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Yield and Nutrient Uptake of Green Gram (Vigna Radiata L.) and Weeds as Influenced by Different Integrated Weed Management Practices in Western Uttar Pradesh

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A R T I C L E I N F O

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A B S T R A C T

The aim of the study is to assess the performance of post-emergence applications of Imazethapyr and Quizalofop-ethyl in combination with pre-emergence applications of Pendimethalin on green gram (Vigna radiata L.). The results revealed that treatment T2 (weed-free) had the best financial return (Rs 91250 ha-1) and B:C ratio (2.72), while among the herbicides treatments T10 and T8 had the highest net financial return (Rs 92706 ha-1) and B:C ratio (3.14), respectively.

INTRODUCTION

One of the main pulse crop in India among pulses is green gram [Vigna radiata (L.) Wilczek.] which grows in arid and semi-arid areas. It thrives in locations with low and unpredictable rainfall, light textured soils with limited water holding capacity, and is also drought-resistant. It is a short duration crop and works well in a variety of multiple and intercropping systems. It is cultivated in area about 4.5 million hectares and yields 2.64 million tones with a productivity 555 kg ha^{-1} **(Anonymous 2020-21).**

The main weeds in the test field were *Echinochloa colonum (L.)*, *Cynodon dactylon (L.), Eleusine indica (L.), Digitaria sanguinalis (L.), Trianthema portulacstrum (L.), Trianthema monogyna (L.), Celosia argentia (L.), Amaranthus viridis (L.), Parthenium hysterophorus (L.),* and *Cyperus rotundus (L.).*

Weeds play a substantial role in the decline of green gram production. This can be ascribed to the fact that it is typically grown using residual soil moisture without any weed management at all. In green gram, weeds can result in yield losses of up to 80%. (Gurjar *et al*., 2001). Weeds compete with crops for natural and applied resources, resulting in a decrease in agricultural production in both quantity and quality.

According to a recent study (Dixit and Varshney, 2007), manual weeding followed by herbicides was the most effective at reducing weed density and biomass. According to (Savu *et al.,* 2006), integrated weed management was the most cost-effective method. Application of Pendimethalin 1.0 kg a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 20 DAS + one-hand weeding 40 DAS resulted in higher yield, gave the highest net monetary returns, and B:C ratio, and was found to be the most efficient and cost-effective method for reducing weeds and increasing green gram yield.

THEORETICAL REVIEW

Materials and Methods

The field experiment was carried out at CRC farm of the Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut (U.P.) located in Indo-Gangetic plains of Western Uttar Pradesh. During the crop growing season, the weekly mean maximum temperature ranged from 39.49 °C to 31.83 °C, while the weekly mean minimum temperature ranged from 21.71 °C to 30.19 °C. The area receives mean annual rainfall of 867 mm. During the crop period, the average relative humidity ranged from 93.7% to 37.7%. The soil of experimental site was sandy loam in texture, low in available nitrogen and organic carbon, medium in available phosphorus and potassium and slightly alkaline in reaction. The predominant soil having pH 7.4, bulk density 1.49 g/cm^3, low organic carbon content (0.42%). The gross and net plot size were 5.0 x 3.6 m^2 and 4.0 x 1.8 m^2, respectively. A field research using four herbicides with and without hand weeding, weed-free conditions, and control (weedy check) was done in green gram to determine the optimal weed control technique. Three replications and a randomised block design were used for the experiment. Weedy check, Weed free, one hand weeding 20 DAS, two hand weeding 20 and 40 DAS, Quizalofop-ethyl 50 g a.i./ha Post - emergence (20

DAS), Quizalofop-ethyl 50 g a.i./ha Post - emergence (20 DAS) + one hand weeding 40 DAS, Imazethapyr 50 g a.i./ha Post emergence (20 DAS), Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS, Pendimethalin 1.0 kg a.i./ha Pre emergence and Pendimethalin 1.0 kg a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS were the ten weed management treatments used for the experimentation. Plant-to-plant distance was maintained ~ 10 cm in a row spacing of 30 cm. As per advice, 100 kg/ha of diammonium phosphate (DAP) was applied during seed bed preparation. After pre-sowing irrigation, the field was prepared, and further irrigation was administered as needed to guarantee proper germination. Pendimethalin was applied as pre-emergence within 24 hours of sowing, whereas Imazethapyr was applied 20 days after sowing (DAS). Other practices were followed as per recommendation for this region. In order to collect data on weed population and dry weight in each plot (just prior to Imazethapyr application) at 25, 50 DAS and at harvest an iron square of 0.25 m^2 (side 0.5 m) through random sampling was utilised. For dry matter, weeds collected from 0.25 m^2 areas were dried under the sun and then in an oven at 70 $^{\circ}C$ for 72 h, weighed (g/m^2). Economics of treatments was computed on the basis of prevailing market price of inputs and outputs under each treatment. Statistical analysis of the data was done as per the standard analysis of variance technique for the experimental designs following SPSS software based programme, and the treatment means were compared at $P<0.05$ level of probability using t-test and calculating CD values.

METHODOLOGY

Provide a clear and shortened version of your methods in conducting the research, the population and sample, and means of data analysis.

RESULTS AND DISCUSSION

Influence of herbicides on weeds:

Different integrated weed management practices-based treatments had a substantial impact on the density of total weeds. Among weed control treatments, the highest total weed density (17.6, 18.2 and 17.5 m-2) was found under weedy check treatment, at 25, 50 DAS and at harvest, respectively.

