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Integrated weed management in chickpea *(Cicer arietinum* L.)

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ABSTRACT

A field experiment was conducted during Rabi season 2022-2023 at research field, department of Agronomy, School of Agricultural sciences, G. H. Raisoni University, Saunsar, Dist- Chhindwara (M.P.) using four herbicides combined with Hand weeding for effectively controlling of both groups of weeds, their effect on production economics on chickpea. The experiment was carried out in Randomized Block Design with three replications. The treatments consist of eight weed management practices. We observed treatment Oxyfluorfen 0.120 kg/ha (PE) + Imazethapyr (POE) 50 g/ha @ 35 DAS + 1 hoeing @ 60 DAS minimum and significantly lowest total weed counts compared to rest of treatment then Imazethapyr 10% SL @ 63 g/ha (POE) at 25 DAS + 1 hoeing at 50 DAS, Pendimethalin 30 % EC @ 1.0 kg/ha (PE) + Quizalfop-p-ethyl 5% EC @ 0.060 kg/ha (POE) at 45 DAS then Pendimethalin 30% EC @ 1 kg/ha (PE) + 1 hoeing at 30 DAS. The important growth attribute, *viz.* plant height, number branches/plant, crop dry matter accumulation and important yield contributing characters, *viz.* number pods/plant, number of seeds/pods, text

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weight, growth values, *viz*. grain and straw yield significantly in the treatment Oxyfluorfen 0.120 kg/ha (PE) + Imazethapyr (POE) 50 g/ha @ 35 DAS + 1 hoeing @ 60 DAS and it as at per with Imazethapyr 10% SL @ 63 g/ha (POE) at 25 DAS + 1 hoeing at 50 DAS , Pendimethalin 30 % EC @ 1.0 kg/ha (PE) + Quizalfop-p-ethyl 5% EC @ 0.060 kg/ha (POE) at 45 DAS *fb* then Pendimethalin 30% EC @ 1 kg/ha (PE) + 1 hoeing at 30 DAS. Economic study revealed that, the maximum net monetary returns were obtained with the treatment Oxyfluorfen 0.120 kg/ha (PE) + Imazethapyr (POE) 50 g/ha @ 35 DAS + 1 hoeing @ 60 DAS (Rs 70946/ha) but it was at par with treatment Imazethapyr 10% SL @ 63 g/ha (POE) at 25 DAS + 1 hoeing at 50 DAS , (Rs 63401/ha), Pendimethalin 30 % EC @ 1 kg/ha (PE) + Quizalfop-p-ethyl 5% EC @ 0.050 kg/ha (POE) @ 45 DAS, (60608/ha), *fb* Pendimethalin 30% EC @ 1 kg/ha (PE) + 1 hoeing at 30 DAS, (Rs 55683/ha).Where, B:C ratio (1.65) is highest in also with the treatment Oxyfluorfen 0.120 kg/ha (PE) + Imazethapyr (POE) 50 g/ha @ 35 DAS + 1 hoeing @ 60 DAS.

KEYWORDS: weed flora, weed control efficiency, Weed dry weight, and yield.

INTRODUCTION

The chickpea is a very beneficial crop and one of India's major pulse crops. It is grown under irrigation- and soil-conserving conditions. Chickpea output has decreased as a result of many limitations, including biotic and abiotic causes. Wilt, dry root rot, and blight are the three main biotic restrictions in Karnataka. Additionally, weeds cause significant production harm by competing with crops for resources like space, nutrients, water, and light. One of the most significant chickpea yield prevention variables is poor weed management. In contrast to crops, weeds should remove plant nutrients from the soil. Weeds consume the most water when conditions are rain-fed, which worsens the drought and reduces crop productivity. The majority of weed species, which naturally grow more quickly than chickpeas and inhibit crop development, absorb sunlight, and negatively impact photosynthesis and plant yield (Rao 2000). Farmers typically physically weed their fields to control weeds. Although chickpea is particularly vulnerable to weed competition and weeds can cause up to a 75% yield loss, manual weed management has become a challenging undertaking due to the rise in labour costs and labour shortages (Chaudhary et al. 2005). In chickpeas, weed control is a crucial part of plant protection, enhancing the crop's capacity for output. The goal of the

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investigation was therefore to determine how different weed control techniques affected chickpea productivity in the Doon Valley.

