

Integrated Water and Weed Management of Sugar Beet Crop by Using Different Mulching in New Reclaimed Areas

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ABSTRACT

Soil and water agro-management techniques play a critical role in grown crops to increase productivity. Mulching is one of the good agriculture practices methods to conserve soil moisture, control weeds and improve soil physical properties. Two field experiments were implemented at Wadi El-Natron Research Station, Water Management Research Institute, National Water Research Center, Egypt, during 2017/2018 and 2018/2019 winter seasons to evaluate the effect of four mulching types, No Mulch (NM, Control), Rice Straw Mulch (RSM), White Polyethylene Film Mulch (WPFM) and Black Polyethylene Film Mulch (BPFM) of sugar beet (*Beta vulgaris L. cv. Zwanpoly*) yield and quality as well as water use efficiency for root (WUE_{root}) and sugar (WUE_{sugar}) in sandy soil. Significant differences among mulching types were observed. The results indicated that, both BPFM and WPFM recorded the highest sucrose values (21.14 and 19.77%), purity (85.88 and 82.01%), extractable sugar (19.49 and 17.68%), root yield (58.70 and 53.92 ton ha⁻¹) and sugar yield (11.44 and 9.53 ton ha⁻¹) in the 1st and 2nd season, respectively. On the contrary, NM recorded the highest impurities percentage and low weed control efficiency. Average of WUE_{root} (6.08, 7.36, 9.78 and 9.97 kg m⁻³) and WUE_{sugar} (0.89, 1.16, 1.73 and 1.94 kg m⁻³) resulted from NM, RSM, WPFM, and BPFM, respectively, as an average in two seasons. Weed control efficiency values were (40.9, 30.45, 5.2 and zero%) for BPFM, WPFM, RSM, and NM, respectively and that helped in maintaining higher moisture content in the crop root zone.

Keywords: Mulching, Sugar beet, WUE, Polyethylene.

INTRODUCTION

Mulching is one of the best agronomic practices in conserving soil moisture, prevents weed growth and sequentially reduces the application of chemical herbicide and improves soil structure (Patil *et al.*, 2013, Sharma *et al.*, 2017), as well as reduces evaporation and save irrigation water (Yamanaka *et al.*, 2004). In general, areas with a high rich of water or wind erosion, mulch systems

are already well established, it can help to improve soil fertility and reduce nitrogen leaching as well which obtain a high field emergence and a good plant development (Teasdale, 1996, Petersen and Rover, 2004), also controlling weeds completion (DeBaets *et al.*, 2011, Sturm *et al.*, 2016).

There are various types of mulch such as surface mulching, polyethylene mulching, pebble mulching, dust mulching live vegetative barriers, straw mulching ...etc. Zhang *et al.* (2009) and Kanani *et al.* (2016) reported that mulching increased the biological yield and water use efficiency compared to no mulch treatment, fresh yield increased by 76 and 49% as well as water use efficiency that increased by 143 and 100% under rice straw mulch treatment compared to control and gravel mulch treatments, respectively. Also, Dregseth *et al.* (2003) reported that oat mulch increased sugar beet root yield by 6.8% compared with No-mulch. At the same trend, Afshar *et al.* (2018) mentioned that growing sugar beet with mulch can be successfully implemented without or minimal negative impact on sugar beet productivity with less accumulation of impurities in beetroots. Sodium, potassium and amino N content were significantly influenced by mulch treatment, likewise, impurities reduce sucrose loss to molasses (SLM) which indicated that more sucrose can be produced during the extraction process and increase the sugar production in final. Malik *et al.* (2018b) found that black polyethylene film mulch was better compared to straw mulch. BPFM and the straw mulch produced 11.96 to 19.45% higher root yield, 14.33 to 22.68% higher sugar yield, 17.07 to 30.68% higher root crop WUE and WUE for sugar increased by 19.57 to 33.53% compared to no mulch treatment. On the other hand, Yonts *et al.* (2002) mentioned that mulch did not affect sugar beet root and sucrose yield, however Yi *et al.* (2007) and Li *et al.* (2012) noticed the positive response of mulch application as straw and plastic sheet mulch significantly decreased water loss by evaporation. Straw

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mulching increased plant height, dry matter weight, seed index and yield of maize, however, plastic sheet mulch was more effective in conserving soil water than straw mulch. Tunio *et al.* (2007) and Salman *et al.* (2015) tested different mulches, control (no mulch), wheat straw, sugarcane trash and plastic sheet mulch on sunflower crop. They showed that germination and yield differed significantly among mulching treatments compared to control. The plastic sheet recorded the highest yield and efficiently control weeds. Covering soybean row by 3 tons of wheat straw per hectare can improve emergence and yield by lowering the maximum soil temperature and conserving soil moisture (Singh and Jolly, 2008).

The effect of mulch practice on sugar beet yield and water use efficiency in newly reclaimed areas has not been widely investigated, therefore, the target of this investigation was to study the effect of different mulching types on yield, quality and water use efficiency of sugar beet under drip irrigation in new reclaimed soil.

MATERIALS AND METHODS

Experimental design

Two field experiments were conducted at Wadi El-Natroun Station of Water Management Research Institute, El-Behera Governorate, Egypt. The experiments implemented during 15th and 16th of September 2017/2018 and 2018/2019 seasons, respectively, study the effect of four mulching types on

quality and yield of sugar beet (*Beta vulgaris L. cv. Zwanpoly*) as well as water use efficiency in sandy soil under a drip irrigation system. The application efficiency was calculated by using the equation according to Wu and Gitlin (1973):

$$E_a = (q_{min} / q_{avg}) \times 100$$

where: q_{min} is the Minimum emitter flow rate and q_{avg} Mean emitter flow rate ($l\ h^{-1}$)” and found that the application efficiency of the irrigation network was 88%. This value was calculated before starting the experiment. Soil Physical and chemical analyses of the experimental site are presented in Table (1 and 2). The experimental design arrangement was randomized complete blocks with four replicates. Irrigation system components consisted of water source from well, control head, pump, filtration unit, pressure regulator, pressure gauges, flow meter, and control valves. Mainline of 160mm diameter PVC pipe was connected with sub mainline 110mm diameter and manifold lines of 75 and 63mm diameters. Lateral emitters were made from polyethylene (PE) with 16mm diameter, 25m length and 30cm between emitters. Emitters discharge was $3.8\ l\ h^{-1}$ at 1.2 bar operating pressure. Plot area dimensions were 15 length x 3.5m width and was consisting of 5 rows with 1m distance between each plot.

