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Minakshi Yadav
Master Scholar, Department of Agronomy, School of Agricultural Sciences, Jaipur National University, Jaipur, Rajasthan, India

Yasir Ajeej Tamboli
Assistant Professor, Department of Agronomy, School of Agricultural Sciences, Jaipur National University, Jaipur, Rajasthan, India

Rajendra Kumar Bansal
Director & Professor, Department of Plant Pathology, School of Agricultural Sciences, Jaipur National University, Jaipur, Rajasthan, India

Ajeet Singh
Assistant Professor, Department of Agronomy, School of Agricultural Sciences, Jaipur National University, Jaipur, Rajasthan, India

Ganesh Ram Chaudhary
Professor, Department of Agronomy, School of Agricultural Sciences, Jaipur National University, Jaipur, Rajasthan, India

EVD Sastry
Professor & Head, Department of Plant breeding and genetics, School of Agricultural Sciences, Jaipur National University, Jaipur, Rajasthan, India

Corresponding Author:
Minakshi Yadav
Master Scholar, Department of Agronomy, School of Agricultural Sciences, Jaipur National University, Jaipur, Rajasthan, India

Assessment of weed control efficiency, weed index, weed persistence index and growth response of chickpea (*Cicer arietinum* L.) under integrated weed management practices

Minakshi Yadav, Yasir Ajeej Tamboli, Rajendra Kumar Bansal, Ajeet Singh, Ganesh Ram Chaudhary and EVD Sastry

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Abstract
The present study was conducted during 2024-25 at the Agronomy Research Farm, Jaipur National University, Jaipur, Rajasthan, to evaluate Integrated Weed Management (INM) practices in chickpea (*Cicer arietinum* L.). The experiment, laid out in a Randomized Block Design with three replications, included ten weed management treatments: T_1-Weedy check (unweeded control), T_2-Weed-free condition maintained throughout the crop growth period, T_3 -Application of Pendimethalin 30% EC @ 1.0 kg ha^{-1} as pre-emergence (PE), T_4-Pendimethalin 30% EC @ 1.0 kg ha^{-1} (PE) followed by one hoeing at 30 days after sowing (DAS), T_5- Oxyfluorfen 23.5% EC @ 0.120 kg ha^{-1} (PE), T_6-Propaquizafop 10% EC @ 0.075 kg ha^{-1} as post-emergence (PoE) at 30 DAS, T_7-Oxyfluorfen 23.5% EC @ 0.120 kg ha^{-1} (PE) + one hoeing at 30 DAS, T_8-Pendimethalin 30% EC @ 1.0 kg ha^{-1} (PE) + Propaquizafop 10% EC @ 0.075 kg ha^{-1} (PoE) at 30 DAS, T_9-Quizalfop-p-ethyl 5% EC @ 0.050 kg ha^{-1} (PoE) at 30 DAS, and T_{10}-Pendimethalin 30% EC @ 1.0 kg ha^{-1} (PE) + Quizalfop-p-ethyl 5% EC @ 0.050 kg ha^{-1} (PoE) at 30 DAS. The study revealed that weed free (T_2) and pendimethalin 30% EC @ 1 kg ha^{-1} (PE) + one hoeing at 30 DAS (T_4) produced significantly higher plant height, number of branches per plant and dry matter accumulation and was at par with oxyfluorfen 23% EC @ 0.120 kg ha^{-1} (PE) + one hoeing at 30 DAS (T_7) by effectively reducing weed population and dry weight. The weedy check consistently recorded the highest weed infestation, lowest weed control efficiency and higher weed index and weed persistence index. Whereas, Integrated weed management did not significantly affect plant stand.

