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Utilization of Indigenous Mulches on the Growth and Yield of Different Tomato Varieties in Catarman, Camiguin, Philippines

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ABSTRACT

Tomato (Lycopersicon esculentum Mill.) is one of the major commercial vegetable crops and is widely grown both in the highland and lowland areas in the Philippines. Many tomato growers face challenges in choosing the appropriate varieties and the cost of production. Mulching as one of the cultural practices can be employed to provide a favorable environment for improved growth performance. The present study was carried out to observe the effects of variety and indigenous mulch on the growth performance of tomato. The study was laid out in a 3 x 5 factorial experiment in a Randomized Complete Block Design with three replications under field conditions at Tangaro, Catarman, Camiguin from October 2015 to February 2016. Three popular tomato (Factor A) varieties namely, Diamante Max F1, Improve Pope and Marimar F1 and four mulching materials (Factor B) viz. rice straw, cogon grass, napier grass, and saw dust with a control (no mulch) were experimentally evaluated to identify its potentiality on the growth performance of tomato. Results of the study showed that V1 (Diamante Max F1) produced the highest (4.28 t/ha) fruit yield, while V2 (Improve Pope) showed the lowest (0.8 t/ha) fruit yield. The mulching showed positive effect in some growth parameters, weeds incidence, and insect and disease infestation/infection. The combination of variety and mulch exhibited positive variation in some growth parameters, yield components, weeds incidence, and insect and disease infestation/infection. The combination V1M4 (Diamante Max F1 and Saw dust) produced the maximum yield (5.08 t/ha) and thus the experiment revealed that saw dust, napier grass and rice straw mulches have the potentiality to increase in yield of tomato. Potential of these varieties and the different mulches needed to be further tested for verification under different growing season to elicit substantial conclusions.

INTRODUCTION

Tomato (Lycopersicon esculentum Mill.) is one of the major commercial vegetable crops and is widely grown both in the highland and lowland areas in the Philippines. It ranked second in terms of the total area planted and the volume of production is estimated at 17, 228.31 ha and 207, 655.1 tons of the top 6 vegetables grown (BAS, 2014). The world's average tomato productivity was 34.84 tons/ha (FAO, 2009) and the average productivity of the Philippines was 12.05 tons/ha, while for Camiguin, it was estimated to be about 9.79 tons/ha (BAS, 2014).

Although it ranks second to eggplant in terms of total production area, seasonality of production and limited domestic supply continues to plague the industry. Fresh market tomato production is filled with many challenges because it is a high-management crop (Palada & Davis, 2001). Tomatoes require intensive hand labor input for operations such as staking, fertilization, mulching, cultivation, pruning, tying, training, spraying, and harvest. Tomatoes are also highly vulnerable to insect and disease damage.

Mulching is a cultural management practice in vegetable production in which the soil surface is covered with any material (organic or inorganic) to provide a favorable environment (prevention of soil moisture loss, weed suppression, maintenance of soil temperature and promote soil productivity) for plant growth and development for an increase production (Grassbaugh et al., 2009; Basnet, 2022). Synthetic mulch such as plastic mulch has been commonly used in vegetable production however due to its cost and difficulty in its disposal, vegetable farmers opt to find alternative. One of which is the use of indigenous or organic mulch which are locally available (Marín-Guirao et al., 2022).

Organic mulches were found to be very effective for growth performance of vegetables through improved water content in the soil, heat energy and addition of organic nitrogen and minerals thereby improving the soil nutrient status (Saeed & Ahmad, 2009). Various indigenous materials are being used as mulches, such as rice hulls, sawdust, and rice straw, among others (Sinkevičienė et al., 2009). Mulch regulates soil temperature (Kar & Kumar, 2007), creates suitable condition for germination, improves soil moisture, suppresses weed growth (Jodaugienė et al., 2006), and saves labor cost (Schonbeck, 2008) which ultimately increases the yield of tomatoes.

In Camiguin setting, wherein mostly farmers cannot afford plastic mulching materials, indigenous or organic mulch is a good traditional substitute for mulching. Also, with the numerous tomato varieties available from local nurseries, retailers, and seed company catalogs, it can be challenging for the farmers to select a variety that is suited to the local climate and will fit their needs for end use. Although many tomato varieties will grow in the Province of Camiguin, little is known about their actual production. Also, there is a need for information on tomato cultivar

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performance under organic management in the tropics. Thus, this study was conducted to determine the effect of various indigenous mulches on growth and yield of different varieties of tomato.

MATERIALS AND METHODS

The study was conducted at Crop Science laboratory research area of the Institute of Agriculture, Camiguin Polytechnic State College – Catarman Campus, Tangaro, Catarman, Camiguin, from October 2015 to February 2015.

