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RESEARCH ARTICLE

Integrated weed management options in *Kharif* groundnut

V.J. Patel*, D.D. Chaudhari and H.K. Patel[1]

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ABSTRACT

A field experiment was conducted during *Kharif* seasons of 2022-2024 to evaluate the integrated weed management options and identify effective and economic option in groundnut. The pre-emergence application (PE) of oxyfluorfen + pendimethalin (tank-mix) 188 + 500 g/ha followed by (*fb*) intercultural operation (IC) and hand weeding (HW) at 40 days after seeding (DAS) recorded the lowest weed biomass. The tallest groundnut plants and pod yield was observed with IC *fb* HW at 20 and 40 DAS and diclosulam + pendimethalin (tank-mix) 25.2+500 g/ha PE *fb* IC + HW at 40 DAS. Pendimethalin + imazethapyr (ready-mix) 800 g/ha PE and diclosulam + pendimethalin (tank-mix) 25.2 + 500 g/ha (PE) recorded higher weed management indices values. The other effective weed control options, under labour-scarce conditions, in groundnut include: IC *fb* HW at 20 and 40 DAS; quizalofop ethyl + imazethapyr (ready-mix) 90 g/ha and post-emergence application (PoE) propaquizafop + imazethapyr (ready-mix) 125 g/ha integrated with IC + HW at 40 DAS.

Keywords: Diclosulam + pendimethalin; Groundnut, Pendimethalin + imazethapyr; Propaquizafop + imazethapyr; Quizalofop ethyl + imazethapyr Weed management

INTRODUCTION

Groundnut (*Arachis hypogaea* L.), commonly known as peanut, is a vital edible oilseed crop in India and belongs to the family Leguminosae. Its kernels, rich in oil (47–49%) and protein (around 20%) are highly digestible and typically consumed as roasted, fried or salted. In the 2022-23 season, India produced 10.30 m t of groundnut with a productivity of 2.075 t/ha (Anon 2023). Major groundnut-producing states include Gujarat, Andhra Pradesh, Tamil Nadu, Karnataka, Maharashtra, Madhya Pradesh, Uttar Pradesh, Rajasthan, Punjab and Odisha. Despite its economic importance, groundnut production is often hampered by suboptimal agronomic practices and inadequate weed management.

Groundnut fields typically infested with mix of narrow-leaf weeds, broad-leaved weeds and sedges. Due to its slow initial growth, short stature and underground pod development, groundnut is particularly vulnerable to weed infestation. The critical period of crop-weed control is 4-9 weeks after sowing for grasses and 3-6 weeks for broad-leaved weeds (Wesley et al. 2008). The groundnut fields are invaded by a wide range of weed species including grasses, broad-leaved weeds and sedges, which can lead to significant yield reductions ranging from 30% to 80% (Rao *et al.* 2014). Effective and timely weed control is therefore, essential to realize the groundnut yield potential.

The selective herbicides may suppress specific group of weeds, but often failed to control complex weed flora, which varies with agro-ecological conditions and management practices. Pre-emergence herbicides offer limited duration of control, allowing late-emerging weeds to escape from the applied herbicide. Hence, integrating herbicide application with sound cultural practices is crucial for managing weeds and boosting *Kharif* groundnut productivity. Thus, a study was conducted to evaluate the effectiveness of integrated weed management options, with herbicide mixtures as component, in controlling weeds and enhancing *Kharif* groundnut productivity.

MATERIALS AND METHODS

A field experiment was conducted during three consecutive *Kharif* season of the year 2022, 2023 and 2024 in loamy sand soil of AICRP on Weed Management Farm, B. A. College of Agriculture, Anand Agricultural University, Anand, Gujarat state, India. The soil of the experimental field was low in available nitrogen and medium in available phosphorous and high in potassium. Twelve weed

AICRP- Weed Management, Anand Agricultural University, Anand, Gujarat 388110, India

[1] Department of Ag. Microbiology, Anand Agricultural University, Anand, Gujarat -388110, India

