Evaluating the power of precision

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Growers shifting to narrow row spacing for winter crops are increasingly asking whether precision seeding technology can be applied to crops such as cereals and canola to reduce seed costs and improve crop establishment.

Precision planters with seed singulation metering systems have been used in horticulture and summer cropping systems for many years but are less commonly used to plant winter crops in the Australian wheat belt.

Precision planters are widely used in horticulture and to sow wide-row broadacre crops such as corn, cotton, sorghum, soybeans and sunflowers because plant spacing and uniform timing of emergence is essential for achieving maximum yield, particularly in sunflowers, corn and cotton.

The minimum row width that can be achieved with a precision planter is determined by the width of the seed metering units on the bar, so precision planters are appropriate for planting crops that require low plant densities or wide rows – anything from 240mm to 735mm.

Direct-drill seeders can achieve narrower rows because the seed is metered centrally using a mass flow metering device, then delivered to each furrow opener via long feed tubes, which allows furrow opener units to be spaced closer along the tool bar than is possible with a precision planter.

Precision planters and seed singulation systems are less commonly used for narrow-row broadacre crop types, particularly winter crops grown in the Australian wheat belt. Yield of these crops is not as strongly impacted by uniform plant spacing, so the benefits of precision planting are not as evident in cereal crops as they are in row crops.

However, the advantages of precision planting, such as accurate seed placement, uniform emergence and reduced disease pressure, also need to be considered.

Precision planters can be used to plant beans, vetch, chickpeas and canola and in some cases can provide benefits over direct drill air seeders/planters in narrow-row broadacre crops.

In Western Canada, many growers are keen to trial precision planters for planting their canola crops because of the high cost of hybrid canola seed and uneven emergence patterns, and growers who produce wide-row crops and canola are questioning whether they need two planting machines or can sow their canola with a precision planter.

PRECISION PLANTING HAS CLEAR BENEFITS IN CROPS SUCH AS CORN BUT THE PICTURE IS LESS CLEAR WHEN IT COMES TO WHEAT.

Issues

There are good reasons precision planters are not used to plant all crop types. In some cases, particularly with canola, precision seed placement and lower seeding rates can result in crops lodging or leaning over, This can create inefficiencies during windrowing and/or harvest.

Another factor to consider is the risk of low plant establishment. Planting crops at slightly higher seeding rates than is necessary to achieve the target plant population often provides a buffer against poor crop establishment.

There is also the question of whether precision planting compromises early weed competition, which is important for Australian winter crops. Greater spacing between plants will increase the time taken for the crop to develop a full canopy and out-compete weeds. If weeds have more time and space to grow, any yield increase or cost saving will need to be greater than any yield loss or other cost of increase due to weed pressure.

Studies across a range of environments have found that, in wheat crops with yield potential less than 3.5t/ha, increasing row spacing up to 30cm has no effect on yield. However, in high-yielding environments there is likely to be a yield penalty associated with wider row spacing.

Pulses are more tolerant of wider row spacing than cereals. In particular, the yield of faba beans increased with wider row spacing in trials in SA during 2006. This research found faba beans sown on 36cm row spacing yielded 24% more than beans in rows 18cm apart, with 20% higher yield from beans sown on 54cm row spacing. (Grains Research and Development Corporation 2011). The yield increase was attributed to increased podding at the wider row spacings.

This study also found that faba beans sown on wide row spacings use less water during early development stages than those in closer-spaced rows, so there is more soil water available for flowering and grain fill, which contributes to the higher yield potential.

It is not clear if the use of precision planters and seed singulation in cereal and pulse crops will have the same effect as wide row spacing.

Technologies

Precision planters commonly use single or double discs to open the furrow, with gauge wheels on both sides of the opening device to increase seed depth accuracy and separate seed placement from furrow closing and soil firming. Other planting components such as seed firmers, furrow closing devices and residue managers can be used with precision planters.

Many of the precision planters used for corn and other summer crops do not have the capability to apply granular fertiliser during the seeding pass, so a second pass would be required to apply a solid starter fertiliser at seeding.

Some newer precision planter models do have a granular fertiliser option, which involves use of a tine opener that allows fertiliser to be placed in the furrow ahead of the seed, enabling one-pass seeding.

What is it?

Precision planting or seeding involves metering, delivering and placing single seeds in the furrow at uniform depth and equal spacing. This enables the number of seeds and plants per linear meter to be determined at seeding.

