

Effect of Bamboo Leaf Litter Mulch on Weed Suppression of Sweet Corn (*Zea mays saccharata* Sturt)

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Abstract

The issue of weed competition becomes increasingly critical in sweet corn cultivation when weeds are not controlled during the early stages of crop growth. This study aimed to determine the appropriate application rate of bamboo leaf litter mulch for effective weed suppression while simultaneously enhancing the growth and yield of sweet corn. The experiment was conducted within the experimental area of the Faculty of Agriculture, Universitas Gunung Leuser, Kutacane, Aceh Province, Indonesia. The experiment was arranged using a non-factorial Randomized Complete Block Design (RCBD) consisting of three treatment and three replications. The treatments were defined as D0=0, D1=2, D2=4 kg m⁻¹ of bamboo leaf litter mulch, which correspond to 0, 20, 40 t ha⁻¹, respectively. The observed variables included weed control percentage, weed cover, number of weed species, weed population density, and fresh weed biomass. Crop growth parameters were also recorded, including plant height, stem circumference, and number of leaves at 10, 20, 30, and 40 DAP. Yield-related parameters consisted of ear diameter, ear length, ear weight, kernel weight, and dry shelled grain yield. Application of bamboo leaf litter mulch at 20 t ha⁻¹ effectively enhanced weed control percentage at 10 and 20 DAP reach 60 to 93.67%, while reducing weed cover percentage at 10, 20, and 30 DAP reach 5,33 to 23,33%, as well as decreasing weed fresh weight at 20 DAP. Furthermore, this treatment promoted sweet corn growth by increasing plant height at 20 and 40 DAP, leaf number at 30 DAP, and improving cob length, cob weight, and grain yield of sweet corn.

Keywords: bamboo leaf litter, weed suppression, yield of sweet corn

1. Introduction

The success of sweet corn production systems is not determined solely by the genetic potential of the crop and the availability of production inputs, but also by the ability of the

agroecosystem to regulate interactions among organisms occurring within it. One of the biotic components that exerts the most substantial influence on the growth dynamics of sweet corn is the presence of weeds in the surrounding environment. Weeds are generally defined as plants that grow in undesirable locations and have the potential to interfere with agricultural production systems. Their presence should not merely be viewed as spontaneous vegetation; rather, weeds function as competitive organisms possessing highly efficient ecological adaptation strategies that enable them to exploit environmental resources effectively [1], [2].

The presence of weeds triggers interspecific competition between weeds and sweet corn plants. This competition involves the contest for essential resources such as sunlight, water, nutrients, and growing space. Weed species that exhibit faster growth rates and superior physiological adaptability often dominate the acquisition of these resources, thereby reducing their availability to sweet corn plants. Consequently, sweet corn experiences competitive stress that can diminish the efficiency of physiological processes including photosynthesis, respiration, and assimilate translocation [3], [4], [5]. Agronomic losses caused by weeds are not restricted to competition for growth resources alone, but are also associated with alterations in the vegetation community structure within agroecosystems. The dominance of particular weed species may modify the microclimatic conditions surrounding crop plants, including light intensity, temperature, and air humidity [6].

The issue of weed competition becomes increasingly critical in sweet corn cultivation when weeds are not controlled during the early stages of crop growth. Under such circumstances, competition may persist throughout the critical period of crop development. The critical period of weed interference represents the stage at which weed presence exerts the greatest impact on yield reduction. In sweet corn, weed competition during this period can restrict leaf area development, reduce photosynthetic capacity, and interfere with plant biomass accumulation. These physiological disturbances subsequently affect ear formation, reduce ear size, and ultimately decrease kernel quality [7]. Various weed management strategies have been developed to minimize these negative impacts. Weed control approaches are commonly categorized into mechanical, chemical, and ecological methods [8]. Among these approaches, ecologically based weed management strategies have gained increasing attention.

