E-ISSN: 2618-0618
P-ISSN: 2618-060X

NAAS Rating (2025): 5.20
www.agronomyjournals.com
2025; 8(10): 117-122
Received: 27-07-2025
Accepted: 05-09-2025

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Performance of herbicidal combinations for weed and nutrient studies in sugarcane (*Saccharum officinarum* L.)

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DOI: https://www.doi.org/10.33545/2618060X.2025.v8.i10b.3962

Abstract
Weeds and cultivated plants vie for growth, yet the most detrimental phase for crops occurs during the essential timeframe of competition between weeds and crops, specifically in sugarcane from 30 to 90 days. Cultural approaches to managing weeds are very successful; however, challenges arise due to the restricted access to farming labour during important weeding times and the high costs associated with hiring workers. As a result, chemical methods for weed control are gaining increased acceptance. A field experiment was conducted during the *Suru* season of 2024 at the Research Farm, Regional Sugarcane and Jaggery Research Station, Shiroli (*Pulachi*), Kolhapur, Maharashtra to evaluate the efficacy of novel herbicidal combinations for effective weed control in sugarcane (*Saccharum officinarum* L.) and their impact on nutrient uptake and soil fertility under sub-montane conditions. The study focused on the performance of different weed management practices against prevalent weed flora comprising *Dinebra retroflexa*, *Brachiaria eruciformis*, *Echinochloa colona* (grasses); *Amaranthus viridis*, *Parthenium hysterophorus*, *Ipomoea* spp., *Portulaca oleracea* (broad-leaved weeds); and *Cyperus rotundus* L. (sedge).
The results indicated that nutrient concentrations (N, P, and K) in both sugarcane and weed biomass did not differ significantly across treatments. However, the total nutrient uptake by sugarcane was highest under the weed-free treatment, reflecting improved growth and nutrient assimilation compared to the weedy check. Among herbicidal treatments, the post-emergence application of 2,4-D sodium salt + metribuzin + Pyrazosulfuron ethyl (ready mix) @ 3.0 kg a.i. ha^{-1} at the 2-4 leaf stage of weeds followed by earthing-up at 120 days after planting (DAP) (T_3) recorded the lowest nutrient depletion by weeds. This was closely followed by the pre-emergence application of clomazone (30% WP) + sulfentrazone (28% WP) @ 2.5 kg a.i. ha^{-1}, supplemented by one inter-cultivation operation at 60 DAP (T_2). Treatment T_3 proved most effective in optimizing nutrient use efficiency and minimizing competition from weed flora, thereby supporting better crop growth and sustaining soil fertility.

Keywords: Sugarcane, herbicide combinations, nutrient uptake, weed control, soil fertility, sub-montane zone, 2,4-D sodium salt, metribuzin, pyrazosulfuron ethyl

Introduction
Sugarcane (*Saccharum officinarum* L.) is a versatile and economically vital crop with the remarkable ability to adapt to a wide range of agro-climatic conditions. This adaptability makes it a reliable income-generating crop for farmers even under sub-optimal or stress-prone environments. Beyond its primary role in sugar production, sugarcane serves as a critical raw material for a range of industries including jaggery manufacturing, bioethanol production, biodegradable products, and livestock feed, enhancing its value in a circular bioeconomy (Mishra *et al*., 2021) [9]. In India, sugarcane cultivation supports the livelihood of approximately 50 million farmers and their dependents, while the sugar industry and its allied sectors employ around 0.6 million skilled and unskilled workers. The sector plays a key role in rural development by mobilizing local resources, creating employment opportunities, and boosting farm income (Solomon, 2016) [19]. Despite its economic potential, sugarcane productivity is severely constrained by weed infestation, particularly during the early stages of crop growth. The crop typically takes 3-5 weeks to germinate, during which the inter-row spacing and slow initial growth provide a competitive advantage to weeds. Weeds compete directly with the crop

for essential resources such as nutrients, moisture, light, and space, and can significantly suppress crop growth and yield. The critical period of crop-weed competition in sugarcane is reported to range from 30 to 90 days after planting (DAP), during which effective weed control is crucial to avoid substantial productivity losses (Patel *et al*., 2006) [12]. Weeds are considered the single largest biotic constraint to global agricultural production, contributing to an estimated 34% of total potential yield losses, compared to 18% and 16% attributed to pests and diseases, respectively (Oerke, 2006) [11]. In sugarcane, weed-induced yield losses have been reported to range from 12% to as high as 72%, depending on the intensity of infestation and the timeliness of control measures (Rathika *et al*., 2023) [15]. Therefore, a comprehensive understanding of weed species composition, critical periods of interference, and the effectiveness of various weed management practices is essential for optimizing sugarcane productivity and sustaining soil health. (Suganthi *et al*., 2019) [20]

