MISR JOURNAL OF AGRICULTURAL ENGINEERING
https://mjae.journals.ekb.eg/
ISSN-Print: 1687-384X
ISSN-Online: 2636-3062

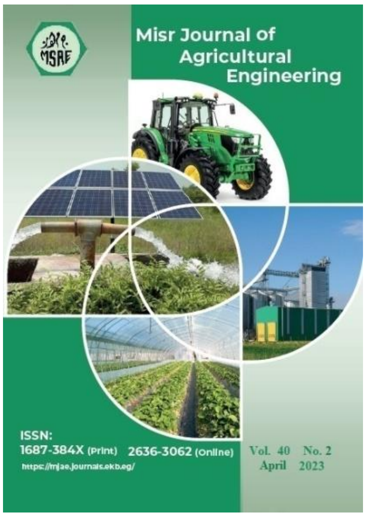
Misr J. Ag. Eng., 40 (2): 109 - 122
DOI: 10.21608/mjae.2023.186476.1094

UTILIZATION OF SOIL MULCH FOR INCREASING FURROW IRRIGATION EFFICIENCY AND WATER PRODUCTIVITY

Mohamed Ali[1], Harby Mostafa[2&*] and Mohamed El Ansary[3]

[1] Grad. Stud., Ag. Eng. Dept., Fac. of Ag., Benha U., Qalyobia, Egypt.
[2] Prof. of Ag. Eng., Fac. of Ag., Benha U., Qalyobia, Egypt.
[3] Prof. Emeritus of Ag. Eng., Fac. of Ag., Benha U., Qalyobia, Egypt.

* E-mail: harby.mostafa@fagr.bu.edu.eg



Keywords:
Plastic mulch; Furrow irrigation; Squash; Water Productivity.

ABSTRACT

The increasing demand of water in the country highlights the need to introduce low-input and water saving technologies for agricultural sustainability and crop production, mainly in semi-arid region. The aim of this study was to investigate the effectiveness of plastic mulch at field scale on improving the performance of surface irrigation in contrast to conventional practices. Therefore, a field experiment was conducted to test the combined effect of furrow irrigation lengths and furrow plastic mulching on crop growth, yield and water productivity of squash. The experiment was laid out with furrow irrigation method and plastic mulch with different furrows lengths (15, 30 and 40 m). Two experimental furrow plots were prepared, the first was mulched furrows (MF) and the second was non-mulched furrows (NMF). The results indicated that the amount of applied water was less in MF by 10% than that in NMF treatments. It may be due to the higher soil moisture content (26.6%) before irrigation than NMF (22.7%) as a direct effect of mulching. The highest yield of squash crop was obtained from MF treatment with 30m furrow length (10.7 t/fed) followed by 15 m furrow length (10.5 t/fed) under MF too. Regarding the different irrigation practices with plastic mulch, maximum irrigation water productivity (5.11 to 5.41 kg/m^3) was obtained in the mulched furrow irrigated squash with plastic mulch. The water saving was thus 10.44% under MF treatments when compared to non-mulched furrows irrigation method NMF.

1. INTRODUCTION

Use of moisture conservation methods are a prime need of the hour. There is an urgent need to evaluate methods to prevent excessive loss of water from soil surface, which can otherwise be utilized by the crop for its physiological development. Area under cultivation in Egypt is increasing day by day and water scarcity is alarming to meet the food demand in future. There is dire need to switch over from traditional method of irrigation to modern techniques on which, work has been already initiated. Basin, border and furrow are the traditional surface irrigation methods, which are used to irrigate crops in Egypt. Closely related furrow irrigation is the surface irrigation which utilizes the water for irrigation more efficiently as compared to other surface irrigation methods (**Maurya, et al., 2018**). Furrow irrigation provides better on farm water management capabilities, reduces the flow rates per unit width, and is applicable to more severe and variable topographical conditions (**Bristow, et al., 2020**). In addition, the operational flexibility is also important for achieving higher efficiency for each irrigation method throughout a season. Accordingly, irrigation methods require fundamental changes in water management in order to use the limited water resources efficiently. The use of water-saving strategies is therefore critical for dry-land cropping systems considering that rainfall is not only low in absolute amount but is also unevenly distributed (**Cui et al., 2010**). One water-saving strategy that may have contributed to the increase is the adoption of plastic mulching technology that is most commonly used worldwide (**Daryanto et al., 2017**). Nationwide, plastic mulching has increased maize and wheat grain production by 33.7% and 33.2%, respectively (**Liu et al., 2014**). **Hatami et al. (2012)** examined the effects between-row spacing, in-row spacing and mulch treatments and found that these factors had significant effects on yield and yield ingredients (weight of fruit and number of fruit per plant). They also found that water productivity increased by the application of plastic film that was 33 kg/m^3 on 100×30, pattern with the plastic covering at full furrow and half ridge. However, the study on the effects of different furrow without and furrow with plastic sheet combined farming practices on water saving. **Jiang et al., (2012)** reported that percentage of saved water and water saving efficiencies of Mung bean increased by 22.73% - 40.38% as compared to those under the flat farming practice under different furrow without and furrow with plastic sheet. Likewise, effect of inter-row polyethylene sheet on the crop water productivity of furrow and drip irrigated maize indicated that the inter-row polyethylene sheet is an efficient technique for increasing the crop water and plant productivity. The experiment was under taken among the amount of water and mulching practice to investigate and evaluate the effect of furrow irrigation level and mulching on water productivity, yield and yield component of head cabbage (**Shelemew et al., 2022**). Total yield harvested from black plastic mulch were 9.33ton/ha. High yield of 16.60 ton/ha was recorded from full irrigation (100%ETc) and when half of irrigation water applied the yield were 9.4 ton/ha which showed significant difference between the two irrigation level. Water productivity of 4.3kg/m^3 and 3.8kg/m^3 were produced under 50%ETc and 100%ETc respectively. It was found that 50%ETc irrigation level saved 50% of water as compared to full irrigation and can irrigate additional land with the amount of water saved. An experiment was conducted by **Abebe et al. (2020)** to investigate the effects of mulching materials and furrow irrigation techniques on maize yield and water productivity under semiarid conditions. Results indicate that both grain yield and water productivity were affected by the main effect of furrow irrigation techniques and mulching materials ($P \leq 0.05$). The conventional furrow irrigation (8193 kg/ha) and white plastic mulch (7930 kg/ha) resulted in the maximum grain yield. The alternate furrow irrigation (1.90 kg/m^3) and the white plastic mulch (1.69 kg/m^3) resulted in the maximum water productivity.

