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IMPACT OF MULCHING TYPES ON WEED INFESTATION, GROWTH PARAMETERS, AND YIELD COMPONENTS OF MAIZE (Zea mays L.) DURING RAINY SEASON

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Abstract

This experiment was conducted at the Agronomy Farm, Yezin Agricultural University, Myanmar, to evaluate the effects of different mulching types on weed infestation, maize growth, and yield. The study followed a randomized complete block design (RCBD) with three replications and seven treatments: control (no mulch), cowpea mulch, green gram mulch, lablab bean mulch, maize stover mulch, rice straw mulch, and black plastic mulch, using the maize variety CP 808. All mulch treatments significantly reduced weed density and dry weight compared to the control at 15, 35, 55, and 75 days after sowing (DAS). The lowest weed dry weight was observed under black plastic mulch, followed by rice straw and maize stover mulch. Among living mulches, cowpea mulch was most effective in suppressing weeds. Significant variations were also recorded in total dry matter (TDM), leaf area index (LAI), and crop growth rate (CGR). Maize stover mulch produced the highest TDM at vegetative and tasseling stages, while cowpea mulch had the highest TDM at the grain-filling stage. The highest LAI occurred under black plastic mulch at the vegetative stage and cowpea mulch at grain filling. CGR was highest under black plastic mulch from vegetative to tasseling and under lablab bean mulch from tasseling to grain filling. Cowpea mulch produced the highest grain yield, followed by green gram mulch. Overall, cowpea mulch exhibited superior performance, second with green gram mulch, indicating their potential for improving weed control, growth, and grain yield of maize during the rainy season.

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1. Introduction

Maize (*Zea mays* L.) is a major global cereal crop vital for food and nutritional security due to its adaptability, versatility, and high yield potential. It serves as a staple food for livestock feed, and industrial raw material (FAO, 2021). In Myanmar, maize cultivation has expanded rapidly for both domestic use and export. However, productivity remains constrained by agronomic challenges, particularly weed infestation, which severely competes with maize for light, moisture, nutrients, and space causing yield losses of 30-80% without effective control (Sharma & Rayamajhi, 2022).

Efficient and sustainable weed management is therefore essential, especially under tropical conditions where weed growth is vigorous. Mulching offers an eco-friendly approach that suppresses weeds, conserves soil moisture, regulates temperature, and improves soil structure (Schonbeck, 2023). Organic mulches such as rice straw, maize stover, and leguminous crops (e.g., cowpea, green gram, lablab bean) provide additional soil fertility benefits through decomposition, while black plastic mulch effectively suppresses weeds and conserves moisture but poses environmental concerns (Shogren, 2000).

Beyond weed control, mulching enhances physiological traits such as leaf area index (LAI), crop growth rate (CGR), and total dry matter (TDM), which contribute to higher photosynthesis, biomass, and yield (Jat et al., 2011; Ahmad et al., 2018). However, comparative studies on different mulching materials, especially legume living mulches, are limited in Myanmar. Therefore, this study was undertaken to identify suitable mulching practices for smallholder maize farmers, promote sustainable weed management, and enhance maize productivity under Myanmar's rainfed conditions. the present study was conducted with the following objectives.

2. Objectives

1. To evaluate the effect of different mulching types on weed infestation at various days after sowings of maize
2. To assess the influence of mulching on maize growth parameters and yield of maize
3. To identify the most suitable mulching material for improving maize yield through better weed control and physiological growth performance

3. Materials and Methods

3.1 Experimental site and design

The experiment was conducted at the field of the Agronomy farm, Yezin Agricultural University (YAU), Myanmar, during the rainy season (June to October), 2024. The soil type was loamy sand. The total area of the experiment size was 1,075 m^2, with individual plot of 7 m × 5 m, by 1 m alleys with spacing of 75 cm × 25 cm using the CP 808 tested variety. The study was laid out in a randomized complete block design (RCBD) with three replications. Seven treatments were applied: control (no mulch) (T1), cowpea mulch (T2), green gram mulch (T3), lablab bean mulch (T4), maize stover mulch (T5), and rice straw mulch (T6) and black plastic mulch (T7). Maize stover mulch and rice straw mulch (8 tons ha^{-1}) was applied uniformly over the soil surface after maize sowing on the same day. For the black plastic mulch treatment, the plastic was laid over the soil surface, and holes were made at designated planting spots using a four-inch PVC pipe. Maize seeds were then sown into these pre-punched holes. For the legume living mulch treatments (T2, T3, and T4), two rows of legumes, were sown between maize rows using a seed rate of 10 kg ha^{-1} after maize sowing on the same day. To reduce resource competition between maize and the living mulches during crop development, the legumes were cut their average height exceeded about 30 cm, leaving stubble of 10–15 cm above ground level. The harvested fresh green masses were then evenly distributed between the maize rows as mulch. The green masses of living mulches were shown in Table 1.

