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EFFECT OF PLASTIC MULCHING AND DEFICIT IRRIGATION ON YIELD, WATER PRODUCTIVITY, SOIL TEMPERATURE AND CHARACTERISTICS OF MAIZE

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Abstract

Combining mulch and deficit irrigation may lead to an increase of crop yield and water productivity with water saving, especially in arid regions. For optimum maize production, soil moisture content, soil temperature and water productivity, an open field experiment conducted in 2017 and 2018 seasons. A split-plot design was used with four replications. Three mulch treatments namely [black mulched trickle irrigation (BMT), transparent mulched trickle irrigation (TMT) and trickle irrigation without mulching (WMT) as control] were allotted to the main plots, and three irrigation treatments [0.7, 0.85 and 1.0 evapotranspiration (ETc)] were devoted to sub-plot. The highest potential ETc was detected under WMT treatment with 1.0 ETc (13162 $m^3 ha^{-1}$), while the lowest ETc was registered under TMT treatment with 0.7 ETc (7983 $m^3 ha^{-1}$). On the other hand, for the second growing season, the highest and lowest potential ETc were (13338 and 8124 $m^3 ha^{-1}$) for WMT with 1.0 ETc and TMT with 0.7 ETc, respectively. The highest yield observed on 2017 were 11.39 and 9.37 ton ha^{-1} for BMT with 0.85 ETc and 1.0 ETc, respectively, while for 2018 growing seasons the highest yield observed were 11.27 and 9.82 ton ha^{-1} for BMT with 0.85 ETc and 1.0 ETc, respectively. The temperature values for soil were greater below the transparent mulch than below the black mulch. The increment of grain yield components by using the plastic mulching especially black plastic films comparing to open field may be due to stimulated root growth caused by increased soil temperature and moisture given under mulching coverings with plastic films, leading to increase grain yield per plant.

Key words: Maize yield, Soil moisture, Temperature regimes, Water productivity.

Introduction

Maize (*Zea mays* L.) positions as the foremost important cereal trim within the around the world in terms of grain generation. Maize grains are expended by humans directly or after preparing, and are regularly the most component of creature bolster. Vegetable oil, sugar syrup, liquor as biofuel, and feedstock for the fabricating of plastic are commonly determined from maize seeds. Mulch is one of the organization sharpens, which make strides the water proficiency of soil. Any fabric scattered on the surface of soil to secure it from sun oriented radiation, vanishing or raindrops is called mulch. Mulching can influence the soil temperature, and soil dampness substance (El-Hendawy and Schmidhalter, 2010) and specifically impact on the grain yield of crops (Kresoviæ *et al.,* 2016).

Mulching invigorates the microbial action within the soil through enhancement of soil agro-physical properties (Strizaker *et al.,* 1989). Mulching too minimizes the utilize of N fertilizer (Jones *et al.,* 1977), warms the soil (Singh *et al.,* 1988), moves forward the soil physical condition (Kwon *et al.,* 1988; Lal, 1989), and smothers weed development (Iruthayaraj *et al.,* 1989; Mohler and Calloway, 1992) and seem account for expanded surrender (Siti *et al.,* 1994; Ravinder *et al.,* 1997; Nagalakshmi, 2002). Concurring to Opara-Nnadi (1989) mulch makes a difference to move forward the soil environment for ideal trim development and surrender. Mulches are either natural or inorganic (plastic film). Plastic film mulches much development has continuously ended up a incredible breakthrough in rural generation ensured development ordinarily spoken to by plastic film mulching has significantly progressed edit generation (Liang *et al.,* 1999). Largely, mulches may lead to viable changes in soil characteristics (Vousta *et al.,* 1996).

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The surface film mulching favorably affects the soil dampness administration by controlling evaporation from the soil surface (Raeini-Sarjaz and Barthakur, 1997). This design expanded surrender and water productivity altogether (Midega *et al.,* 2013; Saidou *et al.,* 2003; Sharma *et al.,* 2011), due to expanding soil temperature (Special *et al.,* 2007; Hadrian *et al.,* 2006), expanding of accessible soil moisture (Fisher, 1995; Wang *et al.,* 2009), and diminishing soil evaporation from evapotranspiration (ET) (Li *et al.,* 2013; Wang *et al.,* 2011). Evapo-transpiration comprising of soil evaporation and plant transpiration (T), could be a major component of the water adjust in biological systems (Argentine *et al.,* 2007). Utilizing mulching film to move forward the development and yield crops has long been recognized (Sedaghati, *et al.,* (2016). Mulching film jam warm and dampness, diminishes weight from weeds and pathogens, and moderates water and fertilizer (Sampathkumar *et al.,* 2012).

Development with mulch has been demonstrated to be useful to trim development, such as, expanding soil dampness temperature (Zhou *et al.,* 2009; Zhao *et al.,* 2012), improving water productivity (Wang *et al.,* 2011), making strides supplement take-up in soils (Tooth *et al.,* 2011), plays an critical part in weed control (Steinmetz *et al.,* 2016), and expanding agrarian generation (Zhou *et al.,* 2009; Gao *et al.,* 2014) with generally low investment costs (Zhu *et al.,* 2017). The mulched medications essentially expanded soil water substance at distinctive soil profundities (Fan,Y. *et al.,* 2017).

