Journal of Agricultural Sciences (Belgrade) https://doi.org/10.2298/JAS2304403O
Vol. 68, No. 4, 2023 UDC: 635.64:631.544.7(669)
Pages 403-412 Original scientific paper

EFFECT OF SAWDUST MULCH ON SOIL PROPERTIES AND PERFORMANCE OF TOMATOES (*LYCOPERSICUM ESCULENTUM*) IN AN ALFISOL IN SOUTHWESTERN NIGERIA

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Abstract: Mulching is an effective method of manipulating crop growing environment to increase yield. A field experiment was carried out at the Teaching and Research Farm of the Federal College of Forestry Jericho (Ibadan). The study aimed to examine the effect of sawdust mulching on selected soil properties, growth and yield of two tomato varieties. The study was a 4 x 2 factorial experiment laid out in a randomized completely block design (RCBD) with four replications. Factor one consisted of four treatments, namely: T0 (control), T1 (sawdust mulch [SDM] at 10 t ha^{-1}), T2 (SDM at 20 t ha^{-1}) and T3 (SDM at 30 t ha^{1}). The second factor was the two tomato varieties (UC82B and Ibadan local). Plant height, stem girth, number of leaves and branches were collected at a 2-week interval while the number of fruits, fruit weight (kg/ha) and yield parameters were measured at maturity. The Genstat statistical software package was used for data analysis and an LSD test was performed at the 5% level of significance. The sawdust mulch used had a low nitrogen content (0.60%) and a moderate organic carbon content (38.6%). The use of sawdust mulch had a major impact on tomato yield, while there was not any significant variation among the examined tomato varieties. UC82B (117.92 kg ha^{-1}) at 30 t ha^{-1} SDM plot had the highest yield, followed by Ibadan local (103.93 kg ha^{-1}) at 30 t ha^{-1} SDM plot, while Ibadan local (61.94 kg ha^{-1}) at the control plot had the lowest yield. In this study, the tomato performed best with sawdust mulch at 30 t ha^{-1} and is therefore recommended to farmers in the study area to maximize tomato production.

Key words: tomato, sawdust, mulching, soil.

Introduction

Tomato (*Lycopersicon esculentum* Mill.) belongs to the family *Solanaceae* and is a common and important fruity vegetable. It is rich in vitamins A and B as well as iron. This vegetable is very popular among the various tribes in Nigeria as

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an ingredient in salads and sauces/soups (Ploey and Heuvelink, 2005). Tomato is grown all over Nigeria, with an average yield of 15–20 t ha^{-1} recorded in the forest ecological zone of the south and up to 60 t ha^{-1} in the savanna ecozone of the north. Tomato is grown during the period when rainfall is scarce, and the soil moisture (250 mm) is exhausted by evapotranspiration. Water directly affects the fruit production in tomato plants (Santana and Vieira, 2010), which makes the use of irrigation indispensable for cultivation. The success of tomato cultivation largely depends on the adequate application of manures and fertilizers, efficient use of available soil moisture, plant spacing, timing of planting and weed control (Kayum et al*.,* 2008). To achieve a high-quality yield, the tomato requires high soil moisture during the entire growing (vegetation) period and moderate humidity, which is associated with the tomato's high transpiration coefficient. Various factors affect the quality and yield of tomatoes, including inadequate use of available moisture and nutrients, and unfavorable temperature (Brault et al., 2002). Mulching is an effective method of manipulating crop growing environment to increase yield and improve product quality by controlling weed growth, ameliorating soil temperature, conserving soil moisture, reducing soil erosion, improving soil structure and enhancing organic matter content (Hochmuth et al., 2001). Mulching can also protect soils from wind and water, erosion and compaction. Mulching of soil surface can limit evaporation and erosion, improve the available water capacity of the soil, regulate soil temperature, suppress the weed development and improve soil fertility (Clare et al., 2015). Sawdust mulch could increase the soil oxygen diffusion rate, maintain a more uniform soil temperature, reduce the surface crusting and soil bulk density, and increase the aeration porosity and soil moisture (Tran, 2005; Khan et al., 2000). Nigeria produces several million tons of sawdust annually, which is basically waste from the timber industry and pollutes the environment. While most of it is incinerated, an increasing amount is used as mulch by horticulturalists, small fruit growers, and nurseries. It is also increasingly used as litter in barns and feed lots and can become a valuable commodity which can be considered for agricultural utilization in soil conservation. The use of sawdust on a trial and error basis usually leads to good results. Like other highly carbonaceous organic matter, certain woods or barks contain tannins and other extractives that may have more or less toxic effects on plants and soil microorganisms. This study is therefore aimed at determining the effect of sawdust mulch on the soil properties for growth and yield of two tomato varieties.

