NATIONAL WORKING PARTY ON PESTICIDE APPLICATIONS

COMMENT ON THE APVMA'S PROPOSED APPROACH TO SPRAY DRIFT MANAGEMENT

JULY 2018

BACKGROUND – THE NWPPA

In March 2010, a broad-based industry technical working party, the National Working Party on Pesticide Applications (NWPPA) was established to consider the potential outcomes of policy changes and spray drift reviews being undertaken by the Australian Pesticide and Veterinary Medicines Authority (APVMA).

The Working Party is a collection of interested stakeholders, including grower groups, chemical companies, spray applicators, academics, and research and development corporations, working to provide the scientific data to underpin a science based regulatory system. To achieve this the Working Party developed an integrated research program.

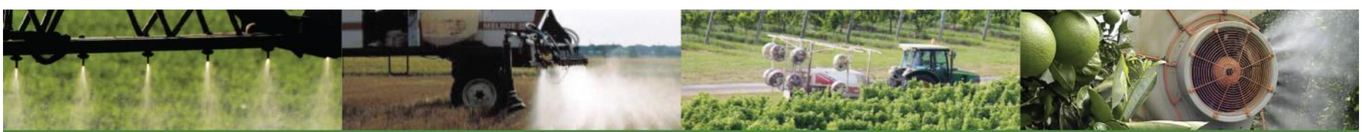
The NWPPA was established to assist stakeholders to work with these policy changes and outcomes resulting from proposed reviews of existing chemical products. At a meeting in April 2011, stakeholders agreed that the role for the NWPPA was to:

- Facilitate targeted research that supports the use of practical no spray downwind buffers.
- Support and facilitate the development of a national training framework for pesticide application that would, for example, support the implementation of drift reduction technologies (DRTs) (lower buffer distances), best management practices and improve product efficacy.
- Provide a forum to assist growers and other stakeholders understand current APVMA policy and work with regulators to provide realistic and practical risk management.
- Seek and facilitate investment from stakeholders and affected parties in support of a national coordinated program that supports the use of practical downwind buffers.

The vision of the working party is that the regulatory system is science-based and recognises the use of drift reduction technologies, spray application education and best practice, and facilitates access to reduced buffer zones for applicators when appropriate DRTs are implemented.

The NWPPA Executive Committee (EC) guides the work of the NWPPA and comprises technical representatives from spray manufacturers, grower groups, spray applicators and research and development corporations from across viticulture, horticulture and broad acre agriculture.

The EC is supported by the Technical Working Group, (TWG), a group of scientists from the APVMA, Department of Environment, GRDC, Plant Health Australia, The University of Queensland and chemical regulatory experts. The TWG reviews available (and commissioned) data that could support a technical approach to the spray drift assessment of pesticides and that would meet the needs of the NWPPA and regulators. The TWG has compiled companion technical scientific reports and papers and has reviewed the 2018 APVMA consultation proposals.



The current proposals generally demonstrate the effectiveness of a flexible DRT system for vertical sprayers and aerial application. The NWPPA supports the proposals as the system is designed to deliver:

- Scientifically justifiable deposit curves.
- Clearer guidelines on Regulatory Acceptable Levels (RALs) used to establish buffer zones.
- Simplified and consistent label statements.
- Faster assessment by APVMA through use of a Spray Drift Risk Assessment Tool (SDRAT).
- Increased flexibility by an end user's Spray Drift Management Tool (SDMT).
- Encouragement for drift reducing technologies.

COMMENT ON PROPOSALS

Case studies developed by the APVMA using the AGDISP ground modelling approach set out in the consultation paper, showed that the boom sprayer buffer distances predicted were generally greater than those predicted using the current policy (AgDRIFT).

The NWPPA would like to provide detailed comment on the methods used to determine downwind deposition values from ground boom sprayers.

Since March 2018, the TWG has worked extensively to re-evaluate the performance of AGDISP Ground.

The TWG sourced raw field data from the US Spray Drift Task Force (SDTF) as well as spray drift deposit data from Australian studies to form a benchmark against which the model outputs could be compared. The TWG also sourced recent droplet size distributions (DSDs) from Australian and international wind tunnel facilities. The TWG sourced 47 measurements from the US Dept. of Agriculture (USDA) Agricultural Research Service (ARS), 35 measurements from the University of Nebraska, North Platte, USA (UNL) and three measurements from the Centre for Pesticide Application and Safety, the University of Queensland, Gatton, (CPAS) Australia.

On the basis of this recent work, the NWPPA proposes that the following input parameters are modified and applied to AGDISP Ground as follows:

(1) Droplet Size Distributions (DSDs)

The NWPPA proposes that the DSDs are no longer based on the ASABE reference libraries in AGDISP (which we believe were appropriate when they were generated with best practice in the 1990s but may have only been tested in one laboratory with detection equipment that has since been superseded), but instead make use of an average of the more recent data from the three wind tunnel laboratories. To avoid bias towards those laboratories with the greatest number of measurements, the TWG calculated the average of the data from each laboratory and then determined the mean of all the results. A Rosin-Rammler distribution was then fit to this data. The TWG recommends that the same updated DSD data is applied for calculating the spray distribution for both aerial and ground scenarios.

The TWG identified an additional error in the Rosin-Rammler conversion used in the consultation paper. The correction information has been provided to the APVMA.

