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RESEARCH ARTICLE

Participatory research on management of guinea grass (*Megathyrsus maximus*) in sugarcane with pre- and post-emergence herbicides

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ABSTRACT

In India, guinea grass (*Megathyrsus maximus*) is a valuable forage since its introduction during 1793 to increase the forage quality. Lately, it invaded variable environments as weed in crops such as sugarcane and citrus orchards. A total of four participatory research experiments were conducted during spring season using a randomized complete block design with three replications. The objective was to evaluate efficacy of different pre- and post-emergence herbicides to manage *M. maximus* in sugarcane. The pre-emergence application (PE) of metribuzin 1.4 kg/ha, diuron 1.6 kg/ha, sulfentrazone + clomazone 1.45 kg/ha and post-emergence application (PoE) of 2,4-D sodium salt + metribuzin + pyrazosulfuron-ethyl 2.4 kg/ha and 2,4-D sodium salt + metribuzin + chlorimuron 2.02 kg/ha recorded maximum control of *M. maximus* at 30, 60 days after application and at harvest. Furthermore, these treatments resulted in significantly higher cane yield and were at par with each other. Multiple cohorts of *M. maximus* appears in crop up to 5-6 months of planting of sugarcane, and hence, the highest cane yield was observed in weed free, while physical control measures were costly resulting in lower B:C. Thus, this study underscores the importance of integrated weed management practices for the profitable and sustainable control of *M. maximus* in sugarcane.

Keywords: Chlorimuron, Clomazone, 2,4-D, Diuron, Guinea grass, Metribuzin, Pyrazosulfuron-ethyl, Sulfentrazone, Sugarcane, Weed management

INTRODUCTION

Sugarcane occupied 90.2 thousand hectares in Punjab with average cane yield of 832.5 quintals per hectare during 2023-24. Among the several factors affecting sugarcane productivity, weed infestation is considered as one of the most significant biotic constraints responsible for yield reduction (Kaur *et al.* 2025a). Sugarcane is grown primarily in Hoshiarpur and some pockets of Patiala, Gurdaspur and Jalandhar of Punjab. In sugarcane, guinea grass (*Megathyrsus maximus* (Jacq.) B.K. Simon and Jacobs) is becoming a major weed problem at farmers' fields in Hoshiarpur and Jalandhar. The infestations of this weed in sugarcane fields could cause yield losses of up to 40% (Kuva *et al.* 2003).

Megathyrsus maximus is considered an important forage species due to its high biomass production, palatability and tolerance to grazing, it has also become a highly invasive plant in several ecosystems. Although it originates from the humid tropical and subtropical regions of Africa but has been widely introduced into many other parts of the world (Soti and Thomas 2022). It is a perennial, C_4, tufted invasive plant that is capable of reproducing through both seeds and vegetative structures such as rhizomes and stolons. This adaptability allows it to thrive in diverse environments, including savannas, grasslands, tropical forests, cultivated pastures and agricultural fields, particularly in sugarcane-growing areas (Rhodes *et al.* 2021). The characteristics that contribute to the high productivity and rapid growth of *M. maximus* also make it difficult to manage, and its spread beyond intended areas often results in its establishment as a problematic weed (Ho *et al.* 2016).

Megathyrsus maximus is tolerant to shade but sensitive to frost and its aggressive growth can suppress native grass species, thereby affecting their establishment. Each plant produces numerous panicles bearing seeds that mature and disperse gradually over several weeks. Seeds are commonly spread by birds and arthropods that feed on them, while their ability to adhere to moist surfaces facilitates mechanical dispersal (CABI 2020). Human-mediated dispersal also plays an important role, as

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seeds can be transported through vehicles, machinery and mowing equipment (Veldman and Putz 2010). The species spreads rapidly, maintains a high reproductive capacity and forms long-lived, robust plants that compete strongly with other vegetation (Zanine *et al.* 2018). Its ability to form dense stands may lead to mono-dominance, altering plant community structure by shading and outcompeting other plant species (Hejda *et al.* 2009). *M. maximus* has higher photosynthetic efficiency, rapid seedling growth, and substantial biomass accumulation (Ho *et al.* 2016).

