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RESEARCH ARTICLE

Bio-efficacy of nicosulfuron against mixed weed flora in maize and its residual effect on succeeding crops

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ABSTRACT

A field study was conducted during *Spring* and rainy *(Kharif)* season of 2017 at N.E. Borlaug Crop Research Centre of G.B. Pant University of Agriculture and Technology, Pantnagar U.S. Nagar, Uttarakhand, India to evaluate the effective dose of nicosulfuron for weed control in maize while assessing its effect on growth and yield of maize along with its residual effect on succeeding pea and cowpea fodder. Eight treatments were tested which include: post-emergence application (PoE) of nicosulfuron at different doses (30, 36, 42 and 50 g/ha), tembotrione 120 g/ha PoE, pre-emergence application (PE) of atrazine 1000 g/ha, hand weeding twice at 20 and 40 days after seeding (DAS) and weedy check. The weed community during both the seasons in the experimental area consisted of, grassy weeds: *Phalaris minor, Eleusine indica, Digitaria sanguinalis, Echinochloa colona* and *Panicum maximum*, broad-leaved weeds (BLW): *Trianthema monogyna, Chenopodium album, Phyllanthus niruri, Parthenium hysterophorus* and *Mallugo stricta* and a sedge *Cyperus rotundus*. Nicosulfuron at 50 g/ha resulted in 50-100% weed control, depending on the weed species. Nicosulfuron at 50 and 42 g/ha were equally effective in increasing grain yield of maize when compared with tembotrione and was found superior over atrazine during both the season. No phytotoxic symptoms on maize and no residual effect on succeeding pea and cowpea fodder crop were observed, at any doses of nicosulfuron. Hence, nicosulfuron at 42 g/ha PoE may be safely used for effective weed management and improved yield of maize.

Keywords: Atrazine, Maize, Nicosulfuron, Tembotrione, Weed management

INTRODUCTION

Maize (*Zea mays* L.) is one of the important cereals in the world agricultural economy both as a food and fodder crop. It has higher yield potential than any other cereal. In India, it is grown over an area of 9.7 Mha with total production of 28.6 MT and average productivity of 2.945 t/ha (GOI 2022). Weed infestation at early crop growth create competition for various resources, *viz.* nutrients, water, sunlight and space results reduction in grain yield, which also depends on weeds intensity and type of weed flora. The yield losses varied due to season long weed infestation and range from 30% to complete crop failure in maize (Pandey *et al.* 2001). The manual weeding is expensive, time and energy consuming and timely availability of labors for agricultural operation is a major problem. Hence, herbicides are an appropriate alternative strategy to manage weeds as they control weeds timely and effectively and also offer great scope for minimizing the cost of weed management (Ishrat *et al.* 2012). The pre-emergence herbicide options are available in maize (Singh *et al.* 2015) but the post-emergence herbicides for managing weeds in maize are less. Nicosulfuron, a sulfonylurea is a systemic selective herbicide and a new alternative for post-emergence control of both annual and perennial weeds in maize (Lum *et al.* 2005). It displays genera-selectivity, therefore, ensures its effectiveness for managing weeds associated with the maize – even the grasses that are closely related to maize. Nicosulfuron belonging to sulfonylurea derivatives is an acetolactate synthase ALS inhibitor (EFSA 2012, HRAC 2012), which blocks the production of amino acids, such as valine, leucine and isoleucine, and, as a result, it interferes with the formation of proteins and other functional plant components. This herbicide was registered for post-emergence applications to control grass and some dicot weeds in maize in China (China Pesticide Information Network 2012). Hence, a field study was conducted to assess the effective dose of nicosulfuron

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for weed management in maize and quantify its phytotoxic effect on growth and yield of maize along with its residual effect on succeeding pea and cowpea fodder.

MATERIAL AND METHODS

The field study was conducted in *Spring* and *Kharif* (rainy) seasons of 2017. The experimental site was situated at 29^0 N latitude, 79° E longitude at an elevation of 243.8 m above MSL at Norman E. Borlaug, Crop Research Center of G.B. Pant University of Agriculture and Technology, Pantnagar. The soil of experimental area was loamy, medium in organic matter (0.67%), available nitrogen (210 kg/ha), phosphorus (17.5 kg/ha) and potassium (181.2 kg/ha) with having natural reaction (pH 7.5). The climate is very hot in summers and cold in winters.

