Best practices for aerial and ground spray applications to cotton

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Achieving the best outcome from spray application requires the careful consideration of many factors. The aim of spray application is to transfer active ingredients through the atmosphere to the target in an effective manner with minimal off-target losses. Application technique needs to be matched to the target and weather conditions. Movement of spray beyond the target area is undesirable as it represents wastage of product and exposure of non-target sensitive areas to potentially damaging materials.

This chapter provides guidance on factors to be considered in optimizing spray application . New technologies and information are continually becoming available, so this is meant as a summary guide only. Readers should consult additional information where available.

Planning

The development of a comprehensive pesticide application management plan (PAMP) is an important part of the Best Management Practice (BMP) program in cotton. The PAMP for farming enterprises should be completed prior to the season and should cover;

- Farm layout;
- Identification of sensitive areas, potential hazards and awareness zones;
- Communications procedures;
- Pesticide Management Guidelines; and,
- Accident and emergency procedures.

Having a PAMP in place helps to ensure that everyone involved in pesticide application has a clear understanding of their responsibilities.

Meet your legal obligations

Always read and follow the label when handling and applying chemicals and be aware of federal and state regulations for chemical application. Staff responsible for handling and applying pesticides must be qualified according to relevant state and federal requirements. There may also be workplace health and safety requirements related to storage and use of hazardous substances, which require risk assessments to be completed, in addition to maintaining a manifest and Safety Data Sheets for those substances deemed to be hazardous.

Users are not absolved from compliance with the directions on the label or the conditions of the permit by reason of any statement made or not made in this publication.

Communication and neighbour notification

Prior to spray application and product selection check the proximity of susceptible crops and sensitive areas such as houses, schools, waterways and riverbanks.

It is good practice to notify neighbours of your spray intentions, regardless of label requirements. By doing this, sensitive crops or areas that you may be aware of can be accounted for.

Open communications with neighbours is critical due to Roundup Ready cotton. Roundup Ready herbicide drift onto fields of non-Roundup Ready cotton can result in serious yield losses.

Check to see if a map of the sensitive areas in your district is available, and make neighbours aware if it is available.

Weather conditions

Since sprays are released into the atmosphere, weather conditions at the time of application will have an effect on spray transport and deposition. Monitor weather conditions regularly during spray applications (this means continual visual observations and actual measurement at least every 20-30 minutes).

Every grower should use an electronic weather meter to measure meteorological data at the site of application. This can be done with handheld equipment (e.g. Kestrel 3000, 3500, 4000 or equivalent). Alternatively there are on board weather stations available utilising GPS input to provide weather information and logging whilst spraying (such as the Topcon or Watchdog systems).

Growers can also subscribe to websites that provide forecasts of conditions for spraying up to 10 days in advance. These sites evaluate all of the following factors to produce tables indicating times that would be suitable for spraying. You can access the websites at either Spraywisedecisions.com.au or Syngenta.com.au for more information.

Temperature and humidity

Higher ambient air temperatures and lower relative humidity conditions increase evaporation rates. Since droplet size of water-based sprays decreases rapidly with higher evaporation rates, drift tends to increase. Studies have shown that an

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increase in air temperature from 10°C to 20°C may require an increase in buffer zone size from just a few percent to over 100%, depending on the accompanying wind speed.

Water-based sprays should not be applied under conditions of high temperature and low relative humidity (RH). Spraying is best conducted when the delta T (the difference between the wet bulb and dry bulb) is more than 2 and less than 10°C. For example, spraying can be carried out if the temperature is;

- 20°C and RH ≥24%
- 25°C and RH ≥33%
- 30°C and RH ≥40%
- 35°C and RH ≥45%

When using coarse sprays at high water volume rates, evaporation may be less significant, which may allow some applications to continue into marginal delta T conditions (where soil moisture exists, and the targets are not in a stressed condition).

Never start a spraying operation when the delta T is above 10-12.

What is a surface temperature inversion?

Surface Temperature Inversions are the most hazardous atmospheric conditions for spray applications, especially when combined with high humidity. An inversion exists when the air temperature increases with altitude instead of decreasing. Inversions usually occur on clear, calm nights and persist well into the morning, until the ground heats sufficiently to lift the inversion, or when sufficient wind causes the air to mix, breaking the inversion layer (see Figure 12).

High humidity increases the drift hazard under inversion conditions as it extends the life of small droplets (less than 100 microns). Droplets suspended within an inversion tend to travel parallel to the ground, and cool air drains to the lowest point in the landscape, carrying with it chemical that remains suspended.

Windy or turbulent conditions help to reduce the likelihood of surface temperature inversions forming. Smoke generators can be used to detect inversion conditions. Under an inversion smoke will not continue to rise, but will drift along at a constant height under the inversion 'blanket'.

Do not spray during surface temperature inversion conditions.

Thermals are updrafts during the heat of the day cause rapidly shifting wind directions.

Also avoid spraying in these conditions.

Wind speed at night and inversions

Still conditions or very light and variable winds (typically less than 4 km/h) greatly increase the risk of spray movement away from the target and so should be avoided for spray applications.

FIGURE 11: effect of atmospheric stability

Smoke	Condition	Notes	Spray?
	NEUTRAL (e.g. morning)	Cool breeze (4–15 km/h) Optimum spray conditions.	✔
	UNSTABLE (e.g. afternoon)	Hot. Low windspeed, thermal activity. Risk of upward movement of fine droplets.	✗
	INVERSION (e.g. night)	Low windspeed. Hot during day. Risk of significant off-target deposition of fine droplets.	✗
	STABLE (e.g. dusk)	Low windspeed. Risk of off-target spray deposition.	✗

Such conditions may indicate local surface temperature inversion conditions. Spray Drift that occurs under these conditions may travel long distances, often damaging large areas, with very uniform symptoms.

Figure 11 below shows the effect of atmospheric stability on the dispersion of sprays in the atmosphere. The behaviour of smoke or dust under various stability conditions may assist with selection of the preferred spraying conditions. Neutral atmospheric stability conditions (e.g. morning with a light cool breeze) are best for most applications.

Wind speed

Wind speed affects the distance that a droplet will travel before deposition, impaction or evaporation. Wind speeds of 3–15 km/h are recommended (8–10 km/h are ideal) for spraying with a ground rig. Labels usually require wind speed to be measured at the site of application.

Higher wind speeds usually pose greater risk that product will evaporate quicker or be blown off target. At wind speeds of 11–15 km/h, use low drift nozzles or higher application volumes. Avoid spraying when wind speeds exceed 4.5m/s or 16 km/h.

Scandinavian studies have suggested that an increase in wind speed from ~5 km/h to ~16 km/h at an air temperature of 10°C will require a 25% increase in buffer zone size for herbicide applications.

FIGURE 12: Later in the day inversions start to form

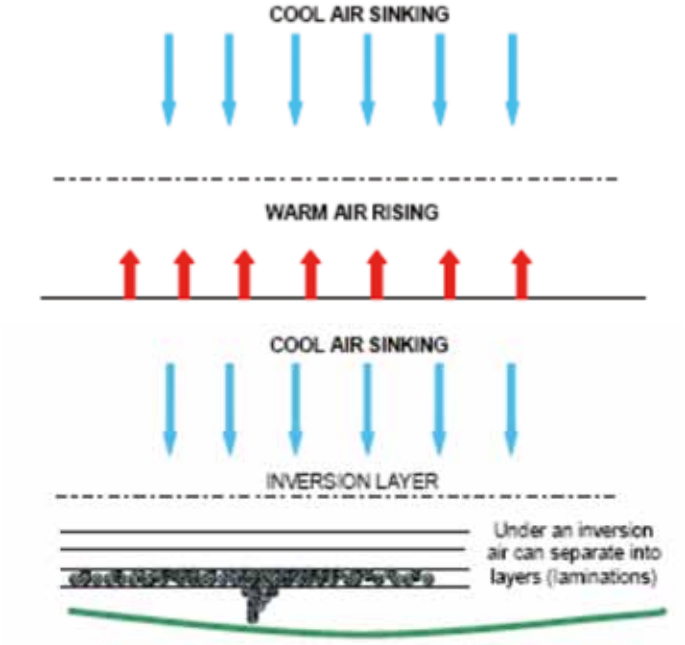
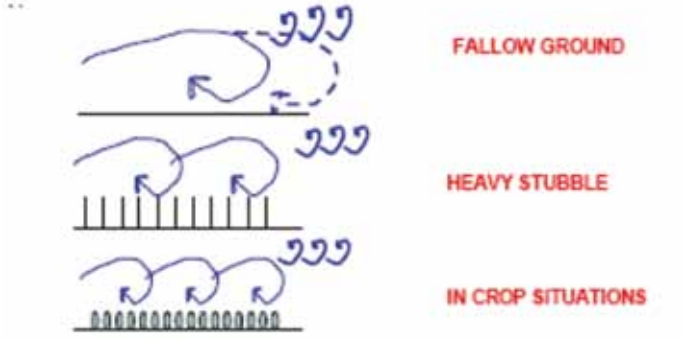


FIGURE 13: Wind movement over different surfaces



Buffers

Vegetative buffers tend to be more effective than bare ground in intercepting spray that moves off target during spray application. Good buffers can reduce drift by as much as 60 to 90 per cent.

Farm planning should consider where the protection of sensitive areas can be improved by enhancing vegetative buffers. Effective buffers are comprised of a mixture of tree and shrub species with foliage all the way to the ground. The planting arrangement and density allows for air to partly flow through the barrier. Barriers without airflow act like impermeable walls. The wind containing the spray drift is deflected up and over the top of the barrier which increases the effective release height and increases the far-field drift potential. Do not position barriers where airflow will be obstructed by adjacent objects such as turkey's nests.

