

Optimising Product Performance and Minimising Spray Drift



With the potential to inflate chemical bills, reduce product efficacy and cause damage to sensitive crops and the environment, spray drift represents a major challenge for applicators of crop protection products.



Spray drift involves the movement of chemicals outside the intended target area, most commonly through small driftable droplets (less than 150 µm) being blown off-target through the effects of wind and air movement (known as droplet drift).

Spray drift (droplet drift) generally occurs as a consequence of crop protection products being applied using inappropriate or poorly set-up spray equipment or under unsuitable application conditions.

Given the risk factors contributing to spray drift are relatively well understood, there are a range of simple steps that applicators can

take when planning and implementing a spray program to both optimise product performance and minimise the risk of spray drift.

This Technote focuses on minimising spray drift when undertaking ground application with a conventional spray boom and hydraulic nozzles, however many of the general principles discussed also apply when utilising other application equipment.

The seven key steps

There are a range of risk factors which are known to contribute to spray drift, therefore through taking these into account in planning and implementing a spray program, applicators can greatly reduce the risk of spray drift.

Table 1 outlines the seven key steps (questions) that an applicator should take into account in planning and implementing a spray program.

1	Goal What is the goal of my spray program? (what weed/insect/disease am I targeting?)
2	Product What is the most appropriate product to achieve the goal of my spray program?
3	Target What is the target that the product must hit in order to achieve the goal of my spray program?
4	Spray Quality What spray quality is recommended to optimise the performance of my selected product ?
5	Nozzle and Equipment What nozzle and equipment set-up will consistently deliver the spray quality I require?
6	Weather and Sensitive Areas Are the weather conditions suitable for spraying and what sensitive areas do I need to take into account when conducting a spray drift risk assessment?
7	Spray Records and Training What spray records do I need to keep and what additional training is available?

Table 1: Seven key steps to optimising product performance and minimising spray drift.

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1. The Goal

In line with the principles of Integrated Pest Management (IPM), the first step in any spray program should be to consider whether the application of a crop protection product represents the most appropriate control option available. After establishing the need to spray, the planning phase of a spray program can commence and the seven key steps can be considered.

The first step is to identify the ultimate **goal** of a spray program, including what weed(s), insect pest(s) or plant disease(s) are being targeted.

2. The Product

It is then necessary to consider what **product(s)** will prove the most effective in meeting the goal of the spray program. This consideration should take into account the efficacy of a certain product on the weed, insect or disease in question, as well as the objectives of any overarching resistance management, IWM or IPM strategies.

Applicators should ensure that the selected product is registered, has an approved permit or can be legally used for the control of the targeted insect(s), weed(s) or disease(s) in the crop or use situation in question.

In selecting a product, it can also be important to consider the relative driftability of a certain formulation and product in comparison to alternative options. This is particularly the case when assessing the risk of vapour drift (as opposed to droplet drift), with the relative volatility of a product having a significant bearing on the risk of it vaporising and moving off target after application (e.g. low volatility 2,4-D products v/s high volatility 2,4-D products).

Consideration should also be given to influence of other tank additives such as spray adjuvants or water conditioners on droplet size and spray drift risk. While it is claimed certain surfactants and additives (e.g. lecithin and oil-based products) can reduce the number of small driftable droplets, other tank additives (e.g. non-ionic surfactants) are thought to have the opposite effect. In assessing the potential influence of adjuvants on spray drift risk, applicators are encouraged to seek specific advice from their adjuvant manufacturer or alternately to contact the Syngenta Technical Advice Line.

3. The Target

In order to ensure the success of a spray program, an applicator should consider both the nature and mode of action of the selected product and consider how the product must interact with **the target** in order to achieve optimal performance.

In simple terms, the target is where a product must hit in order to ensure its optimal performance. A target can vary greatly depending on the mode of action of a particular product and the insect pest(s), weed(s) or the plant disease(s) of concern.

In many cases the target is the problem weed, pest or disease itself. For instance, when applying SPRAY.SEED to control grass and broadleaf weeds in a fallow situation, applicators need to directly target the green leaf area of the problem weeds. However in other cases, the target may be a particular area of the cropping environment such as the soil surface or the canopy of the crop. This is the case with a pre-emergent herbicide such as BOXER GOLD, where applicators need to target the soil surface prior to weed emergence, ensuring the product can be properly incorporated through the action of sowing.

