Original Research Article

Effect of tillage and weed management practices on dry matter, yield and nutrient uptake by plant and depletion by weed in lentil crop (*Lens culinaris* M.)

ABSTRACT:

Aims: To evaluate the impact of tillage and weed management techniques on Plant dry weight, Yield, nutrient uptake by plant and depletion by weed in lentil crop (*Lens culinaris* M.).

Place and Duration of Study: A field study was conducted at Research Farm of Tirhut College of Agriculture, Dr. Rajendra Prasad Central Agricultural University, Pusa, Bihar, India, from Oct 2020 to Mar 2021.

Methodology: The experiment followed a split-plot design with three replications. The main plots consisted of three tillage practices (M_1: Zero tillage, M_2: Minimum tillage, and M_3: Conventional tillage), while subplots included five weed management practices [T_1: control, T_2: 1 hand weeding at 20 DAS, T_3: chlorimuron-ethyl 4 g/ha (pre-emergence) + paddy straw mulching (5.0 t/ha), T_4: quizalofop-ethyl 40 g/ha at 20 DAS (post-emergence) and T_5: chlorimuron-ethyl 4 g/ha (pre-emergence) + quizalofop-ethyl 40 g/ha at 20 DAS (post-emergence)].

Results: Among the tillage practices conventional found most effective in term of increasing plant dry weight, grain yield, straw yield, nutrient uptake by crop while effectively reduce the weed dry matter and nutrient depletion by the weed. Among the weed management practices hand weeding proved to be the most effective weed management practice, leading to higher plant dry matter, grain yield, straw yield and nutrient uptake by crop and least weed dry matter weight and nutrient depletion by weeds. Among the chemical weeding chlorimuron ethyl (PE) + paddy straw mulching showed comparable effectiveness to hand weeding in all the parameters. These results highlight the importance of tillage practices and effective weed management techniques in optimizing plant growth, yield, nutrient uptake, and weed control.

Keywords: [Weed management, Mulching, Tillage, Pulses, Herbicides, Nutrient depletion by weed] *the keywords should be in alphabetical order*

1. INTRODUCTION

Lentil (*Lens culinaris* M.) is an annual, bushy plant cultivated mostly in marginal and sub-marginal regions of northern and central India. It ranks sixth among all pulse crops grown in India and is the second most important pulse crop after chickpea during the *rabi* season. India is the top and second-ranked country for lentil area and production, contributing 28.38% and 21.41% of the global acreage and production, respectively [1]. Lentils are cultivated on approximately 1.51 million hectares of land in India, with a yield of 1.56 million ~~tonnes~~tons and a productivity of 1032 kg per hectare.

Lentil production faces several limitations, including poor management practices and cultivation on marginal and sub-marginal soils. Weed control is the most significant production limitation for lentils, which negatively impacts production due to its modest stature, extended duration, and slow starting growth. Yield of lentils may decrease by 60% due to weed interference, but it can increase to 84% with proper weed control [2, 3].

Over the past few decades, various cultivation techniques have been studied to increase the production potential of different crops. Among these techniques, soil tillage plays a crucial role in maximizing crop yield potential by reducing weed density through weed uprooting or burying weed seeds or propagation material in deeper layers. It also enhances water and nutrient availability for the crop. Although tillage alone cannot entirely eliminate the weed problem, pre-emergence herbicide applications is recommended since lentil is a relatively poor weed competitor during its early growth period. However, pre-emergence herbicide application can only control weeds for the first few weeks, and subsequently emerging weeds also compete with crop plants. Pendimethalin is one of the commonly used herbicides as a pre-emergence treatment for weed control in lentil. However, it is important to investigate the effectiveness of pre- and post-emergence herbicides along with tillage practices for effective weed management in lentil.

The effect of integrated management strategies on lentil weed, growth, and production remains poorly understood which is critical for developing effective strategies to increase lentil production under such conditions. In this context, an experiment was conducted to evaluate the impact of tillage and weed management techniques on Plant dry weight, Yield, nutrient uptake by plant and depletion by weed in lentil crop (*Lens culinaris* M.). The study aimed to identify the best combination of tillage and weed management strategies for maximizing lentil production.