The aim of this study was to investigate the effectiveness of plastic mulch of furrow irrigation on squash crop yield and its water productivity, as well as on improving the performance of furrow irrigation method and its water distribution uniformity.

2. MATERIALS AND METHODS

Experimental site

Field experimental study was conducted in private farm at Minya Alqamh, Sharkia governorate, Egypt - during two summer seasons of 2019 and 2020 from mid-April to end July. This study aimed to investigate the effect of plastic sheet mulching on furrow irrigation performance and crop water productivity under clay soil conditions. The location represents clay soil conditions of the Nile Delta region. The dominant soil of the experimental site was clay textured throughout the profile (5.4% coarse sand, 10.2% fine sand, 14.2% silt and 70.2% clay). The field capacity, wilting point and electrical conductivity values were 39%, 18.7% and 2.1 dSm^{-1} respectively.

Experimental layout and design

The experiment was laid out in furrow irrigation system with two main treatments namely plastic mulched furrows (MF) and non-mulched furrows (NMF) (as control), and the sub main treatments were three furrow lengths (15, 30 and 40 m) as in Fig (1). Each of the two main plots consisted of 9 irrigation furrows each three of them represent one of the sub main treatments (furrow lengths). The spacing between furrows was 0.7m in the all treatments.

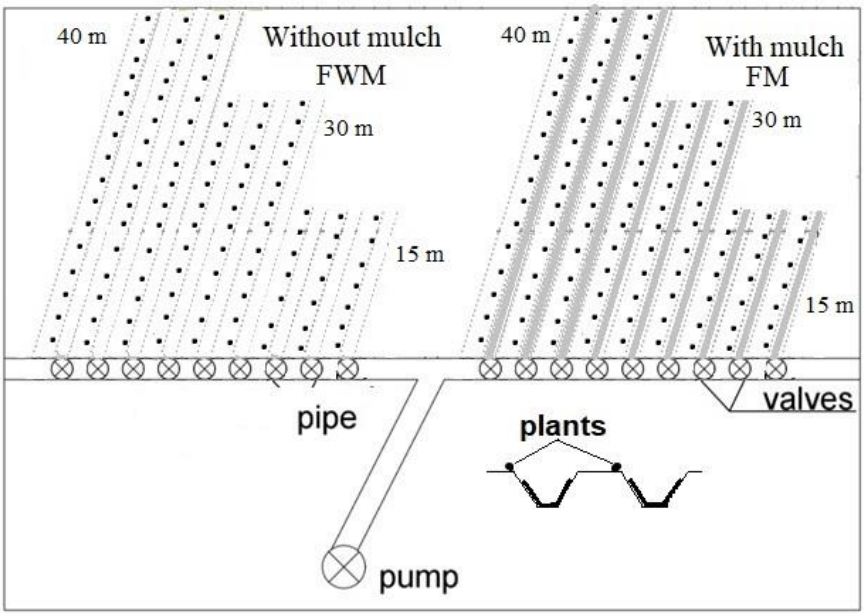


Fig.1: A schematic diagram of the experimental treatments and the irrigation network components.

The experimental irrigation network consisted of (i) 6.5 HP gasoline engine water pump, (ii) Main lines of 75 mm diameter P.V.C pipes (iii) the pipe was provided with several 1 inch valves to control the amount of water add to each furrow. In the mulched furrow treatments, black polyethylene sheet of 0.08 mm thickness was manually laid out on the furrow bottom and fixed at sides of furrow to two third of the ridges for sowing the crop. The process of supplying the plant with water was based on filling the furrow with water to the level of the plastic cover, then the water will infiltrate into the furrow sides.

Type of crop under study

The selected crop for experimentation was squash (zucchini) (Aziad Hybrid F1) variety. It was sown by seeding rate of (3 kg/fed) in April of the two seasons. Two seeds were sown in each hole with 70 cm between holes on the furrow and 70 cm spacing between furrows. After full germination, the best plant has been selected to be left in each hole for production. Fertilizer requirements for zucchini have been applied according to the recommendations of Agricultural Research Center, ARC.

Irrigation management

Soil moisture was monitored gravimetrically through soil depths (0-20, 20-40 and 40-60cm) layers. Soil samples were taken from each 20cm layer up to 60cm soil depth at four points along each furrow.

