Plant Archives Vol. 26, Supplement 2, 2026 pp. 3191-3197 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org
DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2026.v26.supplement-2.406

INFLUENCE OF PRE AND POST EMERGENCE HERBICIDES ON WEED DENSITY, WEED DRY WEIGHT, PERCENT WEED CONTROL, WEED CONTROL EFFICIENCY AND YIELD OF CROP IN CHICKPEA AND MUSTARD INTERCROPPING

Muskan, Amit Dhankar, Abha Thakur* and Janak Yadav
Faculty of Agriculture, Maharishi Markandeshwar (Deemed to be) University, Mullana, Ambala (Haryana), India 133207
*Corresponding author E-mail: amitdhankarhau@gmail.com
(Date of Receiving : 08-05-2026; Date of Revision : 29-06-2026; Date of Acceptance : 22-07-2026)

ABSTRACT

A field experiment was conducted during the rabi seasons of 2024–25 at the Research Farm of Maharishi Markandeshwar (Deemed to be University), Mullana, Ambala, Haryana, to study the “Influence of Pre and Post Emergence Herbicides on Weed Density, weed dry weight, Percent Weed Control, Weed control efficiency and Yield of crop in Chickpea and Mustard Intercropping”. Thirteen herbicidal treatments were evaluated, along with a weed free and weedy check. Among pre-emergence (PRE) herbicides pendimethalin, quizalafop-ethyl and pendimethalin + imazethapyr (RM) were applied alone or in combination with hand weeding (HW). Among post-emergence (PoE) herbicides oxyfluorfen, clodinafop-propargyl were applied. Among the herbicidal treatments, pendimethalin followed by oxyfluorfen (T_6) recorded the highest weed control at 60 DAS (95.4%) and 90 DAS (95.7%), while pendimethalin + imazethapyr (T_{10}) provided the best early-season weed control (81% at 30 DAS). Paddy straw mulch (T_{11}) also maintained consistently high weed control efficiency (91.7–93.2%) across all stages. Severe phytotoxicity (80% and 85%) to chickpea crop upon PoE application of oxyfluorfen (T5).
***Keywords* :** chickpea; herbicides; phytotoxicity; weed control efficiency; yield and percent weed control.

Introduction

Chickpea (*Cicer arietinum* L.) is a major pulse crop, while mustard (Brassica juncea L.) is one of the most important oilseed crops cultivated during the winter season. Among oilseed crops in India, mustard ranks second after soybean and contributes approximately one-third of the country’s total oilseed production. During [2023–24], mustard was cultivated over an area of about [9.18] million hectares with a total production of [13.26] million metric tonnes, whereas chickpea was cultivated over an area of about [9.58] million hectares with a total production of [11.03] million metric tonnes (Anonymous, 2023). Intercropping involves cultivating two or more crops simultaneously on the same piece of land in a defined spatial arrangement. It is recognized as an efficient and sustainable cropping system that often enhances productivity and stability relative to sole cropping. Intercropping increases cropping intensity and provides higher returns per unit area by utilizing natural resources such as solar radiation, soil moisture, nutrients, and space more efficiently in both temporal and spatial dimensions. Additionally, intercropping contributes to agroecological sustainability by suppressing weeds, reducing pest and disease incidence, and improving soil health. In this context, chickpea–mustard intercropping has emerged as a promising agronomic strategy for improving productivity, profitability, and sustainability of cropping systems. The chickpea–mustard system facilitates efficient utilization of light, water, nutrients, and available growing space. Contrasting growth habits and rooting patterns of the two crops reduce interspecific competition and promote complementary resource use. Inclusion of chickpea also enhances soil fertility through biological nitrogen fixation, which can benefit the associated mustard crop.

