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Evaluation of different herbicide application on the nutrient uptake of spring planted sugarcane (*Saccharum officinarum* L.) in Varanasi

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Abstract
A field experiment was conducted during the year 2018-2019 at Agriculture Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi (Uttar Pradesh) to Evaluation of different herbicide application on the nutrient uptake of spring planted sugarcane (*Saccharum officinarum* L.) in Varanasi. The treatments comprises *viz*. Halosulfuron methyl 6% + Metribuzin 50% WG PE @ 1.0 kg a.i. ha^{-1}, Halosulfuron methyl 6% + Metribuzin 50% WG PE@ 1.125 kg a.i. ha^{-1}, Halosulfuron methyl 6% + Metribuzin 50% WG PE@ 1.25 kg a.i. ha^{-1}, Halosulfuron methyl 75% WG -PE@ 0.09 kg a.i. ha^{-1}, Metribuzin 70% WP-PE@ 2.0 kg a.i. ha-1, Halosulfuron methyl 6% + Metribuzin 50% WG-POE@ 1.0 kg a.i. ha-1, Halosulfuron methyl 6% + Metribuzin 50% WG-POE@ 1.125 kg a.i. ha^{-1}, Halosulfuron methyl 6% + Metribuzin 50% WG-POE@ 1.25 kg a.i. ha-1, Halosulfuron methyl 75% WG –POE@ 0.09 kg a.i. ha-1, Metribuzin 70% WP-POE@ 2.0 kg a.i. ha^{-1}, 2,4-D Dimethyl amine salt 58% SL-POE@ 6.0L. ha^{-1}, Hand weeding (30,60 and 90 DAP) and untreated control was laid out in randomized block design with replicate thrice. The highest uptake of N, P and K was noticed in crop given three hand Weedings at 30, 60 and 90 DAP, In herbicidal treatment application with halosulfuron methyl 6% + metribuzin 50% WG 1.25 kg ha-1 POE recorded significantly higher uptake of nutrient. However, the lowest nutrient uptake by cane stalk, green top and trash was recorded under the untreated plot.

Keywords: Sugarcane, herbicide, nutrient uptake, halosulfuron methyl

Introduction
Sugarcane (*Saccharum officinarum* L.) is an important crop for sugar and bioenergy worldwide. This industry is the second largest agro-based industry after textiles, which ranks India second, among sugarcane producing countries and sharing 20 percent of the world sugarcane area. It is an important commercial cash crop in India contributes nearly 7.5 percent of the gross value of agricultural production in the country. It is the main source of sugar in India and holds an important agricultural commercial cash crop (Dev *et al.*, 2013) [2] which provides gainful employment to a large number of people. In sugarcane growing areas, nutsedge is considered to be a major weed problem. Nutsedge is one of the most difficult perennial weed of the world, particularly in moisture retentive soils of the tropics and sub tropics. Due to continuous use of atrazine, metribuzin and 2,4-D in sugarcane fields, the population of grassy and broad leaved weeds has been decreased; whereas the population of Cyperus species has increased tremendously. Over the past few years, sugarcane growers in India have experienced an increase infestation of purple (*C. rotundus* L.) and yellow nutsedge (*Cyperus esculentus* L.). C. rotundus population has been reported to be 60–80% of total weed flora in sugarcane fields in India (Raskar 2004; Roshan *et al*. 2006) [6, 7]. The crop also need frequent irrigation and fertilizer application during early crop growth thereby increase the weeds menace many folds in the crop (Singh *el al*., 2008) [2, 8-10]. This lower productivity is mainly due to heavy weed infestation in the early growth stage and poor weed management practices (Srivastava *et al.*, 2002) [7, 11, 12]. The critical period of crop-weed competition has been recorded to be 60-120 days after planting in spring cane and 150 days in autumn cane (Singh *et al*., 2011) [2, 8-10]. Due to variation in the selectivity of the herbicides, some of the weeds are not controlled and becoming more competitive. Usage of herbicides also influence the species composition of the weed seed bank and may increase or decrease it, depending on the chemicals used (Ball, 1992) [1].