For high yield, soil water depletion should not exceed 65% of the total available water (p=65%) (**Abd El-Mageed et al., 2016**). Soil moisture depletion (SMD) at any soil moisture level was observed with the following expression as:

$$\mathbf{SMD= (FC- MC) \times Dzr}$$

Where: FC = Volumetric soil moisture content at field capacity (mm), MC = Volumetric moisture content at time of irrigation (mm), and Dzr = Depth of effective root zone (mm).

Regular soil samples were collected from experimental plots before and after irrigation for gravimetric soil moisture determination. The gravimetric soil moisture is then determined using the expression:

$$\mathbf{MC\ (\%) = [(Ww - Wd)/ Wd]. 100}$$

Where MC is the soil moisture content at time of sampling (%), Ww is weight of wet soil (gm) and Wd is weight of dry soil (gm).

Irrigation time

Water advance front was determined for the furrow irrigation treatments during irrigation of squash (zucchini) crop. When irrigation water starts to move from head to tail of the field, the time was recorded with the help of stopwatch at every 10 m stations along the length of the field. Wooden stakes were placed every 10 m spacing along the furrow length. When water front crossed 10 m distance marks or stations, the time was recorded. In this pattern water advance, front time was recorded at each wooden stake (station). Irrigation water was closed when water advance front was at 3m before reaching the furrow tail end dike. Faster advance is one of the main parameter for efficient surface irrigation system.

Water distribution uniformity of furrow irrigation

To fully express the efficiency of an irrigation system, the distribution uniformity of water applied needs to be evaluated. Distribution Uniformity (DU) is the ratio of minimum infiltrated amount to the average infiltrated depth over the field (**Wang and Wenying, 2011**). DU was directly measured from soil moisture content difference before and after irrigation of the soil along the furrow length, and the root depth of the crop was taken as zone of distribution and finally it was computed by equation given below:

$$D_u = \frac{Z_{\min}}{Z_{Av}} * 100$$

where: DU is distribution uniformity (%), Z_{min} is the minimum infiltrated depth, and Z_{Av} is the mean of depths infiltrated over the length.

Measurements and Calculations

Soil moisture distribution

For each treatment, four locations were taken along the row of plants. The soil water content was determined using the gravimetric method. Moisture content for each treatment was measured at 0.2 m increments to a depth of 0.60 m before irrigation and 48 hours after irrigation.

Growth parameters of squash (zucchini) crop

Three vegetative samples were taken during the growth period at the middle and end of the growing seasons. The following characteristics were measured:

1. **Germination ratio (**the germinated plants were counted along with non-grown plants. On the basis of numbers of grown and non-grown plants, germination percentages were determined).
2. **Vegetative growth (**length, weight, number and area of leaves, and root length and weight)
3. **Productivity (**The fruits were harvested by collecting in the appropriate phase for fresh consumption and the consumer’s taste. They are easy fruits that are quick to perish, and trained workers collected them).

Irrigation water productivity (WP)

Irrigation water productivity is an indicator of effective use of irrigation unit for increasing crop yield. WP was calculated from following equation **(FAO, 2002);**

$$\boldsymbol{WP\ (kg/m^3)} = \frac{\boldsymbol{yield\ (kg/fed.)}}{\boldsymbol{Total\ applied\ irrigation\ water\ (m^3/fed.)}}$$

Total seasonal water application for mulched and non-mulched treatments was 525 and 470 mm respectively.

Data Analysis

The least significant difference (LSD) test was applied at 5% level of significance to compare means showing significant differences.

3. RESULTS AND DISCUSSION

1. Effect of plastic mulched furrow on soil moisture content and water distribution uniformity

The mulched furrow treatments (MF) recorded significantly ($P \leq 0.05$) high moisture content over without non-mulched furrows (NMF) treatments as shown in Figs (2&3). However, there is no significant difference among the mulched furrow lengths. Before irrigation, the highest moisture content was 26.7 % under MF as an average for the three lengths. The moisture content directly before the irrigation in MF registered 17.4 % increase over non- mulched furrows NMF.

From the observation on moisture content, mulched practice could improve the availability of soil water to crops compared to non-mulched practice and therefore increase the leaf area index and reduce leaf senescence as discussed by **Zhang et al. (2017),** which implies that plant transpiration would be greatly promoted and that soil water utilization would thereby be enhanced due to the stomata having a larger opening than that in non-mulched practice (**Liu et al., 2014**).

Distribution uniformity (DU) calculated for NMF were 79%, 75.2% and 70.3% at 15, 30, and 40 m, respectively, as shown in Table (1). For MF, calculated DU increased to 87.2%, 85.1% and 84.3% at 15, 30, and 40 m, respectively. This result seems closely related to that of **Mekonnen et al. (2021)** who observed that distribution uniformity of surface irrigation greater than 80% are homogenous, greater than 70% slightly homogenous and less than 70% non-homogenous.

