



EFFECTS OF DIFFERENT MULCHING MATERIALS ON PERFORMANCE OF OKRA (*ABELMOSCHUS ESCULENTUS* MOENCH L.) IN MUBI NORTH, ADAMAWA STATE, NIGERIA

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Abstract

A field experiment was conducted in 2015 rainy season to assess the effect of different mulching materials on Okra's performance at the Students' Demonstration Farm of Federal Polytechnic Mubi. The aim of the experiment was to determine the influence of different mulching materials on the growth and yield of okra. The experimental area was prepared and treatment plots were marked out at 2×2 m sizes at an alley of 0.5 m apart on a 9.5 m area. Treatments consisted of 3 types of mulching materials (Sawdust, Rice straw and dry grass mulches) at the rates of 0, 5 and 10 t/ha each and were laid out in a Randomized Complete Block Design (RCBD) replicated 3 times. Data were collected on germination and seedling establishment counts, plant heights, the number of leaves, days to 50% flowering, days to 50% podding and number of pods per plant. Analysis of variance was used for data analysis. Results indicated that plots treated with 10 t/ha of SDM, RSM and GDM had higher seed germination by 87.50%, 70.81% and 79.20%, respectively. Growth parameters such as plant height, number of leaves and stem girths significantly ($P \leq 0.05$) increased with increasing mulching rates at 2, 4 and 6-WAS. The effects of SDM, RSM and DGM on days to 50% Okra flowering was 46.67, 49.00 and 48.33 respectively, and was 50.67, 52.33 and 51.00 on days to 50% podding. The number of pods produced per Okra plant significantly ($P \leq 0.05$) increased by 10 t/ha application over the control. The 10 t/ha application was the most suitable and implementable rate for growth and yield of Okra in Mubi environment.

Keywords: Mulching material, application rates, Performance, Okra.

1. Introduction

The Majority of subsistence farmers are still unable to adopt farming practices with high yielding potentials due to their limited knowledge of farm management options (Ofori, 2014). Reports have shown that heavy organic mulches used as a form of soil management practices were effective for a number of vegetable crops such as okra, spinach, tomato, and pepper (Hernandez, 1982; Grubben, 1999; Dalorima *et al.*, 2014).

Mulches with plant residues and synthetic materials are good examples of established farming techniques for increasing the profitability of many horticultural crops (Igbal, 2009). Other mulching materials such as dried grass, straws, dried leaves, sawdust, wood chips, peat, and cut branches spread over soil surfaces have been reported to conserve soil moisture and improve soil structure and infiltration rates and weed suppression (William, 2005). Mulching potted plants with various organic and inorganic mulch was found to conserve an average of 35% more soil water content over approximately 6 weeks of no irrigation than plants with no mulch. Mulch was shown to increase plant health and vitality, as indicated by stomatal conductance, by an average of 44% than plants with no mulch. The recommended mulch type for use in gardens is bark chips in both summer and winter seasons (Stelli *et al.*, 2018).

Traditionally, favorable water, soil, and plant relationship is created by placing mulching materials over soil surfaces. Micro-climate around a plant and soil is significantly affected by mulch in terms of thermodynamics in the environment, particularly soil moisture in the root zones and the physical, chemical, and biological properties of soils. Hence, pests and diseases are moderated, while crop growth and yields are improved (Igbal,

2009). However, a decline in soil organic matter content causes loss of soil productivity and is considered as one of the major problems of soil fertility management in the tropics.

Okra is one of Nigeria's priority vegetable crops and is ranked 3rd in production after tomato and onion (Grubben, 1999). It is grown in Nigeria because of its tender pods, rich in vitamins A, B, C, calcium, magnesium, potassium, and other vital minerals, particularly iodine (Premsekhar *et al*, 2009). Studies also show that okra contains high amounts of prominent vitamins and other minerals that help control diabetes, colon cancer, and body weights. Hence, it serves in boosting food digestion, healthy pregnancy, protection against free radiation, and relief from respiratory issues such as cough and constipation (Mike, 2013). Basic nutrient demands for okra growth are primarily supplied by the usually scarce and costly inorganic fertilizers, thereby providing alternative sources of organic fertilizers for okra production.

Although several materials can be used as mulches for soil moisture retention, their individual potentials may vary widely. There is, therefore, the need to evaluate these materials so as to select the best for increased, economical and sustainable production of okra by farmers in the study area. This research is an attempt in this direction

2. Materials and Methods

2.1 Description of the Study area

Mubi is located in the North-eastern part of Adamawa State, between latitudes 9°26' and 10°10'N and longitudes 13°10' and 13°44'E (Figure 1).