(2) Canopy Selection

'No canopy' was selected in the AGDISP Ground model in the APVMA consultation documentation. The TWG found that a closer agreement could be achieved with field deposition data if a canopy height of 0.2 m was selected, a canopy height that also was dominant in the field trials.

Changing from ‘no canopy’ to ‘canopy height’ was also found to improve the overall stability of AGDISP ground by reducing the occurrence of the deposition profile ‘kick’ and slightly smoothing the curves. It is proposed that a canopy height of 0.2m is selected in the model and used for both aerial and ground scenarios.

A sensitivity analysis found that when a canopy height of 0.2 m was selected for assessments using aircraft, the aerial deposition curves tended to be smoothed. There was very little effect on resulting buffers compared to when no canopy was used.

(3) Atmospheric stability

AGDISP has a number of settings related to atmospheric stability (vertical air movement). The TWG assessment suggests that modelling should be conducted using the ‘Day-Moderate’, setting not the ‘Night-Overcast’, given that all the field studies were undertaken during the day and hence used in the validation work.

It should be noted that many labels have statements that indicate spraying must not be undertaken under inversion conditions, a finite extremely stable atmospheric condition which usually occurs during the night.

(4) Removal of Swath Width Offset

The AGDISP manual recommends that a ‘swath offset’ of ½ be used for all modelling. However, this setting although appropriate for aerial application, implies that the last nozzle is 10 metres from the edge of the treated area during ground boom sprayer application (for the default 20-meter-wide boom proposed in the APVMA standard scenarios) and gives relatively poor correlation of the deposition profiles in the first few meters outside the treated area. The NWPPA suggests that removing the ½ swath offset and correcting this default is intuitively more accurate and will improve correlation against field data for ground boom spraying. Indeed, the ground field study data did not include any swath offset which further supports this application in validation modelling.

Assessment by the TWG showed that downwind deposit values close to the field edge were closer to the field rate than when ½ swath offset was used as in the consultation.

The default ½ ‘swath offset’ is still appropriate for aerial applications.

(5) Boom Height Reduction

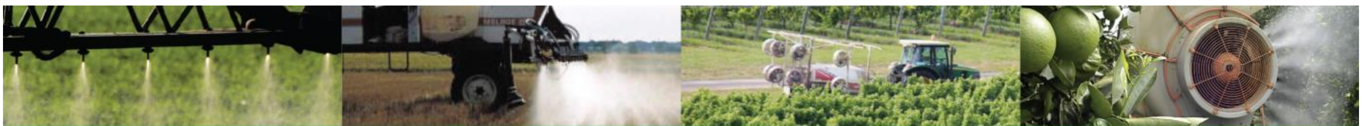
In the Consultation proposal, the boom height proposed for APVMA standard scenarios is 60 cm above ground (to cover the worst case of 80° nozzles on standard spacings/overlap).

The NWPPA suggests that this is reduced to 50 cm as this would be more reflective of industry best/ normal practice in Australia. (Higher boom heights could be captured in permits/future-SDMT to accommodate for the larger buffer zones that would be required).

(6) Nozzle Type

The APVMA consultation paper used flat fan nozzle types for all scenarios. The validation work conducted by the TWG indicated that the air injection (AI) setting was more appropriate for the fine sprays and that the flat fan (FF) setting was more appropriate for ultra-coarse scenarios.

After significant analysis, the TWG proposes that the downwind curves be weighted between the AI and FF model outputs as indicated in the table below. Rather than a linear even weighting between droplet size boundaries, analysis showed that a better spacing between calculated deposition curves could be achieved by weighting the difference between $Dv_{0.1}$ values.



This requires that the AGDISP ground model is run for both nozzle type = 'flat fan' and nozzle type = 'air injection' for each case, and the downwind deposit curve proportioned between the two outputs based on DSD, (Table 1).

Category	Proportion (weighting) between AI and FF	Comment
Fine	0.00	= AI curve
Medium	0.22	= AI + 0.22*(difference between FF and AI)
Coarse	0.41	= AI + 0.41*(difference between FF and AI)
Very Coarse	0.60	= AI + 0.60*(difference between FF and AI)
Extremely Coarse	0.75	= AI + 0.75*(difference between FF and AI)
Ultra Coarse	1.00	= FF curve

Table 1. Spray Quality weightings to be used between AI and FF Droplet Size Distributions.

The use of the terms "AI" and "FF" in AGDISP are not really related to actual nozzle mechanics but rather to prior considerations at the time of the research and model development. It should be noted that since the initial SDTF field studies and AgDRIFT modelling were done, new nozzle types and operational uses such as spray pressure ranges have become standard in Australian spraying which means that the prior types of AI and FF do not cover all nozzle types anymore. Indeed, most spraying in Australia now uses nozzles that are hybrids between flat fan and air induction, which further supports the use of a combination of the model types henceforth.

(7) Downwind Distance

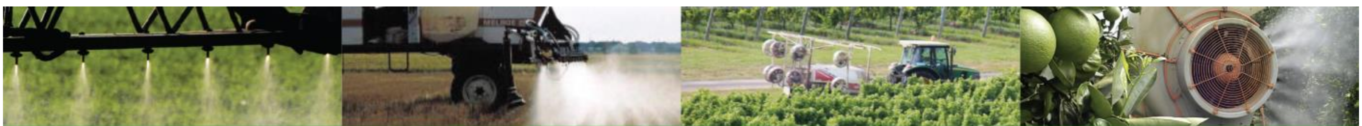
The SDTF deposition data were measured out to 396 metres and therefore the NWPPA proposes when using AGDISP Ground, downwind buffers could be calculated with confidence out to 400 metres for ground boom spraying rather than terminating at 300 metres under the current policy.