Keywords: Growth, weed control efficiency, weed index, weed persistence, Index Integrated Weed Management (INM), chickpea

Introduction
Chickpea (*Cicer arietinum* L.), belonging to the family Leguminosae, is the third most important legume crop globally, after peas and beans. It is believed to be native to south-eastern Turkey and Syria, from where it spread to other regions. In India, chickpea is the premier rabi-season legume and an integral component of cropping systems due to its suitability in rotations and crop diversification. It contributes significantly to soil fertility through biological nitrogen fixation and organic matter addition. Chickpea seeds are highly nutritive, rich in protein (20 g/100 g), carbohydrates, minerals, and vitamins such as vitamin A, C, K, and folic acid. They provide 358 kcal per 100 g, making them one of the most energy-dense legumes. Chickpea is a source of essential amino acids, and its sprouted seeds are recommended for preventing scurvy. The tender leaves, known locally as "Aamb", are consumed as vegetables and have medicinal value. The dry plant residues, or "Bhoosa", are a valuable protein-rich cattle feed. Chickpea also serves as a cheap source of protein for both human and animal consumption.
According to the Second Advance Estimates for 2023-24, India has 11.07 million ha under chickpea, producing 11.57 million tonnes with an average yield of 1046 kg ha^{-1}. In Rajasthan, 19.73 lakh ha produced 23.45 lakh tonnes at 1189 kg ha^{-1} (Anonymous, 2023) [1]. Major states-Madhya Pradesh, Maharashtra, Rajasthan, Karnataka, Andhra Pradesh, Uttar Pradesh and

Gujarat contribute over 90% of production. With per capita pulse availability declining from 69 g in 1961 to 35.9 g in 2004 (Moorthy & Dubey, 2004) [13], improving chickpea productivity is vital for food and nutritional security

Weeds are a major constraint in chickpea, causing 30-75% yield losses (Mukherjee, 2007 and Chaudhary *et al*., 2011) [14 & 27] by competing for nutrients, water, light, and space, especially during the first 60 days after sowing (Singh and Singh, 2000) [27]. In rainfed conditions, weeds worsen drought stress by efficiently using limited soil moisture (Rao, 2000) [21]. Manual and mechanical weeding are effective but labor-intensive and costly, making chemical control with pre- and post-emergence herbicides a practical alternative. Herbicides like pendimethalin, oxyfluorfen, propaquizafop, and quizalofop-ethyl control both grassy and broadleaf weeds, with varying effectiveness depending on soil and weed flora. Studies show that combinations such as pendimethalin + quizalofop or pendimethalin + imazethapyr give the highest yields and harvest index (Kumar *et al.,* 2020) [20]. Therefore, integrated weed management combining cultural, mechanical, and chemical methods is crucial for sustainable chickpea production. This study evaluates the performance of different weed management practices in chickpea.

Materials and Methods

Experimental Site

The study was conducted at the Research Farm of the School of Agricultural Sciences, Jaipur National University, Jaipur, Rajasthan, situated at 26°85' N latitude and 75°87' E longitude, with an elevation of 390 m. The site falls under the NARP agro-climatic zone IIIa, corresponding to the Semi-Arid Eastern Plain Zone of Rajasthan.

Weather

The region has a hot semi-arid climate with extreme temperatures and moderate rainfall. Summer highs reach 45°C, while winter lows drop to 5°C. Annual rainfall averages 527 mm, with humidity ranging from 20-30% in summer to 60-80% during the monsoon. Winds typically blow at 5-15 km/h, gusting up to 40 km/h during dust storms. Sunshine lasts 8-10 hours in summer, 6-8 hours in winter, and 4-6 hours during the monsoon. In the 2024-25 rabi season, temperatures ranged from 33.8 °C to 8.6 °C, with occasional rainfall.

Sampling and analyses

The soil in the experimental area is sandy loam of Gangetic alluvial origin, with 66.57% sand, 23.82% silt, and 9.61% clay. It has an alkaline pH of 7.79, low organic carbon (0.44%), and moderate levels of nitrogen (176.23 kg/ha), phosphorus (18.83 kg/ha), and high potassium (266.19 kg/ha). Physical analysis showed a bulk density of 1.58 Mg/m^3, particle density of 2.51 Mg/m^3, and porosity of 39.94%. The soil was analyzed using methods like the International Pipette Method and techniques for pH, conductivity, and nutrient analysis, as per established research standards. The procedures used were based on Piper (1950) [19] and Black (1950) [4], Olsen *et al*. (1954) [15], Richards (1954) [19], Subbaiah and Asija (1956) [23] and Jackson (1973) [8].