Table 1. Soil physical properties of experimental Site

| Soil layer (cm) | Particle size distribution % | | | Texture class | Bd ($gm\ cm^{-3}$) | Moisture content by weight (%) | | |
|-----------------|------------------------------|------|------|---------------|----------------------|--------------------------------|------|------|
| | Sand | Silt | Clay | | | F. C | W.P | A.W |
| 0–20 | 94.5 | 3.5 | 2.0 | Sandy | 1.65 | 8.03 | 3.33 | 4.7 |
| 20-40 | 95.0 | 3.3 | 1.7 | | 1.56 | 9.13 | 3.14 | 5.99 |
| 40-60 | 95.7 | 3.0 | 1.3 | | 1.44 | 10.07 | 2.99 | 7.08 |

Table 2. Soil chemical properties of experimental Site

| Soil layer Cm | SAR | PH | EC ($dS\ m^{-1}$) at 25°C | Soluble anions ($meq\ l^{-1}$) | | | | Soluble cations ($meq\ l^{-1}$) | | | |
|---------------|------|------|-----------------------------|----------------------------------|-------------------------------|-----------------|-------------------------------|-----------------------------------|------------------|-----------------|----------------|
| | | | | CO ₃ ²⁻ | HCO ₃ ⁻ | Cl ⁻ | SO ₄ ²⁻ | Ca ⁺⁺ | Mg ⁺⁺ | Na ⁺ | K ⁺ |
| 0–20 | 1.66 | 8.23 | 1.46 | 0.1 | 0.93 | 1.98 | 9.61 | 6.23 | 2.24 | 3.44 | 0.51 |
| 20-40 | 1.74 | 8.11 | 1.56 | 0.1 | 1.15 | 2.05 | 9.85 | 6.45 | 2.26 | 3.76 | 0.58 |
| 40-60 | 1.84 | 7.97 | 1.63 | 0.1 | 1.33 | 2.11 | 10.16 | 6.65 | 2.29 | 3.91 | 0.65 |

Table 3. Chemical Analysis of Irrigation Water

| PH | EC (dS m ⁻¹) at 25°C | Soluble anions (meq l ⁻¹) | | | | Soluble cations (meq l ⁻¹) | | | | SAR | RSC | ESP | Ca/Na% |
|------|----------------------------------|---------------------------------------|-------------------------------|-----------------|-------------------------------|----------------------------------------|------------------|-----------------|----------------|------|-----|------|--------|
| | | CO ₃ ²⁻ | HCO ₃ ⁻ | Cl ⁻ | SO ₄ ²⁻ | Ca ⁺⁺ | Mg ⁺⁺ | Na ⁺ | K ⁺ | | | | |
| 7.14 | 1.18 | 0.1 | 4.7 | 10.6 | 8.15 | 1.8 | 2.8 | 18.4 | 0.55 | 12.1 | 0.2 | 78.1 | 9.8 |

Studied treatments

In this study, we were focused on four mulch treatments: (1) Control, No Mulch (NM), (2) Rice Straw Mulch (RSM): 8.5 ton.ha⁻¹ (5 cm height), (3) White Polyethylene Film Mulch (WPFM) and (4) Black Polyethylene Film Mulch (BPFM). WPFM and BPFM consisted of transparent white and black coloured polyethylene strip sheets of 15m length with 0.75m width laid down on the soil surface up the lateral line. Holes of 0.05m in diameter were created over each emitter in the center of the sheet for planting. Seeds were placed in hills 30 cm apart within row. Seedlings were thinned at 4-6 leaf stage (after once month from sowing) to ensure one plant per hill. Other agricultural practices were made as described by the Egyptian Ministry of Agriculture. The total amount of irrigation water was 6369, 6145, 5509 and 5888(calculated or recommended) m³.ha⁻¹ for NM, RSM, WPFM, and BPFM, respectively. Chemical analysis of irrigation water presented in Table (3). Harvest was done after 180 days from sowing.

Studied traits

1. Quality traits

At harvest, samples of ten sugar beet plants were taken randomly from the central area of each plot to determine the following juice quality traits: Total Soluble Solids (T.S.S)% was determined by using a digital refractometer, model PRI (ATAGO). Sucrose was determined by using saccharometer on lead acetate extract of fresh macerated roots (Carruthers and Oldfield, 1960). Purity % according to Carruthers et al. (1962) as follow: Purity % = (Sucrose / T.S.S)* 100. Impurities component i.e. K, Na, and amino N (milleq/100gm beet) according to the method as described by A.O.A.C (1980). Impurities percentage was determined according to Carruthers and Oldfield (1960) as follows

$$\text{Impurities \%} = ((K + Na) * 0.0343) + (\text{Amino N} * 0.094) + 0.29$$

Extractable sugar percentage that calculated according to Renfield *et al.* (1993) as follows:

$$\text{Extractable Sugar} = \text{Sucrose \%} - 0.029 - (0.343 (Na + K) - 0.094 (\text{amino-N}))$$

2. Yield

At harvest, plants of three middle rows from each plot were uprooted and topped to determine the following parameters: root and Sugar yield (ton ha⁻¹).

$$\text{Sugar Yield (ton.ha}^{-1}\text{)} = \text{Root Yield (ton.ha}^{-1}\text{)} * \text{Extractable Sugar \%}$$

3. Weed Parameters

Weed population count

The total number of weeds present in 1.0 m² area in a permanently marked sampling area was counted at 30, 60, 90, 120 DAT in each treatment.

