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Evaluation of Different Weed Management Strategies for Enhancing Growth and Yield of Chickpea (*Cicer arietinum* L.)

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Abstract— *The field experiment entitled "Evaluation of Different Weed Management Strategies for Enhancing Growth and Yield of Chickpea (Cicer arietinum L.)" was conducted during the Rabi season to evaluate the effectiveness of different weed management practices in chickpea. Ten treatments comprising manual weeding and pre and post-emergence herbicide applications were evaluated. The results revealed that weed management practices significantly influenced weed population, weed dry matter, growth and yield attributes of chickpea. Two hand weeding at 30 and 45 DAS (T2) recorded the highest plant height (69.84 cm), number of branches plant^{-1} (6.92), pods plant^{-1} (47.86), grains pod^{-1} (1.52), seed yield (1665.61 kg ha^{-1}), stover yield (1849.67 kg ha^{-1}) and biological yield (3515.28 kg ha^{-1}). It also recorded the lowest weed dry matter (12.50 g m^{-2}) and weed index (0.00%). Among herbicidal treatments, imazethapyr 10% SL @ 75 g a.i. ha^{-1} (T8) recorded the lowest weed population at harvest (4.10 m^{-2}) and comparatively lower weed dry matter (17.93 g m^{-2}) and weed index (6.25%). It also produced a higher seed yield of 1561.55 kg ha^{-1}. However, propaquizafop 10 EC @ 100 g a.i. ha^{-1} (T10) recorded the highest number of pods plant^{-1} (44.32) and grains pod^{-1} (1.45) among herbicidal treatments. Overall, two hand weeding at 30 and 45 DAS proved most effective in reducing weed competition and improving chickpea productivity, while imazethapyr 10% SL @ 75 g a.i. ha^{-1} emerged as a promising herbicidal alternative for effective weed management in chickpea.*

Keywords— ***Chickpea, weed management, imazethapyr, pendimethalin, weed control, seed yield.***

I. INTRODUCTION

Chickpea (*Cicer arietinum* L.) is one of the most important pulse crops cultivated worldwide and plays a significant role in ensuring food and nutritional security. It belongs to the family Fabaceae and is widely grown in tropical, subtropical and temperate regions. Chickpea is an important source of dietary protein, carbohydrates, vitamins and minerals, particularly for vegetarian populations. In addition to its nutritional importance, chickpea contributes to sustainable agricultural production through biological nitrogen fixation, improvement of soil fertility and diversification of cropping systems (Rajput *et al*., 2025; Korbu *et al*., 20200). In India, it is an important rabi-season pulse crop cultivated under rainfed as well as irrigated conditions. However, its productivity is often limited by several biotic and abiotic factors, among which weed infestation is one of the major constraints.

Weeds are considered a serious problem in chickpea cultivation because they compete with the crop for essential growth resources, particularly nutrients, moisture, sunlight and space (Khan *et al*., 2023) Chickpea is generally a slow-growing crop during its initial growth stages and

develops a relatively weak canopy, which makes it less competitive against rapidly growing weeds. The presence of weeds during the early stages of crop growth adversely affects plant establishment, vegetative growth and reproductive development (Scavo and Mauromicale, 2020). Severe weed infestation may result in reduced plant height, fewer branches, poor pod formation and ultimately lower grain yield. The extent of yield reduction depends on the weed species, their density, duration of infestation, soil moisture conditions and prevailing environmental factors (Liliane and Charles, 2020). The weed flora associated with chickpea generally comprises both grassy and broad-leaved weeds, along with sedges. Commonly occurring weed species include *Chenopodium album*, *Anagallis arvensis*, *Melilotus indica*, *Fumaria parviflora*, *Medicago denticulata*, *Phalaris minor* and *Cynodon dactylon*. The composition and intensity of weed infestation vary according to geographical location, cropping system, soil type and climatic conditions (Minhas *et al*., 2023). Uncontrolled weed growth during the critical stages of crop development can substantially reduce crop productivity (Hakeem *et al*., 2025). Recent research has also demonstrated that prolonged weed competition adversely affects crop dry matter accumulation, growth rate and seed yield.