MATERIAL AND METHODS

A field experiment entitled "Assessment of Integrated Weed management in Rabi Chickpea *(Cicer arietinum* L.)" was conducted during *rabbi* season 2022-23 at research field, department of Agronomy, School of Agricultural sciences, G. H. Raisoni University, Saunsar, Dist- Chhindwara (M.P.). The experimental soil was sandy silty clay texture, pH of 8.16, which was moderately alkaline, having low availability of N (175.26 kg/ha), medium available P (17.83 kg/ha) and high in available K (335.46 kg/ha). The weed control treatments of comprised of T_1: Weedy check; T_2: Pendimethalin 30% EC @ 1.0 kg/ha (PE) + 1 hoeing at 30 DAS; T_3: Alachlor 1.0 kg/ha (PE) + 1 hoeing at 45 DAS; T_4: Imazethapyr 10% SL @ 63 g/ha (POE) at 25 DAS + 1 hoeing at 50 DAS; T_5: Oxyfluorfen 23.5% EC @ 0.120 kg/ha (PE); T_6: Pendimethalin 30 % EC @ 1.0 kg/ha (PE) + Quizalfop-p-ethyl 5% EC @ 0.060 kg/ha (POE) at 45 DAS; T_7: Quizalfop-ethyl 5% EC @ 0.060 kg/ha (POE) at 30 DAS + 1 hand weeding at 50 DAS; and T^8: Oxyfluorfen 23.5% EC @ 0.120 kg/ha (PE) + Imazethapyr 10% SL @ 50 g/ha at 35 DAS + 1 hoeing at 60 DAS. The treatment was laid out in a randomized block design with three replications. The PE Pendimethalin was sprayed after sowing on wet soil and PoE was applied as per treatment with the help of knap-sack sprayer fitted with flood-jet nozzle with release rate of 600 L water/ha. Variety of chickpea was grown 'Vijay" on November 2022.

The AICRP on Weed Management (ICAR) standard procedure and intention for weed survey were followed, with net plot sizes of 4 m x 4 m and gross plot sizes of 3.54 m x 3.54 m square quadrats being plotted in a randomized manner to determine the total and relative values of density, frequency, standing value index, and summed dominance ratio for each of the weeds (Raju 1997). The weeds were baked until they reached a certain weight, and the appropriate conversion formula was used to turn them into g/m^2.

RESULTS AND DISCUSSION

Weed flora

Eighteen weed species predominated during experimentation. In the experimental plot, the grass weed species like Cynodon dactylon, Eleusine indica and Digitaria sanguinalis were found. Weed species with broad leaves, including Parthenium hysterophorus L. Physalis

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minima L. Euphorbia hirta L. Commelina benghalensis L. Amaranthus viridis, Portulaca oleracea L. Chenopodium album, Vicia hirsute, Anagalis arvensis, Melilotus alba, Portylaca oleracea, Alternanthera sessilis, Physalis minima, Trichodesma zeylanicum, Argemone Mexicana and Cirsium arvense were seen.

The only sedge detected in the experimental plot was Cyperus rotundus L.

Effect on weeds

Application of Oxyfluorfen 23.5% EC @ 0.120 kg/ha (PE) + Imazethapyr 10% SL @ 50 g/ha at 35 DAS + 1 hoeing at 60 DAS, Imazethapyr 10% SL @ 63 g/ha (POE) at 25 DAS + 1 hoeing at 50 DAS, Pendimethalin 30 % EC @ 1.0 kg/ha (PE) + Quizalfop-p-ethyl 5% EC @ 0.060 kg/ha (POE) at 45 DAS and Pendimethalin 30% EC @ 1.0 kg/ha (PE) + 1 hoeing at 30 DASshowed significant control of observed species of sedges, grasses and broad leaves weed. The weedy check reported the significantly maximum total number of sedges, grasses and broad leaves weed.

Except, treatment Oxyfluorfen 23.5% EC @ 0.120 kg/ha (PE) + Imazethapyr 10% SL @ 50 g/ha at 35 DAS + 1 hoeing at 60 DAS and Imazethapyr 10% SL @ 63 g/ha (POE) at 25 DAS + 1 hoeing at 50 DAS none of the weed control treatment was effectively controlled the Cyperus rotundas weed species of sedges at all stages of crop period.

Amid various herbicidal treatments highest overall weed species recorded in the treatment Alachlor 1.0 kg/ha (PE) + 1 hand hoeing at 45 DAS (107.15, 77.24, 92.26 and 98.14 $m^{-2)}$.

