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COMPARATIVE OF CULTURAL AND CHEMICAL CONTROL FOR WEED SUPPRESSION IN MAIZE (*ZEA MAYS*) CULTIVATION

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Abstract:

Weed suppression is a critical factor in maize (*Zea mays*) cultivation, influencing crop growth and yield. This study aimed to compare the effectiveness of cultural (silver shine mulching) and chemical (Atrazine herbicide) weed control methods in maize production. The experiment included three treatments consist of T1 (without control), T2 (mulching), and T3 (herbicide application). Various agronomic parameters including plant height, dry weight of cob, biomass, number of productive tillers, and weed dry weight were evaluated. The results indicated that T2 and T3 significantly reduced weed biomass compared to T1, with no significant difference between T2 and T3 in weed suppression. T2 exhibited an ecofriendly and sustainable approach, while T3 provided rapid and effective weed control. Additionally, maize plants in T2 and T3 had higher biomass and cob weight due to reduced competition of weeds for nutrients. The study concludes that both mulching and herbicide application are viable weed management strategies, with the choice depending on cost, labor availability, and environmental considerations. Future research should explore the long-term impacts of these methods on soil fertility and other significant issues.

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Keyword:

Herbicides, Maize (Zea Mays), Silver Mulch, Weed Density, Weed Suppression

Introduction

Maize is one of the most important cereal crops globally, serving as a staple food and a key component in animal feed including in Malaysia and also for industrial applications at certain developing countries (Nik, 2023). However, more than a third of the global population uses maize as their main source of nutrition, especially in sub-Saharan Africa, Southeast Asia and Latin America (Guzzon et al., 2021). Weed infestation in maize cultivation is a major challenge affecting plant growth and yield. Uncontrolled weed populations compete with maize plants for essential resources such as nutrients, water, space and others which leading to significant yield losses. The uncontrolled presence of weeds also causes environmental, economic and health problems. Among the many plant pests, weeds are the most dangerous and need to be emphasized because weeds cause the highest yield loss (37%), while animals (18%), diseases (16%) and viruses (2%) respectively. Kaur et al., (2024) reported that bentgrass (*Agrostis stolonifera*) absorbed more phosphorus (P) than crop plants on acidic soils deficient in P. For cereal crops, the presence of weed seeds decreased the market value of the yield to a large extent (Maqsood et al., 2020). Thus, farmers commonly rely on chemical herbicides for quick and effective weed control, but excessive chemical use poses risks of soil degradation, environmental pollution and herbicide resistance. Alternatively, cultural weed control methods such as mulching offer a sustainable solution but require higher labor and material costs. This study seeks to determine weed control method consists of mulching or herbicide application, which is more effective in suppressing weeds while promoting maize growth and yield.

Literature Review

Maize (*Zea mays*), a member of Poaceae family and the Maydae tribe. It is a cereal crop native to Mexico and Central America, which highly adaptable to diverse agroecological conditions and serves as a major global food source, contributing over 30% of caloric intake for more than 4.5 billion people in 94 developing countries (Shiferaw et al., 2021, Gheith et al., 2022). Maize establishes in warm, humid climates with well-structured, slightly acidic to neutral soils, requiring temperatures between 18°C and 33°C and annual rainfall of 600–1500 mm (Alptekin et al., 2023, Canadia Food Inspection Agency, 2021). Macronutrients such as phosphorus, nitrogen and potassium are crucial for optimum maize growth performance and yield production. Maize used for human consumption, livestock feed, and as a raw material for industrial products like oil, alcohol, and starch (Lone et al., 2021, Ly et al., 2023). Besides that, maize flour contains mineral and vitamins as well as recorded has the most kcal per 100g (355 kcal with 15% moisture) followed by wheat flour (352 kcal) and rye flour (348 kcal). Oerke et al., (2005) revealed that under weed pressure, maize yield decreased by 37%. Yield is significantly impacted by weed invasion, predominantly during early growth stages. Dominant and common weed found in maize consists of *Cyperus* spp., *Amaranthus viridis, Ageratum conyzoides, Eleusine indica* and others reducing plant height and maize yield nearly 30% (Tong & Lim, 2022, KnezEvic et al., 1995).

