Broadleaf weed control in chickpea – Dalwallinu 2021

Dr Harmohinder Dhammu, Research Scientist and Mark Seymour, Senior Research Scientist, DPIRD

Key Messages

- Chickpea varieties - CBA Captain and Neelam showed similar competitiveness against broadleaf weeds. Competition of RR canola (mimicked wild radish) and broad leaf weeds with these varieties to maturity accumulated 4.2t/ha dry biomass and reduced chickpea seed yield by 35% compared to weed free plots.
- Majority of the herbicides and herbicide mixtures registered 95-100% weed control efficiency against RR canola and broadleaf weeds and yielded on par with weed free plots. Application of flumetsulam 800 at 25g/ha at 4-5 node stage of chickpea reduced canola/weed biomass by 69% and increased chickpea seed yield by 25%.
- Incorporated by sowing application (IBS) of herbicides/mixtures appeared safer than their post-seeding pre-emergent application (PSPE). IBS application of fomesafen, flumioxazin, terbuthylazine + isoxaflutole, and simazine + diuron + isoxaflutole had no significant negative effect on root nodules of CBA Captain.

Aim/s

To compare two chickpea varieties for their competitiveness against broadleaf weeds and evaluate efficacy of new and old herbicides and herbicide mixtures for broadleaf weed control in chickpea.

Background

Weeds are one of the main production problems in chickpeas and can reduce seed yield and quality significantly. New chickpea variety CBA Captain has better plant vigour and height than WA standard variety Neelam. Taller varieties with vigorous plant growth have been reported to be more competitive against weeds. Reflex®(fomesafen), Terrain (flumioxazin)® and Palmero® TX (terbythylazine + isoxaflutole) have recently been registered as pre-emergent herbicides in chickpeas for broadleaf weed control.

Table 1: Trial Details

Trial Location	Brad McIlroy, Pithara/Dalwallinu (GPS: -30.3801406, 116.6683540)
Plot size & replication	1.8m centres x 10m sown x 3 replications, Criss-cross/split plot design
Soil type	Loam/Clay loam
Paddock rotation	2020 - Oats, 2019 - Wheat, 2018 - Wheat
Sowing date	12/05/2021
Sowing rate	CBA Captain 140 kg/ha and Neelam 90 kg/ha and target density was 45 plants/m^2.
Fertiliser	Superphosphate 100kg/ha, (9.1P, 10.5S, 20.0Ca), applied at seeding
Seed treatment	The seed was treated with 200mL/100kg seed thiram (360g/L) + thiabendazole (200g/L). TagTeam® inoculant (Group N) at 5 kg/ha was applied at sowing.
Herbicides, Insecticides & Fungicides	Propyzamide 500 at 1 L/ha on 11/5/21, chlorothalonil (720g/L) at 1.5L/ha on 8/6/21, clethodim (240g/L) 0.33L + buthroxydim (250g/kg) 180g/ha on 5/08/21, and alpha-cypermethrin (100g/L) at 0.16L/ha on 4/10/21.
Harvest Date	29/11/2021

Treatments

Main plot herbicide treatments

Plus, and minus post-emergent Flumetsulam 800 (e.g., Broadstrike®) at 25 g/ha at 4-5 chickpea node stage across sub-plot treatments.

