Using precision spraying technology for weed management

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As a broad-acre row crop, cotton is well placed to take advantage of developments in precision agriculture. One of the next major steps in precision agriculture in the cotton industry should be in the area of weed management.

Weeds are a major problem in cotton production. Weed management inputs often cost over $300 per hectare.

Weeds can also directly reduce cotton yields and/or quality through competition for inputs and contamination of cotton lint. Weed infestations can also negatively impact on production by harbouring insect pests or diseases, and reducing cultivation, irrigation and/or harvesting efficiency.

Traditionally, weed management in cotton has relied heavily on the use of residual herbicides applied pre-sowing or at-planting, supplemented by inter-row cultivation, hand chipping and additional in-crop residual herbicides.

Decisions regarding the use of these residual herbicides (products and rates) have been made on a field wide basis, or often on a property wide basis. Weed management in fallows has relied heavily on cultivation and glyphosate herbicide, with some phenoxy herbicide used during the winter months.

A recently-released, weed-activated sprayer which uses video imaging to target weeds. This model is designed for shielded, inter-row spraying.

LOCAL DISTRIBUTION

But unlike insect pests, most weed pests are relatively immobile. Weed seeds generally end up only a short distance from the parent weed (one or two metres at the most), although seed distribution can be modified by influences such as harvesting equipment, slashing and cultivation.

Consequently, weeds normally occur in patches, which correspond to the presence of uncontrolled individual weeds in previous seasons. These patches may persist for many years, where plants continue to emerge from the soil seed bank over a long period of time, or where a few individuals emerge and escape control each season.

Alternatively, these patches may disappear after

only one or two seasons if all individuals are controlled each season and viable seeds do not remain in the soil seed bank for more than one or two seasons.

Typically, cotton growers' response to weed patchiness has been to apply a rate of herbicide that is sufficiently heavy to control most weeds within a field including the heavily infested patches, even though much of the field may only be lightly infested with weeds or may not be infested at all.

But with the commercial advent of precision detection and spray technology, a new era of smarter and better weed management is becoming possible. With the availability of these technologies, cotton growers will be able to identify weed patches and specifically treat weeds in these patches. It will be feasible to apply a low rate of herbicide to a field and increase the rate on known weed patches.

TARGETED APPLICATION

In its simplest form, this technology allows the cotton grower to apply post-emergence herbicides specifically targeted to weeds. The WASP sprayer, which became available in Australia in the 1990s, showed the potential for this strategy. The WASP was set up as a broadacre sprayer that targeted weed patches and medium to large individual weeds.

With these sprayers it was feasible to apply a low rate of herbicide (or no herbicide) to the majority of a field, and to apply a high rate on patches and larger weeds. These sprayers were successfully used in fallows, and frequently resulted in excellent weed control with a saving of up to 90 per cent in herbicide use when compared with a whole field spray.

As well as reducing spray costs, this technology has the potential to reduce the risk of weeds developing herbicide resistance, as it allows herbicide rates to be more closely tied to weed size and allows some of the more expensive alternative herbicides to be used at an acceptable cost.

In a more sophisticated form, the concept has the potential to enable cotton growers to target residual herbicides to weed patches. To achieve this, weed detection sensors need to be linked to a GPS mapping system so that the presence of weeds can be accurately mapped within each field.

This information could be collected from a weed activated spraying system during spraying, but could also be collected during other passes in the

field, from sensors mounted on other equipment such as cultivators, spraying and harvesting equipment. Weed detection during these operations should enable more accurate prediction of weed problems from uncontrolled weeds.

This would be especially true if weed detection sensors were mounted on harvesting equipment. This information on weed populations will need to be integrated and then fed to herbicide application equipment, so that herbicides can be applied to known weed patches. In the case of residual herbicides, these targeted applications could be made weeks or even months before the weeds are apparent.

These weed maps will also allow the development of weed problems (species shifts and the development of herbicide resistant weeds) to be accurately monitored over time, and could be used to predict the development of weed problems before they are of economic significance.

Application of this concept for nutgrass control is already being explored and appears to be very practical. Nutgrass is one of the most serious weeds of Australian cotton production, affecting a large proportion of properties throughout the industry, but it is a very patchy weed, often seriously affecting only a small proportion of any given field.

Nutgrass is best managed with a combination of high rates of glyphosate in-crop and Zoliar applied pre-planting. But this management is complicated by two problems. First, cotton has poor tolerance to glyphosate, which in-crop needs to be applied through a shielded sprayer. Second, Zoliar is relatively expensive, can cause crop damage and needs to be applied and soil-incorporated in autumn or winter prior to weed emergence.

Both these difficulties can be overcome using a weed-activated mapping and spraying system (WAMS), such that herbicide need only be applied to nutgrass patches (previously identified and mapped in the case of Zoliar) — reducing cost and eliminating the risk of herbicide drift to crop areas where nutgrass is not present.

A further factor in the equation is soil type. The efficacy of many residual herbicides is related to factors such as soil pH and soil clay content. Maximum safe herbicide rates on a light, sandy soil may be as little as half the maximum safe rate on a heavier soil.

Yet both heavy and light soil can occur within a single field. Ideally the herbicide rate should

vary within a field in response to changes in soil type where these occur. Field maps of soil characteristics could also be incorporated into the program controlling application rates.

As weed detection technology improves, it should be possible to distinguish between some of the more common weed species, so that weed maps could identify not just the presence of weeds but the distribution of different species within a field. If multiple tanks and booms were then fitted to a spray rig, it would be feasible to apply different herbicides in a single pass, with herbicide rates and combinations being managed to give best control of all the weeds in a field.

MANY ADVANTAGES

The advantages of developing a weed activated mapping and spraying system are many. Such a system would address many of the problems currently encountered in cotton production.

These problems include the cost of herbicides, the negative effect of herbicides on cotton and the environment, and the development of herbicide resistant weeds. Most of the herbicides currently used in cotton are not completely safe to the cotton plant, especially at the maximum use rate.

By using mapping to target weed patches with high herbicide rates and reduce rates over the majority of a cotton field, this technology will improve cotton yield and earliness, and reduce the amount of herbicide used.

This overall reduction in herbicide use will reduce costs and reduce the negative impact of herbicides on cotton and the environment. More appropriate spray selection will also go a long way to reducing the risk of herbicide resistant weeds developing.

While the development of a fully integrated, weed activated mapping and spraying system is in the future, technology is advancing rapidly and components of this system will soon become available. Work on developing components of this system is already underway, with developments such as the Rees unit, integrating weed detection, spraying and GPS mapping, and the weed mapping and variable spray rate work undertaken by Jim Pratley’s group at Wagga.

Funding for a PhD position based at Narrabri to work on integrating the various components of the system has also been made available through the Australian Cotton Cooperative Research Centre. Now we just need a student to undertake the work. When it is all put together, best practice weed management will be a reality.