Department of Primary Industries and Regional Development
GOVERNMENT OF WESTERN AUSTRALIA

Broadleaf weed control in CBA Captain chickpea – Mingenew 2021

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Key Messages

- RR canola which was sown into plots to mimic wild radish produced 4.1 t/ha of biomass by maturity and reduced the seed yield of CBA Captain chickpea by 47% compared to weed free plots.
- Majority of the herbicides and herbicide mixtures registered 95-100% weed control efficiency against RR canola and produced similar seed yields to weed free plots. Application of flumetsulam 800 at 25g/ha at 4-5 node stage of chickpea reduced canola biomass by 99% and increased chickpea seed yield by 74%.
- Post-seeding pre-emergent application of a three-way mix of Simazine 900 835g + diuron 900 333g + isoxaflutole 750 100g/ha and post-emergent application of REDPI21 at 4-5 node stage caused significant seed yield loss of chickpea.
- Pre-emergent 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 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 and impede in crop harvesting. A new chickpea variety CBA Captain was released during 2020. Reflex®(fomesafen), Terrain® (flumioxazin)® and Palmero® TX (terbythylazine + isoxaflutole) herbicides have recently been registered as pre-emergent herbicides in chickpeas for broadleaf weed control. Limited information is available on effect of these new herbicides/mixture on new chickpea variety and weeds.

Table 1: Trial Details

Trial Location	Yanda Corabella, Coalseam Road, Nangetty
Plot size & replication	1.8m centres x 10m sown x 3 replications, Criss-cross/split plot design
Soil type	Red loam
Paddock rotation	2020: barley, 2019: barley, 2018: barley
Sowing date	25/05/2021
Sowing rate	CBA Captain 140 kg/ha to target a density of 45 plants/m^2
Fertiliser	AgNP 80kg/ha, (10.9N, 22.7P, 1.2S, 0.1Cu, 0.2Zn), 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 900 at 560g/ha and chlorpyrifos (500g/L) 0.2L + alpha-cypermethrin (100g/L) 0.5L/ha on 25/5/21, chlorothalonil (720g/L) at 1.5L/ha on 15 June, 30 June and 19 July 2021, and alpha-cypermethrin (100g/L) at 0.5L + chlorpyrifos (500g/L) 0.5L/ha on 30/8/21.
Harvest Date	3/11/2021

Table2: 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	5.9	19	217	2.3	6	1	0.043	0.45
10-20	5.0	21	228	2.4	5	1	0.031	0.33
20-30	5.6	8	192	2.1	3	2	0.026	0.18

Table 3: Monthly Rainfall (mm) at South Holmwood station near the trial site (Source: BOM station - 8060).

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Apr-Oct	Annual
2021	0	27	31	45	72	49	102	18	10	37	2	0	333	393
Average	12	14	18	24	50	68	62	45	24	14	9	7	287	347

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 4: Sub-plot herbicide treatments

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

- **Canola seed spreading:** The trial site had very low weed burden, so to 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.
- **Treatments application dates:** IBS and PSPE: 25 May 2021, and 4-5 chickpea node stages: 15 June 2021.
- **Herbicide treatments application machinery:** A Spray rig fitted with air induction nozzles (Teejet AIXR110-02) calibrated to deliver 80L/ha water volume was used.
- **Trial seeding:** 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.
- **Canola/weed counts and dry weight:** In herbicide treatment plots, canola count on 1 July and 7 Oct and weed biomass cut on 7 Oct were done from the whole plot (9 m^2) area. However, in untreated control plots the first count on 1 July was from 1m x 0.75m area, but on 7 Oct, the count and biomass cut were from 0.5 m x 0.75 cm area at two spots per plot. The canola/weed count was converted to number/m^2 and dry weight to kg/ha. Weed control efficiency (WCE) was calculated by using the following formula:

$$\text{WCE (\%)} = \frac{\text{Dry weight of weeds in untreated control plots - dry weight of weeds in treatment plots}}{\text{Dry weight of weeds in untreated control plots}} \times 100$$

- **Herbicides' effect on nodulation:** To determine the effect of 5 selected herbicide treatments (including untreated control) on nodulation, 20 chickpea plants at early podding stage were dug very carefully from each replicated treatment plot on 8 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.

Results and Discussion

The trial was sown into moist soil following 10mm of rainfall in two days prior to seeding and 58 mm rain fell within one week of the trial seeding. Chickpea plant establishment was excellent and on average it was 58 plants/m^2 as compared to the target density of 45 plants/m^2. Average seed yield of the trial was 1.5t/ha.

Effect of herbicides on canola/weeds and chickpea (Table 5)

Untreated control plots (no post-em. flumetsulam) recorded 8 canola plants/m^2 on 1 July (5 weeks after sowing) which increased to 11 plants/m^2 by 7 Oct. Uncontrolled canola plants (mimicking wild radish) throughout life cycle of the crop produced 4.1t/ha dry biomass and reduced chickpea seed yield by 47% as compared to weed free plots.

