__Original Research Article__

Effect of Different Weed Management Practices on Growth Characters of Mungbean under Mid-hills of Himachal Pradesh, India

Abstract

Weed management in mungbean is one of the most efficient ways to improve its growth, as uncontrolled weed growth causes a significant decrease in crop growth. Effects of various herbicides applied at different rates as pre-emergence or as post-emergence were studied on growth characterstics in mungbean. It is usually infested and its growth parameter is adversely affected by a number of weed species that compete with the crop from germination to harvest, affecting the crop growth adversely. A field experiment titled "Effect of Different Weed Management Practices on Growth Characters of Mungbean under Mid-hills of Himachal Pradesh" was conducted during the *kharif* season of 2022 at Chamelti Agriculture Farm, MS Swaminathan School of Agriculture, Shoolini University of Biotechnology and Management Sciences, District Solan. The soil of the experimental field was sandy loam in texture, slightly alkaline in reaction with EC in a safer range, medium in organic carbon, available nitrogen, potassium, and high in available phosphorus. The experiment was laid out in randomized block design with three replications comprising ten weed management treatments *viz.* (T_1) Pendimethalin 30 EC @ 1.0 kg a.i. ha^{-1} PE, (T_2) Pendimethalin 30 EC @ 1.0 kg a.i. ha^{-1} PE *fb* one HW at 20 DAS, (T_3) Pendimethalin 30 EC @ 0.75 kg a.i. ha^{-1} PE *fb* Imezathapyr 10% SL @ 70 g ha^{-1} PoE at 20 DAS, (T_4) Pendimethalin 30 EC @ 0.75 kg a.i. ha^{-1} PE *fb* Oxyfluoren @ 50 g a.i. ha^{-1} PoE at 25 DAS, (T_5) Pendimethalin @ 0.75 kg a.i. ha^{-1} PE *fb* Quizolofop ethyl @ 50 g ha^{-1} PoE at 20 DAS, (T_6) Imazethapyr 10% SL @ 70 g a.i. ha^{-1} PoE at 20 DAS, (T_7) One-hand weeding at 25 DAS, (T_8) Two-hand weeding at 20 and 35 DAS, (T_9) Weedy check and (T_{10}) Weed free. The recommended dose of fertilizer (20:40:20 kg ha^{-1}) was applied through Urea, SSP, and MOP at the time of sowing. Pusa Baishaki variety of mungbean was used for sowing. Weed management practices were done as per treatment. Other crop management practices were followed as per the recommendation of the area. Data on growth characters revealed that application of (T_2) Pendimethalin 30EC @ 1.0 kg a.i. ha^{-1} PE *fb* one HW at 20 DAS registered higher growth parameters *viz.* plant height, number of branches $plant^{-1}$, dry matter accumulation and trifoliate leaves which was statistically at par with (T_3), (T_4) and (T_5). Thus, study suggest that mungbean can successfully grown under Mid-hills of Himachal Pradesh on (T_2) Pendimethalin 30 EC @ 1.0 kg a.i. ha^{-1} PE *fb* one HW at 20 DAS.

Keywords: Mungbean, weed, herbicide, yield, PE, POE

1. INTRODUCTION

Pulses hold significant importance in both human dietary and animal feed contexts. As leguminous crops, they play a pivotal role in agricultural systems due to their remarkable capacity to harness atmospheric nitrogen, contribute substantial organic matter to soil, and good yield harvests with minimal input requirements, even in challenging environmental and soil conditions (Meena and Dudi, 2018). India, the largest global producer and consumer of pulses, contributes a substantial 25% to worldwide production and satisfies 15% of the global consumption.

Weeds represent a significant factor contributing to crop yield reductions, often causing more economic losses than insects, fungi and other pests. Nevertheless, the economic impact of weeds varies considerably among different crops, geographical regions, and soil types. Effectively managing or controlling weed infestations in pulse crops has the potential to substantially enhance both their overall yields and nitrogen fixation capabilities. Specifically, in Himachal Pradesh, where the agricultural landscape covers 30,760 hectares and produces 50,570 metric tons of pulses (Statistical abstract of H.P. 2021-22), weed infestations pose a significant challenge to mungbean cultivation. Some of the primary weed species commonly observed in mungbean fields in Himachal Pradesh include *Echinochloa colona, Echinochloa crusgalli, Digitaria sanguinalis, Ageratum conyzoides, Ageratum houstonianum, Galinsoga parviflora, Commelina sp., Amaranthus viridis* L., and *Conyza stricta*. Managing these weed species is crucial to ensure the successful cultivation and optimal yield of mungbean in this region.