Mulch can diminish soil temperature and hold way better root development in maize in case of coarse finished soil and grain yield (Liu *et al.,* 2009). Water stress on maize has been appeared to diminish plant tallness, leaf range record and root development (Xu, *et al.,* 2015). Mulch cover shields the soil from sun-based radiation subsequently diminishing four evaporation from the soil. Soil biota increment beneath mulched soil environment in this manner progressing supplement cycling and natural matter builds up over a period of a few a long time (Holland, 2004). Decreased soil development diminishes cultivate vitality prerequisites and generally cultivating costs as less region needs to be worked (Monzon *et al.,* 2006). Amid the hot summer days (July–August), tall soil temperature quickens dissipation at the soil surface and diminishes soil dampness, with a ensuing negative affect on the development and improvement of the edit. The negative impacts of tall temperature may, nevertheless, be minimized by utilizing mulching with appropriate materials (Kader *et al.,* 2017).

The impact of mulching on soil temperature is be that as it may, exceedingly variable; it depends on the sort of mulch and color of the plastic film. Plastic film mulching is more compelling for decreasing soil-moisture consumption/loss compared to straw mulching. Whereas dark plastic mulch increments soil temperature (Ibarra *et al.,* 2012), silver color plastic mulch diminishes it (Lamont, 1993). The color of the plastic mulch influences the microclimate around the trim by altering radiation budget (absorptivity vs. reflectivity) of the surface (Filipoviæ *et al.,* 2016) that can decrease soil-water utilization (Deng, Shan, Zhang, & Turner, 2006) and increase water productivity (Kumar and Dey, 2011).

A low water prerequisite water system framework for development of maize is in this manner required for ideal utilize of this restricted water assets. Utilize of plastic mulch may overcome this issue. As an imperative cultivating strategy, plastic mulching has been utilized broadly due to the critical benefits it confers in terms of surrender increment and water preservation (Sun *et al.,* 2014). In common, there has a few writing on the utilize of plastic mulch to diminish soil disintegration and water preservation (Ingman *et al.,* 2015).

Layout and spacing between laterals influenced the dispersion of soil moisture content and nitrate, yield arrangement, and net benefits of trickle irrigation system. Near horizontal dispersing more often than not gives a more prominent flat-water substance conveyance consistency, yield and water productivity (Chen and Wang, 2010 and Chen *et al.,* 2015). In arid regions, irrigation water is the major limiting resource for agricultural yield. Water productivity is a critical pointer for assessing the water-saving effectiveness of inundated field crops (Kiziloglu *et al.,* 2009; Rudnick *et al.,* 2016; Kang *et al.,* 2017). In more considers water productivity was extended from 1.24 to 1.60 kg m^{-3} when grain yield from 6.5 to 9.5 t ha^{-1} (Fan *et al.,* 2017 and by Liu *et al.,* 2011). In advanced maize generation, expanded yields per unit zone come from expanding the ideal planting thickness (Grassini *et al.,* 2011). In addition, in arid regions, water is the major factor limiting agricultural yield (Aguilar *et al.,* 2007; Abdelraouf and Ragab, 2018).

Plastic mulches have been effectively utilized to progress neglected productivity and increment the sum of put away soil water accessible for plant utilize (Wang *et al.,* 2001). In any case, most former work has concentrated on the impact of decrepit on trim surrender; few considers have compared the water storage efficiency among distinctive sorts of mulching frameworks. This explore was outlined to optimize yield of the maize, soil moisture and temperature administrations as well as water productivity.

Materials and Methods

Experimental location characteristics

Two field experiments were accomplished at the Agricultural Research and Experiment Station, of Faculty of Agriculture, Cairo University, Giza, Egypt (latitude 30.1113N, longitude 31.4138E, and mean altitude 74 m above sea level) throughout the two progressive seasons of 2017 and 2018. The soil of the test location is classified as clay soil (Table 1). Irrigation water has been gotten from a profound well found within the exploratory region, with pH 7.2, and an normal electrical conductivity of 0.83 dS m^{-1}(Table 1).

Crop administration

Maize (*Zea mays* L.) was directly sown on 5 and 13 June in both growing seasons 2017 and 2018, respectively, inside the 7cm breadth round-cut gap of the polythene sheet. The gap on plastic sheet was made by a sharp conclusion press slide. Plants were spaced 24cm×60cm within and between rows, respectively, which made a plant population of (70000) plant ha^{-1}. Seeds were sown in hills by hand in both side of ridges, thereafter (before the first irrigation) were thinned to one plant per hill. On the other hand, the control treatment (non-plastic mulch treatment), the seeds were moreover sown in ridges keeping up above-mentioned dispersing. Calcium super phosphate fertilizer (15.5% P_2O_5) was added uniformly before sowing at the rate of 60 kg ha^{-1}. In expansion, the ammonium nitrate (33.5% N) was added at the rate of 300 kg ha^{-1} was comprised in two break even with dosages some time recently the primary and subsequent irrigation.

Standard agricultural practices were trailed through the growing seasons. The weed management was approved out during the growing season by hoeing twice times, before the first and the second irrigations, while the pest control was done according to practices used at the experimental station. The other cultural practices were applied as recommended by the Agricultural Research Center (ARC), Giza, Egypt.

