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Performance of integrated weed management practices on weed dynamics, productivity and profitability of Greengram (*Vigna radiata* L.) under rice-wheat-green gram cropping system in western Uttar Pradesh

Pooja Singh, Vivek, Preeti Singh, Mandvi Shrivastava and Akshay Ujjwal

Abstract

The field experiment was conducted at Crop Research Station Sardar Patel University of Agriculture & Technology in Meerut, (U.P) during kharif season 2021 to evaluate the effectiveness of post-emergence application of Imazethapyr in conjunction with pre-emergence application of Pendimethalin on green gram (*Vigna radiata* L.). The experiment laid out in randomized block design with 3 replication and comprised of treatments Control (Weedy check) T₁, Weed free (T₂), one hand weeding 20 DAS (T₃), two hand weeding 20 and 40 DAS (T₄), Quizalofop-ethyl 50 g a.i./ha Post - emergence (20 DAS) (T₅), Quizalofop-ethyl 50 g a.i./ha Post - emergence (20 DAS) + one hand weeding 40 DAS (T₆), Imazethapyr 50 g a.i./ha Post emergence (20 DAS) (T₇), Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS (T₈), Pendimethalin 1.0 kg a.i./ha Pre emergence (T₉) and Pendimethalin 1.0 kg a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS (T₁₀). The outcomes showed that T₁₀ and T₈ had comparable maximum weed control efficiencies at harvest. The results also showed that, among the various treatments, T₂ (weed-free) had the maximum grain production (14.1 q ha⁻¹), which was comparable to treatment T₁₀'s (13.8 q ha⁻¹) and was followed by treatment T₇ (12.4 q ha⁻¹). The results showed that treatment T₂ had the best net financial return (Rs. 91250 ha⁻¹) and B:C ratio (2.72), while among herbicides treatment T₁₀ and T₈ had the highest net financial return (Rs. 92706 ha⁻¹) and B:C ratio (3.14), respectively.

Keywords: Green gram, herbicide, weed dynamics, productivity, profitability

Introduction

Green gram [*Vigna radiata* (L.) Wilczek.] is one of the main pulse crops in India growing in arid and semi-arid regions. It is resistant to drought and is best suited for light textured soils with low water holding capacity, as well as in areas with low and erratic rainfall. As a leguminous crop, green gram increases the fertility of soil by fixing 30-40 kg atmospheric nitrogen per hectare. It is cultivated in area about 4.5 million hectares and produce 2.64 million tones with productivity 548 kg ha⁻¹ (Anonymous 2020-21) [1].

Major weeds of experimental field were *Echinochloa colonum* (L.), *Cynodon dactylon* (L.), *Eleusine indica* (L.), *Digitaria sanguinalis* (L.), *Trianthema portulacstrum* (L.), *Trianthema monogyna* (L.), *Celosia argentea* (L.), *Amaranthus viridis* (L.), *Parthenium hysterophorus* (L.), and *Cyperus rotundus* (L.). One of the major constrains in greengram production is weed competition. This can be attributed to the fact that it is traditionally grown on residual soil moisture without any control of weeds in general. The yield losses due to weeds in green gram range between 25 to 80% (Gurjar *et al.*, 2001) [7]. Weeds compete with crops for natural and applied resources, thereby causing reduction in quantity and quality of agricultural productivity. Integrated weed management approach involves the use of two or more weed control techniques like preventive, cultural, mechanical, biological and chemical in a well-planned sequence. In a recent research, (Dixit and Varshney, 2007) [4] reported that hand weeding followed by herbicides depicted least density and biomass for weeds. (Savu *et al.*, 2006) [13] found that the integrated weed management was found to be the most economical.

Materials and Methods

The field experiment was laid out at CRC farm of the Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut (U.P.) located in Meerut, Uttar Pradesh. The weekly mean maximum temperature during crop growing period varied between 39.49 to 31.83 °C, whereas the mean minimum temperature was between 21.71 to 30.19 °C. The area receives mean annual rainfall of 867 mm. The mean relative humidity during crop period varied between 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. The predominant soil having pH 7.4, bulk density 1.49 g/cm³, low organic carbon content (0.42%). The gross and net plot size were 5.0 x 3.6 m² and 4.0 x 1.8 m², respectively. To determine the optimum weed control method in gram, field research was carried out with four herbicides with and without manual weeding, weed-free conditions, and control (weedy check). Experiment was laid out randomized block design with three replications. Ten weed management treatments Control (Weedy check) T1, Weed free (T2), one hand weeding 20 DAS (T3), two hand weeding 20 and 40 DAS (T4), Quizalofop-ethyl 50 g a.i./ha Post - emergence (20 DAS) (T5), Quizalofop-ethyl 50 g a.i./ha Post - emergence (20 DAS) + one hand weeding 40 DAS (T6), Imazethapyr 50 g a.i./ha Post emergence (20 DAS) (T7), Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS (T8), Pendimethalin 1.0 kg a.i./ha Pre emergence (T9) and Pendimethalin 1.0 kg a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS (T10) were used for the experimentation. Plant-to-plant

