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EFFECT OF WEED MANAGEMENT PRACTICES ON YIELD AND ECONOMICS OF INDIAN MUSTARD (*Brassica juncea* L.) UNDER THE GIRD REGION OF MADHYA PRADESH INDIA

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ABSTRACT

A field experiment was conducted during the rabi seasons of 2023–24 and 2024–25 at the experimental farm of Vikrant University, Gwalior, Madhya Pradesh, India, to evaluate the effect of different weed management practices on yield attributes, yield, and economics of Indian mustard (*Brassica juncea* L.) under the Gird agro-climatic region. The experiment was laid out in a Randomized Block Design (RBD) with three replications and different weed management treatments involving pre-emergence and post-emergence herbicides along with manual weeding practices. The results revealed that integrated weed management practices significantly improved yield attributes and productivity of mustard compared to weedy check. Among the treatments, integrated application of pre-emergence pendimethalin followed by post-emergence herbicidal application and hand weeding recorded superior yield attributes, seed yield, stover yield, and harvest index. The highest seed yield, net return, and benefit-cost ratio were observed under integrated weed management treatments due to effective suppression of weed flora and improved crop growth. The weedy check treatment recorded the lowest yield and economic returns owing to severe crop-weed competition. The findings indicated that integrated weed management practices can be effectively adopted for sustainable mustard production and higher profitability under the Gird region of Madhya Pradesh.

***Keywords* :** Indian mustard, weed management, yield attributes, economics, herbicides, integrated weed management, benefit-cost ratio.

Introduction

Indian mustard (*Brassica juncea* L.) is one of the most important oilseed crops cultivated in India and contributes significantly to the national edible oil economy. It occupies a prominent position among rabi oilseed crops due to its adaptability under diverse agro-climatic conditions, short duration, and wide industrial utility. Mustard seeds contain 37–49% oil and 35–40% protein in seed meal, making it an economically important crop for both edible oil production and livestock feed.

India is one of the major producers of rapeseed-mustard in the world. Despite the substantial area under cultivation, productivity of mustard remains comparatively low because of several biotic and abiotic constraints. Among these, weed infestation is considered one of the major limiting factors affecting mustard productivity. Weeds compete with crop plants for moisture, nutrients, light, and space during the critical growth stages, thereby reducing crop yield and quality.

In the Gird region of Madhya Pradesh, mustard fields are predominantly infested with grassy, broad-leaved, and sedge weeds such as *Chenopodium album*, *Phalaris minor*, *Cynodon dactylon*, and *Cyperus rotundus*. These weeds cause significant yield reduction if not controlled effectively during the early crop growth period. Traditional manual weeding practices are effective but are becoming increasingly expensive and labor-intensive due to rising labor costs and labor scarcity.

Integrated weed management involving the judicious use of herbicides in combination with cultural and manual practices offers an effective and economical approach for weed control in mustard. Herbicides such as pendimethalin, oxyfluorfen, quizalofop-p-ethyl, imazethapyr, and propaquizafop have shown promising results in reducing weed density and improving crop productivity.

Therefore, the present investigation entitled "Effect of Weed Management Practices on yield and economics of Mustard (*Brassica juncea* L.) under the Gird Region of Madhya Pradesh" was undertaken to evaluate the influence of different weed management practices on yield and economics of mustard cultivation.

Materials and Methods

Experimental Site

The field experiment was conducted during the rabi seasons of 2023–24 and 2024–25 at the Crop Research Farm, School of Agricultural Sciences, Vikrant University, Gwalior, Madhya Pradesh, India. The experimental site falls under the Gird agro-climatic zone characterized by semi-arid climatic conditions.

Soil and Climatic Conditions

The soil of the experimental field was sandy loam in texture with moderate fertility status. The region experiences subtropical climatic conditions with cool winters and moderate rainfall. The average annual rainfall of the region ranges between 650–750 mm.

Experimental Design and Treatments

The experiment was laid out in a Randomized Block Design (RBD) with three replications to evaluate the efficacy of different weed management practices. The experiment consist of ten treatments, *Viz.,* **T_1:** Pendimethalin @ 1000 g ha^{-1} as pre-emergence (PE); **T_2:** Metribuzin @ 175 g ha^{-1} as pre-emergence (PE); **T_3:** Oxyfluorfen @ 250 g ha^{-1} as pre-emergence (PE); **T_4:** Clodinafop-propargyl @ 60 g ha^{-1} as post-emergence (PoE); **T_5:** Propaquizalafop @ 100 g ha^{-1} as post-emergence (PoE); **T_6:** Pendimethalin @ 1000 g ha^{-1} as pre-emergence followed by one hand weeding (HW) at 45 days after sowing (DAS); **T_7:** Metribuzin @ 175 g ha^{-1} as pre-emergence followed by one hand weeding at 45 DAS; **T_8:** Clodinafop-propargyl @ 60 g ha^{-1} as post-emergence followed by one hand weeding at 45 DAS; **T_9:** Weed-free; and **T_{10}:** Weedy check.