Table 2: Sub-plot herbicide treatments

NO	Herbicides	Product rate/ha	Timing
1	Untreated Control (Captain)		
2	Untreated Control (Neelam)		
3	Weed Free (Captain) - Simazine fb Isoxaflutole	835 g fb 100 g	IBS fb PSPE
4	Weed Free (Neelam) - Simazine fb Isoxaflutole	835 g fb 100 g	IBS fb PSPE
5	Fomesafen 240 (e.g., Reflex®)	1.5 L	IBS
6	Fomesafen 240	1.25 L	PSPE
7	Fomesafen fb isoxaflutole 750 (e.g., Balance®)	1 L fb 100 g	IBS fb PSPE
8	Fomesafen + isoxaflutole	1 L + 100g	PSPE
9	Fomesafen + isoxaflutole + Metribuzin 750	1 L + 100g + 180 g	PSPE
10	Fomesafen + simazine 900	1L + 835 g	IBS
11	Fomesafen + terbuthylazine 750	1L + 1 kg	IBS
12	Fomesafen + diuron 900	1 L + 835 g	IBS
13	Flumioxazin 500 (e.g., Terrain®)	180 g	IBS
14	Flumioxazin + simazine 900	180 g + 835 g	IBS
15	Flumioxazin fb isoxaflutole + metribuzin 750	1 kg fb 100 g + 180 g	IBS fb PSPE
16	Simazine900 + isoxaflutole 750	835 g + 100 g	IBS
17	Terbuthylazine 750 + isoxaflutole 750	1 kg + 100g	IBS
18	Simazine 900 + isoxaflutole 750	835 g + 100 g	PSPE
19	Terbuthylazine 750 + isoxaflutole 750	1 kg + 100g	PSPE
20	Simazine 900 + isoxaflutole + metribuzin	835 g + 100 g + 180 g	IBS
21	Simazine 900 + isoxaflutole + metribuzin	835 g + 100 g + 180 g	PSPE
22	Simazine 900 + diuron 900 + isoxaflutole	835 g + 333 g + 100 g	PSPE
23	Cyanazine 900 (e.g., Bladex®) fb isoxaflutole	1.1 kg fb 100 g	IBS fb PSPE
24	BADPI21	200 mL	IBS
25	REDPI21	1.25 kg	4-5 nodes

Cyanazine 900, Diuron 900, flumioxazine 500, fomesafen 240, isoxaflutole 750, metribuzin 750, simazine 900 and terbuthylazine 750 formulations were used. IBS = Incorporated by sowing, PSPE = Post seeding pre-emergent, fb = followed by. Terbuthylazine 750g + isoxaflutole 75g/kg = Palmero®TX 1Kg. Untreated control and Weed Free plots of CBA Captain and Neelam were paired plots in all three reps.

- **Treatments application dates:** IBS: 11 May 2021, PSPE: 13 May 2021 and 4-5 chickpea node stages: 16 June 2021.
- **Herbicide treatments application machinery:** A Spray rig fitted with air induction nozzles (Teejet AIXR110-02) calibrated to deliver 100L/ha water volume was used.
- **Canola seed spreading:** The trial site had very low weed burden, so to achieve trial objectives and mimic wild radish, Roundup Ready® canola (DG408RR) seed was spread on soil surface in each plot before application of IBS treatments and trial seeding aiming at 3-5 plants/m^2.
- **Trial seeding and soil moisture:** A cone-seeder fitted with knifepoints and press wheels was used for seeding chickpea at 5 cm depth. There was very low level of stubble present in the paddock. Gravimetric soil moisture (on dry weight basis) at the time of seeding at 0-10 cm and 10-20 cm depth was 15.4% and 19.4%, respectively.
- **Canola/weed counts and dry weight:** In herbicide treatment plots, canola and weed count on 5 July and 21 Oct and weed biomass cut on 21 Oct were done from the whole plot (9 m^2) area. However, in untreated control plots first count on 5 July was on whole plot basis, but on 21 Oct, the count and biomass cut were from 0.5 m x 0.75 cm quadrat per plot. The canola/weed count was converted to number/m^2 and dry weight to kg/ha.
- **Herbicides' effect on nodulation:** To determine the effect of 5 selected herbicide treatments (including untreated control) on nodulation, 20 CBA Captain plants at early podding stage were dug very carefully from each replicated treatment plot on 17 September 2021. The plant roots were assessed according to 0 to 8 nodule assessment scale as described by Howieson et. al. (2016), where 0 =no nodules and 8 = extremely abundant nodules.

Table3: Soil Composition

Depth (cm)	pH ($CaCl_2$)	Col P (mg/kg)	Col K (mg/kg)	S (mg/kg)	N (NO_3) (mg/kg)	N (NH_4) (mg/kg)	EC (ds/m)	OC (%)
0-10	7.1	22	730	5.3	11	1	0.156	1.09
10-20	7.5	11	661	8.9	10	< 1	0.178	0.92
20-30	7.0	7	542	13.3	7	1	0.238	0.59

Table 4: Monthly Rainfall (mm) at Dalwallinu (Source: BOM Dalwallinu station - 8297).