Materials

Tomato varieties used in the study were Improve Pope, Diamante Max F1, and Marimar F1 and indigenous mulch which are locally available were rice straw, cogon grass, Napier grass and sawdust.

Methods

Experimental Design and Treatments

The two factorial experiment was laid out in a Randomized Complete Block Design (RCBD) with 3 × 5 (15) treatment combinations with three (3) replications. Ten (10) plants per treatment was taken. Factor A were the tomato varieties, and Factor B was the different type of mulching materials. The different treatment combinations were as follows;

Table 1: Treatment Combinations

Factor A (Tomato Variety)	Factor B (Indigenous Mulch)		Treatment Combination Code (VM)	Treatment Number (T)
Variety 1 Diamante Max F1	Control	M0	V1M0	T1
	Rice straw	M1	V1M1	T2
	Cogon grass	M2	V1M2	T3
	Napier grass	M3	V1M3	T4
	Saw dust	M4	V1M4	T5
Variety 2 Improve Pope	Control	M0	V2M0	T6
	Improve Pope	M1	V2M1	T7
	Cogon grass	M2	V2M2	T8
	Napier grass	M3	V2M3	T9
	Saw dust	M4	V2M4	T10
Variety 3 Marimar F1	Control	M0	V3M0	T11
	Rice straw	M1	V3M1	T12
	Cogon grass	M2	V3M2	T13
	Napier grass	M3	V3M3	T14
	Saw dust	M4	V3M4	T15

Experimental Area

An experimental area of 225 square meters (5.0 m x 45.0 m) was used in this study. There were six furrows with an alleyway of 1.0 m (center to center distance), and each furrow had a dimension of 0.5 m x 3.0 m by treatment (each treatment comprises two furrows with five plants per furrow).

Statistical Analysis

All data gathered was tabulated and analyzed using the analysis of variance (ANOVA) of a factorial experiment in a Randomized Complete Block Design (RCBD). The difference among treatments was analyzed using Tukey's test.

Cultural Management Practices

Soil Sampling

Soil samples were collected from the experimental area before land preparation for soil analysis. Taken samples were submitted to the Department of Agriculture Regional Office 10, Regional Soil Testing Laboratory at Cagayan de Oro City. The result is presented in Table 2

Land preparation and Lay-outing

Table 2: Soil Analysis result of the experimental area

Soil Data	Result
Organic Matter (%)	2.8
Phosphorus (ppm)	127
Potassium (ppm)	S
pH	5.29
Source: DA-Region X, 2013	

The land was plowed and harrowed twice thoroughly using animal-drawn equipment. A total area of around 225 square meters was used in the study, which was divided into six (6) plots. Each treatment is comprised of two (2) plots. The distance between plots was 1 meter. Each plot has a dimension of 0.5 x 3 meters and contains five (5) plants per plot. Bamboo slats were used to label each furrow for every treatment in each replication.

Seedling Establishment

The seedling was raised in seedling trays using a sterilized sowing medium such that healthy, vigorous seedlings were produced. Seedlings were raised in an enclosed site protected with nylon netting to keep them safe from infestations prior to transplanting.

Transplanting

Under favorable environmental conditions, plants were transplanted when they reached the five-leaf stage about four to five weeks after sowing.

Mulching

A one-inch layer of indigenous mulch was overlayed on the surface around the base of the plant immediately after establishment of transplanted seedlings.

Fertilization

Fertilizer application was done using vermicast based on the recommended rate (250 g/hill). The basal application was done first, then side dressing followed during 15 DAT or 20 DAT and 45 DAT.

Weeding/Cultivation

Removal of weeds was done along with cultivation to facilitate proper aeration and growth.

Pest and Disease Control

The entire area was grown with companion plants such as Marigold to minimize the incidence of pests and diseases.

Trellising

Trellising was done two weeks after transplanting or just before flowering. Any system of trellising with the use of available materials can be adopted as long as the fruits are raised from the soil to prevent fungal disease development on the fruits.

Harvesting

Harvesting should be best done in the morning when there is less transpiration and moistures loss of the fruits. Harvest fruits at a 3-4 day interval. At least 7-8 harvests can be done using a determinate type.

Marketing

Fresh tomatoes will be directly marketed to the municipality of Catarman. The researcher will facilitate the marketing process of the produced.

