AATCC Review

02 September 2024: Received
05 October 2024: Revised
11 November 2024: Accepted
27 November 2024: Available Online

https://aatcc.peerjournals.net/

Original Research Article

Open Access

Efficacy of Pre and Post Emergence of Herbicides on Weed Dynamics and Weed Index and its Effect on Productivity and Economics of Chickpea (*Cicer arietinum* L.) under Rainfed Condition

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ABSTRACT

An experimental trail was conducted at Bihar Agricultural College, Sabour, Bhagalpur during 2021-22 to find the bio-efficacy of pre and post-emergency of herbicides under rainfed conditions in north Bihar (India). The significantly higher chickpea seed yield (1.74 t ha^{-1}) and net return (₹ 72564 ha^{-1}) were recorded with application of topramezone @ 25 g ha^{-1} at 25 DAS over unweeded check (0.98 t ha^{-1} ₹ 33558 ha^{-1}) respectively and remained at par with pendimethalin @ 1000 g ha^{-1} as PE fb 1 hand weeding (HW) 30 DAS (1.73 t ha^{-1}, ₹ 69826 ha^{-1}), oxyfluorfen @ 100 g ha^{-1} as PE fb 1 HW at 30 DAS (1.67 t ha^{-1}, ₹ 67439 ha^{-1}), topramezone @ 20 g ha^{-1} at 25 DAS (1.66 t ha^{-1}, ₹ 69306 ha^{-1}) and pendimethalin @ 1000 g ha^{-1} as PE fb quizalofop-ethyl @ 50 g ha^{-1} at 25 DAS (1.58 t ha^{-1}, ₹ 64859 ha^{-1}) respectively whereas maximum plant height (21.70 cm) dry matter accumulation (42.24 g m^{-2}) and no of pods plant^{-1} (25.16) were recorded with application of pendimethalin @ 1000 g ha^{-1} as PE fb 1 HW at 30 DAS and seed index of chickpea was recorded non-significant.

Keywords: *Chickpea, Weed Dynamics, Weed Index, Yield, Economics,*

INTRODUCTION

Chickpea (*Cicer arietinum* L.) is a very important pulse crop in the world as well in India. In India it covers about thirty-eight percent (38%) of area under pulse and contributes about fifty percent of the total pulse production, in India chickpea covers about 10.17 million hectare area and production 11.35 million tons with productivity 1116 kg ha^{-1} [1]. In Bihar it cover an area of about 521.90 thousand ha with production of 538.0 thousand tones and productivity of 1031 kg ha^{-1} [6] Weed infestation in chickpea offer serious competition to the extent of seventy five percent [3]. In chickpea the initial sixty days growth period are considered to be the critical period for weed crop competition [14]. The chickpea productivity is poor due to various biological and physical constraints in which weed are prominent one. Early and heavy flushes of weeds recognized as a major bottleneck in realizing the full yield potential of chickpea [5]. The initial growth of chickpea is slow as a result a broad spectrum of weeds is infested heavily. The fast growing and early emergence of weeds cause crop weed competition for light, moisture, nutrients and space as a result it causes heavy reduction in growth and yield in chickpeas up to 40-75 % [4, 3 & 11]. In present time labour cost increase day by day and also scarcity of manpower at the period of chickpea sown so manual weed management has become a difficult task to maintain the crop. Keeping in view of above sentence suitable herbicide for effective weed control on mixed population is must require for better adoption in this crop by farmers. In chickpeas after emergence of weeds a suitable post-emergence (PoE) herbicide are not available therefore present investigation was formulated and to evaluate the efficacy of different per and post-emergence herbicides for broad-spectrum weed control and their effects on the growth and yield of the chickpea.

