Available online at www.ijpab.com

DOI: http://dx.doi.org/10.18782/2582-2845.8027

ISSN: 2582 – 2845

Ind. J. Pure App. Biosci. (2020) *8*(2), 484-489

Research Article

Indian Journal of Pure & Applied Biosciences

Evaluation of Isoproturon for Control of *Chenopodium* spp. in Wheat

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Received: 5.03.2020 | Revised: 12.04.2020 | Accepted: 19.04.2020

ABSTRACT

A pot experiment to evaluate the efficacy of different doses of post-emergence herbicide isoproturon against broadleaf weed Chenopodium spp. was conducted during Rabi season of 2017-18 in the screen house at Department of Agronomy, Chaudhary Charan Singh Haryana Agricultural University, Hisar (Haryana) in wheat crop. It is applied at three doses (0.5X, X and 2.0X) in experiment under Completely Randomised Design (CRD) replicated thrice with six populations of Chenopodium spp. named as Siswal 1, Siswal 2, Saharwa, Charkhi Dadri, H.A.U. 1 and H.A.U. 2 populations collected from farmers fields of Haryana. Untreated pots were maintained as control for comparison. In observations, plant height, chlorophyll fluorescence, electrical conductivity (EC), percent control, fresh weight and dry weight were observed. Results revealed that isoproturon provided 100 per cent control to all populations even at half of the recommended dose of this herbicide. This is the key finding of this study because intervention with post-emergence isoproturon could resolve the problem of resistant Chenopodium spp. being faced by the farmers.

Key words: *Chlorophyll fluorescence, Efficacy, Isoproturon, Chenopodium spp., Population.*

INTRODUCTION

Wheat *(Triticum aestivum* L.) is one of the most important food grain crop which is grown with an approximately area 221.3 mha with a production and productivity of, 726.9 mt and 3290 kg/ha respectively (FAO STAT, 2016). India, is the second largest producer of wheat in the world contributing about 99.8 mt of grain with the productivity of 3220 kg/ha from the area 30.6 mha (Anonymous, 2018). Haryana is the major wheat growing state of India with an area of about 2.53 mha with 11.7 mt production and 4.62 t/ha productivity (Anonymous, 2018a). In crop production, weeds infestation is one of the biotic limiting production and productivity. A yield reduction of 10-50% by weed is very common in wheat; complete loss of crop has also been reported under certain cases (Malik & Singh, 1995).

Manual weeding is cumbersome and is less efficient due to close spacing and similarity of grass weeds at early stage. Some broadleaf weeds also cause significant reduction in crop yield.

Cite this article: Shalu, Singh, S., Sunil, Loura, D., & Priyanka (2020). Evaluation of Isoproturon for Control of *Chenopodium* spp. in Wheat, *Ind. J. Pure App. Biosci. 8*(2), 484-489. doi: http://dx.doi.org/10.18782/2582-2845.8027

Chenopodium album is a major broadleaf weed of *Rabi* season and is a serious problem of cotton/pearl millet-wheat rotation in Haryana (Singh et al., 1995) as well as in other regions of the Indo-Gangetic plains of India. This besides reducing the yield, it also interferes with manual harvesting and reduce the quality of the produce. Complaints of poor efficacy of several herbicides against *Chenopodium album* and *Chenopodium murale* have been reported recently from the farmer fields of different locations of Haryana states. Recently resistance too evolved in *Avena ludoviciana*, *Rumex dentatus*, *Chenopodium album* and *Polypogon monspeliensis* to several herbicides (Singh et al., 2017). Occurrence of herbicide resistance in *C. album* has been reported recently (Singh, 2016; Singh et al., 2017) in India. *C. album* has evolved resistance globally to 17 herbicides under different cropping system (Heap, 2019)

Therefore, there is need to know about the status of herbicide resistance/poor efficacy of different herbicides against *Chenopodium album.* Also, there is need to understand the level of resistance in different populations under different cropping systems, particularly non rice –wheat rotations where *Chenopodium* is the most dominant weed. In addition, there is need to evaluate alternate herbicidal options for its management, so that the problem of herbicide resistance may be tackled effectively. This will also help in devising strategies to check its further spread in different cropping systems.

MATERIALS AND METHODS

2.1. Experimental sites*:* The experiment was conducted in the screen house, Department of Agronomy in Chaudhary Charan Singh Haryana Agricultural University, Hisar during *Rabi* season of 2017-18. The site is situated at 29^{o}.10' North latitude, 75^{o}46' East longitude and an altitude of 215.2 m above mean sea level.

2.2. Treatment details: Isoproturon was applied at three doses (0.5X, X and 2.0X) in pot experiment under Completely Randomized Design with three replications.

2.3. Planting material: Seeds of five populations of *Chenopodium* spp. were collected from different locations where farmers reported poor control with recommended herbicides, whereas seeds collected from Research farm, CCSHAU Hisar population was used as standard check for comparison.

