Original Research Article

Effect of weed management practices on nutrient content and their uptake by black gram crop (*Vigna mungo* L.)

ABSTRACT

Aim: To study the effect of weed management practices on nutrient content and uptake by black gram.

Study design: Randomized block design.

Place and Duration of Study: One yearfield experiment atResearch Farm, School of Agriculture, Abhilashi University, Chail Chowk, Mandi, (H.P.).

Methodology: The experiment was conducted with three replications and seven treatments *viz.*- T_1=Weedy check, T_2=Weed free, T_3=Hand weeding (20 & 40 DAS), T_4=Imazethapyr @ 70 g ha^{-1} (PE) + Hand weeding (30 DAS), T_5=Metolachlor @ 1.0 kg a.i. ha^{-1} (PE) + Hand weeding (30 DAS), T_6=Pendimethalin + Imazethapyr 900 g a.i. ha^{-1} (3-4 leaf stage), T_7= Imazethapyr + Imazamox @ 70 g a.i. ha^{-1} (PoE).

Results: The study of data revealed non-significant impact of weed management practices on nitrogen, phosphorousand potassium in grains and straw of black gram crop, whereas, the maximum content of all these nutrients were found under treatment T_2. However, the application of treatment T_2 also recorded the significantly maximum uptake of nitrogen, phosphorous and potassium by grains, straw and total uptake by black gram crop, which was statistically at par with treatment $T_{3.}$ The minimum content ofnitrogen, phosphorousand potassium in grains, strawandalong with their uptake by grains, straw and total uptake by black gram crop were found under treatment T_1 = Weedy check during the field experiment.

Conclusion: This study showed non-significant effect ofweed management practices on the nutrient content in grains and straw of black gram, while, it has significantly affected the nutrient uptake by grains, straw and total uptake by black gram crop.

Keywords: *Black gram, Pendimethalin,Metolachlor, Imazethapyr,Imazamox, nutrient content and uptake.*

1. INTRODUCTION

Black gram (*Vigna mung*o L.) is a pulse crop belonging to family Leguminosae which is originated in India. It is also known as urdbean, mash, kalai etc. It is grown in India, Pakistan, Srilanka, Burma and some other countries of south-east Asia, Africa and America.

Black gram is one of the major pulse crops cultivated in India. Being a crop with a short growing season, it fits very well with the cropping system since it clears the field quickly, allowing numerous winter crops- like mustard, lentils, and others-to be cultivated in areas with minimal rainfall.In India, produces approximately 2.7 million tonnes from an approximately 4.4 m ha^{-1} area with an average yield of 598 $kgha^{-1}$**(Directorate of Economics and Statistics, 2021) [1].**It is mostly grown in southern and eastern states of India. In India black gram predominantly grown in Andhra Pradesh, Tamil Nadu, Karnataka, Maharashtra, Rajasthan, Gujarat, Madhya Pradesh, Punjab, Orisa, Bihar, Uttar Pradesh and West Bengal**(Nair et al., 2023) [2].** India is the biggest producer and user of black grams worldwide. With an average output of 501 kg per hectare in 2020–21, it produces roughly 23.4 lakh tons of black gram yearly from 46.7 lakh hectares of area (agricoop.in). Andhra Pradesh produced 3.65 lakh tons of black gram on 3.93 lakh ha^{-1} of land (des.ap.gov.in). The second advance estimate for 2021-2022 states that black gram was cultivated on 3.93 lakh ha^{-1}, producing 3.65 lakh tons and 929 kg ha^{-1} of productivity***(2-BLACKGRA_January to December 2021, n.d.).*****[3]**

The production of the black gram crop is reduced by infestation of the weeds, because weeds restrict the availability of many resources, such as light, space, water andnutrients, at every stage of the crop **(Buriro et al., 2003) [4]**. Because herbicides are scarce and expensive to use, their use has become essential. Both the applied and native nutrients are heavily depleted by weeds. The issue will only get worse in the future when there is moisture stress since weeds' dense foliage covers the majority of the soil moisture that is accessible at the root zone depth. The production of the crops is reduced by 30 to 50% as a result of the weeds' intense competition with it for nutrients, moisture, light, and space **(Nadeem et al., 2022) [5]**and**(Javaid et al., 2022) [6].** Black gram grain yield was decreased by up to 42%, according to **(Malliswari et al., 2008) [7]**at Tirupati, Andhra Pradesh, when weeds persisted throughout the crop's growth season. On the other hand, **(Begum and Rao., 2006) [8]** reported that unchecked weed growth in Bapatla in Karnataka resulted in a 51% loss in the grain yield of uncultivated beans. To fully use the production potential of urdbean, research must be done to determine the key period of crop-weed competition and to develop an adequate weed management program. Among the various obstacles to increased productivity and black gram output, weeds are a major issue during the *kharif* season, contributing to losses of up to 50–60%**(Das et al., 2014) [9].** The most frequent weeds that reduce black gram grain yield include *Acalyphaindica, Cynodondactylon, Commelinabengalensis, Cyprus rotandus,* and *Partheneumhystorophorus*.One of the main causes of the poor yield of black gram crop during the rainy *(Kharif)* season is a severe weed infestation. Rainy season weather is typically hot and muggy, making grassy weeds like *Echinochloacolona,Cyperusrotundus,Cynodondactylon,* and *Saccharumspontaneum*, as well as broad-leaved weeds like *Digeriaarvensis,Commelinabenghalensis,* and *Abelmoschusmoschatus,* pose a significant threat to crop plants throughout their growth cycle. According to **(Singh.,2011) [10], (Singh et al., 2018) [11]** uncontrolled weeds can reduce grain yield in (*Kharif)* black gram by as much as 41.6%. Therefore, it becomes essential to control the weeds as early as possible.

