Journal of Experimental Agriculture International

Volume 46, Issue 8, Page 674-681, 2024; Article no.JEAI.121442
ISSN: 2457-0591
(Past name: American Journal of Experimental Agriculture, Past ISSN: 2231-0606)

Impact of Various Weed Control Methods on Weed Density, Weed Control Efficiency, and Seed Yield in Lentil (*Lens culinaris* Medik L.)

Satya Narayan Gurjar [a], Arvind Verma [b], Mahendra Choudhary [c*], Raghuveer Choudhary [d], Khemendra Choudhary [e] and Roshan Choudhary [f]

[a] Krishi Vigyan Kendra, Hindaun City, Karauli, Rajasthan, India.
[b] Department of Agronomy, RCA, MPUAT, Udaipur, Rajasthan, India.
[c] Department of Agronomy, COA, G. B. pant university of agriculture and technology, Pantnagar, Uttarakhand, India.
[d] Department of Agronomy, Junagadh Agriculture University, Junagadh, Gujarat, India.
[e] Department of Agronomy, CCS Haryana Agricultural University, Hisar, Haryana, India.
[f] Department of Agronomy, SKNAU, Jobner, Jaipur, Rajasthan, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: https://doi.org/10.9734/jeai/2024/v46i82750

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/121442

Original Research Article

Received: 02/06/2024
Accepted: 04/08/2024
Published: 08/08/2024

**Corresponding author: E-mail: mcrchoudhary99@gmail.com;*

Cite as: *Gurjar, Satya Narayan, Arvind Verma, Mahendra Choudhary, Raghuveer Choudhary, Khemendra Choudhary, and Roshan Choudhary. 2024. "Impact of Various Weed Control Methods on Weed Density, Weed Control Efficiency, and Seed Yield in Lentil (Lens Culinaris Medik L.)". Journal of Experimental Agriculture International 46 (8):674-81. https://doi.org/10.9734/jeai/2024/v46i82750.*

ABSTRACT

A field experiment was carried out during the rabi season of 2021-22 at the Instructional Farm of Agronomy, RCA, MPUAT, Udaipur. The study utilized a Factorial Randomized Block Design with 20 treatment combinations and three replications. The experiment tested ten chemical weed management practices in factor A, including three different concentrations of pendimethalin (500 g ha^{-1}, 750 g ha^{-1}, and 1000 g ha^{-1}, applied pre-emergence), three concentrations of imazethapyr (50 g ha^{-1}, 60 g ha^{-1}, and 70 g ha^{-1}, applied post-emergence), and three combinations of pendimethalin and imazethapyr (500 g ha^{-1}, 750 g ha^{-1}, and 1000 g ha^{-1}, applied pre-emergence). A control group with no herbicide application was also included. Additionally, hand weeding at 40 days after sowing (DAS) and a control treatment were considered as factor B. The experimental results indicated that hand weeding at 40 DAS significantly reduced weed density and achieved the highest weed control efficiency with maximum grain yield. Among the chemical treatments, the combination of pendimethalin and imazethapyr at 1000 g ha^{-1} PE recorded the lowest total weed density and maximum grain yield and weed control efficiency. This result was comparable to the treatments with pendimethalin + imazethapyr at 750 g ha^{-1} PE and 500 g ha^{-1} PE. Overall, HW at 40 DAS and application of pendimethalin + imazethapyr 1000g ha^{-1} PE could be more productive, and capable for reducing weed population.

Keywords: Intergraded weed management; lentil; weed density; productivity.

1. INTRODUCTION

Pulses, encompassing a variety of leguminous crops, play an integral role in human diets due to their rich nutritional profile. These crops are high in protein, ranging from 20-27%, and are abundant in fiber, vitamins, and essential amino acids. They also contain 15 vital mineral components necessary for human health, making them a significant food source globally [1]. The protein content in pulses is particularly crucial for populations in developing countries where animal protein may be scarce or expensive.