distance was maintained ~ 10 cm in a row spacing of 30 cm. To ensure proper germination, field was prepared after *pre-sowing* irrigation and subsequent irrigation was given as per requirement. Imazethapyr was applied 20 days after sowing (DAS), whereas Pendimethalin in was applied as pre-emergence within 24hr of sowing. Other practices were followed as per recommendation for this region. An iron square of size 0.25 m² (side 0.5 m) was used to take observations on weed population and weed dry weight through random sampling in each plot at 25 (just before application of Imazethapyr), 25, 50 and at harvest. The total number of weeds were counted species wise in each plot separately and analyzed. For dry matter, weeds collected from 0.25 m² areas were dried under the sun and then in an oven at 70 °C for 72 h, weighed (g/m²). 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.

Results and Discussion

Influence of weedicides on weeds

Density of total weeds was affected significantly by various treatments involving integrated weed management practices. 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.

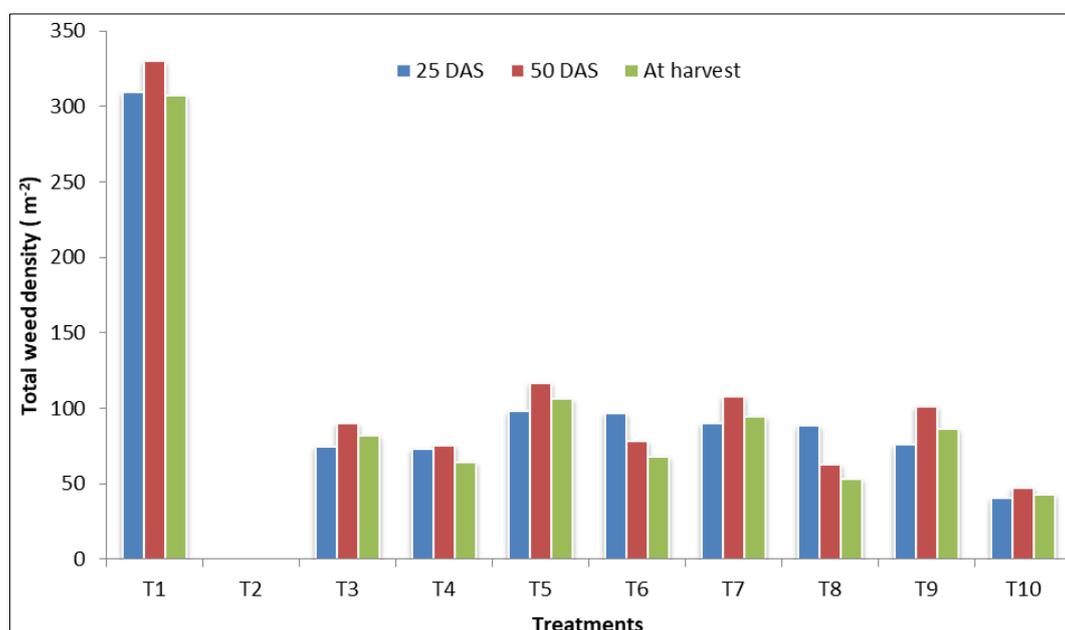


Fig 1: Effect of weed management practices on total weeds density (m⁻²) in green gram at different stages

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)
	S.Em+	0.30	0.34	0.32
	C.D.(P=0.05)	0.88	0.98	0.92

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.

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)^[12] & Kumar *et al.*, (2016)^[9].

