International Journal of Statistics and Applied Mathematics

ISSN: 2456-1452
Maths 2023; SP-8(6): 1003-1007

https://www.mathsjournal.com
Received: 17-09-2023
Accepted: 04-11-2023

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Impact of post emergence herbicide on growth, yield, soil fertility and nutrient uptake by weed and crop in sugarcane

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Abstract
A field experiment was conducted during 2022-23 at Agronomy Research Farm, RCSM College of Agriculture, Kolhapur with an objectives to study the effect of different herbicide on yield and uptake of nutrient by sugarcane and weed and their effect on soil fertility. The dominant weed species observed during experiment were *Dinebra retroflexa*, *Brachiaria eruciformis*, *Digitaria sanguinalis* among grasses; *Amaranthus viridis*, *Chrozophora rottleri*, *Trianthema portulacastrum*, *Ipomoea hederacea*, *Portulaca oleracea* among broad leaves weed and *cyperus iria* among sedge. The result showed that the nutrient content with respect to N, P and K percent in weed and sugarcane did not differ significantly due to different weed management practices while highest uptake of nutrient by sugarcane found with weed free treatment over weedy check. Among the herbicidal treatments, post emergence (PoE) application of 2, 4-D amine salt 58% SL @ 1.4 kg a.i ha^{-1} + Metribuzin 70% WP 0.875 kg a.i ha^{-1} at 30 Days after planting recorded lowest depletion of nutrient by weed followed by treatment post emergence application of Mesotrione 2.27% + Atrazine 22.7% SC @ 0.875 kg a.i. ha^{-1} at 30 DAP. Among the herbicidal treatments, highest yield attributes and yield of sugarcane was obtained in treatment 2, 4-D amine salt 58% SL @ 1.4 kg a.i ha^{-1} + Metribuzin 70% WP 0.875 kg a.i ha^{-1} at 30 DAP.

Keywords: Sugarcane, 2, 4-D, Metribuzin, Uptake

Introduction
Sugarcane scientifically named (*Saccharum officinarum* L.), serves as a versatile and economically valuable plant within the poaceae family (formerly identified as Gramineae) in the order Glumoflorae and has been cultivated for centuries. Its remarkable ability to thrive in diverse environmental conditions ensures that farmers can attain favorable yields even in challenging situations. Sugarcane plays a crucial role in numerous industries, extending beyond its primary function in sugar production. It exhibits significant potential in the creation of jaggery, ethanol, environmentally friendly products, and serves as a valuable resource for livestock feed (Mishra *et al.*, 2021) [8]. The process of sugarcane propagation from setts usually includes the emergence of buds, typically occurring within two to four weeks, depending on environmental factors. The initial slow growth of sugarcane and wider row spacing can create a window for weeds to thrive in the open spaces between rows, outpacing sugarcane in growth. This situation results in competition with the primary sugarcane crop, leading to a struggle for essential resources such as light, nutrients, moisture, space *etc*. (Srivastava *et al*., 2005) [15]. Yield reduction due to weeds in sugarcane varied from 12 to 72 percent (Rathika *et al*, 2023) [14] Therefore knowledge about weed plants, crucial periods for crop weed competition and the effect of weed management practices on crop growth and performance and weed flora are significant for adopting a weed management (Suganthi *et al*, 2019) [17]. The present experiment was done by considering all these factor for the selection of effective weed management practices to avoid nutrient losses and yield reduction in sugarcane.