Beyond their nutritional value, pulses serve as exemplary crops for sustainable agricultural practices. They thrive in low-cost, low-fertility soils and marginal lands, which often remain underutilized. This adaptability makes pulses particularly appealing to small and marginal farmers in regions like the Indian subcontinent. The low cultivation costs and resilience of pulses provide an economical and reliable crop option for these farmers, who may not have access to expensive agricultural inputs.

One of the most remarkable benefits of growing pulses is their ability to enhance soil fertility. Pulses have a unique symbiotic relationship with nitrogen-fixing bacteria, allowing them to convert atmospheric nitrogen into a form usable by plants. This natural fertilization process enriches the soil, reducing the need for synthetic fertilizers and improving soil health over time. Consequently, pulses play a pivotal role in sustainable cropping patterns, contributing to the long-term viability of agricultural systems.

Lentil (*Lens culinaris* Medik L.) stands out as one of the oldest and most important pulse crops cultivated for human consumption. Primarily consumed as dry grain, lentils are a dietary staple in many cultures due to their versatility and nutritional benefits. The global significance of lentils is underscored by their extensive cultivation, covering a total area of 95.7 million hectares and yielding approximately 92.3 million tonnes annually [2].

Despite their hardiness and benefits, lentil crops face significant challenges, with weed infestation being one of the most formidable. Weeds are a major constraint in lentil cultivation worldwide, capable of reducing yields by up to 80%. These unwanted plants compete with lentils for essential resources such as nutrients, moisture, and space. Additionally, weeds often serve as hosts for insects, pests, and pathogens that can further damage lentil crops.

The issue of weed management in lentil cultivation is exacerbated by the crop's growth characteristics. Lentils exhibit poor early development and have a relatively short height, making them vulnerable to being overshadowed and outcompeted by more aggressive weed species. Consequently, effective weed management is crucial, especially during the initial stages of crop growth. Yadav et al. [3] emphasize the importance of diligent weed control within the first 40-45 days after sowing to ensure healthy crop establishment and optimal yields.

Effective weed management in lentil cultivation requires a combination of strategies tailored to local conditions and available resources. One common approach is mechanical weed control, such as hand weeding, which, although labor-intensive, can be highly effective in reducing weed density and dry matter. Hand weeding at critical growth stages, particularly around 40 days after sowing, has been shown to significantly enhance weed control efficiency.

Chemical weed management is another widely used strategy, involving the application of herbicides to control weed populations. Various herbicides, such as pendimethalin and imazethapyr, are commonly used in lentil fields. These chemicals can be applied at different concentrations and stages of crop growth, either pre-emergence or post-emergence, to maximize their efficacy while minimizing potential harm to the lentil plants.

Integrating mechanical and chemical weed control methods often yields the best results, combining the precision of manual weeding with the broad-spectrum effectiveness of herbicides. Additionally, implementing crop rotation and intercropping practices can help manage weed populations by disrupting their life cycles and reducing their prevalence in lentil fields.

2. MATERIALS AND METHODS

The experiment was laid out at the Instructional Farm, Rajasthan College of Agriculture, Udaipur. It falls under agro climatic zone IVa "Sub-Humid Southern Plain and Aravali Hills" of Rajasthan. The average annual rainfall of the region is around 637 mm, most of which is contributed by the South-West monsoon from July to September. Minimum and maximum temperatures ranged between 3.3 to 12.4°C and 20.9 to 37.7°C, respectively during crop growth period. While, the minimum and maximum relative humidity ranged between 17.1 to 70.6 per cent and 48.8 to 96.0 per cent, respectively during the same period. The soil of the experiment field was clay loam in texture, slightly alkaline in reaction (PH 8.6), medium in available nitrogen (298.1 kg ha^{-1}) and phosphorus (22.12 kg ha^{-1}) while high in available potassium status (452.5 kg ha^{-1}).