Data Gathered

The following data were gathered:

Growth Parameters:

1. Plant height - was taken during 15, 30, and 45 DAT from 5 randomly selected plants. Plant height was measured from base at the soil level up to the shoot longest shoot.
2. Days to 50% flowering – was determined by counting the number of days after transplanting to 50% of the plants in a plot have open flowers.
3. Days to 1st harvest - refers to the number of days after transplanting that 50% of the plants in a plot have mature green fruits ready to harvest.
4. Plant Vigor – was taken at 30 DAT and 45 DAT.
   i - Most vigorous
   ii - Vigorous
   iii - Moderately vigorous
   iv- Weak
   v- Very weak
5. Percent Survival – the number of standing plants was counted from 15, 30, and 45 DAT divided by the total number of plants per plot times 100.

Yield and its Component:

6. Number of Fruits – the number of marketable and non-marketable fruits harvested per plant was counted and recorded from first harvest up to last harvest.
7. Fruit yield – fruits harvested in each plant per plot from first up to last harvest was weighed and classified into marketable and non-marketable.
8. Number of Fruits – the number of marketable and non-marketable fruits harvested per plant was counted and recorded from first harvest up to last harvest.
9. Fruit weight - Average weight (grams) of 10 fruits from the second harvest was recorded.
10. Fruit size –fruit size was determined by selecting ten randomly fruit samples at maturity and the cross-sectional area was measured. Fruit size was then categorized based on the following scale.
    i. Very small (<3 cm)
    ii. Small (3 - 5 cm)
    iii. Intermediate(5.1 - 8 cm)
    iv. Large (8.1 - 10 cm)
    v. Very large (>10 cm)

Source: IPGRI

11. Marketable yield per hectare – the total marketable yield was obtained by adding the yields of harvest. The marketable yield was converted into tons per hectare using the following formula:

Marketable Yield per hectare (t/ha)=(marketable yield (kg))/(harvested area (m^2) x 10 .....(1)

12. Insect and disease rating - was taken one month after transplanting and during the first harvest using the scale below:
    1 = No infection/infestation
    2 = Slightly infected/infested
    3 = Moderately infected/infested

4 = Slightly Severe
5 = Severe infection/Infestation

13. Weeds infestation – was taken one month after transplanting and during the first harvest using the scale below:

1 = No infestation
2 = Slightly infested
3 = Moderately infested
4 = Slightly severe
5 = Severe infestation

RESULTS AND DISCUSSION

Table 3 shows the mean plant height of tomatoes at different growth stages, which was determined from five (5) randomly selected plants per treatment and was measured from the base of the plant to the longest shoot. Statistical analysis showed no significant differences among treatments which implies that the plant height did not vary among different tomato varieties. However, V3 (Marimar F1) exhibits taller plants with a mean plant height of 66.48 cm; V1 (DM) with 65.22 cm; and V2 (IP) exhibited the shortest plant with 60.14 cm at 60DAT.

Table 3: Effects of different variety on the growth of tomato

TREATMENTS	PLANT HEIGHT, (cm)			
	15 DAT	30 DAT	45 DAT	60 DAT
V¬1	10.39	29.24	55.41	65.22
V2	11.23	28.93	49.21	60.14
V3	10.91	30.72	55.77	66.48
HSDα0.05	ns	ns	ns	ns

V1 = Diamante Max F1, V2 = Improve Pope, V3 = Marimar F1
**significant **highly significant nsnon-significant*

Table 4 presents the mean plant height of tomatoes subjected to different indigenous mulch measured from the base at the soil level up to the highest shoot. A significant difference was observed at 30 DAT, with M4 exhibiting taller plants and M0 exhibiting shorter plants. However, no significant differences were observed among treatment means from 15, 45, and 60 DAT. It implies that the plant height did not vary among the different mulches used.

Table 4: Effects of different mulching treatments on the growth of tomato

TREATMENTS	PLANT HEIGHT, (cm)			
	15 DAT	30 DAT	45 DAT	60 DAT
M0	10.39	26.63 b	50.93	60.64
M1	11.29	28.56 ab	52.64	65.41
M2	11.02	31.20 ab	51.43	63.50
M3	10.56	29.21 ab	52.53	62.25
M4	10.95	32.55 a	59.80	67.92
HSDα0.05	ns	*	ns	ns

M0 = Control, M1 = Rice straw, M2 =Cogon grass, M3 = Napier grass, M4 = Sawdust
**significant **highly significant nsnon-significant*

Table 5 presents the combined effects of variety and mulching on the plant height monitored at 15, 30, 45, and 60 DAT. Statistical analysis shows a highly significant effect of plant height at 15 DAT and a significant effect at 30 DAT. However, no significant differences were observed at 45 and 60 DAT.