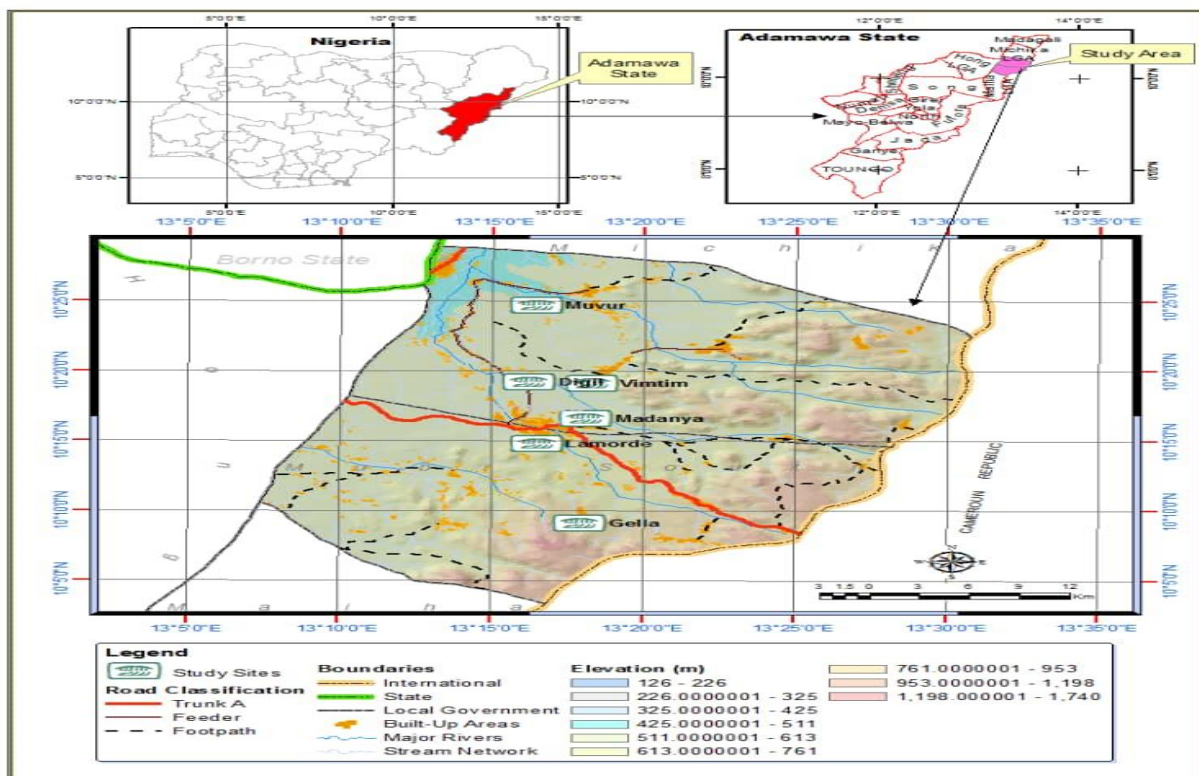


Figure 1. Map of the Study Area



It is bordered by the mountain ranges of the Mandara of the Republic of Cameroun to the East, Michika local government area to the North, Hong to the South and Askira-Uba to the West. It occupies a landmass of about 506.440 square kilometers. Mubi has an estimated population of 759.045 with a population density of 160.5 persons per square kilometres. The soils are largely of sandy clay loam, sandy loam or loam textured.

2.2 Land Preparation and Experimentation and Data Collection

A portion of land was cleared in Mubi as indicated in Figure 1, plowed, demarcated and prepared manually using a hoe shovel, measuring tape and pegs. The research was carried out during the 2015 rainy season. The plots were well levelled in order to obtain a good tilt. Field was made in to 12 plots each measuring 2×2 m and separated by 0.5 m as pathways between plots and laid in a Randomized Complete Block Design (RCBD), then replicated 3 times. The total land area for the experiment was 9.5×9.5 m (90.25 m²). A local variety okra seeds (*Dankwadam*) was sourced from a seed shop at the Mubi main market and sown to the seed beds. Treatments consisted of 3 different mulching materials: sawdust, rice straw and dry grass. The materials were carefully selected and collected. The rice straw and sawdust were chopped into smaller pieces for ease of application. The treatments were applied based on the principles of randomization as described by Gomez and Gomez (1984). The materials were applied at 0, 5 and 10 t/ha. Maximum of 3 seeds were sown at a distance of 40×45 cm between crop stands and rows (Bawa, 2002). The seedlings were later thinned down to 2 plants per stand at 3 weeks after sowing (WAS) (Sani and Eleduna, 2014). Weeds were controlled manually using a hoe and hand picking at 3, 6 and 9-WAS. Crop started flowering and podding at 7 and 8-WAS and some at 9-WAS. Matured pods were collected 4 times at an interval of 3 days.

