



International Journal of Research in Agronomy

E-ISSN: 2618-0618
P-ISSN: 2618-060X
© Agronomy
NAAS Rating (2026): 5.20
www.agronomyjournals.com
2026; 9(8): 1355-1360
Received: 11-06-2026
Accepted: 15-07-2026

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Effect of integrated weed management on weed density, growth and yield of autumn-planted sugarcane

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DOI: <https://www.doi.org/10.33545/2618060X.2026.v9.i8q.6430>

Abstract

A field experiment was conducted to find out the most effective and remunerative integrated weed management practices for autumn-planted sugarcane at Main Sugarcane Research Station, Junagadh Agricultural University, Kodinar, Gujarat, India during 2021-22, 2022-23 and 2023-24. The experiment was laid out in Randomized Block Design with three replications. The treatment consists of viz. T₁- Control (Weedy check), T₂- Weed free, T₃- Three hand weeding (HW) at 30, 60 and 90 DAP and two inter culturing (IC) at 45 and 90 DAP, T₄- Diuron (PE) 2.0 kg/ha followed by (fb) IC + HW at 60 DAP, T₅- Diuron (PE) 2.0 kg/ha fb IC + HW at 60 DAP fb IC + HW at 90 DAP, T₆- Ametryne (EPoE) 2.0 kg/ha fb IC + HW at 60 DAP, T₇- Ametryne (EPoE) 2.0 kg/ha fb IC + HW at 60 DAP fb IC + HW at 90 DAP, T₈- Metribuzin (PE) 1.5 kg/ha fb IC at 60 DAP, T₉- Tank-mix pendimethalin 0.75 kg/ha+ metribuzin 0.75 kg/ha (PE) fb IC + HW at 60 DAP, T₁₀- Tank-mix pendimethalin 0.75 kg/ha+ metribuzin 0.75 kg/ha (PE) fb IC + HW at 60 DAP fb IC + HW at 90 DAP, T₁₁- Paraquat dichloride (EPoE) 0.5 kg/ha fb IC + HW at 60 DAP and T₁₂- Paraquat dichloride (EPoE) 0.5 kg/ha fb IC + HW at 60 DAP fb IC + HW at 90 DAP. Sugarcane variety Co 6304 was planted in rows, spaced 90 cm during autumn season for conducting this experiment. The perusal of pooled data indicated that significantly highest tillers, millable cane height, number of millable canes, cane yield (128.15 t/ha) and commercial cane sugar yield (15.37 t/ha) was obtained under treatment T₂-weed free as compared to other treatments but it remained at par with T₇- Ametryne (EPoE) 2.0 kg/ha followed by inter culturing + hand weeding at 60 DAP followed by inter culturing + hand weeding at 90 DAP (cane yield 122.55 t/ha) and T₃- three hand weeding at 30, 60 and 90 days after planting and two inter culturing at 45 and 90 days after planting (cane yield 118.94 t/ha). The quality parameters of sugarcane viz. brix, sucrose, purity and CCS percent were also significantly higher in these treatments. Lowest weed density and weed dry matter at harvest was observed under T₇- ametryne (EPoE) 2.0 kg/ha fb IC + HW at 60 DAP fb IC + HW at 90 DAP and T₃- three HW at 30, 60 and 90 DAP and two IC at 45 and 90 DAP. Highest weed control efficiency was obtained in weed free plot (80.70%) followed by treatment T₇ (78.13%) and T₃ (77.07%). The higher net returns (Rs. 117069/ha) and BCR (1.43) were obtained under T₇- ametryne (EPoE) 2.0 kg/ha fb IC + HW at 60 DAP fb IC + HW at 90 DAP followed by T₃- three HW at 30, 60 and 90 DAP and two IC at 45 and 90 DAP.

