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Herbicide efficacy in chickpea (*Cicer arietinum* L) with different weed management methods on productivity, nutrient uptake and profitability

Mausmi Rastogi, Vivek, RK Naresh, Shipra Yadav, Shivangi, M Sharath Chandra, Himanshu Tiwari and Pradeep Kumar Singh

Abstract
A field experiment was conducted during *rabi* season (2020-21), to assess the performance of post-emergence application of Imazethapyr in combination with pre-emergence application of Oxyfluorfen on chickpea (*Cicer arietinum* L.). The treatments comprised of Control (Weedy check) T_1, Weed free T_2, one hand weeding 25 DAS T_3, two hand weeding 25 and 50 DAS T_4, Oxyfluorfen 100 g a.i./ha Pre emergence T_5, Oxyfluorfen 100 g a.i./ha Pre emergence + one hand weeding 25 DAS T_6, Imazethapyr 50 g a.i./ha Post emergence (25 DAS) T_7, Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS T_8, Oxyfluorfen 100 g a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 25 DAS T_9 and Oxyfluorfen 100 g a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS T_{10} respectively was laid down in Randomized Block Design (RBD) with three replications and their treatments effects were evaluated in terms of weed dynamics growth, yield, Nutrient uptake and profitability of chickpea. The results revealed that the maximum weed control efficiency at 60 and 90 DAS in Oxyfluorfen 100 g a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS was found at par with Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS and significantly higher than the rest of treatments. Among the different integrated weed management treatments the significantly highest grain yield (24.8 q ha^{-1}), total NPK content and uptake by grain and straw was recorded in weed free treatment followed by (23.7 q ha^{-1}) with the application of Oxyfluorfen 100 g a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS which were at par (22.6 q ha^{-1}) with the application of Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS and the lowest total NPK content and uptake was found with the application of Oxyfluorfen 100 g a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS respectively. The highest net monetary return (₹ 103102 ha^{-1}) and B: C ratio (2.67) was obtained with weed free treatment among all the treatments, while among herbicides treatments the highest net monetary return (₹ 100102 ha^{-1}) and B:C ratio (2.82) was obtained with Oxyfluorfen 100 g a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS which was found at par with Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS. Thus, it concluded that the Oxyfluorfen 100 g a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS found to be better for higher productivity and profitability of chickpea crop due to non availability of laborers.

Keywords: Chickpea, herbicide, weed dynamics, nutrient uptake, productivity, profitability

Introduction
Pulses are a crucial component of Indian agriculture. For the vegetarian community, they are the most readily available and inexpensive source of edible protein as well as important amino acids. This may be due to the fact that India has a significant population of malnourished and destitute people, prompting the government to encourage a cereal-centric diet centred on subsidised rice and wheat. This is also visible in the planting pattern, with low soil quality in the areas where pulses are sown. However, the focus is gradually turning away from only hunger and toward the greater goal of malnutrition. As a result, a greater emphasis on pulses, which are nutritionally better, has become necessary. Aside from the nutritional advantages, there are other advantages as well. Pulses play an important role in the economy of rainfed farming communities in a variety of ways. They increase soil fertility, are well-suited to intercropping and mixed farming systems, crop rotation, and animal feed. Pulses are also good for the environment. They are essential to sustainable agriculture because they enrich the soil through nitrogen fixation (Anonymous, 2019) [2]. Through increased productivity and the Green Revolution, India has achieved self-sufficiency in food grain production, particularly in cereal crops.

India is the world's largest producer and consumer of pulses, though production lags behind consumption. Despite population growth, the net availability of food grains per capita per day has increased from 144.1 kg year-1 in 1951 to 179.6kg year-1 in 2019, whereas the net availability of pulses has decreased from 25kg year-1 in 1961 to 17.5 kg year^{-1} in 2019 (Anonymous, 2020) [1]. In developing countries, particularly India, where vegetarian populace predominates, pulses are the second most important component of the diet after cereal Pulses play a significant role in diversifying the traditional cropping systems because of their ability to fit well in the crop rotations. Due to their, ability to fix atmospheric nitrogen, they can produce protein efficiently (Havlin *et al.*, 2014) [9]. Chickpea is one of the most important rabi pulse crops in India accounting for 44.50% of the total pulse production from 35.21 per cent of the total pulse area during 2017-18.It also has qualities like low glycaemia index, gluten-free and acts as a functional food (Rao, 2002) [19]. Chickpea, being slow in its early growth and short stature, is highly susceptible to weed competition and often considerable yield losses up to 75 per cent (Chaudhary *et al.*, 2005) [4] may occur if weed growth remains unchecked at appropriate time. They compete with the crop for nutrients, space, light, water and carbon dioxide. Thus weed management in chickpea is an important component of plant protection and improving production potential of the crop.