Table 6 presents the mean number of days to 50% flowering, days to the first harvest, and plant vigor of different tomato varieties. Results revealed that no significant differences were observed in the number of days to 50% flowering and the number of days to 1st

Table 5: Combined effects of variety and mulching on the growth of tomato

TREATMENTS	PLANT HEIGHT, (cm)			
	15 DAT	30 DAT	45 DAT	60 DAT
V1M0	9.84 b	26.40 ab	57.67	67.60
V1M1	12.02 a	29.98 a	54.20	63.87
V1M2	9.57 b	28.69 a	52.20	67.98
V1M3	9.22 b	28.07 ab	50.20	63.13
V1M4	11.31 a	33.07 a	62.80	63.53
V2M0	12.23 a	30.84 a	50.07	60.13
V2M1	11.93 ab	27.93 a	52.20	66.37

V2M2	12.28 a	30.90 a	48.43	56.92
V2M3	10.69 ab	24.68 b	43.98	54.24
V2M4	8.99 b	30.32 a	51.39	63.04
V3M0	10.00 b	22.65 b	45.07	54.20
V3M1	9.92 b	27.79 a	51.53	66.00
V3M2	11.22 ab	34.01 a	53.67	65.60
V3M3	11.77 a	34.89 a	63.40	69.40
V3M4	12.53 a	34.27a	65.20	77.20
HSDα0.05	**	*	ns	ns
CV (%)	9.37%	12.05%	20.48%	18.10%

M0 = Control, M1 = Rice straw, M2 =Cogon grass, M3 = Napier grass, M4 = Sawdust
**significant **highly significant nsnon-significant*

harvest. V2 produced its first flowers earlier as compared to V1 and V3; however, V3 and V1 were harvested earlier compared to V2.

Vigor rating of different tomato varieties was monitored at 30 DAT and 60 DAT. Statistical analysis showed highly significant differences among Varieties. Results showed that among all the varieties, V2 (Improve Pope) showed a weak stand at 30 DAT and 60 DAT compared to other varieties. On the other hand, V3 (Marimar F1) exhibited the lowest mean at 30 DAT and 60 DAT, which can be described as more vigorous as compared to the other tomato lines.

Table 6: Effects of variety on the number of days to 50% flowering, first harvest and plant vigor

Treatments	Days To 50% Flowering	Days To 1st Harvest	Plant Vigor	
			30 DAT	@ 1st Harvest
V1	33.07	65.60	2.27 b	2.37 b
V2	32.93	66.40	3.21 a	3.35 a
V3	34.47	65.60	2.17 b	2.36 b
HSDα0.05	ns	ns	**	**

V1 = Diamante Max F1, V2 = Improve Pope, V3 = Marimar F1
**significant **highly significant nsnon-significant*

The number of days to 50% flowering and number of days to the first harvest showed no significant differences due to different mulching treatments (Table 7). M4 produced earlier flowers hence harvested earlier. However, significant variation was observed in plant vigor 30 DAT and 60 DAT, with M4 as the more vigorous compared to other mulching treatments.

Table 7: Effects of different mulching treatments on the number of days to 50% flowering, first harvest and plant vigor

Treatments	Days To 50% Flowering	Days To 1st Harvest	Plant Vigor	
			30 DAT	@ 1st Harvest
M0	36.11	66.00	2.84 a	3.09 a
M1	32.89	66.33	2.67 ab	2.68 ab
M2	33.89	66.00	2.38 ab	3.05 a
M3	32.44	65.33	2.62 ab	2.40 ab
M4	32.11	65.33	2.24 b	2.24 b
HSDα0.05	ns	ns	*	**

M0 = Control, M1 = Rice straw, M2 =Cogon grass, M3 = Napier grass, M4 = Sawdust
**significant **highly significant nsnon-significant*

Table 8 presents the combined effects of variety and different mulching treatments on the number of days to 50% flowering, number of days to first harvest, and plant vigor. The interaction between varieties and mulches had an insignificant effect on the number of days to flowering, the number of days to first harvest, and plant vigor at 60 DAT and a highly significant effect on plant vigor at 30 DAT with V3M3 as the most vigorous and V2M3 the weakest.

Table 8: Combine effects of variety and different mulching treatments on the number of days to 50% flowering, first harvest, and plant vigor

Treatments	Days To 50% Flowering	Days To 1st Harvest	Plant Vigor	
			30 DAT	@ 1st Harvest

V1M0	36.00	65.00	2.73 a	2.20
V1M1	33.00	66.00	2.13 b	2.33
V1M2	31.67	66.00	1.93 b	2.73
V1M3	32.33	65.00	2.73 b	2.60
V1M4	32.33	66.00	1.80 b	2.00
V2M0	34.67	67.00	2.93 a	3.87
V2M1	31.33	67.00	3.47 a	3.44
V2M2	32.00	66.00	3.00 a	3.62
V2M3	34.67	66.00	3.53 a	2.67
V2M4	32.00	66.00	3.13 a	3.13
V3M0	37.67	66.00	2.87 a	3.20
V3M1	34.33	66.00	2.40 b	2.27
V3M2	38.00	66.00	2.20 b	2.80
V3M3	30.33	65.00	1.60 c	1.93
V3M4	32.00	65.00	1.80 b	1.60
HSDα0.05	ns	ns	**	ns
CV (%)	166%	2.25%	15.23%	20.99%