Table 1. Effect of Integrated Weed Management Practices on Total Weeds Density (M^{-2}) in Green Gram at Different Stages

Treatments		Total weed density (m^{-2})		
		25 DAS	**50 DAS**	**At harvest**
T_1	Control (Weedy check)	17.6(309.3)	18.2(330.1)	17.5(307.0)
T_2	Weed free	1.0(0.0)	1.0(0.0)	1.0(0.0)
T_3	One hand weeding 20 DAS	8.6(74.2)	9.5(90.1)	9.1(81.7)
T_4	Two hand weeding 20 and 40 DAS	8.5(72.8)	8.7(75.5)	8.1(63.9)
T_5	Quizalofop-ethyl 50 g a.i./ha Post - emergence (20 DAS)	10.0(98.3)	10.8(116.7)	10.4(106.4)

T_6	Quizalofop-ethyl 50 g a.i./ha Post - emergence (20 DAS) + one hand weeding 40 DAS	9.8(96.7)	8.9(78.5)	8.3(68.0)
T_7	Imazethapyr 50 g a.i./ha Post emergence (20 DAS)	9.5(90.0)	10.4(107.9)	9.8(94.2)
T_8	Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS	9.4(88.3)	8.0(62.7)	7.3(53.0)
T_9	Pendimethalin 1.0 kg a.i./ha Pre emergence	8.8(75.6)	10.1(101.0)	9.3(86.3)
T_{10}	Pendimethalin 1.0 kg a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS	6.4(40.2)	6.9(46.8)	6.6(42.8)
	SEm+	**0.30**	**0.34**	**0.32**
	C.D.(P=0.05)	**0.88**	**0.98**	**0.92**

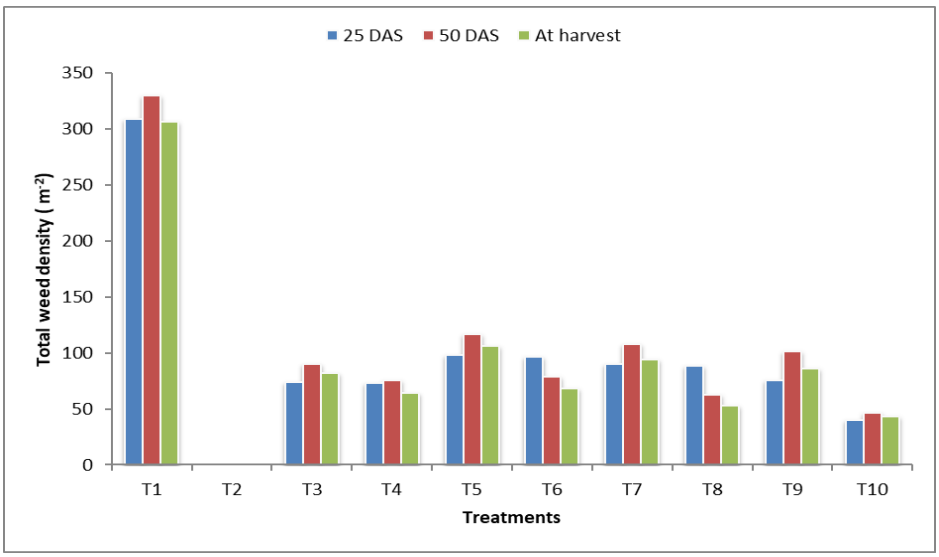

Figure 1. Effect of Weed Management Practices on Total Weeds Density (M-2) in Green Gram at Different Stages

Among all the treatments except weed free, the lowest total weed density was observed (6.4 m^{-2}) in the treatment of Pendimethalin 1.0 kg a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS. At 50 DAS and at harvest the lowest total weed density (6.9 m^{-2} & 6.6 m^{-2}) was observed with the application of Pendimethalin 1.0 kg a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS, which was found statistically at par with Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS (8.0 & 7.3 m^{-2}) at 50 DAS and at harvest, respectively.

Total weed dry weight was affected significantly by various treatments involving integrated weed management practices. Among weed control treatments, significantly the highest total weed dry weight (7.5, 11.2 & 12.6 g m^{-2}) was found in weedy check at 25, 50 DAS and at harvest. This was due to the fact that at later stage most of the weed growth ceased because of leaf

senescence, and thereby resulted in reduction in dry matter accumulation of weeds. Higher infestation of weeds under weedy check was also reported by **Patil *et al.*, (2014) & Kumar *et al.*, (2016).**

Table 2. Effect of Integrated Management Practices on Total Weeds Dry Weight (G M^{-2}) at Different Stages

Treatments		Total weed dry weight (g m^{-2})		
		25 DAS	**50 DAS**	**At harvest**
T_1	Control (Weedy check)	7.5(55.7)	11.2(125.5)	12.6(156.9)
T_2	Weed free	1.0(0.0)	1.0(0.0)	1.0(0.0)
T_3	One hand weeding 20 DAS	5.4(28.7)	7.8(59.5)	8.4(70.1)
T_4	Two hand weeding 20 and 40 DAS	5.3(27.3)	6.6(42.2)	7.4(53.2)
T_5	Quizalofop-ethyl 50 g a.i./ha Post - emergence (20 DAS)	5.8(32.5)	8.2(67.0)	8.9(79.1)
T_6	Quizalofop-ethyl 50 g a.i./ha Post - emergence (20 DAS) + one hand weeding 40 DAS	5.6(31.2)	6.8(44.6)	7.5(55.6)
T_7	Imazethapyr 50 g a.i./ha Post emergence (20 DAS)	5.7(31.5)	8.2(65.5)	8.8(76.8)
T_8	Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS	5.5(30.3)	6.4(39.4)	7.2(50.9)
T_9	Pendimethalin 1.0 kg a.i./ha Pre emergence	5.6(30.5)	7.9(61.4)	8.6(72.5)
T_{10}	Pendimethalin 1.0 kg a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS	4.1(15.7)	5.9(34.2)	6.7(43.3)
	SEm+	**0.18**	**0.26**	**0.28**
	C.D.(P=0.05)	**0.52**	**0.74**	**0.82**

