Effect of organic and inorganic mulching materials on tomato growth and development in Kenya

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Effect of organic and inorganic mulching materials on tomato growth and development in Western Kenya

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Abstract

Tomatoes fall among the most widely eaten vegetables with good nutritive value and a wide array of advantages. Yields have been increasing worldwide because of better cultivars and more intensive use of modern technology, but in Kenya there has been a slow progression. Based on the above analysis manipulation of growing environment has the potential to improve tomato yield. Therefore, the current study was conducted to generate more information on the influence of manipulation of root microclimate using inorganic and organic mulching materials on two tomato varieties growth. The site was in Bungoma County at Mabanga Agricultural Training Centre for two seasons of 2014 and 2015. The field experiment was laid out in a Randomized Complete Block Design (RCBD) in split-plot arrangement, replicated four times. The two tomato varieties include Cal J (determinate) and Tylka F1 (semi-determinate) grown on seed beds mulched with different mulching materials. These were black polyethylene film, transparent polyethylene film, sugarcane trash and no mulch (control). Data collected on growth parameters were subjected to ANOVA using GenStat statistical package, and means separated using Fischer's Projected LSD at 95% confidence level. Results showed that mulching significantly (P≤0.05) influenced the number of branches and height of the two tomato varieties in both seasons. The white polythene mulch produced the highest number of branches per plant (10) as well as trusses (30) in Cal-J variety. The same treatment and variety produced the tallest plants at 143.7 cm while the shortest plants were in the control treatment of variety Tylka F1.

Keywords: Cultivars, growth and development, mulching, root microclimate, tomato

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Introduction

The tomato (*Lycopersicon esculentum*) belongs to the family Solanaceae (also known as the nightshade family), genus Lycopersicon, sub-family Solanoideae. Tomatoes are one of the most widely eaten vegetables with good nutritive value, containing good amounts of potassium, B-carotene (vitamin A) and vitamin C. Tomato is low in calories, such that 100 g of its edible portion contains 20 kcal. Consequently, it forms an effective diet for weight loss recipes, especially when eaten raw. Numerous varieties and cultivars exist for fresh production. They range from small, sweet tasting cherry tomatoes to large beefsteak tomatoes with different colours, shelf-life and flavours (Dorais et al., 2001).

In Kenya, over 85% of tomato is produced by smallholder farmers under open field condition (HCDA, 2010). Despite the favourable climatic conditions, tomato yields in the county remain far below the potential 60 tons per hectare because of various constraints where water stress is one of the main challenges that farmers encounter. Mulching could improve the crop stands and increase yield by providing an enabling environment for optimal plant growth. Irrigated and mulched treatments have been reported to induce denser root growth relative to the bare and rain-fed ones (Kumara and Dey, 2011). The properties of some mulch benefit plant growth by preserving soil structure and acting as a barrier to the action of rainfall that can cause compaction and erosion. Additionally, less compacted soil provides a conducive environment for root growth and seedling emergence.

Some mulching materials can improve the structure and fertility as they are decomposed and incorporated into the soil. Both natural and synthetic mulches are approved for the use in organic vegetable production under certain circumstances. The use of polyethylene film (mulch) to cover plant beds for commercial production of fresh-market tomatoes dates back to the 1960s. In Kenya, a lot of studies have been done to increase tomato production. However, only a fraction of these studies is directed toward research on the impact of different mulching materials on tomato growth, development and yield.

Materials and Methods

Study Sites

The experiments were conducted out at the Mabanga Agriculture Training Centre (ATC) in Bungoma County during the short rain season from September 2015 to March 2016. Mabanga ATC is situated on latitude 0°26' N and longitude 34° W at an elevation of 1,360 meters above sea level. Annual rainfall varies from 1800-2000 mm. Rainfall is bimodal, with "short rains" from October to December and "long rains" from March to June, with a mean monthly temperature of 22.5°C (Jaetzold and Schmidt, 2006). Soil is loamy and sandy in texture, acidic, poor in organic matter and low in available nitrogen. However, it is deep, well

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drained, and ranges in colour from dark red to dark reddish brown.