Dry weight of weeds (g. m⁻²) was recorded at periodical intervals i.e., 30, 60, 90, 120 DAT in each treatment. The weeds were uprooted from the 1 m² area selected randomly each time and were oven-dried to a constant weight at 65°C and the oven-dry weight of weeds was recorded. The dry weight of weeds was expressed as g per 1.0 m²

Weed control efficiency (%) (WCE) denotes the magnitude of weed reduction due to weed control treatment. It was worked out by using the formula suggested by Mani *et al.* (1973) and expressed in percentage.

$$WCE (\%) = \frac{\text{Dry weight of weed in unweeded control} - \text{Dry weight of treatment plot}}{\text{Dry weight of weed in unweeded control}} \times 100$$

4. Amount of applied water

The depth of irrigation was calculated according to the equation given by Israelsen and Hansen (1962).

$$D_{aiw} = \frac{F \cdot C. - \theta 1}{100} \times Bd \times d$$

Where:

D_{aiw} : Depth of irrigation water applied. (mm)

F.C. : Soil moisture content at field capacity by weight. (%)

$\theta 1$: Soil moisture content before irrigation by weight. (%)

Bd : Bulk density. (gm cm^{-3})

d : Soil depth. (mm)

5. Water use efficiency

Water use efficiency for root and sugar yield was measured according to Jensen (1983).

$$WUE_{root} (\text{kg. m}^{-3}) = \frac{\text{Root Yield} (\text{kg. ha}^{-1})}{\text{Actual Applied Water} (\text{m}^3. \text{ha}^{-1})}$$

$$WUE_{sugar} (\text{kg. m}^{-3}) = \frac{\text{Sugar Yield} (\text{kg. ha}^{-1})}{\text{Actual Applied Water} (\text{m}^3. \text{ha}^{-1})}$$

6. Economic evaluation

Costs, including the costs of the network, irrigation, labours, mulch material, soil preparation, fertilizers, weed control, and pesticides.

Gross Return, including the prices in Egyptian Pound (LE) which paid for harvesting of sugar beet yield (ton ha^{-1}).

Net Return = Gross Return – Costs.

The average prices were taken from the local market prices. The economic evaluation was done using the methods described by CIMMYT (1988).

Statistical analysis:

Quality traits, beet yields and water use efficiency were statistically analyzed according to Snedecor and Cochran (1976) using analysis of variance technique of computer software package (Mstat-c, 1989). Comparison among treatment means was done using least significant differences (L.S.D) at 5% level of probability according to Steel and Torrie (1980).

RESULTS AND DISCUSSION

Mulching effects on juice quality

Data presented in Table (4) shows that the four mulching treatments, i.e. NM, RSM, WPFM, and BPFM, significantly affected the quality traits in terms of sucrose, purity, potassium, sodium, amino N and impurities percentage in both seasons, except amino N and impurities in the second season. BPFM recorded the highest sucrose (21.10 and 21.18%) and purity (85.77 and 85.98%) in the first and second season along with the lowest amine-N impurities percentage (1.65% and 0.76) in the 1st season, respectively, followed by WPFM, RSM, and NM in descending order. Using BPFM recorded a significant increase in sucrose by 6.96, 14.61 and 19.30% and in purity percentage by 4.71, 8.28 and 10.41%, on the other hand, impurities percentage reduced by 24.50, 38.49 and 46.38% compared to WPFM, RSM, and NM, respectively. These results are in harmony with those obtained by Helaly *et al.* (2017) and Malik *et al.* (2018a) whom they reported that black or white film mulch and straw mulch increased sugar content of sugar beet by 2.35 and 3.78% as well as *Physalis Pubescens* by 8.10 and 38.20%, respectively compared to no mulch. In general, different kinds and color mulches increased sugar content followed by straw mulch (Parmar *et al.*, 2013). Positive effect of mulching on juice quality might be due to the promotion effect in plant growth, metabolic process and translocation of carbohydrates from tops to roots (Helaly *et al.*, 2017).

Mulching effects on sugar beet yield

Beet yields differed significantly among mulch treatments in both seasons as well as extractable sugar percentage (Table 5). Consequently, of the positive

effect of mulching on sugar beet growth and quality, the highest root yield (58.51 and 58.90 ton ha⁻¹), extractable sugar (19.45 and 19.52%) and sugar yield (11.38 and 11.50 ton ha⁻¹) in the first and second season, respectively, resulted from BPFM followed by WPFM, RSM and NM. An increase recorded for using each mulching types i.e. root yield increased by 16.8, 39.2 and 51.6%, extractable sugar 7.7, 20.5 and 32.8%, sugar yield increased by 25.8, 67.7 and 101.3% as well for RSM, WPFM and BPFM treatment compared to no mulch (NM) (Fig. 1).

Mulching can enhance the available soil moisture condition by collecting micro efficient or ineffective precipitation, reducing soil evaporation and restraining runoff (Chen *et al.*, 2019), especially, polyethylene mulch that increase soil temperature and microclimate modification (Sarkar and Singh, 2007, Malik *et al.*,

2018b). So sugar beet plants grew quickly and consequently, the photosynthetic rate and production of dry matter increased which significantly increased root yield compared with no mulch. As sucrose content increased and impurities decreased, extractable sugar percentage increased. This increase in root yield and extractable sugar % increased sugar yield by using different mulching types. These results are in agreement with those obtained by Artyszak *et al.* (2014) who mentioned that grew sugar beet crop under straw mulch treatment increased root yield by 25% and sugar yield by 11.3% compared to no mulch. Malik *et al.* (2018a) found that the highest root and sugar yield produced by black film mulch treatment. In contrast, Tegen *et al.* (2016) reported that straw mulch treatment enhances yield compared to BPFM.