Weed, insect-pest, and disease infestations, the use of local cultivars, insufficient fertiliser use, and a lack of knowledge about crop management practices are all important reasons for low chickpea productivity. Inadequate weed management is one of these factors that frequently leads to low yield. According to studies conducted under the All India Coordinated Pulse Improvement Project, weed management was found to be the most important production input, accounting for 27.6 percent of total yield. Weeds are a significant contributor to chickpea yield loss. This is due to the fact that it has traditionally been grown on residual soil moisture with no weed control in general. Weeds cause yield losses ranging from 25 to 80 percent in chickpea (Aslam *et al.*, 2007) [3]. Weeds compete with crops for natural and applied resources, resulting in a decrease in agricultural productivity quantity and quality (Rao *et al.* 2015) [20]. The major weeds associated with chickpeas differ depending on the crop and location. The following is a list of economically significant weeds in specific crops (Rao *et al.*, 2012). Herbicides are the most effective and fastest way to control weeds. Herbicides used wisely reduce yield losses caused by weeds and thus increase chickpea yields. Pre-emergence herbicides provide effective and cost-effective weed control when used correctly (Hassan *et al.* 2003). Khan *et al.* (2012) [15] evaluated the influence herbicides on weeds and chickpea yield. They concluded that Isoproturon 500 EW was very effective in suppressing chickpea-associated weeds by significantly lowering weed density when compared to the control respectively.

A well-planned sequence of two or more weed control strategies from five main categories, namely preventative, cultural, mechanical, biological, and chemical, is used in an integrated weed management approach. Waqas *et al.* (2016) [26] found that hand weeding followed by herbicides resulted in the lowest density and biomass for weeds. Vaishya *et al.* (1996) [25] concluded that integrated weed management was the most cost-effective. Application of Oxyfluorfen 100 g a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS produced higher yield and had the highest net monetary returns and B:C ratio among the chemical weed control treatments, and was found to be the most effective and economical in controlling weeds and increasing chickpea yield. The weed-free treatment yielded the highest gross monetary returns because crop growth favoured greater partitioning of assimilates and their relative accumulation, resulting in higher yields**.** While the application of Oxyfluorfen 100 g a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS yielded the highest net monetary returns and B: C ratios, this could be attributed to increased yield and a lower cost of cultivation when compared to weed free treatment. These findings are consistent with those of Surjit Singh *et al.* (2008) [23].

The purpose of the current field experiment to evaluate the performance of Chickpea on weed dynamics, Nutrient uptake, productivity and profitability under different integrated weed management practices of western Uttar Pradesh.

Materials and Methods

The field experiment was conducted at CRC farm of the Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut (U.P.) during 2020-21 located in Indo-Gangetic plains of Western Uttar Pradesh. Meerut lies on national highway 58 and is at a distance of 70 km from Delhi. The weekly mean maximum temperature during crop growing period varied between 37.6^{0}C to 15.4^{0}C, whereas the mean minimum temperature was between 5.9 ^{0}C to 20.7 ^{0}C. The area receives mean annual rainfall of 845 mm, of which more than 80% is in the month of July- September through south-west monsoon. The mean relative humidity during crop period varied between 77.5 to 31.3 per cent. Before sowing of chickpea, soil samples to a depth of 0-15 cm were taken randomly from 10 places in the experimental field. The collected samples were mixed homogenously and a composite soil sample was drawn, air dried, powdered and allowed to pass through 2 mm sieve for analyses of soil physical and chemical properties. The soil of experimental site was sandy loam in texture, low in available nitrogen and organic carbon, medium in available phosphorus and potassium and slightly alkaline in reaction. The predominant soil at the experimental site is classified as *Typic Ustochrept* with sandy-loam texture having *p*H 7.4, bulk density 1.49 g/cm^3, low organic carbon content (0.42%), Soil samples for 0–15 cm depth at the site were collected and tested prior to applying treatments and the basic properties were low available nitrogen, low organic carbon, available phosphorus, available potassium medium and alkali in reaction. The gross and net plot size were 4.0 x 3.0 m^2 and 2.0 x 1.8 m^2, respectively. In order to find out the best weed control treatment in gram, field investigation was carried out with four herbicides with and without hand weeding, weed free conditions and control (weedy check). Experiment was laid out randomized block design with three replications. Ten weed management treatments [Weedy check, Weed free, One hand weeding (25 DAS), Two hand weeding (25 and 50 DAS), Oxyfluorfen 100 g a.i./ha Pre emergence, Oxyfluorfen 100 g a.i./ha Pre emergence + one hand weeding 25 DAS, Imazethapyr 50 g a.i./ha Post emergence (25 DAS), Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS, Oxyfluorfen 100 g a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 25 DAS and Oxyfluorfen 100 g a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS were used for the experimentation. Plant-to-plant distance was maintained ~ 10