Weed infestation is a major biotic constraint limiting the productivity of both chickpea and mustard across diverse agroclimatic regions. Weeds compete with crops for essential resources nutrients, soil moisture, light, and space adversely affecting crop growth, yield components, and final grain or oilseed yield. Under severe infestation, uncontrolled weed growth can reduce chickpea yields by 30–54% (Mukherjee, 2007). In mustard, yield losses of 20–30% are commonly reported and may exceed 80% depending on weed density, species composition, and duration of competition (Punier *et al*., 2010). The severity of weed competition is particularly high during early crop growth because both species exhibit slow initial growth, limited ground cover, and reduced canopy development. During this vulnerable period, weeds establish rapidly and can dominate the crop environment, reducing crop vigour and resource-use efficiency. The critical period of crop–weed competition for chickpea generally occurs between 30 and 45 days after sowing (DAS) (Hakeem *et al*., 2025). For mustard, the critical period is reported as 15–40 DAS, during which weeds can cause approximately 25–50% yield loss depending on the prevailing weed flora, crop growth stage, and competition intensity (Yadav *et al*., 2017).

Material and Method

A field experiment was conducted during the rabi seasons of 2024–25 and 2025–26 at the Research Farm of Maharishi Markandeshwar (Deemed to be University), Mullana, Ambala, Haryana, (India). The experimental site is situated at 30°32’28” N latitude, 77°16’92” E longitude and an altitude of 264 m above mean sea level. The experimental field had a sandy loam texture with a slightly alkaline reaction (pH 8.13), low available nitrogen and medium levels of available phosphorus and potassium. The experiment was laid out in a Randomized Block Design (RBD) with three replications and 13 treatments. The details of different weed management treatments applied during course of experiment is given below (Table 1). Phytotoxicity symptoms on the crop were assessed at weekly intervals starting from seven days after herbicide application (DAHA) up to 21 DAHA, using a 0– 10 visual rating scale, where 0 indicated no injury and 10 represented complete plant death (11). Weed density was determined by placing a 0.25 m² quadrat randomly at two locations per plot, identifying and counting all weed species within the quadrat. Data were expressed in number of weeds per square meter (m^{-2}) and subjected to square root transformation ($\sqrt{X + 1}$) before statistical analysis to normalise variance. For weed dry weight estimation, the weeds within the quadrat were uprooted, initially sun-dried and then oven-dried at 70 °C until a constant weight was achieved. The dried samples were weighed and expressed as g m^{-2}. Weed control efficiency on dry weight basis and per cent weed control on weed density basis was calculated using the following formula:

WCE (%) = (Weed dry weight in weedy plot - Weed dry weight in treated plot /Weed dry weight in weedy plot) X 100

Percent weed control = (Weed density in weedy plot - Weed density in treated plot /Weed density in weedy plot) X 100

Pre-emergence herbicides were applied immediately after sowing using a knapsack sprayer fitted with a flat-fan nozzle, ensuring uniform spray coverage. Post-emergence herbicides were applied at the recommended crop growth stage under favorable weather conditions using the same sprayer calibrated to deliver the required spray volume. Sequential treatments involved the application of pre-emergence herbicides followed by post-emergence herbicides or manual weeding as per the treatment schedule. Paddy straw mulch was uniformly spread over the soil surface immediately after sowing at the specified rate.

Table 1 : Details of weed management treatment applied in intercropping.

Treatment Details	Dose (g ha^{-1})	Time of Application
T_1: Pendimethalin	1000	PRE
T_2: Pendimethalin *fb* one hand weeding	1000	PRE *fb* 30 DAS
T_3: Clodinafop-propargyl	60	PoE
T_4: Pendimethalin *fb* clodinafop-propargyl	1000 + 60	PRE *fb* PoE
T_5: Oxyfluorfen	100	PoE
T_6: Pendimethalin *fb* oxyfluorfen	1000 + 100	PRE *fb* PoE
T_7: Quizalafop-ethyl	60	PRE
T_8: Quizalafop-ethyl *fb* one hand weeding	60	PRE *fb* 30 DAS
T_9: Quizalafop-ethyl *fb* clodinaafop- propargyl	60 + 60	PRE *fb* PoE
T_{10}: Pendimethalin + imazethapyr (RM)	500	PRE

T_{11}: Paddy straw mulch	5 t ha^{-1}	-
T_{12}: Weed free	-	Hoeing at 30 and 60 DAS
T_{13}: Weedy check	-	-