2. MATERIAL AND METHODS

A field study was conducted at Research Farm of Tirhut College of Agriculture, Dr. Rajendra Prasad Central Agricultural University, Pusa, Bihar, India, from October 2020 to March 2021. The experiment followed a split-plot design with three replications. The main plots consisted of three tillage practices (M_1: zero tillage, M_2: minimum tillage, and M_3: conventional tillage), while subplots included five weed management practices [T_1: control, T_2: 1 hand weeding at 20 DAS, T_3: chlorimuron-ethyl 4 g/ha (pre-emergence) + paddy straw mulching (5.0 t/ha), T_4: quizalofop-ethyl 40 g/ha at 20 DAS (post-emergence), and T_5: chlorimuron-ethyl 4 g/ha (pre-emergence) + quizalofop-ethyl 40 g/ha at 20 DAS (post-emergence)]. Sowing was done manually using pre-treated seeds, and herbicides were applied as per the treatments. All field management procedures were carried out uniformly throughout all plots. The experimental field had sandy loam soil with an initial fertility of soil was; available N = 189.50 kg/ha, P = 35.15 kg/ha, K = 132.79 kg/ha, soil organic matter 0.38%, pH of 8.20, and EC of 0.31 dS/m at 25 °C.

At sowing, furrows were opened, and fertilizers (20:40:20:20 kg NPKS/ha) were applied using urea, DAP, MOP, and phospho-gypsum as sources. In conventional tillage, the plot was ploughed twice, in minimal tillage, once; and in zero tillage, no tillage was done. After tillage, planking was performed, and sowing was done manually on October 27, 2020. Pre-treated seeds of variety HUL-57 were sown at a distance of 30 cm in row spacing manually at a seed rate of 40 kg/ha, with plant intra-row spacing maintained at 10 cm by thinning 14 days after planting.

Herbicides were prepared in a mug by dissolving them in half a litre of water and then adding water to make up the required amount of spray solution. Spraying was done using a flat fan-nozzle fitted knapsack sprayer with 600 litres of water per hectare. Quizalofop-ethyl and chlorimuron-ethyl were spread at 20 DAS and 2 DAS, respectively. After spraying chlorimuron-ethyl, paddy straw was applied to the inter-row space of the crop as mulch at a rate of 5.0 t/ha. Field management procedures such as fertiliser application and pest and disease control were uniformly carried out throughout all plots in accordance with local standards.

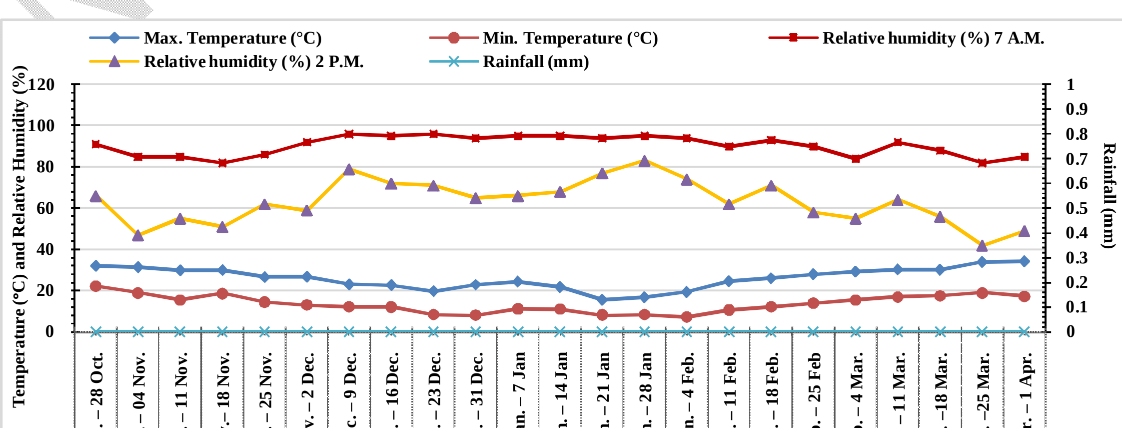

Figure 1: Meteorological data during the experiment period (October-March)

The dry matter of the plant was calculated by cutting the plants at the base of the second row of the plot. The plant samples were sun-dried for four to five days and then oven-dried at 65°C until reaching a consistent weight. The harvested grain was threshed, winnowed, and cleaned to determine the seed yield of each net plot, which was then independently balanced at 12% moisture and converted to kg/ha. Weed dry weight is measured by placing a 0.25 m^2 quadrate measuring 0.5 m × 0.5 m in two locations on each plot at harvest. Complete quadrate weeds were trimmed close to the ground, washed, and sun-dried separately for 3–4 days before being dried at 65°C. The dried sample was weighed in grams (g) and converted to grams per square meter (g/m^2).

