Original Research Article

Effect ofDifferent Weed Management Practices on Growth Characters of Mungbean under Mid-hills of Himachal Pradesh

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 characters 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, 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.

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

1. INTRODUCTION

Pulses are important food crops for human consumption and animal feed. Being leguminous in nature, they are considered to be important components of cropping systems because of their viability to fix atmospheric nitrogen, add substantial amounts of organic matter to the soil and produce reasonable yields with low inputs under harsh climatic and soil conditions. (Meena Dudi, 2018). India is the largest producer and consumer of pulse in the world, accounting for 25 % of global production and 15% consumption.

Weeds are a major factor in the yield reduction of crops as they cause more economic losses than insects, fungi, and other pests. However, there is a significant difference in economic losses by weeds between various crops, locations, and soil types. The management or control of weed infestation in pulses crop has the potential to increase their yields and N fixation yields [2]. In India, mungbean (*Vigna radiata* L. *Wilczek*) is the third most valuable pulse crop, followed by chickpea, pigeonpea, In Himachal Pradesh, area and production of pulses is 30,760 hectares and 50,570 Mt (Statistical abstract of H.P. 2021-22). The major weeds of mungbeancrop observed in Himachal Pradesh are*Echinochloacolona*, *Echinochloacrussgalli*, *Digitariasanguinalis*, *Ageratum conyzoides*, *Ageratum houstonianum*, *Galinsoga parviflora*, *Commelinasp*, *Amaranthus viridis* L. and *Conyza stricta*.

Mungbean (*Vigna radiata* L. *Wilczek*) is an important grain legume containing a high amount of digestible protein, amino acids, sugar, minerals, soluble dietary fibers, and vitamins. In Kenya, green gram production is done mainly by smallholder farmers for food and sale. The crop is mainly grown in arid and semi-arid regions and plays important role towards achieving improved human nutrition and health conditions, reducing poverty through food security and enhancing ecosystem resilience as a source of human food, animal feed, soil nitrogen and soil health. Statistics show that though average area under production has been growing since 1978, average production has been fluctuating and consumption increasing steadily upholding constant deficit which is catered for through imports. (Muchomba*et al.*, 2023).

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Mungbean contributes 14% in the total pulses area and 7% in total pulses production of India. India is its primary origin, mainly cultivated in East Asia, Southeast Asia and the Indian subcontinent. It is the third most important pulse crop of India grown in nearly 16 percent of the total pulse area of the

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country. India alone accounts for 65% of the world acreage and 54% of the world's production. It is the third most important pulse crop of India in terms of area cultivated (3.55 mha) and production (1.82 mt) next to chickpea and pigeon pea, (IIPR, 2010). In India, moong beans are an important crop and are widely cultivated in different states. According to the IIPR, the area under mungbean cultivation in India was around 5.13 million hectares in 2020-21, with a total production and yield of approximately 3.9 million tonnes and 601 kg ha^{-1}. Mungbean being resistant to drought conditions, low soil fertility conditions as well as shady conditions, results in production of very nutritious and healthy seeds rich in amino acids and proteins (Jiang *et al.*, 2012). Mungbean pods and sprouts are usually consumed as a vegetable and are rich source of vitamins as well as minerals. These are major source of protein for vegetarians as non-vegetarians can fulfill their protein requirement from animals. Mungbean crop is a short duration crop and being a leguminous crop, it fixes the atmospheric nitrogen. It is used as a mixed crop or an intercrop or as a rotational crop in order to improve the nitrogen status of the soil and break the disease cycle or pest cycle (Ranawake*et al.,* 2011). However, mungbean production is seriously constrained with weeds, which account for 30-50 per cent of yield loss (Sekhon *et al.,* 2004). It was observed that species combinations and importance of weed communities differwith agroforestry system because; some studies have documented inhibitory allelopathic effects of trees on weed germination and growth (Kaur *et al.,* 2011).

Weeding and hoeing are common cultural and manual weed management methods for greengram. Manual weeding at right stage is difficult, time consuming and expensive due to intermittent rainfall during rainy season and scanty labour, therefore, farmers rarely adopt manual weeding for weed control. Under such situation, herbicides use with suitable dose remains the pertinent choice for controlling the weeds. Herbicides in isolation, however, are unable do complete weed control because of their selective kill. Their use can be made more effective, if supplemented with hand weeding or hoeing etc. A judicious combination of chemical and cultural methods of weed control would not only reduce the expenditure on herbicides but would benefit the crop by providing proper aeration and conservation of moisture (Prakash *et al.*, 1991).