The recommended agronomic practices were followed uniformly for all treatments except weed management interventions.

Crop Management

Mustard variety suitable for the region was sown at recommended spacing and seed rate during both years of experimentation. Fertilizers were applied as per recommended dose of nutrients. Irrigation and other cultural operations were carried out as per crop requirement.

Observations Recorded

The number of siliquae per plant was recorded by counting all the mature siliquae borne on five randomly selected plants from the net plot area of each treatment, and the mean value was expressed on a per-plant basis. The number of seeds per siliqua was determined by counting the seeds from ten randomly selected siliquae collected from the sampled plants, and the average was expressed as the number of seeds per siliqua. The length of siliqua (cm) was measured from the base to the tip of ten randomly selected mature siliquae using a digital Vernier caliper, and the average value was expressed in centimetres. The test weight (1000-seed weight) was determined by weighing 1000 clean, well-filled seeds from each treatment using a precision electronic balance, and the values were expressed in grams.

Seed yield was determined from the net plot area after harvesting, drying, threshing, and cleaning the produce, and the values were expressed in kg ha^{-1}. Biological yield was recorded as the total above-ground biomass harvested from each net plot prior to threshing and expressed in kg ha^{-1}. Stover yield was calculated by deducting seed yield from the corresponding biological yield and expressed in kg ha^{-1}. Harvest index (%) was computed as the ratio of seed yield to biological yield and expressed as a percentage using the following formula:

Harvest Index (%) = (Seed Yield / Biological Yield) × 100

Economic evaluation of the treatments was performed by calculating the common cost of cultivation, treatment cost, total cost of cultivation, gross returns, net returns, and benefit-cost ratio. The common cost of cultivation (Rs. ha^{-1}) included expenses incurred on land preparation, seed, fertilizers, irrigation, plant protection measures, harvesting, threshing, and other operations common to all treatments. The treatment cost (Rs. ha^{-1}) comprised the expenditure on herbicides, their application, and manual weeding specific to each treatment. The total cost of cultivation (Rs. ha^{-1}) was calculated by adding the common cost of cultivation and the treatment cost. Gross returns (Rs. ha^{-1}) were computed on the basis of the prevailing market prices of seed and stover yields. Net returns (Rs. ha^{-1}) were obtained by deducting the total cost of cultivation from the gross returns. The benefit-cost ratio (B:C ratio) was calculated by dividing the gross returns by the total cost of cultivation.

Statistical Analysis

The data obtained from the experiment were subjected to statistical analysis using the analysis of variance (ANOVA) technique appropriate for Randomized Block Design as described by Gomez and Gomez (1984). Treatment means were compared using critical difference (CD) at 5% level of significance. The analysis was done using the agri analyze software.

Results and Discussion

Effect on Yield Attributes and yield

Different weed management practices significantly influenced the number of siliquae plant^{-1} during both years of experimentation. The highest number of siliquae plant^{-1} was recorded under weed-free treatment (312.46), followed by T_7–Metribuzin @ 175 g ha^{-1} fb HW at 45 DAS (298.73) and T_6–Pendimethalin 1000 g ha^{-1} (PE) fb HW at 45 DAS (287.54), whereas the lowest number of siliquae plant^{-1} was observed under weedy check (198.42). The increase in siliquae number may be attributed to reduced crop–weed competition for nutrients, moisture, light and space during the critical stages of crop growth. Effective weed control improved crop vigour and enhanced assimilate production and translocation towards reproductive organs, resulting in higher siliquae formation. Similar findings have been reported by Sharma *et al.* (2005).

The number of seeds siliqua^{-1} was significantly affected by different weed management practices. The maximum number of seeds siliqua^{-1} was recorded under weed-free treatment (15.82), followed by T_7–Metribuzin @ 175 g ha^{-1} fb HW at 45 DAS (15.34) and T_6–Pendimethalin 1000 g ha^{-1} (PE) fb HW at 45 DAS (14.91), whereas the minimum number of seeds siliqua^{-1} was recorded under weedy check (10.26). The higher seed number under integrated weed management practices may be due to better nutrient availability, efficient photosynthesis and improved source–sink relationship resulting from effective weed suppression. Similar observations were reported by Raj *et al.* (2020).

