

EFFECT OF POST-EMERGENCE HERBICIDES ON WEED GROWTH AND PRODUCTIVITY OF HORSEGRAM (*MACROTYLOMA UNIFLORUM L.*)

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ABSTRACT

A field experiment was conducted during *kharif 2022* at the Agricultural Research Station, Ananthapuram, Andhra Pradesh, to evaluate the efficacy of different post-emergence herbicides on weed control, growth, yield, and economics of horse gram (*Macrotyloma uniflorum L.*) under rainfed conditions. The experiment was laid out in a randomized block design with eight treatments and three replications. The treatments were consisting of T1: Imazethapyr + imazamox @ 50 g/ha as PoE at 15 – 20 DAS, T2: Imazethapyr + imazamox @ 75 g/ha as PoE at 15 – 20 DAS, T3: Propaquizafop 2.5% + imazethapyr 3.75% @ 1000 ml /ha as PoE at 15 – 20 DAS, T4: Propaquizafop 2.5% + imazethapyr 3.75% @ 1500 ml /ha as PoE at 15 – 20 DAS, T5: Clodinofof propargyl 8% + aciflourfen sodium 16.5 @ 500 ml /ha as PoE at 15 – 20 DAS, T6: Clodinofof propargyl 8% + aciflourfen sodium 16.5 @ 750 ml /ha as PoE at 15 – 20 DAS, T7: Hand weeding at 15-20 DAS and 35-40 DAS and T8: Weedy check. Results revealed that hand weeding twice at 15–20 and 35–40 days after sowing recorded the lowest weed density, highest weed control efficiency (WCE), and superior growth and yield attributes. Among herbicidal treatments, Propaquizafop 2.5% + Imazethapyr 3.75% @ 1500 ml/ha as PoE at 15–20 DAS recorded significantly lower weed density and higher WCE, followed by Propaquizafop + Imazethapyr @ 1000 ml/ha, due to their complementary control of both grassy and broadleaf weeds. The highest seed yield (1116 kg/ha) and bhusa yield (1942 kg/ha) were obtained in hand weeding twice, while Propaquizafop + Imazethapyr @ 1500 ml/ha achieved 908 kg/ha seed yield with a higher benefit-cost ratio (2.41), indicating its economic advantage.

Keywords: Economics, Horse gram, Post Emergence Herbicide, Seed yield, Weed Control Efficiency

INTRODUCTION

Horse gram is an arid, drought resistant and climate resilient legume crop in India (Kiran Kumar *et al.*, 2023). In Andhra Pradesh, horse gram is cultivated on approximately 1.5 lakh hectares with annual production of around

90,000 metric tons and average productivity of about 600 kg/ha (Indiastat, 2024). It is mainly cultivated as contingent crop in scarce rainfall zone with poor management practices. Under these conditions, weeds pose a serious threat to the productivity of horsegram due to greater

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competition for nutrients, water, space and sunlight. The critical period of weed competition in horsegram is during first 30 days of sowing. Being a short duration crop, care should be taken on proper weed management to improve the productivity of horsegram. If sufficient labour is available, hand weeding at 20 and 40 DAS helps in effective weed control and conserves moisture, especially in rainfed agriculture. The traditional method of weed control, such as hand weeding and mechanical weeding, may be effective but expensive and time-consuming.

Unpredictable rainfall and labour scarcity during critical stage are posing problems for effective weed management. In such situation, use of herbicides offers a viable alternative for weed management in horsegram cultivation. Herbicides can effectively control weeds, improve crop yield by minimizing competition for essential resources like water, nutrients and sunlight. Application of pendimethalin and imazethapyr as pre-emergence (PE) and post-emergence (PoE), respectively, have shown promising results in greengram (Singh *et al.*, 2017). However, narrow time window of application often makes the PE herbicides less preferred choice among the farmers. Also, application of a single herbicide is often ineffective in controlling diverse weed flora. On the contrary, either ready or tank mixes of compatible herbicides with varying modes of action may ensure effective control of diverse weed flora and check shifting of weed flora complex and herbicide resistance (Banerjee *et al.*, 2018). In general, there is paucity of information on the impact of new herbicide ready mixes available in Indian market on the performance of horsegram.