Material and Methods

The study was carried out at the Crop Section of the Teaching and Research Farm of the Federal College of Forestry, Ibadan, Oyo state. The climatic conditions in the region are tropical with rainfall ranging from 1300 mm to1600 mm. The

average temperature is about 28.9°C, the average relative humidity is 80–85% and the ecological climatic conditions of the region have two distinct seasons: dry season from November to March and rainy season from April to October (FRIN, 2019). The initial soil sample was taken at 0–15 cm, air-dried and sieved with a 2-mm sieve before laboratory analysis was carried out to determine the physical and chemical properties of the soil. The particle size analysis was carried out using the Bouyoucos hydrometer method (Bouyoucos, 1965. The soil bulk density was determined using the core method as described by Blake and Hartage (1986). The soil pH was determined with the pH meter using a glass electrode in a 1:1 soil to water ratio (Udo and Ogunwale, 1986). The organic carbon of the soil was determined using the Walkley Black wet oxidation method (Udo and Ogunwale, 1986). The determination of total nitrogen was done as described by Kjeldahl (1883). The available P was determined with a spectrophotometer using the Mehlich method (Mehlich, 1984). The determination of exchangeable cations (K, Ca, Na and Mg) was done after extraction with ammonium acetate, whereby K and Na were quantified using a flame photometer, Ca and Mg were analyzed with an atomic absorption spectrophotometer. Extractable micronutrients (Fe, Mn, Cu and Zn) were determined after extraction of the soil with 0.1N HCl solution and analyzed with an atomic absorption spectrophotometer. A subsample of one (1) g of sawdust was taken for analysis of total nitrogen, phosphorus content and cations – potassium (K), sodium (Na), magnesium (Mg) and calcium (Ca), using the procedures generally used for plant samples (Tran, 2005). The experimental field was cleared, plowed and leveled manually with a hoe and a cutlass. The entire field was partitioned into 32 experimental plots, each covering a total land area of 36.0 m^2. The study was a 4 x 2 factorial experiment laid out in a randomized completely block design (RCBD) with four replications. Factor one consisted of four treatments, namely: T0 (control), T1 (sawdust mulch at 10 t ha^{-1}), T2 (sawdust mulch at 20 t ha^{-1}) and T3 (sawdust mulch at 30 t ha^{-1}). The second factor included the two tomato varieties (UC82B and Ibadan local) obtained from the National Horticultural Research Institute (NIHORT). The seeds were sown in germination trays containing sieved top soil, while the germinated seedlings were transplanted two weeks after sowing. Watering was done only in the morning, while weeding was carried out regularly to minimize the nutrient uptake by weeds from the soil. The data collected included: plant height, stem girth, number of leaves, branches at a 2-week interval between the 2^{nd} and the 10^{th} week after transplanting, while the number of fruits per plant, fruit weight per plant (kg ha^{-1}) and yield parameters were measured at maturity. The mulched soil was taken to the laboratory to determine the physical and chemical properties of the soil after harvest. The collected data were statistically analyzed using the Genstat statistical software package and significant means were separated using the least significant difference (LSD) at a 5% level of significance.

Results and Discussion

The analysis of the chemical and physical properties of the pre-experimental soil showed that the particle size distribution of the soil was that of a sandy loam. The soil pH (6.07) was slightly acidic, total nitrogen (1.71 g kg^{-1}) and available phosphorus (12.44 mg kg^{-1}) were moderate, which were within the critical range for total nitrogen (1.6–2.0 g kg^{-1}) and available phosphorus (7–20 mg kg^{-1}), respectively (Adeoye and Agboola, 1985). The organic carbon content was 15.51 g kg^{-1} which was above the critical level of 10–14 g kg^{-1} (Adeoye and Agboola, 1985). This implies that the soil was suitable for tomato production. The chemical analysis of the sawdust used in the experiment showed that the nutrient concentration of the sawdust had a low nitrogen content (0.60%) and a moderate organic carbon content (38.6%) (Table 1).

Table 1. Physical and chemical properties of the soil and sawdust used before planting.