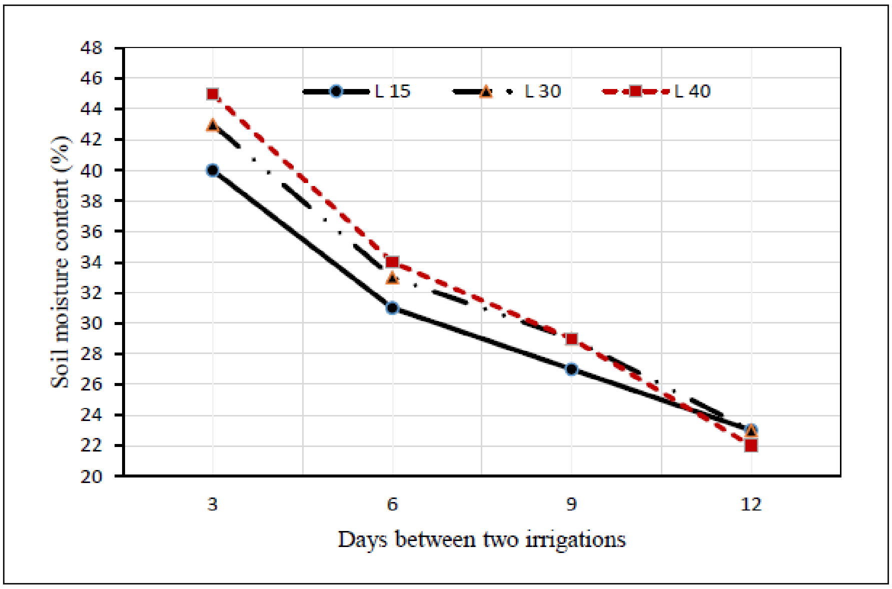


Fig.2: Soil moisture content at time after irrigations for furrow without mulch under different lengths

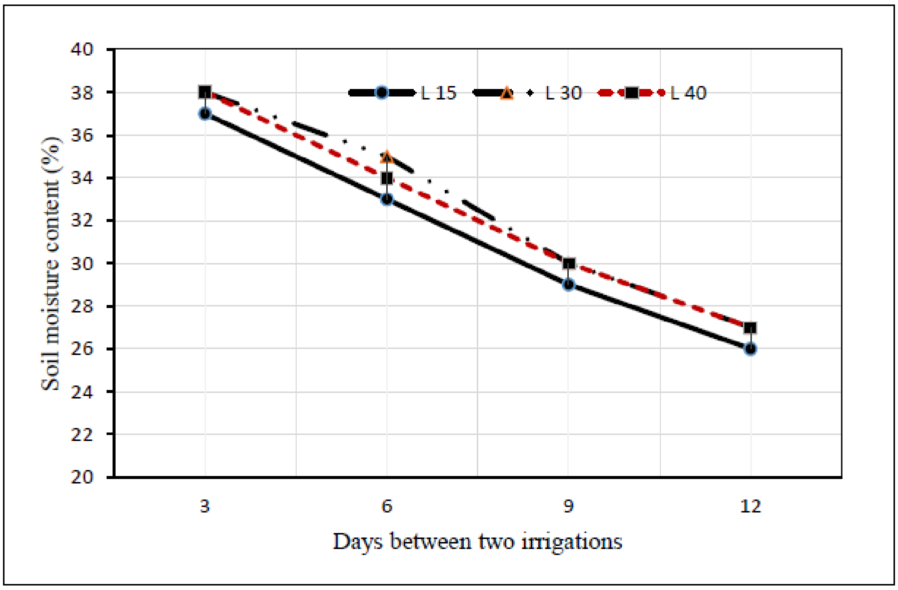


Fig. 3: Soil moisture content at time after irrigations for furrow with mulch under different lengths

FAO (2002) also suggested that the average distribution efficiency DU of 75% as sufficient and DU of 60% as poor. In this study, it was found that soil moisture in the 0–40 cm layer decreased in conventional (NMF) treatments while in mulched (MF) treatments soil moisture storage slightly increased in case of MF. This was mainly because plastic mulch reduced the soil water evaporation. **Gaimei et al. (2017)** also reported that the integrative effect of plastic film mulch on soil water retention was better than the non-mulched treatments. Furthermore, it was found that soil water storage also varied between different lengths, since there was no significant difference among 30 m and 40 m furrow lengths but 15 m length treatment was less in soil moisture storage in all treatments.

Table (1): Distribution Uniformity (DU) for mulched and non-mulched furrows treatments

	Length, (m)	NMF	MF
DU %	15	79	87.2
	30	75.2	85.1
	40	70.3	84.3

2. Advanced Rate and Time Saving

The advance time was recorded at four stations along the furrows for 40m length only and the total irrigation time for all treatments as shown in Table (2). These results have the same trend to those obtained in many research studies (**Amer and Attafy, 2017; El-Sanat, 2018; Elkholy, et al., 2021**). Mulched furrow (MF) treatments showed 2, 3.2 and 4.2 minutes less time was taken compared to conventional furrows method for 15m, 30m, and 40m respectively. It is worth to note that actual advance time in completing the advance phase for MF was 1.9, 5.1 and 7.2 minutes for 15m, 30m, and 40m furrow lengths respectively. This could be attributed to that, the plastic mulched furrow bottom increased forward movement of irrigation water first until furrows to be filled, and then the lateral water movement begins to infiltrate in furrow edges.

Table 2: Average advance time and time saving during different irrigations

Treatment	Length (m)	NMF	MF	Time saving %
Average advance time (min)	15	16.2	14.2 (1.9)*	12.3
	30	28.7	25.5 (5.1)*	11.1
	40	41.3	37.1 (7.2)*	10.2

*The actual arrival time to the furrow's end duo to the presence of mulch

The average time of irrigation for both MF and conventional irrigated plots (NMF) of different lengths during 2nd, 4th and 6th irrigations for cultivation of squash crop were shown in Table (2). It can be observed that a reduction of 10.2 to 12.3% occurred in the advance time in completing the advance phase during MF in various lengths compared to NMF. The reduction of time was expected as the water moved relatively faster over the plastic sheet during mulch-hole irrigation as compared with conventional irrigation water (**Fan, et al. 2011**).