The optimum height for a buffer is 1.5 times the release height of the spray. Trees and shrubs are able to act as an effective barrier for ground applied sprays from early in their development. Most guidelines suggest that the optimum width of the barrier is 20 m with a 10 m maintenance strip on either side.

Adopting best spray practice

Summary of factors that influence spray drift and best practice

Setting appropriate spray release height

The amount of chemical left in the air may increase by up to 10 times as nozzle height increases from 50cm above the target to 1m above the target. It is important to set the height of the boom at the minimum practical height to achieve the correct spray pattern for the nozzles. Vertical movement of the spray boom should be minimised. Limit vertical movement by tuning the boom suspension and matching travel speed to release height. Alternatively consider fitting auto boom height.

Auto boom height devices use ultrasonic sensors to detect the height of the boom above the target. These adjust the boom hydraulically to maintain the nozzles at a constant height above the target. Generally these systems will require a machine with good hydraulic capacity, but allow the machine to maintain boom height at travel speeds up to 28 km/h.

Travel speed

Air velocity affects deposition of droplets onto the target. Increased operating speeds can cause spray to be diverted back into upward wind currents and vortexes behind the spray boom. Special care should be taken when using high speed, high clearance sprayers and some "floaters" whose tires may become more like fans when driven at high speeds. Small droplets can become trapped in these air patterns and contribute to drift. Speeds above 15 km/h have been shown to increase the risk of drift for boom spraying and speeds above 10 km/h increase the risk from shielded sprayers.

Setting pressure range

Only ever operate nozzles within the pressure range recommended by the manufacturer. Higher or lower than recommended pressures changes the droplet spectrum and the spray pattern, affecting both the risk of drift and the efficacy of the spray application.

Be aware that many air induction nozzles will require slightly more pressure than the minimum indicated on the manufacturers spray chart. Always assess the spray pattern at various pressures, to determine an appropriate minimum operating pressure.

Where automatic rate controllers are fitted to the machine, carefully consider the true range of speeds the machine is likely to operate, from the slowest field to the fastest field. Identify what the pressure at the nozzle will be at your lowest speed and your fastest speed and identify a nozzle that will produce the required spray quality across that range of speeds.

Operating at recommended pressures can also minimise wear and tear on nozzles.

Record keeping

It is always good practice to maintain accurate records of every spray application made on your property. These records provide a valuable management tool for comparing spray applications and identifying factors that may have contributed when an application does not perform as well as expected. Accurate records can also assist in identifying issues such as the onset of resistance and sensitivity of the target to particular products or tank mixes.

State Based Legislation – Requirements for Record Keeping

Under the Records Regulations of the NSW Pesticides Act, when spraying you must record the weather and relevant spray details. An example form is presented on page 147.

Spray log books can be purchased from DEEDI In Toowoomba Client services centre on 074688 1460 or 07 4688 1360 or DEEDI Dalby – phone 07 4669 0800. Spray log books are also available from I&I NSW, Yanco Phone 1800 138 351.

Spraywise decisions log books are available through Croplands dealers

Federal Legislation – Label Requirements for Record Keeping

It may also be a requirement of many product labels to maintain an accurate spray record. Where the label requires a record to be made this detail must be recorded in addition to any state based requirements for record keeping.

Labels may require that a spray record be made within 24 hours of the application occurring and that the record retained for a minimum of two years:

The details that must be recorded within the federal requirements for a spray record will be stated on the label, but will typically include the following:

1. Date with start and finish times of application;
2. Location address and paddock/s sprayed;
3. Full name of the product;
4. Amount of product used per hectare and the number of hectares applied to;
5. Crop/situation and weed/pest;
6. Wind speed and Direction during application;
7. Air temperature and relative humidity during application;
8. Nozzle brand, type, spray angle, nozzle capacity and system pressure measured during application; and,
9. Name and address of person applying this product.

(Additional record details may be required by the state or territory where this product is used.)

Hence it will be important to ensure that the record keeping system or log book you use allows you to record all of the above details to ensure you meet your legislative requirements.

Selecting water volume

Always follow label recommendations for water volumes for application. Typically in crop applications to cotton will require application volumes of 100 L/sprayed hectare or more.

Whereas, for fallow spraying with translocated herbicides (such as Glyphosate and the phenoxys) equivalent efficacy has been shown for medium, coarse and even extremely coarse spray qualities at 50 L/ha. Equivalent efficacy in fallow spraying situations has also been shown at 70 L/ha and greater for products with minimal translocation, such as Spray Seed.

When using larger than a medium spray quality for translocated products, increasing water rate does not necessarily increase efficacy, and in some situations may actually reduce performance in the field.

Higher water rates with fully translocated products can reduce efficacy when a marginal rate of product is used, when water quality may be marginal or where diluting the adjuvants included in the product reduces the products performance.

Nozzle selection

Spray nozzles produce a range of droplet sizes called the droplet size spectrum. Nozzle manufacturers now use internationally recognised classifications for droplet size spectrums referred to as the Spray Quality. These are Very fine, Fine, Medium, Coarse, Very coarse and Extremely coarse.

The APVMA has released a document which specifies the standards it will accept for the definition of spray quality, which includes the ASAE standard, the BCPC standard, and a coarse spray quality definition for aerial application.

Each time you move from one classification to the next coarser classification you approximately half the driftable fraction (eg from medium to coarse, or from coarse to very coarse). Hence it is always advisable to use the largest spray quality classification that will provide acceptable efficacy.

For a step by step guide to selecting nozzles see page 144.

Interpreting information about spray nozzles

Nozzle manufacturers provide information on the droplet size spectrum performance of nozzles and atomizers under specific operating conditions. Most nozzle catalogues only provide such information for applications of water under ground spraying conditions.

Real tank mixes may produce different spectrums than those suggested in nozzle catalogues. Tank mixes with lower surface tension and viscosity than water will tend to favour greater production of smaller droplets.

In aerial applications sprays tend to be much finer than the ground-based nozzle catalogue data would suggest. This is primarily due to air shear. Models are available for some nozzles and atomizers to indicate the droplet size classification under aerial conditions.

A comprehensive set of such models and tables of droplet size information are available from the United States Dept. of Agriculture at *http://apmru.usda.gov/downloads/downloads.htm* and, for aerially-applied 2,4-D sprays, from wind tunnel droplet size research from *www.aerialag.com.au*.

Maintenance and hygiene

Calibration – replace worn nozzles

The output of each nozzle should be checked pre-season and regularly during the season. Nozzles that vary more than 10% from the manufacturer's specifications should be replaced.

Regularly check wheel sensors and flow meters for accuracy, check pressure across the boom for evenness and monitor total volumes against areas on your GPS logs to indicate when things may have changed since your last calibration.

Decontamination

Application equipment that has been used to apply herbicides should be thoroughly decontaminated before being used to apply any product to a susceptible crop. Strictly follow the method of decontamination recommended on the label. No matter how much time is spent decontaminating the equipment there is always a risk of herbicides residues causing a problem.

Tank mix considerations

Always follow the manufacturers' recommendations for mixing. Where multiple product tank mixes and adjuvants are added to the one tank, incorrect mixing order can reduce the efficacy of those products.

Using adjuvants to increase droplet size

More can be done to manipulate droplet size with nozzle selection, than with the addition of an adjuvant.

Many adjuvants, especially non-ionic wetters (wetter 1000 products) increase the amount of drift. Whereas some adjuvants can increase droplet size, but care should be taken in assuring that there is a decrease in small driftable droplets with diameter below 100–200µm, and not just an increase in the average or volume median diameter of the spray. When considering adjuvants, compatibility with the tank mix and spraying system should also be considered, since some adjuvants do not perform as well with some combinations of other factors. For example, many polymers cause a decrease in spray angle from cone nozzles which may adversely affect spray formation and coverage.

Emulsion-based adjuvants often perform better for reduction in small droplets than solution-based adjuvants for the same surface tension. However, actual performance is specific to the conditions.

Tank mix temperature

Recent research has shown that the temperature of the tank mix relative to the air may have an effect on the droplet size spectrum produced at atomization. Often a temperature difference where the liquid is greater than 6°C warmer than the ambient air can reduce the small droplet proportion of the spray.

Product types

The selection of product may affect the tank mix physical properties, which can affect droplet size and likelihood of off-target losses.

The impact of a given amount of drift off target will depend on the product's toxicity to what is present in the affected areas. Alternative pest control methods (e.g. cultural, mechanical, biological) may allow pesticides to be avoided or used at lower rates in conjunction with other methods. Where chemicals are used, preference should be given to products which offer the lowest effects on non-target organisms and the environment. To compare the relative toxicities of insecticides to non-target insect species such as beneficials and bees, refer to Table 19, page 58-59.

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Types of drift

Sprayed pesticides can drift as droplets and particles or as vapours.

