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Effect of pre and post-emergence herbicides on growth and yield of horsegram [*Macrotyloma uniflorum* (L.) Verdc.]

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Abstract
A field experiment entitled "Effect of pre- and post-emergence herbicides on growth and yield of horsegram [*Macrotyloma uniflorum* (L.) Verdc.]" was conducted during the post-*kharif* season of 2024 at the Research cum Instructional Farm, Barrister Thakur Chhedilal College of Agriculture and Research Station, Bilaspur (C.G.). The study was laid out in a Randomized Block Design with three replications and evaluated ten weed management treatments: (T_1) Control, (T_2) Weed free, (T_3) Pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence, (T_4) Oxyfluorfen (23.5% EC) @ 100 g a.i. ha^{-1} as pre-emergence, (T_5) Imazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS, (T_6) Quizalofop ethyl (5% EC) @ 50 g a.i. ha^{-1} as post-emergence at 20 DAS, (T_7) Pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence + Imazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS, (T_8) Pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence + Quizalofop ethyl (5% EC) @ 50 g a.i. ha^{-1} as post-emergence at 20 DAS, (T_9) Oxyfluorfen (23.5% EC) @ 100 g a.i. ha^{-1} as pre-emergence + Imazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS and (T_{10}) Oxyfluorfen (23.5% EC) @ 100 g a.i. ha^{-1} as pre-emergence + Quizalofop ethyl (5% EC) @ 50 g a.i. ha^{-1} as post-emergence at 20 DAS. The results revealed that the (T_2) Weed free recorded the highest growth, yield attributes, grain yield, and gross returns, while among herbicidal treatments, (T_7) Pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence + Imazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS and (T_8) Pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence + Quizalofop ethyl (5% EC) @ 50 g a.i. ha^{-1} as post-emergence at 20 DAS were most effective in improving yield and controlling weeds. Although (T_2) Weed free produced the maximum yield, the highest benefit-cost ratio was observed with (T_7) Pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence + Imazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS followed by (T_8) Pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence + Quizalofop ethyl (5% EC) @ 50 g a.i. ha^{-1} as post-emergence at 20 DAS. These treatments efficiently suppressed broad-leaved weeds, grasses, and sedges, resulting in higher weed control efficiency and lower weed index. The study suggests that integrating Pendimethalin with either Imazethapyr or Quizalofop ethyl provides an economical and effective weed management strategy for horsegram under Chhattisgarh conditions.

Keywords: Horsegram, Pendimethalin, Oxyfluorfen, Imazethapyr, Quizalofop ethyl, Yield, Economics

Introduction
Horsegram (*Macrotyloma uniflorum* (L.) Verdc.) is a leguminous pulse belonging to the Fabaceae family. Although it is nutritionally rich and has multiple uses, it remains an underexploited legume. Its seeds are commonly consumed as dal and form an ingredient in traditional dishes such as rasam in Indian cuisine. Beyond human consumption, horsegram serves as a high-protein livestock feed, contributing to cattle nutrition, and is also used as green manure, improving soil fertility in agricultural systems. Known by various regional names, horsegram reflects its widespread cultivation and cultural significance: in Sanskrit, it is called Kulattha; in Bengali, Kurti-kalai; in Tamil, Kollu; in Telugu, Ullavallu; in Malayalam, Muthira; and in other regions, Gahot. This diversity of names highlights its importance across different parts of India (Naik *et al.*, 2022) [20]. Horsegram is highly valued for its nutritional richness, making

it an important component of the diet, particularly in areas where it is grown. It contains approximately 25% protein and 60% carbohydrates, along with essential amino acids, making it a significant energy source. The crop also supplies important nutrients such as fats, iron, and molybdenum, enhancing its overall nutritional profile. In India, horsegram is appreciated not only for its dietary value but also for its ethno-medicinal significance, with consumption linked to various health benefits, establishing it as a pulse crop with both nutritional and medicinal properties (Kalyani *et al*., 2023) [15].

In India, horsegram is grown as a pulse crop and accounts for about 0.33 percent of all grain production. In India, horsegram was planted on 0.458 million hectares in 2019-2020, yielding 0.297 million tonnes of product and 6.48 q ha^{-1} of productivity (Anonymous, 2020) [2]. Horsegram exhibits excellent adaptability to diverse soil and climatic conditions, making it a resilient crop, especially in areas with low rainfall and fluctuating temperatures. It grows well in regions receiving 200-700 mm of rainfall and temperatures between 20-35°C, demonstrating notable drought tolerance. Regarding soil, horsegram is highly versatile, performing well in loams, black cotton soils, clayey paddy soils, sandy and shallow soils, stony uplands, and reclaimed forest lands. This adaptability supports its widespread cultivation across multiple agro-ecological zones in India.

Maintaining a weed-free environment is essential for maximizing yield and securing income in horsegram cultivation. Effective weed management strategies play a key role in minimizing yield losses and ensuring crop success. Such strategies may include cultural practices like crop rotation, mulching, and intercropping, as well as mechanical methods such as manual weeding and the use of appropriate tools. Additionally, the judicious use of herbicides can be an integral part of weed management if applied carefully according to recommended guidelines to reduce environmental impact (Singh *et al*., 2017) [33]. Among pre-emergence options, pendimethalin has been shown to be effective in pulse crops; it is a selective herbicide absorbed through roots and leaves, causing susceptible weeds to die shortly after germination or emergence. Studies indicate that pre-emergence application of pendimethalin efficiently controls early-emerging broadleaf and annual grassy weeds (Khairnar *et al*., 2013) [16]. However, if the pre-emergence application is missed, farmers must rely on post-emergence herbicides. Limited research on post-emergence herbicides in horsegram has prompted evaluation of imazethapyr and quizalofop-ethyl, both of which have demonstrated efficacy in other pulse crops. These systemic post-emergence herbicides are absorbed through roots and foliage, translocated via the xylem and phloem, and accumulate in meristematic regions, effectively controlling major annual and perennial grasses as well as broadleaf weeds in leguminous crops (Gelot *et al*., 2018) [11]. For effective weed control, herbicides must be selected based on weed species and growth stage, with strict adherence to recommended rates and timing, ensuring optimal control while minimizing risks to non-target organisms, human health, and the environment.