Experimental setup

The experiment was laid out in Randomized Block Design with three replications. The experiment consists of ten treatments as follows, T_1-Weedy check (unweeded control), T_2-Weed-free condition maintained throughout the crop growth period, T_3 - Application of Pendimethalin 30% EC @ 1.0 kg ha^{-1} as pre-emergence (PE), T_4-Pendimethalin 30% EC @ 1.0 kg ha^{-1} (PE) followed by one hoeing at 30 days after sowing (DAS), T_5-Oxyfluorfen 23.5% EC @ 0.120 kg ha^{-1} (PE), T_6-Propaquizafop 10% EC @ 0.075 kg ha^{-1} as post-emergence (PoE) at 30 DAS, T_7-Oxyfluorfen 23.5% EC @ 0.120 kg ha^{-1} (PE) + one hoeing at 30 DAS, T_8-Pendimethalin 30% EC @ 1.0 kg ha^{-1} (PE) + Propaquizafop 10% EC @ 0.075 kg ha^{-1} (PoE) at 30 DAS, T_9-Quizalfop-p-ethyl 5% EC @ 0.050 kg ha^{-1} (PoE) at 30 DAS, and T_{10}-Pendimethalin 30% EC @ 1.0 kg ha^{-1} (PE) + Quizalfop-p-ethyl 5% EC @ 0.050 kg ha^{-1} (PoE) at 30 DAS. All standard agronomic practices were followed. Growth attributes were recorded from five randomly selected plants per plot, while crop and weed dry matter were measured using a 1.0 m² quadrat at two random locations. Data were statistically analyzed, and correlation coefficients were calculated as per Gomez and Gomez (1984) [7].

Results and Discussion

The data presented in Table 1 to 5 revealed that the influence integrated weed management practices on weed flora, total weed count, weed dry matter at harvest (g), weed control efficiency (%), weed index (%), weed persistence index as well as significantly enhanced the growth parameters *viz.* plant height (cm), number of branches plant per and dry matter accumulation (g) at 30, 60, 90 DAS and at harvest, respectively.

Major weed flora

The experimental site was dominated by grasses, with ten predominant weed species recorded (Table 1). Grasses included *Cynodon dactylon*, *Eragrostis major* and *Digitaria sanguinalis*; broadleaf weeds were *Parthenium hysterophorus*, *Physalis minima*, *Euphorbia geniculata*, *Commelina benghalensis*, *Amaranthus viridis*, and *Portulaca oleracea*; while *Cyperus rotundus* was the only sedge species.

Total weed count (m^{-2})

The total weed population in chickpea as influenced by different weed control treatments at various growth stages is summarized in Tables 2 shows that no weed emergence was recorded under the weed-free treatment throughout the crop growth period. At 30 DAS, the weed-free up to 45 DAS treatment recorded the lowest weed count (0.00 m^{-2}), followed by pendimethalin 30% EC @ 1 kg ha^{-1} (PE), pendimethalin + propaquizafop, pendimethalin + one hoeing and pendimethalin + quizalfop-p-ethyl, which were statistically at par (36.56-37.60 m^{-2}). At later stages (60, 90 DAS and harvest), pendimethalin 30% EC @ 1 kg ha^{-1} (PE) + one hoeing at 30 DAS recorded the lowest weed count, followed closely by oxyfluorfen 23% EC @ 0.120 kg ha^{-1} (PE) + one hoeing. Pre-emergence herbicides (pendimethalin and oxyfluorfen) effectively suppressed grass and broadleaf weeds but were less effective against sedges; however, supplementary hoeing enhanced overall weed control. The weedy check consistently recorded the highest weed counts (132.24-184.16 m^{-2}) due to the absence of any control measures. Similar findings were reported by Dungarwal *et al.* (2002) [6], Kumar *et al.* (2015) [11], Yadav *et al.* (2017) [30] and Jaswal and Menon (2020) [9].