Materials and Methods

Experimental site: A field experiment was carried out during the *Suru* season of 2024-25 at the Research Farm, Regional Sugarcane and Jaggery Research Station, Shiroli (*Pulachi)*, Kolhapur, Maharashtra, located in the sub-montane zone. The climatic conditions during the cropping season were generally favourable for sugarcane growth. The region received a total rainfall of 1486.1 mm distributed over 89 rainy days. The minimum temperature ranged between 11.9 °C and 23.0 °C, while the maximum temperature varied from 25.4 °C to 39.3 °C.

Soil charterers: The experimental field soil was classified as silty loam in texture, exhibiting low available nitrogen (281.76 kg ha^{-1}), medium available phosphorus (19.85 kg ha^{-1}), and high available potassium content (317.48 kg ha^{-1}) along with 0.83% organic carbon.

Experimental set-up: The experiment was laid out in a Randomized Block Design (RBD) comprising nine treatments, each replicated three times. The treatment details are as follows:

- T_1: Pre-emergence (PE) application of Clomazone 22.5% WP + Metribuzin 21% WP (ready mix) @ 2.5 kg a.i. ha^{-1} followed by one inter-cultivation at 60 days after planting (DAP) (partial earthing up)
- T_2: PE application of Clomazone 30% WP + Sulfentrazone 28% WP (ready mix) @ 2.5 kg a.i. ha^{-1} followed by one inter-cultivation at 60 DAP
- T_3: Post-emergence (PoE) application of 2,4-D sodium salt + Metribuzin + Pyrazosulfuron ethyl (ready mix) @ 3.0 kg a.i. ha^{-1} at 2-4 leaf stage of weeds followed by earthing up at 120 DAP
- T_4: PoE application of Halosulfuron methyl + Metribuzin (ready mix) @ 1.0 L a.i. ha^{-1} at 2-4 leaf stage followed by earthing up at 120 DAP
- T_5: PoE application of Topramezone + Atrazine (ready mix) @ 3.0 L a.i. ha^{-1} at 2-4 leaf stage followed by earthing up at 120 DAP
- T_6: PE application of Atrazine 80% WP @ 2.5 kg a.i. ha^{-1} followed by one inter-cultivation at 60 DAP
- T_7: PoE application of 2,4-D sodium salt (WP) @ 2.5 kg a.i. ha^{-1} at 2- 4 leaf stage followed by earthing up at 120 DAP
- T_8: Weed free check
- T_9: Weedy check

Healthy two-budded sets of sugarcane variety Co 86032 were planted using the ridge-and-furrow method in the first week of January, maintaining a row spacing of 150 cm. A total of 25,000 setts per hectare were planted. Each gross plot measured 9.00 m × 9.00 m, while the net plot area was 6.00 m × 6.00 m.

Recommended fertilizer doses were applied at 250 kg N, 115 kg P_2O_5, and 115 kg K_2O per hectare using urea, single super phosphate, and muriate of potash, respectively. Herbicidal treatments were applied as aqueous solutions at a spray volume of 750 L ha^{-1} for PE and 550 L ha^{-1} for PoE applications using a knapsack sprayer fitted with a flat fan nozzle. All plots, except the weedy check, received earthing up during the second fortnight of May.

Observation to be recorded: Nutrient analysis for nitrogen (N), phosphorus (P), and potassium (K) content was performed on weed biomass at earthing-up stage and sugarcane biomass at harvest. Nitrogen content was estimated using the micro-Kjeldahl method, phosphorus by the vanado-molybdate phosphoric yellow colorimetric method at 430 nm using a spectrophotometer, and potassium using flame emission photometry, as described by Jackson (1967) [3]. Analysis of soil sample separately for each treatment were done separately after harvesting of sugarcane for nitrogen, phosphorus and potassium by adopting Alkaline $KMnO_4$ method (Subbiah and Asija, 1956), Olsen's method (Olsen, 1954), Flame photometer method (Jackson, 1973) [4].

