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Research Article

Effect of pre and post-emergence herbicides on growth and yield of chickpea under Doon Valley conditions of Uttarakhand

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ABSTRACT
A field experiment was conducted during Rabi season 2018-2019 at Doon (P.G.) College of Agriculture Science and Technology, Selaqui, Dehradun (Uttarakhand) using four herbicides, with Hand Weeding applied for effectively controlling of weeds, their effect on yield and production economics on Chickpea (*Cicer arietinum* L.) variety used 'Pant Gram-186'. The dominant weed species were among monocot weeds were *Phalaris minor*, *Cynodon dactylon*, *Brachiaria mutica*, and *Cyperus rotundus*, and the dicot weed species *Parthenium hysterophorus*, *Medicago denticulate*, *Convolvulus arvensis*, *Melilotus indica*, *Chenopodium album*, were observed during the growing season. Weed dry weight of monocot and dicot weed was the lowest observed in hand weeding carried out 30 and 60 days after sowing. Higher Weed control efficiency up to (93.11 %) was recorded by Hand weeding at 30 and 60 days after sowing. This treatment too recorded greater yield attributes and seed and Stover yield (1811 kg/ha and 2247 kg/ha) and maximum net monetary return (Rs 35016) and Benefit: Cost ratio and 1.88.
Keywords: Weed, weed density, Weed control efficiency, yield.

INTRODUCTION
Chickpea is a valuable pulse crop that delivers nutritious food for the growing world population and will become gradually most important with climate change (Muehlbauer & Sarker, 2017). Chickpea is a yearly legume crop but their productivity is very low in India. Chickpea is a poor competitor to weeds because of its gentle growth rate and partial leaf development at an early stage of growth and development (Ratnam, Rao, & Reddy, 2011). The bulk of the crop variety in India is dominated by the sweet Desi, and Kabuli Chana is also grown in partial areas. In India chickpea is consumed widely with fresh and green vegetables, sprouted, cooked, and baked. It is also used to assimilate exhausted fallow lands by applying a crop rotation system. The existence of aggressive and noxious weed species is the main contest of all parts of countries over the world aims for crop production. The major chickpea-growing countries over the World are India, Turkey, Russia, Pakistan, Australia, Burma, United States, Tanzania, Canada, Argentina, Spain, Yemen, Syria, Iran, and Mexico. In India Chickpea is grown an average area of 8.84 million ha with an average production of 8.32 million tones and average productivity of 942 kg/ha (Anonymous 2018). Major gram or chickpea growing states Madhya Pradesh, Utter Pradesh, Rajasthan, Maharashtra, Gujarat, Andhra Pradesh, and Karnataka which sharing over 95% area. In Uttarakhand, Chickpea grown an area of 668 ha with an annual production of 531 metric tons and average productivity of 795 kg/ha (Anonymous 2018). First, 30-40 days chickpea grows slowly so it's a poor competitor of weeds and limited leaf area development at early stages of crop growth and establishment if weed is deserted under such condition, resulting in yield loss of 68% (Kumar et al. 2014). There were significant differences among the treatments in number of leaves, number of branches, number of seeds per pod and hundred seeds weight. No significant differences occur between chickpea cultivars in all parameters measured except in the number of seeds per pod and hundred seeds weight (Mohammed, et al 2020). The actual weed control method is important to have a strong agricultural sector which can be evaluated from a field experiment that contains many methods for choice and recommended by researchers for farmer's Proper time weed management plays a vital role in the effective cultivation of the crop. Hence, the current study was carried out to study the effectiveness of dissimilar herbicides on mixed weed flora and their effect on

weed control and the growth and yield of chickpea. In chickpea weeds germinate and grow quickly in many flushes so, the application of a single herbicide is not effective and reasonable for weed control under such conditions. Keeping in opinion this fact, this field trial having different pre and post-emergence herbicide and physical weed controlling techniques was recommended to find out the proper and actual weed management practice through a critical period of crop-weed interfering in chickpea.