(8) Wind speed

The APVMA consultation document used wind speeds of 10 and 20 km/hr for ground for ground spraying and 7, 14 and 20 km/hr for aerial spraying in the Spray Drift Management Tool (SDMT). The ground application wind speeds were selected to accommodate, and offset anomalies generated by AGDISP Ground.

However, with the suggested parameter changes detailed here, the overall stability of the AGDISP version 8.28 ground model scenarios has been improved and it is proposed that the same wind speeds should now apply to both ground and air scenarios and assessments.

A summary of these proposed changes is presented in Table 2.



	Input Parameter	APVMA Consultation Paper	Proposed Revision	Applies to:	Comment
1	Droplet Size Distribution (DSD)	RR fit of ASABE reference distributions in AGDISP	**Rosin-Rammler fit of average of 3 labs data**	Ground and Air	Uses newer data and accounts for interlaboratory variation
2	Canopy	No canopy	**Canopy height = 0.2m**	Ground and Air	
3	Atmospheric stability	Night - Overcast	**Day - Moderate**	Ground and Air	
4	Swath Offset	1/2	**0**	Ground	Air to stay with ½ offset
5	Boom height	0.6 m	**0.5 m**	Ground	Air to remain at 3 m
6	Nozzle type	Flat Fan	**Graduated between AI and FF based on DSD**	Ground	Not an input setting for air
7	Max downwind distance	300 m	**400 metres**	Ground	Air to remain at 800 m
8	Wind speeds	10, 20 km/hr	**7, 14, 20 km/hr**	Ground	Same as Air

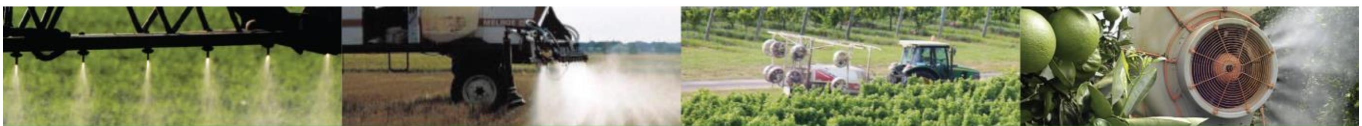
Table 2. Summary of revisions to AGDISP 8.28 Ground proposed by the NWPPA

VALIDATION

Having tested evidence-based settings for AGDISP Ground, the TWG compared the performance of the revised model with field trial data. With access to the raw field data from the US Spray Drift Task Force (SDTF) as well as spray drift deposit data from Australian studies, the field trial downwind deposition was compared with respective deposit predictions generated by AGDISP Ground.

The actual measured DSD data from the SDTF studies (at New Mexico State University and Daratech, Victoria) was used for the AGDISP Ground v field data comparison. The SDTF data were transformed using the APVMA Rosin-Rammler conversion but still based upon the original SDTF DSDs.

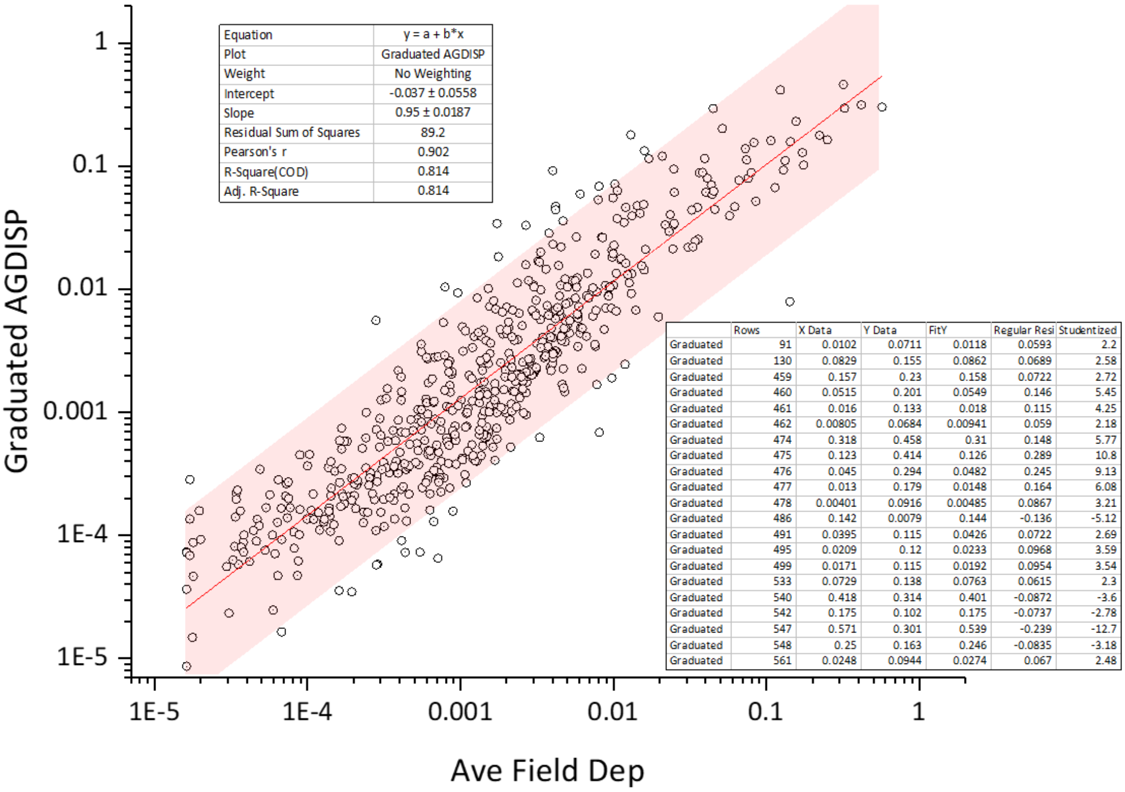
Key input parameters used in the validation are listed in Table 3



