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INFLUENCE OF WEED MANAGEMENT STRATEGIES ON GROWTH PARAMETERS AND YIELD OF CHICKPEA (*CICER ARIETINUM* L.)

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ABSTRACT

A field experiment was carried out during the *Rabi* season of 2024–25 at Crop Research Centre-1, School of Agriculture, ITM University, Gwalior (M.P.) to evaluate the influence of weed management practices on chickpea (*Cicer arietinum* L.). The treatments included rice straw mulch at 2, 4, and 6 t ha^{-1}, herbicidal applications of Metolachlor, Pendimethalin, Oxyfluorfen, and Metribuzin, along with weedy and weed-free checks, arranged in a factorial randomized block design. The results indicated that rice straw mulch at 6 t ha^{-1} and Metribuzin at 125 g a.i. ha^{-1} significantly reduced weed density and weed index while recording higher weed control efficiency. These treatments improved crop productivity by enhancing grain yield, stover yield, biological yield and harvest index, producing yield levels nearly comparable to the weed-free check. Among herbicides, Metribuzin was most effective, while the integrated use of rice straw mulch and Metribuzin emerged as a practical, eco-friendly, and economically viable approach for sustainable weed management in chickpea.

Key words : Chickpea, Weed management, Mulching, Herbicides, Growth attributes, Yield components, Grain yield, Straw yield, Harvest index, Metribuzin, Rice straw mulch.

Introduction

Chickpea (*Cicer arietinum* L.) is one of the world's most important grain legumes, ranking third after dry beans and dry peas. Cultivated since ancient times, it remains a staple food in South Asia, Africa, and the Mediterranean. Its seeds are valued for high protein content (21–30%), carbohydrates, dietary fiber, and essential minerals such as iron, phosphorus, and zinc (Wood and Grusak, 2007). As an affordable protein source, chickpea is crucial in vegetarian diets, while bioactive compounds contribute to health benefits, classifying it as a functional food (Mallikarjuna *et al*., 2007).

Agronomically, chickpea contributes to sustainability through nitrogen fixation, improving soil fertility and reducing dependence on synthetic fertilizers (Gaur *et al*., 2012). It thrives in arid and semi-arid climates due to low input requirements and adaptability to marginal soils. Globally, chickpea covers about 17 million hectares with 17.2 million tonnes production and 1012 kg ha^{-1} productivity (FAOSTAT, 2023). India dominates global production with 9.85 million ha area, 11.99 million tonnes production and 1217 kg ha^{-1} productivity (Anonymous, 2021). Madhya Pradesh leads with 2.21 million ha, 3.09 million tonnes, and 1468 kg ha^{-1} productivity (Anonymous, 2023). In the Gird region—Gwalior, Morena, and Bhind—chickpea occupies large areas; Gwalior alone covers about 92,000 ha with 1400–1500 kg ha^{-1} yield (Department of Agriculture, MP, 2023).

Despite its importance, chickpea yields are constrained by several factors, with weed infestation being particularly severe. The crop grows slowly in early stages, has a shallow root system and limited canopy, making it vulnerable to weeds (Ali *et al*., 2011). Weeds compete for water, nutrients, light, and space, reducing plant vigor, pod formation and seed size. Yield losses range from 40% to 80%, depending on weed flora and intensity (Vaishya *et al*., 1996).

In the Gird region, common weeds include grassy species (*Phalaris minor*, *Avena ludoviciana*), broadleaf weeds (*Chenopodium album*, *Melilotus indica*, *Fumaria parviflora*, *Anagallis arvensis*), and sedges (*Cyperus rotundus*). These germinate quickly, grow aggressively, and compete strongly with chickpea (Kumar *et al*., 2020). Left uncontrolled, they can drastically reduce yield and impair crop quality.

Herbicides offer efficient control, especially for large-scale cultivation. Pre-emergence herbicides such as pendimethalin, metolachlor, oxyfluorfen, and metribuzin provide broad-spectrum control. However, chickpea is sensitive to many chemicals, and the margin between effective and phytotoxic doses is narrow (Singh *et al*., 2012). Misuse may cause crop injury, reduced nodulation, residues, and resistance (Patel *et al*., 2016).

Integrated Weed Management (IWM) offers a sustainable approach by combining cultural, mechanical and chemical methods to minimize environmental risks (Harker and O'Donovan, 2013). Cultural strategies like early sowing, higher seed rates, and competitive cultivars enhance chickpea's weed suppression. Rotations with cereals help reduce specific weed populations. Mechanical operations, though limited, remain useful where feasible.

Mulching has gained prominence among IWM strategies. Applying crop residues like rice straw acts as a physical barrier, suppressing weeds while improving soil moisture, organic matter, and microclimate (Mahmood *et al*., 2015). Studies show that higher mulch rates effectively reduce weed density and enhance chickpea growth and yield. Combined with herbicides, mulching ensures short- and long-term suppression, improves soil health and reduces chemical dependence.