For chemical analysis of crop and weeds, the plant and weed samples were washed with tap water, followed by 0.1 N HCL and double distilled water. The washed samples were then dried in the shade and subsequently in an oven at 65 °C for 48 hours. The dried samples were ground using a Willey's mill and stored in butter paper for further analysis of nutrient content (NPK). Nitrogen content was estimated using Kjeldahl's method, while P uptake was measured using the vanadate-yellow color method. The potassium content was measured using a Flame photometer [4], and the calibration curve was used for estimation. The total nutrient uptake by the crop and depletion by weeds were calculated using the following formulas:

$$\text{Total nutrient uptake by crop (kg/ha)} = \frac{\text{Nutrient (\%) in plant} \times \text{Biological yield (kg/ha)}}{100}$$

$$\text{Total nutrient depletion by weed (kg/ha)} = \frac{\text{Nutrient (\%) in weed} \times \text{Weed dry matter (kg/ha)}}{100}$$

The data obtained from the experiment was subjected to statistical analysis using the widely used software, SPSS. In order to determine the significance of the observed results, a p-value threshold of ≤ 0.05 was adopted. The analysis was further supplemented by employing Duncan's Multiple Range Test (DMRT) to assess the specific differences among the groups or variables under investigation. DMRT is a post-hoc test commonly used in statistical analysis to compare means and identify significant variations between multiple treatments or conditions. By utilizing these analytical tools, we aimed to gain a comprehensive understanding of the data and draw reliable conclusions based on the statistical evidence obtained.

3. RESULTS AND DISCUSSION

1. Plant dry weight

The impact of tillage and weed control techniques on plant dry matter was significant. Conventional tillage and minimum tillage resulted in significantly higher plant dry matter than zero tillage. Hand weeding was the most effective weed management practice, resulting in the highest plant dry matter. Chlorimuron ethyl (PE) + paddy straw mulching was equally effective as hand weeding. Quizalofop ethyl at 20 DAS was less effective than other treatments, with lower plant dry matter after the weedy check.

2. Grain yield

The grain yield was significantly influenced by tillage and weed management practices. Conventional and minimum tillage practices produced a significantly higher yield compared to zero tillage. All weed management practices resulted in significantly higher grain yield compared to the weedy check. Hand weeding increased the grain yield significantly compared to remaining treatments, while being at par with chlorimuron-ethyl (PE) + paddy straw mulching.

3. Straw yield

The weed management treatments had a significant impact on straw yield. Conventional tillage recorded a significantly higher straw yield than zero tillage but was similar to minimum tillage. All the weed management treatments produced significantly higher straw yield than the weedy check. Manual weeding resulted in a significantly greater straw yield than quizalofop ethyl as PoE, but was similar to chlorimuron ethyl (PE) + paddy straw mulching and chlorimuron ethyl (PE) + quizalofop ethyl at 20 DAS.

4. NPK-uptake by crop (kg/ha)

The utilization of tillage practices had a profound impact on the uptake of essential nutrients (NPK) by crops in this research study. Among the various tillage methods examined, conventional tillage demonstrated a notably higher uptake of NPK by crops compared to both minimum tillage and zero tillage. Similarly, minimum tillage also exhibited a significant enhancement in NPK uptake by crops compared to zero tillage.

The research findings indicated a significant increase in the total uptake of essential nutrients (NPK) by crops when subjected to various weed management treatments compared to the weedy check. Among the weed management methods examined, manual weeding demonstrated the highest NPK uptake by crops, which was significantly greater than chemical weeding, except for the uptake of phosphorus (P) and potassium (K) in the case of chlorimuron ethyl + paddy straw mulching. The uptake of P and K in hand weeding and chlorimuron ethyl + paddy straw mulching treatments was found to be statistical similar. Among the chemical weed management approaches, the combination of chlorimuron ethyl (PE) and paddy straw mulching, as well as chlorimuron ethyl (PE) and quizalofop ethyl at 20 days after sowing (DAS), exhibited similar but notably higher NPK uptake by crops compared to the application of quizalofop ethyl as PoE.