System Installation and Experimental Treatments

A field plot of 27.9×15m was selected for the experimental studies. The field plot was divided into 36 equal plots of 3.1×3m. Each plot consists of two ridges 0.60 m apart and represented a single treatment. The experiment was laid out following a split-plot design in a randomized complete block arrangement with three mulch treatments (black mulched trickle irrigation (BMT), transparent mulched trickle irrigation (TMT) and trickle irrigation without mulching (WMT) as control treatment), and three irrigation treatments [0.7, 0.85 and 1.0 evapotranspiration (ETc) : 1 time of potentiel corp evapotranspiration]. Each treatment condition was repeated four times (R1, R2, R3 and R4; Fig. 1).

The irrigation was performed on 16 mm (ID) laterals, one per row of maize, by a trickle scheme of emitters (4 Lh^{-1}) spaced 30 cm apart by each plant. Every plot had a 50 mm diameter PE manifold pipeline. The irrigation water, pumped from a profound well, was transported to the manifolds along the boundary of the plots by means of 63 mm diameter PE pipes. At a pressure of 100 KPa the self-compensating emitters operate. The plastic mulch used was for (BMT) black polyethylene (40 μm) and clear transparent polyethylene (100 µm) for (TMT).

Soil moisture was determined at a depth of 15 cm below the surface of the soil using a neutron probe. In the field, the neutron probe was calibrated by correlating the neutron probe count ratio with volumetric water content measured using gravimetric method and bulk density. Between two crops, a 100 cm neutron tube was put up near the middle of each plot and 15, 30, 45, 60 and 75 cm away from lateral. In order to determine the changes in ground water conservation or percolation,

Table 1: Some physical and chemical properties of soil at the experimental site in 2017 and 2018 seasons.

Soil analysis	Growing season	
Physical properties	2017	2018
Sand (%)	32.3	32.5
Silt (%)	29.0	30.5
Clay (%)	38.7	37.0
Texture class	Clay loam	Clay loam
Chemical properties		
pH	7.52	7.61
EC (dS m^{-1})	1.8	1.9
Organic matter (%)	2.0	2.4
Total $CaCO_3^{-2}$ (%)	3.2	3.7
Available N (mg kg^{-1})	41.5	51.3
Available P (mg kg^{-1})	7.6	8.2
Available K (mg kg^{-1})	220.7	235.1

Chemical analysis of Irrigation water at the experimental site										
pH	EC(dS m^{-1})	Soluble cations (meq L^{-1})				Soluble anions (meq L^{-1})			SAR(%)	T.S.S*
		Ca^{++}	Mg^{++}	Na^{+}	K^{+}	Cl^{-}	HCO^{-3}	SO_4^{-2}		
7.20	0.83	3.60	2.60	0.90	0.18	1.00	5.00	1.28	0.51	0.00

* T.S.S: Total Suspended Solids in irrigation water.

measurements of soil moisture were taken at 10 cm depth, which was lower than the root zone overtime, before and after each irrigation. Through SURFER 9 software, which was used to graph readings after obtaining the calibration curve, the soil moisture content was represented as contour lines. The irrigation schedule was based on calibrated neutron test measurements, while irrigation was performed at an efficient root distribution area at 85 percent of field capacity.

Crop water requirement

For the calculation of reference evapotranspiration (ETo) in the CROPWAT program the Penman-Monteith, technique of FAO (Allen *et al.*, 1998) was used. The requirements of plant water (ETc), during the growing season, were calculated from ETo using crop coefficient (Kc) equation:

$$ET_c = Kc.\ ETo \quad (1)$$

Where ETc is the potential evapotranspiration, K_c is the crop coefficient, and ET_o is the reference evapotranspiration. Because during the experimental period there was no precipitation, the net irrigation requirement was equivalent to ETc. The Kc for cultivation of maize was determined by the FAO (2010) equation as follows:

$$K_C = \frac{ET_C}{ET_O} \quad (2)$$

Data recording

Ten guarded crops on harvest, the plant height measured in cm from the surface of soil was sampled randomly from each floor to the flag leaf point. Ear weight/ plant in g, ear height in cm and ear length in g. Shelling%, calculated by dividing grain weight on ear weight and multiplied by 100, grain yield/plant (g) and 100 kernel weight (g) were determined on 10 random ears from each plot. Grain yield in kg was weighed from whole area of each experimental unit (sub-plot) and then adjusted into ton per hectare. The grain yield per hectare was adjusted based on 15.5% grain moisture content. The water productivity (kg m^{-3}) was computed using Eq. (3) given by Bhushanet al. (2007).

$$\text{Water productivity (kg m}^{-3}) = \frac{\text{yield (kg ha}^{-1})}{\text{plant water consumption (m}^3\text{ ha}^{-1})} \quad (3)$$

Soil temperature

For each therapy, a total of 27 thermometers were mounted on the surface of the soil, 5 cm and 10 cm from the soil surface. From the planting date to the end of the growing season, the temperature was registered. Each six hours of the day was measured and twice a week.

Statistical analysis

Test of normality distribution was carried out according to Shapiro and Wilk, method (1965), by using SPSS v. 17.0 (2008) software package. Combined analysis of variance of a RCBD across the two seasons was computed after carrying out Bartelet test according to Steel et al. (1980). Snedecor and Cochran (1994) calculated LSD estimates to evaluate the mean variations, by using MSTAT C software package.