Keywords: Sugarcane, integrated weed management, ametryne, hand weeding, cane yield

Introduction

Sugarcane (*Saccharum officinarum* L.) is a remunerative cash crop, occupies important position in Indian agriculture. The longer time (35-45 days) required by the crop to germinate, initial slow crop growth, wider spacing, heavy manuring coupled with frequent irrigation provides congenial condition for weed growth that leads to intense competition of weed with crop plants for nutrients, moisture, light, CO₂ and space. For getting higher yield from sugarcane crop, weed management play a vital role. Weeds are considered as a major biotic constraint for high production and 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) ^[9]. The extent of loss varies from region to region depending on the extent of competition decided by the density and dry matter accumulation of weeds. Poor growth of sugarcane resulting from weed infestation causes quality depression in sugarcane. Weeds harbor certain disease and insect pests that attack sugarcane and thus lead to indirect losses. A weedy 'plant cane' leads to a weedy 'ratoon cane'. Uncontrolled weeds may cause 12-72 per cent reduction in cane yield depending on the crop (Verma, 2000 and Tomer *et al.*, 2003) ^[12, 11]. Providing a weed-free environment in sugarcane is absolutely

essential to realize the full potential of a variety and to make best use of the key production factors. It is more appropriate that weeds, unlike insect and diseases often cause hidden symptoms of damage prior to harvest of sugarcane and possibly also because of fatalistic attitude that weeds will always be present. Labour shortage is also faced by the sugarcane growers.

Different methods of weed management have their own benefits and limitations. Adoption of preventive measures, cultural practices, mechanical methods and chemical control are required in the new paradigms of weed management in sugarcane. For control of diverse weed flora in sugarcane use of herbicides are also required. Integration of above techniques will be the key to sustainable weed management in sugarcane for maintaining or enhancing the crop productivity, profitability and environmental quality. Integrated weed management (IWM) is a science-based decision-making process that coordinates the use of environmental information, weed biology and ecology, and all available technologies to control weeds by the most economical means, while posing the least possible risk to people and the environment (Sanyal, 2008) [7]. IWM in sugarcane typically combines pre-emergence herbicides with one or two post-emergence sprays supplemented by timely interculturing, mulching with trash or green manure and crop rotation where feasible, thereby extending the weed-free period through the critical 120-day window and beyond. Therefore, the present investigation was conducted with objective to find out economical and effective weed management system in sugarcane.

Materials and Methods

The field experiment was undertaken during 2021-22, 2022-23 and 2023-24 at Main Sugarcane Research Station, Junagadh Agricultural University, Kodinar, Gujarat. The soil of experimental field was medium in organic carbon (0.65%), available phosphorus (24.16 kg/ha) and high in potassium (421.00 kg/ha) having the pH of 8.25 and EC of 0.42 dsm⁻¹. The experiment was conducted in randomized block design with three replications. Twelve treatments including T₁- Control (Weedy check), T₂-Weed free, T₃- Three hand weeding (HW) at 30, 60 and 90 DAP and two inter culturing (IC) at 45 and 90 DAP, T₄- Diuron (PE) 2.0 kg/ha followed by (fb) IC + HW at 60 DAP, T₅- Diuron (PE) 2.0 kg/ha fb IC + HW at 60 DAP fb IC + HW at 90 DAP, T₆- Ametryne (EPoE) 2.0 kg/ha fb IC + HW at 60 DAP, T₇- Ametryne (EPoE) 2.0 kg/ha fb IC + HW at 60 DAP fb IC + HW at 90 DAP, T₈- Metribuzin (PE) 1.5 kg/ha fb IC at 60 DAP, T₉- Tank-mix pendimethalin 0.75 kg/ha+ metribuzin 0.75 kg/ha (PE) fb IC + HW at 60 DAP, T₁₀- Tank-mix pendimethalin 0.75 kg/ha+ metribuzin 0.75 kg/ha (PE) fb IC + HW at 60 DAP fb IC + HW at 90 DAP, T₁₁- Paraquat dichloride (EPoE) 0.5 kg/ha fb IC + HW at 60 DAP and T₁₂- Paraquat dichloride (EPoE) 0.5 kg/ha fb IC + HW at 60 DAP fb IC + HW at 90 DAP were tested.