Results and Discussion

Weed flora

The major weed flora observed in the experimental field comprised predominantly of broad-leaved species such as *Chenopodium album*, *Coronopus didymus*, *Rumex dentatus*, *Fumaria parviflora*, *Convolvulus arvensis*, *Anagallis arvensis* and *Melilotus alba*, exhibiting a relative density ranging from 48.6–62.7 %. Among the narrow-leaved weeds, *Cynodon dactylon*, *Polypogon monspeliensis* and *Phalaris minor* were present, with relative densities ranging between 19.2–25.6 %. Similar weed compositions were reported by earlier studies at comparable agro-ecological sites

Weeds density

The weed management treatments significantly influenced broad-leaved weed, grassy weed, and total weed density at 30 and 90 DAS. The weed-free treatment (T_{12}) consistently recorded the lowest weed density throughout the crop growth period. Among the herbicidal treatments, pendimethalin + imazethapyr (T_{10}) was the most effective at 30 DAS by providing excellent early-season weed control. At 90 DAS, the sequential application of pendimethalin followed by oxyfluorfen (T_6) recorded the lowest weed density among all herbicide treatments, indicating sustained weed suppression. Pendimethalin followed by one hand weeding (T_2) and oxyfluorfen alone (T_5) also effectively reduced weed density compared with individual herbicide applications. Paddy straw mulch (T_{11}) proved to be an effective non-chemical weed management practice by suppressing both broad-leaved and grassy weeds. Individual applications of clodinafop-propargyl (T_3) and quizalafop-ethyl (T_7) were comparatively less effective in controlling the mixed weed flora. The weedy check (T_{13}) recorded the highest weed density at all stages due to the absence of weed control measures. Overall, sequential herbicide application provided better season-long weed control than single herbicide application. Therefore, pendimethalin followed by oxyfluorfen emerged as the most effective practical herbicidal treatment for reducing weed density throughout the crop growth period.

Table 2: Effect of herbicides on weed density at 30 DAS

Treatment Details	Dose (g ha^{-1})	Time of Application	Broad-leaf weeds	Grassy weeds	Total weeds
T_1: Pendimethalin	1000	PRE	6.50(41.3)	3.69(12.6)	7.41(53.9)
T_2: Pendimethalin *fb* one hand weeding	1000	PRE *fb* 30 DAS	6.64(43.1)	3.66(12.3)	7.51(55.4)
T_3: Clodinafop-propargyl	60	PoE	8.59(72.9)	6.94(47.2)	11.00(120.1)
T_4: Pendimethalin *fb* clodinafop-propargyl	1000 + 60	PRE *fb* PoE	6.62(42.8)	3.86(13.9)	7.60(56.7)
T_5: Oxyfluorfen	100	PoE	8.63(73.5)	6.86(46.1)	10.98(119.6)
T_6: Pendimethalin *fb* oxyfluorfen	1000 + 100	PRE *fb* PoE	6.56(42.1)	3.77(13.2)	7.50(55.3)
T_7: Quizalafop-ethyl	60	PRE	8.42(69.8)	4.85(22.5)	9.66(92.3)
T_8: Quizalafop-ethyl *fb* one hand weeding	60	PRE *fb* 30 DAS	8.45(70.5)	4.98(23.8)	9.76(94.3)
T_9: Quizalafop-ethyl *fb* clodinaafop- propargyl	60 + 60	PRE *fb* PoE	8.59(72.9)	4.76(21.7)	9.78(94.6)
T_{10}: Pendimethalin + imazethapyr (RM)	500	PRE	3.59(11.9)	3.54(11.5)	4.94(23.4)
T_{11}: Paddy straw mulch	5 t ha^{-1}	-	2.43(4.9)	2.12(3.5)	3.07(8.4)
T_{12}: Weed free	-	Hoeing at 30 and 60 DAS	1(0.00)	1(0.00)	1(0.00)
T_{13}: Weedy check	-	-	8.72(75.1)	6.98(47.8)	11.13(122.9)
SE(m) ±			0.07	0.06	0.08
C.D at 5% level of significance			0.19	0.17	0.25

