Effect of row spacing, nitrogen and weed control on crop and weed in a wheat - lupin - canola rotation

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Key messages

- Wide rows reduced establishment in all crops. Wide rows also reduced grain yield of wheat but grain yield of lupin and RR canola remained unaffected by row spacing.
- Alternative herbicides provided better level of weed control in wheat and lupin but weed control in canola was excellent. Management factors including rotation of crops and herbicides from 2012 to 2014 reduced annual ryegrass by 99.5%.
- Flexi N reduced canola establishment but increased crop vigour and grain yield of RR canola compared to Urea N.

Aims

Proximity factors such as row spacing changes the spatial distribution of crop plants and alters the intensity of crop-weed competition. Narrow row spacing is likely to facilitate crop plant with greater competitive ability than weeds, compared to wide row spacing. Management of nitrogen (N) may greatly affect the growth of weeds. While weeds may have easy access to N applied on the soil surface at sowing time, strategic N placement may maximise the access of crop plants to N compared to weed plants such as annual ryegrass. This study was undertaken to manage the high density annual ryegrass population by N placement and application of new alternative herbicides under normal and wide row spacing in a wheat-lupin-canola or lupin-wheat-canola rotation at Cunderdin WANTFA site, Western Australia (WA).

Method

To complement research and development of ACIAR funded collaborative project in Bangladesh on conservation agriculture between Murdoch University and Department of Agriculture and Food, Western Australia, a rotation trial was conducted from 2012 to 2014 at Cunderdin, Western Australia.

Treatments

Table 1 shows the rotations, herbicides, row spacing and N rates and sources. Wheat plots of 2012 were rotated by lupin crop in 2013 while lupin plots of 2012 were rotated by wheat crop in 2013 season. Roundup Ready® (RR) canola crop was grown in 2014 season in all wheat and lupin plots of 2013 (Table 1).

Triflur X® (trifluralin 480 g/L) at 2 L/ha and Sakura® (pyroxasulfone 850 g/kg) at 118 g/ha were applied in wheat crop to control weeds. Gesatop® Granules (simazine 900 g/ha) at 1 kg/ha and Outlook® (dimethenamid-P 720 g/L) at 1 L/ha were applied in all lupin crops in 2012 and 2013. Wheat and canola crops received three nitrogen treatments viz., N_{25} (25 kg N/ha drilled in front of tynes as urea (46% N)), N_{50} (50 kg N/ha drilled in front of tynes as urea) and Flexi N_{50} (50 kg N/ha, as urea-ammonium nitrate (32%N)) placed below crop seed at sowing time. Roundup Attack® (glyphosate 690 g/L) was applied at 900 g/ha in 2014 RR Canola at 2- and 5-leaf stages. Double super (17.5% P) and Flexi N treatment were applied at sowing time in all crops. The trials were conducted in a randomised complete block design with four replications using a unit plot of 20 m by 2 m.

Data analysis

Data were subjected to ANOVA using Genstat 15th Edition. Means were separated by LSD.

Table 1. Crop rotation and, row spacing, herbicides and nitrogen rates as applied in each crop within each rotation from 2012 to 2014 season at Cunderdin, Western Australia. Crops in the alternative rotation received the same treatments as in the main rotation in all seasons.

Management	2012	2013	2014
Rotation 1	Wheat	Lupin	RR Canola
Row spacing (cm)	(i) 22 (ii) 44	(i) 22 (ii) 44	(i) 22 (ii) 44
Herbicide	(i)Trifluralin (H1) (ii) Sakura® ((H2)	(i) Simazine (H1) (ii) Outlook® ((H2)	Roundup Attack® ((glyphosate)
Nitrogen (kg N/ha)	(i) 25 as Urea, (ii) 50 as Urea (iii) 50 as Flexi N	Nil	(i) 25 as Urea, (ii) 50 as Urea (iii) 50 as Flexi N
Rotation 2	Lupin	Wheat	RR canola

Results

The main weed species was annual ryegrass (resistant to Group A herbicides) with an average of 1200 plants/m^2 before spraying any herbicides in 2012 season.