Considering this, the present study was formulated to evaluate the effect of different post-emergence herbicides on weed density, growth, yield attributes, yield and economics of horsegram.

MATERIAL AND METHODS

Field experiment was conducted at Agricultural Research Station, Ananthapuram under AINP on Arid legumes during kharif, 2022. The experimental site was located in scarce rainfall zone of Andhra Pradesh with average annual rainfall of 520 mm and geographical coordinates of the site are approximately 14.68° N latitude and 77.60° E longitude. The soil at the experimental site is red sandy loam. Soils were slightly alkaline with pH of 7.84, EC of 0.07 with low organic carbon (0.07%), low nitrogen (242.9 kg/ha) low phosphorus (25.7 kg/ha), medium in potassium (281 kg/ha) and low micronutrients (Copper-0.08 ppm, Manganese-0.59 ppm, iron-0.43 ppm, zinc-0.50 ppm). Experiment was laid in RBD with three replications and eight treatments comprised of T1: Imazethapyr + imazamox @ 50 g/ha as PoE at 15 – 20 DAS, T2: Imazethapyr + imazamox @ 75 g/ha as PoE at 15 – 20 DAS, T3: Propaquizafop 2.5% + imazethapyr 3.75% @ 1000 ml /ha as PoE at 15 – 20 DAS, T4: Propaquizafop 2.5% + imazethapyr 3.75% @ 1500 ml /ha as PoE at 15 – 20 DAS, T5: Clodinafop propargyl 8% + aciflourfen sodium 16.5 @ 500 ml /ha as PoE at 15 – 20 DAS, T6: Clodinafop propargyl 8% + aciflourfen sodium 16.5 @ 750 ml /ha as PoE at 15 – 20 DAS, T7: Hand weeding at 15-20 DAS and 35-40 DAS and T8: Weedy check. ATPHG 11 was taken as test variety and sowing was done with seed drill. 4 kg of Nitrogen, 10 kg of Phosphorus and 8 kg potash supplying fertilizers were broadcasted per ha. before sowing. The average maximum temperature over the recorded period was 34.9°C, and the average minimum temperature was 21.3°C. The average morning relative humidity was 85.4 per cent, while the average evening relative humidity was 45.8 per cent. The average wind speed was 7.50 kmph. The total rainfall received during crop growth period was 293 mm. *Commelina diffusa*, *Commelina*

benghalensis, *Celosia argentea*, *Andrographis spp*, *Leucas aspera*, *Cyperus rotundus*, *Digitaria sanguinalis*, were the major weeds observed in horsegram. Harvesting was done with sickles to ground level and dried. Threshing was done by trampling with tractor and seed and bhusa yield was recorded separately. Economics were calculated by taking prevailing labour wages and market prices of inputs and outputs into consideration. The collected data were subjected to statistical analysis using SPSS. Analysis of variance (ANOVA) was performed to determine the significance of treatment effects. Means were compared using the Least Significant Difference (LSD) test at a 5 percent probability level.

RESULTS AND DISCUSSION

Lowest weed density and highest weed control efficiency were recorded in hand weeding at 15-20 DAS and 35-40 DAS (Table 2 & Fig. 1). The reduction in weed density in hand weeding at 15-20 DAS and 35-40 DAS (T7) indicating its superiority over all herbicidal treatments. Manual weeding effectively uproots weeds and desiccates the weeds thereby preventing their regeneration and reducing subsequent weed competition. Similar observations were made by Taku *et al.* (2023), who reported that hand weeding significantly reduces weed population and enhances crop growth through the complete removal of weeds at critical growth stages. Among herbicidal treatments, Propaquizafop 2.5% + Imazethapyr 3.75% @ 1500 ml/ha (T4) recorded the lowest weed density and higher WCE, followed by Propaquizafop 2.5% + Imazethapyr 3.75% @ 1000 ml/ha (T3). The superior performance of these treatments might be attributed to the synergistic action of the grass killer (Propaquizafop) and broadleaf herbicide (Imazethapyr), providing broad-spectrum control over both monocot and dicot