cm in a row spacing of 30 cm. Diammonium phosphate (DAP) was applied 100 kg/ha at the time of seed bed preparation as per recommendation. To ensure proper germination, field was prepared after *pre-sowing* irrigation and subsequent irrigation was given as per requirement. Imazethapy was applied 25 days after sowing (DAS), whereas Oxyfluorfen in was applied as pre-emergence within 24 hr of sowing. Other practices were followed as per recommendation for this region. An iron square of size 0.25 m^2 (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), 30, 60 and 90 DAS. The total number of weeds were counted species wise in each plot separately and analysed. For dry matter, weeds collected from0.25 m^2 areas were dried under the sun and then in an oven at 70 $^{\circ}C$ for 72 h, weighed (g/m^2). Economics of treatments was computed on the basis of prevailing market price of inputs and outputs under each treatment. The total cost of cultivation of crop was calculated on the basis of different operations performed and materials used for raising the crop including the cost of fertilizers and seeds. The cost of labour incurred in performing different operations was also included. 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 (12.6, 12.2 and 10.9 m^{-2}) was found under weedy check treatment, at 30, 60 and 90 DAS, respectively.

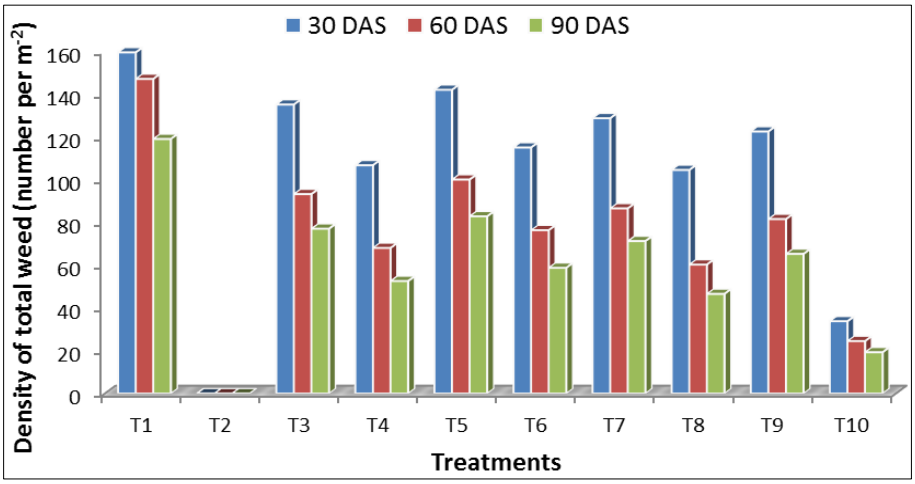

Fig 1: Effect of weed management practices on density of total weeds (m^{-2}) in chickpea at different stages

Among all the treatments except weed free, the lowest total weed density was observed (6.8 m^{-2}) in the treatment of Oxyfluorfen 100 g a.i./ha Pre emergence + one hand weeding 25 DAS, at 30 DAS. At 60 and 90 DAS the lowest total weed density (5.0 m^{-2} & 4.5 m^{-2}) was observed with the application of Oxyfluorfen 100 g a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS, which was found statistically at par with Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS (7.8 & 6.9 m^{-2}) at 60 and 90 DAS, respectively.

Total weed dry weight was affected significantly by various treatments involving integrated weed management practices. Among weed control treatments, significantly the highest total weed dry weight (8.9, 13.0 & 13.5 g m^{-2}) was found in weedy check while the lowest total dry weight (6.5, 7.8 & 8.1 g m^{-2}) was found in two hand weeding treatment at 30, 60 and 90 DAS. 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 were also reported by Singh *et al.* (2017) [24].

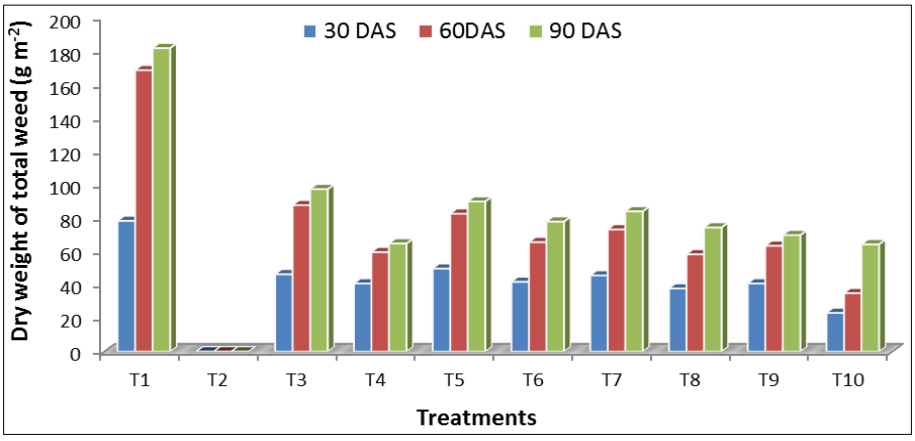

Fig 2: Effect of weed management practices on dry weight of total weed (g m^{-2}) in chickpea at different stages