V1 = Diamante Max F1, V2 = Improve Pope, V3 = Marimar F1
M0 = Control, M1 = Rice straw, M2 = Cogon grass, M3 = Napier grass, M4 = Saw dNLPHMP0047694135ust
**significant **highly significant nsnon-significant*

Plant survival rate showed significant variation due to different varieties at 30 DAT, 45 DAT, and 60 DAT except at 15 DAT (Table 9). It can be observed that tomato varieties that have poor growth at an early seedling stage have consequently low percent survival in the latter growth stage. The percent survival rate among the different tomato varieties could be attributed to environmental factors and insect and pest damage.

Different indigenous mulches exhibited significant effect on percentage survival at 30 DAT and 45 DAT except for 15 DAT and 60 DAT (Table 10).

The interaction between varieties and mulches had an insignificant effect on the plant survival of tomatoes (Table 11).

The varieties showed a significant variation in the total

Table 9: Effects of different variety on plant survival of tomato

Treatments	Plant Survival (%)			
	15 DAT	30 DAT	45 DAT	60 DAT
V¬1	82.00a	70.7ab	72.7a	63.3a
V2	80.7a	62.7b	46.0b	40.7b
V3	88.0a	76.7a	74.0a	70.0a
HSDα0.05	ns	*	**	**

*V1 = Diamante Max F1, V2 = Improve Pope, V3 = Marimar F1, *significant **highly significant ^{ns}non-significant*

Table 10: Effects of different mulching treatments on plant survival of tomato

Treatments	Plant Survival (%)			
	15 DAT	30 DAT	45 DAT	60 DAT
M0	82.2a	76.7a	72.2a	66.7
M1	78.9a	56.7b	50.0b	47.8
M2	83.3a	66.7ab	60.0ab	56.7
M3	84.4a	71.1ab	65.6ab	54.4
M4	88.9a	78.9a	73.3a	64.4
HSDα0.05	ns	*	*	ns

*M0 = Control, M1 = Rice straw, M2 =Cogon grass, M3 = Napier grass, M4 = Sawdust, *significant **highly significant ^{ns}non-significant*

Table 11: Combined effects of variety and mulching on plant survival of tomato

Treatments	Plant Survival (%)			
	15 DAT	30 DAT	45 DAT	60 DAT
V1M0	83.3	76.7	76.7	70.0
V1M1	80.0	60.0	63.3	53.3
V1M2	80.0	56.7	63.3	56.7
V1M3	80.0	76.7	76.7	56.7
V1M4	86.7	76.7	83.3	80.0
V2M0	83.3	73.3	60.0	50.0
V2M1	76.7	53.3	30.0	40.0
V2M2	76.7	66.7	50.0	50.0
V2M3	83.3	53.3	36.7	33.3
V2M4	83.3	66.7	53.3	30.0
V3M0	80.0	80.0	80.0	80.0
V3M1	80.0	56.7	56.7	50.0
V3M2	93.3	76.7	66.7	63.3
V3M3	90.0	83.3	83.3	73.3
V3M4	96.7	86.7	83.3	83.3
HSDα0.05	ns	ns	ns	ns
CV (%)	13.76%	18.81%	22.48%	33.41%

*V1 = Diamante Max F1, V2 = Improve Pope, V3 = Marimar F1, M0 = Control, M1 = Rice straw, M2 = Cogon grass, M3 = Napier grass, M4 = Sawdust *significant **highly significant ns non-significant*

number of fruits number of marketable and non - marketable fruits per plant (Table 12). V3 has the highest total number of fruits per plant, number of marketable fruits, and number of non-marketable fruits.