	Input Parameter	Input Values used for Revised AGDISP Ground vs Field Trial comparison
1	Droplet Size Distribution (DSD)	**Rosin-Rammler fit of average of raw SDTF DSDs**
2	Canopy	**Canopy height = 0.2m**
3	Atmospheric stability	**Day - Moderate**
4	Swath Offset	**0**
5	Boom height	**As per Field Trial**
6	Nozzle type	**Graduated between AI and FF based on DSD**
7	Max downwind distance	**400 metres**
8	Wind speeds	**As per Field Trial**

Table 3. Summary of revisions to AGDISP 8.28 Ground proposed by the NWPPA

Results of this analysis are summarised in Figure 1a, where a scattergram (log scales) of field vs revised AGDISP 8.28 Ground are compared. The red shaded element indicates the 95th percentile of confidence on the correlation and shows a list of outliers which don't fall within this bound. Figure 1b shows the same information using an alternative graphical approach. A Coefficient of Determination or R^2 value of 81% was achieved and the trend line correlated closely with the field data.



Equation	y = a + b*x
Plot	Graduated AGDISP
Weight	No Weighting
Intercept	-0.037 ± 0.0558
Slope	0.95 ± 0.0187
Residual Sum of Squares	89.2
Pearson's r	0.902
R-Square(COD)	0.814
Adj. R-Square	0.814

	Rows	X Data	Y Data	FitY	Regular Resi	Studentized
Graduated	91	0.0102	0.0711	0.0118	0.0593	2.2
Graduated	130	0.0829	0.155	0.0862	0.0689	2.58
Graduated	459	0.157	0.23	0.158	0.0722	2.72
Graduated	460	0.0515	0.201	0.0549	0.146	5.45
Graduated	461	0.016	0.133	0.018	0.115	4.25
Graduated	462	0.00805	0.0684	0.00941	0.059	2.18
Graduated	474	0.318	0.458	0.31	0.148	5.77
Graduated	475	0.123	0.414	0.126	0.289	10.8
Graduated	476	0.045	0.294	0.0482	0.245	9.13
Graduated	477	0.013	0.179	0.0148	0.164	6.08
Graduated	478	0.00401	0.0916	0.00485	0.0867	3.21
Graduated	486	0.142	0.0079	0.144	-0.136	-5.12
Graduated	491	0.0395	0.115	0.0426	0.0722	2.69
Graduated	495	0.0209	0.12	0.0233	0.0968	3.59
Graduated	499	0.0171	0.115	0.0192	0.0954	3.54
Graduated	533	0.0729	0.138	0.0763	0.0615	2.3
Graduated	540	0.418	0.314	0.401	-0.0872	-3.6
Graduated	542	0.175	0.102	0.175	-0.0737	-2.78
Graduated	547	0.571	0.301	0.539	-0.239	-12.7
Graduated	548	0.25	0.163	0.246	-0.0835	-3.18
Graduated	561	0.0248	0.0944	0.0274	0.067	2.48

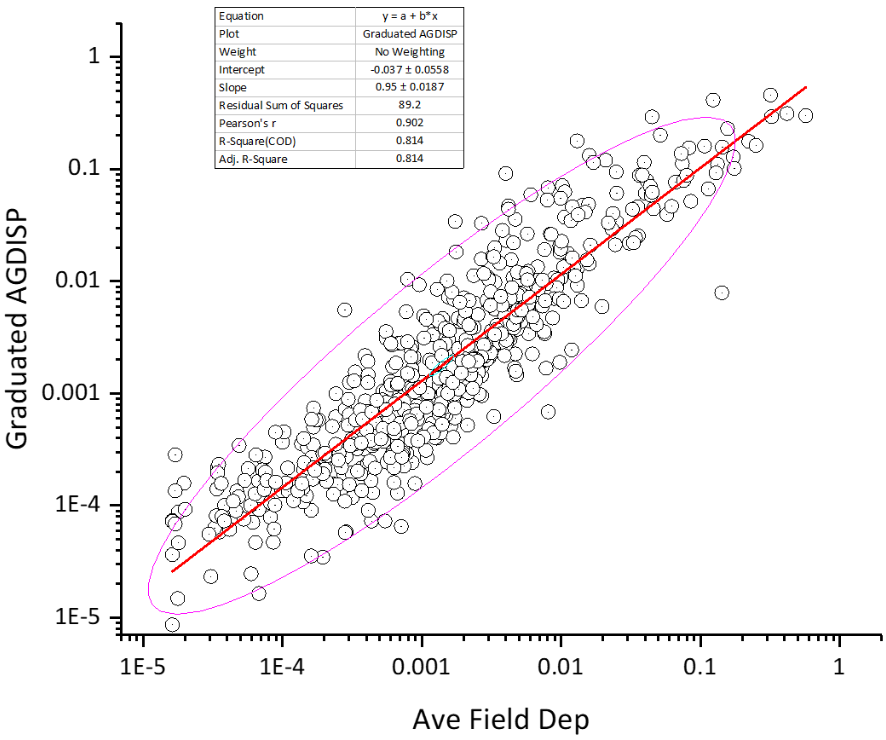


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Figure 1a and 1b. Analysis and comparison of field trial and AGDISP Ground predicted deposition values