Experimental design and treatments

The experimental design was split-plot in a randomized complete block design with four replicates. The experiment treatments consisted of two tomato varieties determinate tomato variety (Cal-J) and semi-determinate tomato variety Tylka F1 for the main plot treatment and three mulching materials Transparent white polyethylene film, black polyethylene film, sugarcane trash and the control (bare soil) as sub-plots.

Cultural operations

The field was ploughed and harrowed to attain relatively fine tilth. The tomatoes was established at the spacing of 60 cm x 45 cm on raised beds. The seedlings were raised in the cell trays for two weeks and transplanted in polythene pots 4"x5" size filled with soil and manure mixture at the ratio of 1:1 volume/volume, for three weeks when they attained five to seven leaves or at the first flower bud initiation. All the other agronomic practices were done as recommended for the varieties.

Data collection and analysis

The plant growth parameters measured included plant height, stem weights and number of branches per plant. Plant height was measured from the soil surface to the highest point of the plant using the tape measure at transplanting, at the middle of development stage (60 days after transplanting), and the late stage of development (90 days after transplanting).

Analysis of variance (ANOVA) was carried out to test the significant influence of the treatments on dependent variables using GenStat Statistical package Version 15.1 at 95% confidence level. Mean separation was conducted where significant differences were observed using Fischer's Projected LSD at $P \leq 0.05$.

Results and Discussion

Branches per plant

Significant differences ($P \leq 0.05$) were computed on the number of branches per plant among the two varieties; Cal-J had the higher number (seven) in both seasons (Table 1). During the first season, the white polythene mulching material had significantly the highest number of branches (six) per plant compared to the other treatments. However, during the second season, the mulching materials did not show significant differences even though white polythene mulch still had the highest number of branches per plant. Interaction between tomato varieties and mulching materials were revealed during the first season on the number of branches per plant.

The conservation of soil moisture may help in preventing the loss of water through evaporation from the soil, thus facilitating maximum utilization of moisture by the plants. Mulching with plastic is a method by which soil moisture can be conserved (Ashrafuzzaman et al.,

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Table 1. Influence of tomato varieties and mulching materials on the number of branches per plant of tomato at Mabanga ATC during the short rains of 2014 and long rains season of 2015

Variety	Season One	Season Two
Cal-J	7a	7a
Tylka F1	2b	2b
P-Value	**<.001**	**<.001**
Mulch Treatment		
Black Polythene Mulch	4b	5a
No Mulch	4b	4a
Sugarcane Trash Mulch	4b	4a
White Polythene Mulch	6a	5a
P-Value	**0.008**	**0.331**
V*M Interaction	*	**NS**

Means followed by different letters in each column are significantly different at P≤0.05

2011). Awodoyin et al. (2007) reported that mulched tomato plants had more branches than the un- mulched plants, which supported the present results. Hamid et al. (2012) opined that plants grown over plastic mulches considerably produced the most number of leaves relative to control treatment. The microclimate condition in the root zone improved by the mulches might have provided a suitable condition for producing higher number of leaves in the plants. Mukherjee et al. (2012) reported that unmulched tomato plants had more branches than that of mulched plants, which contradicts the present results.

Plant height

There were significant differences (P≤0.05) between the tomato varieties and mulching materials on the plant height of tomato in both seasons (Table 2). Tylka F1 variety was taller than Cal-J variety at both 25 days after transplanting and 60 days after transplanting. The black and white polythene mulches led to the tallest plants during both seasons at 60 days after transplanting with minimal and inconsistent differences recorded at 25 days after transplanting.

