



E-ISSN: 2278-4136

P-ISSN: 2349-8234

www.phytojournal.com

JPP 2021; 10(2): 217-220

Received: 18-12-2020

Accepted: 16-02-2021

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Effect of different herbicide combinations with allelopathic plant extracts on growth and qualitative characters of sugarcane (*Saccharum officinarum* L.)

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Abstract

A field experiment was conducted at Agricultural Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh during spring season of 2018-19 and 2019-20 to study the effect of different herbicide combinations with allelopathic plant extracts on growth and quality of sugarcane. Different treatments failed to show any significant effect on germination and qualitative characters of sugarcane. However, maximum plant height was observed with weed free (3 hand weeding at 30, 60 and 90 DAP) during both the years. In case of chemicals, significantly higher plant height at harvest was found with pre-emergence application of halosulfuron methyl + metribuzin which was statistically at par with application of halosulfuron methyl + metribuzin (75% R.D) + 25% SWE and halosulfuron methyl + metribuzin (75% R.D) + 25% SUWE during both the year of the study.

Keywords: allelopathic, brix, extraction, sucrose and sugarcane

Introduction

Sugarcane (*Saccharum officinarum* L.) crop occupies an important position in Indian agriculture. It is the most important and celebrated crop cultivated widely in India since time immemorial (Lal *et al.*, 2006) [5]. India ranks second in sugarcane grown area and production after Brazil. Sugarcane accounts for an area and production of around about 5.04 m ha and 411.16 mt, respectively and average productivity of 81.5 t ha⁻¹ in India (IISR, 2020) [4]. Uttar Pradesh has the prime position in area and production of sugarcane, accounting for about 2.18 m ha area and 179.71 mt of production (IISR, 2020) [4]. In India, productivity of sugarcane is low as compared to other sugarcane growing countries of the world due to higher weed infestation. The reasons for low yield of sugarcane includes improper land preparation, conventional planting methods, less than recommended seed rate, heavy weed infestation, shortage of irrigation water, imbalanced fertilizer application, less support price, lack of coordination between growers and mill owners, natural calamities, delayed harvesting, pests and disease incidence, poor management of ratoon crop and salinity. Among the various factors limiting cane production, weed infestation is one of the major biotic constraints in sugarcane production (Malik and Gurmani, 2005) [6].

A relatively weed free environment during early stages of crop growth can be better ensured by the use of pre-emergence herbicides that control weeds right at germination itself. Chemical weed control is time saving and easier. Now a day's dependence and enormous use of single herbicide or herbicides having the same mode of action may result in the development of resistance in weeds and accumulation of residue in the soil in long term via continuous use of the same herbicide in same season. So there is urgent need to controlling of weeds through allelopathic plant extracts combined with herbicides is a new option (Cheema and Khaliq, 2000) [2]. In the development of any new weed control strategy, safety and efficacy are the two primary concerns. Therefore, safety (in relation to plants, environment and human health) and efficacy (in relation to environmental tolerance, level of damage to the weed and ability to be integrated within the crop production system) are the major criteria in the selection of suitable allelopathy extracts (Singh *et al.*, 2005) [10].

However, information regarding controlling of weeds by different herbicide combination with allelopathic plant extracts for sugarcane in Uttar Pradesh is lacking. Keeping in view the above discussed facts of sufficient information and sparse related research, the present investigation was undertaken to find out the effect of different herbicide combination with allelopathic plant extracts on growth and qualitative characters of sugarcane.