Results and Discussion

Potential evapotranspiration and water productivity

For the first growing season, the highest potential evapotranspiration (ETc) was detected under WMT treatment with 1.0 Etc (13162 m^3 ha^{-1}), while the lowest (Etc was registered under TMT treatment with 0.7 ETc (7983 m^3 ha^{-1}). On the other hand, for the second growing season, the highest and lowest potential evapotranspiration were (13338 and 8124 m^3 ha^{-1}) for WMT with 1.0 ETc and TMT with 0.7 ETc, respectively (Table 2).

Irrigation scheduling started through measuring of soil moisture content by neutron probe. It was noted that the number of irrigation events has the lowest value (N = 39) for TMT treatment followed by BMT treatment, which almost similar to TMT (N = 38) treatment, while the highest value registered for WMT treatment (N = 48). Non-mulched treatment reduces irrigation intervals comparing with mulched treatments BMT and TMT.

The findings showed that the quantities of water used decreased in order of TMT < BMT < WMT. On the other hand, the water productivity had an reverse order, where it follows the order BMT > TMT > WMT.

The treatments that achieved the highest yields during the both growing seasons were observed to be the treatments that registered the highest soil moisture content according to samples taken At the end of the season. Where the highest yield observed on 2017 were 11.39 and 9.37-ton ha^{-1} for BMT with 0.85 ETc and 1.0 ETc, respectively, while for 2018 growing seasons the highest yield observed were 11.27 and 9.82-ton ha^{-1} for BMT with 0.85 ETc and 1.0 ETc, respectively. The BMT treatment achieved an increment in yield by 116% and 115% for 2017 and 2018, comparing with WMT, respectively.

Although, BMT consumed more water than TMT, the water productivity was greater than TMT treatment, because this treatment produce highest yield 10.52 ton ha^{-1} at 0.85 ETc of crop water requirement. Therefore, the highest water productivity (1.0 kg m^{-3}) was achieved for the BMT treatment. The lowermost water productivity (0.6 kg m^{-3}) achieved for the WMT treatment because this treatment produce second lowest yield (8.155 ton ha^{-1}) and lowest irrigation efficiency 89.1% at 1.0 ETc.

Soil moisture content

Irrigation water for the efficient root area distribution region was presented to offset the root area soil water deficiency (60 cm) (Allen *et al.*, 1998). The monitoring the soil content of water in trickle irrigation plots showed that, in comparison to the non-mulched plots as shown in Fig. 2, a depth less than 60 cm was negligible.

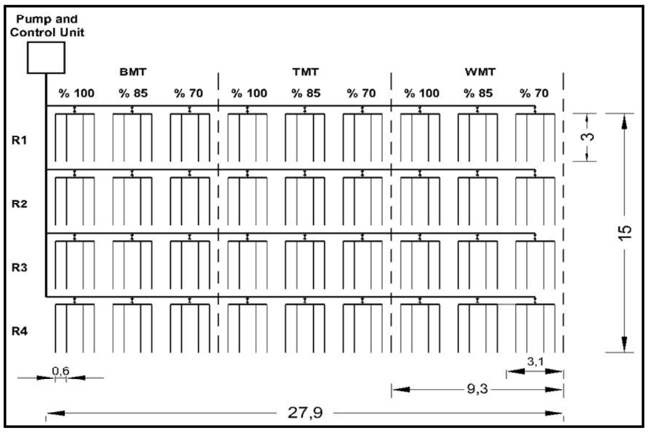

Fig. 1: Layout of maize experiment and irrigation system.

The measurements show that plastic mulching has a significant impact on the efficiency of irrigation by excellent estimation of the size of the bulb in the emitter and understanding its changes in moisture in location and time, while using the plastic mulch trickle irrigation reduces both soil evaporation and water dispersion in soil from rows.

The measured measurements show that plastic mulching has a marked impact on irrigation efficiency by excellent estimating the size of the wetting bulb under the emitter and the changes in moisture in location and in time, while using plastic mulch tricking irrigation reduces both surface evaporation and water distribution in the soil far from the laterals. These findings also agree with the outcomes collected by Pawar *et al.*, (2003), Yaghi *et al.*, (2014) and Ahmed *et al.*, (2014), which has an intense impact on agricultural water distribution patterns, root distribution, fertilizer effectiveness, and water utilization, and eventually maize output.

The results indicated that all mulches increase soil moisture and water productivity. The evaporation from soil surface decreased in the transparent and black mulches treatments, therefore, the soil moisture decreased compared to non-mulched treatment. Mulches with beneficial soil circumstances have therefore had a beneficial impact on maize plant growth, and have helped increase vegetative development and yield.

Table 3: Potential evapotranspiration (ETc), grain yield and water productivity of maize under mulch and irrigation treatments for the both growing seasons.