Material and Methods

A field experiment was carried out during the *post-kharif* season of 2024 at the Instructional Cum Research Farm, Barrister Thakur Chhedilal College of Agriculture and Research Station, Bilaspur (C.G.). Horsegram was sown at the recommended depth using 25 kg seed ha^{-1}, with fertilization applied at a rate of 20:50:20 kg ha^{-1} ($N:P_2O_5:K_2O$). Prior to sowing, seeds were treated with Bavistin and Rhizobium culture to ensure healthy germination. The crop was irrigated immediately after sowing to promote uniform emergence. Pre-emergence herbicides were applied the day following sowing, while post-emergence herbicide sprays were carried out at 20 DAS, using a knapsack sprayer with a flat fan nozzle and 500 litres of water ha^{-1}. In the weed-free plots, hand weeding was performed every seven days. Standard cultural practices recommended for horsegram were followed throughout the growing period. Observations were recorded on various growth and yield parameters, including plant population, plant height, number of leaves, number of primary branches, dry matter accumulation, crop growth rate, relative growth rate, leaf area index, leaf area duration, number of pods, number of seeds, pod length, test weight, biological yield, grain yield, stover yield, and harvest index. Statistical analysis was conducted following Gomez and Gomez (1984), and the critical difference (CD) at 5% probability was calculated wherever significant differences were observed. Additionally, the economic analysis of horsegram was carried out in terms of net return, gross return, and benefit-cost ratio.

Results and Discussions

Effect on crop

The treatment with weed free (T_2) followed by pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence + imazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS (T_7) was found to have the highest plant height, number of leaves, number of primary branches, dry matter accumulation leaf area duration and leaf area index at 20 DAS, significantly more than any other treatment, with the exception of treatment withimazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS (T_5), quizalofop ethyl (5% EC) @ 50 g a.i. ha^{-1} as post-emergence at 20 DAS (T_6) and control plot (T_1). However, at 40, 60 DAS and at harvest, significantly the highest plant height, number of leaves, number of primary branches, dry matter accumulation, leaf area duration and leaf area index were recorded under weed free (T_2) followed by pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence + imazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS (T_7) which was at par with pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence + quizalofop ethyl (5% EC) @ 50 g a.i. ha^{-1} as post-emergence at 20 DAS (T_8). Treatment oxyfluorfen (23.5% EC) @ 100 g a.i. ha^{-1} as pre-emergence + imazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS (T_9) next superior treatment and which was at par with oxyfluorfen (23.5% EC) @ 100 g a.i. ha^{-1} as pre-emergence + quizalofop ethyl (5% EC) @ 50 g a.i. ha^{-1} as post-emergence at 20 DAS(T_{10}) and were significantly superior over the treatments quizalofop ethyl (5% EC) @ 50 g a.i. ha^{-1} as post-emergence at 20 DAS (T_6), pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence (T_3), oxyfluorfen (23.5% EC) @ 100 g a.i. ha^{-1} as pre-emergence (T_4) and imazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS (T_5). The lowest was recorded under control plot (T_1).

The number of pods, pod length, number of seeds, test weight, biological yield, grain yield, stover yield and harvest index that plants are able to produce is dependent on a variety of factors, including the size, efficiency and duration of their photosynthetic systems as well as the translocation of dry matter into economic sinks. The cumulative function of the yield components results in the final build-up of yield. The black gram crop may have used moisture, nutrients, light and space more efficiently in the absence of weed competition, as evidenced by the higher number of pods, pod length, number of seeds, test weight, biological yield, grain yield, stover yield and harvest index under the conditions mentioned above. Comparable results were noted by Mishra *et al*. (2017) [22].

Data related to number of pods, pod length, number of seeds, test weight, grain yield, biological yield, stover yield and harvest index as affected by various weed management practices on horsegram are presented in Table 7 and 8 reveals that amongst weed management practices, maximum under weed free (T_2), followed by pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence + imazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS (T_7) which was at par with pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence + quizalofop ethyl (5% EC) @ 50 g a.i. ha^{-1} as post-emergence at 20 DAS (T_8). Treatment oxyfluorfen (23.5% EC) @ 100 g a.i. ha^{-1} as pre-emergence + imazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS (T_9) next superior treatment and which was at par with oxyfluorfen (23.5% EC) @ 100 g a.i. ha^{-1} as pre-emergence + quizalofop ethyl (5% EC) @ 50 g a.i. ha^{-1} as post-emergence at 20 DAS(T_{10}) and were significantly superior over the treatments pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence (T_3), oxyfluorfen (23.5% EC) @ 100 g a.i. ha^{-1} as pre-emergence (T_4), imazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS (T_5) and quizalofop ethyl (5% EC) @ 50 g a.i. ha^{-1} as post-emergence at 20 DAS (T_6). All The above treatments were significantly superior over the treatments of control plot (T_1). Similar findings also reported by Bhowmick *et al.* (2015) [3]. Test weight and harvest index were recorded not significant.

