



Evaluation of Integrated Weed Management in Sugarcane

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Abstract: This study aimed to evaluate the effectiveness of Integrated Weed Management (IWM) strategies on sugarcane yield and productivity in Nepal. The trial was conducted during 2020-2021 at the National Sugarcane Research Program, Jeetpur, Bara. The trial was laid out in a randomized complete block design with three replications and 12 weed management treatments, including various herbicides, plastic mulching, intercropping, and hand weeding. The results showed that plastic mulching was the most effective treatment, yielding 122.44 t/ha, significantly reducing weed density, and improving plant height and millable cane count. Similarly, the combination of Atrazine + Metribuzin (Pre) followed by 2,4-D (Post) produced high yields of 107.05 t/ha and 107.31 t/ha in both years, demonstrating strong weed control. These results confirm that minimizing weed competition through effective management strategies can promote optimal sugarcane growth, improving yield and overall productivity. The study highlights the crucial role of efficient weed management in enhancing sugarcane farming in Nepal.

Keywords: Herbicide, Weed Density, Sugarcane, Mulching, Yield.

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1. Introduction

Sugarcane (*Saccharum officinarum* L.) is a key cash and industrial crop in Nepal, significantly contributing to the national economy. The crop's cultivation has expanded substantially in recent decades due to increasing demand for sugar and related products. From 1985 to 2019, the area under sugarcane cultivation in Nepal grew fourfold, from 17,480 hectares to 68,565 hectares, while total production surged from 408,260 tons to 3,400,175 tons (MoAD, 2020). Despite these increases, Nepal ranks 34th globally among sugarcane-producing countries (FAOSTAT, 2018), with national productivity averaging 49.59 tons per hectare (MoAD, 2020). This relatively low productivity highlights the need for improved agricultural practices, particularly in weed management, which is a key factor influencing sugarcane yield and quality.

Weeds compete with sugarcane for essential resources such as water, nutrients, light, and space, leading to significant yield reductions if not effectively controlled. Research across various regions has documented substantial yield losses due to weeds, with typical reductions ranging from 28-38% (Singh & Tamor, 2005). In extreme cases, such as in Thailand and Ethiopia, yield losses due to weeds have reached as high as 70-80% (Suwanarak, 1990; Yirefu et al., 2013). In India, cane yield losses have been reported to range from 12-72%, depending on the region and weed species present (Rana & Rana, 2016). Similarly, the Australian sugarcane industry faces annual losses estimated at \$70 million due to weeds (Epe, 2018). In Nepal, particularly in regions like Nawalparasi, weed infestation poses a significant challenge, with a weed index value

of 0.7 reflecting the severity of the problem (Bharati et al., 2018). Traditional weeding practices, which rely heavily on manual labor, are becoming increasingly unsustainable due to labor shortages, high costs, and the labor-intensive nature of the work. There is a positive correlation between the frequency of weeding and sugarcane yield in Nepal, with a 1% increase in weeding frequency resulting in a 0.288% yield increase (Pandey & Devkota, 2020). However, these traditional methods are less viable under current conditions, underscoring the need for more efficient and sustainable weed management approaches, such as Integrated Weed Management (IWM).

IWM is a comprehensive strategy that combines chemical, mechanical, biological, and cultural practices to manage weed populations effectively and sustainably. This approach is particularly well-suited to Nepal's diverse agricultural conditions, offering a flexible framework that can be tailored to the specific needs of different sugarcane-growing regions. IWM reduces reliance on chemical herbicides, minimizing environmental risks and the development of herbicide-resistant weeds. It also integrates cultural practices like mulching and intercropping, which suppress weed growth and improve soil health, further enhancing the sustainability of sugarcane farming. Economically, IWM reduces production costs by optimizing herbicide use and lowering labor requirements, making sugarcane farming more cost-effective. Improved weed control through IWM leads to higher yields, increasing the economic viability of sugarcane farming and contributing to the agricultural sector's overall productivity and profitability in Nepal. Therefore, adopting IWM is crucial for

addressing the persistent challenges of weed management in sugarcane cultivation, improving productivity, ensuring environmental sustainability, and securing the future of sugarcane farming in Nepal. Thus, an experiment was conducted at NSRP, Jeetpur to evaluate the effectiveness of Integrated Weed Management (IWM) strategies in enhancing sugarcane yield and productivity in Nepal.