Plant height was measured using a ruler from the best of the plant to the longest leaf. Plant girth was measured using a string tied round the plant and measuring the length. Leaves were counted physically and results recorded.

2.3 Data Collection

Data on germination and seedling establishment was obtained by physical counting of the number of germinated seedlings at 2-WAS, while the seedling establishment was determined as follows:

$$\% \text{ Seedling establishment} = \frac{\text{Number of Seeds Germinated}}{\text{Number of Seeds Sown}} \times 100\%$$

Plant height was taken at 3, 5 and 7-WAS by measuring the shoots from the ground level to the terminal bud of the 4 tagged plants and their mean values were taken and recorded. Number of leaves per plant was also obtained by physical counting of leaves from the 4 tagged plants, while the plant stem diameter were determined using digital Vanier caliper. Mean values of both parameters were also taken and recorded. Days to 50% flowering and days to 50% podding were obtained from regular observation of plots from the first flower and pods until 50% flowering and podding were observed. Number of pods per plant was recorded from the 4 tagged observation plants on each plot and their averages were taken and recorded.

The data collected were subjected to analysis of variance (ANOVA) the randomized complete block design (RCBD) of Statistics 9.4 generalized linear model. The differences among plot means of measured parameters were compared using standard error (SE) and separated using LSD at 5% level of significance.

3. RESULTS AND DISCUSSION

3.1 Okra germination and seedling establishment count

The results on the effects of different mulching material applications on okra seed germination and seedling establishment during the 2015 cropping season is presented in Table 3.1. The results show that, out of the 3 treatments, the 10 t/ha rate ($P < 0.05$) significantly influenced both okra seed germination counts and seedling establishments. The 10 t/ha rate of sawdust mulch (SDM) produced higher seed germination (87.50%), followed by dry grass mulch (DGM) and rice straw mulch (RSM) by 79.20% and 70.81% respectively. Conversely, the germinated seeds were relatively influenced by the higher application rate of 10 t/ha during seed establishment processes. The 10 t/ha rate of SDM, DGM and RSM influenced okra seedling establishment by 81.96%, 72.21% and 58.33%. The results show that the higher the treatment rates, then the better the okra seed germination efficiencies in the study area.

Table 3.1: Effect of different mulching materials on Okra percentage germination and seedling establishment count at 2-WAS in Mubi.

Mulching materials rates (t/ha)		Germination Count (%)	Seedling establishment (%)
SDM	0	66.70	54.12
	5	77.10	68.04
	10	87.50	81.96
RSM	0	66.50	54.14
	5	68.78	56.24
	10	70.81	58.33
DGM	0	66.81	54.19
	5	73.04	63.20
	10	79.20	72.21

Key: SDM= sawdust mulch, RSM=rice straw mulch, DGM=dry grass mulch

This agrees with earlier reports by Wein *et al.* (1993) and Azizur (1998), who mentioned that growth conditions for plants are better under mulches. Mugalla *et al.* (1990) added that organic mulch could offer a barrier against weed, moisture loss, erosion, insect, and disease injury, which encourages plant establishment of crops with potentially higher quality.

3.2 Effect of different mulching materials on okra plant heights

Table 3.2 presented the results. The effect of different mulching materials on okra plant heights at 2, 3 and 6-WAS. The results showed that the mulching materials generally influenced the okra plant heights. The 10 t/ha rate of RSM produced the tallest plants (14.67 cm), followed by SDM and then DGM which produced plant heights of 6.96 cm and 6.23 cm respectively at 2-WAS. Similarly, the 10 t/ha rate's dominant influence on the okra plant heights was still observed at both 4 and 6-WAS. The variations in plant heights was still linked to the differing treatment effects as was the case for both germination counts and seedling establishments in this study. The significant effect of plant height under different mulching materials as against control plots portrays the potential values and efficiency of nutrients available in the organic mulch in improving the physical and chemical conditions of the soils. This agrees with the claim that okra plants' growth is better under mulching condition (Wein *et al.*, 1993). This study's results corroborates with the findings of Dalorima *et al.* (2014), who reported a significant increase in okra plant heights with sawdust mulches to be taller (23.90 cm) than those grown on control plots with 19.10 cm high.

