Indian Journal of Weed Science **52**(4): 336–339, 2020

Print ISSN 0253-8040 Online ISSN 0974-8164

Indian Journal of Weed Science

Bio efficacy and phyto-toxicity of dicamba 48%SL against broad-leaved weeds in maize

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Article information

DOI: 10.5958/0974-8164.2020.00067.2

Type of article: Research article

Received : 7 August 2020
Revised : 12 December 2020
Accepted : 15 December 2020

Key words
Bioefficacy
Dicamba
Maize
Phytotoxicity
Weeds

ABSTRACT

A field experiment was conducted to evaluate the bio-efficacy of dicamba 48% SL on the associated broad-leaf weeds of maize and to assess its phyto-toxicity on the crop in GBPUA&T, Pantnagar for two consecutive years during 2016 and 2017. The results revealed that application of dicamba 48% SL at 300 and 360 g/ha provided superior control of broad-leaved weeds as compared to 2,4-D Amine salt 58% SL 500 g/ha in maize. The same two treatments *i.e.* dicamba 48% SL at 300 and 360 g/ha also provided a total weed control efficiency of 100% in all the stages of crop growth. Maximum grain yield was recorded in the weed free plots to the tune of 5.45 t/ha and 5.22 t/ha in 2016 and 2017, respectively, which was at par with dicamba 48% SL at 300, 360 and 720 g/ha and the other yield attributing characters followed the same trend in both the years. However, numerically maximum yield was obtained in weed free plots, probably due to effectiveness of dicamba only against the broad-leaf weeds but hand weeding took care of broad spectrum of weeds. It was also revealed that, there were no symptoms of phytotoxicity on maize at any doses of dicamba 48% SL. Hence, it may be concluded that dicamba 48% SL at 300 g/ha was found to be effective against broad-leaved weeds in maize in Pantnagar region of Uttarakhand.

INTRODUCTION

Maize (*Zea mays* L.) is the third most vital cereal crop of India, commonly called as queen of cereals due to its very high genetic yield potential. It serves dual uses like both fodder and grain purpose. Out of several biotic factors, weeds are the most important yield reducing factor. In maize crop, it is evident that weeds cause 28 to 100% yield reduction as per infestation of weeds (Patel *et al*. 2006). In Indian condition, the associated weeds cause yield reduction by 27-60%, based on the growth and persistence of weed population in maize crop (Kumar *et al*. 2015 and Jat *et al*. 2012). However, Yakadri *et al*. (2015) reported that due to initial slow growth rate and wider spacing of maize during the first 3-4 weeks is congenial to offer severe competition, which brings in 30-93% yield losses among all the weed species associated with maize crop. Broad-leaf weeds are very much dominant over grassy weeds and sedges. Kannan and Chinnagounder (2014), reported 12 species of broad-leaved weeds, 5 species of grasses and a sedge weed is associated with maize. The same type of result was also reported by Ravisankar *et al*. (2013). This fact reveals the importance of broad-leaf weeds in maize crop. Chemical weed management in maize by using herbicides is gaining importance now a day due to its effectiveness and economic point of view. Among the post-emergence herbicides, dicamba (3,6-dichloro-2-methoxybenzoic acid) is very effective in controlling the broad-leaf weeds in maize. The current experiment was conducted to standardize the effective dose of the herbicide concerned, as well as to assess its bioefficacy on broad-leaf weeds and phyto-toxicity on maize.

MATERIALS AND METHODS

A two years field experiment was carried out during 2016 and 2017 at G. B. Pant University of Agriculture & Technology, Pantnagar (lat/long/altitude), U.S. Nagar, Uttarakhand. The crop received total rainfall of 1290.2 mm and the average maximum and minimum temperatures were 32.4ºC and 24.1ºC (June to September). The soil of the experimental site was sandy loam with a high percentage of organic carbon *i.e.* 0.82%. The pH of soil was 7.2. Available N, P and K content in the soil was 252.6, 17.8 and 283.4 kg/ha, respectively.

Maize variety of *'Gaurav'* was grown with a seed rate of 22 kg/ha. Sowing was done manually with 60 × 25 cm plant in geometry during both of the years in a plot of 2.5 x 5.0 m. The crop was provided with to 120:60:40 kg N, P and K/ha. All phosphatic and potassic fertilizers were applied as at basal and N was applied in three splits (50% basal, 25% at knee height, and 25% at tasseling). The experiment was conducted in a randomized block design (RBD) with three replications. The required amount of herbicides was applied using 500 L/ha of water with knap-sack sprayer fitted with a flat-fan nozzle.