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Apr-Oct	Annual
2021	1	33	115	39	80	34	114	26	5	35	44	2	334	529
Average	22	15	28	14	36	35	51	40	22	13	11	12	211	299

Results and Discussion

The trial was sown into moist soil following 40mm of rainfall in the week prior to seeding. Chickpea plant establishment was excellent and on average it was 74 plants/m^2 as compared to the target density of 45 plants/m^2.

Effect of Chickpea varieties on suppression of canola/weeds (Table 5)

Untreated control plots recorded 5 canola plants/m^2 on 5 July (7 weeks after sowing) which increased to 14 plants/m^2 by 21 Oct. Weed count on 21 Oct had 90% proportion as canola plants and the remaining 10% of the weeds were wild radish, cape weed, doublegee and marshmallow. On average, uncontrolled weeds throughout life cycle of the crop produced 4.2t/ha dry biomass and reduced seed yield of chickpea by 35% as compared to weed free plots.

The results indicate that CBA Captain and Neelam's ability to compete against weeds was on par in this trial as both varieties recorded similar canola/weed numbers and their dry weight. Resultant yield loss of both varieties was also similar - around 35%. CBA Captain grew significantly taller (68cm) than Neelam (60cm), but Neelam produced significantly greater number of branches per plant (3.4) than CBA Captain (2.4). Contribution of chickpea plant characters like height, branching, vigour etc in generating crop competition against locally important weeds need to be analysed in detail. This will help breeders to breed chickpea varieties that are more competitive against weeds.

Table 5: Chickpea varieties effect on weed number, weed dry weight and chickpea seed yield.

Weed treatments	Chickpea varieties	Weeds/m^2 5 July 2021	Weeds/m^2 21 Oct 2021	Weed Dry Weight (kg/ha) 21 Oct 2021	Chickpea Seed Yield (kg/ha)	Yield loss (%) over weed free
Weedy	Captain	5 b	14 b	3850 b	687 a	34.9
	Neelam	5 b	14 b	4563 b	709 a	35.3
Weed Free	Captain	0 a	0 a	0 a	1056 b	
	Neelam	0 a	0 a	0 a	1095 b	
lsd (0.05)		-	-	-	313	-

On an average weed count and dry weight on 21 Oct 2021 had around 90% of proportion canola plants and the remaining 10% were wild radish, cape weed, doublegee and marshmallow weeds. Weed count per metre square and dry weight are back transformed values of log link and log (weeds dry weight+1) data transformations, respectively. Figures followed by same letters are not significantly different.

Effect of herbicides on canola/weeds and CBA Captain chickpea (Table 6 and 7)

Application of flumetsulam 800 at 25g/ha did not reduce canola and weeds number/m^2 but reduced weed dry biomass (69%) and canola plant height (19%) significantly resulting in chickpea seed yield improvement by 25% as compared to no flumetsulam use (Table 6). Interaction of flumetsulam with pre-emergent herbicides for weed dry weight and chickpea seed yield was not significant (Table 7). Flumetsulam is the only registered and available in the market post-emergent weed control option for chickpeas. These results are in line with flumetsulam (e.g., Broadstrike®) herbicide label which states that it can reduce group B herbicide susceptible wild radish's biomass by 50-70% and plants may still set viable seeds.

All pre-emergent (pre-em) herbicide treatments and REDPI21 applied post-em reduced canola/weed numbers and their dry biomass significantly. Majority of the treatments registered weed control efficiency (WCF) in the range of 95-100%. Flumioxazin (e.g., Terrain) and BADPI21 applied before seeding, and formesafen 240 at 1.25L/ha applied PSPE recoded weed control efficiency between 91-95%.

Interestingly, new herbicides like fomesafen and flumioxazin either alone and in mixture with other herbicides had a few canola or other weeds survive, whereas simazine and terbuthylazine in mixture with isoxaflutole, metribuzin and diuron provided all most weed free conditions. These few weed survivals had no significant negative impact on chickpea seed yield but could have returned weed seeds to soil-seedbank which can

contribute to continuous weeds problem in crop rotations. However, it has been observed that wild radish appears to be more susceptible to formesafen than volunteer canola especially hybrid canola (personal communication with Ben Parkin, Syngenta).