Further work was then undertaken to remove some outliers on the basis of field trial evidence, for example excessive wind speed or boom height values. Indeed, the SDTF also eliminated outliers in its analyses based on wind direction deviation exceeding 30º from the ideal -90º to the spray direction (when the wind angle deviates by >30º from "downwind to the application direction", deposition at the furthest collectors will not be assured, which supports the removal of such wind direction outliers).

An assessment was then performed by grouping field trials together according to droplet size (ASABE category) applied during the trial. Average meteorological conditions across these grouped trials were used as the weather input values in AGDISP Ground. The revised AGDISP Ground prediction generated downwind deposit values close to the mean field deposit results (e.g. Figure 2.)

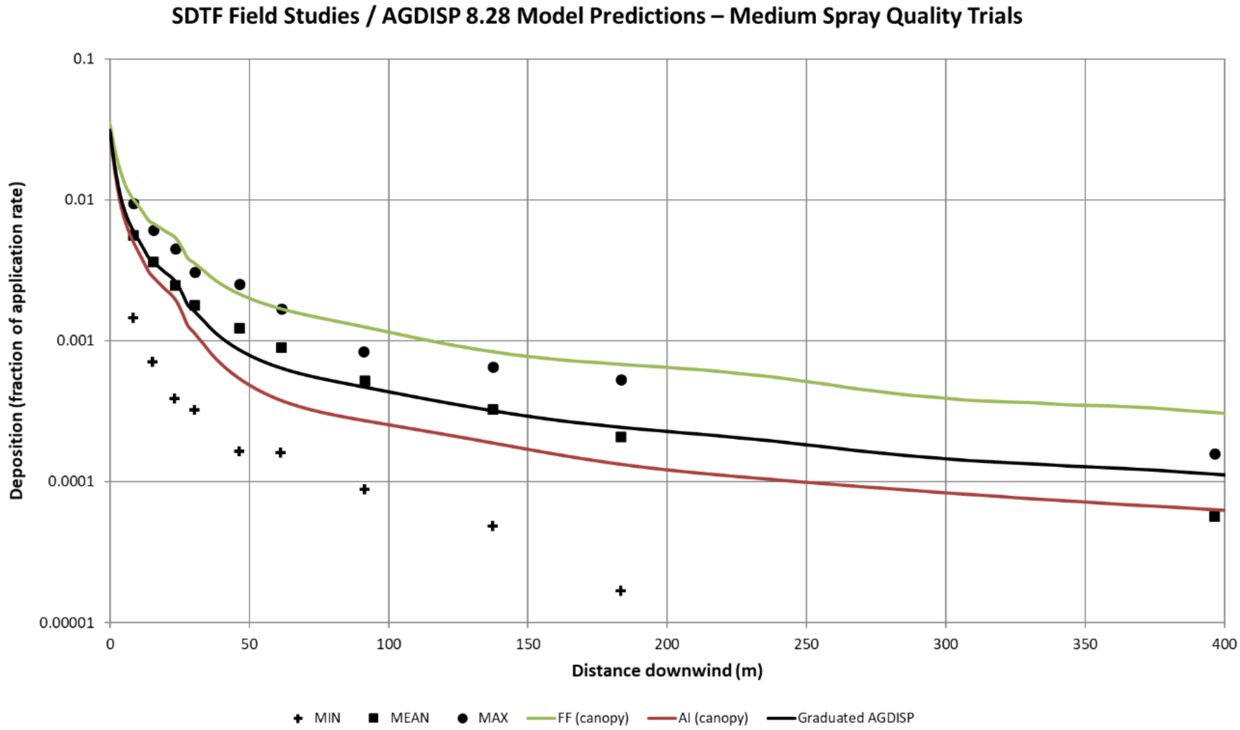


Figure 2. Example of a comparison of grouped downwind field trials and AGDISP Ground predicted deposition values (Medium Spray Quality)

This approach increased the predictive performance of AGDISP Ground. Figure 3 shows a scatterplot of AGDISP Ground deposit values correlated with field trials grouped according to spray quality (droplet size classification). The scatterplot and the trendline demonstrated a stronger correlation than the individual trials with an R^2 value above 0.94. This graph also demonstrates the effectiveness of the graduated weighted transition between flat fan and air injection nozzles illustrated with blue dots (input parameter 6, above).