* Corresponding author email: avjpatel28@aau.in

management were tested including: pre-emergence application (PE) of pendimethalin 30% EC 750 g/ha followed by (*fb*) inter-cultivation (IC) + hand weeding (HW) at 40 days after seeding (DAS), flumioxazin 50% SC (flumioxazin) 125 g/ha *fb* IC + HW at 40 DAS, diclosulam 84% WDG (diclosulam) 25.2 g/ha PE *fb* IC + HW at 40 DAS, Oxyfluorfen 23.5% EC (oxyfluorfen) + pendimethalin (tank-mix) 188+500 g/ha PE *fb* IC + HW at 40 DAS, diclosulam + pendimethalin (tank-mix) 25.2+500 g/ha PE *fb* IC + HW at 40 DAS, pendimethalin 30% + imazethapyr 2% EC (pendimethalin + imazethapyr) (ready-mix) 800 g/ha PE *fb* IC + HW at 40 DAS, sodium-acifluorfen 16.5% + clodinafop-propargyl 8% EC (sodium-acifluorfen + clodinafop-propargyl) (ready-mix) 245 g/ha PoE *fb* IC + HW at 40 DAS, fluazifop-p-butyl 11.1% w/w + fomesafen 11.1% w/w SL (fluazifop-p-butyl + fomesafen) (ready-mix) 250 g/ha PoE *fb* IC + HW at 40 DAS, propaquizafop 2.5% + imazethapyr 3.75% w/w ME (propaquizafop + imazethapyr) (ready-mix) 125 g/ha PoE *fb* IC + HW at 40 DAS, quizalofop-ethyl 7.5% + imazethapyr 15% w/w EC (quizalofop-ethyl + imazethapyr) (ready-mix) 90 g/ha PoE *fb* IC + HW at 40 DAS, IC *fb* HW at 20 and 40 DAS and weedy check. A randomized block design with three replications was used.

The groundnut variety GG 34 was sown on 16th June, 23rd June and 20th July 2022, 2023 and 2024, respectively with a row spacing of 30 x 10 cm, using seed rate of 120 kg/ha. Fertilization was done using the recommended basal dose of 12.5 kg N and 25 kg P, O… /ha applied through urea and single super phosphate, respectively. All other recommended agronomic practices were followed to ensure optimal crop growth. Pre-emergence herbicides were applied the day after sowing and post-emergence herbicides were sprayed at 20 DAS using a battery-operated knapsack sprayer equipped with a flat-fan nozzle with 500 liters of water/ha. Weed density and dry weight (biomass) were assessed through destructive sampling at four randomly selected spots within the net plot using a 0.25 m² iron quadrat. Additional observations on crop growth and yield attributes were also recorded from the net plot area. All collected data were statistically analyzed following the standard procedures outlined by Cochran and Cox (1957).

Weed Control Efficiency (WCE), weed Index (WI), weed persistence index (WPI), agronomic management index (AMI), weed management index (WMI) and integrated weed management index (IWMI) were calculated using the formula given by Sharma (2017) are as under:

$$\textbf{WCE (\%)} = \frac{DWC - DWT}{DWC} \times 100$$

Where, DWC= Dry weight of weeds in unweeded control plot
DWT= Dry weight of weeds in treated plot.

$$\textbf{WI (\%)} = \frac{X - Y}{X} \times 100$$

Where, X= Highest yield from treatment
Y= Yield from particular treatment

$$\textbf{WPI} = \frac{WT}{Wc} \times \frac{Wpc}{W_{PT}}$$

Where, Wc =Weed dry weight in unweeded control plot
W_T = Weed dry weight in treated plot
W_{PC} = Weed population in unweeded control plot
W_{PT} = Weed population in treated plot

$$\textbf{AMI} = \frac{\frac{Y_T - Yc}{Yc} - \frac{Wc - E_T}{Wc}}{\frac{Wc - W_T}{Wc}}$$

Where, Y_T = Yield from treated plot
Yc = Yield from unweeded control plot
Wc = Weed dry weight in unweeded control plot
W_T = Weed dry weight in treated plot

$$\textbf{WMI} = \frac{\frac{Y_T - Yc}{Yc}}{\frac{Wc - W_T}{Wc}}$$

Where, Y_T = Yield from treated plot
Yc = Yield from unweeded control plot
Wc = Weed dry weight in unweeded control plot
W_T = Weed dry weight in treated plot

$$\textbf{IWMI} = \frac{WMI + AMI}{2}$$

Where, WMI= Weed management index
AMI = Agronomic management index

RESULTS AND DISCUSSION

Effect on weeds

The experimental field was dominated by diverse weed flora consisting of both broad-leaved and grassy weeds. The grassy weeds accounted for 47% and broad-leaved weeds for 43% of the total weeds. *Digitaria sanguinalis, Commelina benghalensis, Dactyloctenium aegyptium* and *Eleusine indica* were monocot weeds while *Digera arvensis, Phyllanthus niruri, Oldenlandia umbellate* and *Trianthema monogyna* were dicot weeds that dominated the experimental field during three years of experimentation.

