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Effect of weed management practices on weed indices, growth, yield attributes and quality in *suru* sugarcane

Tulshidas S Kadam, Jayashri P Bholane and Pradnya D Sapkal

Abstract
A field experiment was conducted at Research Farm, Agronomy Section, RCSM College of Agriculture, Kolhapur, Maharashtra (India) during 2022-23 with an objective of studying effect of weed management practices on sugarcane. The experiment was laid out in randomized block design with seven treatments, each of which replicated three times. The statistically analyzed data on given objective reveled that all weed management treatments have shown significant impact on growth and yield attributes of sugarcane over weedy check. Among the herbicidal treatments, Post emergence application (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 days after planting (DAP) recorded significantly lowest weed count, weed index and weed dry weight with maximum weed control efficiency over weedy check treatment. The growth of sugarcane in terms of tillers, plant height, dry weight with highest number of millable canes, number of internodes, and single cane weight, commercial cane sugar yield (CCS) and cane yield (t ha^{-1}) were recorded in treatment 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 (DAP). The quality parameter with respect to brix not affected by any weed management practices.

Keywords: Sugarcane, weed management, 2, 4-D, metribuzin

1. Introduction
Sugarcane (*Saccharum officinarum* L.), belonging to the Poaceae family, is a highly valuable crop with diverse applications. Beyond its primary role in sugar production, it serves as a fundamental raw material for various industries, offering potential for jaggery, ethanol, biodegradable products, and livestock feed (Mishra *et al*, 2021) [8]. Recognized as imperative for socioeconomic betterment of agriculture community (Bee *et al*, 2020) [2]. However, sugarcane faces challenges such as slow initial growth and wider row spacing, creating opportunities for weed proliferation. Weed competition during the critical period of crop-weed interaction, underscores the necessity for effective control measures to prevent maximum yield losses (Patel *et al*, 2006) [10]. Farmers employ mechanical, cultural, and chemical methods to address these challenges, with chemical weed control preferred due to its time efficiency, ease of application, and cost-effectiveness, without affecting sugarcane growth and quality (Raskar, 2004) [13]. In this context, the current study was undertaken to recognizing the influence of weed management practices on sugarcane and on weed.

2. Materials and Methods
An experiment was carried out at Research Farm, Agronomy Section, RCSM College of Agriculture, Kolhapur, Maharashtra (India) during 2022-23. 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 (PoE) 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 dimensions of gross and net plot were 6.00 m x 5.00 m and 4.80 m x 4.00 m respectively. The recommended quantity of fertilizer was applied (250 kg N: 115 kg P_2O_5: 115 kg K_2O ha^{-1}). 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.

3. Results and Discussions

3.1 Weed studies

3.1.1 Weed flora: Weed flora observed in sugarcane during experimentation include *Dinebra retroflexa*, *Brachiaria erusiformis*, *Digitaria sanguinalis*, *Echinochloa colonum*, *Dactylactenium aegyptium* among grasses; *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* among broad leaves weed and *Cyperus iria* among sedges. Similar weed species were observed by Bera and Ghosh, (2013) [3] and Rao and Padal (2015) [12].

3.1.2 Effect of weed management on weed count: Table 1 indicated the periodically observed value on mean total weed count of monocot, dicot and sedges weed at 45, 60, 75 DAP and at earthing up affected by various weed management treatments. Among herbicidal treatments, significantly lowest total count of monocot, dicot and sedges was observed in the treatment 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 DAP. The next best treatment which recorded lowest total weed population was PoE application of Mesotrione 2.27% + Atrazine 22.7% SC @ 0.875 kg a.i. ha^{-1} at 30 DAP. This might be due to broad spectrum effect herbicide belongs to different mode of action effectively suppressed the weed for longer time. Considerably highest total weed population recorded under weedy check. Similar result were also reported by Ghodke *et al*. (2020) [6] and Ombase *et al*. (2019). [9]

Table 1: Density of weed as influence by different weed management practices

Treatments	Total weed count (No m^{-2})			
	45 DAP	60 DAP	75 DAP	Earthing up
Post emergence application of Metribuzin 70% WP @ 0.56 kg a.i. ha^{-1} at 30 DAP	30.67	63.33	84.67	100.00
Post emergence application of Metribuzin 70% WP @ 0.70 kg a.i. ha^{-1} at 30 DAP	30.00	57.00	76.33	95.00
Post emergence application of Mesotrione 2.27% + Atrazine 22.7% SC @ 0.875 kg a.i. ha^{-1} at 30 DAP	21.67	31.33	46.67	63.00
Post emergence application of Ametryne 80% WG @ 2 kg a.i. ha^{-1} at 30 DAP	27.00	39.67	62.00	86.67
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	16.00	23.33	35.33	46.00
Weed Free	4.33	4.33	8.67	7.33
Weedy Check	53.67	84.33	105.00	128.00
S.Em±	0.83	1.72	2.33	2.42
CD @ 5%	2.56	5.31	7.19	7.46
General Mean	26.19	43.33	59.81	74.38