When assessing how a product must interact with the target in order to achieve optimal performance, an applicator should take into account three key factors:

- **Retention** - how long the product must remain in contact with the target;
- **Coverage** - how evenly the product needs to cover the target; and
- **Distribution** - how closely spaced the droplets need to be on the target.

The relative importance of each of these factors, in particular retention and coverage, has a major bearing on the most appropriate spray quality for a particular application under particular conditions.

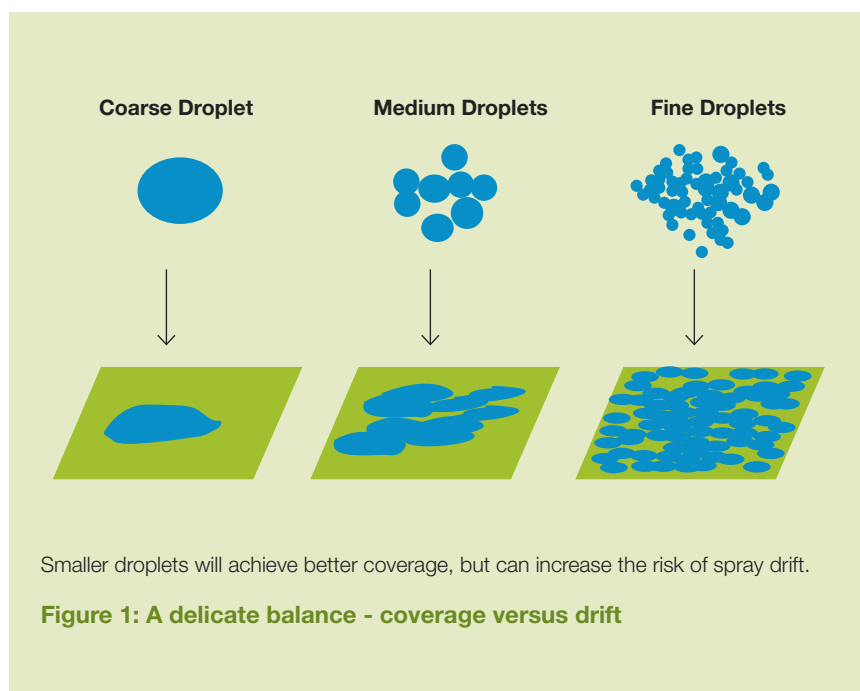
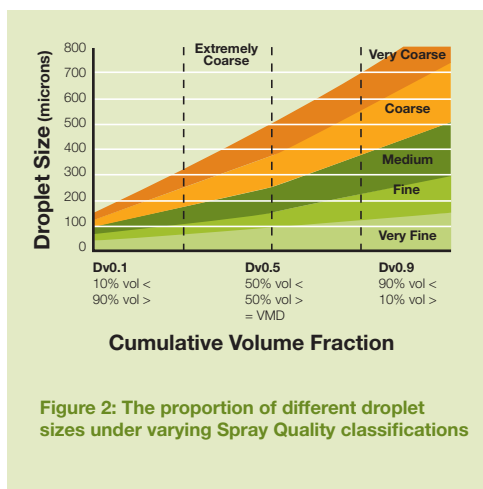


Figure 1: A delicate balance - coverage versus drift

4. Spray Quality

Spray quality classifications (Very Fine/Fine/Medium/Coarse/Very Coarse/Extremely Coarse) are based on the uniform droplet size classification system (based on the British Crop Protection Council specifications and in accordance with the American Society for Agricultural and Biological Engineers (ASABE) Standard (S-572)) which has been adopted by nozzle manufacturers globally.



Spray quality classifications provide applicators with an indication of the entire droplet size spectrum produced by a nozzle, including the proportion of smaller droplets considered to be driftable (droplets at or below 150 µm).

Many of Syngenta's product labels and our Broadacre Application Guide (Table 2) provide applicators with a recommended spray quality range for the application of different Syngenta products.

In selecting a suitable spray quality from within the recommended range, applicators should select the coarsest spray quality capable of ensuring product efficacy, while also minimising the proportion of fine driftable droplets produced. In the case of many herbicide products (e.g. SPRAY.SEED and AXIAL), recent trials have demonstrated that through increasing water rates (from 50 to 80+ L/ha) applicators can utilise a coarse spray quality to minimise drift, while achieving comparable or better product efficacy.