Table 3: Effect of herbicides on weed density at 90 DAS

Treatment Details	Dose (g ha^{-1})	Time of Application	Broad-leaf weeds	Grassy weeds	Total weeds
T_1: Pendimethalin	1000	PRE	6.66(43.4)	4.40(18.4)	7.93(61.8)
T_2: Pendimethalin *fb* one hand weeding	1000	PRE *fb* 30 DAS	2.66(6.1)	2.32(4.4)	3.39(10.5)
T_3: Clodinafop-propargyl	60	PoE	8.51(71.4)	5.51(29.4)	10.09(100.8)
T_4: Pendimethalin *fb* clodinafop-propargyl	1000 + 60	PRE *fb* PoE	5.75(32.1)	3.36(10.3)	6.59(42.4)

T_5: Oxyfluorfen	100	PoE	2.1(3.4)	2.00(3)	2.72(6.4)
T_6: Pendimethalin *fb* oxyfluorfen	1000 + 100	PRE *fb* PoE	2.05(3.2)	1.82(2.3)	2.55(5.5)
T_7: Quizalafop-ethyl	60	PRE	6.94(47.2)	4.53(19.5)	8.23(66.7)
T_8: Quizalafop-ethyl *fb* one hand weeding	60	PRE *fb* 30 DAS	2.92(7.5)	2.19(3.8)	3.51(11.3)
T_9: Quizalafop-ethyl *fb* clodinaafop- propargyl	60 + 60	PRE *fb* PoE	6.34(39.2)	3.77(13.2)	7.31(52.4)
T_{10}: Pendimethalin + imazethapyr (RM)	500	PRE	3.44(10.8)	4.40(18.4)	5.50(29.2)
T_{11}: Paddy straw mulch	5 t ha^{-1}	-	2.57(5.6)	2.32(4.4)	3.32(10)
T_{12}: Weed free	-	Hoeing at 30 and 60 DAS	1(0.00)	1(0.00)	1(0.00)
T_{13}: Weedy check	-	-	8.81(76.7)	7.13(49.8)	11.29(126.5)
SE(m) ±			0.07	0.04	0.06
C.D at 5% level of significance			0.19	0.13	0.19

Weeds dry weight

The weed management treatments significantly reduced the dry weight of broad-leaved weeds, grassy weeds, and total weeds at all growth stages. The weed-free treatment (T_{12}) consistently recorded the lowest weed dry weight throughout the crop growth period. At 30 DAS, pendimethalin + imazethapyr (T_{10}) was the most effective herbicidal treatment, recording the lowest weed dry weight among the herbicide treatments. At 90 DAS, the sequential application of pendimethalin followed by oxyfluorfen (T_6) produced the minimum weed dry weight, indicating effective season-long weed suppression. Oxyfluorfen alone (T_5) and pendimethalin followed by one hand weeding (T_2) also significantly reduced weed biomass compared with individual herbicide applications. Paddy straw mulch (T_{11}) effectively suppressed weed growth and recorded lower weed dry weight than most herbicide treatments. The ready-mix pendimethalin + imazethapyr (T_{10}) was highly effective during the early crop stage but its effectiveness declined at later stages. Pendimethalin alone (T_1) and quizalafop-ethyl alone (T_7) provided only moderate weed control. Clodinafop-propargyl alone (T_3) recorded comparatively higher weed dry weight among the herbicide treatments, indicating poor control of mixed weed flora. The weedy check (T_{13}) recorded the highest weed dry weight at 30 and 90 DAS due to unchecked weed growth. Overall, sequential herbicide applications were superior to single herbicide applications in reducing weed biomass. Therefore, pendimethalin followed by oxyfluorfen (T_6) proved to be the most effective practical herbicidal treatment for minimizing weed dry weight throughout the crop season.