On a global scale, legumes are consciously incorporated into crop rotations alongside cereals, serving as essential components of modern commercial farming systems. This practice aims to enhance the sustainability of agriculture by mitigating environmental concerns, particularly with regards to nitrogen (N) requirements (Islam *et al.* 2023). Among these legumes, mungbean (*Vigna radiata* L. Wilczek) stands out as a significant grain legume, maximize a rich composition of easily digestible protein, essential amino acids, sugars, minerals, soluble dietary fibers and vitamins (Sehrawat *et al.* 2021). In the context of Kenya, the cultivation of green gram is primarily undertaken by smallholder farmers, both for sustenance and sale. This crop mainly grow in arid and semi-arid regions, playing a pivotal role in advancing human nutrition and health standards. It also contributes significantly to poverty alleviation through improved food security and reinforces ecosystem resilience by serving as a valuable resource for human nutrition, animal feed, soil nitrogen enrichment, and overall soil health. Notably, statistical data reveals a consistent growth in the average cultivated area for green gram production since 1978. However, the average production levels have exhibited fluctuations, while consumption has steadily risen. This scenario has led to a persistent deficit, which is compensated for through imports (Muchomba *et al.* 2023).

Mungbean, a vital contributor to India's agricultural landscape, occupies 14% of the total pulses area and contributes 7% to the overall pulses production in the country (Choudhary *et al*., 2017). This pulse crop finds its origins in India and is extensively cultivated across East Asia, Southeast Asia, and the Indian subcontinent. Within India, mungbean ranks as the third most important pulse crop, covering approximately 16% of the total pulse area nationwide. Remarkably, India alone accounts for a staggering 65% of global mungbean acreage and 54% of its production, a testament to its agricultural significance. In terms of cultivation scale, mungbean holds the third position in India, following chickpea and pigeon pea, with an impressive 3.55 million hectares under cultivation and a production volume of 1.82 million metric tonnes, as documented by IIPR in 2010. This crop plays a vital role in India's agricultural diversity and economic prosperity. Mungbean stands out for its flexibility, growing in adverse conditions such as drought, low soil fertility, and shade. This resilience results in the production of highly nutritious seeds rich in amino acids and proteins (Jiang *et al.*, 2012). Mungbean pods and sprouts are commonly consumed as vegetables, serving as abundant sources of essential vitamins and minerals. They play a vital role in meeting the protein needs of vegetarians, while non-vegetarians fulfill their protein requirements through animal sources. Beyond its nutritional ability, mungbean is recognized for its short growth cycle and nitrogen-fixing capabilities, owing to its leguminous nature. It is often used as a mixed crop, intercrop or rotational crop to enhance soil nitrogen levels and disrupt disease or pest cycles (Ranawake *et al.,* 2011). However, mungbean production faces significant challenges, primarily from weed infestations, which can lead to yield losses ranging from 30% to 50% (Sekhon *et al*., 2004). Interestingly, the specific weed species and their impact vary in agroforestry systems, as some studies have documented inhibitory allelopathic effects of trees on weed germination and growth (Kaur *et al*., 2011). These complexities underline the importance of effective weed management strategies in sustaining mungbean cultivation.

Weeds pose a substantial warning to mungbean crops, causing a significant reduction in grain yield ranging from 45% to 80% (Khairnar *et al.,* 2014), (Singh *et al.*, 2014), and (Kaur *et al.,* 2016). While hand weeding has proven effective for weed control (Singh *et al.*, 2002), (Singh et al., 2010) the high cost of labor associated with this method increases the overall production expenses for the crop (Sharma *et al*., 2016).