Managing weeds is a crucial part of protecting plants and enhancing agricultural productivity.It involves controlling the weeds so that the crop maintains its capacity for production without suffering damage from the weeds.Weed management is done through the mechanical, cultural and chemical methods. Use of biological control methods in field crops is being considered, but still not much in use**(Nadeem et al., 2022)[5]** and**(Maqbool et al., 2023) [12]**. Weeds have serious impact on agricultural production. It is estimation that in general weeds cause 5% loss in agricultural production in most of developed countries, 10% loss in less developed countries and 25% loss in least developed countries**(Weed-Management system,2018) [13].**Management of weeds is one of the most crucial factors for achieving higher productivity. In order to gain good economical yield of black gram, weeds must be kept under check. Manual weeding is one of the effective methods to control weeds during the critical period. But timely weed management has become difficult due to unavailability of labour and escalating wages during peak period. Hence, herbicides are considered as alternative and effective weed control measure to implement in larger area then hand weeding. Chemical weed control (Herbicide) is quick, more effective. Herbicides are substances that inhibit or completely eradicate weed growth in order to control weed development. Herbicides plays a significant and essential role in weed control strategies that produce large yields **(Baghestani et al., 2005)[14].**

However, weed control challenges have been becoming even more problematic as the number of herbicide-resistant weeds are continues to grow during the crop growing season in pulse crops **(Khan et al., 2023a, b, c) [15] [16] [17]**. Weeds directly responsible to reduce the productivity and deteriorate grain quality in crops**(Khan et al., 2022 a, b)[18] [19]**. Even in 21st century, hand weeding and mechanical weeding are becoming the most effective method to control the weeds, however, high labour wages and non-availability of labour during the peak periods of agricultural operations, timely weeding becomes difficult to attain. Some weeds developing resistance to key pulse herbicides such as imazethapyr and imazamox, the challenges will become even more difficult in the future. The degree of competition offered by these weeds in urd bean is quite intensive at the early vegetative stages (25-30 DAS) which is considered a critical period of the crop-weed competition. The black-gram crop fails to compete with associated weeds in the early stages **(Choudhary et al., 2012**) **[20]**due to its short height and a prolonged lag phase of growth. Therefore, weed-control measures have become crucial for ensuring healthy crop growth, especially during the early stages of growth.

Chemical weed management in pulse crops has been found effective and economical. Pre-emergence herbicides such as imazethapyr and metolachlor has been found effective in early stage of weeds but, second flesh of weeds were controlled by post-emergence herbicide, such as Imazethapyr, Imazamox and Pendimethalin which may not be possible in manual or mechanical weeding due to its high cost of cultivation **(Mohanty et al., 2020) [21].**The application of pre-emergence of imazethapyr in mixture with the post-emergence application of pendimethalin provided the best control of weeds and result in higher grain yield and also minimizing weed density or dry matter **(Danga et al., 2020)[22].**

Compared to the herbicides available for use in cereal crops, the options for controlling broad-leaved weeds in pulse crops with selective herbicides are often limited. In order to effectively control weeds during the crop growth period of urd beans (a short-duration legume) and ultimately increase crop productivity, preand post-emergent herbicides are taken into account in the planning and execution in the current investigation.With the following goals in mind, the current study on weed management has been planned to maximize the chances of using herbicides that are specifically targeted to urd beans in the rotation to minimize the weed problems **(Kumar et al. 2022) [23].**

2. MATERIAL AND METHODS

Description of study area

The experiment entitled was carried out at Research farm of the School of Agriculture, Abhilashi University, Chail Chowk, Mandi (H.P) during the *kharif* season of 2023. The experimental farm is situated at 30^0 32' N latitude and 74^0 53'E longitude, with an elevation of 1391 m above mean sea level. The pH of the experimental field was slightly acidic in reaction (5.43) with electrical conductivity of 0.005dS m^{-1}, high in organic carbon (0.87%), medium in nitrogen (248.77 kg ha^{-1}), medium in phosphorus (22.95 kg ha^{-1}) and medium in potassium (271.44 kg ha^{-1}).

