Pesticide application to green beans

All major green bean production regions in Queensland and Australia need to apply insecticides, fungicides and herbicides to manage insects, diseases and weeds in fresh market or processing bean production. Insects, diseases, weeds and plant viruses can damage all stages of green bean growth, though the flowering and pod development stages are critical, as damaged pods can not be marketed.


Figure 1. Air-assist boom sprayer forcing droplets into the crop

A range of ground-based hydraulic and air assisted spraying equipment is used in most Queensland production areas. When ground access is difficult (extended wet periods) aircraft and helicopters are occasionally used. Although choice of equipment plays a significant role in the effectiveness of any spray application, plant architecture, water volume and ground speed are also significant factors in good spray coverage, particularly on the pods.

Unfortunately, only small proportions of spray released above the plants will find its way to the flowers and pods - the critical targets. Leaves filter out a large proportion of spray applied from overhead. Equipment that directs spray closer to the pods has a much better chance of getting greater and more even deposits on the pods. There is tremendous scope for improving application techniques with both aerial and ground-based spray equipment.

Consider air-assisted sprayers for spraying beans as they have considerable benefits, including better spray drift management and spray penetration.

Regular maintenance of spray equipment including calibration and assessing spray coverage are essential for effective pest and disease control. A poor spray application outcome leads to a poor crop outcome as damaged or blemished product is unsaleable.

Factors causing poor control

Factors that can cause poor insect pest and disease control include:

- reduced potency of the active ingredient (e.g. breakdown due to exposure to sunlight)
- poor equipment setup or calibration leading to insufficient active ingredient applied or excessive run-off of the product due to the use of too high a water volume
- rain or irrigation following spraying
- poor timing of spray application - spray applied too late because of bad weather (rain or high winds) or poor crop monitoring information
- a mix of incompatible chemicals (cocktails)
- poor water quality
- low humidity
- high temperatures
- resistance to the active ingredient.

Consider all these factors, and whether you are trying to control an insect or a disease, when spraying any crop. A good knowledge of the life cycle and most appropriate application timing to control the pest or disease in green beans is also necessary.

Pesticide application methods

The commonly used pesticide application techniques for targeting insecticides and fungicides to flowers and pods of green beans are discussed below.

To be effective, the equipment used must be able to efficiently apply chemicals to the target. This depends on many factors, including the type of equipment, droplet production, droplet size, amount of water applied, water quality and spray drift.

Aircraft

Aircraft are sometimes used in green bean production, when access by ground rigs is limited, e.g. after wet weather. There is a lot of debate about the effectiveness of aircraft compared with ground-based sprayers. The application volumes used by aircraft when spraying beans may be 40-60 L/ha. These volumes are very high compared with conventional volumes applied by aircraft, such as low volume spraying (20-30 L/ha) or ultra-low volume (ULV) spraying (2-5 L/ha), in cropping systems such as cotton.

The types of nozzles used to deliver this volume are either CP nozzles or the Micronair AU5000. The CP nozzle is a hydraulic nozzle that gives the operator a lot of flexibility. It has multiple orifice sizes (used to alter flow rate) and three angles on a deflector plate (used to alter droplet size).

The Micronair AU5000 is controlled droplet application (CDA) equipment. It consists of a cage that can be made to spin at a range of speeds by altering the pitch on three blades. Faster rotational speeds produce smaller droplets and slower speeds produce larger droplets.

When applying any type of pesticide, remember that:

- Calibrating agricultural aircraft used for spraying is very important
- Reducing swath widths aircraft will improve spray penetration and uniformity of spray deposition across a paddock.
- Ensuring that a precise swath width is flown across a paddock is also critical. This can be achieved by using track guidance (differential global positioning systems, DGPS) or by placing markers in the field so pilots know where to fly each pass.

Ground-based sprayers

Ground-based sprayers used to apply pesticides to beans are:

- over-the-top booms with hydraulic nozzles
- over-the-top booms with hydraulic nozzles and air assistance
- spray directed from the side across multiple rows using an air-shear cannon.

The two main principles used for droplet formation on these booms are hydraulic pressure and air shear. Hydraulic pressure is used to produce droplets from nozzles such as flat fans and hollow cones. Sprayers using the air-shear principle produce droplets by using high velocity air (>200km/hr) to shatter the spray liquid into droplets.