Materials and Methods

An experiment was carried out at Research Farm, Agronomy Section, RCSM College of Agriculture, Kolhapur, Maharashtra (India) during 2022-23 season. General the climatic condition favorable for crop with rainfall received during the period of field experiment was 1402.1 mm in 79 rainy days. The minimum temperature ranged from 12.8 ºC to 20.1 ºC, while the maximum temperature fall within the range of 24.7 ºC to 38.2 ºC. The soil of experimental field characterized as sandy clay loam, exhibited low available nitrogen (223.1 kg ha^{-1}), medium available phosphorus (18.25 kg ha^{-1}), high available potassium (389.5 kg ha^{-1}), and medium organic carbon (0.56%).The experiment followed a randomized block design consisting of seven treatments, each of which was replicated three times. The treatment comprises *viz*., T_1- Post emergence application of Metribuzin 70% WP @ 0.56 kg a.i. ha^{-1} at 30 DAP, T_2- Post emergence application of Metribuzin 70% WP @ 0.70 kg a.i. ha^{-1} at 30 DAP, T_3- Post emergence application of Mesotrione 2.27% + Atrazine 22.7% SC @ 0.875 kg a.i. ha^{-1} at 30 DAP, T_4- Post emergence application of Ametryne 80% WG @ 2 kg a.i. ha^{-1} at 30 DAP, T_5 - Post emergence application of 2, 4-D amine salt 58% SL @ 1.4 kg a.i. ha^{-1} + Metribuzin 70% WP @ 0.875 kg a.i. ha^{-1} at 30 DAP, T_6-Weed free, T_7-Weedy check. The healthy setts of sugarcane variety CoM-0265 were planted using the ridges furrow method with a spacing of 120 cm between rows, utilizing 25,000 two-budded setts per hectare in 1st week of February. The experimental setup featured a gross plot measuring 6.00 m x 5.00 m and a net plot with dimensions of 4.80 m x 4.00 m. Precision was maintained in the application of the recommended fertilizer quantities: 250 kg N, 115 kg P_2O_5, and 115 kg K_2O per hectare, delivered through urea, single super phosphate, and muriate of potash. Application of herbicide as per treatment were done as solution in water at the rate of 500 lit ha^{-1} with the help of knapsack sprayer fitted with flat pan nozzle. Earthing up was performed on all treatment plots at second fortnight of June, excluding the weedy check.

The analysis for nitrogen, phosphorus and potassium were done in weed at earthing up and sugarcane at harvest stage by adopting micro-kjeldhal's as outlined by (Jackson 1967) [2], vanado-molybdate phosphoric yellow colour method at 430 nm using spectrometer (Jackson 1967) [2] and flame emission photometry method (Jackson 1967) [2], respectively. The uptake of these nutrients was calculated separately by using formula.

$$\text{Nutrient uptake (N/P/K kg ha}^{-1}\text{)} = \frac{\text{Nutreint concentration(N/P/K \%) x Dry matter yield (kg ha}^{-1}\text{)}}{100}$$

Analysis of soil sample separately for each treatment were done separately after harvesting of sugarcane for nitrogen, phosphorus and potassium by adopting Alkaline KMnO4 method (Subbiah and Asija, 1956) [16], Olsen's method (Olsen, 1954) [10], Flame photometer method (Jackson, 1973) [3].

Results and discussion

Weed flora

Weed flora observed among grassy weed *Dinebra retroflexa, Brachiaria eruciformis, Digitaria sanguinalis, Echinochloa colonum, Dactylactenium aegyptium were dominant weed species;* among broad leaves weed *Ageratum conyzoides, Spilanthes calva, Amaranthus viridis, Amaranthus spinosus, Alternanthera sessilis, Chrozophora rottleri, Phyllanthus niruri, Merremia emarginata, Trianthema portulacastrum, Commelina benghalensis, Corchorus acutangulus, Ipomoea hederacea, Portulaca oleracea, Physalis minima were observed while Cyperus iria among segdes.* Bera and Ghosh, (2013) [1], Pratap *et al*. (2013) [12] and Rao and Padal (2015) [15] recorded similar weed flora.

Growth, yield attributes and yield of sugarcane

Table 1 indicated that growth, yield attributes and yield of sugarcane were significantly affected by imposed treatments. The weed free treatment recorded highest values for these parameter over weedy check treatment. Among the different herbicidal tretments, the highest number of tillers and cane yield (t ha^{-1}) were recorded in PoE application of 2, 4-D 58% SL @ 1.4 kg a.i. ha^{-1} + Metribuzin 70% WP @ 0.875 kg a.i. ha^{-1} at 30 DAP and statistically it was on par with treatment PoE application of Mesotrione 2.27% + Atrazine 22.7% SC @ 0.875 kg a.i. ha^{-1} at 30 DAP. Regarding observation recorded for dry matter accumulation in sugarcane, millable canes and single cane weight; the highest values for each of these parameter were observed in PoE application of 2, 4-D 58% SL @ 1.4 kg a.i. ha^{-1} + Metribuzin 70% WP @ 0.875 kg a.i. ha^{-1} at 30 DAP meanwhile treatments PoE application of Mesotrione 2.27% + Atrazine 22.7% SC @ 0.875 kg a.i. ha^{-1} at 30 DAP and PoE application of Ametryne 80% WG @ 2 kg a.i. ha^{-1} at 30 DAP. These results were confirmed with findings of Ombase *et al*. (2019) [11] and Yadav (2020) [18].

