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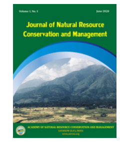

Bio-efficacy of flumioxazin against mixed weed flora in the wastelands of Himachal Pradesh

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ABSTRACT

A field experiment was conducted during *kharif* 2021 at the Research Farm of the Department of Agronomy, College of Agriculture CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur, to study the bio-efficacy of flumioxazin against mixed weed flora in a wasteland. The experiment was laid out in Randomized Block Design with three replications. Nine weed control treatments, including flumioxazin 150 g/ha, 200 g/ha, 250 g/ha, 300 g/ha, 500 g/ha, oxyfluorfen 1000 g/ha, weed-free check, glyphosate 4000 g/ha and untreated control were evaluated in randomized block design with three replications. The primary weeds in the experiment area were *Synedrella nodiflora*, *Cynodon dactylon*, *Parthenium hysterophorus*, *Cyperus sp*, *Ageratum conyzoides*, *Erigeron canadensis* and *Centella asiatica*. The results revealed that post-emergence application of flumioxazin 500 g/ha, being statistically alike with flumioxazin 300 g/ha, flumioxazin 250 g/ha, flumioxazin 200 g/ha, and glyphosate 4000 g/ha, was quite effective in controlling weeds with higher weed control efficiency. Hence flumioxazin can be opted for to achieve better weed control in a wasteland.

Keywords: Flumioxazin, weed control, wasteland

INTRODUCTION

There is a marked increase in non-cropped land in India due to growing economic conditions. In addition to the existing wastelands, cultivated lands are being kept fallow for several purposes. These fallow lands are infested with obnoxious weeds like *Lantana camara*, *Ageratum houstonianum*, *Mikania micrantha* and *Parthenium hysterophorus* (Datta et al. 2018). Distribution of invasive alien species in Himachal Pradesh based on habitat shows that 44% of invasive species were most abundant in a wasteland and followed by cultivated fields (20%), along roadsides (16%) and forest (9%) (Sekar et al. 2015). Climate change and variability play an important role in establishing and redistributing species in different agro-climatic zones. Importing food grains also facilitated many invasive species entering, establishing and spreading in non-cropped areas (Duary and Mukherjee 2013).

Various methods are being used to manage weeds from non-cropped areas. However, the chemical control method is less time-consuming, less tedious and inexpensive compared to other control methods and also has high weed control efficiency. Successful control of these weeds has been achieved by several herbicides, and control varies with herbicides, rates applied and growth stages of weeds. The non-cropped weed management strategies must incorporate using a minimum number of applications of any one herbicide per season, rotating herbicides and using tank mixes with different chemistry. For this number of herbicides have been recommended for controlling weeds under such situations and are being used by the farming community. Flumioxazin is one such herbicide which is effective in controlling both grassy as well as broad-leaved weeds in non-cropped areas. Flumioxazin works by inhibiting of plant enzyme protoporphyrinogen oxidase, which is essential for the synthesis of chlorophyll. Flumioxazin is a non-selective, pre and post-emergence herbicide that controls a broad spectrum of non-cropped land weeds. Hence the present investigation was conducted to evaluate the efficacy and phytotoxicity of flumioxazin 50% SC against mixed weed flora (broad-leaved weeds, sedges and grassy weeds) in non-cropped areas.

MATERIALS AND METHODS

The field experiment was carried out at the research farm of the Department of Agronomy, Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishvavidyalaya, Palampur (32.6° N, 76.3° E) during *kharif* 2021. The experimental site was a wasteland, the soil of which was silty clay loam in texture, acidic in reaction (5.84), medium in organic carbon (0.81%), low in available nitrogen (235.1 kg/ha), medium in available phosphorus (16.57 kg/ha) and available potassium (158.7 kg/ha). Nine weed control treatments *viz.,* flumioxazin 150 g/ha, 200 g/ha, 250 g/ha, 300 g/ha, 500 g/ha, oxyfluorfen 1000 g/ha, weed-free check, glyphosate 4000 g/ha and untreated control were evaluated in randomized block design with three replications. Herbicides were applied using 750 litres of water/ha with a flat fan nozzle attached to a Knapsack sprayer as per treatments. Weed count and weed dry weight were recorded from two spots using a quadrate of 50 X 50 cm and expressed as number and g/m^2, respectively. The data on weed count and weed dry weight were subjected to ($\sqrt{x}$ + 1) square root transformation before statistical analysis. The weed control efficiency of different treatments was calculated as per the following formula given by Mishra and Tosh (1979).