Product	Ideal Spray Quality	Recommended Spray Water Volume L/ha
Fungicides		
ALTO® 100 SL	Medium	100 - 300
AMISTAR® XTRA	Medium	50 - 100
BRAVO WEATHERSTIK®	Medium	200
TILT® 250 EC	Medium	50 - 100
TILT® XTRA	Medium	50 - 100
Insecticides		
AFFIRM®	Medium	> 80
KARATE® WITH ZEON TECHNOLOGY	Medium	30 - 100
PEGASUS®	Medium	> 100
PIRIMOR® WG	Medium	30 - 100
SUPRACIDE® 400 EC	Medium	50 - 100
Herbicides		
AXIAL®	Medium	50 - 100
BOXER GOLD®	Medium - Coarse	50 - 100
CADENCE®	Medium - Coarse	> 50
DUAL GOLD®	Medium - Coarse	> 60
ENVOKE®	Medium - Coarse	> 100
FUSILADE FORTE®	Medium - Coarse	50 - 100
GESAGARD®	Medium - Coarse	50 - 100
GESAPRIM®	Medium - Coarse	50 - 100
GESATOP®	Medium - Coarse	50 - 200
GRAMOXONE®	Medium - Coarse	30 - 200
LOGRAN®	Medium - Coarse	30 - 200
LOGRAN® B-POWER	Medium - Coarse	50 - 100
MONUMENT®	Medium - Coarse	50 - 100
PRIMEXTRA GOLD®	Medium - Coarse	60 - 120
REGLONE®	Medium - Coarse	> 100
SPRAY.SEED® 250	Medium - Coarse	50 - 200
TOPIK® 240 EC	Medium - Coarse	50 - 110
PGRs		
MODDUS®	Medium - Coarse	50 - 250

Table 2: Recommended spray quality and water volumes for Syngenta's broadacre products

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5. Nozzle and Equipment

After identifying a spray quality capable of optimising product efficacy and minimising drift, it is then necessary to consider what **nozzle and equipment** set-up is best able to consistently and evenly deliver this desired droplet spectrum.

In order to identify a suitable nozzle and equipment setup, an applicator should refer to a nozzle selection guide prepared by a reputable nozzle manufacturer (refer to Fig. 3).

When referring to a nozzle selection guide, an applicator should firstly consider the speed (km per hour) at which they wish to carry out their spraying operation.

In making a decision on operating speed, an applicator should remember that for every two-fold increase in application speed, the amount of spray drift created through turbulence can increase by around four-fold.

With a preferred operating speed in mind, it is then necessary to scroll down the corresponding column on the nozzle selection guide and identify what nozzle size (eg: 01, 015, 02, 025, 03) and pressure combinations are capable of delivering the required application rate (L/ha) at the identified operating speed.

With a number of possible options identified, an applicator should then review which of these possible nozzle and pressure combinations can be reasonably and safely achieved given the pump and plumbing capacity of their spray rig.

In deciding on a suitable operating pressure, it is important to keep in mind that for conventional nozzles and many air-induction nozzles, as pressure increases spray quality becomes finer (therefore increasing the likelihood of drift). Therefore, through choosing a lower operating pressure, applicators can reduce the risk of spray drift, decrease their nozzle wear and also minimise potential OH&S risks arising from any spray line blow outs.

After deciding what nozzle size and pressure combinations can be realistically and safely achieved, it is then necessary to identify what nozzle design, in the identified size, is capable of producing the required spray quality at the selected pressure.

In selecting the best nozzle for a spray task, an applicator should always seek to operate at the middle of an individual nozzle's pressure range. Through operating in the middle of a nozzle's pressure range, an applicator has a greater chance of maintaining a consistent spray quality and proper spray pattern. This can be particularly important when applying products using a variable rate controller.