A further analysis was conducted to calculate the difference between predicted and observed deposition values (the residual) (Figure 4). The residuals from this scatterplot are expressed as a factor of average field deposition,

where:

$$\text{Residual Value} = \frac{\text{Field Value} - \text{AGDISP Value}}{\text{Field Value}}$$

The residuals show that no data points were correlated worse than a factor of 2 of average field data, demonstrating that a stronger correlation was obtained with an analysis of the grouped trials rather than the individual trials. The tendency for AGDISP Ground to slightly over predict downwind deposition values is also illustrated. This is consistent with prior modelling of aerial application scenarios.

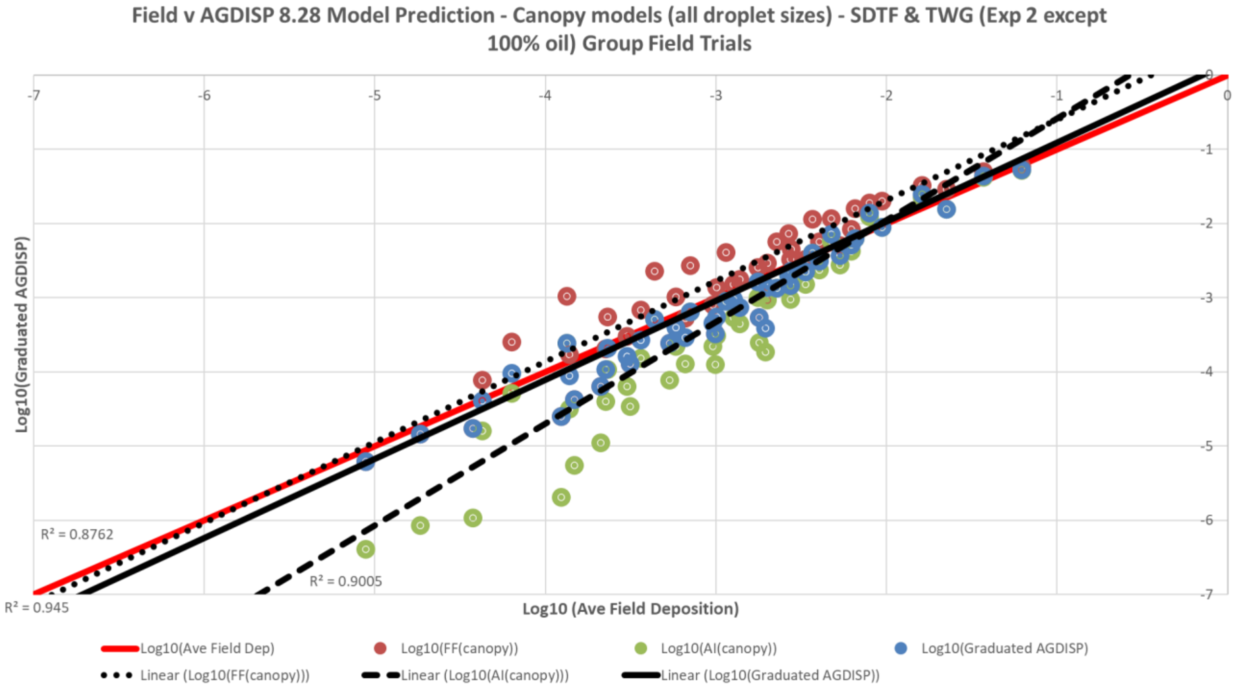


Figure 3. AGDISP Ground deposit values corelated with field trials grouped according to spray quality

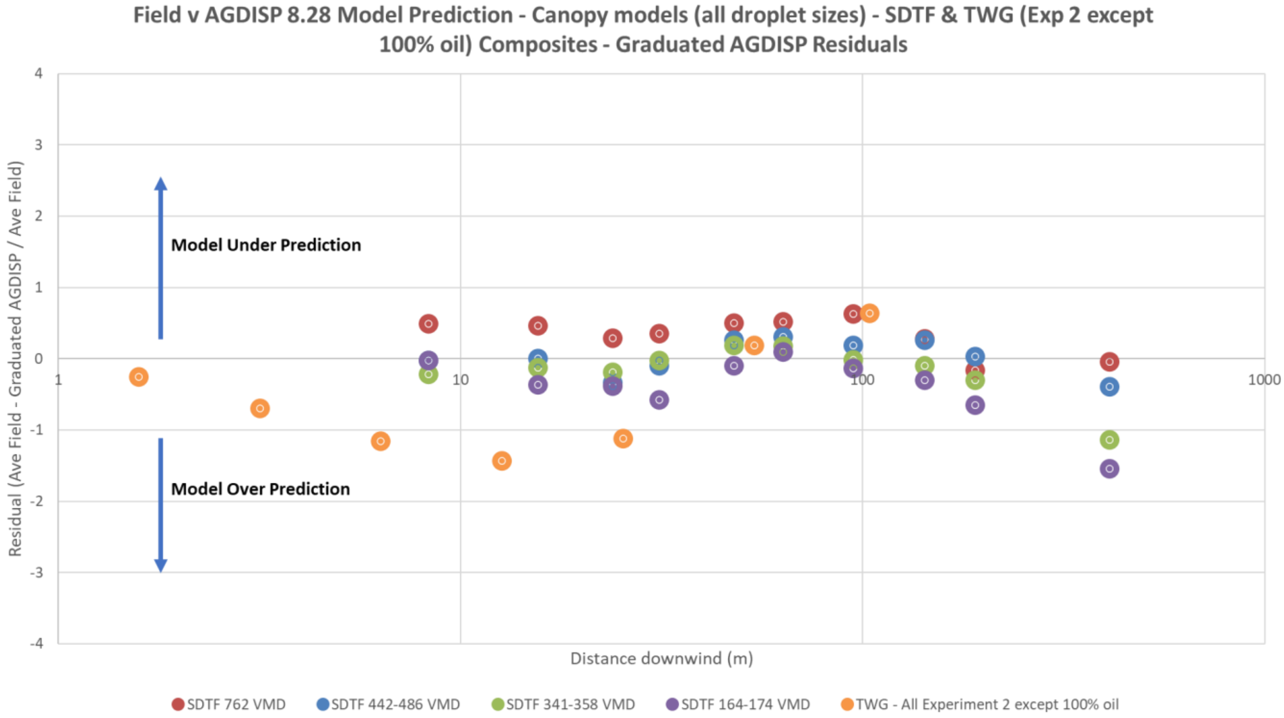
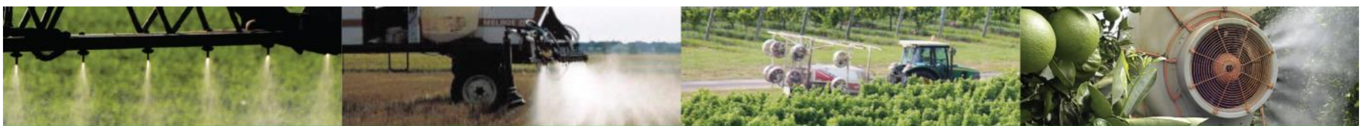