5. Weed dry matter

The dry matter of weeds is significantly influenced by tillage practices, as revealed in this study. Conventional tillage, despite recording the lowest weed dry weight, exhibited similar results to minimum tillage, both of which significantly reduced weed dry weight compared to zero tillage. Furthermore, weed management treatments exhibited a considerable reduction in weed dry matter when compared to the weedy control. Among the various weed control techniques examined, manual weeding resulted in significantly lower dry weights of weeds compared to chemical weeding. Within the chemical weed management methods, both chlorimuron ethyl (PE) + paddy straw mulching and chlorimuron ethyl (PE) + quizalofop ethyl at 20 days after sowing (DAS) demonstrated similar performance in reduction of weed dry matter, with both treatments significantly reducing the dry weight of weeds compared to quizalofop ethyl using PoE.

6. NPK-depletion by weed (kg/ha)

The analysis of NPK depletion caused by weeds revealed that tillage practices have a significant impact on reducing NPK depletion by weeds. Among the different tillage practices examined, conventional tillage was found to be most effective in reducing NPK depletion by weeds compared to minimum and zero tillage. Likewise, minimum tillage significantly reduced NPK depletion caused by weeds compared to zero tillage. The implementation of weed management treatments was found to considerably reduce NPK depletion caused by weeds compared to the weedy check. Among the various weed management methods, manual weeding resulted in the lowest NPK depletion by weeds, which was comparable to the performance of chlorimuron ethyl (PE) + paddy straw mulching and chlorimuron ethyl (PE) + quizalofop ethyl at 20 days after sowing (DAS). However, manual weeding was significantly lower in NPK depletion compared to quizalofop ethyl at 20 DAS. Similarly, for nitrogen (N) depletion, chlorimuron ethyl (PoE) + quizalofop ethyl and quizalofop ethyl (PoE) did not show significant variation. However, there was a significant variation observed in PK depletion among these treatments.

DISCUSSION

Weather data

Achieving optimal yield potential in crops requires aligning the prevailing weather conditions with a balanced approach to the three growth phases: vegetative, reproductive, and seed development. However, formulating a specific formula to accomplish this goal under field conditions has not been established yet [5]. In general, the weather conditions during the lentil crop's entire growth period were favourable, despite the absence of winter rains during the experimental season. Instead, irrigation was employed at the beginning, and soil moisture was carefully maintained. The minimum temperature, maximum temperature, and relative humidity throughout the crop season did not deviate significantly from the typical meteorological data observed in the region (**Figure 1**).

Plant dry weight

Dry matter accumulation in plants varies across different growth stages, with a general increase from germination to harvest. In this study, significantly higher amounts of dry matter were observed under conventional tillage compared to zero tillage. This can be attributed to the improved soil conditions achieved through tillage practices, which reduce compaction and bulk density, leading to enhanced seed germination and root proliferation. Vigorous root growth enables increased nutrient and moisture uptake, resulting in higher production of photosynthates. Conventional tillage practices also effectively control weeds, reducing competition and improving moisture and nutrient absorption, ultimately leading to higher plant dry matter accumulation. Rana (2018) also reported that conventional tillage significantly increases the dry weight of the soybean crop as compared to minimum and zero tillage [6].

Furthermore, weed control techniques had a greater impact on plant dry weight than the weedy control. Both hand weeding and chemical weeding resulted in more dry matter accumulation compared to the weedy check. This is likely due to the effective reduction of weed populations through weed management practices, which eliminated weed competition and improved nutrient availability and moisture conditions. The supportive ecology created by weed control techniques facilitated the efficient utilization of growth elements, enabling plants to accumulate more dry matter. Conversely, the weedy check, with higher weed infestation, limited crop plant growth. Chandrakar *et al*. (2016) and Kumar *et al.* (2018a) reported that manual weeding led to enhanced the dry matter of plants compared to quizalofop-ethyl, chlorimuron-ethyl, and control plots in lentil crop [7,8].

Grain yield and Straw yield

The yield is the deciding factor in determining the effectiveness of any agronomic study. Conventional and minimum tillage produced similar but remarkably greater yields over zero tillage. The greater yield in conventional and minimum tillage could be due to tillage practices reduce soil compaction and bulk density, which support increasing root length, root biomass, nodulation, and bacterial activity. Furthermore, it lowers crop-weed competition and improves crop availability by providing an adequate and balanced proportion of plant nutrients, moisture, space, and sunshine during the growth and reproductive stages, which ultimately contributes to yield. Gürsoy *et al.* (2014) reported that lentil crop gave higher grain yields in conventional, planting systems as compared to reduce and zero-till [9]. The lower in yield under zero-tillage may be due to greater weed infestation and bulk density, which negatively affect the uptake of nutrients and water. Zaman and Islam (2020) reported that zero tillage decreased by 9.67 % seed yield compared to conventional tillage [10].