Table 1: Effect of pre and post-emergence herbicides on plant height of horsegram

Treatments	Plant height (cm)			
	20 DAS	40 DAS	60 DAS	At harvest
T_1 - Control	17.32	34.45	51.27	65.34
T_2 - Weed free	19.95	41.25	63.54	78.25
T_3 - Pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence	18.91	36.88	55.55	68.95
T_4 - Oxyfluorfen (23.5% EC) @ 100 g a.i. ha^{-1} as pre-emergence	18.88	36.67	55.26	68.43
T_5 - Imazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS	17.67	36.28	54.95	67.88
T_6 - Quizalofop ethyl (5% EC) @ 50 g a.i. ha^{-1} as post-emergence at 20 DAS	17.53	35.98	54.76	67.23
T_7 - Pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence + Imazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS	19.12	39.92	61.29	75.12
T_8 - Pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence + Quizalofop ethyl (5% EC) @ 50 g a.i. ha^{-1} as post-emergence at 20 DAS	19.06	39.74	61.05	74.56
T_9 - Oxyfluorfen (23.5% EC) @ 100 g a.i. ha^{-1} as pre-emergence + Imazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS	18.99	38.35	58.94	72.04
T_{10} - Oxyfluorfen (23.5% EC) @ 100 g a.i. ha^{-1} as pre-emergence + Quizalofop ethyl (5% EC) @ 50 g a.i. ha^{-1} as post-emergence at 20 DAS	18.94	38.23	58.47	71.47
SEm (±)	0.27	0.43	0.66	0.81
CD (5%)	0.79	1.28	1.97	2.41

Table 2: Effect of pre and post-emergence herbicides on number of branches of horsegram.

Treatments	Number of primary branches $plant^{-1}$			
	20 DAS	40 DAS	60 DAS	At harvest
T_1 - Control	2.21	4.26	6.28	6.54
T_2 - Weed free	2.82	6.13	9.04	9.42
T_3 - Pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence	2.48	5.14	7.33	7.64
T_4 - Oxyfluorfen (23.5% EC) @ 100 g a.i. ha^{-1} as pre-emergence	2.51	5.06	7.23	7.53
T_5 - Imazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS	2.27	4.98	7.15	7.45
T_6 - Quizalofop ethyl (5% EC) @ 50 g a.i. ha^{-1} as post-emergence at 20 DAS	2.25	4.92	7.07	7.36
T_7 - Pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence + Imazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS	2.59	5.86	8.59	8.95
T_8 - Pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence + Quizalofop ethyl (5% EC) @ 50 g a.i. ha^{-1} as post-emergence at 20 DAS	2.56	5.75	8.42	8.77
T_9 - Oxyfluorfen (23.5% EC) @ 100 g a.i. ha^{-1} as pre-emergence + Imazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS	2.52	5.52	7.92	8.25
T_{10} - Oxyfluorfen (23.5% EC) @ 100 g a.i. ha^{-1} as pre-emergence + Quizalofop ethyl (5% EC) @ 50 g a.i. ha^{-1} as post-emergence at 20 DAS	2.58	5.48	7.80	8.12
SEm (±)	0.06	0.08	0.12	0.14
CD (5%)	0.18	0.24	0.36	0.39

Table 3: Effect of pre and post-emergence herbicides on number of leaves of horsegram.

Treatments	Number of leaves $plant^{-1}$			
	20 DAS	40 DAS	60 DAS	At harvest
T_1 - Control	4.79	6.64	11.08	7.17
T_2 - Weed free	6.45	9.92	16.56	10.71
T_3 - Pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence	5.72	8.05	14.24	8.69
T_4 - Oxyfluorfen (23.5% EC) @ 100 g a.i. ha^{-1} as pre-emergence	5.63	7.91	14.11	8.54
T_5 - Imazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS	5.02	7.72	13.99	8.34
T_6 - Quizalofop ethyl (5% EC) @ 50 g a.i. ha^{-1} as post-emergence at 20 DAS	4.88	7.68	13.86	8.29
T_7 - Pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence + Imazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS	5.94	9.33	15.98	10.08
T_8 - Pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence + Quizalofop ethyl (5% EC) @ 50 g a.i. ha^{-1} as post-emergence at 20 DAS	5.89	9.16	15.87	9.89
T_9 - Oxyfluorfen (23.5% EC) @ 100 g a.i. ha^{-1} as pre-emergence + Imazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS	5.85	8.71	15.05	9.41

T_{10} - Oxyfluorfen (23.5% EC) @ 100 g a.i. ha^{-1} as pre-emergence + Quizalofop ethyl (5% EC) @ 50 g a.i. ha^{-1} as post-emergence at 20 DAS	5.78	8.63	14.89	9.32
SEm (±)	0.17	0.14	0.17	0.15
CD (5%)	0.48	0.40	0.51	0.42

Table 4: Effect of pre and post-emergence herbicides on dry matter accumulation of horsegram.

Treatments	Dry matter accumulation (g $plant^{-1}$)			
	20 DAS	40 DAS	60 DAS	At harvest
T_1 - Control	1.69	3.33	11.85	15.78
T_2 - Weed free	3.28	12.19	28.56	38.37
T_3 - Pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence	2.42	5.59	16.68	22.35
T_4 - Oxyfluorfen (23.5% EC) @ 100 g a.i. ha^{-1} as pre-emergence	2.36	5.52	16.33	21.88
T_5 - Imazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS	1.82	5.47	15.97	21.40
T_6 - Quizalofop ethyl (5% EC) @ 50 g a.i. ha^{-1} as post-emergence at 20 DAS	1.75	5.42	15.64	20.96
T_7 - Pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence + Imazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS	2.66	10.05	25.45	34.10
T_8 - Pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence + Quizalofop ethyl (5% EC) @ 50 g a.i. ha^{-1} as post-emergence at 20 DAS	2.61	9.91	24.12	32.32
T_9 - Oxyfluorfen (23.5% EC) @ 100 g a.i. ha^{-1} as pre-emergence + Imazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS	2.55	7.87	21.03	28.18
T_{10} - Oxyfluorfen (23.5% EC) @ 100 g a.i. ha^{-1} as pre-emergence + Quizalofop ethyl (5% EC) @ 50 g a.i. ha^{-1} as post-emergence at 20 DAS	2.49	7.68	19.84	26.59
SEm (±)	0.16	0.54	1.01	1.39
CD (5%)	0.46	1.59	3.02	4.12

Table 5: Effect of pre and post-emergence herbicides on leaf area indexof horsegram.