The sugarcane variety Co 6304 was planted at 90 cm row spacing using 35000 three budded setts/ha. The recommended dose of fertilizers was 250, 125 and 125 kg/ha N, P₂O₅ and K₂O, respectively. Full dose of phosphorus and potash and 15% nitrogen was applied in the planting rows uniformly in all the plots at the time of planting. Remaining nitrogen was applied in three splits @ 30, 20 and 35% at 60, 90 and 150 days after planting. Sugarcane was planted during the month of October-November and harvested in the following year in the IInd fortnight of November. Irrigation, earthing up and all other recommended agronomic practices were followed and plant protection measures were adopted as per need. Weed free condition was done by hand weeding at 20 days' interval up to 120 DAP as per treatment. Inter culturing was done by bullock

drawn cultivator (*Daanti*) followed by blade harrow (*Raap*). Pre-emergence herbicides were sprayed at 3-4 DAP as per sufficient soil moisture availability. Early post emergence (EPoE) spray of herbicides was done at 15-20 DAP. The herbicides were applied using flat fan nozzles calibrated to deliver 500 litre/ha of the spray solution.

Growth parameters like germination percent, number of tillers were recorded at the respective stages of crop growth. Five millable canes were randomly taken from the plot at sugarcane harvesting and observations on growth and yield attributes (millable cane height, cane diameter and single cane weight) and juice quality parameters (brix, sucrose, purity, CCS and extraction percent) were recorded. Cane juice was extracted with sugarcane crusher and juice quality was estimated as per method given by Spencer and Meade (1955) [10]. Sugar yield was calculated by the formula: Sugar yield (t/ha) = CCS% x cane yield (t/ha)/100.

Weed density and weed dry weight were measured with a 50 cm × 50 cm quadrat placed randomly at three spots per plot. The fresh sample of weeds were sun-dried, then oven-dried at 70 °C until constant weight, and expressed as weed biomass (g/m²). Weed control efficiency was estimated using the formula as: WCE (%) = [WDC-WDT/WDC] × 100, Where, WDC = Weed dry matter production recorded in the untreated control plot and WDT = Weed dry matter production was measured in the treated plots. To homogenize the variance, weed density and biomass data were transformed using the square root formula ($\sqrt{(x + 0.5)}$). The data were statistically analysed through analysis of variance (ANOVA) appropriate for the experimental design and treatment differences were tested using the F-test at a 5% significance level (Gomez and Gomez, 1984) [4]. Since the year-to-year variation was minimal and not statistically significant in most of the parameters, the data from three years were combined and presented as pooled results.

Results and Discussion

Growth and yield attributes

The pooled data (Table 1) showed that numbers of tillers at 90 DAP were significantly higher under treatment T₂- weed free plot (126.79 thousand/ha) as compared to other treatments but remained at par with the treatment T₇- ametryne (EPoE) 2.0 kg/ha fb IC + HW at 60 DAP fb IC + HW at 90 DAP (119.29 thousand/ha), treatment T₃- three hand weeding at 30, 60 and 90 DAP and two inter culturing at 45 and 90 DAP (115.09 thousand/ha) and treatment T₁₀- Tank-mix pendimethalin 0.75 kg/ha+ metribuzin 0.75 kg/ha (PE) fb IC + HW at 60 DAP fb IC + HW at 90 DAP (114.87 thousand/ha). The significantly highest millable cane height (223.33 cm) was obtained under treatment T₂- weed free plot and remained at par with treatment T₃, T₆, T₇, T₈, and T₁₀ on pooled basis. Further perusal of pooled data revealed that significantly highest single cane weight (1.266 kg) was obtained under treatment T₂- weed free plot and remained at par with treatment T₃ (1.208 kg), T₆ (1.161 kg) and T₇ (1.251 kg). The other growth parameters and yield attributes like germination per cent and stalk diameter could not reach to the level of significance on pooled basis. The further critical examination of pooled data presented in Table 1 revealed that weed free plot produced significantly higher (NMC) number of millable canes (118.12 thousand/ha) as compared to other treatments but remained at par with the application of ametryne (EPoE) 2.0 kg/ha fb IC + HW at 60 DAP fb IC + HW at 90 DAP (115.69 thousand/ha), three hand weeding at 30, 60 and 90 DAP and two inter culturing at 45 and 90 DAP (111.33 thousand/ha) and tank-mix pendimethalin 0.75 kg/ha+ metribuzin 0.75 kg/ha (PE) fb IC + HW at 60 DAP fb IC + HW at 90 DAP (110.90 thousand/ha).

