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Short Communication

Bioassay for herbicide residues applied to control weeds in grassland

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Abstract

A laboratory experiment was conducted during *Kharif* 2021 at Department of Agronomy, College of Agriculture, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur, to study the residue of flumioxazin herbicide in soil taken from field with treated flumioxazin through bioassay. 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 completely randomized block design with three replications in field experiment. Rice, maize, wheat, oats, mustard and cucumber were used as indicator plant in bioassay to test the residual effect of flumioxazin in the soil of treated plots. Two growth parameters i.e. shoot length and root length were measured for all plant species. Soil samples were collected at 30 and 60 days after spray and analyzed for residue using bioassay. The results revealed that shoot length and root length of all the six indicator plants were not significantly affected by residue of various herbicides during the period of investigation. Therefore all the six indicator crops viz. wheat, maize, rice, oats, mustard and cucumber successfully be grown under field condition after the application of this herbicide.

Key words: Bioassay, Flumioxazin, residue

In the agricultural production system, herbicides are used quite extensively throughout the world. Herbicides should have a fate in the soil that effectively suppresses weeds for a long enough time to provide crops a competitive edge, but also fade from the soil before the crop season is over to allow for the safe planting of succeeding crops. When applied to field, herbicide not only kills the targeted weeds but also has the potential to leave behind undesirable residues that are harmful for the environment (Haney *et al*. 2000). However, a very quick loss of herbicide from the soil will result in inadequate weed control, which is deemed to be unacceptable for crop growth. The fate of chemicals in the soil is influenced by soil conditions in addition to the type of herbicide used and in clayey soils the effect is more as compare to sandy soil. For these reasons, bioassay tests are conducted to determine the residual effects of various herbicides. The majority of the time, whole plant bioassay or root extension bioassay has been used to assess herbicide bioavailability (Pannacci *et al*. 2006).

A bioassay is an experiment for estimating the potency of a herbicide by analysis of the reaction that follows its application to living organisms (Streibig 1988). Bioassay technique used in herbicide studies are based on the response of chosen organism, superior plants or micro organisms to the chemical. Various means of assessment were used: germination, weight or size of plant parts, modification in physiological activities such as photosynthesis and transpiration and typical symptoms (Horowitz 1976). The herbicide or chemical residue remaining in the soil can be detected by residual phytotoxicity effect at concentrations high enough to negatively impact crop growth, yield and quality (Pestemer *et al*. 1980). The cucumber, oats and sorghum are most frequently used indicator plant because they have a marked sensitivity to many herbicides and are easy to grow (Horowitz

1976). In view of the above facts the present investigation was conducted to study the residues of flumioxazin in soil through bioassay.

The experiment was carried out at Department of Agronomy, Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishvavidyalaya, Palampur during *Kharif* 2021. The soil samples from 0-15 cm depth were collected replication wise from the plot where 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 applied to control mixed weed flora in grassland. The soil of the experimental site was silty clay loam in texture, acidic in reaction (5.22), medium in organic carbon (0.93%), low in available nitrogen (250.8 kg/ha), medium in available phosphorus (18.32 kg/ha) and available potassium (150.2 kg/ha). Two kg soil was taken randomly at 30 and 60 days after spray, from five spots in each plot (5 m x 4 m = 20 m^2). Soil was filled in petridishes and a laboratory experiments with nine 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 completely randomized block design with three replications. Seeds of six indicator crops viz. wheat, maize, rice, oats, mustard and cucumber were grown in petri dishes in the soil collected from herbicide sprayed grassland plots. These crop seeds were allowed to grow under laboratory conditions under close supervision for nine days. All of the crop plants were removed from the petri dishes after nine days and their plant height and root length were measured as parameters to evaluate the after effects of various herbicides applied on grassland. Plant height was taken from the soil surface to tip of the plant. Root length was taken after washing off the soil and measured from the point of growth to the tip of the longest roots. The effects of residue in soil were determined based on the responses through the growth components of the seedlings.

Root and shoot length of all the six indicator crops *viz*. wheat, maize, rice, oats, mustard and cucumber were not significantly affected by the residues of different herbicides when applied under field conditions.