Among the herbicides at 30 DAS the total dry weight observed (5.5 g m^{-2}) was lowest with the application of Oxyfluorfen 100 g a.i./ha Pre emergence + one hand weeding 25 DAS than rest of the treatments. At 60 DAS total dry weight observed (6.0 g m^{-2}) was significantly lowest with the application of Oxyfluorfen 100 g a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS, which was statistically at par with Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS and Oxyfluorfen 100 g a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 25 DAS (7.7 and 8.0 g m^{-2}). Significantly lower total dry weight at 90 DAS (8.1 g m^{-2}) observed with the application of Oxyfluorfen 100 g a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS was found at par with Oxyfluorfen 100 g a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 25 DAS and Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS (8.4 and 8.7 g m^{-2}) and significantly lower than the remaining treatments.

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 60, 90 DAS, respectively. Among the herbicides highest weed control efficiency (79.25%) and (64.66%) with the application of Oxyfluorfen 100 g a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS followed by Oxyfluorfen 100 g a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 25 DAS (62.42% & 61.63%) at 60, 90 DAS, respectively. This result is in corroboration with the findings of Kachhadiya *et al.* (2009) [13].

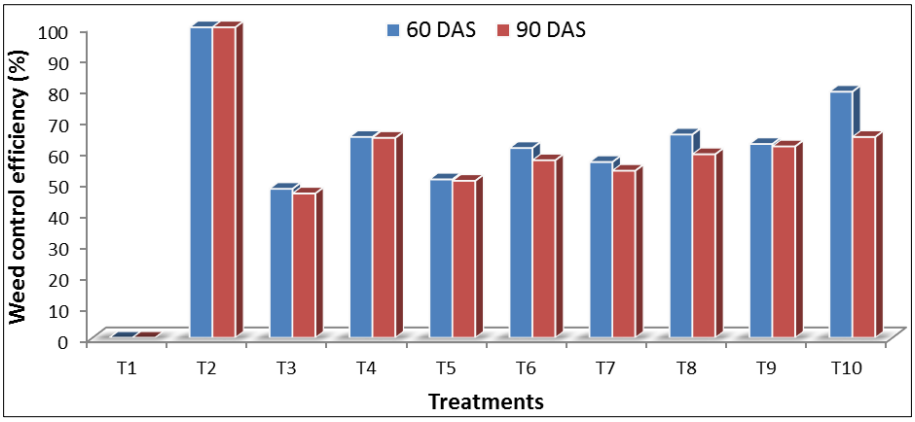

Fig 3: Effect of weed management practices on weed control efficiency in chickpea at 60 & 90 DAS

Influence on nutrient content and uptake by crop

Among the herbicides, the highest nitrogen content in chickpea grain and straw was found with the application of Oxyfluorfen 100 g a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS (3.58 & 1.52%) which were statistically at par with Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS (3.44 & 1.47%).

Table 1: Nitrogen, phosphorus and potassium content (%) by chickpea as influenced by weed management treatments

Treatment	N Content (%)		P Content (%)		K Content (%)	
	Grain	Straw	Grain	Straw	Grain	Straw
Control (Weedy check)	3.01	1.17	0.41	0.21	0.70	1.34
Weed free	3.62	1.57	0.59	0.31	0.90	1.82
One hand weeding 25 DAS	3.17	1.29	0.46	0.22	0.76	1.40
Two hand weeding 25 and 50 DAS	3.41	1.41	0.52	0.25	0.84	1.57
Oxyfluorfen 100 g a.i./ha Pre emergence	3.16	1.26	0.45	0.22	0.74	1.38
Oxyfluorfen 100 g a.i./ha Pre emergence + one hand weeding 25 DAS	3.29	1.40	0.50	0.25	0.82	1.52
Imazethapyr 50 g a.i./ha Post emergence (25 DAS)	3.23	1.32	0.47	0.23	0.78	1.42
Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS	3.44	1.47	0.55	0.27	0.86	1.62
Oxyfluorfen 100 g a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 25 DAS	3.28	1.36	0.48	0.23	0.80	1.47
Oxyfluorfen 100 g a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS	3.58	1.52	0.57	0.30	0.88	1.70
S.Em±	0.12	0.05	0.02	0.02	0.03	0.05
CD (P= 0.05)	0.35	0.14	0.05	0.04	0.08	0.16

Among the herbicides, the highest phosphorus content in chickpea grain and straw were found with the application of Oxyfluorfen 100 g a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS (0.57 & 0.30%), which were statistically at par with Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS (0.55 & 0.27%). The lowest potassium (0.70 & 1.34%) of chickpea grain and straw were found in weedy check at harvest. The highest chickpea grain and straw potassium content (0.90 & 1.82%) were observed in weed free treatment similar result was observed by Raghavendra and Gundappagol (2017) [18].

