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Root-Knot Nematode, *Meloidogyne javanica* Reproduction, Potential Crop Yields and Water Use Efficiency at Drip-Irrigated Sugarbeet Fields as Affected by Water Deficit under Semi-Arid Conditions

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ABSTRACT

Two field experiments were carried out in sandy soil during two consecutive growing seasons; 2021/22 and 2022/23, at West Nubaryia region in Egypt. The experimental area, which is naturally infested with *Meloidogyne javanica*, were prepared to evaluate the influence of three deficit irrigation (DI) rates i.e. 40, 60 and 80% from irrigation water requirements (IWR), compared to full (100% from IWR) irrigation rate on reproduction parameters, final population (Pf) and reproduction factor (Rf) of *M. javanica* root-knot nematode and productivity of sugarbeet. Var. Merador as well as water use efficiency (WUE). The result showed that the DI rates of 40, 60 and 80% from IWR decreased ($P \leq 0.05$) significantly Pf and Rf values of *M. javanica* on sugarbeet plants compared to full (100% of IWR) irrigation rate. Increasing DI from 100 to 80, 60 and 40% of IWR significantly, ($P \leq 0.05$) decreased Pf number from 26036 to 18115, 9878 and 5371, respectively and Rf from 12.70 to 8.84, 4.82 and 2.62-fold, compared to initial population, respectively. The sugarbeet yield components, roots, gross sugar and white sugar yields , and quality index then were achieved the highest ($P \leq .0.05$) significant values with an average of 21.85, 3.75 and 3.15 tons/fed and 84.64% , respectively under DI rate of 80% from IWR, while the lowest ones (11.21, 1.8 and 1.47 tons/fed and 78.59%, respectively) were recorded at DI rate of 40% from IWR, compared to full (100% of IWR) irrigation rate, The highest ($P \leq 0.05$) significant values of WUE for gross sugar yield (1.91 kg/m^3 water) and white sugar yield (1.61 kg/m^3 water) as commercial yields for sugarbeet crop , also , were recorded at DI rate of 80% from IWR, however, the lowest ones (1.27 and 1.02 kg/m^3 water , respectively)were achieved by full (100% of IWR) irrigation rate. The previous results revealed that the DI rate of 80% from IWR has significant benefits in four terms of saving irrigation water, reducing damage caused by nematode, increasing yield quantity and quality, and increasing WUE. Thus, it was concluded that the application of the DI rate of 80% of IWR may led to enhance the efficiency of IPM programs to control root-knot nematodes at drip irrigated sugarbeet fields in sandy soils under semi-arid conditions.

***Key words*:** sugarbeet, root- knot nematodes, *Meloidogyne javanica*, deficit irrigation rate, sugar yield, roots yield, drip irrigation, water use efficiency, nematode reproduction. Semi-arid conditions.

INTRODUCTION

Sugarbeet is an important strategic crop in Egypt. It is the first crop for sugar production. The decrease in yield is due to a number of factors, including bacteria, fungi, viruses, and especially nematodes, which reduce the productivity and quality of the crop. Root-knot nematodes, *Meloidogyne incognita* and *M. javanica* have been described as major

nematodes pests of sugarbeet causes noticeable losses in crop. Losses in roots and sugar yields of 58 and 64%, respectively, were reported on sugarbeet cultivars susceptible to *M. incognita* root- knot nematode (Gohar and Maareg, 2005). Egyptian farmers use trickle irrigation systems for crop production in the open field, especially in newly reclaimed areas, as one of the effective means of preserving limited water resources, Many researchers studied the influence of deficit irrigation water on sugarbeet productivity and water use efficiency in sandy soil under drip irrigation method, Most of their results showed that there is a positive relationship between the amount irrigation water and sugarbeet productivity (roots yield and sugar yield), and a negative relationship between water quantity and water use efficiency (WUE) values for roots yield and sugar yield (Selim et al., 2010; Masri et al., 2015; El- Kady, 2015; El-Kholi, 2017; Makhluf and Abd El-All, 2017; El-Kady et al., 2019). Deficit irrigation has another advantage to diminish plants disease and pests particular those effected by both irrigation water and soil moisture content (Colella et al., 2014).

Many factors affected nematode growth and development including temperature, soil moisture and host plant. Soil moisture is important for the growth and development of root knot nematodes (Hunter, 2000; Karajeh and Al- Ameiri, 2010; Mahadeen et **al.,** 2011; Mohawesh, 2016; Maareg et al., 2018 and Yassin, 2018)**.** There have been few studies in the literature, thus far, that investigate the influence of deficit irrigation on root-knot nematode *Meloidogyne* spp. infecting sugarbeet under field conditions.