Consider the following when applying any type of pesticide using ground-based sprayers:

- Air-assisted sprayers offer many advantages compared to conventional spray booms. An axial flow fan, usually hydraulically powered, is used to create air that is ducted through a bag attached along the boom. This air is released as an air curtain along the bottom of the air bag.
- The air curtain produced by these sprayers assists in reducing drift and improves spray penetration into the crop canopy. The air curtain also produces turbulence within the crop, which can improve coverage on the undersides of leaves and hard-to-get-at targets, such as bean flowers and pods.
- Spray nozzles are the most important component of your spray boom. They meter the pesticide mixture emitted, and hence affect the application volume and pesticide dose per hectare. The nozzles should also produce droplets of an appropriate size to ensure good coverage. Unfortunately nozzles wear and need replacing. The frequency of replacement depends on the products used through them, the nozzle material and the amount of use.
- Nozzles come in a range of types (e.g. hollow cone, flat fan, twin-fan patterns, air induction and many more). All nozzles are designed for a specific job which often relates to the droplet quality they produce. Off-target drift is a concern making the spray quality of a nozzle particularly important. Spray quality relates to the range of droplet sizes produced, especially at the fine end of the droplet spectrum.
- For the nozzle types listed above, grower experience and research have found that there is a significant improvement when using air assistance rather than no air or conventional hydraulic booms. There is generally a significant improvement when using hollow cones compared to the twinjet or flat fan nozzles with and without air assistance.
- Application volumes vary considerably (100-1300 L/ha) when pesticides are applied to beans. Increasing volumes will not necessarily increase spray deposits on the flowers and pods, especially if the pods are drenched and run-off occurs. This is one situation where more is not better - in fact, it is much worse. Nozzle size and type must be matched correctly to water application volume to ensure effective crop coverage.

Techniques for assessing equipment performance

There are some simple techniques growers can use to assess the efficiency of spray application equipment.

Basic calibration

The first step in assessing the effectiveness of your spray equipment is to determine what volume of water you are applying per hectare and ensuring it is evenly distributed across the width of your boom. Basic boom calibration will identify any short comings in your equipment such as worn, blocked or defective nozzles. Poorly calibrated sprayers with worn or blocked nozzles will cost you money through wasted chemical and poor pest control.

Though replacing a full set of spray nozzles is not cheap it is a very good investment in your cropping future. A well maintained machine is your first step to effective pest, disease and weed control, making regular sprayer calibration a good investment.

Fluorescent dyes for visual observation

Fluorescent dyes that show up under ultraviolet lights are ideal for visually inspecting the spray deposit through a green bean canopy. A pink dye is best for seeing the droplet deposits on flowers and pods. Yellow dyes show up well on leaves but are very hard to see on flowers. An orange dye is also available.

The spray deposit is best viewed on the crop in the field and at night. This requires a special ultraviolet light, attached to a generator or power supply nearby or with its own battery supply. Viewing in the paddock makes it possible to observe the affect on the spray deposit of the interaction between adjacent plants. For instance, leaves from adjacent plants may completely cover the flowers and pods, making depositing spray on these targets nearly impossible. If plants are taken to a dark room, it is difficult to appreciate the influence of neighbouring plants, resulting in a misleading evaluation of the equipment's performance.

Water sensitive paper

Water sensitive paper (WSP) is useful but has many limitations and the interpretation of spray deposit results can be misleading. WSP is produced on small cards of varying sizes, depending on the situation in which they are used. WSP has a yellow surface and, when water-based droplets hit the surface they leave a blue stain. Although WSP is relatively cheap and can be placed almost anywhere in the bean canopy, it should be cut to size to match the target.

Here are some keys points to remember when using water sensitive paper:

- The card surface is sensitive to moisture and high humidity. Take care when handling cards (wear gloves) and store the cards in sealed plastic bags when keeping them for extended periods.
- Spray droplets hitting the card leave a stain that is larger than the actual droplet size. This is called the spread factor. A spread factor of two means that the stain size is twice the true droplet size. For water sensitive paper, the spread factor varies and depends on droplet size. Do not use water sensitive paper to determine droplet size.
- Droplets smaller than 50 µm will evaporate before leaving a stain on water sensitive paper. The card is therefore biased towards collecting larger droplets and will not give a true indication of the fine end of the droplet spectrum.
- To give a true indication of spray deposit and penetration, cards must be the same size and orientation as the target. Simulating bean flowers or pods with WSP is very difficult.

Clay based spray additives for visual observation

Clay based marker additives are now available and allow easy visual assessment of spray coverage in the crop. These additives are mixed with water and turn white when dried on the leaf, allowing easy assessment of coverage and crop penetration.

The basics of spray application

Know your product

Pesticides have different modes of action. A sound knowledge of a pesticide's mode of action will help you understand the application and timing requirements to maximise results.

Contact insecticides kill by direct contact at the time of application, or by the insect contacting the spray residue on the plant surface after application.

Stomach poisons need to be eaten by the pest in a lethal dose for the pesticide to work. Large caterpillars require higher doses than small caterpillars.

After application, pesticides will persist on the plant for varying periods of time before breaking down.