The experiment consisted of twenty treatments combinations i.e., two levels of weeding (control, hoeing at 20 DAS and weeding at 40 DAS) and ten weed management chemicals *viz*., Pendimethalin 500 g ha^{-1}, Pendimethalin 750 g ha^{-1}, Pendimethalin 1000 g ha^{-1}, Imazethapyr 50 g ha^{-1}, Imazethapyr 60 g ha^{-1}, Imazethapyr 70 g ha^{-1}, Pendimethalin + Imazethapyr 500 g ha^{-1}, Pendimethalin + Imazethapyr 750 g ha^{-1}, Pendimethalin + Imazethapyr 1000 g ha^{-1}, and Control. These were replicated thrice in Factorial Randomized Block Design (FRBD). Lentil variety Kota Masoor-3 was used as test crop at the seed rate of 60 kg ha^{-1} at an inter-row spacing of 30 cm and plant spacing of 15 cm. The seed is sown at a uniform depth of 2-3 cm. A uniform dose of 20 kg N + 40 kg P2O5 ha^{-1} was applied. Urea and DAP were used as a source of nitrogen and phosphorus.

2.1 Weed Studies

2.1.1 Weed flora composition

The experiment field was infested with annual and perennial broadleaf weeds. The prominent weed species were *Chenopodium album* L., *Chenopodium murale* L., *Melilotus indica* (L.) All, *Malva parviflora* L., *Fumaria parviflora* L. found at 30 & 60 DAS and at harvest during *rabi* 2021-22 in lentil crop.

2.1.2 Weed density

In each plot, broadleaved and grassy weed counts were recorded at 30, 60 and at harvest. For estimating weed density, a quadrate (0.50 m x 0.50 m) was placed randomly at two spots in each plot. Broad-leaved, grassy and sedges weed counts were taken and expressed as numbers m^{-2}. The mean data were subjected to square root transformation $\sqrt{(x+0.5)}$ to normalize their distribution (Gomez and Gomez, 1984), where "x" is the original data.

2.1.3 Weed dry matter

The dry weight of broad-leaved, grassy and sedge weeds was recorded of in g m^{-2} at the time of removal of weeds under 0.25 m^2 area (quadrate of 0.50 m x 0.50 m) at 30, 60, and at harvest. All the weeds falling within quadrate were cut close to the ground and were collected category wise in paper bags, then these weed samples were weighed after drying them in oven at 70 ^{0}C for 8 hours and data on dry matter were analyzed as per the standard procedure.

Table 1. Weed flora composition at different stages of lentil

S. No.	Weed Species	Weed Flora composition (%)		
		30 DAS	60 DAS	At harvest
1.	*Chenopodium album* L.	24.65	22.9	22.80
2.	*Chenopodium murale* L.	19.14	19.86	19.77
3.	*Fumaria parviflora* L.	10.69	9.92	9.97
4.	*Convolvulus arvensis* L.	4.84	5.70	5.84
5.	*Phalaris minor* Retz.	15.04	15.57	15.55
6.	*Melilotus indica* (L.)	15.09	15.21	15.19
7.	*Malva parviflora* L.	10.52	10.80	10.85

2.1.4 Weed control efficiency

In order to evaluate the weed control treatments for their efficacy, weed control efficiency of each treatment was computed by using the following formula suggested by Mani et al*.* [4].

$$WCE = \frac{DMC - DMT}{DMC} \times 100$$

Where,
DMC = Dry matter weight of weeds in control plot
DMT = Dry matter weight of weeds in treated plot

2.2 Statistical Analysis

In order to test the significance of data recorded, standard procedure as suggested by Cocharan et al*.* [5] was employed using the technique of analysis of variance for the Factorial Randomized Block Design (FRBD). The significance in treatment effects were adjudged by calculating critical difference at 5 percent level of significance, wherever the results were found significantly by the 'F' test.

3. RESULTS AND DISCUSSION

3.1 Weed Density

The data pertaining to the effect of treatments on weed density at 30, 60 DAS and at harvest are given in Table 2.

3.2 Grassy Weeds

A perusal of the data reveals that the lowest grassy weed density at 30 DAS (4.47 m^{-2}), 60 DAS (2.79 m^{-2}) and at harvest (4.37 m^{-2}) was observed with HW at 40 DAS which was 44.60, 68.61 a percent higher than control (8.07 m^{-2}, 8.89 $m^{-2}$and 9.93 m^{-2} respectively). Kumar et al. [6] at Kanpur (U.P) in an experiment conducted in lentil found that hand weeding at 30 & 45 DAS resulted in total weed density.