Consequently, the utilization of herbicides emerges as a more cost-effective approach for weed management (Balyan *et al.*, 2016) and (Singh and Singh 2017). However, it's important to note that certain herbicides may exert adverse effects on the growth, yield and nutrient uptake of the crop, as well as its symbiotic relationship with *Rhizobium* bacteria. This underscores the growing importance of investigating the impact of herbicides on the symbiotic partnership between *Rhizobium* and leguminous crops, as well as on overall crop growth and yield. The influence of herbicides can demonstrate in multiple ways, both directly and indirectly. They may directly affect *Rhizobium* survival and nodule formation (Singh and Wright 2002), or have an impact on nitrogenase activity (Fan *et al.*, 2017). Assessing the effects of herbicides on various aspects of crop growth and yield is crucial when recommending their use in agricultural practices. Furthermore, in the case of pulse crops, it becomes important to understand how herbicides may affect symbiotic parameters, such as nodule number, nodule dry weight and leghemoglobin content within nodules. These parameters serve as indicators of the plant's nitrogen-fixing ability and hold significant influence over crop growth. To ensure the sustainable use of herbicides, it's essential to prioritize products that exhibit a high level of selectivity for the target crop, a factor of utmost importance when making recommendations to farmers.

2. MATERIALS AND METHODS

The fieldwork was done in the *kharif* season of 2022 at Chamelti Agriculture Farm, MS Swaminathan School of Agriculture, Shoolini University of Biotechnology and Management Sciences, District Solan and is situated at a latitude 30^0 85'67.30 N and longitude 77^0 13'20.38 E and an elevation of 1284 meters above mean sea level (AMSL). The experiment was laid out in randomized block design with three replications and ten weed management treatments *viz.* (T_1) Pendimethalin 30 EC @ 1.0 kg a.i. ha^{-1} PE, (T_2) Pendimethalin 30 EC @ 1.0 kg a.i. ha^{-1} PE *fb* one HW at 20 DAS, (T_3) Pendimethalin 30 EC @ 0.75 kg a.i. ha^{-1} PE *fb* Imezathapyr 10% SL @ 70 g ha^{-1} PoE at 20 DAS, (T_4) Pendimethalin 30 EC @ 0.75 kg a.i. ha^{-1} PE *fb* Oxyfluoren @ 50 g a.i. ha^{-1} PoE at 25 DAS, (T_5) Pendimethalin @ 0.75 kg a.i. ha^{-1} PE *fb* Quizolofop ethyl @ 50 g ha^{-1} PoE at 20 DAS, (T_6) Imazethapyr 10% SL @ 70 g a.i. ha^{-1} PoE at 20 DAS, (T_7) One-hand weeding at 25 DAS, (T_8) Two-hand weeding at 20 and 35 DAS, (T_9) Weedy check and (T_{10}) Weed free. The soil of experimental field was sandy loam in texture, slightly alkaline in reaction with EC in safer range, medium in organic carbon, available nitrogen, potassium and high in available phosphorus. The mungbean variety Pusa baisakhi was sown on 16th June, 2022 at a row spacing of 30 × 10 cm using seed rate of 12 kg ha^{-1} and Recommended dose of nitrogen, phosphorus and potassium (20:40:20 kg ha^{-1}) through urea, SSP and MOP at time of sowing. All the data were subjected to analysis of variance (ANOVA) as per the standard procedures. The comparison of treatment means was made by critical difference (RBD) at p=0.05.

3. RESULTS AND DISCUSSION

3.1 Plant height (cm)

Plant height is a reliable index of plant growth and development representing the structural build-up over a period of time and offers an immediate comparison of the different treatments. The data on the effect of weed management practices on mungbean intensification on plant height. Table1 shows data on plant height at 30, 60 DAS and at harvest stage. To record plant height, the tagged mungbean plants measured with the help of meter scale from the base of the plant to the tip of the last fully opened leaf at 30, 60 DAS and at harvest. Plant height at harvest was measured from the ground level to the uppermost portions of the leave and the mean values thus worked out are presented in centimeters (cm). Significantly higher plant height was observed under (T_{10}) Weed free over rest of the treatments. Among the weed management practices (T_2) Pendimethalin 30 EC @ 1.0 kg a.i. ha^{-1} PE *fb* one HW at 20 DAS, which was statistically at par with (T_3) Pendimethalin 30 EC @ 0.75 kg a.i. ha^{-1} PE *fb* Imezathapyr 10% SL @ 70 g ha^{-1} PoE at 20 DAS and (T_4) Pendimethalin 30 EC @ 0.75 kg a.i. ha^{-1} PE *fb* Oxyfluoren @ 50g a.i. ha^{-1} PoE at 25 DAS and (T_5) Pendimethalin @ 0.75 kg a.i. ha^{-1} PE *fb* Quizolofop ethyl @ 50g ha^{-1} PoE at 20 DAS, at all the stages of crop growth. However, the lowest plant height was recorded under weedy check treatment. In a weedy condition, weeds take a bigger portion of the resources available in the soil and environment for their growth during the early stages of crop growth. According to Tewari *et al*. (2004), the observed maximum plant height can likely be attributed to more efficient weed management practices. These practices effectively reduce the competition between weeds and the primary crop for essential resources, including light, nutrients and moisture. Consequently, the implementation of effective weed control treatments reduces the overall competition between crops and weeds, leading to significant enhancements in crop growth, as evidenced by increased plant height. This improvement in plant height has a stream, flow effect on the reproductive structures of the crop and facilitates the efficient translocation of photosynthates to the sink. These outcomes align with the research conducted by Yadav *et al.* (2014), strengthen the positive impact of effective weed management on crop growth and reproductive success.