Effective weed management is therefore essential for achieving higher productivity and profitability in chickpea cultivation (Kumar *et al*., 2025). Different weed control strategies, including manual, mechanical, chemical and integrated methods, are being adopted to minimize crop-weed competition. Manual methods such as hand weeding and hoeing are effective in removing weeds but require considerable labour, time and operational costs (Tiwari *et al*., 2022). Mechanical methods provide an alternative for controlling weeds between crop rows; however, their effectiveness depends on crop spacing, soil conditions and the availability of suitable equipment. Chemical weed management through pre-emergence and post-emergence herbicides offers a timely and efficient approach for controlling different weed species. Pre-emergence herbicides help suppress weed emergence during the initial stages of crop establishment, whereas post-emergence herbicides control emerged weeds during crop growth (Kousta *et al*., 2024). Integrated weed management, involving the judicious combination of chemical and non-chemical approaches, has considerable potential for improving weed control efficiency and reducing dependence on individual weed management practices. The integration of pre-emergence herbicides with timely hand weeding or mechanical hoeing can provide prolonged weed suppression, improve crop growth and enhance yield attributes (Lenka *et al*., 2026). Furthermore, appropriate weed management practices can improve the availability and utilization of soil moisture and nutrients by reducing competition between crops and weeds. Selection of an appropriate weed management strategy should consider weed composition, herbicide effectiveness, crop safety, labour availability and economic returns.

In view of the considerable yield losses caused by weeds and the availability of different weed control approaches, it is important to evaluate their relative effectiveness under specific agro-climatic conditions. Therefore, the present investigation entitled " Evaluation of Different Weed Management Strategies for Enhancing Growth and Yield of Chickpea (*Cicer arietinum* L.)" was undertaken to evaluate the comparative performance of different weed management practices on weed suppression, growth, yield attributes and yield of chickpea. The study also aims to identify an effective and economically viable weed control strategy for improving chickpea productivity.

II. MATERIALS AND METHODS

A field experiment entitled " Evaluation of Different Weed Management Strategies for Enhancing Growth and Yield of Chickpea (*Cicer arietinum* L.)" was conducted during the *Rabi* season of 2025–26 at the Research Farm of Mewar University, Gangrar, Chittorgarh, Rajasthan. The experimental site falls under a semi-arid climatic region characterized by hot summers, cool winters and moderate rainfall, mainly received during the monsoon season. The Rabi season provides favourable conditions for chickpea cultivation. The soil of the experimental field was analysed before sowing to determine its initial fertility status. Representative soil samples were collected from a depth of 0–15 cm and analysed for pH, electrical conductivity, organic carbon and available nitrogen, phosphorus and potassium using standard analytical methods. The experiment was conducted using chickpea variety GNG 2144 in a Randomized Block Design (RBD) comprising ten treatments replicated three times. The net plot size was 1.8 × 3.0 m (5.4 m²), while the gross plot size was 2.0 × 3.5 m (7.0 m²). The crop was sown at a spacing of 30 × 10 cm (row-to-row × plant-to-plant). Irrigation and other recommended agronomic practices were followed uniformly in all treatments. The experiment comprised ten weed management treatments, including manual and chemical methods. Treatment T1 was maintained as an unweeded control, while T2 received two hand weedings at 30 and 45 DAS. Treatments T3 and T4 received pendimethalin @ 0.25 and 0.50 kg *a.i.* ha^{-1} as pre-emergence applications, respectively. Treatments T5 and T6 received quizalofop-ethyl 5% EC @ 50 and 75 g *a.i.* ha^{-1}, respectively. Treatments T7 and T8 received imazethapyr

10% SL @ 50 and 75 g *a.i.* ha^{-1}, respectively, while T9 and T10 received propaquizafop 10% EC @ 50 and 100 g *a.i.* ha^{-1}, respectively, as post-emergence applications. Observations on weed density, weed dry matter, weed control efficiency, crop growth, yield attributes and yield were recorded. The experimental data were statistically analysed using the analysis of variance technique for Randomized Block Design as described by Gomez and Gomez (1984). The significance of treatment effects was tested at the 5% probability level.