Previous studies (Tiwari *et al*., 2017; Kumar *et al*., 2020) highlight the benefits of improved weed control, but site-specific evaluations under Gird's agro-ecological conditions are limited. Localized research considering weed flora, soil type, and cropping practices is essential for practical farmer recommendations.

Materials and Methods

The field experiment was conducted during the *rabi* season of 2024–25 at CRC-1, ITM University, Gwalior, situated in the Gird region of Madhya Pradesh. The experimental site falls under a semi-arid, sub-tropical climate, well suited for chickpea cultivation. The soil of the field was sandy clay loam in texture with medium fertility status, which provided a suitable base for the study.

The experiment was laid out in a randomized block design (RBD) with fourteen treatments replicated three times. Each gross plot measured 3.6 × 4.0 m, while the net plot for data collection was 3.0 × 3.6 m. Buffer zones of one meter were maintained between plots to avoid the overlapping effect of treatments. The design and randomization were followed as per the method of Fisher and Yates (Panse and Sukhatme, 1985), ensuring statistical validity and minimizing field variability.

The treatments consisted of different combinations of rice straw mulch levels and pre-emergence herbicides, along with two controls. Three levels of rice straw mulch, i.e., 2, 4 and 6 tonnes per hectare, were combined with four herbicides, namely Metolachlor at 1250 g a.i./ha, Pendimethalin at 1000 g a.i./ha, Oxyfluorfen at 250 g a.i./ha and Metribuzin at 125 g a.i./ha. These combinations aimed to evaluate the integrated effect of mulching and chemical weed control on chickpea performance. In addition, a weed-free check maintained through manual weeding and a weedy check without any weed control were included as controls for comparison. This treatment structure made it possible to assess not only the individual effects of mulching and herbicides but also their combined influence on weed suppression, soil environment, and crop productivity.

The test crop was chickpea (*Cicer arietinum* L.) variety RVS 203, chosen for its adaptability to the region and stable yield performance. Sowing was undertaken with a seed rate of 80 kg/ha, maintaining a spacing of 30 cm between rows and 10 cm between plants. Fertilizer was applied uniformly across all plots at the recommended dose of 20:60:20 kg N, P_2O_5 and K_2O per hectare as basal at sowing to eliminate fertility bias. This ensured that any observed differences in growth and yield could be attributed primarily to the treatments.

The experimental approach combined cultural and chemical methods of weed management. Rice straw mulch was expected to reduce weed germination, conserve soil moisture, and improve the microclimate of the crop, while herbicides offered selective and timely control of the dominant weed flora. The weed-free check provided a reference point for maximum attainable yield under ideal weed-free conditions, whereas the weedy check reflected the extent of yield losses due to weed competition.

All plots were carefully managed throughout the season with timely irrigation, plant protection measures, and other standard agronomic practices to ensure uniform crop growth. Observations were recorded on weed density, weed dry matter, crop growth parameters, yield attributes, and final yield. The data were subjected to statistical analysis to evaluate treatment effects and draw reliable conclusions. The analysis of variance (ANOVA) and other statistical interpretations were carried out using online tool Agri Analyze (Popat *et al.*, 2024).

Results and Discussion

Different weed species at harvest stage

At harvest, weed density of chickpea was significantly influenced by weed management treatments. The weed-free check (C1) maintained zero weeds, while the weedy check (C2) recorded the highest density (190.58 m^{-2}), dominated by Chenopodium album, Anagallis arvensis, and Phalaris minor. Rice straw mulch at 6 t ha^{-1} (R3) reduced weed density to 105.26 m^{-2}, while Metribuzin @125 g a.i. ha^{-2} (H4) was most effective among herbicides (76.55 m^{-2}). The suppression under R3 was due to mulch-induced physical barriers, while H4's efficacy was attributed to broad-spectrum residual control, corroborating earlier reports.

Weed control efficiency and weed index of weed

The results on weed control efficiency (WCE) and weed index (WI) indicated significant differences among treatments (Table 4.8). The weed-free check (C1) achieved 100% WCE with 0% WI, while the weedy check (C2) had 0% WCE and the highest WI (48.38%), confirming severe yield loss due to weed competition.

Among mulching treatments, rice straw mulch at 6 t ha^{-1} (R3) recorded the highest WCE (78.51%) and the lowest WI (11.47%), followed by R2 (75.39% WCE, 23.44% WI) and R1 (70.02% WCE, 35.09% WI). This demonstrates that higher mulch levels effectively suppressed weeds and

Table 1 : Effect of Weed Management Practices on density (no. m^{-2}) of different weed species at harvest stage in chickpea.