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DOI: https://doi.org/10.21276/AATCCReview.2024.12.04.433

MATERIALS AND METHODS

The experiment was carried and laid out during rabi season of 2021-22 on the research farm of Bihar Agricultural University, Sabour, Bhagalpur (Bihar). The experimental plot was provided and has sufficient basic infrastructure facilities, with assured irrigation as well as proper drainage facility with uniform slope. The Bhagalpur is situated between 25°50' N latitude and 87°19' E longitude at analtitude of 52.73 meter above mean sea level with middle gangetic plain region of agro-climatic zone III A.

The Bhagalpur region receives average rainfall of 130 mm and average monthly temperature during the growth period of chickpea was 33.0°C. The nature of soil was clay loam in texture with pH (7.4), organic carbon (0.53 %), low in available nitrogen (159.88 kg ha^{-1}), medium in available phosphorous (26.94 kg ha^{-1}), and medium in available potassium (196.69 kg ha^{-1}). There were thirteen (13) treatments combination *viz* T_1: weedy check, T_2 :weed free, T_3: pendimethalin @ 1000 g ha^{-1} as PE fb 1 HW at 30 DAS, T_4: oxyfluorfen @ 100 g ha^{-1} as PE fb 1 HW at 30 DAS, T_5: imazethapyr @ 40 g ha^{-1} at 25 DAS, T_6 : quizalofop-ethyl @ 50 g ha^{-1} at 25 DAS, T_7: topramezone @ 20 g ha^{-1} at 25 DAS, T_8: topramezone @ 25 g ha^{-1} at 25 DAS, T_9: clodinafop-propargyl + Na-acifluorfen @ 500 g ha^{-1} at 25 DAS, T_{10}: pendimethalin @ 1000 g ha^{-1} as PE fb imazethapyr @ 40 g ha^{-1} at 25 DAS, T_{11}: pendimethalin @ 1000 g ha^{-1} as PE fb quizalofop-ethyl @ 50 g ha^{-1} at 25 DAS, T_{12}: oxyfluorfen @ 100 g ha^{-1} as PE fb imazethapyr @ 40 g ha^{-1} at 25 DAS and T_{13}: oxyfluorfen @ 100 g ha^{-1} as PE fb

quizalofop-ethyl @ 50 g ha^{-1} at 25 DAS tested in a randomized block design (RBD) with three replications. The following the recommended seed rate i.e. 75 kg ha^{-1}. The size of each plot was 5.0 m x 3.0 m with the spacing of crop 30 cm ×10 cm having ten rows of five meter row length. The estimated quantity of fertilizers was applied plot wise as a basal just after harvest of rice crop. The recommended dose of fertilizer in chickpea are 20 and 40 N, P_2O_5 kg ha^{-1} respectively through urea, and DAP were applied uniformly to all the plots, all fertilizer were applied in a single dose *i.e.* basal application. Intercultural operations were done as and when required. No any irrigation was given i.e. crop was grown in rainfed condition. The mature crop were harvested when crop colour change from green to brown.

RESULT AND DISCUSSION

In experiment field the dominant weed flora were comprised of Grasses: *Cynodondactylon, Phalaris minor, Fumaria parviflora.* Sedges: *Cyperus rotundus*. Broad leaved weeds: *Argemone mexicana, Solanum nigrum, Anagallis, arvensis, Chenopodium album, Rumex dentatus, Melilotusindica, Vicia sativa* were found dominated weeds.