Table 2: Effect of integrated weed 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)	
	S.Em+	0.18	0.26	0.28
	C.D.(P=0.05)	0.52	0.74	0.82

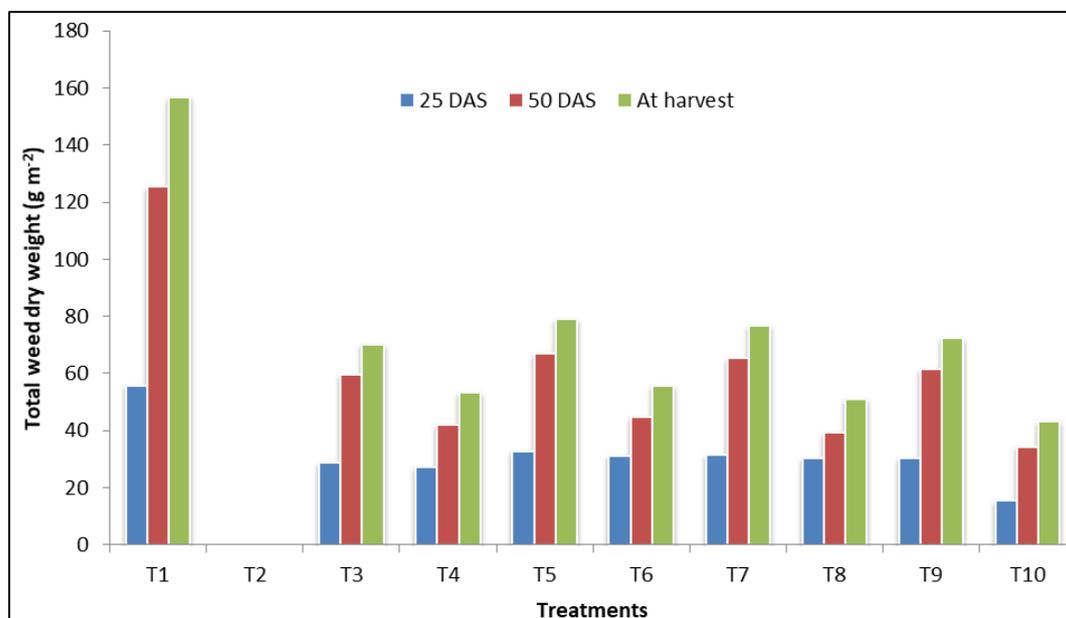


Fig 2: Effect of weed management practices on total weeds dry weight (g m⁻²) at different stages

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)^[17] & Chhodavadia *et al.*, (2013)^[3].

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)^[6].

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

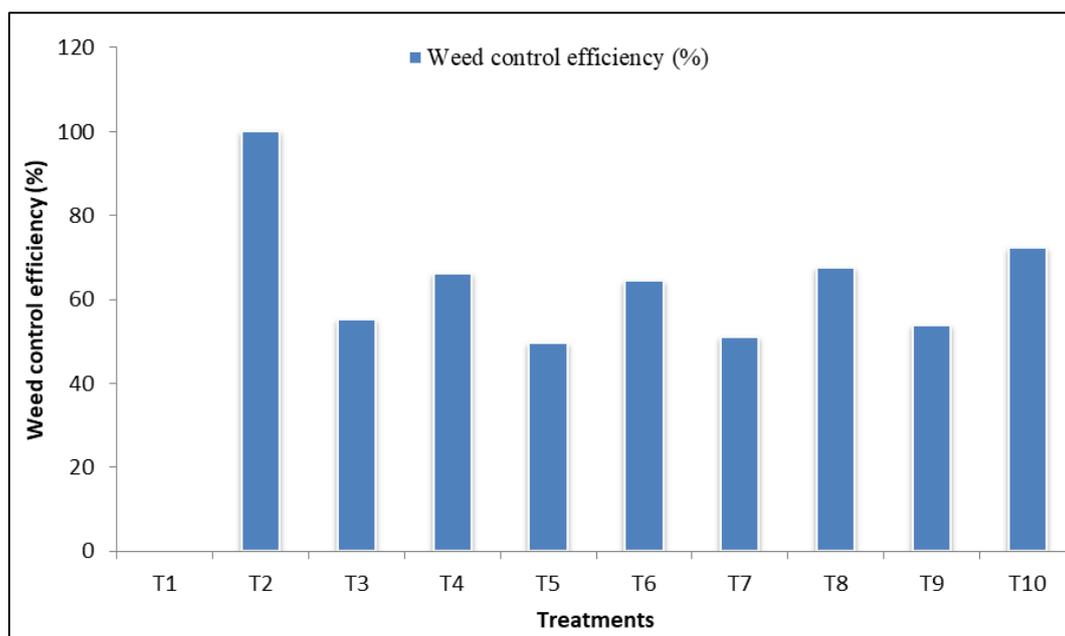


Fig 3: Effect of weed management practices on weed control efficiency (%) at harvest