III. RESULTS AND DISCUSSION

Growth parameters

Data presented in Tables 1, 2 and 3 revealed that different weed management practices significantly influenced weed population, weed dry matter, weed index, plant height and number of branches per plant. The minimum weed population at 20 DAS (17.40 weeds m^{-2}) was recorded under T4, *i.e.,* pendimethalin @ 0.50 kg *a.i.* ha^{-1}, whereas at 40, 60 DAS and harvest, the minimum values of 5.80, 4.20 and 3.60 weeds m^{-2}, respectively, were recorded under T2, i.e., two hand weedings at 30 and 45 DAS. Similarly, the minimum weed dry matter (12.50 g m^{-2}) and weed index (0.00%) were recorded under T2, followed by T8, i.e., imazethapyr 10% SL @ 75 g *a.i.* ha^{-1}, with 17.93 g m^{-2} weed dry matter and 6.25% weed index. Regarding crop growth, the maximum plant height at 30 DAS (20.18 cm), 60 DAS (41.42 cm) and at harvest (69.84 cm), along with the maximum number of branches per plant (2.61, 4.86 and 6.92, respectively), was recorded under T2. Among herbicidal treatments, T10, i.e., propaquizafop 10% EC @ 100 g *a.i.* ha^{-1}, recorded comparatively higher plant height and number of branches per plant. The maximum weed population, weed dry matter and weed index, along with the minimum plant height and number of branches, were recorded under T1 (control).

The superior performance of T2 might be attributed to the effective removal of emerged weeds through hand weeding at critical stages of crop growth, which reduced competition for moisture, nutrients, sunlight and space. Consequently, better availability of growth resources favoured plant height, branching and overall crop development. Among herbicidal treatments, the comparatively better performance of T8 in reducing weed dry matter and weed index might be due to effective suppression of susceptible weed species. Similarly, the improved growth under T10 could be associated with reduced weed competition and better utilization of available resources by the crop. The effectiveness of manual and chemical weed management practices in improving chickpea growth and reducing weed infestation has also been reported by Hakeem *et al*., (2025), Shiv *et al*., (2023) and Reddy *et al*. (2025). These findings indicate that timely weed management is essential for minimizing crop-weed competition and improving the growth performance of chickpea.

Yield parameters

Data presented in Tables 4 and 5 revealed that different weed management practices significantly influenced yield attributes, yield and harvest index of chickpea. The maximum number of pods per plant (47.86) and grains per pod (1.52) were recorded under T2, i.e., two hand weedings at 30 and 45 DAS, which was statistically at par with T10 for number of pods per plant (44.32) and grains per pod (1.45). Similarly, the maximum seed yield per plot (0.90 kg), seed yield (1665.61 kg ha^{-1}), stover yield (1849.67 kg ha^{-1}), biological yield (3515.28 kg ha^{-1}) and harvest index (47.38%) were recorded under T2. Among herbicidal treatments, T8, i.e., imazethapyr 10% SL @ 75 g *a.i.* ha^{-1}, recorded the highest seed yield (1561.55 kg ha^{-1}), stover yield (1789.67 kg ha^{-1}), biological yield (3351.22 kg ha^{-1}) and harvest index (46.60%). The minimum values of yield attributes, seed yield, stover yield, biological yield and harvest index were recorded under T1 (control).

The improvement in yield attributes and yield under T2 might be attributed to effective weed removal at critical stages of crop growth, which minimized competition for essential growth resources and facilitated better plant growth, flowering and pod development. Reduced weed competition might have enhanced the translocation and accumulation of photosynthates towards reproductive structures, resulting in a greater number of pods per plant and grains per pod. Among herbicidal treatments, the comparatively higher yield under T8 might be due to effective suppression of susceptible weeds, resulting in improved crop growth and better utilization of available nutrients and moisture. The higher biological yield under effective weed management treatments further indicates improved biomass production and crop productivity. Similar findings regarding the beneficial effects of effective manual and chemical weed management practices on chickpea yield and yield attributes were reported by Nath *et al*., (2024), Murat *et al*., (2022) and Iqbal *et al*. (2021).