Table 1. Green masses of living mulches in Yezin, 2024

Type of mulch	Green masses (g m^{-2})			
	1st time (26 DAS)	2nd time (40 DAS)	3rd time (58 DAS)	Total
Cowpea mulch	1691.58	1577.58	477.76	3746.92
Green gram mulch	666.56	655.41	199.70	1521.67
Lablab bean mulch	484.46	292.22	91.26	867.94

3.2 Land preparation and crop management

Land preparation was done as usual. Based on the recommendations of the Department of Agricultural Research (DAR), a basal application of fertilizer was applied at the rates of 56.81 kg N ha^{-1}, 55.58 kg P_2O_5 ha^{-1}, and 37.05 kg K_2O ha^{-1}. In addition, top dressing was applied at 20 and 40 days after sowing (DAS), with 28.41 kg N ha^{-1} and 18.53 kg K_2O ha^{-1} to support the nutrient requirements of maize. Pesticides were applied as needed throughout the cropping season to manage pests and maintain plant health.

3.3 Data collection

Weed infestation

Weed infestation was recorded at 15, 35, 55 and 75 DAS by placing 1 m^2 quadrats randomly twice in the middle of each plot along the diagonal. To determine weed infestation, the weeds were pulled out from each 1 m^2 quadrats and then counted and determined weed density. The collected weeds were oven dried at 70℃ for 72 hours to obtain total weed dry weight (g m^{-2}) (Demjanova et al., 2009).

Weed control efficiency (WCE) was also determined by formula, Amare et al. (2014):

$$\mathrm{WCE} = \frac{\mathrm{WDC} - \mathrm{WDT}}{\mathrm{WDC}} \times 100$$

Where: WCE = Weed control efficiency,

WDC = Weed dry mass from control plot (untreated),

WDT = Weeds dry matter from treated plot

Plant height (cm): Plant height of maize was measured from randomly selected five plants in each plot at ten days intervals starting from 10 to 70 DAS.

Total dry matter (g m^{-2}): The total dry matter of maize was recorded at maximum growth stage, tasseling stage and grain filling stage. The sample plants were dried in the oven at 70ºC for 3 days and then weighted.

Leaf area index (LAI): The leaf area of maize plants was measured at maximum growth stage, tasseling stage and grain filling stage. Leaf area index was calculated by the formula described by Watson (1956).

$$\text{LAI} = \frac{\text{Sum of the leaf area of all leaves}}{\text{Ground area of field where the leaves have been collected}}$$

Crop growth rate (CGR): CGR of maize was measured in g m^{-2} day^{-1} by the formula, Hunt (1978).

$$\text{CGR} = \frac{\text{Total dry matter at second sampling} - \text{Total dry matter at first sampling}}{\text{Time between second and first sampling} \times \text{Ground area}}$$

Yield (ton ha^{-1}): Yield of maize was measured from harvest area of (10 m^2) at the center of each plot. Then, the total grain yield from each plot was weight and converted to ton ha^{-1}.

$$\text{Grain yield (ton ha}^{-1}\text{)} = \frac{(100 - \text{moisture}) \text{ (Field weight (kg)} \times \text{shelling \%} \times 10{,}000 \text{ m}^2)}{85 \times \text{harvested area (m}^2) \times 1000}$$

(Centro International De Mejoramiento De Maiz Y Trigo [CIMMYT], 1985)

Where, 85 = adjusted factor of grain moisture to 15%

10,000 sq. meter = conversion factor to an area of one hectare of a plot

Mean temperature and rainfall data of Yezin during rainy season, 2024 were presented in figure 1.