Further, the lowest grassy weed density at 30 DAS (1.50 m^{-2}), 60 DAS (1.49 m^{-2}) and at harvest 1.50 m^{-2}) was observed with pendimethalin + imazethapyr 1000 g ha^{-1} PE which was at par with pendimethalin + imazethapyr 750 g ha^{-1} PE and pendimethalin + imazethapyr 500 g ha^{-1} PE. The maximum weed density was recorded with control and all the treatments recorded statistically lower weed density than this treatment. Dubey et al. [7] reported that pre-emergence application of pendimethalin at 1 kg ha^{-1} resulted in plant dry matter

The interaction effect of manual hand weeding and chemical weed management was found to be significant on the density of grassy weeds at 60 DAS. The treatment combination HW at 40 DAS with pendimethalin + imazethapyr 1000 g ha^{-1} PE (1.83, 0.98 m^{-2}, and 1.00 m^{-2}) recorded significantly lower weed density and it was found superior to rest of all the treatments combinations.

3.3 Broad-Leaved Weeds

The data reveals that different weed management practices tended to reduce the density of broad-leaved weeds at 30, 60 DAS and harvest stage as compared to control (57.34 m^{-2}). The lowest weed density was observed HW at 40 DAS (18.28 m^{-2}, 26.25 m^{-2}, and 20.92 m^{-2}) which was 68.10 percent higher than the control. Sharma [8] discovered that two-hand weeding at 20 and 40 DAS reduces the broad leaf weed density

In addition to that the highest weed density was found in control (155.17 m^{-2}) whereas, the minimum broad-leaved weed density was witnessed in pendimethalin + imazethapyr 1000 g ha^{-1} PE (10.42 m^{-2}, 17.12 m^{-2} and 20.92 m^{-2}) at 30, 60 DAS and harvest stage respectively which was at par with pendimethalin + imazethapyr 750 g ha^{-1} PE and pendimethalin + imazethapyr 500 g ha^{-1} PE. The interaction effect on weed density