Materials and Methods

An experiment was conducted during two successive spring seasons of 2018-19 and 2019-20, at Agricultural Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh (situated at 25°10' N latitude and 83°03' E longitude with an altitude of 128.93 m above mean sea level). The soil was sandy clay loam in texture having a pH of 7.26, EC 0.29 (dSm⁻¹), low in organic carbon (0.40%) and low available nitrogen (226.83 kg ha⁻¹), medium in available phosphorus (17.70 kg ha⁻¹) and potassium (236.92 kg ha⁻¹). The experiment was conducted in randomized block design with replicate thrice consisted of twelve treatments *viz.* (T₁) Halosulfuron methyl + Metribuzin, (T₂) Halosulfuron methyl + Metribuzin (75% R.D) + 25% SWE, (T₃) Halosulfuron methyl + Metribuzin (75% of R.D) + 25% SUWE, (T₄) Halosulfuron methyl + Metribuzin 50% (75% of R.D) + 25% PWE, (T₅) Halosulfuron methyl + Metribuzin (50% of R.D) + 25% SWE + 25% SUWE, (T₆) Halosulfuron methyl + Metribuzin (50% of R.D) + 25% SWE + 25% PWE, (T₇) Halosulfuron methyl + Metribuzin (50% of R.D) + 25% SUWE + 25% PWE, (T₈) Halosulfuron methyl + Metribuzin (25% of R.D) + 25% SWE + 25% SUWE + 25% PWE, (T₉) Halosulfuron (25% of R.D) + 25% SWE + 25% SUWE + 25% PWE, (T₁₀) Metribuzin (25% of R.D) + 25% SWE + 25% SUWE + 25% PWE, (T₁₁) Weed free (3 hand Weeding) and (T₁₂) Weedy check (control). The treatments were allocated randomly to each plot. Urea, di ammonium phosphate and murate of potash were used as a source of nitrogen, phosphorus and potassium. The crop was uniformly fertilized with 180 kg N, 80 kg P₂O₅ and 60 kg K₂O ha⁻¹ giving a full dose of phosphorus and potassium as basal and nitrogen applied as basal as well as top dressing. The total rainfall experienced during the crop growth season was 824.5 mm in 2018-19 and 1197 mm in 2019-20. Effective rainfall was also brought into concern for irrigation. Seed canes were obtained from healthy cultivar Co 239 (Karan 6), which is fit for the spring season. Canes were cut into 3 budded setts and treated with 0.25% solution of emissan for 10-15 minutes to check any fungal disease. The crop was planted in the 2nd week of April during both the years. The herbicide combination with allelopathic plant extracts spray was applied at 3, 30 and 60 days after planting. The treated setts were set horizontally at 75 cm distance from row to row. After planting, the setts were covered with loose soil. Other crop management methods were accompanied as per the recommendation of the area.

Statistical analysis and interpretation of data

Data recorded on relative composition of weeds in the experiment was subjected to analysis by using Fisher's method of analysis of variance (ANOVA) and interpreted as outlined by Gomez and Gomez (1984) [3]. The levels of significance used in 'F' and 't' test was $p = 0.05$. Critical difference values were calculated where F test was found significant.

Results and Discussions

The outcomes of the study showed that different herbicide combination with allelopathic plant extracts failed to show

any significant effect on germination (%) and qualitative characters *viz.* juice extraction (%), brix (%) and juice sucrose (%) are presented in Table 1-2.

Further, perusal of data (Table 1) advocated that application of herbicide combination with allelopathic plant extracts did not influence significantly on germination of sugarcane at 30 and 45 days after planting during both the years of investigation. The maximum germination per cent (39.0 and 42.76) at 30 DAP was observed with pre-emergence application of halosulfuron methyl + metribuzin (75% R.D) + 25% SUWE. Similar trend was observed at 45 DAP. However, minimum germination (35.00 and 38.77%) was observed with pre-emergence application of halosulfuron methyl + metribuzin (75% R.D) + 25% PWE at 30 DAP during both the years. In case of 45 DAP, minimum germination (39.88%) was observed with application of metribuzin (75% R.D) + 25% SWE + 25% SUWE + 25% PWE during first year. In second year (2019-20) of experimentation minimum germination (42.92%) was observed with pre-emergence application of halosulfuron methyl + metribuzin (50% R.D) + 25% SWE + 25% PWE at 45 DAP. These might have been due to better physiochemical conditions of soil which aided to upsurge the germination percentage (%). Similar trends were also observed by Sathyvelu *et al.* (2002) [8] and Agrawal *et al.* (1997) [1].