Weed control

In 2013 season, 60% annual ryegrass was controlled by simazine at 2 L/ha and 80% by Outlook® at 1 L/ha in lupin crop, as compared to 60% by trifluralin at 2 L/ha and by 68%by Sakura® at 118 g/ha**.** Weed control in lupin crop in 2012 was similar to 2013 season but weed control in wheat crop was very poor in 2012. As a result, wheat crop in 2012 was sprayed out to reduce the seed production of annual ryegrass.

Despite application of alternative effective herbicides in 2012 and 2013 seasons, 70 to 140 plants/m^2 of annual ryegrass were still surviving in 2013 lupin crop and 115 to 126 plants/m^2 of annual ryegrass were surviving in 2013 wheat crop (Figure 1). So, we decided to grow a RR canola crop as the third crop in both the rotations in 2014**.**

In RR canola in 2014, annual ryegrass was controlled by 99% to 100%, with 5 to 9 young and week seedlings/m^2 of annual ryegrass emerged at the flowering stage of RR canola (Figure 1).

Flexi N_{50} had higher initial weed plants than N_{25} or N_{50} in wheat crops, indicating a possible stimulation of annual ryegrass emergence by Flexi N. The annual ryegrass plant number was lower in 22 cm row space than 44 cm under flexi N.

As result of rotation of herbicides with the rotation crops from 2012 to 2014, this Group A-resistant annual ryegrass that had 1200 plants/m^2 before any herbicide application in 2012 and 400 to 800 plants/m^2 in 2012 crops, was reduced to 70 to 140 plants/m^2 in 2013 lupin, to 115 to 126 plants/m^2 in 2013 wheat crop, and to only 5 to 9 plants/m^2 in RR canola crop in 2014 (Figure 1). This was a 99.5% reduction in annual ryegrass density at the end of this trial.

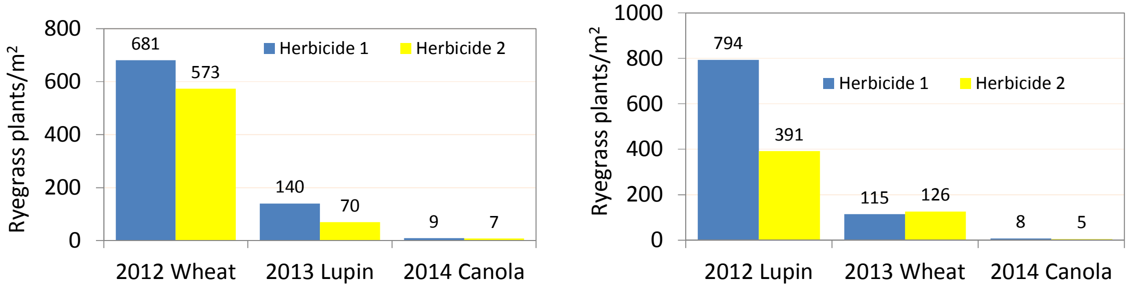

Figure 1. Effect of crop rotations and rotations of herbicides on the population dynamics of annual ryegrass from 2012 to 2014 in wheat-lupin-RR canola (Rotation 1,left graph) and lupin-wheat-RR canola (Rotation 2, right graph) at Cunderdin, Western Australia. Herbicide 1 was simazine for lupin and trifluralin in wheat while herbicide 2 was Outlook® for lupin and Sakura® for wheat crop. The only herbicide used in RR canola was Roundup Attack®.

Crop establishment

Row spacing of 44 cm reduced crop establishment by 20% to 25% compared to 22 cm rows. Flexi N (N_{50}) reduced canola establishment both in 22 cm and 44 cm rows in 2014 canola crop compared to Urea (N_{25} or N_{50}) (Figure 2). However, flexi N increased crop vigour of canola by 15%.

