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Effect of mulching practice as soil moisture conservation for tomato production under supplemental irrigation in Yabello district of Borana zone

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The purpose of this paper is twofold: first, to identify the general use of the internet and examples of main social media used by residents of Bangladesh and second, to discover their potential in building marketing communication between FMCG manufacturers and consumers. The research method used is a quantitative survey (face-to-face interviews) on the sample of 100 consumers conducted in September 2022 in Dhaka, the capital of Bangladesh. The majority of respondents have regular access to internet facilities and mainly two social media platforms are used: Facebook and YouTube. Product information is sent to these media platforms for making purchasing decisions of the products of the FMCG market. Mostly males and the youngest group of respondents show the highest interest to social media. This study contributes to the literature to develop the understanding of marketing communications from the perspective of FMCG manufacturers entering Bangladesh, as it is being the emerging market.

Keywords: social media, marketing communication, Bangladesh, FMCG market

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INTRODUCTION

Tomato (Lycopersiconesculentum Mill.) is a vegetal of countless economic overgrownworldwide and is commercially cultivated on all over continents (Biswas *et al.*, 2015). Tomato is an essential element in the diet of the world population as it has high levels of lycopene and minerals, resulting in benefits to human health(Hashmi *et al.*, 2015). Yet, average yield of tomato in Ethiopia is low, ranging from 6.5-24.0 Mg ha^{-1} compared with average yields of 51, 41, 36 and 34 Mg ha^{-1} in America, Europe, Asia and the entire world, respectively(Iizumi and Sakai, 2020).

Thevaroussoil moisture conservation practices have been studied, aiming to enhance the yield and quality of tomato production. Among the technologies used in the cultivation of vegetables in recent years, soil mulching with plastic polythenele or/and residue material has stood out (Lopes *et al.*, 2011). In some vegetable species, this practice has been important in improving tomato development, yield and yield quality (Zangoueinejad *et al.*, 2018).

Soil mulching is a technique used in crops grown around the world, especially for vegetables, which can encourage several benefits (Moreno *et al.*, 2016). Mulching improves soil water retention capacity, contributes to early crop

development, changes the soil temperature and reduces weed incidence, and all these factors contribute to increased yield. However, these effects may vary according to soil type, climate, and material used for mulching (Ghosh *et al.*, 2006).The mulching can be done with organic materials such as straw or with inorganic materials such as plastic films. The choice of mulching material depends on the climate, the cost-benefit ratio, and the crop to be grown (Wang, Yin and Zeng, 2019). Mulching materials have a direct influence on the microclimate near the plant, which can have positive or negative impacts on plant physiological metabolism (Kader *et al.*, 2017). Beneficial effects of soil mulching have been reported for different crops, including tomato (Kosterna, 2014), potato (Zhao *et al.*, 2014), and maize (Wang, Yin and Zeng, 2019).

The plastic film has become the main material used for soil mulching in recent years, especially in vegetable production. The most popular types of plastic mulching films on the market are black mulch film and white mulch film. Other colors of plastic mulch films that are being studied, include silver, red, blue, yellow, and green films (Caruso *et al.*, 2019). However, the effects of these colored mulch films on plant development and production are still inconclusive. In this context, it is evident that information on the use of different plastic mulching films is still incipient. Thus, the study aimed to evaluated the effects of different mulchingmaterials on yield and yield components of tomato under supplemental irrigation.

Materials and Methods

Description of study area

The study was carried out in Qadalle watershed, which is found in Yabello district of Borana zone of Oromia National Regional State. Yabello is the capital town for the Borana zone and is situated south to Addis Ababa at a distance of 570 km. The Borana lowland is usually known as the southern rangelands. The Qadalle scheme is made of micro earthen dam diverted from runoff water. It founds at 04°53.294` N and 038°16.113` Ewith 1450m sea level, respectively. The annual average temperature and rainfall is 19 to24°C and 300 to1000 mm, respectively. The annual precipitation distribution is bimodal with 60% falling from April to May and 30% from October to November. The vegetation comprised in Borana is mainly a mixed savanna which is dominated by perennial grasses (*Cenchrus, Pennisetum, and Chrysopogon species*) and woody plants (Coppock, 2014). The Borana pastoralists traditionally depend mainly on cattle, but also on goat and sheep and nowadays though few on camel for household food security and a few donkeys and camels for transport.