Frequent irrigation and fertilizer application further promote weed growth in sugarcane cropping systems (Krishnaprabhu 2020). Furthermore, the slow initial growth of sugarcane leaves inter-row spaces exposed for an extended period, creating favourable conditions for rapid weed proliferation in later crop growth stages (Kaur *et al.* 2025a, 2025b). This weed has become very problematic as it continues to emerge during monsoon months even after 4-5 months of planting. Considering the strong competitive ability of *M. maximus* and the substantial yield losses associated with its infestation, timely and efficient weed management is essential to maintain higher productivity in sugarcane (Kaur *et al.* 2025a, 2025b). Therefore, the present participatory studies were conducted at the farmers' fields with known history of infestation by *M. maximus* to evaluate the efficacy of different pre- and post-emergence herbicides for effective and economical management of *M. maximus* in sugarcane.

MATERIALS AND METHODS

Two separate participatory research experiments were conducted in 2024 and 2025 at of four locations in Punjab. One experiment involved evaluation of pre-emergence herbicides (Trial-I) against *M. maximus* in sugarcane and it was conducted at one location of district Hoshiarpur (31.8686° N latitude and 75.6019° E longitude) Punjab, India for two years (2024 and 2025). In other experiment, evaluation of post-emergence herbicides (Trial-II) against *M. maximus* in sugarcane was carried out at two locations in Hoshiarpur (31°32'N and 75°55'E), and one location in Jalandhar (31°19'34"N and 75°34'34"E), *i.e.* a total of three locations during 2024. These locations are characterized by a semi-humid, subtropical climate, featuring hot, dry summers from April to June, followed by a humid monsoon period between July and September. The winter season starts mildly in October and November and becomes colder through December to February. In Trial-I, five treatments were evaluated including pre-emergence application (PE) of metribuzin 70% WP (metribuzin) 1.4 kg/ha, diuron 80% WP (diuron) 1.6 kg/ha, sulfentrazone 28% + clomazone 30% WP (sulfentrazone + clomazone) 1.45 kg/ha along with weed free and weedy check. In Trial-II, post-emergence application (PoE) of two brands of 2,4-D sodium salt 44% + metribuzin 35% + pyrazosulfuron-ethyl 1% WDG (2,4-D sodium salt + metribuzin + pyrazosulfuron-ethyl) 2.40 kg/ha and 2,4-D sodium salt 48% + metribuzin 32% + chlorimuron 0.8% WDG (2,4-D sodium salt + metribuzin + chlorimuron) 2.02 kg/ha were evaluated along with weed free and weedy check. A randomized complete block design with three replications was used.

The seedbed was prepared by one ploughing with a disc harrow followed by two ploughings with a cultivator, and each ploughing was followed by planking to obtain a fine tilth. Sugarcane cv. Co 15023 was sown in experiment of pre-emergence herbicides while Co 5009, Co 118 and Co 238 were planted in fields where post-emergence herbicides were evaluated. During both years, planting of sugarcane setts was done in mid- to end-March at four locations (Trial I: 15-3-2024 and 22-3-2025, and Trial II: 16-3-2024, 18-3-2024 at Hoshiarpur & 22-3-2024 at Jalandhar) with a seed rate of 87.5 q/ha (three-budded setts) in 75 cm wider rows using the trench method and irrigation was given thereafter. The gross plot area was 50 m × 10 m (500 m^2). Pre-emergence herbicides were sprayed as soon as field comes in field capacity (within 4 days of planting, 18-3-2024 and 26-3-2025) using flood jet nozzle with a spray volume of 500 litres. Application of post-emergence herbicides was done during mid-June (12-6-2024, 15-6-2024 and 16-6-2024 at three locations) at 3-5 weed leaf stage using flood jet nozzle with a spray volume of 500 L/ha under sufficient soil moisture conditions. Before the application of post-emergence herbicides, weeds were controlled by blind tillage and interculture operations till the complete emergence of sugarcane plants (farmers' practice). The plots were kept weed free with regular weeding (manual/mechanical) throughout the crop season.