Weed management treatments considerably increased grain yield than weedy check. Hand weeding considerably increased grain yield compared to the remaining weed management treatments. Ali *et al.* (2014) revealed that manual weeding remarkably increased the crop biomass and seed production of lentil than control [11]. The higher yield in weed management practices was obtained because it provided a weed-free environment for the crop throughout the crop's growth period, and the crop didn't have to compete for nutrients and water, which improved growth as well as yield indices like number of branches, pods, seeds/pod, and test weight, all of which combined increased grain yield. In weedy check excessive growth of weeds created severe crop-weed competition, which substantially decreased the yield and growth attributes and finally had a negative impact on yield. Sirisha *et al.* (2020) concluded that quizalofop ethyl (PoE) treatment increased grain production, straw yield than to weedy check [12]. Kumar *et al.* (2018b) noted that grain yield of lentil were remarkably higher in hand weeding twice afterwards, quizalofop-ethyl as PoE, chlorimuron ethyl as PPI, and lowest in weedy check [13].

Straw yield (q/ha)

Straw yield in crops is significantly influenced by vegetative development, including plant height, dry matter accumulation, and other related characteristics. The implementation of effective agronomic and weed management practices also plays a crucial role in regulating straw yield. Tillage methods contribute to increased straw yield by promoting plant height, branch and leaf count, and overall dry weight, which collectively impact the final straw production. Monsefi *et al.* (2014) also recorded a significantly higher stover yield of lentil under conventional tillage as compared to zero tillage [14].

Among the weed control techniques, hand weeding resulted in a significantly higher straw yield compared to quizalofop ethyl while being on par with the performance of chlorimuron ethyl (PE) + paddy straw mulching and chlorimuron ethyl (PE) + quizalofop ethyl. Yadav *et al.* (2013) and Dhuppar *et al.* (2013) registered that the stover yield and biological yield of lentil was higher in manual weeding than weedy check [15, 16].

The higher straw yield achieved under weed management treatments can be attributed to the reduction in weed growth during the vegetative and reproductive growth stages. This allows the crop to benefit from the available growth elements, leading to increased crop growth, dry matter accumulation, and ultimately higher straw yield. Singh *et al.* (2014) also reported that manual weeding twice gave highest total biomass of lentil followed by quizalofop ethyl, chlorimuron ethyl and lowest in weedy check plot [17].

NPK-uptake by crop (kg/ha)

Total nutrient (NPK) uptake by crop depends upon nutrient content and grain and straw production. Tillage and weed management treatments remarkably affected nutrient uptake by the crop. Out of all tillage practices, conventional tillage registered markedly higher nutrient uptake than minimum and zero tillage. Nayak *et al.* (2018) observed that under conventional tillage, soybean takes significantly higher nutrients (NPK) than minimum tillage [18]. The possible reason behind the higher uptake of nutrients by crop under conventional and minimum tillage might be a favourable soil physical environment that enhances root growth, root length and density. Lower bulk density helps in greater uptake of plant nutrients, which gives higher nutrient content in seed and straw and produces more grain yield and by product.

Weed management treatments also considerably improved the nutrient uptake by crop than weedy check. Hand weeding recorded remarkably higher P & K uptake by crop than chemical weeding except chlorimuron ethyl (PE) + paddy straw mulching but in the case of N, it recorded a significantly higher value than all chemical weeding. Among chemical weeding, the combined application of chlorimuron ethyl (PE) + mulching and chlorimuron ethyl (PE) + quizalofop ethyl (PoE) did not show significant difference in NPK uptake by crop, but these recorded remarkably higher nutrient uptakes than quizalofop ethyl (PoE). This was apparently as a result of higher nutrient content in seed and straw and a higher yield of grain and straw. Chander *et al.* (2013) reported that hand weeding increases the nutrient uptake by crop, chlorimuron ethyl (PPI) + quizalofop ethyl (POE), quizalofop ethyl (POE) in soybean [19] and in lentil (Kumar *et al.,* 2018b) as compared to weedy check [13].