Treatment Setup and Experimental Design

The different moisture conservation materials used for this study were: black polyethylene mulch, transparent polyethylene below root zone, organic mulch and without mulching. The experiment was laid in a RCBD with three replication. The experiments were conducted for three consecutiveyears (2012, 2013 & 2014 E.C). Improved and recommended varieties of tomato (Miya) was used as test crop. Six rows and six plants per row with 70 cm between rows and 30 cm between plants were used for this experiment.Irrigation area waspurposively selected due to the presence of the stored water for supplemental irrigation.The blanket recommendation of fertilizer rate was calculated at the rate of 79kgha^{-1}of Urea and 142kgha^{-1} NPS were applied at transplanting time and 50 kgha^{-1}urea was applied at early flowering stage.All the agronomic practices were uniformly applied to all treatments as per the recommendation.

Data Collected and Statistical Analysis

Data were collected on parameters including number of primary branch, plant height, marketable yield and total fruit yield (kg/ha).

Number of Primary branch: Counted at maturity from 5 randomly selected plants in each plot

Plant Height: transplanting date to the day on which 50% of the plant height in each plot

Days to first harvest: the number of days from transplanting to the first picking day

Fruit yield (kg/ha): Sum of fruit weight per plot from successive harvest (kg) was taken and converted to ton per hectare.Analysis of variance for the collected parameters was performed as per the methods described by (Allison, 2001) using SAS computer software for randomized complete block design and treatment mean comparison is done by Fisher's list significance difference (LSD) at 5%.

Water productivity

Water productivity was estimated as a ratio of fruit yield of onion to the total crop water consumption by evapotranspiration (ETc) through the growing season and calculated using the following equation (Zwart and Bastiaanssen, 2004).

$CWP = Y/ET$ (1) *Where, CWP is crop water productivity (kg/m³), Y tomato yield (kg/ha) and ET is the seasonal crop water consumption by evapotranspiration (m³/ha).*

Partial budgetanalysis

Economic analysis of the irrigation system was computed, based on investment, operation and production costs (Economics and Manual, 1988). In this research, a partial budgeting approach based on economic evaluation of the product was used. To assess the economic viability of the different mulching materials for moisture conservation costs were calculated (Biswas *et al.*, 2015). The net income for each treatment was computed by subtracting all the production costs from the gross incomes.

Results and Discussions

Selected soil physico-chemical properties of the experimental site

From the result,the soil textural class of study area is sandy loam (Table 1). The experimental site has 25.06% and 11.16% field capacity (FC) and permanent wilting point (PWP) respectively (Figure 3). The average total available water (TAW) by volume percentage is also estimated as 139mm/m. Irrigation scheduling of tomato was determined by considering soil type of experimental site and variable depth (refill to field capacity). But, mostly close supervision was used to add water according to the condition or moisture level of the plot until the plant has estabilished and adapted to the new environment and irrigation schedule were started measuring of soil water content.TheSame procure was also adopted by (Yaghi, Arslan and Naoum, 2013).