Therefore, the aim of this study is to assess the impact of different selected deficit irrigation rates on reproduction parameters of *Meloidogyne javanica* nematode, potential crop yields and water use efficiency at drip irrigated sugarbeet fields under semi-arid conditions.

MATERIALS AND METHODS

In this work, two field experiments were carried out in sandy soil naturally infected with root-knot nematode, *Meloidogyne javanica* at a drip irrigated agricultural area under semi-arid conditions at West Nubaryia region, Egypt (30° 54¯ 54¯ N latitude and 29° 57¯ 53¯ E longitude) to study the influence of three deficit irrigation (DI) rates compared to full irrigation rate on the reproduction parameters, final population (Pf) and reproduction factor (Rf) of root- knot nematode, *M. javanica* and sugarbeet productivity as well as water use efficiency (WUE). Deficit irrigation rates were used in this study as follows: 40, 60 and 80 % of estimated irrigation water requirements (IWR) according to Allen et al. (1998) formula, (ETc= ETo x.Kc.) The ETo is the reference evapotranspiration, in mm/ day and calculated from meteorological parameters were obtained from central laboratory for Agricultural Climate (CLAC) Agriculture Research Center (ARC) by using the CROPWAT model (Smith, 1992) Kc is crop coefficient as recorded by Allen et al. (1998) and were 0.35, 0.77, 1.2 and 0.70 for initial, development, mid and late growth stages. The total quantity of applied irrigation water under the studies deficit irrigation 40, 60, 80, and 100% from IWR. were 956, 1434, 1912 and 2390 m^3 in the first season, and 1004, 1506, 2008 and 2510 m^3 in the second season, respectively. The treatments of each field experiment were four-deficit irrigation rates (40, 60, 80 and 100% from IWR). There was 2.0 m separation between each treatment in order to minimize lateral water movement among treatments. Each treatment replicated six times (six plots). The plot area was 21.0 m² (6 x3.5 m) which consisted of six rows (6 m long and 0.5 m apart). Sugarbeet cv. Merador (classified as a nematode sensitive variety by Maareg et al., 2018a) was selected for planting in two seasons. Six random soil samples (500 g soil / plot) were determined

from each treatment for nematode extraction using modified Baermann's technique (Hussey and Barker, 1973) to calculate the initial nematode population (Pi). The Pi densities calculated in the first and second seasons were 2150 and 2010J2s/ 200 g soil, respectively. The seeds were sown in the first week of October in the two seasons at the rate of three seeds per hole at the depth of 4-5 cm and separated at the distance of 30 cm. After completing the cultivation of the seeds, all treatments were initially irrigated with the same amount of water until the seedling thinning process is completed to accomplish initial uniform water content and to reach IWR. The seedlings were thinned to a single plant in the hill at the 4-leaf stage. All treatments were managed throughout the growing seasons by standard farming practices. At harvest time, plants of each plot were collected and cleaned. The roots and top were separated and weighted (Kg/ plot), and converted to estimate roots yields (tons/ fed).Ten kg roots were sampled at random from each plot and sent to Nubaryia Sugar Factory to determine, sugar percentage and impurity parameters, alpha amino acid, potassium (K) and sodium (Na) concentrations (as mill equivalents/ 100 g beet/root).

From the previous estimates, the following was calculated:

-Loss sugar % = [0.343(k +Na) + 0.094 (α – amino N) + 0.29]
- White sugar % = sucrose % - loss sugar %
- White sugar yield (tons / fed) = white sugar % x roots yield (tons/ fed)
- Gross sugar yield (tons/ fed) = sucrose% x roots yield (tons/fed)
- Quality index = (white sugar % / sucrose %) x 100.

The plant water use efficiency ″ WUE‟ (kg/m^3 water) was determined as the total yield (kg/fed) divided by the amount of irrigation water applied (m^3/ fed) throughout the growing season.

Also, the nematode (J_2) in soil sample was extracted using Baermann′s method (Hussey and Barker, 1973; Barker, 1985). However, the different stages of nematode in roots samples were stained with acid fuchsin- lactophenol according to Byrd et al. (1983) and counted. The numbers of nematode in soil and root system were used to calculate the final nematode population (Pf) and reproductive factor Rf (Rf= Pf / Pi). Combined data of the two seasons were analyzed by MSTAT computer software and LSD (least significant differences) at 0.05 level of probability was used to compare among the treatments.