One promising strategy is the use of organic mulch as a soil surface cover. Organic mulch functions by modifying the soil microenvironment, thereby suppressing weed germination and growth [9], [10]. The mulch layer covering the soil surface reduces light penetration, which is required by many weed seeds to initiate germination. In addition, organic mulch provides several agronomic benefits for both soil and crop plants. During decomposition, organic materials derived from mulch contribute to increasing soil organic matter content, improving soil structure, enhancing cation exchange capacity, and stimulating biological activity through the proliferation of soil microorganisms [11], [12]. These improvements in the physical and biological stability of soil ultimately create a more favorable environment for crop growth and development.

One biomass resource with considerable potential for use as organic mulch is bamboo leaf litter. Bamboo leaves represent abundant natural litter in tropical environments and are often underutilized in agricultural systems. Bamboo leaves contain allelochemical compounds capable of influencing seed germination and plant growth [13]. These compounds may exert allelopathic effects on weed seeds located both on the soil surface and within the upper soil layer [14], [15]. Therefore, the use of bamboo leaf litter as mulch may function not only as a physical barrier but also as a biochemical agent capable of suppressing weed population dynamics within

agroecosystems [16], [17]. The effectiveness of organic mulch in suppressing weed growth is strongly influenced by the application rate used. Insufficient mulch thickness often fails to adequately cover the soil surface, allowing weeds to germinate and grow [18]. Bamboo leaves contain relatively high levels of lignin and cellulose, resulting in a slower decomposition rate compared to softer leaf mulches. This characteristic prolongs soil surface protection and reduces the frequency of mulch reapplication. Based on these considerations, research examining the effects of different application rates of bamboo leaf litter mulch on weed dynamics as well as on the growth and yield of sweet corn is necessary. This study aimed to determine the appropriate application rate of bamboo leaf litter mulch for effective weed suppression while simultaneously enhancing the growth and yield of sweet corn.

2. Material and Methods

The experiment was conducted within the experimental area of the Faculty of Agriculture, Universitas Gunung Leuser, Kutacane, Southeast Aceh Regency, Aceh Province, Indonesia. The study was carried out from September to November 2025. The materials utilized in this research included sweet corn (*Zea mays saccharata* Sturt.) seeds and bamboo leaf litter used as organic mulch. The equipment employed during the experiment consisted of hoes, cutter knives, measuring tapes or rulers, an analytical balance, sampling frames, sacks, and standard stationery for field data recording. The experiment was arranged using a non-factorial Randomized Complete Block Design (RCBD) consisting of three treatment levels and three replications, resulting in nine experimental plots, number of plants per plot as many as 16. The treatments were defined as D0 = 0 kg m⁻¹, D1 = 2 kg m⁻¹, and D2 = 4 kg m⁻¹ of bamboo leaf litter mulch, which correspond to 0, 20, and 40 t ha⁻¹, respectively. The organic mulch was applied at the time of planting. The observed variables included weed control percentage, weed cover, number of weed species, weed population density, and fresh weed biomass. Crop growth parameters were also recorded, including plant height, stem circumference, and number of leaves at 10, 20, 30, and 40 days after planting (DAP). Yield-related parameters consisted of ear diameter, ear length, ear weight, kernel weight, and dry shelled grain yield. All data collected from field observations were statistically analyzed using analysis of variance (ANOVA). When significant treatment effects were detected, mean separation was performed using Duncan’s New Multiple Range Test (DNMRT) at a 5% significance level.

3. Results and Discussion

Weed Suppression Percentage (%)

Table 1. Average percentage of weed suppression at 10, 20, 30, and 40 days after planting (DAP) as affected by the application rate of bamboo leaf litter organic mulch in sweet corn cultivation.

Treatment	Weed Suppression Percentage			
	10	20	30	40
<u>application rate of bamboo leaf litter organic mulch</u>	----- % -----			
0 t ha ⁻¹	55.67a	23.33a	21.67a	0.00a
20 t ha ⁻¹	93.67b	76.67b	65.00a	26.67a
40 t ha ⁻¹	93.00b	60.00b	58.33a	20.00a

The numbers followed by the same letter in the same column are not significantly different in Duncan’s 5% test.