Weed Dry Matter at Harvest

Data on weed dry matter at harvest presented in Table 3 as influenced by different weed control treatments. The weedy check treatment recorded the highest weed dry matter (13.56 g m^{-2}), significantly greater than all other treatments, due to higher weed population and resource utilization. In contrast, the weed-free treatment accumulated the lowest dry matter. Among herbicidal treatments, pendimethalin 30% EC @ 1 kg ha^{-1} (PE) + one hoeing at 30 DAS (4.16 g m^{-2}) and oxyfluorfen 23% EC @ 0.120 kg ha^{-1} (PE) + one hoeing at 30 DAS (4.92 g m^{-2}) recorded the lowest weed dry matter and were statistically at par. Lower weed dry matter in these treatments was attributed to effective weed suppression during the critical growth period. These results are in agreement with Singh *et al.* (2006) [26], Bhutada and Bhale (2014) [3], Kumar *et al*. (2015) [11] and Kumar *et al*. (2020) [20].

Weed Control Efficiency and Weed Index

The data presented in Table 3 & Fig. 1 on weed control efficiency (WCE) and weed index (WI) reflect the effectiveness of weed management and its impact on yield. At harvest, the weed-free up to 45 DAS treatment recorded the highest WCE (100%) and minimum WI (0.00%), indicating complete weed suppression and no yield loss. Among herbicidal treatments, pendimethalin 30% EC @ 1 kg ha^{-1} (PE) + one hoeing at 30 DAS (WCE: 90.67%, WI: 10.38%) and oxyfluorfen 23% EC @ 0.120 kg ha^{-1} (PE) + one hoeing at 30 DAS (WCE: 86.94%, WI: 12.52%) were statistically at par and superior to other treatments. The weedy check recorded the lowest WCE (0%) and highest WI (52.57%) due to uncontrolled weed growth. Higher WCE and lower WI in integrated treatments were attributed to reduced weed density and dry matter, effective suppression by pre-emergence herbicides, and supplemental hoeing, which minimized crop-weed competition and improved yield. These results are in agreement with Poonia (2013) [20], Bhutada and Bhale (2014) [3], Rathod *et al.* (2017) [22] and Singh *et al.* (2020) [25].

Weed Persistence Index

Among the weed control treatments, the lowest weed persistence index (Table3 & Fig. 1) was recorded in weed-free plots up to 45 days (0.00), followed by pendimethalin 30% EC @ 1 kg ha^{-1} (PE) + 1 hoeing at 30 DAS (0.54), which was comparable to oxyfluorfen 23% EC @ 0.120 kg ha^{-1} (PE) + 1 hoeing at 30 DAS (0.62). These treatments outperformed others due to effective weed management and better crop growth, while the highest index was observed in the weedy check (1.00). These results align with Poonia.

Plant Population

Plant population is a key indicator of crop establishment and survival. Integrated weed management practices had no significant effect on plant stand, and herbicide treatments at recommended doses were safe for chickpea. The slight reduction at harvest was mainly due to periodic removal of plants for dry matter analysis (Table 4).

Plant height (cm)

Plant height, a key indicator of vegetative growth and crop vigor, exhibited significant improvement under integrated weed management practices at all stages of growth (Table 4 & Fig. 2). At 30 DAS, plant height differences among weed control treatments were non-significant. However, the weed-free up to 45 DAS treatment recorded the highest height (18.44 cm), followed by pendimethalin 30% EC @ 1 kg ha^{-1} (PE) + one hoeing at 30 DAS (18.38 cm), while the weedy check showed the lowest (16.52 cm). Plant height increased up to harvest, with growth slowing after 90 DAS. At 60 DAS, the weed-free treatment recorded the tallest plants (50.57 cm), comparable to integrated treatments with pendimethalin, oxyfluorfen, quizalofop-p-ethyl, and propaquizafop, while the weedy check was shortest (43.31 cm). Similar trends continued at 90 DAS and harvest (weed-free: 59.17 and 60.54 cm; weedy check: 48.08 and 49.42 cm). Increased height under effective weed management is attributed to reduced competition for light, nutrients, and moisture, consistent with Patel *et al*. (2006) [17], Aslam *et al.* (2007) [2], and Singh *et al.* (2008) [28].