Treatment	Sedges	Grassy weed	Broad weed leaf				Other weeds	Total weeds
	Cyperus rotundus	*Phalaris minor*	*Chenopodium album*	*Anagallis arvensis*	*Convolvulus arvensis*	*Melilotus indica*		
Rice straw mulch								
R.S.M at 2t/ha	2.67(6.74)	4.25(18.36)	5.14(26.67)	4.04(16.21)	4.61(21.28)	5.56(31.32)	5.18(27.53)	12.04(148.11)
R.S.M at 4t/ha	2.40(5.33)	3.94(15.64)	4.63(21.47)	3.63(12.98)	4.16(17.49)	4.97(25.08)	4.79(23.54)	10.96(121.55)
R.S.M at 6t/ha	2.19(4.39)	3.67(13.82)	4.43(19.73)	3.48(11.99)	3.80(14.39)	4.49(20.20)	4.47(20.74)	10.10(105.26)
SE(m)±	0.08	0.10	0.12	0.08	0.13	0.18	0.13	0.16
LSD(P=0.05)	0.25	0.28	0.34	0.24	0.39	0.51	0.38	0.48
Herbicides								
Metolachlor at 1250 g/ha	2.25(4.65)	4.83(23.05)	5.56(30.99)	4.35(18.74)	4.73(22.61)	5.58(31.48)	5.88(34.73)	12.87(166.24)
Pendimethalin at 1000 g/ha	2.81(7.49)	3.23(10.21)	4.31(18.27)	3.39(11.11)	4.26(18.20)	5.13(26.72)	3.92(15.10)	10.28(107.10)
Oxyfluorfen at 250 g/ha	2.38(5.26)	4.69(21.62)	5.19(26.68)	4.07(16.22)	4.44(19.45)	5.34(28.25)	5.74(32.53)	12.23(150.00)
Metribuzin at 125 g/ha	2.23(4.55)	3.06(8.89)	3.87(14.56)	3.05(8.85)	3.33(10.63)	3.97(15.68)	3.72(13.38)	8.75(76.55)
SE(m)±	0.10	0.11	0.14	0.10	0.15	0.20	0.15	0.19
LSD(P=0.05)	0.28	0.33	0.39	0.28	0.45	0.59	0.44	0.55
Check plots								
Weed free check	0.71(0.00)	0.71(0.00)	0.71(0.00)	0.71(0.00)	0.71(0.00)	0.71(0.00)	0.71(0.00)	0.71(0.00)
Weedy check	3.26(10.49)	4.98(24.34)	5.91(34.42)	4.63(20.93)	5.11(25.60)	6.21(38.15)	6.09(36.66)	13.81(190.58)
R×H interaction								
SE(m)±	0.17	0.20	0.24	0.17	0.27	0.35	0.26	0.33
LSD(P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS

Table 2 : Effect of Weed Management Practices on weed control efficiency, weed index of weed.

Treatment	Weed control efficiency (%)	Weed index (%)
Rice straw mulch		
R.S.M at 2t/ha	70.02	22.12
R.S.M at 4t/ha	75.39	15.28
R.S.M at 6t/ha	78.51	11.47
SE(m)±	–	–
LSD (P=0.05)	–	–
Herbicides		
Metolachlor at 1250 g/ha	66.88	27.72
Pendimethalin at 1000 g/ha	77.68	11.20
Oxyfluorfen at 250 g/ha	69.69	19.68
Metribuzin at 125 g/ha	84.31	6.58
SE(m)±	–	–
LSD (P=0.05)	–	–
Check plots		
Weed free check	100	0.00
Weedy check	0	30.43
R×H interaction		
SE(m)±	–	–
LSD (P=0.05)	–	–

Metribuzin (H4) gave the highest WCE (84.31%) and lowest WI (6.58%), followed by Pendimethalin (H2) with 77.68% WCE and 11.20% WI. H1 and H3 were less effective. These results confirm the broad-spectrum efficacy of H4, consistent with earlier reports.

Weed dry matter accumulation

The data on weed dry matter accumulation at 30, 60, 90 DAS and harvest (Table 3) revealed significant differences among treatments. The weed-free check (C1) recorded zero weed biomass at all stages, whereas the weedy check (C2) showed continuous increase from 37.92 g m^{-2} at 30 DAS to 112.75 g m^{-2} at harvest, confirming unchecked weed proliferation. Among mulching treatments, rice straw mulch at 6 t ha–¹ (R3) consistently recorded the lowest weed dry matter (37.42 g m^{-2} at harvest), followed by R2 (45.25 g m^{-2}), both significantly superior to R1 (52.65 g m^{-2}). Herbicidal treatments were more effective, with Metribuzin (H4) recording the lowest weed dry matter (27.21 g m^{-2} at harvest), followed by Pendimethalin (H2, 38.07 g m^{-2}), while H1 and H3 were less effective. The superior performance of H4 may be attributed to its residual activity suppressing successive weed flushes, in agreement with Pandey *et al*. (2018).