Application of simazine 900 at 835g/ha in mixture either with isoxaflutole or isoxaflutole + metribuzin or diuron + isoxaflutole and terbuthylazine 750 1kg + isoxaflutole 750 100g/ha (e.g., Palmero® TX 1kg/ha) PSPE caused visible bleaching of chickpea leaves within one month of these treatments' application. These symptoms were outgrown with time without any negative impact on chickpea seed yield compared to weed free treatment.

Fomesafen 240 applied PSPE at 1.25L/ha yielded significantly lower than weed free and on par with untreated control. This treatment also recoded significantly lower chickpea dry biomass as compared to weed free (data not shown). Interestingly, fomesafen applied PSPE at lower rate (1L/ha) in mixture with other herbicides yielded at par with weed free treatment. Similarly, a mixture of simazine + isoxaflutole applied IBS and simazine IBS followed by isoxaflutole PSPE were comparatively better yielding than simazine + isoxaflutole applied PSPE. There was 13mm and 40mm rain fell within 2 and 4 weeks after pre-em treatments application, respectively. This caused seeding -furrow filling and it could have resulted in higher concentration of the herbicide in the furrows and yield loss. These results are in-line with the previous trial results and formesafen (e.g., Reflex®) label instructions.

REDPI21 at 1.25 L/ha applied at 3-5 node stage of chickpea resulted in severe desiccation of crop soon after application. However, it appears that due to good growing conditions during 2021, chickpea plants recovered quite well and there was no significant negative effect on seed yield. It is worth mentioning that visual negative effect on crop biomass and plant height was evident up to crop maturity.

A potential new pre-emergent herbicide BADPI21 recorded 94% weed control efficiency and yielded on par with weed free control plots. This needs further testing to confirm the results.

Effect of selected herbicides on root nodules of CBA Captain

Application of fomesafen, flumioxazin, terbuthylazine + isoxaflutole, and simazine + diuron + isoxaflutole before seeding (IBS) did not have significant negative effect on root nodules of chickpeas (at early podding stage) compared to untreated control. The nodule score ranged from 5.4 (simazine + diuron + isoxaflutole) to 6.2 (fomesafen), where 5 = ample and 6 = abundant nodules. These treatments also had no significant negative effect on plant shoot and root dry weight of chickpea (data not shown).

Acknowledgements

Thanks to DPIRD/GRDC co-investment funding (DAW1903-004RTX) for this research work. Thanks to Liebe Group and Brad McIlroy for the trial site, DPIRD Research Facility Wongan Hills, and Salzar Rahman and David Nicholson Technical Officers, Northam, for their excellent technical assistance. Thanks to Karyn Reeves, Research Scientist/Biometrician for data analysis.

References

Howieson, J.G. and Dilworth, M.J. (Eds.). 2016. Working with Rhizobia. Australian Centre for International Agricultural Research: Canberra.

Peer review: Mark Seymour

Contact: Dr Harmohinder Dhammu, harmohinder.dhammu@dpird.wa.gov.au, 0403 156 942

Table 6: Effect of flumetsulam 800 at 25g/ha at 4-5 node stage of chickpea on weed number and dry weight, canola (as weed) plant height and chickpea seed yield.

Flumetsulam treatments	Weeds/m^2 5 July 21	Weeds/m^2 21 Oct 21	Canola height (cm)	Weeds Dry Weight (kg/ha) 21 Oct	Chickpea Seed Yield (kg/ha)	Yield loss (%) due to no flumetsulam use
Minus flumetsulam	3a	9a	109b	1737 b	787 a	25
Plus flumetsulam	2a	6a	88a	545 a	986 b	
lsd (0.05)	-	-	12	-	166	-

Weed count per metre square and dry weight are back transformed values of log link and log (weeds dry weight+1) data transformations, respectively. Figures followed by same letters are not significantly different.

Table 7: Effect of herbicide treatments on weed count, weeds dry weight, weed control efficiency (WCE), and seed yield of CBA Captain chickpea.