Table 1 indicates that the application rate of bamboo leaf litter organic mulch exhibited a pronounced weed-suppressive capacity, particularly during the early growth stages. This phenomenon suggests that the presence of mulch functions as an ecological barrier that modifies

the microhabitat conditions at the soil surface. The mulch layer restricts the penetration of light radiation and reduces fluctuations in soil temperature, both of which act as physiological cues that stimulate the germination of weed seeds in the soil seed bank. Many weed species require light stimuli and temperature variation to break seed dormancy; therefore, soil surfaces covered by mulch tend to inhibit the germination process [19], [20], [21]. Furthermore, the results also demonstrate that the percentage of weed suppression gradually declined across the observation periods. This decline indicates the occurrence of ecological dynamics between mulch decomposition processes and the adaptive capacity of weeds under environmental pressure. From a biogeochemical perspective, organic mulch gradually undergoes fragmentation and mineralization due to the activity of soil microorganisms, leading to a less compact soil-covering structure [16], [22]. Under such conditions, a proportion of weed seeds may regain access to light and growing space that was previously restricted. In addition, several weed species possess adaptive morphological traits, such as the ability for hypocotyl elongation or high early growth vigor, allowing them to penetrate mulch layers that have begun to degrade.

Weed Cover Percentage (%)

Table 2. Average percentage of weed cover at 10, 20, 30, and 40 days after planting (DAP) as affected by the application rate of bamboo leaf litter organic mulch in sweet corn cultivation.

Treatment	Weed Cover Percentage			
	10	20	30	40
<u>application rate of bamboo leaf litter organic mulch</u>	----- % -----			
0 t ha ⁻¹	53.00a	69.67a	70.00a	82.00a
20 t ha ⁻¹	11.33b	18.00b	23.33b	50.00a
40 t ha ⁻¹	5.33c	8.67c	12.00c	33.33a

The numbers followed by the same letter in the same column are not significantly different in Duncan’s 5% test.

Table 2 indicates that the application of bamboo leaf litter organic mulch significantly reduced the percentage of weed cover at 10, 20, and 30 days after planting in sweet corn cultivation. The lower weed cover observed in the mulched treatments was not solely attributed to the physical barrier that restricts weed germination, but was also associated with the limited capacity of weeds to expand their canopy over soil surfaces covered by organic materials. The mulch layer reduces the available space for horizontal colonization, thereby constraining the development of weed canopy architecture [17]. This phenomenon may also be related to the increasing early competition between sweet corn plants and weeds. As sweet corn plants develop, their canopy gradually expands and enhances the shading effect on the soil surface. The combined influence of soil coverage by mulch and shading from the crop canopy leads to a substantial reduction in light intensity reaching the soil surface, which subsequently suppresses the vegetative growth of weeds. Furthermore, an increase in weed cover was observed at each observation period. This pattern is likely associated with the gradual decomposition of mulch materials, which progressively reduces the thickness of the soil-covering layer. Some weed species possessing morphological adaptation strategies, such as creeping growth habits or the ability to produce tillers, can exploit the emerging gaps within the mulch layer [23], [24]. Nevertheless, the bamboo leaf litter mulch applied at 40 t ha⁻¹ consistently resulted in the lowest weed cover, indicating that thicker mulch layers possess a greater capacity to suppress the spatial expansion of weed communities within the sweet corn agroecosystem.

Number of Weed Species

Table 3. Average Number of Weed Species at 10, 20, 30, and 40 days after planting (DAP) as affected by the application rate of bamboo leaf litter organic mulch in sweet corn cultivation.

