6	0.78	0.20	0.07	0.07	0.03	0.02	0.012
			3.2	1.83	0.48	0.22	0.11	0.05	0.02	0.02
			2.3	4.42	0.47	0.17	0.06	0.03	0.013	0.004
		Mean	2.7	2.34	0.38	0.15	0.08	0.04	0.02	0.011
		SD		1.88	0.15	0.08	0.03	0.010	0.006	0.006
16	0.7		3.5	0.70	0.23	0.11	0.06	0.04	0.02	0.01
			3.1	0.50	0.11	0.05	0.04	0.015	0.010	0.008
			2.4	0.45	0.09	0.04	0.013	0.008	0.007	0.003
		Mean	3.0	0.55	0.14	0.07	0.04	0.02	0.013	0.008
		SD		0.13	0.08	0.04	0.02	0.02	0.008	0.005
16	1.1		2.8	1.65	0.52	0.16	0.13	0.05	0.04	0.02
			3.1	0.97	0.04	0.17	0.07	0.03	0.03	0.02
			2.1	2.15	0.24	0.10	0.03	0.014	0.011	0.010
		Mean	2.6	1.59	0.26	0.14	0.08	0.03	0.03	0.02
		SD		0.59	0.24	0.04	0.05	0.02	0.014	0.006

Application volume rates
At 12 km/h = 100 L/ha
At 16 km/h = 75 L/ha
Wind speed at 2m above ground level

Table 6. Airborne spray deposits with nozzle ABJ025 at 3 bar (1.00 L/min nozzle flow rate)

Forward speed	Boom height		Wind Speed	Total airborne spray drift in sampling frame (0.5m x 2m) at downwind distances (ml spray per square metre)				
km/h	m		ms^{-1}	2m	4m	8m	12m	20m
12	0.7		3.1	0.76	0.42	0.18	0.14	0.11
			2.7	0.74	0.47	0.32	0.23	0.14
			2.2	0.39	0.22	0.13	0.12	0.07
		Mean	2.7	0.63	0.37	0.21	0.17	0.11
		SD		0.21	0.13	0.10	0.06	0.04
12	1.1		2.6	0.94	0.51	0.28	0.21	0.13
			3.2	2.06	1.11	0.60	0.35	0.25
			2.3	1.65	0.61	0.39	0.20	0.08
		Mean	2.7	1.55	0.74	0.42	0.25	0.15
		SD		0.57	0.32	0.16	0.08	0.09
16	0.7		3.5	0.62	0.37	0.17	0.14	0.09
			3.1	0.98	0.58	0.39	0.27	0.17
			2.4	0.37	0.24	0.16	0.12	0.08
		Mean	3.0	0.65	0.39	0.24	0.18	0.11
		SD		0.30	0.17	0.13	0.08	0.05
16	1.1		2.8	1.33	0.79	0.33	0.23	0.14
			3.1	1.40	0.75	0.51	0.32	0.18
			2.1	0.85	0.42	0.28	0.18	0.10
		Mean	2.6	1.19	0.66	0.37	0.24	0.14
		SD		0.30	0.20	0.12	0.07	0.04

Application volume rates
At 12 km/h = 100 L/ha
At 16 km/h = 75 L/ha
Wind speed at 2m above ground level

Data for ground deposited drift are presented below in the following figures

Figure 1. Nozzle XR11003: Ground deposited drift downwind as percentage of application rate

Figure 2. Nozzle 03F110: Ground deposited drift downwind as percentage of application rate

Figure 3. Nozzle ABJ025: Ground deposited drift downwind as percentage of application rate