Several weed control methods have been applied for maize cultivation consist of physical, mechanical, cultural, biological and chemical control. Common application of herbicides names Atrazine is effective but poses concerns for soil microbial health due to its persistence and slow degradation (Liu et al., 2023, Singh et al., 2024). Besides that, persistence and excessive used of herbicides could lead to herbicides resistance. Cultural control refers to the manipulation of the crop environment to make it less conducive to pest attack and weed infestation, including practices such as crop rotation, planting time, mulching, sanitation, and optimal plant spacing (Radosevich et al., 2007). Alternatively, cultural methods like silver shine mulching help suppress weed density, conserve soil moisture, and enhance crop productivity while also reducing pest infestations (Ahirwar et al., 2023, Hutton & Handley, 2007). Proper nutrient application and timely management, particularly during key growth stages such as 25 and 40 days after transplanting (DAT), are crucial to ensure vigorous growth and maximum yield (Miao et al., 2022).

Methodology

Research Design

The experiment was conducted using a Randomized Complete Block Design (RCBD) with three treatments consist of T1 (control), T2 (silver shine mulching) and T3 (Atrazine herbicide application).

Table 1: Layout of Experimental Design

BLOCK 1	BLOCK 2	BLOCK 3	BLOCK 4
T1	T3	T2	T3
T2	T2	T3	T1
T3	T1	T1	T2

Planting Procedure

The maize variety used was 988 King Corn and the study was conducted under controlled greenhouse conditions. Seeds were treated with fungicide (Thiram, 80% w/w) before used in the experiments. Maize seeds were soaked in water and germinated in a seedling tray filled with peatmoss. The watering was done twice daily, early morning and late evening. The germinated seeds were transplanted into polybags sizes 16 cm X 16 cm upon 10 to 14 days after sowing. About 11 kg of soil from UiTM Jasin's share farm was placed in all polybags. For cultural weed control, silver shine mulch was applied to the soil surface before transplanting of the seedlings while, chemical control method requires Atrazine application upon seedlings at 15-20 days and again at 40 days (Shukla et al., 2023).

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Maize Growth Performance

The samples were collected at different growth stages of maize to assess the effects of weed management techniques. Sampling was carried out systematically, ensuring consistency across all treatments. Growth parameters such as plant height (cm), stem diameter (cm) and number of productive tillers were recorded during the harvesting stages. Cobs were harvested at maturity, dried and weighed to assess yield differences among treatments.

Weed Biomass and Composition

Weed biomass was collected by manually uprooting from designated sample plots, dried in a controlled environment and weighed to determine dry biomass weight. Weed composition refers to identifying weed species in each treatment area and their density. The density was calculated as the number of weed plants per unit area, providing insights into the dominance and competitiveness of different weed species. This helps in understanding the weed suppression efficiency of each treatment. All collected data were recorded systematically and subjected to statistical analysis using SPSS software to determine treatment effects.

Data Analysis

The data obtained were statistically analysed by one-way ANOVA using Statistical Package for the Social Sciences (SPSS) version 21.0. The significant differences among treatments were tested using Tukey post hoc.

Results and Discussion

This study evaluated the comparative effectiveness of cultural (silver shine mulching, T2) and chemical (atrazine herbicide, T3) weed control methods against a control (T1) in maize (*Zea mays*) cultivation under greenhouse conditions. The following results, summarized in Table 2, highlight the efficacy of each treatment and its implications for maize productivity and sustainable weed management.

Table 2: Comparative Effects of Weed Management Treatments on Maize Growth and Weed Suppression

Parameter	T1 (Control)	T2 (Silver Mulching)	T3 (Atrazine Herbicide)
Plant Height (cm)	$112.60^{a} \pm 3.34$	$151.58^{a} \pm 3.34$	$122.58^{a} \pm 3.34$
Number of Productive Tillers	$8.60^{a} \pm 0.23$	$8.57^{a} \pm 0.23$	$8.77^{a} \pm 0.231$
Stem Diameter (cm)	$5.94^{a} \pm 0.11$	$6.14^{a} \pm 0.11$	$6.09^{a} \pm 0.111$
Dry Weight of Cob (g)	$31.65^{a} \pm 5.99$	$39.95^{a} \pm 5.99$	$34.05^{a} \pm 5.99$
Dry Weight of Biomass Plant (g)	$35.65^{a} \pm 3.34$	$37.00^{a} \pm 3.34$	$39.55^{a} \pm 3.34$
Dry Weight of Weeds (g)	$0.21^{a} \pm 0.05$	$0.011^{a} \pm 0.05$	$0.012^{a} \pm 0.05$

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Notes: Values are presented as mean ± standard error.