Treatments	Leaf area index			
	20 DAS	40 DAS	60 DAS	At harvest
T_1 - Control	0.61	0.68	0.75	0.71
T_2 - Weed free	0.98	1.16	1.28	1.26
T_3 - Pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence	0.82	0.81	0.89	0.86
T_4 - Oxyfluorfen (23.5% EC) @ 100 g a.i. ha^{-1} as pre-emergence	0.81	0.81	0.89	0.86
T_5 - Imazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS	0.65	0.80	0.88	0.85
T_6 - Quizalofop ethyl (5% EC) @ 50 g a.i. ha^{-1} as post-emergence at 20 DAS	0.63	0.79	0.87	0.84
T_7 - Pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence + Imazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS	0.86	1.05	1.16	1.14
T_8 - Pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence + Quizalofop ethyl (5% EC) @ 50 g a.i. ha^{-1} as post-emergence at 20 DAS	0.85	1.04	1.14	1.13
T_9 - Oxyfluorfen (23.5% EC) @ 100 g a.i. ha^{-1} as pre-emergence + Imazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS	0.84	0.93	1.02	1.00
T_{10} - Oxyfluorfen (23.5% EC) @ 100 g a.i. ha^{-1} as pre-emergence + Quizalofop ethyl (5% EC) @ 50 g a.i. ha^{-1} as post-emergence at 20 DAS	0.82	0.92	1.01	0.99
SEm (±)	0.04	0.04	0.04	0.05
CD (5%)	0.11	0.10	0.12	0.13

Table 6: Effect of pre and post-emergence herbicides on leaf area durationof horsegram.

Treatments	Leaf area duration (days)			
	20 DAS	40 DAS	60 DAS	At harvest
T_1 - Control	6.46	10.72	12.01	10.91
T_2 - Weed free	9.25	23.54	26.36	25.61
T_3 - Pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence	7.86	14.04	15.72	15.23
T_4 - Oxyfluorfen (23.5% EC) @ 100 g a.i. ha^{-1} as pre-emergence	7.85	13.99	15.67	15.17
T_5 - Imazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS	6.55	13.94	15.61	15.10
T_6 - Quizalofop ethyl (5% EC) @ 50 g a.i. ha^{-1} as post-emergence at 20 DAS	6.51	13.88	15.55	15.02
T_7 - Pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence + Imazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS	7.92	20.49	22.95	22.64
T_8 - Pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence + Quizalofop ethyl (5% EC) @ 50 g a.i. ha^{-1} as post-emergence at 20 DAS	7.90	20.38	22.83	22.50
T_9 - Oxyfluorfen (23.5% EC) @ 100 g a.i. ha^{-1} as pre-emergence + Imazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS	7.89	17.24	19.31	18.40
T_{10} - Oxyfluorfen (23.5% EC) @ 100 g a.i. ha^{-1} as pre-emergence + Quizalofop ethyl (5% EC) @ 50 g a.i. ha^{-1} as post-emergence at 20 DAS	7.87	17.13	19.19	18.26
SEm (±)	0.42	1.01	1.08	1.17
CD (5%)	1.27	3.01	3.22	3.48

Table 7: Effect of pre and post-emergence herbicides on number of pods, pod length, number of seeds and test weight of horsegram.

Treatments	Number of pods plant^{-1}	Pod length (cm)	Number of seeds pod^{-1}	Test weight (gm)
T_1 - Control	12.16	4.56	4.18	28.71
T_2 - Weed free	29.12	6.97	6.39	30.65
T_3 - Pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence	17.21	5.43	4.98	29.49
T_4 - Oxyfluorfen (23.5% EC) @ 100 g a.i. ha^{-1} as pre-emergence	16.78	5.35	4.91	29.44
T_5 - Imazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS	16.32	5.26	4.83	29.27
T_6 - Quizalofop ethyl (5% EC) @ 50 g a.i. ha^{-1} as post-emergence at 20 DAS	15.98	5.14	4.72	29.08
T_7 - Pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence + Imazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS	25.95	6.56	6.02	30.41
T_8 - Pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence + Quizalofop ethyl (5% EC) @ 50 g a.i. ha^{-1} as post-emergence at 20 DAS	24.56	6.40	5.87	30.19
T_9 - Oxyfluorfen (23.5% EC) @ 100 g a.i. ha^{-1} as pre-emergence + Imazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS	21.34	5.98	5.49	29.82
T_{10} - Oxyfluorfen (23.5% EC) @ 100 g a.i. ha^{-1} as pre-emergence + Quizalofop ethyl (5% EC) @ 50 g a.i. ha^{-1} as post-emergence at 20 DAS	20.73	5.90	5.41	29.61
SEm (±)	1.06	0.13	0.12	1.94
CD (5%)	3.14	0.38	0.34	NS

Table 8: Effect of pre and post-emergence herbicides on grain yield, stover yield, biological yield and harvest index of horsegram.