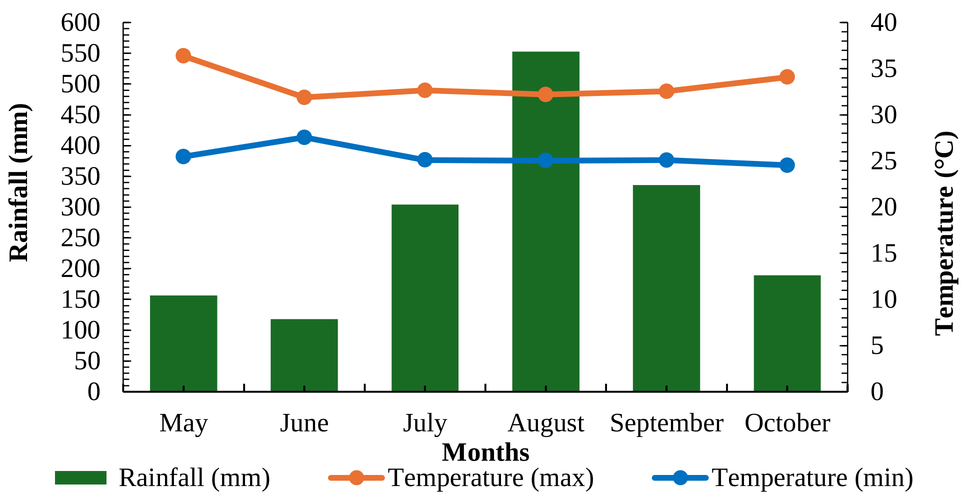

Figure. 1 Mean temperature and rainfall data of Yezin during rainy season, 2024

3.4 Data analysis

All the data were subjected for analysis of variance (ANOVA) using Statistix software (version 8.0), and treatment means were compared using the Least Significant Difference (LSD) test at a 5% level of significance (Gomez & Gomez, 1984).

4. Results and Discussion

4.1 Weed density

The study evaluated the effectiveness of different mulch treatments in suppressing weeds at 15, 35, 55, and 75 DAS (Table 4.1). Mulch type significantly affected weed density throughout the growing period. Black plastic mulch consistently recorded the lowest densities (58.00, 30.00, 24.00, and 20.00 weeds m²), confirming its superior suppression through light and moisture exclusion. The control (maize without mulch) had the highest weed densities (960.00, 417.00, 382.00, and 324.00 weeds m²), highlighting the need for mulching. Among living mulches, green gram was most effective due to its dense canopy and followed by cowpea and lablab bean. Maize stover and rice straw also significantly reduced weeds compared with the control. At 35 and 55 DAS, the control had the highest weed counts (417.00 and 382.00 weeds m²), while black plastic mulch maintained the lowest (30.00 and 24.00 weeds m²). Green gram mulch effectively reduced weeds (115.00 and 104.00 weeds m²) through shading and rapid coverage. Maize stover and rice straw further decreased weed numbers below 53 and 50 weeds m², respectively, due to surface smothering. By 75 DAS, maize stover and rice straw reduced weeds to 44.00 weeds m², confirming their lasting suppression through shading and physical obstruction (Bond & Grundy, 2001).

Table 4.1. Mean values of weed density as affected by different mulches in Yezin

Treatments	Weed density (number m^{-2})			
	15 DAS	35 DAS	55 DAS	75 DAS
T1 (Maize Sole (control))	960.00 a	417.00 a	382.00 a	324.00 a
T2 (Cowpea mulch)	614.00 c	102.00 b	90.00 c	66.00 c
T3 (Green gram mulch)	638.00 b	115.00 b	104.00 b	80.00 b
T4 (Lablab bean mulch)	612.00 c	109.00 b	95.00 bc	70.00 c
T5 (Maize Stover Mulch)	324.00 d	52.00 c	48.00 d	44.00 d
T6 (Rice straw mulch)	332.50 d	53.00 c	50.00 d	44.00 d
T7 (Black plastic mulch)	58.00 e	30.00 d	24.00 e	20.00 e
$LSD_{0.05}$	22.23	16.21	10.80	9.83
Pr>F	<0.0001	<0.0001	<0.0001	<0.0001
CV%	2.96	8.70	6.41	7.15

DAS = Days after sowing

Means followed by the same letter within each column were not significantly different.

4.2 Weed dry weight

Mulch treatments significantly affected weed dry weight at all sampling times (Table 4.2). The control showed the highest weed biomass (28.36-24.35 g from 15-75 DAS), confirming poor weed suppression without mulch. At 35 DAS, the control recorded 32.84 g, while black plastic mulch had the lowest (1.25 g), showing strong weed suppression through light and moisture blockage. At 55 DAS, black plastic mulch maintained minimal weed biomass (1.24 g) compared with the control (30.12 g), indicating lasting suppression. Among living mulches, green gram was most effective (10.08 g and 9.52 g at 35 and 55 DAS), followed by lablab bean and cowpea. Maize stover and rice straw also reduced weed biomass below 6 g through smothering and shading. By 75 DAS, black plastic mulch another time recorded the lowest weed biomass (1.06 g), followed by green gram (6.05 g). Cowpea, lablab bean, maize stover, and rice straw maintained low levels (<4.00 g), attributed to canopy cover and physical barriers. Overall, black plastic and green gram mulches provided the most consistent and effective weed suppression.