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Weeds cause 45–80% reduction in grain yield of mungbean (Khairnar *et al.,* 2014; Singh *et al.,* 2014; Kaur *et al.,* 2016). Weeds can be effectively controlled by hand weeding (Singh *et al.*, 2002, 2010), however human labour is very costly and, therefore, increases the cost of production of crop (Sharma *et al.*, 2016). Therefore, use of herbicides is a more economical approach for weed control (Balyan *et al.,* 2016; Singh and Singh 2017). However, some herbicides may have some adverse effects on growth, yield and nutrient uptake of crop and its symbiosis with Rhizobium. Therefore, it has become more important to investigate the effects of herbicides on Rhizobium-legume symbiosis and crop growth and yield. Herbicides may directly affect the Rhizobium survival and nodule formation or indirectly through their effect on host plants. Herbicides may affect rhizobia (Singh and Wright 2002b), nodulation (Singh and Wright 2002a) and nitrogenase activity (Singh and Wright 1999; Fan *et al.*, 2017). Effect of herbicides on crop growth and yield attributes is important to measure while making their recommendation to any crop. However, in pulses, it is useful to know the effect of herbicides on symbiotic parameters also such as nodule number, nodule dry weight and leghaemoglobin content in nodules, which is measure of nitrogen fixing ability of the plant. These parameters have significant influence on crop growth. High selectivity of herbicide to crop is necessary for recommendation of product 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, 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 tenweed 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 16^{th} 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 DISCUSSIONS

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. 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 highest plant height might be due to the better weed management and minimizing the competition of weeds with main crop for resources *viz.*, light, nutrients and moisture with those effective weed control treatments. Thus, reduced crop-weed competition resulted into overall improvement of crop growth as measured by plant height, which led to better reproductive structure and translocation of photosynthates to the sink. The results corroborated with the findings of Yadav *et al.* (2014).

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3.2Number 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 brancheswas 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. This might be due to less competition among the plants for resources like moisture and nutrients was due to less population and dry biomass of weeds which might have led to an increased availability of resources, resulting in highest growth of mungbean under dust mulching (Verma *et al*., 2008 and Mirjha*et al*., 2013). Verma *et al*. (2008) and Singh *et al*. (2014) also reported higher nodulation under effective weed management practices in mungbean. Weeding facilitates plants to have more resources for growth and development. This may be attributed to less competition for crop to light, nutrients and free space in weed free environment (Komal *et al*., 2015). These results are in agreement with the findings of Singh *et al.*2019, Singh *et al.* 2017, Hasanain*et al.* (2019).

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 brancheswas 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 were recorded under weedy check treatment. According to Tewari *et al.* (2004), the highest dry matter accumulation might be due to the better weed management and minimizing the competition of weeds with main crop for resources *viz*., light, nutrients and moisture with those effective weed control treatments. Thus, reduced crop-weed competition resulted into overall improvement of crop growth as measured dry matter accumulation, which led to better reproductive structure and translocation of photosynthates to the sink. The results corroborated with the findings of Yadav *et al.* (2014).

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3.4 Number of trifoliate leaves plant^{-1}

Data on the number of trifoliate leaves at 30, 60 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 might be due to less competition among the plants for resources like moisture and nutrients was due to less population and dry biomass of weeds which might have led to an increased availability of resources, resulting in highest growth of mungbean under dust mulching (Verma *et al*., 2008 and Mirjha*et al*., 2013). Verma *et al*. (2008) and Singh *et al*. (2014) also reported higher nodulation under effective weed management practices in mungbean. Weeding facilitates plants to have more resources for growth and development. This may be attributed to less competition for crop to light, nutrients and free space in weed free environment (Komal *et al*., 2015). These results are in agreement with the findings of Singh *et al.*(2017);Hasanain*et al.* (2019).

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}

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

	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

CONCLUSIONS

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).

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. 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.