Total weed count (m^{-2}) as influenced by various weed management practices

Treatment	Total weed count (m^2)			
	30 DAS	60 DAS	90 DAS	At harvest
T1: Weedy check	8.50	9.70	10.10	11.30
T2: Pendimethalin 30% EC @ 1.0 kg/ha (PE) + 1 hoeing at 30 DAS	5.10	4.20	4.70	5.00
T3: Alachlor 1.0 kg/ha (PE) + 1 hoeing at 45 DAS	6.50	5.60	7.90	8.20
T4: Imazethapyr 10% SL @ 63 g/ha (POE) @ 25 DAS + 1 hoeing at 50 DAS	3.54	2.80	2.90	3.10
T5: Oxyfluorfen 23.5% EC @ 0.120 kg/ha (PE)	6.10	5.20	7.79	8.10

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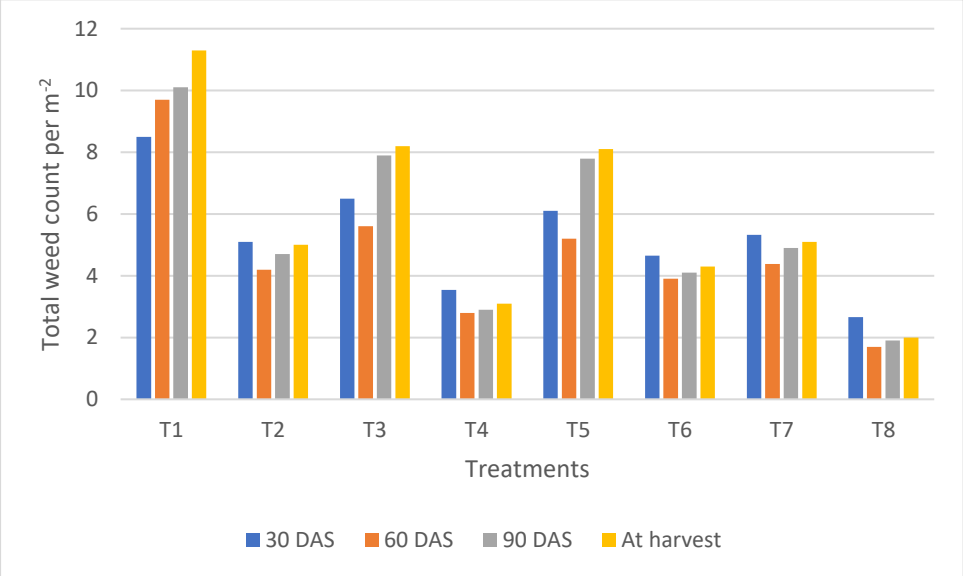
T6: Pendimethalin 30 % EC @ 1.0 kg/ha (PE) + Quizalfop-p-ethyl 5% EC @ 0.060 kg/ha (POE) @ 45 DAS	4.65	3.90	4.10	4.30
T7: Quizalfop-ethyl 5% EC @ 0.060 kg/ha (POE) @ 30 DAS + 1 hand weeding @ 50 DAS	5.33	4.38	4.90	5.10
T8: Oxyfluorfen 23.5% EC @ 0.120 kg/ha (PE) + Imazethapyr 10% SL @ 50 g/ha @ 35 DAS + 1 hoeing @ 60 DAS	2.66	1.70	1.90	2.00
General Mean	5.29	4.29	5.29	5.63
F Value	2.908*	4.403**	11.961**	3.494*
SEd	0.9280	1.031	0.710	0.8158
CD 1%	2.7624	3.070	2.113	2.4284
CV	21.1444	26.5900	14.7992	30.7414



Weed index and weed control efficiency.

The weed index contrasts optimum therapy with weed loss. Thus, it demonstrates the extent of yield loss brought on by insufficient weed management. Greater weed-related harm is indicated by a higher weed count.

The information on how the weed index is impacted by different weed management methods is reported in Table and depicted in Fig.

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A minimal weed index with Oxyfluorfen 23.5% EC @ 0.120 kg/ha (PE) + Imazethapyr 10% SL @ 50 g/ha at 35 DAS + 1 hoeing at 60 DAS (10.38%) was determined to be at par with the treatment Imazethapyr 10% SL @ 63 g/ha (POE) at 25 DAS + 1 hoeing at 50 DAS (12.52%) by data analysis from various weed control treatments. Due to efficient weed control and improved crop development, these treatments outperformed alternative treatments. Because there were no weed management measures taken, the treatment of the weedy check (49.57%) resulted in a noticeably higher weed index.