Unweeded *i.e.* check plot produced significantly maximum weed dry weight (g m^{-2}) (table 1) at all the growth stages i.e. at 30, 60, 90 DAS and at harvest. At 30 days of crop growth the application of topramezon @ 20g ha^{-1} PoE at 25-30 DAS produced significantly maximum weed dry weight (2.04 g m^{-2}) but remained at par with imazethapyr @ 40 g ha^{-1} at 25 DAS (1.90 g m^{-2}), quizalofop-ethyl @ 50 g ha^{-1} at 25 DAS (1.95 g m^{-2}), topramezone @ 25 g ha^{-1} at 25 DAS (1.90 g m^{-2}), clodinafop-propargyl + Na-acifluorfen @ 500 g ha^{-1} at 25 DAS (2.00 g m^{-2}) and unweeded check (2.27 g m^{-2}). Weed free plots was recorded significantly lowered dry weight at 30 DAS (0.71 g m^{-2}), 60 DAS (0.71 g m^{-2}), 90 DAS (2.33 g m^{-2}) and at harvest (2.55 g m^{-2})and among herbicide application, pendimethalin @ 1000 g ha^{-1} as PE fb 1 HW at 30 DAS recorded significantly lowerweed dry weight at 30 DAS (1.34 g m^{-2}), 60 DAS (3.01 g m^{-2}), 90 DAS (5.60 g m^{-2}) and harvest (6.12 g m^{-2}). At 60 DAS, 90 DAS and at harvest the treatment quizalofop-ethyl @ 50 g ha^{-1} at 25 DAS (5.11, 9.68, 10.42g m^{-2}) respectively, were found significantly superior the weed dry weight over all herbicide applications except at 60 DAS it remained at par with the treatment of imazethapyr @ 40 g ha^{-1} at 25 DAS (5.00 g m^{-2}), weed free plot was recorded minimum weed density in all growth stages while application of pendimethalin @ 1000 g ha^{-1} as PE fb 1 HW at 30 DAS without hand weeding gave the minimum weed density in all growth stages as a result the dry weight of weeds have good results but found phytotoxic on weeds. The similar result was found by [7] that reduced the weed biomass by 44.9, 40.2, 34.7, 33.0, 27.6, 34.7, 50.3 and 41.7 % respectively under the different treatments. Also this result are conformity by [13 & 2] they reported that the pendimethaline is an effective pre-emergence herbicide (0.50-0.75 kg ha^{-1}) for control of annual broad leaved and grassy weeds in chickpea they also reported that the application of oxyfluorfen (0.25 kg ha^{-1}) as pre emergence is also very effective to control broad leaved weeds. Application of different dosage of pre and post emergence of herbicides influenced significantly on plant height (cm) and dry matter accumulation (g m^{-2}) at 60 DAS (Table 2) while numerical value of weed index was maximum recorded in weed free plot (45.51) while with herbicide application maximum weed index was recorded in treatments of clodinafop-propargyl + Na-acifluorfen @ 500 g ha^{-1} at 25 DAS (31.78) followed by imazethapyr @ 40 g ha^{-1} at 25 DAS (27.05) and minimum weed index was recorded in treatment pendimethaline @ 1000 g ha^{-1} as PE fb 1 HW at 30 DAS (1.88). These results conform to those of [15 & 8].

At 60 DAS Significantly maximum plant height (21.70 cm)was produced with application of Pendimethalin @ 1000 g ha^{-1} as PE fb 1 HW at 30 DAS of crop which was significantly superior over all the treatments except the treatment imazethapyr @ 40 g ha^{-1} at 25 DAS (18.70 cm), quizalofop-ethyl @ 50 g ha^{-1} at 25 DAS (18.57 cm), clodinafop-propargyl + Na-acifluorfen @ 500 g ha^{-1} at 25 DAS (18.50 cm) and weedy check plot (17.23 cm). at 60 DAS the maximum dry matter accumulation (42.24 g m^{-2}) was produced with application of pendimethalin @ 1000 g ha^{-1}as PE fb 1 HW at 30 DAS over unweeded control plot (28.67g m^{-2}) and remained at par with all the treatments except the treatment imazethapyr @ 40 g ha^{-1} at 25 DAS (35.06 g m^{-2}), clodinafop-propargyl + Na-acifluorfen @ 500 g ha^{-1} at 25 DAS (34.29 g m^{-2}) and weedy check plot (28.67 g m^{-2}). Application of different dosages of pre and post-emergence of herbicides significantly influenced the effect on number of pods $plant^{-1}$ while 100 seed weight (g), was found non-significant among the all the treatments (table 3). Significant maximum number of pods $plant^{-1}$ (25.16) was produced with the application of pendimethaline @ 1000 g ha^{-1} as PE fb 1 HW at 30 DAS over unweeded control plot (17.17) and remained at par with all the treatments except application of imazethapyr @ 40 g ha^{-1} at 25 DAS (18.06) and quizalofop-ethyl @ 50 g ha^{-1} at 25 DAS (18.86). In the weedy check plot the chickpea seed yield reduced by 83.67 % by different types of weeds over the weed-free plot. Significantly maximum seed yield (1.74t ha^{-1}) was recorded with application of topramezone @ 25 g ha^{-1} at 25 over unweeded check (0.98 t ha^{-1}) and remained at par with pendimenthalin @ 1000 g ha^{-1} as PE fb 1 HW at 30 DAS, oxyfluorfen @ 100 g ha^{-1} as PE fb 1 HW at 30 DAS, topramezone @ 20 g ha^{-1} at 25 DAS and pendimethalin @ 1000 g ha^{-1}as PE fbquizalofop-ethyl @ 50 g ha^{-1} at 25 DAS by producing 1.73,1.67, 1.66 and 1.58 t ha^{-1} seed yield of chickpea, respectively.