Treatment detail

The experiment was laid out in a randomized block design (RBD) with seven treatments and three replications. The treatments used in the experiment were- T_1= Weedy check, T_2 = Weed free, T_3 = Hand weeding (20 & 40 DAS), T_4 = Imazethapyr @ 70 g ha^{-1} (PE) + Hand weeding (30 DAS), T_5 = Metolachlor @ 1.0 kg a.i. ha^{-1} (PE) + Hand weeding (30 DAS), T_6 = Pendimethalin + Imazethapyr 900 g a.i. ha^{-1} (3-4 leaf stage), T_7 = Imazethapyr + Imazamox @ 70 g a.i. ha^{-1} (PoE).

Agronomic practices

The recommended doses of nitrogen, phosphorous and potassiumwas 25:50:25 kg ha^{-1} which was applied through Urea, DAP and MOP. The various herbicidal application was given according to the treatments. The application of herbicides was done with the knapsack power sprayer using 500 L ha^{-1} of water or sufficient moisture was maintained in the soil at the time of herbicide application. Hand weeding wasdone by removing the weeds manually with the help of khurpi. In case of weedy check treatments, weeds were allowed to grow freely in that plots and in weed free plots weeds were always removedfrom plot.After the harvest of the crop, the samples of the crop plant were collected from every plot and were cleaned and dried under the shade. After the drying of the samples under shade, the samples were oven-dried at 60 ± 2°C for 24 to 48 hours until their weight was constant and then samples were finely powdered with a mixer grinder. After the grinding process, the samples were used for the analysis of nitrogen, phosphorous and potassium content in grains and straw of black gram crop. The Kjeldahl digestion and distillation method was used to determine the nitrogen content described by **Jackson, 1973 [24]**. The venadomolybdate phosphoric yellow color method was used for determining the phosphorus content given by **Jackson, 1973 [24]**. The flame photometer method was used for determining the potassium content given by **Jackson, 1973 [24]**. The nitrogen, phosphorous and potassium (kg ha^{-1}) uptake by grains and straw of black gram crop in each treatment was calculated by multiplying the nitrogen, phosphorous and potassium content (%) with yields of grains and straw (q ha^{-1}). The total uptake of different nutrients was calculated after summing their uptake by grain and straw of black gram crop.

3. RESULTS AND DISCUSSION

3.1 Nitrogen content (%) and uptake (kg ha^{-1})

The perusal of data on nitrogen content and their uptake by grains and straw as well as their total uptake by black gram crop are presented in Table-1 and shown in Fig.-1. The data revealed that significant difference was not observed in the content of nitrogen in grains and straw of black gram due to different treatments of weed management practices. However, highest nitrogen content in grains (3.48%) and straw (1.19%) of black gram were recorded under treatment T_2 (Weed free), whereas lowest nitrogen content in grains (2.87%) and straw (1.02%) were found under weedy check.

The maximum uptake of nitrogen by grains, straw as well as total uptake of nitrogen were significantly influence by different treatments of weed management practices in black gram crop.The maximum nitrogen uptake by grains (50.65 kg ha^{-1}) and straw (33.61 hg ha^{-1}) as well as total uptake of nitrogen (84.26 kg ha^{-1}) by black gram crop was found in treatment T_2 (Weed free) which was statistically at par with treatment T_3[Hand weeding (20 & 40 DAS)] (41.44 kg ha^{-1}) and T_5 [Metolachlor @ 1.0 kg a.i. ha^{-1} (PE) + Hand weeding (30 DAS)] (35.91 kg ha^{-1}), while, the minimum nitrogen uptake by grains (13.58 kg ha^{-1}), straw (9.98kg ha^{-1}) and total uptake of nitrogen (23.55 kg ha^{-1}) by black gram crop were observed under weedy check during the field experiment.

The treatment weed freerecorded highest weed control over all the treatments. Among chemical weed control methods application of Metolachlor (pre-emergence) and Hand weeding (30 DAS) recorded highest weed control which was closely followed by Imazethapyr (pre-emergence) and Hand weeding (30 DAS). Applying of these treatments in black gram crop noted the maximum nitrogen content and uptake by the crop, which has been showed to have a longer-lasting effect on weed population control. This reduces crop-weed competition for light, space and nutrients and rase high grain yield and dry matter accumulation and greater availability of nitrogen which ultimately resulted in increase in nitrogen content and uptake. Similar results were reported by **(Mansoori et al., 2015) [25], (Halvankar et al., 2005) [26]** and**(Aggrawal et al., 2014) [27].**

Table1. Impact of weed management practices on nitrogen content (%) and their uptake (kg ha^{-1}) by black gram crop