3.2 Number of branches (plant^{-1})

To record number of total branches produced plant^{-1} counted at 60 DAS and at harvest stage of five randomly tagged plants in all the treatments. The mean of five plants were recorded as the number of branches plant^{-1}. Data on the number of branches at 60 and at the time of harvest are shown in Table 2. Significantly higher number of branches was observed under (T_{10}) Weed free over rest of the treatments. Among the weed management practices (T_2) Pendimethalin 30 EC @ 1.0 kg a.i. ha^{-1} PE *fb* one HW at 20 DAS, which was statistically at par with (T_3) Pendimethalin 30 EC @ 0.75 kg a.i. ha^{-1} PE *fb* Imezathapyr 10% SL @ 70 g ha^{-1} PoE at 20 DAS and (T_4) Pendimethalin 30 EC @ 0.75 kg a.i. ha^{-1} PE *fb* Oxyfluoren @ 50g a.i. ha^{-1} PoE at 25 DAS and (T_5) Pendimethalin @ 0.75 kg a.i. ha^{-1} PE *fb* Quizolofop ethyl @ 50g ha^{-1} PoE at 20 DAS, at all the stages of crop growth. However, the lowest branches were recorded under weedy check treatment at all the stages, during the course of observations recorded. The likely reason for this phenomenon could be the reduced competition among plants for crucial resources such as moisture and nutrients. This reduced competition arises from the lower population and dry biomass of weeds, resulting in a more abundant availability of resources. This, in turn, contributes to the remarkable growth of mungbean plants when subjected to dust mulching, as highlighted by Verma *et al.* (2008) and Mirjha *et al.* (2013). Moreover, studies conducted by Verma *et al.* (2008) and Singh *et al.* (2014) have also reported increased nodulation in mungbean under effective weed management practices. Weeding serves to provide plants with greater access to resources for their growth and development. This can be attributed to the reduced competition for essential resources such as light, nutrients, and free space in a weed-free environment, a concept supported by the research of Komal *et al.* (2015). These findings were similar to Singh *et al.* (2017) and Hasanain *et al.* (2019), further substantiating the positive impact of effective weed management on crop growth and development.

3.3 Dry matter accumulation plant^{-1} (g)

Dry matter accumulation is an important index indicating the photosynthetic efficiency of the crop which ultimately influences the crop yield. The data on the effect of weed management practices on mungbean intensification on the dry matter accumulation recorded at 30, 60 DAS and at harvest. Significantly higher number of total branches was observed under (T_{10}) Weed free over rest of the treatments. Among the weed management practices (T_2) Pendimethalin 30 EC @ 1.0 kg a.i. ha^{-1} PE *fb* one HW at 20 DAS, which was statistically at par with (T_3) Pendimethalin 30 EC @ 0.75 kg a.i. ha^{-1} PE *fb* Imezathapyr 10% SL @ 70 g ha^{-1} PoE at 20 DAS and (T_4) Pendimethalin 30 EC @ 0.75 kg a.i. ha^{-1} PE *fb* Oxyfluoren @ 50g a.i. ha^{-1} PoE at 25 DAS and (T_5) Pendimethalin @ 0.75 kg a.i. ha^{-1} PE *fb* Quizolofop ethyl @ 50g ha^{-1} PoE at 20 DAS, at all the stages of crop growth. However, the lowest dry matter accumulation was recorded under weedy check treatment. As per the findings of Tewari *et al.* (2004), the highest accumulation of dry matter in the crop can likely be attributed to more efficient weed management practices. These practices effectively reduce the competition between weeds and the primary crop for essential resources, including light, nutrients and moisture. Consequently, the implementation of effective weed control treatments diminishes the overall competition between crops and weeds, leading to significant enhancements in crop growth, as evidenced by increased dry matter accumulation. This improvement in dry matter accumulation has a stream, flow effect on the reproductive structures of the crop and facilitates the efficient translocation of photosynthates to the sink. These outcomes align with the research conducted by Yadav *et al.* (2014), and strengthen the positive impact of effective weed management on crop growth and reproductive success. Singh *et al*. (2022).