Treat-ments		ETc(m^{3}ha^{-1})		Grain yield (ton ha^{-1})		Water productivity (kg m^3)	
		2017	2018	2017	2018	2017	2018
Mulch	BMT	10107 b	10344 b	9.80 a	9.87 a	0.977 a	1.006 a
	TMT	9761 b	9905 b	8.40 b	8.46 b	0.913 a	0.863 ab
	WMT	11251 a	11470 a	8.31 b	7.87 b	0.757 b	0.742 b
$LSD_{0.05}$	493.02	675.13	0.808	0.598	0.148	0.147	
Irrigation	0.7 ETc	8546 c	8732 c	8.39 b	7.85 b	1.046 a	0.960 a
water	0.85 ETc	10415 b	10679 b	9.30 a	9.34 a	0.894 b	0.916 a
applied	1.0 ETc	12159 a	12308 a	8.83 ab	9.02 a	0.707 c	0.736 b
$LSD_{0.05}$	54.132	102.36	0.635	0.573	0.077	0.096	
BMT	0.7 ETc	8288.0 f	8474.0 f	8.65 bc	8.53 cd	1.04 a	1.01 a
	0.85 ETc	10064.0 d	10438.0 d	11.39 a	11.27 a	1.07 a	0.98 ab
	1.0 ETc	11840.0 b	12026.0 b	9.37 b	9.82 b	0.79 cd	0.76 c
TMT	0.7 ETc	7983.0 f	8124.0 f	7.93 c	7.21 e	0.99 a	0.89 bc
	0.85 ETc	9781.5 d	9986.0 d	8.37 bc	9.05 bc	0.83 bc	0.91 bc
	1.0 ETc	11390.0 c	11442.0 c	8.89 bc	9.14 bc	0.78 cd	0.75 cd
WMT	0.7 ETc	9313.4 e	9546.0 e	8.59 bc	7.81 de	0.91 b	0.82 c
	0.85 ETc	11287.7 c	11436.0 c	8.13 c	7.71 de	0.72 d	0.73 cd
	1.0 ETc	13162.0 a	13338.0 a	8.22 c	8.09 de	0.62 d	0.61 d
$LSD_{0.05}$	335.44	470.75	1.100	0.951	0.149	0.170	

Yield and agronomic traits

There was a significant difference ($P < 0.05$) among the three mulch treatments. BMT treatment gave the highest values of ear weight/plant in both seasons (193.8 - 206.7 g), plant height (260 – 250.2 cm), ear height (135.6 – 135.8 cm), ear length (16.2 – 16.5 cm), seed index (32.6 – 32 g), yield/p (169.2 – 179.6 g), shilling (%) (87.4 – 86.8 %) and yield ha^{-1} (9.60 – 9.29 ton), respectively. While the WMT treatment gave the lowest values of ear weight/p in both seasons (140 – 138.8 g), plant height (204.6 – 198.8 cm), ear height (90.8 – 88.8 cm), seed index (28 – 26.7 g), yield/ p (116.2 – 117.1 g), shilling (%) (82.4 – 84.3 %) and yield ha^{-1} (8.24 – 8.10 ton), respectively, except ear length the mulching with white plastic sheet record the lowest values of ear length (14.1 – 13.3 cm).

Mulch covers likely play one of the main roles in the two seasons was to reduce the