Sugar industry in Maharashtra state is the second largest agro-based industry next to cotton in which higher investment is made and has brought about desirable changes in social, economic, educational and political life in rural areas. It employs over 40 million cane growers and about 3.5 lakh skilled and unskilled workers. India maintains the second position, next to Brazil in terms of sugarcane production (Shrivastava *et al*., 2011). In India, 26.34 million tonnes of sugar produced with a recovery of 10.25%. Sugarcane productivity in India is low (66.08 t ha^{-1}).

Materials and methods

A field experiment was conducted at Agricultural Research Farm of Institute of Agricultural sciences, Banaras Hindu University, Varanasi to Evaluation of different herbicide application on the nutrient uptake of spring planted sugarcane in Varanasi during the year 2018-2019. The soil of the experimental field was clay loam in texture with pH 7.57, EC 0.42 dSm^{-1} with low availability of nitrogen, medium in available phosphorus and potash. It is located on $25^{0}18'$ N latitude, $83^{0}3'$ E longitude and at an altitude of 75.70 meters above mean sea level in the Northern Gangetic alluvial plains. The temperature during winter dips down to 4.5 ºC and it goes up to 42.0 ºC during summer season. The average rainfall of the region is around 845.6 mm and 78% of the total rainfall is received during July-September by South-West monsoon. The tillering period for sugarcane is very limited and sugarcane experiences very hot and dry weather during April to June. Grand growth period is also limited due to start of cold weather from October onward. Field was dominated with *C. rotundus* and *Cynodon dactylon*, though grassy and broad leaf weeds were also present at small densities. The treatments comprises *viz*. Halosulfuron methyl 6% + Metribuzin 50% WG PE @ 1.0 kg a.i. ha^{-1}, Halosulfuron methyl 6% + Metribuzin 50% WG PE@ 1.125 kg a.i. ha^{-1}, Halosulfuron methyl 6% + Metribuzin 50% WG PE@ 1.25 kg a.i. ha^{-1}, Halosulfuron methyl 75% WG-PE@ 0.09 kg a.i. ha^{-1}, Metribuzin 70% WP-PE@ 2.0 kg a.i. ha-1, Halosulfuron methyl 6% + Metribuzin 50% WG-POE@ 1.0 kg a.i. ha-1, Halosulfuron methyl 6% + Metribuzin 50% WG-POE@ 1.125 kg a.i. ha^{-1}, Halosulfuron methyl 6% + Metribuzin 50% WG-POE@ 1.25 kg a.i. ha-1, Halosulfuron methyl 75% WG –POE@ 0.09 kg a.i. ha-1, Metribuzin 70% WP-POE@ 2.0 kg a.i. ha^{-1}, 2,4-D Dimethyl amine salt 58% SL-POE@ 6.0L. ha^{-1}, Hand weeding (30,60 and 90 DAP) and untreated control was laid out in randomized block design with replicate thrice. The powdered samples were used for chemical analysis of nitrogen, phosphorus and potassium using standard analysis process Micro-kjeldhal, Vandomolybdate yellow colour method and Flame-photometric method respectively. The uptake of nutrient by different part of cane was calculated by using per cent content and dry matter. Sugarcane early maturing variety Co 0239 (Karan-6) was planted during spring season on March 11, 2018 at 75 cm row to row distance using 75.0 q seed cane/ha. Fertilizers doses of 120 kg N/ha, 60 kg P2O5/ha and 40 kg K_2O/ha was applied to the experimental crop. Emisan (0.25%) @ 500 g ha^{-1} was used for treatment of setts. The nutrient uptake was calculated separately for cane stalk, green tops and trash and summed together to get the total uptake. To work out the nutrient accumulation in each part their dry matter yield was multiplied by their respective nutrient status.

Results and Discussion

Effects on nutrient uptake

Nitrogen uptake (kg ha^{-1})

Scanning of the data pertaining to nitrogen uptake by cane stalk, green tops, trash in (Table 1) indicated that it was significantly affected by different weed control treatments. The data further revealed that nitrogen accumulation by cane stalk, green top and trash was significantly higher in hand weeding (30, 60 and 90 DAP) among all the weed control treatments. Among herbicidal treatments, application halosulfuron methyl 6% + metribuzin 50% WG 1.25 kg ha^{-1} POE recorded maximum nitrogen uptake by a cane which was significantly high over the N uptake from Halosulfuron methyl 75% WG both POE and PE and Metribuzin 70% WP both POE and PE but remain at par for N uptake with other herbicidal treatments. However, significantly lowest nitrogen uptake by cane stalk, green top and trash was associated untreated plot. The similar observation pointed out by Vasuki (2005) [14] and Maurya S *et al*., (2020) [5].