Test weight was significantly improved under effective weed management treatments. The highest test weight was recorded under weed-free treatment (5.61 g), followed by T_7–Metribuzin @ 175 g ha^{-1} fb HW at 45 DAS (5.42 g) and T_6–Pendimethalin 1000 g ha^{-1} (PE) fb HW at 45 DAS (5.28 g), whereas the lowest test weight was observed under weedy check (3.94 g). Improved test weight under integrated weed management may be attributed to better translocation of photosynthates and enhanced nutrient uptake owing to reduced weed competition. Similar results were reported by Dash and Shukla (2025).

Weed management practices significantly influenced mustard seed yield. The highest seed yield was recorded under weed-free treatment (2501.67 kg ha^{-1}), followed by T_7–Metribuzin @ 175 g ha^{-1} fb HW at 45 DAS (2379.22 kg ha^{-1}) and T_6–Pendimethalin 1000 g ha^{-1} (PE) fb HW at 45 DAS (2238.84 kg ha^{-1}), whereas the lowest seed yield was recorded under weedy check (1276.35 kg ha^{-1}). The increase in seed yield under integrated weed management practices may be attributed to effective control of weeds throughout the crop growth period, resulting in better utilization of nutrients, moisture, light and growing space. Enhanced crop growth and superior yield attributes ultimately contributed to higher seed yield. Similar findings were reported by Singh *et al.* (2013).

Stover yield was significantly affected by different weed management practices. The highest stover yield was recorded under weed-free treatment (6098.05 kg ha^{-1}), followed by T_7–Metribuzin @ 175 g ha^{-1} fb HW at 45 DAS (5804.41 kg ha^{-1}) and T_6–Pendimethalin 1000 g ha^{-1} (PE) fb HW at 45 DAS (5625.98 kg ha^{-1}), whereas the lowest stover yield was observed under weedy check (3408.35 kg ha^{-1}). Higher stover yield may be attributed to greater vegetative growth, higher dry matter accumulation and effective weed suppression. Similar observations were reported by Bamboriya *et al.* (2017).

Different weed management practices significantly influenced the biological yield of mustard. The highest biological yield was recorded under weed-free treatment (8599.72 kg ha^{-1}), followed by T_7–Metribuzin @ 175 g ha^{-1} fb HW at 45 DAS (8183.63 kg ha^{-1}), which was statistically at par with T_6–Pendimethalin 1000 g ha^{-1} (PE) fb HW at 45 DAS (7864.82 kg ha^{-1}). The lowest biological yield was observed under weedy check (4684.70 kg ha^{-1}). Harvest index was not significantly influenced by different weed management practices, although numerically higher values were observed under weed-free treatment (29.09%) followed by T_7–Metribuzin @ 175 g ha^{-1} fb HW at 45 DAS (29.07%). The improved biological yield and harvest index under integrated weed management treatments may be attributed to enhanced crop growth, efficient dry matter production and better partitioning of assimilates towards economic yield. Similar findings were reported by Raj *et al.* (2020), Ankit Singh *et al.* (2020), and Dash and Shukla (2025).

Table 1: Effect of different weed management practices on Yield attributes of mustard

Tr. No.	Treatments	Yield attributes			
		Number of siliquae per plant	**Number of seed per siliquae**	**Length of siliquae (cm)**	**Test weight (g)**
T_1	Pendimethalin 1000g ha^{-1} (PE)	245.79	13.59	5.11	3.80
T_2	Metribuzin 175g ha^{-1} (PE)	260.28	14.38	5.43	3.80
T_3	Oxyfluorfen 250g ha^{-1} (PE)	239.48	13.25	4.97	3.79
T_4	Clodinafop propargyl 60g ha^{-1} (PoE)	218.54	12.09	4.51	3.75
T_5	Propaquizalafop 100g ha^{-1} (PoE)	229.02	12.64	4.74	3.78
T_6	Pendimethalin 1000g ha^{-1} (PE) *fb* HW at 45 DAS	295.02	16.27	6.26	3.87
T_7	Metribuzin 175g ha^{-1} *fb* HW at 45 DAS	304.22	16.75	6.47	3.88
T_8	Clodinafop propargyl 60g ha^{-1} *fb* HW at 45 DAS	276.60	15.27	5.84	3.85
T_9	Weed Free	326.05	17.86	7.02	3.93
T_{10}	Weedy check	187.85	10.52	3.98	3.72
S. Em±		6.61	0.52	0.16	0.14
C.D. (P=0.05)		19.64	1.55	0.48	NS