Results and Discussion

Weed Flora: Weed dynamics is the changes in weed species composition, density and behaviour over time are critically important in the context of sugarcane weed management treatments. For understanding and managing weed dynamics their impacts and the effectiveness of weed control strategies and ultimately resulting in the sugarcane productivity.

The predominant weed species observed in the experimental field encompassed a diverse spectrum of weed types presented in Table No.1. Among the grassy weeds, *Dinebra retroflexa*, *Brachiaria eruciformis*, *Echinochloa colona*, and *Dactyloctenium aegyptium* were dominant. Broad-leaved weeds included *Ageratum conyzoides*, *Parthenium hysterophorus*, *Amaranthus viridis*, *Amaranthus spinosus*, *Phyllanthus niruri*, *Euphorbia hypericifolia*, *Commelina benghalensis*, *Corchorus acutangulus*, *Ipomoea spp.*, *Portulaca oleracea*, and *Physalis minima*. The prominent sedge species identified was *Cyperus rotundus* L. The weed flora observed during the study is in agreement with the findings of Bera and Ghosh (2013) [1], Pratap *et al*., (2013) [13], Suganthi, *et al*., (2017) [21], Ramesha *et al*., (2018) [14] who reported similar weed spectra in sugarcane fields under sub-tropical conditions.

Weed count: Data presented in Table 2 indicated that the post-emergence (PoE) application of 2,4-D sodium salt + metribuzin + Pyrazosulfuron ethyl (ready-mix) at 3.0 kg a.i. ha^{-1} applied at the 2-4 leaf stage of weeds and followed by earthing-up at 120 DAP (Treatment T_3), recorded the lowest weed density at 120 DAP. This treatment significantly suppressed the population of grasses, broad-leaved weeds, and sedges compared to other treatments, highlighting the superior efficacy of this herbicidal combination in early and sustained weed control. This change might be due to at 120 DAP, Ipomoea (a vigorous broadleaf weed) dominates in all plots and Ipomoea is a deep-rooted, late-emerging, fast-growing weed, its seed germinate over a long period, post-emergence herbicides could be applied around crops as they are effective against to control weeds based on foliage contact or translocation, so even late-season flushes like Ipomoea can be managed. In treatment T_3 contain of 2,4-D sodium salt, Metribuzine, Pyrazosulfuron ethyl are systemic and work well against *Ipomoea spp*. Kathiresan *et al*., (2004) [7], Sarala *et al*., (2011) [16] Chand *et al*., (2014) [2] Singh and Kumar (2013) [17].

Nutrient content in sugarcane: Data on nutrient content and uptake in sugarcane are presented in Table 3. Statistical analysis revealed that nutrient concentrations of nitrogen (N), phosphorus (P), and potassium (K) in sugarcane were not significantly influenced by different weed management practices. However, among the herbicidal treatments, T_3- PoE application of 2,4-D sodium salt + Metribuzine + Pyrazosulfuron ethyl (ready mix) @ 3 kg a.i. ha^{-1} at 2-4 leaf stage of weeds *fb* earthing up at 120 DAP recorded numerically higher values of nutrient content in sugarcane. This could be linked to improved physiological efficiency of the crop, resulting from better light interception and root development under weed-free conditions.

Nutrient Uptake by Sugarcane: Data presented in Table 3 revealed that nutrient uptake (kg ha^{-1}) by sugarcane was significantly influenced by weed management treatments. Efficient nutrient uptake is the keystone of a productive and profitable sugarcane cultivation. It directly impacts every aspect of the crop, from initial establishment and growth to final yield and sugar recovery, ultimately determining the economic viability for the farmer. Among the treatments, the highest uptake of nitrogen (N), phosphorus (P), and potassium (K) was recorded in T_3- PoE application of 2,4-D sodium salt + Metribuzine + Pyrazosulfuron ethyl (ready mix) @ 3 kg a.i. ha^{-1} at 2-4 leaf stage of weeds *fb* earthing up at 120 DAP with corresponding uptake values of 325.0 kg N ha^{-1}, 71.7 kg P ha^{-1}, and 376.0 kg K ha^{-1}, respectively. This was closely followed by T_2- pre-emergence (PE) application of clomazone 30% WP + sulfentrazone 28% WP (ready mix) @ 2.5 kg a.i. ha^{-1} followed by one inter-cultivation at 60 DAP which recorded uptake values of 298.0 kg N ha^{-1}, 66.2 kg P ha^{-1}, and 348.0 kg K ha^{-1}. The enhanced nutrient uptake in these treatments may be attributed to improved weed suppression, which reduced competition for nutrients and allowed for greater dry matter accumulation and nutrient translocation within the crop. These findings are consistent with those of Kumar *et al*., (2021), Kadam *et al*., (2023) [8] who also reported increased nutrient uptake under efficient herbicidal weed control regimes in sugarcane.