Table 2. Effect of weed management on weed density at 30, 60 DAS and harvest

Treatment	Weed density (No. m^{-2})								
	30 DAS			60 DAS			Harvest		
	Broadleaved weeds	Grassy weeds	Total weeds	Broadleaved weeds	Grassy weeds	Total weeds	Broadleaved weeds	Grassy weeds	Total weeds
Levels of manual weeding									
Control	7.00 (57.34)	2.64 (8.07)	7.45 (65.40)	7.46 (59.30)	2.90 (8.89)	7.48 (68.19)	7.30 (57.69)	3.05 (9.93)	7.80 (67.62)
HW at 40 DAS	3.86 (18.28)	1.99 (4.47)	4.30 (22.75)	4.86 (26.25)	1.77 (2.79)	5.13 (29.04)	4.32 (20.92)	2.09 (4.37)	4.75 (25.29)
S.Em. ±	0.047	0.038	0.047	0.54	0.018	0.14	0.026	0.014	0.17
CD(P=0.05)	0.135	0.110	0.135	0.156	0.52	0.40	0.074	0.041	0.48
Chemical weed management									
Pendimethalin 500 g ha^{-1} PE	6.24 (41.17)	2.72 (7.00)	6.79 (48.17)	7.70 (61.41)	2.87 (8.50)	7.66 (69.91)	7.35 (56.07)	3.13 (9.67)	7.91 (65.74)
Pendimethalin 750 g ha^{-1} PE	5.94 (38.35)	2.84 (7.83)	6.55 (46.19)	6.66 (45.44)	2.73 (7.83)	6.66 (53.27)	6.93 (52.00)	2.94 (8.67)	7.43 (60.67)
Pendimethalin 1000 g ha^{-1} PE	5.32 (29.61)	2.07 (4.17)	5.67 (33.78)	6.95 (49.35)	3.01 (9.17)	7.07 (58.52)	6.38 (42.17	2.97 (8.83)	6.91 (51.00)
Imazethapyr 50 g ha^{-1} PoE	5.09 (27.51)	2.00 (3.83)	5.43 (31.34)	6.15 (38.37)	2.36 (5.45)	6.08 (43.72)	6.29 (41.83)	2.80 (7.83)	6.74 (49.67)
Imazethapyr 60 g ha^{-1} PoE	5.11 (27.99)	1.82 (3.00)	5.39 (30.99)	6.11 (39.38)	1.94 (3.50)	5.91 (42.88)	5.70 (36.08)	2.48 (6.00)	6.12 (42.08)
Imazethapyr 70 g ha^{-1} PoE	4.52 (21.90)	2.00 (3.83)	4.89 (25.73)	6.09 (38.30)	2.13 (4.17)	5.96 (42.47)	5.61 (33.33)	2.13 (4.17)	5.79 (37.50)
Pendimethalin + Imazethapyr 500 g ha^{-1} PE	3.68 (14.81)	1.53 (1.83)	3.94 (16.65)	4.25 (19.06)	1.82 (2.83)	4.27 (21.89)	3.91 (16.17)	1.91 (3.17)	4.26 (19.33)
Pendimethalin + Imazethapyr 750 g ha^{-1} PE	3.23 (11.17)	1.46 (1.67)	3.50 (12.83)	4.02 (17.12)	1.46 (1.67)	4.02 (18.79)	3.46 (12.00)	1.45 (1.67)	3.60 (13.67)
Pendimethalin + Imazethapyr 1000 g ha^{-1} PE	3.10 (10.42)	1.40 (1.50)	3.37 (11.92)	3.49 (13.03)	1.40 (1.49)	3.69 (14.52)	2.90 (9.00)	1.40 (1.50)	3.15 (10.50)
Control (No herbicides)	12.12 (155.17)	5.31 (28.00)	13.23 (183.1)	10.21 (106.41)	3.61 (13.78)	10.24 (120.19)	9.59 (94.38)	4.48 (20.03)	10.56 (114.83)
S.Em. ±	4.203	0.086	0.106	0.122	0.040	1.511	0.058	0.032	0.940
CD(P=0.05)	12.032	0.245	0.302	0.348	0.115	4.326	0.166	0.092	2.690

Data subjected toS $\sqrt{x + 0.5}$ *transformation and figures in parenthesis are original weed count per sq.*

of broad-leaved weeds was found significant due to manual hand weeding and chemical weed management. The treatment combination HW at 40 DAS with a ready mix combination of pendimethalin + imazethapyr 1000 g ha^{-1} PE (3.33 m^{-2}, 5.00 m^{-2}, and 3.00 m^{-2}) recorded significantly lower weed density. However, it remained at par with pendimethalin + imazethapyr 750 g ha^{-1} PE and pendimethalin + imazethapyr 500 g ha^{-1} PE. Similar findings were also observed by Bhattarai et al. [9] and Kumar *et al*. [10].

3.4 Total Weeds

The density of total weeds was influenced due to different weed management treatments (Table 2). The lowest weed density was observed with HW at 40 DAS (22.75 m^{-2}, 29.04 m^{-2} and 25.29 m^{-2}) which was 65.21 63.21 and 62.47 percent higher than the control.

The data further indicated that the lowest total weed density was observed with the pre-emergence application of pendimethalin + imazethapyr 1000 g ha^{-1} PE (11.92 m^{-2}, 14.52 m^{-2} and 10.50 m^{-2}) which was found at par with pendimethalin + imazethapyr 750 g ha^{-1} PE and pendimethalin + imazethapyr 500 g ha^{-1} PE. Interaction effect of manual hand weeding and chemical weed management was found significant on density of broad-leaved and total weeds at 30, 60DAS, and at the harvest stage. The treatment combination ready mixture of pendimethalin + imazethapyr 1000 g ha^{-1} PE with HW at 40 DAS recorded significantly lower weed density. However, it remained at par with the combination of HW at 40 DAS with ready mixture of pendimethalin + imazethapyr 750 g ha^{-1} PE and pendimethalin + imazethapyr 500 g ha^{-1} PE.