3.4 Number of trifoliate leaves plant^{-1}

Data on the number of trifoliate leaves at 30, 60 DAS and at harvest are shown in Table 4.

The outcomes show a significant distinction between all treatments. At 30 DAS, significantly higher Number of trifoliate leaves was observed under (T_{10}) Weed free over rest of the treatments. Among the weed management practices (T_2) Pendimethalin 30 EC @ 1.0 kg a.i. ha^{-1} PE *fb* one HW at 20 DAS, which was statistically at par with (T_3) Pendimethalin 30 EC @ 0.75 kg a.i. ha^{-1} PE *fb* Imezathapyr 10% SL @ 70 g ha^{-1} PoE at 20 DAS and (T_4) Pendimethalin 30 EC @ 0.75 kg a.i. ha^{-1} PE *fb* Oxyfluoren @ 50g a.i. ha^{-1} PoE at 25 DAS and (T_5) Pendimethalin @ 0.75 kg a.i. ha^{-1} PE *fb* Quizolofop ethyl @ 50g ha^{-1} PoE at 20 DAS, at all the stages of crop growth. However, the lowest trifoliate leaves were recorded under weedy check treatment. This phenomenon can likely be attributed to the reduction in competition among plants for vital resources like moisture and nutrients. This decrease in competition is a direct result of the lower weed population and reduced dry biomass, leading to a more abundant availability of these essential resources. Consequently, this abundance of resources significantly contributes to the impressive growth of mungbean plants when subjected to dust mulching, similar findings were of Verma *et al.* (2008) and Mirjha *et al.* (2013). Furthermore, research conducted by Verma *et al.* (2008) and Singh *et al.* (2014) has also highlighted an increase in nodulation in mungbean under effective weed management practices. Weeding plays a crucial role in affording plants greater access to resources for their growth and development. This can be attributed to the reduced competition for essential resources such as light, nutrients, and available space in a weed-free environment, a concept supported by the research conducted by Komal *et al.* (2015). These findings resonate with the results obtained by Singh *et al.* (2017) and

Hasanain *et al.* (2019), further substantiating the positive impact of effective weed management on the growth and development of crops.

Table 1: Plant height (cm) of mungbean as influenced by weed management practices at periodic intervals

Treatments	Plant height (cm)		
	30 DAS	60 DAS	At harvest
T_1: Pendimethalin 30 EC @ 1.0 kg a.i. ha^{-1} PE	18.71	45.84	47.73
T_2: Pendimethalin 30 EC @ 1.0 kg a.i. ha^{-1} PE *fb* one HW at 20 DAS	21.53	56.79	58.07
T_3: Pendimethalin 30EC @ 0.75 kg a.i. ha^{-1} PE *fb* Imezathapyr 10% SL @ 70 g ha^{-1} PoE at 20 DAS	21.47	55.72	57.11
T_4: Pendimethalin 30 EC @ 0.75 kg a.i. ha^{-1} PE *fb* Oxyfluoren @ 50 g a.i. ha^{-1} PoE at 25 DAS	20.72	54.86	55.56
T_5: Pendimethalin @ 0.75 kg a.i. ha^{-1} PE *fb* Quizolofop ethyl @ 50 g ha^{-1} PoE at 20 DAS	20.80	55.30	56.52
T_6: Imazethapyr 10% SL @ 70 g a.i. ha^{-1} PoE at 20 DAS	19.05	46.34	48.20
T_7: One hand weeding at 25 DAS	17.52	43.36	45.02
T_8: Two hand weeding at 20 and 35 DAS	19.90	49.19	50.38
T_9: Weedy check	16.29	41.75	42.85
T_{10}: Weed free	21.99	58.82	60.97
SEm±	0.42	0.84	0.98
LSD (p= 0.05)	1.25	2.48	2.91

Table 2: Number of branches ($plant^{-1}$) of mungbean as influenced by weed management practices at periodic intervals