Table 4: Effect of herbicides on weed dry weight at 30 DAS

Treatment Details	Dose (g ha^{-1})	Time of Application	Broad-leaf weeds	Grassy weeds	Total weeds
T_1: Pendimethalin	1000	PRE	4.38(18.17)	1.7(1.89)	4.59(20.06)
T_2: Pendimethalin *fb* one hand weeding	1000	PRE *fb* 30 DAS	4.42(18.53)	1.69(1.85)	4.62(20.38)
T_3: Clodinafop-propargyl	60	PoE	5.81(32.81)	2.92(7.55)	6.43(40.36)
T_4: Pendimethalin *fb* clodinafop-propargyl	1000 + 60	PRE *fb* PoE	4.4(18.4)	1.76(2.09)	4.63(20.49)
T_5: Oxyfluorfen	100	PoE	5.9(33.81)	2.97(7.84)	6.53(41.65)
T_6: Pendimethalin *fb* oxyfluorfen	1000 + 100	PRE *fb* PoE	4.37(18.1)	1.73(1.98)	4.59(20.08)
T_7: Quizalafop-ethyl	60	PRE	5.69(31.41)	2.15(3.6)	6(35.01)
T_8: Quizalafop-ethyl *fb* one hand weeding	60	PRE *fb* 30 DAS	5.72(31.73)	2.19(3.81)	6.04(35.53)
T_9: Quizalafop-ethyl *fb* clodinaafop- propargyl	60 + 60	PRE *fb* PoE	5.81(32.81)	2.11(3.47)	6.11(36.28)
T_{10}: Pendimethalin + imazethapyr (RM)	500	PRE	2.47(5.12)	1.65(1.73)	2.8(6.84)
T_{11}: Paddy straw mulch	5 t ha^{-1}	-	1.76(2.11)	1.22(0.49)	1.9(2.6)
T_{12}: Weed free	-	Hoeing at 30 and 60 DAS	1(0.00)	1.00	1.00
T_{13}: Weedy check	-	-	6.09(36.05)	3.10(8.6)	6.76(44.65)
SE(m) ±			0.05	0.02	0.06
C.D at 5% level of significance			0.13	0.06	0.18

Table 5: Effect of herbicides on weed dry weight at 90 DAS

Treatment Details	Dose (g ha^{-1})	Time of Application	Broad-leaf weeds	Grassy weeds	Total weeds
T_1: Pendimethalin	1000	PRE	9.82(95.48)	6.13(36.62)	11.54(132.1)
T_2: Pendimethalin *fb* one hand weeding	1000	PRE *fb* 30 DAS	2.8(6.83)	2.16(3.65)	3.39(10.5)
T_3: Clodinafop-propargyl	60	PoE	12.37(152.08)	7.26(51.74)	14.31(203.83)
T_4: Pendimethalin *fb* clodinafop-propargyl	1000 + 60	PRE *fb* PoE	7.97(62.6)	3.99(14.94)	8.86(77.53)
T_5: Oxyfluorfen	100	PoE	1.94(2.75)	1.92(2.69)	2.54(5.43)
T_6: Pendimethalin *fb* oxyfluorfen	1000 + 100	PRE *fb* PoE	1.76(2.1)	1.84(2.37)	2.34(4.47)
T_7: Quizalafop-ethyl	60	PRE	7.75(59)	5.32(27.32)	9.34(86.32)
T_8: Quizalafop-ethyl *fb* one hand weeding	60	PRE *fb* 30 DAS	3.07(8.4)	1.9(2.61)	3.47(11.01)
T_9: Quizalafop-ethyl *fb* clodinaafop- propargyl	60 + 60	PRE *fb* PoE	8.8(76.44)	4.83(22.31)	9.99(98.75)
T_{10}: Pendimethalin + imazethapyr (RM)	500	PRE	4.39(18.25)	6.01(35.14)	7.38(53.4)
T_{11}: Paddy straw mulch	5 t ha^{-1}	-	3.19(9.17)	3.09(8.53)	4.32(17.69)
T_{12}: Weed free	-	Hoeing at 30 and 60 DAS	1.00	1.00	1.00
T_{13}: Weedy check	-	-	13.32(176.41)	10.15(102.09)	16.71(278.5)
SE(m) ±			0.09	0.05	0.11
C.D at 5% level of significance			0.26	0.14	0.32

Percent weed control

The weed-free treatment (T_{12}) achieved 100% weed control at 30, 60, and 90 DAS and was the most effective treatment throughout the crop growth period. Among the herbicidal treatments, pendimethalin followed by oxyfluorfen (T_6) recorded the highest weed control at 60 DAS (95.4%) and 90 DAS (95.7%), while pendimethalin + imazethapyr (T_{10}) provided the best early-season weed control (81% at 30 DAS). Paddy straw mulch (T_{11}) also maintained consistently high weed control efficiency (91.7–93.2%) across all stages. Sequential applications involving herbicides or hand weeding were more effective than single herbicide applications in maintaining season-long weed control. The weedy check (T_{13}) recorded 0% weed control, confirming severe weed infestation in the absence of weed management.