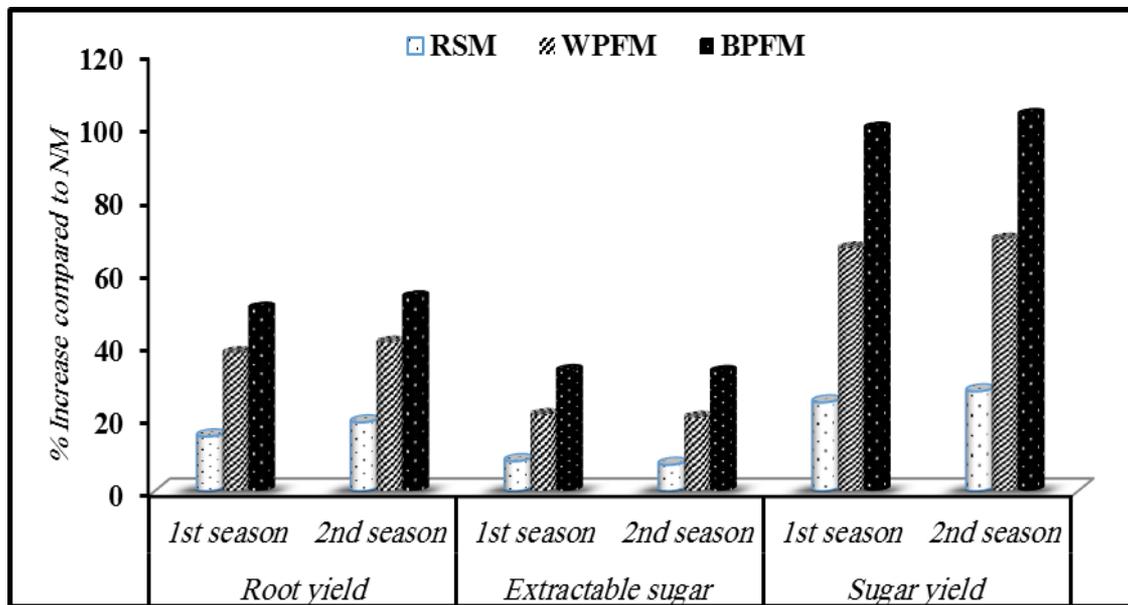


Fig. 1. Percent increase in root yield, extractable sugar and sugar yield of rice straw mulch (RSM), white polyethylene film mulch (WPFM) and black polyethylene film mulch (BPFM) compared to control, no mulch (NM) in 2018-19 and 2019-20 seasons

Table 4. Quality traits of sugar beet roots as affected by different mulching type in 2018/2019 and 2019/2020 seasons

| Treatment | sucrose % | | purity % | | K | | Amino-N | | Na | | Impurities % | |
|-------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|
| | 1 st season | 2 nd season |
| NM | 17.65 d | 17.79 d | 77.45 d | 78.11 d | 5.57 a | 5.70 a | 1.84 a | 1.86 a | 1.95 a | 1.97 a | 3.01 a | 3.07 a |
| RSM | 18.47 c | 18.42 c | 79.47 c | 79.14 c | 5.21 b | 5.21 b | 1.27 b | 1.27 a | 1.44 b | 1.47 b | 2.65 b | 2.65 a |
| WPFM | 19.74 b | 19.79 b | 82.13 b | 81.90 b | 4.03 c | 4.05 c | 0.99 c | 0.91 a | 0.99 c | 1.00 c | 2.21 c | 2.11 a |
| BPFM | 21.10 a | 21.18 a | 85.77 a | 85.98 a | 3.04 d | 3.05 d | 0.76 d | 0.75 a | 0.62 d | 0.65 d | 1.65 d | 1.61 a |
| L.S.D at 5% | 0.40 | 0.14 | 1.68 | 0.21 | 0.23 | 0.03 | 0.06 | N.S | 0.06 | 0.03 | 0.09 | N.S |

Means followed by the same letter are statistically equalled at 5% level, NM: no mulch (Control), RSM: Rice straw mulch, WPFM: White polyethylene film mulch and BPFM: Black polyethylene film mulch
N.S. Not significant

Table 5. Sugar beet root yield, extractable sugar and sugar yield as affected by different mulching type in 2018/2019 and 2019/2020 season

| Treatment | Root yield (ton ha ⁻¹) | | Extractable sugar % | | Sugar yield (ton ha ⁻¹) | |
|-------------|------------------------------------|------------------------|------------------------|------------------------|-------------------------------------|------------------------|
| | 1 st season | 2 nd season | 1 st season | 2 nd season | 1 st season | 2 nd season |
| NM | 39.00 d | 38.46 d | 14.63 d | 14.72 d | 5.71 d | 5.66 d |
| RSM | 44.81 c | 45.68 c | 15.82 c | 15.77 c | 7.09 c | 7.20 c |
| WPFM | 53.74 b | 54.10 b | 17.68 b | 17.67 b | 9.50 b | 9.56 b |
| BPFM | 58.51 a | 58.90 a | 19.45 a | 19.52 a | 11.38 a | 11.50 a |
| L.S.D at 5% | 2.09 | 0.39 | 0.34 | 0.12 | 0.39 | 0.08 |

Means followed by the same letter are statistically equalled at 5% level, NM: no mulch (Control), RSM: Rice straw mulch, WPFM: White polyethylene film mulch and BPFM: Black polyethylene film mulch

Mulching effects on Amount of irrigation water applied and water use efficiency.

