



EFFECT OF GRASS MULCH ON PERFORMANCE OF TOMATO (*Lycopersicon lycopersicum* Karst.) CULTIVARS DURING THE HOT SEASON IN THE SEMI-ARID ZONE OF NIGERIA

A.S. Wali¹, B.H. Kabura² and I.A. Lassa³

¹Department of Agronomy, Ahmadu Bello University, Zaria, Nigeria/
Department of Farming System Research, Lake Chad Research Institute
P.M.B 1293, Maiduguri, Nigeria

²Department of Crop Production, University of Maiduguri, Nigeria

³Department of Agronomy, Bayero University Kano, Nigeria

ABSTRACT

A field experiment was conducted in 2008 and 2009 at Salam Farm of Ngaburari village of Konduga Local Government Area of Borno State (Lat.12⁰N and Long. 13⁰13'E) to determine the effects of mulching on some cultivars of tomato (*Lycopersicon lycopersicum*, Karst.) under the hot weather condition in the Semi-Arid Region of Nigeria. The treatments consisted of five cultivars of tomato (Tandino, Danbaga, Roma VF, UC82B and Dansyria) and six grass mulch (*Pennisetum pedicelatum* Trin) levels (0, 2.5, 5, 7.5, 10 and 12.5 tons per hectare (t ha⁻¹)) which were laid out in a strip-plot design and replicated three times. The characters studied include; plant height, number of leaves, leaf area, number of fruits per plant, weight of fruits per plant and yield in t ha⁻¹. The results showed that mulching from 5 t ha⁻¹ was generally favourable for the growth characters, while 7.5 t ha⁻¹ and above was favourable for yield characters and yield. Mulching from 5 t ha⁻¹ was generally favourable for the growth characters, while 7.5 t ha⁻¹ and above was favourable for yield characters and yield. The interaction between Roma VF and 7.5 t ha⁻¹ mulching produced the best yield (4.25 t ha⁻¹) compared to other treatments interactions hence recommended in the study area. Though mulching increased yield over the control for all the cultivars studied, there is the need to evaluate other strategies to further increase the yield of tomato during the hot season in the semi-arid region of Nigeria.

Keywords: Tomato cultivars; Grass mulching; Growth and Yield Characters

INTRODUCTION

Tomato (*Lycopersicon lycopersicum*, Karst.) is one of the most popularly consumed vegetables globally. The popularity of the crop stems from its acceptable flavor, nutritive value (high in vitamin C and A), the short life cycle and high productivity (Adil *et al.*, 2003). FAO (2012) estimated the world production of tomato in 2012 at 159.3 million metric tonnes with China leading with 48.5 million metric tonnes followed by United States of America recording 15.5 million metric tonnes. Africa produced 10.8% of the world production with

Morocco leading producer in Africa at 12.1 million metric tonnes and Nigeria is the fourth in Africa with an estimated output of 1.10 million metric tonnes and average yield of 5-6 t ha⁻¹. This was lower than average yield of 13.5 t ha⁻¹ in Africa and world average of 22.0 t ha⁻¹.

In Nigeria, it is mostly cultivated in the semi-arid region during the cool dry season (harmattan period) using irrigation. High temperature and low relative humidity limit the production of tomato to the cooler period of the year (Rodriguez, 2007). As such, the availability of fresh tomato is always limited during the hot period (Kabura *et al.*, 2009). During the hot period, temperature rises up to 40°C in this region. Optimum day, night and soil temperatures for tomato production are 32°C, 22°C and 25°C, respectively (Orzolek, 2000). One way to achieve improved production condition is the use of mulch.

Mulch is any material spread on ground to protect the plant from heat, rain drop, cold, drought or to keep the fruit clean (McCraw, 2007). Mulching have been used to enhance productivity in tomato (Agele *et al.*, 2000; Ashrafuzaman *et al.*, 2010; Tswana *et al.* 2017) and other crops (Maged, 2006) through its effect particularly on soil environment in terms of soil temperature and moisture regulation, texture and fertility improvement (Sakar *et al.*, 2007; Zangouejnejad *et al.*, 2018) and weed control (Hudu *et al.*, 2002; Zangouejnejad *et al.*, 2018). However, the degree of response to temperature stress differs with crop variety (Adil *et al.*, 2003; Mitterbauer and Esch, 2007). Similarly, mulching was reported to increase the yield of other vegetables such as okra (Shivaraj *et al.*, 2018), cucumber (Maged, 2006), peppers (Mata *et al.*, 2002), lettuce (Manal *et al.* 2018) water melon (Reddy *et al.* 2018) and potato (Razzaque and Ali, 2009).