The forward speeds and boom heights are represented for each of the nozzle types

12/0.7 = 12 km/h forward speed and 0.7m boom height

12/1.1= 12 km/h forward speed and 1.1m boom height

16/0.7= 16 km/h forward speed and 0.7m boom height

16/1.1= 16 km/h forward speed and 1.1m boom height

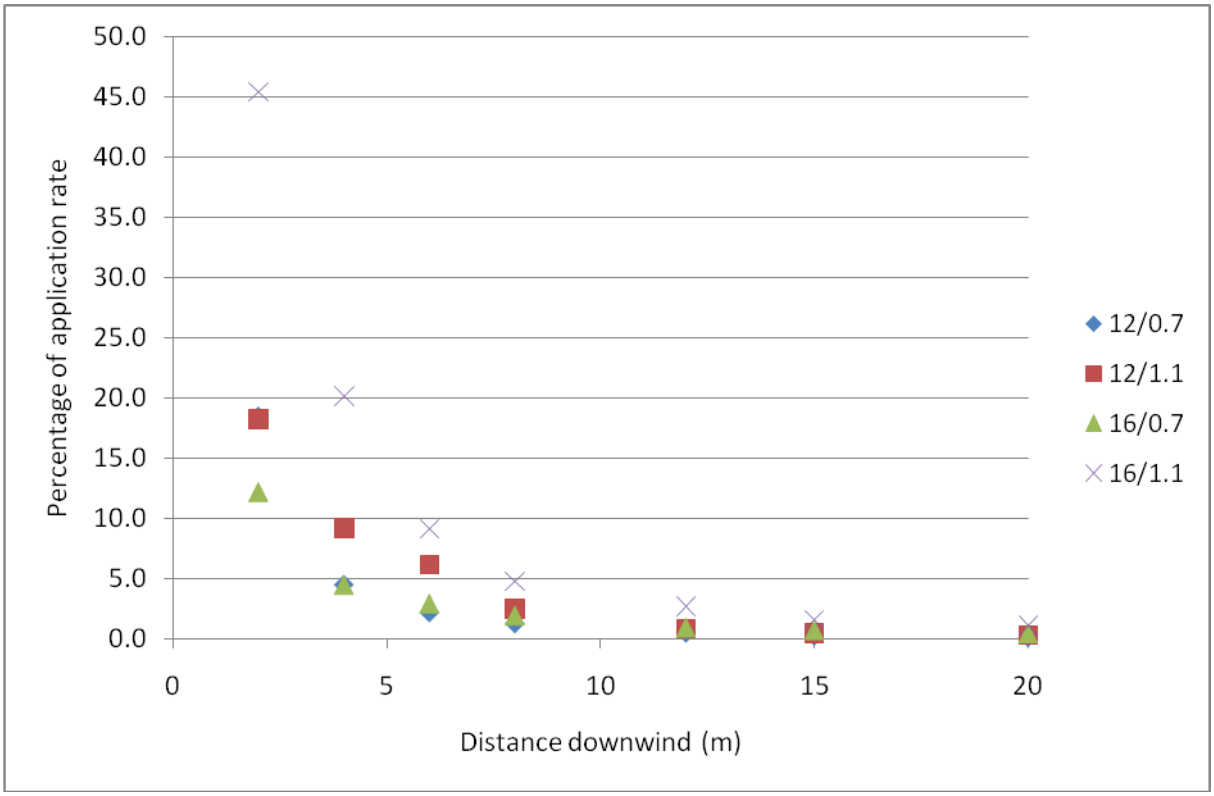

Figure 1. Nozzle XR11003: Ground deposited drift downwind as percentage of application rate