Maize: The root and shoot length of indicator maize plant were not significantly influenced by different herbicidal treatments applied in grassland at 30 and 60 DAS (Table 1). Flumioxazin 150 g/ha, 200 g/ha, 250 g/ha, 300 g/ha, 500 g/ha, oxyfluorfen 1000 g/ha, glyphosate 4000 g/ha residue did not affect the root and shoot length of maize plant. Bioassay results showed that these herbicides to be secure on the succeeding crops and there are no harmful effects from the herbicides used and this might be due to detoxification of herbicide in soil. These results are in

Table 1. Residual effect of different treatments on root and shoot length of maize and wheat

Treatment	Dose (g/ha)	Maize				Wheat			
		Root length (cm)		Shoot length (cm)		Root length (cm)		Shoot length (cm)	
		30 DAS*	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS
Flumioxazin 50% SC	150	14.7	16.3	9.2	8.8	12.5	13.3	3.6	4.1
Flumioxazin 50% SC	200	14.7	16.0	9.5	8.5	13.3	13.7	4.1	4.0
Flumioxazin 50% SC	250	15.0	16.7	8.6	8.6	13.3	13.5	4.1	3.6
Flumioxazin 50% SC	300	14.7	16.3	8.5	8.6	13.2	13.7	4.0	3.6
Flumioxazin 50% SC	500	15.0	16.6	8.5	8.6	13.7	13.0	4.7	4.2
Oxyflurfen 23.5% EC	1000	14.7	16.7	9.2	8.8	13.8	13.0	4.4	3.9
Weed free check (Two hand weeding)	0, 30 DAS	14.7	16.0	8.8	8.8	13.0	12.7	3.9	4.1
Glyphosate 41% SL	4000	14.0	15.9	9.7	9.1	14.0	13.3	4.3	3.9
Untreated control	-	14.7	16.3	9.8	9.3	13.3	13.4	4.3	4.2
S.Em±	-	1.0	0.8	0.7	0.7	1.4	1.3	0.5	0.4
CD (P=0.05)	-	NS	NS	NS	NS	NS	NS	NS	NS

*DAS: days after spray

close conformity with the findings of Priya *et al*. (2017).

Wheat: Similar to the maize, root and shoot length wheat plant were also not significantly affected by residue of various herbicides during the period of investigation (Table 1). There were no harmful effects from the herbicides used because of the initial inactivation of glyphosate in soil by reversible adsorption to clay and organic matter. These results are in close conformity with the findings of Palhano *et al*. (2018).

Rice : The root and shoot length of indicator rice plant remained unaffected due to the residue of different herbicides (Table 2). Flumioxazin 150 g/ha, 200 g/ha, 250 g/ha, 300 g/ha, 500 g/ha, oxyfluorfen 1000 g/ha, glyphosate 4000 g/ha residue did not affect the root and shoot length of rice plant. Residues of herbicide had no adverse effect on indicator rice plants due to the rapid detoxification of herbicides in soil. Rapid detoxification of oxyfluorfen in soil was also reported by Priya *et al*. (2017) in rice crop.

Mustard: Similar to the rice, root and shoot length of wheat plant were not significantly influenced by residue of various herbicides during the period of investigation (Table 2). There were no harmful impacts from flumioxazin herbicide because of the quick dissipation rate of flumioxazin in the soil. Similar results with flumioxazin herbicides were reported by Sondhia and Dixit (2008).

Oats: The root and shoot length of indicator oats plant were not significantly influenced by different herbicidal treatments applied in grassland at 30 and 60 DAS (Table 3). Flumioxazin 150 g/ha, 200 g/ha, 250 g/ha, 300 g/ha, 500 g/ha, oxyfluorfen 1000 g/ha and glyphosate 4000 g/ha residue did not affect the root and shoot length of oats plant. There were no harmful effects from the herbicides used this might be due to quick dissipation rate and detoxification of herbicides. These results are in close conformity with the findings of Palhano *et al*. (2018).