Droplet and particle drift

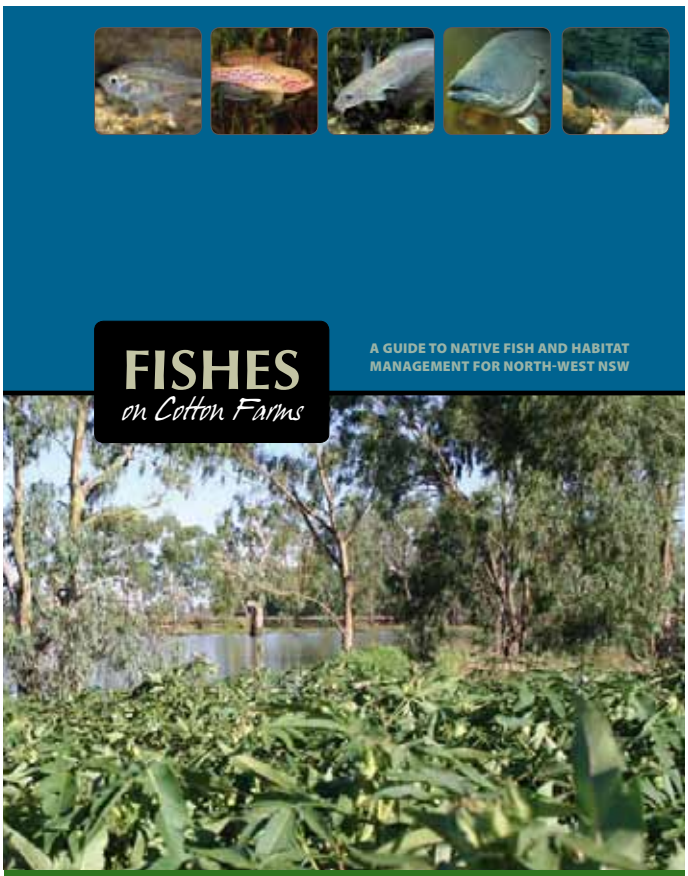
Droplet and particle drift is the most common cause of off-target damage from pesticides. It is particularly obvious where herbicides drift onto susceptible crops.

It occurs when any form of pesticide is applied in unsuitable weather conditions and/or with inappropriate application parameters. Water in the spray droplets evaporates resulting in finer droplets and particles of herbicide. As the size of the droplet declines, so too does their rate of fall towards the ground. Smaller droplets remain airborne longer and hence are susceptible to further evaporation and drift away from the intended target. Herbicide particle drift damage to susceptible crops has been reported up to 30 km from the spray source.

Droplet and particle drift is the easiest form of drift to prevent. Under good spraying conditions, droplets are carried down by air turbulence and gravity to collect on the intended plant surfaces.

Vapour drift

Vapour drift is the movement of volatile components of herbicides in air currents during or after application. Volatility refers to the likelihood that the herbicide will turn into a gas. Vapours may arise directly from spray or from the target surface after droplet deposition. Volatilisation from the target surface can occur hours or days after application. The risk of vapour drift can be avoided by choosing active ingredients with low volatility. The ester forms of 2,4-D and MCPA have high volatility, while the amine and salt forms have low volatility.



NEW Fishes on Cotton Farms Guide available through the Cotton Catchment Communities CRC; www.cottoncrc.org.au or (02) 6799 1534

Actives with low volatility are still susceptible to droplet and particle drift. Some examples of vapour drift risk from some different products are shown in the table on page 150.

New approaches to chemical labels

The APVMA are applying a spray drift risk assessment to all new registered products, and progressively to those existing products that have been subject to review. To access or download the APVMA document that explains this approach, check the APVMA website apvma.gov.au

The new labels will include some new requirements, such as:

Mandatory spray qualities

Some labels already have a mandatory spray qualities, such as those on products containing 2,4-D, which state… 'spray quality must not be smaller than a coarse to very coarse spray quality according to the ASAE Standard S-572'.

New labels will also have a spray quality requirement, typically stating either medium spray quality or larger or coarse spray quality or larger. This will be linked to a wind speed range and other measures for mitigating spray drift risk.

Mandatory wind speed range

Some labels already have a mandatory wind speed range, such as those on products containing 2,4-D, which states… 'wind speeds must be above 3 km/h and less than 15 km/h as measured at the site of application.'

This approach will be applied to all new labels, with the wind speed range varying depending on the level of risk associated with each product, and the method of application. In many cases the wind speed range will also be linked to the size of a no-spray zone.

In the majority of labels the wind speed range will be above 3 km/h and less than 15 km/h or above 3 km/h and less than 20 km/h, depending on the level of risk associated with that product

No spray zones

Some product labels may refer to a mandatory no spray zone. This is the downwind distance between the sprayed area and a sensitive area. The NO SPRAY ZONE cannot be sprayed when the wind is towards the sensitive area (which may be a residence, public area, water body, pasture, terrestrial vegetation or another susceptible crop).

The distance required for the NO SPRAY ZONE may differ for the various types of sensitive areas

Always check the label to see of a no spray zone is required, and how wide the no spray zone has to be for the product you wish to apply

Additional considerations for aerial applications

Boom length

The forces that provide lift and flight of aircraft also produce wake and vortex effects of the air into which spray droplets are released. If droplets become entrained in these airflows, their trajectory and path can change. To minimise this effect, boom length should not exceed 65 to 75% of the wingspan.

The strength of vortices tends to increase when a slower flight speed or greater weight is used and when the lift increases, for example when the aircraft climbs at the end of a flight line. Therefore, spray should not be applied when the aircraft is climbing, but only when the aircraft is level over the target. Also, if helicopters are flown very slowly, the airflow behaviour can cause droplets to be carried up by the rotor vortices, with an increase in spray drift potential.

Air shear

The production of small droplets that may be more prone to drift can be reduced by minimizing air shear at the nozzle tip where the liquid meets the airblast from the aircraft motion. Reducing flight speed (e.g. using slower helicopters rather than higher speed fixed wing aircraft) can reduce this shear, but may affect productivity rates and optimal operation. Reducing the nozzle angle is an effective way to reduce air shear. In the case of deflector nozzles, the nozzle angle and the deflector angle can be reduced to provide minimal air shear conditions. The lowest air shear occurs for nozzle angles which are 0° straight back.

Pressure

The relative velocity of the air and liquid is important in affecting droplet size. For most nozzles, lower liquid pressure produces coarser sprays, within the optimal operating range for the nozzle. However, with very narrow angle sprays such as those from solid stream and narrow angle flat fan nozzles, higher pressure generally produces coarser sprays. Consult nozzle manufacturer information for specific recommendations on pressure range settings for optimal droplet size and application criteria.

Rotary atomizers

Some rotary atomizer manufacturers provide models for predicting droplet size with their equipment based on operational parameters such as rotation rate, flight speed and liquid flow rate for specific product types.

Coarser droplets can be produced by increasing the drag on the atomiser to lower the rotation rate. Using windmill blade-driven atomizers allow selection of rotation rate through changing the blade angle. Droplet size also tends to increase with higher flow rates. There may be a change in the mode of atomization from direct droplet through ligament and sheet breakup as flow rate increases, each of which tend to produce progressively coarser sprays.

Specialised aerial equipment

Some spray equipment allows in-flight optimization of application conditions. For example,

- Booms can sometimes be lowered after take-off, allowing spray release height to be reduced with lower drift potential;
- Chambers are being developed for reversing the venturi effect where the nozzle can be positioned in a relatively lower airstream velocity reducing the number of small droplets;
- Wing tip modification devices can reduce vortices and modify wake effects to prevent spray from drifting, but under some circumstances could also affect aircraft handling and airframe lifetimes; and,
- Electrostatic spraying systems may help with droplet wrap-around onto lower leaf surfaces, but drift reduction will ultimately depend more on droplet size than forces such as electrostatic charge.

Further information:

"Spray Drift Management Principles, Strategies and Supporting Information", www.publish.csiro.au/Books/download.cfm?ID=3452.

SPRAYpak – Cotton Growers' Spray Application Handbook, 2nd Edition, available from CRDC.

Spraywise – Broadacre Application Guide – Available through Croplands Distributors.

The spray drift model 'AgDRIFT', is available for free download from www.agdrift.com. Fact sheets on droplet size classification, and drift management in aerial and ground applications are also available at this website.

For more information about using vegetative barriers in spray drift management, see the Queensland guidelines: Anon (1997) Planning Guidelines: Separating Agricultural and Residential Land Uses. Dept of Natural Resources, Queensland and Dept of Local Government and Planning, Queensland. DNRQ 97088. Available for free download at www.nrm.qld.gov.au/land/planning/pdf/public/plan_guide.pdf.

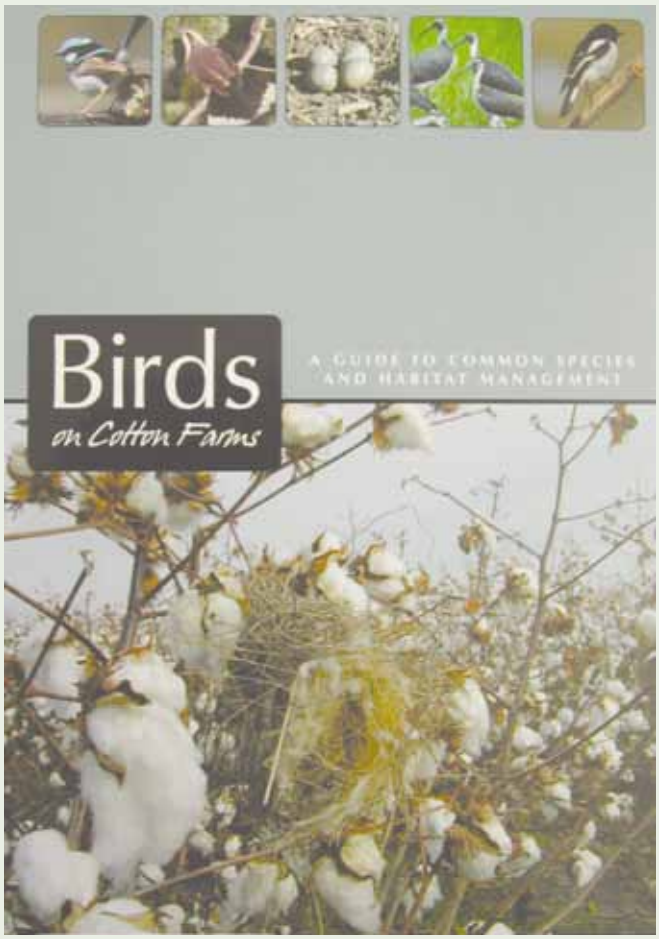
Comprehensive information about droplet spectrums of nozzles under aerial application conditions is available from the United States Dept. of Agriculture at http://apmru.usda.gov/downloads/downloads.htm. For aerially-applied 2,4-D sprays, from wind tunnel research, see www.aerialag.com.au.