2. Materials and Methods

Experimental site

The field experiment was conducted at the research block of the National Sugarcane Research Program in Jeetpur, Bara, Nepal, during the 2020-2021 growing season. The research site is situated at 27°06'48" N latitude and 84°57'07" E longitude, with an elevation of 98 meters above sea level. The area experiences a hot and humid climate during the summer and cooler conditions in winter. The average maximum temperature at the site ranges from 22.7°C to 34.5°C, while the average minimum temperature varies

between 8.5°C and 25.9°C. The site receives an average annual rainfall of 1550 mm.

The soil exhibited a grayish-brown color and a sub-angular blocky structure. The texture was identified as sandy loam. The soil pH was measured as moderately acidic, with a value of 5.96. The organic matter content was low, recorded at 1.0%. Similarly, the total nitrogen content was low, with a value of 0.06%. In contrast, the available phosphorus level was high, measuring 33.76 ppm, and the extractable potassium content was also high, at 145.29 ppm.

Experimental design and treatment details

The experiment was conducted in a randomized complete block design with three replications. A total of twelve treatments were included in the experiment and their details are given in Table 1. The size of each plot was 22.5 m².

Details of treatments

S.N.	Details of treatments	Symbol
1	Atrazine@ 2.0 kg a.i./ha + Metribuzin @ 0.5 kg a.i./ha as pre-emergence	Atrazin + Metribuzin (Pre)
2	Oxyfluorfen@ 0.3 kg a.i./ha as Pre-emergence	Oxyfluorfen (Pre)
3	Atrazine@ 2.0 kg a.i./ha + Metribuzin @ 0.5 kg a.i./ha as pre-emergence fb 2,4-D Amine Salt @1.5 kg a.e./ha as post-emergence	Atrazine + Metribuzin (Pre) fb 2,4-D (Post)
4	Oxyfluorfen @ 0.3 kg a.i./ha as pre-emergence fb 2,4-D Amine Salt @1.5 kg a.e./ha as post-emergence	Oxyfluorfen (Pre) fb 2,4-D (Post)
5	Plastic mulching 25 micrometers (µm)	Plastic Mulching
6	Pea intercropping @ 75 kg/ha	Pea intercropping
7	Tembotrione @0.1 kg a.i./ha as post-emergence	Tembotrione (Post)
8	Atrazine@ 2.0 kg a.i./ha + Metribuzin @ 0.5 kg a.i./ha as pre-emergence fb Tembotrione @0.1 kg a.i./ha as post-emergence	Atrazine + Metribuzin (Pre) fb Tembotrione (Post)
9	Pendimethalin @ 1.5 kg a.i./ha as pre-emergence fb Tembotrione @0.1 kg a.i./ha as post-emergence	Pendimethalin (Pre) fb Tembotrione (Post)
10	Atrazine@ 2.0 kg a.i./ha + Pendimethalin @ 1.5 kg a.i./ha as pre-emergence	Atrazin+Pendimethalin (Pre)
11	Hand weeding @ 45 days after sowing and 90 days after sowing	Hand weeding
12	Control (no weeding)	Control

Cultural practices

The land was prepared with a mouldboard to remove the hard pan of the soil and then with a rotavator to obtain a fine seed bed and finally levelled. The ridges were made at a row spacing of 0.90 m and the sets having two buds of sugarcane variety Co-05011 were placed in the furrows and covered with thin layers of soil. The sowing date was 14 December, 2022 and harvesting was 27 January 2023. The fertilizer applied at the rate of 150:60:40 NPK kg/ha. Other cultural practices were done as per sugarcane production technology recommendations by the National Sugarcane Research Program, Jeetpur, Bara.

Observations recorded and data analysis

The number of millable canes and cane yield per plot were recorded at the time of harvest after removing leaves and the top portion and converted into per hectare. Weed species will be counted from 1m² quadrants on different days after sowing and weed density was calculated.