Table 1. Selected soil physico-chemical analysis of experimentalsite (0–20 cm

Soil parameters	**%**
Sand (%)	65.12
Silt (%)	17.12
Clay (%)	17.76
Texture	Sady Loam
Soil pH	7.24
Electrical conductivity (dS/m)	0.77
Organic matter (%)	0.9
Bulk density (g/cm3)	1.38
Field capacity vol. (%)	27.7
Permanent wilting point vol. (%)	12.1
TAW (mm/m)	97.10

The resulton soil moisture content under different mulch materials recorded during the cropping period for 0-20 cm soil depth is shown in Table 2. The data revealed that the mulch material under study was found effective in conserving soil moisture.. The highest (26.8 %) moisture was conserved underBlack polyethylene mulch (BPM)as compared to plots with no mulched. Where as, the lowest (18.9%) moisture was recorded under no mulch.The higher water retention noted both under BPM and Organic mulch (OM) may be due to formation of impermeable vapour barrier at soil surface as compared to white polyethylene mulch(WPM)and no mulch which being porous allowed diffusion of water under vapour pressure gradient. In line with the present studies which was from 0-20cm soil depth as it found in the range of 0-60cm soil depth,(Teame, Tsegay and Abrha, 2017)had also reported significant improvement of soil moisture at 0-60 cm soil depth in sesame as compared with nomulched plots.

Table 2:- Effects different mulching materials on soil moisture content at soil sampling depth of 0-20cm

Treatments	Ave. moisture content (%)
Black polyethylene mulch	26.8
Whitepolyethylene mulch	22.5
Organic mulch	24
With no mulch	18.9

Main effect of mulch on the yield and yield components of tomato

The statistical analysis in Table 3 shows that average weight of fruits, marketable and un marketable fruit yields are significantly affected by the mulch applied during study season. However, the effect of year on plant height, was not significant. This may be due to supplementary irrigation water used for each year when there is shortage or absences of rainfall happened. The outcomesgained from this study are in agreement with of (Biswas *et al.,* 2015).Other reports by (Mishra *et al.*, 2012) stated that water stress scaused a significant reduction in stem elongation, leaf expansion (leaf area), number of leaves, and plant heights. (Yaghi, Arslan and Naoum, 2013) also recommended that the decrease in plant height is a form of response showing that plants have adapted to lower transpiration. But in this study there was no time faced water shortage during the trial period as supplementary irrigation was applicale to refill the water below field capacity.

Table 2:- Mean square value of tomato yield and yield components under different mulching materials at Yabello for three (2012, 2013 and 2014) consecutive years.

Variation	DF	MY (tonha^{-1})	UMY(tonha^{-1})	NPB	PHT (cm)	Water productivity (Kg/m^3)
Year	2	40.05**	170.40**	2.62**	305.0^{ns}	4.032*
Rep (with in Year)	6	10.54ns	1.5^{ns}	1.17^{ns}	157.00^{ns}	39^{ns}
Treatments	3	932.3**	98.7**	7.72***	1700.89**	195**
Treatments*year	6	43.2**	3.1**	3.66**	11.68^{ns}	75**
Error	22	2.13	8.7	0.32	50.6	3.87
CV (%)		5.22	7.77	18.75	12.9	2.8

*MY = Marketable yield; UMY=Unmarketable yield; NPB=Number of primary branch; PHT=Plant height; cm=Centimeter,tha^{-1}=ton per hectare, ns=non-significant;***= significant at p<0.001; **= significant at p<0.01 and *= significant at p<0.05*

The maximum plant height of tomato (71.0cm)was recordedwith black polyethylenemulching where as,the minimum tomato plant height 38.33cmwas recoreded with no mulch. These results were in line with the findings of (Ashrafuzzaman *et al.*, 2011).The plot mulched with black polyethylene gavesignificantly highest yield (42.2 tonha^{-1}) and lowest yield (19.18 tonha^{-1}) was obtained from no mulching treatment, respectively.The highest unmarketable yield (12.66tonha^{-1})were again recorded from black polyethylene mulch. In this case, the vegetative growth of the crop was vigor in black polyethylene and this high vegetativse growth may favor the occurrence of insect, pest and fruitdeteriorationthat may lead to high unmarketable yield.