Birds on Cotton Farms

'Birds on Cotton Farms' has been re-printed by the Cotton Catchment Communities CRC. The guide provides cotton growers of Northern New South Wales and Southern Queensland with an easy to use field guide of common bird species and their habitat requirements in the farming landscape. Some simple management practices that cotton growers can employ to maintain and improve local bird population densities and diversity are outlined.

Within the Guide there is a checklist of more than 300 bird species known to occur on farms, grasslands, wetlands and woodlands across these cotton production regions. This list represents more than one-third of all Australian birds. Also included are photographs of 118 common and significant bird species plus a brief description of their appearance, behaviour, habitat and preferred diet. The guides are available through:

The Cotton Catchment Communities CRC;
Locked Bag 1001 Narrabri NSW, 2390
Phone (02) 6799 1534 www.cottoncrc.org.au



Nozzle selection process for ground application

Regardless of the machines capacity, we should have enough flexibility with the nozzles we select to allow us to achieve the desired application volumes, without having to unnecessarily sacrifice speed and still meet all legal requirements for nozzle type and spray quality.

Basic process for selecting nozzles and questions to ask

Step 1

Determine the required application volume (L/Ha) and the required spray quality (check the label or manufacturers recommendation) and identify your average operating speed (must ensure boom stability). e.g. Coarse Droplets or Larger at 70 L/ha using a 50cm nozzle spacing on a single spray line, at a travel speed of 16 km/h. If you are not using a 50cm nozzle spacing create a new chart to match your nozzle spacing by downloading the spreadsheet from ispray.com.au (go to toolbox and download custom spray charts).

Step 2

Use a nozzle chart to determine the range of nozzles sizes and operating pressures that will give you the desired L/Ha at your average operating speed (km/h) e.g 70L/ha at 16 km/h

e.g. Using the nozzle chart in Figure 1 for a 50cm nozzle spacing, move across the top row until you reach your average operating speed. Then work your way down the column until you reach the L/ha you were hoping to achieve, finding which orifice sizes and pressures will match your situation.

Using the chart, we find that we could use an 015 orifice at 7 bar, an 02 orifice at 4 bar or an 025 orifice at 2.5 bar. All of these nozzle sizes could give us about 70L/ha at 16 km/h.

Step 3

Identify the types of nozzles based on their operating pressure at the average speed, and identify the most appropriate minimum operating pressure for each nozzle type (the SPRAYWISE charts are useful for evaluating suitable minimum operating pressures for each of the nozzles)

For example:

015 @ 7 bar = High pressure air induction (minimum pressure = 4 bar)
02 @ 4 bar = Low pressure air induction (minimum pressure = 2 bar)
025 @ 2.5 bar = Pre-orifice e.g. LD or standard TT (minimum pressure > 1.5 bar)

Step 4

Use the minimum operating pressure for each nozzle type to identify at what speed the desired L/ha is achieved (Dropping below this pressure means nozzles will not work properly).

Note: regardless of the nozzle type selected, the speed at which the nozzles no longer perform well is approximately the same for all nozzle types (in this example that is around 11-12 km/h)

16kph	nozzle type	min pressure	min speed
015 @ 7 bar	high pressure AI	4 bar	12 km/h
02 @ 4 bar	low pressure AI	2 bar	11/12 km/h
025 @ 2.5 bar	pre-orifice/ Low Drift	1.5 bar	11/12 km/h

Ask yourself, do you spend much of your spraying time below the minimum speed? – if you do, there are two possible outcomes.

a) If no minimum hold is set in the automatic rate controller, the nozzle may not work as effectively. e.g. fan angle collapse and overlap is poorer, with air induction nozzles the droplets may not have as much air in them and the retention of droplets on foliage may be reduced.

b) If the minimum hold function is set at that pressure and you travel at lower speeds, you will be overdosing those areas. While this may not create immediate problems with some knock down herbicides, it does cost you money, and with some products that have residual activity it may inhibit crops and create greater plant back problems.

To remedy this would require a small increase in the application volume, which will increase the speed range available, or use of large enough headlands so that you reduce the area overdosed (not preferred for controlled traffic situations).

Step 5

Identify the practical range of the nozzle, this will be based on the manufacturers recommended pressure range, or the limits or your machine.

Ask yourself, what range of volumes can I get out of each nozzle?

Nozzle type	Volume range at 16 km/h
015 high pressure AI	4-8 bar = 70 L/ha to 75 L/ha
02 low pressure AI	2-6 bar = 70 L/ha to 84 L/ha
025 pre-orifice	1.5- 5 bar = 70L/ha to 96 L/ha

Step 6

Determine which nozzle types provide the greatest flexibility with the pressure range you have available with your machine. You must also remember to consult the product labels to determine if any restrictions on nozzle type exist. Some labels still say not to use pre-orifice or air induction nozzles, however this is slowly changing.

Typical application volume	Medium spray quality (lower risk areas)	Coarse or larger spray quality	Extremely coarse spray quality (higher risk areas)
Low range 50–70 L/ha	Older insecticides with short residual Translocated herbicides on medium targets	2,4–D and tank mixes Fully translocated products	Fully translocated herbicides Moderate targets Very sensitive areas
High range 70–100 L/ha	Small targets In-crop spraying, contact type products Penetration and coverage in large broadleaf crops	Most products and most targets Soil applieds Stubble and cereal penetration. Some contacts at higher volumes	Pre-ems Fully translocated herbicides, most targets, very sensitive areas

Nozzle selection

Step 7

Go to the spray quality charts and select nozzles that meet your requirements.

Most farms need to have at least 2 sets of nozzles, such as a winter set and a summer/pre-emergent set. For example you may choose a nozzle that is coarse at your lower volume range and medium at higher volume to go from fallow to in-crop in winter (such as a pre-orifice nozzle or low pressure air induction), and have another set that stays coarse through your volume range to do summer fallow and pre-emergent spraying (such as a coarser low pressure air induction).

FIGURE 1: L/ha for various nozzle sizes, pressures and travel speeds

Nozzle Size	Bar	l/min/ nozzle	Litres per sprayed hectare at 50 centimetre nozzle spacing, water only													
			10	12	14	15	16	17	18	20	22	24	25	26	28	30
01 Orange	1	0.23	28	23	20	18	17	16	15		13					
	2	0.32	38	32	27	26	24	23	21	19	17					
	3	0.39	47	39	33	31	29	28	26	23	21					
	4	0.45	54	45	39	36	34	32	30	27	25					
	5	0.50	60	50	43	40	38	35	33	30	27					
	6	0.55	66	55	47	44	41	39	37	33	30					
	7	0.59	71	59	51	47	44	42	39	35	32					
015 Green	1	0.34	41	34	29	27	26	24	23	20	19					
	2	0.48	58	48	41	38	36	34	32	29	26	24	23	22	21	19
	3	0.59	71	59	51	47	44	42	39	35	32	30	28	27	25	24
	4	0.68	82	68	58	54	51	48	45	41l	37	34	33	31	29	27
	5	0.76	91	76	65	61	57	54	51	46	41	38	36	35	33	30
	6	0.83	100	83	71	66	[illegible]	59	55	50	45	42	40	38	36	33
	7	0.90	109	90	77	72	68	64	60	54	49	45	43	42	39	36
02 Yellow	1	0.46	55	46	39	37	[illegible]	32	31	28	25	23	22	21	20	18
	2	0.65	78	65	56	52	49	46	43	39	35	33	31	30	28	26
	3	0.79	95	79	68	63	[illegible]	56	53	47	43	40	38	36	34	32
	4	0.91	109	91	78	73	68	64	61	55	50	46	44	42	39	36
	5	1.02	122	102	87	82	77	72	68	61	56	51	49	47	44	41
	6	1.12	134	112	96	90	84	79	75	67	61	56	54	52	48	45
	7	1.21	145	121	104	97	91	85	81	73	66	61	58	56	52	48
025	1	0.57	68	57	49	46	[illegible]	40	38	34	31	29	27	26	24	23
	2	0.81	97	81	69	65	61	57	54	49	44	41	39	37	35	32
	3	0.99	119	99	85	79	74	70	66	59	54	50	48	46	42	40
	4	1.14	137	114	98	91	[illegible]	80	76	68	62	57	55	53	49	46

Say I wanted to spray at 16 km/hr @ at 70 L/Ha with a COARSE or larger spray quality which nozzle size & type would you select ?

Legal responsibilities in applying pesticides

Mark Scott, Industry & Investment NSW
Lisa Dixon, ClemClear

Pesticides Act

The Pesticides Act 1999 is the primary legislative instrument controlling the use of pesticides in NSW and is administered by the Department of Environment, Climate Change and Water (DECCW). The underlying principle of the Pesticides Act is that pesticides must only be used for the purpose described on the product label and all the instructions on the label must be followed. Consequently, all label directions must be read by or explained to the user prior to each use of the pesticide.