Table 4.2. Mean values of weed dry weight as affected by different mulches in Yezin

Treatments	Weed dry weight (g)			
	15 DAS	**35 DAS**	**55 DAS**	**75 DAS**
T1 (Maize Sole (control))	28.36 a	32.84 a	30.12 a	24.35 a
T2 (Cowpea mulch)	12.20 b	8.92 b	8.04 c	5.12 c
T3 (Green gram mulch)	12.78 b	10.08 b	9.52 b	6.05 b
T4 (Lablab bean mulch)	12.16 b	9.76 b	8.60 bc	5.48 bc
T5 (Maize Stover Mulch)	6.48 c	5.36 c	5.48 d	3.98 d
T6 (Rice straw mulch)	6.56 c	5.90 c	5.58 d	3.96 d
T7 (Black plastic mulch)	1.32 d	1.25 d	1.24 e	1.06 e
$LSD_{0.05}$	0.77	2.27	1.36	0.76
Pr>F	<0.0001	<0.0001	<0.0001	<0.0001
CV%	4.56	14.45	9.35	7.19

DAS = Days after sowing

Means followed by the same letter within each column were not significantly different.

4.3 Weed control efficiency

Weed control efficiency (WCE) in maize differed significantly among mulch treatments at all observation periods (15, 35, 55, and 75 DAS) (Table 4.3). Black plastic mulch consistently achieved the highest WCE, reaching 95.63% at 75 DAS, and significantly surpassed all other treatments. Among organic mulches, maize stover and rice straw maintained high WCE values above 80% from 35 DAS onward, reflecting strong and lasting weed suppression. Living mulches, cowpea, green gram, and lablab bean showed moderate but significant efficacy, with WCE ranging from 54.89% to 78.97% across the sampling stages. Their efficiency improved progressively, likely due to increased canopy coverage and competition as growth advanced. Overall, black plastic mulch proved to be the most effective weed management practice, while maize stover and rice straw offered strong and sustainable alternatives. Although less effective, living mulches still provided substantial weed suppression compared with the control, underscoring the importance of appropriate mulch selection for efficient weed management in maize cultivation.

Table 4. 3 Mean values weed control efficiency as affected by different mulches in Yezin

Treatments	Weed Control Efficiency (%)			
	15 DAS	**35 DAS**	**55 DAS**	**75 DAS**
T1 (Maize Sole (control))	0.00 e	0.00 d	0.00 e	0.00 e
T2 (Cowpea mulch)	56.95 c	72.70 c	73.13 c	78.97 c
T3 (Green gram mulch)	54.89 d	69.14 c	68.39 d	75.10 d
T4 (Lablab bean mulch)	57.04 c	70.19 c	71.28 cd	77.50 cd
T5 (Maize Stover Mulch)	77.14 b	83.57 b	81.76 b	83.63 b
T6 (Rice straw mulch)	76.87 b	81.62 b	81.45 b	83.72 b
T7 (Black plastic mulch)	95.39 a	96.13 a	95.89 a	95.63 a
$LSD_{0.05}$	1.46	4.42	3.00	3.63
Pr>F	<0.0001	<0.0001	<0.0001	<0.0001
CV%	1.64	4.40	2.99	2.57

DAS = Days after sowing

Means followed by the same letter within each column were not significantly different.

4.4 Plant height

Plant height of maize was recorded at 10-day intervals from 10 to 70 days after sowing (DAS). Across all treatments, a progressive increase in plant height was observed throughout the growth period (Figure 2). Statistically significant differences ($p \leq 0.05$) among treatments were recorded at 20, 30, 50, 60, and 70 DAS, whereas differences at 10 and 40 DAS were not significant. At 70 DAS, the shortest plants were observed in the control (no mulch) treatment (180.21 cm), likely due to increased competition from weeds for essential resources such as nutrients, water, and light. In contrast, the tallest plants were found in the black plastic mulch treatment (190.27 cm), followed by lablab bean (189.57 cm), rice straw (185.90 cm), maize stover (185.50 cm), green gram (183.37 cm), and cowpea mulch (181.26 cm). The application of mulch improved soil microclimate conditions minimized weed competition, and enhanced resource availability, thereby promoting vigorous plant growth. Taller maize plants are more efficient at intercepting solar radiation, which is critical for photosynthetic activity and subsequent biomass accumulation.