Weed dry matter

Weed dry weight is the outcome of the degree of weed flora and its vigour. Weed dry matter also increases with the progression of the age of crop from germination up to harvest. Tillage practices significantly reduced weed dry matter. Among tillage practices, conventional tillage recorded lowest weed dry matter. The possible reason behind this was that in zero-tillage, weeds grew in the least disturbed conditions, benefited more from all growth stimuli, and collected more dry matter. The lower dry matter accumulation under conventional tillage was, due to inversion and disturbance of soil to a great extent, which suppressed weed growth efficiently. Sindhu (2017) also reported that the weed population and dry weight of weeds were greater under zero tillage as compared to conventional tillage in maize and wheat crop [20].

Weed management practices also significantly reduced weed dry matter compared to control. Out of all the weed control treatments, manual weeding registered least dry matter of weed. Among chemical weeding, chlorimuron ethyl (PE) + paddy straw mulching recorded lowest weed dry matter, followed by chlorimuron ethyl (PE) + quizalofop ethyl and quizalofop ethyl. Lhungdim *et al.* (2013) also reported same result in the lentil crop [21]. Weedy check uninterrupted weed enjoyed all growth factors more aggressively as much more weed dry matter accumulated. Manual weeding recorded lowest weed dry matter. As a result of under hand weeding, all types of weeds were destroyed at 20 DAS; hence, weed dry weight reduced drastically and slowly tended to increase towards maturity. Similarly, lower weed dry weight under chlorimuron ethyl and paddy straw mulching could be due to broad-spectrum weed suppression at first, with new flushes of weed emerging at later stages not being able to reach full development beneath the shadow of the crop plant. While in PE with PoE herbicide treatment, PE controlled weed density and growth at initial stage, and PoE application of quizalofop ethyl supported it by controlling and suppressing narrow leaf weeds by inhibiting the function and structure of cells, so the combined result of pre- and post-emergence of herbicide reduced the weed growth and dry matter (Singh *et al.* 2014) [17].

Nutrient depletion by weed

The nutrients depleted by weeds are an outcome of total weed dry weight and the concentration of nutrients (NPK) in the weeds. As a result, the higher the weed dry matter, the greater the depletion of nutrients by weeds. Nutrient exhaustion by weeds was significantly affected by tillage and weed management treatments. Zero-tillage weeds removed a greater quantity of plant nutrients from the soil, which could be due to enhanced weed growth resulting in a higher accumulation of weed dry matter in comparison to conventional and minimum tillage. Rana (2018) also reported that

(NPK) removal by weed under zero tillage is higher in comparison to minimum tillage and conventional tillage [6].
Weed management treatments considerable decreased the nutrients (NPK) depletion by weeds over weedy check. Hand weeding and chemical weeding significantly reduced nutrient depletion by weeds. The explanation for the low nutrient depletion in weed control treatments could be attributed to reduced weed population and dry weight as a consequence of the efficient reduction of weed biomass in these treatments, clearing the path for increased nutrient absorption by plants, resulting in lower dry matter accumulation by weeds, which in turn recorded lower depletion of NPK. In contexts of higher NPK depletion by weeds in weedy check plot, this could be due to intense weed interference, unimpeded growth of weeds, and higher weed dry matter accumulation, which leads to greater depletion of nutrients. Kumar and Das (2008) reported that NPK-depleted by weeds were remarkably lower in manual weeding twice compared to weedy check [22]. quizalofop ethyl (PoE), PPI use of chlorimuron ethyl + use of quizalofop ethyl as PoE, and hand weeding twice reduce the NPK depletion by weed in soybean Chander *et al.* (2013) [19] and lentil Kumar (2014) [23].

4. CONCLUSION

The research findings unveil the superiority of conventional tillage over other methods, showcasing its remarkable efficacy in bolstering plant dry weight, grain yield, straw yield, and nutrient uptake by crops while effectively curbing weed dry matter and nutrient depletion caused by weeds, surpassing the limitations of zero tillage. Furthermore, the study emphasizes the unrivalled performance of hand weeding as the ultimate weed management practice, exhibiting exceptional outcomes in terms of elevated plant dry matter, grain yield, straw yield, nutrient uptake by crops, and remarkably reduced weed dry matter weight and nutrient depletion caused by weeds. Notably, among the chemical weed management approaches, the combined use of chlorimuron ethyl (PE) and paddy straw mulching emerges as a comparable alternative to hand weeding across all parameters evaluated. These findings underscore the critical significance of adopting appropriate tillage practices and deploying efficient weed management strategies to maximize plant growth, yield, nutrient uptake, and weed control, ensuring optimal agricultural productivity.