Treatments	Grain yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest index (%)
T_1 - Control	514.58	903.51	1418.09	36.29
T_2 - Weed free	1165.42	1596.25	2761.67	42.20
T_3 - Pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence	703.57	1114.45	1818.02	38.70
T_4 - Oxyfluorfen (23.5% EC) @ 100 g a.i. ha^{-1} as pre-emergence	691.24	1106.26	1797.50	38.46
T_5 - Imazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS	686.73	1098.72	1785.45	38.46
T_6 - Quizalofop ethyl (5% EC) @ 50 g a.i. ha^{-1} as post-emergence at 20 DAS	662.46	1092.65	1755.11	37.74
T_7 - Pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence + Imazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS	1022.54	1438.62	2461.16	41.55
T_8 - Pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence + Quizalofop ethyl (5% EC) @ 50 g a.i. ha^{-1} as post-emergence at 20 DAS	1003.71	1430.57	2434.28	41.23
T_9 - Oxyfluorfen (23.5% EC) @ 100 g a.i. ha^{-1} as pre-emergence + Imazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS	868.13	1276.47	2144.60	40.48
T_{10} - Oxyfluorfen (23.5% EC) @ 100 g a.i. ha^{-1} as pre-emergence + Quizalofop ethyl (5% EC) @ 50 g a.i. ha^{-1} as post-emergence at 20 DAS	854.78	1269.75	2124.53	40.23
SEm (±)	43.61	50.13	95.89	1.86
CD (5%)	129.58	148.95	284.92	NS

Effect on weeds

The weed flora identified in the experimental field comprised monocot, sedge and dicot species, reflecting the diverse weed population typically associated with field crops and presented in Table 9. Among the monocots, *Echinochloa crusgalli* (barnyard grass), *Eichinochloa colonum* (Sawan) and *Cynodon dactylon* (doob grass) were dominant grassy weeds, which are known for their aggressive growth and highly competitive ability with crops due to rapid tillering and efficient nutrient utilization.

Weed control efficiency of different weed species at 20, 40, 60 DAS and at harvest are presented in Table 12. The results show that the treatment weed free (T_2) had the significantly highest weed control efficiency at 20 DAS, followed by pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence + imazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS (T_7). This was comparable to pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence + quizalofop ethyl (5% EC) @ 50 g a.i. ha^{-1} as post-emergence at 20 DAS (T_8), oxyfluorfen (23.5% EC) @ 100 g a.i. ha^{-1} as pre-emergence + imazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS (T_9), oxyfluorfen (23.5% EC) @ 100 g a.i. ha^{-1} as pre-emergence + ouizalofop ethyl (5% EC) @ 50 g a.i. ha^{-1} as post-emergence at 20 DAS (T_{10}), pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence (T_3) and oxyfluorfen (23.5% EC) @ 100 g a.i. ha^{-1} as pre-emergence(T_4). The lowest WCE was observed in T_1 - Control (0%), as no weed management measure was applied.

However, weed free (T_2) had by far the highest weed control efficiencyat 40, 60 DAS and at harvest. Pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence + imazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS (T_7), followed closely behind and was on at par with pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence + quizalofop ethyl (5% EC) @ 50 g a.i. ha^{-1} as post-emergence at 20 DAS (T_8). The next best treatment was oxyfluorfen (23.5% EC) @ 100 g a.i. ha^{-1} as pre-emergence + imazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS (T_9), which was comparable to oxyfluorfen (23.5% EC) @ 100 g a.i. ha^{-1} as pre-emergence + ouizalofop ethyl (5% EC) @ 50 g a.i. ha^{-1} as post-emergence at 20 DAS (T_{10}). These treatments were significantly better than pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence(T_3), oxyfluorfen (23.5% EC) @ 100 g a.i. ha^{-1} as pre-emergence(T_4), imazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS(T_5) and quizalofop ethyl (5% EC) @ 50 g a.i. ha^{-1} as post-emergence at 20 DAS(T_6). The minimum WCE recorded under control (T_1).

Weed index had remarkably influenced by weed management practices are presented in table 13. Maximum weed index was noticed under control plot (T_1), which was 55.85%. Similar results confirm the findings of Tiwari *et al*. (2017) [35] and Yassin *et al*. (2023) [38]. Whereas, minimum weed index was registered under Pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence + imazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS (T_7), which was12.26% followed by pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence + quizalofop ethyl (5% EC) @ 50 g a.i. ha^{-1} as post-emergence at 20 DAS (T_8), which was 13.88%.

Table 9: Weed flora identification.

S. No.	Common name	Family	Scientific name
Monocot			
1	Barnyard grass	Poaceae	*Eichnochloa crusgalli*
2	Doob grass	Poaceae	*Cynodon dactylon* (L.)
3	Sawan	Poaceae	*Eichinochloa colonum*
Sedges			
3	Motha	Cyperaceae	*Cyperus rotundus* (L.)
4	Hoorahgrass	Cyperaceae	*Fimbrystylis milicea*
Dicot			
5	Monarch redstem	Lythraceae	*Ammania baccifera*
6	False daisy	Asteraceace	*Eclipta alba*
7	Water primerose	Onagraceae	*Ludwigia parviflora*
8	European water clover	Marsileaceae	*Marselia quadrifolia*
9	Hazardana	Phyllanthaceae	*Phyllanthus* spp.
10	Congresgrass	Asteraceace	*Parthenium hysterophorus*

Table 10: Effect of pre and post-emergence herbicides on weed density of horsegram.

Treatments	Weed density (m^{-2})			
	20 DAS	40 DAS	60 DAS	At harvest
T_1 - Control	14.92	19.22	22.85	24.82
T_2 - Weed free	0.00	0.00	0.00	0.00
T_3 - Pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence	9.87	8.36	6.77	5.77
T_4 - Oxyfluorfen (23.5% EC) @ 100 g a.i. ha^{-1} as pre-emergence	9.98	8.42	6.82	5.81
T_5 - Imazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS	14.56	8.56	6.93	5.91
T_6 - Quizalofop ethyl (5% EC) @ 50 g a.i. ha^{-1} as post-emergence at 20 DAS	14.85	8.78	7.11	6.06
T_7 - Pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence + Imazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS	9.45	5.23	4.24	3.61
T_8 - Pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence + Quizalofop ethyl (5% EC) @ 50 g a.i. ha^{-1} as post-emergence at 20 DAS	9.67	5.34	4.33	3.68
T_9 - Oxyfluorfen (23.5% EC) @ 100 g a.i. ha^{-1} as pre-emergence + Imazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS	9.78	6.68	5.41	4.61
T_{10} - Oxyfluorfen (23.5% EC) @ 100 g a.i. ha^{-1} as pre-emergence + Quizalofop ethyl (5% EC) @ 50 g a.i. ha^{-1} as post-emergence at 20 DAS	9.82	6.75	5.47	4.66
SEm (±)	0.70	0.43	0.35	0.28
CD (5%)	2.08	1.29	1.04	0.83

Table 11: Effect of pre and post-emergence herbicides on weed dry matter of horsegram.