Nutrient content in sugarcane

Data pertaining to the nutrient content (%) and their uptake in sugarcane are presented in Table 2 clearly indicated that the concentration of nutrient in sugarcane did not influenced significantly due to various weed management practices. However among the herbicidal treatments, PoE application of 2, 4-D 58% SL @ 1.4 kg a.i. ha^{-1} + Metribuzin 70% WP @ 0.875 kg a.i. ha^{-1} at 30 DAP recorded numerically higher values of nutrient content in sugarcane. This might be due to lower competition between weed and crop for available nutrient, light, space.

Nutrient content in weed

Statistically analysed data regarding nutrient content in monocot, dicot and sedges weed are presented in Table 3 indicated that nutrient content in weed under different weed management practices did not showed any significant variation but numerically lowest nutrient content were recorded in PoE application of 2, 4-D 58% SL @ 1.4 kg a.i. ha^{-1} + Metribuzin 70% WP @ 0.875 kg a.i. ha^{-1} at 30 DAP among the different herbicides used. This might be due to supressing effect of combined used of herbicide on different weed species. Similar results were reported by Jangir *et al*. (2018) [4] in mustard and Nazir *et al*. (2021) [9] in rice.

Uptake by sugarcane

Data pertaining to the nutrient uptake in sugarcane are presented in Table 2 clearly indicated that uptake of nutrient (kg ha^{-1}) was showed significant variation. Among the herbicidal treatments, the uptake was highest (350.37, 82.61, and 452.29 N, P and K kg ha^{-1} respectively.) under treatment PoE application of 2, 4-D 58% SL @ 1.4 kg a.i. ha^{-1} + Metribuzin 70% WP @ 0.875 kg a.i. ha^{-1} at 30 DAP over weedy check, while treatment PoE application of Mesotrione

2.27% + Atrazine 22.7% SC @ 0.875 kg a.i. ha^{-1} at 30 DAP was on par with it. This might be due to greater absorption of essential nutrients by the sugarcane due to highest dry matter accumulation, availability of nutrients, and the concentration of nutrients within the plant. The obtained results were conformity with the findings of Kumar *et al*. (2021) [6].

Dry matter and nutrient removal by weed

Data presented in Table 4 indicated that dry matter accumulation and nutrient removal by different weed were significantly influenced by different weed management treatments. Among the different herbicidal treatments, PoE application of 2, 4-D 58% SL @ 1.4 kg a.i. ha^{-1} + Metribuzin 70% WP @ 0.875 kg a.i. ha^{-1} at 30 DAP recorded significantly lowest dry matter in monocot and dicot weed. The dry matter of sedges was also lowest in same treatment and which was comparable with Post emergence application of Mesotrione 2.27% + Atrazine 22.7% SC @ 0.875 kg a.i. ha^{-1} at 30 DAP. The lowest total uptake of nutrient were also reported by same treatments. This might be due to decreased weed population and reduced weed biomass, leading to an overall enhancement in the effectiveness of weed control in these treatments. The highest removal of N, P and K by weed under weedy check treatment (28.41, 13.95, and 46.70 N, P, and K kg ha^{-1} respectively.) this might be due to higher weed density with greater dry matter accumulation in weed. The results are accordance with findings of Kalaiyarasi (2012) [5].

Soil fertility

Data pertaining to soil nutrient status are presented in Table 5 revealed that the various weed management practices did not affected significantly with respect to availability of nitrogen, phosphorus and potassium from soil to the plant. However mean values for soil available nutrient were 244.3 N, 20.63 P and 340.18 K kg ha^{-1} respectively. However numerically highest values were recorded in treatment PoE application of 2, 4-D 58% SL @ 1.4 kg a.i. ha^{-1} + Metribuzin 70% WP @ 0.875 kg a.i. ha^{-1} at 30 DAP. This is due to reduction of lossws caused by weed due to lower weed density and dry matter.

Conclusion

It was concluded from the experiment the among the herbicidal treatments, PoE of 2, 4-D amine salt 58% SL @ 1.4 kg a.i. ha^{-1} + Metribuzin 70% WP @ 0.875 kg a.i. ha^{-1} at 30 DAP obtained higher values of growth and yield attribute and yield parameter of sugarcane. The highest uptake of nutrient by sugarcane and lowest nutrient depletion by weed were also recorded in same treatments. The concentration of nutrient in sugarcane as well as in weed species remain unaffected by different imposed treatments. The available soil nutrient status and organic carbon percentage did not varied due to different weed management practices.