During the *Spring* season, (Feb to May, 2017) total growing period of crop, the total rainfall received was 38.0 mm and the relative humidity ranged from 20.7-93.0%. The average maximum and minimum temperatures were 31.2^0C and 15.5^0C, respectively. During succeeding cowpea fodder crop growing season (June to July 2017), the total rainfall was received 475.0 mm and the relative humidity ranged from 21.9-93.9%. The average maximum & minimum temperature was 34.9^0C and 25.0^0C, respectively. In the *Kharif* season, (July to October, 2017) the total rainfall was received 1290.2 mm and the relative humidity ranged from 46.1-93.9% during total growing period of maize crop. The average maximum and minimum temperatures were 32.4^0C and 23.8^0C, respectively. During succeeding pea crop growing season (November, 2017 to April, 2018) the total rainfall was received 55.8 mm and the relative humidity ranged from 19.0-96.0%. The average maximum and minimum temperature were 26.1^0C and 10.8^0C, respectively.

The experiment was laid out in randomized complete block design with eight treatments and three replications. The treatments consist of nicosulfuron 60D with four doses (30, 36, 42 and 50 g/ha) as post-emergence (PoE), standard check *i.e.*, tembotrione 120 g/ha PoE and atrazine 1000 g/ha as pre-emergence (PE) along with hand weeding twice at 20 and 40 days after seeding (DAS) and weedy check. The maize varieties *P-1844* (hybrid) and *Gaurav* (composite) was sown as test crop during *spring* and *Kharif* 2017, respectively. The crop was sown on 03.02.2017 during *spring* and 18.07.2017 during *Kharif* at 60 x 25 cm spacing in plot size 15 m^2 as per standard agronomic practices except weed control treatments. It was harvested on 24.05.2017 and 11.10.2017 during *Spring* and *Kharif* 2017, respectively.

All the herbicides except atrazine were sprayed at 3-5 leaf stages of weeds using battery operated knapsack sprayer fitted with flat fan nozzle using 500 l/ha volume of water, whereas, atrazine was applied 1-2 days after sowing of maize crop.

The density (no./m^2) and dry matter (biomass) of dominated weed species, that was categorized in grassy, broad-leaved weeds (BLWs) and sedges, was recorded at 45 days after herbicide application (DAA) using a quadrat (0.25 m x 0.25 m) to assess the weed flora. Collected samples were first sun-dried and then dried in an oven at 60 ± 2^0C for 4-5 days till constant dry weight was achieved. The data on weed density and biomass was subjected to square root transformation $(\sqrt{x+1})$ to normalize their distribution. Visual assessment of herbicide toxicity by phytotoxic symptoms, *viz.* leaf tip injury/ wilting/ vein clearing/ necrosis/ epinasty and hyponasty on maize crop was monitored 3, 7, 14 and 21 DAA. The yield attributing characters were recorded at harvest time. Grain yield was calculated by threshing of total plot biomass and presented in tons per hectare.

To assess the residual effect the herbicide treatments on succeeding crop, germination percentage and grain yield of pea and cowpea fodder were also recorded separately for each plot and converted to per hectare during respective succeeding season. The succeeding cowpea fodder and pea crop was also sown in RBD with 9 treatments, which were used in *Kharif* season, in 3 replications. Cowpea variety, UPC 5286 was sown on 25.05.2017 with seed rate 25kg/ha and pea variety, *Pant Pea 25* was sown with seed rate of 75 kg/ha on 20.11.2017. Cowpea fodder and pea was harvested on 16.07.2017 and 03.04.2018, respectively.

For determining the statistical difference between the treatments and to draw conclusions, the data obtained during the course of investigation were subjected to statistical analysis adapted in statistical package STPR-3 programme for the Randomized Complete Block Design, designed and developed by Department of Mathematics and Statistics of College of Basic Science and Humanities (CBSH), GBPUA&T, Pantnagar.

RESULT AND DISCUSSION

Weed flora

The experimental field was infested with natural population of grassy (33 and 49.3%), BLW (13.1 and