All pesticide users should take reasonable care to protect their own health and the health of others when using a pesticide. They should also make every reasonable attempt to prevent damage occurring from the use of a pesticide, such as off-target drift onto sensitive areas or harm to endangered and protected species.

A regulation was gazetted in 2009 requiring all commercial pesticide users, i.e. all farmers and spray contractors, to keep records of their pesticide application

While no set form is required for records they must include the following:

- Full product name,
- Description of the crop or situation,
- Rate of application and quantity applied,
- Description of the equipment used,
- Address of the property, identification of the area treated and order of paddocks treated,
- Date and time of the application (including start and finish),
- Name, address, and contact details of the applicator and of the employer or owner if an employee or contractor is the applicator,
- Estimated wind speed and direction (including any significant changes during application),
- Other weather conditions specified on label as being relevant (e.g. temperature, rainfall, relative humidity).

An example form that captures all the information required by the Pesticides Regulation 2009 is provided on the following page. Notes on how to fill it in, can be downloaded from the I&I NSW website. A self-carbonating record book is available for purchase through the DEEDI Dalby and Toowoomba offices and through the I&I NSW SMARTtrain National Support Centre at Yanco.

Records must be made within 24 hours of application, be made in legible English, and kept for 3 years.

The Pesticides Regulation 2009 also requires all commercial pesticide users to be trained in pesticide application.

The training of aerial applicators, pest control operators and fumigators is recognised as satisfying the requirements of the regulation. Apart from these groups, all commercial users must have a prescribed qualification. Only domestic use, such as home gardens, is excluded, provided the pesticide is a specific domestic/home garden product. Covered by the regulation is pest control by/on:

- Public authorities, e.g. State Rail,
- Golf courses, sporting fields and bowling greens,
- Agricultural, horticultural, aquacultural and forestry operations,
- Businesses, educational institutions, and hospitals.

The minimum prescribed training qualification will be the AQF2 unit of competency, 'Apply chemicals under supervision', although owner-applicators are encouraged to train and be assessed in the two higher AQF3 competencies, 'Prepare and apply chemicals' and 'Transport, handle and store chemicals'.

Growers are recommended to undertake the SMARTtrain course, Chemical Application, or the standard ChemCert course, both of which cover the higher AQF3 competencies. For growers with literacy and/or numeracy problems, the lower level AQF2 competency will provide a minimum qualification that satisfies the Regulation.

In Queensland the Chemical Usage (Agricultural and Veterinary) Control Act 1988 (Chem Usage Act) imposes requirements on all users of pesticides similar to those under the NSW Pesticides Act 1999. The Chemical Usage Act requires users to only use agricultural chemical products registered for the particular purpose. Also all users must apply agricultural chemical products according to product label instructions, including any use instructions or restraints that may be listed that relate to wind speed and offtarget drift restriction controls. There are heavy penalties imposed on anyone found to have breached the Chemical Usage Act by failing to observe label instructions.

Under the Agricultural Chemicals Distribution Control Act 1966 (ACDC Act) aerial distribution contractors in the business of aerial distribution (application) of agricultural chemicals and ground distribution contractors in the business of ground distribution of herbicides must be licensed. In addition agricultural pilots and ground commercial operators working for or engaged by these contractors must undergo prescribed training and also be licensed. There is no requirement for growers applying agricultural chemicals on their own land to undertake training or to hold a licence. However, Queensland growers are strongly encouraged to undergo some form of vocational training or further training with Chemcert or a registered training organisation such as SMARTtrain or TAFE so their skills and knowledge in application technology and handling, storing and transporting chemicals are maintained and kept up to date.

In Queensland cotton growers are not required under legislation to keep records of spraying activities they carry out themselves on their own property unless a product label has an instruction which requires them to do so. This differs to the situation in NSW. However it is considered good farming management practice to keep records and therefore all Queensland growers are strongly encouraged to keep records of all their chemical applications along the same lines as NSW growers are required to do so by law.

Licensed aerial and ground distribution contractors are required to make records of all their spraying activities and keep these for a minimum of 2 years. The required records are set out under section 26 of the ACDC Act.

Additional advice on legal responsibilities in applying pesticides in Qld. Geoff Cowles OAM, Biosecurity Queensland, a service of DEEDI, Qld.

PESTICIDE APPLICATION RECORD SHEET

NSW DEPARTMENT OF
PRIMARY INDUSTRIES

Location, Applicator, Date of Application					
Property/holding (residential address):					Date:
Applicator's full name:			Owner (if not applicator):		
Address			Address		
		Phone:			Phone:
Mobile:	Fax:	Email:	Mobile:	Fax:	Email:
Sensitive areas (including distances, buffers): N / W / Treated Area / E / S			Comments (including risk control measures for sensitive areas):		
Host/Pest					
Paddock number/name:		Paddock area:		Order of paddocks sprayed:	
Crop/situation:			Type of animals:		
Crop/pasture variety:			Age/growth stage		
Growth Stage:			Mob/paddock/shed:		
Pest/disease/weed:			Animals – number treated:		
			Pest density/incidence: ❑ Heavy ❑ Medium ❑ Light		
Application Data					
Full label product name:			Rate/dose:	Water rate L/ha:	
Permit No:		Expiry date:	Additives/wetters:		
Total L or kg:		WHP:	ESI:	Date suitable for sale:	
Equipment type:		Nozzle type:		Nozzle angle:	Pressure:
Date last calibrated:		Water quality (pH or description):			

Weather

❑ Showers ❑ Overcast ❑ Light cloud ❑ Clear sky

Rainfall (24 hours before and after)

Before: mm During: mm After: mm

Time (show time in this column	Temperature °C	Relative humidity (%)	Wind speed	Direction	Variability (e.g. gusting)
Start:					
Finish:					

Comments:

* When using herbicides in mixtures with fungicides and insecticides, an ESI may apply to the non-herbicide component of the mixture.

Hazardous Substances and Dangerous Goods Legislation

Many registered pesticides are classified as hazardous substances and most of those that are not pose some risk to the health of those who use them or are exposed to them.

The Occupational Health and Safety Act 2000, and the Hazardous Substances section of the Occupational Health and Safety Regulation 2001, detail legal requirements of suppliers, employers and employees in the workplace for hazardous substances management. The Act and accompanying Regulation are intended to protect workers from both the short and long-term health effects of exposure to hazardous substances and to improve current health and safety practices by:

- Provision of health and safety information to workers (including a list or register of all hazardous substances and an MSDS (Material Safety Data Sheet) for each hazardous substance),
- Consultation with workers,
- Training of workers,
- Assessment of the risks arising from hazardous substances exposure,
- Control of the risks, and
- Recording of the risk assessment and control measures implemented, training of both those applying and exposed to hazardous substances, and health surveillance (if warranted by the risk assessment in respect of organophosphates).

Both storage and use are covered by the OH&S legislation. Records of training and risk assessments have to be kept for 5 years.

Dangerous Goods legislation has been revised to bring it into line with hazardous substances legislation. The new requirements came into force after a phase-in period ending September 1, 2006. The main requirements include;

- Provision of MSDSs;
- Carrying out and documenting risk assessments; and,
- Keeping a register of Dangerous Goods.

All these requirements already apply to hazardous substances. In practice, the only change will be to add to existing management and recording and record systems any Dangerous Goods that are not also hazardous substances.

Storage limits have changed. Premises storing large quantities require placarding of both the storage shed and the entrances to the premises. If very large quantities are stored, which would be rare on-farm, a manifest, site plan and written emergency plan are required. Consult your local WorkCover office for advice.

Farm chemicals are registered pesticides, and many are either hazardous substances or Dangerous Goods or both. As different legislation applies to each category, farmers must ensure their pesticide use complies with all relevant legislation.

WorkCover NSW's *Code of practice for the safe use and storage of chemicals* (including pesticides and herbicides) in agriculture is an approved industry code of practice and provides practical guidance for farm chemical users to comply with the legislation. This has recently been revised to reflect the new Dangerous Goods requirements. Copies can be obtained from your local WorkCover office, by download from the WorkCover website – www.workcover.nsw.gov.au – or by phoning 1300 799 003.

The cotton industry's guidelines for handling, storage and application of pesticides can be found in Part 1 and 2 of the *Australian Cotton Industry Best Management Practices Manual.*

Pesticides and The Environment

The cotton industry's guidelines for minimising risk to the environment is another component of myBMP.

Most insecticides are toxic to aquatic organisms, bees and birds. Fungicides and herbicides are relatively safe to bees in terms of their active ingredients, but their carriers and surfactants may be toxic. The risks that a particular product poses to the environment are reflected in statements on the label under headings like 'Protecting wildlife, fish, crustacea and the environment'.

Protecting bees

The cotton growing environment is a high risk environment for bees. Bees are particularly susceptible to many of the insecticides used on cotton farms, such as abamectin, fipronil, indoxacarb, pyrethroids and profenofos. The productivity of hives can be damaged if bees or the hives are contaminated. Insecticides that are particularly toxic to bees are identified as such with the following special statement on the label;

Dangerous to bees. DO NOT spray any plants in flower while bees are foraging.

The relative toxicities of cotton insecticides to honeybees are listed in Table 19 on page 58–59.

Table 19 ranks the acute toxicities of products to bees based on LD50 information. The residual toxicity of insecticides, that is, the amount of time the product remains toxic to bees after the time of application, should also be considered when information is available. For the majority of insecticides used in cotton the residual toxicities are unknown. Table 39 summarises the currently available information.