S.N.	Treatments	Nitrogen content (%)		Nitrogen uptake (kg ha^{-1})		
		Grain	Straw	Grain	Straw	Total
T_1	Weedy check	2.87	1.02	13.58	9.98	23.55
T_2	Weed free	3.48	1.19	50.65	33.61	84.26
T_3	Hand Weeding (20 & 40 DAS)	3.35	1.16	41.44	31.10	72.54

T_4	Imazethapyr @ 70 g ha^{-1} (PE) + Hand weeding (30 DAS)	3.09	1.09	33.80	24.93	58.73
T_5	Metolachlor @ 1.0 kg a.i. ha^{-1} (PE) + Hand weeding (30 DAS)	3.12	1.12	35.91	26.90	62.81
T_6	Pendimethalin + Imazethapyr 900 g a.i. ha^{-1} (3-4 leaf stage)	3.02	1.07	30.40	23.52	53.92
T_7	Imazethapyr + Imazamox @ 70 g a.i. ha^{-1} (PoE)	2.96	1.03	28.65	20.93	49.58
	SEm±	0.10	0.06	0.55	0.47	0.54
	CD (*P* = .05)	NS	NS	1.73	1.47	1.69

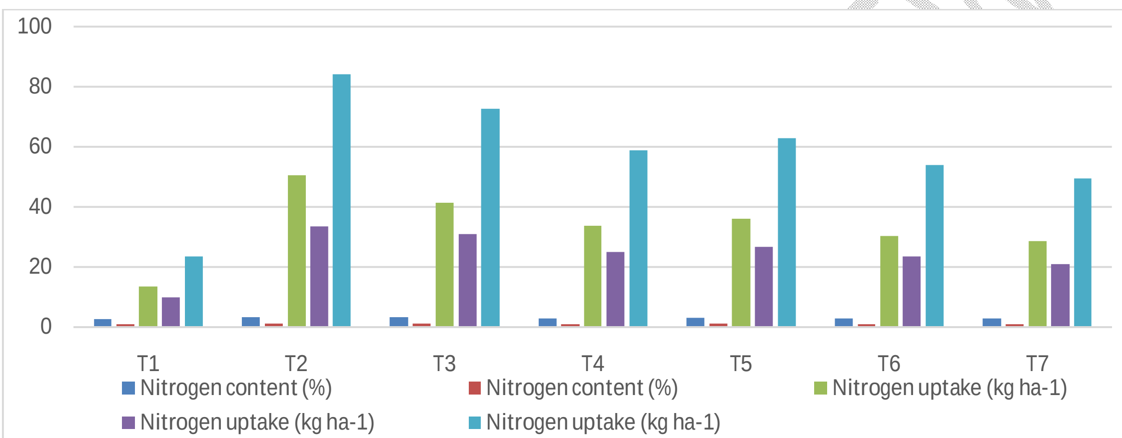

Fig. 1. Impact of weed management practices on nitrogen content (%) and their uptake (kg ha^{-1}) by black gram crop

3.2 Phosphorus (P) content (%) and uptake (kg ha^{-1})

The data presented in Table -2 and depicted in Fig.-2 illustrated the findings of phosphorous content, uptake and their total uptake by black gram crop. The results revealed that the content of phosphorous in grain and straw of black gram were did not influenced significantly by the application of different weed management practices. However, the maximum phosphorus content in grain (0.44%) and straw (0.25%) was observed under the treatment T_2 (Weed free), whereas, lowest phosphorus content in grain (0.32%) and straw (0.13%) were noted in weedy check.

However, different treatments of weed management practices had significant impact on the uptake as well as the total uptake of phosphorous by grain and straw. The result shows that the highest phosphorous uptake by grain (5.80 kg ha^{-1}) and straw (7.06 kg ha^{-1}) as well as total uptake of phosphorous (12.86 kg ha^{-1}) was observed in the treatment T_2 (Weed free) as compare to the rest of the treatments,however, it was at par with treatment T_3[Hand weeding (20 & 40 DAS)] (5.20 kg ha^{-1} and 6.43 kg ha^{-1}) and T_5 [Metolachlor @ 1.0 kg a.i. ha^{-1} (PE) + Hand weeding (30 DAS)] (4.49 kg ha^{-1}and 5.04 kg ha^{-1}). The minimum phosphorus uptake by grains (1.51 kg ha^{-1}),straw (1.27 kg ha^{-1}) and total uptake of phosphorous (2.79kg ha^{-1}) were observed underweedy checkduring the field experiment.

Table2. Impact of weed management practices on phosphorous content (%) and their uptake (kg ha^{-1}) by black gram crop.

