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Efficacy of Some Plant Mulches and Tomato Cultivars on the Growth Parameters and Wilt of Tomato (*Lycopersicon esculentum Mill*) in Owerri, Imo State, South East, Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The experiment was conducted on the effects of some mulching materials and some tomato cultivars on the growth parameters and wilt disease of tomato. The design used was 3 x 4 factorial in Randomized Complete Block Design (RCBD), in four (4) replications. The work was carried out in 2015 cropping seasona at the Teaching and Research Farm of the School of Agriculture and Agricultural Technology, Federal University of Technology, Owerri, Imo State, Nigeria. on growth parameters and disease incidence on tomato were collected and statistically analyzed, using Genstat Version 4 analytical Software, while the means were separated for difference using Fisher' Least Significant Difference Protocol. Wilt incidence was significantly ($P<0.05$) affected by tomato cultivars at the sixth week after transplanting (WAT). Wilt severity was lowest (1.75) at 2nd WAT. The number of fruits for Rio Grande cultivars significantly ($P<0.05$) increased at 8 WAT. For effective management of tomato wilt, ROMA VF cultivars should be grown under grass, while Tropimech tomato cultivars should be left unmulched.

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1. INTRODUCTION

The majority of plant diseases are incited by fungi, infecting all parts of tomato plant-leaves, stems, flowers, roots and fruits. *Fusarium* wilt is of world - wide importance, having been reported in at least 32 countries [1]. It was regarded as the most common and destructive disease of tomato. Amati et al. [2], listed the symptoms to include, wilting of leaves from the bottom up, yellowing and curling of leaves at the edges, a brown stain when the stems or roots are cut.

These constraints have impacted negatively on the production of tomato in Owerri, leading to little or no production of the crop in the area. Consequently, farmers, sellers and buyers have solely depended on the purchases from some major production zones of the country. These problems could be contained when the crop is produced in the geographical areas of the south east of the country, including.

Many efforts have been made to achieve this through different disease control methods. Ploetz [3] reported the availability of fungicidal control of diseases and its expensive nature and high risk of environmental pollution and hazards to humans. Thomason and Caswell [4], reported the costly nature of synthetic chemical control of soil-borne pathogenic fungi and nematodes. Anastasia et al. [5] corroborated the foregoing, stating the side/residual effects of such chemicals.

The influence of cultural practices, including the effectiveness of some plant mulches, in the control of plant diseases has been studied. Obasi et al. [6] reported the use of resistant cultivars and application of mulch on seedbeds to control pathogenic fungi. In south east (including Owerri), there is dearth of scientific and research information regarding the effect of such cultural practices on fusarium wilt of tomato. Such cultural practices include use of plant mulches and tomato cultivars in the control and management of tomato control wilt. The study area is infected with the fusarium pathogens that constitute one of the factors that lead to low yield and less attractive fruit production. Wisdom and Akpan [7] defined and outlined role of mulching in relation to crop husbandry and disease management: application of a covering laying of materials to the soil surface to modify soil physical properties, create favourable environment for root development and nutrient uptake and reduce soil erosion and degradation. Valverde and Bandy [8], specified the reduction of soil temperatures, which have significant effects on the ability of soil-borne plant pathogens to cause diseases. This paper, therefore, seeks to bridge this gap and to proffer solutions to the problem.

2. MATERIALS AND METHODS

The experiments (in the field and in the laboratory) were carried out at the Teaching and Research Farm and at the Crop science and Technology of School of Agriculture and Agricultural Technology, Federal University of Technology, Owerri, Imo State. The climate of the area is mainly tropical, and characterized by a heavy bimodal rainfall pattern [9]. Owerri is also characterized by mean annual rainfall of about 2500 mm, which spans a period from early March to October, with a dry spell (August Break). The minimum and maximum mean annual temperatures are, respectively, 22.5^0C and 31.9^0C [10].