RESULTS AND DISCUSSION

In this study, the influence of deficit irrigation (DI) rates, 40, 60 and 80% of irrigation water requirements (IWR) were compared to full (100% IWR) irrigation treatment on reproduction parameters of root-knot nematode, *Meloidogyne javanica*, sugarbeet productivity and water use efficiency (WUE) for roots and sugar yields in sandy soil naturally contaminated with *M. javanica* at drip irrigated sugarbeet plants field under semi-arid conditions. The combined analysis of the obtained data at the end of the two growing seasons was tabulated (Tables 1 and 2).

Reproduction of root-knot nematode, *Meloidogyne javanica* on sugarbeet cv. Merador as influenced by different deficit irrigation rates

The results in Table (1) revealed the efficacy of the tested deficit irrigation (DI) rates on nematode reproduction parameters, final population (Pf) density and reproduction factor (Rf) on sugarbeet plants as compared with full (100% IWR) irrigation treatment. Data indicated that the DI rates have a significant ($P \leq 0.05$) affect Pf number. All studied

DI rates (40, 60 and 80% of IWR) significantly (P≤0.05) reduced the Pf number compared to those in the full (100% IWR) irrigation treatment Increasing DI rate significantly, (P≤0.05) decreased Pf number, and any increase in DI rate applied was followed by a respective decrease in number of Pf. When sugarbeet plants irrigated with 80, 60 and 40% of IWR DI rates, the Pf number of *M. javanica* nematode reduced from 26036 (at full irrigation rate of 100% IWR) to 18115, 9878 and 5371 juveniles, respectively. The highest (P≤0.05) significant reduction in Pf number was observed at the middle and high DI rates (60 and 40%), with an average of 62.06 and 79.37 %, respectively, while, the lowest one (30.42%) was achieved at low DI rate of 80% from IWR, compared to full (100% IWR) irrigation rate treatment, as shown in Table (1).

Moreover, data illustrated a negative and significant (P≤0.05) response of Rf value to the gradual increase in the DI rate. Increasing DI significantly, (P≤0.05) decreased Rf value, and any increase in DI rate was always followed by a significant decrease in value of Rf. Nematode, *M. javanica* on irrigated sugarbeet plants at full (100% IWR) irrigation rate recorded the highest (P≤0.05) significant Rf value (12.70- fold), followed by DI rates of 80, 60 and 40% of IWR, with an average of 8.84, 4.82 and 2.62 fold, respectively compared to initial nematode population (Pi).

Shortly, the values of Pf and Rf as reproduction parameters of root-knot nematode *M. javanica* were declined (P≤0.05) significantly with increasing DI rate from 100 to 80, 60 and 40% of IWR, and the lowest values of Pf number (5371) and Rf value (2.62-fold) were obtained at the highest DI rate (40% of IWR).as shown in Table (1).

Table 1: Reproduction of root-knot nematode, *Meloidogyne javanica* on sugarbeet cv. Merador as influenced by deficit irrigation rates in combined analysis of 2021/22 and 2022/23 growing seasons under field conditions**.**

Irrigation rates from IWR	Reproduction parameters		
	Final population density(P_f)		Reproduction Factor (R_f)
	Number	Reduction%	
100 %	26036[a]	-----	12.70[a]
80 %	18115[b]	30.42	8.84[b]
60 %	9878[c]	62.06	4.82[c]
40 %	5371[d]	79.37	2.62[d]

The means within columns followed by the same letters are not significantly different at 0.05 probability level. IWR= irrigation water requirements

The significant reduction in values of Pf and Rf of *M. javanica* at the DI rates of 60 and 40% from IWR could be attributed to the reduction in both irrigation water amount and soil moisture content. In general water and soil moisture are an important factor affecting nematode growth, development, survival and infection (Port, 1979; Towson and Apt, 1983, Duncan et al., 1998 and Hunter, 2000). Increasing water stress decreased the water from 1 to 10 bars around the root-knot nematode, *M. javanica*, which

increases the percentage second stage juvenile (J2) mortality and reduces the percentage of eggs hatching (Mohawesh and Karajeh, 2013).