Among the herbicides, the highest nitrogen uptake grain and straw (84.85 and 53.66 kg ha^{-1}) were found with the application of Oxyfluorfen 100 g a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS, which was significantly at par (77.74 & 50.86 kg ha^{-1} respectively) with the application of Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS.

Table 2: Nitrogen, phosphorus and potassium uptake (kg ha^{-1}) by chickpea as influenced by weed management treatments

Treatment	N uptake (kg ha^{-1})		P uptake (kg ha^{-1})		K uptake (kg ha^{-1})	
	Grain	Straw	Grain	Straw	Grain	Straw
Control (Weedy check)	37.02	26.56	5.04	4.77	8.61	30.42
Weed free	89.78	55.89	14.63	11.04	22.32	64.79
One hand weeding 25 DAS	48.18	33.02	6.99	5.63	11.55	35.84
Two hand weeding 25 and 50 DAS	68.54	44.84	10.45	7.95	16.88	49.93
Oxyfluorfen 100 g a.i./ha Pre emergence	46.14	31.25	6.57	5.46	10.80	34.22
Oxyfluorfen 100 g a.i./ha Pre emergence + one hand weeding 25 DAS	56.59	39.06	8.60	6.98	14.10	42.41
Imazethapyr 50 g a.i./ha Post emergence (25 DAS)	52.00	34.98	7.57	6.10	12.56	37.63
Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS	77.74	50.86	12.43	9.34	19.44	56.05
Oxyfluorfen 100 g a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 25 DAS	62.65	41.62	9.17	7.04	15.28	44.98
Oxyfluorfen 100 g a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS	84.85	53.66	13.51	10.59	20.86	60.01
S.Em±	2.39	1.56	0.37	0.29	0.59	1.73
CD (P= 0.05)	6.90	4.51	1.06	0.83	1.70	5.01

The highest phosphorus content in chickpea grain and straw were found with the application of Oxyfluorfen 100 g a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS (0.57 & 0.30%), which were statistically at par with Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS (0.55 & 0.27%). The highest potassium uptake by grain and straw 20.86 and 60.01 kg ha-1 respectively, were found with the application of Oxyfluorfen 100 g a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS, which was statistically at par with (19.44 and 56.05 kg ha-1) Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS.

Influence on nutrient content and uptake by weeds

The nitrogen, phosphorus and potassium content in weed ranged from (0.0 to 1.71, 0.0 to 0.76 and 0.0 to 1.90 (%) under different treatments. The lowest nitrogen, phosphorus and potassium content 0.0, 0.0 & 0.0 (%) was observed in weed free, respectively because no weed were allowed to grow in this field Chandrakar *et al.* (2015) [5], Chavada *et al.* (2018) [6] also reported similar results.

Among the herbicides, the lowest total nitrogen content 1.21 (%) was found with the application of Oxyfluorfen 100 g a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS, which was significantly lower than the remaining herbicide treatments. The lowest phosphorus content 0.43 (%) was found with the application of Oxyfluorfen 100 g a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS, which was significantly lower than the remaining herbicide treatments. The lowest potassium content 1.52 (%) was found with the application of Oxyfluorfen 100 g a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS, which was significantly lower than the remaining treatments. Singh *et al.* (2017) [24] and Chavada *et al.* (2018) [6] also reported similar results.

Table 3: NPK content (%) in weed as influenced by integrated weed management treatments at 60 Days

Treatment	Nutrient content (%)		
	N	P	K
Control (Weedy check)	1.71	0.76	1.90
Weed free	0.00	0.00	0.00
One hand weeding 25 DAS	1.68	0.66	1.88
Two hand weeding 25 and 50 DAS	1.51	0.57	1.64
Oxyfluorfen 100 g a.i./ha Pre emergence	1.71	0.71	1.92
Oxyfluorfen 100 g a.i./ha Pre emergence + one hand weeding 25 DAS	1.54	0.60	1.81
Imazethapyr 50 g a.i./ha Post emergence (25 DAS)	1.63	0.64	1.84
Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS	1.27	0.47	1.58
Oxyfluorfen 100 g a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 25 DAS	1.56	0.62	1.82
Oxyfluorfen 100 g a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS	1.21	0.43	1.52
S.Em±	0.07	0.03	0.06
CD (P= 0.05)	0.20	0.10	0.17

The lowest nitrogen uptake (4.22 kg ha^{-1}) was found with the application of Oxyfluorfen 100 g a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS, which was significantly lower than the remaining herbicide treatments. The lowest phosphorus (1.50 kg ha^{-1}) was found with the application of Oxyfluorfen 100 g a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS, which was significantly lower than the remaining herbicide treatments. The lowest potassium uptake (5.30 kg ha^{-1}) was found with the application of Oxyfluorfen 100 g a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS.