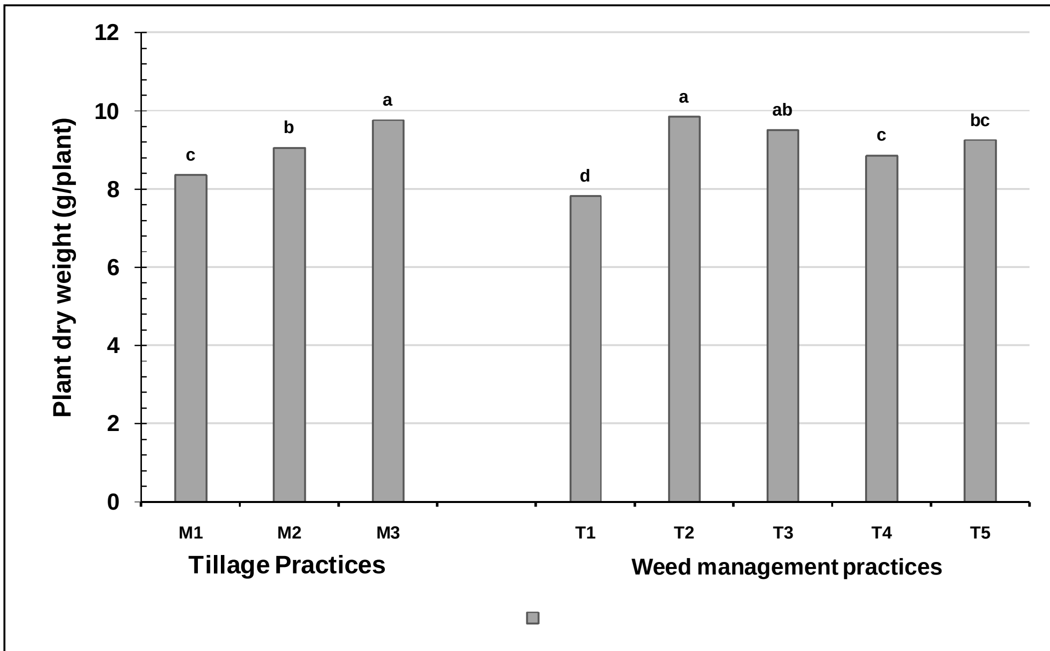

Figure 2. Effect of tillage and weed management practices on plant dry matter at harvest of lentil
(Different letters in each column indicate significant differences at p=0.05, figures sharing the same case letter in a column do not differ significantly (p≤ 0.05) by the least significant difference test.)