All recommended agronomic practices for fertilizer, water and insect-pest management were followed for raising the crop (Kaur *et al.* 2025a). The crop was fertilized with 150:30 kg N and P/ha through application of 325 kg urea/ha and 187 kg/ha single super phosphate. The entire dose of phosphorus was applied at the time of planting at all experimental locations. Nitrogen was applied in two equal splits: half of the recommended dose was top-dressed along the crop rows at the time of first irrigation after crop emergence, while the remaining half was applied alongside the cane rows one month later. To protect the crop from lodging, earthing up was carried out at the end of June before the onset of the monsoon. The crop was propped at the end of August using the trash-twist method. The crop was harvested manually in November-December (depending upon maturing time of each variety) during both years.

The bio-efficacy of treatments was assessed based on weed density and biomass of *M. maximus*. Weed observations were recorded using a quadrat of 50 cm × 50 cm placed at two randomly selected locations within each plot at 30 and 60 days after application (DAA) and at harvest. For analysis, the average values from both quadrats were converted to number per square meter (no./m^2) for weed density and grams per square meter (g/m^2) for weed biomass. Observations on cane length, number of millable canes and cane yield were also recorded at harvest. Economics were worked out and B:C was calculated by dividing net returns over variable cost of cultivation. Analysis of variance (ANOVA) was performed to evaluate the efficacy of different pre- and post-emergence herbicides for the control of *M. maximus* in sugarcane. Statistical analysis of the recorded data was performed using CPCS-1 software, version 3.2.3 (Cheema and Singh 1991). The data was subjected to pooled analysis after performing Levene's test for checking homoskedasticity of variance of locations and years. Weed density and biomass data were subjected to square root transformation before analysis to normalize the data distribution. The significance of treatment means was tested using Fisher's least significant difference (LSD) test at the 5% probability level (p=0.05).

RESULTS AND DISCUSSION

Density and biomass of *M. maximus*

The density and biomass of *M. maximus* at 30, 60 DAA and at harvest were significantly influenced by all the pre- and post-emergence herbicidal treatments over the weedy check. The pre- and post-emergence herbicides were effective in controlling *M. maximus*. In Trial-I, metribuzin 1.4 kg/ha, diuron 1.6 kg/ha and sulfentrazone + clomazone 1.45 kg/ha recorded cent percent (100%) control of *M. maximus* density at 30 DAA, 58.3%, 83.3% and 75.0%, respectively at 60 DAA and 38.2%, 47.1% and 44.1%, respectively at harvest over weedy check (**Table 1**). This indicated that the pre-emergence herbicides were effective up to 30 days of planting. But thereafter, metribuzin was least effective while diuron and premix of sulfentrazone + clomazone retained its effectiveness even up to 60 days of planting. Pre-emergence application of diuron permits normal germination of weed seeds but inhibits chlorophyll synthesis, which subsequently results in depletion of food reserves and eventual death of young seedlings (Ferrell *et al.* 2004). Pre-emergence application of sulfentrazone 1.2 kg/ha provided higher control of weeds in sugarcane (Kalaiyarasi 2012). Further, pre-emergence application of metribuzin 1.4 kg/ha, diuron 1.6 kg/ha and sulfentrazone + clomazone 1.45 kg/ha recorded 100.0% control of *M. maximus* biomass at 30 DAA, 77.9%, 85.4% and 82.9% at 60 DAA and 39.5%, 52.3% and 50.3% at harvest, respectively over weedy check plots (**Table 1**). These results are in line with Pringgani *et al.* (2025) and de Castro *et al.* (2024) who reported that application of pre-emergence herbicides significantly reduced the weed biomass in sugarcane.