Table 4: NPK uptakes (kg ha^{-1}) in weed as influenced by integrated weed management treatments at 60 Days

Treatment	Nutrient uptake (kg ha^{-1})		
	N	P	K
Control (Weedy check)	28.76	12.78	31.96
Weed free	0.00	0.00	0.00
One hand weeding 25 DAS	14.70	5.78	16.45
Two hand weeding 25 and 50 DAS	8.97	3.39	9.74

Oxyfluorfen 100 g a.i./ha Pre emergence	14.09	5.85	15.82
Oxyfluorfen 100 g a.i./ha Pre emergence + one hand weeding 25 DAS	10.07	3.92	11.84
Imazethapyr 50 g a.i./ha Post emergence (25 DAS)	11.90	4.67	13.43
Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS	7.38	2.73	9.18
Oxyfluorfen 100 g a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 25 DAS	9.86	3.92	11.50
Oxyfluorfen 100 g a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS	4.22	1.50	5.30
S.Em±	0.4	0.08	0.45
CD (P= 0.05)	1.2	0.25	1.35

Crop Productivity

Grain yield was affected significantly by various treatments involving integrated weed management practices. Among weed control treatments, the lowest grain yield (12.3 q ha^{-1}) was found in weedy check. The highest grain yield (24.8 q ha^{-1}) was found in weed free.

Among the herbicides the significantly highest grain yield (23.7 q ha^{-1}) was recorded with the application of Oxyfluorfen 100 g a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS, which was statistically at par with Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS (22.6 q ha^{-1}). Oxyfluorfen 100 g a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS recorded (92.68%) higher grain yield over weedy check.

Table 5: Effect of integrated weed management treatment on grain, straw and biological yield (q ha^{-1}) and harvest index at harvest of chickpea

Treatments	Yield (q ha^{-1})			Harvest Index
	Grain	Straw	Biological	
Control (Weedy check)	12.3	22.7	35.0	35.1
Weed free	24.8	35.6	60.4	41.1
One hand weeding 25 DAS	15.2	25.6	40.8	37.3
Two hand weeding 25 and 50 DAS	20.1	31.8	51.9	38.7
Oxyfluorfen 100 g a.i./ha Pre emergence	14.6	24.8	39.4	37.1
Oxyfluorfen 100 g a.i./ha Pre emergence + one hand weeding 25 DAS	17.2	27.9	45.1	38.1
Imazethapyr 50 g a.i./ha Post emergence (25 DAS)	16.1	26.5	42.6	37.8
Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS	22.6	34.6	57.2	39.5
Oxyfluorfen 100 g a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 25 DAS	19.1	30.6	49.7	38.4
Oxyfluorfen 100 g a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS	23.7	35.3	59.0	40.2
S.Em±	0.70	1.10	1.80	1.37
CD (P= 0.05)	2.02	3.17	5.19	NS

Biological yield was affected significantly by various treatments involving integrated weed management practices. Among weed control treatments, the lowest biological yield (35.0 q ha^{-1}) found in weedy check. The highest biological yield (60.4 q ha^{-1}) was found in weed free. Similar findings were reported by Deva and kolhe (2018) [7].

Among the herbicides, the highest biological yield (59.0 q ha^{-1}) was recorded with the application of Oxyfluorfen 100 g a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS, which was statistically at par with Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS (57.2 q ha^{-1}). Oxyfluorfen 100 g a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS (68.57%) higher biological yield over weedy check.

Harvest index was non-significantly affected by various treatments involving integrated weed management practices. Among weed control treatments, the lowest harvest index (35.1%) was found in weedy check while the highest harvest index (41.1%) in weed free. Among the herbicides the highest harvest index (40.2%) recorded with the application of Oxyfluorfen 100 g a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS than rest of the treatments. Oxyfluorfen 100 g a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS recorded (14.53%) higher harvest index over weedy check. Similar findings were reported by Poonia and pithia (2013) [17].

Economics

Cost of cultivation was affected by various treatments involving integrated weed management practices. Among weed control treatments, the lowest cost of cultivation (Rs. 29638 ha^{-1}) found in weedy check, which was lower than the remaining treatments. The highest cost of cultivation (Rs. 38638 ha^{-1}) was found in weed free treatment, which was higher than other treatments. Among the herbicides, the highest cost of cultivation (Rs. 35543 ha^{-1}) was recorded with the application of Oxyfluorfen 100 g a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS, followed by two hand weeding at 25 and 50 DAS (Rs. 34638 ha^{-1}). Hossain (2017) [11] and Kaushik *et al.* (2016) [14] 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. 71055 ha^{-1}) was found in weedy check, which was significantly lower than the remaining treatments.