Number of branches plant^{-1} at maturity

The number of branches per plant at various growth stages differed significantly among weed control treatments (Table 5 Fig. 2). The mean number of branches per plant at 30, 60, 90 DAS, and at harvest was 3.89, 13.67, 19.85, and 19.85, respectively. The weed-free up to 45 DAS treatment recorded the highest number of branches (4.43, 17.62, 25.12, and 25.12), which was statistically at par with pendimethalin 30% EC @ 1 kg ha^{-1} (PE) + one hoeing at 30 DAS, oxyfluorfen 23% EC @ 0.120 kg ha^{-1} (PE) + one hoeing at 30 DAS, and other integrated treatments. The weedy check consistently had the lowest number of branches (3.53, 9.31, 13.61, and 13.60 at 30, 60, 90 DAS, and harvest). Higher branching under effective weed management is attributed to reduced crop-weed competition and better nutrient availability, supporting vegetative growth, consistent with Singh *et al.* (2008) [28], Pedde *et al.* (2013) [18], and Patel *et al.* (2016) [16].

Dry Matter Accumulation (g/m^2)

Dry matter accumulation reflects the efficiency of resource utilization under a favorable crop production environment. Data presented in Table 5 & Fig. 2 revealed that dry matter production per plant of chickpea was significantly influenced by weed management treatments. The mean dry matter per plant increased progressively with crop age, measuring 1.80, 15.90, 29.82, and 32.04 g $plant^{-1}$ at 30, 60, 90 DAS and at harvest, respectively. At 30 DAS, the weed-free up to 45 DAS treatment recorded the highest dry matter accumulation (2.28 g $plant^{-1}$), which was statistically at par with pendimethalin 30% EC @ 1 kg ha^{-1} (PE) + one hoeing at 30 DAS (2.17 g $plant^{-1}$) and oxyfluorfen 23% EC @ 0.120 kg ha^{-1} (PE) + one hoeing at 30 DAS (2.09 g $plant^{-1}$). The lowest dry matter accumulation was noted under the weedy check (1.37 g $plant^{-1}$). A similar trend was observed at later stages, with the weed-free treatment producing the highest dry matter (18.43, 34.81, and 37.09 g $plant^{-1}$ at 60, 90 DAS and harvest) and the weedy check the lowest (12.52, 23.07, and 25.18 g $plant^{-1}$). Higher dry matter under effective weed control is attributed to reduced crop-weed competition and better light, nutrient, and moisture utilization, consistent with Singh *et al.* (2008) [28] and Patel *et al.* (2016) [16].

Table 1: Weed flora associated in the experimental plot of chickpea

Weed species	Common name	Family
Grasses		
Cynodon dactylon	*Bermuda grass*	*Poaceae*
Eragrostis major	*Chimanchara*	*Poaceae*
Digitaria sanguinalis L.	*Large crabgrass*	*Poaceae*
Broad leaves weed		
Parthenium hysterophorus L.	*Congress grass*	*Asteraceae*
Physalis minima L.	*Sunberry*	*Solanaceae*
Euphorbia geniculata L.	*Wild poinsettia*	*Euphorbiaceae*
Commelina benghalensis L.	*Day flower*	*Commelinaceae*
Amaranthus viridis	*Slender amaranth*	*Amaranthaceae*
Portulaca oleracea L.	*Common purslane*	*Portulacaceae*
Sedges		
Cyperus rotundus L.	*Purple nut sedge*	*Cyperaceae*

Table 2: Total weed count (m-2) in chickpea as influenced by various weed management practices