Weed biomass at 60 DAS showed considerable variation across treatments and years (**Table 1**). The weedy check recorded significantly the highest weed biomass and the lowest values were recorded with oxyfluorfen + pendimethalin 188 + 500 g/ha PE *fb* IC + HW at 40 DAS, which provided broad-spectrum control of both grassy and broad-leaved weeds. This integrated approach is particularly effective in groundnut as it ensured suppression of late-emerging weeds and maintaining a weed-free environment throughout the crop's growth period. The ready-mix combination of pendimethalin + imazethapyr 800 g/ha PE *fb* IC + HW at 40 DAS also caused notable reduction of weed dry biomass. Confirming findings of Venkateshwara *et al*. (2020). Other treatments such as diclosulam 25.2 g/ha PE *fb* IC + HW at 40 DAS, sodium-acifluorfen + clodinafop-propargyl (ready-mix) 245 g/ha PoE *fb* IC + HW at 40 DAS, fluazifop-p-butyl + fomesafen (ready-mix) 250 g/ha PoE *fb* IC + HW at 40 DAS, propaquizafop + imazethapyr (ready-mix) 125 g/ha PoE *fb* IC + HW at 40 DAS, quizalofop- ethyl + imazethapyr (ready-mix) 90 g/ha PoE *fb* IC + HW at 40 DAS and IC *fb* HW at 20 and 40 DAS were next best in the order of reducing weed biomass. Similar results were recorded at groundnut harvest.

Effect on weed indices

Pendimethalin + imazethapyr (ready-mix) 800 g/ha *fb* IC + HW at 40 DAS and diclosulam +

Table 1. Weed biomass and weed control efficiency by weed management treatments in *Kharif* groundnut

Treatment	Weed biomass at 60 DAS (g/m^2)			Weed biomass at harvest (g/m^2)			Weed control efficiency (%) at harvest		
	2022	2023	2024	2022	2023	2024	2023	2024	Average
Pendimethalin 750 g/ha PE *fb* IC + HW at 40 DAS	6.06(36.5)	4.36(18.1)	3.56(11.8)	8.80(77.2)	7.13(52.4)	5.61(30.7)	85.48	89.52	80.90
Flumioxazin 125 g/ha PE *fb* IC + HW at 40 DAS	5.73(31.9)	3.41(10.8)	3.09(8.67)	9.06(84.6)	6.17(37.2)	5.63(30.7)	89.70	89.52	81.27
Diclosulam 25.2 g/ha PE *fb* IC + HW at 40 DAS	5.37(28.0)	4.41(20.1)	4.63(20.5)	6.61(43.7)	7.24(52.0)	6.86(46.3)	85.60	84.20	83.84
Oxyfluorfen + pendimethalin (tank-mix) 188+500 g/ha PE *fb* IC + HW at 40 DAS	4.51(19.4)	2.97(7.84)	2.46(5.20)	6.05(35.7)	7.09(49.4)	4.71(21.6)	86.32	92.63	88.00
Diclosulam + pendimethalin (tank-mix) 25.2+500 g/ha PE *fb* IC + HW at 40 DAS	5.07(24.7)	3.75(14.1)	3.72(12.9)	6.77(44.8)	7.76(59.7)	5.94(34.5)	83.46	88.23	84.32
Pendimethalin + imazethapyr (ready-mix) 800 g/ha PE *fb* IC + HW at 40 DAS	4.53(19.7)	3.59(12.1)	2.95(7.73)	5.45(29.2)	7.04(52.1)	5.48(29.5)	85.57	89.93	87.76
Sodium-acifluorfen + clodinafop- propargyl (ready-mix) 245 g/ha PoE *fb* IC + HW at 40 DAS	6.15(36.8)	3.57(12.0)	4.30(17.6)	6.60(42.9)	6.93(50.3)	7.14(50.0)	86.07	82.94	83.69
Fluazifop-p-butyl + fomesafen (ready-mix) 250 g/ha PoE *fb* IC + HW at 40 DAS	5.23(26.5)	3.17(9.16)	4.03(15.5)	6.01(35.2)	7.19(52.4)	7.90(61.9)	85.48	78.87	83.21
Propaquizafop + imazethapyr (ready-mix) 125 g/ha PoE *fb* IC + HW at 40 DAS	5.63(31.1)	3.09(8.56)	3.44(10.8)	8.97(80.0)	6.38(40.5)	5.79(32.5)	88.78	88.91	81.41
Quizalofop-ethyl + imazethapyr (ready-mix) 90 g/ha PoE *fb* IC + HW at 40 DAS	4.77(21.9)	3.85(13.9)	4.53(19.7)	7.77(59.8)	7.91(63.1)	7.00(48.1)	82.52	83.58	80.36
IC *fb* HW at 20 and 40 DAS	4.65(20.7)	3.41(11.0)	4.37(18.2)	8.09(64.5)	6.84(47.3)	6.99(48.1)	86.90	83.58	81.16
Weedy check	18.0(323)	16.1(258)	16.8(284)	15.5(239)	19.0(361)	17.1(293)	-	-	-
F test	0.86	1.34	0.98	1.70	2.37	1.04	-	-	-