S.N.	Treatments	Phosphorous content (%)		Phosphorous uptake (kg ha^{-1})		
		Grain	Straw	Grain	Straw	Total
T_1	Weedy check	0.32	0.13	1.51	1.27	2.79
T_2	Weed free	0.44	0.25	5.80	7.06	12.86
T_3	Hand Weeding (20 & 40 DAS)	0.42	0.24	5.20	6.43	11.63
T_4	Imazethapyr @70g ha^{-1} (PE) + Hand weeding (30 DAS)	0.38	0.19	4.16	4.35	8.50
T_5	Metolachlor @ 1.0 kg a.i. ha^{-1} (PE) + Hand weeding (30 DAS)	0.39	0.21	4.49	5.04	9.53
T_6	Pendimethalin + Imazethapyr 900g a.i. ha^{-1} (3-4 leaf stage)	0.36	0.18	3.62	3.96	7.58
T_7	Imazethapyr + Imazamox @70g a.i. ha^{-1} (PoE)	0.35	0.15	3.39	3.05	6.44
	SE(m)±	0.02	0.02	0.06	0.06	0.13
	CD (*P*= .05)	NS	NS	0.19	0.21	0.42

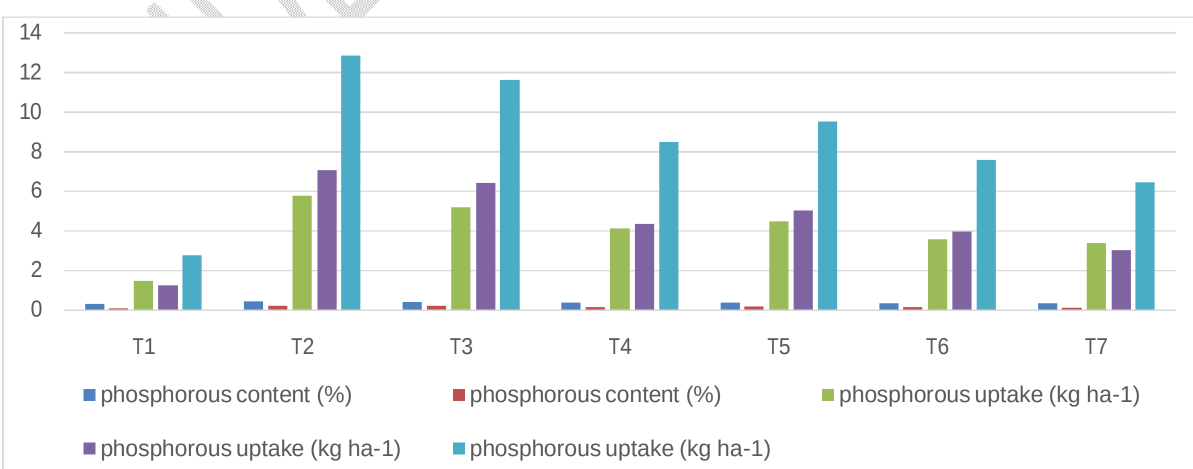

Fig. 2. Impact of weed management practices on phosphorous content (%) and their uptake (kg ha^{-1}) by black gram crop

Weed free treatment recorded maximum phosphorous content and their uptake of black gram crop and this treatment was closely followed by some herbicides like- Metolachlor (pre-emergence), Imazethapyr (pre-emergence),Pendimethalin, Imazethapyr (PoE) and twice hand weeding at various stages of black gram crop. This might due to the combination of herbicide with hand weeding has showed the longer effect on controlling weed populations resulting in low crop- weed competition of plant and weed for nutrients, but the direct effect of phosphorous nutrition and indirect effect of phosphorous on nodulation and nitrogen fixation thereby more N and P uptake by crop. Similar results were also reported by (**Karche et al., 2012) [28],(Malliswari et al., 2008) [29]** and**(Verma et al., 2017) [30].**

3.3Potassium (K) content (%) and uptake (kg ha^{-1})

The data related to potassium content and uptake along with total uptake of potassium by grains and straw of the black gram crop is indicated in Table -3 and illustrated in Fig.-3. The study of data revealed that there was not found any significant variation in the potassium content of black gram by grains and straw. The highest potassium content in grains (1.27 %) and straw (2.41 %) were recorded in the treatment T_2 (Weed free) plot, whereas, lowest content in grain (1.05 %) and straw (2.04 %) were noted under weedy check.

The uptake of potassium by grains, straw and total uptake of black gram crop was significantly affected by different treatments of weed management practices. The highest potassium uptake by grain (16.75 kg ha^{-1}) and straw (68.06 kg ha^{-1}) as well as total uptake of potassium (84.81 kg ha^{-1}) was noted under the treatment T_2 (Weed free) which was statistically at par with treatment T_3 [Hand weeding (20 & 40 DAS)] (15.09 kg ha^{-1} and 62.20 kg ha^{-1}) and T_5 [Metolachlor @ 1.0 kg a.i. ha^{-1} (PE) + Hand weeding (30 DAS)] (13.24 kg ha^{-1} and 15.61 kg ha^{-1}), whereas the minimum potassium uptake by grains (4.97 kg ha^{-1}) and straw (19.95 kg ha^{-1}) or total (24.92 kg ha^{-1}) were observed under weedy check during the field experiment.