NOZZLE CAPACITY	Nozzle	BAR	L/Min	l/ha							
				8	10	12	16	19	20	25	30
01 Orange	1	0.23	35	28	23	17	15	14	11	9	8
	2	0.32	48	38	32	24	21	19	15	13	11
	3	0.39	59	47	39	29	26	23	19	16	13
	4	0.45	68	54	45	34	30	27	22	18	15
	5	0.50	75	60	50	38	33	30	24	20	17
	6	0.55	83	66	55	41	37	33	26	22	19
	7	0.59	89	71	59	44	39	35	28	24	20
	8	0.64	96	77	64	48	43	38	31	26	22
015 Green	1	0.34	51	41	34	26	23	20	16	14	12
	2	0.48	72	58	48	36	32	29	23	19	17
	3	0.59	89	71	59	44	39	35	28	24	20
	4	0.68	102	82	68	51	45	41	33	27	23
	5	0.76	114	91	76	57	51	46	37	30	26
	6	0.83	125	100	83	62	55	50	40	33	29
	7	0.90	135	108	90	68	60	54	43	36	31
	8	0.96	144	115	96	72	64	58	46	38	33
02 Yellow	1	0.46	69	55	46	35	31	28	22	18	16
	2	0.65	98	78	65	49	43	39	31	26	22
	3	0.79	119	95	79	59	53	47	38	32	27
	4	0.91	137	109	91	68	61	55	44	36	31
	5	1.02	153	122	102	77	68	61	49	41	35
	6	1.12	168	134	112	84	75	67	54	45	38
	7	1.21	182	145	121	91	81	73	58	48	42
	8	1.29	194	155	129	97	86	77	62	52	44
025 Lilac	1	0.57	86	68	57	43	38	34	27	23	20
	2	0.81	122	97	81	61	54	49	39	32	28
	3	0.99	149	119	99	74	66	59	48	40	34
	4	1.14	171	137	114	86	76	68	55	46	39
	5	1.28	192	154	128	96	85	77	61	51	44
	6	1.40	210	168	140	105	93	84	67	56	48
	7	1.51	227	181	151	113	101	91	73	60	52
	8	1.62	243	194	162	122	108	97	78	65	56
03 Blue	1	0.68	102	82	68	51	45	41	33	27	23
	2	0.96	144	115	96	72	64	58	46	38	33
	3	1.18	177	142	118	89	79	71	57	47	41
	4	1.36	204	163	136	102	91	82	65	54	47
	5	1.52	228	182	152	114	101	91	73	61	52
	6	1.67	251	200	167	125	111	100	80	67	57
	7	1.80	270	216	180	135	120	108	86	72	62
	8	1.93	290	232	193	145	129	116	93	77	66

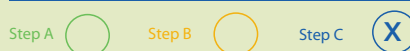


Figure 3: TeeJet® Nozzle Selection Guide



Finding a suitable nozzle to apply

Jake wants to apply Syngenta's **BOXER GOLD** at a rate of 60 L/ha. In line with the **BOXER GOLD** label, Jake decides he wants to apply the product using a coarse spray quality.

Step A

Jake generally conducts his spraying at a speed of 18 kph. In starting the process of selecting the correct nozzle, Jake finds the corresponding 18kph column on the TeeJet nozzle capacity chart (see opposite).

Step B

In order to identify what nozzle size and pressure combinations are capable of delivering his required 60 L/ha at his desired operating speed, Jake scrolls down the 18kph column.

Jake identifies the following nozzle size and pressure combinations capable of delivering his required 60 L/ha:

015	02	025	03
7 bar	4 bar	2.5 bar	2 bar

Step C

Given the standard diaphragm pump on Jake's spray rig is only able to operate at between 1– 5 bar pressure, Jake immediately rules out the 015 @ 7 bar option.

Step D

With a range of achievable combinations in mind, Jake then refers to the Nozzle Selection Guide to identify a suitable design from TeeJet's range capable of delivering a coarse (c) spray quality.



In reviewing all of the possible combinations, the only nozzle capable of producing a coarse spray quality while delivering 60 L/ha at 18 kph is an 02 sized AIXR TeeJet operated at 4 bar.

With 4 bar very close to the middle of the AIXR TeeJet's pressure range (3.5 bar), the nozzle represents an ideal choice for Jake to use when applying **BOXER GOLD**.

NOZZLE SELECTION GUIDE

AIXR TeeJet	BAR										
	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6
AIXR110015	XC	VC	VC	C	C	C	C	M	M	M	M
AIXR11002	XC	XC	VC	VC	C	C	C	C	C	M	M
AIXR110025	XC	XC	XC	VC	VC	C	C	C	C	C	C
AIXR11003	XC	XC	XC	VC	VC	C	C	C	C	C	C

Turbo TeeJet	BAR										
	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6
TT11001	C	M	M	M	F	F	F	F	F	F	F
TT110015	C	C	M	M	M	M	M	F	F	F	F
TT11002	C	C	C	M	M	M	M	M	M	M	F
TT110025	VC	C	C	M	M	M	M	M	M	M	M
TT11003	VC	C	C	C	C	M	M	M	M	M	M

Turbo TeeJet Induction	BAR									
	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6
TTJ60-11002	C	C	C	C	M	M	M	M	M	M
TTJ60-110025	VC	C	C	C	C	C	C	M	M	M
TTJ60-11003	VC	C	C	C	C	C	C	C	M	M