This increase in growth parameters might be due to the fact that these weed management practices eliminates weed competition during the most sensitive growth stages. This allows sugarcane to maximize tillering, internode elongation and cane thickening,

hence the significantly higher millable cane height, single cane weight and number of millable canes were obtained. These findings are in conformity with Mondal *et al.* (2020) ^[6], Yadav *et al.* (2020) ^[13] and Kadam *et al.* (2023) ^[5].

Table 1: Effect of weed management practices on growth parameters and yield attributes of sugarcane (pooled data of three years)

Treatments	Germination % (45 DAP)	Tillers at 90 DAP ('000/ha)	Millable cane height (cm) at harvest	Stalk diameter (cm) at harvest	Single cane weight (kg) at harvest	NMC (000/ha) at harvest
T ₁	56.08	70.28	166.30	2.47	0.868	87.07
T ₂	58.59	126.79	223.33	2.60	1.266	118.12
T ₃	54.92	115.09	213.96	2.54	1.208	111.33
T ₄	56.60	104.19	193.01	2.53	0.983	101.49
T ₅	58.25	107.61	204.84	2.51	1.056	105.74
T ₆	57.01	108.72	208.18	2.53	1.161	105.66
T ₇	56.63	119.29	221.47	2.59	1.251	115.69
T ₈	57.90	110.61	207.42	2.56	1.097	107.24
T ₉	57.19	110.24	198.49	2.52	1.046	97.72
T ₁₀	57.71	114.87	206.29	2.53	1.117	110.90
T ₁₁	57.85	97.87	192.42	2.54	1.032	94.14
T ₁₂	55.53	106.33	199.40	2.51	1.020	99.59
SEm±	1.71	4.63	6.05	0.04	0.042	3.34
C D (P= 0.05)	NS	13.08	17.09	NS	0.118	9.43
C V%	8.99	12.90	8.95	5.20	11.51	9.58

Cane yield

The perusal of data (Table 2) indicated that significantly highest cane yield was obtained under T₂ (Weed free) plot (128.15 t/ha) as compared to other treatments except T₃-3 HW at 30, 60 and 90 DAP and 2 IC at 45 and 90 DAP (118.94 t/ha) and T₇-Ametryne (EPoE) 2.0 kg/ha *fb* IC + HW at 60 DAP *fb* IC + HW at 90 DAP (122.55 t/ha) during the individual years as well as in pooled analysis. The traditional practice of weed management viz. weed free and three hand weeding with interculturing twice recorded maximum yield attributes and yield of the crop. Weed free environment provides the greater resources to the crop, availability particularly nutrient, water and light at the critical crop stage due to reduced weed crop competition might have produced higher yields. Further perusal of integrated weed management treatments indicated that the application of ametryne (EPoE) 2.0 kg/ha *fb* IC + HW at 60 DAP *fb* IC + HW at 90 DAP produced significantly higher cane yield (122.55 t/ha) as compared control (86.00 t/ha), although it remained at par with the treatment having three hand weeding at 30, 60 and 90 DAP and two inter culturing at 45 and 90 DAP (118.94 t/ha). Similar trend was also observed in the individual years. In 3rd year of experimentation treatment T₂ (weed free plot) also remained at par with T₁₀. Among the herbicide treatments, the highest cane yield was obtained with the application of ametryne 2.0 kg/ha as early post-emergence followed by two inter culturing and hand weeding. The superiority of this treatment over others might have been attributed to its efficacy in suppressing the weed growth, which led to the better availability of nutrients and soil water. Similar results were also reported by Farooq *et al.* (2014) ^[3]. Additionally, Mondal *et al.* (2020) ^[6] found that application of ametryne 1.0 kg/ha at 30 days after planting followed by 2,4-D 1.0 kg/ha at 60 DAP effectively suppressed the grasses, sedges and broad-leaved weeds, improved yield attributes and registered

higher cane yield (102.49 t/ha), juice recovery (52.80%) and B:C ratio (2.90) due to better weed control efficiency.