The removal of weeds at regular interval by hand weeding and using of several herbicides, such as metolachlor, Pendimethalin, imazamox accounted for less count of weed population in treatment weed free.In general, pre-emergence application of herbicide was better than the post- emergence application for controlling weed count. It may be due to less competition of plant and weed for nutrients, but in treatment weedy check the rate of nutrients content and uptake of potassium by plants was very slow. This is due to weed suppress the vegetative growth of plants by competition to light, nutrients and moisture. Similar results were also reported by **(Nautiyal et al.,2021)[31]** and**(DeepikaPainkraet al., 2020)[32].**

Table 3. Impact of weed management practices on potassium content (%) and their uptake (kg ha^{-1}) by black gram crop

S.N.	Treatments	Potassium content (%)		Potassium uptake(kg ha^{-1})		
		Grain	Straw	Grain	Straw	Total

T_1	Weedy check	1.05	2.04	4.97	19.95	24.92
T_2	Weed free	1.27	2.41	16.75	68.06	84.81
T_3	Hand Weeding (20 & 40 DAS)	1.22	2.32	15.09	62.20	77.29
T_4	Imazethapyr @ 70 g ha^{-1} (PE) + Hand weeding (30 DAS)	1.14	2.01	12.47	45.97	58.44
T_5	Metolachlor @ 1.0 kg a.i. ha^{-1} (PE) + Hand weeding (30 DAS)	1.15	2.15	13.24	51.64	64.88
T_6	Pendimethalin + Imazethapyr 900 g a.i. ha^{-1} (3-4 leaf stage)	1.09	2.09	10.97	45.94	56.91
T_7	Imazethapyr + Imazamox @ 70 g a.i. ha^{-1} (PoE)	1.07	2.06	10.36	41.86	52.22
	SEm±	0.05	0.23	0.19	0.83	1.01
	CD (*P*= .05)	NS	NS	0.61	2.58	3.15

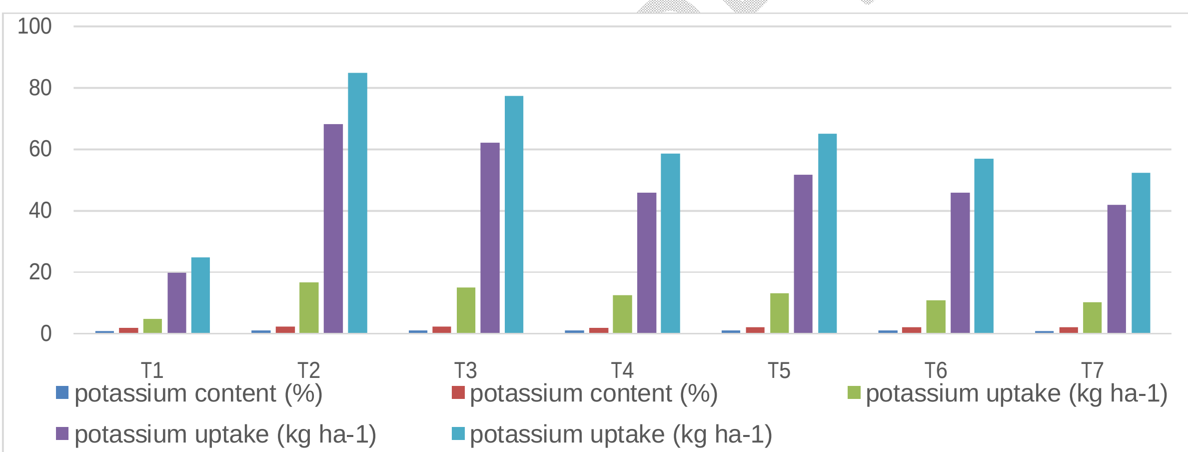

Fig. 3. Impact of weed management practices on potassium content (%) and their uptake (kg ha^{-1}) by black gram crop

4. CONCLUSION

In conclusion, application of different weed management practice failed to show significant effects on the nutrient content *i.e*. nitrogen, phosphorousand potassiumin grains and straw of black gram crop. However, the maximum nitrogen, phosphorousand potassium content in grains and straw were recorded under treatment T_2 (Weed free) and minimum under weedy check. Whereas, the various weed management practices have significant effect on the uptake of nitrogen, phosphorousand potassiumby black gram crop during the field study. The highest uptake of nitrogen, phosphorousand potassium by grains, straw as well as total uptakeby black gram crop was found underthe treatment T_2 (Weed free), which was statistically at par with treatments T_3 [Hand weeding (20 & 40 DAS)]. While, the minimum uptake of nitrogen, phosphorousand potassium was observed under weedy check during the field study.

