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Impact of different broad spectrum herbicides on yield and economics of chickpea crop (*Cicer arietinum* L.)

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Abstract
A field experiment was conducted during rabi season of 2020-21 and 2021-22 at Instructional Cum Research Farm of IGKV, Raipur (Chhattisgarh) to assess the effect of various post-emergence herbicides in chickpea. The results indicated that among different herbicides, as a consequence of effective weed control, topramezone 20.6 g a.i./ha at 14 DAS recorded significantly highest seed yield and stover yield which was significantly superior over all the other treatments but harvest index was recorded highest in topramezone 20.6 g a.i./ha at 21 DAS. In unweeded control, uncontrolled weed growth caused reduction in seed yield of chickpea. Net returns and B:C ratio was found maximum with topramezone 20.6 g a.i./ha at 14 DAS which was significantly superior over other treatments.

Keywords: Chickpea, seed and stover yield, economics, post emergence herbicides

Introduction
Chickpea is a member of the Fabaceae family. It was grown in an area of 8.4 million ha and producing 10.13 million tonnes with productivity of 1.07 t/ha during 2019-20 in India (Anonymous 2019) [6]. Yield losses in chickpea from weed competition vary considerably, depending on the level of the weed infestation, the weed species, and the level of inputs available. The productivity of chickpea is relatively very low due to many constraints i.e. biotic and abiotic elements. Poor weed management practice is the most yield-limiting factor in chickpea. Weeds can remove the nutrients from the soil more effectively than the crops. Being slow in early vigour and shortened plant, chickpea is highly vulnerable to crop-weed competition leads up to 75% losses in yield due to weeds (Chaudhary *et al*., 2005) [9]. Nabi and Ansari (1977) [13] reported that weeds not only compete with crops for water, light and nutrient but also impart physiological disorder to man and livestock and economic resources. Malik (1983) [12] reported that hand weeding did not increase the seed yield of chickpea, while application of 1.5 kg ha^{-1} maloran (chlorbromuron), 2.5 kg tribunil (Methbenzthiazuron) or 4 kg grain (Terbutran) ha^{-1} increased yields from 0.82 to 0.95, 0.91 and 1.41 t ha^{-1} respectively. Mahoney (1981) [11] found that net returns were relatively higher with chemical weed control and resulted in seed yield**s** of 1.87 t ha^{-1} compared with 1.34 t ha^{-1} without weed control. Ali *et al*. (1988) [4] and Pandey (1981) [15], reported that the application of weedicides help in controlling weeds population, increase in grain yields and net return. Cultural and mechanical methods of weeding are prevalent in our country, although experimental results revealed that chemical operations have been very effective and economical (Nabi and Ansari, 1977) [13]. In India, a large number of new herbicides i.e. imazethapyr, imazamox, clodinafop-propargyl, quizalofop-ethyl, topramezon have been available in the market for better weed control associated with pulses and have no any adverse effect on the performance of the crop. Since the action of the herbicide is considerably influenced by the type of soil, nature of crop, dose, and time of application against specific weeds for a particular locality, it will be a practical guide to the farmers. This present investigation, was, therefore, conducted to evaluate the impact of different post-emergence herbicides, which can be cost effective and acceptable to the growers of this crop.

Material and Methods
A field experiment was carried out during Rabi 2020-21 and 2021-22 at Instructional Cum Research Farm of IGKV, Raipur (Chhattisgarh) to assess the efficiency of different post-emergence herbicides in chickpea. The soil of the experimental plot was sandy loam with neutral soil pH (7.1), low in available nitrogen (235 kg ha^{-1}), medium in available P (12.26 kg ha^{-1}) and high exchangeable K (389.5 kg ha^{-1}).