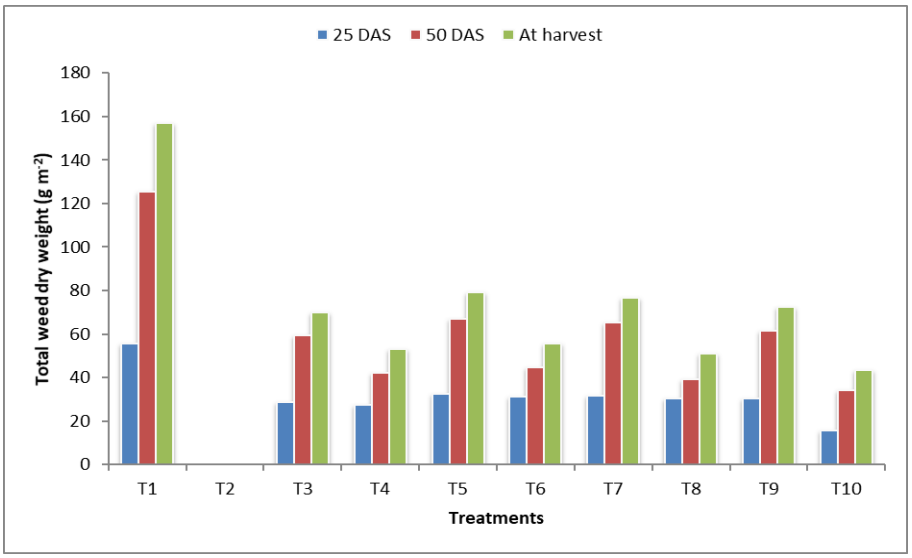

Figure 2. Effect of Weed Management Practices on Total Weeds Dry Weight (G M^{-2}) at Different Stages

Among the herbicides at 25 DAS the total dry weight observed (4.1 g m^{-2}) was lowest with the application of Pendimethalin 1.0 kg a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS than rest of the treatments. At 50 DAS total dry weight observed (5.9 g m^{-2}) was significantly lowest with the application of Pendimethalin 1.0 kg a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS, which was statistically at par with Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS (6.4 g m^{-2}). Significantly lower total dry weight at harvest (6.7 g m^{-2}) observed with the application of Pendimethalin 1.0 kg a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS was found at par with Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS (7.2 g m^{-2}) and significantly lower than the remaining treatments was also reported by **Yadav *et al.,* (2010) & Chhodavadia *et al.,* (2013).**

Weed Control Efficiency (WCE)

Weed control efficiency was affected significantly by various treatments involving integrated weed management practices. Among weed control treatments significantly the highest weed control efficiency (100.0 %) was found in weed free at harvest, respectively. Among the herbicides highest weed control efficiency (72.4%) with the application of Pendimethalin 1.0 kg a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS was at par with Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS (67.6%) at harvest, respectively. This result is in corroboration with the findings of **Gupta *et al.* (2013).**

Table 3. Effect of Weed Management Practices on Weed Control Efficiency (%) at Harvest

Treatments		Weed control efficiency (%)
T_1	Control (Weedy check)	0.0
T_2	Weed free	100.0
T_3	One hand weeding 20 DAS	55.3
T_4	Two hand weeding 20 and 40 DAS	66.1
T_5	Quizalofop-ethyl 50 g a.i./ha Post - emergence (20 DAS)	49.6
T_6	Quizalofop-ethyl 50 g a.i./ha Post - emergence (20 DAS) + one hand weeding 40 DAS	64.6
T_7	Imazethapyr 50 g a.i./ha Post emergence (20 DAS)	51.1
T_8	Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS	67.6
T_9	Pendimethalin 1.0 kg a.i./ha Pre emergence	53.8
T_{10}	Pendimethalin 1.0 kg a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS	72.4
	SEm+	**2.3**
	C.D.(P=0.05)	**6.7**

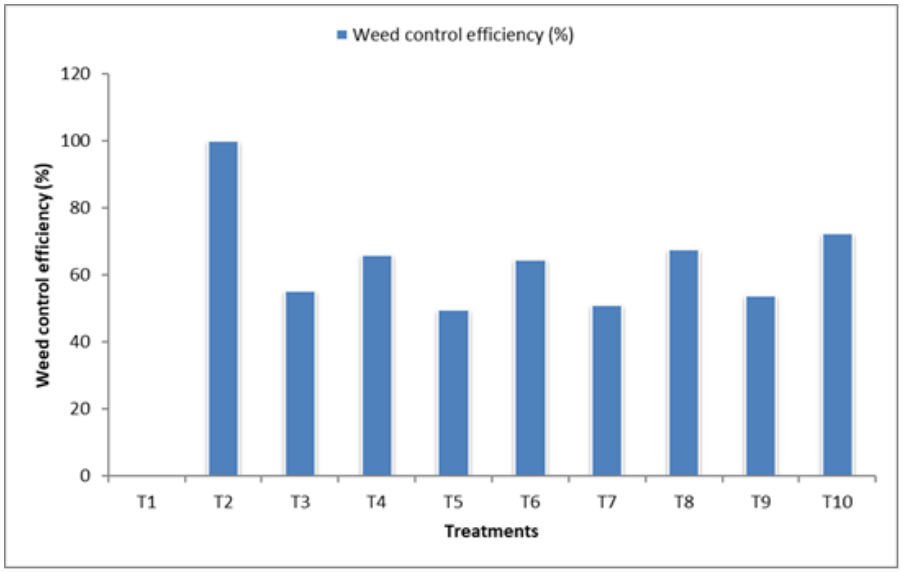

Figure 3. Effect of Weed Management Practices on Weed Control Efficiency (%) at Harvest

Influence on Nutrient Content by Crop

Among the herbicides, the highest nitrogen content in green gram grain and straw was found with the application of Pendimethalin 1.0 kg a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS (3.96 & 0.74%) followed by Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS (3.93 & 0.71%).