Table 1: Nitrogen uptake as influenced by weed control treatments in sugarcane

Treatments	Dose ha-1		Time	Nitrogen uptake (kg ha-1)		
	a.i. (g)	Formulation		Cane stalk	Green tops	Trash
Halosulfuron methyl 6% + Metribuzin 50% WG	60+500	1000	PE	225.63	101.88	68.48
Halosulfuron methyl 6% + Metribuzin 50% WG	67.5+562.5	1125	PE	248.66	107.54	76.77
Halosulfuron methyl 6% + Metribuzin 50% WG	75+25	1250	PE	253.50	109.67	78.90
Halosulfuron methyl 75% WG	67.5	90	PE	185.72	86.58	61.29
Metribuzin 70% WP	1400	2000	PE	213.57	100.29	67.27
Halosulfuron methyl 6% + Metribuzin 50% WG	60+500	1000	POE	218.88	94.87	63.92
Halosulfuron methyl 6% + Metribuzin 50% WG	67.5+562.5	1125	POE	245.38	107.48	72.20
Halosulfuron methyl 6% + Metribuzin 50% WG	75+25	1250	POE	270.59	109.74	84.56
Halosulfuron methyl 75% WG	67.5	90	POE	195.49	97.12	61.50
Metribuzin 70% WP	1400	2000	POE	197.40	92.74	64.28
2,4-DDimethyl amine salt 58% SL	3500	6000	POE	237.68	103.78	71.05
Hand weeding	-	-	30,60 &90	319.20	157.96	103.77
untreated control	-	-		152.11	73.56	43.13
LSD (*P*=0.05)				58.48	18.41	28.19
S.Em.±				20.04	5.81	9.32

Phosphorus uptake (kg ha^{-1})

It is evident from the analyzed result (Table 2) that all the weed control treatment led to a significant increase in phosphorus uptake by cane stalk, green top and trash by sugarcane. Further, scanning of data revealed that maximum phosphorus uptake was associated with hand weeding a (30,

60 and 90 DAP) which was significantly higher than other weed control treatments. In herbicidal treatment application with halosulfuron methyl 6% + metribuzin 50% WG 1.25 kg ha-1 POE recorded significantly higher phosphorus uptake. This treatment was closely followed by halosulfuron methyl 6% + metribuzin 50% WG 1.25 kg ha-1 PE. It was significant over weedy check and application of pre &post emergence of halosulfuron methyl 75% WG 0.90 kg ha-1 PE, and metribuzin 70% WP 2.0 kg ha-1. However, the lowest phosphorus uptake by cane stalk, green top and trash was recorded under the untreated plot. This was also reported by Suganthi *et al*., (2013) [13] and Singh *et al.*, (2017) [2, 8-10].

Table 2: Phosphorus uptake as influenced by weed control treatments in sugarcane

Treatments	Dose ha^{-1}		Time	Phosphorus uptake (kg ha^{-1})		
	a.i. (g)	Formulation		Cane stalk	Green tops	Trash
Halosulfuron methyl 6% + Metribuzin 50% WG	60+500	1000	PE	26.23	8.29	9.52
Halosulfuron methyl 6% + Metribuzin 50% WG	67.5+562.5	1125	PE	30.05	9.10	10.36
Halosulfuron methyl 6% + Metribuzin 50% WG	75+25	1250	PE	30.86	9.17	10.64
Halosulfuron methyl 75% WG	67.5	90	PE	21.83	6.56	7.96
Metribuzin 70% WP	1400	2000	PE	25.49	7.59	8.90
Halosulfuron methyl 6% + Metribuzin 50% WG	60+500	1000	POE	26.06	8.04	9.16
Halosulfuron methyl 6% + Metribuzin 50% WG	67.5+562.5	1125	POE	29.02	8.72	9.86
Halosulfuron methyl 6% + Metribuzin 50% WG	75+25	1250	POE	32.64	9.82	10.95
Halosulfuron methyl 75% WG	67.5	90	POE	23.02	6.80	8.60
Metribuzin 70% WP	1400	2000	POE	23.54	6.90	8.81
2,4-DDimethyl amine salt 58% SL	3500	6000	POE	27.97	8.61	9.55
Hand weeding	-	-	30,60 &90	37.26	12.25	13.02
untreated control	-	-		17.42	4.94	6.31
LSD (*P*=0.05)				6.75	4.35	3.47
S.Em.±				2.31	1.49	1.19