MATERIALS AND METHODS

Site description

A field experiment was conducted in sandy loam soils of Uttarakhand having pH 7.7 during rabi season 2018-2019 at experimental farm of Doon (P.G) College of Agriculture Science and Technology, Selaqui, Dehradun (Uttarakhand). Geographically, Selaqui is situated at 20 km west from the Dehradun, state capital of Uttarakhand, India, which is located at 30˚19'05"N and latitude 78°01'44"E/30.318°N 78.029° longitude and at an altitudes of 516 m above mean sea level (MSL).

Dehradun, lies in the subtropical climate with three distinct seasons; rainy season (June – October), winter season (November – December) and spring season (March – May). The hottest months of the year are April, May and June, when the maximum temperature goes higher as 37°C and coolest months from November to February with minimum temperature of 3.5 to 10°C and ever cooler. Average annual rainfall of the site is 2173.3 mm. Monthly meteorological data of the experimental site during cropping season was received from Forest Research Institute (FRI) Dehradun.

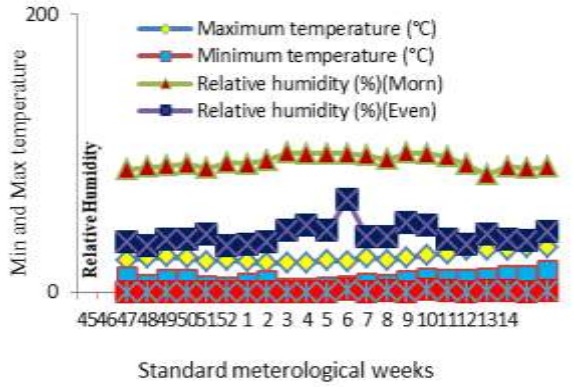

Fig. 1. Climate data during crop growing period

Experimental design and treatments

The experiment was carried out by Randomized block design with three replications. The experiments consist of Eleven weed management treatments, viz. pendimethalin 30 EC 700 g/ha at 2 Days after sowing PE, pendimethalin 30 EC 1100 g/ha at 2 Days after sowing PE, pendimethalin 30 EC 1200 g/ha at 2 Days after sowing PE, pendimethalin (extra) 38.5 % CS 900 g/ha at 2 Days after sowing PE, oxyfluorfen 23.5 EC 130 g/ha at 2 Days after sowing PE, metribuzin 70 WP 150 g/ha at 2 Days after sowing PE, oxyfluorfen 23.5 EC + metribuzin 70 WP 130 + 200 g/ha at 2 Days after sowing PE, oxyfluorfen 23.5 EC 130 g/ha at 10 Days after sowing early PoE, metribuzin 70 WP 200 g/ha at 20 Days after sowing PoE , Hand weeding twice 30 and 60 Days after sowing and weedy check.

Crop management

Seed of chickpea Pant gram-186 were manually sown with Recommended dose of fertilizers Nitrogen (25 kg/ha), Phosphorus (50 kg/ha) and Potash (25 kg/ha) were applied through DAP and MOP, respectively. Different intercultural operations such as thinning, gap filling, irrigation and plant protection measures like using insecticide were don according to the requirements during crop growing periods.

Sampling and measurements

The biometrical observations like Weed population calculated by small quadrants ($0.1m^2$) weed density measure by number of species in a unit area. Dry weight of weeds and crop were taken dried the crop and weed sample in oven at 105 ^{0} c at 30 and 60 days after sowing and at harvest. Growth and yield attributes Characters, seed and stover yield recorded and economics like B: C were also calculated by dividing gross return by total cost of cultivation of chickpea based on local market price during the experimental period.

Statistical analysis

The practical data were recorded in MS Excel and were subjected to analysis of variance, and Duncan's multiple range test at the level 0.05 (DMRT) for mean separation based on (Gomez 1984).