Commercial cane sugar

The pooled data presented in Table 2 indicated that significantly highest commercial cane sugar (CCS) was obtained under weed free plot (15.37 t/ha) as compared to other treatments except T₃ and T₇ during the individual years as well as in pooled analysis. Further perusal of integrated weed management treatments showed that the T₇-early post-emergence application of ametryne 2.0 kg/ha *fb* IC + HW at 60 DAP *fb* IC + HW at 90 DAP produced significantly higher commercial cane sugar (14.55 t/ha) as compared control, although it remained at par with the treatment having three hand weeding at 30, 60 and 90 DAP and two inter culturing at 45 and 90 DAP (14.06 t/ha) in pooled analysis. Similar trend was observed in individual years of experimentation. The higher commercial cane sugar yield under ametryne 2.0 kg/ha at early post-emergence followed by inter cultivation and hand weeding at 60 and 90 DAP may be attributed to effective and prolonged weed suppression during the critical crop-weed competition period of sugarcane. Ametryne controlled the initial flush of grasses and broad-leaved weeds, while subsequent inter cultivation and hand weeding removed surviving and late-emerging weeds. Consequently, weed-mediated depletion of nutrients, moisture, light and space was reduced, resulting in better tillering, leaf-area development, stalk growth, millable cane number and cane yield. Since CCS yield is a product of cane yield and recoverable sugar percentage, the improvement in CCS was probably caused mainly by increased cane yield rather than by a major change in juice quality. These findings are consistent with those reported by Kadam *et al.* (2023) ^[5] and Abd EL-Lattief *et al.* (2025) ^[11].

Table 2: Effect of weed management practices on cane yield and commercial cane sugar

Treatments	Cane yield (t/ha)				CCS (t/ha)			
	2021-22	2022-23	2023-24	Pooled	2021-22	2022-23	2023-24	Pooled
T ₁	81.11	87.63	89.27	86.00	8.23	9.13	9.45	8.94
T ₂	128.57	130.21	125.67	128.15	15.43	15.51	15.16	15.37
T ₃	120.97	116.63	119.23	118.94	14.11	13.83	14.25	14.06
T ₄	95.89	92.43	102.66	96.99	10.81	10.19	11.48	10.82
T ₅	100.93	95.19	103.78	99.97	11.49	11.14	12.57	11.73
T ₆	104.26	106.08	104.38	104.91	11.79	11.66	11.42	11.62
T ₇	122.50	120.56	124.59	122.55	14.62	14.31	14.73	14.55
T ₈	116.08	106.86	101.04	107.99	13.57	11.87	11.88	12.44
T ₉	100.36	101.07	104.79	102.07	11.38	11.86	12.17	11.80
T ₁₀	117.32	105.50	110.72	111.18	13.55	12.45	13.13	13.05
T ₁₁	92.48	97.68	97.85	96.00	9.93	10.61	11.04	10.53
T ₁₂	96.96	104.84	100.72	100.84	10.83	12.12	11.62	11.52
SEm+	6.88	7.84	6.98	4.18	0.92	0.98	0.98	0.55
C D (P=0.05)	20.19	23.00	20.47	11.82	2.70	2.89	2.87	1.57
C V%	11.20	12.89	11.29	11.81	13.12	14.14	13.64	13.64

Quality parameters

The critical examination of pooled data presented in Table 3 revealed that the quality parameters of sugarcane viz. brix, sucrose, purity and CCS (Commercial Cane Sugar) percent were significantly higher under treatment T₂- weed free plot as compared to control. The next significantly higher values were obtained under T₇- ametryne (EPoE) 2.0 kg/ha fb IC + HW at 60 DAP fb IC + HW at 90 DAP and T₃- three hand weeding at 30, 60 and 90 DAP and two inter culturing at 45 and 90 DAP. Extraction per cent did not undergo significant changes due to integrated weed management treatments. The increase in brix, sucrose, purity and CCS percent under weed-control treatments

might have been happening because effective weed management reduces crop-weed competition during the critical early and mid-growth phases, allowing sugarcane to accumulate more photosynthates and partition them into sucrose in the stalks. Ametryne (EPoE) followed by inter culturing + hand weeding at 60 and 90 DAP or the intensive mechanical regime of three hand weeding plus two inter culturing, both keep the crop much cleaner than unweeded checks, which translates into better cane quality. Abd EL-Lattief *et al.* (2025)^[1] also observed that all quality traits of sugarcane were insignificantly affected by irrigation levels and weed control treatments.