A precision planter differs from a direct-drill air seeder in that it has a precision seed metering system that enables seed 'singulation'. Under this system every seed is handled individually at the point of delivery, unlike direct-drill seeding, which relies on mass flow seed metering devices and results in seeds being randomly placed in the furrow. Figure 2 and Figure 3 illustrate the differences in seed placement using direct drill seeding and a precision planter.

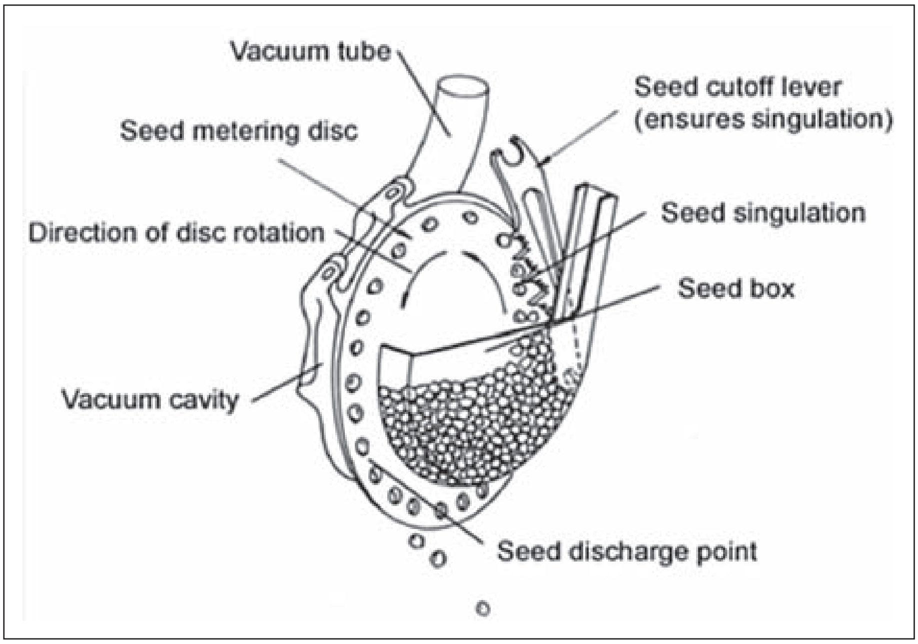

FIGURE 1: A DIAGRAM OF A VACUUM DISC TYPE PRECISION SEED METER (MURRAY ET AL. 2006).

Benefits

The benefits of precision planting when sowing row crops such as corn and sunflowers are clear because there is a yield penalty if uniform plant spacing and emergence are not achieved.

Precision planting reduces seed mortality rates because each seed is singulated and positioned in the furrow. Seedlings from seeds sown with this level of precision have a greater chance of survival because they face less competition from other crop plants for moisture, nutrients and light.

It is generally accepted that precision planters achieve 75-90% emergence rates, as opposed to some direct-drill machines (such as John Deere 50/60/90-series single disc drills) which have 50-85% emergence rates. Higher emergence means lower seeding rates are required to achieve the required plant numbers.

A reduction in seeding rate will reduce seed costs, which can be substantial, especially when seeding hybrid varieties.

Since the plants in precision-planted crops are evenly spaced there is more airflow through the crop canopy and lower humidity in the crop. This can improve pollination, reduce the risk of foliar diseases and lift yield potential in some environments. Uniform emergence and crop development also means increased efficacy and less crop damage from fungicide and herbicide applications.

Mechanisms

Different precision planters use different types of seed metering devices to achieve seed singulation. The main point of difference between them is how individual seeds are separated from the bulk of seeds in the seed box.

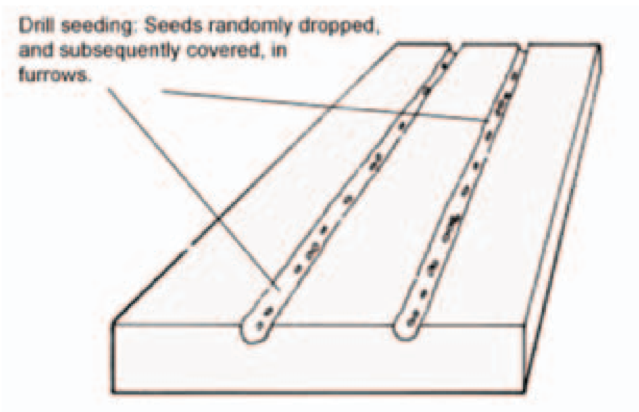

FIGURE 2: SEED PLACEMENT USING A DIRECT DRILL PLANTER (MURRAY ET AL. 2006).