Application of flumetsulam 800 alone at 25g/ha reduced canola numbers on average by 75% and canola biomass by 99% resulting in a 74% chickpea seed yield increase compared to no flumetsulam use. Flumetsulam (alone) reduced number of canola plants significantly within three weeks of its application and the residual effect continued up to crop maturity. Interaction of flumetsulam with pre-emergent herbicides was significant in reducing canola plant numbers and dry weight in many cases and increasing chickpea seed yield for fomesafen + diuron IBS. Flumetsulam is the only registered herbicide which is available in the market for post-emergent weed control in chickpea. These results are in line with flumetsulam (e.g., Broadstrike®) herbicide label which states that it can control volunteer canola up to 8 leaf stage or 10cm diameter size plants. The label further states that under ideal conditions, it can reduce Group B/2 herbicide susceptible wild radish's biomass by 50-70%, whilst surviving plants may still set viable seeds.

All pre-emergent herbicide treatments and REDPI21 applied post-emergent reduced canola numbers and their dry biomass significantly. Majority of the treatments registered weed control efficiency in the range of 95-100%. Fomesafen + diuron applied before seeding, formesafen 240 at 1.25L/ha applied PSPE and BADPI21 applied post-emergent recorded weed control efficiency between 87-94%.

Interestingly, new herbicides like fomesafen and flumioxazin either alone or in mixture with other herbicides (without post-em. flumetsulam) had a few canola survive. These few canola/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). Moreover, fomesafen (e.g., Reflex) label does not claim volunteer canola control or suppression, whereas flumioxazin (e.g., Terrain) label claims volunteer canola and wild radish suppression.

Flumioxazin applied before seeding alone or in mixture with simazine or followed by isoxaflutole + metribuzin PSPE reduced chickpea plant population significantly and chickpea growth was visually affected up to crop maturity, but there was no significant negative effect on chickpea seed yield. These negative visual effects from flumioxazin are in line with previous trial results. Due to good growing conditions last year, chickpea plants might have compensated the negative effect on plant density through higher branching, a greater number of pods per plant and higher seed weight. Addition of simazine or isoxaflutole + metribuzin to flumioxazin improved its weed control efficiency from 95 to almost 100%.

Three-way mix of Simazine 900 835g + diuron 900 333g + isoxaflutole 100g/ha applied PSPE caused visually around 15% biomass reduction that was evident up to flowering stage of chickpea and ultimately translated into significant seed yield loss as compared to weed free plots. The negative effect on crop biomass from this treatment was also noticed in another similar trial at Binnu during 2021. This treatment registered 100% weed control efficiency (WCE). In contrast, Fomesafen 240 applied PSPE at 1.25L/ha recorded lower WCE (89%) without any significant negative impact on seed yield of chickpea. Further, fomesafen applied PSPE at a lower rate of 1L/ha in mixtures with other herbicides or applied IBS at 1.5L/ha produced better WCE (96-97%). 58mm and 99mm of rain fell within 1 and 4 weeks after pre-emergent treatments application respectively,

however, seeding-furrow filling was not noticed. The seeding-furrows appeared to be in-tact up to chickpea maturity. To understand the reasoning of lower efficacy on canola/weeds of fomesafen applied PSPE compared to IBS needs further investigation.

REDPI21 at 1.25 L/ha applied at 4-5 node stage of chickpea resulted in severe desiccation of crop soon after application. Due to good growing conditions during 2021, chickpea plants recovered quite well with time. However, visual negative effect on crop biomass and plant height was evident up to crop maturity and as a result there was significant negative effect on chickpea seed yield. This treatment registered 100% weed control efficiency.

A potential new pre-emergent herbicide BADPI21 recorded 87% 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, and terbuthylazine + isoxaflutole, before seeding and simazine + diuron + isoxaflutole PSPE did not have significant negative effect on root nodules of chickpeas (at early podding stage) compared to untreated control. The nodule score ranged from 2.7 (flumioxazin and untreated control) to 4 (fomesafen and terbuthylazine + isoxaflutole), where 3 = moderate and 4 = adequate nodules. These treatments also had no significant negative effect on plant shoot and root dry weight of chickpea (data not shown).

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References

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Peer review: Mark Seymour

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Plate 1: Untreated control plot (Left), Reflex® (fomesafen) at 1.25L/ha PSPE (Centre) and Terrain® (flumioxazin) at 180g/ha IBS (Right). Photos taken on 8 September 2021.

Table 5: Effect of herbicide treatments on canola count and dry weight (as a weed), weed control efficiency (WCE), and seed yield of chickpea (cv Captain).