Table 13 presents the mean effect of different mulching treatments on the total number of fruits per plant, marketable and non-marketable fruits per plant. Statistical analysis showed no significant difference among treatments; however, tomatoes subjected to M4 (sawdust) produced the highest number of produced fruits with 78.44, followed by M1 (rice straw) with 58.67, and M0 (control) obtained the lowest produce with 45.56. The

Table 12: Effects of variety on the total number of fruits per plant, marketable and non-marketable fruits per plant

Treatments	Number of Fruits Per Plant	Number of Marketable Fruits	Number of Non-Marketable Fruits	
V¬1	77.47 a	75.07 a	2.40 b	66.7
V2	21.67 b	19.67 b	2.00 b	47.8
V3	89.40 a	79.27 a	10.13 a	56.7
HSDα0.05	**	**	**	54.4

*V1 = Diamantie Max F1, V2 = Improve Pope, V3 = Marimar F1, *significant **highly significant ns non-significant*

Table 13: Effects of different mulching treatments on the total number of fruits per plant, marketable and non-marketable fruits per plant

Treatments	Number of Fruits Per Plant	Number of Marketable Fruits	Number of Non-Marketable Fruits	
M0	45.56	42.22	3.33	66.7
M1	58.67	55.00	3.67	47.8
M2	53.11	49.22	3.89	56.7
M3	78.44	71.67	6.78	54.4
M4	78.44	71.89	6.56	
HSDα0.05	ns	ns	ns	

*M0 = Control, M1 = Rice straw, M2 =Cogon grass, M3 = Napier grass, M4 = Sawdust, *significant **highly significant ns non-significant*

combined effects between variety and mulching on the number of fruit per plant, number of marketable fruits, and number of non – marketable fruits were found to be insignificant (Table 14). However, numerically the highest number of fruits per plant was found from V3M3 with a treatment combination of Napier grass mulch and Marimar F1.

The varieties showed significant variation among the parameter studied (Table 15). Results revealed that V3 had a maximum total weight, marketable and non-marketable weight, and weight per fruit, with V1 having larger fruit size and more yield in tons/ha. The marked variation in individual parameters was observed due to the influence of different varieties. Statistical analysis showed no

Table 14: Combined effects of variety and mulching on the total number of fruits per plant, marketable and non-marketable fruits per plant

Treatments	Number of Fruits Per Plant	Number of Marketable Fruits	Number of Non-Marketable Fruits	
V1M0	67.33	66.00	1.33	66.7
V1M1	83.67	82.33	1.33	47.8
V1M2	83.67	75.67	2.67	56.7
V1M3	73.67	68.67	5.00	54.4
V1M4	84.33	82.67	1.67	
V2M0	19.67	18.00	1.67	
V2M1	15.00	14.00	1.00	
V2M2	21.33	20.33	1.00	
V2M3	19.67	18.67	1.00	
V2M4	32.67	27.33	5.33	
V3M0	49.67	42.67	7.00	
V3M1	77.33	68.67	8.67	
V3M2	59.67	51.67	8.00	
V3M3	142.00	127.67	14.33	
V3M4	118.33	105.67	12.67	
HSDα0.05	ns	ns	ns	
CV (%)	20.73%	20.1%	27.39 %	

*V1 = Diamante Max F1, V2 = Improve Pope, V3 = Marimar F1, M0 = Control, M1 = Rice straw, M2 = Cogon grass, M3 = Napier grass, M4 = Sawdust, *significant **highly significant nsnon-significant*

Table 15: Effects of variety on yield and yield components of tomato

Treatments	Weight Of Fruits Per Plant, G			Weight Per Fruit, G	Fruit Size	Yield, Tons/ Ha
	Total Weight	Marketable	Non-Marketable			
V¬1	1321.00 a	1275.33 a	27.67 ab	26.49 a	29.40 b	4.28 a
V2	276.67 b	260.47 b	16.20 b	18.72 b	1.75 a	0.87 b
V3	1000.40 a	940.93 a	59.47 a	27.88 a	1.25 a	3.13 a
HSDα0.05	**	**	*	**	**	**

*V1 = Diamante Max F1, V2 = Improve Pope, V3 = Marimar F1, *significant **highly significant nsnon-significant*

significant effect on the total weight, marketable and non - marketable weight, weight per fruit, fruit size, and yield tons/ha on the different mulching treatments (Table 16). The combined effects between mulching and variety on total weight, total marketable, non- marketable weight, fruit size, and yield tons/ha showed no significant effect except for the weight per fruit (Table 17). The incidence of weeds was monitored at 30 and 60 DAT (Table 18).