DAP: Days after planting

3.1.3 Effect on weed management on weed dry weight

By examining data of Table 2 evident that within herbicidal treatments, 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 DAP outperformed other herbicide treatments by recording significantly the lowest total weed dry matter of monocot, dicot and sedges and this difference was statistically significant. This might be due to reducing weed biomass for longer by combined effect of broad-spectrum herbicide 2, 4-D amine salt responsible for brust cell wall of weeds by uncontrolled growth due to mimicking natural plant growth harmone (specifically, indole acetic acid) and metribuzin responsible for inhibiting photosynthesis by blocking of electron transfer in photosystem II. The next best treatment which recorded lowest total weed dry matter was PoE application of Mesotrione 2.27% + Atrazine 22.7% SC @ 0.875 kg a.i. ha^{-1} at 30 DAP. At every observation stage, the weedy check plot exhibited the highest total weed dry matter, this might be due to uncontrolled weed growth. Similar result also reported by Pratap *et al*. (2013) [11], Shyam and Singh (2015) [14] and Ombase *et al*. (2019) [9].

Table 2: Dry matter of weed as influence by different weed management practices

Treatments	Total dry matter of weeds (g m^{-2})			
	45 DAP	60 DAP	75 DAP	Earthing up
Post emergence application of Metribuzin 70% WP @ 0.56 kg a.i. ha^{-1} at 30 DAP	57.18	84.86	139.61	255.57
Post emergence application of Metribuzin 70% WP @ 0.70 kg a.i. ha^{-1} at 30 DAP	52.07	71.91	138.48	195.18
Post emergence application of Mesotrione 2.27% + Atrazine 22.7% SC @ 0.875 kg a.i. ha^{-1} at 30 DAP	27.25	56.14	114.37	151.05
Post emergence application of Ametryne 80% WG @ 2 kg a.i. ha^{-1} at 30 DAP	37.41	57.29	126.88	182.62
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	14.34	23.84	59.62	98.38
Weed Free (hand weeding at 30, 60. 90 DAP)	2.17	4.30	15.53	9.69
Weedy Check	79.64	158.09	243.85	336.99
S.Em±	1.84	1.72	5.49	5.39
CD @ 5%	5.68	5.33	16.92	16.63
General Mean	38.58	65.2	119.8	175.64

3.1.4 Effect on weed control efficiency

Data presented in Table 3 revealed that the periodical weed control efficiency of different treatments recorded at 45, 60, 75 DAP and at earthing showed significant variation. Among the herbicidal treatments, 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 DAP showed highest weed control efficiency. The increased weed control effectiveness in these treatments might be due to synergistic impact of herbicide combinations on suppressing all weed populations. These result are consistent with findings of Ghodke *et al*. (2020) [6].

3.1.5 Effect on weed index

Observations on weed index at harvest are recorded and presented in Table 3 revealed that significant variation regarding weed index were observed among different weed management practices. Superiority over the weedy condition in relation to the weed index was exhibited by all weed control treatments. Among the herbicidal treatments lowest (6.83%) weed index was recorded under treatment PoE 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 which was at par with treatment Mesotrione 2.27% + Atrazine 22.7% SC @ 0.875 kg a.i. ha^{-1} at 30 DAP. This might be due to the excellent weed control provided by these treatments, which results in more efficient use of available resources *viz*. moisture, light, nutrient etc. in balanced proportion by reducing unnecessary competition, resulting in greater yields in these treatments when compared with the rest of the treatments. Similar result were reported by Singh and Kaur (2003) [15] and Choudhary and Singh (2015) [4].

Table 3: Weed control efficiency and weed index influenced by weed management practices

Treatments	Weed control efficiency (%)				Weed index (%)
	45 DAP	60 DAP	75 DAP	Earthing up	
Post emergence application of Metribuzin 70% WP @ 0.56 kg a.i. ha^{-1} at 30 DAP	28.06	28.89	42.59	24.08	28.64
Post emergence application of Metribuzin 70% WP @ 0.70 kg a.i. ha^{-1} at 30 DAP	34.61	60.75	43.09	42.08	26.52
Post emergence application of Mesotrione 2.27% + Atrazine 22.7% SC @ 0.875 kg a.i. ha^{-1} at 30 DAP	65.74	68.95	52.87	55.18	9.68
Post emergence application of Ametryne 80% WG @ 2 kg a.i. ha^{-1} at 30 DAP	53.00	63.24	47.80	45.79	14.32
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	81.99	81.57	75.65	70.80	6.83
Weed Free (hand weeding at 30, 60, 90 DAP)	97.28	97.71	93.56	97.12	-
Weedy Check	-	-	-	-	57.20
S.Em±	2.32	1.71	1.97	1.65	1.92
CD @ 5%	7.16	5.26	6.07	5.08	5.92
General Mean	51.52	57.30	50.79	47.86	20.45

3.2 Effect on growth parameter

The data presented in Table 3 indicated that among the germination percentage of sugarcane was not affected significantly by different weed management treatments. Among the herbicidal treatments, highest number of functional leaves, highest plant height and leaf area index recorded in treatment PoE 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 and which was comparable to remaining treatment except weedy check. Regarding dry matter accumulation in sugarcane, treatment PoE 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 recorded highest dry matter accumulation 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 were on par with it. These result are consistent with findings of Dhankar (2019) [5], Banerjee *et al*. (2014) [1] and Zafar *et al*. (2010) [17].