Table 3: Effect of weed management practices on quality parameters of sugarcane (pooled data of three years)

Treatments	Brix (%)	Sucrose (%)	Purity (%)	C.C.S (%)	Juice Extraction (%)
T ₁ : Control (Weedy check)	18.91	15.56	80.88	10.38	53.09
T ₂ : Weed free	20.04	17.47	85.86	12.00	56.54
T ₃ : 3 HW at 30, 60 and 90 DAP and 2 IC at 45 and 90 DAP	19.93	17.23	84.91	11.79	56.15
T ₄ : Diuron (PE) 2.0 kg/ha fb IC + HW at 60 DAP	19.87	16.58	82.35	11.15	55.22
T ₅ : Diuron (PE) 2.0 kg/ha fb IC + HW at 60 DAP fb IC + HW at 90 DAP	19.61	17.08	85.49	11.73	55.20
T ₆ : Ametryne (EPoE) 2.0 kg/ha fb IC + HW at 60 DAP	19.69	16.44	82.20	11.05	53.94
T ₇ : Ametryne (EPoE) 2.0 kg/ha fb IC + HW at 60 DAP fb IC + HW at 90 DAP	20.07	17.36	84.81	11.88	55.57
T ₈ : Metribuzin (PE) 1.5 kg/ha fb IC at 60 DAP	19.91	16.92	83.53	11.48	54.91
T ₉ : Tank-mix pendimethalin 0.75 kg/ha+ metribuzin 0.75 kg/ha (PE) fb IC + HW at 60 DAP	19.88	17.01	83.98	11.58	54.58
T ₁₀ : Tank-mix pendimethalin 0.75 kg/ha+ metribuzin 0.75 kg/ha (PE) fb IC + HW at 60 DAP fb IC + HW at 90 DAP	19.91	17.17	84.88	11.73	55.69
T ₁₁ : Paraquat dichloride (EPoE) 0.5 kg/ha fb IC + HW at 60 DAP	19.36	16.27	82.98	10.97	54.63
T ₁₂ : Paraquat dichloride (EPoE) 0.5 kg/ha fb IC + HW at 60 DAP fb IC + HW at 90 DAP	19.86	16.84	83.19	11.42	55.79
SEm+	0.20	0.17	0.95	0.16	0.71
C D (P= 0.05)	0.58	0.49	2.70	0.46	NS
C V%	3.11	3.07	3.42	4.28	3.87

Dominant weed flora

The major weed flora observed during early stage of crop growth were *Cyperus rotundus* L., *Parthenium hysterophorus* L., *Brachiaria reptans* Gard. & Hubb, *Brachiaria ramosa* (L.) Stapf., *Physalis minima* L., *Digera arvensis* Forssk., *Indigofera glandulosa* L., *Convolvulus arvensis* L., *Commelina benghalensis* L., *Cynodon dactylon* (L.) Pers. and *Amaranthus viridis* Hook. F.

Weed density, dry matter of weeds and WCE

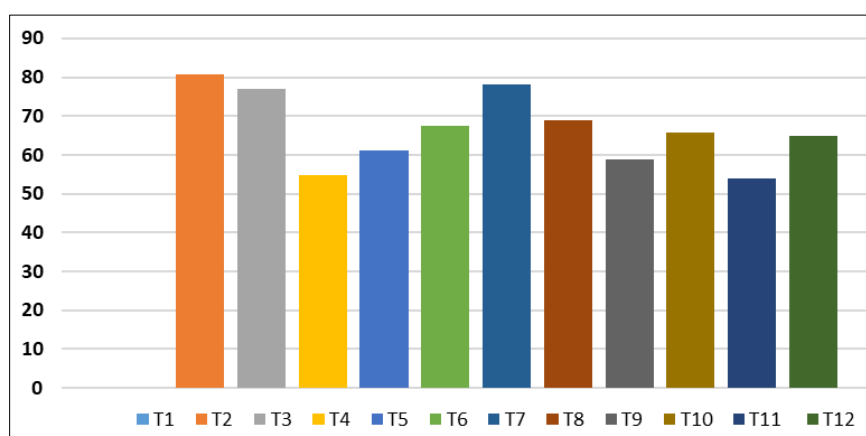
Further reference to pooled data (Table 4) showed that significantly maximum weed density and weed dry matter

