EFFECT OF MULCH MATERIAL ON SOIL PHYSICAL PROPERTIES, YIELD AND YIELD COMPONENTS OF TOMATO (*Lycorpersicum esculentum L.)* IN MOKWA, NIGER STATE, NIGERIA.

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ABSTRACT

A field experiment was conducted to investigate the effect of different mulch material on physical soil properties, yield and yield component of tomatoes (Lycorpersiconesculeutum L.) at Mokwa college of Agriculture, Mokwa, Niger state, during dry season November 2019-Februray, 2020.The experiment consisted of three mulch materials, namely; plastic mulch (PM), plant residue (PR) and no-mulch (NM) and it was laid out in a Randomized Complete Block Design (RCBD). Data were collected on yield and yield components of tomatoes using standard procedures. Soil was sampled before application of the treatments and after application for laboratory analysis of some physical soil properties. The results showed that the mulch has an impact on physical soil properties that are influenced by management (Bulk Density, Soil Moisture and Soil Temperature). Also, yield and yield component of tomato was significantly influenced by mulch materials. Plastic mulch recorded significantly higher yield (27.75 t/ha) compared toplant residue mulch (17.75 t/ha) and no mulch (11.00 t/ha). This study has demonstrated that mulching improves both soil physical properties and yield of tomato.

Key words: Plastic Mulch, Plant Residue, Tomato, Yield, soil properties

INTRODUCTION

Tomato (*Lycopersicumesculentum L.)* is the most important vegetable crop in the world with respect to area and productivity (GOP, 2007/2008). World tomato production in 2001 was about 105 million hectares (Shankara *et. al,* 2005). Since it has a relatively short duration and gives a high yield, it is economically attractive and the area under cultivation is increasing daily. Although the use of improved varieties and fertilizers has increased tomato production to some extent, the full potential of the crop production has not yet been achieved in developing countries compared to progressive countries (Rashidi *et. al,* 2010). Developing countries are faced with great challenges to meet input resources in order to sustain their production. Therefore, there is need to increase the productivity of the crop by improving the soil condition upon which it is grown. One of the ways to achieve this is by introducing advanced and sophisticated methods of irrigation and improved water management practices (Zaman, 2000) Among the management practices for increasing water use efficiency is mulch.

Mulch is any material spread on the surface of soil to protect it against rain drop, solar radiation or evaporation. Many materials have been used as mulch, such as plastic film, crop residue, straw, paper pellets, gravel-sand, rock fragment, volcanic ash, poultry and live-stock litters, city rubbish, etc. However, plastic film and straw were

used most commonly (Khurshid *et al.* 2006). Mulch provides a better soil environment (Anikwe*et al*. 2007) moderates soil temperature (Sarkar and Sigh, 2007; Srker *et al.*, 2007). It increases soil porosity and water infiltrations during intensive rain (Globe and Kulig, 2008), and control run-off and soil erosion (Bhatt and Khara, 2006). Application of mulch soon after planting is sometimes beneficial. Crops are influenced by a variety of factors when mulching is used. Weed is an important factor determining crop yield and also, mulches are important for weed control (Bilaslis, 2001; Jodaugiene, 2006). Mulch can have positive or negative effects on crops apart from its impacts on weeds, but there is a need to adopt such practices and combination of organic mulch in order to decrease the production cost. In Nigeria, the high cost of tomato on the market justifies that the production is far lower than the demand. If proper nutrient management is adopted by the tomato producer, the production will certainly increase to meet the demand. Therefore, the present investigation had the following objectives:

1. To determine the effect of plastic mulch and plant residues on soil physical properties.
2. To determine the effect of plastic mulch and plant residue on yield and yield component of tomato.

Materials and Methods

The study was conducted in Mokwa local government area of Niger state, the area is located at latitude $80^{0}30^{1}$N and 110 N and longitude 4030E and 6089 301E in the southern guinea savannah, and about 308m above sea level. It lies within guinea savanna belt (Reuben, 1981). It is characterized by long rainy season and a short dry season. Mean annual precipitation is 1175mm 1 yr, evapo-transpiration is 2149mm, temperature is 280C and sunshine period is 8 hours. The soil moisture is austistic and soil moisture regime is hyper-thermic (Anborg, 1985).