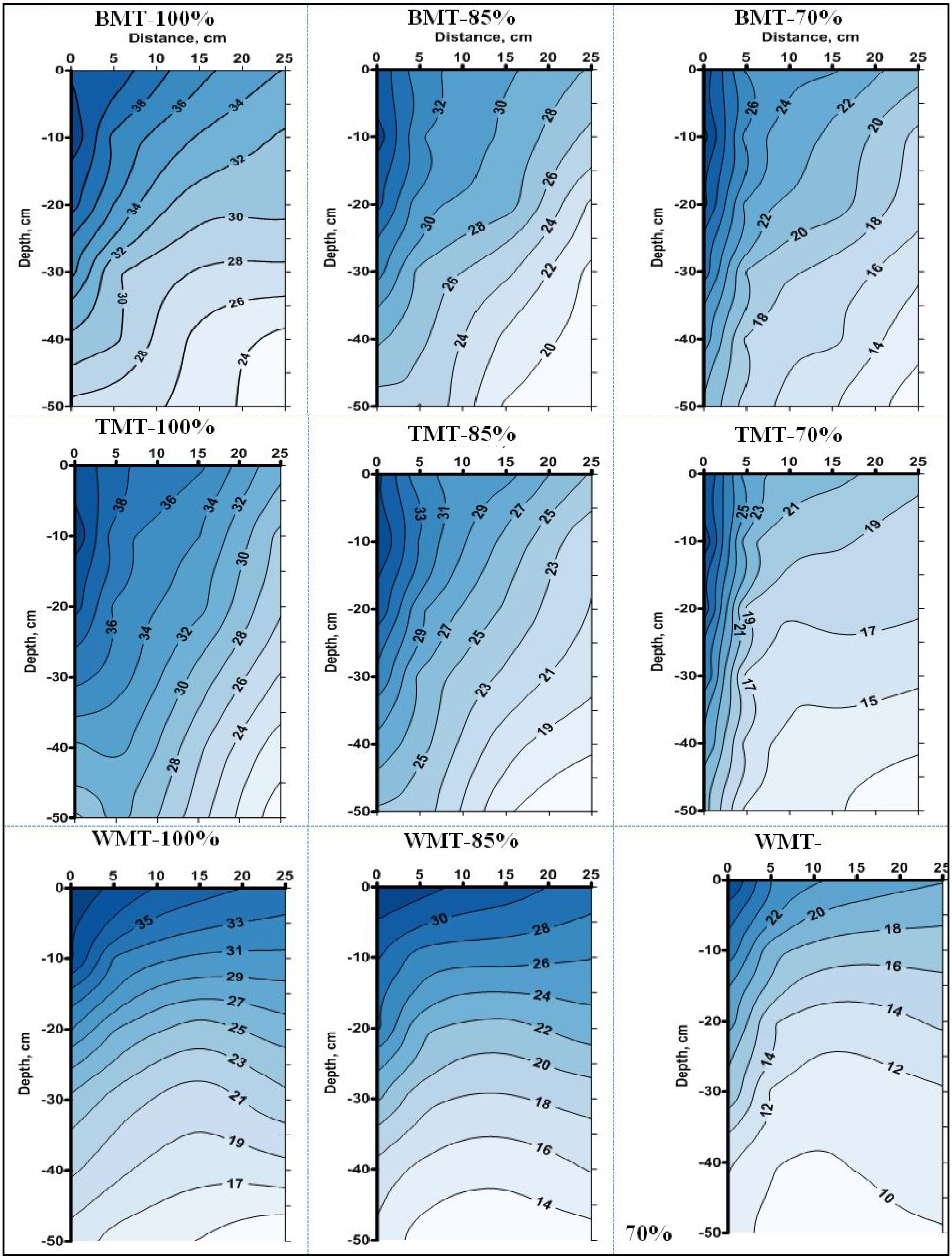

Fig. 2: Soil moisture content diagrams after irrigation for different treatments (average of the two growing seasons 2017 and 2018).

evaporation of soil. Hatfield *et al.*, (2001) indicated that the soil water evaporation was reduced by 34-50% because of crop mulching. The increase in maize yields for Xu *et al.*, (2015) amounted to 15 to 27%, whereas in maize plastic movie mulching it was 70 percent higher than in WMT therapy for Liu *et al.*, (2015). The greater yield in plastic mulch treatments was ascribed to all development and yield contributing parameters, which had better output. The plant height was much greater than the leaf number, the length of the leaves, cob length, the number of grains per cob row, 1000-grain weight. Several studies have shown that mulches have positive impacts on output amount and quality in separate plants.

The best seeding and biomass yield, 100-seed weight, and head diameters of sunflower were achieved in the combined implementation of plastic mulch and straw layer burial plot (Zhao *et al.*, 2016). White plastic pail had the best results in relation to the production of grain in the

Table 4: Mean performance of Mulch, deficit Irrigation and Mulch × deficit Irrigation Interaction for yield component during 2017 and 2018 seasons.

Treatments		**Ear weight (g)**		**Plant height (cm)**		**Ear height (cm)**		**Ear length (cm)**	
		2017	**2018**	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Mulch	BMT	193.8 a	206.7 a	260.0 a	250.2 a	135.6 a	135.8 a	16.2 a	16.5 a
	TMT	153.8 b	154.2 b	228.4b	227.3 b	109.6 b	104.0 b	14.1 a	13.3 ab
	WMT	140.0 b	138.8 b	204.6c	198.8 c	90.8 c	88.8 c	15.3 b	15.9 b
$LSD_{0.05}$		19.58	18.70	10.69	7.93	14.12	6.32	1.13	3.01
Irrigation	0.7 ETc	162.5 a	165.4 a	224.6 b	216.2 b	107.1 b	107.3 a	14.9 a	15.6 a
water	0.85 ETc	168.8 a	171.7 a	235.8 a	233.6 a	116.7 a	107.7 a	16.4 ab	15.7 a
applied	1.0 ETc	156.3 a	162.5 a	232.6 ab	226.5 a	112.3 ab	113.5 a	14.2 b	14.4 a
$LSD_{0.05}$		ns	ns	9.31	10.13	9.00	ns	1.70	1.52
BMT	0.7 ETc	193.8 ab	215.0 a	260.0 a	252.5 a	145.0 bc	147.5 ab	15.8 bc	16.8 ab
	0.85 ETc	212.5 a	208.8 a	263.8 a	254.5 a	130.0 a	123.0 a	18.5 a	17.5 a
	1.0 ETc	175.0 bc	196.3 a	256.3 a	243.5 ab	131.8 bc	136.8 a-d	14.3 bc	15.3 a-d
TMT	0.7 ETc	156.3 cde	155.0 bc	207.5 c	197.3 c	86.3 c	88.3 bcd	13.8 c	14.0 bcd
	0.85 ETc	138.8 de	145.0 bcd	238.8 b	248.8 ab	127.5 c	108.8 d	14.0 c	12.8 d
	1.0 ETc	166.3 bcd	162.5 b	239.0 b	236.0 b	115.0 bc	115.0 cd	14.5 bc	13.0 cd
WMT	0.7 ETc	137.5 de	126.3 d	206.3 c	198.8 c	90.0 bc	86.3 abc	15.3 bc	16.0 abc
	0.85 ETc	155.0 cde	161.3 b	205.0 c	197.5 c	92.5 ab	91.3 ab	16.8 ab	16.8 ab
	1.0 ETc	127.5 e	128.8 cd	202.5 c	200.0 c	90.0 c	88.8 a-d	13.8 c	15.0 a-d
$LSD_{0.05}$		30.61	28.27	15.79	16.01	2.64	3.14	2.64	3.14