RESULTS AND DISCUSSION

The dominant weed flora present in experiment field was, *Cynodon dactylon* (L.), *Phalaris minor Brachiaria mutica* and *Eleusine indica*, *Cyperus rotundus* (L.) of monocot weeds and *Chenopodium album*, *Medicago denticulate*, *Euphorbia hirta*, *Diger arvensis Convolvulus arvensis*, *Parthenium hysterophorus* of dicot weeds during of growing season, similar weeds was reported by Singh (2010).

Effect on weeds

weed density and dry weight suggestively fluctuated with the weed control practices Hand weeding at 30 and 60 Days after sowing recorded lesser density of monocot and dicot weed dry weight at 30 and 60 days after sowing. Higher weed density and dry weight were observed in the weedy check plot. Treatments that hand-weeding 30 and 60 Days after sowing resulted in

Table 1. Weed density, weed dry weight and weed control efficiency at different days influenced different weed management practices

Treatment	Density of weeds (no./m^2)				Dry weight of weeds (g)				Weed control efficiency (%)	
	Monocot		Dicot		Monocot		Dicot			
	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS
Pendimethalin 30 EC 700 g/ha at 2 DAS PE	12.68 (161.00)	11.77 (138.76)	13.30 (176.96)	12.60 (158.92)	1.37 (1.89)	1.10 (1.23)	2.51 (6.32)	2.56 (6.60)	81.33	82.32
Pendimethalin 30 EC 1100 g/ha at 2 DAS PE	9.17 (84.02)	8.53 (72.90)	9.02 (86.10)	8.18 (66.99)	1.02 (1.05)	0.93 (0.88)	1.90 (4.01)	1.24 (1.56)	85.36	89.10
Pendimethalin 30 EC 1200 g/ha at 2 DAS PE	14.17 (201.67)	12.88 (166.10)	14.83 (220.10)	14.32 (205.22)	1.61 (2.98)	1.44 (2.09)	2.64 (6.93)	2.30 (5.32)	68.65	71.50
Pendimethalin (extra) 38.5 % CS 900 g/ha at 2 DAS PE	14.25 (203.10)	13.26 (175.96)	14.42 (207.96)	13.75 (189.21)	1.41 (1.99)	1.36 (1.86)	2.63 (6.99)	2.45 (6.01)	74.62	73.50
Oxyfluorfen 23.5 EC 130 g/ha at 2 DAS PE	11.73 (137.80)	10.85 116.80)	11.28 (127.30)	11.08 (122.79)	1.10 (1.21)	1.07 (1.16)	2.18 (4.56)	1.99 (3.99)	80.32	84.74
Metribuzin 70 WP 150 g/ha at 2 DAS PE	14.25 (203.12)	13.65 (186.52)	14.96 (223.90)	14.59 (213.00)	3.31 (10.96)	3.02 (9.12)	2.86 (8.21)	2.68 (7.20)	49.21	51.21
Oxyfluorfen 23.5 EC + metribuzin 70 WP 130 + 200 g/ha at 2 DAS PE	10.09 (102.90)	9.49 (90.20)	10.22 (104.45)	9.64 (93.71)	1.11 (1.20)	1.01 (1.03)	2.02 (4.12)	1.56 (2.46)	84.63	85.10
Oxyfluorfen 23.5 EC 130 g/ha at 12 DAS early PoE	14.00 (196.01)	11.80 (139.30)	12.54 (157.40)	11.71 (137.20)	1.32 (1.75)	1.14 (1.31)	2.41 (5.81)	2.34 (5.66)	76.93	82.87
Metribuzin 70 WP 200 g/ha at 30 DAS PoE	12.72 (161.80)	11.12 (124.10)	11.68 (136.49)	10.39 (108.00)	1.14 (1.31)	1.07 (1.16)	2.36 (5.66)	1.93 (3.79)	77.97	84.97
HW twice 30 and 60 DAS	7.78 (60.60)	5.77 (33.40)	8.35 (69.80)	7.11 (51.00)	0.94 (0.89)	0.70 (0.49)	1.76 (3.10)	1.05 (1.12)	89.05	93.11
Weedy check	14.83 (220.90)	13.93 (194.32)	21.83 (476.70)	20.73 (430.00)	5.30 (28.19)	4.40 (19.72)	4.98 (24.84)	4.68 (21.92)	0.00	0.00
LSD (p=0.05)	0.96	0.91	0.88	0.93	2.1	2.7	2.9	2.5	Ns	Ns