Data enumerated in Table 1 varied significantly by application of herbicide combination with allelopathic plant extracts on plant height at harvest. Perusal of the data revealed that three hoeings at 30, 60 and 90 DAP (weed free) exerted maximum plant height as compared to other treatments during both the years. Among the herbicide and combinations with allelopathic plant extracts treatments, the maximum plant height (429.77 and 436.12 cm) was recorded with pre-emergence application of halosulfuron methyl + metribuzin which was statistically at par with application of halosulfuron methyl + metribuzin (75% R.D) + 25% SWE and halosulfuron methyl + metribuzin (75% R.D) + 25% SUWE during both the year of the study. This was just because of higher weed and crop competition for climatic resources which have been more competently utilized by weeds than sugarcane. These results are related with those of Mohamed *et al.* (1990) [7] and Singh *et al.* (2001) [9].

A cursory glance of Table 2 revealed that qualitative characters like juice extraction, brix and sucrose (%) failed to show any significant effect by application of herbicide combination with allelopathic plant extracts. Crop grown with any of the weed control treatments produced higher values than that grown under weedy condition. Higher values of qualitative characters was recorded under three hoeings at 30, 60 and 90 DAP (weed free) of sugarcane in 2018-19 and 2019-20, respectively higher than rest of the treatments. In case of herbicide combinations with allelopathic plant extracts, maximum juice extraction (56.54 and 57.21%), brix (19.60 and 19.67%) and sucrose (17.29 and 17.45%) was observed with application of halosulfuron methyl + metribuzin (50% R.D) + 25% SWE + 25% SUWE during both the years of study. Singh *et al.* (2005) [10] was opinion that quality was not influenced significantly either by herbicides or by conventional practice.

Table 1: Effect of different herbicide combinations with allelopathic plant extracts on germination (%) and plant height at harvest of sugarcane

Treatments	Dose (g a.i. ha ⁻¹)	Germination (%)		Germination (%)		Plant height (cm)		
		30 DAP		45 DAP		At harvest		
		2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	
T ₁	Halosulfuron methyl + Metribuzin	67.5+652.5	37.99	41.75	40.20	44.57	429.77	436.12
T ₂	Halosulfuron methyl + Metribuzin (75% R.D) + 25% SWE	50.62 + 421.8	38.67	42.44	43.55	45.92	415.82	422.17
T ₃	Halosulfuron methyl + Metribuzin (75% of R.D) + 25% SUWE	50.62 + 421.8	39.00	42.76	44.21	47.58	413.75	420.10
T ₄	Halosulfuron methyl + Metribuzin (75% of R.D) + 25% PWE	50.62 + 421.8	35.00	38.77	40.88	45.25	410.88	417.23
T ₅	Halosulfuron methyl + Metribuzin (50% of R.D) + 25% SWE + 25% SUWE	33.6 + 281.25	35.02	38.78	39.90	43.26	425.21	431.56
T ₆	Halosulfuron methyl + Metribuzin (50% of R.D) + 25% SWE + 25% PWE	33.6 + 281.25	35.68	39.44	40.56	42.92	406.28	412.63
T ₇	Halosulfuron methyl + Metribuzin (50% of R.D) + 25% SUWE + 25% PWE	33.6 + 281.25	37.00	40.76	41.88	44.24	402.40	408.75
T ₈	Halosulfuron methyl + Metribuzin (25% of R.D) + 25% SWE+ 25% SUWE + 25% PWE	16.8 + 140.62	36.36	39.12	41.24	45.60	399.98	406.33
T ₉	Halosulfuron (25% of R.D) + 25% SWE+ 25% SUWE + 25% PWE	16.8	37.67	40.44	42.55	46.92	400.22	406.57
T ₁₀	Metribuzin (25% of R.D) + 25% SWE+ 25% SUWE + 25% PWE	140.62	36.00	40.10	39.88	43.25	397.49	403.84
T ₁₁	Weed free (3 hand Weeding)	----	35.34	39.10	40.22	44.59	451.14	457.49
T ₁₂	Weedy check (control)	---	35.99	38.51	40.87	45.24	386.79	379.14
	SEm±	---	1.22	1.18	1.34	1.51	9.01	9.43
	LSD (P=0.05)	---	NS	NS	NS	NS	27.13	28.41