Treatments		**Seed index (g)**		**Yield / plant (g)**		**Shilling (%)**	
		2017	**2018**	**2017**	**2018**	**2017**	**2018**
Mulch	BMT	32.6 a	32.0 a	169.2 a	179.6 a	87.4 a	86.8 a
	TMT	31.0 b	30.8 b	131.7 b	130.0 b	85.3 ab	84.4 a
	WMT	28.0 c	26.7 c	116.2 b	117.1 b	82.4 b	84.3 a
$LSD_{0.05}$		0.89	1.08	21.42	23.29	4.33	ns
Irrigation	0.7 ETc	31.0 a	30.4 a	140.8 a	140.8 a	86.1 a	85.0 a
water	0.85 ETc	31.8 a	30.8 a	144.5 a	147.5 a	85.2 a	85.6 a
applied	1.0 ETc	28.8 b	28.2 b	131.7 a	138.3 a	83.8 a	84.8 a
$LSD_{0.05}$		0.98	1.23	18.01	ns	ns	ns
BMT	0.7 ETc	33.5 a	32.6 a	171.3 ab	183.8 a	88.3 a	85.6 a
	0.85 ETc	33.1 a	32.7 a	183.8 a	182.5 a	86.7 ab	87.2 a
	1.0 ETc	31.1 bc	30.8 ab	152.5 bc	172.5 a	87.2 ab	87.5 a
TMT	0.7 ETc	29.4 d	30.0 bc	140.0 cd	132.5 bcd	89.6 a	85.5 a
	0.85 ETc	32.5 ab	31.5 ab	113.8 de	122.5 bcd	81.5 bc	84.4 a
	1.0 ETc	31.1 bc	30.9 ab	141.3 bcd	135.0 bc	84.9 abc	83.2 a
WMT	0.7 ETc	30.1 cd	28.7 c	111.3 de	106.3 d	80.4 c	83.9 a
	0.85 ETc	29.9 cd	28.4 c	136.0 cd	137.5 b	87.4 ab	85.2 a
	1.0 ETc	24.2 e	22.9 d	101.3 e	107.5 cd	79.4 c	83.8 a
$LSD_{0.05}$		1.58	1.97	30.80	28.68	6.30	ns

plastic mulch treatments. The second was the black plastic mulch and the third was the black plastic mulch. However, all plastic mulch therapy was better than rice straw mulch therapy. Sedaghati *et al.*, (2016) have also demonstrated improved mulch therapy but no major distinctions in output between the white and black plastic mulches. Li *et al.*, (2013) have shown that plastic mulching could serve as an obstacle to water vapor evaporation, improve storage of soil moisture and improve bioactivity.

The advantages of plastic mulch have been commonly recorded in reducing water loss through evaporation, lower salt accumulation, soil moisture preservation, plant development and plant water productivity (Xie *et al.*, 2005; Deng *et al.*, 2006 ; Chakraborty *et al.*, 2008 ; Liu *et al.*, 2009).

Contrary to the results in our research, the mild water deficit (0.75–0.80 ecc) does not seem to reduce maize output (Farré and Faci 2009; El-Hendawy and Schmidhalter 2010; Sampathkumar and coll. 2012). Against the same backdrop, Di Paolo and Rinaldi (2008) noted that the deficit in water has decreased only slightly. Vories et al. (2009) found that maize returns in the United States Mid-South were enough for concentrations of as low as 0.60 ETc. The use of smaller furrow longitudes, the improvement of irrigation cut-offs, and the choice of suitable water application rates and tight furrow shapes are specific practice areas that have been demonstrated to improve irrigation efficiency (Kang *et al.*, 2000; Ampas