Higher seed output in the respective treatments contributed to lower weed index, and vice versa. By using cultural and chemical control approaches in conjunction with hoeing at 30 DAS, the minimum value of the weed index in each treatment shows reduced losses caused by weeds because of less crop-weed competition during the growth stage of the crop, leading to improved yield. These results corroborated Singh et al. (2020)'s findings.

Amid various herbicidal treatments highest overall weed index recorded in the treatment Alachlor 1.0 kg/ha (PE) + 1 hand hoeing at 45 DAS (46.38)

The effectiveness of weeds treated by various treatments in comparison to weedy check is measured by weed control efficiency.

The information on the effectiveness of weed control as affected by various weed control treatments is provided in Table and visually displayed in Fig.

Among other herbicidal treatments treatment Oxyfluorfen 23.5% EC @ 0.120 kg/ha (PE) + Imazethapyr 10% SL @ 50 g/ha at 35 DAS + 1 hoeing at 60 DAS (82.30%) noted significantly greater value of weed control efficiency which was found at par with treatment Imazethapyr 10% SL @ 63 g/ha (POE) at 25 DAS + 1 hoeing at 50 DAS (72.56%) The significantly lowest weed control efficiency was recorded from the treatment weedy check (0.00%).

Amid various herbicidal treatments lowest weed control efficiency found in the treatment Alachlor 1.0 kg/ha (PE) + 1 hand hoeing at 45 DAS (27.43%).

Due to the herbicides' maximal absorption and greater assimilation happening right after weed emergence, the application of the herbicides pendimethalin and oxyfluorfen before

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emergence decreases the density of the weeds and resulting in a high effectiveness in weed control. Lower weed intensity and dry weight compared to weedy check are characteristics of integrated weed control treatments, which may contribute to their greater weed control effectiveness.

These results were consistent with those reached by Singh et al. (2020), Rathod et al. (2017), Bhutada and Bhale (2014), Poonia et al. (2013), Singh and Jain (2017), and Poonia et al.

Weed Index (%) and weed control efficiency (%)

Treatment	Weed index (%)	Weed control efficiency (%)
T1: Weedy check	49.57	00
T2: Pendimethalin 30% EC @ 1.0 kg/ha (PE) + 1 hoeing at 30 DAS	38.14	55.75
T3: Alachlor 1.0 kg/ha (PE) + 1 hoeing at 45 DAS	46.38	27.43
T4: Imazethapyr 10% SL @ 63 g/ha (POE) @ 25 DAS + 1 hoeing at 50 DAS	12.52	72.56
T5: Oxyfluorfen 23.5% EC @ 0.120 kg/ha (PE)	40.05	29.20
T6: Pendimethalin 30 % EC @ 1.0 kg/ha (PE) + Quizalfop-p-ethyl 5% EC @ 0.060 kg/ha (POE) @ 45 DAS	23.83	61.94
T7: Quizalfop-ethyl 5% EC @ 0.060 kg/ha (POE) @ 30 DAS + 1 hand weeding @ 50 DAS	39.52	54.86
T8: Oxyfluorfen 23.5% EC @ 0.120 kg/ha (PE) + Imazethapyr 10% SL @ 50 g/ha @ 35 DAS + 1 hoeing @ 60 DAS	10.38	82.30
General Mean	32.54	48.00
F Value	3.792*	
SEd	1.24	1.1041
CD 1%	4.88	14.06
CV	11.24	

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Yield attributes and yield

Plant height was found to be important for various weed management methods at 30 DAS. However, among several herbicidal treatments, treatment Oxyfluorfen 23.5% EC @ 0.120 kg/ha (PE) + Imazethapyr 10% SL @ 50 g/ha at 35 DAS + 1 hoeing at 60 DAS was shown to numerically increase plant height (18.36 cm).

Imazethapyr 10% SL @ 63 g/ha (POE) at 25 DAS + 1 hoeing at 50 DAS (17.56 cm) came next. Lowest plant height was measured by a weedy check at 13.90 cm. Up to harvest, chickpea plant height greatly grew, however from 90 DAS until harvest the rate of increase in plant height was reduced. With the exception of 30 DAS, chickpea plant height consistently followed a similar trajectory during all observational days.