Soil parameters	Content in soil	Sawdust (%)
pH (H_2O 1:1)	6.07	6.30
Organic carbon (g kg^{-1})	15.5	38.6
Organic matter (g kg^{-1})	26.72	
Total nitrogen (g kg^{-1})	1.71g	0.60
Available phosphorus (mg kg^{-1})	12.44	0.150
Exchangeable cations (cmol kg^{-1})		
Na	0.40	0.130
K	0.60	0.210
Mg	0.66	0.230
Ca	3.97	1.050
Extractable micronutrients (mg kg^{-1})		
Mn	88.0	158.60
Fe	103.0	174.00
Cu	1.14	22.39
Zn	1.17	11.80
Particle size distribution g kg^{-1}		
Sand	80.0	
Silt	14.0	
Clay	6.0	
Textural class	Sandy loam	

The effect of sawdust mulch on plant height (cm) showed that there was a significant difference in the plant height from the 2^{nd} to the 10^{th} week after transplanting (WAT) as influenced by sawdust across the tomato varieties used while at 10 WAT. UC82B at 30 t ha^{-1} SDM (138.2 cm) had the highest plant height and the lowest value was recorded by Ibadan local variety at the control plot (86.3 cm) (Table 2). This showed that sawdust mulch enhanced the growth of tomato

plants in this study and this is in line with the report of Awodoyin and Ogunyemi (2005) that mulched plants showed growth superiority over unmulched plants due to the change in soil profile and reduced nutrient uptake by weeds. There was no significant difference between the tomato varieties and the interaction of sawdust and tomato varieties at the plant height from 2 to 10 WAT (Table 2).

Table 2. The effect of mulching materials on plant height (cm) of UC82B and Ibadan local plants from the 2nd to the 10th week after transplanting.

Mulching materials	Varieties	2WAT	4WAT	6WAT	8WAT	10WAT
T0	Ibd local	17.87	33.43	59.3	78.9	86.3
	UC82B	20.77	29.53	47.5	81.1	88.9
T1	Ibd local	20.63	39.10	77.3	91.6	110.9
	UC82B	26.17	41.47	83.2	114.9	130.5
T2	Ibd local	23.57	47.00	93.1	102.8	125.3
	UC82B	24.50	44.77	89.0	125.5	131.4
T3	Ibd local	23.8	44.47	88.8	124.8	136.0
	UC82B	25.90	47.10	93.4	123.7	138.2
LSD MM		**	**	**	**	**
LSD VAR		Ns	Ns	Ns	Ns	ns
LSD.MM× VAR		Ns	Ns	Ns	Ns	ns

The effect of mulching materials on the number of leaves of UC82B and Ibadan local from the 2nd to the 10th week after transplanting is presented in Table 3. The result showed that there was no significant difference in the tomato varieties used at the 2nd and the 10th week after transplanting, but there was a significant difference in the effect of sawdust used at 4, 8 and 10 WAT. Likewise, there was a significance difference in the interaction between mulching materials and tomato varieties at 4 WAT (Table 3).

Table 3. The effect of mulching materials on the number of leaves of UC82B and Ibadan local plants from the 2nd to the 10th week after transplanting.

Mulching materials	Varieties	2WAT	4WAT	6WAT	8WAT	10WAT
T0	Ibd local	25.33	41.00	58.00	69.00	81.00
	UC82B	23	39	56	69.33	85.3
T1	Ibd local	25	38.67	58	75.33	110.7
	UC82B	25	44.67	56	75.33	112.7
T2	Ibd local	25	41.67	59	74.33	110.2
	UC82B	26	42.67	56.67	80.00	116.7
T3	Ibd local	25	43.67	58.33	86.33	123.7
	UC82B	25	44	60	89.33	130.3
LSD MM		Ns	*	Ns	**	**
LSD VAR		Ns	Ns	Ns	Ns	ns
LSD.MM× VAR		Ns	*	Ns	Ns	ns

At 10 WAT, UC82B also recorded the highest number of leaves produced at 30 t ha^{-1} SDM (130.3), while the lowest number was produced by Ibadan local (81.0) at the control plot. This also agrees with the primary objective of mulching which includes weed control, soil moisture conservation and temperature modifications (Hochmuth et al., 2001) to promote better crop growth.