Table 3 : Effect of Weed Management Practices on dry matter of weed at different stages of chickpea.

Treatment	Dry matter (g m^{-2}) of weed			
	30 DAS	60 DAS	90 DAS	At harvest
Rice straw mulch				
R.S.M at 2t/ha	4.17(17.33)	4.68(21.88)	6.45(45.25)	7.15(52.65)
R.S.M at 4t/ha	3.80(14.07)	4.24(17.88)	5.88(34.58)	6.56(43.21)
R.S.M at 6t/ha	3.54(20.69)	3.96(15.68)	5.36(30.08)	6.05(37.42)
SE(m)±	0.08	0.12	0.28	0.20
LSD (P=0.05)	0.25	0.35	0.80	0.57
Herbicides				
Metolachlor at 1250 g/ha	4.38(18.79)	4.91(24.17)	6.89(47.26)	7.63(59.10)
Pendimethalin at 1000 g/ha	3.65(13.10)	4.07(16.29)	5.43(30.69)	6.15(38.07)
Oxyfluorfen at 250 g/ha	4.21(17.37)	4.74(22.12)	6.56(42.79)	7.31(53.33)
Metribuzin at 125 g/ha	3.10(9.16)	3.45(11.45)	4.71(21.80)	5.25(27.21)
SE(m)±	0.12	0.14	0.32	0.30
LSD (P=0.05)	0.36	0.41	0.93	0.88
Check plots				
Weed free check	0.71(0.00)	0.71(0.00)	0.71(0.00)	0.71(0.00)
Weedy check	6.19(37.92)	8.56(72.99)	9.99(99.47)	10.64(112.75)
R×H interaction				
SE(m)±	0.21	0.34	0.55	0.53
LSD (P=0.05)	NS	NS	NS	NS

minimized yield reduction.

Herbicidal treatments were superior to mulching.

Table 4 : Effect of Weed Management Practices on yield of chickpea.

Treatment	Yield (kg ha^{-1})			Harvest index(%)
	Grain	Stover	Biological	
Rice straw mulch				
R.S.M at 2t/ha	2008.71	4172.23	6180.94	32.55
R.S.M at 4t/ha	2185.01	4279.62	6464.63	33.75
R.S.M at 6t/ha	2283.34	4587.23	6870.57	33.16
SE(m)±	50.45	104.17	130.77	–
LSD (P=0.05)	146.64	302.76	380.08	–
Herbicides				
Metolachlor at 1250g/ha	1864.34	3934.73	5799.08	32.14
Pendimethalin at 1000g/ha	2290.46	4566.52	6856.98	33.41
Oxyfluorfen at 250 g/ha	2071.66	4166.02	6237.68	33.21
Metribuzin at 125 g/ha	2409.62	4718.17	7127.79	33.85
SE(m)±	58.26	120.28	151.00	–
LSD (P=0.05)	82.37	349.60	438.88	–
Check plots				
Weed free check	2579.21	5134.95	7714.15	33.47
Weedy check	1794.24	3796.63	5590.86	32.13
R×H interaction				
SE(m)±	100.90	208.33	261.53	–
LSD (P=0.05)	NS	NS	NS	–

Yield

Grain and stover yields of chickpea were significantly influenced by both mulch and herbicidal treatments. Among mulch levels, R3 (rice straw mulch at 6 t ha^{-1}) consistently recorded the highest grain (2283.34 kg ha^{-1}), stover (4587.23 kg ha^{-1}) and biological yields (6870.57 kg ha^{-1}), which can be attributed to improved soil moisture conservation, moderated temperature, and weed suppression. Similarly, herbicidal treatments showed marked variation, with H4 (Metribuzin @ 125 g a.i./ha) producing the highest grain (2409.62 kg ha^{-1}), stover (4718.17 kg ha^{-1}) and biological yield (7127.79 kg ha^{-1}). The weed-free check (C1) recorded maximum productivity (grain 2579.21 kg ha^{-1}, stover 5134.95 kg ha^{-1}), while the weedy check (C2) registered the lowest yields (grain 1794.24 kg ha^{-1}, stover 3796.63 kg ha^{-1}), confirming the detrimental effect of weed competition. Harvest index remained statistically unaffected, but showed minor numerical variation. Overall, effective mulching and metribuzin application ensured superior yield performance by sustaining growth and reducing weed pressure.

Conclusion

Rice straw mulch at 6 t ha^{-1} and Metribuzin at 125 g a.i./ha proved most effective in suppressing weeds, enhancing nutrient uptake, and improving growth, yield, and economics of chickpea under Gird region conditions. This integrated approach offers superior productivity and profitability, warranting further validation for future recommendations.

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