3. Hasanain, M., Shukla, D.K., Singh, R.K., Gouda, H.M., Sadhukhan, R., Singh, V.K. and Kumar, J. 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. 2019; 64 (3): 418-4
4. Hasanain, M., Shukla, D.K., Singh, R.K., Gouda, H.M., Sadhukhan, R., Singh, V.K. and Kumar, J. 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. 2019; 64 (3):
5. IIPR. All India Coordinated Research Project on Mungbean, Urdbean, Lentil, Lathyrus, Rajmash and Pea, ICAR.2010.
6. 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.
7. 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
8. 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. J Pl. Interac. 6:297–302.
9. Khairnar, C.B., Goud, V.V. and Sethi, H.N. 2014. Pre- and post-emergence herbicides for weed management in mungbean. Indian J Weed Sci. 46:392–395.
10. Komal, S., Singh, P. and Yadav, R. S. (2015). Effect of weed management on growth, yield and nutrient uptake of greengram. Indian Journal Weed Science 47: 2
11. Mirjha, P.R., Prasad, S.K., Singh, M.K., Paikra, R.H., Patel, S. and Majumdar, M. Effect of weed control measures on weeds, nodulation, growth and yield of mungbean (Vigna radiata). Indian Journal of Agronomy. 2013; 58 (4): 615-617.
12. Muchomba, M.K., Muindi, E.M. and Mulinge, J.M. 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.2023; 24(2) 1-11.
13. Prakash V, Prasad K and Singh P. 1991. Chemical weed control in soybean. Indian Journal of Weed Science. 1991; 23(1&2): 29- 31.
14. Ranawake, A.L., Dahanayaka, N., Amarasingha, U.G.S, Rodrigo, W.D.R.G., Rodrigo, U.T.D. Effect of water stress on growth and yield of mung bean (Vigna radiate L). Tropical Agricultural Research and Extension. 2011; 14(4).

15. 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.
16. 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.2016; 48:90–92.
17. Singh G, 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.
18. Singh G, Wright D. Effects of herbicides on nodulation and growth of two varieties of peas (*Pisum sativum*). Acta Agron Hung.2002a; 50:337–348.
19. Singh G, Wright D. In vitro studies on the effects of herbicides on the growth of rhizobia. Letters Appl Microbiology.2002b. 35:12-16.
20. Singh R, Singh G. Economic analysis of application of weed management practices in kharif and summer mungbean [*Vigna radiata* (L.) *Wilczek*]. International Journal of Current Microbiology Applied Science. 2017; 6:3182–3190.
21. Singh, G., Aggarwal, N. and Ram, H. Effect of row spacing and weed management practices on weeds, growth and yield of pigeonpea [*Cajanus cajan* (L.) Millsp.]. Indian Journal of Agricultural Science.2010; 42:241–243
22. Singh, G., Aggarwal, N. and Ram, H. Efficacy of post-emergence herbicide imazethapyr for weed management in different mungbean (*Vigna radiata*) cultivars. Indian Journal of Agricultural Science.2014; 84:540–543.
23. Singh, G., Sekhon, H.S., Gumber, R.K., Singh, S.J. Weed management in timely and late sown chickpea (*Cicer arietinum* L.). Environmental Ecology. 2002; 20:443–449.
24. Singh, M.K., Kumar, P. and Prasad, S.K. Agri-horticultural system and weed management practices effect on growth and yield of mungbean. An International Quarterly Journal of Life Science. 2014; 9(4): 1449-14
25. Singh, R. and Singh G. Economic Analysis of Application of Weed Management Practices in kharif and Summer Mungbean [*Vigna radiata* (L.) *Wilczek*]. International Journal of Current Microbiology and Applied Sciences .2017; 6(12): 3182-31.
26. Statistical abstract of Himachal Pradesh 2021-2022, Department of Economics and Statistics, Government of Himachal Pradesh, Shimla.30-40.

27. Tewari, A.N., Rathi, J.P.S., Tiwari, S.N. and Tripati, A.K. Efficacy of imazethapyr- a selective herbicide in green gram with special reference to Parthenium hysterophorus control. Farm Science Journal. 2004; 13 (2): 114-115.
28. Verma, S.K., Singh, S.B., Rai, O.P. and Singh, G. Effect of mulching and irrigation on weeds and yield of summer greengram in saline soil. Indian Journal of Agricultural Science.2008; 78: 1082-85.
29. Yadav, R.S, Singh S.P, Sharma, V and Bairwa, R.C. 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. 2014;97.