To date, little information is available on tomato production during the hot season as well as optimum quantity of mulch material to be used. This study was carried out with the objective of identifying best tomato cultivar and the optimum mulch level for higher fruit yield during the hot season in the semi-arid region for nutritional and economic sustainability.

MATERIALS AND METHOD

Study Area

Experiment was conducted at Salam Farm in Ngaburari village of Konduga Local Government Area, Borno State (Lat. 12° N and Long. 13°13' E) during the hot seasons (March to June) of 2008 and 2009. The areas are characterized by natural vegetation with sparse trees (5-9 m tall), dominated by widely spaced shrubs and grasses (Abubakar, 2000). Short and erratic rainfall, usually falling between the months of June and September (500 – 800 mm/annum). Minimum and maximum temperature range from 16.8°C – 41.3°C Table 1. The soils in the study area are reddish-brown with little profile differentiation, generally described texturally as sandy and sandy loam with low organic matter content (Ogigirigi, 1993; Kabura *et al.*, 2009).

Treatments and Experimental Design

The treatments consisted of five cultivars of tomato (Tandino, *Danbaga*, Roma VF, UC-82B and *Dansyria*) and six grass (*Pennisetum pedicellatum* Trin.) mulch (0, 2.5, 5, 7.5, 10 and 12.5 t ha⁻¹) which were laid out in a strip-plot design. The treatments were replicated

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three times in three blocks of 174 m² and alleys between the blocks of 0.5 m width. Each of the blocks having thirty treatments plots each of 4 m² separated by 0.5 m alleys.

The five cultivars of tomato were obtained from the Horticultural Unit of the Borno State Agricultural Development Programme (BOSADP), Maiduguri. These cultivars were chosen because they are among the most commonly grown tomato cultivars in this region. The grass mulch (*Pennisetum pedicellatum* Trin) used for the study was chosen because it is the common grass in the region.

Land Preparation and Crop Management

The experimental area was cleared manually and harrowed with a tractor. The land was properly levelled and the beds marked out. The edges of each bed were raised to prevent run-off during irrigation. The beds were then thoroughly irrigated for three days before transplanting. Fertilization was done based on Borno State Agriculture Development Programme, BOSADP (1993) recommendation. Basal application of 330 kg/ha NPK (15:15:15) at transplanting and top dressing with 100 kg/ha urea in two split doses of 50 kg/ha each at 3 weeks after transplanting (WAT) and 6 WAT.

The seedlings for each of the five (5) cultivars of tomato were raised in a 0.5 x 1 m bed. The grass was weighed with a spring scale to provide the required weight for each treatment. The mulch was spread manually by hand to each plot and the seedlings were transplanted thereafter. Seedlings were transplanted (5 weeks after sowing in the nursery) when they attained transplanting stage. The plots were irrigated to field capacity before transplanting the seedlings at inter and intra-row spacing of 60 cm x 60 cm. A day after transplanting, water was applied at field capacity to each plot at the evening time. Subsequently, the plots were irrigated at four-days intervals until final harvest.

Data Collection and Analysis

Growth data collected at 10 WAT include; plant height, number of leaves per plant and leaf area while yield parameters include; number of fruits, fruits weight per plant and fruit Yield (t ha⁻¹). The data collected were subjected to analysis of variance (ANOVA) and the differences among the means were separated at 5 % level of probability using Duncan's Multiple Range Test (DMRT) as reported by Duncan (1955) using statistical software Statistix 8, version 8.0.

RESULTS

Effect of Tomato Cultivars and Mulching on Growth Characters

Table 2 showed treatments effect on growth characters during 2008, 2009 and combined across the two years. The result on plant height recorded significant effect of mulching on tomato cultivars in the two years and the combined analysis. Cultivar *Dansyria* was consistently significantly taller than all the other cultivars in both years and in the combined analysis throughout the period of the experiment. The other cultivars were comparable with respect to this parameter.