Table 16: Effects of different mulching treatments on yield and yield components of tomato

Treatments	Weight Of Fruits Per Plant, G			Weight Per Fruit, G	Fruit Size	Yield, Tons/ Ha
	Total Weight	Marketable	Non-Marketable			
M0	634.78	610.89	23.89	21.64	1.68	1.97
M1	846.22	793.78	22.44	24.23	1.61	2.74
M2	714.11	672.33	41.78	25.26	1.50	2.24
M3	996.89	952.44	44.44	26.93	1.80	3.17

M4	1138.11	1098.44	39.67	23.76	1.74	3.66
HSDα0.05	ns	ns	ns	ns	ns	ns

*M0 = Control, M1 = Rice straw, M2 =Cogon grass, M3 = Napier grass, M4 = Sawdust, *significant **highly significant nsnon-significant*

Table 17: Combine effects of variety and mulching treatments on yield and yield components of tomato

Treatments	Weight Of Fruits Per Plant, G			Weight Per Fruit, G	Fruit Size	Yield, Tons/ Ha
	Total Weight	Marketable	Non-Marketable			
V1M0	1095.00	1074.00	21.00	24.53 a	2.00	3.40
V1M1	1506.00	1402.00	14.00	26.20 a	2.00	4.97
V1M2	1273.667	1223.33	50.33	31.53 a	2.00	4.08
V1M3	1192.33	1153.33	39.00	24.40 a	2.00	3.84
V1M4	1538.00	1524.00	14.00	25.80 a	2.00	5.08
V2M0	290.00	276.00	14.00	13.87 b	1.97	0.92
V2M1	186.66	173.33	13.33	18.50 b	1.50	0.58
V2M2	231.33	217.67	13.67	18.04 b	1.50	0.72
V2M3	214.3	202.67	11.67	27.13 a	2.00	0.68
V2M4	461.00	432.67	28.33	16.07 b	1.80	1.44
V3M0	519.33	482.67	36.67	26.53 a	1.07	1.61
V3M1	846.00	806.0	40.00	28.00 a	1.33	2.68
V3M2	637.33	576.00	61.33	26.20 a	1.00	1.92
V3M3	1584.00	1501.33	82.67	29.25 a	1.40	5.00
V3M4	1415.33	1338.67	76.67	29.40 a	1.43	4.46
HSDα0.05	ns	ns	ns	*	ns	ns
CV (%)	23.57%	26.38%	24.07%	16.49%	17.06%	24.4 1%

*V1 = Diamante Max F1, V2 = Improve Pope, V3 = Marimar F1, M0 = Control, M1 = Rice straw, M2 =Cogon grass, M3 = Napier grass, M4 = Sawdust, *significant **highly significant nsnon-significant*

Statistical analysis showed highly significant variation among different varieties at 30 DAT with V3 moderately infested, however, the result at 60 DAT showed no significant difference among varieties.

Table 18: Effects of different mulching treatments on yield and yield components of tomato

Treatments	Weeds Incidence	
	30 DAT	60 DAT
V¬1	3.13 a	2.00
V2	2.07 b	2.27
V3	3.27 a	2.00
HSDα0.05	**	ns

*V1 = Diamante Max F1, V2 = Improve Pope, V3 = Marimar F1, *significant **highly significant nsnon-significant*

A significant variation in the weeds incidence was observed in different mulching (Table 19). It implies that the different mulch types highly affect the crop incidence of weeds. Awodoyin et al. (2007) reported in their study that mulching increased the yield of tomatoes through modification of the crop growing environment by reducing weed infestation, soil moisture depletion, and ameliorating soil temperatures.

This helps to reduce herbicide usage, thus preventing environmental pollution and ensuring production of organic food.

Table 19: Effects of different mulching treatments on weeds incidence of tomato

Treatments	Weeds Incidence	
	30 DAT	60 DAT
M0	3.33 ab	2.67 a
M1	2.22 c	2.22 ab
M2	2.33 bc	1.22 c
M3	2.67 abc	2.44 ab
M4	3.56 a	1.89 b
HSDα0.05	**	**

*M0 = Control, M1 = Rice straw, M2 =Cogon grass, M3 = Napier grass, M4 = Sawdust, *significant **highly significant nsnon-significant*

Table 20 presents the combined effects of variety and mulching on weeds incidence of tomato at 30 DAT and 60 DAT. Statistical analysis showed no significant variation among treatments at 30 DAT; however, a highly significant difference was observed at 60 DAT among treatments with V1M2 and V1M4 showed less or no weeds infestation.

Table 20: Combined effects of variety and mulching on weeds incidence of tomato

Treatments	Weeds Incidence	
	30 DAT	60 DAT
V1M0	3.67	2.67
V1M1	2.00	2.00
V1M2	3.33	2.00
V1M3	3.00	3.00
V1M4	3.67	2.00
V2M0	2.67	3.67
V2M1	2.00	2.00
V2M2	1.67	1.67
V2M3	1.67	2.33
V2M4	2.33	2.33
V3M0	3.67	3.00
V3M1	2.67	1.67
V3M2	2.00	1.67
V3M3	3.33	2.00
V3M4	4.67	2.67
HSDα0.05	ns	ns
CV (%)	27.63%	20.81%