weeds. Similar findings were reported by Patel *et al.* (2021) and Kumar *et al.* (2022), who found that the combination of post-emergence herbicides was more effective than single herbicide applications in achieving higher weed control efficiency and yield advantage. In contrast, Imazethapyr + Imazamox @ 50 g/ha (T₁) and 75 g/ha (T₂) recorded the lowest WCE, indicating their limited efficacy in controlling mixed weed flora at the given doses. The highest weed density in the weedy check (T₈) was due to the absence of weed control measures, leading to higher weed biomass accumulation and greater crop-weed competition. These results are in agreement with Choudhary *et al.* (2020) and Singh *et al.* (2021), who reported that unchecked weed growth significantly suppresses crop growth and yield through competition for moisture, nutrients and light.

The data on plant height, number of branches/plant, no. of pods/plant, number of seeds/pod, pod length, seed and bhusa are presented in Table 1. Plant height, no. of pods/plant, seed and bhusa yield were significantly influenced by post emergence herbicides. Whereas, these herbicides did not exert significant influence on number of branches/plant, number of seeds/pod and pod length. Plant height, no. of pods/plant, seed and bhusa yield were significantly higher with hand weeding twice at 15-20 DAS and 35-40 DAS (T7) followed by Propaquizafop 2.5% + imazethapyr 3.75% @ 1500 ml /ha as PoE at 15 – 20 DAS (T4) and Propaquizafop 2.5% + imazethapyr 3.75% @ 1000 ml /ha as PoE at 15 – 20 DAS (T3) with significant parity between these two treatments. Significantly taller plants were observed in hand weeding twice at 15-20 DAS and 35-40 DAS (T7) (79.6 cm). Among herbicide treatments, the tallest plants were observed in Propaquizafop 2.5% + imazethapyr 3.75% @ 1500 ml /ha as PoE at 15 – 20 DAS (T4) (66.2 cm) and Propaquizafop

2.5% + imazethapyr 3.75% @ 1000 ml /ha as PoE at 15 – 20 DAS (T3) (64.2 cm). The number of branches per plant varied from 6.13 to 10.1. Hand weeding twice at 15-20 DAS and 35-40 DAS (T7) had the highest number of branches (10.1), followed by Propaquizafop 2.5% + imazethapyr 3.75% @ 1500 ml /ha as PoE at 15 – 20 DAS (T4) (9.45) and Propaquizafop 2.5% + imazethapyr 3.75% @ 1000 ml /ha as PoE at 15 – 20 DAS (T3) (8.91). Treatments hand weeding twice at 15-20 DAS and 35-40 DAS (T7), Propaquizafop 2.5% + imazethapyr 3.75% @ 1500 ml /ha as PoE at 15 – 20 DAS (T4) and Propaquizafop 2.5% + imazethapyr 3.75% @ 1000 ml /ha as PoE at 15 – 20 DAS (T3), which had higher numbers of branches per plant, likely benefited from reduced weed pressure, which otherwise competes for nutrients and space. It suggests that this treatment provided optimal conditions for horsegram growth by effectively reducing weed competition. This observation aligns with findings from Kumar *et al.* (2017), who reported that effective weed management practices can enhance plant growth by minimizing competition for light, nutrients and water. Pod length ranged from 4.14 cm in weedy check (T8) to 5.30 cm in hand weeding twice at 15-20 DAS and 35-40 DAS (T7). Among herbicide treatments, Propaquizafop 2.5% + imazethapyr 3.75% @ 1500 ml /ha as PoE at 15 – 20 DAS (T4) recorded higher pod length (5.22 cm) followed by Propaquizafop 2.5% + imazethapyr 3.75% @ 1000 ml /ha as PoE at 15 – 20 DAS (T3) (5.11). The number of pods per plant was highest in hand weeding twice at 15-20 DAS and 35-40 DAS (T7) (113.3) and lowest in weedy check (T8) (37.3). Among herbicide treatments, Propaquizafop 2.5% + imazethapyr 3.75% @ 1500 ml /ha as PoE at 15 – 20 DAS (T4) recorded higher no. of pods/plant (94.4) followed by Propaquizafop 2.5% + imazethapyr 3.75% @ 1000 ml /ha as PoE at 15 – 20 DAS (T3) (87.1) and Clodinafop propargyl 8% +