The recorded data were subjected to analysis of variance (ANOVA) and treatment means were separated using the least significant test (LSD) at a 5% level of significance. The GenStat discovery 15th edition software was used for ANOVA and mean separation test.

3. Results and Discussion

The dominant broadleaf weeds observed in the sugarcane experimental field included *Ageratum* spp., *Amaranthus* spp., *Argemone mexicana* L., *Solanum nigrum* L., and *Vicia sativa* L. The dominant narrow-leaf weeds included *Cynodon dactylon* (L.) Pers., *Cyperus* spp., *Eleusine indica* (L.) Gaertn., *Echinochloa* spp., *Dactyloctenium aegyptium* (L.) Willd., and *Digitaria sanguinalis* (L.) Scop., among others.

Impact on Weed Dynamics

In 2078/79, plastic mulching exhibited significantly reduced weed densities of 8, 10, and 13.67/m² at 45, 90, and 135 days after sowing (DAS) with the weed control (WC) percentage of 90.78, 82.47, and 81.75 respectively compared to the un-weeded plot (table 1). Similarly, in 2079/80, weed densities were further significantly reduced to 1.67, 0.33, and 0 at 30, 90, and 135 DAS, with WC reaching 96.2%, 99.4%, and 100% (table 3). The minimal weed density observed under plastic mulching indicates its capacity to suppress weed emergence and growth through physical barriers. These results align with previous findings by Singh et al. (2018), who reported that mulching effectively reduced weed competition in sugarcane fields. The pre-emergent application of Atrazine + Metribuzin and post emergence application of Atrazine + Metribuzin followed by (fb) 2,4-D as post emergence also performed well with a WC % of 83.8, and 70.7 in both the years (table 1 and 3). Chauhan and Abugho (2013) found that pre-emergent herbicides like Atrazine and Metribuzin effectively suppressed early-stage weed growth, minimizing competition for resources critical for sugarcane establishment. Similarly, Singh et al. (2018) reported significant reductions in weed density and improved crop yields with these herbicides.

Effect on Sugarcane Growth and Yield

Plastic mulching produced the significantly higher yield in both the years (112 and 122.4 t/ha), with superior plant height (205.7 and 227 cm) and millable cane count (106,667 and 123148 per hectare) (table 2 and 4). These findings are consistent with the hypothesis that effective weed control reduces competition for nutrients, water, and light, thereby promoting optimal crop growth (Singh et al., 2016). Similarly, Pre emergence application of Atrazine + Metribuzin followed by 2,4-D Sodium salt as post emergence also showed a significant positive impact, yielding 91.87 t/ha in 2078/79 (table 2). In 2079/80, the combination of Atrazine + Metribuzin (Pre) gave a yield of 107.05 t/ha, while Atrazine + Metribuzin (Pre) fb 2,4-D (Post) gave a very similar yield of 107.31 t/ha (Table 4). There was strong negative correlations between cane yield and weed density (Figure 1 & 2). These herbicide treatments are known for their strong weed control capabilities, which help in reducing weed competition and promoting healthy crop growth (Singh et al., 2019). The pre-emergence herbicides, especially when followed by post-emergence applications like 2,4-D, allow for better weed suppression throughout the growing season, leading to higher yields. This finding is consistent with studies showing that herbicide-based weed control can be a highly effective strategy for improving sugarcane productivity, though attention must be paid to proper herbicide management to avoid crop injury and environmental concerns (López et al., 2018).

4. Conclusion

The study indicates that effective weed management significantly enhances sugarcane yield and growth. Among various treatments, plastic mulching emerged as the most effective in controlling weed density, achieving high weed control percentages (WC) and resulting in the highest yield (122.44 t/ha) with superior plant height and millable cane count. Similarly, the herbicide combination of Atrazine + Metribuzin (Pre), followed by 2,4-D (Post), showed strong weed control, leading to yields of 107.05 t/ha and 107.31 t/ha, confirming the efficacy of pre- and post-emergence herbicide treatments. Weed competition, particularly from broadleaf and narrowleaf weeds, was effectively minimized by both plastic mulching and herbicide applications, resulting in optimal conditions for sugarcane growth and high productivity.

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