Broadleaf weed control in chickpea at Binnu 2021

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Key Messages

- Majority of the pre-emergent herbicides and herbicide mixtures registered 88-100% weed control efficiency against wild radish. Post-emergent application of flumetsulam 800 at 25g/ha alone at 4-5 node stage of chickpea reduced wild radish number by 86%.
- Interaction of post-emergent flumetsuam with pre-emergent herbicides/mixtures for wild radish control was positive, whereas for chickpea seed yield it was negative in majority of the cases.
- Pre-emergent application of flumioxzin alone and in mixture with other herbicides, BADPI21 and simazine + diuron + isoxaflutole caused 21 to 41% loss in chickpea seed yield.
- 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. 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. Limited information is available on effect of these new herbicides/mixture on new chickpea variety and weeds.

Table 1: Trial Details

Trial Location	Kyle Carson, Binnu
Plot size & replication	1.8m centres x 10m sown x 3 replications, Criss-cross/split plot design
Soil type	Red loamy sand (0-10cm) and sandy loam (10-50cm)
Paddock rotation	2020: Fallow
Sowing date	24/05/2021
Sowing rate	CBA Captain 140 kg/ha and Neelam 90 kg/ha and target density was 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 500 at 1 L/ha on 11/5/21, chlorothalonil (720g/L) at 1.5L/ha on 15/6, 30/6 and 27/7/21, clethodim (240g/L) 0.5L/ha on 22/07/21, clethodim (240g/L) 0.33L + butroxydim (250g/kg) 180g/ha + Hasten 1% on 6/08/21, and alpha-cypermethrin (100g/L) at 0.16L/ha on 26/08/21.
Harvest Date	19/10/2021

Table2: Soil Composition (3rd rep)

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	5.1	35	197	2.1	7	<1	0.033	0.33
10-20	4.7	24	242	3.7	4	<1	0.034	0.34
20-30	5.3	7	156	3.6	2	<1	0.023	0.24

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	14	35	22	39	67	53	128	17	13	41	2	0	358	431

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	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.

- **Treatments application dates:** IBS: 24 May, PSPE: 26 May 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 at 23 cm row spacing was used for seeding chickpea at 5 cm depth. There was very low level of stubble present in the paddock.
- **Chickpea plant count:** Chickpea plant count was done using 100 cm x 46 cm (2 rows at 23 cm row spacing) quadrat from two spots per plot on 14 July 2021 and converted to plants/m^2.
- **Wild radish count:** Wild radish count on 2 July 2021 was done from the whole plot (8 m^2) area and was converted to number/m^2. Weed control efficiency (WCE) was calculated by using the following formula:

$$\text{WCE (\%)} = \frac{\text{Wild radish/m}^2\text{ in untreated control plots} - \text{wild radish/m}^2\text{ in treatment plots}}{\text{Wild radish/m}^2\text{ in untreated control plots}} \times 100$$

- **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 9 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 49 mm rain fell within one week of the trial seeding. Chickpea plant establishment was excellent and on average it was 56 plants/m^2 as compared to the target density of 45 plants/m^2. Average seed yield of the trial was 1.5t/ha (3rd replication only). Neelam plant establishment was around 25% less than CBA Captain.

There was a gradient in soil type and wild radish population from replication 1 to 3. The soil type was lighter and wild radish population was higher in rep 1 and 2 than rep 3. Replication 3 was almost free of wild radish. Even within rep 1 and 2, wild radish population and chickpea plant growth was very uneven. So only replication 3 that was looking quite uniform with good chickpea plant growth was harvested. The trial was also infested with uneven population of ryegrass during early chickpea growth stages (early Aug). The ryegrass was controlled with use of clethodim and clethodim + butroxydim. It is quite likely that ryegrass competition might have affected chickpea seed yield in some plots to some extent in replication 3.

Effect of herbicides on wild radish and chickpea

Untreated control plots (no post-em flumetsulam) recorded 6-7 wild radish/m^2 on 11 August (11 weeks after sowing) in rep 1 and 2 (Table 5).

Post-emergent application of flumetsulam 800 alone at 25g/ha reduced wild radish numbers by 86%. Interaction of flumetsulam with pre-emergent herbicides in reducing wild radish plant numbers appeared positive (Table 5) but was negative for chickpea seed yield in majority of cases (Table 6). Significant negative effect of flumetsulam on chickpea seed yield have been recorded in previous WA trials. Flumetsulam is the only registered post-emergent weed control option for chickpea that is available in the market.