Table 4. Effect of Integrated Weed Management Practices on Nitrogen, Phosphorus and Potassium Content (%) in Grains and Straw of Green Gram

Symbol	Treatment	N content (%)		P content (%)		K content (%)	
		Grain	Straw	Grains	Straw	Grains	Straw
T_1	Control (Weedy check)	3.04	0.49	0.20	0.10	0.39	1.10
T_2	Weed free	4.00	0.75	0.36	0.24	0.56	1.37
T_3	One hand weeding 20 DAS	3.87	0.66	0.29	0.18	0.49	1.23
T_4	Two hand weeding 20 and 40 DAS	3.91	0.70	0.31	0.21	0.51	1.28
T_5	Quizalofop-ethyl 50 g a.i./ha Post - emergence (20 DAS)	3.27	0.55	0.22	0.11	0.40	1.11
T_6	Quizalofop-ethyl 50 g a.i./ha Post - emergence (20 DAS) + one hand weeding 40 DAS	3.89	0.68	0.30	0.20	0.50	1.25
T_7	Imazethapyr 50 g a.i./ha Post	3.66	0.58	0.24	0.13	0.43	1.13

	emergence (20 DAS)						
T_8	Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS	3.92	0.71	0.33	0.22	0.52	1.32
T_9	Pendimethalin 1.0 kg a.i./ha Pre emergence	3.73	0.62	0.26	0.14	0.47	1.17
T_{10}	Pendimethalin 1.0 kg a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS	3.96	0.74	0.35	0.24	0.54	1.34
	SEm (±)	**0.13**	**0.02**	**0.01**	**0.01**	**0.02**	**0.04**
	C.D. (P=0.05)	**0.39**	**0.07**	**0.03**	**0.02**	**0.05**	**0.13**

Among the herbicides, the highest phosphorus content in green gram grain and straw were found with the application of Pendimethalin 1.0 kg a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS (0.35 & 0.24%), which were statistically at par with Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS (0.33 & 0.22%). The lowest potassium (0.39 & 1.10%) of green gram grain and straw were found in weedy check at harvest. The highest green gram grain and straw potassium content (0.56 & 1.37%) were observed in weed free treatment similar result was observed by **Yadav *et al.* (2014).**

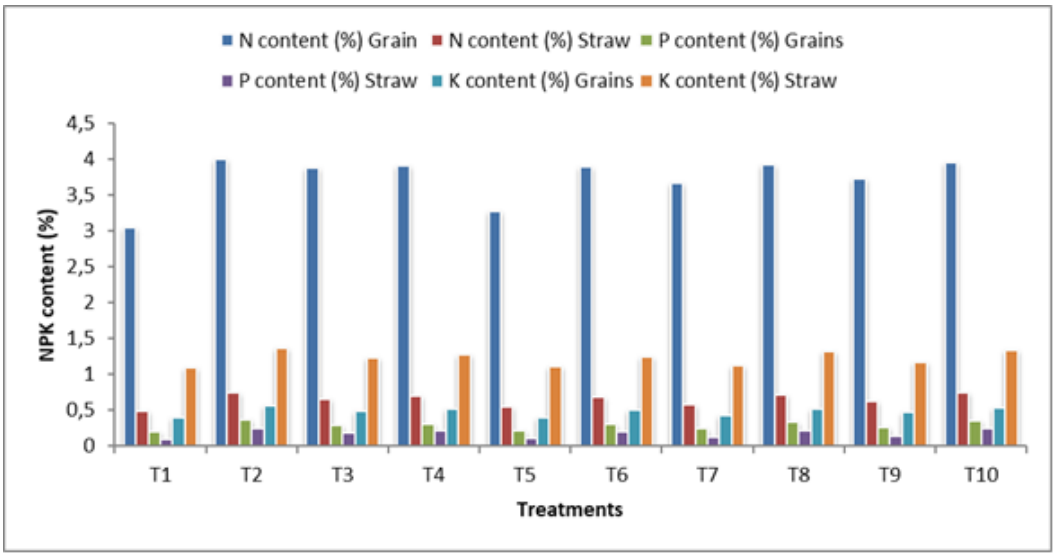

Figure 4. Effect of Integrated Weed Management Practices on Nitrogen, Phosphorus and Potassium Content (%) in Grains and Straw of Green Gram

Influence on Nutrient Uptake by Crop

Among the herbicides, the highest nitrogen uptake grain and straw (54.6 and 26.0 kg ha^{-1}) were found with the application of Pendimethalin 1.0 kg a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS followed by (48.6 & 23.9 kg ha^{-1} respectively) with the application of Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS. The lowest nitrogen uptake in grain and straw was recorded in the control plot (15.8 and 9.1 kg ha^{-1}).