3. Effects of mulching on squash growth parameters

The germination of squash seed in mulched and conventional plots under different lengths are shown in Fig (4). Squash seeds were sown after the upper plastic edge on the side of the furrow (between the middle and upper third of furrows) and on the same position for conventional furrows. It was observed from the experiment that seed germination rate was very high that was 92 to 98% and mortality rate was 2-8% of the mulched-furrows. On the other hand, the seed germination rate was observed as 80 to 89% and mortality rate was noted only as 11-20% in case of conventional furrows sowing method. It was observed that germination ratio was higher in the short furrows (15 m) in NMF, due to the low moisture uniformity in long furrows, while in MF, there was no significant difference between different lengths. **Santosh et al. (2020)** and **Mekonnen et al. (2021)** studied that temperature greatly influence germination of the seeds.

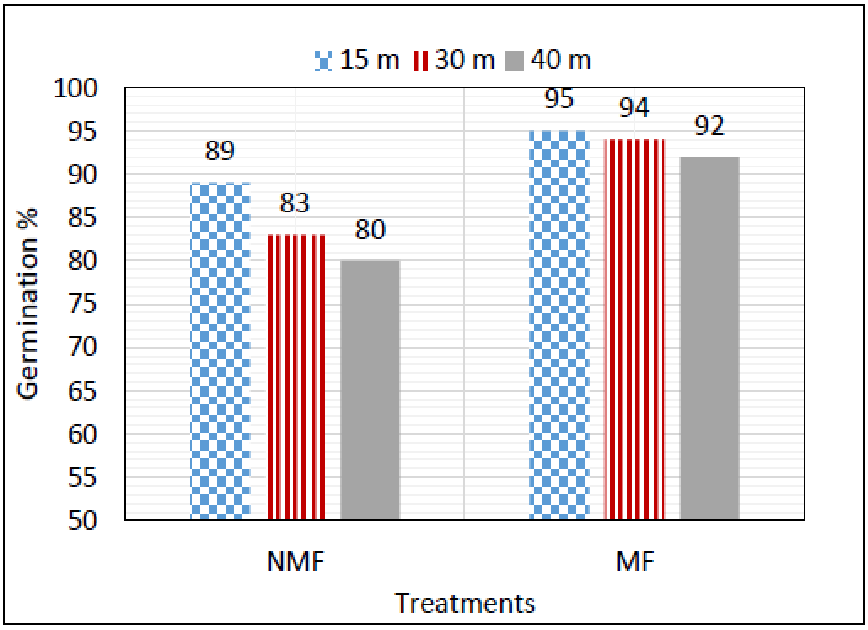


Fig. (4): Effect of different treatments on germination ratio

Squash growth parameters were presented in Table (3). The analysis of variance showed that the plant heights for selected 10 different plants were less (non-significant) changed by using plastic sheet at furrow bottom. It was determined that the average values of plant height were recorded for MF an increase with 3.7, 8.2 and 3.2% more than NMF for 15, 30 and 40 m furrow lengths respectively. The same trend was obtained by **Amer and Attafy (2017)** working on squash.

It was determined that the average values of plant weight were increased by 1, 4.6 and 3.8 % under treatment MF as compared to those under NMF for 15, 30 and 40 m furrow lengths respectively. For mulching treatments, results are in line with those of **Shelemew et al. (2022)** who reported that, plant weight were significantly affected by the mulching treatments.

Number of leaves per plant were not significantly affected ($P < 0.05$) by mulching on MF. Between the mulched treatments, number of leaves per plant under (MF) increased by 3% as an average than those under NMF. The leaf area increased gradually with increasing plant height and the value was higher under mulched treatments than under non-mulched plots. The same trend was obtained by **Amer and Attafy (2017)** working on squash. They reported that LA and plant leaf number were significantly affected by mulching. Chlorophyll ratio is increased with mulched treatments, with the average of 48.5 more increase in the case of MF, than non-mulched NMF treatments.

Table (3): Effect of irrigation techniques on squash growth parameters

Treatments	Length (m)	Plant high (cm)	Plant weigh (g)	Leaves area (cm^2)	N. Leaves	Chlorophyll	Root length (cm)	Roots weight (g)
NMF	**15**	56.2	910	403.3	34.1	48.0	46.2	49.1
	30	53.4	900	384.4	34.4	44.5	46.3	49.2
	40	52.1	896	371.3	33.2	42.3	44.7	48.3
	Mean	**53.9**	**902**	**386.3**	**33.9**	**44.9**	**45.7**	**48.9**
MF	**15**	58.3	919	470.4	35.2	49.0	25.2	26.2
	30	56.4	942	465.9	35.2	48.5	23.3	27.0
	40	55.1	930	465.0	35.3	48.0	25.0	26.0
	Mean	**56.6**	**930.3**	**467.1**	**35.2**	**48.5**	**24.5**	**26.4**

The MF treatment showed good performance for root length and weight with non-significant effect in comparable with NMF (Table 3). These results are supported by (**Abd El-Mageed et al., 2016**) who reported same root growth, and root weight in furrow method although there was non-significant effect between different sowing methods either on NMF or MF on root growth. This may be due to availability of more soil moisture and soluble nutrients in the root zone where plastic sheets were used, facilitating it to uptake and stopping leaching. Hence, it created better conditions for the growth and a well development of plant root system (**Hirich et al., 2014**).