Fig. 1: Effect of different weed management practices on Yield attributes of mustard

Table 2: Effect of different weed management practices on yield of mustard

Tr. No.	Treatments	Yield			
		Seed yield (kg ha^{-1})	**Stover yield (kg ha^{-1})**	**Biological yield (kg ha^{-1})**	**Harvest index (%)**
T_1	Pendimethalin 1000g ha^{-1} (PE)	1822.27	4665.09	6487.36	28.09
T_2	Metribuzin 175g ha^{-1} (PE)	1934.67	4936.42	6871.09	28.16
T_3	Oxyfluorfen 250g ha^{-1} (PE)	1769.81	4548.59	6318.40	28.01
T_4	Clodinafop propargyl 60g ha^{-1} (PoE)	1603.36	4163.02	5766.39	27.81
T_5	Propaquizalafop 100g ha^{-1} (PoE)	1690.47	4356.33	6046.80	27.96
T_6	Pendimethalin 1000g ha^{-1} (PE) *fb* HW at 45 DAS	2271.64	5593.18	7864.82	28.88
T_7	Metribuzin 175g ha^{-1} *fb* HW at 45 DAS	2379.22	5804.41	8183.63	29.07
T_8	Clodinafop propargyl 60g ha^{-1} *fb* HW at 45 DAS	2080.02	5214.96	7294.99	28.51
T_9	Weed Free	2501.60	6098.12	8599.72	29.09
T_{10}	Weedy check	1275.97	3408.73	4684.70	27.24
S. Em±		38.67	93.93	132.60	--
CD (P = 0.05)		114.89	279.08	393.97	--

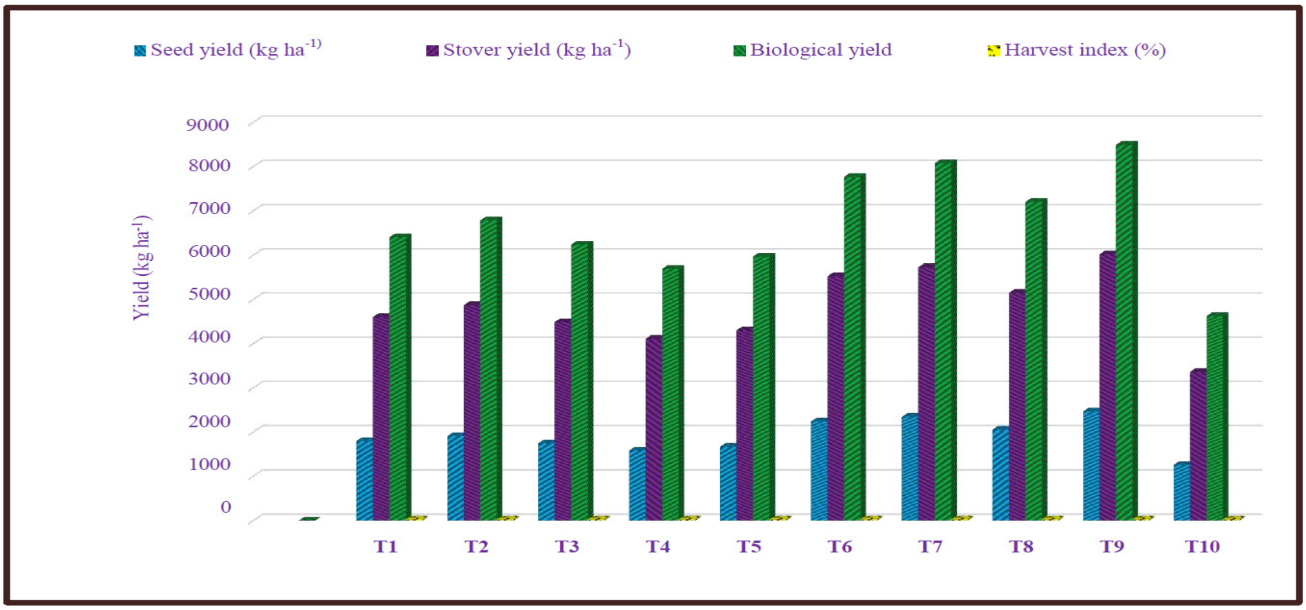

Fig 2: Effect of different weed management practices on yield of mustard

Effect on Economics

Gross return was significantly influenced by different weed management treatments. The highest gross return was recorded under the weed-free treatment (Rs. 156,063 ha^{-1}), followed by T_7–Metribuzin @ 175 g ha^{-1} fb hand weeding at 45 DAS (Rs. 148,435 ha^{-1}) and T_6–Pendimethalin 1000 g ha^{-1} (PE) fb hand weeding at 45 DAS (Rs. 139,360 ha^{-1}), whereas the lowest gross return was observed under the weedy check (Rs. 80,044.2 ha^{-1}). The higher gross return under effective weed management practices may be attributed to increased seed yield and efficient utilization of nutrients, moisture, light and space due to reduced weed competition. Similar findings have been reported by Sharma *et al.* (2004), Daiyib *et al.* (2025), Maurya *et al.* (2025).