aciflourfen sodium 16.5 @ 500 ml /ha as PoE at 15 – 20 DAS (T5) (72.8). Less weed density in hand weeding twice at 15-20 DAS and 35-40 DAS (T7), resulting in higher WCE, increased plant height, branches/plant and pods/plant in horsegram. Higher growth and yield attributes were observed in hand weeding twice at 15-20 DAS and 35-40 DAS (T7) which can be attributed to reduced weed density and higher weed control efficiency (WCE) resulted less competitiveness of weeds with the crop, creating a more favorable environment for crop growth and development. The better performance of combination of herbicides was due to its synergistic effect in controlling population as well as dry matter accumulation of different weed flora complex. These results are in tune with the findings of Katoch *et al.* (2023) and Poornima *et al.* (2018) .

Seed yield ranged from 648 kg/ha in weedy check (T8) to 1116 kg/ha in hand weeding twice at 15-20 DAS and 35-40 DAS (T7). Higher seed yield was recorded in hand weeding twice at 15-20 DAS and 35-40 DAS (T7) with 1116 kg/ha followed by Propaquizafop 2.5% + imazethapyr 3.75% @ 1500 ml /ha as PoE at 15 – 20 DAS (T4) with 908 kg/ha. Bhusa yield followed a similar trend, with hand weeding twice at 15-20 DAS and 35-40 DAS (T7) having the highest yield (1942 kg/ha) and weedy check (T8) has the lowest (1036 kg/ha). Among the herbicide treatments Propaquizafop 2.5% + imazethapyr 3.75% @ 1500 ml /ha as PoE at 15 – 20 DAS (T4) recorded higher bhusa yield of 1563 kg/ha followed by Propaquizafop 2.5% + imazethapyr 3.75% @ 1000 ml /ha as PoE at 15 – 20 DAS (T3) with 1544 kg/ha. The superior performance of hand weeding twice at 15-20 DAS and 35-40 DAS (T7) can be attributed to the effective and continuous suppression of weeds, which minimized competition for essential growth resources such as light, nutrients, moisture, and space, allowing the crop to utilize these resources

Table 1. Effect of post-emergence herbicides on growth and yield of horsegram

Treatments	Plant height at harvest (cm)	No. branches /plant	Pod length (cm)	No. pods/ plant	No.of seeds /Pod	Seed yield (kg/ha)	Bhusa yield (kg/ha)
T1: Imazethapyr + imazamox @ 50 g/ha as PoE at 15-20 DAS	38.1	8.33	4.44	41.3	4.64	691	1146
T2: Imazethapyr + imazamox @ 75 g/ha as PoE at 15-20 DAS	38.6	8.03	5.05	44.0	4.77	658	1061
T3: Propaquizafop 2.5% + imazethapyr 3.75% @ 1000 ml /ha as PoE at 15 – 20 DAS	64.2	8.91	5.11	87.1	4.67	846	1544
T4: Propaquizafop 2.5% + imazethapyr 3.75% @ 1500 ml /ha as PoE at 15 – 20 DAS	66.2	9.45	5.22	94.4	4.78	908	1563
T5: Clodinofof propargyl 8% + aciflourfen sodium 16.5 @ 500 ml /ha as PoE at 15-20 DAS	57.7	8.31	5.03	72.8	4.77	792	1447
T6: Clodinofof propargyl 8% + aciflourfen sodium 16.5 @ 750 ml /ha as PoE at 15-20 DAS	51.2	8.28	4.94	70.8	4.55	781	1351
T7: Hand weeding at 15-20 DAS and 35-40 DAS	79.6	10.1	5.30	113.3	5.11	1116	1942
T8: Weedy check	36.2	6.13	4.14	37.3	4.43	648	1036
S.Em+	2.63	0.35	0.52	4.72	0.41	49.6	96.7
CD @ 5 %	7.13	NS	NS	12.7	NS	138	269