Table 5. Nitrogen, Phosphorus and Potassium Uptake (Kg Ha^{-1}) by Green Gram as Influenced by Integrated Weed Management Treatments

Symbol	Treatment	N uptake (kg ha^{-1})		P uptake (kg ha^{-1})		K uptake (kg ha^{-1})	
		Grain	Straw	Grain	Straw	Grain	Straw
T_1	Control (Weedy check)	15.8	9.1	1.0	1.9	2.0	20.4
T_2	Weed free	56.4	26.6	5.1	8.5	7.9	48.6
T_3	One hand weeding 20 DAS	36.8	20.3	2.8	5.5	4.7	37.9
T_4	Two hand weeding 20 and 40 DAS	45.7	22.5	3.6	6.7	6.0	41.1
T_5	Quizalofop-ethyl 50 g a.i./ha Post - emergence (20 DAS)	27.8	15.7	1.9	3.1	3.4	31.6
T_6	Quizalofop-ethyl 50 g a.i./ha Post - emergence (20 DAS) + one hand weeding 40 DAS	42.0	21.7	3.2	6.4	5.4	39.9
T_7	Imazethapyr 50 g a.i./ha Post emergence (20 DAS)	33.3	17.3	2.2	3.9	3.9	33.8
T_8	Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS	48.6	23.9	4.1	7.1	6.4	44.5
T_9	Pendimethalin 1.0 kg a.i./ha Pre emergence	35.1	19.0	2.4	4.3	4.4	35.8
T_{10}	Pendimethalin 1.0 kg a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS	54.6	26.0	4.8	8.4	7.5	47.2
	SEm±	**1.5**	**0.7**	**0.12**	**0.22**	**0.20**	**1.4**
	CD (P= 0.05)	**4.4**	**2.2**	**0.36**	**0.64**	**0.58**	**4.1**

The highest phosphorus uptake in green gram grain and straw were found with the application of Pendimethalin 1.0 kg a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS (4.8 & 8.4%) followed by Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS (4.1

& 7.1%). The highest potassium uptake by grain and straw 7.5 and 47.2 kg ha^{-1} respectively, were found with the application of Pendimethalin 1.0 kg a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS followed by (6.4 and 44.5 kg ha-1) Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS.

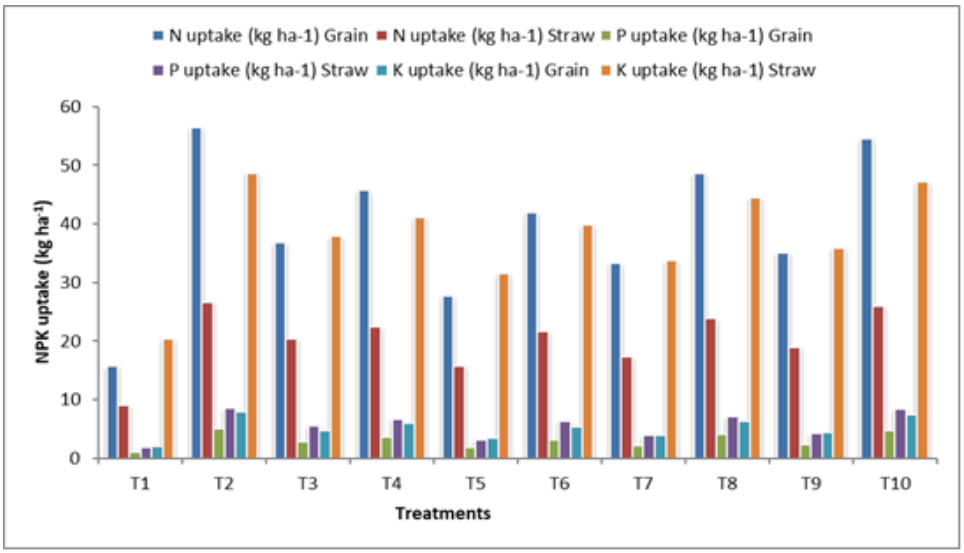

Figure 5. Effect of Integrated Weed Management Practices on Nitrogen, Phosphorus and Potassium Uptake (Kg Ha^{-1}) in Grains and Straw of Green Gram

Influence on Nutrient Content by Weeds

The nitrogen, phosphorus and potassium content in weed ranged from (1.45 to 1.75, 0.16 to 0.34 and 1.04 to 1.30 (%) under different treatments. The lowest nitrogen, phosphorus and potassium content 1.45, 0.16 & 1.04 (%) was observed in weed free, respectively because no weed were allowed to grow in this field **Nagender *et al.* (2018) and Tiwari *et al.* (2018)** also reported similar results.

Among the herbicides, the lowest total nitrogen content 1.47 (%) was found with the application of Pendimethalin 1.0 kg a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS, which was significantly lower than the remaining herbicide treatments. The lowest phosphorus content 0.21 (%) was found with the application of Pendimethalin 1.0 kg a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS, which was significantly lower than the remaining herbicide treatments. The lowest potassium content 1.11 (%) was found with the application of Pendimethalin 1.0 kg a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS, which was significantly lower than the remaining treatments. **Jadhav (2013)** and **Osari *et al.* (2019)** also reported similar results.

Table 6. Effect of Integrated Weed Management Practices on Nutrient Content (%) of Weeds at Harvest

Symbol	Treatments	Nutrient content (%)		
		Nitrogen	Phosphorus	Potassium
T_1	Control (Weedy check)	1.75	0.34	1.30
T_2	Weed free	1.45	0.16	1.04
T_3	One hand weeding 20 DAS	1.60	0.27	1.22
T_4	Two hand weeding 20 and 40 DAS	1.51	0.23	1.17
T_5	Quizalofop-ethyl 50 g a.i./ha Post - emergence (20 DAS)	1.55	0.32	1.27
T_6	Quizalofop-ethyl 50 g a.i./ha Post - emergence (20 DAS) + one hand weeding 40 DAS	1.58	0.26	1.20
T_7	Imazethapyr 50 g a.i./ha Post emergence (20 DAS)	1.64	0.30	1.25
T_8	Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS	1.61	0.22	1.14
T_9	Pendimethalin 1.0 kg a.i./ha Pre emergence	1.62	0.29	1.23
T_{10}	Pendimethalin 1.0 kg a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS	1.47	0.21	1.11
	SEm (±)	**0.03**	**0.01**	**0.04**
	C.D. (P=0.05)	**0.09**	**0.03**	**0.12**