Table 6 : Percent weed control of total weeds

Treatment Details	Dose (g ha^{-1})	Time of Application	30 DAS	60 DAS	90 DAS
T_1: Pendimethalin	1000	PRE	56.1	45.1	51.1
T_2: Pendimethalin *fb* one hand weeding	1000	PRE *fb* 30 DAS	54.9	90.6	91.7
T_3: Clodinafop-propargyl	60	PoE	-	19.0	20.3
T_4: Pendimethalin *fb* clodinafop-propargyl	1000 + 60	PRE *fb* PoE	53.9	67.0	66.5
T_5: Oxyfluorfen	100	PoE	-	94.7	94.9
T_6: Pendimethalin *fb* oxyfluorfen	1000 + 100	PRE *fb* PoE	55.0	95.4	95.7
T_7: Quizalafop-ethyl	60	PRE	24.9	41.3	47.3
T_8: Quizalafop-ethyl *fb* one hand weeding	60	PRE *fb* 30 DAS	23.3	90.4	91.0
T_9: Quizalafop-ethyl *fb* clodinaafop- propargyl	60 + 60	PRE *fb* PoE	23.0	49.7	58.6
T_{10}: Pendimethalin + imazethapyr (RM)	500	PRE	81.0	76.2	76.9
T_{11}: Paddy straw mulch	5 t ha^{-1}	-	88.4	84.4	85.1
T_{12}: Weed free	-	Hoeing at 30 and 60 DAS	100.0	100.0	100.0
T_{13}: Weedy check	-	-	0.0	0.0	0.0

Weed Control Efficiency

The weed-free treatment (T_{12}) recorded the highest weed control efficiency (100%) at 30, 60, and 90 DAS, indicating complete weed suppression throughout the crop season. Among the herbicidal treatments, pendimethalin followed by oxyfluorfen (T_6) achieved the highest weed control efficiency at 60 DAS (98.2%) and 90 DAS (98.4%), whereas pendimethalin + imazethapyr (T_{10}) was the most effective at the early stage with 84.7% WCE at 30 DAS. Paddy straw mulch (T_{11}) also maintained consistently high weed control efficiency (93.0–94.2%) throughout the crop period. Overall, sequential herbicide applications and integrated weed management practices were more effective than single herbicide applications, while the weedy check (T_{13}) recorded 0% weed control efficiency due to uncontrolled weed growth.

Table 7: Effect of herbicides on weed control efficiency at 30, 60 and 90 DAS

Treatment Details	Dose (g ha^{-1})	Time of Application	30 DAS	60 DAS	90 DAS
T_1: Pendimethalin	1000	PRE	55.1	47.2	52.6
T_2: Pendimethalin *fb* one hand weeding	1000	PRE *fb* 30 DAS	54.4	96.5	96.2
T_3: Clodinafop-propargyl	60	PoE	-	35.2	26.8
T_4: Pendimethalin *fb* clodinafop-propargyl	1000 + 60	PRE *fb* PoE	54.1	75.1	72.2
T_5: Oxyfluorfen	100	PoE	-	97.8	98
T_6: Pendimethalin *fb* oxyfluorfen	1000 + 100	PRE *fb* PoE	55	98.2	98.4
T_7: Quizalafop-ethyl	60	PRE	21.6	48.2	69
T_8: Quizalafop-ethyl *fb* one hand weeding	60	PRE *fb* 30 DAS	20.4	96.3	96
T_9: Quizalafop-ethyl *fb* clodinaafop- propargyl	60 + 60	PRE *fb* PoE	18.8	60	64.5
T_{10}: Pendimethalin + imazethapyr (RM)	500	PRE	84.7	81	80.8
T_{11}: Paddy straw mulch	5 t ha^{-1}	-	94.2	93	93.6
T_{12}: Weed free	-	Hoeing at 30 and 60 DAS	100	100	100
T_{13}: Weedy check	-	-	0	0	0