3.5 Weed Control Efficiency

The data showing the effect of the treatments on weed control efficiency at 30, 60 DAS and at harvest are given in Table 3.

An examination of data illustrates that weed control efficiency at 30, 60 DAS and at harvest stage varied due to various weed management practices. Application of HW at 40 DAS (78.40, 63.32 and 66.73 %) was found most effective in controlling all types of weed flora in lentil. Dhuppar et al. [11] found that among all the weed management treatments, hand weeding gave the highest weed control efficiency

Further, the pre-emergence application of pendimethalin + imazethapyr (94.01, 89.08 and 91.80 %) was found most effective in controlling all types of weed flora in lentil. The next in order of superiority pendimethalin + imazethapyr 750 g ha^{-1} PE and pendimethalin + imazethapyr 500 g ha^{-1} PE. The combined effect of manual hand weeding and chemical weed management with respect to weed control efficiency at 60 DAS was found to be significant. The treatment HW at 40 DAS combined with pendimethalin + imazethapyr 1000 g ha^{-1} PE (92.47 %) and it recorded significantly higher weed control efficiency over other combinations. However, it was followed by pendimethalin + imazethapyr 750 g ha^{-1} PE (89.14 %) and pendimethalin + imazethapyr 500 g ha^{-1} PE (85.98 %) with HW at 40 DAS.

Table 3. Effect of weed management on weed control efficiency

Treatment	Weed control efficiency (%)		
	30 DAS	**60 DAS**	**Harvest**
Levels of manual weeding			
Control	74.94	57.67	55.73
HW at 40 DAS	78.40	63.32	66.73
S.Em. ±	0.287	0.632	0.299
CD(P=0.05)	0.821	1.810	0.857
Chemical weed management			
Pendimethalin 500 g ha^{-1} PE	73.98	43.76	44.20
Pendimethalin 750 g ha^{-1} PE	76.34	56.78	51.35
Pendimethalin 1000 g ha^{-1} PE	82.16	51.63	56.99
Imazethapyr 50 g ha^{-1} PoE	83.84	63.38	59.21
Imazethapyr 60 g ha^{-1} PoE	84.14	66.41	67.13
Imazethapyr 70 g ha^{-1} PoE	87.03	65.49	69.18
Pendimethalin +Imazethapyr 500 g ha^{-1} PE	91.69	82.84	84.04
Pendimethalin + Imazethapyr 750 g ha^{-1} PE	93.48	85.57	88.40
Pendimethalin + Imazethapyr 1000 g ha^{-1} PE	94.01	89.08	91.80
Control (No herbicides)	0.00	0.00	0.00

Table 4. Effect of chemical weed management and manual weeding on seed yield

Treatments	Seed yield (kg ha^{-1})
Levels of manual weeding	
Control	1285
HW at 40 DAS	1622
S.Em. ±	16
CD(P=0.05)	46
Chemical weed management	
Pendimethalin 500 g ha^{-1} PE	1486
Pendimethalin 750 g ha^{-1} PE	1493
Pendimethalin 1000 g ha^{-1} PE	1480
Imazethapyr 50 g ha^{-1} PoE	1504
Imazethapyr 60 g ha^{-1} PoE	1500
Imazethapyr 70 g ha^{-1} PoE	1494
Pendimethalin +Imazethapyr 500 g ha^{-1} PE	1573
Pendimethalin + Imazethapyr 750 g ha^{-1} PE	1584
Pendimethalin + Imazethapyr 1000 g ha^{-1} PE	1598
Control (No herbicides)	821
S.Em. ±	36
CD	102

3.6 Grain Yield

There was a significant influence of different weed control treatments on seed yield. The highest seed yield (1622 kg ha 1) was recorded in HW at 40 DAS over control (1285 kg ha-1). Further, with regards to chemical weed management, the greatest seed yield was found in pendimethalin + imazethapyr 1000 g ha-1 PE (1598 kg ha-1) [12-16]. However, it was at par with imazethapyr 50 g ha-1 PoE (1504 kg ha-1), imazethapyr 60 g ha-1 PoE (1500 kg ha-1), pendimethalin + imazethapyr 500 g ha-1 PE (1573 kg ha-1), pendimethalin + imazethapyr 750 g ha 1 PE (1584 kg ha-1). These results in respect to grain yields were in close conformity with the earlier findings of Bhattarai *et al.* [9] and Dubey *et al.* [7].