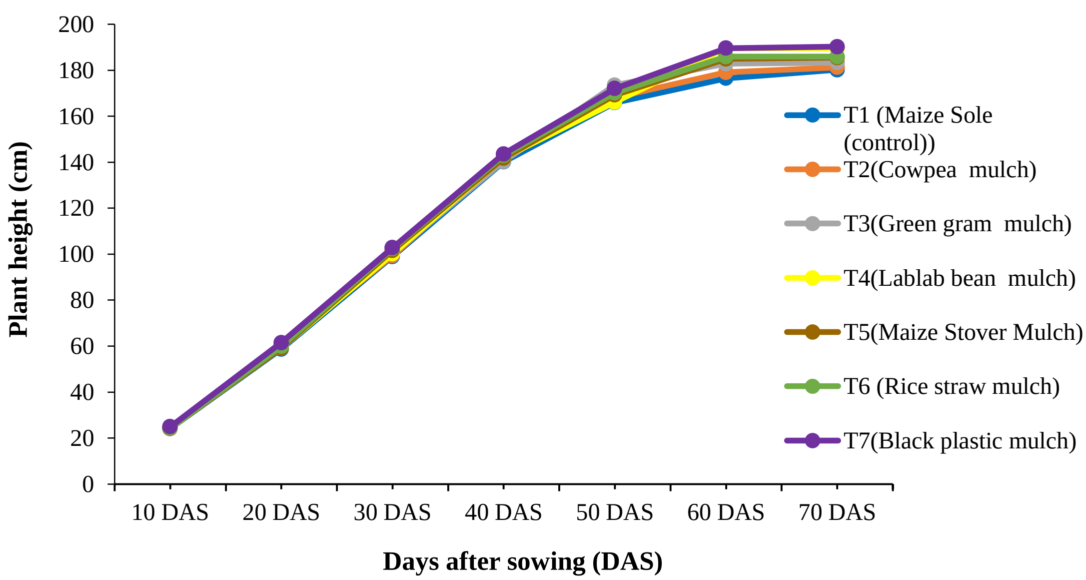

Figure. 2 Mean values of plant height as affected by different mulches in Yezin

4.5 Total dry matter of maize

The total dry matter accumulation of maize under various mulch treatments increased markedly from the maximum vegetative stage to the grain filling stage. Significant differences ($p \leq 0.01$) in total dry matter were observed among treatments at the maximum vegetative, tasseling, and grain filling stages (Figure 3). The lowest total dry matter values were recorded in the control (no mulch) plots, with 230.72 g, 391.24 g, and 644.70 g at the respective growth stages. This reduction is likely attributed to unfavorable soil conditions such as nutrient depletion and intense weed competition during the rainy season, which restricted plant growth. The highest total dry matter was recorded in black plastic mulch and maize stover mulch, followed by cowpea mulch, particularly at the maximum vegetative and tasseling stages.

At the grain filling stage, cowpea mulch produced the highest dry matter, statistically comparable to black plastic mulch. The enhanced dry matter accumulation under mulched treatments may be due to improved nutrient availability, moisture conservation, and effective weed suppression, which are especially critical during the reproductive stages of maize.