Experiment was laid out in randomized block design with four replications. The treatments consisted of eight weed management practices *viz*., T1- Topramezone 20.6 g a.i./ha at 14 DAS, T2- Topramezone 20.6 g a.i./ha at 21 DAS, T3- Topramezone 25.7 g a.i./ha at 14 DAS, T4- Topramezone 25.7 g a.i./ha at 21 DAS, T5- Quizalofop-p-ethyl 100 g a.i./ha at 25 DAS, T6- Unweeded control, T7- Weed free check (manual weed control/Recom. Practice), T8- Another treatment with recommended practice (with pre + post emergence/manual control herbicide). Herbicides applied as pre-emergence in treatment T_1, T2, T3, T4 and T_5 respectively. Herbicide dissolved thoroughly in water @ 500 liter as ha^{-1}. Chickpea variety Indira chana-1 was sown on 29 November 2020-21 and 03 December 2021-22 with seed rate (80 kg ha^{-1}) and spacing (30 x 10 cm). Crop was uniformly fertilized with 20:50:20 kg N: P: K ha^{-1} as basal.

Data on seed yield, stover yield, and harvest index were recorded. Economic analysis of data was also done using the cost of inputs and selling price of produce obtained after processing of harvested material. All the data were statistically analyzed. Critical difference value at 5% were oftenly used to determine the significance of differences between treatment means.

Results and Discussion

Seed and stover yield (kg/ha)

Data on seed yield of chickpea was significantly influenced by different weed control treatments and are presented in Table 1 and Fig 1. Weed free check (manual weed control/Recom. Practice) recorded significantly higher seed yield (1824.96 kg/ha and 1822.07 kg/ha) during both the years and on mean basis but among the herbicidal treatment topramezone 20.6 g a.i./ha at 14 DAS recorded highest seed yield (1741.51 and 1739.4 kg ha^{-1}) of chickpea which was statistically at par with Topramezone 25.7 g a.i./ha at 14 DAS and Topramezone 20.6 g a.i./ha at 21 DAS and was significantly superior over rest of the treatments. It was largely due to reduced weed crop competition in these treatments, however, unweeded control exhibited their lower value.

Data pertinent to the stover yield of chickpea was significantly influenced by various weed control treatments and are presented in Table 1 and Fig 1. Among the herbicidal treatment Maximum stover yield (2704.36 and 2723.20 kg ha^{-1}) was recorded under topramezone 20.6 g a.i./ha at 14 DAS which was found at par with Topramezone 25.7 g a.i./ha at 14 DAS and Topramezone 20.6 g a.i./ha at 21 DAS and was significantly superior over rest of the treatments. The higher stover yield in above treatments might be due to lesser weeds during early crop growth period, higher yield attributes and pod yield which leads to higher stover yield. Treatment Quizalofop-p-ethyl 100 g a.i./ha at 25 DAS registered significantly lowest stover yield.

Harvest Index

The harvest index (HI) data based on two years and on mean basis presented in Table 1 and Fig 1. Among herbicidal treatment higher harvest index (39.44 and 39.46) recorded under treatment Topramezone 20.6 g a.i./ha at 21 DAS during both the years and on mean basis which was at par with the treatment Topramezone 20.6 g a.i./ha at 14 DAS, Topramezone 25.7 g a.i./ha at 14 DAS and Quizalofop-p-ethyl 100 g a.i./ha at 25 DAS. The minimum harvest index was obtained (18.14 and 18.04) under unweeded control due to low seed yield and more crop-weed competition. Maximum harvest index under these treatments might be due to proper reproductive growth due to timely translocation of photosynthesis from source to sink thus increase the seed production ratio in total produce.