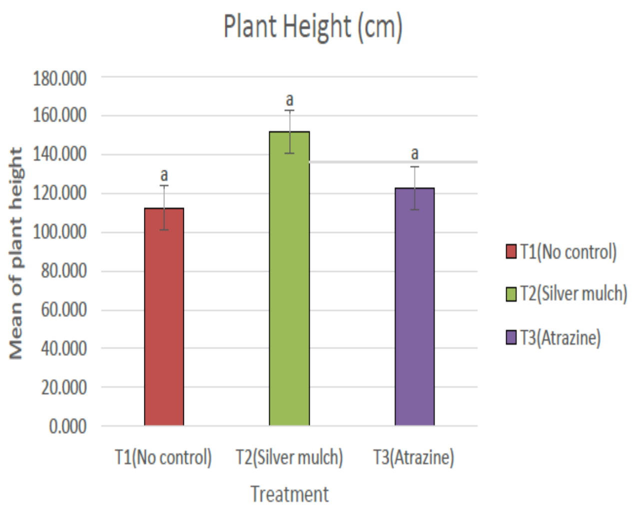

Figure 1: Graph of Mean Comparison for Plant Height (cm)

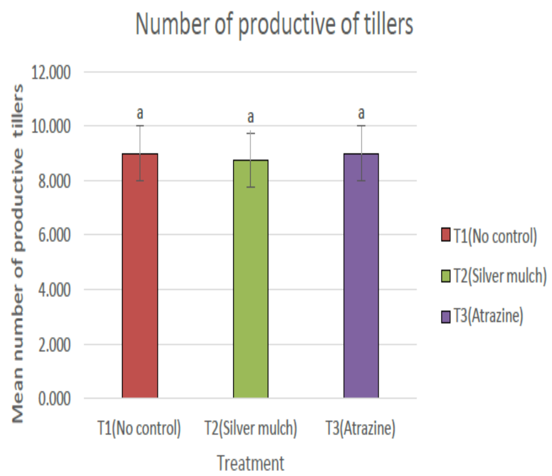

Figure 2: Graph of Mean Comparison for Number of Productive Tillers

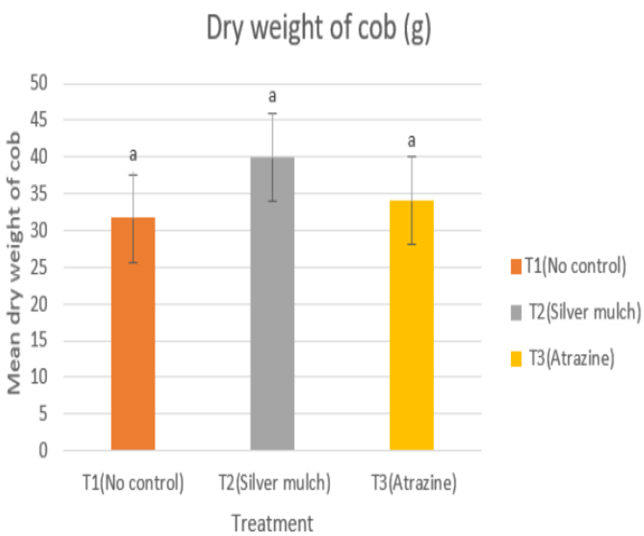

Figure 3: Graph of Mean Comparison for Weight of Cob (g)