IV. CONCLUSION

The present investigation revealed that different weed management practices significantly influenced weed population, weed dry matter, growth, yield attributes and yield of chickpea. Among the evaluated treatments, two hand weedings at 30 and 45 DAS (T2) proved most effective in reducing weed infestation and improving crop

growth and productivity, resulting in the highest seed yield (1665.61 kg ha^{-1}), stover yield (1849.67 kg ha^{-1}) and biological yield (3515.28 kg ha^{-1}). It also recorded the highest plant height (69.84 cm), number of branches plant^{-1} (6.92) and pods plant^{-1} (47.86). However, among herbicidal treatments, imazethapyr 10% SL @ 75 g *a.i.* ha^{-1} (T8) recorded comparatively lower weed population at harvest (4.10 m^{-2}), weed dry matter (17.93 g m^{-2}) and weed index (6.25%), along with a higher seed yield (1561.55 kg ha^{-1}). Therefore, two hand weedings at 30 and 45 DAS may be considered the most effective weed management practice, while imazethapyr 10% SL @ 75 g *a.i.* ha^{-1} may be recommended as a promising herbicidal alternative for effective weed management and improved chickpea productivity under the agro-climatic conditions of Chittorgarh, Rajasthan.

Table 1 Effect of weed control strategies on weed population (number m^{-2}) at different growth stages of chickpea

Treatments	Weed count (numbers m^{-2})			
	20 DAS	40 DAS	60 DAS	At harvest
T_1-Control (No weeding)	32.80	42.50	45.80	39.40
T_2-Two hand weeding at 30 and 45 DAS.	31.60	5.80	4.20	3.60
T_3-Pendamethalin @ (0.25 kg *a.i.* ha^{-1} pre-emergence)	21.80	17.60	18.40	16.80
T_4-Pendamethalin @ (0.50 kg) *a.i.* ha^{-1} pre-emergence)	17.40	12.80	13.60	11.90
T_5-Quizalofop ethyl 5% EC 50 g *a.i.* ha^{-1} post emergence)	31.40	24.60	9.50	8.80
T_6-Quizalofop ethyl 5% @ 75 g *a.i.* ha^{-1} post emergence)	30.80	20.20	7.80	7.10
T_7-Imazethapyr 10 %SL @ 50 g *a.i.* ha^{-1} post emergence)	30.60	19.40	7.90	4.80
T_8-Imazethapyr 10 % @ 75 g *a.i.* ha^{-1} post emergence)	29.80	16.80	6.40	4.10
T_9-Propaquizafop 10 EC @ 50 g *a.i.* ha^{-1} post emergence)	31.00	23.00	9.20	8.30
T_{10}-Propaquizafop 10 EC @ 100 g *a.i.* ha^{-1} post emergence)	30.20	18.60	7.00	6.50
SEm±	1.22	0.79	0.68	0.47
CD 5%	3.64	2.35	2.02	1.40

Table 2 Effect of weed control strategies on weed dry matter and weed index in chickpea

Treatments	Weed dry matter (g m^{-2})	Weed Index (%)
T_1-Control (No weeding)	148.53	51.52
T_2-Two hand weeding at 30 and 45 DAS.	12.50	0.00
T_3-Pendamethalin @ (0.25 kg *a.i.* ha^{-1} pre-emergence)	50.33	31.28
T_4-Pendamethalin @ (0.50 kg) *a.i.* ha^{-1} pre-emergence)	36.80	22.53
T_5-Quizalofop ethyl 5% EC 50 g *a.i.* ha^{-1} post emergence)	29.10	28.77
T_6-Quizalofop ethyl 5% @ 75 g *a.i.* ha^{-1} post emergence)	23.60	17.51
T_7-Imazethapyr 10 %SL @ 50 g *a.i.* ha^{-1} post emergence)	22.60	13.77
T_8-Imazethapyr 10 % @ 75 g *a.i.* ha^{-1} post emergence)	17.93	6.25
T_9-Propaquizafop 10 EC @ 50 g *a.i.* ha^{-1} post emergence)	27.40	30.00
T_{10}-Propaquizafop 10 EC @ 100 g *a.i.* ha^{-1} post emergence)	20.33	20.05
SEm±	1.30	3.27
CD 5%	3.86	9.71

Table 3 Effect of weed control strategies on plant height and number of branches plant^{-1} at different growth stages of chickpea