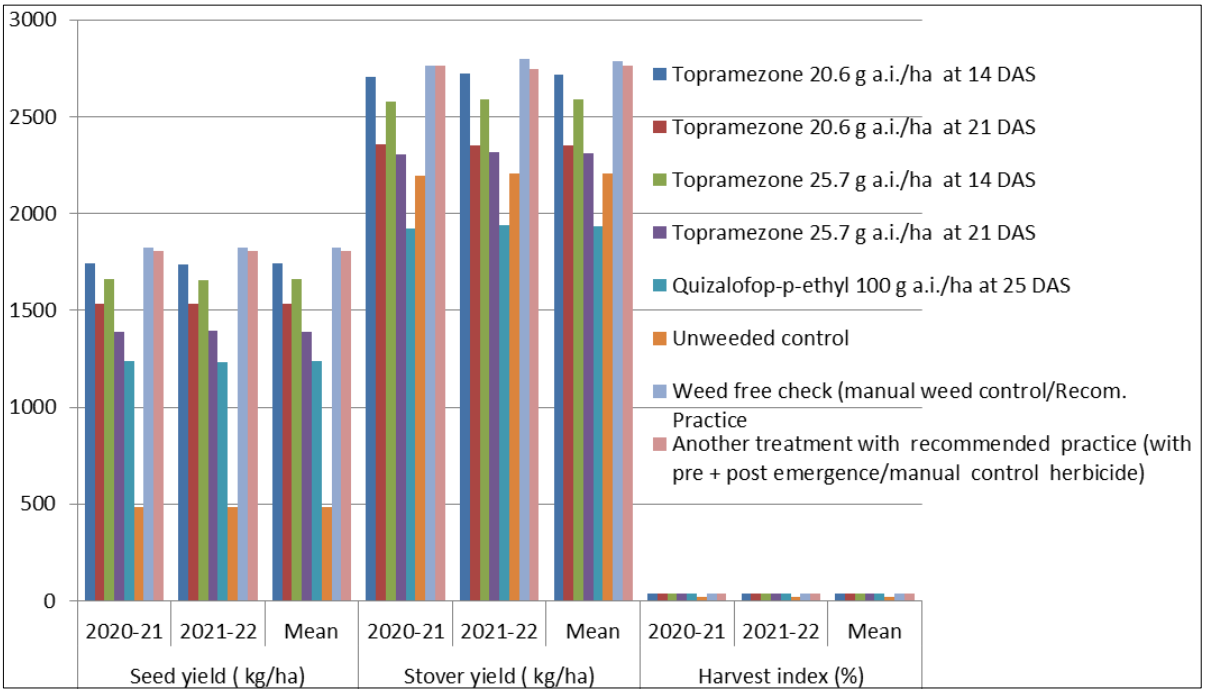

Fig 1: Effect of post-emergence herbicides on seed yield, stover yield and harvest index of chickpea

Table 1: Seed and Stover yield (kg/ha) and harvest index (%) of chickpea as influenced by different weed control measures

Treatment	Seed yield (kg/ha)			Stover yield (kg/ha)			Harvest index (%)		
	2020-21	2021-22	Mean	2020-21	2021-22	Mean	2020-21	2021-22	Mean
Topramezone 20.6 g a.i./ha at 14 DAS	1741.51	1739.47	1740.49	2704.36	2723.20	2717.52	39.17	38.98	39.08
Topramezone 20.6 g a.i./ha at 21 DAS	1536.45	1533.91	1535.18	2357.79	2352.97	2351.93	39.44	39.46	39.45
Topramezone 25.7 g a.i./ha at 14 DAS	1663.10	1656.52	1659.81	2574.98	2591.70	2586.70	39.25	39.00	39.12
Topramezone 25.7 g a.i./ha at 21 DAS	1389.23	1393.63	1391.43	2302.76	2314.07	2313.20	37.68	37.64	37.66
Quizalofop-p-ethyl 100 g a.i./ha at 25 DAS	1236.30	1234.35	1235.33	1923.58	1937.54	1933.97	39.13	38.92	39.03
Unweeded control	486.68	485.72	486.20	2197.27	2206.21	2206.92	18.14	18.04	18.09
Weed free check (manual weed control/Recom. Practice	1824.96	1822.07	1823.51	2765.75	2798.61	2784.75	39.79	39.45	39.62
Another treatment with recommended practice (with pre + post emergence/manual control herbicide)	1805.39	1804.16	1804.78	2763.22	2744.96	2764.09	39.54	39.65	39.59
S.Em±	58.55	57.80	58.14	99.84	95.50	95.30	0.83	0.73	0.76
CD at 5%	172.20	169.99	170.98	293.62	280.88	280.29	2.45	2.15	2.25

Economics

Data based on two years and on the mean basis revealed that gross return, net return and B:C ratio significantly influenced by all weed management practices on chickpea are presented in Table 2. The highest gross returns (Rs. 91732.55 ha^{-1} and Rs. 95723.92 ha^{-1}) was recorded with Weed free check (manual weed control/Recom. Practice) and lowest gross returns (Rs. 25923.04 ha^{-1} and Rs. 26977.93 ha^{-1}) was recorded with Unweeded control. Among herbicidal treatments, the highest gross returns (Rs. 87603.10 ha^{-1} and Rs. 91436.04 ha^{-1}) were recorded with Topramezone 20.6 g a.i./ha at 14 DAS which was at par with Topramezone 25.7 g a.i./ha at 14 DAS and Topramezone 20.6 g a.i./ha at 21 DAS and was significantly superior over rest of the treatments.