Consider the impact of insecticides on beneficial insects. Broad spectrum products can decimate a range of beneficial insects. Don't underestimate the contribution of beneficial insects in controlling pests. Smart operators choose soft option pesticides and allow beneficial insects to help control pests.

Fungicides can be either protective or curative, that is some will protect against infection while others control an existing infection, read the labels and know your products. Applying an inappropriate product at the wrong stage can cost you a lot of money and lost production.

Herbicide timing is important, is it a pre or post plant product and what weeds does it control?

Know your target

The target will vary from leaves to flowers, pods or even the pests, depending on the plant growth stage. Ultimately, the aim of growing green beans is to produce undamaged pods. Therefore, it is important to control insects and other pests early when they are exposed on the leaves, pods or flowers. Other growth stages, such as seedling emergence and the vegetative growth stage, may be equally important in some production regions.

Spray deposit uniformity affects the ability of insecticides and fungicides to effectively control insect pests and diseases. Several factors influence spray uniformity and distribution, including the:

- application equipment (including nozzle size)
- crop canopy
- target position in the crop.

If the application equipment is not delivering a uniform dose across the paddock, you are wasting your money by over dosing some sections and under dosing others. Blocked or worn nozzles, or even subtle changes in travel speed will contribute to variable application across the paddock.

The crop canopy has a large influence on spray penetration and distribution. Distribution on the plant is very difficult to manipulate when spraying over the top with a boom. The deposit is highest in the top part of the canopy and reduces rapidly as you move down the canopy. Unfortunately, the plant canopy is dense, and the flowers and pods are down in the canopy. A large proportion of the spray volume will be filtered out (blocked) by leaves before getting anywhere near the pods.

Know your equipment

The most expensive sprayer will perform poorly if used inappropriately. Regular calibration of equipment is important, (measuring each nozzles output, replacing worn nozzles and calculating the sprayer output), so the correct quantity of pesticide can be added to the tank. A range of nozzle types are available and each has specific operating requirements, such as pressure, spacing and height, to perform optimally. Controlled droplet application (CDA) equipment and sprayers using the air-shear principle for generating droplets also have specific operating parameters to work efficiently.

Finally, make sure your equipment is cleaned down at the end of each day. Thoroughly flush out sprayers with clean water to prevent a build up of chemicals. When chemicals are changed or spraying is completed at the end of the season, a more thorough clean is required and decontamination may be necessary. For most chemicals, refer to the pesticide label for specific cleaning instructions. The following general procedure may be used:

1. Hose down the inside of the tank and fill to approximately one-third full with water.
2. Operate for 10 minutes with water flushing through nozzles.
3. Drain remaining water.
4. Repeat steps 1, 2 and 3.
5. Remove nozzle tips and screens and clean in detergent solution.
6. Fill tank with water to approximately one-third full and add a cleaning agent if required. Leave overnight and then drain.

Other resources

- Deuter, P, Wright, R, Duff, J, Walsh, B, Napier, T, Hill, L, Dimsey, R & Learmonth, S 2005, *Growing guide: sweet corn grower's guide*, Department of Primary Industries and Fisheries, Brisbane.
- Heisswolf, S, Davis, B, Carey, D, Henderson, C, Walsh, B & Bagshaw, J 2004, *Growing guide: brassica grower's handbook*, Department of Primary Industries and Fisheries, Brisbane.
- Brassica best practice-Integrated pest management ute guide
- McDougall, S, Napier, T, Valenzisi, J, Watson, A, Duff, J, Geitz, G & Franklin, T 2002, *Integrated pest management in lettuce: information guide*, NSW Agriculture, Orange, NSW.

Further information

- An integrated approach to pest management [https://www.daf.qld.gov.au/plants/fruit-and-vegetables/vegetables/green-beans/ipm-for-green-beans/integrated-approach-to-pest-mgt]
- Beneficial insects in an IPM system [https://www.daf.qld.gov.au/plants/fruit-and-vegetables/vegetables/green-beans/ipm-for-green-beans/beneficial-insects-in-an-ipm-system]
- Crop monitoring [https://www.daf.qld.gov.au/plants/fruit-and-vegetables/vegetables/green-beans/ipm-for-green-beans/crop-monitoring]
- Cultural practices in an IPM system [https://www.daf.qld.gov.au/plants/fruit-and-vegetables/vegetables/green-beans/ipm-for-green-beans/cultural-practices-in-an-ipm-system]
- Biological management options in an IPM system [https://www.daf.qld.gov.au/plants/fruit-and-vegetables/vegetables/green-beans/ipm-for-green-beans/biological-mgt-options-in-ipm]
- Chemical management options in an IPM system [https://www.daf.qld.gov.au/plants/fruit-and-vegetables/vegetables/green-beans/ipm-for-green-beans/chemical-mgt-options-in-ipm]