The amount of irrigation water applied for sugar beet throughout the studied growing seasons under mulching treatments is given in Table (6). The irrigation system plays an important role to save water in the field by using good agricultural practises. Obtained data revealed that the higher amount of irrigation water applied was found under NM, while the lowest was found WPFM. WPFM decreased the amount of irrigation water applied compared with another mulching from 6373, 6147 and 5886 to 5512 m³ ha⁻¹ in

the first season and 6368, 6148, 5890 to 5509 m³ ha⁻¹ in the second season compared with NM, RSM and BPFM.

Mulching types significantly increased water use efficiency for both root (WUE_{root}) and sugar (WUE_{sugar}) in the two growing seasons (Table 6). RSM increased WUE_{root} by 19.1 and 23 % and WUE_{sugar} by 27.8 and 31.5%, WPFM increases WUE_{root} by 59.3 and 62.6% and WUE_{sugar} by 92.5 and 95.3% and BPFM recorded the highest WUE_{root} (62.3 and 65.6%) as well as WUE sugar (115.7 and 119.7%) compared to NM in the 1st and 2nd season, respectively (Fig. 2).

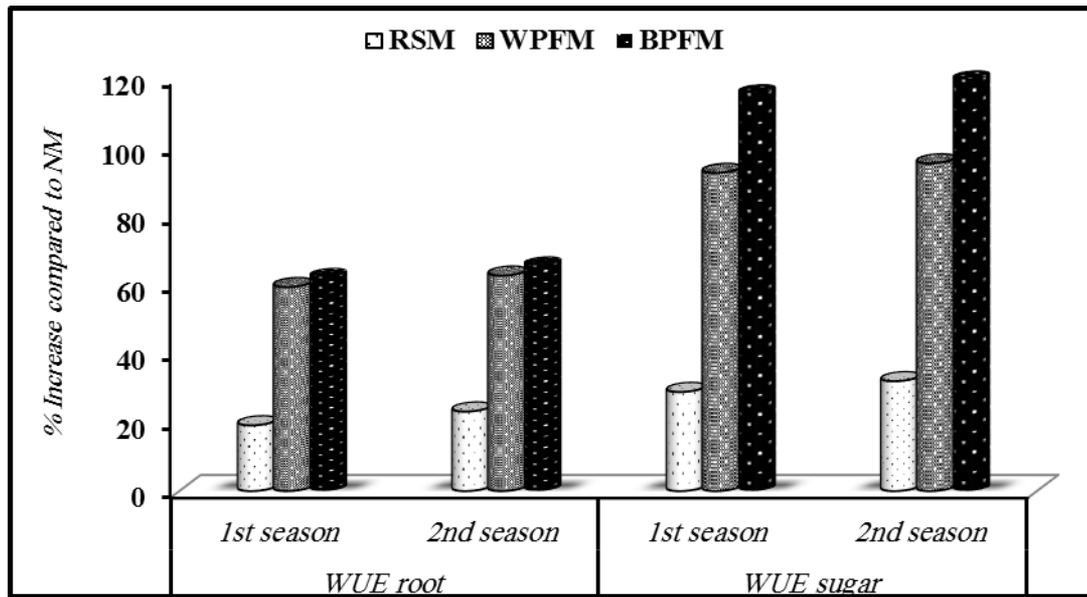


Fig. 2. Percent increase in water use efficiency for root (WUE root) and for sugar (WUE sugar) of rice straw mulch (RSM), white polyethylene film mulch (WPFM) and black polyethylene film mulch (BPFM) compared to control, no mulch (NM) in 2018-19 and 2019-20 season

Table 6. Amount of irrigation water and water use efficiency for root (WUE_{root}) and sugar (WUE_{sugar}) as affected by different mulching type in 2018/2019 and 2019/2020 seasons

| Treatment | Amount of irrigation water (m ³ ha ⁻¹) | | WUE root (kg m ⁻³) | | WUE sugar (kg m ⁻³) | |
|-------------|---------------------------------------------------------------|------------------------|--------------------------------|------------------------|---------------------------------|------------------------|
| | 1 st season | 2 nd season | 1 st season | 2 nd season | 1 st season | 2 nd season |
| NM | 6373 | 6368 | 6.12 c | 6.04 d | 0.90 d | 0.89 d |
| RSM | 6147 | 6148 | 7.29 b | 7.43 c | 1.15 c | 1.17 c |
| WPFM | 5512 | 5509 | 9.75 a | 9.82 b | 1.72 b | 1.74 b |
| BPFM | 5886 | 5890 | 9.94 a | 10.00 a | 1.93 a | 1.95 a |
| L.S.D at 5% | | | 0.67 | 0.06 | 0.13 | 0.06 |

Means followed by the same letter are statistically equalled at 5% probability level, NM: no mulch (Control), RSM: Rice straw mulch, WPFM: White polyethylene film mulch and BPFM: Black polyethylene film mulch.

Such results match with the recommendation of Malik *et al.* (2018b) who mentioned that for sustainable and efficient use of the available water resources, field-scale water-saving strategies must be applied to enhance the water productivity and crop yield, and noticed that using black film and straw mulch saved irrigation water up to 66.53% compared to no mulch. Gan *et al.* (2013) noticed that using plastic film mulch has proved effective for increasing crop productivity and WUE in semiarid areas. The relatively low WUE noted for no mulch treatment may be due to the uninterrupted supply of solar radiation that reached the earth surface and thus increased the amount of non-beneficial evaporation and ultimately led to towards lower WUE (Mukherjee *et al.*, 2010, Malik *et al.*, 2018a), whereas the highest WUE under BPFM may be attributed to prevent most of the soil evaporation. In general, mulches improve WUE (Xie *et al.*, 2005).

Mulching effects on Weed Parameters

Total number of weeds (Table 7) was increased in treatment NM, while decreased by using BPFM. The control treatment (NM) had the highest mean weeds number (60.3 broad leaves and 21.7 grasses m⁻²), which was expected as no mulch was applied. In contrast, shredded BPFM had the lowest mean of weeds number (41.3 broad leaves and 16.3 grasses m⁻²), making it the most effective at controlling weeds.