2.4. Pot preparation*:* For filling the pots, soil was collected from Agronomy Research Farm which was not exposed to any herbicides application from the last two years. It was air-dried, crushed, well ground to pass through a sieve of 2 mm pore size and. Plastic pots (8cm diameter) were filled with 2 kg soil composing sand, field soil and vermi-compost (2:3:1).

RESULTS

Isoproturon dose-response studies

Plant height

No significant differences were recorded in plant height of *Chenopodium* populations at spraying, 2 and 4 WAT of isoproturon application (Table 1). When data were averaged over treatments, significantly higher plant height (cm) was recorded in Saharwa (13.2-14.7) which was statistically similar with Siswal 1 (13.2-14.4), Siswal 2 (13.2-14.2), H.A.U. 1 (12.8-14.3), H.A.U. 2 (13.3-14.2) and Charkhi Dadri populations (13.2-14.4) at 2 and 4 WAT. Application of isoproturon at all doses resulted in statistically similar plant height among all the population at spraying, 2 and 4 WAT. Half and double dose of isoproturon had no difference in plant height over recommended dose, respectively at 2 and 4 WAT, among all the populations.

Plant chlorophyll fluorescence

Table 2 presents the data on chlorophyll fluorescence of *Chenopodium* populations as affected by the application of isoproturon at 1, 2 and 7 DAT. When data were averaged over treatments, significantly higher chlorophyll fluorescence (Fv/Fm) was observed in Saharwa (0.506-0.506-0.228) which was statistically similar with Siswal 1 and Siswal 2 populations but significantly differ with Charkhi Dadri, H.A.U. 1 and H.A.U. 2 populations, respectively at 1, 2 and 7 DAT.

Half dose of isoproturon resulted in 50% and 59% higher chlorophyll fluorescence over recommended dose, whereas double dose resulted in 64% and 35% lower chlorophyll fluorescence than recommended dose, respectively at 1 and 2 DAT, among all the populations.

Per cent control

Significantly higher per cent control of *Chenopodium* populations was observed with the application of isoproturon at 1, 2 and 4 WAT (Table 3). But no significant difference was observed among all the populations, respectively at 1, 2 and 4 WAT (mean data over herbicide doses). Mean per cent mortality of all populations was found statistically similar at 1, 2 and 4 WAT. Half dose of isoproturon resulted in lower mortality over recommended dose, but the difference was non-statistical, whereas double dose resulted in higher mortality than recommended dose, but statistically similar, respectively at 1, 2 and 4 WAT.

Electrical conductivity (EC)

Isoproturon had significant effect on the EC of *Chenopodium* populations, before and after boiling observed at 1 WAT (Table 4). Significantly lower EC (ds/m) was observed in Saharwa (0.114-0.162) *fb* Charkhi Dadri (0.118-0.169), H.A.U. 2 (0.114-0.178), H.A.U. 1 (0.114-0.178), Siswal 2 (0.125-0.183) and Siswal 1 populations (0.114-0.192), respectively before and after boiling at 1 WAT (mean data over herbicide doses). Half dose of isoproturon resulted in 16.4-19% lower EC over recommended dose, whereas double dose resulted in 26%-39% higher EC than recommended dose, respectively at before and after boiling at 1 WAT.

Fresh and dry weight

Significant variations on fresh and dry weight of *Chenopodium* populations were observed at harvest with the application of isoproturon (Table 5). When data were averaged over isoproturon doses, fresh and dry weight was (g/pot) non-significant among all populations at harvesting. Mean fresh and dry weight was found statistically similar among all the population at 1000 and 2000 g/ha at harvesting. Half dose of isoproturon resulted in 35% and 50% higher fresh and dry weight, respectively over recommended dose, whereas double dose resulted in 21% lower fresh weight but no difference was observed in dry weight, respectively than recommended dose at harvesting.

Table 1: Plant height of *Chenopodium* populations as influenced by isoproturon at spraying, 2 and 4 WAT

Populations	Plant height (cm)														
	Spraying					2 WAT					4 WAT				
	IPU (g/ha)														
	0	500	1000	2000	Mean	0	500	1000	2000	Mean	0	500	1000	2000	Mean
Siswal 1	12.3	12.3	11.7	12.0	12.1	16.7	12.3	11.7	12.0	13.2	21.7	12.3	11.7	12.0	14.4
Siswal 2	12.0	11.7	11.7	11.7	11.7	17.7	11.7	11.7	11.7	13.2	22.0	11.7	11.7	11.7	14.2
Saharwa	11.7	11.7	12.3	12.0	11.9	16.7	11.7	12.3	12.0	13.2	22.7	11.7	12.3	12.0	14.7
H.A.U. 1	12.0	11.7	11.3	12.0	11.7	16.3	11.7	11.3	12.0	12.8	22.3	11.7	11.3	12.0	14.3
Charkhi Dadri	12.7	12.3	11.8	11.7	12.1	17.0	12.3	11.8	11.7	13.2	21.7	12.3	11.8	11.7	14.4
H.A.U. 2	12.0	11.8	11.3	11.8	11.7	18.3	11.8	11.3	11.8	13.3	22.0	11.8	11.3	11.8	14.2
Mean B	12.1	11.9	11.7	11.9		17.1	11.9	11.7	11.9		22.9	11.9	11.7	11.9	
CD (P=0.05)															
Population	NS					NS					NS				
IPU	NS					0.6					0.6				
Population x IPU	NS					NS					NS				