Table 2: Effect of cultivar and grass mulch on growth characters in 2008 and 2009 hot period

Treatment	Plant height (cm)			Number of leaves			Leaf area (cm ²)		
	2008	2009	Mean	2008	2009	Mean	2008	2009	Mean
Cultivar (A)									
Tandino	44.67b	41.72b	44.19b	79.39c	109.39b	94.39d	654.6d	886.3c	770.5c
<i>Danbaga</i>	44.56b	41.06b	42.78b	70.17d	87.28e	78.72e	723.5dc	891.9c	807.6c
Roma VF	44.06b	42.28b	43.17b	103.56b	104.50c	104.03c	833.1c	782.0c	807.6c
UC 82-B	45.67b	42.61b	44.14b	132.00a	94.78d	113.39b	1902.4a	1341.3b	1621.9b
<i>Dansyria</i>	51.89a	48.44a	50.17a	105.39b	143.26a	124.33a	1510.1b	2002.3a	1756.1a
SE (\pm)	2.21	0.85	1.43	2.86	1.08	1.56	68.24	61.91	42.73
Grass Mulch (t ha ⁻¹) (B)									
0	44.47c	34.00d	39.23c	93.27b	103.81b	93.03b	1073.5d	1150	1111.7
2.5	45.73bc	38.80c	42.27c	97.93a	107.73a	103.83ab	1124.4c	1205.6	1165
5.0	45.13c	43.67b	44.40b	99.87a	109.67a	104.77a	1147.8bc	1232.7	1190.3
7.5	48.27a	46.53a	47.4a	99.93a	108.53a	104.23ab	1160.9ab	1216.2	1188.5
10.0	48.20a	48.67a	48.13a	98.87a	108.73a	103.80ab	1128.8a	1085.6	1106.5
12.5	47.60ab	48.20a	47.90a	98.73a	107.60a	103.17ab	1113.9ab	1193.3	1153.6
SE (\pm)	0.91	0.87	0.56	0.91	0.93	2.38	16.08	69.77	51.46
Interaction									
A x B	NS	Ns	NS	NS	NS	NS	NS	NS	NS

Means followed by same letter(s) within a treatment group are not significantly different at 5% level of significance using DMRT. NS = Not Significant.

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Mulching had also significant effect on plant height of tomato in both years and in the combined analysis. Generally, mulching from 7.5 – 12.5 t ha⁻¹ produced plants of similar heights which were significantly taller than plants grown under 0 - 5 t ha⁻¹ mulch. The control treatment (0 t ha⁻¹ mulch) produced significantly the shortest tomato plants in both years and in the combined analysis.

In 2008, UC-82B significantly produced the highest number of leaves than other cultivars. That was followed by *Dansyria* and *Roma* which were comparable while *Danbaga* produced the least number of leaves. In 2009 and the combined *Dansyria* produced significantly the highest number of leaves while *Danbaga* produced the least. Mulching also had significant effect on number of leaves produced per plant in both years and combined. In 2008 and 2009 all the treated plots recorded similar number of leaves that was significantly higher than the untreated control. However, in the combined analysis mulching at 5 t ha⁻¹ produced significantly higher number of leaves than the control which were at par with all treated plots with respect to this parameter.

The result on the leaf area showed that in 2008 UC-82B produced the largest leaf area compared to all other cultivars while in 2009 and the combined analysis, *Dansyria* significantly produced the largest leaf area compared to all other cultivars. Mulching had a significant effect on the leaf area of tomato in 2008 which tomato with the highest leaf area was produced on application of mulch at 10 t ha⁻¹ which was comparable to application of 7.5 and 12.5 t ha⁻¹. Application of mulch in 2009 and the combined was not significant with respect to the leaf area per plant.

Effect of Tomato Cultivars and Mulching on Yield and Yield Characters

Table 3 showed the effect of cultivar and mulching on yield and yield characters of tomato plants in 2008, 2009 and in the combined analysis.

Roma VF produced highest number of fruits in both years and the combined analysis which was however comparable to Tandino in 2008. *Danbaga* produced the least number of fruits throughout the study period. Mulching had significant effect on number of fruits produced per plant. Mulching from 7.5 – 12.5 t ha⁻¹ generally produced similar number of fruits which were significantly higher than plants grown under 0 - 5 t ha⁻¹ mulching in 2008, however in 2009 and the combined analysis, application of 10 and 12.5 t ha⁻¹ mulch recorded many fruits than other treated rates with the untreated control recording least number of fruits.