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REFERENCES

1. Directorate of Economics and Statistics. "Ministry of agriculture and farmers welfare department of agriculture, cooperation and farmers welfare," in Third Advance Estimates of Production of Food grains for 2020-21 (Government of India)2021.
2. Nair RM, Chaudhari S, Devi N, Shivanna A, Gowda A, Boddepalli VN, Pradhan H, Schafleitner R, Jegadeesan S, Somta P. Genetics, genomics, and breeding of black gram [*Vigna mungo* (L.) Hepper]. Front Plant Sci. 2024 Jan15;14:1273363. doi: 10.3389/fpls.2023.1273363. PMID: 38288416; PMCID: PMC10822891.
3. https://angrau.ac.in/downloads/AMIC/OutlookReports/2021/2-BLACKGRA_January%20to%20December%202021.pdf
4. Buriro UA, Oad FC, Agha SK, Solangi GS. Post emergence weed control in wheat. Journal of Applied Sciences. 2003;3:424-427.
5. Nadeem MA., Khan BA, Chadar AR, Maqbool R, Raza A, Javaid MM,Irfan M. Weed control and sustainable rice production through rice intensification system and conventional practices of weed competition periods and age of transplanted seedlings. Semina: CiênciasAgrárias.2022;43(5), 2271-2292.
6. Javaid MM, Mahmood A, Alshaya DS, AlKahtaniMD, WaheedH, WasayaA, KhanSA, NaqviM, HaiderM, ShahidMA, NadeemMA, AzmatS, KhanBA, , BalalRM, AttiakA and FiazS. Influence of environmental factors on seed germination and seedling characteristics of perennial ryegrass (*Loliumperenne* L.). Scientific Reports. 2022;12(1):1-11.
7. Malliswari T, Reddy MP, Sagar KG and Chandrika V. Effect of irrigation and weed management practices on weed control and yield of black gram. Indian J. Weed Sci. 2008;40(1&2):85-86.

8. Begum G and Rao AS. Efficacy of herbicides on weeds and relay crop of black gram. Indian Journal of Weed Science. 2006;38:145-147.

9. Das R, Patra BC, Mandal MK and Pathak A. Integrated weed management in blackgram (*Vigna mungo* L.) and its effect on soil micro-flora under sandy loam soil of West Bengal. The Bioscan. 2014;9(4):1593–1596.

10. Singh G. Weed Management in summer and *kharif* season black gram [*Vigna mungo* L. Hepper]. Indian Journal of Weed Science. 2011;43(1&2):77-80.

11. Singh G, Virk HK and Khanna V. Weed management in black gram [*Vigna mungo* L. Hepper] through sole and combined application of pre and post-emergence herbicides. Journal of Crop and Weed. 2018;14(2):162-167.

12. Maqbool R, Alawadi HFN, Khan BA, Nadeem MAN, Mahmood A, Javaid MM,Ali B. Exploring the effect of zinc and boron application on oil contents, protein contents, growth and yield of sunflower. Semina: CiênciasAgrárias.2023;44(4):1353-1374.

13. Zimdahl RL. Chapter 22 - Weed-Management Systems, Editor(s): Zimdahl RL, Fundamentals of Weed Science (Fifth Edition), Academic Press, 2018;Pages 609-649, ISBN 9780128111437, https://doi.org/10.1016/B978-0-12-811143-7.00022-6.

14. Baghestani, MA, Zand E, Rahimian MH and Soufizadeh S. Morphological and physiological characteristics which enhance competitiveness of winter wheat (*Triticum aestivum*L.) against Goldbachialaevigata. Iranian Journal of Weed Science. 2005; 1: 111–126.

15. Khan BA, Nadeem MA, Nawaz H, Amin MM, Abbasi GH, Nadeem M,Ayub M. A. Pesticides: impacts on agriculture productivity, environment, and management strategies. In Emerging Contaminants and Plants: Interactions, Adaptations and Remediation Technologies (pp. 109-134). Cham: Springer International Publishing.2023a.

16. Khan BA, Nadeem MA, Iqbal M, Yaqoob N, Javaid MM, Maqbool R, Oraby H. Chitosan nanoparticles loaded with mesosulfuron methyl and mesosulfuron methyl+ florasulam+ MCPA isooctyl to manage weeds of wheat (*Triticum aestivum* L.). Green Processing and Synthesis, 2023b;12(1), 20228152.

17. Khan BA, Nadeem MA, Najeeb, Alawadi H, Javaid MM, Mahmood A, Qamar R, Iqbal M, Mumtaz A, Maqbool R, Oraby H,Elnaggar N. Synthesis, characterization, and evaluation of nanoparticles of clodinofoppropargyl and fenoxaprop-P-ethyl on weed control, growth, and yield of wheat (*Triticum aestivum* L.). Green Processing and Synthesis, 2023c;12(1): 20230105.