Treatment	Number of Weed Species			
	10	20	30	40
<u>application rate of bamboo leaf litter organic mulch</u>	-----	-----	-----	-----
0 t ha ⁻¹	5.67a	6.00a	7.00a	27.00a
20 t ha ⁻¹	3.33a	5.33a	5.33a	7.33a
40 t ha ⁻¹	3.33a	3.67a	5.67a	8.33a

Table 3 shows that the application of bamboo leaf litter mulch at different rates has not yet reduced the number of weed species in sweet corn cultivation. This condition indicates that, over time, the weed seedbank present in the soil gradually begins to germinate. In addition, bamboo leaves possess a relatively rigid structure and contain a high proportion of lignocellulosic compounds, resulting in a slower decomposition process [25], [26]. These characteristics allow bamboo leaf residues to persist longer on the soil surface, indicating that the allelopathic compounds contained in the bamboo leaves have not yet been fully decomposed. Weeds exhibit several biological attributes that make them highly competitive within agroecosystems. Most weed species have rapid germination ability, high vegetative growth rates, aggressive rooting systems, and extremely high reproductive capacity [27], [28]. Many weed species are capable of producing thousands to tens of thousands of seeds within a single life cycle, which subsequently accumulate in the soil as part of the weed seedbank. Consequently, the number of weed species tends to remain relatively similar across the different application rates of bamboo leaf litter mulch.

Number of Weed Population

Table 4. Average Number of Weed Population at 10, 20, 30, and 40 days after planting (DAP) as affected by the application rate of bamboo leaf litter organic mulch in sweet corn cultivation.

Treatment	Number of Weed Population			
	10	20	30	40
<u>application rate of bamboo leaf litter organic mulch</u>	-----	-----	-----	-----
0 t ha ⁻¹	6.33a	6.33a	7.00a	7.00a
20 t ha ⁻¹	4.33a	4.33a	5.33a	6.00a
40 t ha ⁻¹	3.00a	5.00a	6.00a	6.00a

Table 4 indicates that the application of bamboo leaf litter mulch at different rates has not yet effectively reduced the weed population in sweet corn cultivation. This finding suggests that several weed species are capable of adapting to environmental conditions modified by mulch application, particularly through more vigorous seedling growth or the ability to penetrate the mulch layer. Furthermore, many weed species possess seed dormancy mechanisms that allow their seeds to persist in the soil for extended periods, sometimes for several years, until environmental conditions become favorable for germination [29], [30]. Such ecological traits make weeds a highly persistent component of agricultural vegetation and difficult to eliminate permanently from cultivated fields [31]. Consequently, the observed weed population tends to remain relatively similar among the different mulch treatments. This pattern is further supported by the number of weed species presented in Table 3, which also shows relatively comparable values across treatments.

Fresh Weed Biomass (g)

Table 5. Average Fresh Weed Biomass at 10, 20, 30, and 40 days after planting (DAP) as affected by the application rate of bamboo leaf litter organic mulch in sweet corn cultivation.

Treatment	Fresh Weed Biomass			
	10	20	30	40
<u>application rate of bamboo leaf litter organic mulch</u>	g			
0 t ha ⁻¹	7.92a	15.83a	22.89a	51.37a
20 t ha ⁻¹	2.80b	3.60b	17.72a	38.20a
40 t ha ⁻¹	2.88b	5.77b	7.49a	26.03a

The numbers followed by the same letter in the same column are not significantly different in Duncan’s 5% test.

Table 5 indicates that the application of bamboo leaf litter mulch at a rate of 20 t ha⁻¹ was capable of reducing the fresh biomass of weeds in sweet corn cultivation. This phenomenon is associated with a sequence of ecological processes initiated following the application of organic bamboo leaf litter mulch. The presence of mulch suppresses weed emergence and growth, which is reflected in the increased percentage of weed control (Table 1). Consequently, the proportion of soil surface covered by weeds becomes lower (Table 2). As weed growth is suppressed, the overall weed biomass produced within the cropping system is reduced, ultimately leading to a decrease in fresh weed weight. These observations suggest the existence of a positive relationship between the level of weed control, the percentage of weed cover, and the resulting fresh weed biomass [32], [33], [34].