Treatments	Plant height (cm)			Number of branches plant^{-1}		
	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest
T_1-Control (No weeding)	17.86	32.74	55.42	2.18	3.72	5.18
T_2-Two hand weeding at 30 and 45 DAS.	20.18	41.42	69.84	2.61	4.86	6.92
T_3-Pendamethalin @ (0.25 kg *a.i.* ha^{-1} pre-emergence)	18.42	35.68	60.18	2.31	4.06	5.68
T_4-Pendamethalin @ (0.50 kg) *a.i.* ha^{-1} pre-emergence)	18.86	37.12	62.74	2.42	4.32	6.02
T_5-Quizalofop ethyl 5% EC 50 g *a.i.* ha^{-1} post emergence)	18.72	36.48	61.86	2.36	4.20	5.86
T_6-Quizalofop ethyl 5% @ 75 g *a.i.* ha^{-1} post emergence)	19.18	38.02	64.18	2.49	4.48	6.24
T_7-Imazethapyr 10 %SL @ 50 g *a.i.* ha^{-1} post emergence)	18.36	35.92	60.74	2.28	4.02	5.72
T_8-Imazethapyr 10 % @ 75 g *a.i.* ha^{-1} post emergence)	18.82	37.46	63.12	2.40	4.36	6.06
T_9-Propaquizafop 10 EC @ 50 g *a.i.* ha^{-1} post emergence)	19.02	37.78	63.68	2.46	4.42	6.16
T_{10}-Propaquizafop 10 EC @ 100 g *a.i.* ha^{-1} post emergence)	19.52	39.24	66.38	2.55	4.64	6.52
SEm±	0.71	1.44	2.18	0.08	0.15	0.26
CD 5%	2.11	4.27	6.49	0.25	0.45	0.76

Table 4 Effect of weed control strategies on yield attributes of chickpea

Treatments	Number of pods Plant^{-1}	Number of grain pod^{-1}
T_1-Control (No weeding)	30.42	1.18
T_2-Two hand weeding at 30 and 45 DAS.	47.86	1.52
T_3-Pendamethalin @ (0.25 kg *a.i.* ha^{-1} pre-emergence)	35.64	1.27
T_4-Pendamethalin @ (0.50 kg) *a.i.* ha^{-1} pre-emergence)	39.18	1.34
T_5-Quizalofop ethyl 5% EC 50 g *a.i.* ha^{-1} post emergence)	37.82	1.31
T_6-Quizalofop ethyl 5% @ 75 g *a.i.* ha^{-1} post emergence)	41.46	1.39
T_7-Imazethapyr 10 %SL @ 50 g *a.i.* ha^{-1} post emergence)	36.72	1.29
T_8-Imazethapyr 10 % @ 75 g *a.i.* ha^{-1} post emergence)	40.26	1.36
T_9-Propaquizafop 10 EC @ 50 g *a.i.* ha^{-1} post emergence)	41.08	1.38
T_{10}-Propaquizafop 10 EC @ 100 g *a.i.* ha^{-1} post emergence)	44.32	1.45
SEm±	1.66	0.06
CD 5%	4.94	0.18

Table 5 Effect of weed control strategies on yield and harvest index of chickpea

Treatments	Seed yield plot^{-1} (kg)	Seed yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest index %
T_1-Control (No weeding)	0.44	811.93	1250.00	2061.93	39.20
T_2-Two hand weeding at 30 and 45 DAS.	0.90	1665.61	1849.67	3515.28	47.38
T_3-Pendamethalin @ (0.25 kg *a.i.* ha^{-1} pre-emergence)	0.62	1144.66	1479.67	2624.33	43.62
T_4-Pendamethalin @ (0.50 kg) *a.i.* ha^{-1} pre-emergence)	0.70	1290.48	1619.67	2910.14	44.34
T_5-Quizalofop ethyl 5% EC 50 g *a.i.* ha^{-1} post emergence)	0.64	1186.42	1509.67	2696.08	44.00
T_6-Quizalofop ethyl 5% @ 75 g *a.i.* ha^{-1} post emergence)	0.74	1373.98	1669.67	3043.65	45.14
T_7-Imazethapyr 10 %SL @ 50 g *a.i.* ha^{-1} post emergence)	0.78	1436.29	1719.67	3155.96	45.51
T_8-Imazethapyr 10 % @ 75 g *a.i.* ha^{-1} post emergence)	0.84	1561.55	1789.67	3351.22	46.60
T_9-Propaquizafop 10 EC @ 50 g *a.i.* ha^{-1} post emergence)	0.63	1165.86	1490.00	2655.86	43.90
T_{10}-Propaquizafop 10 EC @ 100 g *a.i.* ha^{-1} post emergence)	0.72	1331.59	1649.67	2981.25	44.67
SEm±	0.03	51.98	71.61	106.92	1.27
CD 5%	0.08	154.45	212.78	317.69	3.77

