Effect of different doses and time of applications of topramezone on weed dynamics, growth and yield of chickpea (*Cicer arietinum* L.) in Bihar, India

ABSTRACT:

Aims: To study the different levels of doses and time applications of topramezone on weed, growth and yield of chickpea (*Cicer arietinum* L.) in Bihar.

Place and Duration of Study: Agronomy research farm of Tirhut College of Agriculture, Dholi, Muzaffarpur (Bihar), during the *rabi* 2020-21.

Methodology: The experiment was carried out in an RBD design with three replications and ten treatments: topramezone (20.6 and 25.7 g/ha) applied at 14, 21, and 28 DAS, and quizalofop-p-ethyl (100 g/ha) applied at 25 DAS as post-emergence (PoE), pre-emergence (PE) application of valor 1000 g/ha + one hand weeding (HW) at 30 DAS, weed-free control (WFC), and weedy check.

Results: PE application of valor 1000 g/ha + one HW 30 DAS recorded maximum plant height, number of branches/plants, plant dry matter, seed and straw yield while registered lowest weed dry weight and WCE as compared to all other herbicide treatments. Among all PoE-treated treatments, spray of topramezone (25.7 g/ha) after 21 days of sowing recorded maximum of all these growth parameters at harvest and lowest weed dry matter and highest WCE as compared to other PoE applications.

Keywords: [Topramezone, post-emergence, pre-emergence, quizalofop, chickpea, herbicide and pendimethalin}

1. INTRODUCTION

Chickpea (*Cicer arietinum* L.) is an important pulse crop around the world. India is the largest chickpea-producing country; it accounts for 75% of the world's production. In India, Madhya Pradesh, Rajasthan, Maharashtra, Bihar, Uttar Pradesh, and Gujarat are leading chickpea-producing states. It can grow from light sandy loam to heavy-textured clay soils, and it fixes biological nitrogen. Due to slow early growth rate and inadequate leaf area at initial phases of crop growth, weeds in such conditions caused higher yield losses [1, 16, 17]. The initial 30 to 60-day period is serious for crop-weed competition in chickpea [2]. Appropriate weed-control practices play an important role in the successful cultivation of the crop. So, poor management of weeds is one of the most important yield-limiting factors in chickpea. Manual weeding is laborious and intensive, which therefore limits the production area. Appropriate herbicide for successful control of mixed weed flora in chickpea is requires the use of pendimethalin at 1.0 kg/ha [3, 18], as pre-emergence provides effective control of weeds at early crop growth stages. However, later flushes of weeds can only be controlled by the application of post-emergence herbicides [4]. It is necessary to identify more effective herbicides with a broad spectrum of weed control in chickpea. Topramezone is recently developed, highly selective pyrazole-structured herbicide for the control of BLWs and NLWs after emergence, generally used in maize. Topramezone treatment resulted in strong photo-bleaching symptoms on the shoots and *fb* sensitive weed plant death. 4-HPPD activity was strongly inhibited by topramezone. The target broadleaf weeds and grasses bleached after exposure to sunlight, and the plant perished as a result. Keeping in view the above problems, the present experiment was planned to investigate the efficacy of herbicides for broad-spectrum weed management and their effects on the growth and yield of the chickpea.

2. MATERIAL AND METHODS

The research was conducted at the Tirhut College of Agriculture's agronomical research farm at Dholi, Muzaffarpur (Bihar). It is situated in the mid-Indo-Gangatic area and lies at 25^0 99' North latitude, 85^0 60" East longitude, and an altitude of 52.18m above mean sea level. The soil, as an average of crop growth, is bound to have a significant impact on the rate of plant growth, and subsequently, the final output. For analyzing different soil physio-chemical properties, soil samples were randomly collected from farm before sowing. The different soil parameters and calculation processes are shown below in Table 1.

Table 1 Soil parameters before the experiments

Parameters	Initial Value	Method	Remarks
Sand (%)	65	International Pipette Method [5]	Sandy loam
Silt (%)	21		
Clay (%)	15		
BD (g/cc)	1.43	Core Sampler Method	
EC (dS/m)	1.13	EC bridge, [6]	
pH	7.84	1:2.5 Soil water suspension [6]	Alkaline
OC (%)	0.45	Walkley & Black method [7]	Low
N (kg/ha)	239	Alkaline $KMnO_4$ method [8]	Low
Phosphorus (kg/ha)	17.6	0.5M $NaHCO_3$ extractable P [9]	Medium
Potassium (kg/ha)	128	1N NH_4OAc [6]	Medium

Various herbicidal doses were sprayed as per pre-scheduled work plan. The valor (mixture of Pendimethalin 30% + Imazethapyr 2%) 1000 g/ha was sprayed as PE, Topramezone 33.6 SC 20.6 g/ha PoE at 14, 21, and 28 DAS (T_1, T_2 & T_3), Topramezone 25.7 g/ha PoE at 14, 21 and 28 DAS (T_4, T_5 & T_6) and Quizalofop-p-ethyl 100 g/ha at 25 DAS (T_7) was applied as PoE for better weed management.