Nutrient content in weed: Data presented in Table 4 revealed Nutrient content (%) in grassy weeds, broad-leaved weeds, and sedges under various treatments is presented in Table 3. The results indicated non-significant differences across treatments; however, numerical variations were noted. The lowest nutrient content in weeds was observed in T_3- PoE application of 2,4-D sodium salt + Metribuzine + Pyrazosulfuron ethyl (ready mix) @ 3 kg a.i. ha^{-1} at 2-4 leaf stage of weeds *fb* earthing up at 120 DAP, suggesting effective nutrient suppression through competitive exclusion and herbicidal efficacy. In contrast, the highest nutrient content in weed biomass was recorded under, T_5- PoE application of Topramezone + Atrazine (ready mix) @ 3 L a.i. ha^{-1} at 2-4 leaf stage of weeds *fb* earthing up at 120 DAP, possibly due to lower weed suppression efficacy against certain species. It is pertinent to note that the content of the nutrients is an inherited character and is not affected due to use of herbicides and managemental aspects.

These observations align with previous reports by Kadam *et al*., (2023) [8] Jangir *et al*. (2018) [5] in mustard and Nazir *et al*., (2021) [10] in rice, who also found that integrated and selective herbicide applications significantly influenced nutrient accumulation patterns in weeds and crop plants.

Nutrient Removal by Weeds: Data on weed nutrient removal are presented in Table 4. The results demonstrated that nutrient uptake by weeds varied significantly across weed management treatments. The weedy check (T_9) recorded the highest weed nutrient removal, with uptake values of 58.8 kg N ha^{-1}, 19.4 kg P ha^{-1}, and 65.0 kg K ha^{-1} this due to higher weed density, higher dry matter accumulation by weeds.

Among the herbicidal treatments, the lowest nutrient removal by weeds were noted in PoE application of 2,4-D sodium salt + Metribuzine + Pyrazosulfuron ethyl (ready mix) @ 3 kg a.i. ha^{-1} at 2-4 leaf stage of weeds fb earthing up at 120 DAP (T_3- 14.0, 5.4, 19.0 N, P, K Kg ha^{-1} respectively). The reduction in weed nutrient uptake in this treatment may be attributed to the broad-spectrum activity of the herbicide mixture, which effectively suppressed both grassy and broad-leaved weeds. These results are in close agreement with the findings of Kalaiyarasi (2012) [6], Kadam *et al*., (2023) [8] who reported similar reductions nutrient drain in weed-managed systems.

Soil Fertility: Data on soil nutrient availability post-harvest are presented in Table 5. The results indicated that weed management treatments did not result in statistically significant differences in soil nutrient availability. However, numerical differences were observed. The overall mean available nutrient values across treatments were 274.3 kg N ha^{-1}, 27.67 kg P ha^{-1}, and 361.6 kg K ha^{-1}.

Among the treatments, the highest values were recorded in T_3-PoE application of 2,4-D sodium salt + Metribuzine + Pyrazosulfuron ethyl (ready mix) @ 3 kg a.i. ha^{-1} at 2-4 leaf stage of weeds fb earthing up at 120 DAP which maintained 288.0 kg N ha^{-1}, 28.4 kg P ha^{-1}, and 368.0 kg K ha^{-1}. The preservation of soil fertility in this treatment can be attributed to reduced nutrient losses due to effective weed suppression, leading to lower weed nutrient uptake and greater conservation of soil nutrients for crop utilization.