3.3 Effect on yield attributes and yield

The data presented in Table 4 indicated 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, single cane weight and number of millable cane and found to be at par with 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. Regarding observation on number of tillers and number of internodes recorded highest in treatment 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 DAP and treatment Mesotrione 2.27% + Atrazine 22.7% SC @ 0.875 kg a.i. ha^{-1} at 30 DAP on par with it. As regard to commercial cane sugar yield (t ha^{-1}) and cane yield (t ha^{-1}), by implementing distinct weed management strategies, there was a significant increase in cane yield when compared to a sugarcane crop that had been affected by weed infestation in the weedy check during the entire growing season. Among the herbicidal treatments, highest CCS yield (t ha^{-1}) and cane yield (t ha^{-1}) were recorded 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 and it was found to be comparable with PoE application of Mesotrione 2.27% + Atrazine 22.7% SC @ 0.875 kg a.i. ha^{-1} at 30 DAP. These result are consistent with findings of Ghodke *et al*. (2020) [6].

3.4 Effect on quality of sugarcane

Data presented regarding brix (o^0) in Table 5 showed that weedy check and other weed control treatment did not showed significant variation. This might be due to quality is likely determined by factors other than weed control, such as enzymes and nutritional aspects. This implies that the quality of sugarcane is not directly related to the effectiveness of weed control measures. Similar result were obtained on sugarcane quality parameter by Waghmare *et al*. (2018) [16], and Lokhande *et al*. (2018) [7] Ombase *et al*. (2019) [9].

Table 4: Germination percentage, tillers count plant height, functional leaves, leaf area index and dry weight of sugarcane influenced by weed management practices.

Treatments	Germination (%) at 45 DAP	Functional leaves (No. plant^{-1})	Leaf area index	Tillers count at 180 DAP (x10^3 ha^{-1})	Plant height (cm)	Dry weight (g plant^{-1})
Post emergence application of Metribuzin 70% WP @ 0.56 kg a.i. ha^{-1} at 30 DAP	81.46	13.20	3.87	79.34	439.47	275.25
Post emergence application of Metribuzin 70% WP @ 0.70 kg a.i. ha^{-1} at 30 DAP	83.33	13.27	3.98	80.90	446.03	342.62
Post emergence application of Mesotrione 2.27% + Atrazine 22.7% SC @ 0.875 kg a.i. ha^{-1} at 30 DAP	83.33	13.40	4.00	94.96	468.36	380.42
Post emergence application of Ametryne 80% WG @ 2 kg a.i. ha^{-1} at 30 DAP	81.44	13.33	3.90	88.19	446.83	369.42
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	83.33	13.67	4.06	98.26	471.60	394.37
Weed Free	85.17	14.53	4.19	101.21	474.98	406.34
Weedy Check	81.44	9.20	2.66	74.48	364.07	232.87
S.Em±	3.31	0.45	0.11	2.93	13.07	12.29
CD @ 5%	NS	1.41	0.35	9.03	40.27	37.88
General Mean	82.78	12.94	3.8	88.19	444.48	343.04

Table 5: Quality, yield attribute and yield of sugarcane as influenced by different weed management practices

Treatments	Brix (0^0)	Internodes (No. plant^{-1})	Single cane weight (kg plant^{-1})	Millable cane (x 10^3 ha^{-1})	CCS (t ha^{-1})	Cane yield (t ha^{-1})
Post emergence application of Metribuzin 70% WP @ 0.56 kg a.i. ha^{-1} at 30 DAP	17.65	22.27	1.70	68.33	11.94	103.05
Post emergence application of Metribuzin 70% WP @ 0.70 kg a.i. ha^{-1} at 30 DAP	18.15	22.20	1.73	69.99	12.10	106.23
Post emergence application of Mesotrione 2.27% + Atrazine 22.7% SC @ 0.875 kg a.i. ha^{-1} at 30 DAP	18.27	24.93	1.81	81.66	15.14	130.52
Post emergence application of Ametryne 80% WG @ 2 kg a.i. ha^{-1} at 30 DAP	18.32	22.40	1.80	74.99	14.35	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	18.65	25.07	1.84	83.33	15.58	134.78
Weed Free	18.73	25.67	1.86	86.66	16.89	144.50
Weedy Check	17.58	19.80	1.33	54.99	6.87	61.87
S.Em±	0.52	0.71	0.02	3.36	0.45	2.86
CD @ 5%	NS	2.19	0.07	11.26	1.42	8.82
General Mean	18.93	23.19	1.72	74.27	13.26	114.97

4. Conclusion

The experiment conclude that the among the herbicidal treatment, 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} responsible for maximum reduction of weed density and weed dry weight with highest weed control efficiency and minimum weed index. The highest growth, yield attributes, and yield (134.78 t ha^{-1}) without affecting the quality of the *suru* sugarcane also recorded in the same treatment.

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