The higher seed yield of chickpea under topramezone @ 25 g ha^{-1} at 25 DAS was due to the low phytotoxicity of herbicides on crop. Application of topramezone @ 25 g ha^{-1} at 25 DAS proved phytotoxic with poor weed dry weight (3.36, 5.76 and 6.31 g m^{-2}) at 60 DAS, 90 DAS and at harvest of chickpea as a result seed yield of chickpea increase. However, results showed that application of topramezone @ 25 g ha^{-1} at 25 DAS gave more yields over unweeded control plots and hand weeded plot in combination with herbicide. Weedy situation prevailing throughout the crop period caused 43.68 % reduction of chickpea yield over topramezone @ 25 g ha^{-1} at 25 DAS herbicide. Hence, topramezone herbicide without hand weeding was found inadequate forgetting higher chickpea seed yield under rainfed conditions in north Bihar. Topramezone @ 25 g ha^{-1} at 25 DAS herbicide was found best weed management practice and may be recommended for rainfed condition for north Bihar, however, application enhanced the braching of crop significantly and found phytotoxic on the weeds under rainfed condition.

The maximum cost of production was incurred in weed free plot (₹ 35486ha^{-1}) due to more number of labour involved, regarding herbicide application maximum cost of production was incurred in clodinafop-propargyl + Na-acifluorfen @ 500 g ha^{-1} at 25 DAS (₹ 32174 ha^{-1}) net return was maximum under topramezone @ 25 g ha^{-1} at 25 DAS (₹ 72564 ha^{-1}) but statistically at par to pendimethalin @ 1000 g ha^{-1} as PE fb 1 HW at 30 DAS (₹ 69826 ha^{-1}), oxyfluorfen @ 100 g ha^{-1} as PE fb 1 HW at 30 DAS (₹ 67439 ha^{-1}), topramezone @ 20 g ha^{-1} at 25 DAS (₹ 69306 ha^{-1}), pendimethalin @ 1000 g ha^{-1} as PE fbquizalofop-ethyl @ 50 g ha^{-1}

at 25 DAS (₹ 64859 ha^{-1}) particularly less weed management cost was observed by [9, 10, 5 & 12].

CONCLUSION

From this experiment we conclude that the application of topramezone @ 25 g ha^{-1} at 25 DAS, herbicide without hand weeding in chickpea recorded higher yield and economic returns, as weedy situation prevailing throughout the crop period and hence topramezone @ 25 g ha^{-1} at 25 DAS herbicide improve the seed yield up to 43.68% over control plot.

Funding: The research was conducted under the all India coordinated research project on weed management by the Bihar Agricultural University, Sabour, Bhagalpur, Bihar

Future scope of the study: This experiment needs to be conducted at multiple locations and should be repeated for more number of years for confirming the result obtained and for arriving at conclusive suggestions.