4. Effect of mulching on yield, water productivity (WP) and water saving

The yield of squash was significantly ($p < 0.05$) affected by mulch. Table (4) revealed that, the application of furrow plastic mulch showed a significant increase in total yield of the squash crop as compared to non-mulched treatment for all different lengths. There was significant difference observed under MF with increase of 31.2 % and 40.2 % more than NMF in 30 and 40 m furrow lengths respectively, but there was no observed effect in squash yield on 15 m furrow length. These results are in agreement with those reported by **Wang and Wenying (2011)** and **Parmar et al. (2013).**

Regarding to the effect of mulched furrows on water productivity of squash under different furrow lengths, maximum water productivity WP (5.11 to 5.41 kg/m^3) was obtained in MF. So mulching with different furrow lengths significantly increased WP to 35.8 % in MF treatments compared with NMF treatment. There were no significant differences between the studied furrow lengths in the same techniques. In general, mulching increased WP and grain yield due to reduction in evaporation, enhanced transpiration and deep percolation, leading to increased yields and WP (**Zhang et al., 2017**).

Table (4): Effect of irrigation techniques on yield and WP

Parameters	Length m	Irrigation Techniques		LSD
		NMF	**MF**	
Yield (ton/fed)	**15**	9.5 [a]	10.5[a]	1.3
	30	8.0 [b]	10.7 [a]	
	40	7.2 [b]	10.1 [a]	
	Mean	**8.23**	**10.43**	
WP (kg/m^3)	**15**	4.76 [a]	5.31 [a]	0.87
	30	3.62 [b]	5.41 [a]	
	40	3.26 [b]	5.11 [a]	
	Mean	**3.88**	**5.28**	

The total water required by squash crop during entire crop growth period under the control treatment NMF for normal furrow irrigation method was 525.7 mm, as shown in Fig (5) The water saving was thus 10.44% under treatment MF when compared to NMF. These results are matching with **Siyal et al. (2012)** who reported that placing a plastic sheet on the bottom of the furrow prevents direct vertical infiltration from the bottom of the furrow which increase the water saving efficiency of furrow irrigation method. Results are in agreements with the findings by **Haile et al. (2021)**, who reported that vertical infiltration from the furrow or border decreased with the using of plastic sheet on furrow and border bottom and increased the water saving efficiency of irrigation practice.

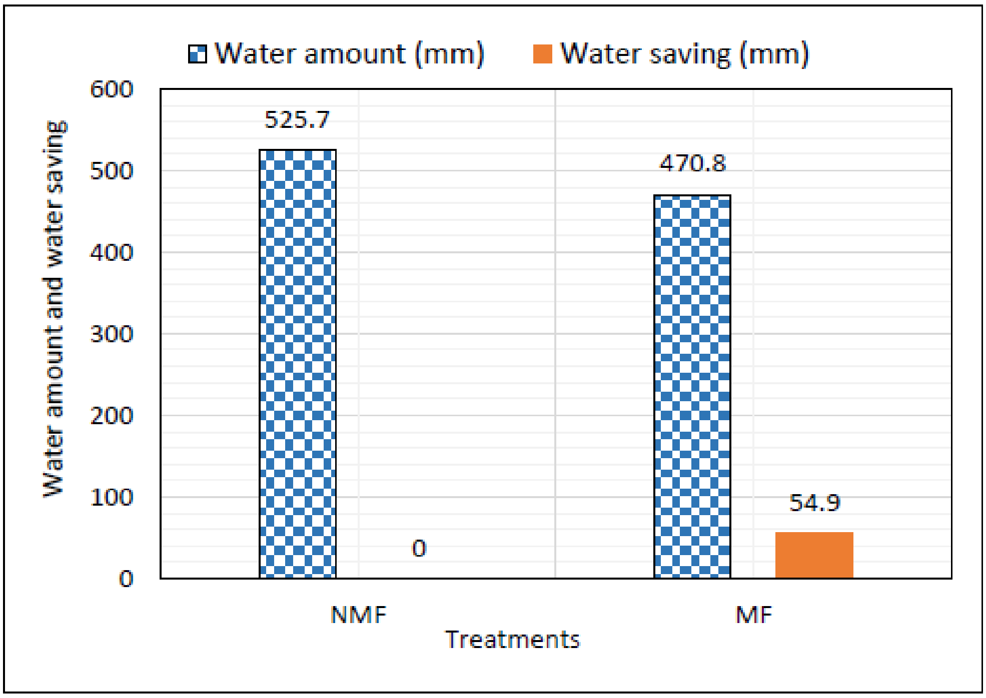


Fig (5): Effect of plastic mulched furrows on irrigation water saving

4. CONCLUSION

Generally, mulching showed significant effect on soil moisture conservation and agronomic parameters. According to the findings of this experiment, the highest soil water content was obtained using plastic mulch in furrow bottom. In this experiment, application of mulch played a greater role in distribute water uniformly, due to this available water to plants root not varied appreciably. Therefore, the total yield of squash was increased by 38% and water saved by 10%. The availability of high soil moisture resulting in increases in photosynthetic rate and thereby increasing vegetative growth such as plant height, leaf area, and root length. The increment in number of leaves must have led to an increment in leaf area; hence, increased light interception and photosynthesis. These effects are translated in terms of total fresh weights of fruits, which showed a positive response to increasing moisture conservation practice and total yield.