The main vegetation of the area is characterized with tall grasses, shrubs, some trees, and tall grasses, etc.. Some parts of the area however, had been put to cultivation of arable crops such as cereals and tubers such as yam and cassava, while part of the site is used for field experiments with experimental crops such as cowpea, cassava, maize, tomato being planted. The major soil order within the experimental site is Gleysol (Higgins, 1957; Babalola 2010).

Field Work

The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications to randomize the mulch levels. The experiment consisted of three mulch levels, i.e. plastic-mulch (Black Plastic Mulch: PM), plant residue (PR) and no-mulching (NM) and was conducted between November, 2019 to February, 2020. The size of each plot was 6.0m long and 3.0m wide. A buffer zone of 1.5m spacing was provided between plots. One of the commercial varieties of tomato; Roman VF variety was transplanted manually at 60 × 60cm spacing. Before transplanting, recommended levels of N (60 kgha-1), P (50 kg ha-1) and K (33 kg ha -1) were used as 20-10-10 at 250kg/ha. Metribuzin (Sencor) (1. 75kg.Iper ha) was also applied for weed control. Before transplanting, the soil was well irrigated in all treatments. Black plastic-film measuring 60.0 cm long × 30.0cm wide and 0.25mm thick was used to cover the experimental beds (raised beds, 25cm high), of appropriate plots and was held down with

forked sticks and pegs to prevent it from being blown away by the wind. This was done one week before transplanting. The insecticides and fungicides were applied according to general local practices and recommendations. Regular watering was done at an average of six times in a week. All other necessary operations except those under study were kept normal and uniform for all the treatments.

Soil Sampling and Analysis

In order to determine soil physical properties of the experimental site, a composite soil sample was collected from 18 points in the entire plots before treatment and after treatment application from each plot. Soil samples were analyzed in the laboratory for particle size distribution, and was determined by the hydrometer method. (Gee and Bauder, 1986). Dry bulk density was determined by the core method (Blake and Hartge, 1986). The soil temperature is measured with a soil thermometer every 10 days in the soil layer 0-15cm, measuring unit- o C. The soil moisture was also measured at 50cm depth by gravimetric method (Black, 1965).

Data Collection

Tomatoes were harvested three times and standard procedures (Srivastava *et al*, 1994) were adopted for recording the data on yield and yield components. Yield, plant population density (PPD) and number of fruits per plant (NEPP) were determined by counting plants and harvesting the fruits of the two middle rows of each plot. Other parameters, i.e., fruit weight (FW), fruit length (FL) and fruit diameter (FD) were determined from the 20 samples taken randomly from harvested fruits of the two middle rows of each plot (Jain *et al*, 2000).

DATA ANALYSIS

Data collected were subjected to analysis of variance (ANOVA) means were separated by Duncan's Multiple Range Test (DMRT) at P ≤0. 05 (Steel and Torrie, 1984).

RESULT AND DISCUSSION

Effects of Mulch material on soil physical properties

Particle Size fraction

The predominant particle size fraction is sand (87.4%). The low silt to clay ratio is an indication of low weathering intensity as a ratio of < 0.15 indicates low to moderate while a ratio of >0.15 indicates high intensity (Young,1976), Soil texture was loamy sand and it can be attributed to the parent material in the area, which is granitic in nature. It has been reported by Babalola *et al* (2007) that particle size fraction, soil texture, colour, consistence, and structure are soil properties that are ephemeral i.e., they cannot be changed by management.

Table 1: Soil physical properties of the study area

Soil parameters mulch	At planting	Plastic mulch (pm)	After planting (Residue)	No (Nm)
% Sand	89.3	87.4	85.3	87.6
% Silt	3.4	4.3	3.9	4.1
% Clay	7.3	8.3	10.8	8.3
Texture	loamy sand	loamy sand	loamy sand	loamy sand
Bulk density (g/m^3)	1.43	1.38	1.32	1.40
Soil temperature 10cm (depth)	28.2	37.4	32.7	30.1
Soil moisture %	25.33	32.66	30.77	29.14

Bulk Density

The result obtained for bulk density shows that the lowest bulk density value was recorded at the plottreated with plant residue 1.32 g/cm3 while the values reported before planting, plant residue mulch and no mulching are 1.43, 1.38, 1.40g/cm3respectively. Plant residue cover is known to protect the oil from the harmful effects of rain drops and soil erosion thus, influencing bulk density. Mulching has been reported to sustain pore-size distribution and increase in root activity (Adeniyan*et al*, 2008).