Acknowledgement: The all author wish to thank, the all India coordinated research project on weed management ICAR-Directorate of Weed Research, (voluntary centre), Bihar Agricultural College, Sabour for sparing their valuable time in providing precious information.

Author Contributions: all authors are equally contributed.

Author Statement: all authors are agreed and approved the final manuscript.

Note-All authors agreed that written informed consent was obtained from all participants prior to publish.

Conflict of Interest: We declare no known conflict of interest.

Ethical Approval: This article does not contain any ill ethical studies by any of the authors.

Table 1. Effects of weed management practices on weed dry matter (g m^{-2}) in chickpea

Treatments		Weed dry matter (g m^{-2})			
		30 DAS	60 DAS	90 DAS	At harvest
T_1	Weedy check	2.27 (4.67)	8.73 (75.67)	13.56 (183.47)	14.08 (197.67)
T_2	Weed free	0.71 (0.00)	0.71 (0.00)	2.33 (4.91)	2.55 (6.00)
T_3	Pendimethalin @ 1000 g ha^{-1} as PE *fb* 1 HW at 30 DAS	1.34 (1.33)	3.01 (8.58)	5.60 (30.83)	6.12 (37.00)
T_4	Oxyfluorfen @ 100 g ha^{-1} as PE *fb* 1 HW at 30 DAS	1.41 (1.50)	3.16 (9.50)	5.63 (31.17)	6.24 (38.50)
T_5	Imazethapyr @ 40 g ha^{-1} at 25 DAS	1.90 (3.11)	5.00 (24.50)	9.39 (87.67)	9.86 (96.67)
T_6	Quizalofop-ethyl @ 50 g ha^{-1} at 25 DAS	1.95 (3.33)	5.11 (25.67)	9.68 (93.15)	10.42 (108.00)
T_7	Topramezone @ 20 g ha^{-1} at 25 DAS	2.04 (3.67)	3.48 (11.67)	5.93 (34.67)	6.47 (41.33)
T_8	Topramezone @ 25 g ha^{-1} at 25 DAS	1.90 (3.13)	3.36 (10.83)	5.76 (32.66)	6.31 (39.37)
T_9	Clodinafop-propargyl + Na-acifluorfen @ 500 g ha^{-1} at 25 DAS	2.00 (3.50)	4.42 (19.17)	9.17 (83.61)	9.70 (93.67)
T_{10}	Pendimethalin @ 1000 g ha^{-1} as PE *fb* imazethapyr @ 40 g ha^{-1} at 25 DAS	1.39 (1.44)	3.58 (12.33)	7.24 (52.00)	8.03 (64.00)
T_{11}	Pendimethalin @ 1000 g ha^{-1} as PE *fb* quizalofop-ethyl @ 50 g ha^{-1} at 25 DAS	1.51 (1.80)	3.81 (14.00)	7.66 (58.33)	8.30 (68.33)
T_{12}	Oxyfluorfen @ 100 g ha^{-1} as PE *fb* imazethapyr @ 40 g ha^{-1} at 25 DAS	1.45 (1.60)	3.62 (12.67)	7.49 (55.67)	7.63 (57.67)
T_{13}	Oxyfluorfen @ 100 g ha^{-1} as PE *fb* quizalofop-ethyl @ 50 g ha^{-1} at 25 DAS	1.42 (1.52)	3.85 (14.33)	8.05 (64.33)	8.69 (75.00)
S.Em(±)		0.07	0.11	0.10	0.06
C.D.*(P=0.05)*		0.22	0.32	0.28	0.16

Data subjected to sq. root ($\sqrt{x+0.5}$) transformation. Figures in parentheses are original values.