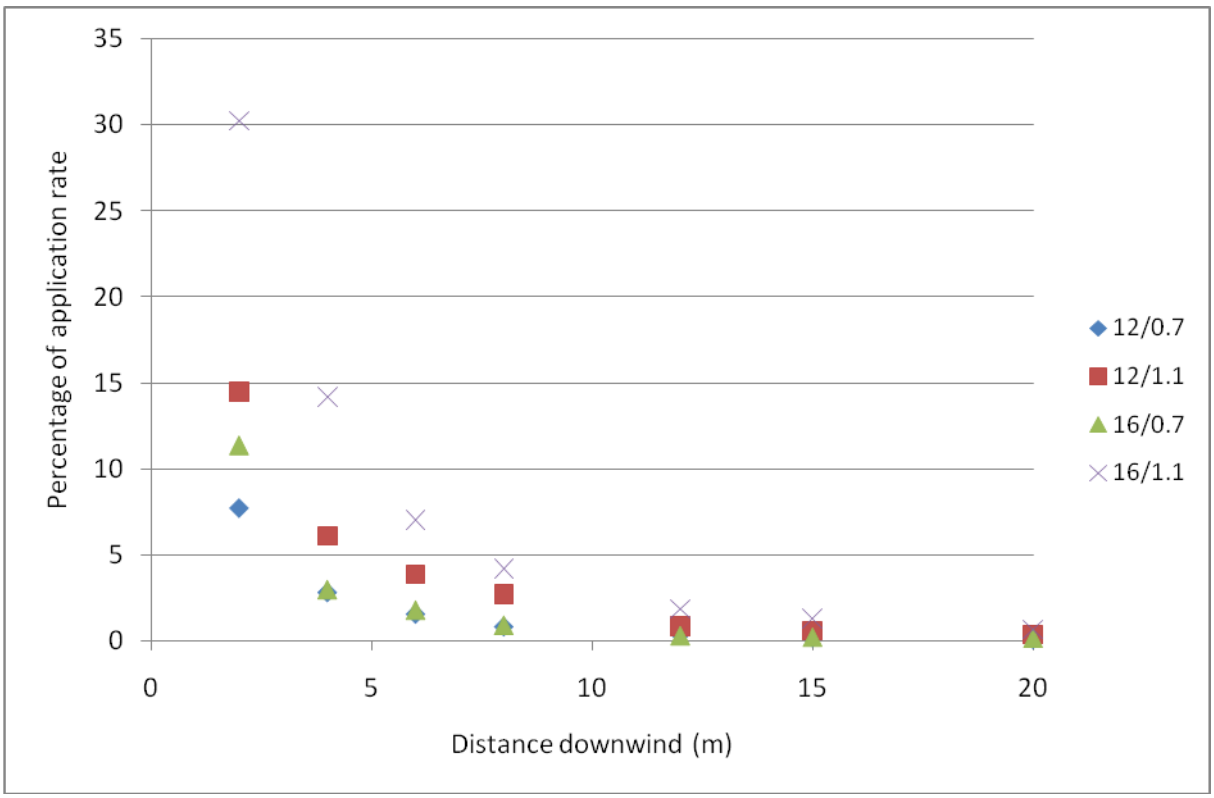

Figure 2. Nozzle 03F110: Ground deposited drift downwind as percentage of application rate

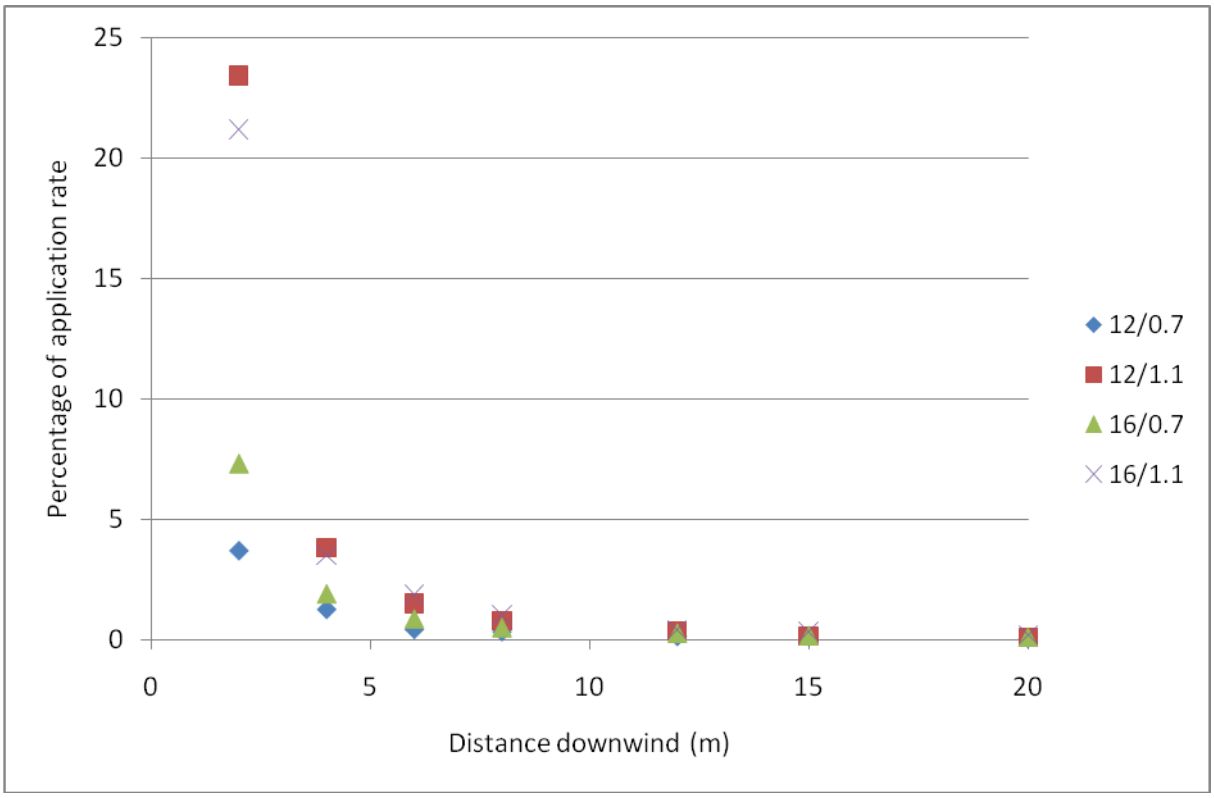

Figure 3. Nozzle ABJ025: Ground deposited drift downwind as percentage of application rate

The results will be discussed further in the SID5 for project PS2022 together with the data for the field studies with tall crops and all of the airborne drift data. The data indicate that there is increased drift with the higher boom height and forward speeds. In general the 16 km/h speed and 1.1m boom height results in the greatest amount of drift.

As there are only three replicate data sets for each treatment the influence of wind speed may result in data points which do not appear to follow the trend. For example in Figure 3 there is greater drift at 2m downwind of the treated area with the 12 km/h than with the 16 km/h forward speed at the boom height of 1.1m, although the average wind speeds are similar as shown in Table 5.

References to published material

9. This section should be used to record links (hypertext links where possible) or references to other published material generated by, or relating to this project.

Details of these references will be included with reporting of project PS2022