All pre-emergent (pre-em) herbicide treatments and REDPI21 applied post-emergent reduced wild radish numbers and registered weed control efficiency (WCE) in the range of 88-100%. Lowest weed control efficiency of 72% was recorded with formesafen 240 at 1.25L/ha applied PSPE followed in an ascending order by 85% with BADPI21 200mL/ha and 85% with fomesafen + diuron both applied IBS. These results are in line with another trial conducted at Mingenew during 2021.

Interestingly, new herbicides like fomesafen and flumioxazin either alone or in mixture with other herbicides (without post-em flumetsulam) had a few wild radish survive. These few weed survivals appeared to have no 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.

Flumioxazin applied before seeding alone or in mixture with simazine or followed by isoxaflutole + metribuzin PSPE had lower chickpea plant population and recoded lower chickpea seed yield also compared to weed free plots. The negative effects from flumioxazin on plant population in line with previous trial results (Table 6). Higher uptake of flumioxazin by chickpea due to possible interaction of lighter soil type with heavy rain of 49mm and 94mm with in one and four weeks of seeding (respectively), might have caused this negative effect. Addition of simazine or isoxaflutole + metribuzin to flumioxazin improved its weed control efficiency by 7-8% (Table 5).

Three-way mix of Simazine 900 835g + diuron 900 333g + isoxaflutole 100g/ha applied PSPE resulted in lower seed yield (59%) as compared to weed free plots. The negative effect on crop biomass and seed yield from this treatment was also noticed in another similar trial at Mingenew during 2021. This treatment registered 96% weed control efficiency (WCE). In contrast, Fomesafen 240 applied PSPE at 1.25L/ha recorded lowest WCE (72%) in the trial without any negative impact on seed yield of chickpea. Further, fomesafen applied PSPE at lower rate (1L/ha) in mixture with other herbicides or applied IBS at 1.5L/ha recorded better WCE (85-96%). To understand the reasoning of lower efficacy on wild radish 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 (20%) was evident up to crop maturity and as a result lower seed yield was recoded (17% yield loss compared to weed free plots). This treatment registered 98% weed control efficiency.

A potential new pre-emergent herbicide BADPI21 recorded lower weed control efficiency (81%) and seed yield (68%) as compared to weed free plots. The treatment performed quite poorly in terms of WCE and crop safety at this site compared to Mingenew and Dalwallinu sites during 2021. The soil type at this site was lighter than other sites. This needs further testing to confirm the results.

Effect of selected herbicides on root nodules of CBA Captain (Table 7)
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 3.9 (flumioxazin and simazine + diuron + isoxaflutole) to 5.1 (fomesafen and untreated control), where 4 = adequate nodules and 5 = ample nodules. These treatments also had no significant negative effect on plant shoot and root dry weight, and root /shoot ratio of chickpea except root weight per plant was significantly lower in simazine + diuron + isoxaflutole compared to untreated control.

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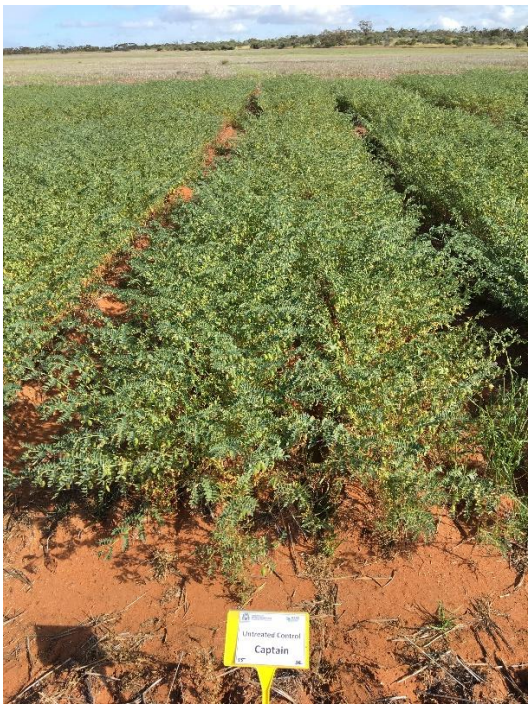