No	Herbicides	Product rate/ha	Timing	Weeds/m^2 No flumetsulam 21 Oct 2021	Weeds/m^2 Plus flumetsulam 21 Oct 2021	Weed dry weight (Kg/ha) 21 Oct 2021	WCE (%)	Seed yield (Kg/ha)	Yield (%) increase over UTC
1	Untreated Control (UTC)			20 a	11. a	3215.3 j	0.0	687 a	0
2	Weed Free - simazine fb isoxaflutole	835g fb 100g	IBS fb PSPE	0 a	0 a	0 a	100.0	1056 defg	54
3	Formesafen 240 (e.g., Reflex®)	1.5L	IBS	0.2 a	0.2 a	10.5 def	99.7	912 abcdef	33
4	Formesafen 240	1.25L	PSPE	1.6 a	0.1 a	197.9 hi	93.8	750 abc	9
5	Formesafen fb isoxaflutole 750	1L fb 100g	IBS fb PSPE	0.2 a	0.1 a	5.5 bcde	99.8	1113 defg	62
6	Formesafen + isoxaflutole 750	1L + 100g	PSPE	0.7 a	0.3 a	41.3 fgh	98.7	1126 efg	64
7	Formesa + isoxaflu + metribuzin 750	1L + 100g + 180g	PSPE	0.2 b	0 a	1.8 abcd	99.9	1109 defg	61
8	Formesafen + simazine 900	1L + 835g	IBS	0.4 a	0.4 a	48.2 fgh	98.5	1050 defg	53
9	Formesafen + terbuthylazine 750	1L + 1kg	IBS	0.3 a	0.2 a	27.1 efg	99.2	1208 g	76
10	Formesafen + diuron 900	1L + 835g	IBS	0.9 a	0.6 a	138.1 hi	95.7	1043 defg	52
11	Flumioxazin 500 (e.g.,Terrain®)	180g	IBS	0.9 a	0.6 a	272.1 i	91.5	867 abcd	26
12	Flumioxazin + simazine 900	180g + 835g	IBS	0.6 a	0.5 a	127.9 ghi	96.0	1232 g	79
13	Flumioxazin fb isoxaflu + metri 750	180g fb 100g + 180g	IBS fb PSPE	0 a	0 a	0 a	100.0	1084 defg	58
14	Simazine900 + isoxaflutole 750	835g + 100g	IBS	0.04 a	0.04 a	1.8 abcd	99.9	1053 defg	53
15	Terbuthylazine 750 + isoxaflutole 750	1kg	IBS	0.1 b	0 a	1.4 abc	100.0	886 abcde	29
16	Simazine 900 + isoxaflutole 750	835g + 100g	PSPE	0.1 b	0 a	1.6 abcd	100.0	889 abcde	29
17	Terbuthylazine 750 + isoxaflutole 750	1kg	PSPE	0 a	0 a	0 a	100.0	984 cdefg	43
18	Simazine 900 + isoxaflu + metri	835g + 100g + 180g	IBS	0 a	0 a	0 a	100.0	1033 defg	50
19	Simazine 900 + isoxaflu + metri	835g + 100g + 180g	PSPE	0 a	0 a	0 a	100.0	998 cdefg	45
20	Simazine 900 + diuron 900 + isoxaflu	835g + 333g + 100g	PSPE	0.1 b	0 a	0.7 abc	100.0	1152 fg	68
21	Cyanazine 900 (e.g., Bladex®) fb isoxaflu	1.1kg fb 100g	IBS fb PSPE	0.4 b	0 a	3.9 bcd	99.9	942 bcdef	37
22	BADPI21	200mL	IBS	1.2 a	0.7 a	183.7 hi	94.3	1065 defg	55
23	REDPI21	1.25kg	3-5 nodes	0.1 a	0.1 a	6.8 cde	99.8	1020 defg	49
lsd (0.05)				5 (for interaction)		-		252	-

UTC = Untreated Control, IBS = Incorporated by sowing, PSPE = Post seeding pre-emergent, fb = followed by, fomesa = fomesafen, isoxaflu = isoxaflutole (e.g., Balance®), metri = metribuzin. On an average weed count and dry weight had around 90% of proportion canola plants and the remaining 10% were wild radish, cape weed, doublegee and marshmallow weeds. Weed count per metre square and dry weight are back transformed values of log link and log (weeds dry weight+1) transformations, respectively. Weed counts followed by same letters for each herbicide treatment across No flumetsulam and Plus flumetsulam are not significantly different. Weed dry weight and seed yield sharing common letters are not significantly different. WCE is based on weed dry weight.