Treatment		Total weed count (m-2)			
		30 DAS	60 DAS	90 DAS	At harvest
T_1	Weedy check	11.54 (132.24)	12.81 (163.13)	13.45 (179.87)	13.61 (184.16)
T_2	Weed free	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
T_3	Pendimethalin 30% EC @ 1 kg ha^{-1} (PE)	6.09 (36.57)	7.41 (54.24)	8.05 (64.06)	8.30 (68.17)
T_4	Pendimethalin 30% EC @ 1 kg ha^{-1} (PE) + 1 hoeing at 30 DAS	6.15 (37.19)	4.83 (22.75)	5.351 (28.04)	5.73 (32.19)
T_5	Oxyfluorfen 23% EC @ 0.120 kg ha^{-1} (PE)	7.23 (51.58)	8.52 (71.82)	9.10 (82.1)	9.47 (88.96)
T_6	Propaquizafop 10% EC @ 0.075 kg ha^{-1} (PoE) at 30 DAS	11.06 (121.45)	9.67 (92.65)	10.01 (99.37)	10.27 (104.69)
T_7	Oxyfluorfen 23% EC @ 0.120 kg ha^{-1} (PE) + 1 hoeing at 30 DAS	7.29 (52.43)	5.68 (31.68)	6.00 (35.45)	6.31 (39.21)
T_8	Pendimethalin 30% EC @ 1 kg ha^{-1} (PE) + Propaquizafop 10% EC @ 0.075 kg ha^{-1} (PoE) at 30 DAS	6.10 (36.56)	5.98 (35.09)	6.39 (40.21)	6.64 (43.47)
T_9	Quizalfop-p-ethyl 5% @ 0.050 kg ha^{-1} (PoE) at 30 DAS	10.98 (119.72)	9.50 (89.47)	9.95 (98.12)	10.19 (103.08)
T_{10}	Pendimethalin 30% EC @ 1 kg ha^{-1} (PE) + Quizalfop-p- ethyl 5% @ 0.050 kg ha^{-1} (PoE) at 30 DAS	6.18 (37.6)	5.88 (34)	6.29 (38.92)	6.56 (42.4)
S.Em±		0.27	0.28	0.29	0.31
CD (p=0.05)		0.79	0.82	0.88	0.92

Table 3: Weed dry matter (g m^{-2}), weed control efficiency (%), weed index (%) and weed persistence index in chickpea as influenced by various weed management practices

Treatments		Dry matter at harvest (g m^{-2})	Weed control efficiency (%)	Weed index (%)	Weed Persistence index
T_1	Weedy check	13.56 (183.32)	0.00	52.57	1.00
T_2	Weed free	0.71 (0.00)	100.00	0.00	0.00
T_3	Pendimethalin 30% EC @ 1 kg ha^{-1} (PE)	7.33 (53.19)	71.10	37.05	0.78
T_4	Pendimethalin 30% EC @ 1 kg ha^{-1} (PE) + 1 hoeing at 30 DAS	4.16 (17.38)	90.67	10.38	0.54
T_5	Oxyfluorfen 23% EC @ 0.120 kg ha^{-1} (PE)	8.62 (73.89)	59.79	38.14	0.84
T_6	Propaquizafop 10% EC @ 0.075 kg ha^{-1} (PoE) at 30 DAS	9.49 (89.55)	51.24	47.19	0.86
T_7	Oxyfluorfen 23% EC @ 0.120 kg ha^{-1} (PE) + 1 hoeing at 30 DAS	4.92 (23.93)	86.94	12.52	0.62
T_8	Pendimethalin 30% EC @ 1 kg ha^{-1} (PE) + Propaquizafop 10% EC @ 0.075 kg ha^{-1} (PoE) at 30 DAS	5.38 (28.61)	84.54	26.76	0.66
T_9	Quizalfop-p-ethyl 5% @ 0.050 kg ha^{-1} (PoE) at 30 DAS	9.40 (87.95)	52.11	46.38	0.86
T_{10}	Pendimethalin 30% EC @ 1 kg ha^{-1} (PE) + Quizalfop-p- ethyl 5% @ 0.050 kg ha^{-1} (PoE) at 30 DAS	5.30 (27.54)	85.12	23.83	0.65
S.Em±		0.26	1.35	1.23	0.03
CD (p=0.05)		0.78	4.02	3.67	0.10

Table 4: Plant population (000 ha^{-1}) and plant height (cm) of chickpea as influenced by integrated weed management practices