In the same context, Davis et al. (2014) found that the root- knot nematode, *M. incognita* decreased as the level of irrigation water decreased. Mohawesh and Karajeh (2015*)* reported that the DI rates used at 80 and 60% of full irrigation rate had controlled the root-knot nematode. *M. javanica* in tomato and eggplant. Also, the number of galls caused by *M. javanica* root-knot nematode on eggplant roots was significantly low at DI rates of 20, 40 and 60% of field capacity (Fc), but the Pf was clearly lesser at DI rates of 20, 40% of Fc than both 80 and 100% of Fc rates. (Karajeh and Mohawesh, 2016). On the other hand, Maareg et al. (2018a) reported that the reduction in Pf and Rf values were decreased significantly at 75, 50 and 25% of IWR than that full (100% of IWR) irrigation rate treatment. The highest and lowest reduction were obtained at 25 and 75 % of IWR DI rates, respectively.

Yield components, quality index and water use efficiency of sugarbeet cv. Merador infesting with root-knot nematode, *Meloidogyne javanica* as influenced by different deficit irrigation rates

Data in Table (2) shows the effect of different deficit (DI) rates, 80, 60 and 40% from IWR on yield components of sugarbeet, (roots, gross sugar and white sugar yields and quality index as well as water use efficiency (WUE), compared with full (100% from IWR) irrigation rate treatment. Significant ($P \leq 0.05$) differences in yield components parameters, roots yield, gross sugar yield and white sugar yields, (tons/fed) due to DI rates application detected, the values of roots, gross sugar and white sugar yield (tons/fed) were gradually increased significantly as the DI rate decreased from 40 to 60% of IWR and reached their maximum values at the rate of 80% of IWR, to decrease at the full (100% IWR) irrigation rate.

In general, sugarbeet plants under the low DI (80% of IWR) were achieved the highest ($P \leq 0.05$) significant values for roots, gross sugar and white sugar yield, compared to plants under any of full (100% of IWR) irrigation rate and other DI rates (40 and 60% of IWR). The irrigated sugarbeet plants at high DI rates of 40 and 60% from IWR were recorded the lowest significant ($P \leq 0.05$) values of roots (11.21 and 15.63), gross sugar (1.87 and 2.67), white sugar (1.47 and 2.12 tons/fed), respectively, than those irrigated at low DI and full irrigation rates (80 and 100% of IWR), but plants irrigated at low DI rate (80% f IWR) were obtained the highest ($P \leq 0.05$) significant values for their yields (roots, gross sugar and white sugar with an average of (21.85, 3.75 and 3.15 tons/fed, respectively), compared to plants irrigated at full (100% of IWR) irrigation rate (18.29, 3.10 and 2.50 tons/fed, respectively), as shown in Table (2).

From previous results sugarbeet plants under the low DI rate (80% from IWR) were achieved the highest significant values for yield components, compared to plants under any of full (100%) irrigation rate and other DI rates (40 and 60 % of IWR). The increase in the roots, gross sugar, and white sugar yields at the DI rate of 80% is significantly higher than those at the full (100%) irrigation treatment by 19.46, 20.97 and 26.0 %., respectively.

The high sugarbeet productivity at the DI rate 80% of IWR could be attributed to the production of chemical signals inside the plant root cells (i.e. absicisic acid), which translocated to the leaves allowing the plant for better adaptation against drought (Sahim et al., 2014).

Table 2: Yield components, quality index % and water use efficiency (WUE) of sugarbeet infesting with, *Meloidogyne javanica* root-knot nematode as influenced by deficit irrigation rates in combine analysis of 2012/22 and 2022/23 growing seasons under field condition.

Irrigation rates for IWR	Root yield tons fed^{-1}	Gross sugar yield tons fed^{-1}	White sugar yield tons fed^{-1}	Quality index %	Water use efficiency (WUE) Kg/ m^3 for		
					Roots yield Kg/m^3 water	Gross sugar yield Kg/m^3 water	White sugar yield Kg/m^3 water
100 %	18.29[b]	3.10[b]	2.50	80.64[b]	7.47[d]	1.27[c]	1.02[d]
80 %	21.85[a]	3.75[a]	3.15	84.64[a]	11.15[b]	1.91[a]	1.61[a]
60 %	15.63[c]	2.67[c]	2.12	79.39[c]	10.63[c]	1.82[b]	1.44[c]
40 %	11.21[d]	1.87[d]	1.47	78.50[c]	11.44[a]	1.90[a]	1.50[b]

The means within columns by the same letters are not significantly different at 0.05 probability level.
IWR= irrigation water requirements

In addition, in this study the DI rate of 80% from IWR significantly reduced the damage size caused by nematode on sugarbeet, compared to the full (100%) irrigation rate. Besides reducing nematode infestation, the sugarbeet productivity was enhanced (Maareg et al., 2018a). On the other hand, the reduction in the productivity of sugarbeet at DI rate of 40% could be referred to the reduction in biomass production (Kirnak et al., 2001) and the reduction in soil moisture, which could influence nutrients uptakes and its rate of diffusion which in turn reduced the root elongation (Eid and Ibrahim, 2010; Grzebisz et al., 2013).