The increased stem length in mulched plants may be due to better availability of soil moisture and optimum rhizosphere temperature provided by the mulches. Changes in the plant height of tomato have been observed under different mulches, whereby plastic mulch increased the plant height more than other mulches (Ocharo et al., 2018). This result conforms to the finding of Easson and Fearnehough (2000) in forage maize. Similar results were also documented by Ocharo *et al*. (2018) who found that mulch had a significant effect on total

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Table 2. Effect of tomato varieties and mulching materials on the plant height of tomato at Mabanga ATC during the short rains of 2014 and long rains season of 2015

Variety	25 DAT	60 DAT	25 DAT	60 DAT
Cal-J	48.2a	105.0a	25.8b	48.1b
Tylka F1	49.7a	111.2a	33.8a	88.0a
P-Value	0.742	0.379	<.001	<.001
Mulch Treatment				
Black Polythene Mulch	50.3a	134.8a	31.5a	73.3a
No Mulch	52.3a	77.5b	29.5a	60.3c
Sugarcane Trash Mulch	46.2a	82.2b	28.3a	65.5b
White Polythene Mulch	48.5a	137.8a	29.8a	69.0b
P-Value	**0.221**	**<.001**	**0.505**	**<.001**
V*M Interaction	**NS**	**NS**	**NS**	**NS**

DAT-Days after transplanting, Means followed by different letters in each column are significantly different at P≤0.05

chlorophyll content in green pepper under black plastic mulch, and showed the greatest total chlorophyll content among the mulches thereby enhancing plant heights positively.

The low loss of moisture under the mulches was likely due to preclusion of direct contact among the dry air and soil, which reduced water loss into the atmosphere via evaporation. Also, mulches reduce impact of raindrops and splash, thereby preventing soil compaction, reducing surface run-off and increasing water infiltration (Siborlabane, 2000). All these combined to increase the soil moisture content and reduce moisture depletion. As moisture depletion is least under the plastic mulches so the rate of moisture recharging ability would be least because water infiltration will be prevented. Nonetheless, capillary movement of water molecules through the soil pores from the water table will supply water to the root zone of the crop grown under plastic mulch (Nodar et al., 2016).

Shoot weight

There were significant influences (P≤0.05) of treatments on the shoot weight of tomato in both seasons as shown in Table 3. The varieties exhibited significant differences during the first season where Tylka F1 was heavier than Cal-J, while no significant differences (P≤0.05) were observed during the second season. The mulching materials differed significantly in both seasons where the black polythene, sugarcane and white polythene mulch had heavier shoots compared the control.

The increase in tomato fresh shoot weight may be due to the varying moisture regimes

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Table 3. Effect of tomato varieties and mulching materials on the shoot weight (g) of tomato at Mabanga ATC during the short rains of 2014 and long rains season of 2015

Variety	Season One	Season Two
Cal-J	4337b	594a
Tylka F1	4692a	595a
P-Value	**<.001**	**0.535**
Mulch Treatment		
Black Polythene Mulch	5049a	639a
No Mulch	2623b	476b
Sugarcane Trash Mulch	4850a	600a
White Polythene Mulch	5536a	663a
P-Value	**0.022**	**<.001**
V*M Interaction	**NS**	**NS**

Means followed by different letters in each column are significantly different at P≤0.05

in the soil for the different mulching materials used. Probably, the black polythene, white polythene and sugarcane mulches conserved more moisture due to their lower evaporative losses than the unmulched treatment. Sugarcane trash is readily available in cane growing zones of Kenya thus, can be accessed ad libitum by tomato growers. Alabi (2006) reported that the increase in the number of leaves would increase photosynthetic surfaces and the current photosynthates produced would enhance the physiological activities leading to production of more assimilates used to significantly increase shoot density.

Conclusion

Based on the experimental results, it was observed that mulching significantly improved growth parameters of tomato in both seasons across the two varieties. The parameters measured in this study have a strong, positive correlation to tomato yield. It is therefore, recommended that white and black polythene mulches be used in tomato growing.

Conflict of interest

The three authors declare no conflict of interest in the study.

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