In Trial-II, all post-emergence herbicides namely formulations of 2,4-D sodium salt + metribuzin + pyrazosulfuron-ethyl 2.4 kg/ha and 2,4-D sodium salt + metribuzin + chlorimuron 2.02 kg/ha resulted in 97.4%, 97.9% and 97.9% control of *M. maximus* density at 30 DAA, 57.7%, 59.6% and 60.9%, respectively at 60 DAA and 38.5%, 39.2% and 39.6%, respectively at harvest over weedy check plots (**Table 3**). Similarly, these herbicides recorded 93.6%, 93.7% and 93.8% control of *M. maximus* biomass at 30 DAA, 67.2%, 67.5% and 67.9% at 60

Table 1. Effect of pre-emergence application of herbicides on density and biomass of *M. maximus* at 30 days after application (DAA), 60 DAA and at harvest in Trial-I at Hoshiarpur farmers fields (pooled over two years)

Treatment	Density (no./m^2)			Biomass (g/m^2)		
	30 DAA	60 DAA	At harvest	30 DAA	60 DAA	At harvest
Metribuzin 1.40 kg/ha	1.00 (0)	2.32 (5)	4.71 (21)	1.00 (0)	6.67 (44)	19.77 (391)
Diuron 1.60 kg/ha	1.00 (0)	1.82 (2)	4.40 (18)	1.00 (0)	5.44 (29)	17.50 (308)
Sulfentrazone + clomazone 1.45 kg/ha	1.00 (0)	1.91 (3)	4.51 (19)	1.00 (0)	5.91 (34)	17.86 (321)
Weedy check	3.05 (8)	3.60 (12)	5.92 (34)	9.62 (92)	14.14 (199)	25.43 (646)
Weed free	1.00 (0)	1.00 (0)	1.00 (0)	1.00 (0)	1.00 (0)	1.00 (0)
LSD (p=0.05)	0.21	0.52	0.32	0.27	1.47	2.74

*Data were subjected to ($\sqrt{x+1}$) transformation. Figures in parentheses are original values

DAA and 50.2%, 50.4% and 50.7% at harvest, respectively over weedy check plots (**Table 4**). These results are in line with Jaiswal *et al.* (2024) who reported that 2,4-D sodium salt + metribuzin + pyrazosulfuron-ethyl 2.4 kg/ha produced lowest density of grasses, broad-leaved weeds and sedges at 75 DAA in sugarcane. The use of three-way post-emergence herbicide is important for achieving a greater extent of weed control as reported by Kumar *et al.* (2023). Ramesha *et al.* (2018) also observed that 2,4-D sodium salt + metribuzin + pyrazosulfuron-ethyl recorded significantly lower weed biomass over weedy check in sugarcane. Metribuzin is a synthetic organic compound commonly used as both a pre- and post-emergence herbicide. Pyrazosulfuron-ethyl and chlorimuron-methyl herbicides act by inhibiting the enzyme acetolactate synthase, which is essential for the biosynthesis of certain amino acids. It is effective against newly emerging and difficult to control

Table 2. Effect of pre-emergence application of herbicides on yield attributes and yield of sugarcane in Trial-I at Hoshiarpur farmers fields (pooled over two years)

Treatment	Cane length (m)	Millable canes (000/ha)	Cane yield (t/ha)	Economics	
				Net returns (x10^3 Rs./ha)	B:C
Metribuzin 1.40 kg/ha	3.13	145	84.03	229.98	1.92
Diuron 1.60 kg/ha	3.20	151	87.70	246.11	2.07
Sulfentrazone + clomazone 1.45 kg/ha	3.17	149	86.03	234.06	1.89
Weedy check	3.10	114	57.37	122.83	1.06
Weed free	3.20	163	93.37	230.94	1.47
LSD (p=0.05)	NS	14	11.27	-	-