Figure 4. Residual values for predicted and observed spray deposition values

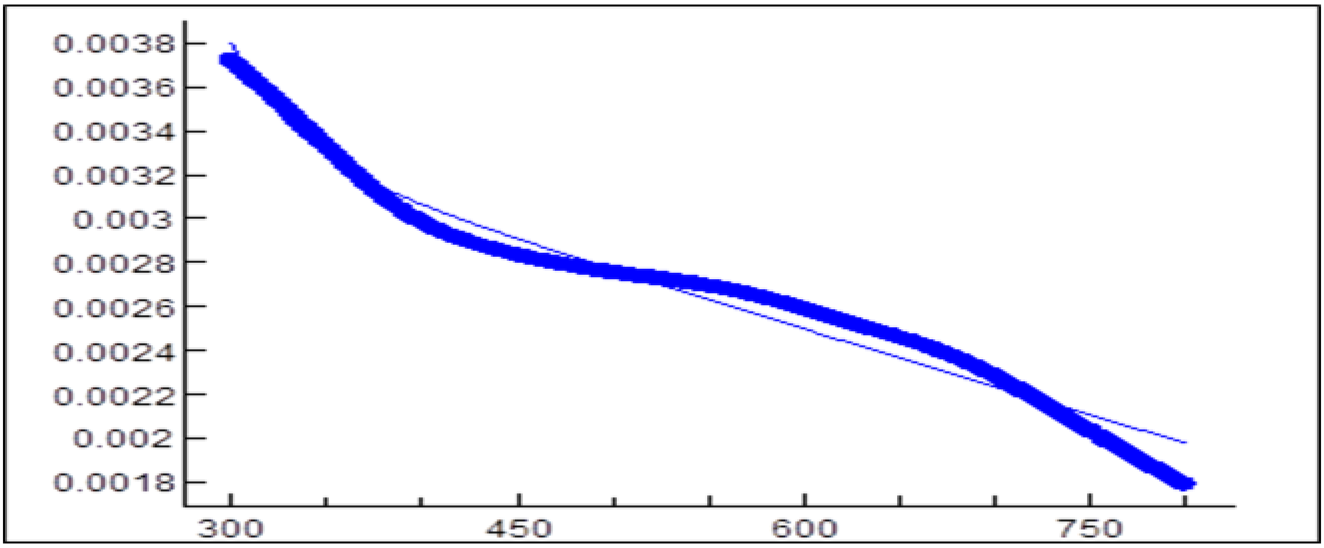


Additional analysis was also conducted to determine the effect of the revised model input values on aerial application deposition curves.

Figure 5a shows the 300-800 metre deposition curve generated by AGDISP for a Coarse spray quality, fixed wing aircraft in a windspeed of 20 km/hr.

Figure 5b shows the same analysis with the default model droplet size distributions replaced with the new distributions sourced by the TWG. The same distance, DSD and aircraft type (300-800 m downwind, 20 kph Coarse spray, fixed wing) are plotted against the new DSD distribution.

The new DSD generated a smoother more consistent model output as shown below.