more efficiently for better vegetative and reproductive growth. Similar findings were reported by Poornima *et al.* (2018) and Katoch *et al.* (2023), who observed that timely and effective weed removal enhances crop growth, photosynthetic activity and yield potential.

The enhanced seed and bhusa yields under Propaquizafop + Imazethapyr combinations (T4 and T3) may be due to their broad-spectrum control over both grassy and broadleaf weeds and their residual activity, which ensured prolonged weed suppression during the crop's

critical growth stages. Singh *et al.* (2022) and Meena *et al.* (2021) also reported that herbicide mixtures with complementary modes of action improve weed control efficiency, nutrient use efficiency, and ultimately yield in pulse and oilseed crops. Higher yields in effective weed control treatments can also be linked to improved crop canopy structure, higher photosynthetic rate, and better assimilate partitioning toward reproductive organs. According to Kumar *et al.* (2019) and Reddy *et al.* (2020), maintaining a weed-free environment

Table 2. Weed density, weed control efficiency and economics of horsegram as influenced by application of post emergence herbicides

Treatments	Weed density (no./m ²)	WCE (%)	Cost of cultivation (Rs/ha)	Gross Returns (Rs/ha)	Net Returns (Rs/ha)	B:C ratio
T1: Imazethapyr + imazamox @ 50 g/ha as PoE at 15-20 DAS	36.7	43.2	11432	22123	10691	1.94
T2: Imazethapyr + imazamox @ 75 g/ha as PoE at 15-20 DAS	36.0	44.3	11900	21045	9145	1.77
T3: Propaquizafop 2.5% + imazethapyr 3.75% @ 1000 ml /ha as PoE at 15-20 DAS	23.3	63.9	11550	27061	15511	2.34
T4: Propaquizafop 2.5% + imazethapyr 3.75% @ 1500 ml / ha as PoE at 15 – 20 DAS	22.7	64.9	12075	29056	16981	2.41
T5: Clodinofof propargyl 8% + aciflourfensodium 16.5 @ 500 ml / ha as PoE at 15 – 20 DAS	30.7	52.5	11615	25344	13729	2.18
T6: Clodinofof propargyl 8% + aciflourfensodium 16.5 @ 750 ml / ha as PoE at 15 – 20 DAS	29.3	54.7	12170	25003	12833	2.05
T7: Hand weeding at 15-20 DAS and 35-40 DAS	4.2	93.5	16600	35701	19101	2.15
T8: Weedy check	64.7	-	10150	20725	10575	2.04