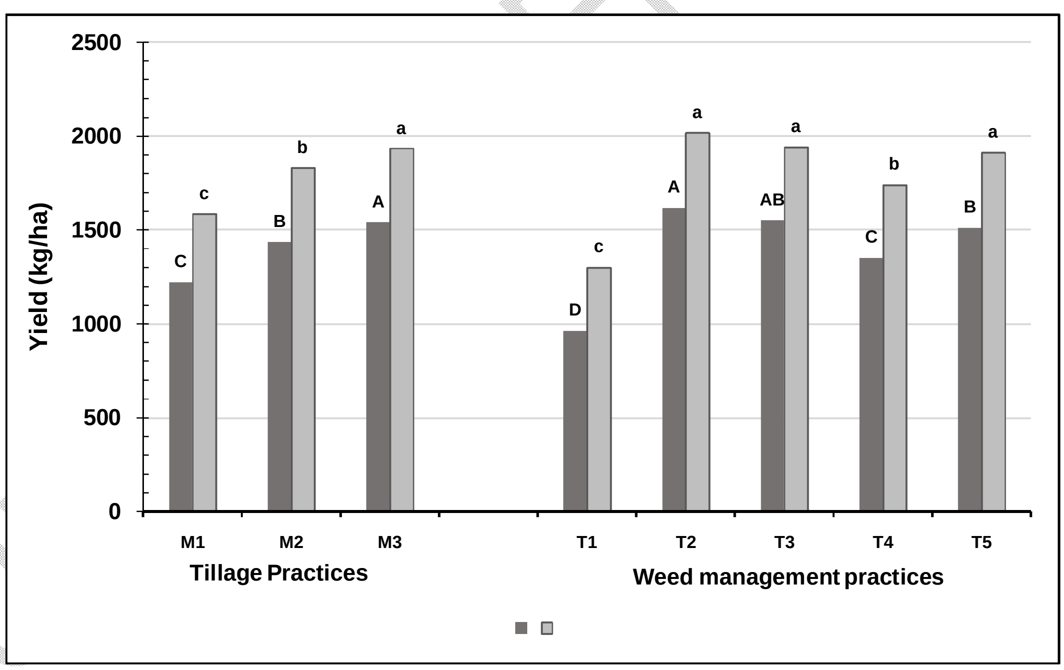

Figure 3. Effect of tillage and weed management practices on grain yield and straw yield of lentil
(Different letters in each column indicate significant differences at p=0.05, figures sharing the same case letter in a column do not differ significantly (p≤ 0.05) by the least significant difference test.)

Table 1: Effect of tillage and weed management practices nutrient (NPK) Uptake by the lentil

	Treatments	NPK-uptake by crop		
		N uptake (kg/ha)	P uptake (kg/ha)	K uptake (kg/ha)
	Tillage practices (M)			
M_1	Zero tillage	70.75[c]	5.52[c]	34.55[c]
M_2	Minimum tillage	84.31[b]	6.51[b]	41.60[b]
M_3	Conventional tillage	91.60[a]	7.13[a]	44.45[a]
	Weed management practices (T)			
T_1	Weedy check	56.67[d]	4.36[d]	27.73[d]
T_2	Hand weeding at 20 DAS	95.94[a]	7.43[a]	46.55[a]
T_3	Chlorimuron-ethyl 4 g/ha (PE) + Paddy straw mulching (5.0 t/ha)	91.15[b]	7.12[ab]	44.48[ab]
T_4	Quizalofop-ethyl 40 g/ha at 20 DAS	78.71[c]	6.10[c]	38.98[c]
T_5	Chlorimuron-ethyl 4 g/ha (PE) + Quizalofop-ethyl 40 g/ha at 20 DAS	88.60[b]	6.93[b]	43.28[b]
	Interaction (M × T)			
	LSD (*P*= 0.05)	NS	NS	NS

Different letters in each column indicate significant differences at p=0.05, figures sharing the same case letter in a column do not differ significantly (p≤ 0.05) by the least significant difference test. (NS: non-significant)

Table 2: Effect of tillage and weed management practices on weed dry matter and NPK depletion by the weed

	Treatments	Weed dry matter At harvest (g/m^2)	NPK-depletion by weed		
			N depletion (kg/ha)	P depletion (kg/ha)	K depletion (kg/ha)
	Tillage practices (M)				
M_1	Zero tillage	10.37^a (112.93)*	18.42^a	2.84^a	16.51^a
M_2	Minimum tillage	7.70^b (67.27)	12.11^b	1.91^b	10.21^b
M_3	Conventional tillage	6.62^c (51.79)	9.21^c	1.43^c	8.19^c
	Weed management practices (T)				
T_1	Weedy check	13.20^a (176.20)	29.24^a	4.54^a	25.69^a
T_2	Hand weeding at 20 DAS	5.68^d (34.46)	7.38^c	1.14^c	6.52^c
T_3	Chlorimuron-ethyl 4 g/ha (PE) + Paddy straw mulching (5.0 t/ha)	6.62^c (47.35)	8.41^c	1.28^c	7.19^c
T_4	Quizalofop-ethyl 40 g/ha at 20 DAS	8.45^b (74.32)	12.11^b	1.90^b	10.72^b
T_5	Chlorimuron-ethyl 4 g/ha (PE) + Quizalofop-ethyl 40 g/ha at 20 DAS	7.20^c (54.31)	9.10b^c	1.42^c	8.07^c
	Interaction (M × T)				
	LSD ($p \leq 0.05$)	NS	NS	NS	NS

**Figures in parentheses () are the actual value of weed dry matter and outside the parentheses are square root ($\sqrt{x} + 0.5$) transformed values Different letters in each column indicate significant differences at p=0.05, figures sharing the same case letter in a column do not differ significantly (p≤ 0.05) by the least significant difference test. (NS: denote the non-significant)*

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