*Data were subjected to $(\sqrt{x+1})$ transformation

Table 3. Effect of post-emergence application of herbicides on density of *M. maximus* at 30 days after application (DAA), 60 DAA and at harvest in participatory trials at different locations (Trial-II: pooled over three locations)

Treatment	Density (no./m^2)											
	30 DAA				60 DAA				At harvest			
	HSR-I	HSR-II	JAL	Pooled mean	HSR-I	HSR-II	JAL	Pooled mean	HSR-I	HSR-II	JAL	Pooled mean
2,4-D sodium salt + metribuzin +	1.21	1.14	1.00	1.12	2.70	3.03	2.86	2.86	4.19	4.49	4.25	4.30
pyrazosulfuron-ethyl 2.40 kg/ha	(0.50)	(0.33)	(0.00)	(0.28)	(6.33)	(8.33)	(7.33)	(7.33)	(16.67)	(19.33)	(17.33)	(17.77)
2,4-D sodium salt + metribuzin +	1.14	1.14	1.00	1.09	2.62	2.95	2.80	2.79	4.16	4.67	4.27	4.29
pyrazosulfuron-ethyl 2.40 kg/ha	(0.33)	(0.33)	(0.00)	(0.22)	(6.00)	(8.00)	(7.00)	(7.00)	(16.33)	(19.00)	(17.33)	(17.55)
2,4-D sodium salt + metribuzin +	1.14	1.14	1.00	1.09	2.55	2.99	2.74	2.76	4.16	4.67	4.24	4.28
chlorimuron 2.02 kg/ha	(0.33)	(0.33)	(0.00)	(0.22)	(5.66)	(8.00)	(6.66)	(6.77)	(16.33)	(19.00)	(17.00)	(17.44)
Weedy check	3.15	3.43	3.29	3.39	3.99	4.57	4.23	4.26	5.22	5.74	5.40	5.46
	(9.0)	(13.0)	(10.00)	(10.66)	(15.00)	(20.00)	(17.00)	(17.33)	(26.33)	(32.00)	(28.33)	(28.88)
Weed free	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
LSD (p = 0.05)	0.48	0.67	0.53	0.28	0.90	0.95	0.99	0.47	0.69	0.80	0.85	0.39

*Data were subjected to $(\sqrt{x+1})$ transformation. Figures in parentheses are original values; HSR-I & II: Two locations in Hoshiarpur, and JAL: Jalandhar

Table 4. Effect of post-emergence application of herbicides on biomass of *M. maximus* at 30 days after application (DAA), 60 DAA and at harvest in participatory trials at different locations (Trial-II: pooled over three locations)

Treatment	Biomass (g/m^2)											
	30 DAA				60 DAA				At harvest			
	HSR-I	HSR-II	JAL	Pooled mean	HSR-I	HSR-II	JAL	Pooled mean	HSR-I	HSR-II	JAL	Pooled mean
2,4-D sodium salt + metribuzin +	3.24	2.85	1.00	2.37	10.11	11.84	11.46	11.14	16.33	18.56	17.24	17.38
pyrazosulfuron-ethyl 2.40 kg/ha	(13.3)	(14.0)	(0.0)	(9.11)	(103.0)	(139.7)	(131.0)	(124.5)	(268.3)	(345.0)	(298.3)	(303.9)
2,4-D sodium salt + metribuzin +	2.80	2.83	1.00	2.20	9.98	11.74	11.39	11.04	16.29	18.54	17.19	17.34
pyrazosulfuron-ethyl 2.40 kg/ha	(13.3)	(13.7)	(0.0)	(9.00)	(101.7)	(138.3)	(130.0)	(123.4)	(266.7)	(344.3)	(296.7)	(302.5)
2,4-D sodium salt + metribuzin +	2.77	2.83	1.00	2.20	10.00	11.72	1.39	11.04	16.03	18.44	17.00	17.17
chlorimuron 2.02 kg/ha	(13.0)	(13.7)	(0.0)	(8.88)	(100.0)	(136.7)	(129.3)	(122.0)	(263.3)	(344.0)	(294.0)	(300.4)
Weedy check	11.88	12.17	11.94	11.99	1934	19.71	19.43	19.49	24.30	25.19	24.49	24.66
	(140.6)	(147.7)	(141.3)	(143.2)	(375.0)	(388.3)	(377.3)	(380.2)	(593.3)	(635.0)	(601.7)	(610.0)
Weed free	1.00(0)	1.00(0)	1.00(0)	1.00 (0)	1.00(0)	1.00(0)	1.00(0)	1.00(0)	1.00(0)	1.00(0)	1.00(0)	1.00 (0)
LSD (p = 0.05)	4.90	5.72	0.77	3.75	3.84	2.46	2.51	1.49	4.48	3.34	3.86	1.94