$$\text{Weed control efficiency (\%)} = \frac{\text{DWC} - \text{DWT}}{\text{DWC}} \times 100$$

Where,

DWC - weed dry weight (g/m^2) in control plot, and

DWT - weed dry weight (g/m^2) in the treated plot

RESULTS AND DISCUSSION

The dominant weed flora in the experimental site included *Synedrella nodiflora*, *Cynodon dactylon*, *Parthenium hysterophorus*, *Cyperus sp*, *Ageratum conyzoides*, *Erigeron canadensis* and *Centella asiatica*. A similar type of weed flora in non-cropped areas has also been observed by Angiras (2014), Pooja et al. (2021) and Kumar et al. (2021) under the mid-hill conditions of Himachal Pradesh. Different weed control treatments significantly influenced the total weed density at all the stages of observation (Table 1). The significantly highest density of total weeds was recorded in untreated control at all the stages of observation. Weed free check resulted in a significantly lower count of total weeds as compared to other treatments. Among herbicide treatments, flumioxazin 250 g/ha behaved statistically similarly with flumioxazin 300 g/ha, flumioxazin 500 g/ha, flumioxazin 200 g/ha, and glyphosate 4000 g/ha, and resulted in significantly lower density of total weeds at all the stages of observation as compared to other treatments. This is because of the effective control of the weeds with flumioxazin which reduced the species-wise weed density, which ultimately

Table 1. Effect of weed control treatments on total weed count (No./m^2) at different stages of observation

Treatment	Dose (g/ha)	Stages of observation		
		15 DAS	30 DAS	60 DAS
Flumioxazin 50% SC	150	6.50(41.33)	5.97(34.67)	6.71(44.00)
Flumioxazin 50% SC	200	5.84 ^{a}(33.33)	4.10 ^{a}(16.00)	5.08 ^{a}(25.33)
Flumioxazin 50% SC	250	4.96 ^{a}(24.00)	3.49^a(12.00)	4.40 ^{a}(18.67)
Flumioxazin 50% SC	300	4.59 ^{a}(21.33)	3.58 ^{a}(12.00)	4.28 ^{a}(17.33)
Flumioxazin 50% SC	500	4.54 ^{a}(20.00)	3.20 ^{a}(9.33)	4.26 ^{a}(17.33)
Oxyfluorfen 23.5% EC	1000	7.37(53.33)	6.77(45.33)	7.55(56.00)
Weed free check (Two hand weeding)	0, 30 DAS	1.00(0.00)	1.00(0.00)	1.00(0.00)
Glyphosate 41% SL	4000	5.74 ^{a}(32.00)	3.93 ^{a}(14.67)	5.32 ^{a}(28.00)
Untreated control	-	8.85(77.33)	9.91(97.33)	11.36(128.00)
S.Em±	-	0.52	0.33	0.34
CD (P=0.05)	-	1.55	1.03	1.10

Values given in the parentheses are the means of original values, Data subjected to ($\sqrt{x}$ + 1) square root transformation; DAS: days after spray

Table 2. Effect of weed control treatments on weed dry matter (g/m²) in the wasteland at different stages of observation