No	Herbicides	Product rate/ha	Timing	Canola/m^2 1 July		Canola/m^2 7 Oct		Canola dry weight (kg/ha) 7 Oct		WCF (%) based on	Seed yield (kg/ha)	
				Flumetsulam 800 25g/ha						Minus	Flumetsulam	
				Minus	Plus	Minus	Plus	Minus	Plus	flumetsulam	Minus	Plus
1	Untreated Control (UTC)			8 b	3a	11 b	1a	4109 b	27 a	0	889 a	1543 b
2	Weed Free - simazine fb isoxaflutole	835g fb 100g	IBS fb PSPE	0 a	0 a	0 a	0 a	0 a	0 a	100	**1674 a**	1538 a
3	Fomesafen 240 (e.g., Reflex®)	1.5L	IBS	1 b	0 a	1 b	0 a	126 b	0 a	97	1637 a	1761 a
4	Fomesafen 240	1.25L	PSPE	2 b	0.2 a	2 b	0 a	446 b	0 a	89	1563 a	1737 a
5	Formesa fb isoxaflu 750 (e.g., Balance)	1L fb 100g	IBS fb PSPE	2 b	0.2 a	1 b	0 a	112 b	0 a	97	1568 a	1584 a
6	Fomesafen + isoxaflutole	1L + 100g	PSPE	2 b	1a	1 b	0 a	103 b	0 a	97	1546 a	1657 a
7	Formesa + isoxaflu + metribuzin 750	1L + 100g + 180g	PSPE	2 b	0 a	1 b	0 a	149 b	0 a	96	1516 a	1681 a
8	Fomesafen + simazine 900	1L + 835g	IBS	1 b	0 a	1 b	0 a	182 b	0 a	96	1695 a	1780 a
9	Fomesafen + terbuthylazine 750	1L + 1kg	IBS	0.2 b	0 a	0.2 a	0 a	22 a	0 a	99	1655 a	1735 a
10	Fomesafen + diuron 900	1L + 835g	IBS	1a	1 a	1 b	0 a	244 b	0 a	94	1367 a	1695 b
11	Flumioxazin 500 (e.g.,Terrain®)	180g	IBS	1 b	0.2 a	0.4 b	0 a	202 b	4 a	95	1372 a	1387 a
12	Flumioxazin + simazine 900	180g + 835g	IBS	0.2 b	0 a	0.1 a	0 a	15 a	0 a	100	1527 a	1346 a
13	Flumioxazin fb isoxaflu + metri 750	180g fb 100g + 180g	IBS fb PSPE	0 a	0 a	0.1 a	0 a	22 a	0 a	99	1362 a	1428 a
14	Simazine900 + isoxaflutole 750	835g + 100g	IBS	0 a	0 a	0.1 a	0 a	15 a	0 a	100	1674 a	1667 a
15	Terbuthylazine 750 + isoxaflutole 750	1kg	IBS	1 b	0.2 a	0 a	0 a	8 a	0 a	100	1525 a	1512 a
16	Simazine 900 + isoxaflutole 750	835g + 100g	PSPE	1 b	0 a	1 b	0 a	48 a	0 a	99	1556 a	1614 a
17	Terbuthylazine 750 + isoxaflutole 750	1kg	PSPE	1 b	0 a	0 a	0 a	0 a	0 a	100	1506 a	1730 a
18	Simazine 900 + isoxaflutole + metribuzin	835g + 100g + 180g	IBS	1 b	0 a	0.3 b	0 a	60 a	0 a	99	1513 a	1464 a
19	Simazine 900 + isoxaflutole + metribuzin	835g + 100g + 180g	PSPE	0.2 b	0 a	0.3 b	0 a	25 a	0 a	99	1520 a	1475 a
20	Simazine 900 + diuron 900 + isoxaflutole	835g + 333g + 100g	PSPE	1 b	0 a	0 a	0 a	0 a	0 a	100	1272 a	1283 a
21	Cyanazine 900 (e.g., Bladex®) fb isoxaflu	1.1kg fb 100g	IBS fb PSPE	2 b	0.2 a	0.5 b	0 a	55 a	0 a	99	1534 a	1638 a
22	BADPI21	200mL	IBS	1 b	0 a	1 b	0 a	542 b	0 a	87	1334 a	1445 a
23	REDPI21	1.25kg	3-5 nodes	0 a	0 a	0 a	0 a	3 a	0 a	100	1098 a	1169 a
lsd (0.05) for interaction				6		-		-		-	349	

IBS = Incorporated by sowing, PSPE = Post seeding pre-emergent, fb = followed by, fomesa = fomesafen, isoxaflu = isoxaflutole (e.g., Balance®), metri = metribuzin. Canola count on 1 July, and canola count per metre square and dry weight on 7 Oct are back transformed values of log link and square root transformations, respectively. Different parameters followed by same letters for each herbicide treatment across Minus and Plus flumetsulam are not significantly different. Figures in RED are significantly lower than weed free (minus flumetsulam). Weed control efficiency is based on canola dry weight in minus flumetsulam treatments.