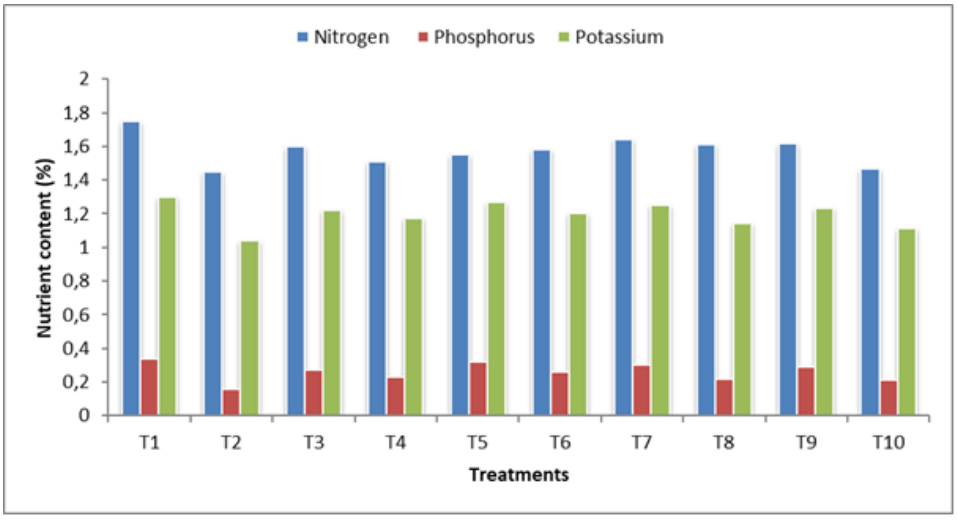

Figure 6. Effect of Integrated Weed Management Practices on Nutrient Content (%) of Weeds at Harvest

Influence on Nutrient Uptake by Weeds

The lowest nitrogen uptake (6.4 kg ha^{-1}) was found with the application of Pendimethalin 1.0 kg a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS, which was significantly lower than the remaining herbicide treatments. The lowest phosphorus (0.90 kg ha^{-1}) was found with the application of Pendimethalin 1.0 kg a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS, which was significantly lower than the remaining herbicide treatments. The lowest potassium uptake (4.8 kg ha^{-1}) was found with the application of Pendimethalin 1.0 kg a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS.

Table 7. Effect of Integrated Weed Management Practices on Nutrient Uptake (Kg Ha^{-1}) of Weeds at Harvest

Symbol	Treatments	Nutrient uptake (kg ha^{-1})		
		Nitrogen	Phosphorus	Potassium
T_1	Control (Weedy check)	27.5	5.3	20.4
T_2	Weed free	0.0	0.0	0.0
T_3	One hand weeding 20 DAS	11.2	1.9	8.6
T_4	Two hand weeding 20 and 40 DAS	8.0	1.2	6.2
T_5	Quizalofop-ethyl 50 g a.i./ha Post - emergence (20 DAS)	12.2	2.5	10.0
T_6	Quizalofop-ethyl 50 g a.i./ha Post - emergence (20 DAS) + one hand weeding 40 DAS	8.8	1.4	6.7
T_7	Imazethapyr 50 g a.i./ha Post emergence (20 DAS)	12.6	2.3	9.6
T_8	Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS	8.1	1.1	5.8
T_9	Pendimethalin 1.0 kg a.i./ha Pre emergence	11.7	2.1	8.9
T_{10}	Pendimethalin 1.0 kg a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS	6.4	0.9	4.8
	SEm (±)	**0.3**	**0.1**	**0.5**
	C.D. (P=0.05)	**0.9**	**0.3**	**1.3**

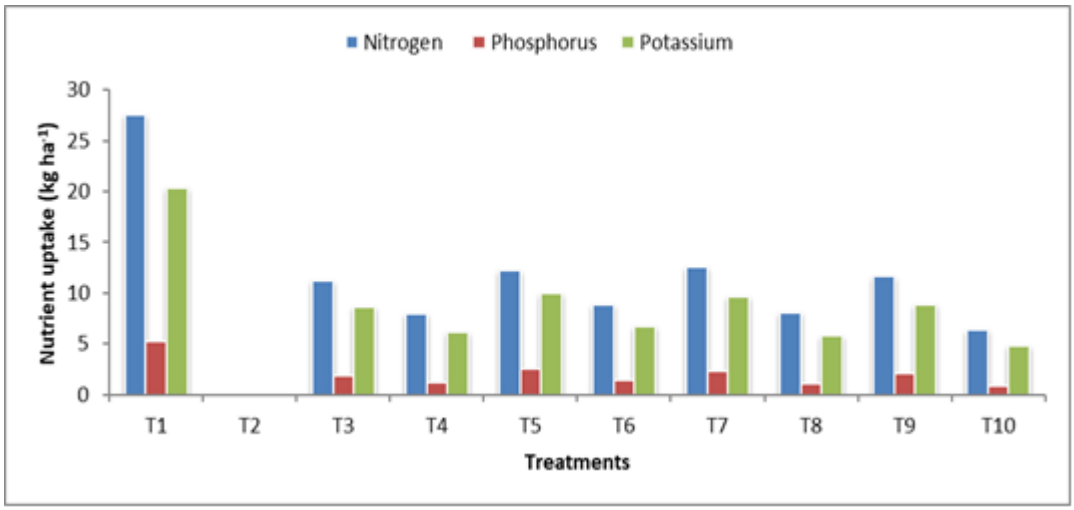

Figure 7. Effect of Integrated Weed Management Practices on Nutrient Uptake (Kg Ha^{-1}) of Weeds at Harvest

Crop Productivity

Grain yield was affected significantly by various treatments involving integrated weed management practices. Among weed control treatments, the lowest grain yield (5.2 q ha^{-1}) was found in weedy check. The highest grain yield (14.1 q ha^{-1}) was found in weed free.