Treatment	Dose (g/ha)	Stages of observation		
		15 DAS	30 DAS	60 DAS
Flumioxazin 50% SC	150	3.43(10.88)	3.68(12.69)	4.38(18.17)
Flumioxazin 50% SC	200	2.81 [a](7.08)	2.93[a](7.76)	3.78 [a](13.46)
Flumioxazin 50% SC	250	2.27 [a](4.36)	2.42 [a](5.06)	3.00[a](8.18)
Flumioxazin 50% SC	300	1.98 [a](3.08)	2.10[a](3.56)	2.51 [a](5.46)
Flumioxazin 50% SC	500	2.01[a](3.18)	2.18 [a](3.90)	2.46 [a](5.18)
Oxyfluorfen 23.5% EC	1000	3.55(11.74)	3.89(14.32)	4.54(19.82)
Weed-free check (Two hand weeding)	0, 30 DAS	1.00(0.00)	1.00(0.00)	1.00(0.00)
Glyphosate 41% SL	4000	2.70 [a](6.48)	2.82 [a](6.96)	3.54 [a](11.52)
Untreated control	-	4.68(20.96)	5.27(26.88)	6.86(45.18)
S.Em±	-	0.41	0.43	0.48
CD (P=0.05)	-	1.23	1.29	1.44

Values given in the parentheses are the means of original values, Data subjected to ($\sqrt{x+1}$) square root transformation; DAS: days after spray

Table 3. Effect of weed control treatments on weed control efficiency (%) in the wasteland at different stages of observation

Treatment	Dose (g/ha)	Weed control efficiency		
		15 DAS	30 DAS	60 DAS
Flumioxazin 50% SC	150	48.09	52.79	59.78
Flumioxazin 50% SC	200	66.22	71.13	70.21
Flumioxazin 50% SC	250	79.20	81.18	81.89
Flumioxazin 50% SC	300	85.31	86.76	87.92
Flumioxazin 50% SC	500	84.83	85.49	88.53
Oxyfluorfen 23.5% EC	1000	43.99	46.73	56.13
Weed-free check (Two hand weeding)	0, 30 DAS	100.00	100.00	100.00
Glyphosate 41% SL	4000	69.08	74.11	74.50

DAS: days after the spray

resulted in the significantly lowest total weed count. These results are in close conformity with the findings of Datta et al. (2018) and Kaur et al. (2020). The effectiveness of glyphosate against weeds in non-cropped areas was also reported by Kumar et al. (2021).

All the weed control treatments significantly influenced the dry matter accumulation of total weeds at all the stages of observation (Table 2). There was a gradual increase in total weed dry matter accumulation from 15 DAS up to 60 DAS in all the weed control treatments. The highest total weed dry matter accumulation was observed in untreated control at all stages. Weed free check resulted in significantly lower dry weight of weeds as compared to other treatments. All the weed control treatments showed a significant reduction in total weed dry matter over untreated control at all the stages of observation. Among various herbicide treatments, flumioxazin 250 g/ha behaved statistically alike with flumioxazin 200 g/ha, flumioxazin 300 g/ha, flumioxazin 500 g/h, and glyphosate 4000 g/ha resulted in significantly lower total dry matter of weeds at all the stages of observation. This is because of the effective control of the weeds with flumioxazin which reduced the species-wise weed dry weight, which ultimately resulted in the significantly lowest total weed dry matter. The effectiveness of glyphosate in controlling weeds has also been reported by Corbett et al. (2004) and Pooja et al. (2021).

Weed control efficiency also followed the same trend as that of weed dry matter with hand weeding, resulting in the highest weed control efficiency at all the stages of observation (Table 3). Among different weed control treatments, flumioxazin 300 g/ha recorded higher weed control efficiency of 85.31 and 86.76 at 15 and 30 DAS, respectively. However, flumioxazin 500 g/ha recorded maximum weed control efficiency of 88.53 per cent at 60 DAS. These treatments were followed by flumioxazin 250 g/ha, flumioxazin 200 g/ha and glyphosate 4000 g/ha. The lowest weed control efficiencies were achieved with oxyfluorfen 1000 g/ha. The higher weed control efficiencies achieved by different herbicide treatments were due to a significant reduction in the dry weight of weeds through effective control over untreated control. Similar results were reported by Sridhara et al. (2019).

CONCLUSION

The study indicated that flumioxazin 250 g/ha can be used for effective control of weeds in non-cropped wastelands.

CONFLICT OF INTEREST: The authors have no conflict of interest

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