Table 2.Effects of weed management practices on plant height (cm), dry matter accumulation (g m^{-2}) at 60 DAS, weed index (%) and phytotoxicity on crop (10) at 30 DAS in chickpea

Treatments		Plant height (cm) at 60 DAS	Dry matter accumulation (g/m^2) at 60 DAS	Weed Index (%)	Phytotoxicity on crop (10) at 30 DAS
T_1	Weedy check	17.23	28.67	45.51	0
T_2	Weed free	22.00	45.58	0.00	0
T_3	Pendimethalin @ 1000 g ha^{-1} as PE *fb* 1 HW at 30 DAS	21.70	42.24	1.88	0
T_4	Oxyfluorfen @ 100 g ha^{-1} as PE *fb* 1 HW at 30 DAS	21.30	41.57	4.37	0
T_5	Imazethapyr @ 40 g ha^{-1} at 25 DAS	18.70	35.06	27.05	2
T_6	Quizalofop-ethyl @ 50 g ha^{-1} at 25 DAS	18.57	36.18	26.07	0
T_7	Topramezone @ 20 g ha^{-1} at 25 DAS	20.68	39.69	10.09	0
T_8	Topramezone @ 25 g ha^{-1} at 25 DAS	20.82	40.19	6.69	0
T_9	Clodinafop-propargyl + Na-acifluorfen @ 500 g ha^{-1} at 25 DAS	18.50	34.29	31.78	6
T_{10}	Pendimethalin @ 1000 g ha^{-1} as PE *fb* imazethapyr @ 40 g ha^{-1} at 25 DAS	20.27	37.35	21.52	2
T_{11}	Pendimethalin @ 1000 g ha^{-1} as PE *fb* quizalofop-ethyl @ 50 g ha^{-1} at 25 DAS	20.57	39.27	12.45	0
T_{12}	Oxyfluorfen @ 100 g ha^{-1} as PE *fb* imazethapyr @ 40 g ha^{-1} at 25 DAS	20.30	37.54	19.50	2
T_{13}	Oxyfluorfen @ 100 g ha^{-1} as PE *fb* quizalofop-ethyl @ 50 g ha^{-1} at 25 DAS	20.53	39.10	16.25	0
S.Em(±)		0.72	2.30	-	-
C.D.*(P=0.05)*		2.09	6.72	-	-

Table 3. Effects of weed management practices on yield attributes, yield (t ha^{-1}) and economics of chickpea

Herbicides		No. of pods $plant^{-1}$	100 seed weight (g)	Grain yield (t ha^{-1})	Cost of cultivation (₹ ha^{-1})	Net return (₹ ha^{-1})
T_1	Weedy check	17.17	18.17	0.98	24390	33558
T_2	Weed free	25.50	21.43	1.80	35486	69675
T_3	Pendimethalin @ 1000 g ha^{-1} as PE *fb* 1 HW at 30 DAS	25.16	21.73	1.73	31589	69826
T_4	Oxyfluorfen @ 100 g ha^{-1} as PE *fb* 1 HW at 30 DAS	23.49	20.65	1.67	31033	67439
T_5	Imazethapyr @ 40 g ha^{-1} at 25 DAS	18.06	18.47	1.31	25734	52294
T_6	Quizalofop-ethyl @ 50 g ha^{-1} at 25 DAS	18.86	18.42	1.33	26774	52561
T_7	Topramezone @ 20 g ha^{-1} at 25 DAS	20.96	20.00	1.66	28347	69306
T_8	Topramezone @ 25 g ha^{-1} at 25 DAS	21.64	20.33	1.74	29190	72564
T_9	Clodinafop-propargyl + Na-acifluorfen @ 500 g ha^{-1} at 25 DAS	22.38	20.67	1.22	32174	39836
T_{10}	Pendimethalin @ 1000 g ha^{-1} as PE *fb* imazethapyr @ 40 g ha^{-1} at 25 DAS	19.86	18.78	1.41	27383	56331
T_{11}	Pendimethalin @ 1000 g ha^{-1} as PE *fb* quizalofop-ethyl @ 50 g ha^{-1} at 25 DAS	20.78	19.49	1.58	28423	64859
T_{12}	Oxyfluorfen @ 100 g ha^{-1} as PE *fb* imazethapyr @ 40 g ha^{-1} at 25 DAS	21.46	19.02	1.44	27338	58499
T_{13}	Oxyfluorfen @ 100 g ha^{-1} as PE *fb* quizalofop-ethyl @ 50 g ha^{-1} at 25 DAS	22.23	19.29	1.50	28378	60480
S.Em(±)		1.51	0.80	0.07	-	3898
C.D.*(P=0.05)*		4.40	NS	0.20	-	11378