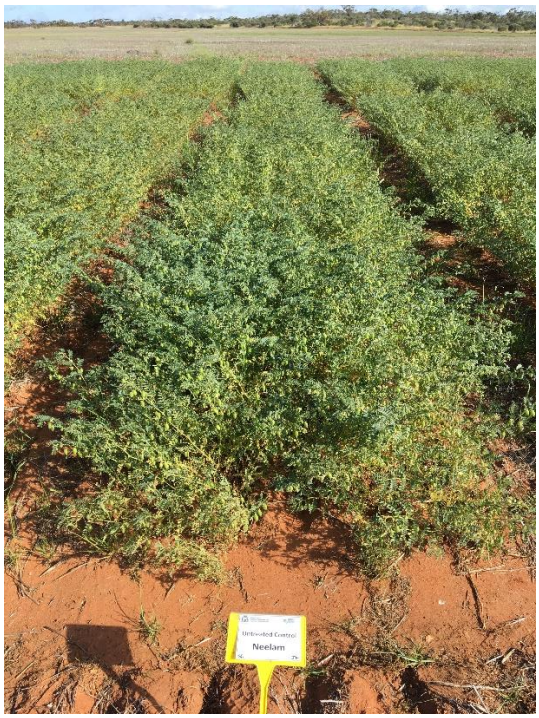

Plate 1: Untreated control plots - CBA Captain (Left) and Neelam (Right) in Rep 3. Photos taken on 9 September 2021.

Table 5: Effect of herbicide treatments on wild radish number and weed control efficiency 11 weeks after sowing and 8 weeks after flumetsulam application on 11-08-2021. The results are average of rep 1 and 2 only. Weed control efficiency is based on Untreated control (Captain) without flumetsulam.

No	Herbicides	Product rate/ha	Timing	Wild radish plants/m^2		Weed control efficiency (%)	
				Flumetsulam			
				Minus	Plus	Minus	Plus
1	Untreated Control (Captain)			6	1	**0**	86
2	Untreated Control (Neelam)			7	1	-18	88
3	Weed Free (Captain) - simazine fb isoxaflu	835g fb 100g	IBS fb PSPE	0	0	100	100
4	Weed Free (Neelam) - Simazine fb Isoxaflu	835g fb 100g	IBS fb PSPE	0	0	100	100
5	Fomesafen 240 (e.g., Reflex®)	1.5L	IBS	1	0.1	88	98
6	Fomesafen 240	1.25L	PSPE	2	0	72	100
7	Fomesafen fb isoxaflu 750 (e.g., Balance®)	1L fb 100g	IBS fb PSPE	1	0	92	100
8	Fomesafen + isoxaflutole	1L + 100g	PSPE	1	0	89	99
9	Fomesafen + isoxaflutole + metribuzin	1L + 100g + 180g	PSPE	1	0	89	100
10	Fomesafen + simazine 900	1L + 835g	IBS	1	0	90	100
11	Fomesafen + terbuthylazine 750	1L + 1kg	IBS	0	0	96	100
12	Fomesafen + diuron 900	1L + 835g	IBS	1	0.1	85	99
13	Flumioxazin 500 (e.g., Terrain®)	180g	IBS	1	0.1	91	99
14	Flumioxazin + simazine 900	180g + 835g	IBS	0	0	99	100
15	Flumioxazin fb isoxaflutole + metribuzin	1kg fb 100g + 180g	IBS fb PSPE	0.1	0	98	100
16	Simazine900 + isoxaflutole 750	835g + 100g	IBS	0	0	97	100
17	Terbuthylazine 750 + isoxaflutole 750	1kg + 100g	IBS	0	0	95	100
18	Simazine 900 + isoxaflutole 750	835g + 100g	PSPE	0	0	95	100
19	Terbuthylazine 750 + isoxaflutole 750	1kg + 100g	PSPE	0	0	100	100
20	Simazine 900 + isoxaflutole + metribuzin	835g + 100g + 180g	IBS	1	0	89	100
21	Simazine 900 + isoxaflutole + metribuzin	835g + 100g + 180g	PSPE	0	0	95	100
22	Simazine 900 + diuron 900 + isoxaflutole	835g + 333g + 100g	PSPE	0	0	96	100
23	Cyanazine 900 (e.g., Bladex®) fb isoxaflu	1.1kg fb 100g	IBS fb PSPE	0.4	0	93	99
24	BADPI21	200mL	IBS	1	0	81	99
25	REDPI21	1.25kg	4-5 nodes	0	0.1	98	99

IBS = Incorporated by sowing, PSPE = Post seeding pre-emergent, fb = followed by, and isoxaflu = isoxaflutole (e.g., Balance.