Amid various herbicidal treatments at 30, 60, 90 DAS and Harvest lowest plant height recorded in the treatment Alachlor 1.0 kg/ha (PE) + 1 hand hoeing at 45 DAS (12.90, 26.20, 32.75 and 32.50)

Different treatments had a substantial impact on plant^{-1}'s branch count at 30 DAS. The treatment Oxyfluorfen 23.5% EC @ 0.120 kg/ha (PE) + Imazethapyr 10% SL @ 50 g/ha at 35 DAS + 1 hoeing at 60 DAS recorded considerably the greatest value of the number of branches plant^{1} (7.26), which was found to be comparable to the use of herbicidal treatments Imazethapyr 10% SL @ 63 g/ha (POE) at 25 DAS + 1 hoeing at 50 DAS (6.93), Pendimethalin 30 % EC @ 1.0 kg/ha (PE) + Quizalfop-p-ethyl 5% EC @ 0.060 kg/ha (POE) at 45 DAS (4.83), and Oxyfluorfen 23.5% EC @ 0.120 kg/ha (PE) (5.53) respectively.

The average seed yield per hectare was 14.94. The Oxyfluorfen 23.5% EC @ 0.120 kg/ha (PE) + Imazethapyr 10% SL @ 50 g/ha at 35 DAS + 1 hoeing at 60 DAS treatment had the highest observed seed production (18.78 q ha-1), which was considerably higher than that of the other treatments.

Imazethapyr 10% SL @ 63 g/ha (POE) at 25 DAS + 1 hoeing at 50 DAS recorded the considerably next greatest seed production among the different herbicide treatments (17.43 q ha^{-1}), followed by Pendimethalin 30% EC @ 1 kilogram/ha (PE) + Quizalfop-p-ethyl 5% EC @ 0.050 kg Ha (POE) @ 30 DAS (16.10 q ha^{-1}).

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Yield contributing characters of crop as influenced by various weed management practices.

Treatments	No. of pods plant^{-1}	No. of grains plant^{-1}	Weight of pods plant $^{-1}$ (g)	Weight of grains plant^{-1} (g)	No. of grain pod^{-1}	100 seed weight plant^{-1} (g)
T1: Weedy check	25.333	30.12	11.890	4.50	1.10	12.45
T2: Pendimethalin 30% EC @ 1.0 kg/ha (PE) + 1 hoeing at 30 DAS	27.700	37.82	16.130	5.44	1.31	14.90
T3: Alachlor 1.0 kg/ha (PE) + 1 hoeing at 45 DAS	26.333	35.45	13.917	5.19	1.16	13.28
T4: Imazethapyr 10% SL @ 63 g/ha (POE) @ 25 DAS + 1 hoeing at 50 DAS	29.000	38.10	17.580	5.58	1.44	15.10
T5: Oxyfluorfen 23.5% EC @ 0.120 kg/ha (PE)	27.000	36.22	14.910	5.33	1.20	13.80
T6: Pendimethalin 30 % EC @ 1.0 kg/ha (PE) + Quizalfop-p-ethyl 5% EC @ 0.060 kg/ha (POE) @ 45 DAS	28.330	37.94	17.273	5.47	1.38	15.07
T7: Quizalfop-ethyl 5% EC @ 0.060 kg/ha (POE) @ 30 DAS + 1 hand weeding @ 50 DAS	27.667	36.47	15.790	5.35	1.25	14.01
T8: Oxyfluorfen 23.5% EC @ 0.120 kg/ha (PE) + Imazethapyr 10% SL @ 50 g/ha @ 35 DAS + 1 hoeing @ 60 DAS	30.667	39.42	21.167	5.70	1.50	16.80
General Mean	27.500	35.75	16.08	5.19	1.29	14.41
F Value	3.883*	2.459**	6.564**	1.458*	2.638*	5.428**
SEd	0.5798	1.0067	0.9750	0.1727	0.0661	0.6303
CD 1%	2.3015	3.9960	3.8701	0.5140	0.1969	1.8762
CV	18.93	24.28	17.14	16.45	14.25	13.54

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Cost of cultivation, Gross monetary return. Net monetary return and B:C ratio as influenced by various weed management practices.