*All Figures are subjected to transformed values to square root (√x+0.5). * DAS (days after sowing), Rs (Indian rupees), PE (Post Emergence)

best weed management of both groups of weeds than other treatments because firstly weed was controlled by hand weeding 30 Days after sowing. And whatever weeds emerged later were effectively controlled by subsequent hand weeding carried out 60 Days after sowing Ratnam (2011), Murade (2013). Significantly the weed density and dry weight of monocot and dicot weeds in the control plot were recorded highest than respected treatments.

Weed index and weed control efficiency

Weed control efficiency was calculated at 30 and 60 Days after sowing on the basis of weed dry weight and it's stated as %. Data related to weed control efficiency and the dry weight of weeds are presented in Table 1. At 30 and 60 days after sowing Maximum weed control efficiency (93.11 %) and minimum weed index (0.19%) were recorded in hand weeding twice. higher weed control efficiency (93.11 %) of treatment of Hand weeding at 30 and 60 Days after sowing Singh (2017), Gore. (2018), whereas weedy check recolored zero value. Among herbicidal treatment maximum weed control efficiency (89.10 %) was observed in the application of pendimethalin 30 EC 1100 g/ha at 2 Days after sowing Pendimethalin 30 EC 700 g/ha at 2 Days after sowing PE was the best among the rest of the treatments. one hand weeding at an early stage was able to control weed density of broadleaf weeds (BLW) Dewangan et al. (2016).

Yield attributes and yield

The maximum plant height was recorded at 60 days after sowing and 90 Days after sowing in Hand Weeding 30 and 60 Days after sowing up to (51.02 & 54.11 cm) Pedde (2013) and lowest in weedy check. Crop dry weight at 60 and at harvest, a significant number of branches, number of pods/plant and test weight were recorded higher at harvest under pendimethalin 30 EC 1100 g/ha at 2 Days after sowing PE Singh (2009), Muhammad (2011) and Gore (2015), pendimethalin 30 EC 700 g/ha at 2 DAS PE pendimethalin (extra) 38.5 % CS 900 g/ha at 2 DAS PE, pendimethalin (extra) 38.5% CS 950 g/ha at 2 DAS PE, oxyfluorfen 23.5 EC 130 g/ha at 2 DAS PE,

metribuzin 70 WP 150 g/ha at 2 DAS PE, oxyfluorfen 23.5 EC + metribuzin 70 WP 130 + 200 g/ha at 2 DAS PE, oxyfluorfen 23.5 EC 130 g/ha at 12 DAS early PoE, metribuzin 70 WP 200 g/ha at 30 DAS PoE, Hand Weeding twice 30 and 60 DAS, weedy check Hand Weeding twice at 30 and 60 DAS.

Yield and harvest index

The higher seed and stover yield were (1118 & 2230 kg/ha) recorded under Hand Weeding twice at 30 and 60 days after sowing. Among the herbicidal treatment pendimethalin 30 EC 1100 g/ha at 2 DAS PE, oxyfluorfen 23.5 EC + metribuzin 70 WP 130 + 200 g/ha at 2 DAS PE shows great performance against rest of treatments Chandrakar (2015), Verma (2018). However lowest, seed and stover yield of chickpea observed in observed in weedy check due to higher weed density (Table 2). Management of weeds at early stage in the season will help to reduced crop-weed competition. Hand weeding at 30 and 60 DAS shows best performance to controlling of weeds at early stage resulted higher growth and yield of chickpea. These results are in agreement with Patil (2016), Chourasiya et al. (2016). The weed management by two Hand Weeding weed shows higher weed control efficiency Rathod and Patil 2016. Whereas Indrajeet, et al. 2020 observed post-emergence application of imazethapyr + imazamox @ 60 g a.i. ha-1 at 20 days after sowing recorded significantly lowest weed density & weed dry weight at 60 days after sowing and highest weed control efficiency at harvest, which was statistically at par with quizalofop-ethyl + imazethapyr @ 60+50 g a.i. ha-1 at 20 days after sowing. As a consequence of effective weed control, quizalofop-ethyl + imazethapyr @ 60+50 g a.i. ha-1 at 20 days after sowing recorded significantly highest grain yield, straw yield and harvest index which was significantly superior over hand weeding twice at 30 and 50 days after sowing. In weedy check, uncontrolled weed growth caused significant reduction in grain yield of chickpea. Net returns and B:C ratio was found maximum with quizalofop-ethyl + imazethapyr @ 60+50 g a.i. ha-1 at 20 days after sowing which was significantly superior over weedy check.

