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Effect of pre and post emergence herbicides on yield and economics of chickpea (*Cicer arietinum* L.)

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Abstract
A field experiment was conducted during rabi season of 2021-22 at Instructional-cum-Research Farm, IGKV, Raipur. The soil of experimental site was clayey, low in available nitrogen, medium in available phosphorus and potassium. The experimental design was Randomized Block Design (RBD) having 12 weed management treatments and three replications. The results showed that significantly higher growth characters, yield attributes, seed yield, stover yield and harvest index were obtained under metribuzin *fb* topramezone 350 and 32.25 g ha^{-1}, but it was at par with metribuzin *fb* topramezone 350 and 25.8 g ha^{-1} and hand weeding twice. The minimum values of above character were observed under unweeded control plot. The treatment metribuzin *fb* topramezone 350 and 37.8 g ha^{-1} were effective in reducing weed density, weed dry matter accumulation, lowest weed growth rate and therefore providing maximum weed control efficiency. While, weed index were higher control and lower in metribuzin *fb* topramezone 350 and 32.25 g ha^{-1}.

Keywords: Chickpea, Rabi season, Randomized block design, herbicides

Introduction
Pulses are significant sources of protein, vitamins, and minerals. They are also abundant in macro and micronutrients, which are beneficial for a sustainable crop system. The high protein content of pulses, enhancement of the physical structure and fertility of the soil, compatibility with mixed and intercropping systems, and increased yields are only a few of the additional advantages.

A cool-season legume crop grown for food all over the world is chickpea. After field pea and French bean, chickpea is the third-most significant crop of pulses in the world. It is a self-pollinating legume that is assumed to have originated in southern Syria and eastern Turkey. India ranked first in the area (118.99 lakh ha) and production (113.80 lakh tones) with 67 and 66% of world area and production, respectively. The highest productivity of 2138 kg ha^{-1} is recorded in Ethiopia followed by Mexico, Canada and USA. Chickpea production in Chhattisgarh is 331.68 thousand metric tons which occupies the area of 335.03 thousand hectare and accounts productivity of 990 kg ha^{-1} (Government of Chhattisgarh, Statistics 2017-18). Chickpea yield is low due to various production constraints, such as biotic and abiotic factors. The main constraints include dry root rot and blight among the wilting biotic constraints. Besides that the weeds also contribute significant yield loss by competing for space, nutrients, water and light. Lack of weed management is one of the most significant factors decreasing chickpea yield (Chaudhary *et al*., 2005) [2].

Weeds can be controlled using a variety of techniques, including mechanical, chemical, and manual methods. Manual weeding is effective method of weed control, however, is that it is less cost-effective than chemical weed control due to a labour scarcity. Herbicide use in chickpea is very efficient, rapid, and time-saving (Ahmed *et al*., 2005) [1]. Herbicide application greatly reduces weed growth, which led to a 50% increase in yield over untreated fields (Hosseini *et al*., 1997) [5]. Selective herbicides are particularly successful at controlling weeds. By using successful weed control techniques, crop output can be increased. Looking to the problem of weeds and also to find out the best method of weed control in chickpea, a field experiment was conducted with three replications and twelve weed management treatments.

Materials and Methods
A filed experiment was conducted at Research cum Instructional Farm of Indira Gandhi Krishi Vishwavidyalaya, Raipur during rabi season of 2021-22.

The climate of the region was sub-humid to semi-arid. The soil of the experimental field was clayey with low, medium and high in N, P and K, respectively and neutral in reaction. The test variety was Indira Chana-1. The experiment was laid out in Randomized Block Design (RBD) having three replications and twelve treatments *viz.*T_1: topramezone 13.4 g ha^{-1}, T_2: topramezone 19.35 g ha^{-1}, T_3: topramezone 25.28 g ha^{-1}, T_4: topramezone 32.25 g ha^{-1}, T_5: topramezone 37.8 g ha^{-1}, T_6: metribuzin *fb* topramezone 350 and 13.4 g ha^{-1}, T_7: metribuzin *fb* topramezone 350 and 19.35 g ha^{-1}, T_8: metribuzin *fb* topramezone 350 and 25.28 g ha^{-1}, T_9: metribuzin *fb* topramezone 350 and 32.25 g ha^{-1}, T_{10}: metribuzin *fb* topramezone 350 and 37.8 g ha^{-1}, T_{11}: Hand weeding twice and T_{12}: control. During crop growth period, various yield attributing characters like pods $plant^{-1}$, seed pod^{-1}, seed index, seed yield and stover yield were taken as per schedule and requirement of investigation.