*Data were subjected to $(\sqrt{x+1})$ transformation. Figures in parentheses are original values; HSR-I & II: Two locations in Hoshiarpur, and JAL: Jalandhar weeds, being absorbed through both roots and foliage and subsequently translocated to the meristematic regions. Kaur *et al.* (2025a) also reported that 2,4-D sodium salt + metribuzin + chlorimuron 2.02 kg/ha resulted in 136.2% and 133.9%, 87.9% and 375% and 41.9% and 37.9% reduction of biomass of grasses, broad-leaved weeds and sedges at Kapurthala and Ludhiana, respectively compared to weedy plots at 60 DAA.

Sugarcane yield attributes and yield

Different pre- and post-emergence herbicidal treatments had significant impact on the sugarcane's yield attributes and yield over weedy check but there was non-significant effect of all weed control treatments on cane length in both experiments (**Table 2** and **5**). Weed free plots recorded higher number of millable canes and cane yield which was statistically at par with pre-emergence applications of metribuzin 1.4 kg/ha, diuron 1.6 kg/ha and sulfentrazone + clomazone 1.45 kg/ha. The millable canes and cane yield in various treatments of Trial-I ranged from 114 to 163 thousand/ha and 57.37 to 93.37 t/ha, respectively (**Table 2**). Metribuzin 1.4 kg/ha, diuron 1.6 kg/ha and sulfentrazone + clomazone 1.45 kg/ha recorded 27.2%, 32.5% and 30.7% more number of millable canes and 46.5%, 52.9% and 50.0% higher cane yield over weedy check plots. Lower competition between crop and *M. maximus* in weed free plots reflected a greater number of millable cane and cane weight. Thus, sugarcane yield could be increased with integration of pre-emergence herbicides with interculture or follow-up application of post-emergence herbicides. Effective management of weeds with pre-emergence herbicides reduces competition for essential resources such as space, light, moisture and nutrients between younger plants of sugarcane plants and weeds, thereby contributing to improved crop productivity (Singh *et al.* 2019).

In Trial-II, all post-emergence herbicides resulted in at par number of millable canes and cane yield but significantly higher than weedy check (**Table 5**). However, effect of all weed control treatments on cane length was found non-significant. two tested formulations of 2,4-D sodium salt + metribuzin + pyrazosulfuron-ethyl 2.4 kg/ha and 2,4-D sodium salt + metribuzin + chlorimuron 2.02 kg/ha recorded 28.6%, 27.6% and 27.6% more number of millable canes and 44.5%, 43.3% and 42.4%, respectively higher cane yield over weedy check. Weed infestation adversely affects sugarcane tillering, leading to a reduction in the number of millable canes and consequently lowering cane yield (Zafar *et al.* 2010). Application of herbicidal treatments resulted in a marked increase in number of millable canes, which consequently resulted significantly higher cane yield over the weedy check treatment. Weed competition can decrease millable stalks by 32% compared to weed free plots was also reported by El-Shafai *et al.* (2010). Results of our study are in line with Jaiswal *et al.* (2024) also reported that weed management through application of 2,4-D sodium salt + metribuzin + pyrazosulfuron-ethyl 2.4 kg/ha could improve the cane yield by 36.76% over the weedy check plots. Further, Kaur *et al.* (2025a) reported that 2,4-D sodium salt + metribuzin + chlorimuron 2.02 kg/ha resulted in 33.7% and 24.5% more millable canes and 38.6% and 35.2% higher cane yield at Kapurthala and Ludhiana, respectively, over unsprayed weedy check.