SWE- Sorghum water extract, SUWE- Sunflower water extract, PWE- Parthenium water extract

Table 2: Effect of different herbicide combinations with allelopathic plant extracts on juice extraction (%), brix (%) and juice sucrose (%) of sugarcane

Treatment	Dose (g a.i. ha ⁻¹)	Juice extraction (%)		Brix (%)		Juice sucrose (%)		
		2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	
		T ₁	Halosulfuron methyl + Metribuzin	67.5+652.5	56.44	57.11	19.51	19.63
T ₂	Halosulfuron methyl + Metribuzin (75% R.D) + 25% SWE	50.62 + 421.8	56.20	56.88	19.45	19.61	17.00	17.31
T ₃	Halosulfuron methyl + Metribuzin (75% of R.D) + 25% SUWE	50.62 + 421.8	55.85	56.52	18.89	18.95	16.89	17.24
T ₄	Halosulfuron methyl + Metribuzin (75% of R.D) + 25% PWE	50.62 + 421.8	55.82	56.49	19.31	19.48	16.68	17.21
T ₅	Halosulfuron methyl + Metribuzin (50% of R.D) + 25% SWE + 25% SUWE	33.6 + 281.25	56.54	57.21	19.60	19.67	17.29	17.45
T ₆	Halosulfuron methyl + Metribuzin (50% of R.D) + 25% SWE + 25% PWE	33.6 + 281.25	55.74	56.41	19.22	19.38	16.71	17.00
T ₇	Halosulfuron methyl + Metribuzin (50% of R.D) + 25% SUWE + 25% PWE	33.6 + 281.25	55.65	56.33	19.19	19.35	16.58	17.03
T ₈	Halosulfuron methyl + Metribuzin (25% of R.D) + 25% SWE+ 25% SUWE + 25% PWE	16.8 + 140.62	55.54	56.22	19.10	19.26	16.66	16.90
T ₉	Halosulfuron (25% of R.D) + 25% SWE+ 25% SUWE + 25% PWE	16.8	56.41	57.08	19.06	19.23	16.44	16.85
T ₁₀	Metribuzin (25% of R.D) + 25% SWE+ 25% SUWE + 25% PWE	140.62	55.05	55.84	19.01	19.18	17.13	16.76
T ₁₁	Weed free (3 hand Weeding)	-	57.46	58.14	19.80	19.96	17.35	17.67
T ₁₂	Weedy check (control)	-	55.16	55.73	18.71	18.60	17.03	17.61
	SEm±	-	1.72	1.72	0.60	0.51	0.56	0.55
	LSD (P=0.05)	-	NS	NS	NS	NS	NS	NS

SWE- Sorghum water extract, SUWE- Sunflower water extract, PWE- Parthenium water extract

Conclusion

From data presented it might reasonably be argued that the germination and qualitative characters not influenced by different herbicide combination with allelopathic plant extracts during both the years of study. However, significantly maximum plant height was recorded with pre-emergence application of halosulfuron methyl + metribuzin which was statistically at par with application of halosulfuron methyl + metribuzin (75% R.D) + 25% SWE and halosulfuron methyl + metribuzin (75% R.D) + 25% SUWE during both the year of the study.

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