Bees are generally active between 7:00 am and 4:00 pm and most bees forage within a 2 to 4 km radius of their hive. They may travel up to 7 km away in search of pollen and nectar, though only when nearby pollen and nectar sources are in

Protect bees when using Regent Insecticide

The Regent Insecticide label states:

'Dangerous to bees. DO NOT apply where bees from managed hives are known to be foraging, and crops, weeds or cover crops are in flower at the time of spraying, or are expected to flower within 28 days (7 days for pastures and sorghum).

Before spraying, notify beekeepers to move hives to a safe location with an untreated source of nectar, if there is any potential for managed bees to be affected by the spray or spray drift. If an area has been sprayed inadvertently, in which the crop, weeds or cover crop were in flower or subsequently came into flower, notify beekeepers in order to keep managed bees out of the area for at least 28 days (7 days for pastures and sorghum) from the time of spraying. Where the owner of managed hives in the vacinity of a crop to be sprayed is not known, contact your State Department of Primary Industries/Agriculture, citing the registration number, for assistance in contacting the owner.'

decline or are of poor quality. Bees collect nectar from extra-floral nectaries (eg under leaves) as well as from cotton flowers so they may forage in cotton crops before, during and after flowering. As well as bees foraging in cotton crops, damage may occur to bees when pesticides drift over hives or over neighbouring vegetation that is being foraged by bees eg. coolibah.

Coolibah trees (Eucalyptus microtheca) are a primary source of nectar and pollen for honey bees. These trees grow on the black soil plains along many of the river courses in the cotton growing areas. Budding and flowering occurs in response to good spring rains. In northem NSW the buds appear in November and the trees begin to flower mid-late December finishing about the end of January, budding and flowering times vary by a few weeks in both the southern and central Qld areas. When heavy budding occurs beekeepers often move large numbers of hives into cotton growing areas for honey production.

With good communication and good will, it is possible for apiarists and cotton growers to work together to minimise risks to bees, as both the honey industry and cotton industry are important to regional development.

The pesticide risk to bees can be reduced by:

- Applying pesticides toxic to bees in the evening when bees are not foraging;
- Notifying the apiarist when beehives are in the vicinity of crops to be sprayed to allow removal of the hives before spraying. Beekeepers require as much notice possible, preferably 48 hours, to move an apiary;
- Where possible, using EC and granular formulations in preference to wettable powders which are particularly hazardous to bees. Micro-encapsulated formulations such as that used for lambda-cyhalothrin are particularly hazardous to bees because of their persistence in the environment and because bees transport the micro-capsules back to the hive along with the pollen;
- Inform contract pesticide applicators operating on the property of the locations of apiaries;
- Paying particular attention to windspeed and direction, air temperature and time of day before applying pesticides;
- Using buffer zones as a mechanism to reduce the impact of spray drift or overspray; and,
- Avoiding drift and contamination of surface waters where bees may drink (see advice on risk management for aquatic organisms).

Bee Alert

The Cotton CRC website hosts a voluntary service called **'Bee Alert'** that aims to improve communication between hive owners and cotton growers. Bee Alert is a free service which allows beekeepers to regularly update information about their hives on the web page for use by cotton growers. The Cotton CRC oversees the placement of data, allowing the Regional Cotton Extension Officer to be notified when new listings are made in a region. Communication with growers and aerial operators can then be co-ordinated locally. Each Bee Alert provides;

- A description of where the hives are located;
- The likely duration of their stay; and,
- Contact details for the apiarist to be used in the event that hives may need to be moved.

Further information about protecting bees or to contact the owner of bee hives

NSW Apiarist Association
Ms Julie Lockhart, Secretary
PO Box 3018, Toongabbie East, NSW 2146
Phone (02) 9631 3934. Fax (02) 9631 0585

QLD Beekeepers Association Inc.
Mr Bob Johnson, State Secretary
PO Box 49, Mapleton QLD 4560
Phone: (07) 5445 7512
Email: qba@hypermax.net.au

I&I NSW
Dr Doug Somerville,
Technical Specialist – Honeybees
PO Box 389, Goulburn NSW 2580
Phone: (02) 4828 6619. Mobile: 0427 311 410
Email: doug.somerville@dpi.nsw.gov.au

DEEDI
Peter Warhurst, Apiary Officer
Locked Bag 17, Warwick QLD 4370
Phone: (07) 4661 6623. Mobile: 0428 616 623
Email: peter.warhurst@dpi.qld.gov.au

TABLE 39: Cotton insecticides with known residual toxicities to honey bees

Active Ingredient	Chemical group	Residual toxicity to bees[1]	Comment
fipronil	phenyl pyrazole	7 to 28 days	Long residual. See label extract above.
clorfenapyr	pyrrole	2 days	Foraging beaviour could be affected for longer than 2 days[2].
spinosad	spinosyn	1 day	Not hazardous once the spray has dried. Avoid drift onto hives.
betacyfluthrin	synthetic pyrethroid	>1 day	Longer residual expected in Australian conditions.
esfenvalerate	synthetic pyrethroid	1 day	
lambda–cyhalothrin	synthetic pyrethroid	>7 days	Micro-encapsulated formulation has longer residual.
carbaryl	carbamate	up to 7 days	
chlorpyrifos	organophosphate	up to 1 day	
dimethoate	organophosphate	up to 3 days	
parathion	organophosphate	1 day	Depending on weather conditions, residual may be 4–6 days[3].

Source: Primefact 149, Pesticides – a guide to their effect on honey bees.
[1] Residual toxicity is the amount of time the pesticide remains toxic after application. Data is derived from United States field trials conducted by the University of California (Atkins et al. 1981, Reducing pesticide hazards to honey bees) and Washington State University (Mayer et al. 1999, How to reduce bee poisoning from pesticides) unless otherwise indicated.
[2] APVMA, when formerly the National Registration Authority.
[3] United States Environment Protection Agency.

When communicating with beekeepers, encourage them to use this service, particularly when apiaries are being placed within bee flight range of flowering crops.

Cotton CRC weblink;

www.cottoncrc.org.au/content/Industry/Tools/BeeAlert/Bee_Sites_All_Regions.aspx

Protecting the aquatic environment

The risk to aquatic organisms can be managed by:

- Preventing drift into surface waters during application;
- Locating mixing/loading and decontaminating facilities away from surface waters and providing such facilities with bunding and sumps to prevent movement of either concentrate or rinsate into surface waters;
- Installing valves which prevent back-flow when filling spray tanks from surface waters and in suction lines for chemigation systems which draw directly from surface waters;
- Avoiding aerial application of spray on fields during irrigation;
- Building sufficient on-farm storage capacity (including provision for storm run-off) to contain pesticide contaminated tail water from irrigation;
- Spraying in an upstream direction, when it is necessary to spray near surface waters, to reduce the maximum concentration at any one point in the watercourse;
- Using only registered products to control aquatic weeds, e.g. Roundup Bioactive rather than Roundup; and,
- Avoiding disposal of used containers in surface waters and on flood plains and river catchments.

RELATIVE HERBICIDE VOLATILITY

Active Ingredient	Product Example
HIGH VOLATILITY*	
2,4-D ethyl ester	Estercide 800
2,4-D isobutyl ester	2,4-D Ester 800
2,4-D n-butyl ester	AF Rubber Vine Spray
SOME VOLATILITY	
MCPA ethylhexyl ester	LVE MCPA
MCPA isooctyl ester	LVE MCPA
2,4-D isooctyl ester	Low Volatile Ester 400
triclopyr butoxylethyl ester	Garlon 600
picloram isooctyl ester	Access
LOW VOLATILITY	
MCPA dimethyl amine salt	MCPA 500
2,4-D dimethyl amine salt	2,4-D Amine 500
2,4-D diethanolamine salt	2,4-D Low Odour 500
2,4-D isopropylamine salt	Surpass 300
2,4-D triisopropylamine	Tordon 75-D
2,4-DB dimethyl amine salt	Buttress
dicamba dimethyl amine salt	Banvel 200
triclopyr triethylamine salt	Tordon Timber Control
picloram triisopropylamine	Tordon 75-D
picloram triethylamine salt	Tordon Granules

From Mark Scott, Agricultural Chemicals Officer, Industry & Investment NSW.
* The APVMA has taken the decision to continue to suspend the registration of products containing high volatile ester forms of 2,4-D, namely the ethyl, butyl and isobutyl esters. Refer to page 152 for more information.

Protecting birds

The organophosphate and carbamate insecticides can be particularly toxic to birds, especially in granular formulations. Bird kills from diazinon, monocrotophos and carbofuran have been well documented in Australia and overseas. Insecticidal seed dressings can pose similar risks. Just a few seeds and granules can be lethal. Spillages can be very hazardous as birds can easily ingest a toxic dose from a small area.

Risks to birds from granular products can be managed by:

- Ensuring complete incorporation beneath the soil, particularly at row ends where spillage may occur; and,
- Immediate clean up of spillage, however small.

Bait materials for control of rodents or soil insect pests can also be hazardous to birds, either through direct consumption of the bait or from feeding on bait-affected animals or pests. The risks to birds from baits can be managed by:

- Ensuring even bait distribution, with no locally high concentrations;
- Not baiting over bare ground or in more open situations, such as near crop perimeters, where birds may see the baits;
- Not baiting near bird habitat such as remnant native vegetation;
- Use of bait stations which prevent access by birds, particularly near bird habitat;
- Only baiting where pest pressure is high;
- Baiting late in the evening when birds have finished feeding;
- Prompt collection and burial of rodent carcasses where these occur in open situations; and,
- Immediate clean up of spillage, however small.