Table 3 :-Mean value of tomato yield and yield components under different mulching practices at Yabello.

Treatments	MY (tha^{-1})	UMY(tha^{-1})	NPB	PHT (cm)	Water productivity (Kg/m^3)
Black Polyethylene mulch	42.20^{a}	12.66^{a}	4.43^{a}	71.00^{a}	4.032^{a}
White Polyethylene mulch	22.45^{c}	6.38^{c}	2.68^{b}	50.83^{b}	3.924^{ab}
Organic mulch	28.11^{b}	8.38^{b}	2.93^{b}	59.00^{a}	3.953^{a}
Control	19.18^{d}	5.09^{d}	2.53^{b}	38.33^{c}	3.725^{b}
LSD Value	1.58	0.75	0.612	8.29	*

**Means with the same letter are not significantly different and LSD =least significant difference* MY = Marketable yield; UMY=Non-marketable yield; NPB=Number of primary branch;PHT=Plant height; cm=Centimeter and* tha^{-1}*= ton per hectare*

Black polyethylene mulching produced maximum yield attributes compared to no mulching. This increase in the yield was probably associated with the conservation of moisture and improved microclimate both beneath and above the soil surface which was maintained throughout the life period of crop. Then, when plants are set out in the warmer soil, they familiarize easier, blossom faster, and produce fruit earlier. Increased yield in black polyethylene mulched plots could be largely attributed to the increased soil temperature that resulted in an enhancement of favorable soil environment around roots of tomato plants, which led to increasing plant growth and, hence, increasing nutrients uptake. These results suggest that moisture and temperature have relationship with soil microbial activity that in turn determines pant growth.The yield increased due to the applied mulching which can be attributed to a lower rate of water loss from the soil by evaporation, leading to significant conservation of moisture. Hence, higher total yield was obtained.Applied mulch increases transpiration, thereby leading to more photosynthetic efficiency that resulted in increased yield as reported by (Liu *et al.*, 2014).

Partial budget analysis s

Partial budgetanalysis was done to select the most economically feasible moisture conservation practices. The partial budget for threeconsequtive years of experiments showed that the highest net benefit was obtained from black polythene mulching for tomato production whereas, the lowest net benefit was obtained from no mulch (Table 4). However, the results in the table below of benefit-cost ratio (BCR) of each treatment were computed as theratio of NI earned to the total cost (TVC) expended. From the economic analysis, black polythene mulch was economically the most feasable in with optimum net benefit.These results were in line with the findings of (Economics and Manual, 1988).

Table 4:- Partial budget analysis for the different mulching mterials for tomato production

Treatments	Total variable cost (birr)	Tomato sale (birr/kg)	MY (kg-ha)	Gross benefit	Net benefit (birr)	%
Black Polyethylene mulch	112500	60	4220	253200	140,700	-
White Polyethylene mulch	237500	60	2245	134700	102,800	37,900
Organic mulch	63000	60	2811	168660	105,660	35,040
Control	62500	60	1918	115080	52,580	88,120

Conclusions and Recommendation

In conclusion, the overall studies had revealed that mulches caused significant effect on the moisture conserving as compared to without mulched plots. The use of black polyethylene mulch recorded 26.8% higher soil moisture content closely followed by Organic mulch. The resulting change in the soil moisture conservation had also reflected on thefruit yield. The highest fruit yield was recorded underblack polyethylene mulchs with a yield of 42.02tonha^{-1}followed by organic mulching with 28.11tonha^{-1}. The finding shown that, maximum water productivity was obtained through application of black polythene mulch treatment and the minimum water productivity was obtained by irrigation with no mulch. From this result, it is concluded that, application of mulchingon influence for improving water productivity. As such under Lowlands of Borana plateau, the practice of mulching particularly with black polyethylene mulch can be recommended for increased tomato fruit yield and yield components.

CONFLICT OF INTERESTS

We have no any conflict of interests.

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