Concerning the effect of type of mulching on weed biomass, obtained result showed that BPFM decreased the value by about 40.1, 37.6 and 15.25% compared with NM, RSM and WPFM. The highest value of weed biomass (643.7 g m⁻²) was obtained by using NM, while the lowest value was obtained by using BPFM.

As regard to the effect of mulching types on weed control efficiency, the values were (40.91, 30.35, 5.2 and zero% for BPFM, WPFM, RSM and NM, respectively) that helped in maintaining higher moisture content in the crop root zone.

Table 7. The weed parameters under different treatments as an average in both seasons

| Treatment | Weed number m ⁻² | | Weed biomass (g m ⁻²) | Weed control efficiency (WCE) (%) |
|-----------|-----------------------------|---------|-----------------------------------|-----------------------------------|
| | Broad-leaved | Grasses | | |
| NM | 60.3 | 21.7 | 643.7 | 0 |
| RSM | 57.3 | 18.3 | 610.0 | 5.2 |
| WPFM | 48.7 | 17.3 | 448.3 | 30.35 |
| BPFM | 41.3 | 16.3 | 380.3 | 40.91 |

Table 8. The economic Evaluation of the present study

| Treatment | 1 st season | | | 2 nd season | | |
|-----------|-----------------------------------------------|-------------------------------------|-----------------------------------|-----------------------------------------------|-------------------------------------|-----------------------------------|
| | Total production costs, L.E. ha ⁻¹ | Total return, L.E. ha ⁻¹ | Net return, L.E. ha ⁻¹ | Total production costs, L.E. ha ⁻¹ | Total return, L.E. ha ⁻¹ | Net return, L.E. ha ⁻¹ |
| NM | 11783.9 | 21693.8 | 9909.8 | 11663.9 | 21528.0 | 9864.1 |
| RSM | 13909.5 | 25844.2 | 11934.6 | 13549.5 | 26288.8 | 12739.3 |
| WPFM | 15768.7 | 32700.8 | 16932.1 | 15168.7 | 32987.5 | 17818.8 |
| BPFM | 12079.9 | 37592.7 | 25512.8 | 11239.9 | 37961.1 | 26721.1 |

Economic Evaluation

This study evaluated the effect of different types of mulching on some characteristics of the crop, irrigation and economic analysis of sugar beet. The data listed in Table 8 as economic analysis for two seasons indicated that treatment BPFM gave the best values of the net return and net profit followed by treatment WPFM then treatment NM which had the lowest value. Thus, the highest value of net return and total return under BPFM were treatments 25512.8 and 37592.7 in the first season, while in the second season were 26721.1 and 3761.1 LE ha⁻¹. The lowest value of net return and total return under NM were treatments 9909.8 and 21693.8 in the first season, while in the second season were 9864.1 and 21528.0 LE/ha. The highest value of total production cost was obtained by using WPFM while the lowest value was obtained by using NM under in the first and second season.

CONCLUSION

Quality and beet yields were affected significantly by various mulching types. Both black and white polyethylene mulch positively affect sucrose, purity and extractable sugar percentage as well as root and sugar yield followed by rice straw mulch. Decreasing the amount of applied water and increasing beet yield-enhancing water use efficiency for both root and sugar yield. It can be recommended that plastic film mulch is preferentially applied for sugar beet production in newly reclaimed soils under semi-arid regions where scared irrigation water and high weed competition in sugar beet fields.

REFERENCES

- A.O.A.C. 1980. Official Methods of Analysis, *Association of Official Analytical Chemists, Washington, D.C.* 376-384.
- Afshar, R. K., C.Chen, J.Eckhoff and C. Flynn. 2018. Impact of a living mulch cover crop on sugarbeet establishment, root yield, and sucrose purity, *Field Crop Research*. 223: 150–154. <https://doi.org/10.1016/j.fcr.2018.04.009>
- Artyszak, A., D.Gozdowski and K. Kucińska. 2014. The yield and technological quality of sugar beet roots cultivated in mulches, *Plant Soil Environment*. 60(10): 464-469. <https://doi.org/10.17221/428/2014-PSE>
- Carruthers, A. and J. E. T.Oldfield. 1960. Methods for the assessment of beet quality, *Technological Value of the Sugar Beet*. 63(1): 103-105.
- Carruthers, A., J. E. T.Oldfield and H. J. Teague. 1962. Assessment of beet quality. Paper Presented to the 15th Annual Technical Conference, *British Sugar Corporation LTD*. 36.
- Israelsen, O.W. and V.E. Hansen. 1962. Irrigation principles and practices (3rd ed.), John Wiley and Sons Inc. New York.
- Chen, Y., S. Chai, H. Tian, Y. Chai, Y. Li, L.Chang and H. Cheng. 2019. Straw strips mulch on furrows improves water use efficiency and yield of potato in a rainfed semi-arid area, *Agricultural Water Management*. 211:142-151. <https://doi.org/10.1016/j.agwat.2018.09.048>
- CIMMYT. 1988. From Agronomic Data to Farmer Recommendations: An Economics Training Manual, *Completely revised edition. Mexico. D.F.*
- DeBaets, S., J. Poesen, J. Meersmans and L. Serlet. 2011. Cover crops and their erosion-reducing effects during concentrated flow erosion,” *Catena*. 85(3):237-244. <https://doi.org/10.1016/j.catena.2011.01.009>
- Dregseth, R.J., M.A. Boetel, A.J. Schroeder, R.B. Carlson and J. S. Armstrong. 2003.Oat cover cropping and soil insecticides in an integrated sugar beet root maggot (Diptera: Otitidae) management program,” *J. of Economic entomology*. 9 (5): 1426-1432. <https://doi.org/10.1093/jee/96.5.1426>
- Gan, Y., K.H.M.Siddique, N.C.Turner, X.G. Li, J.Y.Niu, C.Yang, L.Liu and Q.Chai. 2013. Ridge furrow mulching systems- an innovative technique for boosting crop productivity in semiarid rain-fed environments, *Advanced in Agronomy*. 118: 429-476. <https://doi.org/10.1016/B978-0-12-405942-9.00007-4>
- Helaly, A.A., Y.A. Goda, A.S.El-Rehim, A.A.Mohamed and O.H. El-Zeiny. 2017. Effect of polyethelene mulching type on the growth, yield and fruits quality of *Physalis pubescens*, *Advanced Plants Agricultuer Research*. 6 (5): 1-7. 10.15406/apar.2017.06.00229
- Jensen, M. G. 1983. Design and Operation of Farm Irrigation Systems, *ASAE, Michign, USA*. 82. [https://doi.org/10.1016/0378-3774\(82\)90048-8](https://doi.org/10.1016/0378-3774(82)90048-8)
- Kanani, E., H.Dehghanisanij and S. Akhavan. 2016. Effects of different irrigation methods and mulch on corn (zea mayz l) evapotranspiration, yield, water use efficiency in a semi-arid climate,” 2nd World Irrigation Forum (WIF2).11: 6-8. Chiang Mai, Thailand. https://www.icid.org/wif2_full_papers/wif2_w.1.4.22.pdf
- Li, S. X., Z. H.Wanga, S. Q. Li, Y. J.Gao and X. H. Tiana. 2013. Effect of plastic sheet mulch, wheat straw mulch and maize growth on water loss by evaporation in dryland areas of China, *Agricultural Water Management*. 116: 39 – 49. <https://doi.org/10.1016/j.agwat.2012.10.004>
- Malik, A., A.S.Shakir, M.J.Khan, Naveedulah, M.Latif, M.Ajmal and S. Ahmad. 2018a. Effects of different mulching techniques on sugar beet performance under semi-arid subtropical climatic conditions, *Pakistan J. of Botany*. 50(3): 1219-1224.
- Malik, A., A.S.Shakir, Naveedulah, M.J.Khan, M.Latif, M.S.Khattak and T.A. Khan. 2018b. Interactive effect of deficit irrigation and mulching on sugar beet production in Pakistan, *Pakistan J. of Botany*. 50(5): 1775-1783.