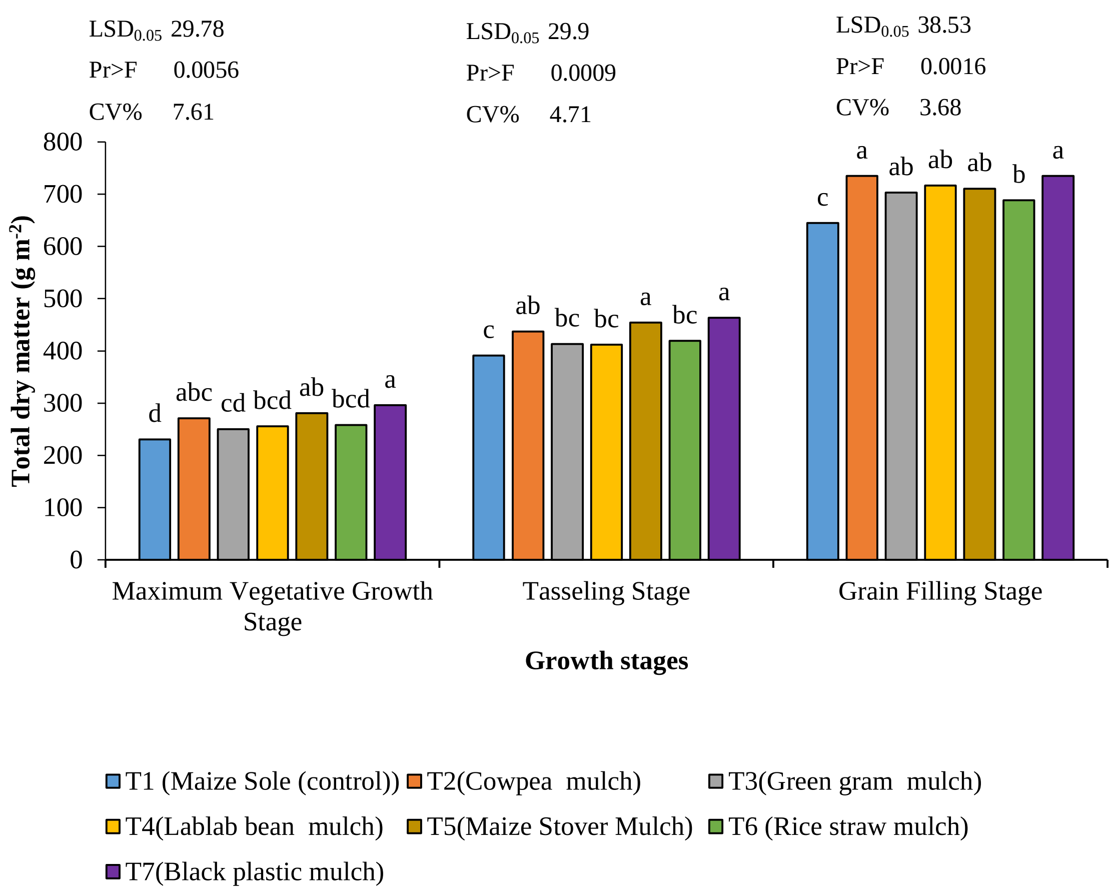

Figure. 3 Mean values of total dry matter of maize as affected by different mulches in Yezin

4.6 Leaf area index of maize

Mulch type significantly affected maize LAI across growth stages (Figure 4). During the vegetative stage, black plastic mulch recorded the highest LAI (4.28), followed by maize stover mulch (4.14), while the control and rice straw had the lowest values. At tasseling, cowpea mulch showed the highest LAI (3.90), with green gram close behind (3.79), whereas black plastic had the lowest (3.22). During grain filling, cowpea again led (3.57), while both the control and black plastic recorded the lowest (2.98). High early LAI under black plastic mulch reflected improved soil moisture and temperature regulation, but its effect declined later, likely due to microclimate or nutrient limits. Legume mulches, particularly cowpea, maintained higher LAI in reproductive stages through better nitrogen supply and soil moisture. Maize stover mulch also enhanced early LAI but was less effective later than cowpea.