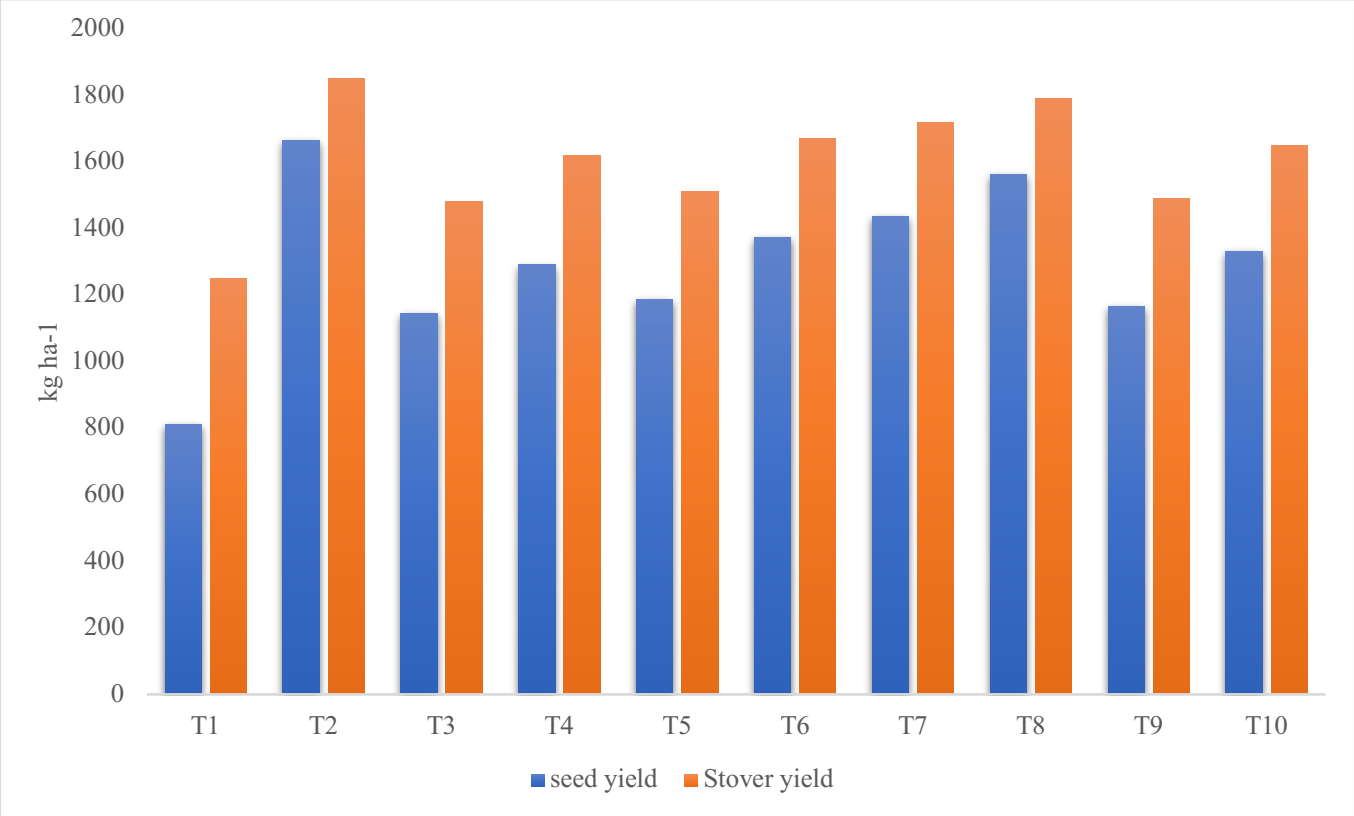


Fig 1: Effect of weed control strategies on grain and stover yield of chickpea

REFERENCES

[1] Gomez, K. A., & Gomez, A. A. (1984). Statistical procedures for agricultural research (2nd ed.). John Wiley & Sons.

[2] Hakeem, S. A., Matloob, A., Ghazy, A. H., Fiaz, S., Ali, M., Haq, T. U., & Ul Haq, M. Z. (2025). Critical period of weed-crop competition in irrigated chickpea as a tool for judicious weed control. *Scientific Reports*, *15*(1), 32116.