Influence on yield parameters of green gram

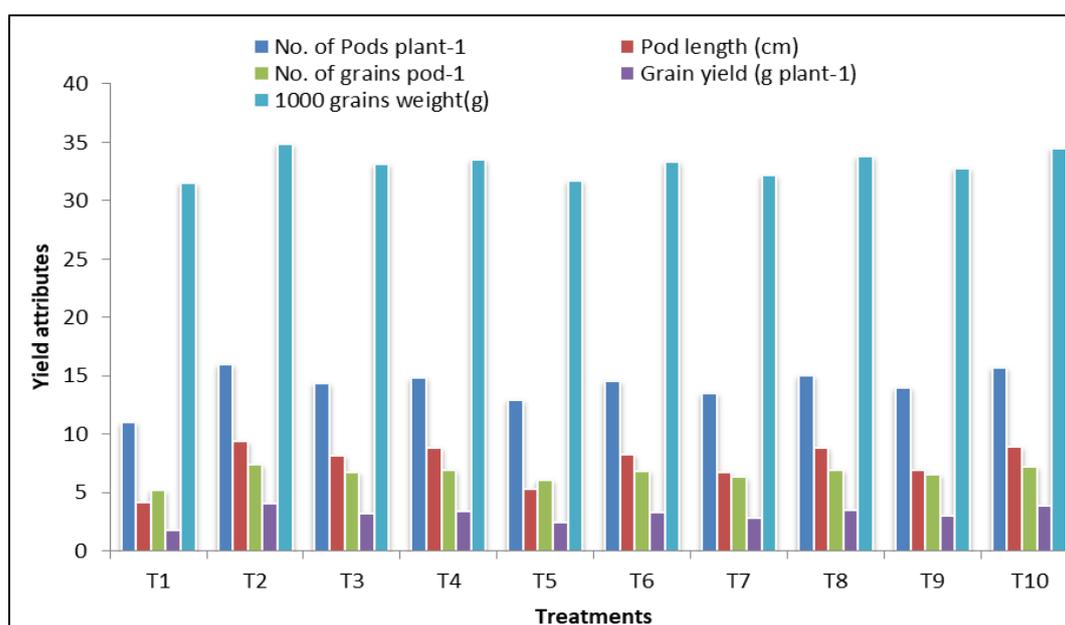
Number of pods plant⁻¹ was affected significantly by various treatments involving integrated weed management practices. Among weed control treatments, the lowest number of pods plant⁻¹ (11.0 pods plant⁻¹) was found in weedy check which was significantly lower than the remaining treatments. The highest number of pods plant⁻¹ (16.0 pods plant⁻¹) was found in weed free which was significantly higher than other treatments.

Among the herbicides, the highest number of pods plant⁻¹

(15.7 pods plant⁻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 (15.0 pods plant⁻¹) and Quizalofop-ethyl 50 g a.i./ha Post - emergence (20 DAS) + one hand weeding 40 DAS (14.6 pods plant⁻¹). Pendimethalin 1.0 kg a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS recorded (41.8%) more pods plant⁻¹ over weedy check.

Table 4: Effect of Integrated weed management practices on yield attributes

Symbol	Treatment	Yield attributes				
		No. of Pods plant ⁻¹	Pod length (cm)	No. of Grains pod ⁻¹	Grain yield (g plant ⁻¹)	Test weight(g)
T ₁	Control (Weedy check)	11.0	4.2	5.2	1.8	31.5
T ₂	Weed free	16.0	9.4	7.4	4.1	34.8
T ₃	One hand weeding 20 DAS	14.4	8.2	6.7	3.2	33.1
T ₄	Two hand weeding 20 and 40 DAS	14.8	8.8	6.9	3.4	33.5
T ₅	Quizalofop-ethyl 50 g a.i./ha Post - emergence (20 DAS)	12.9	5.3	6.1	2.5	31.7
T ₆	Quizalofop-ethyl 50 g a.i./ha Post - emergence (20 DAS) + one hand weeding 40 DAS	14.6	8.3	6.8	3.3	33.3
T ₇	Imazethapyr 50 g a.i./ha Post emergence (20 DAS)	13.5	6.7	6.4	2.8	32.2
T ₈	Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS	15.0	8.8	6.9	3.6	33.8
T ₉	Pendimethalin 1.0 kg a.i./ha Pre emergence	14.0	6.9	6.6	3.0	32.7
T ₁₀	Pendimethalin 1.0 kg a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS	15.7	8.9	7.2	3.9	34.5
	S.Em (±)	0.5	0.3	0.3	0.1	1.2
	C.D. (P=0.05)	1.5	0.8	0.7	0.3	NS