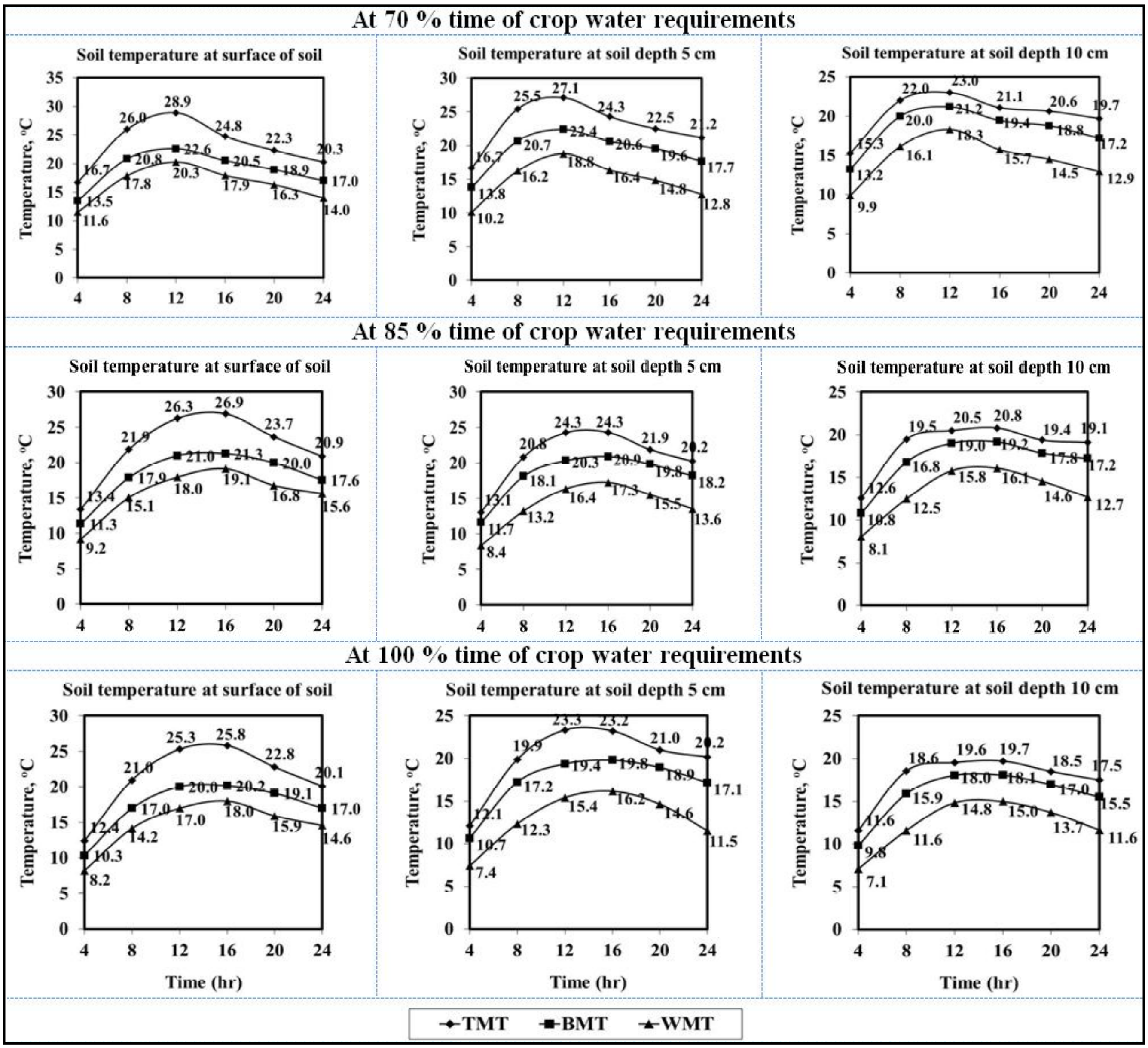

Fig. 3: Average of soil temperature for both seasons under mulched and non-mulched treatments for maize at different soil depths (soil surface, 5cm and 10cm) and 70, 85 and 100% of irrigation water applied.

and Baltas 2009). Kresoviæ *et al.*, (2016) found that a water stress had significant impact on yield response: as an average of the three years, a grain yield increase of 47.8, 32.8 and 22.9% was observed in 100, 75 and 50% irrigation treatments compared to rain fed (control) treatment, respectively.

Soil temperature

Each 4 hours, during the day and 2 times a week, the Soil temperature was assessed at soil surface and 2 depths of 5 and 10 cm. As shown in Fig. 3 the outcomes are shown on average in both years. Soil temperature values with mulching are significantly greater than soil values without plastering. The mulching can prevent the soil surface from cooling due to evaporation. The soil temperature values were higher under a transparent pail than below the black pail. This clear plastic mulch can warm up (as an average during day) (6.8, 8 and 5.7^{O}C), (6.5, 6.7 and 5.4^{O}C) and (6.6, 7.1 and 5.3^{O}C) to a depths of 0, 5 and 10 cm for crop water requirements percent 70, 85 and 100%, respectively, whereas black plastics permit warming of (2.6, 4.3 and 3.7^{O}C), (2.5, 4.1 and 3.5^{O}C) and (2.6, 4.3 and 3.4^{O}C) at the same previous depths and crop water requirements percent compared to non-mulched treatments.

The plastic mulch applies to transparent or black soil temperature, but transparent plastic mulch raises the soil temperature above that of black mulch, particularly during the initial weeks after transplantation, when crops lacked sufficient canopies for soil shade. The degree of contact between the floor and floor can have a strong effect on the performance of the floor, often as thermal contact resistance. If a rough soil surface creates an air room between the plastic mixer and the soil, the warming of the soil can be less than anticipated by a specific mixture.

The transparent plastic moves by the sun and heats the soil. The radiant heat remains under a layer of water under the plastic at night through a so-called greenhouse effect. Black plastic mulch takes up the sunlight and gets very hot and less energy flows into warming up the soil. These results support those of Lamont (2005) and Ngouajio and Ernest (2005) who have shown transparent mulch to be only 5% short-wave radiation, but only 11% transmit 84% of short Wave radiation, whereas surface temperature can not reach concentrations in dark plastics as a result of low retention rates. This means that transparent plastic heats the earth, passing light to the surface of the earth instead of warmth as dark plastics.

Conclusion

From the above outcomes it may be stated that, in comparison with control therapy, the plastic mulch coverings, treatments and soil temperatures have increased in average and soil moisture levels. The increment of yield components by using the plastic mulching especially black plastic films comparing to open field may be due to stimulated root growth caused by increased soil temperature and moisture given under mulching coverings with plastic films, leading to increase grain yield per plant.

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