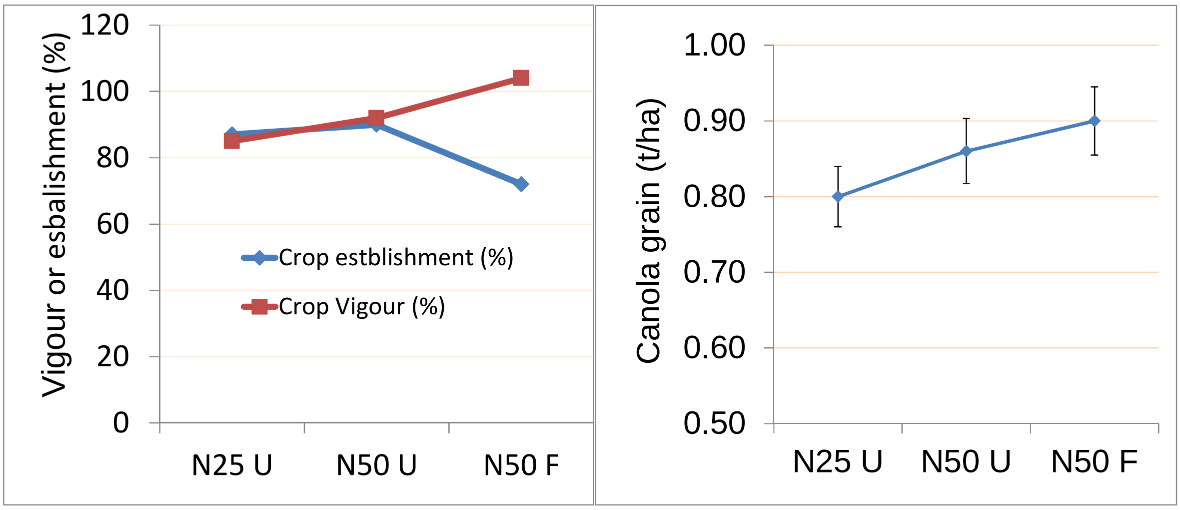

Figure 2. Effect of nitrogen rate and sources on establishment, vigour and grain yield of canola in 2014 at Cunderdin, WA. N25 U = 25 kg N/ha as urea; N50 U = 50 kg N/ha as urea; N50 F= 50 kg N/ha as Flexi N.

Grain Yield

Increases in row spacing from 22 cm to 44 cm reduced wheat yield by 29% in 2013 season while row spacing did not influence lupin grain yield in either season, suggesting that unlike wheat, lupin plant growth is plastic to produce vegetative growth and yield. Sakura® was more effective on weeds in wheat crop than trifluralin while Outlook® was more effective in lupin crop than simazine, leading to an increase in grain yield of wheat and lupin in both seasons. The extent of wheat grain yield increase due to Sakura® was greater in 44 cm than 22 cm (data not presented).

Row spacing of 44 cm reduced canola crop establishment by 20% to 25% compared to 22 cm rows. Flexi N further reduced canola establishment both in 22 cm and 44 cm rows in 2014 but increased crop vigour by 15% and grain yield by 12% in RR canola in 2014 season (Figure 2).

Conclusion

Wide rows (44 cm) reduced crop establishment by 20% to 25% in all crops compared to 22 cm row spacing. Wide rows also reduced grain yield of wheat but grain yield of lupin and canola remained unaffected by row spacing. Alternative herbicides (Sakura® and Outlook®) provided better level of weed control (68% to 80%) in wheat and lupin but weed control in canola was 99 to 100%. Flexi N banded below crop seed at sowing time of canola reduced canola establishment by 25% but increased canola crop vigour by 15% and grain yield by 12%. Flexi N also increased emergence of ryegrass (more in 44 cm rows than 22 cm rows) than urea N. Management factors including rotation of crops and herbicides reduced annual ryegrass by 99.5%. Once annual ryegrass burden has reduced to a low level, it is highly important that annual ryegrass should be maintained at a low level to sustain grain productivity.

Key words

Resistant ryegrass, crop rotation, herbicide rotation, row spacing, Flexi N, weed control, grain yield, ryegrass population dynamics.

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