Table 6: Effect of herbicide treatments on chickpea plant density on 3 Weeks after sowing and seed yield (% of Captain weed free - WF). Chickpea plant density in Captain weed free plots was 73 plants/m^2 and seed yield was 1.8t/ha. The results are based on replication 3 only.

No	Herbicides	Product rate/ha	Timing	Chickpea plant Number (% of WF Captain)		Chickpea seed yield (% of WF Captain)	
				Flumetsulam			
				Minus	Plus	Minus	Plus
1	Untreated Control (Captain) - UTC Captain			81	99	63	74
2	Untreated Control (Neelam)			75	73	74	74
3	Weed Free (Captain) - simazine fb isoxaflu	835g fb 100g	IBS fb PSPE	**100**	73	**100**	75
4	Weed Free (Neelam) - Simazine fb Isoxaflu	835g fb 100g	IBS fb PSPE	75	72	104	74
5	Fomesafen 240 (e.g., Reflex®)	1.5L	IBS	100	96	101	89
6	Fomesafen 240	1.25L	PSPE	81	76	111	77
7	Fomesa fb isoxaflutole 750 (e.g., Balance®)	1L fb 100g	IBS fb PSPE	90	73	94	38
8	Fomesa + isoxaflutole	1L + 100g	PSPE	61	99	106	91
9	Fomesa+ isoxaflutole + metribuzin 750	1L + 100g + 180g	PSPE	73	99	85	79
10	Fomesa + simazine 900	1L + 835g	IBS	67	99	100	53
11	Fomesa + terbuthylazine 750	1L + 1kg	IBS	81	73	108	75
12	Fomesa+ diuron 900	1L + 835g	IBS	73	79	109	94
13	Flumioxazin 500 (e.g., Terrain®)	180g	IBS	48	57	69	40
14	Flumioxazin + simazine 900	180g + 835g	IBS	69	69	77	51
15	Flumioxazin fb isoxaflutole + metribuzin	1kg fb 100g + 180g	IBS fb PSPE	63	61	79	77
16	Simazine900 + isoxaflutole 750	835g + 100g	IBS	79	85	92	83
17	Terbuthylazine 750 + isoxaflutole 750	1kg + 100g	IBS	75	63	99	77
18	Simazine 900 + isoxaflutole 750	835g + 100g	PSPE	81	70	87	96
19	Terbuthylazine 750 + isoxaflutole 750	1kg + 100g	PSPE	54	78	72	57
20	Simazine 900 + isoxaflutole + metribuzin	835g + 100g + 180g	IBS	79	75	94	83
21	Simazine 900 + isoxaflutole + metribuzin	835g + 100g + 180g	PSPE	85	81	96	77
22	Simazine 900 + diuron 900 + isoxaflutole	835g + 333g + 100g	PSPE	82	75	59	83
23	Cyanazine 900 (e.g., Bladex®) fb isoxaflu	1.1kg fb 100g	IBS fb PSPE	82	64	106	91
24	BADPI21	200mL	IBS	57	82	68	43
25	REDPI21	1.25kg	4-5 nodes	67	88	83	58

IBS = Incorporated by sowing, PSPE = Post seeding pre-emergent, fb = followed by, and fomesa = fomesafen, isoxaflu = isoxaflutole 750 (e.g., Balance®).

Table 7: Table: Effect of herbicide treatments on CBA Captain root nodules, shoot and root weight (g) per plant and root/shoot ratio. Results are based on all three replications.

No	Herbicides	Product rate/ha	Timing	Nodule Score	Shoot weight (g)	Root Weight (g)	Root/shoot ratio
1	Untreated Control (Captain)			5.1	5.2	0.98	0.20
5	Fomesafen 240 (e.g., Reflex®)	1.5 L	IBS	5.1	6.6	0.89	0.15
13	Flumioxazin 500 (e.g., Terrain®)	180 g	IBS	3.9	5.2	0.66	0.13
17	Terbuthylazine 750 + isoxaflu	1 kg + 100g	IBS	4.1	5.8	0.78	0.14
22	Sima 900 + diuron 900 + isoxaflu	835 g + 333 g + 100 g	PSPE	3.9	3.8	**0.54**	0.22
lsd (0.05)				2	3.3	0.40	0.08

IBS = Incorporated by sowing, PSPE = Post seeding pre-emergent, isoxaflu = isoxaflutole (e.g., Balance®) and sima = simazine. Root nodule score 4 means adequate nodules and 5 means ample nodules.