Treatments		Plant Population (000 ha^{-1})		Plant height (cm)			
		20 DAS	At Maturity	30 DAS	60 DAS	90 DAS	At Maturity
T_1	Weedy check	216269	212638	16.52	43.31	48.08	49.42
T_2	Weed free	217217	213704	18.44	50.57	59.17	60.54
T_3	Pendimethalin 30% EC @ 1 kg ha^{-1} (PE)	215530	211975	18.24	46.29	54.48	55.95
T_4	Pendimethalin 30% EC @ 1 kg ha^{-1} (PE) + 1 hoeing at 30 DAS	215950	212398	18.38	49.42	57.42	58.78
T_5	Oxyfluorfen 23% EC @ 0.120 kg ha^{-1} (PE)	216533	212938	17.32	45.76	52.06	53.40
T_6	Propaquizafop 10% EC @ 0.075 kg ha^{-1} (PoE) at 30 DAS	217902	214461	16.78	44.67	49.48	50.82
T_7	Oxyfluorfen 23% EC @ 0.120 kg ha^{-1} (PE) + 1 hoeing at 30 DAS	216115	212527	17.40	48.70	55.71	57.07
T_8	Pendimethalin 30% EC @ 1 kg ha^{-1} (PE) + Propaquizafop 10% EC @ 0.075 kg ha^{-1} (PoE) at 30 DAS	217821	214038	18.17	47.87	54.55	55.98
T_9	Quizalfop-p-ethyl 5% @ 0.050 kg ha^{-1} (PoE) at 30 DAS	217156	213551	16.92	45.18	51.31	52.64
T_{10}	Pendimethalin 30% EC @ 1 kg ha^{-1} (PE) + Quizalfop-p- ethyl 5% @ 0.050 kg ha^{-1} (PoE) at 30 DAS	216923	213635	18.18	48.32	54.68	56.05
S.Em±		2,587	1,906	0.97	1.46	2.18	2.20
CD (p=0.05)		NS	NS	NS	4.39	6.53	6.60

Table 5: Number of branches plant^{-1} and Dry matter accumulation plant^{-1} (g) of chickpea as influenced by integrated weed management practices

Treatments		Number of branches plant^{-1}				Dry matter accumulation plant^{-1} (g)			
		30 DAS	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS	At Maturity
T_1	Weedy check	3.53	9.31	13.61	13.60	1.37	12.52	23.07	25.18
T_2	Weed free	4.43	17.62	25.12	25.12	2.28	18.43	34.81	37.09
T_3	Pendimethalin 30% EC @ 1 kg ha^{-1} (PE)	3.67	12.68	18.38	18.38	1.80	14.42	27.20	29.42
T_4	Pendimethalin 30% EC @ 1 kg ha^{-1} (PE) + 1 hoeing at 30 DAS	4.33	16.68	24.08	24.07	2.17	17.27	32.57	34.84
T_5	Oxyfluorfen 23% EC @ 0.120 kg ha^{-1} (PE)	3.66	12.53	18.13	18.12	1.77	14.32	26.92	29.13
T_6	Propaquizafop 10% EC @ 0.075 kg ha^{-1} (PoE) at 30 DAS	3.58	10.12	15.22	15.22	1.34	13.81	25.68	27.86
T_7	Oxyfluorfen 23% EC @ 0.120 kg ha^{-1} (PE) + 1 hoeing at 30 DAS	4.10	16.54	23.74	23.73	2.09	17.22	32.44	34.70
T_8	Pendimethalin 30% EC @ 1 kg ha^{-1} (PE) + Propaquizafop 10% EC @ 0.075 kg ha^{-1} (PoE) at 30 DAS	3.89	15.36	22.06	22.07	1.84	16.78	31.56	33.80
T_9	Quizalfop-p-ethyl 5% @ 0.050 kg ha^{-1} (PoE) at 30 DAS	3.62	10.42	15.82	15.82	1.44	17.32	32.10	34.30
T_{10}	Pendimethalin 30% EC @ 1 kg ha^{-1} (PE) + Quizalfop-p- ethyl 5% @ 0.050 kg ha^{-1} (PoE) at 30 DAS	4.07	15.44	22.34	22.32	1.91	16.90	31.82	34.07
SEm±		0.18	0.58	0.82	0.82	0.11	0.72	1.38	1.38
CD (p=0.05)		0.54	1.74	2.47	2.46	0.33	2.17	4.14	4.13