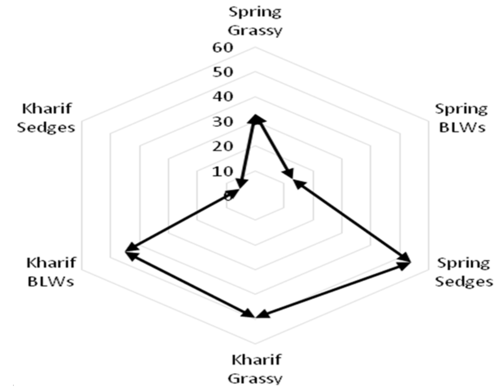

Figure 1. Relative weed composition (%) at 45 DAA

45.4%) and sedges (53.9 and 5.3%), respectively during *spring* and *Kharif*, 2017 (**Figure 1**). The dominant weeds in *Kharif* season were *Eleusine indica, Echinochloa colona, Digitaria sanguinalis* and *Panicum maximum* among grassy weeds and *Parthenium hysterophorus, Mallugo stricta* and, *Trianthema monogyna* among BLW and *Cyperus rotundus* among sedges. During *spring* season, *Eleusine indica, Digitaria sanguinalis* and *Phalaris minor* among grassy, *Trianthema monogyna, Chenopodium album* and *Phyllanthus niruri* among BLW and *Cyperus rotundus*, the sedge were the predominant weeds (**Table 1**).

Effect on weed

The density of all weeds differed significantly amongst tested weed management treatments during both the seasons. The lowest density of all grassy weeds was observed with all the doses of nicosulfuron during both *Spring* and *Kharif*, 2017 (**Table 1**).

Significantly lowest density of *Eleusine indica* was observed with nicosulfuron at 50 g/ha during *spring* 2017, while it was completely controlled with 50 and 42 g/ha during *Kharif* 2017. It was found at par with nicosulfuron at 36 g/ha during *Kharif* 2017. The density of *Digitaria sanguinalis* was also reduced significantly with nicosulfuron at 42 g/ha and was at par with nicosulfuron at 50 g/ha during *spring* 2017. All the doses of nicosulfuron, except 30 g/ha and tembotrione at 120 g/ha were found effective in reducing the density of *Digitaria sanguinalis* during *kharif* 2017 (**Table 1**). Nicosulfuron at 42 and 50 g/ha recorded significantly lowest *Phalaris minor* density in *spring* maize and was found at par with nicosulfuron at 36 g/ha and tembotrione at 120 g/ha. *Echinocloa colona* and *Panicum maximum* were completely controlled with nicosulfuron at 50 g/ha during *Kharif* season.

Among BLW, *Trianthema monogyna*, *Chenopodium album*, *Phyllanthus niruri* were completely controlled with nicosulfuron at 50 g/ha in the *spring* season. The density of broad-leaved weeds during *Kharif* season was found lower with increased dose of nicosulfuron. Nicosulfuron at 50 g/ha and was found superior over tembotrione and atrazine in reducing *Parthenium hysterophorus* and *Mallugo stricta* density in *Kharif* 2017. Thus, the higher dose *i.e.* 50 g/ha of nicosulfuron was found to be more effective to manage BLW in both the seasons. Mitkov *et al.* (2019) also reported the efficacy of nicosulfuron against *Echinochloa crus-galli* and *Chenopodium album* in maize. Zhang *et al.* (2013) observed that nicosulfuron at 40 g per liter was safe to maize in China and its efficacy was greater than tembotrione on broad-leaved weeds.

Table 1. Effect of treatments on weed density (no./m^2) at 45 DAA in maize during *Spring* and *Kharif* 2017