**Fig 4:** Effect of Integrated weed management practices on yield attributes

Pod length (cm) was affected significantly by various treatments involving integrated weed management practices. Among weed control treatments, the lowest pod length (4.2 cm) was found in weedy check which was significantly lower than the remaining treatments. The highest pod length (9.4 cm) was found in weed free which was significantly higher than other treatments.

Among the herbicides, the highest pod length (8.9 cm) 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 (8.8 cm) and Quizalofop-ethyl 50 g a.i./ha Post - emergence (20 DAS) + one hand weeding 40 DAS (8.3 cm). Pendimethalin 1.0 kg a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS (111.9%) more pod length over weedy check.

Number of grains pod⁻¹ was affected significantly by various treatments involving integrated weed management practices. Among weed control treatments, the lowest number of grains pod⁻¹ (5.2 grains pod⁻¹) was found in weedy check. The highest number of grains pod⁻¹ (7.4 grains pod⁻¹) was found in

weed free. Among the herbicides, the highest grains pod⁻¹ (7.2 grains pod⁻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 (6.9 grains pod⁻¹), Quizalofop-ethyl 50 g a.i./ha Post - emergence (20 DAS) + one hand weeding 40 DAS (6.8 grains pod⁻¹) and Pendimethalin 1.0 kg a.i./ha Pre emergence (6.6 grains pod⁻¹). Pendimethalin 1.0 kg a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS recorded (38.4%) more grains pod⁻¹ over weedy check.

Grain yield plant⁻¹ was affected significantly by various treatments involving integrated weed management practices. Among weed control treatments, the lowest grain yield plant⁻¹ (1.8 g plant⁻¹) was found in weedy check. The highest grain yield plant⁻¹ (4.1 g plant⁻¹) was found in weed free. Among the herbicides, the highest grain yield plant⁻¹ (3.9 g plant⁻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 (3.6 g plant⁻¹). Pendimethalin 1.0 kg a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 20 DAS + one hand weeding 40 DAS recorded (116.6%) more grain yield plant⁻¹ over weedy check.

Integrated weed management did not bring any significant variation in test weight of green gram by various treatments involving integrated weed management practices. Among weed control treatments, the lowest test-weight (31.5 g) was found in weedy check. The highest test-weight (34.8 g) found in weed free. Among the herbicides, the highest test-weight (34.5 g) 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. Similar results have also been reported by Sheoran, (2008) [14] and Jadhav *et al.* (2013) [8]. Integrated weed management i.e, herbicides and hand weeding has been reported to be superior over application of herbicide alone by earlier workers as well (Tiwari *et al.*, 2018;

Osari *et al.*, 2019) [17, 11].

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 5: 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
	S.Em (±)	0.4	1.1	1.5	0.9
	C.D. (P=0.05)	1.1	3.3	4.4	2.6