Table 3.2: Effect of different mulching materials on Okra plant height at 2, 4 and 6-WAS

Mulching materials rate (t/ha)		Plant Height (cm)		
		2-WAS	4-WAS	6-WAS
SDM	0	5.81 ^b	11.00 ^b	34.67 ^b
	5	6.61 ^{a^b}	12.00 ^b	38.00 ^b
	10	6.96 ^a	15.33 ^a	44.67 ^a
	SE (±)	0.39	0.79	4.14
RSM	0	11.67 ^b	10.67 ^a	20.67 ^a
	5	12.67 ^{ab}	12.00 ^a	25.67 ^b
	10	14.67 ^a	13.00 ^a	42.00 ^a
	SE (±)	0.75	0.92	2.74
DGM	0	5.99 ^a	9.67 ^b	21.00 ^c
	5	6.06 ^a	12.00 ^a	36.00 ^b
	10	6.23 ^a	13.33 ^a	43.33 ^a
	SE (±)	0.13	0.67	2.53

Key: Means having the same letter are not significantly different from one another statistically.

This agrees with the claim that growth of okra plants is better under mulching condition [9]. The results of this study corroborates with the findings of [4], who reported a significant increase in okra plant heights with sawdust mulches to be taller (23.90 cm) than those grown on control plots with 19.10 cm high.

3.3 Effects of different mulching materials on the number of leaves per plant of okra

Table 3.3 presents the results of the effects of different mulching materials on the number of leaves per okra plant. The results indicated that okra leaf production was significantly ($P \leq 0.05$) increased by the 10 t/ha rate. However, at 2-WAS, there were no significant ($P \leq 0.05$) differences among the treatment levels on the number of okra leaves, except for the RSM treatment. The treatment effects became more conspicuous on variations in the number of leaves at 4 and 6-WAS. Though, the treatment effects were proportional to the treatment rates of each of the mulching materials used. This outcome was perhaps due to sufficient decomposition and the release of stocked nutrients in the mulching materials over time. The significant differences observed in the number of leaves per plant in this trial could be linked to the varietal, environmental or the mulching material type and their application rates.

The outcome also concurs with the reports of Abdul-Baki and Spence (1992) and Streck *et al.* (1995), who mentioned that plant responses to mulching depend on the type of mulching material used. Sani and Eleduma (2014) also reported a higher number of leaves per plant with banana leaves mulch (4.57 leaves per plant) at 4-WAS, followed by wood shaving mulching (4.57 leaves per plant), than with control treatment with only 3.57 leaves per plant. Later at 6-WAS, wood shaving produced the highest number of leaves per plant (8.67 leaves), followed by dry grass mulching (8.53 leaves), than with fresh grass of *Panicum maximum* that produced barely 6 leaves per plant. Over time, this improvement could have been due to slow release of plant nutrients in the mulching material source.

3.4 Effect of different mulching materials on okra Stem girth

Table 3.4 presents the results of the effects of different mulching materials on okra stem girth. The results showed that the mulching materials significantly ($P \leq 0.05$) increased the stem girths regardless of the treatment rates and growth phases. The okra stem girths were uniformly influenced by the 5 and 10 t/ha rates of SDM, RSM and DGM treatments at 2, 4 and 6-WAS, except at 4-WAS, where the SDM treatment rates produced significant ($P \leq 0.05$) differences among okra stem girths in this study.

Table 3.3: Effect of different mulching materials on number of leaves of Okra at 2, 4 and 6-WAS

Mulching material rate (t/ha)	Number of Leaves per plant			
	2-WAS	4-WAS	6-WAS	
SDM	0	2.67 ^b	3.13 ^c	11.67 ^b
	5	2.93 ^b	3.42 ^b	12.67 ^{ab}
	10	3.50 ^a	3.81 ^a	14.67 ^a
	SE (±)	0.19	0.09	0.75
RSM	0	2.67 ^b	3.13 ^b	12.00 ^b
	5	3.13 ^a	3.49 ^a	12.33 ^b
	10	3.27 ^a	3.55 ^a	14.33 ^a
	SE (±)	0.15	0.08	0.72
DGM	0	2.87	3.15 ^b	11.00 ^b
	5	3.10	3.48 ^a	12.67 ^a
	10	3.33	3.66 ^a	13.33 ^a
	SE (±)	0.24	0.10	0.33

Key: Means following the same letter (s) within the same treatment column are statistically not significant ($P \geq 0.05$) at 5% level significance