The experimental design used was a 3 x 4 factorial in Randomized Complete Block Design (RCBD) [11] replicated four (4) times. The treatments included (i) three levels of factor A: three tomato cultivars – ROMA VF cultivars (A_1), RIO GRANDE cultivar (A_2) and TROPIMECH cultivar (A_3). (ii) Four levels of factor B: four mulch materials – No mulch (B_O) – the control, Grass mulch (B_1), Wood shavings (B_2) and Palm kernel shells (B_3). There were a total of 48 treatment combinations (that is 12 treatments per block). The treatments were randomly assigned to the experimental plots by the use of random numbers [11]. Randomization was done separately for each block.

3. TRANSPLANTING TO THE EXPERIMENTAL PLOTS

Transplanting of the three tomato cultivars seedlings (ROMA VF, RIO DRANDE and TROPIMECH) was done to the experimental plots at six (6) weeks. The spacing distance was 0.75 x 0.50m, between and within rows, respectively, giving a plant population of 12 plants per plot. Transplanting was done in the month of May, 2015. Nursery trays were adequately watered before the crops were lifted.

Enough soil lumps were included in the trowel as the seedlings were uprooted to ensure minimal root distortion and damage, and high survival percentage in the field. Transplanting was done in the early hours of the morning and late in the evening to reduce transplanting shock due to hash field conditions.

4. APPLICATION OF MULCHING MATERIALS

The treatments, comprising the dry grass, wood shavings and palm kernel shells, were randomly applied to the various plots. The control plot did not receive any mulch application. Mulching was done one week after transplanting (WAT). Each plot was closely monitored to determine the incidence and severity of fungal diseases.

5. DETERMINATION OF DISEASE INCIDENCE AND SEVERITY

Disease incidence was assessed by visually counting the number of infected plants in a plot and multiplying by one hundred (100).

$$Thus\ Disease\ incidence\ (DI) = \frac{Number\ of\ infected\ plants}{Total\ number\ of\ (healthy\ and\ infected)\ plants} x\ 100$$

Disease incidence was assessed per plot and recorded in percentage.

5.1 Disease Severity (DS)

This is the proportion of the plant affected by the disease; this was estimated using the observation and scoring method according to the format described by Ford and Herwitt, (1980).

Table 1. Ford and Hewitt (1980) = Rating scale of disease severity

Disease severity	Scale	Interpretation
1-20	1	Slight infection
21-40	2	Moderate infection
41- 60	3	Severe infection
61- 80	4	Very severe infection
81- 100	5	Leaves completely infected

Disease assessment was based per plot

6. RESULTS AND DICUSSION

The effect of plant mulches and tomato cultivars on the number of tomato leaves was shown in the Table 2. Analysis of variance showed significant (P< 0.05) difference in the number of leaves due to the effect of plant mulches and tomato cultivars at two weeks after transplanting. Plant mulches showed similar significant (P< 0.05) effect in the 4th and 6th weeks after transplanting.

Habtamu et al. (2016), reported the influence of mulching and varieties on growth and yield parameters of tomato. The tomato cultivar that recorded the highest mean number of leaves was Tropimech (8.26), mulched with wood shavings. Tomato cultivars significantly (P<0.05) affected tomato number of leaves in 2nd week and 6th week after transplanting respectively. The effect of grass mulch on tomato growth performance was attributed to its favourable effect on soil temperature and soil moisture (Habtamu et al. 2016).

The result of analysis of variance indicated a significant (< 0.05) effect on the height of tomato by tomato cultivars at 3nd and 4th weeks of transplanting (Table 3). Tropimech cultivar was the highest plant (24.17 cm) under wood shavings mulch at 4th week after transplanting. Schonbeck and Evanylo [12] gave credence to this result by stating the effects of mulches on soil properties in relation to tomato production. Similarly Rwezaula et al. [13], observed varying effectiveness of mulch types in enhancing performance as a result of different capacities in absorbing moisture due to their aggregate nature and in allowing air circulation.

I general, mulching seemed to promote better performance of tomato variety in most of the yield components, including plant height [13].