Foliar applied insecticide sprays can also be hazardous to birds, either because of direct contact with the sprayed chemical, or by feeding on sprayed insect pests or crops. Even where birds are not killed, they may be sufficiently affected to make them more vulnerable to predation. Contaminated seed and insects collected from sprayed fields by parent birds can also be lethal to young chicks still in the nest. Risks to feeding and nesting birds can be managed by:

- Minimising drift into remnant vegetation, wildlife corridors, nesting sites, or other bird habitats;
- Actively discouraging birds from feeding in crops which are to be sprayed;
- Spraying late in the day when birds have finished feeding; and,
- Using only low toxicity chemicals when large concentrations of birds are nesting nearby.The best way to manage any long term adverse environmental risks is to follow the protection statements on labels, minimise spray drift, and to dispose of chemical containers and waste in accordance with label directions and codes of practice.

Recycle Chemical Containers

Recycling is now possible for properly rinsed metal and plastic containers used for farm chemicals. drumMUSTER is the national program for the collection and recycling of non-returnable crop production and animal health product chemical containers.

The containers when presented at a drumMUSTER receival site MUST BE: Free of chemical residue with the lids removed. Some stains are acceptable but physical chemical residue is not. Dirt, dust and mould are not reasons for rejection.

Inspection of containers at drumMUSTER collection points is necessary to ensure that containers can be safely recycled. There must be no product residue on the inside or the outside of the container, including the thread and cap. Visible residues could be powder, flake, coloured /dark fluid or clear fluid.

Preparing chemical drums for recycling

Always follow these procedures to ensure your drums are suitable for delivery to a collection centre:

- Triple or pressure rinse your containers immediately after use (residues are more difficult to remove when dry). Pour the rinse water back into the spray tank.
- Thoroughly clean the container thread and outside surfaces with a hose into the spray tank. Rinse all caps separately in a bucket of clean water, and pour the rinsate into the spray tank.
- Inspect the container, particularly the thread and screw neck to ensure all chemical residue has been removed.
- Metal containers should be punctured using a steel rod or crowbar, this should be done by passing it through the neck/pouring opening and out the base of the container. This also allows the containers to vent and remove any residual odour.
- Allow the containers to drain completely and air dry them (this may take a number of days) to ensure they do not retain any rinse water.
- Store cleaned containers in a sheltered place with caps removed, where they will remain clean and dry until they can be delivered to a *drumMUSTER* collection centre.

If containers are rejected the user is responsible for ensuring that the container is taken back to the property and cleaned using all rinsate to make up an application of the same chemical according to the label recommendations.

For information on the *drumMUSTER* program phone 1800 008 707 or contact your local representative:

Northern NSW	Southern QLD	Northern QLD
Phil Tucker	Colin Hoey	Bill Davis
0427 925 274	0428 964 576	0427 691 760

Safely dispose of unwanted chemicals

ChemClear is an industry stewardship program which is funded to collect currently registered agricultural and veterinary chemicals at the end of their life cycle, or, when they become surplus. The program is targeted to meet disposal requirements of ag and vet chemical users, and, whilst doing so diverts potential hazardous chemicals from being dumped in landfills, creeks or being inappropriately disposed of in the community.

Unwanted rural chemicals may result from; discontinued use of a chemicals because of changes in cropping or animal practices, development of newer, more effective or safe chemicals, changes in a chemicals registration through the APVMA and/or banning from use, unknown product, sale of property, inherited product and deceased estates. Any unwanted or unknown chemicals held on farm are potential hazards to people, the environment and the community. The ChemClear program arranges for the collection of unwanted chemicals for their appropriate environmental disposal.

Registering to use the ChemClear program

There are six simple steps in using the program;

1. Take an inventory of any unwanted rural chemicals. The inventory should include all identifiable features of the container including label, manufacturer, expiry date, size of container and the remaining quantity of chemical left in the container.
2. Register the inventory for the next collection in your area. Book on; free-call 1800 008 182 or at; www.chemclear.com.au
3. Continue to store your registered chemicals safely and securely.
4. ChemClear will contact you direct to advise the location for retrieval.
5. Prepare chemicals for delivery to collection site.
6. Deliver chemicals.

The cost to use the ChemClear service depends on the chemical to be collected. Group 1 chemicals are collected free of charge under the program. These chemicals are currently registered ag and vet chemicals manufactured by companies supporting the Industry Waste Reduction Stewardship initiative. Group 2 chemicals are those chemicals that are no longer registered, unknown, unlabelled, out of date, or mixed ag and vet chemicals. A fee applies for disposal.

IMPORTANT: USE OF PESTICIDES

Pesticides must only be used for the purpose for which they are registered and must not be used in any other situation or in any manner contrary to the directions on the label. Some chemical products have more than one retail name. All retail products containing the same chemical may not be registered for use on the same crops. Registration may also vary between States. Check carefully that the label on the retail product carries information on the crop to be sprayed.

This publication is only a guide to the use of pesticides. The correct choice of chemical, selection of rate, and method of application is the responsibility of the user. Pesticides may contaminate the environment. When spraying, care must be taken to avoid spray drift on to adjoining land or waterways.

Pesticide residues may accumulate in animals treated with any pesticides or fed any crop product, including crop residues, which have been sprayed with pesticides. In the absence of any specified grazing withholding period(s), grazing of any treated crop is at the owner's risk. Withholding periods for stock treated with any pesticides or fed on any pesticide treated plant matter must also be observed. Animals which test positive for chemical residues (i.e. with readings which exceed maximum residue limits for certain chemicals) at slaughter will be rejected. Pesticide residues may also contaminate grains, oils and other plant products for human use and consumption. Growers should observe harvest withholding periods on the pesticide label and should not assume that in the absence of a withholding period or after the expiry of a withholding period that the plant products will be free of pesticide residues.

Some of the chemical use patterns quoted in this publication are approved under Permits issued by the Australian Pesticides and Veterinary Medicines Authority (APVMA) at the time the publication was prepared. Persons wishing to use a chemical in a manner approved under Permit should obtain a copy of the relevant Permit from the APVMA and must read all the details, conditions and limitations relevant to that Permit, and must comply with the details, conditions and limitations prior to use.

APVMA Review of Endosulfan

Les Davies, APVMA

The use of endosulfan in cotton has significant restrictions. Ensure label directions are adhered to. New information on endosulfan is being considered by the APVMA to determine if further regultory action is warranted in Australia.

Suspension of 2,4-D High Volatile Esters (HVE)

The APVMA has taken the decision to continue the suspension of registration and label approvals of products containing high volatile ester (HVE) forms of 2,4-D, namely the ethyl, butyl and isobutyl esters. These suspensions are in effect until 30 April 2010. This suspension does not affect the availability of 2,4-D low volatile ester or 2,4-D amine formulations.

During the period of suspension new instructions for use apply to all products containing 2,4-D HVEs. Where the new instructions are inconsistent with the label instructions on the container, the new instructions in the Notice must be followed. A summary of the new directions for use are below.

Directions for use for 2,4-D HVEs

Restraints

This is a PHENOXY HERBICIDE that can cause severe damage to native vegetation and susceptible crops such as cotton, grapes, tomatoes, oilseed crops and ornamentals.

DO NOT apply this product between 1 September and 30 April. Use only within the SPRAY WINDOW - 1 May to 31 August.

DO NOT apply this product by air.

DO NOT apply this product:

- In aquatic situations;
- To sugar cane;
- To rights of way; or,
- As a harvest aid/salvage spray.

DO NOT apply more than 800 g 2,4-D active equivalents per hectare (1L/ha).

DO NOT apply if crop or weeds are stressed due to dry or excessively moist conditions.

DO NOT use unless wind speed is more than 3 km /hour and less than 15 km /hour as measured at the application site.

DO NOT apply with smaller than Coarse to Very Coarse spray quality according to ASAE S572 definition for standard nozzles.

DO NOT use if rain is likely within 6 hours.

Within 24 hours of completing a 2,4-D HVE application all users must make and keep a record of each application. The details required include;

- Information about the farm owner and applicator, notification of neighbours and area treated.
- Crop situation and pest details.
- Weather conditions at the application site, such as temperature, humidity, wind speed and direction at the beginning and end of the application.
- Application details including details of the equipment used, ground speed, product rate and application volumes and the use of spray additives.
- A statement saying the information on this record is accurate and correct, followed by the signature of the user.

For convenience, a 2,4-D record-keeping form can be obtained from the APVMA website – www.apvma.gov.au/chemrev/downloads/2_4_d_sprayrecord.pdf. Some suppliers did not respond to APVMA request for data (http://www.apvma.gov.au/products/review/docs/2_4_d_noticesusp.pdf). Thus certain 2,4-D HVE products cannot legally be supplied, even during the winter spray window.

Buffer zones

There must be a buffer zone of 100m between field edges and downwind water bodies, native vegetation and sensitive crops.

Permissible dates of application of 2, 4-D HVEs

Application of 2, 4-D ethyl ester, butyl ester or isobutyl ester must only take place during a spray window between **1 May and 31 August.**

Vic, WA, Tas and Qld currently have mechanisms whereby the use of specific chemicals (including 2,4-D is restricted to geographical areas and/or time zones due to the higher risk for adverse off-target crop or environmental effects. These state restriction on 2, 4-D use may place additional requirements on users within this spray equipment. Users must consult their local authority or department of agriculture to ensure they meet state requirements.