Results and Discussion

Number of pods $plant^{-1}$

Among all the treatments, highest number of pods $plant^{-1}$ (36.23) was recorded with treatment T_9: metribuzin *fb* topramezone 350 and 32.25 g ha^{-1}, but it was at par with T_1: topramezone 13.4 g ha^{-1}, T_2: topramezone 19.35 g ha^{-1}, T_3: topramezone 25.28 g ha^{-1}, T_4: topramezone 32.25 g ha^{-1}, T_5: topramezone 37.8 g ha^{-1}, T_6: metribuzin *fb* topramezone 350 and 13.4 g ha^{-1}, T_7: metribuzin *fb* topramezone 350 and 19.35 g ha^{-1}, T_8: metribuzin *fb* topramezone 350 and 25.28 g ha^{-1}, T_{10}: metribuzin *fb* topramezone 350 and 37.8 g ha^{-1} and T_{11}: hand weeding twice. Lowest number of pods $plant^{-1}$ (18.66) was recorded with treatment T_{12}: control.

Number of seeds pod^{-1}

Seed pod^{-1} was not affected by specific weed control methods. However, numerically highest seeds pod^{-1} was recorded in T_9: metribuzin *fb* topramezone 350 and 32.25 g ha^{-1} and the lowest seeds pod^{-1} was recorded in control plot, respectively. This resulted in improved weed control, greater availability of nutrients and moisture, and favourable photosynthetic pigment resulted in transfer from source to sink. Similar results were found by Varshney and Arya (2004) [9] and Chaudhary *et al*. (2005) [2].

Seed weight (g)

However, the highest seeds pod^{-1} was recorded in T_9: metribuzin *fb* topramezone 350 and 32.25 g ha^{-1} and lowest in control, respectively. Similar results were found by Upadhyaya and Bhalla (2002) [8] and Dewangan *et al.* (2016) [3].

Seed and stover yield (kg ha^{-1})

Highest seed and stover yield (1469.64 and 2829.46 kg ha^{-1}, respectively) was recorded in treatment T_9: metribuzin *fb* topramezone 350 and 32.25 g ha^{-1}, but it was at par with treatments T_3: topramezone 25.28 g ha^{-1}, T_4: topramezone 32.25 g ha^{-1}, T_7: metribuzin *fb* topramezone 350 and 19.35 g ha^{-1}, T_8: metribuzin *fb* topramezone 350 and 25.28 g ha^{-1} and T_{11}: hand weeding twice. Lowest seed yield (282.44 and 870.53 kg ha^{-1}, respectively) was recorded in control. Greater seed yield was attributed due to higher values of yield contributing characters *viz* number of pods $plant^{-1}$, number of seeds pod^{-1} and 100 seed weight which resulted in proper utilization of resources like nutrient, moisture, light and space by chickpea crop and ultimately low weed competition. Similar results were found by Punia and Pithia (2013) [7].

Harvest index (%)

Highest harvest index was registered in T_{10}: metribuzin *fb* topramezone 350 and 37.8 g ha^{-1} (39.23%) followed by T_6: metribuzin *fb* topramezone 350 and 13.4 g ha^{-1} (38.35%). On the other hand significantly lowest harvest index was found in control (24.50%). Maximum harvest index under weed management practices might be due to proper translocation of photosynthates at reproductive stage from source to sink thus increased the seed production ratio in total produce. This result was conformity with Chaudhary *et al.* (2005) [2] and Pooniya *et al.* (2009) [6] findings.

Weed flora composition

The predominant weed species observed in the experimental field were *Medicago denticulate* L., *Chenopodium album* L., *Cichorium intybus* L., *Echino chloacolona* L., *Physallis minima* L.

Weed control efficiency

Weed control efficiency data indicated that at 30, 60 and 90 DAS the highest weed control efficiency was recorded under T_{10}: metribuzin *fb* topramezone 350 and 37.8 g ha^{-1} (91.91%), (83.23%), (84.90%) respectively and the lowest weed control efficiency was recorded under T_1: topramezone 13.4 g ha^{-1}.

Weed index

The lowest weed index was recorded under treatment T_9: metribuzin *fb* topramezone 350 and 32.25 g ha^{-1} (0.00%) followed by T_8: metribuzin *fb* topramezone 350 and 25.28 g ha^{-1} (2.37%).

The maximum weed index under T_{12}: control (80.70%) followed by T_1: topramezone 13.4 g ha^{-1} (41.48%) was due to the fact that there was lowest seed yield reported under weedy check was because of high infestation of weeds. Similar results were found by Ali *et al*. (2013).

Economics

The data revealed that highest gross return (Rs. 79251 ha^{-1}), net realization (Rs. 39555 ha^{-1}) were reported in T_9: metribuzin *fb* topramezone 350 and 32.25 g ha^{-1} and higher benefit: cost ratio (2.00) were reported in T_3: topramezone 25.28 g ha^{-1} alone, along with T_7: metribuzin *fb* topramezone 350 and 19.35 g ha^{-1}, T_8: metribuzin *fb* topramezone 350 and 25.28 g ha^{-1}, T_9: metribuzin *fb* topramezone 350 and 32.25 g ha^{-1}.

The lowest gross realization (Rs. 15557 ha^{-1}), net realization (Rs. -16069 ha^{-1}) and B: C ratio (0.49) were recorded in control plot.

Table 1: Yield attributes of chickpea as influenced by various herbicide treatments.