Tomato cultivars had significant (P< 0.05) effect on wilt disease incidence at the 6th week after transplanting (Table 4). The least wilt of tomato (85.42) occurred under the control treatment (no mulch) in the Tropimech tomato cultivar. However, RIO GRANDE tomato recorded the highest wilt infection (100%) under grass mulch. Agbenin et al. [14] noted the observed differences in the wilt disease incidence to be due to innate resistance qualities of various cultivars. A variety of effects on plant diseases, positive and negative, result from the use of mulches. Mulches contribute to disease management in various ways. Reduction or prevention of soil splashing is an important function of mulches in the management of some plant pathogens [15,16]. However, mulches do not always reduce disease incidence [17]. This is evidenced from the high disease incidence observed in the cultivars mulched with palm kernel shell.

Table 2. Effect of plant mulches and tomato cultivars on the number of tomato leaves per plant in 2015

Tomato cultivar/ Mulch type	2 WAT					4 WAT					6 WAT				
	No mulch	Grass mulch	Wood shavings	Palm kernel shell	Mean	No mulch	Grass mulch	Wood shavings	Palm kernel shell	Mean	No mulch	Grass mulch	Wood shavings	Palm kernel shell	Mean
ROMA VF	4.92	5.08	5.58	5.42	5.25	7.83	6.00	5.83	5.67	6.33	3.25	1.50	1.50	1.50	1.94
RIO GRANDE	5.42	5.84	5.83	5.34	5.61	5.75	8.00	6.38	6.42	6.64	0.00	0.00	1.25	0.00	0.31
TROPIMECH	8.08	6.84	6.75	7.42	7.27	8.38	8.08	8.54	8.04	8.26	7.79	7.50	0.00	5.25	5.14
Mean	6.14	5.92	6.05	6.06		7.32	7.36	6.92	6.71		3.68	3.00	0.92	2.25	
LSD $_{(0.05)}$ Cultivar:	0.66					1.02					2.94				
LSD $_{(0.05)}$ Mulch:	0.76					1.18					3.39				
LSD $_{(0.05)}$ Cultivar x Mulch:	1.32					2.05					5.87				

Table 3. Effect of mulch materials and tomato cultivars on the height (cm) of tomato plant in 2015

Tomato cultivar/ Mulch type	2 WAT					4 WAT					6 WAT				
	No mulch	Grass mulch	Wood shavings	Palm kernel shell	Mean	No mulch	Grass mulch	Wood shavings	Palm kernel shell	Mean	No mulch	Grass mulch	Wood shavings	Palm kernel shell	Mean
ROMA VF	14.33	12.75	14.33	13.83	13.81	13.58	14.33	12.92	13.84	13.67	6.50	4.00	0.00	0.00	2.63
RIO GRANDE	16.5	14.25	15.83	15.83	15.60	13.17	19.79	17.42	18.09	17.12	0.00	8.75	0.00	0.00	2.19
TROPIMECH	19.84	17.67	19.08	17.5	18.52	20.46	22.25	24.17	20.29	21.79	14.00	15.00	0.00	7.00	9.00
Mean	16.89	14.89	16.41	15.72		15.74	18.79	18.17	17.41		6.83	9.25	0.00	2.33	
LSD $_{(0.05)}$ Cultivar:	1.07					3.72					8.78				
LSD $_{(0.05)}$ Mulch:	1.24					4.30					10.14				
LSD $_{(0.05)}$ Cultivar x Mulch:	2.14					7.44					17.57				

Table 4. Effect of mulch materials and tomato cultivars on tomato wilt disease incidence (%) per plot in 2015