Plant Height (cm)

Table 6. Average Plant Height of sweet corn at 10, 20, 30, and 40 days after planting (DAP) as influenced by weed management through the application of bamboo leaf litter organic mulch

Treatment	Plant Height			
	10	20	30	40
<u>application rate of bamboo leaf litter organic mulch</u>	cm			
0 t ha ⁻¹	24.67a	37.33a	59.57a	95.77a
20 t ha ⁻¹	26.33a	49.00b	87.17a	99.33ab
40 t ha ⁻¹	28.33a	49.00b	91.83a	116.77b

The numbers followed by the same letter in the same column are not significantly different in Duncan’s 5% test.

Table 6 indicates that the application of bamboo leaf litter mulch at a rate of 40 t ha⁻¹ was able to increase the plant height of sweet corn at 20 and 40 DAP. The reduction of weed competition within the rhizosphere shared with sweet corn plants enables the crop root system to expand more extensively, thereby enhancing its capacity to absorb water and nutrients. In particular, the availability of essential macronutrients such as nitrogen, phosphorus, and potassium becomes more accessible for crop uptake, which plays a crucial role in supporting vegetative growth of sweet corn. When nutrient availability in the soil improves as a consequence of effective weed suppression, weeds experience nutrient limitation that interferes with cellular division, vegetative tissue formation, and reproductive organ development [35], [36]. This condition ultimately favors crop growth and contributes to the observed increase in plant height. The suppression of weeds allows growth resources such as water, nutrients, and physical growing space to be utilized more efficiently by sweet corn plants. Moreover, bamboo leaf litter mulch contributes to maintaining soil moisture and moderating soil temperature fluctuations, thereby creating a more favorable microenvironment for plant physiological processes. Under these conditions, root-mediated absorption of water and nutrients can proceed more efficiently [37]. Furthermore, the gradual

decomposition of bamboo leaf litter contributes to the enrichment of soil organic matter. Increased soil organic matter improves soil structure, enhances cation exchange capacity, and promotes better soil aeration and porosity, which collectively support improved root development and overall vegetative growth of sweet corn.

Stem Circumference (mm)

Table 7. Average Stem Circumference of sweet corn at 10, 20, 30, and 40 days after planting (DAP) as influenced by weed management through the application of bamboo leaf litter organic mulch

Treatment	Stem Circumference			
	10	20	30	40
<u>application rate of bamboo leaf litter organic mulch</u>	----- mm -----			
0 t ha ⁻¹	1.50a	2.00a	3.03a	4.10a
20 t ha ⁻¹	1.50a	2.50a	3.75a	4.93a
40 t ha ⁻¹	1.53a	2.50a	4.13a	5.17a

Table 7 indicates that the application of bamboo leaf litter mulch had not yet resulted in a measurable increase in the stem circumference of sweet corn plants. Although the mulch application potentially reduced weed competition and contributed to improvements in soil microclimatic conditions as well as the physical and chemical properties of the soil, these changes were not sufficient to stimulate a significant enlargement of stem girth in sweet corn. This condition suggests that the improvement of soil conditions and partial suppression of weeds did not yet fully support the development of a more extensive root system. Consequently, the uptake of essential nutrients particularly nitrogen, which plays a fundamental role in vegetative tissue formation may not have reached an optimal level for promoting stem thickening [38], [39], [40]. In addition, vigorous weed growth may have formed a dense vegetative canopy that partially covered the soil surface and reduced the penetration of solar radiation reaching the sweet corn plants. Reduced light interception limits the amount of photosynthetically active radiation available for chlorophyll absorption, thereby decreasing the net photosynthetic rate of the crop. As a consequence, the production of assimilates required for vegetative growth becomes restricted, which ultimately limits biomass accumulation. This physiological limitation may also contribute to the reduced expansion of stem circumference observed in sweet corn plants.