Treatments	Weed dry matter (g m^{-2})			
	20 DAS	40 DAS	60 DAS	At harvest
T_1 - Control	46.76	57.66	70.84	76.94
T_2 - Weed free	0.00	0.00	0.00	0.00
T_3 - Pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence	29.61	25.08	20.31	16.73
T_4 - Oxyfluorfen (23.5% EC) @ 100 g a.i. ha^{-1} as pre-emergence	29.94	25.26	20.46	16.85
T_5 - Imazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS	45.68	25.68	20.80	17.13
T_6 - Quizalofop ethyl (5% EC) @ 50 g a.i. ha^{-1} as post-emergence at 20 DAS	46.55	26.34	21.34	17.57
T_7 - Pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence + Imazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS	28.35	15.69	12.71	9.47
T_8 - Pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence + Quizalofop ethyl (5% EC) @ 50 g a.i. ha^{-1} as post-emergence at 20 DAS	29.01	16.02	12.98	9.69
T_9 - Oxyfluorfen (23.5% EC) @ 100 g a.i. ha^{-1} as pre-emergence + Imazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS	29.34	20.04	16.23	13.37
T_{10} - Oxyfluorfen (23.5% EC) @ 100 g a.i. ha^{-1} as pre-emergence + Quizalofop ethyl (5% EC) @ 50 g a.i. ha^{-1} as post-emergence at 20 DAS	29.46	20.25	16.40	13.51
SEm (±)	2.05	1.33	1.08	1.20
CD (5%)	6.12	3.98	3.21	3.57

Table 12: Effect of pre and post-emergence herbicides on weed control efficiency of horsegram.

Treatments	Weed control efficiency (%)			
	20 DAS	40 DAS	60 DAS	At harvest
T_1 - Control	0.00	0.00	0.00	0.00
T_2 - Weed free	100.00	100.00	100.00	100.00
T_3 - Pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence	26.45	56.50	71.32	78.26
T_4 - Oxyfluorfen (23.5% EC) @ 100 g a.i. ha^{-1} as pre-emergence	25.94	56.19	71.12	78.10
T_5 - Imazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS	0.00	55.46	70.64	77.74
T_6 - Quizalofop ethyl (5% EC) @ 50 g a.i. ha^{-1} as post-emergence at 20 DAS	0.00	54.32	69.88	77.17

T_7 - Pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence + Imazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS	28.39	72.79	82.06	87.70
T_8 - Pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence + Quizalofop ethyl (5% EC) @ 50 g a.i. ha^{-1} as post-emergence at 20 DAS	27.37	72.22	81.68	87.41
T_9 - Oxyfluorfen (23.5% EC) @ 100 g a.i. ha^{-1} as pre-emergence + Imazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS	26.86	65.24	77.09	82.63
T_{10} - Oxyfluorfen (23.5% EC) @ 100 g a.i. ha^{-1} as pre-emergence + Quizalofop ethyl (5% EC) @ 50 g a.i. ha^{-1} as post-emergence at 20 DAS	26.68	64.88	76.85	82.45
SEm (±)	1.83	2.34	1.52	1.59
CD (5%)	5.46	6.98	4.51	4.74

Table 13: Effect of pre and post-emergence herbicides on weed index of horsegram.

Treatments	Weed index (%)
T_1 - Control	55.85
T_2 - Weed free	0.00
T_3 - Pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence	39.63
T_4 - Oxyfluorfen (23.5% EC) @ 100 g a.i. ha^{-1} as pre-emergence	40.69
T_5 - Imazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS	41.07
T_6 - Quizalofop ethyl (5% EC) @ 50 g a.i. ha^{-1} as post-emergence at 20 DAS	43.16
T_7 - Pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence + Imazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS	12.26
T_8 - Pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence + Quizalofop ethyl (5% EC) @ 50 g a.i. ha^{-1} as post-emergence at 20 DAS	13.88
T_9 - Oxyfluorfen (23.5% EC) @ 100 g a.i. ha^{-1} as pre-emergence + Imazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS	25.51
T_{10} - Oxyfluorfen (23.5% EC) @ 100 g a.i. ha^{-1} as pre-emergence + Quizalofop ethyl (5% EC) @ 50 g a.i. ha^{-1} as post-emergence at 20 DAS	26.65