Treatment	Cost of cultivation (₹ ha^{-1})	Gross monetary return (₹ ha^{-1})	Net monetary return (₹ ha^{-1})	B:C ratio
T1: Weedy check	37644	70398	32754	0.87
T2: Pendimethalin 30% EC @ 1.0 kg/ha (PE) + 1 hoeing at 30 DAS	42140	94023	51883	1.23
T3: Alachlor 1.0 kg/ha (PE) + 1 hoeing at 45 DAS	41021	82947	41926	1.02
T4: Imazethapyr 10% SL @ 63 g/ha (POE) @ 25 DAS + 1 hoeing at 50 DAS	41114	101415	60301	1.46
T5: Oxyfluorfen 23.5% EC @ 0.120 kg/ha (PE)	39594	82257	42663	1.06
T6: Pendimethalin 30 % EC @ 1.0 kg/ha (PE) + Quizalfop-p-ethyl 5% EC @ 0.060 kg/ha (POE) @ 45 DAS	42356	99964	57608	1.36
T7: Quizalfop-ethyl 5% EC @ 0.060 kg/ha (POE) @ 30 DAS + 1 hand weeding @ 50 DAS	41025	86690	45665	1.11
T8: Oxyfluorfen 23.5% EC @ 0.120 kg/ha (PE) + Imazethapyr 10% SL @ 50 g/ha @ 35 DAS + 1 hoeing @ 60 DAS	42814	108260	65446	1.52
General Mean		90744	49780	1.20
SEd		9360.27	9060.54	0.1934
CD 1%		6732	6806	0.13

Economic implication

Here, Oxyfluorfen 23.5% EC @ 0.120 kg/ha (PE) + Imazethapyr 10% SL @ 50 g/ha at 35 DAS + 1 hoeing at 60 DAS significantly recorded the highest value of net returns (65446 ha^{-1}), which was at par with treatment Imazethapyr 10% SL @ 63 g/ha (POE) at 25 DAS + 1 hoeing at 50 DAS (60301 ha^{-1}). These therapies were found to be superior than other therapies. The weedy check treatment (32754 ha^{-1}) had the lowest net financial returns.

The better net financial returns in the treatment Oxyfluorfen 23.5% EC @ 0.120 kg/ha (PE) + Imazethapyr 10% SL @ 50 g/ha at 35 DAS + 1 hoeing at 60 DAS were due to significant seed and straw yields as well as decreased cultivation expenses.

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Economics of chickpea as affected by various weed management practices

Treatment	Cost of cultivation (₹ ha^{-1})	Gross monetary return (₹ ha^{-1})	Net monetary return (₹ ha^{-1})	B:C ratio
T1: Weedy check	37644	70398	32754	0.87
T2: Pendimethalin 30% EC @ 1.0 kg/ha (PE) + 1 hoeing at 30 DAS	42140	94023	51883	1.23
T3: Alachlor 1.0 kg/ha (PE) + 1 hoeing at 45 DAS	41021	82947	41926	1.02
T4: Imazethapyr 10% SL @ 63 g/ha (POE) @ 25 DAS + 1 hoeing at 50 DAS	41114	101415	60301	1.46
T5: Oxyfluorfen 23.5% EC @ 0.120 kg/ha (PE)	39594	82257	42663	1.06
T6: Pendimethalin 30 % EC @ 1.0 kg/ha (PE) + Quizalfop-p-ethyl 5% EC @ 0.060 kg/ha (POE) @ 45 DAS	42356	99964	57608	1.36
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General Mean		90744	49780	1.20
SEd		9360.27	9060.54	0.1934
CD 1%		6732	6806	0.13

CONCLUSION

For effective control of weeds and higher seed yield as well as economical returns under the treatments Oxyfluorfen 23.5% EC @ 0.120 kg/ha (PE) + Imazethapyr 10% SL @ 50 g/ha at 35 DAS + 1 hoeing at 60 DAS, followed by Imazethapyr 63 g/ha (POE) @ 25 DAS + 1 Hand hoeing @ 50 DAS.

Based on a year of testing, it was possible to draw the conclusion that the most cost-effective and profitable method was to apply Oxyfluorfen 1 kg/ha (PE) before the emergence, followed by spraying Imazethapyr 50 g/ha @ 25 DAS + 1 hoeing @ 50 DAS.

The aforementioned judgement was reached after a year of research. The research must be repeated for further findings confirmation.

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