IPU, isoproturon; WAT, weeks after treatment.

Table 2: Chlorophyll fluorescence (Fv/Fm) of *Chenopodium* populations as influenced by isoproturon at 1, 2 and 7 DAT

Populations	Chlorophyll fluorescence (Fv/Fm)														
	1 DAT					2 DAT					7 DAT				
	IPU (g/ha)														
	0	500	1000	2000	Mean	0	500	1000	2000	Mean	0	500	1000	2000	Mean
Siswal 1	0.846	0.570	0.380	0.263	0.515	0.850	0.393	0.270	0.147	0.415	0.868	0.013	0.013	0.000	0.224
Siswal 2	0.872	0.600	0.400	0.273	0.536	0.838	0.514	0.367	0.253	0.493	0.889	0.000	0.000	0.000	0.222
Saharwa	0.869	0.543	0.360	0.253	0.506	0.911	0.526	0.340	0.245	0.506	0.911	0.000	0.000	0.000	0.228
H.A.U. 1	0.836	0.410	0.290	0.148	0.421	0.837	0.357	0.270	0.147	0.403	0.836	0.000	0.000	0.000	0.209
Charkhi Dadri	0.852	0.517	0.267	0.210	0.461	0.852	0.487	0.240	0.197	0.444	0.853	0.000	0.000	0.000	0.213
H.A.U. 2	0.852	0.573	0.443	0.157	0.506	0.852	0.417	0.213	0.120	0.400	0.853	0.000	0.000	0.000	0.213
Mean B	0.854	0.536	0.357	0.217		0.857	0.449	0.283	0.185		0.868	0.002	0.002	0.000	
CD (P=0.05)															
Population	0.025					0.028					0.006				
IPU	0.020					0.023					0.005				
Population x IPU	0.049					0.057					0.013				

IPU, isoproturon; DAT, days after treatment.

Table 3: Per cent control of *Chenopodium* populations as influenced by isoproturon at 1, 2 and 4 WAT

Populations	Mortality (%)														
	1 WAT					2 WAT					4 WAT				
	IPU (g/ha)														
	0	500	1000	2000	Mean	0	500	1000	2000	Mean	0	500	1000	2000	Mean
Siswal 1	0 (0)	77.9 (93.3)	79.3 (95.0)	89.4 (99.9)	61.6 (72.1)	0 (0)	81.2 (98.3)	81.2 (99.9)	89.4 (99.9)	62.9 (74.6)	0 (0)	85.3 (98.3)	89.4 (99.9)	89.4 (99.9)	66.0 (74.6)
Siswal 2	0 (0)	89.4 (99.9)	89.4 (99.9)	89.4 (99.9)	67.0 (75.0)	0 (0)	89.4 (99.9)	89.4 (99.9)	89.4 (99.9)	67.0 (75.0)	0 (0)	89.4 (99.9)	89.4 (99.9)	89.4 (99.9)	67.0 (75.0)
Saharwa	0 (0)	89.4 (99.9)	89.4 (99.9)	89.4 (99.9)	67.0 (75.0)	0 (0)	89.4 (99.9)	89.4 (99.9)	89.4 (99.9)	67.0 (75.0)	0 (0)	89.4 (99.9)	89.4 (99.9)	89.4 (99.9)	67.0 (75.0)
H.A.U. 1	0 (0)	89.4 (99.9)	89.4 (99.9)	89.4 (99.9)	67.0 (75.0)	0 (0)	89.4 (99.9)	89.4 (99.9)	89.4 (99.9)	67.0 (75.0)	0 (0)	89.4 (99.9)	89.4 (99.9)	89.4 (99.9)	67.0 (75.0)
Charkhi Dadri	0 (0)	89.4 (99.9)	89.4 (99.9)	89.4 (99.9)	67.0 (75.0)	0 (0)	89.4 (99.9)	89.4 (99.9)	89.4 (99.9)	67.0 (75.0)	0 (0)	89.4 (99.9)	89.4 (99.9)	89.4 (99.9)	67.0 (75.0)
H.A.U. 2	0 (0)	89.4 (99.9)	89.4 (99.9)	89.4 (99.9)	67.0 (75.0)	0 (0)	89.4 (99.9)	89.4 (99.9)	89.4 (99.9)	67.0 (75.0)	0 (0)	89.4 (99.9)	89.4 (99.9)	89.4 (99.9)	67.0 (75.0)
Mean B	0 (0)	87.5 (98.9)	87.7 (99.9)	89.4 (99.9)		0 (0)	88.0 (99.9)	88.0 (99.9)	89.4 (99.9)		0 (0)	88.7 (99.7)	89.4 (99.9)	89.4 (99.9)	
CD (P=0.05)															
Population	2.4 (1.5)					1.7 (NS)					NS (NS)				
IPU	2.0 (1.3)					1.4 (0.4)					0.9 (0.4)				
Population x IPU	4.8 (NS)					3.4 (NS)					NS (NS)				