Effect on crop economics

The data on cost of cultivation, gross return, net return, and benefit: cost (B:C) ratio as influenced by different weed management treatments are presented in Table 14. The highest cost of cultivation (₹ 32,136.78 ha^{-1}) was recorded under T_8 - Pendimethalin (30% EC) 850 g ha^{-1} as pre-emergence + Quizalofop ethyl (5% EC) 50 g ha^{-1} as post-emergence at 20 DAS, followed by T_7 - Pendimethalin (30% EC) 850 g ha^{-1} as pre-emergence + Imazethapyr (10% SL) 75 g ha^{-1} as post-emergence at 20 DAS, while the minimum cost of cultivation was noted under the control plot (T_1) (₹ 27,468.78 ha^{-1}). The highest gross return (₹ 95,627.98 ha^{-1}) and net return (₹ 56,873.20 ha^{-1}) were obtained under T_2 - Weed free, followed by T_7 (gross return ₹ 83,961.13 ha^{-1} and net return ₹ 52,224.35 ha^{-1}) and T_8 (gross return ₹ 82,442.66 ha^{-1} and net return ₹ 50,305.88 ha^{-1}). The highest B:C ratio (1.65) was recorded under T_7 - Pendimethalin (30% EC) 850 g ha^{-1} as pre-emergence + Imazethapyr (10% SL) 75 g ha^{-1} as post-emergence at 20 DAS, which was closely followed by T_8 - Pendimethalin (30% EC) 850 g ha^{-1} as pre-emergence + Quizalofop ethyl (5% EC) 50 g ha^{-1} as post-emergence at 20 DAS (B:C ratio 1.57). These treatments were economically superior due to better weed management resulting in higher grain yield, despite slightly higher cultivation cost. However, the minimum gross return, net return, and B:C ratio were recorded under control plot (T_1), which yielded the lowest economic returns due to severe weed competition throughout the crop growth period. These results are in agreement with findings of Reddy *et al*. (2022) [27].

Table 14: Effect of pre and post-emergence herbicides on economics of horsegram cultivation.

Treatments	Cost of cultivation (₹ ha^{-1})	Gross return (₹ ha^{-1})	Net return (₹ ha^{-1})	B:C ratio
T_1 - Control	27468.78	42521.67	15052.89	0.55
T_2 - Weed free	38754.78	95627.98	56873.20	1.47
T_3 - Pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence	29852.78	57957.28	28104.50	0.94
T_4 - Oxyfluorfen (23.5% EC) @ 100 g a.i. ha^{-1} as pre-emergence	29088.78	56958.59	27869.81	0.96
T_5 - Imazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS	29352.78	56586.48	27233.70	0.93
T_6 - Quizalofop ethyl (5% EC) @ 50 g a.i. ha^{-1} as post-emergence at 20 DAS	29752.78	54635.78	24883.00	0.84
T_7 - Pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence + Imazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS	31736.78	83961.13	52224.35	1.65
T_8 - Pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence + Quizalofop ethyl (5% EC) @ 50 g a.i. ha^{-1} as post-emergence at 20 DAS	32136.78	82442.66	50305.88	1.57
T_9 - Oxyfluorfen (23.5% EC) @ 100 g a.i. ha^{-1} as pre-emergence + Imazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS	30973.78	71365.11	40391.33	1.3
T_{10} - Oxyfluorfen (23.5% EC) @ 100 g a.i. ha^{-1} as pre-emergence + Quizalofop ethyl (5% EC) @ 50 g a.i. ha^{-1} as post-emergence at 20 DAS	31372.78	70287.03	38914.25	1.24

Conclusions

Weed free plot (T_2) have registered higher growth, yield attributes and yield as well as gross return followed by pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence + imazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS (T_7) and pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence + quizalofop ethyl (5% EC) @ 50 g a.i. ha^{-1} as post-emergence at 20 DAS (T_8) of *post-kharif* horsegram as compared to other weed management practices. However, the benefit: cost ratio was higher under (T_7) followed by (T_8).

Pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence + imazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS (T_7) and pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence + quizalofop ethyl (5% EC) @ 50 g a.i. ha^{-1} as post-emergence at 20 DAS (T_8) were next best performing treatments, it had the potential to control broad spectrum of weeds *i.e.* broad, narrow leaved weeds and sedges. Weed control efficiency at harvest also recorded higher values in both the treatments. Minimum weed index was recorded under pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence + imazethapyr (10% SL) @ 75 g a.i. ha^{-1} as post-emergence at 20 DAS (T_7) *i.e.* 12.26% followed by pendimethalin (30% EC) @ 850 g a.i. ha^{-1} as pre-emergence + quizalofop ethyl (5% EC) @ 50 g a.i. ha^{-1} as post-emergence at 20 DAS (T_8) *i.e.* 13.88%.