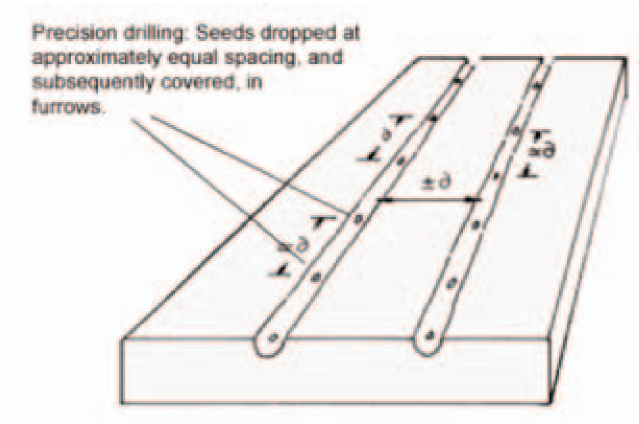

FIGURE 3: SEED PLACEMENT USING A PRECISION PLANTER (MURRAY ET AL. 2006).

TABLE 1: TYPES OF PRECISION SEED METERING DEVICES.

Type of precision seed metering device	How it works
Plate	Uses a horizontal, inclined or vertical plate with evenly-spaced holes or indents on it to single out and transport individual seeds to the delivery tube. The holes/indents are matched to seed size, so the seed size must be uniform and plates need to be changed for crops with different seed sizes.
Belt	Similar to the plate type. A conveyor belt with evenly-spaced holes singles out seeds and transports them to the delivery tube.
Vacuum disc	A fan creates a vacuum which sucks individual seeds to holes in a rotating disc. The holes are smaller than the seed size, so seeds are held in place until they are knocked off the disc or released by a change in air pressure. Scrapers or seed cutoff levers are used to remove any 'doubles' (two seeds vacuumed to one hole) from the rotating disc. A change in air pressure at the base of the device allows the seed to drop from the rotating disc and enter the seed delivery tube.
Pressurised drum	Seeds enter a pressurised, rotating drum that has a series of equally spaced holes that are smaller than the seed size. The air pressure pushes and holds seeds against the holes. The drum rotates past a cut-off brush that knocks off any excess seeds. Each singlulated seed remains held to a hole in the drum until it reaches a position where the air pressure is reduced and the seed drops into a discharge manifold.
Finger (plateless)	Multiple seeds are collected from the bulk seed using spring-loaded, cam-operated fingers that rotate vertically. The seed is held between the fingers and an indented backing disc. As the fingers rotate around the stationary backing plate the seed moves over the indents and excess seed is dropped, resulting in seed singulation. Single seeds are then deposited through a hole in the backing plate onto a conveying system that transports them to the delivery system.

PRECISION PLANTER DEMONSTRATIONS

During May 2015, there will be a number of demonstration sites planted using a new NDF seed-singulation system.

A new NDF seed-singulation system will be demonstrated in SA during May.

Information regarding location and times of the demonstrations will be available on the SANTFA website and post-emergence field days will be held once the crop is up.

The project is funded through the National Landcare Program Innovation Grant program.

Table 1 summarises the main singulation mechanisms and how they work.

The most commonly used seed metering device used in precision planters is the vacuum disc. Figure 1 shows how the vacuum disc works to single out seeds from the seed box and deliver them to the seed tube.

Negative air pressure creates a vacuum that sucks seeds to the small holes in the vertical disc. The system does not rely on seeds falling into cells or holes, like a plate type metering device, so the hole size on the disc does not need to be matched to the seed size. This means crops with different seed sizes can be sown with the same discs, as long as the seeds are not small enough to fit through the holes.

The air pressure (vacuum) must be sufficient to hold the seed to the rotating disc but still allow 'doubles' to be removed as they move past the seed cutoff lever, so the air pressure can be adjusted to match the seed being sown.

References:

Grains Research and Development Corporation 2011, ***Crop Placement and Row Spacing Southern Fact Sheet***, GRDC, Canberra.

Murray, J R, Tullberg, J N and Basnet, B B. 2006. ***Planters and their components; types, attributes, functional requirements, classification and description.*** ACIAR Monograph No. 121.

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