accumulation occurred in weedy check plot and lowest weed density and weed dry matter accumulation was observed under treatment T₇- ametryne (EPoE) 2.0 kg/ha fb IC + HW at 60 DAP fb IC + HW at 90 DAP and treatment T₃- three hand weeding at 30, 60 and 90 DAP and two inter culturing at 45 and 90 DAP. Highest weed control efficiency (80.70%) was obtained in weed free plot followed by treatment T₇ (78.13%) and T₃ (77.07%). Singh *et al.* (2012)^[8] also reported that lowest density as well as dry weight of total weeds were recorded under the treatment of three hoeing at 30, 60 and 90 days after harvesting of main sugarcane crop.

Table 4: Effect of weed management practices on weed density, dry matter of weeds (pooled data of three years) and weed control efficiency

Treatments	Weed density (No./m ²)	Dry matter of weeds (g/m ²)	WCE (%)
T ₁ : Control (Weedy check)	6.98 (48.73)	8.37 (69.94)	-
T ₂ : Weed free	2.94 (8.28)	3.70 (13.50)	80.70
T ₃ : 3 HW at 30, 60 and 90 DAP and 2 IC at 45 and 90 DAP	3.60 (12.69)	4.04 (16.04)	77.07
T ₄ : Diuron (PE) 2.0 kg/ha fb IC + HW at 60 DAP	5.67 (32.13)	5.55 (31.60)	54.82
T ₅ : Diuron (PE) 2.0 kg/ha fb IC + HW at 60 DAP fb IC + HW at 90 DAP	5.17 (26.87)	5.22 (27.28)	61.00
T ₆ : Ametryne (EPoE) 2.0 kg/ha fb IC + HW at 60 DAP	5.05 (26.20)	4.76 (22.72)	67.51
T ₇ : Ametryne (EPoE) 2.0 kg/ha fb IC + HW at 60 DAP fb IC + HW at 90 DAP	3.45 (11.64)	3.93 (15.29)	78.13
T ₈ : Metribuzin (PE) 1.5 kg/ha fb IC at 60 DAP	4.13 (17.10)	4.66 (21.65)	69.05
T ₉ : Tank-mix pendimethalin 0.75 kg/ha+ metribuzin 0.75 kg/ha (PE) fb IC + HW at 60 DAP	5.66 (31.68)	5.40 (28.79)	58.84
T ₁₀ : Tank-mix pendimethalin 0.75 kg/ha+ metribuzin 0.75 kg/ha (PE) fb IC + HW at 60 DAP fb IC + HW at 90 DAP	4.98 (24.75)	4.93 (23.93)	65.78
T ₁₁ : Paraquat dichloride (EPoE) 0.5 kg/ha fb IC + HW at 60 DAP	5.67 (32.01)	5.60 (32.15)	54.04
T ₁₂ : Paraquat dichloride (EPoE) 0.5 kg/ha fb IC + HW at 60 DAP fb IC + HW at 90 DAP	5.22 (27.13)	4.99 (24.54)	64.91
SEm±	0.24	0.25	
C D (P= 0.05)	0.69	0.70	
C V%	14.99	14.65	

Weeds data were subjected to square root transformation ($\sqrt{x + 0.5}$). Figures given in parenthesis are original values.

**Fig 1:** Weed control efficiency (%) of different treatments in sugarcane at harvest

Economics

A perusal of mean data of three years (Table 5) indicated that cost of cultivation and net return of sugarcane were influenced to a great extent by different integrated weed management treatments. The higher net returns (Rs. 117069/ha) and BCR (1.43) were obtained under treatment T₇- ametryne (EPoE) 2.0 kg/ha fb IC + HW at 60 DAP fb IC + HW at 90 DAP followed by T₃- three hand

weeding at 30, 60 and 90 DAP and two inter culturing at 45 and 90 DAP which recorded the highest net return of Rs. 106849/ha and benefit cost ratio 1.39. Although treatment T₈- Metribuzin (PE) 1.5 kg/ha fb IC at 60 DAP also recorded benefit cost ratio 1.43 which is already under recommendation for sugarcane. Choudhary and Singh (2015) [2] also confirmed the similar findings.