- Mani, V.S., M.L.Malla and K.C.Gautam. 1973. Bhagwandas. Weed killing chemicals in potato cultivation, *Indian Farming*. VXXII. 17-18.
- Mstat-c. 1989. "Users Guide: A Microcomputer Program for the Design, Management and Analysis of Agronomic Research Experiments," *Michigan University, East Lansing, MC, USA*. 17-18.
- Mukherjee, A., M. Kundua and S.Sarkara. 2010. Role of irrigation and mulch on yield, evapotranspiration rate and water use pattern of tomato (*Lycopersion esculentum* L.)," *Agricultural Water Management*. 98(1):182-189. <https://doi.org/10.1016/j.agwat.2010.08.018>
- Parmar,H. N., N. D.Polara and R. R. Viradiya. 2013. Effect of Mulching Material on Growth, Yield and Quality of Watermelon (*Citrullus Lanatus* Thunb) Cv. Kiran, *Universal J. of Agricultural Research*. (1) 2: 30 – 37. DOI: 10.13189/ujar.2013.010203
- Patil, S.S., T.S.Kelkar and S.A. Bhalerao. 2013. Mulching: A Soil and Water Conservation Practice, *Research J.of Agriculture and Forestry Sci*. (1) 3: 26-29.
- Petersen, J. and A. Rover. 2004. Comparison of sugar beet cropping systems with dead and living mulch using a glyphosate-resistant hybrid," *J. of Agronomy and Crop Sci*. 191(1): 55-63. <https://doi.org/10.1111/j.1439-037X.2004.00134.x>
- Renfield, E., A.Emmerich, G.Baumarten, C.Winner and U. Beiss. 1993. Zur vorausage des melosse suckers aus rubenanalyses," Zuker. In: 1st ed. In: Cock, D.A., Scott, R.K. (Eds.), *The Sugar Beet Crop 27*. Chapman & Hall (World Crop Series), London, UK. 2–15 (1974).
- Salman, A., A.S. R.Muhammad, F.S.Muhammad, S.Z.Syeda, H.K. Imran, A.Muhammad, S.Abdul Manan, I.Rashid and S. Muhammad. 2015. Mulching strategies for weeds control and water conservation in cotton, *ARNP J. of Agricultural and Biological Sci*. 10 (8): 299-306. <http://www.arnpjournals.com/jabs/rese...>
- Sarkar, S. and S. R. Singh. 2007. Interactive effect of tillage depth and mulch on soil temperature, productivity and water use pattern of rainfed barley (*Hordium vulgare* L.), *Soil Tillage Research*. 92 (1-2): 79-86. <https://doi.org/10.1016/j.still.2006.01.014>
- Sharma, R. and S.Bhardwaj. 2017. Effect of mulching on soil and water conservation -A review.*Agricultural Reviews*. 38(4): 311-315. 10.18805/ag.R-1732
- Singh, G. and R. S. Jolly. 2008. Improving emergence of soybean (*Glycine max*) with straw mulch and other practices under normal and crusted soil conditions, *Acta Agronomica Hungarica*. 56(3):275-283. <https://doi.org/10.1556/AAgr.56.2008.3.3>
- Snedecor, G. A. and W. G. Cochran. 1976. *Statistical Methods*, Iowa State University Press, Amess.
- Steel, R. G. and H. H. Torrie. 1980. *Principles and Procedures of Statistics, second ed. Mc Grow Hill, New York*.
- Sturm, D.J., C. Kunz and R. Gerhards. 2016. Inhibitory effects of cover crop mulch on germination and growth of *Stellaria media* (L.) Vill., *Chenopodium album* L. and *Matricaria chamomilla* L. *Crop Protection*. 90: 125-131. 10.1016/j.cropro.2016.08.032
- Teasdale, J.R. 1996. Contribution of cover crops to weed management in sustainable agricultural systems, *J. of production agriculture*. 9(4):475-479. <https://doi.org/10.2134/jpa1996.0475>.
- Tegen, H., Y.Dessalegn and W.Mohammed. 2016. Influence of mulching and varieties on growth and yield of tomato under polyhouse, *J. of Horticulture Forestry*. 8 (1): 1–11. <https://doi.org/10.5897/JHF2015.0395>
- Tunio, S. D., M. A.Ansari, H. R.Memon and M. R. Memon. 2007. Effect of different mulches and irrigation frequencies on growth and yield of sunflower," *Pakistan J. of Agriculture, Agricultural Engineering and Veterinary Sci*. 23(1): 1-5.
- Wu, I. P. and H. M. Gitlin. 1973. Hydraulics and uniformity for drip irrigation, *J. of the Irrigation and Drainage Division*. 99(2): 157-168.
- Xie, Z., Y.Wang and F. Li. 2005. Effect of plastic mulching on soil water use and spring wheat yield in arid region of Northwest China, *Agricultural Water Management*. 75(1): 71-83. <https://doi.org/10.1016/j.agwat.2004.12.014>
- Yamanaka, T., M.Inoue and I. Kaihotsu. 2004. Effects of gravel mulch on water vapor transfer above and below the soil surface. *Agricultural Water Management*. 67(2):145-155, <https://doi.org/10.1016/j.agwat.2004.01.002>
- Yi, Z.X., W.X.Zhou, N.M.Tu, X.D. Tu, Y.L.Wu and W.L. Yang. 2007. Effects of no-tillage and straw mulching on soil nutrient content and drought resistance of maize on dry land, *Research Agriculture Modern*. 28(4): 490-493.
- Yonts, C.D., J.A.Smith and R.G. Wilson. 2002. Evaluation of cover crop system for sugar beet production under furrow irrigation, *J. of sugar beet research*. 39(1/2): 25-36.
- Zhang, Q.T., O.A.B. Ahmed, M.Inoue, M. C Saxena, K.Inosako and K. Kondo. 2009. Effects of mulching on evapotranspiration, yield and water use efficiency of Swiss chard (*Beta vulgaris* L. var. flavesces) irrigated with diluted seawater. *J. of Food, Agriculture & Environment*. 7(4): 650-654. J-GLOBAL ID : 201302267671349360