Note: Data subjected to $(\sqrt{x+1})$ transformation. Figures in parentheses are means of original values. ; DAS = days after seeding; PE = pre-emergence application; PoE = post-emergence application; *fb* = followed by; IC = inter-culltivation; HW = hand weeding

Table 2. Groundnut pod yield as influenced by weed management treatments in *Kharif* groundnut

Treatment	Groundnut plant height (cm) at harvest			Groundnut pod yield (kg/ha)				Benefit: cost ratio
	2022	2023	2024	2022	2023	2024	Pooled	
Pendimethalin 750 g/ha PE *fb* IC + HW at 40 DAS	58.0	71.1	61.3	2753	4128	2987	3289	2.49
Flumioxazin 125 g/ha PE *fb* IC + HW at 40 DAS	61.7	68.4	61.0	2413	4056	2973	3148	2.34
Diclosulam 25.2 g/ha PE *fb* IC + HW at 40 DAS	65.9	69.9	62.0	2730	3740	2230	2900	2.20
Oxyfluorfen + pendimethalin (tank-mix) 188+500 g/ha PE *fb* IC + HW at 40 DAS	68.8	69.7	57.7	2313	3857	2673	2948	2.32
Diclosulam + pendimethalin (tank-mix) 25.2+500 g/ha PE *fb* IC + HW at 40 DAS	66.4	73.8	61.7	2690	4059	3017	3255	2.55
Pendimethalin + imazethapyr RM 800 g/ha PE *fb* IC + HW at 40 DAS	64.9	72.4	64.5	2380	4106	2428	2971	2.34
Sodium-acifluorfen + clodinafop-propargyl RM 245 g/ha PoE *fb* IC + HW at 40 DAS	65.1	71.9	63.1	2477	3946	2418	2947	2.24
Fluazifop-p-butyl + fomesafen RM 250 g/ha PoE *fb* IC + HW at 40 DAS	64.1	72.6	62.8	2467	3974	2295	2912	2.21
Propaquizafop + imazethapyr RM 125 g/ha PoE *fb* IC + HW at 40 DAS	67.6	72.9	63.5	2400	4027	3400	3276	2.50
Quizalofop-ethyl + imazethapyr RM 90 g/ha PoE *fb* IC + HW at 40 DAS	69.3	72.6	63.3	2413	3891	3217	3174	2.44
IC *fb* HW at 20 and 40 DAS	66.5	73.1	64.4	2850	3924	3423	3399	2.38
Weedy check	73.8	81.3	71.3	363	855	217	478	0.43
F test	7.51	4.08	NS	458	502	64.60	487	-

Note: Data subjected to $(\sqrt{x+1})$ transformation. Figures in parentheses are means of original values. ; DAS = days after seeding; PE = pre-emergence application; PoE = post-emergence application; *fb* = followed by; IC = inter-culltivation; HW = hand weeding; RM: ready-mix

pendimethalin (tank-mix) 25.2+500 g/ha *fb* IC + HW at 40 DAS consistently recorded high WCE values, low WI and WPI scores and favourable AMI and IWMI. These treatments effectively manaed early emerged weeds, minimized regrowth of the weeds and reduced groundnut yield losses due to weeds. Notably, flumioxazin 125 g/ha *fb* IC + HW at 40 DAS and oxyfluorfen + pendimethalin (tank-mix) 188+500 g/ha *fb* IC + HW at 40 DAS also were effective in controlling weeds, especially in the year 2023 and 2024.