Among the weed management treatments, T_7–Metribuzin @ 175 g ha^{-1} fb hand weeding at 45 DAS recorded the highest net return (Rs. 109,823 ha^{-1}), followed by the weed-free treatment (Rs. 109,223 ha^{-1}) and T_6–Pendimethalin 1000 g ha^{-1} (PE) fb hand weeding at 45 DAS (Rs. 100,165 ha^{-1}). The minimum net return was recorded under the weedy check (Rs. 45,203.8 ha^{-1}). Higher net returns under integrated weed management practices may be attributed to higher seed yield and effective weed suppression, which offset the additional cost of herbicide application and manual weeding. Similar observations have been reported by Mankar (2015), Sharma *et al.* (2004), Maurya *et al.* (2025), and Behera *et al.* (2025).

The highest benefit–cost ratio was recorded under T_7–Metribuzin @ 175 g ha^{-1} fb hand weeding at 45 DAS (2.84), followed by T_6–Pendimethalin 1000 g ha^{-1} (PE) fb hand weeding at 45 DAS (2.56) and T_8–Clodinafop-propargyl 60 g ha^{-1} fb hand weeding at 45 DAS (2.36), whereas the lowest benefit–cost ratio was observed under the weedy check (1.30). The superior benefit–cost ratio under integrated weed management practices may be attributed to effective weed suppression, increased crop productivity and improved profitability. Similar results were reported by Daiyib *et al.* (2025), Maurya *et al.* (2025), Behera *et al.* (2025), and Dash and Shukla (2023).

Table 3: Effect of different weed management practices on Economics of mustard

Tr. No.	Treatments	Common cost of cultivation (Rs. ha^{-1})	Cost of treatment cost (Rs. ha^{-1})	Total cost of cultivation (Rs. ha^{-1})	Gross return (Rs. ha^{-1})	Net return (Rs. ha^{-1})	Benefit-Cost ratio (Rs. re^{-1} invested)
T_1	Pendimethalin 1000g ha^{-1} (PE)	34840.41	1955	36795.4	114013	77218	2.10
T_2	Metribuzin 175g ha^{-1} (PE)	34840.41	1371.65	36212.1	121022	84809.5	2.34
T_3	Oxyfluorfen 250g ha^{-1} (PE)	34840.41	2321	37161.4	110757	73595.8	1.98

T_4	Clodinafop propargyl 60g ha^{-1} (PoE)	34840.41	1440	36280.4	100404	64123.4	1.77
T_5	Propaquizalafop 100g ha^{-1} (PoE)	34840.41	2580	37420.4	105809	68389	1.83
T_6	Pendimethalin 1000g ha^{-1} (PE) *fb* HW at 45 DAS	34840.41	4355	39195.4	139360	100165	2.56
T_7	Metribuzin 175g ha^{-1} *fb* HW at 45 DAS	34840.41	3771.65	38612.1	148435	109823	2.84
T_8	Clodinafop propargyl 60g ha^{-1} *fb* HW at 45 DAS	34840.41	3840	38680.4	129977	91296.8	2.36
T_9	Weed Free	34840.41	12000	46840.4	156063	109223	2.33
T_{10}	Weedy check	34840.41	0	34840.4	80044.2	45203.8	1.30

Conclusion

On the basis of the experiment conducted during Rabi 2025–26, it can be concluded that integrated weed management practices significantly improved biological yield, harvest index, and economics of mustard. Among the treatments, T7–Metribuzin @ 175 g ha^{-1} *fb* HW at 45 DAS proved superior with respect to seed yield (2379.22 kg ha^{-1}), biological yield (8183.63 kg ha^{-1}), net return (Rs. 109823 ha^{-1}), and benefit-cost ratio (2.84).

The weed free treatment recorded the highest biological yield (8599.72 kg ha^{-1}) and gross return (Rs. 156063 ha^{-1}), whereas the weedy check treatment consistently recorded the lowest yield and economic returns due to severe weed competition. Therefore, integrated application of herbicides along with hand weeding can be recommended for sustainable and profitable mustard cultivation under the Gird region of Madhya Pradesh.

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