Deficit irrigation (DI) rates significantly ($P \leq 0.05$) influenced quality index. Decreasing DI rate from 40 to 60 and 80% from IWR achieved variant effects on quality index compared with full (100% of IWR) irrigation rate. Application of rate of 80% from IWR significantly increased quality index (84.64) value by 7.0%, however, application of the rates of 60% (79.39) and 40% (78.50) from IWR significantly ($P\leq 0.05$) decreased such trait by 1.6 and 2.7 %, respectively as compared to 80.64 (full 100% of IWR) irrigation rate, as shown in Table (2).

Also, deficit irrigation rates had a significant ($P \leq 0.05$) effect on water use efficiency (WUE) for roots, gross sugar and white sugar yields (kg/m^3 water). The values of WUE were significantly ($p \leq 0.05$) higher for sugarbeet plants irrigated with tested DI rates, 80, 60 and 40% from IWR when compared with plants irrigated with the full (100%) irrigation rate. The highest values of WUE for roots yield (11.15 and 11.44), gross sugar yield (1.91 and 1.90) and white sugar yield (1.61 and 1.50 kg /m^3 water) were recorded with plants irrigated at the lowest and highest DI rates of 80 and 40% from IWR, respectively(compared the DI rates 60 and 100% IWR). However, the lowest WUE values, 7.47, 1.27 and 1.02 kg/m^3 water for roots, gross sugar white sugar yield, respectively were recorded with plants irrigated with the full (100% from IWR) treatment. The increase in WUE values for treatment sugar yields due to both decrease in pf and Rf of nematode on sugarbeet and increase in productivity of sugarbeet. The economical yield of sugarbeet is gross sugar and white sugar, the increase in WUE values of gross sugar and white sugar was 50.39 and 57.84%, respectively, at 80% DI rate, compared to common treatment (100% of IWR).

The results revealed that the yield components, quality index and water use efficiency (WUE) of drip- irrigated sugarbeet plants (grown in sandy soil natural infested with root- knot nematode) were recorded the highest values under DI rate of 80% from IWR. compared to the 60% and full (100% of IWR) irrigation rates. Results of previous studies on the effect of deficit irrigation rates on the productivity and quality of sugarbeet plants grown in sandy soils free of plant parasitic nematodes infection under drip – irrigation system indicated that: used DI rates, 60, 80 and 100% from IWR had a not significant influence on the produced roots, gross sugar and white sugar yields of sugarbeet, while, the highest significant of quality index was recorded at DI rate of 60% from IWR (Abdel-Nasser et al., 2014). In addition, irrigation sugarbeet plants with DI rate of 75% of IWR recorded the highest significant white sugar and purity percentage values (El- Kady, 2015; Masri et al., 2015 and Makhlouf and Abd El- All, 2017) reported that the highest values of gross sugar and roots yield of sugarbeet, were recorded at full (100% of IWR) irrigation rate compared to the high DI rate of 60% of IWR. However, the highest and lowest values of WUE for both roots and gross sugar yield were obtained by 60% and full (100%from IWR irrigation rates, respectively. The middle DI rate of 80% from IWR) gave the highest significant value of purity %. Also, El-Kholy (2017) found that decreasing drip irrigation rate to 1500m^3resulted in the highest WUE values, while increasing it to 2000 and 2500 m3 increased yield of the roots, gross sugar and white sugar and purity % values. Increasing DI rate from 80 to 60 and 40% from IWR resulted in the lowest and the highest values of sugarbeet productivity and WUE, respectively (El- Kady et al., 2019).

This study showed a high reduction in root – knot nematode infection level, high productivity of crop yields and high increase in crop yield production per cubic water unit (m^3) can be achieved using the DI rate of 80% from IWR. In addition, DI technique show the ability to save irrigation water, especially in areas with limited water.