Among the herbicides the significantly highest grain yield (13.8 q ha^{-1}) was recorded with the application of Pendimethalin 1.0 kg a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS followed by Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS. Pendimethalin 1.0 kg a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS recorded (165.3 %) higher grain yield over weedy check.

Table 8. Effect of Integrated Weed Management Practices on Performance of Green Gram (*Vigna Radiata* L.) and Associated Weeds

	Treatments	Yield (q ha^{-1})			Harvest index (%)
		Grains	Straw	Biological	
T_1	Control (Weedy check)	5.2	18.5	23.7	21.9
T_2	Weed free	14.1	35.5	49.6	28.4
T_3	One hand weeding 20 DAS	9.5	30.8	40.3	23.6
T_4	Two hand weeding 20 and 40 DAS	11.7	32.1	43.8	26.7
T_5	Quizalofop-ethyl 50 g a.i./ha Post - emergence (20 DAS)	8.5	28.5	37.0	23.0
T_6	Quizalofop-ethyl 50 g a.i./ha Post - emergence (20 DAS) + one hand weeding 40 DAS	10.8	31.9	42.7	25.3
T_7	Imazethapyr 50 g a.i./ha Post emergence (20 DAS)	9.1	29.9	39.0	23.3

T_8	Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS	12.4	33.7	46.1	26.9
T_9	Pendimethalin 1.0 kg a.i./ha Pre emergence	9.4	30.6	40.0	23.5
T_{10}	Pendimethalin 1.0 kg a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS	13.8	35.2	49.0	28.1
	SEm (±)	**0.4**	**1.1**	**1.5**	**0.9**
	C.D. (P=0.05)	**1.1**	**3.3**	**4.4**	**2.6**

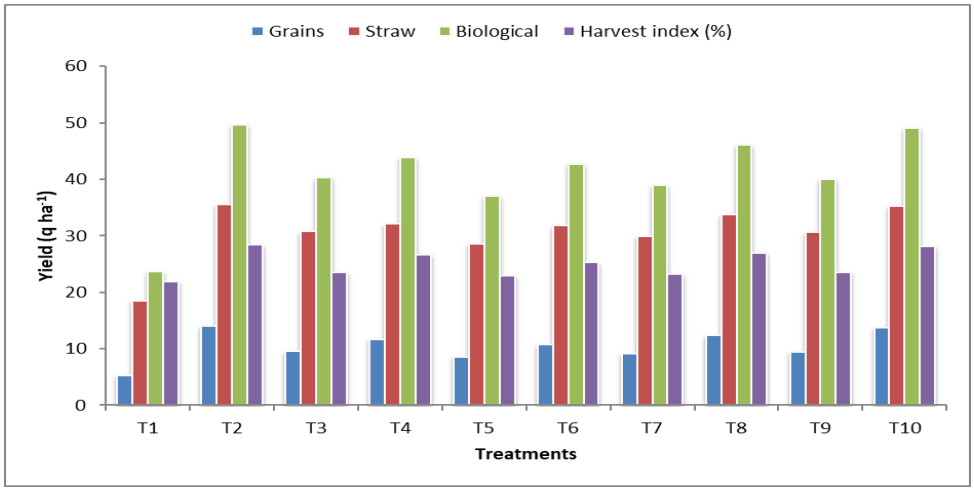

Figure 8. Effect of Integrated Weed Management Practices on Performance of Green Gram (*Vigna Radiate* L.) and Associated Weeds

Biological yield was affected significantly by various treatments involving integrated weed management practices. Among weed control treatments, the lowest biological yield (23.7 q ha^{-1}) found in weedy check. The highest biological yield (49.6 q ha^{-1}) was found in weed free. Similar findings were reported by **Singh (2014).**

Among the herbicides, the highest biological yield (49.0 q ha^{-1}) was recorded with the application of Pendimethalin 1.0 kg a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS, which was statistically at par with Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS (46.1 q ha^{-1}). Pendimethalin 1.0 kg a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS (106.7%) higher biological yield over weedy check.

Harvest index was affected significantly by various treatments involving integrated weed management practices. Among weed control treatments, the lowest harvest index (21.9%) was found in weedy check, while the highest harvest index (28.4%) in weed free. Among the herbicides the highest harvest index (28.1%) recorded with the application of Pendimethalin 1.0 kg a.i./ha Pre

emergence + Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS, which was at par withImazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS. Pendimethalin 1.0 kg a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS recorded (28.3%) higher harvest index over weedy check. Similar findings were reported by **Nagender *et al.* (2018).**

Economics

Cost of cultivation was affected by various treatments involving integrated weed management practices. Among weed control treatments, the lowest cost of cultivation (Rs. 24770 ha^{-1}) found in weedy check, which was lower than the remaining treatments. The highest cost of cultivation (Rs. 33570 ha^{-1}) was found in weed free treatment, which was higher than other treatments. Among the herbicides, the highest cost of cultivation (Rs. 29522 ha^{-1}) was recorded with the application of Pendimethalin 1.0 kg a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS, followed by Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS (Rs. 28920 ha^{-1}). **Singh (2011)** and **Gelot *et al.* (2016)** also reported similar results.