	Treatments	Number of pods plant^{-1}	Number of seeds pod^{-1}	100 seed Weight (g)
T_1	Topramezone 13.4 g ha^{-1}	32.58	1.20	23.81
T_2	Topramezone 19.35 g ha^{-1}	34.12	1.30	24.50
T_3	Topramezone 25.28 g ha^{-1}	34.71	1.45	24.56
T_4	Topramezone 32.25 g ha^{-1}	35.00	1.50	24.61
T_5	Topramezone 37.8 g ha^{-1}	33.00	1.20	24.14
T_6	Metribuzin *fb* Topramezone 350 and 13.4 g ha^{-1}	34.00	1.27	24.47
T_7	Metribuzin *fb* Topramezone 350 and 19.35 g ha^{-1}	35.12	1.60	24.75
T_8	Metribuzin *fb* Topramezone 350 and 25.28 g ha^{-1}	34.28	1.40	24.92
T_9	Metribuzin *fb* Topramezone 350 and 32.25 g ha^{-1}	36.23	1.90	25.08
T_{10}	Metribuzin *fb* Topramezone 350 and 37.8 g ha^{-1}	33.58	1.25	24.30
T_{11}	Hand weeding twice	35.58	1.75	24.54
T_{12}	Unweeded control	18.66	1.10	19.73
	S.Em±	0.99	0.27	1.01
	CD (at 5% level)	2.90	NS	NS

Table 2: Seed yield, Stover yield and harvest index of chickpea as influenced by various herbicide treatments.

	Treatments	Seed yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Harvest index (%)
T_1	Topramezone 13.4 g ha^{-1}	860.06	1625.12	34.18
T_2	Topramezone 19.35 g ha^{-1}	1276.16	2080.83	38.02
T_3	Topramezone 25.28 g ha^{-1}	1370.97	2339.28	36.95
T_4	Topramezone 32.25 g ha^{-1}	1384.68	2359.26	36.98
T_5	Topramezone 37.8 g ha^{-1}	961.51	1733.01	35.68
T_6	Metribuzin *fb* Topramezone 350 and 13.4 g ha^{-1}	1199.99	1929.14	38.35
T_7	Metribuzin *fb* Topramezone 350 and 19.35 g ha^{-1}	1399.99	2393.23	36.91
T_8	Metribuzin *fb* Topramezone 350 and 25.28 g ha^{-1}	1428.98	2694.36	34.66
T_9	Metribuzin *fb* Topramezone 350 and 32.25 g ha^{-1}	1469.64	2829.46	34.18
T_{10}	Metribuzin *fb* Topramezone 350 and 37.8 g ha^{-1}	1134.46	1757.48	39.23
T_{11}	Hand weeding twice	1444.60	2739.61	34.53
T_{12}	Unweeded control	282.44	870.53	24.50
	S.Em±	**36.11**	59.38	-
	CD (at 5% level)	**105.91**	174.15	-

Table 3: Weed control efficiency as influenced by different weed management practices in chickpea at 30, 60 and 90 DAS

	Treatment	Weed control efficiency (%)			Weed Index (%)
		30 DAS	60 DAS	90 DAS	
T_1	Topramezone 13.4 g ha^{-1}	15.43	32.21	38.84	41.48
T_2	Topramezone 19.35 g ha^{-1}	53.99	46.80	53.30	12.81
T_3	Topramezone 25.28 g ha^{-1}	62.07	53.19	56.05	6.33
T_4	Topramezone 32.25 g ha^{-1}	74.98	67.31	65.80	5.39
T_5	Topramezone 37.8 g ha^{-1}	79.59	69.76	67.67	34.31
T_6	Metribuzin *fb* Topramezone 350 and 13.4 g ha^{-1}	33.23	38.53	45.40	18.01
T_7	Metribuzin *fb* Topramezone 350 and 19.35 g ha^{-1}	67.70	57.14	60.28	4.35
T_8	Metribuzin *fb* Topramezone 350 and 25.28 g ha^{-1}	83.32	76.37	72.57	2.37
T_9	Metribuzin *fb* Topramezone 350 and 32.25 g ha^{-1}	87.51	80.65	80.14	-
T_{10}	Metribuzin *fb* Topramezone 350 and 37.8 g ha^{-1}	91.91	83.23	84.90	22.49
T_{11}	Hand weeding twice	86.11	82.66	79.95	1.30
T_{12}	Control	-	-	-	80.70

Conclusion

Metribuzin *fb* topramezone 350 and 32.25 g ha^{-1} recorded higher value for yield and yield contributing characters followed by hand weeding twice and metribuzin *fb* topramezone 350 and 19.35 g ha^{-1}. This treatment also performed better in terms of economic parameters, gave maximum net income but similar B:C ratio *i.e.* 2.00 was found under metribuzin *fb* topramezone and 25.28 g ha^{-1}, metribuzin f*b* topramezone 350 and 19.35 g ha^{-1} and topramezone 25.28 g ha^{-1} alone treatments. Therefore lower dose of topramezone *i.e.* 25.28 g ha^{-1} alone or topramezone 19.35 g ha^{-1} post emergence with metribuzin 350 g ha^{-1} pre emergence is suggested.

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