EFFECT OF IRRIGATION WATER DEFICIT ON WATER AND THERMAL REQUIREMENTS FOR SUGAR BEET IN UPPER EGYPT.

By

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5. Summary and Conclusions

Two field experiments were carried-out at Shandaweel Agricultural Research Station, Sohag Governorate, Upper Egypt in 2018/19and 2019/20 seasons.
The aim of the experiments were to study the effects of three irrigation treatments, three harvest dates and three sugar beet varieties on yield, yield components, quality characters of sugar beet roots, water relations and thermal requirements.

The experiments were carried out in clay loam soil under surface irrigation. The design of the experiments were split-split plot with three replications. He main plots were devoted for irrigation treatments (100%, 85% and 70% WR), the sub- plots were assigned to three harvest dates (180, 195 and 210 days after sowing). The sub-sub plots comprised of three sugar beet varieties (RAVEL, SV841 as a mono-varieties and SA1686 as multi-germ variety). The sub-sub plot area was 10 m^2.

All cultural practices for growing sugar beet were carried out as recommended for the region. The irrigation treatments were applied after the first irrigation till the end of the growing season.

The obtained results could be summarized as followed:

1 - Yield and its components

- The highest value of the root length (cm) was obtained under irrigation with 70% WR in the two growing seasons. While the lowest values were obtained from irrigation with 100% WR in both growing seasons.
- The highest weight of root diameter, above ground biomass, biological yield and root yield were obtained from irrigation with 100% WR. On the contrary, the lowest values of root diameter, above ground biomass, biological yield and root yield were obtained under irrigation with 70% WR in both growing seasons.
- The maximum root length, root diameter, biological yield and root yield were obtained from the longest harvest date (210 days) in both growing

seasons. On the other hand, the shortest harvest date (180 days) reduced the above ground biomass in both growing seasons**.**

- The average values of root length, root diameter, above ground biomass, biological yield and root yield of RAVEL and SA1686 varieties were higher than SV1841 variety in both growing seasons**.**
- There were significant effects among irrigation treatments, harvest dates and varieties on root length, root diameter, above ground biomass, biological yield and root yield in the both growing seasons.
- The interaction effects of irrigation treatments, harvest dates and sugar beet varieties were found insignificant in both growing seasons, except the interaction effect between harvest dates and varieties on root yield in the first season and the interaction between harvest date and variety on above ground biomass in both growing seasons where the interaction between them were significant.

2.) Quality parameters of sugar beet roots:

- Sucrose percentage was significantly affected by irrigation treatments in both growing seasons. Irrigating sugar beet plants with 70 % WR recorded the highest sucrose percentage.
- Sucrose percentage was significantly affected by harvest dates and the highest value was obtained from harvest sugar beet after 210 days from planting in both growing seasons.
- The significant differences among the evaluated sugar beet varieties in sucrose percentage and the RAVEL variety produced the highest value in the both growing seasons.
- Impurities percentages (sodium, Potassium and α- amino nitrogen %) were insignificantly effect by irrigation treatments in both growing seasons.
- Impurities percentages were insignificantly affected by investigated harvesting dates in both growing seasons, except the effect of harvest date on sodium percentage in the second season only.
- Evaluated sugar beet varieties had no significant effect on sodium, potassium and α- amino nitrogen % in both growing seasons.

- Quality of sugar percentage was significantly affected by irrigation treatments in both growing seasons. Irrigating sugar beet plants with 70 % WR recorded the highest sugar quality percentages.
- Sugar quality percentages were significantly affected by harvest dates in the second growing season, where the highest value was obtained from harvest sugar beet after 210 days from planting.
- Significant differences among the evaluated sugar beet varieties in sugar quality percentages was recorded, the RAVEL variety recorded the highest value in the both growing seasons.
- Irrigation with 70% WR produced the heights purity parameters of purity percentage followed by irrigation with 85% WR, then irrigation with 100% WR in the both growing seasons.
- Purity percentage was insignificantly affected by the tested harvesting dates. However, RAVEL variety produced the heights quality parameters of purity percentage.
- Irrigation treatments, harvesting dates and evaluated sugar beet varieties had no significant effect on sugar lost to molasses percentage in both growing seasons.
- Extractable sugar percentage was significantly affected by irrigation treatments, harvesting dates and evaluated sugar beet varieties in both growing seasons. Irrigation at 70% WR produced the heights extractable sugar percentage.
- The highest value of extractable sugar percentage was recorded for the longest harvest dates, namely 210 days followed by 195 days and then by 180 days in both growing seasons.
- RAVEL variety produced the heights quality parameters of extractable sugar percentage, followed by SA1686 variety then SV1841 variety in the two growing seasons.
- Extractability percentage was significantly affected by water irrigation treatments. Irrigation by 70% WR resulted in the highest quality parameters of extractability percentage.

- RAVEL variety produced the highest quality criteria of extractability percentage, followed by SA1686 and then by SV1841 in both growing seasons.
- Irrigated sugar beet plants with 100% WR, recorded the highest sugar yield.
- Increasing season length of sugar beet up to 210 days resulted in increasing sugar yield in ton/fed, as compared to harvest after 180 and 195 days from planting in the both growing seasons.
- The investigated sugar beet varieties significantly differed in sugar yield in both seasons. RAVEL variety yielded significantly higher sugar yield than the other two varieties.