Number of Leaves

Table 8. Average Number of Leaves of sweet corn at 10, 20, 30, and 40 days after planting (DAP) as influenced by weed management through the application of bamboo leaf litter organic mulch

Treatment	Number of Leaves			
	10	20	30	40
<u>application rate of bamboo leaf litter organic mulch</u>	-----			
0 t ha ⁻¹	3.67a	5.33a	5.53a	5.67a
20 t ha ⁻¹	4.00a	5.33a	6.87b	6.87a
40 t ha ⁻¹	4.00a	5.67a	6.73b	7.13a

The numbers followed by the same letter in the same column are not significantly different in Duncan’s 5% test.

Table 8 shows that the application of bamboo leaf litter mulch at a rate of 20 t ha⁻¹ was able to increase the number of leaves of sweet corn at 30 DAP. This increase suggests that the presence of organic mulch contributes to the formation of a more favorable agroecosystem for the development of vegetative plant organs. An increase in leaf number is also closely associated with

improved efficiency of soil water utilization. The mulch layer functions as a protective cover that suppresses the rate of soil evaporation, thereby maintaining more stable water availability within the root zone [41]. Adequate water availability plays a crucial role in supporting cell division and cell elongation processes at the plant growth points, which subsequently stimulates the formation of new leaves. In addition, the gradual decomposition of bamboo leaf litter enhances the activity of soil microorganisms involved in nutrient mineralization processes [42]. This process contributes to increased nitrogen availability in the soil, an essential nutrient for chlorophyll synthesis and leaf tissue development, ultimately supporting the formation and expansion of sweet corn leaves.

Component Yield

Table 9. Average Cob Diameter, Cob Length, Cob Weight, Grain Weight and Grain Yield of sweet corn as influenced by weed management through the application of bamboo leaf litter organic mulch

Treatment	Component Yield				
	Cob Diameter (mm)	Cob Length (cm)	Cob Weight (g)	Grain Weight (g)	Grain Yield (g)
<u>application rate of bamboo leaf litter organic mulch</u>					
0 t ha ⁻¹	11.33a	6.67a	35.27a	20.50a	591.00a
20 t ha ⁻¹	11.67a	8.00b	39.10b	24.10a	1011.33b
40 t ha ⁻¹	12.00a	12.00c	69.53c	38.37a	1543.33b

The numbers followed by the same letter in the same column are not significantly different in Duncan's 5% test.

Table 9 demonstrates that applied bamboo leaf litter mulch at 20 t ha⁻¹ enhanced cob length, cob weight, and grain yield. Weed management through mulch created a more efficient agroecological environment during the reproductive phase, allowing optimal resource utilization. Improved yield components were also linked to enhanced radiation interception by the canopy. In weed-suppressed plots, the sweet corn canopy developed more effectively, promoting photosynthesis and increasing assimilate accumulation [43], [44], [45]. These assimilates were translocated to generative organs, particularly the cob, supporting cob elongation and weight gain. Additionally, bamboo leaf litter mulch contributed to increased soil biological activity. Organic matter decomposition stimulated soil microorganisms involved in nutrient mineralization. Enhanced availability of phosphorus and potassium played a critical role in cob formation and grain filling, with phosphorus supporting reproductive tissue development and energy transfer, and potassium regulating carbohydrate translocation to grains [46], [47]. Well-developed root systems facilitated wider soil exploration for water and nutrients, supporting longer cobs and higher grain weight.

4. Conclusion

Application of bamboo leaf litter mulch at 20 t ha⁻¹ effectively enhanced weed control percentage at 10 and 20 DAP, while reducing weed cover percentage at 10, 20, and 30 DAP, as well as decreasing weed fresh weight at 20 DAP. Furthermore, this treatment promoted sweet corn growth by increasing plant height at 20 and 40 DAP, leaf number at 30 DAP, and improving cob length, cob weight, and grain yield of sweet corn.

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