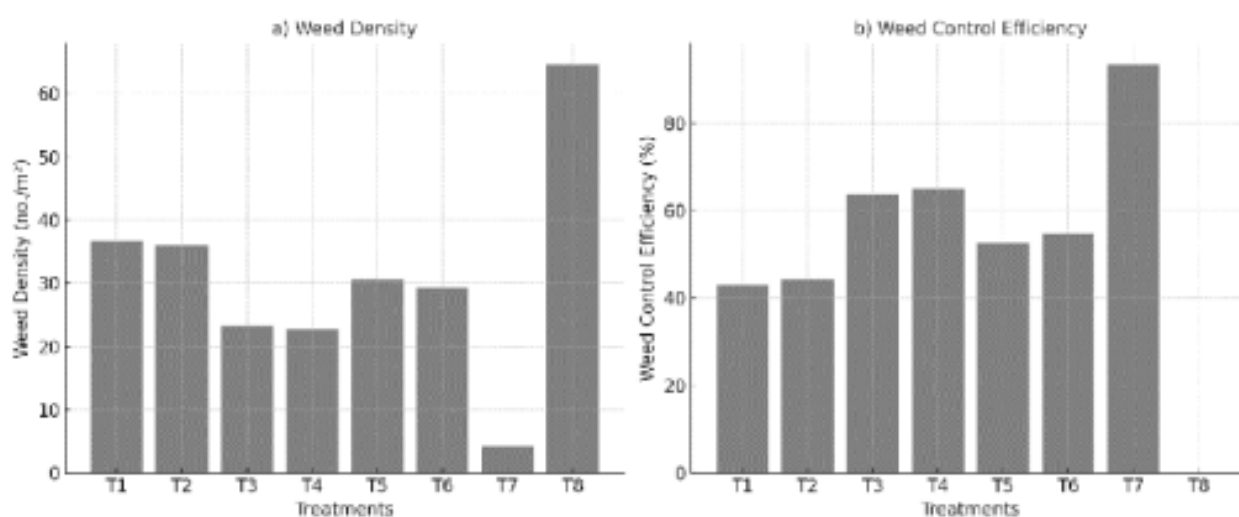


Fig 1. Effect of Post Emergence Herbicide on Weed Density and WCE in Horse gram

during early crop establishment plays a critical role in enhancing yield attributes and final productivity in pulses. Moreover, early weed removal helps reduce competition for soil moisture, particularly under rainfed conditions, which is crucial for optimizing productivity in dryland crops like horsegram. The lowest seed and bhusa yields in the weedy check (T8) were due to severe weed infestation, which led to intense competition for growth resources and substantial depletion of soil nutrients and moisture. This finding corroborates the reports of Choudhary *et al.* (2020) and Bairwa *et al.* (2023), who emphasized that unchecked weed growth drastically reduces crop productivity through higher weed biomass accumulation and greater crop–weed competition.

Economics revealed the cost of cultivation ranged from Rs.10,150/ha in weedy check (T8) to Rs. 16,600/ha in hand weeding twice at 15-20 DAS and 35-40 DAS (T7), indicating that some weed management practices are more cost-intensive than others. Hand weeding twice at 15-20 DAS and 35-40 DAS (T7) had the highest gross returns (Rs. 35,701/ha) and net returns (Rs. 19,101/ha), while weedy check (T8) had the lowest gross returns (Rs. 20,725/ha) and lowest net returns were with Imazethapyr + imazamox @ 75 g/ha as PoE at 15 – 20 DAS (T2) (Rs. 9,145/ha). This shows that despite the higher cost of cultivation, the returns in hand weeding twice at 15-20 DAS and 35-40 DAS are substantially higher, making it economically beneficial. Among herbicide treatments, higher gross returns and net returns were recorded in Propaquizafop 2.5% + imazethapyr 3.75% @ 1500 ml /ha as PoE at 15 – 20 DAS (T4) with Rs. 29,056 and 16,981 /ha, respectively. The B:C ratio was highest in Propaquizafop 2.5% + imazethapyr 3.75% @ 1500 ml /ha as PoE at 15 – 20 DAS (T4) (2.41) followed by Propaquizafop 2.5% + imazethapyr 3.75% @ 1000 ml /ha as PoE at 15 – 20 DAS (T3) (2.34)

and Clodinofof propargyl 8% + aciflourfen sodium 16.5 @ 500 ml /ha as PoE at 15 – 20 DAS (T5) (2.18), suggesting that these treatments are more profitable. Even though hand weeding at 15-20 DAS and 35-40 DAS produced a higher gross and net returns, the B:C ratio was lower because two hand weedings incurred more expenditure to maintain the weed free condition.

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