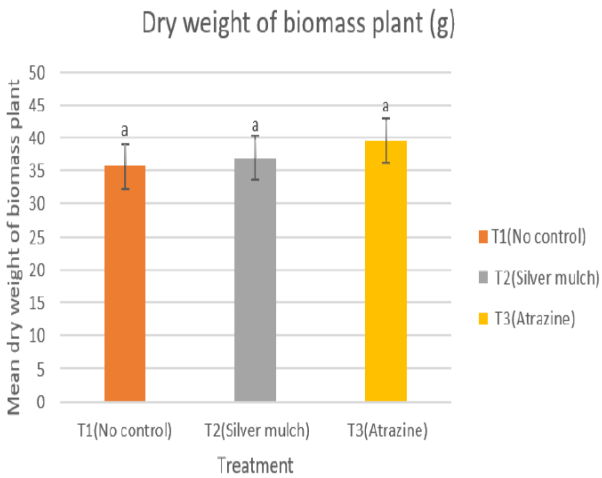

Figure 4: Graph of Mean Comparison for Dry Weight of Biomass Plant (g)

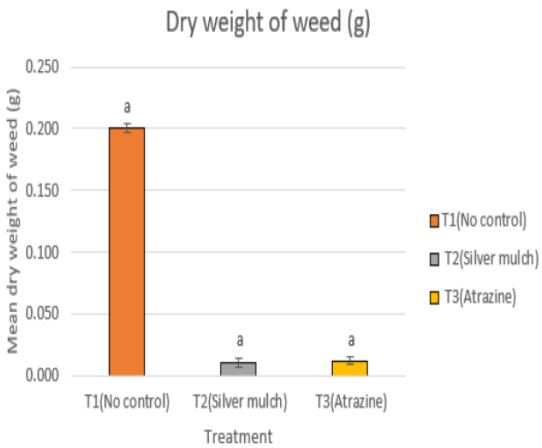

Figure 5: Graph of Mean Comparison for Dry Weight of Weeds (g)

Table 2, Figure 1, Figure 2, Figure 3, Figure 4 and Figure 5 illustrate the efficacy of silver shine mulching (T2) and atrazine herbicide application (T3) in inhibiting weed biomass relative to the control treatment (T1). T2 and T3 decreased weed dry weight to 0.011 g and 0.012 g, respectively, in contrast to 0.201 g in T1. This is consistent with the research by Iqbal et al., (2020), which indicated that mulching establishes a physical barrier restricting light and moisture access, thereby impeding weed germination and growth. Likewise, T3's efficacy is due to atrazine's chemical suppression of weed proliferation, offering swift management as evidenced by (Rajcan & Swanton, 2001).

In terms of maize growth performance, T2 attained the greatest plant height (151.58 cm) and cob weight (39.95 g), suggesting that silver mulching promotes ideal growth circumstances by preserving soil moisture and minimizing weed competition. These findings align with Iqbal et al., which indicated that reflective silver mulch improves maize growth parameters and grain yield by modulating soil microenvironments. T3, exhibiting a plant height of 122.58 cm and cob weight of 34.05 g, surpassed T1 at 112.60 cm and 31.65 g respectively, but was inferior to T2. Nevertheless, maize in T3 may exhibit slower growth due to atrazine's mild phytotoxic

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effects, as stated by Khan et al., 2016. T3 had the highest dry biomass weight at 39.55 g, indicating that herbicide implementation may improve overall plant vigour by reducing weed competition, consistent with the findings of Ghosh et al., (2020).

Despite numerical variations, statistical analysis revealed no significant differences among treatments regarding plant height, number of productive tillers, cob weight and biomass weight. This suggests that whereas T2 and T3 enhanced maize growth relative to T1, which potentially due to external variables such as soil conditions or the greenhouse environment (Lamidi & Afolabi, 2017).

Conclusion and Recommendation

This study concludes that silver shine mulching and atrazine herbicide application are effective weed control methods in maize cultivation. Mulching provides a sustainable and environmentally friendly approach by improving soil health and moisture retention, while herbicide application offers rapid and efficient weed suppression. However, excessive reliance on chemical herbicides can lead to long-term soil degradation and herbicide resistance. Based on these findings, it is recommended that farmers adopt an integrated weed management approach which by combining mulching with selective herbicide use to maximize maize productivity while minimizing environmental risks. Future research should focus on the long-term effects of these methods on soil quality, cost effectiveness and the potential for alternative organic weed control techniques to enhance sustainability in maize production.

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