Crop phytotoxicity

Crop phytotoxicity was recorded in post-emergence treatment of oxyfluorfen at 100 g ha-1 during experiment. In chickpea, the phytotoxicity was 80 % at seven DAHA and 75 % at 14 DAHA and in mustard, the phytotoxicity was 15 % at 7 DAHA and 10 % at 14 DAHA. Crop plants and weeds were both destroyed after the application of oxyfluorfen. The major effect occurred due to the rainfall.

Yield

The significant maximum seed yield (890) of mustard was found in treatment pre-emergence application of pendimethalin + imazethapyr (RM) at 1000 g ha^{-1} and minimum in post-emergence treatment of oxyfluorfen at 100 g ha^{-1} (Table 7) and maximum seed yield (1356) of chickpea was found in treatment hoeing at 30 and 60 DAS and minimum in post-emergence treatment of oxyfluorfen at 100 g ha^{-1} (Table 8) The maximum yield under HW might be due to the early removal of weeds from the crop, which minimised crop weed competition, creating a weed-free environment.

Table 8: Effect of herbicides on yield of mustard

Treatment Details	Dose (g ha^{-1})	Time of Application	seed yield	stover yield	Biological yield
T_1: Pendimethalin	1000	PRE	652	1685	2337
T_2: Pendimethalin *fb* one hand weeding	1000	PRE *fb* 30 DAS	761	1919	2680
T_3: Clodinafop-propargyl	60	PoE	579	1512	2091
T_4: Pendimethalin *fb* clodinafop-propargyl	1000 + 60	PRE *fb* PoE	695	1779	2475
T_5: Oxyfluorfen	100	PoE	381	1168	1549
T_6: Pendimethalin *fb* oxyfluorfen	1000 + 100	PRE *fb* PoE	493	1519	2012
T_7: Quizalafop-ethyl	60	PRE	512	1370	1881
T_8: Quizalafop-ethyl *fb* one hand weeding	60	PRE *fb* 30 DAS	663	1721	2383
T_9: Quizalafop-ethyl *fb* clodinaafop- propargyl	60 + 60	PRE *fb* PoE	590	1555	2145
T_{10}: Pendimethalin + imazethapyr (RM)	500	PRE	890	2210	3100
T_{11}: Paddy straw mulch	5 t ha^{-1}	-	851	2145	2996
T_{12}: Weed free	-	Hoeing at 30 and 60 DAS	902	2340	3242
T_{13}: Weedy check	-	-	393	1080	1473
SE(m) ±			13.6	32.38	45.73
C.D at 5% level of significance			39.96	95.07	134.27

Table 9: Effect of herbicides on yield of chickpea

Treatment Details	Dose (g ha^{-1})	Time of Application	seed yield	Stover yield	Biological yield
T_1: Pendimethalin	1000	PRE	865	2397	3263
T_2: Pendimethalin *fb* one hand weeding	1000	PRE *fb* 30 DAS	1088	2965	4053
T_3: Clodinafop-propargyl	60	PoE	711	1980	2690
T_4: Pendimethalin *fb* clodinafop-propargyl	1000 + 60	PRE *fb* PoE	955	2646	3602

T_5: Oxyfluorfen	100	PoE	161	470	632
T_6: Pendimethalin *fb* oxyfluorfen	1000 + 100	PRE *fb* PoE	176	514	689
T_7: Quizalafop-ethyl	60	PRE	663	1883	2546
T_8: Quizalafop-ethyl *fb* one hand weeding	60	PRE *fb* 30 DAS	882	2456	3338
T_9: Quizalafop-ethyl *fb* clodinaafop- propargyl	60 + 60	PRE *fb* PoE	814	2275	3089
T_{10}: Pendimethalin + imazethapyr (RM)	500	PRE	1214	3272	4486
T_{11}: Paddy straw mulch	5 t ha^{-1}	-	1091	2966	4057
T_{12}: Weed free	-	Hoeing at 30 and 60 DAS	1356	3637	4993
T_{13}: Weedy check	-	-	445	1295	1740
SE(m) ±			24.66	46.8	62.95
C.D at 5% level of significance			72.41	137.43	184.85