Finally, the use of plastic mulch on the furrow bottom produced the best performance in reducing water losses. Moreover, considering the soil moisture storage, the use of plastic mulch treatment in furrow irrigation was suggested as a favorable approach in water and soil management as well as increasing crop yield and water productivity.

5. REFRENCES

Abd El-Mageed, T. A., Semida, W. M. and Abd El-Wahed, M. H. (2016). Effect of mulching on plant water status, soil salinity and yield of squash under summer-fall deficit irrigation in salt affected soil. Agricultural Water Management 173; 1–12

Abebe N., Alemayehu, Y. and Abegaz, F. (2020). Effect of mulching materials and furrow irrigation techniques on yield, water productivity and economic return of maize (Zea mays L.) at werer, middle awash valley, Ethiopia. Int. J. Agri. Biosci., 9(4): 156-162.

Amer, M. H. and Attafy T. M. (2017). Effect of surge flow on some irrigation indices of furrow irrigation system. J. Soil Sci. and Agric. Eng., Mansoura Univ., 8 (12): 703 – 708.

Bristow, L., Šimůnek, J., Helalia, S. A., and Siyal, A. A. (2020). Numerical simulations of the effects furrow surface conditions and fertilizer locations have on plant nitrogen and water use in furrow irrigated systems. Agri. W. Manag., 232, 106044. https://doi.org/10.1016/j.agwat.2020.106044

Cui, Z., Chen, X. and Zhang, F. (2010). Current nitrogen management status and measures to improve the intensive wheat–maize system in China. Ambio 39,376–384.

Daryanto, S., Wang, L. and Jacinthe, P. (2017). Can ridge-furrow plastic mulching replace irrigation in dryland wheat and maize cropping systems?. Agricultural Water Management 190:1–5. http://dx.doi.org/10.1016/j.agwat.2017.05.005

Elkholy, E. M., Attafy, T. M., Elmetwalli, A. H. and Derbala A. (2021). Optimizing Bed Width and Orifice Flow Rate for Irrigating Wheat Crop in the Nile Delta. J. Soil Sci. and Agric. Eng., Mansoura Univ., 12(4): 289-294

El-Sanat, G. A. (2018). Improving irrigation efficiencies through different methods of land leveling and irrigation discharge under using gated pipes at North Delta. J. Soil Sci. and Agric. Eng., Mansoura Univ., 9 (4): 191 – 196.

Fan, Y.M., Xiaoyi, W.B., Gao, W. and Nie, W. (2011). Numerical simulation on soil wetting pattern moisture distribution and infiltration characteristics for film-hole irrigation, Trans. of the Chinese Society for Agric. Mach., http://en.cnki.com.cn/Article_en/CJFDTOTAL-NYJX200811011.htm

FAO, (2002). *Deficit irrigation practices*. Water Reports No. 22. FAO, Rome, Italy.

Gaimei, L., Yuguo, W., Baoliang, C., Nana, L., Wenliang, C. and Wei, Q. (2017). Exploring optimal soil mulching to enhance maize yield and water use efficiency in dryland areas in China. Acta Agriculturae Scandinavica, Section B — Soil & Plant Science, DOI:10.1080/09064710.2017.1394486

Haile, A., Gezie, S. and Tegenu, G. (2021). Effect of furrow method and mulch on bulb yield and water productivity of irrigated onion under central highland vertisol of Ethiopia. Ethiop J Agr Sci 31: 145-157.

Hatami, S., Nourjou, A., Henareh, M. and Pourakbar, L. (2012). Comparison effects of different methods of black plastic mulching and planting patterns on weed control, water-use efficiency and yield in tomato. Int. J. Agri. Sci., 2(10): 928-934.

Hirich, A., Choukr-Allah, R. and Jacobsen, S.E. (2014). Deficit irrigation and organic compost improve growth and yield of Quinoa and Pea. J. Agron. Crop Sci. 200,390–398.

Jiang, S., Gao, X., Liang, J., Wang, P., Gao, J., Qu, Y. and Feng, B. (2012). Effect of different furrow and mulched ridge on water moisture conversation and water saving of spring mung bean planted farmland. J. Agri. Sci., 4 (7):132-141.

Liu, X.E., Li, X.G., Hai, L., Wang, Y.P., Li, F.M. (2014). How efficient is film fully–mulched ridge–furrow cropping to conserve rainfall in soil at a rainfed site?. Field Crops Res. 169, 107–115.

Maurya, R.C., Singh A.K., Singh, S., Singh A., Sahay, R., Tiwari, D.K., and Chandra, V. (2018). Impact of plastic mulching with furrow irrigation on tomato crop at farmer's field in Unnao District. Int. J. of Agric. Sci, 10 (6), pp.-5509-5512.

Mekonnen, E., Bedane, H. and Genemo, G. (2021). Effects of furrow irrigation methods and mulching on growth, yield and water use efficiency of tomato at Bakotibe. Western Shoa. Irrigat Drainage Sys Eng, 10(5): 266.

Parmar, H.N., Polara, N.D. and Viradiya, R.R. (2013). Effect of mulching material ongrowth, yield and quality of watermelon (*Citrullus lanatus thunb*) Cv. J. Agric. Res. 1, 30–37.