*V1 = Diamante Max F1, V2 = Improve pope, V3 = Marimar F1, M0 = Control, M1 = Rice straw, M2 =Cogon grass, M3 = Napier grass, M4 = Sawdust, *significant **highly significant nsnon-significant*

Different varieties exhibited a highly significant effect on the insect and disease infection/infestation (Table 21), with V2 as moderately infested/infected while V1 as slightly infested/infected. Diseases infestations are well-known factors that decrease crop yields and expand production costs (Liliane & Charles, 2020). Fruit worm, armyworm, Bacterial wilt, TYLCV, The plants exhibited stunted growth, size reduction, and curling of the leaves. Blossom end rot and cat facing are the major diseases that are commonly present in tomatoes Table 22 present the

Table 21: Effect of different variety on insect and disease infection/infestation

Treatments	Insect And Disease Infestation	
	30 DAT	60 DAT
V¬1	2.00 b	2.87 b
V2	3.27 a	3.93 a
V3	1.733 b	3.47 ab
HSDα0.05	**	ns
M4	3.56 a	1.89 b
HSDα0.05	**	**

*V1 = Diamante Max F1, V2 = Improve Pope, V3 = Marimar F1, *significant **highly significant nsnon-significant*

mean effect of different mulching on insect and disease infection/infestation. Statistical analysis showed a highly significant difference at 30 DAT. The result showed that M4 (sawdust) had the lowest infestation of insects and diseases, followed by M3 (Napier grass), and the highest infestation of pests and diseases was found in M1 (rice straw). However, at 60 DAT, results showed no significant effect between treatment means.

Table 21: Effect of different variety on insect and disease infection/infestation

Treatments	Insect And Disease Infestation	
	30 DAT	60 DAT
M0	2.56 ab	3.22
M1	2.89 a	3.33
M2	2.33 ab	3.67
M3	2.00 b	3.56
M4	1.89 b	3.33
HSDα0.05	**	ns

*M0 = Control, M1 = Rice straw, M2 =Cogon grass, M3 = Napier grass, M4 = Sawdust, *significant **highly significant nsnon-significant*

The interaction between varieties and mulches had a significant effect on insect and disease infection/infestation at 30 DAT and 60 DAT with V1M4 (Diamante Max F1 + Saw Dust) with no infection/infestation to slightly infected/infested (Table 23).

Table 20: Combined effects of variety and mulching on weeds incidence of tomato

Treatments	Weeds Incidence	
	30 DAT	60 DAT
V1M0	2.33 a	2.67 a
V1M1	3.33 a	3.67 a
V1M2	2.00 b	3.33 a
V1M3	1.33 b	2.67 a
V1M4	1.00 b	2.00 b
V2M0	3.00 a	3.67 a
V2M1	4.00 a	4.00 a
V2M2	3.00 a	4.00 a
V2M3	3.00 a	4.00 a
V2M4	3.33 a	4.00 a
V3M0	2.33 a	3.33 a
V3M1	1.33 b	2.33 b
V3M2	2.00 b	3.67 a
V3M3	1.67 b	4.00 a
V3M4	1.33 b	4.00 a
HSDα0.05	**	*
CV (%)	19.39%	20.63%

*V1 = Diamante Max F1, V2 = Improve Pope, V3 = Marimar F1, M0 = Control, M1 = Rice straw, M2 =Cogon grass, M3 = Napier grass, M4 = Sawdust, *significant **highly significant nsnon-significant*

Tomato Insect Pests and Diseases

Common insect pests found in the experimental area were beet armyworm (Spodoptera exigua), tomato fruitworm (Helicoverpa armigera), and leaf miner (Liriomyza spp.). Tomato diseases present include bacterial wilt (Ralstonia solanacearum), fusarium wilt (Fusarium oxysporum f. lycopersici), and tomato yellow leaf curl virus (TYLCV).

CONCLUSIONS

On the different varieties of tomatoes, among the growth parameters, although majority of cases were non-significant but healthier results were obtained on plant vigor, plant survival, yield and its component, weeds incidence, and insect and disease infection/infestation. Different mulching treatments exhibited improved effects only on few parameters such as the plant height, plant vigor, percent survival, weeds incidence, and insect and disease infestation. The interaction between varieties and mulches had an insignificant effect on plant height, plant vigor, yield and its component except for weight per fruit, weeds incidence and insect and disease infection/infestation but showed comparatively superior than control in all aspects. Therefore, the growth and yield of tomatoes were not significantly all the time but affected by the different varieties and mulching treatments and interactions between these factors were obtained. It is therefore recommended that the potential of these varieties and the different mulches needed to be further tested for verification under different growing season to elicit substantial conclusions. Other parameters or data regarding moisture requirement and nutritional value should be gathered also to fully explore the potentiality of using indigenous mulch.

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