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Effect of integrated weed management practices on growth and yield of *suru* sugarcane (*Saccharum officinarum* L.) in sub montane zone of Maharashtra

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Abstract
A field experiment was conducted on integrated weed management in *suru* sugarcane at PG Research Farm RCSM College of Agriculture, Kolhapur during 2024-2025 with eight treatments, which included three herbicide combinations *viz*. Tembotrione, Mesotrione + Atrazine (ready mix), 2,4-D Sodium salt + Metribuzin + Pyrazosulfuron- ethyl (ready mix) with one hand weeding were studied in randomized block design replicated thrice. In which weed free condition recorded highest yield (140.52 t ha^{-1}) and among herbicidal treatments PoE application of 2,4-D Sodium salt (440 WG) + Metribuzin (350 WG) + Pyrazosulfuron- ethyl (10 WG) (ready mix) @ 3 kg a.i. ha^{-1} at 15-20 DAP *fb* hand weeding at 60 DAP observed highest number of tiller (103.5 thousand ha^{-1}), cane height (347.4 cm), millable cane number (83.33 thousand ha^{-1}), girth (11.21 cm), dry matter accumulation (519.9 g plant^{-1}), number of internodes (17.43 cane^{-1}), length of internode cane^{-1} (11.84 cm) and cane yield (135.83 t ha^{-1}).

Keywords: Sugarcane, hand weeding, chemical method, cane yield, growth, weed competition

Introduction
Sugarcane (*Saccharum officinarum* L.) is a C_4 perennial slow growing crop in subtropical and tropical regions, serving as a source of food and fuel. Its ratooning characteristic can increase the prevalence of pests, diseases, and weeds. Weed control represents a significant cost, averaging around INR 6,000 ha^{-1} (USD 92.42 ha^{-1}) for rainy season crops and INR 4,000 ha^{-1} (USD 61.61 ha^{-1}) for winter crops, accounting for roughly 33% and 22% of total cultivation costs, respectively. Effective weed management is essential for increasing farmers' incomes by reducing losses, lowering production expenses, and enhancing productivity through better resource utilization (N.T. Yaduraju *et al.*, 2018) [3]. With wider spacing weeds poses a major problem, which can be managed by the combination of various cultural and chemical methods Weed infestations can lead to substantial declines in yield, quality, and recovery, with losses varying based on the species and density of the weeds, as well as the crop's growth stage (Srivastava, 2001) [11]. The major weeds reported in sugarcane field were of sedges (*Cyprus rotundus*), grasses (*Cynodon dactlyon, Sorghum halepense, Panicum sp. Dactyloctenium aegyptium, Imperata cylindrica*) and broad leaved weeds (*Chenopodium album, Convolvulus arevensis, Striga asiatica, Portulaca oleraceae, Commelina benghalensis, Trianthema portulacastrum, Amaranthus viridis*). Cultural practices like ploughing, hand weeding and mulching are practiced to control the weeds. However, these methods became cumbersome, time consuming, labour intensive and expensive. Hand weeding is difficult due to non-availability of labour as well as high cost of weeding (Ramesh and Rathika, 2016) [5]. So, management of weeds population we must include effective strategies which is cultural, mechanical, biological and chemical methods, Pyrazosulfuron-ethyl + metribuzin + 2,4-D sodium salt WDG (3000 g ha^{-1}), recorded significantly higher millable cane yield. (Ramesha *et al.*, 2018, Rita Ofosu *et al.*, 2023) [7, 9].

Methods and Materials
A field experiment was conducted on PG research farm of Rajarshee Chhatrapati Shahu Maharaj