Santosh B., Binod J., Roshan, D., Sushma, P., Shiva C. D., and Khem, R. J. (2020). Effect of different mulching on yield and yield attributes of potato in Dadeldhura District, Nepal. Malaysian Journal of Sustainable Agriculture, 4(2): 54-58. DOI: http://doi.org/10.26480/mjsa.02.2020.54.58

Shelemew Z., Ambomsa, A. Hussen, D. and Jelde, A. (2022). Evaluation of the effect mulching practice under furrow irrigation on growth, yield and water productivity of head cabbage at Adami Tulu Agricultural Research Center. Science Research, 10(2): 37-44. doi: 10.11648/j.sr.20221002.13

Siyal, A.A., Bristow, K.L. and Jirka, S. (2012). Minimizing nitrogen leaching from furrow irrigation through novel fertilizer placement and soil surface management strategies. Agricultural Water Management, 115:242- 251.

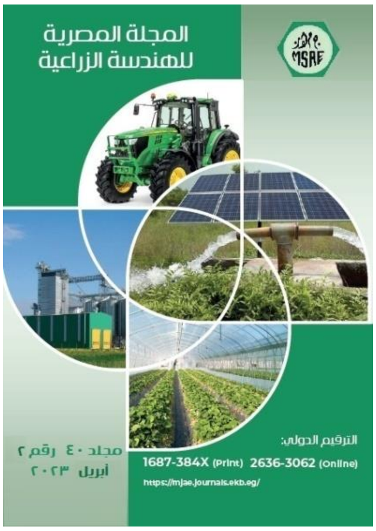
Wang, W. and Wenying, P. (2011). Simple estimation method on Kostiakov infiltration parameters in border irrigation, Water Resource and Environmental Protection (ISWREP), International Symposium on 20-22 May, (Vol:3).

Zhang, Y., Wang, F., Shock, C. C., Yang, K., Kang, S., Qin, J. and Li, S. (2017). Influence of different plastic film mulches and wetted soil percentages on potato grown under drip irrigation. Agr. W. Manag.180:160–171. http://dx.doi.org/10.1016/j.agwat.2016.11.018

استخدام أغطية التربة لزيادة كفاءة الري فى خطوط وإنتاجية المياه

محمد على[١]، حربى مصطفى[٢]، محمد الأنصارى[٣]

[١] طالب دراسات عليا - قسم الهندسة الزراعية - كلية الزراعة بمشتهر - جامعة بنها - مصر.
[٢] استاذ الهندسة الزراعية - كلية الزراعة بمشتهر - جامعة بنها - مصر.
[٣] استاذ الهندسة الزراعية المتفرغ - كلية الزراعة بمشتهر - جامعة بنها - مصر.



الكلمات المفتاحية:
الأغطيه البلاستيكيه؛ الرى في خطوط؛ الانتاجيه المائيه.

الملخص العربى

تعد طريقة الري المستدام ضرورية الآن للتكيف والاعتماد في المناطق التي تكون فيها موارد المياه محدودة. يسلط الطلب المتزايد على المياه في البلاد الضوء على الحاجة إلى إدخال تقنيات منخفضة التكاليف وتوفير المياه من أجل الاستدامة الزراعية وإنتاج المحاصيل ، لا سيما في المناطق شبه القاحلة. لذلك أجريت تجربة حقلية لدراسة التأثير المشترك لطريقة الري بالخطوط وأغطية التربه على النمو والإنتاجية المائية للكوسة. الهدف من هذه الدراسة هو التحقق من فاعلية الاغطية البلاستيكية لخطوط الرى على تحسين أداء الري السطحي والأنتاجية المائية للمحصول مقارنة بالممارسات التقليدية في الزراعة. لذلك نفذت التجربة بطريقة الري السطحى في خطوط مع استخدام الأغطية البلاستيكية لباطن الخطوط مع استخدام أطوال مختلفة للخطوط (١٥ ، ٣٠ و٤٠ م). تم تصميم الخطوط فى قطعتين (مغطاة (MF) وغير مغطاة (NMF)) بكل قطعة ٩ خطوط بعرض ٠,٧ متر (٣ خطوط لكل طول). أشارت النتائج إلى أن قيمة ماء الرى المضاف كانت منخفضة في معاملة MF بنسبة ١٠٪ عن المعامله التقليديه NMF ، قد يكون بسبب المحتوى الرطوبي الأعلى (٢٦,٦٪) للمعاملة ذات الخطوط المغطاه MF قبل الري مقارنة بالمعاملة الغير مغطاه NMF (٢٢,٧٪) كتأثير مباشر لأغطية التربه في باطن الخطوط. تم الحصول على أقصى إنتاج إجمالي لمحصول الكوسة من معاملة الخطوط المغطاه MF بطول ٣٠ مترًا (١٠,٧ طن/فدان) يليه الخطوط بطول ١٥ مترًا (١٠,٥ طن/فدان). فيما يتعلق بمعاملات الري المختلفة باستخدام الأغطية البلاستيكية ، تم قياس أقصى إنتاجية لمياه الري (٥,١١ إلى ٥,٤١ كجم/م^{٣}) في معاملة الخطوط المغطاه MF. بذلك يكون التوفير في المياه ١٠,٤٤٪ تحت معاملات MF بالمقارنة مع طريقة الري بالخطوط الغير مغطاه NMF .