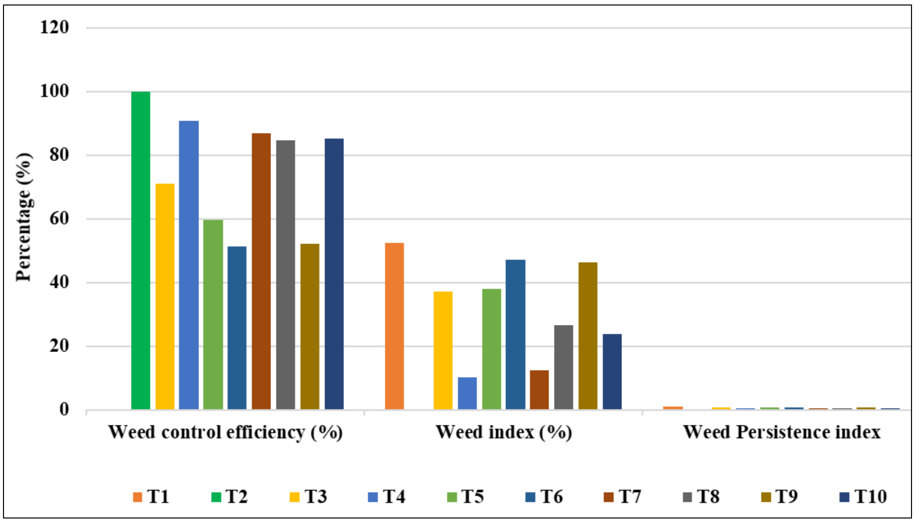

Fig 1: Weed control efficiency (%), Weed index (%) and Weed persistence index in chickpea as influenced by integrated weed management practices

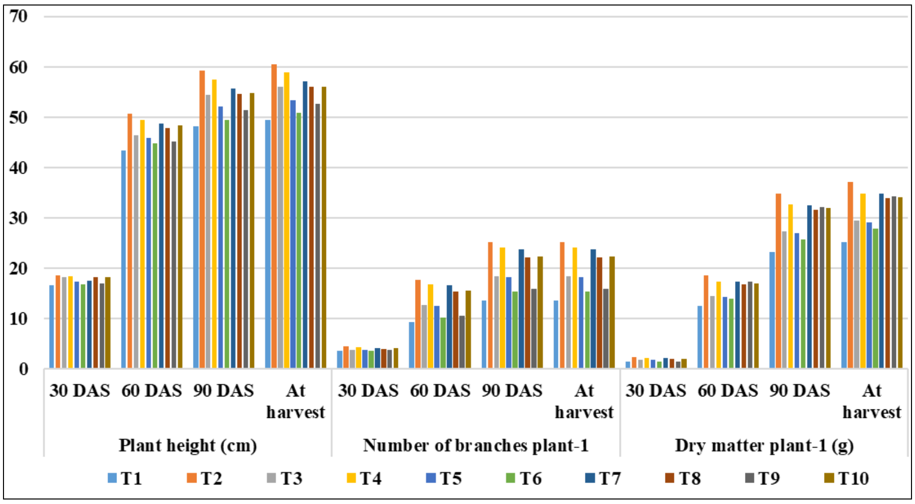

Fig 2: Plant height (cm), Number of branches plant^{-1} and Dry matter plant^{-1} (g) of chickpea as influenced by integrated weed management practices

Conclusion

Based on one year study, it can be concluded that, among the weed management treatments, pendimethalin 30% EC @ 1 kg ha^{-1} (PE) + one hoeing at 30 DAS was most effective, showing the highest weed control efficiency, lowest weed index and minimum weed persistence. This treatment also resulted in superior growth, indicating its effectiveness for improving chickpea productivity.

Future Prospects

The results of this study highlight the critical role of integrated weed management (IWM) practices in enhancing chickpea growth and biomass production. Future research could focus on optimizing IWM strategies by evaluating different herbicide combinations, timings of application and complementary cultural practices to maximize weed control efficiency and chickpea productivity.

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