college of Agriculture, Kolhapur, Maharashtra, 416004 in *suru* season 2024-2025 the soil of experimental site was sandy clay loam in texture, mildly alkaline (pH 7.53), with an electrical conductivity of 0.16 dS m^{-1}. It contained low available nitrogen (250 kg ha^{-1}), medium phosphorus (22.18 kg ha^{-1}), high potassium (335 kg ha^{-1}), and medium organic carbon (0.57%). The experiment was comprised with eight treatments of weed management with the combination of post emergence herbicide and hand weeding (T_1-Post emergence application of Tembotrione (42% SC) @ 286 g a.i. ha^{-1} at 15-20 DAP, T_2- Post emergence application of Tembotrione (42% SC) @ 286 g a.i. ha^{-1} at 15-20 DAP *fb* hand weeding at 60 DAP, T_3-Post emergence application of Mesotrione (2.27% SC) + Atrazine (22.7% SC) (ready mix) @ 3.5 kg a.i. ha^{-1} at 15-20 DAP, T_4-Post emergence application of Mesotrione (2.27% SC) + Atrazine (22.7% SC) (ready mix) @ 3.5 kg a.i. ha^{-1} at 15-20 DAP *fb* hand weeding at 60 DAP, T_5-Post emergence application of 2,4-D Sodium salt (440 WG) + Metribuzin (350 WG) + Pyrazosulfuron- ethyl (10 WG) (ready mix) @ 3 kg a.i. ha^{-1} at 15-20 DAP, T_6-Post emergence application of 2,4-D Sodium salt (440 WG) + Metribuzin (350 WG) + Pyrazosulfuron- ethyl (10 WG) (ready mix) @ 3 kg a.i. ha^{-1} at 15-20 DAP *fb* hand weeding at 60 DAP, T_7 - weed free, T_8 - weedy check). The experiment was laid out in randomized block design in three replications and plot size was 6×6 meter. In the experiment sugarcane variety PDN 15012 was planted on January 01, 2024 with recommended dose of fertilizers (250:115:115) with a row spacing of 120 cm. Herbicide were applied by the help of knapsack sprayer at a spray volume of 500 liters of water ha^{-1}. Data for sugarcane tiller number at 120 days after planting (per meter row length), cane height was taken from the five plants $plot^{-1}$ and the measurement taken with the help of measuring scale at 300 days after planting, girth at harvest taken from tagged five plants from three cane position top, middle, bottom, dry weight was taken at harvest from five plants, number of internodes $cane^{-1}$ at harvest from tagged five plants, length of internode $cane^{-1}$ at harvest from tagged five plants from three cane position top, middle, bottom, millable cane number (per meter row length) and cane yield at harvest was calculated by the expressed formula.

$$Single\ cane\ weight\ (kg/stalk) = \frac{weight\ of\ 5\ stalks}{5\ sample\ stalks\ per\ plot}$$

$$Cane\ yield\ (t/ha) = \frac{Cane\ yield\ \frac{kg}{plot} \times 10}{Plot\ area}$$

Result and Discussion

Weed composition in experimental field

During the experiment period there were various types of weed species infested the field like *Ageratum conyzoides, Alternanthera sessilis, Amaranthus albus, Amaranthus hybridus, Commelina benghalensis, Corchorus olitoris, Cyanadon dactylon, Cyperus rotundus, Digitaria sanguinalis, Dactylactenium aegyptium, Dinebra retroflexa, Echinocloa colona, Ipomoea hederacea, Parthenium hysterophorus, Portulaca oleracea, Physalis minima, Solanum nigrum. In which Echinocloa colona, Digitaria sanguinalis, Corchorus olitoris* were the high in density in experimental plot.

Effect of weed management on growth parameters

Number of tillers

The numbers of tillers were found in the weedy check (T_8) at 120 Days after planting 76.39 thousand ha^{-1} while in weed free check (T_7), 106.25 thousand ha^{-1}, which is at par with T_6-Post emergence application of 2,4-D Sodium salt (440 WG) + Metribuzin (350 WG) + Pyrazosulfuron- ethyl (10 WG) (ready mix) @ 3 kg a.i. ha^{-1} at 15-20 DAP *fb* hand weeding at 60 DAP. Number of tillers were increased in weed free period because of high competition of resources like water, nutrients, light, reduced in high weed infestation plot. Worku Tadele *et al.,* (2022) [13], Firehum *et al.,* (2013) reported high crop weed competition altered the number of tillers.

Cane height

Cane height was directly abundance by the weed density. At 300 days after planting weed free period, we observed the tallest cane 351.40 cm, which is at par with the T_6 347.40 cm and while the weedy check has the lowest height 271.53, this is because of high crop weed competition for moisture, nutrients, light and space. The same result is also reported by the Worku Tadele *et al.,* (2022) [13], Firehum *et al.,* (2013), Kalaiyarasi *et al.,* (2012) [2], who reported the weed free condition have highest height of cane.