Original figures in parenthesis were subjected to angular transformation. IPU, isoproturon; WAT, weeks after treatment.

Table 4: EC of *Chenopodium* populations before and after boiling as influenced by isoproturon at 1 WAT

Populations	EC (ds/m)									
	Before boiling					After boiling				
	IPU (g/ha)									
	0	500	1000	2000	Mean	0	500	1000	2000	Mean
Siswal 1	0.015	0.117	0.143	0.180	0.114	0.023	0.200	0.243	0.300	0.192
Siswal 2	0.017	0.127	0.147	0.210	0.125	0.030	0.180	0.233	0.287	0.183
Saharwa	0.013	0.120	0.147	0.177	0.114	0.023	0.140	0.190	0.293	0.162
H.A.U. 1	0.017	0.117	0.137	0.187	0.114	0.027	0.170	0.213	0.300	0.178
Charkhi Dadri	0.017	0.127	0.150	0.180	0.118	0.027	0.163	0.193	0.293	0.169
H.A.U. 2	0.013	0.127	0.150	0.173	0.116	0.027	0.170	0.193	0.293	0.171
Mean B	0.015	0.122	0.146	0.184		0.026	0.171	0.211	0.294	
CD (P=0.05)										
Population	0.007					0.010				
IPU	0.006					0.008				
Population x IPU	0.014					0.020				

EC, electrical conductivity; IPU, isoproturon; WAT, weeks after treatment.

Table 5: Fresh and dry weight of *Chenopodium* populations as influenced by isoproturon at harvesting

Populations	Weight (g/pot)									
	Fresh Weight					Dry weight				
	IPU (g/ha)									
	0	500	1000	2000	Mean	0	500	1000	2000	Mean
Siswal 1	20.0	1.7	1.3	1.3	6.1	10.0	0.3	0.2	0.2	2.7
Siswal 2	20.0	1.5	1.0	1.0	5.9	10.0	0.3	0.2	0.2	2.7
Saharwa	19.7	2.2	1.5	1.5	6.2	10.3	0.2	0.2	0.2	2.7
H.A.U. 1	19.7	2.7	2.0	1.7	6.5	9.9	0.3	0.2	0.2	2.6
Charkhi Dadri	20.7	3.0	2.0	1.0	6.7	10.0	0.3	0.2	0.2	2.7
H.A.U. 2	20.0	0.5	0.5	0.3	5.3	10.0	0.3	0.2	0.2	2.7
Mean B	20.0	1.9	1.4	1.1		10.0	0.3	0.2	0.2	
CD (P=0.05)										
Population	0.6					NS				
IPU	0.5					0.2				
Population x IPU	NS					NS				

IPU, isoproturon,

DISCUSSION

None of the populations showed resistance against isoproturon and it provided 100% control of all populations even at half of the recommended dose due to inhibition of photosystem II. Because of high mortality, lower values of plant height, chlorophyll fluorescence, fresh and dry weight and high EC was recorded in all the population with the application of isoproturon. These results were well supported with the findings of Chhokar et al. (2017). Similarly Negi et al. (2015) also proved the superiority of isoproturon at 1 kg/ha with significant reduction of dry matter of weeds.

SUMMARY AND CONCLUSION

- Highest % emergence of *Chenopodium* was reported in Siswal 2 *fb* Siswal 1, Saharwa, H.A.U. 1, Charkhi Dadri, and

H.A.U.2 populations. This finding implies that good control as to arrest the seed formation would reduce the carry over weed infestation in the next season and could be used as a tool in resistance management in this weed.

- Isoproturon provided 90– 100% control of all the populations at recommended dose. *Chenopodium* spp. was found highly sensitive to isoproturon when applied as post- emergence. This herbicide provided complete control in all populations even at half of the recommended dose of herbicide. The present study suggests that post-emergence intervention with isoproturon could resolve the problem of resistant *Chenopodium* populations being faced by the farmers without incurring extra cost as post-emergence application of isoproturon.

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