3. RESULTS AND DISCUSSION

Weed dry matter:

All type of weed were observed in the research field, include narrow leaf weed (NLWs), broad leaf weed (BLWs) and sedges (**Table 2**). Weed dry matter production was significantly reduced by all

weed control treatments, and two hand weeded treatment recorded lowest weed dry biomass (g/m^2) as compared to all treatments, but maximum was found in not weeded plots. As compared to all herbicidal treatments, PE application of valor 1.0 kg/ha with one weeding after 30 days of sowing treatment and topramezone 25.7 g/ha applied after 21 days of sowing reduced overall weed density and weed dry biomass, similar findings recorded by Singh and Jain [3]. However, very little effect of herbicide application was observed on sedges because *Cyperus rotundus* is a perennial weed and its control is very difficult. Valor 1.0 kg/ha PE *fb* single HW recorded significantly lower weed dry weight and it was superior to all herbicidal treatments, although all treatments were significantly lower than the weedy check treatment. Topramezone (25.7 g/ha) applied 21 days after sowing suppressed NLWs and BLWs and recorded lower weed dry matter than other topramezone-applied treatments (**Table 4**). Similarly, Mahto *et al.* reported that a 25.2 g/ha dose of topramezone recorded lowest weed dry weight as compared to other doses [10].

Weed control efficiency (WCE)

In all herbicidal treatments, PE application of valor 1.0 kg/ha *fb* single HW recorded highest WCE (weed control efficiency), *fb* topramezone 25.7 g/ha at 21 DAS, and lowest in quizalofop-p-ethyl 100 g/ha at 25 DAS treated plot. It is due to the fact that quizalofop-p-ethyl had no effect on broad-leaved weeds. Among all topramezone treatments, topramezone 25.7 g/ha at 21 DAS treatment had the highest WCE but lowest recorded in topramezone 25.7 g/ha at 14 DAS treatment as compared to all different doses and times of topramezone applications (**Table 4**).

Table 2. Weed flora observed during research

	Common name	Scientific name	Family
NLW			
1	Bermuda grass	*Cynodon dactylon*	Poaceae
2	Barnyard grass	*Echinochloa colona*	Poaceae
3	Wild oat	*Avena fatua*	Poaceae
BLW			
1	Bhang	*Cannabis sativa*	Cannabiaceae
2	Lamb's quarter	*Chenopodium album*	Chenopodiaceae
3	Melilotus	*Melilotus albus*	Fabaceae
4	Blue-scarlet	*Anagallis arvensis*	Primuliaceae
Sedge			
1	Motha	*Cyperus rotundus*	Cyperaceae

Crop growth:

All weed management treatments had greater plant height than the weedy control plot; however, the two hand-weeded treatment had the maximum plant height, branches per plant, and plant dry matter, while the weedy control plot had the lowest. PE application with valor 1.0 kg/ha *fb* one HW treatment recorded considerably higher growth parameters than other herbicidal treatments except T_5 treatments. The highest plant population was observed in the two HW treatments and the lowest in the weedy check across all weed management methods, but there was no significant difference in plant population between treatments. Among all PoE-applied herbicides, topramezone (25.7 g/ha) at 21 DAS treatments recorded 11-42% higher plant dry matter than other topramezone applied treatments and 66% higher as compared to quizalofop-p-ethyl treatment (**Table 3**). It could be due to topramezone 20.6 and 25.7 g/ha (T_1 & T_4) applied at 14 DAS; at this stage, topramezone controlled weeds very well, but new weeds emerged at a later stage due to slow initial growth of chickpea. Whereas, at the other two doses of topramezone (25.7 and 20.6 g/ha) (T_3 & T_6) applied at 28 DAS, the weed control efficacy of topramezone was decreased at this stage due to the fact that a later stage weeds become hardy in nature and are tolerant to herbicide.