At sampling time (30 and 60 days after application (DAA), a quadrate of 0.25 m^2 was placed at four places in each plot marked with wooden pegs and observations like weed population, relative weed density, weed dry weight, weed control efficiency and phyto-toxicity percentage were calculated based on the formulae given below. Yield and yield attributes were calculated on the basis of net plot and expressed in kg/ha.

The data were analyzed by using the standard procedure for randomized block design with the STPR software. Weed density and dry weight were square root transformed by using formula $(\sqrt{x+1})$ before analysis. While the ANOVA indicated significant treatment effects, means were separated at $p<0.05$ and adjusted with Fisher's protected least significant difference (LSD) test.

The phyto-toxicity rating was given as per the list mentioned below: No injury(0), Slight stunting, injury or discoloration(1), Some stand loss, stunting / discoloration(2), Injury more pronounced but not persistent(3), Moderate injury, recovery possible(4), Injury more persistent, recovery doubtful(5), More severe injury, no recovery possible(6), Severe injury, stand loss(7), Almost destroyed few plants surviving(8), Very few plants alive(9), Complete destruction (10). The numbers given in the parentheses are the corresponding phyto-toxicity ratings as per the phyto-toxicity symptoms.

RESULTS AND DISCUSSION

Relative weed density before herbicide application

In *Kharif* 2016 and 2017, the major weed flora observed in maize crop *i.e.* grassy, broad-leaved and sedges were recorded in untreated check plot. The grassy weed flora in experimental field consisted of *Eleusine indica*, *Echinochloa colona*, *Dactyloctenium aegyptium* and *Digitaria sanguinalis,* which accounted 9.0, 8.1, 2.7 and 5.4%, and 11.8%, 6.9%, 6.4% and 4.4% in 2016 and 2017, respectively. Among the broad-leaved weeds, *Celosia argentea* (12.5 and 22.8%), *Trianthema monogyna* (6.3 and 16.3%), and *Phyllanthus niruri* (6.3 and 9.8%), *Cleome viscosa* (4.7 and 11.4%), *Mollugo stricta* (62.5 and 26.0%), where as in sedgs *Cyperus rotundus* (12.6 and 10.8%) and *Cyperus iria* (4.5 and 9.9%), were observed during 2016 and 2017, respectively.

Density of broad-leaf weeds at 30 days after herbicide application

In *Kharif* 2016, at 30 days after application of dicamba 48% SL at all the doses and standard check, 2,4-D amine salt completely controlled all the broad-leaf weeds except *Cleome viscosa* and *Mollugo stricta* with the lowest dose of dicamba at 180 g/ha. Twice hand weeding (20 and 45 DAS) completely controlled all the BLWSs except *Celosia argentea* and *Mollugo stricta.*

In *Kharif* 2017, at 30 days after herbicide application, *Celosia argentea* and *Digera arvensis* were completely controlled under the application of dicamba 48% SL DMA salt at 720 and 360 g/ha. Whereas, rest of the BLWs were completely controlled by all the doses of dicamba 48% SL DMA except its lowest dose at 180 g/ha. Twice hand weeding (20 and 45 DAS) completely controlled the *Phyllanthus niruri* at this stage.

Density of broad-leaf weeds at 60 days after herbicide application

At 60 days after application (DAA) of herbicides all the weeds except *Mollugo stricta* were completely controlled with the application of dicamba 48% SL DMA salt at all the doses and standard check, 2,4-D amine salt at 500g/ha. *Trianthema monogyna* and *Cleome viscosa* were also not effectively controlled with 2,4-D amine salt as compared to other BLWs at this stage in *Kharif* 2016.

Application of dicamba DMA salt at 720 and 360 g/ha, completely controlled all the broad-leaf weeds at 60 days after herbicide application. However, Among the BLWs, *Digera arvensis* and *Phyllanthus niruri* were not controlled with the spray of dicamba 48% SL DMA salt at 300 g/ha. Twice hand weeding (20 and 45 DAS) completely eliminated *Celosia argentea* and *Phyllanthus niruri* amongst all the broad-leaf weeds in *Kharif* 2017.