3.) Sugar beet plants and soil, water relationships

- The highest values of seasonal applied irrigation water were 4045 and 3922 m^3/fed recorded for the longest harvesting dates of 210 days, followed by the 3491 and 3390 m^3/fed for the harvesting date of 195 days and then by 2967 and 2904 m^3/fed for the harvesting date of 180 days in the first and second growing seasons, respectively.
- The grand average values of seasonal water consumptive use regarding irrigation treatments, harvest dates and sugar beet varieties were 2138 and 2073 m^3/fed in the first and the second season, respectively.
- The highest water consumptive used values of 2467 and 2335 m^3/fad were found in full irrigation water treatment 100% WR, followed by 85%WR of 2135 and 2016 m^3/fed and the least was recorded for 70% WR of 1811 and 1675 m^3/fad in the first and the second seasons, respectively.
- The highest water consumptive use was obtained from the longest harvest date of days, namely 2478 and 2219 m^3/fed followed by 195 days, namely 2129 and 2034 m^3/fed and 180 days, namely 1806 and 1773 m^3/fed in the first and the second season, respectively.
- Water consumptive used by RAVEL and SA1686 were slightly higher than that of SV1841 in both growing seasons.

- The highest root water use efficiency values of 15.7 and 16.2 kg/m^3 were obtained from irrigation with 70% WR, followed by 15.3 and 14.9 kg/m^3 under irrigation with 85% WR. The lowest value of WATER USE EFFICIENCY was recorded under irrigation with 100% WR and were 14.5 and 14.5 kg/m^3 in the first and the second seasons, respectively.
- The water use efficiency values of 210 harvest date were 14.3 and 15.9 kg/m^3, the corresponding values for 195 days were 15.1 and 15.2 kg/m^3 and were 16.0 and 14.6 kg/m^3 for 180 days in the first and the second season, respectively.
- The RAVEL and SA1686 attained higher values of roots water use efficiency compared to SV1841 variety, but the differences in root water use efficiency of RAVEL and SA1686 varieties were found insignificant.
- The average values of water use efficiency over the two growing season were 2.33, 2.54 and 2.86 kg sugar/m^3 for 100% WR, 85% WR and 70% WR irrigation treatments, respectively.
- The water use efficiency values were 2.55, 2.57 and 2.61 kg sugar/m^3 for 180 days, 195 days and 210 days harvest date, respectively.
- The RAVEL variety recorded the highest water use efficiency value of 3.08 kg sugar/m^3, followed by SA1686 variety of 2.57 kg/m^3. The lowest 2-year average value of water use efficiency was recorded for the SV1841 variety (2.07 kg sugar/m^3).
- Increasing the amounts of applied irrigation water decreased the value of water productivity of sugar beet roots. The 2-year average values of water productivity were 8.61, 8.98 and 9.52 kg root/m^3 for 100% WR, 85% WR and 70% WR irrigation treatments, respectively.
- The water productivity values were 9.27, 9.07 and 8.77 kg root/m^3 for 180 days, 195 days and 210 days harvest treatments, respectively.
- 2-year water productivity values for RAVEL variety were 9.64 kg root/m^3 and was 9.19 kg root/m^3 for SA1686 variety, both of them were significantly higher than SV1841 variety (8.28 kg of root/m^3 applied water).

- Increasing the amounts of applied irrigation water significantly decreased the water productivity of sugar yield. The 2-year average water productivity values were 1.39, 1.54 and 1.72 kg sugar/m^3 for irrigation with 100% WR, 85% WR and 70% WR irrigation treatments, respectively.
- Increasing harvest date to 210 days after planting decreased the water productivity values. The 2-year water productivity values was 1.54 kg sugar/m^3 applied water for 180 and 195 harvest dates, while the lowest value was 1.53 kg sugar/m^3 and was recorded for the longest harvesting date (210 days).
- The 2-year water productivity values for RAVEL was 1.85 kg sugar/m^3 and 1.53 kg sugar/m^3 for SA1686 varieties and both of them were significantly higher than SV1841 variety (1.23 kg sugar/m^3 applied water).

4.) Growing degree days (GDD)

- The growing degree days (GDD) during the seedling growth stage for the respective three varieties registered 198, 198 and 297 °C in the first season and it were 306, 349 and 349 °C in the second and it were season.
- The GDD during vegetative growth stage for the respective three varieties registered 786, 811 and 657 °C in the first season 654, 554 and 611°C in the second season.
- The GDD of tuber growth stage recorded values of 1120, 1095 and 1150 °C for the first season, and it were 1254, 1311 and 1254 °C for the second season for the first harvest date treatment.
- The GDD values for the tuber growth stage of the three varieties respectively were 1456, 1431 and 1486 °C in the first season, and it were 1610, 1667 and 1610 °C in the second season for the second harvest date treatment.
- These values of GDD in the tuber growth stage reached 1856, 1831 and 1886 °C in the first season; and it were 1926, 1983 and 1926 °C in the second season.

- Values of seasonal GDD were 2104, 2440 and 2840 °C in the first season, and it were 2214, 2570 and 2886 °C in the second season for the three harvest dates treatments, respectively.
- Sugar beet crop needed seasonal growing degree days ranging from 2100 to 2200 °C, if the harvest date done after 180 days from planting, it needed a range between 2400-2600 °C, if harvest done after 195 days from planting, and if the harvest date done after 210 days from planting, it needed a range between 2800-2900 °C.
- **Recommendation**

Form the above results, it could be recommended to maximize sugar beet production (Beta vulgaris var. saccharifera, L.), RAVEL or SA1686 varieties should be cultivated, irrigated with 100% of its water requirements and harvested after 210 days from planting to attain maximum tubers and sugar yield of sugar beet under Upper Egypt conditions. Furthermore, to maximize water use efficiency and water productivity under water shortage situations, irrigation with 70% of water requirement is recommended.