[3] Iqbal, K., Siddiqui, S. U., Khan, I., Ghafoor, A., & Khan, M. I. (2021). Chickpea varietal response to integrated weed management under different irrigation regimes. *Acta Ecologica Sinica*, *41*(2), 164-169.

[4] Khan, I., Khan, M. I., Hashim, S., Fawad, M., Jamal, A., Seleiman, M. F., & Scavo, A. (2023). Managing weed–crop interactions enhance Chickpea (*Cicer arietinum* L.) Chemical Components. *Plants*, *12*(17), 3073.

[5] Korbu, L., Tafes, B., Kassa, G., Mola, T., & Fikre, A. (2020). Unlocking the genetic potential of chickpea through improved crop management practices in Ethiopia. A review. *Agronomy for Sustainable Development*, *40*(2), 13.

[6] Kousta, A., Katsis, C., Tsekoura, A., & Chachalis, D. (2024). Effectiveness and selectivity of pre-and post-emergence herbicides for weed control in grain legumes. *Plants*, *13*(2), 211.

[7] Kumar, N., Nath, C. P., Hazra, K. K., Tripathi, S., Dixit, G. P., Tiwari, K., & Patil, D. H. (2025). Assessing post-emergence herbicides in chickpea (*Cicer arietinum* L.) for economic benefits, yield response, and weed control under different mega-environments in India. *Field Crops Research*, *333*, 110113.

[8] Lenka, S., Pramanik, K., Duary, B., Dash, R., & Mohapatra, R. (2026). Exploring Weed Management Challenges and Mitigation Strategies in Groundnut (Arachis hypogaea L.): A Review. *Agricultural Reviews*, *47*(5), 843.

[9] Liliane, T. N., & Charles, M. S. (2020). Factors affecting yield of crops. *Agronomy-climate change & food security*, *9*, 9-24.

[10] Minhas, W. A., Mumtaz, N., Ur-Rehman, H., Farooq, S., Farooq, M., Ali, H. M., & Hussain, M. (2023). Weed infestation and productivity of wheat crop sown in various cropping systems under conventional and conservation tillage. *Frontiers in plant science*, *14*, 1176738.

[11] Murat, T. U. N. Ç., İPEKEŞEN, S., BAŞDEMİR, F., & RUFAIOGLU, S. B. (2024). The Effect of Alternative Weed Control Methods on Yield Parameters in Chickpea (*Cicer arietinum* L.). *MAS Journal of Applied Sciences*, *9*(4), 1120-1129.

[12] Nath, C. P., Kumar, N., Hazra, K. K., Dutta, A., Praharaj, C. S., Singh, R., ... & Kumar, D. (2024). Five years of conservation tillage and weed management in a rice-chickpea rotation of northern Gangetic Plains of India: Weed growth, yield benefits and economic profitability. *Soil and Tillage Research*, *244*, 106226.

[13] Rajput, A., Panhwar, Q. A., & Babar, H. (2025). Role of leguminous crops by enhancing soil fertility and plant. *Legume Crops for Food Security-Cultivation and Benefits: Cultivation and Benefits*, *211*.

[14] Reddy, M. S., Ghosh, P., Sarkar, K. A., & Kundu, M. (2025). Growth and productivity improvement of chickpea (*Cicer arietinum* L.) through weed management by topramezone. *Legume Research*, *48*(9), 1528-1534.

[15] Scavo, A., & Mauromicale, G. (2020). Integrated weed management in herbaceous field crops. *Agronomy*, *10*(4), 466.

[16] Shiv, S. W. A. T. I., Agrawal, S. B., Verma, B. A. D. A. L., Yadav, P. S., Singh, R. I. C. H. A., Porwal, M. U. S. K. A. N., & PATEL, R. (2023). Weed dynamics and productivity of chickpea as affected by weed management practices. *Pollution Research*, *42*(2), 21-24.

[17] Tiwari, S., Sindel, B. M., Smart, N., Coleman, M. J., Fyfe, C., Lawlor, C., & Kristiansen, P. (2022). Hand weeding tools in vegetable production systems: an agronomic, ergonomic and economic evaluation. *International Journal of Agricultural Sustainability*, *20*(4), 659-674.