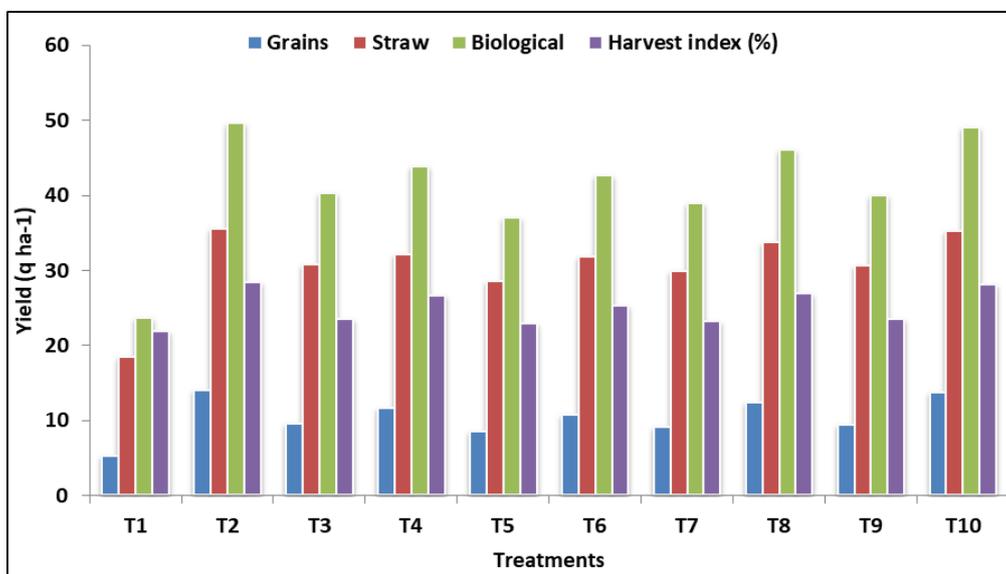


Fig 5: Effect of Integrated weed management practices on performance of green gram (*Vigna radiata* L.) and associated weeds

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) [16]. 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 with 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 (28.3%) higher harvest index over weedy check. Similar findings were reported by Nagender *et al.* (2018)^[10].

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)^[15] and Gelot *et al.* (2016)^[5] 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 6: 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
	S.Em (±)	-	2197	1156	0.08
	C.D. (P=0.05)	-	6275	3302	0.22

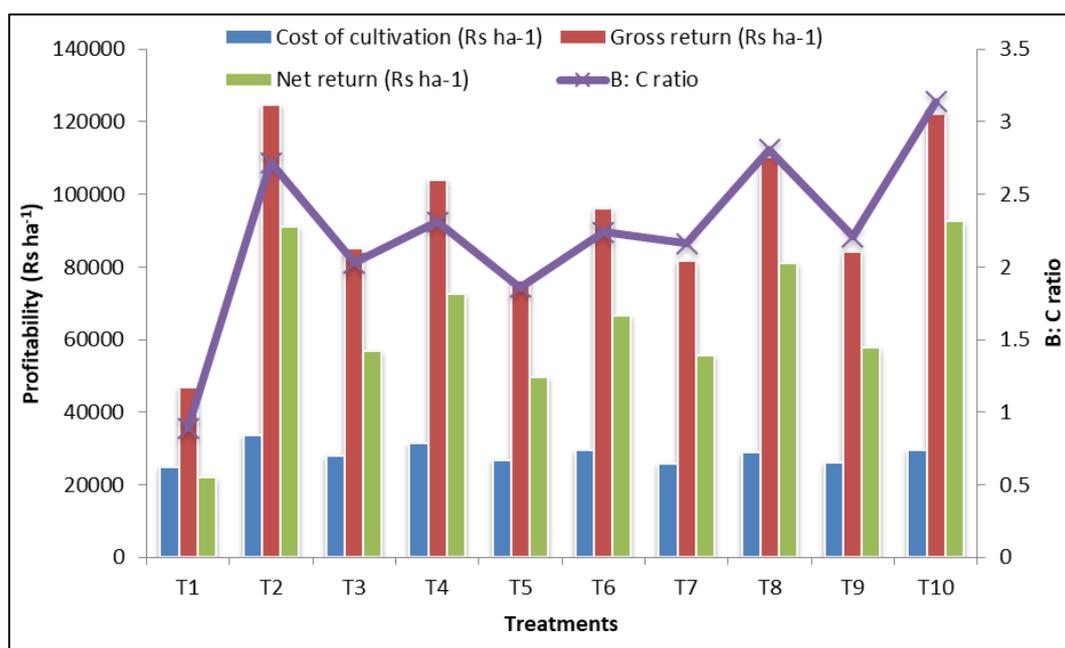


Fig 6: Economics of green gram as affected by integrated weed management practices

The highest gross return (₹ 124820 ha⁻¹) was found in weed free treatment, which was higher than other treatments. Among the herbicidal treatments, the highest gross return (₹ 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 (₹ 110118). 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 (₹ 22020 ha⁻¹) was found in weedy check and significantly lower than the remaining treatments, while the highest net return (₹ 91250 ha⁻¹) was found in weed free treatment and significantly higher than other treatments. Among the herbicides, the highest net return (₹ 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) [15].

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) [11] also reported similar results.

Conclusion

On the basis of two year study outcome from experimental data revealed that the highest growth parameters, yield attributes, yield of green gram and nutrient uptake was observed 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. 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.

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