Treatment	Dose (g/ha)	Grassy							BLWs						Sedges	
		E. indica		*D. sanguinalis*		*P. minor*	*E. colona*	*P. maximum*	*T. monogyna*		*C. album*	*P. niruri*	*P. hysterophorus*	*M. stricta*	*C. rotundus*	
		Spring	*Kharif*	*Spring*	*Kharif*	*Spring*	*Kharif*		*Spring*	*Kharif*	*Spring*		*Kharif*		*Spring*	*Kharif*
Nicosulfuron	30	3.2 (9.3)	3.2 (9.3)	3.2 (9.3)	2.1 (3.3)	2.2 (4.0)	3.0 (8.0)	1.7 (2.0)	1.6 (1.7)	3.4 (10.7)	2.2 (4.0)	1.9 (2.7)	3.6 (12.0)	3.1 (8.7)	6.5 (41.3)	2.8 (6.7)
Nicosulfuron	36	2.2 (4.0)	1.5 (1.3)	2.8 (6.7)	1.0 (0.0)	1.9 (2.7)	2.1 (3.3)	1.0 (0.0)	1.5 (1.3)	2.9 (7.3)	1.6 (1.7)	1.0 (0.0)	3.0 (8.0)	2.1 (3.3)	5.1 (25.3)	1.0 (0.0)
Nicosulfuron	42	2.1 (3.3)	1.0 (0.0)	2.1 (3.3)	1.0 (0.0)	1.5 (1.3)	1.2 (0.7)	1.0 (0.0)	1.0 (0.0)	2.6 (6.0)	1.5 (1.3)	1.0 (0.0)	2.8 (6.7)	1.9 (2.7)	4.7 (21.3)	1.0 (0.0)
Nicosulfuron	50	1.2 (0.7)	1.0 (0.0)	2.2 (4.0)	1.0 (0.0)	1.5 (1.3)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	2.5 (5.3)	1.0 (0.0)	1.0 (0.0)	2.5 (5.3)	1.9 (2.7)	4.6 (20.0)	1.0 (0.0)
Tembotrione	120	3.2 (9.3)	3.4 (10.7)	3.0 (8.0)	1.0 (0.0)	1.9 (2.7)	1.7 (2.7)	2.8 (6.7)	1.5 (1.3)	2.8 (6.7)	2.1 (3.3)	1.0 (0.0)	2.5 (5.3)	2.9 (7.3)	5.0 (24.0)	1.0 (0.0)
Atrazine	1000	4.0 (14.7)	5.5 (29.3)	4.4 (18.7)	2.1 (3.3)	2.8 (6.7)	4.4 (18.7)	3.9 (14.7)	1.9 (2.7)	2.1 (3.3)	3.2 (9.3)	2.4 (4.7)	3.4 (10.7)	5.9 (34.7)	6.9 (46.7)	3.2 (9.3)
Hand weeding twice	20 & 40 DAS	3.4 (10.7)	3.4 (10.7)	2.6 (6.0)	1.0 (0.0)	2.2 (4.0)	2.0 (3.3)	2.4 (4.7)	1.7 (2.0)	2.2 (4.0)	2.1 (3.3)	1.7 (2.0)	1.9 (2.7)	3.5 (11.3)	5.1 (25.3)	2.4 (4.7)
Weedy check		4.3 (17.3)	9.9 (97.3)	4.4 (18.7)	2.5 (5.3)	3.2 (9.3)	4.1 (16.0)	4.2 (16.7)	2.8 (6.7)	5.9 (34.7)	4.1 (14.7)	2.8 (6.7)	6.2 (37.3)	5.9 (34.7)	9.0 (81.3)	3.4 (10.7)
LSD (p=0.05)		0.49	0.56	0.41	0.29	0.48	1.06	0.27	0.36	0.38	0.49	0.26	0.43	0.54	0.97	0.31

*Data were subjected to square root ($\sqrt{x+1}$) transformation for analysis and original value given in parentheses

Significantly lower density of *Cyperus rotundus* was observed with all doses of nicosulfuron except 30 g/ha during *Spring* season and *C. rotundus* was completely eliminated during *Kharif* season (**Table 1**).

The statistical analysis of total weed density during *Spring* and *Kharif* 2017 revealed that the overall density of all grassy and non-grassy weeds was influenced significantly by herbicidal treatments over weedy check. Among all the herbicide treatments, nicosulfuron at 50 g/ha was found to be best with lowest weed density (**Table 2**).

The total weed biomass of all weeds was significantly reduced with nicosulfuron at 50 g/ha, however it was found statistically similar to nicosulfuron at 42 g/ha except on grassy weeds during *Spring* 2017. Hand weeding twice and atrazine caused reduction in weed biomass at 45 DAA but were not effective as nicosulfuron at 50 g/ha (**Table 3**). Post-emergence application of nicosulfuron, mesotrione and tembotrione applied at V4 stage in maize reduced the monocot and dicot weeds in Brazil (Giraldeli *et al.* 2019). The lower total sedges density and biomass Tembotrione at 120 g/ha also recorded by Kaur *et al.* (2018).

Weed control efficiency

Weed control efficiency with respect to grassy (91.5% and 100%), BLW (100% and 87.1%) and sedges (77.4% and 100%) were highest with

Table 2. Effect of treatments on total weed density at 45 DAA in maize during *Spring* and *Kharif* 2017