Treatment effect on weight of fresh tomato per plant was significant. Roma VF had the highest fruit weight per plant followed by Tandino while *Danbaga* had the least fruit weight in the two years and the combined analysis. Mulching at 10 and 12.5 t ha⁻¹ produced plants with higher fruit weight in 2008 and 2009 while in the combined mulching from 7.5 to 12.5 t ha⁻¹ recorded higher and similar fruit weight compared to plants grown under 5 t ha⁻¹ mulch.

The result showed that cultivar significantly affected the yield of tomatoes in 2008, 2009 and in the combined means for the two years. Roma VF significantly produced the highest yield (t ha⁻¹) and was followed by Tandino throughout the study. *Danbaga* significantly produced the least yield in both years and in the combined analysis.

Table 3: Effect of cultivar and grass mulch on yield characters in 2008 and 2009 hot period in Konduga, Nigeria

Treatment	Number of fruits			Fruit weight plant ⁻¹ (g)			Fruit yield (t ha ⁻¹)		
	2008	2009	Mean	2008	2009	Mean	2008	2009	Mean
Cultivar (A)									
Tandino	25.70a	23.56b	24.64b	164.07b	155.06b	159.56b	3.71ab	3.50b	3.60b
<i>Danbaga</i>	11.81c	12.53d	12.17d	56.26d	59.52d	57.89e	1.27d	1.34d	1.30d
Roma VF	26.33a	25.70a	26.11a	169.07a	182.13a	175.75a	3.81a	4.10a	3.93a
UC 82-B	17.09b	17.31c	17.17c	84.51c	107.02c	95.76d	1.95c	2.41c	2.18c
<i>Dansyria</i>	16.89b	17.81c	17.34c	102.86b	114.88c	108.87c	2.25b	2.535c	2.38c
SE (±)	0.36	0.27	0.202	4.931	5.178	3.548	0.101	0.107	0.068
Grass Mulch (t ha ⁻¹) (B)									
0	14.86d	15.87e	15.17e	85.22d	87.86e	86.54d	1.91d	1.93e	1.92d
2.5	18.73c	18.07d	18.40d	111.41c	117.20d	114.31c	2.52c	2.64d	2.54c
5	19.95b	19.08c	19.52c	121.00b	127.36c	124.18b	2.72b	2.87c	2.78b
7.5	21.07a	19.09b	20.48b	128.47	132.12b	13.30a	2.88a	2.67b	2.92a
10	21.83a	22.07a	21.94a	125.77a	14.50a	132.66a	2.83a	3.15a	2.98a
12.5	20.95ab	21.95a	21.42a	121.90b	137.73a	129.41a	2.83a	3.11a	2.92a
SE (±)	0.5	0.27	0.29	2.269	1.608	1.572	0.038	0.026	0.038
Interaction									
A x B	NS	NS	NS	NS	NS	NS	NS	NS	NS

Means followed by same letter(s) within a treatment group are not Significantly different at 5% level of Significance using DMRT. NS = Not Significant.

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Table 4: Interaction effects between cultivar and grass mulch on the yield of tomato (t ha⁻¹) in the combine 2008 and 2009 hot period

Cultivar	Grass Mulch t ha ⁻¹					
	0	2.5	5	7.5	10	12.5
Tantino	2.57ghi	3.42e	3.83cd	3.88cd	3.94bcd	3.95bcd
Danbaga	0.89o	1.16n-o	1.24nm	1.47lm	1.53lm	1.52lm
Roma VF	2.96f	3.67de	4.01b	4.25a	4.32a	4.21ab
UC-82B	1.54l	2.12k	2.21jk	2.39h-k	2.46g-j	2.35h-k
Dansyria	1.65l	2.31ijk	2.40g-j	2.62gh	2.70fg	2.56ghi
SE±			0.145			

Values followed by the same letter(s) are statistically the same at 5% level of significance using Duncan's Multiple Range Test (DMRT).

Similarly, mulching significantly affected the yield of tomato in 2008, 2009 and in the combined analysis. Mulching at 7.5 – 12.5 t ha⁻¹ significantly produced the highest yield in 2008 and the combined while in 2009 mulching at 10 and 12.5 t ha⁻¹ significantly produced the highest fruit yield. The interaction between cultivar and mulching on the yield (t ha⁻¹) of tomato was significant in the combined analysis.