Total weed density and dry weight

Among the weed flora, broad-leaf weeds had the maximum share in both the years. Application of dicamba 48% SL at all the doses except the lower dose (180 and 240 g/ha) completely controlled all the broad-leaf weeds and recorded the lowest total weed density and dry weight at 30 DAA. At 60 days after herbicide application, the total weed density of broad-leaf weeds was effectively reduced by application of dicamba 48% SL DMA at 720 g/ha followed by its lower doses. Similarly, total weed dry weight was also effectively reduced with the application of dicamba 48% SL applied at 720 g/ha followed by its lower doses.

Weed control efficiency

The weed control efficiency in broad-leaf weeds at 60 DAS, was found the highest (100%) with all the doses of dicamba 48%SL except 180 and 240 g/ha in both the years under study.

The yield and yield attributing characters of maize, *viz*. plants (1000/ha), cobs (1000/ha), kernel (wt./cob), kernel (no./cob) and 100 kernel weight (g) were significantly affected by different treatments. In *Kharif* 2016 and 2017, highest grain yield (5.45 t/ha and 5.22 t/ha respectively) was recorded with twice hand weeding (20 and 45 DAS) which was at par

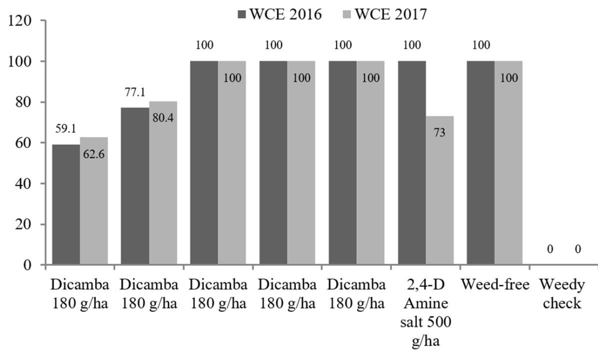

Figure 1. Weed control efficiency at 30 DAS in 2016 and 2017 yield and yield attributing character of maize crop

with dicamba 48% SL DMA applied at 720, 360 and 300 g/ha. Higher grain yield of these treatments was mainly attributed to more number of plants per unit area, thousand cobs per unit area and kernel weight per cob. Weedy check recorded 52.9% and 52.5% lower grain yield as compared to highest grain yield producing treatment *i.e.* hand weeding in 2016 and 2017, respectively.

Table 1. Effect of treatment on total density and dry weight of broad-leaf weeds at 30 and 60 days after herbicide application

Treatment	Weed density (no./m^2)				Weed dry matter (g/m^2)			
	30 DAA		60 DAA		30 DAA		60 DAA	
	2016	2017	2016	2017	2016	2017	2016	2017
Dicamba 48% SL (180 g/ha)	4.5(19.3)	4.3(17.3)	3.3(25.3)	4.2(16.3)	4.3(18.4)	4.1(15.7)	4.8(22.9)	4.6(20.4)
Dicamba 48% SL (240 g/ha)	3.1(9.0)	3.2(9.7)	4.1(15.7)	3.2(9.0)	3.5(11.8)	3.1(8.3)	3.7(12.8)	3.4(10.7)
Dicamba 48% SL (300 g/ha)	1.0(0.0)	1.0(0.0)	1.0(0.0)	1.0(0.0)	1.0(0.0)	1.0(0.0)	1.0(0.0)	1.0(0.0)
Dicamba 48% SL (360 g/ha)	1.0(0.0)	1.0(0.0)	1.0(0.0)	1.0(0.0)	1.0(0.0)	1.0(0.0)	1.0(0.0)	1.0(0.0)
Dicamba 48% SL (720 g/ha)	1.0(0.0)	1.0(0.0)	1.0(0.0)	1.0(0.0)	1.0(0.0)	1.0(0.0)	1.0(0.0)	1.0(0.0)
2,4-D amine salt 58% SL (500 g/ha)	2.9(7.3)	3.3(9.7)	2.6(5.7)	3.6(12.0)	2.3(4.6)	3.4(10.3)	2.8(7.4)	3.9(14.7)
Weed-free HW 20 and 45 DAS	1.0(0.0)	1.0(0.0)	1.0(0.0)	1.0(0.0)	1.0(0.0)	1.0(0.0)	1.0(0.0)	1.0(0.0)
Weedy check	6.6(43.3)	6.5(41.3)	6.7(44.0)	6.5(41.0)	5.7(31.7)	6.7(44.1)	7.5(56.0)	7.3(52.0)
Untreated	6.6(42.3)	6.7(44.0)	6.9(46.7)	6.7(44.3)	5.8(32.9)	6.9(46.3)	7.6(57.5)	7.5(54.5)
LSD (p=0.05)	0.31	0.30	0.33	0.26	0.18	0.15	0.15	0.21