Treatments	Number of branches ($plant^{-1}$)	
	60 DAS	At harvest
T_1: Pendimethalin 30 EC @ 1.0 kg a.i. ha^{-1} PE	6.05	6.17
T_2: Pendimethalin 30 EC @ 1.0 kg a.i. ha^{-1} PE *fb* one HW at 20 DAS	7.47	7.69
T_3: Pendimethalin 30EC @ 0.75 kg a.i. ha^{-1} PE *fb* Imezathapyr 10% SL @ 70 g ha^{-1} PoE at 20 DAS	7.35	7.56
T_4: Pendimethalin 30 EC @ 0.75 kg a.i. ha^{-1} PE *fb* Oxyfluoren @ 50 g a.i. ha^{-1} PoE at 25 DAS	7.01	7.20
T_5: Pendimethalin @ 0.75 kg a.i. ha^{-1} PE *fb* Quizolofop ethyl @ 50 g ha^{-1} PoE at 20 DAS	7.21	7.41
T_6: Imazethapyr 10% SL @ 70 g a.i. ha^{-1} PoE at 20 DAS	6.78	6.91
T_7: One hand weeding at 25 DAS	5.65	5.75
T_8: Two hand weeding at 20 and 35 DAS	6.65	6.79
T_9: Weedy check	3.71	3.80
T_{10}: Weed free	7.77	8.18
SEm±	0.16	0.16
LSD (p= 0.05)	0.48	0.49

Table 3: Dry matter accumulation plant^{-1} (g) of mungbean as influenced by weed management practices at periodic intervals

Treatments	Dry matter accumulation plant^{-1} (g)		
	30 DAS	60 DAS	At harvest
T_1: Pendimethalin 30 EC @ 1.0 kg a.i. ha^{-1} PE	2.15	8.55	10.90
T_2: Pendimethalin 30 EC @ 1.0 kg a.i. ha^{-1} PE *fb* one HW at 20 DAS	3.65	9.72	12.07
T_3: Pendimethalin 30EC @ 0.75 kg a.i. ha^{-1} PE *fb* Imezathapyr 10% SL @ 70 g ha^{-1} PoE at 20 DAS	3.54	9.51	11.86
T_4: Pendimethalin 30 EC @ 0.75 kg a.i. ha^{-1} PE *fb* Oxyfluoren @ 50 g a.i. ha^{-1} PoE at 25 DAS	3.46	9.41	11.76
T_5: Pendimethalin @ 0.75 kg a.i. ha^{-1} PE *fb* Quizolofop ethyl @ 50 g ha^{-1} PoE at 20 DAS	3.51	9.46	11.81
T_6: Imazethapyr 10% SL @ 70 g a.i. ha^{-1} PoE at 20 DAS	2.45	9.27	11.62
T_7: One hand weeding at 25 DAS	1.89	8.56	10.91
T_8: Two hand weeding at 20 and 35 DAS	2.87	9.33	11.68
T_9: Weedy check	1.11	8.59	10.79
T_{10}: Weed free	3.98	10.48	12.83
SEm±	0.10	0.31	0.32

LSD (p= 0.05)	0.31	0.92	0.95

Treatments	Trifoliate leaves plant^{-1}		
	30 DAS	60 DAS	At harvest
T_1: Pendimethalin 30 EC @ 1.0 kg a.i. ha^{-1} PE	3.87	8.78	8.56
T_2: Pendimethalin 30 EC @ 1.0 kg a.i. ha^{-1} PE *fb* one HW at 20 DAS	4.65	10.45	10.39
T_3: Pendimethalin 30EC @ 0.75 kg a.i. ha^{-1} PE *fb* Imezathapyr 10% SL @ 70 g ha^{-1} PoE at 20 DAS	4.59	10.36	10.31
T_4: Pendimethalin 30 EC @ 0.75 kg a.i. ha^{-1} PE *fb* Oxyfluoren @ 50 g a.i. ha^{-1} PoE at 25 DAS	4.45	9.99	9.94
T_5: Pendimethalin @ 0.75 kg a.i. ha^{-1} PE *fb* Quizolofop ethyl @ 50 g ha^{-1} PoE at 20 DAS	4.51	10.12	10.07
T_6: Imazethapyr 10% SL @ 70 g a.i. ha^{-1} PoE at 20 DAS	4.12	9.11	9.01
T_7: One hand weeding at 25 DAS	3.54	8.51	8.42
T_8: Two hand weeding at 20 and 35 DAS	4.26	9.54	9.42
T_9: Weedy check	2.87	7.24	7.18
T_{10}: Weed free	4.78	10.58	10.46
SEm±	0.11	0.26	0.20
LSD (p= 0.05)	0.33	0.79	0.60