AIX TeeJet AIC TeeJet	BAR										
	2	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7
AH110015	VC	VC	VC	VC	C	C	C	C	C	C	C
AH11002	VC	VC	VC	VC	VC	C	C	C	C	C	C
AH110025	XC	VC	VC	VC	VC	VC	VC	C	C	C	C
AH11003	XC	XC	VC	VC	VC	VC	VC	VC	C	C	C

XR TeeJet XRC TeeJet	BAR						
	1	1.5	2	2.5	3	3.5	4
XR11001	F	F	F	F	F	VF	VF
XR110015	F	F	F	F	F	F	F
XR11002	M	F	F	F	F	F	F
XR110025	M	M	F	F	F	F	F
XR11003	M	M	F	F	F	F	F



Droplet size classifications are based on BCPC specifications and in accordance with ASAE Standard S-572 at the date of printing. Classifications are subject to change.

Step **D** Preferred nozzle **C** Possible combination **O**

1 bar = 100 kPa = 15 psi

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*This example is provided as a guide, in reality an applicator is unlikely to select a nozzle based on the ideal requirements for any single product, but rather select a range of different nozzles (2-3 designs) versatile enough to meet all of their different spray application requirements. For specific advice on nozzle selection and Syngenta's range of specialist nozzles please contact the Syngenta Advice Line on 1800 067108 or talk to your local Syngenta Territory Sales Manager.

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In addition to selecting the correct nozzle, applicators should also take into account other aspects of equipment setup which can have an influence on spray drift risk. For instance, boom height has been identified as a critical variable in influencing spray drift risk.

International research suggests that as boom height increases from 50cm to 70cm, the number of fine driftable droplets capable of moving off-target can double. This proportion can double again when boom height is raised from 70cm to 80cm (refer to Fig. 4).



80 cm Boom Height



50 cm Boom Height

Figure 4: The effect of boomheight on spray drift

6. Weather and Sensitive Areas

After selecting an appropriate nozzle and setting up spray equipment to strike a balance between product performance and drift risk, it is then necessary consider external risk factors including the **weather** and any **sensitive areas** in the vicinity of the application area.

Before commencing each spray application, an applicator should conduct an on-ground spray drift risk assessment considering both the prevailing weather conditions and sensitive areas in and around the application site.

Product labels should be the first point of reference when undertaking a risk assessment and determining the suitability of conditions for spraying. General instructions on many product labels specify conditions under which a product can be applied (or not applied), for instance **“DO NOT apply products under weather conditions that may cause spray to drift over nearby susceptible plants or crops, cropping lands or pastures.”**

The Bureau of Meteorology’s Weather Guidelines for Pesticide Spraying provide detailed guidance on suitable conditions for spray application.

In reality there are times of the year where it can prove difficult to identify “recommended” spraying conditions, and pest, disease or weed pressure can necessitate spraying under conditions considered to be marginal. Under these circumstances, applicators should reconsider their product, spray quality, nozzle and equipment selections in order to place a greater emphasis on minimising drift (eg through utilising drift-reducing surfactants, selecting a coarser spray quality, reducing pressure, increasing water rates, lowering boom heights and reducing application speeds).

It is important to remember that there will be instances when spraying **should not occur (or should cease)** until conditions have changed.



To assist growers and advisors to plan their spray programs, Syngenta has developed the Agricast Online Weather and Spray Window Forecasting Tool.

Agricast is available to selected registered users and offers 5-day weather and spray window forecasts incorporating hourly predictions of ground and aerial spraying and Delta T conditions.

For more information on Agricast please visit www.syngenta.com.au

Weather guidelines for spraying

- Read the product label and follow all label instructions
- Spray when wind is steady and ideally 3-15 km/h
- Avoid variable or gusty wind conditions
- Avoid calm conditions (nil wind)
- Spray when wind blows away from sensitive areas
- Avoid spraying in temperatures above 28°C
- Aim to spray when Delta T is between 2 and 8 and not greater than 10 (Figure 5)
- Do not spray when inversion conditions exist
- Aim to spray when the atmosphere is neutrally stable
- Be aware of local topographic and convective influences on wind speed and direction
- Record on-site weather conditions at spray time

For more information visit www.bom.gov.au or contact the Syngenta Advice Line on 1800 067 108.