Acknowledgement

Present investigation was the part of the M. Sc. Research programme. The author are thankful to Department of Agronomy, RCSM College of Agriculture, Kolhapur, Maharashtra (India) for providing necessary facilities during entire research work.

Table 1: Growth, yield attributes and yield of sugarcane as influenced by different weed management practices in sugaracne

Treatments	At 180 DAP	At harvest			
	Tillers count (x10^3 ha^{-1})	Total DMA in sugarcane (t ha^{-1})	Millable canes (x10^3 ha^{-1})	Single cane weight (g cane^{-1})	Cane yield (t ha^{-1})
Post emergence application of Metribuzin 70% WP @ 0.56 kg a.i. ha^{-1} at 30 DAP	79.34	20.69	68.33	1700	103.05
Post emergence application of Metribuzin 70% WP @ 0.70 kg a.i. ha^{-1} at 30 DAP	80.90	26.81	69.99	1727	106.23
Post emergence application of Mesotrione 2.27% + Atrazine 22.7% SC @ 0.875 kg a.i. ha^{-1} at 30 DAP (Premix)	94.96	34.89	81.66	1813	130.52
Post emergence application of Ametryne 80% WG @ 2 kg a.i. ha^{-1} at 30 DAP	88.19	32.72	74.99	1803	123.81
Post emergence application of 2, 4-D amine salt 58% SL @ 1.4 kg a.i. ha^{-1} + Metribuzin 70% WP @ 0.875 kg a.i. ha^{-1} at 30 DAP (Tank mix)	98.26	38.07	83.33	1840	134.78
Weed Free	101.21	39.90	86.66	1860	144.50
Weedy Check	74.48	16.68	54.99	1330	61.87
S.Em±	2.93	1.37	3.36	23.72	2.86
CD @ 5%	9.03	4.25	11.26	72.30	8.82
General Mean	88.19	29.96	74.27	1724.8	114.97

DAP: Days after planting, DMA: Dry matter accumulation

Table 2: Nutrient content and their uptake at harvest in sugarcane as influenced by different weed management practices in sugarcane

Treatments	Nutrient content (%)			Total Nutrient uptake (kg ha^{-1})		
	N	P	K	N	P	K
Post emergence application of Metribuzin 70% WP @ 0.56 kg a.i. ha^{-1} at 30 DAP	0.91	0.20	1.16	187.6	40.77	239.3
Post emergence application of Metribuzin 70% WP @ 0.70 kg a.i. ha^{-1} at 30 DAP	0.91	0.21	1.17	244.3	55.07	315.7
Post emergence application of Mesotrione 2.27% + Atrazine 22.7% SC @ 0.875 kg a.i. ha^{-1} at 30 DAP (Pre-mix)	0.92	0.22	1.18	320.8	76.73	412.8
Post emergence application of Ametryne 80% WG @ 2 kg a.i. ha^{-1} at 30 DAP	0.91	0.22	1.18	298.4	70.19	382.9
Post emergence application of 2, 4-D amine salt 58% SL @ 1.4 kg a.i. ha^{-1} + Metribuzin 70% WP @ 0.875 kg a.i. ha^{-1} at 30 DAP (Tank mix)	0.92	0.21	1.19	350.4	82.61	452.3
Weed Free	0.92	0.22	1.19	367.8	87.17	474.0
Weedy Check	0.90	0.20	1.11	149.7	32.29	185.7
S.Em±	0.02	0.006	0.029	13.2	3.22	18.13
CD @ 5%	NS	NS	NS	40.63	9.92	55.88
General Mean	0.91	0.21	1.16	274.0	63.54	351.8

Table 3: Nutrient content in monocot, dicot and sedges weed as influenced by different weed management practices in sugarcane