الملخص العربي

الإدارة المتكاملة للمياه والحشائش لمحصول بنجر السكر باستخدام نظم مختلفة لتغطية التربة في المناطق المستصلحة حديثاً

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نقاوة (٨٥.٨٨ و ٨٢.٠١٪) و عائد سكر (١٩.٤٩ و ١٧.٦٨٪) و محصول جذور (٥٨.٧٠ و ٥٣.٩٢ طن للهكتار) و محصول سكر (١١.٤٤ و ٩.٥٣ طن للهكتار) للموسم الاول والثانى على التوالي. على خلاف ذلك سجلت المعاملة كنترول (بدون تغطية NM) أعلى نسبة شوائب وأقل كفاءة مقاومة الحشائش. نتج متوسط كفاءة استخدام المياه للجذور (٦.٠٨ و ٧.٣٦ و ٩.٧٨ و ٩.٩٧ كجم م^{-٣}) كذلك كفاءة استخدام المياه للسكر (٠.٨٩ و ١.١٦ و ١.٧٣ و ١.٩٤ كجم م^{-٣}) لموسمى الزراعة من المعاملة كنترول (بدون تغطية) و التغطية باستخدام قش الارز و استخدام فيلم بولى إيثيلين الابيض و فيلم البولى إيثيلين الاسود على التوالي. نتجت كفاءة مقاومة الحشائش (٤٠.٩ و ٣٠.٤٥ و ٥.٢ و صفر) لكلا من المعاملة باستخدام فيلم البولى إيثيلين الاسود تلاه فيلم البولى إيثيلين الابيض تلاه المعاملة باستخدام قش الارز تلاه المعاملة كنترول على التوالي مما ساعد فى الحفاظ على المحتوى الرطوبى فى منطقة الجذور.

الكلمات الدالة: تغطية التربة - بنجر السكر - كفاءة استخدام المياه - بولى إيثيلين.

تلعب ادارة التقنيات الزراعية للتربة والمياه دورا مهما فى زيادة انتاجية المحاصيل. حيث تعد تغطية التربة من اهم الممارسات الزراعية للحفاظ على رطوبة التربة و مقاومة الحشائش وكذلك تحسين الخواص الفيزيائية للتربة.

تمت اقامة تجربتين حقليتين بمحطة البحوث بوادى النطرون، معهد بحوث ادارة المياه، المركز القومى لبحاث المياه، مصرخلال الموسمين الشتويين ٢٠١٧/٢٠١٨ و ٢٠١٨/٢٠١٩ لتقييم تأثير اربعة انواع من تغطية التربة (بدون تغطية كنترول (NM) و التغطية باستخدام قش الارز (RSM) و التغطية باستخدام فيلم بولى إيثيلين ابيض (WPFM) و التغطية باستخدام فيلم البولى ايثيلين الاسود (BPFM)) على محصول وجودة محصول بنجر السكر Beta vulgaris كذلك كفاءة استخدام المياه بالنسبة لمحصولي الجذور والسكر .

أظهرت النتائج فروق معنوية بين أنواع التغطية المختلفة. توالت أهم النتائج المتحصل عليها كالتالى حيث سجل كلا من التغطية باستخدام فيلم البولى إيثيلين الاسود والابيض على التوالي أعلى نسبة سكر (١٩.٧٧ و ٢١.١٤٪) و نسبة