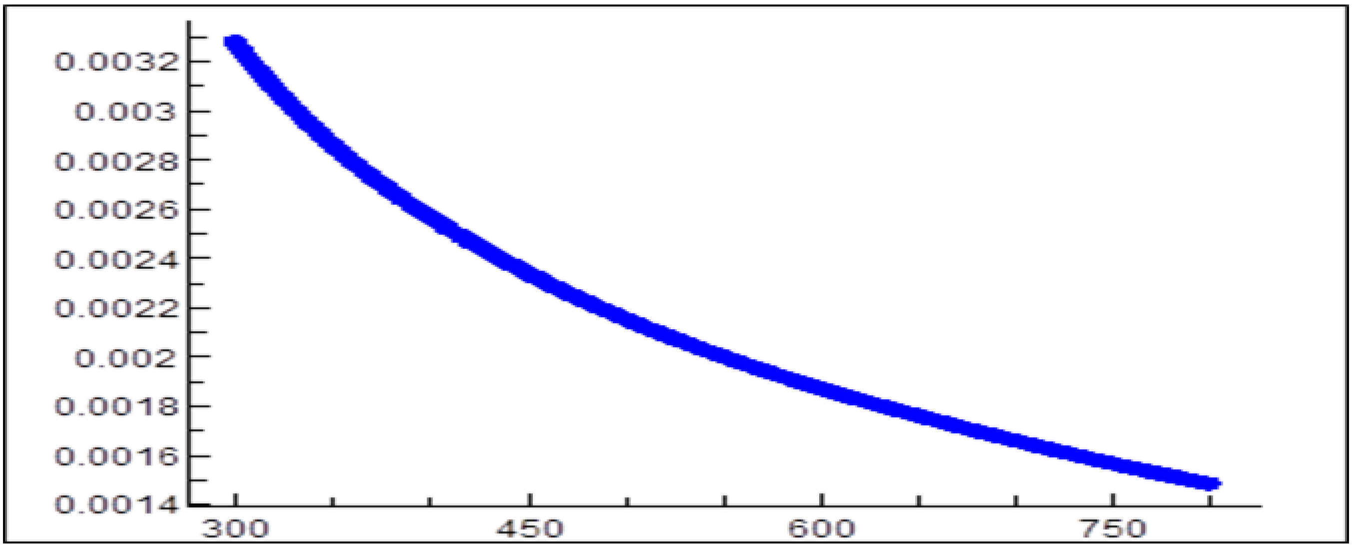


Figure 5a and 5b. A 300-800 metre deposition curve generated by AGDISP for a Coarse spray quality, fixed wing aircraft in a windspeed of 20 km/hr

DISCUSSION

The NWPPA believes that the input parameter refinements, DSD library and nozzle type selection method proposed in this July 2018 submission, when applied to the AGDISP version 8.28 Ground model, will resolve the issues associated with the assessment of spray deposition from boom sprayers in the APVMA consultation documents.

Based on the refinements summarised in this submission, the TWG observed that the majority of predicted deposition values at distances recorded in field trials were within an order of magnitude of field data values and tended to slightly over-predict, which is environmentally-conservative.

When these individual field trails were grouped together according to spray quality, the performance of the revised AGDISP model improved significantly with most of the predicted deposition rates recorded at distances in field trials within a factor of 2.

The revised AGDISP 8.28 model appears to perform within confidence ranges typically found in spray drift field trials and tended to slightly over-predict compared to mean field deposition rates measured in the SDTF and Australian ground field studies. It is proposed therefore that AGDISP 8.28 Ground would be suitable for regulatory use when the new settings and approach are used.

RAL (fraction of rate)	**Down-wind Buffer Distance (metres)**									
	Ground boom				**Fixed wing**			**Helicopter**		
	Current (AgDRIFT)		**APVMA Consult Paper**	**Revised AGDISP Ground**	**Current (AgDRIFT)**	**APVMA Consult Paper**	**Revised AGDISP**	**Current (AgDRIFT)**	**APVMA Consult Paper**	**Revised AGDISP**
	Low Boom	**High Boom**								
0.1	1	1.5	0	2	18	8	14	26	20	30
0.05	2	3	0	2	36	26	36	36	30	46
0.01	8	14	48	20	200	112	124	132	84	124
0.005	14	28	148	32	570	206	204	372	164	190
0.001	86	138	>300	144	>800	>800	>800	>800	>800	742
0.0005	178	242	>300	356						
0.0003	284	>300	>300	>400						

- DSD = COARSE, wind speed = 20 km/hr

Table 4. Down-wind buffers distances calculated using AgDRIFT, AGDISP Ground and AGDISP 8.28 Ground with revised input parameters.

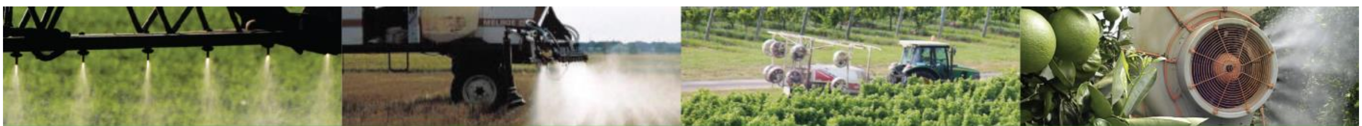


Table 4 shows a comparison the downwind buffers calculated for decreasing Regulatory Acceptable Levels (RALs) using the current method (AgDRIFT), the procedure outlined in the 2017 APVMA Consultation Paper, and the revised AGDISP Ground model 8.28 presented in this submission.

The NWPPA proposes that the APVMA consider these proposals to adopt a refined TWG AGDISP 8.28 Ground model for spray drift exposure risk assessment.

The NWPPA proposes that the approach would enable the impact of DRTs to be quantified and enable the implementation of industry Best Practice to reduce spray drift incidence and exposure and support the adoption of scientifically-supported operational in-field downwind buffer distances. The proposed approach would also reduce or negate the need for ongoing field trials.

CONCLUSION

The NWPPA recommends that the APVMA consider a proposal to adopt a refined AGDISP 8.28 Ground model for spray drift assessment.