Treatment	Dose (g/ha)	Grasses		BLWs		Sedges	
		Spring	*Kharif*	*Spring*	*Kharif*	*Spring*	*Kharif*
Nicosulfuron	30	4.9 (22.7)	4.9 (22.7)	3.1 (8.3)	5.7 (31.3)	6.5 (41.3)	2.8 (6.7)
Nicosulfuron	36	3.8 (13.3)	2.4 (4.7)	2.0 (3.0)	4.4 (18.7)	5.1 (25.3)	1.0 (0.0)
Nicosulfuron	42	3.0 (8.0)	1.2 (0.7)	1.5 (1.3)	4.0 (15.3)	4.7 (21.3)	1.0 (0.0)
Nicosulfuron	50	2.3 (4.7)	1.0 (0.0)	1.0 (0.0)	3.8 (13.3)	4.6 (20.0)	1.0 (0.0)
Tembotrione	120	4.6 (20.0)	4.6 (20.0)	2.3 (4.7)	4.5 (19.3)	5.0 (24.0)	1.0 (0.0)
Atrazine	1000	6.4 (40.0)	8.2 (66.0)	4.2 (16.7)	7.0 (48.7)	6.9 (46.7)	3.2 (9.3)
Hand weeding	20 and 40 DAS	4.7 (20.7)	4.4 (18.7)	2.9 (7.3)	4.4 (18.0)	5.1 (25.3)	2.4 (4.7)
Weedy check	-	6.8 (45.3)	11.7 (162.0)	5.4 (28.0)	10.4 (106.7)	9.0 (81.3)	3.4 (10.7)
LSD (p=0.05)		0.61	0.69	0.55	0.36	0.97	0.31

Data were subjected to square root square root ($\sqrt{x+1}$) transformation for analysis and original value given in parentheses

Table 3. Effect of treatments on total weed dry weight at 45 DAA during *Spring* and *Kharif* 2017

Treatment	Dose (g/ha)	Grasses		BLWs		Sedges	
		Spring	*Kharif*	*Spring*	*Kharif*	*Spring*	*Kharif*
Nicosulfuron	30	3.8(13.6)	3.5(11.5)	2.2(3.9)	4.1(15.8)	2.3(4.1)	2.1(3.6)
Nicosulfuron	36	3.0(8.0)	1.9(2.9)	1.5(1.3)	3.3(9.7)	1.9(2.7)	1.0(0.0)
Nicosulfuron	42	2.4(4.9)	1.2(0.4)	1.2(0.5)	3.0(7.8)	1.8(2.4)	1.0(0.0)
Nicosulfuron	50	1.8(2.3)	1.0(0.0)	1.0(0.0)	2.8(7.0)	1.7(2.1)	1.0(0.0)
Tembotrione	120	3.6(12.0)	3.3(10.1)	1.5(1.3)	3.3(10.2)	1.9(2.5)	1.0(0.0)
Atrazine	1000	4.9(23.6)	5.8(32.9)	2.6(6.0)	5.0(23.7)	2.4(4.7)	2.4(4.7)
Hand weeding	20 and 40 DAS	3.6(12.1)	3.2(9.1)	2.0(3.2)	2.7(6.3)	1.9(2.5)	1.9(2.5)
Weedy check	-	5.3(27.0)	8.3(67.9)	3.5(11.3)	7.4(54.3)	3.2(9.3)	2.7(6.1)
LSD (p=0.05)		0.39	0.44	0.27	0.24	0.26	0.45

Data were subjected to square root square root ($\sqrt{x+1}$) transformation for analysis and original value given in parentheses

Table 4. Effect of treatments on weed control efficiency at 45 DAA during *spring* and *Kharif* 2017

Treatment	Dose (g/ha)	Grasses		BLWs		Sedges	
		Spring	*Kharif*	*Spring*	*Kharif*	*Spring*	*Kharif*
Nicosulfuron	30	49.6	83.1	65.5	70.9	55.9	41.0
Nicosulfuron	36	70.4	95.7	88.6	82.1	71.0	100.0
Nicosulfuron	42	81.9	99.4	95.3	85.6	74.2	100.0
Nicosulfuron	50	91.5	100.0	100.0	87.1	77.4	100.0
Tembotrione	120	55.6	85.1	88.5	81.2	73.1	100.0
Atrazine	1000	12.6	51.6	46.9	56.4	49.5	23.0
Hand weeding twice	20 & 40 DAS	55.2	86.6	71.7	88.4	73.1	59.0
Weedy check	-	-	-	-	-	-	-

Table 5. Yield and yield attributes as influenced by different herbicides treatments in maize during *Spring* and *Kharif* 2017