References

1. Anonymous. Directorate Agriculture Development and Farmer Welfare and Bio-Technology Department, Raipur Chhattisgarh. 2022.
2. Anonymous. Ministry of Agriculture and Farmers Welfare, Department of Agriculture and Farmers Welfare, Directorate of Economics and Statistics. 2020.
3. Bhowmick MK, Duary B, Biswas PK. Integrated weed management in black gram. Indian Journal of Weed Science. 2015;47(1):34-37.
4. Chaudhry S, Verma VK, Vishram S, Ram P, Singh R. Studies on efficacy of herbicides against weeds of blackgram (*Vigna mungo* L.). Advance Research Journal of Crop Improvement. 2014;5(1):40-43.
5. Chhodavadia SK, Mthukiya RK, Dobariya VK. Pre and post emergence herbicide for integrated weed management in summer green gram. Indian Journal of Weed Science. 2013;45(2):116-119.
6. Chicham S, Singh R, Singh G. Weed management in greengram. Indian Journal of Weed Science. 2020;52(1):10-20.
7. Choudhary VK, Kumar SP, Bhagawati R. Integrated weed management in black gram (*Vigna mungo* L.) under mid hills of Arunachal Pradesh. Indian Journal of Agronomy. 2012;54(4):382-385.
8. Deva S, Kolhe SS. Nutrient and weed management practices effect on growth, nodulation, yield, economics and energetics of Chickpea (*Cicer arietinum* L.). International Journal of Fauna and Biological Studies. 2018;5(6):38-44.
9. Gendlal, Patel JR, Shukla RK, Agrawal HP, Sao Y, Chaure NK, Patel CR, Patel M. Effect of weed control practices on growth and yield of black gram (*Vigna mungo* L.). Journal of Plant Development Sciences. 2024;16(4):145-151.
10. Giri P, Jena NK, Behera K, Patra AR. Effect of herbicides on weed, growth, yield and economics of summer green gram (*Vigna radiata* L.) in Balasore district of Odisha. The Pharma Innovation Journal. 2022;11(9):514-517.
11. Gelot DG, Patel DM, Patel KM, Patel IM, Patel FN, Parmar AT. Effect of integrated weed management on weed control and yield of summer greengram (*Vigna radiata* L. wilczek). International Journal of Chemical Studies. 2018;6(1):324-327.
12. Ghosh RK, Ghosh A, Mondal D, Kumar D, Barui K. Pre-emergence herbicides are ancillary apt for annual planning of weed management in system intensification. Indian Journal of Weed Science. 2017;49(2):170-175.
13. Gomez KA, Gomez AA. Statistical procedures for agricultural research. An International Rice Research Institute book. John Wiley and Sons, New York. 1984.
14. Jagadesh VT, Kumar V, Sharma K. Yield and economics of soybean under integrated weed management practices. Indian Journal of Weed Science. 2019;45(1):39-41.
15. Kalyani MSR, Ameena M, Srinivas Y, Shifina S, Susha VS, Sethulakshmi VS. Bio-efficacy of new herbicide molecules for weed management in grain legumes. Journal of Advances in Biology & Biotechnology. 2023;27(1):191-204.
16. Khairnar CB, Goud VV, Sethi HN. Pre- and post-emergence herbicides for weed management in mung bean. Indian Journal of Weed Science. 2013;46(4):392-395.
17. Krishnamurthy K, Raju BG, Raghunath G, Jagnath MK, Prasad TVR. Herbicide efficiency index in sorghum. Indian Journal of Weed Science. 1975;(7):75-79.
18. Lal S, Kewat ML, Suryavanshi T. Weed indices as influenced by propaquizafop and imazethapyr mixture in soybean. International Journal of Current Microbiology and Applied Science. 2017;6(8):3109-3115.
19. Mahajan A, Kumar A, Puniya R, Stanzen L. Pre- and post-emergence herbicides on weed dynamics, microbial population and yield of summer black gram. Indian Journal of Weed Science. 2020;52(4):340-345.
20. Mansoori DS, Ram B, Jadon C, Tetarwal JP. Efficacy of imazethapyr on weed management in soybean. Indian Journal of Weed Science. 2015;43(3-4):169-171.
21. Mishra A, Tosh GC. Chemical weed control studies on dwarf wheat. Journal of Research (Orissa University of Agricultural Science and Technology). 1979;10:1-6.
22. Mishra P, Singh P, Kumar S, Sinha K. Effect of different weed control practices on growth of urdbean. International Journal of Chemical Studies. 2017;6(1):185-186.
23. Naik GR, Anand MR, Kusgal TS, Kalyanamurthy KN, Prakasha HC, Krishna TV. Bio-efficacy of post-emergence herbicides on weed dynamics, yield and economics of horse gram. Mysore Journal of Agricultural Science. 2022;56(3):237-242.
24. Pramila N, Chouhan GS, Nepalia V. Effect of varieties, crop geometries and weed management on nutrient uptake by soybean (*Glycine max*) and associated weeds. Indian Journal of Agronomy. 2004;50:218-220.
25. Rahman MA, Hossain MM, Rokib IA, Ullah MJ, SaidurRahman MS. Yield performance of mungbean (*Vigna radiata* L.) under the application of different herbicides. International Journal of Biosciences. 2005;14(3):340-349.
26. Reddy NR, Subramanyam D, Sumathi V, Umamahesh V, Sagar GK. Performance of ready-mix herbicides for weed control in black gram. Indian Journal of Weed Science. 2020;53(1):104-106.
27. Reddy PK, Rathi JPS, Singh OP, Rajiv B. Production and economics of greengram under various row spacing in relation to weed control methods. Plant Archives. 2022;8(1):471-472.
28. Sai NK, Tigga R, Rajwade R. Effect of date and weed management techniques on density, dry weight, control efficiency of weed and yield of black gram (*Vigna mungo* L.). International Journal of Chemical Studies. 2019;7(6):1472-1476.
29. Singh ID, Stoskopf NC. Harvest index in cereals. Agronomy Journal. 1971;63(2):224-226.
30. Singh G, Virk KK, Khanna V. Weed management in black gram (*Vigna mungo* L.) through sole and combined application of pre and post-emergence herbicides. Journal of Crop and Weed. 2016;14(2):162-167.
31. Singh N, Lal M. Response of different weed management

practices on growth and yield of black gram (*Vigna mungo* L.) under irrigated conditions of Punjab. The Pharma Innovation Journal. 2022;11(12):2425-2429.
32. Singh M, Shekhar KS, Datta D. Herbicide combination for weed management in Urdbean (*Vigna mungo* L.). International Journal of Chemical Studies. 2018;6(4):1594-1597.
33. Singh RS, Kumar R, Kumar M, Singh RP. Weed management in black gram. Bulletin of Environment, Pharmacology and Life Sciences. 2017;6(2):199-200.
34. Susmitha M, Reddy UV, Ramesh PV, Reddy MS. Efficacy of different herbicides on weed dynamics and yield attributes in kharif blackgram (*Vigna mungo* L.). International Journal of Current Microbiology and Applied Science. 2019;8(6):2026-2031.
35. Tiwari VK, Yadav RS, Mahajan R, Kumar S. Effect of weed management practices on yield attribution of urd bean under late sown. Journal of Pharmacognosy and Phytochemistry. 2017;7(1):742-746.
36. Tzudir L, Reddy PR, Kumari S, Singh AP, Yadav R. Response of black gram (*Vigna mungo* L.) to integrated weed management and its effect on weed dynamics. Plant Archives. 2022;22(2):397-402.
37. Watson D. The physiological basis of variation in yield. Advances in Agronomy. 1952;4:101-145.
38. Yassin MM, Kumari BM, Fanish SA, Padmanathan PK. An integrated effect of weed management in black gram. International Journal of Plant & Soil Science. 2023;35(18):1601-1610