Table 5: Economics of different treatments (Mean of 3 years)

Treatments	Pooled cane yield (t/ha)	Cost of cultivation (Rs./ha)	Gross return (Rs./ha)	Net return (Rs./ha)	BCR
T ₁ : Control (Weedy check)	86.00	206019	273050	67031	1.33
T ₂ : Weed free	128.15	301270	406876	105606	1.35
T ₃ : 3 HW at 30, 60 and 90 DAP and 2 IC at 45 and 90 DAP	118.94	270786	377635	106849	1.39
T ₄ : Diuron (PE) 2.0 kg/ha fb IC + HW at 60 DAP	96.99	232055	307943	75888	1.33
T ₅ : Diuron (PE) 2.0 kg/ha fb IC + HW at 60 DAP fb IC + HW at 90 DAP	99.97	243160	317405	74245	1.31
T ₆ : Ametryne (EPoE) 2.0 kg/ha fb IC + HW at 60 DAP	104.91	243329	333089	89760	1.37
T ₇ : Ametryne (EPoE) 2.0 kg/ha fb IC + HW at 60 DAP fb IC + HW at 90 DAP	122.55	272027	389096	117069	1.43
T ₈ : Metribuzin (PE) 1.5 kg/ha fb IC at 60 DAP	107.99	239470	342868	103398	1.43
T ₉ : Tank-mix pendimethalin 0.75 kg/ha+ metribuzin 0.75 kg/ha (PE) fb IC + HW at 60 DAP	102.07	239971	324072	84101	1.35
T ₁₀ : Tank-mix pendimethalin 0.75 kg/ha+ metribuzin 0.75 kg/ha (PE) fb IC + HW at 60 DAP fb IC + HW at 90 DAP	111.18	258434	352997	94563	1.37
T ₁₁ : Paraquat dichloride (EPoE) 0.5 kg/ha fb IC + HW at 60 DAP	96.00	229585	304800	75215	1.33
T ₁₂ : Paraquat dichloride (EPoE) 0.5 kg/ha fb IC + HW at 60 DAP fb IC + HW at 90 DAP	100.84	242927	320167	77240	1.32

Selling price of sugarcane: Rs.3175/tonne.

Conclusion

Based on a three-year study, it can be inferred that integrated weed management involving early post-emergence spray of ametryne at 2.0 kg a.i./ha followed by two inter-culturing and hand weeding at 60 and 90 days after planting (DAP) or three hand weeding at 30, 60, and 90 DAP combined with two inter-culturing at 45 and 90 DAP resulted in higher cane yield and net returns compared to other weed management treatments. Key findings from the study include: Ametryne application: Early post-emergence spray of ametryne @ 2.0 kg a.i./ha followed by two inter-culturing and hand weeding at 60 and 90 DAP. Hand weeding: Three hand weeding at 30, 60, and 90 DAP along with two inter-culturing at 45 and 90 DAP. These practices were found to be advantageous for increasing both cane yield and monetary returns. Therefore, it is recommended that weed control in sugarcane be carried out using either of the following methods- 1: Early post-emergence application of ametryne 80% WG @ 2.0 kg a.i. /ha, followed by two inter-culturing and hand weeding at 60 and 90 DAP, OR 2: Three hand weeding at 30, 60, and 90 DAP, combined with two inter-culturing at 45 and 90 DAP. These approaches are recommended to enhance the net returns for farmers.

Hence it is concluded that application of ametryne 80% WG 2.0 kg/ha at 15-20 DAP followed by inter culturing and hand weeding at 60 and 90 days after planting OR hand weeding at 30, 60 and 90 days after planting and inter culturing at 45 and 90 days after planting would be a cost-effective recommendation for effective weed management and securing higher cane yield and net return in the South Saurashtra Agro Climatic Zone of Gujarat.

Acknowledgement

The authors sincerely express their gratitude to the Directorate of Research and the Dean of Postgraduate Studies, Junagadh Agricultural University, Junagadh, for providing the necessary facilities, continuous support and permission to successfully conduct this study.

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