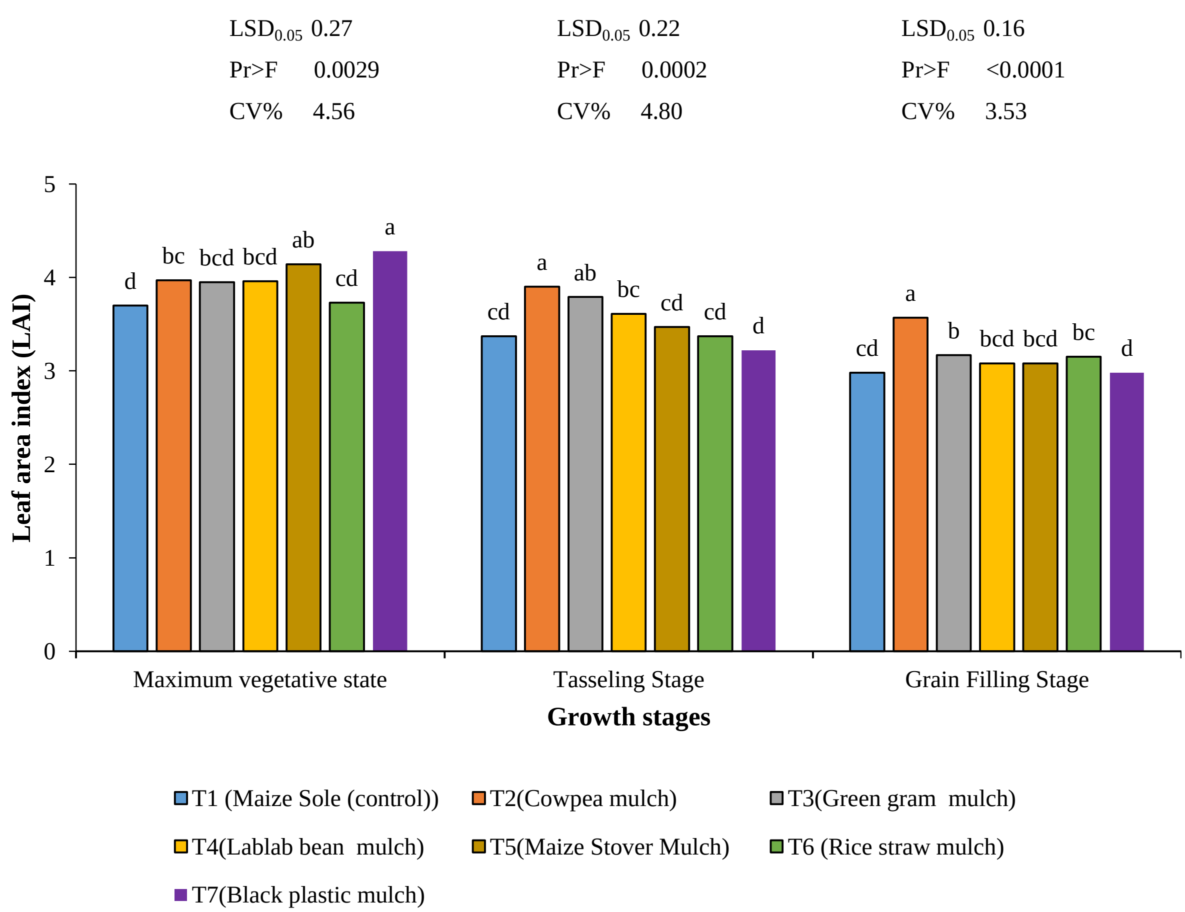

Figure. 4 Mean values of leaf area index of maize as affected by different mulches in Yezin

4.7 Crop growth rate of maize

At the maximum vegetative to tasseling stage (MVGS–TS), maize stover mulch recorded the highest crop growth rate (CGR) (24.82), followed by black plastic (23.94) and cowpea mulch (23.71), while lablab bean mulch had the lowest (22.32). However, differences were not statistically significant (Pr>F=0.4861). During the tasseling to grain filling stage (TS–GFS), CGR was significantly affected by mulch type (Figure 5). Cowpea mulch showed the highest CGR (19.84), comparable to lablab bean (20.32) and green gram (19.30), whereas the control had the lowest (16.21). Maize stover and rice straw mulches were lower than legume and plastic mulches at this stage.

Overall, mulch type had a strong influence on maize CGR, especially during the reproductive phase. Though differences were minimal at the vegetative stage, maize stover mulch enhanced early growth through soil temperature moderation and moisture retention. In later stages, leguminous mulches particularly cowpea and lablab bean improved CGR due to nitrogen enrichment and weed suppression. All mulched plots outperformed the control, confirming the role of mulching in sustaining maize vigor and productivity. Legume-based mulches, especially cowpea, appear most effective for enhancing maize growth and maintaining performance during the rainy season.