Table: 4 Effect of weed management on trifoliate leaves plant^{-1} of mungbean

CONCLUSION

Application of (T2) Pendimethalin 30EC @ 1.0 kg a.i. ha-1 PE fb one HW at 20 DAS registered higher growth parameters *viz.* plant height, number of branches plant^{-1}, dry matter accumulation and trifoliate leaves which was statistically at par with (T_3), (T_4) and (T_5).

REFERENCES

1. Balyan, J.K., Choudhary, R.S., Kumpawat, B.S. and Choudhary, R. Weed management in blackgram under rainfed conditions. Indian Journal of Weed Science.2016; 48:173–177.
2. Choudhary, P., Ghosh, G., Neha and Kumari, S. (2017). Effect on Yield and Benefit Cost Ratio of Green gram at Different Phosphorus Levels and Frequency of Boron Levels. International Journal of Current Microbiology and Applied Sciences. 6(6).
3. Fan. L., Feng, Y., Weaver, D.B., Delaney, D.P., Wehtje, G.R. and Wang G. 2017. Glyphosate effects on symbiotic nitrogen fixation in glyphosate-resistant soybean. Applied Soil Ecology. 2017; 121:11-19.
4. Hasanain, M., Shukla, D.K., Singh, R.K., Gouda, H.M., Sadhukhan, R., Singh, V.K. and Kumar, J. (2019). Effect of fertility levels and weed-management practices on weed- control efficiency, yield and nutrients uptake in summer mung bean (Vigna radiata). Indian Journal of Agronomy. 64 (3): 418-4.
5. IIPR. (2010). All India Coordinated Research Project on Mungbean, Urdbean, Lentil, Lathyrus, Rajmash and Pea, ICAR.
6. Islam, M.S., Hasan, K., Islam, R., Chowdhury, K., Pramanik, M.H., Iqbal, M.A., Rajendran, K., Iqbal, R., Soufan, W., Kamran, M., Liyun, L. and Sabagh, A.E. (2023). Water relations and yield characteristics of mungbean as influenced by foliar application of gibberellic acid (GA_3). Front. Ecol. Evol. 11:1048768.
7. Jiang, S., Gao, X., Liang, J., Wang, P., Gao, J., Qu, Y. and Feng, B. (2012). Effect of different furrow and mulched ridge on water moisture conversation and water saving of spring moong bean planted farmland. Journal of Agricultural Sciences. 4: 132.
8. Kaur, S., Kaur, T. and Bhullar, M.S. (2016). Imidazolinone herbicides for weed control in greengram. Indian J Weed Sci. 48:37–39. doi:10.5958/0974-8164.2016.00008.3
9. Kaur, S., Singh, H.P., Batish, D.R., Kohli, R.K. (2011). Chemical characterization and allelopathic potential of volatile oil of Eucalyptus tereticornis against Amaranthus viridis. Journal of Plant Interaction. 6:297–302.
10. Khairnar, C.B., Goud, V.V. and Sethi, H.N. (2014). Pre- and post-emergence herbicides for weed management in mungbean. Indian Journal of Weed Sci. 46:392–395.
11. Komal, S., Singh, P. and Yadav, R. S. (2015). Effect of weed management on growth, yield and nutrient uptake of greengram. Indian Journal of Weed Science 47: 2