Cucumber: Similar to the oats, root and shoot length cucumber plant was also not significantly affected by residue of various herbicides during the period of investigation (Table 3). There were no harmful impacts from the herbicides used because all the herbicide treatments behaved statistically similar to untreated control in their residual effect.

The shoot length and root length of the all six indicator crops did not exhibit significant residual influence of herbicidal treatments applied in grassland. There were no harmful impacts from flumioxazin herbicide because of the quick dissipation rate of flumioxazin in the soil. Flumioxazin did not affect seedling growth of all the six indicator crops, thus indicating absence of residue. These results are in close conformity with the findings

Table 2. Residual effect of different treatments on root and shoot length of rice and mustard

Treatment	Dose (g/ha)	Rice				Mustard			
		Root length (cm)		Shoot length (cm)		Root length (cm)		Shoot length (cm)	
		30 DAS*	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS
Flumioxazin 50% SC	150	5.7	6.1	3.6	4.6	6.6	5.8	5.1	5.2
Flumioxazin 50% SC	200	6.3	5.7	3.8	4.8	5.1	5.5	5.2	5.3
Flumioxazin 50% SC	250	6.0	5.6	3.6	4.7	5.8	6.5	5.2	6.0
Flumioxazin 50% SC	300	5.5	5.7	3.5	4.6	4.9	6.8	5.1	5.7
Flumioxazin 50% SC	500	5.5	5.5	3.8	4.3	5.5	6.3	5.7	5.4
Oxyflurfen 23.5% EC	1000	5.8	5.7	3.2	4.4	5.3	5.7	5.4	6.1
Weed free check (Two hand weeding)	0, 30 DAS	6.3	5.8	3.5	4.5	5.2	6.4	6.0	6.5
Glyphosate 41% SL	4000	6.4	5.7	3.2	4.8	5.7	5.8	5.7	5.9
Untreated control	-	6.7	6.0	3.5	4.8	5.8	6.5	5.6	5.4
S.Em±	-	0.4	0.7	0.4	0.6	0.7	0.6	0.8	0.6
CD (P=0.05)	-	NS	NS	NS	NS	NS	NS	NS	NS

*DAS: days after spray

Table 3. Residual effect of different treatments on root and shoot length of oats and cucumber

Treatment	Dose (g/ha)	Oats				Cucumber			
		Root length (cm)		Shoot length (cm)		Root length (cm)		Shoot length (cm)	
		30 DAS*	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS
Flumioxazin 50% SC	150	11.0	10.0	8.9	8.7	6.9	7.5	13.9	12.2
Flumioxazin 50% SC	200	10.3	10.4	8.9	8.5	7.5	7.8	12.5	12.5
Flumioxazin 50% SC	250	10.4	10.3	8.3	7.6	6.6	8.6	13.7	12.0
Flumioxazin 50% SC	300	10.7	10.1	8.8	8.0	6.6	8.2	13.5	11.8
Flumioxazin 50% SC	500	10.3	9.9	8.9	7.7	7.4	8.5	13.4	11.9
Oxyflurfen 23.5% EC	1000	11.2	10.2	8.4	8.3	7.4	8.7	13.5	12.2
Weed free check (Two hand weeding)	0, 30 DAS	11.0	10.6	8.8	8.2	7.5	8.4	14.0	11.8
Glyphosate 41% SL	4000	10.8	10.4	8.3	8.4	7.3	8.3	13.4	12.7
Untreated control	-	10.0	10.3	8.4	8.2	6.7	8.4	13.8	12.8
S.Em±	-	1.2	0.4	0.7	0.5	0.8	0.6	1.4	0.7
CD (P=0.05)	-	NS	NS	NS	NS	NS	NS	NS	NS

*DAS: days after spray

of Sondhia and Dixit (2008). Alister *et al*. (2008) also reported that flumioxazin is a herbicide with low environmental risk owing to its reduced soil residue.

Conclusion

The study indicated that flumioxazin applied at different rates did not affect seedling growth of all the six indicator crops, thus indicating absence of residue and these crops can be grown successfully after the application of this herbicide.

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