The highest gross return (₹ 141740 ha^{-1}) was found in weed free treatment, which was higher than other treatments. Among the herbicidal treatments, the highest gross return (₹ 135645 ha^{-1}) was recorded with the application of Oxyfluorfen 100 g a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS, which was statistically at par with (₹ 129490) Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS. Oxyfluorfen 100 g a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS was recorded (90.9%) 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 (₹ 41417 ha^{-1}) was found in weedy check and significantly lower than the

remaining treatments, while the highest net return (₹ 103102 ha^{-1}) was found in weed free treatment and significantly higher than other treatments. Among the herbicides, the highest net return (₹ 100102 ha^{-1}) was recorded with the application of Oxyfluorfen 100 g a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS, which was statistically at par with Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS. Oxyfluorfen 100 g a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS recorded (141.69%) higher net return over weedy check. These findings are in close agreement with the results of Singh *et al.* (2016) [22] Jain *et al.* (2017) [12], Rathod *et al.* (2017) [21] and Deva and Kolhe (2018) [7].

Table 6: Economics of chickpea as affected by various weed management practices

Treatments	Cost of cultivation (₹ ha^{-1})	Gross return (₹ ha^{-1})	Net return (₹ ha^{-1})	B: C ratio
Control (Weedy check)	29638	71055	41417	1.40
Weed free	38638	141740	103102	2.67
One hand weeding 25 DAS	32638	87440	54802	1.68
Two hand weeding 25 and 50 DAS	34638	115320	80682	2.33
Oxyfluorfen 100 g a.i./ha Pre emergence	31848	84020	52172	1.64
Oxyfluorfen 100 g a.i./ha Pre emergence + one hand weeding 25 DAS	34348	98785	64437	1.88
Imazethapyr 50 g a.i./ha Post emergence (25 DAS)	30833	92525	61692	2.00
Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS	33332	129490	96158	2.88
Oxyfluorfen 100 g a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 25 DAS	33043	109640	76597	2.32
Oxyfluorfen 100 g a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS	35543	135645	100102	2.82
S.Em±	-	4012	2829	0.08
CD (P= 0.05)	-	11604	8182	0.24

B: C ratio was affected significantly by various treatments involving integrated weed management practices. Among weed control treatments, the lowest B: C ratio (1.40) was found in weedy check, which was significantly lower than the remaining treatments while the highest B: C ratio (2.67) was recorded in weed free treatment.

Among the herbicides, the highest B: C ratio was recorded with the application of Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS (2.88), which was statistically at par with Oxyfluorfen 100 g a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS (2.82). Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS was recorded (105.71%) higher B: C ratio over weedy check**.** Pedde *et al.* (2013) [16] and Gore *et al.* (2015) [8] also reported similar results.

Conclusion

Based on the results of experimentation, it can be concluded that all weed control practices proved effective in controlling the weeds in chickpea and gave significantly higher grain yield over weedy check. Among the different treatments, manual weeding to keep the plot weed free is the most effective weed control measure to control narrow, broad leaved and sedge weeds and resulted into higher value of weed control efficiency followed by Oxyfluorfen 100 g a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS and Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS. Highest yield of chickpea and nutrient content and uptake was noticed with weed free, which was found statistically at par with the application of Oxyfluorfen 100 g a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS and Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS. Lowest nutrient content and uptake in weeds was noticed with Oxyfluorfen 100 g a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS. Among integrated weed management treatments Oxyfluorfen 100 g a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS was found excellent in gross return, net return, and B: C ratio which was at par with Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS. Although maximum net return was obtained in weed free followed by Oxyfluorfen 100 g a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS but non-availability of human power may be a constraint therefore chemical weed management practice will be better option. Thus the application of Oxyfluorfen 100 g a.i./ha Pre emergence + Imazethapyr 50 g a.i./ha 25 DAS + one hand weeding 50 DAS seems better for higher productivity and profitability of chickpea crop**.**

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References

1. Anonymous. Pocket book of Agricultural Statistics 2019. Directorate of Economics and Statistics, Department of Agriculture Co-operation and Farmers' Welfare, Ministry of Agriculture and Farmers' Welfare, Govt. of India, New Delhi 2020.
2. Anonymous. Agriculture statistics at a glance. Directorate of Economics and Statistics Department of Agriculture and cooperation Ministry of agriculture Govt. of India New Delhi 2019.
3. Aslam M, Ahmad HK, Ahmad E, Himayatullah Khan MA, Sagoo AG. Effect of sowing methods and weed control techniques on yield and yield components of chickpea. Pakistan Journal of Weed Science Research 2007;13(1-2):49-61.
4. Chaudhary BM, Patel JJ, Delvadia DR. Effect of weed management practices and seed rates on weeds and yield of chickpea. Indian Journal of Weed Science 2005;37(3/4):271-272.8.
5. Chandrakar S, Sharma A, Thakur DK. Effect of weed management on weeds and yield of chickpea varities (*Cicer arietinum* L.). Advance Research Journal of Crop Improvement 2015;6:1-4.