Table 3.4: Effect of different mulching materials on Okra stem girth at 2, 4 and 6-WAS

Mulching materials treatment rate (t/ha)	Stem girth (mm)			
	2-WAS	4-WAS	6-WAS	
SDM	0	2.29 ^b	3.13 ^c	4.48 ^b
	5	2.41 ^{ab}	3.42 ^b	4.92 ^{ab}
	10	2.72 ^a	3.81 ^a	5.31 ^a
	SE (±)	0.13	0.09	0.17
RSM	0	2.22 ^b	3.13 ^b	4.63 ^b
	5	2.53 ^a	3.49 ^a	4.99 ^a
	10	2.54 ^a	3.55 ^a	5.05 ^a
	SE (±)	0.10	0.08	0.08
DGM	0	2.35 ^b	3.15 ^b	4.65 ^b
	5	2.53 ^{ab}	3.48 ^a	4.98 ^a
	10	2.69 ^a	3.66 ^a	5.19 ^a
	SE (±)	0.10	0.10	0.11

Key: Means following the same letter (s) within the same treatment column are statistically not significant ($P \geq 0.05$) at 5% level significance

Research results show that the mulching materials ($P \leq 0.05$) significantly influenced okra plant size and/or stem diameters (Bosland & Votava, 2000). Olurokooba *et al.* (2009) also reported significant improvement on irrigated tomato but contradicted by Bawa (2002), who found that increase in the nutrient application did not increase the increase of tomato's morphological characters.

3.5 Effect of different mulching materials on okra yield

Results of application effects of the different mulching materials on okra yield parameters are presented in Table 3.5. The results showed that the mulching material rates significantly ($P \leq 0.05$) decreased the length of

days to 50% flowering and the 50% podding in okra plant in the study area. The 10 t/ha rate of the mulching materials comparably reduced the number of days to 50% flowering and podding to a minimum period of 46.67 and 50.67 days respectively by SDM, followed by a respective reduction to 48.33 and 51 days to 50% flowering and podding by GDM, then the respective reduction to 49 and 52.33 days to 50% flowering and podding induced by the RSM treatment. The treatment effects were found to be proportional to the administered mulching material application rates. The higher the application rate, then the shorter the days to the 50% flowering or 50% podding of the okra plants in this study. This result agrees with the findings of Deng *et al.* (2006) and Remakrishna *et al.* (2006), who reported significant increases in tomato yields, when compared with an un-mulched treatment. Similarly, Dzemeku *et al.* (2009) reported higher fruit numbers and yields in pepper and onion with organic mulches.

Table 3.5: Effect of different mulching materials on Okra yield

Mulching materials treatment rate (t/ha)	Days to 50% flowering	Days to 50% Podding	Number of fruits per plant
SDM 0	50.33 ^a	57.00 ^a	15.33 ^c
5	48.33 ^{ab}	53.67 ^b	18.67 ^b
10	46.67 ^b	50.67 ^b	28.67 ^a
SE (±)	1.23	1.09	1.14
RSM 0	51.00 ^a	55.33 ^a	15.00 ^b
5	51.00 ^a	53.00 ^{ab}	16.33 ^b
10	49.00 ^a	52.33 ^b	20.00 ^a
SE (±)	0.94	1.04	1.04
DGM 0	51.33 ^a	54.00 ^a	16.67 ^b
5	49.67 ^{ab}	52.33 ^a	19.67 ^{ab}
10	48.33 ^a	51.00 ^a	22.00 ^a
SE (±)	0.79	1.19	1.78

Key: Means following the same letter (s) within the same treatment column are statistically not significant ($P \geq 0.05$) at 5% level significance

Slow decomposition of these organic mulching materials in addition to their nutrient potentials might have been responsible for the shortening of the days to 50% flowering and podding in this study. This outcome agrees with Bawa's (2002) report, who opined that days to 50% flowering is a function of nitrogen concentrations in organic mulching sources. Sharma and Mitra (1992) reveal that nutrients in organic manures are released very slowly and are stored for a longer period in the soil, thereby ensuring longer residual effects, improved root development, and higher crop yields.

4.0 Conclusion and Recommendations

The study shows that mulching materials vary in their effects on the performance of okra. The highest treatment i.e. 10 t/ha gave the highest number of fruits, percent germination, seedling establishment, plant height, number of leaves and stem girth regardless of the mulching material. Therefore, the application of 10 t/ha rate of either SDM, RSM and GDM appears to be more effective, and is thus, recommended for adoption among okra farmers in Mubi area and its environs.



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