Crop Yield:

All weed control techniques had significant impact on chickpea seed yield. The highest seed and yield were observed in two hand-weeded treatment, which yielded 120 percent more than the weedy check treatment, despite the weedy check decreased crop yield by 55 percent (**Table 3**). Singh *et al.* reported that weeds on average reduced 40-87 % chickpea yield [11], and similarly, Yadav *et al.* reported that weed infestation reduced 69% of chickpea yield [12]. PE application of valor 1.0 kg/ha + single hand-weeded plot produced the highest seed and straw yield, which was significantly higher than other herbicidal treatments, and seed yielded 109 percent more than weedy check. Pre-

emergence application of pendimethalin (1.0 kg/ha) + one hand weeding after 30 days of sowing was shown to be superior in improving seed production [13, 14].
Topramezone sprayed at 25.7 g/ha at 21-day stage yielded 82% more seed yield than weedy check, 7-48% higher than topramezone 20.6 g/ha (T_1, T_2 & T_3) and 29-57% more than topramezone 25.7 g/ha (T_4 & T_6), and 65% more than quizalofop-p-ethyl 100 g/ha treatment (**Table 3**). Tiwari *et al.* reported that PoE application topramezone at 25.2 g/ha decreased weed growth and enhanced crop yield compared to topramezone at 13.8 g/ha at a lower dose and resulted in a 40.5% greater seed production than the weedy treatment [15]. Whereas, topramezone at 20.6 and 25.7 g/ha in 14 DAS controlled weeds effectively, but new weeds emerged at a later stage due to slow initial growth of chickpea. However, other two doses of topramezone (25.7 and 20.6 g/ha at 28 DAS) gave lower weed control efficiency. This could be due to the fact that a later stage, weeds become hardy in nature and are tolerant to herbicide, and resulting in decreased crop yield.

4. CONCLUSION

In the realm of herbicide treatments, pre-emergence application of valor (pendimethalin + imazethapyr) with single manual weeding was found to be the best treatment for effectively curbing weed growth and bolstering the yield of chickpeas. Furthermore, remarkable results with topramezone (25.7 g/ha) applied at 21 DAS post-emergence for efficiently controlling weed and increase in yield of chickpea showcasing its potential in contributing to weed control and enhanced crop productivity.

Table 3: Differential doses and time applications of topramezone on crop growth parameters of chickpea

Treatments	Plant height (cm) at harvest	Branch/plant at harvest	Plant population (no./m^2) at harvest	Plant dry matter (g/m^2) at harvest
T_1: Topramezone 20.6 g/ha at 14 DAS	47.17	8.36	30.3	259.34
T_2: Topramezone 20.6 g/ha at 21 DAS	49.33	9.67	31.6	321.68
T_3: Topramezone 20.6 g/ha at 28 DAS	47.10	8.58	32.0	294.48
T_4: Topramezone 25.7 g/ha at 14 DAS	46.64	8.11	29.2	252.07
T_5: Topramezone 25.7 g/ha at 21 DAS	51.33	9.81	31.6	357.17
T_6: Topramezone 25.7 g/ha at 28 DAS	47.33	9.06	32.0	318.77
T_7: Quizalofop-p-ethyl 100 g/ha at 25 DAS	45.13	7.07	30.5	215.65
T_8: Valor 1.0 kg/ha + HW at 30 DAS	55.18	10.97	31.8	401.22
T_9: Two HW at 30 DAS and 50 DAS	55.32	11.14	32.6	412.02
T_{10}: Weedy check	43.46	6.05	29.4	205.89
SEm(±)	1.47	0.65	0.85	19.23
CD (P=0.05)	4.38	1.96	NS	57.14

Table 4: Differential doses and time applications of topramezone on weed dry matter accumulation, WCE and chickpea yield

Treatments	Weed dry wt. (g/m^2) at harvest	WCE (%) at harvest	Seed yield (kg/ha)	Straw yield (kg/ha)
T_1: Topramezone 20.6 g/ha at 14 DAS	18.56* (344.8)	42.3	886	1433
T_2: Topramezone 20.6 g/ha at 21 DAS	14.00 (196.1)	67.2	1222	1857
T_3: Topramezone 20.6 g/ha at 28 DAS	17.16 (294.9)	50.7	938	1452
T_4: Topramezone 25.7 g/ha at 14 DAS	20.02 (401.3)	32.8	832	1303
T_5: Topramezone 25.7 g/ha at 21 DAS	12.17 (148.0)	75.3	1308	1964
T_6: Topramezone 25.7 g/ha at 28 DAS	15.49 (240.2)	60.0	1012	1591
T_7: Quizalofop-p-ethyl 100 g/ha at 25 DAS	23.43 (551.8)	10.8	794	1274
T_8: Valor 1.0 kg/ha + HW at 30 DAS	10.44 (109.1)	82.4	1504	2208
T_9: Two HW at 30 DAS and 50 DAS	7.11 (50.4)	91.9	1582	2289
T_{10}: Weedy check	24.81 (618.9)	0.0	717	1163
SEm(±)	0.83	-	96.67	144.29
CD (P=0.05)	2.45	-	287.19	428.63

**Figures in parentheses () are the actual value of weed dry matter and outside the parentheses are square root ($\sqrt{x}$ + 0.5) transformed values*

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