Economic analysis

Net monetary returns and B: C ratio recorded higher (1.88) under the hand weeding twice at 30 and 60 DAS respected to other weed management practices. The result similar find Rathod and Patil (2016) and Dewangan (2016), whereas in chemical treatments pendimethalin 30 EC 1100 g/ha at 2 DAS PE, pendimethalin 30 EC 1200 g/ha at 2 DAS PE shows better performance against rest of the treatments.

Table 2. Weed index, plant height, crop dry matter accumulation, number of branches, yield attributes, yield and economics of chickpea as influenced by different weed management practices economics

Treatment	Plant height (cm)			Number of branches /plant	Number of pods /plant	Seed index (g)	Seed yield (kg/ha)	Net returns (Rs/ha)	B:C ratio
	30 DAS	60 DAS	90 DAS						
Pendimethalin 30 EC 700 g/ha at 2 DAS PE	18.24	44.10	47.70	21.04	42.75	18.55	1089	09121	1.22
Pendimethalin 30 EC 1100 g/ha at 2 DAS PE	22.71	48.62	53.11	25.83	48.12	26.12	1758	32218	1.84
Pendimethalin 30 EC 1200 g/ha at 2 DAS PE	17.45	42.83	46.91	18.10	37.98	18.39	0972	04121	1.15
Pendimethalin (extra) 38.5 % CS 950 g/ha at 2 DAS PE	17.12	42.43	46.12	19.12	41.43	18.48	1084	07320	1.20
Oxyfluorfen 23.5 EC 130 g/ha at 2 DAS PE	19.86	47.10	52.97	24.23	45.33	21.89	1322	22541	1.51
Metribuzin 70 WP 150 g/ha at 2 DAS PE	15.22	41.65	45.09	16.10	37.40	18.20	0873	02353	1.09
Oxyfluorfen 23.5 EC + metribuzin 70 WP 130 + 200 g/ha at 2 DAS PE	21.61	49.85	51.80	23.96	47.20	23.10	1489	28537	1.72
Oxyfluorfen 23.5 EC 130 g/ha at 12 DAS early PoE	18.84	43.11	47.43	22.75	43.95	19.22	1259	17836	1.50
Metribuzin 70 WP 200 g/ha at 30 DAS PoE	19.13	46.91	49.83	23.81	44.10	19.84	1339	21418	1.52
HW twice 30 and 60 DAS	24.56	51.02	54.11	26.12	50.18	27.21	1811	35016	1.88
Weedy check	12.89	31.11	35.72	12.18	28.41	16.11	0474	-14.72	0.52
LSD (p=0.05)	Ns	Ns	Ns	3.61	4.85	Ns	Ns	Ns	Ns

*All Figures are subjected to transformed values to square root (√x+0.5). * DAS (days after sowing), Rs (Indian rupees), PE (Post Emergence)

CONCLUSION

From the final result of present study it may be concluded that for effective control of weeds any single method is not suitable but practices of integrated weed management (IWM) to successful weed control. Higher seed yield as well as economical returns under Hand Weeding twice at 30 and 60 Days after sowing, and in chemical treatment pendimethalin (extra) 38.5% CS at 950 g/ha at 2 DAS PE.

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