Tomato cultivar/ Mulch type	2 WAT					4 WAT					6 WAT				
	No mulch	Grass mulch	Wood shavings	Palm kernel shell	Mean	No mulch	Grass mulch	Wood shavings	Palm kernel shell	Mean	No mulch	Grass mulch	Wood shavings	Palm kernel shell	Mean
ROMA VF	27.08	25.00	20.83	25.00	24.48	72.92	68.75	77.08	68.75	71.88	93.75	93.75	97.92	97.92	95.84
RIO GRANDE	20.83	20.83	27.08	22.92	22.92	68.75	79.17	70.75	70.83	72.38	97.92	100.00	97.92	97.92	98.44
TROPIMECH	22.92	16.67	10.41	12.50	15.63	64.58	77.08	77.08	75	73.44	85.42	93.75	97.92	93.75	92.71
Mean	23.61	20.83	19.44	20.14		68.75	75.00	74.97	71.53		92.36	95.83	97.92	96.53	
LSD $_{(0.05)}$ Cultivar:	7.62					6.24					4.04				
LSD $_{(0.05)}$ Mulch:	8.80					7.21					4.67				
LSD $_{(0.05)}$ Cultivar x Mulch:	15.25					12.49					8.09				

Table 5. Effect of mulch materials and tomato cultivars on tomato wilt disease severity per plot in 2015

Tomato cultivar/ Mulch type	2 WAT					4 WAT					6 WAT				
	No mulch	Grass mulch	Wood shavings	Palm kernel shell	Mean	No mulch	Grass mulch	Wood shavings	Palm kernel shell	Mean	No mulch	Grass mulch	Wood shavings	Palm kernel shell	Mean
ROMA VF	3.00	2.50	2.75	3.25	2.88	4.25	4.00	4.25	4.00	4.13	5.00	5.00	5.00	5.00	5.00
RIO GRANDE	2.25	2.25	2.00	2.50	2.25	4.00	4.25	4.50	4.25	4.25	5.00	5.00	5.00	5.00	5.00
TROPIMECH	2.25	1.75	2.00	2.00	2.00	4.50	4.75	4.25	4.25	4.44	5.00	5.00	5.00	5.00	5.00
Mean	2.50	2.17	2.25	2.58		4.25	4.33	4.33	4.17		5.00	5.00	5.00	5.00	
LSD $_{(0.05)}$ Cultivar:	0.49					0.33									
LSD $_{(0.05)}$ Mulch:	0.57					0.38									
LSD $_{(0.05)}$ Cultivar x Mulch:	0.99					0.66									

The results of the tomato wilt disease severity per plot are presented in Table 5. Tomato cultivars significantly ($P<0.05$) affected the tomato wilt disease severity only in the 2nd weeks after transplanting. Wilt disease severity was highest in ROMA VF tomato (3.25) under palm kernel shell mulch, while Tropimech recorded the least (1.75) under grass mulch. Plant disease is the limiting factor in tomato production in many parts of the world when cultivars with resistance to numerous diseases are not planted [1]. This was also confirmed by the assessment in the field of study. Agbenin et al. [14], observed the difference in levels of resistance by various tomato cultivars and varieties. Wilt disease severity was highest in ROMA VF which was mulched with palm kernel shell. Cook et al. [18] reported the effect of crop residues, including organic mulches, on plant diseases as providing food and a place to live and reproduce for the various pathogens that cause the diseases. Plant residues and mulches also intensify microbial activity of the soil and this, along with a variety of decomposition of products (some phyto-toxic or fungi-toxic), may affect pathogens, susceptibility of the host plants or both [18].

7. CONCLUSION

The result of this present experiment has provided a deep insight into the effect of specified mulch materials and tomato cultivars on the incidence and severity of wilt disease of the tomato. The study has given insight into the management of tomato by using grass to mulch ROMA VF cultivars or planting Tropimech tomato cultivars without mulch. Cultural control of tomato wilt could therefore be done by the use of grass mulch as this offered a significant ($P<0.05$) reduction of tomato wilt (1.75). Also, in terms of the tomato cultivars used, ROMA VF cultivar should be grown under grass mulch, TROPIMECH cultivar should be left unmulched. The study can also be used to formulate effective disease management strategy against the wilt of tomato (*Lycopersicon esculentum).*

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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