In Queensland any 2,4-D ester formulation, whether high or low volatile, is totally banned in Hazardous Area No 2 covering in general terms the Darling Downs and adjacent areas. In addition in Hazardous Area No. 2 any herbicide containing an ester formulation of picloram can only be applied by a licensed commercial operator holding a distribution permit issued by Biosecurity Queensland. In Hazardous Area No 3 which covers a substantial area surrounding the town of Emerald the spraying of ester formulations of 2,4-D can only be undertaken by a licensed commercial operator holding a distribution permit issued by Biosecurity Queensland. To determine if your property is located in either Hazardous Area you will need to consult the atlas linked to the DEEDI website.

Why have 2,4-d hves been suspended?

The high volatile ester forms of 2,4-D have been suspended because they are likely to have unintended harmful effects on non-target vegetation (crops and native vegetation) and/or aquatic organisms. During the suspension the APVMA required active constituent approval holders to provide new data on the physio-chemical properties of high volatile (short chain) esters. The APVMA has assessed the data provided and has decided to extend the suspension period. Registrants are now required to generate and provide additional environmental fate and environmental effects data for assessment. All 2,4-D products (including HVEs) are currently under a spraydrift review.

Is volatilisation the same as drift?

No. The concepts are often confused. Spray drift refers to the physical movement of spray droplets (and their dried remnants) through the air from the nozzle to any off-target site at the time of application. Volatilisation is a process whereby chemical is applied to a target site but evaporates at the time of application or enters the air stream as a vapour. Once in the airstream, the vapour can be blown in the wind and settle on crops and vegetation many kilometres away.

Are there alternatives to 2,4-D HVEs?

The APVMA recognises that the availability of alternatives is important to users. There are many other herbicides registered for the same uses as the HVEs including several other forms of 2,4-D. The APVMA has been advised that the HVEs are generally cheaper than the alternatives, but the cost benefit of chemicals is not a criterion on which the APVMA can make a decision.

Re-entry periods after spraying

Mark Scott, Industry & Investment NSW

The re-entry period is the period in which a treated field must not be re-entered by unprotected persons after the application of a chemical on a crop. This should be considered as part of the risk assessment. Workers including chippers must be advised on the correct time lapse. It is important to observe the re-entry period when contact between foliage and skin is unavoidable. Herbicides are not included in the tables below as they are generally not as toxic.

Always check the label for the re-entry period

Where no re-entry period is stated, a minimum of 24 hours should be observed or until the chemical has dried upon the crop, whichever is the later (subject to risk assessment), unless appropriate Personal Protective Equipment (PPE) is provided and worn as intended. Caution should be exercised when entering wet crops where chemicals have previously been applied, irrespective of the time lapse between application and re-entry.

Even after the re-entry period has been observed, some PPE may be necessary. Appropriate PPE should be indicated by the risk assessment.

Re-entry periods and the PPE to be worn are found in the General Instructions section of the label, which follows the Directions for Use table. All information will be found under the heading 'Re-entry Period'.

Re-entry periods may vary with formulation and product. The examples given in the table below may not be the same for all products with the active ingredient. Older labels for the same product may have different or no re-entry restrictions. Check the label of the product you are using and follow the directions.

If entry is necessary before the time stated, limit duration of entry and wear cotton overalls buttoned to the neck and wrist (or equivalent clothing), a washable hat, and elbow-length chemical resistant PVC gloves. Clothing must be laundered after each day's use.

Re-entry periods may change or be added to labels as chemicals are re-evaluated. Always read the label.

Refer to Table 15, page 36 for the trade names of active ingredients.

INSECTICIDES WITHOUT LABEL RE-ENTRY PERIODS

Active ingredient	Hazard Classification (WHO 2000–2002)
Spinosad, Bt	Unlikely to present acute hazard in normal use
Dicofol, Propargite	Slight
Alpha-cypermethrin, Pirimicarb	Moderate

COMMON INSECTICIDES WITH LABEL RE-ENTRY PERIODS

Active ingredient	Re-entry period
Abamectin	Under field conditions the spray should be allowed to dry on the foliage before re-entry into treated areas.
Acetamiprid	Do not allow entry into treated areas until the spray deposits have dried.
Amitraz	Do not allow entry into treated areas until the spray deposits have dried.
Amorphous silica	Do not allow entry into the treated area until the spray has dried.
Bifenthrin	Do not re-enter treated field/crop until spray deposits have dried.
Beta-cyfluthrin	Do not allow entry into treated areas until spray has dried.
Chlorfenapyr	Do not allow entry into treated areas for 12 hours after treatment.
Chlorpyrifos	Do not allow entry into treated areas until spray deposits have dried.*
Deltamethrin	Do not allow entry into treated areas until the spray deposits have dried.
Diafenthiuron	Do not allow entry into treated areas for 24 hours after treatment.*
Emamectin benzoate	Do not allow entry into treated areas for 12 hours after treatment.
Endosulfan	Re-entry to treated areas is permitted once the spray has dried.
Etoxazole	Do not allow entry into treated areas until the spray has dried.
Gamma cyhalothrin	Do not allow entry into treated areas until spray has dried
Indoxacarb	Do not allow entry into treated areas until spray has dried.
Lambda-cyhalothrin	Do not allow entry into treated areas until the spray has dried.
Methomyl	Do not allow entry into treated areas until at least 24 hours after treatment.
Methoxyfenozide	Do not allow entry into treated areas until spray has dried.
NPV	Do not allow entry into treated areas until spray has dried.
Profenofos	Do not enter treated areas without protective clothing until 24 hours after spraying.
Pymetrozine	Do not allow entry into treated areas until spray has dried.
Pyriproxyfen	Do not allow re-entry into treated area until the spray has dried.
Spinosad	Do not allow entry into treated areas until spray has dried.
Thiametoxam	Do not allow entry into the treated areas until spray has dried.
Thiodicarb	Do not allow entry into treated areas for 1 day after treatment.

*Check label instructions for cotton chippers.

Withholding periods (WHP) after pesticide application

Mark Scott, Industry & Investment NSW

WHP is the minimum time period from when a pesticide is applied to when the treated area is allowed to be grazed, cut for fodder or harvested.

Some pesticide labels prohibit grazing by livestock or cutting fodder for livestock. Where a product has a no grazing WHP, crops treated with the product should not be grazed prior to harvest. Stock that graze the stubble or are fed by-products of the treated crop may develop detectable residues of the chemical. Growers should read the label and contact the chemical manufacturer for advice on managing chemical residues in stock.

Pesticides users must comply with these instructions or they may be prosecuted under offence provisions of the Pesticides Act 1999 for use of a pesticide in disregard of a label.

WITHHOLDING PERIOD AFTER APPLICATION FOR COMMON CHEMICALS

Active ingredient	Crops not to be harvested for:	No grazing or cutting as stock fodder for:
Insecticides/miticides		
Abamectin	20 days	20 days
Acetamiprid	10 days	Do not graze or cut for stock fodder.
Aldicarb	0	Do not graze or cut for fodder. Do not cotton trash to animals feed
Alphamethrin	14 days	not stated
Alpha-cypermethrin	14 days	not stated
Amitraz	21 days	not stated
Amorphous silica	0	0
Bacillus thuringiensis	0	0
Bifenthrin	14 days	not stated
Beta-cyfluthrin	28 days	not stated
Carbaryl	3 days	1 day
Chlorantraniprole	28 days	Do not allow livestock to graze crops, stubble or gin trash
Chlorfenapyr	28 days	Do not graze or cut for fodder
Chlorpyrifos	28 days	28 days
Chlorpyrifos-methyl	28 days	Do not graze crop or stubble
Clothianidin	5 days	Do not graze or cut for stockfeed. Do not feed gin trash to livestock
Cypermethrin	14 days	not stated
Deltamethrin	7 days	not stated
Dicofol	7 days	Do not graze or cut for fodder
Dimethoate	14 days	not stated
Disulfoton	70 days	70 days
Emamectin benzoate	28 days	Do not feed cotton trash from treated areas to animals
Endosulfan	56 days	Do not feed cotton fodder, stubble or trash to livestock.
Esfenvalerate	7 days	not stated
Etoxazole	21 days	Do not graze treated area or cut treated area for stock feed
Fipronil	28 days	Do not graze or cut for fodder
Gamma-cyhaldthrin	21 days	not stated
Imidacloprid	91 days	Do not graze or cut for fodder
Indoxacarb	28 days	Do not graze or cut for fodder
Lambda-cyhalothrin	21 days	not stated
Methidathion	3 days	not stated
Methomyl	0	Do not graze or cut for fodder
Methoxyfenoziole	28 days	Do not graze or cut for fodder
NPV	0	0
Omethoate	21 days	not stated
Paraffinic oil	1 day	not stated
Parathion	14 days	Do not graze or cut for fodder
Pirimicarb	21 days	21 days
Profenofos	28 days	not stated
Propargite	28 days	Do not graze or cut for fodder
Pymetrozine	28 days	Do not graze crop stubble or gin trash
Pyriproxyfen	28 days	Do not graze on or cut for stock feed. Do not feed treated cotton trash to livestock
Spinosad	28 days	Do not graze or cut for fodder
Thiamethoxam	28 days	Do not graze or feed cotton trash to stock
Thiodicarb	21 days	21 days
Growth regulator and defoliant chemicals		
Dimethipin	7 days	7 days
Endothal	1 day	Do not graze
Ethephon	7 days	Do not graze
Ethephon + cyclanilide	7 days	Do not graze
Mepiquat	28 days	Do not graze
Paraquat + diquat	7 days	1 day
Sodium chlorate	0	0
Thidiazuron	0	Do not graze or cut for fodder

The WHP given may not be the same for all products with that active ingredient. Always check the label.
Refer to Table 15 for the trade names of active ingredients.