Table 2. Effect of treatment on yield and yield attribute characters of maize

Treatment	Plant (1000/ha)		Cob (1000/ha)		Kernel wt./cob		Kernel (no./cob)		100 kernel weight (g)		Grain yield (t/ha)	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Dicamba 48% SL (180 g/ha)	68.9	64.7	70.7	67.3	56.8	56.7	332	335	17.1	16.9	3.98	3.87
Dicamba 48% SL (240 g/ha)	76.0	70.0	77.0	74.0	60.8	60.0	347	342	17.5	17.8	4.63	4.45
Dicamba 48% SL (300 g/ha)	78.8	69.3	82.9	74.3	64.1	62.7	357	352	18.0	17.9	5.22	4.65
Dicamba 48% SL (360 g/ha)	81.1	70.1	82.1	74.3	64.8	63.3	361	353	18.5	18.0	5.31	4.77
Dicamba 48% SL (720 g/ha)	80.4	70.0	81.5	73.0	65.9	63.3	354	354	18.5	18.0	5.28	4.68
2,4-D amine salt 58% SL (500 g/ha)	69.7	64.7	72.2	64.7	61.2	60.7	350	347	17.4	17.5	4.33	4.03
Weed-free HW 20 and 45 DAS	80.6	72.0	82.7	77.3	66.0	64.0	358	363	18.4	17.7	5.45	5.22
Weedy check	56.0	50.0	55.0	52.0	45.0	43.3	271	271	16.5	16.2	2.57	2.53
Untreated	56.0	47.7	55.0	50.0	45.1	46.7	276	280	16.3	16.4	2.58	2.38
LSD (p=0.05)	4.0	8.8	3.3	5.9	3.1	4.3	23.7	7.5	1.1	0.8	0.32	0.40

Table 3. Effect of treatments on cost of cultivation, gross return, net return and B:C ratio

Treatment	Cost of cultivation (x10^3 ₹/ha)		Gross return (x10^3 ₹/ha)		Net return (x10^3 ₹/ha)		B:C ratio	
	2016	2017	2016	2017	2016	2017	2016	2017
Dicamba 48% SL (180 g/ha)	28.37	28.37	53.77	55.10	25.40	26.73	0.90	0.94
Dicamba 48% SL (240 g/ha)	28.57	28.57	62.54	63.41	33.97	34.84	1.19	1.22
Dicamba 48% SL (300 g/ha)	28.77	28.77	70.43	66.26	41.66	37.49	1.45	1.30
Dicamba 48% SL (360 g/ha)	28.97	28.97	71.66	67.93	42.69	38.96	1.47	1.34
Dicamba 48% SL (720 g/ha)	30.17	30.17	71.32	66.73	41.15	36.56	1.36	1.21
2,4-D amine salt 58% SL (500 g/ha)	26.44	26.44	58.49	57.47	32.05	31.03	1.21	1.17
Weed-free HW 20 and 45 DAS	33.57	33.57	73.57	71.34	40.00	37.77	1.19	1.12
Weedy check	25.37	25.37	34.65	36.09	9.28	10.72	0.37	0.42
Untreated	25.67	25.67	34.87	33.96	9.20	8.29	0.36	0.32

Phyto-toxicity symptoms

No chlorosis, stunting, leaf tip injury, wilting, vein clearing, epinasty and hyponasty were seen in maize crop due to application of dicamba 48% w/v SL at any of the doses at 1, 3, 5, 7, 10, 15 and 30 DAA.

Economic analysis

The amount of net return was found maximum in dicamba 48% SL DMA applied at 360 g/ha which was ₹ 42687 and 38958 respectively in 2016 and 2017, which was followed by the treatment with dicamba applied at 300 g/ha (₹ 41658 and 37491, respectively in 2016 and 2017). The benefit- cost ratio also followed the similar trend. Maximum B:C ratio was achieved in 48% SL DMA applied at 360 g/ha (1.42 and 1.34 in 2016 and 2017, respectively). Handweeding labbed behind the chemical treatments in terms of net return and B:C ratio due to its high cost of cultivation in terms of labour cost.

Conclusion

Among all the concerned treatments, 48% SL DMA applied at 360 g/ha was found better in terms of yield and net return achieved. Hence, it can be a very suitable option for controlling the broad-leaved weed flora associated with maize crop.

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