Table 1: Weed flora observed in the experimental field

Sr. No.	Botanical name	Local name	Family
Grasses			
1	*Dinebra retroflexa*	Lona	*Poaceae*
2	*Brachiaria erusiformis*	Shippi	*Poaceae*
3	*Echinochloa colonum*	Pakhad	*Poaceae*
4	*Dactylactenium aegyptium*	Crowfoot grass	*Poaceae*
Broad leaved weed			
1	*Ageratum conyzoides*	Osadi	*Asteraceae*
2	*Parthenium hysterophorus*	Gajar gavat	*Asteraceae*
3	*Amaranthus viridis*	Math	*Amaranthaceae*
4	*Amaranthus spinosus*	Katemath	*Amaranthaceae*
5	*Phyllanthus niruri*	Hajardani	*Euphorbiaceae*
6	*Euphorbia hypericifolia*	Dudhani (medium)	*Euphorbiaceae*
7	*Commelina benghalensis*	Kena	*Commelinaceae*
8	*Corchorus acutangulus*	Kduchinch	*Tilliaceae*
9	*Ipomoea spp.*	Khandkhuli	*Convolvulaceae*
10	*Portulaca oleracea*	Common purslane	*Portulacaceae*
11	*Physalis minima*	Ran popati	*Solan*aceae
Sedges			
1	*Cyperus rotundas* L.	Lavala	*Cyperaceae*

Table 2: Weed count (No m^{-2}) as affected by different weed management practices in sugarcane

Treatments		Weed count (No. m^{-2}) 120 DAP			
		Grasses	BLW	Sedges	Total
T_1	PE application of Clomazone (22.5% WP) + Metribuzine (21% WP) (ready mix) @ 2.5 kg a.i. ha^{-1} *fb* one inter-cultivation at 60 DAP (partial earthing up)	5.67 (2.48)	12.33 (3.58)	5.33 (2.41)	23.33 (4.88)
T_2	PE application of Clomazone (30%WP) + Sulfentrazone (28% WP) (ready mix) @ 2.5 kg a.i. ha^{-1} *fb* one inter-cultivation at 60 DAP (partial earthing up)	4.33 (2.20)	11.67 (3.48)	3.33 (1.95)	19.33 (4.45)
T_3	PoE application of 2,4-D sodium salt + Metribuzine + Pyrazosulfuron ethyl (ready mix) @ 3 kg a.i. ha^{-1} at 2-4 leaf stage of weeds *fb* earthing up at 120 DAP	3.67 (2.04)	9.67 (3.19)	2.67 (1.76)	16.00 (4.06)
T_4	PoE application of Halosulfuron methyl + Metribuzine (ready mix) @ 1 L a.i. ha^{-1} at 2- 4 leaf stage of weeds *fb* earthing up at 120 DAP	6.33 (2.61)	14.33 (3.84)	6.33 (2.61)	27.00 (5.24)
T_5	PoE application of Topramezone +Atrazine (ready mix) @ 3 L a.i. ha^{-1} at 2-4 leaf stage of weeds *fb* earthing up at 120 DAP	9.33 (3.13)	23.33 (4.88)	8.00 (2.91)	40.67 (6.42)
T_6	PE emergence application of Atrazine (80%WP) @ 2.5 kg a.i. ha^{-1} *fb* one inter-cultivation at 60 DAP (partial earthing up)	6.67 (2.67)	16.67 (4.14)	7.00 (2.73)	30.33 (5.55)
T_7	PoE application of 2,4-D sodium salt (WP) @ 2.5 kg a.i. ha^{-1} at 2-4 leaf stage of weeds *fb* earthing up at 120 DAP	8.33 (2.97)	20.67 (4.60)	7.67 (2.86)	36.67 (6.10)
T_8	Weed Free Check	0.67 (1.05)	0.67 (1.05)	1.00 (1.22)	2.33 (1.68)
T_9	Weedy Check	10.67 (3.34)	26.67 (5.21)	10.67 (3.34)	48.00 (6.96)
S.Em±		0.44	0.88	0.45	1.20
CD @ 5%		1.35	2.64	1.35	3.60
General Mean		6.18	15.11	5.77	27.07

*Figure in the parenthesis (____) are square root transformation values

Table 3: Nutrient uptake studies of sugarcane as influenced by different weed management practices in sugarcane