Sugarcane dry matter accumulation

Dry matter accumulation in crops is the important indicator for measuring of good crop growth, better health and potential yield. Each treatment showing its effect but weed free treatments have high weed dry matter accumulation 536.87 g $plant^{-1}$ while in herbicidal treatment *fb* hand weeding T_6, 519.85 give better performance and which is also statistically on par with T_7. And lowest was observed in the weedy check 328.69 g $plant^{-1}$, such decline is due to high weed pressure and competition, which restricted the crop from efficiently using available resources. These findings are in agreement with the findings of Zubair *et al.,* (2011) [14], who indicated that extended crop-weed competition drastically decreased cane weight and biomass.

Number of millable cane

All treatments had significantly higher millable canes than the weedy check (T_8). The treatment with the largest mean number of millable canes was the weed free check (T_7) (86.67 thousand ha^{-1}), which was statistically at par to post emergence application of T_6 (83.33 thousand ha^{-1}) and T_4 (80.00 thousand/ha). This may be the result of successful suppression of weeds which was the result of minimizing the divergence of available resource flow, together leading to lower tiller mortality and higher number of millable canes. Lowest number of millable cane (43.33 thousand ha^{-1}) was noticed in weedy check (T_8) due to competition for resources. Similar findings were revealed by Raskar (2004) [8], Shrivastav *et al.,* (2005), Singh *et al.* (2016) [10], and Ombase *et al.* (2019) [4].

Effect of weed management on Yield parameters

Cane girth

Girth of millable cane came was not having statistically significant effect of weed management treatments. These findings are consistent with the earlier work of Raskar *et al.* (2004) [8].

Number of internodes

The number of internodes were highest noted in the weed free (T_7) (17.73), in herbicidal treatments T_6 have 17.43 and the lowest was observed in weedy check, 14.40. The same findings were noted by the Raskar *et al.* (2004) [8].

Length of internodes

The length of internodes was affected by the high weed population because the utilize more resources in comparison to weed free period. So, the maximum length of internodes was found in the weed free (T_7) 12.28 cm, T_6 11.84 cm, T_4 11.63 cm, T_5 11.57 cm which is on par with the T_7 and minimum were noted in the weedy check (T_8) 10.28 cm. The same observation was also observed by Ramesh and Sundri (2006) [6].

Cane yield

All the treatments of weed control were statistically significantly better than the weedy check (T_8) 44.49 t ha^{-1}. Between the treatments T_6 realized 135.83 t ha^{-1}, which was statistically on par with the weed-free check (T_7) 140.52 t ha^{-1}, the high yield was observed due to better management of weed population during crop growth period but mostly suppression of weed at critical crop weed competition period.

Tr	Tillers (thousand ha^{-1})	Plant Height (cm)	Dry matter accumulation (g $plant^{-1}$)	Number of millable cane (000 ha^{-1})	No. of internodes $Cane^{-1}$	Girth of milable cane (cm) $Cane^{-1}$	Length of internode (cm) $Cane^{-1}$	Cane yield (t ha^{-1})
T_1	91.7	312.3	422.8	66.67	16.00	10.93	11.09	119.00
T_2	96.5	316.1	433.0	70.00	16.13	11.06	11.21	121.50
T_3	94.4	313.7	493.4	73.33	16.27	11.11	11.25	125.13
T_4	103.5	337.9	510.9	80.00	16.53	11.18	11.63	132.00
T_5	102.8	335.2	511.1	76.67	16.47	11.04	11.57	128.73
T_6	103.5	347.4	519.9	83.33	17.43	11.21	11.84	135.83
T_7	106.3	351.4	536.9	86.67	17.73	11.24	12.28	140.52
T_8	76.4	271.5	328.7	43.33	14.40	10.25	10.28	44.49
S.Em+	2.96	11.30	19.9	3.18	0.46	0.33	0.28	3.33
CD @ 5%	8.98	34.28	60.3	9.65	1.39	NS	0.86	10.11

Conclusion

Weeds cause major problems in *suru* sugarcane growth and yield reduction in cultivar PDN 15012. Maximum growth and yield reduction was observed in weedy check (T_8) treatment and the maximum growth and yield were achieved in weed free (T_7) and T_6 (Post emergence application of 2,4-D Sodium salt (440 WG) + Metribuzin (350 WG) + Pyrazosulfuron- ethyl (10 WG) (ready mix) @ 3 kg a.i. ha^{-1} at 15-20 DAP *fb* hand weeding at 60 DAP) treatments. These treatments significantly improved crop performance. Based on the experiment findings in sugarcane field integrated weed management practices help to reduce critical period of crop weed competition (120 days after planting), which help to maximize the growth and yield.

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