Treatments	Nutrient content (%) in weed at earthling up								
	Monocot			Dicot			Sedges		
	N	P	K	N	P	K	N	P	K
Post emergence application of Metribuzin 70% WP @ 0.56 kg a.i. ha^{-1} at 30 DAP	0.80	0.39	1.35	0.82	0.42	1.41	0.66	0.34	1.18
Post emergence application of Metribuzin 70% WP @ 0.70 kg a.i. ha^{-1} at 30 DAP	0.78	0.39	1.35	0.80	0.41	1.41	0.63	0.33	1.17
Post emergence application of Mesotrione 2.27% + Atrazine 22.7% SC @ 0.875 kg a.i. ha^{-1} at 30 DAP (Pre-mix)	0.76	0.38	1.30	0.78	0.40	1.36	0.62	0.33	1.11
Post emergence application of Ametryne 80% WG @ 2 kg a.i. ha^{-1} at 30 DAP	0.78	0.37	1.27	0.78	0.39	1.39	0.65	0.33	1.14
Post emergence application of 2, 4-D amine salt 58% SL @ 1.4 kg a.i. ha^{-1} + Metribuzin 70% WP @ 0.875 kg a.i. ha^{-1} at 30 DAP (Tank mix)	0.76	0.36	1.24	0.78	0.40	1.33	0.63	0.33	1.08
Weed Free	0.74	0.36	1.23	0.77	0.37	1.29	0.61	0.35	1.07
Weedy Check	0.83	0.40	1.35	0.88	0.43	1.43	0.70	0.34	1.23
S.Em±	0.01	0.01	0.04	0.02	0.01	0.04	0.018	0.01	0.033
CD @ 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS
General Mean	0.77	0.38	1.30	0.88	0.42	1.43	0.64	0.34	1.14

Table 4: Nutrient removal by weed as influenced by different weed management practices in sugarcane

Treatments	DMA by weed at earthling up (kg ha^{-1})			Total nutrient remove by weed at earthling up (kg ha^{-1})		
	Monocot	Dicot	Sedges	N	P	K
Post emergence application of Metribuzin 70% WP @ 0.56 kg a.i. ha^{-1} at 30 DAP	749.43	1498.90	307.37	20.3	10.33	35.0
Post emergence application of Metribuzin 70% WP @ 0.70 kg a.i. ha^{-1} at 30 DAP	685.13	976.47	290.23	15.1	7.66	26.4
Post emergence application of Mesotrione 2.27% + Atrazine 22.7% SC @ 0.875 kg a.i. ha^{-1} at 30 DAP (Pre-mix)	566.67	810.10	133.77	11.5	5.89	19.9
Post emergence application of Ametryne 80% WG @ 2 kg a.i. ha^{-1} at 30 DAP	657.40	960.37	208.47	14.1	6.91	24.1
Post emergence application of 2, 4-D amine salt 58% SL @ 1.4 kg a.i. ha^{-1} + Metribuzin 70% WP @ 0.875 kg a.i. ha^{-1} at 30 DAP (Tank mix)	362.53	509.63	111.63	7.4	3.68	12.5
Weed Free	30.33	58.57	7.97	0.72	0.35	1.21
Weedy Check	956.67	2040.20	373.07	28.4	13.95	46.70
S.Em±	20.92	46.79	10.26	0.61	0.19	1.21
CD @ 5%	64.47	144.2	31.63	1.91	0.60	3.75
General Mean	572.6	979.18	204.64	13.93	6.96	23.68

Table 5: Soil fertility status as influenced by different weed management practices in sugarcane

Treatments	Available nutrient status in the soil (kg ha^{-1})			Organic Carbon (%)
	N	P	K	
Post emergence application of Metribuzin 70% WP @ 0.56 kg a.i. ha^{-1} at 30 DAP	233.0	20.19	330.8	0.55
Post emergence application of Metribuzin 70% WP @ 0.70 kg a.i. ha^{-1} at 30 DAP	237.7	18.60	334.5	0.58
Post emergence application of Mesotrione 2.27% + Atrazine 22.7% SC @ 0.875 kg a.i. ha^{-1} at 30 DAP (Pre-mix)	255.2	21.00	345.1	0.58
Post emergence application of Ametryne 80% WG @ 2 kg a.i. ha^{-1} at 30 DAP	241.5	20.67	339.2	0.58
Post emergence application of 2, 4-D amine salt 58% SL @ 1.4 kg a.i. ha^{-1} + Metribuzin 70% WP @ 0.875 kg a.i. ha^{-1} at 30 DAP (Tank mix)	259.5	22.14	356.8	0.58
Weed Free	262.1	22.26	362.7	0.56
Weedy Check	220.3	19.55	312.1	0.57
S.Em±	8.87	0.78	10.9	0.016
CD @ 5%	NS	NS	NS	NS
General Mean	244.3	20.63	340.18	0.57

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