Treatments		Nutrient content (%)			Uptake of nutrient (kg ha^{-1})		
		N	P	K	N	P	K
T_1	PE application of Clomazone (22.5% WP) + Metribuzine (21% WP) (ready mix) @ 2.5 kg a.i. ha^{-1} *fb* one inter-cultivation at 60 DAP (partial earthing up)	1.24	0.28	1.45	275	62.9	329
T_2	PE application of Clomazone (30%WP) + Sulfentrazone (28% WP) (ready mix) @ 2.5 kg a.i. ha^{-1} *fb* one inter-cultivation at 60 DAP (partial earthing up)	1.26	0.28	1.48	298	66.2	348
T_3	PoE application of 2,4-D sodium salt + Metribuzine + Pyrazosulfuron ethyl (ready mix) @ 3 kg a.i. ha^{-1} at 2-4 leaf stage of weeds *fb* earthing up at 120 DAP	1.31	0.29	1.51	325	71.7	376
T_4	PoE application of Halosulfuron methyl + Metribuzine (ready mix) @ 1 L a.i. ha^{-1} at 2-4 leaf stage of weeds *fb* earthing up at 120 DAP	1.21	0.27	1.44	246	60.3	316
T_5	PoE application of Topramezone +Atrazine (ready mix) @ 3 L a.i. ha^{-1} at 2-4 leaf stage of weeds *fb* earthing up at 120 DAP	1.15	0.27	1.39	219	57.5	298
T_6	PE emergence application of Atrazine (80%WP) @ 2.5 kg a.i. ha^{-1} *fb* one inter-cultivation at 60 DAP (partial earthing up)	1.19	0.27	1.43	243	59.1	312
T_7	PoE application of 2,4-D sodium salt (WP) @ 2.5 kg a.i. ha^{-1} at 2-4 leaf stage of weeds *fb* earthing up at 120 DAP	1.18	0.27	1.42	233	58.6	306
T_8	Weed Free Check	1.32	0.30	1.53	365	80.6	407
T_9	Weedy Check	1.15	0.26	1.36	170	43.9	226
S.Em±		0.03	0.01	0.03	22.79	2.85	14.94
CD @ 5%		NS	NS	NS	68.35	8.57	44.81
General Mean		1.22	0.27	1.44	263.9	62.31	324.1

Table 4: Nutrient uptake studies of weeds as influenced by different weed management practices in sugarcane

Treatments		Nutrient content (%)			Uptake of nutrient (kg ha^{-1})		
		N	P	K	N	P	K
T_1	PE application of Clomazone (22.5% WP) + Metribuzine (21% WP) (ready mix) @ 2.5 kg a.i. ha^{-1} *fb* one inter-cultivation at 60 DAP (partial earthing up)	1.63	0.61	2.11	16.9	6.3	22.0
T_2	PE application of Clomazone (30%WP) + Sulfentrazone (28% WP) (ready mix) @ 2.5 kg a.i. ha^{-1} *fb* one inter-cultivation at 60 DAP (partial earthing up)	1.54	0.60	2.08	15.1	5.9	20.6
T_3	PoE application of 2,4-D sodium salt + Metribuzine + Pyrazosulfuron ethyl (ready mix) @ 3 kg a.i. ha^{-1} at 2-4 leaf stage of weeds *fb* earthing up at 120 DAP	1.49	0.58	2.06	14.0	5.4	19.0
T_4	PoE application of Halosulfuron methyl + Metribuzine (ready mix) @ 1 L a.i. ha^{-1} at 2- 4 leaf stage of weeds *fb* earthing up at 120 DAP	1.63	0.61	2.13	20.1	7.5	26.1
T_5	PoE application of Topramezone +Atrazine (ready mix) @ 3 L a.i. ha^{-1} at 2-4 leaf stage of weeds *fb* earthing up at 120 DAP	1.82	0.62	2.16	30.2	10.3	35.6
T_6	PE emergence application of Atrazine (80%WP) @ 2.5 kg a.i. ha^{-1} *fb* one inter-cultivation at 60 DAP (partial earthing up)	1.68	0.62	2.14	21.9	8.0	27.8
T_7	PoE application of 2,4-D sodium salt (WP) @ 2.5 kg a.i. ha^{-1} at 2-4 leaf stage of weeds *fb* earthing up at 120 DAP	1.77	0.62	2.15	27.9	9.8	33.9
T_8	Weed Free Check	1.35	0.58	2.04	0.5	0.2	0.8
T_9	Weedy Check	1.96	0.65	2.17	58.8	19.4	65.0
S.Em±		0.12	0.01	0.02	1.90	0.60	1.40
CD @ 5%		NS	NS	NS	5.70	1.81	4.22
General Mean		1.65	0.60	2.11	22.82	8.08	27.86