12. Mirjha, P.R., Prasad, S.K., Singh, M.K., Paikra, R.H., Patel, S. and Majumdar, M. (2013). Effect of weed control measures on weeds, nodulation, growth and yield of mungbean (Vigna radiata). Indian Journal of Agronomy. 58 (4): 615-617.
13. Muchomba, M.K., Muindi, E.M. and Mulinge, J.M. (2023). Overview of Green Gram (*Vigna radiata* L.) Crop, Its Economic Importance, Ecological Requirements and Production Constraints in Kenya. Journal of Agriculture and Ecology Research International. 24(2) 1-11.
14. Ranawake, A.L., Dahanayaka, N., Amarasingha, U.G.S, Rodrigo, W.D.R.G., Rodrigo, U.T.D. (2011). Effect of water stress on growth and yield of mung bean (Vigna radiate L). Tropical Agricultural Research and Extension. 14(4).
15. Sehrawat, N., Mukesh Yadav, M., Sharma, A.K., Kumar, S., Singh, M., Kumar, V., Rakesh, Sharma, P. and Singh, R. (2021). Mungbean (*Vigna radiata* L. *Wilczek*) as Functional Food, Agronomic Importance and Breeding Approach for Development of Climate Resilience: Current Status and Future Perspectives. Asian Journal of Biological and Life Sciences. Vol 10, Issue 1.
16. Sekhon, H.S., Singh, G., Sharma, Poonam., and Sharma, Pushpa., (2004). Agronomic management of mungbean grown under different environments. Proc. of final workshop and planning meeting of 'Improving income and nutrition by incorporating Mungbean in cereal fallows in the Indo-Gangetic plains of south Asia DFID Mungbean Project for 2002-2004', 27–31 May, 2004, PAU, Ludhiana.
17. Sharma, N.K., Mundra, S.L. and Kalita, S. (2016). Effect of weed control on growth and productivity of soybean. Indian Journal of Agricultural Science. 48:90–92.
18. Singh G and Wright D. (1999). Effects of herbicides on nodulation, symbiotic nitrogen fixation, growth and yield of pea (*Pisum sativum*). Journal of Agriculture Science (Cambridge). 1999; 133:21–30.
19. Singh G. and Wright D. (2002b). In vitro studies on the effects of herbicides on the growth of rhizobia. Letters Appl Microbiology. 35:12-16.
20. Singh R. and Singh G. (2017). Economic analysis of application of weed management practices in kharif and summer mungbean [*Vigna radiata* (L.) *Wilczek*]. International Journal of Current Microbiology Applied Sciences. 6(12): 3182-31.
21. Singh, G. and Wright, D. (2002a). Effects of herbicides on nodulation and growth of two varieties of peas (*Pisum sativum*). Acta Agron Hung. 50:337–348.
22. Singh, G., Aggarwal, N. and Ram, H. (2010). Effect of row spacing and weed management practices on weeds, growth and yield of pigeonpea [*Cajanus cajan* (L.) Millsp.]. Indian Journal of Agricultural Science. 42:241–243

23. Singh, G., Aggarwal, N. and Ram, H. (2014). Efficacy of post-emergence herbicide imazethapyr for weed management in different mungbean (*Vigna radiata*) cultivars. Indian Journal of Agricultural Science. 84:540–543.

24. Singh, G., Sekhon, H.S., Gumber, R.K., Singh, S.J. (2002). Weed management in timely and late sown chickpea (*Cicer arietinum* L.). Environmental Ecology. 20:443–449.

25. Singh, K., Ram, H., Kumar, R., Meena, R.K., Kumar, R. and Manisha (2022). Effect of Weed Management Practices on Weed Dynamics, Nutrient Depletion, Productivity and Profitability of Summer Mungbean (*Vigna radiata*) under Zero Tillage Condition. Legume Research- An International Journal. Volume 45 Issue 6: 762-768.

26. Singh, M.K., Kumar, P. and Prasad, S.K. (2014). Agri-horticultural system and weed management practices effect on growth and yield of mungbean. An International Quarterly Journal of Life Science. 9(4): 1449-14

27. Statistical abstract of Himachal Pradesh 2021-2022, Department of Economics and Statistics, Government of Himachal Pradesh, Shimla.30-40.

28. Tewari, A.N., Rathi, J.P.S., Tiwari, S.N. and Tripati, A.K. (2004). Efficacy of imazethapyr- a selective herbicide in green gram with special reference to Parthenium hysterophorus control. Farm Science Journal. 13(2): 114-115.

29. Verma, S.K., Singh, S.B., Rai, O.P. and Singh, G. (2008). Effect of mulching and irrigation on weeds and yield of summer greengram in saline soil. Indian Journal of Agricultural Science. 78: 1082-85.

30. Yadav, R.S, Singh S.P, Sharma, V and Bairwa, R.C. (2014). Herbicidal weed control in green gram in Arid zone of Rajasthan. In: Emerging challenges in weed management, Proceedings of Biennial conference of Indian society of weed science. Directorate of Weed Research, Jabalpur. 97.