In conclusion, the deficit irrigation rate of 80% of IWR achieved four major benefits: reducing damage caused by nematodes, increasing yield and quality, saving irrigation water and improving water use efficiency. Therefore, the DI rate of 80% of IWR can be used to enhance the efficiency of current integrated pest control programs to control root knot in drip-irrigated sugarbeet fields in sandy soils under semi-arid condition.

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DECLARATION

The authors declare that they do not have any actual or potential conflict of interest.

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الملخص العربى

تكاثر نيماتودا تعقد الجذور والانتاجية المحتملة للمحصول وكفاءة استخدام المياة فى حقول بنجر السكر المروية بالتنقيط وتأثرها بنقص المياه فى ظل الظروف شبة القاحلة

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نظرا لندرة المياه فى مصر والتناقص الشديد فى مصادرها خاصتا فى الاراض الرملية المستصلحة حديثا شديدة الاصابة بالنيماتودا وتماشيا مع الزراعة المستدامة وتقليل الفقد فى المياة والمحافظة عليها اقيمت تجربتان حقليتان فى موسمين (٢٢/٢٠٢١ ، ٢٣/٢٠٢٢) بمنطقة غرب النوبارية شبة الجافة فى ارض رملية شديدة الاصابة بنيماتودا تعقد الجذور (ميلويدوجين جافانيكا) بهدف دراسة تأثير ثلاث معدلات من الاجهاد المائى (٤٠ ، ٦٠ ، ٨٠ % من الاحتياجات المائية للمحصول) مقارنة بكمية مياة الرى الشائع استخدامها (١٠٠% من الاحتياجات المائية) على تكاثر النيماتودا وتعدادها والانتاجية المحتملة للمحصول وكفاءة استخدام المياه فى حقول بنجر السكر تحت نظام الرى بالتنقيط .

واظهرت النتائج الاتى :

- التعداد النهائى ومعدل التضاعف لنيماتودا تعقد الجذور (ميليدوجين جافانيكا) قل معنويا مع معدلات الاجهاد المائى ٤٠ ، ٦٠ ، ٨٠ % من الاحتياجات المائية مقارنة بالمعدل ١٠٠% من كمية مياه الرى الشائع استخدامه .
- تزايد معدل الاجهاد من ١٠٠ الى ٨٠ ، ٦٠ ، ٤٠ % من الاحتياجات المائية قلل من التعداد النهائى للنيماتودا معنويا من ٢٦٣٦٠ الى ١٨١١٥ ، ٩٨٧٨ ، ٥٣٦١ وقلل معدل التضاعف معنويا من ١٢,٧٠ الى ٨,٨٤ ، ٤,٨٢ ، ٢,٦٢ (ضعفا من التعداد الاولى) . على التوالى.
- معدل ٨٠% من الاحتياجات المائية حقق اعلى قيم لمحصول الجذور ومحصول السكر الخام ومحصول السكر الابيض وكذلك اعلى نسبة نقاوة (٢١,٨٥ ، ٣,٧٥ ، ٣,١٥ طن / فدان ، ٨٤,٦٤ % على التوالى) بينما اقل قيم لها (١١,٢١ ، ١,٨ ، ١,٤٧ طن/فدان ، ٧٨,٥٩ % على التوالى) حققت بالمعدل ٤٠% من الاحتياجات المائية ، مقارنة بالمعدل ١٠٠%
- اعلى قيم معنوية للاستفادة من استخدام المياه لمحصول السكر الخام (١,٩١ طن/ م٣ مياه) ولمحصول السكر الابيض (١,٦١ طن/ م٣ مياه) . كمحصولان اقتصاديان لبنجر السكر ايضا سجلت مع المعدل (٨٠% من الاحتياجات المائية) بينما اقل قيم لهما (١,٢٧ طن سكر خام / م٣ مياه ، ١,٠٢ طن سكر ابيض / م٣ مياه) سجل مع المعدل ١٠٠%.

مما سبق نجد لمعدل الاجهاد المائى (٨٠ % من الاحتياجات المائية) اربع فوائد كبيرة :

١- توفير مياة الرى
٢- تقليل الضرر الناتج عن الاصابة بالنيماتودا
٣- زيادة المحصول وجودتة
٤- زيادة كبيرة فى كفاءة استخدام المياه

ومن هذة النتائج يمكن استخدام معدل الاجهاد ٨٠% من الاحتياجات المائية لتحسين فعالية استراتجيات المكافحة الحالية لمكافحة نيماتودا تعقد الجذور فى حقول بنجر السكر المروية بالتنقيط فى الاراضى الرملية فى ظل الظروف شبة القاحلة.