The interaction of inter-cultivation followed by hand weeding (IC *fb* HW at 20 and 40 DAS) has emerged as an excellent weed management option and recorded superior IWMI and WMI values. Lakshmidevi *et al*. (2022) also observed higher WCE in groundnut with inter-cultivation twice followed by hand weeding at 20 and 40 DAS. In resource-constrained scenarios particularly paucity of labours, quizalofop-ethyl + imazethapyr (ready-mix) 90 g/ha *fb* IC + HW at 40 DAS and propaquizafop + imazethapyr (ready-mix) 125 g/ha *fb* IC + HW at 40 DAS found to be viable option to attain high weed control efficiency with reduced labour dependency and confirmed observations of Suryavanshi *et al*. (2018) in blackgram.

Effect on groundnut

Phytotoxicity of applied herbicide on groundnut was recorded at 7 days after application. The oxyfluorfen + pendimethalin (tank-mix), sodium-acifluorfen + clodinafop-propargyl and fluazifop-p-butyl + fomesafen showed phytotoxic effect of groundnut leaf injury (score-1) but it was recovered at 14 days after herbicide application. Other applied herbicides were not phytotoxic groundnut.

In terms of crop vigour as indicated by groundnut plant height, significant differences were recorded in 2022 and 2023 whereas, no statistical significance was observed in 2024. IC *fb* HW at 20 and 40 DAS and diclosulam + pendimethalin (tank-mix) 25.2+500 g/ha *fb* IC + HW at 40 DAS recorded the tallest plants during 2022 and 2023, respectively. Groundnut pod yield was significantly influenced by weed management treatments in all years. In 2022 and 2024, IC *fb* HW at 20 and 40 DAS produced significantly higher groundnut pod yield which was followed by diclosulam + pendimethalin (tank-mix) 25.2+500 g/ha *fb* IC + HW at 40 DAS, propaquizafop + imazethapyr (ready-mix) 125 g/ha *fb* IC + HW at 40 DAS and quizalofop-ethyl + imazethapyr (ready-mix) 90 g/ha *fb* IC + HW at 40 DAS. In 2023, pendimethalin 750 g/ha *fb* IC + HW at 40 DAS recorded significantly higher groundnut pod yield which was statistically at par with flumioxazin 125 g/ha *fb* IC + HW at 40 DAS, diclosulam + pendimethalin (tank-mix) 25.2+500 g/ha *fb* IC + HW at 40 DAS and quizalofop-ethyl 7.5% + imazethapyr (ready-mix) 90 g/ha *fb* IC + HW at 40 DAS. Integrating herbicide application with mechanical

Table 3. Effect of different treatments on weed index, weed persistence index (WPI) and agronomic management index (AMI)

Treatment	Weed index (%)				Weed persistence index (WPI) at 60 DAS				Agronomic management index (AMI)			
	2022	2023	2024	Average	2022	2023	2024	Average	2022	2023	2024	Average
Pendimethalin 750 g/ha PE *fb* IC + HW at 40 DAS	3.40	-	12.74	5.38	6.51	1.28	2.83	3.54	12.99	3.48	13.26	9.91
Flumioxazin 125 g/ha PE *fb* IC + HW at 40 DAS	15.33	1.74	13.15	10.07	3.84	1.99	3.39	3.07	11.65	3.17	13.19	9.34
Diclosulam 25.2 g/ha PE *fb* IC + HW at 40 DAS	4.21	9.40	34.85	16.15	2.80	1.04	2.08	1.97	10.48	2.94	10.02	7.81
Oxyfluorfen + pendimethalin (tank-mix) 188+500 g/ha PE *fb* IC + HW at 40 DAS	18.84	6.56	21.91	15.77	3.83	3.35	4.33	3.84	8.16	3.07	11.22	7.48
Diclosulam + pendimethalin (tank-mix) 25.2+500 g/ha PE *fb* IC + HW at 40 DAS	5.61	1.67	11.86	6.38	2.66	2.14	4.11	2.97	10.36	3.49	13.63	9.16
Pendimethalin + imazethapyr (ready-mix) 800 g/ha PE *fb* IC + HW at 40 DAS	16.49	0.53	29.07	15.36	5.94	2.36	6.34	4.88	8.17	3.44	10.33	7.31
Sodium-acifluorfen + clodinafop-propargyl (ready-mix) 245 g/ha PoE *fb* IC + HW at 40 DAS	13.09	4.41	29.36	15.62	4.26	1.80	2.07	2.71	9.26	3.20	11.23	7.90
Fluazifop-p-butyl + fomesafen (ready-mix) 250 g/ha PoE *fb* IC + HW at 40 DAS	13.44	3.73	32.95	16.71	4.52	3.12	2.78	3.47	8.83	3.27	11.14	7.75
Propaquizafop + imazethapyr (ready-mix) 125 g/ha PoE *fb* IC + HW at 40 DAS	15.79	2.45	0.67	6.30	4.04	1.86	2.73	2.88	11.21	3.18	15.50	9.96
Quizalofop-ethyl + imazethapyr (ready-mix) 90 g/ha PoE *fb* IC + HW at 40 DAS	15.33	5.74	6.02	9.03	5.21	2.04	3.08	3.44	9.90	3.30	15.54	9.58
IC *fb* HW at 20 and 40 DAS	-	4.94	-	1.65	4.27	2.34	3.02	3.21	12.47	3.13	16.68	10.76
Weedy check	87.26	79.29	93.66	86.74	-	-	-	-	-	-	-	-
IC *fb* HW at 20 and 40 DAS	9.38	4.13	17.68	10.40	10.93	3.63	17.18	10.58				
Weedy check	-	-	-	-	-	-	-	-				