Data on net return was significantly influenced by various weed control treatments and are presented in Table 2. The data revealed that significantly the highest net return (Rs. 67246.30 ha^{-1} and Rs. 71227.19 ha^{-1}) was accrued with another treatment with recommended practice (with pre + post emergence/manual control herbicide) which was mainly due to higher gross returns recorded in this treatment as a consequence of higher economic yield of chickpea. This was at par with Weed free check (manual weed control/Recom. Practice) and Topramezone 20.6 g a.i./ha at 14 DAS and was significantly superior over rest of the treatments where it was largely due to lower economic yield of chickpea.

Data on benefit: cost ratio as calculated from net return and cost of cultivation of each treatment and was significantly influenced by different weed control treatments and is presented in Table 2. Highest benefit: cost ratio (3.79 and 3.95) was found with Topramezone 20.6 g a.i./ha at 14 DAS) which was found at par with another treatment with recommended practice (with pre + post emergence/manual control herbicide), Topramezone 20.6 g a.i./ha at 21 DAS and Topramezone 25.7 g a.i./ha at 14 DAS which was mainly due to higher economic yield and net returns in these treatments and was significantly superior over rest of the treatments and unweeded control which showed dissimilarity among themselves.

Table 2: Economics of chickpea as influenced by different weed control measures

Treatment	Gross return (Rs.)			Cost of cultivation (Rs.)	Net return (Rs.)			B:C Ratio		
	2020-21	2021-22	Mean	Mean	2020-21	2021-22	Mean	2020-21	2021-22	Mean
Topramezone 20.6 g a.i./ha at 14 DAS	87603.10	91436.04	86551.88	23299.84	64303.26	68136.20	63252.04	3.79	3.95	3.74
Topramezone 20.6 g a.i./ha at 21 DAS	77259.73	80582.26	76236.73	23299.84	53959.89	57282.42	52936.89	3.39	3.53	3.34
Topramezone 25.7 g a.i./ha at 14 DAS	83650.86	87074.22	82550.13	24182.3	59468.56	62891.92	58367.83	3.46	3.60	3.41
Topramezone 25.7 g a.i./ha at 21 DAS	70027.84	73389.33	69255.26	24182.3	45845.54	49207.03	45072.96	2.93	3.08	2.90
Quizalofop-p-ethyl 100 g a.i./ha at 25 DAS	62193.21	64889.52	61348.00	21913	40280.21	42976.52	39435.00	2.86	2.98	2.81
Unweeded control	25923.04	26977.93	25449.15	19383	6540.04	7594.93	6066.15	1.37	1.44	1.35
Weed free check (manual weed control/Recom. Practice	91732.55	95723.92	90722.66	25833	65899.55	69890.92	64889.66	3.41	3.56	3.37
Another treatment with recommended practice (with pre + post emergence/manual control herbicide)	90776.10	94756.99	89699.23	23529.8	67246.30	71227.19	66169.43	3.73	3.90	3.69
S.Em±	2920.71	3020.03	2905.60		2920.71	3020.03	2905.60	0.12	0.13	0.12
CD at 5%	8589.86	8881.96	8545.43		8589.86	8881.96	8545.43	0.36	0.38	0.36

Conclusion

The relevant study based on both the years and on mean basis it can be concluded that highest yield and economics in Chickpea showed significant difference under all the treatments and can be achieved by maintaining weed free through hand weeding throughout crop growth period, where labours are easily available. In case of labours scarcity, application of Topramezone 20.6 g a.i./ha at 14 DAS was also equally effective.

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