Potassium uptake (kg ha^{-1})

It is apparent from the data presented in (Table 3) showed that different weed management treatments had a significant influence on potassium uptake by cane stalk, green top and trash at harvest. The amount of potassium uptake was higher in cane stalk followed by the green top and then trash irrespective of treatments. The maximum potassium uptake was recorded with hand weeding thrice (30, 60 and 90 DAP) which was significantly higher than the rest of other weed control treatments. Among herbicidal treatment halosulfuron methyl 6% + metribuzin 50% WG 1.25 kg ha^{-1} POE recorded significantly higher potassium uptake *fb* halosulfuron methyl 6% + metribuzin 50% WG 1.25 kg ha^{-1} PE. It was statistically at par with halosulfuron methyl 6% + metribuzin 50% WG 1.125 kg ha^{-1} PE and halosulfuron methyl 6% + metribuzin 50% WG 1.125 kg ha^{-1} POE. halosulfuron methyl 6% + metribuzin 50% WG 1.25 kg ha^{-1} POE was significant over the weedy check and rest of weed control treatments. The lowest potassium uptake was recorded in the weedy check. These findings were conformity by El-Shafai *et al*. (2010) [3] and Etheredge and Griffin (2008) [4].

Table 3: Potassium uptake as influenced by weed control treatments in sugarcane

Treatments	Dose ha^{-1}		Time	Potassium uptake (kg ha^{-1})		
	a.i. (g)	Formulation		Cane stalk	Green tops	Trash
Halosulfuron methyl 6% + Metribuzin 50% WG	60+500	1000	PE	297.15	130.57	76.88
Halosulfuron methyl 6% + Metribuzin 50% WG	67.5+562.5	1125	PE	337.66	142.75	83.22
Halosulfuron methyl 6% + Metribuzin 50% WG	75+25	1250	PE	346.46	144.47	92.21
Halosulfuron methyl 75% WG	67.5	90	PE	235.98	120.57	66.96
Metribuzin 70% WP	1400	2000	PE	276.78	128.03	72.41
Halosulfuron methyl 6% + Metribuzin 50% WG	60+500	1000	POE	282.11	132.05	75.23
Halosulfuron methyl 6% + Metribuzin 50% WG	67.5+562.5	1125	POE	325.08	131.94	77.42
Halosulfuron methyl 6% + Metribuzin 50% WG	75+25	1250	POE	391.31	154.76	96.71
Halosulfuron methyl 75% WG	67.5	90	POE	252.31	126.80	71.73
Metribuzin 70% WP	1400	2000	POE	262.31	126.92	69.38
2,4-DDimethyl amine salt 58% SL	3500	6000	POE	311.04	134.93	78.81
Hand weeding	-	-	30,60 &90	420.66	172.31	106.98
untreated control	-	-		200.45	108.26	53.89
LSD (*P*=0.05)				75.54	72.36	21.88
S.Em.±				25.88	24.79	7.50

Conclusion

The highest uptake of N, P and K was noticed in crop given three hand weedings at 30, 60 and 90 DAP. The minimum weed competition with post emergence application of halosulfuron methyl 6% + metribuzin 50% WG 1.25 kg ha^{-1} *fb* halosulfuron methyl 6% + metribuzin 50% WG 1.25 kg ha^{-1} PE throughout the crop period facilitated higher dry matter production and nutrient uptake by the crop. Increase availability of nitrogen, phosphorus and potassium under these treatments as a result of suppression of weeds growth might have been the driving force behind higher dry matter production and nutrient uptake in sugarcane.

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