Gross return was affected significantly by various treatments involving integrated weed management practices. Among weed control treatments, the lowest gross return (Rs. 46790 ha^{-1}) was found in weedy check, which was significantly lower than the remaining treatments.

Table 9. Economics of Green Gram as Affected by Integrated Weed Management Practices

Symbol	Treatments	Cost of cultivation (Rs ha^{-1})	Gross return (Rs ha^{-1})	Net return (Rs ha^{-1})	B: C ratio
T_1	Control (Weedy check)	24770	46790	22020	0.89
T_2	Weed free	33570	124820	91250	2.72
T_3	One hand weeding 20 DAS	28070	85062	56992	2.03
T_4	Two hand weeding 20 and 40 DAS	31370	103944	72574	2.31
T_5	Quizalofop-ethyl 50 g a.i./ha Post - emergence (20 DAS)	26624	76240	49616	1.86
T_6	Quizalofop-ethyl 50 g a.i./ha Post - emergence (20 DAS) + one hand weeding 40 DAS	29704	96266	66562	2.24
T_7	Imazethapyr 50 g a.i./ha Post emergence (20 DAS)	25840	81536	55696	2.16
T_8	Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS	28920	110118	81198	2.81
T_9	Pendimethalin 1.0 kg a.i./ha Pre emergence	26244	84184	57940	2.21
T_{10}	Pendimethalin 1.0 kg a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS	29522	122228	92706	3.14
	SEm (±)	-	**2197**	**1156**	**0.08**
	C.D. (P=0.05)	-	**6275**	**3302**	**0.22**

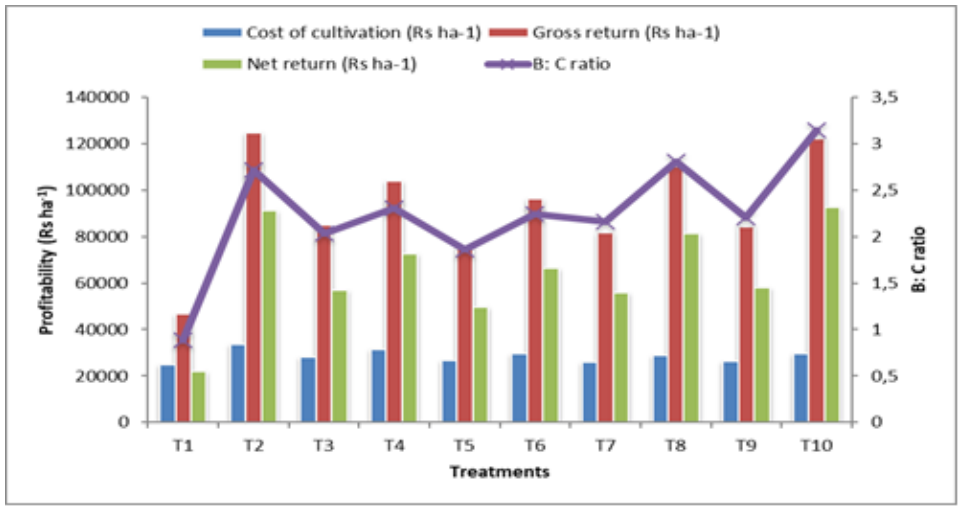

Figure 9. Economics of Green Gram as Affected by Integrated Weed Management Practices

The highest gross return (Rs 124820 ha^{-1}) was found in weed free treatment, which was higher than other treatments. Among the herbicidal treatments, the highest gross return (Rs 122228 ha^{-1}) was recorded with the application of Pendimethalin 1.0 kg a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS followed by Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS (Rs 110118 ha^{-1}). Pendimethalin 1.0 kg a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS was recorded (161.2%) higher gross return over weedy check.

Net return was affected significantly by various treatments involving integrated weed management practices. Among weed control treatments, the lowest net return (Rs 22020 ha^{-1}) was found in weedy check and significantly lower than the remaining treatments, while the highest net return Rs 91250 ha^{-1}) was found in weed free treatment and significantly higher than other treatments. Among the herbicides, the highest net return (Rs 92706 ha^{-1}) was recorded with the application of Pendimethalin 1.0 kg a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS followed by Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS. Pendimethalin 1.0 kg a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS recorded (321.0%) higher net return over weedy check. These findings are in close agreement with the results of **Singh (2011).**

B: C ratio was affected significantly by various treatments involving integrated weed management practices. Among weed control treatments, the lowest B: C ratio (0.89) was found in weedy check, which was significantly lower than the remaining treatments while the highest B: C ratio (2.72) was recorded in weed free treatment.

Among the herbicides, the highest B: C ratio was recorded with the application of Pendimethalin 1.0 kg a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS (3.14) followed by Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS (2.81). Pendimethalin 1.0 kg a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding

40 DAS was recorded (252.8%) higher B: C ratio over weedy check**. Osari *et al.* (2019)** also reported similar results.

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CONCLUSIONS

On the basis of two year study result outcome from experimental data showed that highest yield of green gram and nutrient content and uptake was noticed with weed free, which was found statistically at par with the application of Pendimethalin 1.0 kg a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS and Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS. Lowest nutrient content and uptake in weeds was noticed with Pendimethalin 1.0 kg a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS**.** Among integrated weed management treatments Pendimethalin 1.0 kg a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS was found excellent in gross return, net return, and B: C ratio which was at par with Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS. Thus, it can be concluded that the application of Pendimethalin 1.0 kg a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS is better for higher productivity and profitability of green gram crop.

FURTHER STUDY

This research still needs limitations. So that further research must be carried out on the topic yield and nutrient uptake of green gram (Vigna Radiata l.) and weeds as influenced by different integrated weed management practices in western uttar pradesh.

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