Note: Data subjected to $(\sqrt{x+1})$ transformation. Figures in parentheses are means of original values. ; DAS = days after seeding; PE = pre-emergence application; PoE = post-emergence application; *fb* = followed by; IC = inter-culltivation; HW = hand weeding; RM: ready-mix

Table 4. Effect of different treatments on weed management index (WMI) and integrated weed management index (IWMI)

Treatment	Weed management index (WMI)				Integrated weed management index (IWMI)			
	2022	2023	2024	Average	2022	2023	2024	Average
Pendimethalin 750 g/ha PE *fb* IC + HW at 40 DAS	9.73	4.48	14.26	9.49	11.36	3.98	13.76	9.70
Flumioxazin 125 g/ha PE *fb* IC + HW at 40 DAS	8.74	4.17	14.19	9.03	10.20	3.67	13.69	9.19
Diclosulam 25.2 g/ha PE *fb* IC + HW at 40 DAS	7.98	3.94	11.02	7.65	9.23	3.44	10.52	7.73
Oxyfluorfen + pendimethalin (tank-mix) 188+500 g/ha PE *fb* IC + HW at 40 DAS	6.32	4.07	12.22	7.54	7.24	3.57	11.72	7.51
Diclosulam + pendimethalin (tank-mix) 25.2+500 g/ha PE *fb* IC + HW at 40 DAS	7.89	4.49	14.63	9.00	9.12	3.99	14.13	9.08
Pendimethalin + imazethapyr (ready-mix) 800 g/ha PE *fb* IC + HW at 40 DAS	6.33	4.44	11.33	7.37	7.25	3.94	10.83	7.34
Sodium-acifluorfen + clodinafop-propargyl (ready-mix) 245 g/ha PoE *fb* IC + HW at 40 DAS	7.10	4.20	12.23	7.84	8.18	3.70	11.73	7.87
Fluazifop-p-butyl + fomesafen (ready-mix) 250 g/ha PoE *fb* IC + HW at 40 DAS	6.80	4.27	12.14	7.74	7.81	3.77	11.64	7.74
Propaquizafop + imazethapyr (ready-mix) 125 g/ha PoE *fb* IC + HW at 40 DAS	8.44	4.18	16.50	9.71	9.82	3.68	16.00	9.83
Quizalofop-ethyl + imazethapyr (ready-mix) 90 g/ha PoE *fb* IC + HW at 40 DAS	7.53	4.30	16.54	9.46	8.72	3.80	16.04	9.52
IC *fb* HW at 20 and 40 DAS	9.38	4.13	17.68	10.40	10.93	3.63	17.18	10.58
Weedy check	-	-	-	-	-	-	-	-

Note: Data subjected to $(\sqrt{x+1})$ transformation. Figures in parentheses are means of original values. ; DAS = days after seeding; PE = pre-emergence application; PoE = post-emergence application; *fb* = followed by; IC = inter-culltivation; HW = hand weeding; RM: ready-mix

weeding creates a weed-free environment that promotes optimal groundnut growth and development (Mishra 2020). The weedy check had the lowest groundnut pod yield indicating severe impact of unchecked weeds.

Conclusion

Pendimethalin 750 g/ha PE *fb* IC + HW at 40 DAS, diclosulam + pendimethalin (tank-mix) 25.2+500 g/ha PE *fb* IC + HW at 40 DAS and IC *fb* HW at 20 and 40 DAS consistently outperformed than others, offering a balanced and sustainable weed control, higher groundnut pod yield and benefit cost ratio of *Kharif* groundnut.

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