Table 4 showed treatment interaction in the combined analysis where Roma VF grown from 7.5 to 12.5 t ha⁻¹ mulch produced significantly the highest fruit yield of tomato compared to all other cultivar x mulching interactions. The control (unmulch) of *Danbaga* was significantly the least which was followed by *Danbaga* at 2.5 t ha⁻¹ mulching.

DISCUSSION

Effect of Cultivar on Growth and Yield Characters of Tomato

There was significant variation in plant height, number of leaves and leaf area among the tomato cultivars evaluated. Cultivar *Dansyria* generally appeared vegetative vigorous, taller with much leaves compared to all the other cultivars and was followed by UC-82B and Roma VF. These variations could be due to the genetic potential of the cultivars. Variation among tomato cultivars in growth characters have been reported by several researchers. Kayum *et al.* (2008); Mehta and Asati (2008); Isah (2014) have reported variation among tomato cultivars and have attributed that to the genetic potential of the plant. Similarly, Kayum *et al.* (2008) working with three cultivars of tomato observed significant variation in the number of leaves, leaf area and leaf area index. The variety *Danbaga* consistently produced least vegetative parameters produced the least yield. *Danbaga* as it had the lowest number of leaves, leaf area and shorter cultivars. This finding is in agreement with Ashrafuzzaman *et al.* (2010) who reported variation in number of branches and number of leaves of tomato varieties and stressed that are among the characters which need to be improved for higher number of fruits and yield. Similarly, variation among cultivars in growth parameters have been reported in other crops such as okra (Shivaraj *et al.*, 2018) and cucumber (Magad, 2006).

This study has shown that Roma VF had significantly higher number of fruits than other cultivars. This is in agreement with the studies of Kabura *et al.* (2009) who reported similar behaviour of Roma VF cultivar compared to other tomatoes during the hot period and Kayum *et al.* (2008). Similarly, among the five cultivars of tomato studied, Roma VF consistently had the highest yield in the individual years and the combined analysis, that was followed by Tandino and *Dansyria*. The cultivar *Danbaga* had the least yield. This is in agreement with the studies of Kabura *et al.* (2009) that Roma VF performs better than most tomato cultivars in a similar study area during hot season. The better performance of Roma VF during the hot period over other cultivars could be due to the genetic potential of Roma VF to withstand hot weather.

Effect of Grass Mulch on Growth and Yield Characters of Tomato

The results of this experiment had shown that mulching had significant effect on growth and yield of tomato in both years and in the combined analysis. The growth parameters generally increased with increase in mulching level up to 5 t ha⁻¹ after which it remained constant. This result is in agreement with Kayum *et al.*, (2008) and Ashrafuzaman

et al., (2010) who reported enhancement of the number of leaves, leaf area, leaf area index and number of branches of tomato plants under mulched conditions during hot period.

The result further showed that number of fruits per plant, fruit weight per plant and fruit yield increased significantly with increase in mulching levels from 0 t ha⁻¹ to 7.5 t ha⁻¹ beyond which there was no significant difference. This pattern of the result was consistent in both years of study as well as the combined analysis. The higher yield obtained at higher mulching rates might be due to the ability of the mulch to regulate the crop environment in terms of temperature, moisture conservation, improvement of soil texture and fertility and weed control there by making it suitable for the plants. This corroborate the studies of (Zangouejad *et al.*, 2018) and Anikwe *et al.* (2007) who concluded that mulching enhances growth and yield of plants in the arid lands. Other researchers concluded that mulching reduce leaching of nutrients (Kayum *et al.*, 2008), evapotranspiration (Rashidi *et al.*, 2009), weed control (Samaila *et al.*, 2011; Zangouejad *et al.*, 2018) and increase water use efficiency (Ogwulumba and Ugwuoke, 2011; Zhang *et al.*, 2016).

CONCLUSION

Based on this research finding, mulching from 5 t ha⁻¹ was generally favourable for the growth parameters, while 7.5 t ha⁻¹ and above was favourable for yield and yield components. The interaction between Roma VF and 7.5 t ha⁻¹ mulching produced the best yield (4.25 t ha⁻¹) compared to other treatments interactions. The study also showed- that mulching increased yield over the untreated control for all the cultivars studied. Hence, mulching at 7.5 t ha⁻¹ and Roma VF cultivar recorded higher tomato yield in the hot weather and could be recommended in the study area.

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