The effect of the mulching materials on the number of branches per plant is shown in Table 4. The result shows that there was no significant difference in the tomato varieties used and the interaction between mulching materials and varieties used from 2 to 10 WAT, but there was a significant difference in the effect of mulching materials used at 2, 4, 8 and 10 WAT. At 10 WAT, UC82B (15.67) had the highest number of branches in a plot with 30 t ha^{-1} SDM, followed by Ibadan local (15.67) in a plot with 30 t ha^{-1} SDM and the lowest number of branches was recorded by UC82B (12.33) at the control plot (Table 4).

Table 4. The effect of mulching materials on the number of branches of UC82B and Ibadan local plants from the 2nd to the 10th week after transplanting.

Mulching materials	Varieties	2WAT	4WAT	6WAT	8WAT	10WAT
T0	Ibd local	7.67	8.33	11.33	12	12.33
	UC82B	7	8.67	10.67	11.33	13.33
T1	Ibd local	8.00	10.67	11.67	12.67	14.67
	UC82B	7.33	10	11	13	14.67
T2	Ibd local	8.67	10.33	12	13.33	15.33
	UC82B	8.33	10	11.33	12.67	15.33
T3	Ibd local	8.33	9.67	11.33	13.33	15.64
	UC82B	8.00	10	11.67	12.33	15.67
LSD MM		*	*	Ns	*	**
LSD VAR		Ns	Ns	Ns	Ns	ns
LSD.MM× VAR		Ns	Ns	Ns	Ns	ns

Mulch provides numerous benefits to crop production by improving the physical, chemical and biological properties of the soil. Organic mulches reduce soil temperature while mulches generally reduce soil moisture depletion and weed infestation, which enhances the tomato growth and fruit yield (Hochmuth et al., 2001*).*

The results showed that there was no significant difference in the interaction between the mulching materials and the varieties used at 6 WAT on plant stem diameter, but a significant difference was observed at 2, 4, 8 and 10 WAT. There was no significant difference in the tomato varieties used from 2 to 8 WAT, but there was a significant difference at 10 WAT where UC82B (2.00 cm) had the highest stem girth at 10 t ha^{-1} SDM plot, followed by Ibadan local (1.98 cm) at 10 t ha^{-1} SDM plot and the lowest was obtained by Ibadan local (1.73 cm) at the control plot (Table 5). The lower moisture depletion under the mulches was due to the fact that the soil was not in contact with dry air, which reduced water loss and prevented soil compaction.

Table 5. The effect of mulching materials on stem girth (cm) of UC82B and Ibadan local plants from the 2nd to the 10th week after transplanting.

Mulching materials	Varieties	2WAT	4WAT	6WAT	8WAT	10WAT
T0	1	0.57	1.17	1.53	1.63	1.73
	2	0.60	1.20	1.50	1.63	1.80
T1	1	0.63	1.30	1.57	1.83	1.98
	2	0.67	1.33	1.50	1.84	2.00
T2	1	0.73	1.37	1.53	1.77	1.87
	2	0.63	1.30	1.57	1.80	1.90
T3	1	0.67	1.30	1.50	1.70	1.83
	2	0.73	1.33	1.53	1.77	1.90
LSD MM		*	*	Ns	*	**
LSD VAR		Ns	Ns	Ns	Ns	ns
LSD MM × VAR		Ns	Ns	Ns	Ns	ns

The tomato yield determined in this study revealed that the use of sawdust mulch significantly influenced the number of fruits and the weight of the freshly harvested tomatoes. There was no significant difference in the tomato varieties used in terms of the number of fruits, but there was a significant difference in the weight of freshly harvested tomatoes. In the interaction between varieties and mulching materials, there was a significant difference in the number of fruits but no significant difference in the weight of freshly harvested fruits. UC82B (117.92 kg ha^{-1}) at 30 kg ha^{-1} SDM plot had the highest yield followed by Ibadan local (103.93 kg ha^{-1}) at 30 kg ha^{-1} SDM plot and the lowest yield was recorded by Ibadan local (61.94 kg ha^{-1}) at the control plot (Table 6).

Table 6. Effects of mulching materials on the yield of UC82B and Ibadan local plants.