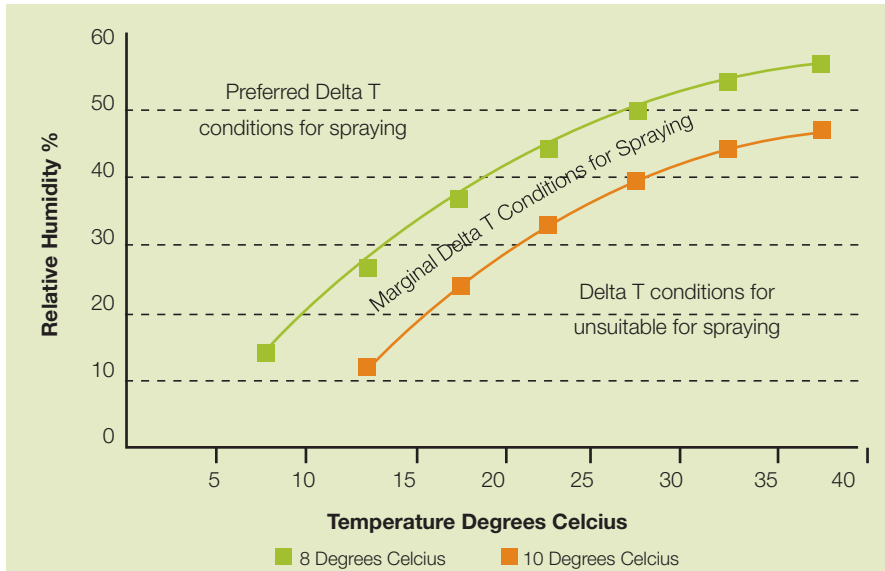


Figure 5: Suitable and unsuitable Delta T conditions

The Delta T value is calculated by subtracting the wet bulb temperature from the dry bulb temperature, or alternately through considering the relative humidity and the dry temperature at the intended time of spraying. **Even if the Delta T conditions are suitable, applicators should take particular care to ensure inversion conditions are not present!**

In addition to weather conditions, an on-ground spray drift risk assessment should consider sensitive crops, locations (public roads, houses) or landscape features (wetlands, creeks, native vegetation) which may have the potential to be impacted by drift. This area is often known as the Spray Drift Awareness Zone (Fig. 6).



Figure 6: Spray Drift Awareness Zone

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In addition, an assessment should take into account:

- any specific product label instructions on the protection of sensitive areas (eg mandatory buffer zones on Gesaprim and Gesatop labels)
- the need to establish no spray buffer zones or vegetative buffers to protect sensitive areas
- preferred wind direction and conditions for spraying to provide additional protection for sensitive areas (spraying should ideally be conducted with a cross-wind, working into the wind towards the unsprayed area); and
- the need to notify neighbours of the intended spray program.

Notification of neighbours

Unfortunately when spray drift occurs it does not respect property boundaries. It is therefore important that applicators maintain good relationships with their neighbours and openly discuss intended spray programs and potential spray drift risks prior to commencement of the application season.

These discussions should focus on identifying mutually acceptable arrangements for ongoing notification during spraying periods.

While professional spray contractors should conduct a detailed risk assessment prior to commencing a spray application, land owners and managers employing contractors should ensure that they directly notify (preferably in writing) contractors of any sensitive areas or known risks in the vicinity of the application area and provide a detailed map.

In addition to the pre-spraying risk assessment, it is important that applicators constantly monitor weather and surrounding conditions during spraying, and cease applying products if conditions change and become unsuitable for application.

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7. Spray Records and Training

In conducting an on-ground spray drift risk assessment it is important to maintain detailed **records** of prevailing conditions, sensitive areas and of the measures taken to minimise potential risks (specific advice on record keeping requirements can be found in Syngenta's Record Keeping Technote).



Although this Technote outlines some general recommendations for minimising the risk of spray drift, striking the correct balance between product performance and minimising drift can be challenging. Applicators are therefore encouraged to undertake recognised farm chemical users **training**, to become accredited and to seek specialist advice when planning and implementing their spray program. More information on recognised training providers can be found at www.syngenta.com.au/stewardship.



The last word ...

The off-target movement of crop protection products in spray drift can impose considerable additional costs on applicators and put at risk neighbouring crops and the farm environment.

Although spray drift is often seen as a major challenge for applicators, through acknowledging the risk factors and taking a number of simple steps when planning and implementing a spray program, it is possible to strike the right balance minimising drift and optimising product performance.

For more information

For more information please contact the Syngenta Advice Line on 1800 067 108 or your local Syngenta representative.

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