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	
T_1	PE application of Clomazone (22.5% WP) + Metribuzine (21% WP) (ready mix) @ 2.5 kg a.i. ha^{-1} *fb* one inter-cultivation at 60 DAP (partial earthing up)	278	28.0	364	0.76
T_2	PE application of Clomazone (30%WP) + Sulfentrazone (28% WP) (ready mix) @ 2.5 kg a.i. ha^{-1} *fb* one inter-cultivation at 60 DAP (partial earthing up)	280	28.1	364	0.77
T_3	PoE application of 2,4-D sodium salt + Metribuzine + Pyrazosulfuron ethyl (ready mix) @ 3 kg a.i. ha^{-1} at 2-4 leaf stage of weeds *fb* earthing up at 120 DAP	288	28.4	368	0.78
T_4	PoE application of Halosulfuron methyl + Metribuzine (ready mix) @ 1 L a.i. ha^{-1} at 2-4 leaf stage of weeds *fb* earthing up at 120 DAP	276	27.6	362	0.78
T_5	PoE application of Topramezone +Atrazine (ready mix) @ 3 L a.i. ha^{-1} at 2-4 leaf stage of weeds *fb* earthing up at 120 DAP	264	27.0	353	0.75
T_6	PE emergence application of Atrazine (80%WP) @ 2.5 kg a.i. ha^{-1} *fb* one inter-cultivation at 60 DAP (partial earthing up)	271	27.3	360	0.78
T_7	PoE application of 2,4-D sodium salt (WP) @ 2.5 kg a.i. ha^{-1} at 2-4 leaf stage of weeds *fb* earthing up at 120 DAP	265	27.2	357	0.76
T_8	Weed Free Check	293	28.6	378	0.77
T_9	Weedy Check	254	26.8	348	0.78
S.Em±		7.76	0.39	5.48	0.01
CD @ 5%		NS	NS	NS	NS
General Mean		274.3	27.67	361.6	0.77

Conclusion
Based on the findings of the field experiment, it can be concluded that among the various herbicidal treatments evaluated, the post-emergence application of 2,4-D sodium salt + Metribuzine + Pyrazosulfuron ethyl (ready mix) @ 3 kg a.i. ha^{-1} at 2-4 leaf stage of weeds fb earthing up at 120 DAP proved to be the most effective. This treatment resulted in the lowest weed count at 120 DAP and highest nutrient uptake by sugarcane and the lowest nutrient depletion by weeds, indicating efficient nutrient utilization and effective weed suppression. However, the nutrient concentrations in both sugarcane and weed biomass were not significantly influenced by the different weed management practices.

Similarly, no significant variation in soil nutrient status or organic carbon content was observed among the treatments at harvest, suggesting that the applied herbicide treatments did not adversely affect soil fertility. The integration of this herbicidal combination with timely cultural practices presents a viable and effective strategy for sustainable weed management in *suru* sugarcane cultivation.

Acknowledgment
The present study was supported by AICRP on Sugarcane, Kolhapur Centre, Regional Sugarcane and Jaggery Research Station, Kolhapur and Agronomy Section, Rajarshee Chhatrapati Shahu Maharaj College of Agriculture, Kolhapur under the jurisdiction of Mahatma Phule Krishi Vidyapeeth, Rahuri, Ahilyanagar, India.

Disclaimers
All opinions and conclusions in this article are those of the authors and do not necessarily reflect the views of their institutions. The authors are solely responsible for the accuracy and completeness of the content and disclaim any liability for direct or indirect losses arising from its use.

Conflict of Interest
The authors declare no conflicts of interest, and no external funding or sponsorship influenced the study design, data collection, analysis, publication decision, or manuscript preparation.