Mulching materials	Varieties	Number of fruits	Fruit weight (kg ha^{-1})
T0	1	13.6	61.94
	2	15.7	80.22
T1	1	16.4	80.44
	2	17.2	94.31
T2	1	17.8	100.81
	2	21.4	100.46
T3	1	227	103.93
	2	21.6	117.92
LSD MM		**	**
LSD VAR		Ns	**
LSD MM × VAR		**	Ns

After harvest, the laboratory results of the soil mulched with sawdust mulch (SDM) showed that the organic carbon (g kg^{-1}) was moderate at 11.4, total nitrogen

(g kg^{-1}) was low at 1.3, available phosphorus (mg Kg^{-1}) was moderate at 14.36, while the exchangeable cations (cmol kg^{-1}) were moderate and extractable micronutrients (mg kg^{-1}) were also moderate (Adeoye and Agboola, 1985).

Table 7. Soils mulched with sawdust after harvesting.

Soil parameters	SDM
pH (H_2O 1:1)	5.60
Organic carbon (g kg^{-1})	11.4
Total nitrogen (g kg^{-1})	1.3
Available phosphorus (mg kg^{-1})	14.36
Exchangeable cations (cmol kg^{-1})	
Na	0.28
K	0.37
Mg	0.91
Ca	2.34
Extractable micronutrients (mg kg^{-1})	
Mn	95.00
Fe	108.00
Cu	1.28
Zn	1.50

Conclusion

The incorporation of mulch materials improved the soil properties, growth and yield of both tomato varieties in the study area. Sawdust when applied as mulch at a rate of 30 t ha^{-1} had an excellent effect on the growth and yield of both tomato varieties. The study therefore recommends that farmers in the study region could use this material to maximize fruit yield in tomato production. The farmers should also be educated on the use of sawdust mulch to improve soil health, which will in turn give rise to a better performance of the crops grown.

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Received: May 31, 2023
Accepted: November 27, 2023

UTICAJ MALČA OD PILJEVINE NA SVOJSTVA ZEMLJIŠTA I PRODUKTIVNOST PARADAJZA (*LYCOPERSICUM ESCULENTUM*) NA ALFISOLU U JUGOZAPADNOJ NIGERIJI

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R e z i m e

Malčiranje je efikasan metod poboljšanja uslova gajanja useva, kako bi se povećao prinos. Poljski eksperiment izveden je na Nastavno-istraživačkom poljoprivrednom imanju Federalnog koledža šumarstva Jeriho (Ibadan). Istraživanje je imalo za cilj da ispita uticaj malčiranja piljevinom na odabrana svojstva zemljišta, rast i prinos dveju sorti paradajza. Istraživanje je predstavljalo četvorofaktorijalni (4 x 2) eksperiment postavljen po potpuno slučajnom blok dizajnu (engl. *randomized completely block design – RCBD*) sa četiri ponavljanja. Faktor jedan se sastojao od četiri tretmana, i to: T0 (kontrola), T1 (primena 10 t ha^{1} malča od piljevine), T2 (primena 20 t ha^{-1} malča od piljevine) i T3 (primena 30 t ha^{-1} malča od piljevine). Drugi faktor su bile dve sorte paradajza (UC82B i lokalna sorta iz Ibadana). Visina biljke, obim stabljike, broj listova i grana prikupljeni su u intervalu od 2 nedelje, dok su broj plodova, masa ploda (kg ha^{-1}) i parametri prinosa mereni u zrelosti. Za analizu podataka korišćen je statistički softverski paket Genstat i urađen je LSD test na nivou značajnosti od 5%. Korišćeni malč od piljevine imao je nizak sadržaj azota (0,60%) i umeren sadržaj organskog ugljenika (38,6%). Upotreba malča od piljevine imala je veliki uticaj na prinos paradajza, dok među ispitivanim sortama paradajza nije bilo značajnijih varijacija. Najveći prinos imao je UC82B (117,92 kg ha^{-1}) na parceli na kojoj je primenjeno 30 t ha^{-1} malča od piljevine, zatim lokalna sorta iz Ibadana (103,93 kg ha^{-1}) na parceli na kojoj je primenjeno 30 t ha^{-1} malča od piljevine, dok je lokalna sorta iz Ibadana (61,94 kg ha^{-1}) na kontrolnoj parceli imala najmanji prinos. U ovom istraživanju, paradajz je pokazao najbolji učinak prilikom primene 30 t ha^{-1} malča od piljevine i stoga se preporučuje poljoprivrednicima na istraživanom području kako bi poboljšali proizvodnju paradajza.

Ključne reči: paradajz, piljevina, malčiranje, zemljište.

Primljeno: 31. maja 2023.
Odobreno: 27. novembra 2023.

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