References

1. Anonymous. 2021. Agricultural Statistics at a Glance - 2019-20. Directorate of Economics and Statistics, Department of Agriculture, Cooperation and Farmers Welfare, Government of India.

2. Ashu and Menon S. 2021. Effect of different weed management practices on weed dry matter accumulation and weed population in chickpea (*Cicer arietinum* L.) and lentil (Lens culinaris L.) intercropping system. International Journal Current Microbiology and Applied Sciences, 10(4): 632–638.

3. Chaudhary, B. M., Patel, J. J. and Delvadia, D. R. 2005. Effect of weed management practices and seed rates on weeds and yield of chickpea. Indian Journal of Weed Science, 37: 271-272.

4. Chopra, N., Chopra, N. K. and Singh, H. P. 2003. Loss in seed yield and quality due to weed stress in chickpea (*Cicer arietinum* L.). Indian Journal of Agricultural Sciences, 73(6):350–351.

5. Dubey, S. K., Jai, D. S., Choudhary, S. K., Kumar, V. and Shruti Suman 2018. Weed management in chickpea under irrigated conditions. Indian Journal of Weed Science, 50(1):85–87.

6. Indian Council of Agricultural Research (ICAR), Indian Institute of Pulse Research (IIPR), E-pulses data book (state-wise, 2014-15).

7. Kashyap, A. K., Kushwaha, H. S. and Mishra, H. 2022. Effect of herbicides on weeds, yield and economics of chickpea. Indian Journal of Weed Science, 54(2): 182–186.

8. Kumar, P. and Chinnamuthu, C. R. 2014. Performance of preemergence herbicide on weeds and plant growth attributes of irrigated black gram (*Vigna mungo* L.). Trends in Biosciences, 7(11): 1055–1058.

9. Manjulatha G., Rajanikanth E., Bamboriya, S. D. and Salakinkop, S. R. 2024. Efficacy of Herbicides on Weed Dynamics and Weed Control Efficiency and its Effect on Productivity and Economics of Kharif Maize, Agriculture Association of Textile Chemical and Critical Reviews Journal, 52-56.

10. Rathod, P. S., Patil, D. H. and Dodamani, B. M. 2017. Integrated weed management in chickpea (Cicer arietinum L.) under rainfed conditions of Karnataka, India. Legume Research, 40(3):580–585.

11. Ratnam, M., Rao, A. S. and Reddy, T. Y. 2011. Integrated Weed Management in Chickpea (*Cicer arietinum* L.). Indian Journal Weed Science, 43(1&2): 70–72.

12. Sethi Indu Bala, Singh, H., Kumar, S., Jajoria, M., Jat, L. K., Kumar, B. N., Suresh, M. and Ram, M. H. 2021. Effect of post-emergence herbicides in chickpea under Agriculture University, Jobner Jaipur, Rajasthan. Indian Journal of Weed Science, 53(1):49–53.

13. Singh, A. and Jain, N. 2017. Integrated weed management in chickpea. Indian Journal of Weed Science, 49(1): 93–94.

14. Singh, G. and Singh, D. 1992. Weed-crop competition studies in chickpea (*Cicer arietinum*). Indian Journal of Weed Science, 24(1&2): 1-5.

15. Singh, M., Kumar, S. and Kumar, R. 2014. Effects of post emergence herbicides on weed control and yield of field pea and their residual effect on succeeding sorghum and mungbean crop. Legume Research, 37(4): 387–394.