4. CONCLUSION

Based on the findings of the investigation entitled "Effect of Weed Management on Weed Density, Growth and Productivity of Lentil (*Lens culinaris* Medik. L.)", it is concluded that for effective weed management higher yield and pre-emergence application of pendimethalin + imazethapyr 1000 g ha^{-1} with one hand weeding at 40 DAS was found superior in controlling complex weed flora of lentil crop grown in southern Rajasthan.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Wang TL, Domoney C, Hedley CL, Casey R, Grusak MA. Can we improve the nutritional quality of legume seeds. Plant Physiology. 2003;131(3):886-891.
2. FAO STAT. Online agriculture statistics; 2018. Available:http//www foastat.org. Retrieved on 15 November 2021.
3. Yadav SS, Rizvi AH, Manohar M, Verma AK, Shrestha R, Chen C, Bahl PN. Lentil growers and production systems around the world in Lentil Springer, Dordrecht; c2007. p. 415-442.
4. Mani VS, Pandita MS, Gautam KC, Das B. Weed killing chemicals in wheat cultivation. PANS. 1973;23:17-18.
5. Cocharan G, Cox M, Willian G. Experimental Design 2 nd Edition, John Wiley and Sons, Inc; 1957.
6. Kumar A, Nandan R, Pandey IB, Patil S. Weed dynamics and performance of lentil as affected by weed management practices under rainfed conditions. Indian Journal of Weed Science. 2018;50(1):46-50.
7. Dubey SK, Kumar A, Singh D, Pratap T, Chaurasiya A. Effect of different weed control measures on performance of chickpea under irrigated condition. International Journal of Current

Microbiology and Applied Sciences. 2018;7(5):3103- 3111.
8. Sharma OL. Weed management in chickpea under irrigated conditions of western Rajasthan. Indian Journal of Weed Science. 2009;41(3-4):182-184.
9. Bhattarai RK, Gyawaly P, Gautam DD, Neupane R, Chaulagain B, Das S. Weed management in lentil (*Lens culinaris*) under mid hills condition of Khumaltar, Nepal. Nepalese Journal of Agricultural Sciences. 2018;17:160.
10. Kumar A, Nandan R, Sinha KK, Ghosh D. Integrated weed management in lentil (*Lens culinaris*) in calcareous alluvial soils of Bihar. Indian Journal of Agronomy. 2018;61(1):75-78.
11. Dhuppar P, Gupta A, Rao DS. Chemical weed management in lentil. Indian Journal of Weed Science. 2013;45(3):189-191.
12. Chavada JN, Patel CK, Patel SB, Panchal PP, Patel GN. Weed management in chickpea under North Gujarat conditions. International Journal of Science, Environment and Technology. 2017;6(3): 2018-2025.
13. Kour R, Sharma BC, Kumar A, Nandan B, Kour P. Effect of weed management on chickpea (*Cicer arietinum*) + Indian mustard (*Brassica juncea*) intercropping system under irrigated conditions of Jammu region. Indian Journal of Agronomy. 2014;59(2):242-246.
14. Nepali A, Verma A, Jatwa T, Pooja, Parik N. Effect of chickpea (*Cicer arietinum* L.) weed management practices on quality parameters, nutrient content and uptake by crop and weed. International Journal of Chemical Studies. 2020;8(1):2203-2206.
15. Poonia TC, Pithia MS. Pre and post-emergence herbicides for weed management in chickpea. Indian Journal of Weed Science. 2013;45(3):223-225.
16. Singh MD, Singh VKR. Weed dynamics and grain yield of bold seeded lentil as influenced by weed management practices. Indian Journal of Weed Science. 2003;35(1,2):148-150.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/121442