6. Chavada JN, Patel CK, Patel SB, Panchal PP, Patel GN. Weed management in chickpea (*Cicer arietinum* L) under north North Gujarat condition 2018.
7. Deva S, Kolhe SS. Effect of irrigation and weed management on weed dynamics and yield of chickpea. Weed Science for Sustainable Agriculture, Environment and Biodiversity 2018.
8. Gore AK, Gobade SM, Patil PV. Effect of pre and post emergence herbicides on yield and economics of chickpea (*Cicer arietinum* L.). International Journal of Tropical Agriculture 2015;33(2):909-912.
9. Havlin JL, Tisdale SL, Neslon WL, Beaton JD. Soil Fertility and Fertilizers-An Introduction to Nutrient Management8th Edition 2014, 51.
10. Hassan G, Khan I. Post emergence herbicidal control of Asphodelus tenuifolius in Desi chickpea (*Cicer arietinum* L.) at Lakki Marwat, Pakistan. Pak. J Weed Sci. Res 2007;13(1-2):33-38.
11. Hussein GS. Effect of sowing date and herbicides on Chickpea (*Cicer arietinum* L.) growth, yield, yield components and companion weeds under rain-fed conditions at Duhok governorate. Kufa Journal for Agricultural Science 2017, 9(2).
12. Jain N, Singh A, Dhakad US. Effect of integrated weed management practices in chickpea. Bhartiya Krishi Anusandhan Patrika 2017;32(1):16-18.
13. Kachhadiya SP, Savaliya JJ, Bhalu VB, Pansuriya AG, Savaliya SG. Evaluation of new herbicides for weed management in chickpea (*Cicer arietinum* L. L.). Legume Research 2009;32(4):293-297.
14. Kaushik SS, Rai AK, Sirothia P, Sharma AK, Shukla AK. Growth, yield and economics of rain fed chickpea (*Cicer arietinum* L.) as influenced by integrated weed management. Indian Journal of Natural Products and Resources (IJNPR) [Formerly Natural Product Radiance (NPR)] 2016;5(3):282-285.
15. Khan IA, Marwat KB, Hassan G, Khan R, Ullah Z. Suppresive capability of herbicides and plant extracts against chickpea weeds. J Anim Plant Sci 2012;22(2):67-9.
16. Pedde KC, Gore AK, Chavan AS. Integrated weed management in chickpea. Indian Journal of Weed Science 2013;45(4):299.
17. Poonia TC, Pithia MS. Pre and post emergence of herbicides for weed management in chickpea. Indian Journal Weed Science 2013;45(3):223-225.
18. Raghavendra KS, Gundappagol RC, Santhosh GP. Impact of herbicide application on beneficial soil microbial community, Nodulation and Yield parameters of chickpea (*Cicer arietinum* L.) 2017.
19. Rao BSN. Pulses and Legumes as f unctional foods. Bulletin of the Nutrition Foundation of India 2002;23(1):1.
20. Rao AN, Chauhan BS. Weeds and Weed Management in India-A Review. In: Weed Science in the Asian Pacific Region. Indian Society of Weed Science, Hyderabad 2015, 87-118.
21. Rathod PS, Patil DH, Dodamani BM. Integrated weed management in chickpea (*Cicer arietinum* L.) under rainfed conditions of Karnataka, India. Legume Research: An International Journal 2017, 40(3).
22. Singh A. Effect of various weed management practices for weed control in chickpea (*Doctoral dissertation*, JNKVV) 2016.
23. Singh S, Walia US, Singh B. Effective control of weeds in Chickpea (*Cicer arietinum* L.). Indian Journal of Weed Science 2008;40(1, 2):51-55.
24. Singh B, Somanagouda G, Das RC, Lal G. Effects of Integrated Weed Management Practices on Nutrient Uptake by Weeds and Chickpea (*Cicer arietinum* L.). International Journal Current Microbiology Application Sciences 2017;6(3):2338-2343.
25. Vaishya RD, Fayaz M, Shrivastava AK. Integrated weed management in chickpea. Indian Journal of Pulses Research 1996;9(1):34-38.
26. Waqas M, Khan IA, Abu-Rizaiza AS, Ihsan M, Daur I. Assessment of herbicides and mulches against weeds and yield of chickpea cultivars. Int. J Biosci 2016;9(1):282-9.