Furthermore, the yield in weed free plots were numerically higher than standalone application of pre- (**Table 2**) and post-emergence (**Table 5**) herbicides. Since cohorts of *M. maximus* emerging later in the season (in monsoon months) may have caused yield reduction. Therefore, it was observed that the tested pre- and post-emergence provided effective control of *M. maximus* for 60-90 days. Moreover, sugarcane is a long duration crop and grand growth of the crop occurring late in June-July months leads to delayed canopy closure, leading to first 120 days of planting as critical period of crop-weed competition (Kaur *et al.* 2025a). The young seedlings of *M. maximus* can

Table 5. Effect of post-emergence application of herbicides on yield attributes and yield of sugarcane in participatory trials at different locations (Trial-II: pooled over three locations)

Treatment	Cane length (m)				Millable canes (000/ha)				Cane yield (t/ha)				Economics	
	HSR-I	HSR-II	JAL	Pooled mean	HSR-I	HSR-II	JAL	Pooled mean	HSR-I	HSR-II	JAL	Pooled mean	Net returns ($x10^3$ Rs./ha)	B:C
2,4-D sodium salt + metribuzin + pyrazosulfuron-ethyl 2.40 kg/ha	3.23	2.93	3.03	3.06	144	123	138	135	89.66	73.33	82.66	81.89	220.36	1.83
2,4-D sodium salt + metribuzin + pyrazosulfuron-ethyl 2.40 kg/ha	3.20	2.93	3.00	3.04	143	123	136	134	89.00	73.00	81.33	81.22	217.58	1.81
2,4-D sodium salt + metribuzin + chlorimuron 2.02 kg/ha	3.16	2.90	3.00	3.02	143	122	136	134	88.33	72.66	81.00	80.66	215.00	1.78
Weedy check	3.10	2.83	2.93	2.95	118	95	101	105	63.00	50.66	56.33	56.66	119.88	1.03
Weed free	3.25	2.94	3.06	3.08	150	133	143	142	95.12	80.21	87.65	87.66	207.19	1.32
LSD (p = 0.05)	NS	NS	NS	NS	16	18	17	9	13.50	13.32	16.50	7.19	-	-

HSR-I and II: Two locations in Hoshiarpur, and JAL: Jalandhar be effectively managed with suitable pre-emergence and early post-emergence herbicides, however, optimal application window is often missed in practice at farmers' fields, resulting in the persistence of well-established stools in sugarcane fields (Fillols and Staier 2019). The B:C was lower in weed free plots in both trials (**Table 2** and **5**) than pre- and post-emergence herbicides, indicating chemical weed management is both cost-effective and timely method to control the weeds. The monitoring and timely control is the foundation for the control of *M. maximus* in sugarcane.

It may be concluded that application of metribuzin 1.4 kg/ha PE, diuron 1.6 kg/ha PE and sulfentrazone + clomazone 1.45 kg/ha PE (within 3-5 days of planting), and 2,4-D sodium salt + metribuzin + pyrazosulfuron-ethyl 2.4 kg/ha PoE and 2,4-D sodium salt + metribuzin + chlorimuron 2.02 kg/ha PoE (at 4-5 weed leaf stage) provided comparable, effective and economical control of *M. maximus* and improved sugarcane productivity.

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