References

1. Bera S, Ghosh RK. Soil microflora and weed management as influenced by atrazine 50% WP in sugarcane. Universal Journal of Agricultural Research. 2013;1(2):41-47. doi:10.13189/ujar.2013.010205.
2. Chand M, Singh S, Bir D, Singh N, Kumar V. Halosulfuron methyl: A new post emergence herbicide in India for effective control of Cyperus rotundus in sugarcane and its residual effects on the succeeding crops. Sugar Tech. 2014;16(1):67-74. doi:10.1007/s12355-013-0263-4.
3. Jackson ML. Plant Chemical Analysis. New Delhi: Prentice Hall of India Pvt. Ltd.; 1967. p. 573.
4. Jackson ML. Soil Chemical Analysis. New Delhi: Prentice Hall of India Pvt. Ltd.; 1973. p. 256-260.
5. Jangir R, Arvadia LK, Rajpurohit DS. Effect of different planting methods and weed management practices on yield and economics of mustard (*Brassica juncea* L.) and weed population, weed dry matter accumulation, weed control efficiency, weed index, nutrient content and uptake by weeds. International Journal of Current Microbiology and Applied Sciences. 2018;7(2):2588-2599. doi:10.20546/ijcmas.2018.702.315.
6. Kalaiyarasi D. Evaluation of Sulfentrazone for weed control in sugarcane and its residual effect on succeeding crops. Coimbatore: Tamil Nadu Agricultural University; 2012.
7. Kathiresan G, Avudathai S. Evaluation of new herbicide for sugarcane in delta region of Tamil Nadu. Sugar Tech. 2004;6:187-189. doi:10.1007/BF02942416.
8. Kadam S, Bholane P, Gajbhiye P, Sonawane A. Impact of post emergence herbicide on growth, yield, soil fertility and nutrient uptake by weed and crop in sugarcane. International Journal of Statistics and Applied Mathematics. 2023;SP-8(6):1003-1007. https://www.mathsjournal.com/archives/2023/vol8/issue6/SP-8-6-46-88.pdf
9. Mishra P, Al Khatib AMG, Kumar Sardar I, Mohammed J, Karakaya K, Dash A, Dubey A. Modeling and forecasting of sugarcane production in India. Sugar Tech. 2021;23(6):1317-1324. https://link.springer.com/article/10.1007/s12355-021-01004-3

10. Nazir A, Bhat MA, Bhat TA, Fayaz S, Mir MS, Basu U, El Sabagh A. Comparative analysis of rice and weeds and their nutrient partitioning under various establishment methods and weed management practices in temperate environment. Agronomy. 2022;12(4):816. doi:10.3390/agronomy12040816.
11. Oerke EC. Crop losses to pests. Journal of Agricultural Science. 2006;144(1):31-43. doi:10.1017/S0021859605005708.
12. Patel DD, Patel CL, Kalaria GB. Effect of planting geometry and weed management on quality and yield of sugarcane. Indian Journal of Sugarcane Technology. 2006;21(1-2):39-42.
13. Pratap T, Singh R, Pal R, Yadav S, Singh V. Integrated weed management studies in sugarcane ratoon. Indian Journal of Weed Science. 2013;45(4):25. doi:10.5958/0974-8164.2013.00005.1.
14. Ramesha YM, Bhanuvally M, Krishnamurthy D, Gaddi AK. Weed management effect on growth and yield of sugarcane. Indian Journal of Weed Science. 2018;50(4):373-376. doi:10.5958/0974-8164.2018.00092.8.
15. Rathika S, Ramesh T, Jagadeesan R. Weed management in sugarcane: A review. The Pharma Innovation Journal. 2023;12(6):3883-3887.
16. Sarala NV, Rao KS, Nagamadhuri KV, Kumar MH. Evaluation of post emergence herbicides for control of creeper weeds in sugarcane. Journal of Sugarcane Research. 2011;1(2):78-81. doi:10.56093/jsr.v1i2.99301.
17. Singh J, Kumar R. Management of weeds for sustainable sugarcane production in sub-tropical India. Indian Journal of Sugarcane Technology. 2013;28(2):95-99.
18. Srivastava TK, Chauhan RS, Lal M. Weed dynamics and their management in sugarcane under different preceding crops and tillage systems. Indian Journal of Agricultural Science. 2005;75(5):256-260.
19. Solomon S. Sugarcane production and development of sugar industry in India. Sugar Tech. 2016;18:588-602. https://www.researchgate.net/publication/310490712_Sugarcane_Production_and_Development_of_Sugar_Industry_in_India
20. Suganthi M, Muthukrishnan P, Chinnusamy C. Crop weed competition in sugarcane: A review. Agricultural Reviews. 2019;40(3):239-242. https://www.researchgate.net/publication/337443104_Crop_Weed_Competition_in_Sugarcane_-_A_Review
21. Suganthi M, Muthukrishnan P. Effect of chemical weed management on quality parameters, yield parameters and yield in sugarcane in western zones of Tamil Nadu. Indian Journal of Weed Science. 2017;32(1-2):44-46.