Conclusion

The results from one-year study clearly indicate that weed management practices significantly influenced weed density, weed dry weight, percent weed control, and weed control efficiency throughout the crop growth period. The weed-free treatment (T_{12}) consistently recorded the lowest weed density and weed dry weight, along with 100% weed control and weed control efficiency at all observation stages. However, although weed-free management was the best treatment experimentally, it requires repeated manual hoeing and is labor-intensive, making it less practical and uneconomical under farmers' field conditions. Among the herbicidal treatments, Pendimethalin @ 1000 g ha^{-1} as pre-emergence followed by Oxyfluorfen @ 100 g ha^{-1} as post-emergence (T_6) emerged as the most effective and practical weed management treatment. It consistently recorded the lowest weed density and weed dry weight at 90 DAS and achieved the highest weed control (95.4–95.7%) and weed control efficiency (98.2–98.4%) among all herbicide treatments, indicating excellent season-long control of both broad-leaved and grassy weeds. The Pendimethalin + Imazethapyr ready-mix @ 500 g ha^{-1} (T_{10}) provided excellent early-season weed control and was highly effective up to 30 DAS, but its effectiveness declined at later crop stages because of the emergence of new weed flushes. Paddy straw mulch (T_{11}) also proved to be an effective non-chemical alternative by maintaining low weed density and high weed control throughout the season. Based on the overall findings, Pendimethalin @ 1000 g ha^{-1} as pre-emergence followed by Oxyfluorfen @ 100 g ha^{-1} as post-emergence (T_6) is recommended for farmers because it provides effective season-long weed control, minimizes weed density and dry weight, and achieves very high weed control efficiency under field conditions. Where herbicide use is limited or organic approaches are preferred, paddy straw mulch @ 5 t ha^{-1} (T_{11}) can be recommended as an effective alternative for sustainable weed management. The significant maximum seed yield (890) of mustard was found in treatment pre-emergence application of pendimethalin + imazethapyr (RM) at 1000 g ha-1and minimum in post-emergence treatment of oxyfluorfen at 100 g ha^{-1} (Table 7) and maximum seed yield (1356) of chickpea was found in treatment hoeing at 30 and 60 DAS and minimum in post-emergence treatment of oxyfluorfen at 100 g ha^{-1} (Table 8) The maximum yield under HW might be due to the early removal of weeds from the crop, which minimized crop weed competition, creating a weed-free environment.

References

Anonymus (2023)

Mukherjee, D. (2007). Techniques of weed management in chickpea- A review. Agricultural Reviews, *Agricultural Research Communications Centre India*, **28**(1), 34.

Punia, S.S., Yadav, D., Brar, A.P., Yadav, R. and Malik, Y. 2010. Different herbicidal effect on yield of Indian mustard (*Brassica juncea*). *Indian Journal of Weed Science* **42** (1 and 2):70-72.

Hakeem, S. A., Matloob, A., Ghazy, A. H., Fiaz, S., Ali, M., Haq, T. U., ... & Ul Haq, M. Z. (2025). Critical period of weed-crop competition in irrigated chickpea as a tool for judicious weed control. *Scientific Reports*, **15**(1), 32116.

Yadav, A.K., Kureel, R.S., Pratap, T., Singh, P.K., Mehta, S. and Dubey, S.K .2017. Effect of various herbicide molecules on weed management in Indian mustard (*Brassica juncea* L. Czern& coss). *J. Pharmacogn. Phytochem*. **6** (6): 2479-2482.

Niranjan IK, Tyagi S, Kumar B, Pradhan AK. Evaluation of different post-emergence herbicides in chickpea (*Cicer arietinum* L.). *Int J Agric Appl Sci*. 2020;**1**(1):87–91. https://doi.org/10.52804/ ijaas2020.1117