Soil Temperature

The result obtained for soil temperature shows that plastic mulched (37.40C) soil compared to other had higher temperature. On the other hand, plant residue mulched soil (37.70c) had a higher soil temperature than no mulch and at planting. The high soil temperature of mulched plots observed in this study were in agreement with the findings of Choi and Chung (1997), who has observed that thermostats placed at the soil surface, recorded an increase in soil temperatures. The findings of Duhr and Dubas (1990), showed an increase of 2.9-3.$_{30c}$ in soil temperature with transparent, plants degradable polythene film mulching. The result shows that different mulching materials have varying effects on soil temperature. These are consistent with the results of Hauada (1991), who observed that polythene films (black, green or transparent) markedly increase soil temperature compared to grass mulch in temperate, sub-tropical and tropical regions. Dionne *et al*, (1999) observed that insulating material covers, such as wood mat and straw affect the soil temperature and the characteristics of

protective soil covers also influence the soil temperature.

This study shows that the polythene mulch offers better insulation than the other mulches and hence the increase in soil temperature.

Soil Moisture

Evaporation from soil accounts for 25-50% of the total quantity of water used in cropping activities (Hu *et al,* 1995). Mulch prevents soil moisture. The amount of moisture stored in the soil was higher under plastic mulch than others. Plastic mulch contained 32.66% soil moisture, plant residue contained 32.77%, no mulch contains 29.14%, while soil moisture at planting is 25.33%. This means there is higher soil moisture storage for plastic mulch, followed by plant residue. The implication of this is that, there will be greater moisture availability to crops under plastic mulch. Chen (1985) and Ramakrishna *et al,* (2006) also reported similar results for plastic mulch. During heavy rain, plastic mulch prevented soil erosion, and rapid infiltration of rain water into soil. Optimum soil moisture ensures good emergence and seedling growth. Research has also shown that mulch provides many benefits to crop production through soil and water conservation, enhanced soil biological activity and improved chemical and physical properties of the soil (Copper, 1973).

Table 2: Effect of mulch on yield and yield components of tomatoes

Mulching Material	Yield (t/ha)	ppD plant t/ha	NF pp	FL (mm)	FD (mm)
Plastic mulch	27.75a	2,33954a	93.00a	11.588	83.83a
Plant Residue	17.75b	1,7984b	81.75b	111.75a	81.85a
No mulching	11.004c	11064c	54.25c	87.95a	70.20b

Means in the same column with different letter differ significantly at 0.05 probability level according to DMRF.

PPD: plant population density; NFPP: number of fruits per plant; FW: fruit weight; FL: fruits length; FD: fruit diameter

Yield and yield components of tomato were significantly influenced by mulch materials. Plastic mulch recorded significantly higher yield (27.75t/ha) compared to plant residue mulch (17.75t/ha) and no mulch (11.00t/ha).

A similar trend was observed for plant population density, number of fruits per plant and fruit weight. However, there is no difference in length and fruit diameter.

The maximum value of PPD (23954 plants/ha), NFPP (17.00), and FW (93kg) was observed in PM plots. In view of the fact that PPD and NFPP were the most important yield components explaining yield of tomato under different mulch levels, the minimum

value of yield (11.00t/ha) was obtained in the case of No mulching plots. The findings are in agreement with those of Anikwe (2004); Majidi*et al,* (2010), and Anikwe*et al* (2007) who concluded that plastic mulch enhanced growth and yield of plants in the arid and semiarid lands. The results are also in line with the finding of Khurshid *et al,* (2006) and Glab and Kulig (2008) that mulching increases soil porosity and reduce soil compaction. The results are also in agreement with those of Sarhar and Singh (2007); Sarha*et al,* (2007); Khurshid *et al,* (2006) and Sayfi and Rashidi (2007) who concluded that mulching reduced evaporation of soil water and increased water use efficiency. All these promote optimum and excellent crop growth and yield.

CONCLUSION

This study has demonstrated that mulching is beneficial to both soil and tomato crop most especially plastic mulch. It is therefore recommended that farmers in the area should use plastic mulch in tomato production. Also, further research is suggested on the influence of tillage and other agronomic/climatic interactions on the yield and yield components of tomatoes in the area. This would provide valuable insights and encourage wide adoption of improved crop and soil management practices for optimum production of the tomato crop.

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