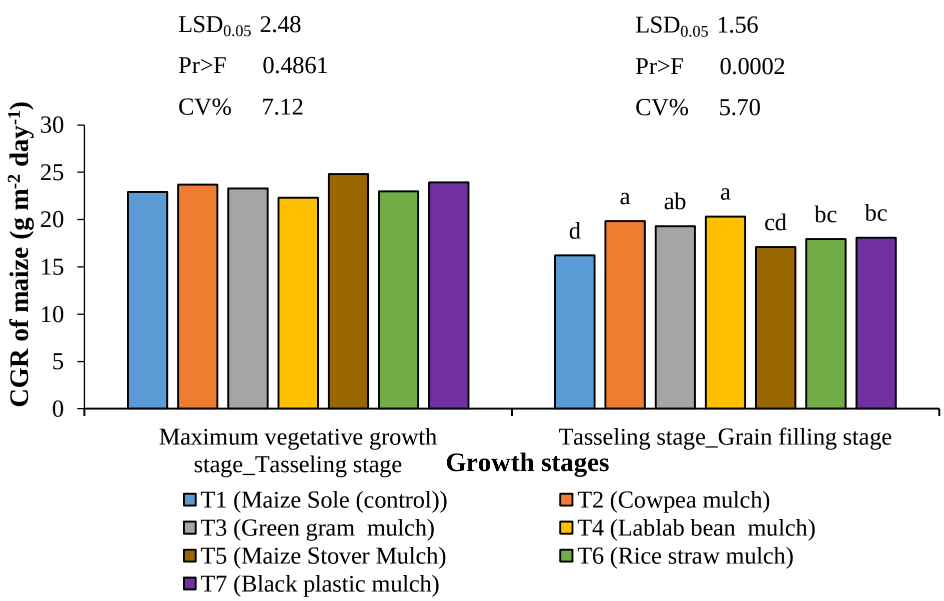

Figure. 5 Mean values of CGR of maize as affected by different mulches in Yezin

4.8 Grain yield of maize

Maize grain yield during the rainy season, 2024 was highly affected by mulch treatments ($p \leq 0.01$) (Figure 6). All mulched plots outperformed the control (6.2 t ha^{-1}), with the highest yield from cowpea mulch (7.18 t ha^{-1}), followed by green gram mulch (6.84 t ha^{-1}). The superior yield under cowpea mulch was due to effective weed suppression, dense canopy cover, and nitrogen fixation that improved soil fertility and nutrient availability. Higher yields in mulched plots were closely linked to improved weed control efficiency, higher LAI, enhanced CGR, and greater total dry matter (TDM). Mulching minimized weed competition, allowing better use of light, water, and nutrients. Increased LAI improved light interception and photosynthesis, while higher CGR and TDM sustained biomass production during tasseling and grain filling. Overall, mulching especially with cowpea optimized agronomic and physiological performance, significantly enhancing maize productivity under rainfed conditions.

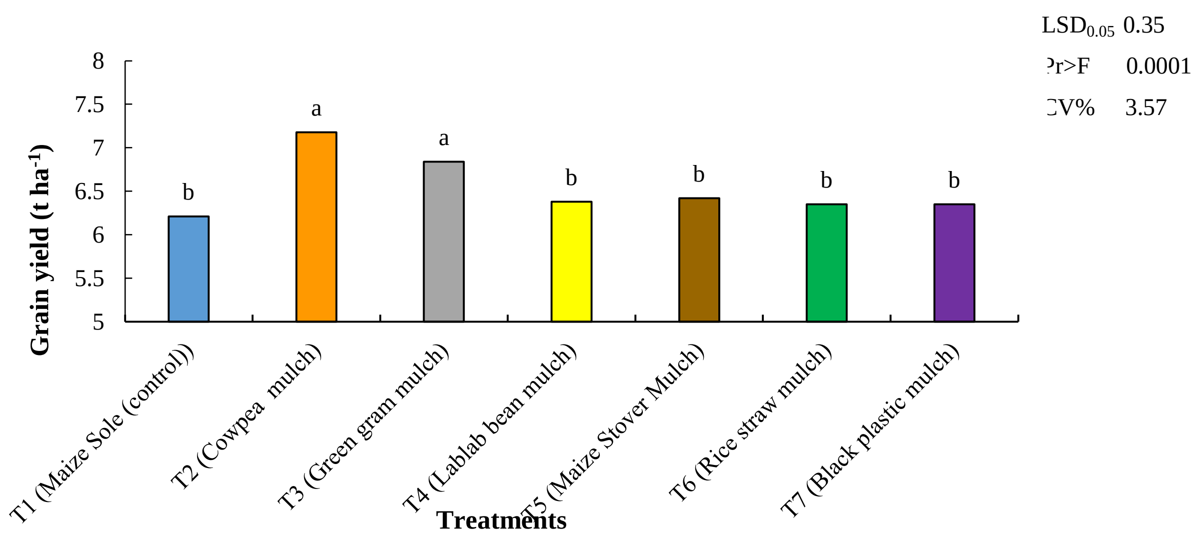

Figure. 6 Mean values of grain yield of maize as affected by different mulches in Yezin

Conclusion

The different mulching treatments significantly affected weed suppression, growth parameters, and yield of maize in Yezin during the 2024 rainy season. Among the inorganic and organic mulches, black plastic mulch exhibited the highest weed control efficiency, followed by rice straw and maize stover mulches during the maximum vegetative growth stages of maize. However, despite their superior weed suppression, these mulches did not produce the highest grain yield due to their high moisture Retention which likely cause waterlogging under high rainfall conditions which adversely affected root function and crop development at tasseling stage and grain filling stage. Among the legume living mulches, particularly cowpea and green gram mulches, mitigated waterlogging more effectively at these stages. Their diverse root systems likely improved soil aeration and oxygen availability under saturated conditions, while simultaneously contributing to soil fertility through biological nitrogen fixation. The cowpea mulch followed by green gram mulch not only maintained effective weed suppression through dense canopy coverage but also improved key physiological traits such as higher leaf area index (LAI), greater crop growth rate (CGR), and higher total dry matter (TDM) accumulation resulting in the highest maize grain yield among treatments. Therefore, cowpea mulch, followed by green gram mulch, proved to be the most effective and sustainable mulching approach for enhancing weed control, growth and yield of maize under rainfed conditions, outperforming the unmulched control.

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