18. Khan BA,Nijabat A, Khan MI, Khan I, Hashim S, Nadeem MA, Ikram M. Implications of Mulching on Weed Management in Crops and Vegetables. In: Akhtar, K., Arif, M., Riaz, M., Wang, H. (eds) Mulching in Agroecosystems. Springer, Singapore. P (199-213).2022a.

19. Khan BA, Nadeem MA, Javaid MM, Maqbool R, Ikram M, Oraby H. Chemical synthesis, characterization, and dose optimization of chitosan-based nanoparticles of clodinofoppropargyl and fenoxaprop-p-ethyl for management of Phalaris minor (little seed canary grass): First report. Green Processing and Synthesis, 2022b;11(1):1118-1127.

20. Choudhary VK, Suresh KP and Bhagawati R. Integrated weed management in black gram (*Vignamungo*L.) under mid hills of Arunachal Pradesh. Indian Journal of Weed Science 2012;57:382-38.

21. Mohanty TR, Saha P, Sahoo KC, Tudu S, Ray M, Sahoo & Mishra N. Weed management in blackgram [*Vigna mungo* L. Hepper] during wet season in North Central Plateau Zone of Odisha. Journal of Food Legumes. 2020;33(3):191-194.

22. Danga M, Mehriya ML, Shukla UN, Mail GR and Laxmi V. Effect of weed management on growth and yield of mungbean [*Vigna radiate* L. Wilczek]. International Journal of Chemical Studies. 2020;8(4):3430-3432.

23. https://www.isws.org.in/IJWSn/File/2022_54_Issue-4_397-410.pdf

24. Jackson ML. Soil chemical analysis, Prentice hall of India, Pvt. Ltd., New Delhi. 1973.

25. Mansoori N, Bhadauria NN and Rajput RL. Effect of weed control practices on weeds and yield of black gram (*Vigna mungo* L.). Legume Research- An International Journal. 2015;38(6):855-857.

26. Halvankar GB, Varghese P, Taware SP and Raut VM. Effect of herbicides on weed dynamics and yield of soybean. Journal of Maharashtra Agriculture University. 2005;30(1):35-37.

27. Aggarwal N, Singh G, Ramand H and Khanna V. Effect of post-emergence application of imazethapyr on symbiotic activities, growth and yield of blackgram (*Vigna mungo* L.) cultivars and its efficacy against weeds. Ind. J of Agro. 2014;59 (3):421-426.

28. Karche RP, Dalwadi MR, Patel JC, Gaikwad VP, Panchal DB. Influence of phosphorus and sulphur on yield, nutrient uptake by summer cluster bean on typicustochrept of Anand. An Asian Journal of Soil Science. 2012;7(2):239-241.

29. Malliswari T, Reddy MP, Sagar KG and Chandrika V. Effect of irrigation and weed management practices on weed control and yield of black gram. Indian J. Weed Sci.2008;40(1&2):85-86.

30. Verma JK, Singh R, Tomar SS, Vivek., Dhyani BP and Kumar S. Effect of pre and post emergence application of different doses of Imazethapyr along with other herbicides on nutrient uptake and weeds. Journal of Plant Development Sciences. 2017;9(1):23-28.

31. Nautiyal D, Rawat A and Manisha. Response of different weed management strategies on Growth & Yield of Black Gram at Dehradun. INDIA, Plant Archives Vol. 22, No. 1, 2022 pp. 115-118

32. Painkra D, Gupta DK, Sinha AK, PaliwalAk, Chouskey N and Singh SK. Effective weed management strategy for blackgram (*Vigna mungo* L.) under north hill situation of Chhattisgarh. The Pharma Innovation 2021;10(7):85-88.

33 Thakur ,Nishant, Sandeep Kumar, and Ravinder Kumar. 2023. “Effect of Different Weed Management Practices on Growth and Yield of Cabbage (Brassica Oleracea Var. Capitata L.)”. International Journal of Plant & Soil Science 35 (19):348-52. https://doi.org/10.9734/ijpss/2023/v35i193561.

34 Bhatt, Kanika, NilutpalSaikia, Jitendra Singh Bohra, KadagondaNithinkumar, ShreyasBagrecha, Tejbal Singh, HarsitaNayak, and Aakash. 2024. “Integrated Nutrient Management (INM) and Varietal

Impact on Toria (Brassica Campestris L. Var. Toria) Growth, Yield, and Economics". Asian Journal of Soil Science and Plant Nutrition 10 (1):23-29. https://doi.org/10.9734/ajsspn/2024/v10i1207.

35 Locke MA, Reddy KN, Zablotowicz RM. Weed management in conservation crop production systems. Weed Biology and management. 2002 Sep;2(3):123-32.

36Bajwa AA. Sustainable weed management in conservation agriculture. Crop protection. 2014 Nov 1;65:105-13.