Treatment	Dose (g/ha)	No. of cob per square meter		Weight/cob (g)		Grain weight/cob (g)		No. of kernels/cob		100 seed weight (g)		Grain yield (t/ha)	
		Spring	*Kharif*	*Spring*	*Kharif*	*Spring*	*Kharif*	*Spring*	*Kharif*	*Spring*	*Kharif*	*Spring*	*Kharif*
Nicosulfuron	30	7.3	8.0	128.0	84.7	103.7	70.7	394	355	26.6	19.9	7.55	5.08
Nicosulfuron	36	8.2	8.9	133.5	91.3	110.2	76.0	404	366	27.2	20.8	9.05	6.70
Nicosulfuron	42	8.4	9.1	134.0	93.3	110.3	77.3	405	372	27.5	20.7	9.11	7.19
Nicosulfuron	50	8.3	9.1	133.9	92.7	111.6	77.0	406	365	27.5	21.1	9.20	6.93
Tembotrione	120	8.2	9.1	134.7	92.7	112.3	77.0	404	366	27.2	21.0	9.14	7.00
Atrazine	1000	8.0	8.7	125.9	85.3	105.2	71.3	388	363	27.1	19.6	8.20	6.19
Hand weeding twice	20 & 40 DAS	8.4	9.2	129.8	87.3	108.2	73.3	397	361	27.7	20.4	8.93	6.73
Weedy check	-	6.5	7.4	101.7	74.7	85.0	62.7	393	328	26.0	19.0	5.54	4.58
LSD (p=0.05)		0.48	0.4	8.2	3.9	6.7	3.8	8.0	7.0	1.2	0.9	0.49	0.44

Table 6. Germination and yield of succeeding crop as influenced by different herbicidal treatment

Treatment	Dose (g/ha)	Cowpea fodder (in *Kharif*)		Pea (in *Rabi*)	
		Germination at 15 DAS (no. of plants/m^2)	Fodder yield (t/ha)	Germination at 15 DAS (no. of plants/m^2)	Grain yield (t/ha)
Nicosulfuron	30	18.7	23.17	63.0	1.19
Nicosulfuron	36	19.5	23.00	60.0	1.23
Nicosulfuron	42	18.8	23.17	65.7	1.27
Nicosulfuron	50	18.3	23.17	61.0	1.24
Tembotrione	120	19.0	23.50	65.5	1.14
Atrazine	1000	19.3	23.17	66.5	1.29
Hand weeding twice	20 and 40 DAS	18.7	23.50	62.8	1.19
Weedy check	-	19.5	23.00	60.2	1.22
Nicosulfuron	82	18.7	23.33	60.8	1.23
LSD (p=0.05)		NS	NS	NS	NS

DAS: Days after sowing, NS- non significant

nicosulfuron at 50 g/ha PoE during *Spring* and *Kharif*, respectively. The next best treatment was nicosulfuron at 42 g/ha (**Table 4**).

Yield parameters and yield

All weed control treatments significantly increased the yield attributing characters and grain of maize over weedy check (**Table 5**) during *Spring* and *Kharif* season.

The maximum grain yield (9.20 t/ha) during *spring* was observed with nicosulfuron at 50 g/ha which was at par with tembotrione at 120 g/ha as well as nicosulfuron at 42 and 36 g/ha which may be attributed to a greater number of cobs per square meter (8.3), grain weight per cob (111.6), number of kernels per cob (406) and 100 seed weight (27.5 g). During *Kharif* season, maximum yield attributes *i.e.*, number of cobs per square meter (9.1), grain weight per cob (77.3 g), number of kernel per cob (372), 100 seed weight (20.7 g) and yield (7.19 t/ha) of maize were observed with nicosulfuron at 42 g/ha which was followed by tembotrione at 120 g/ha and nicosulfuron at 50 g/ha and showed non-significant difference. Nicosulfuron at 50 and 42 g/ha gave 12.2 and 16.3% higher yield as compared to check atrazine during *Spring* and *Kharif* 2017, respectively.

Crop safety and residual effect on succeeding crop

The application of nicosulfuron at single (42 g/ha) or double doses (84 g/ha) resulted in no phytotoxic symptoms on maize crop up to 21 DAA of crop. No phytotoxic effect due to residue of nicosulfuron was recorded on succeeding pea and cowpea fodder crop. The germination of these plants at 15 DAS and final yield were not affected significantly by herbicidal treatments (**Table 6**). This indicated no residual carry-over of nicosulfuron in the soil.

Conclusion

Nicosulfuron at 42 g/ha may be safely used for the effective weed control and achieving higher yield of maize crop as it resulted in lower weed density and biomass, higher weed control efficiency and maize yield without phytotoxicity and residual carry-over.

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