The physiological effect of pre-soaking with tryptophan on sugar beet (*Beta vulgaris* L.) productivity under different levels of salinity stresses

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**Abstract**

Background: Salinity has a negative effect on the productivity of many crops. Therefore, the present study was conducted to investigate the effect of pre-soaking in different concentrations of tryptophan (0.0, 2.5, and 5.0 mM) on growth, yield and root quality of two sugar beet cultivars (DS-9004 and LP-15) under different salinity levels (320, 2000, 4000, 6000, and 8000 ppm) in an effort to reduce salinity damage on sugar beet. The data were collected at 2 stages of growth (75 and 180 days after sowing).

Results: The results revealed that the pre-soaking in tryptophan treatments (2.5 mM) were the most effective treatments under different salinity levels and caused significant increases in all tested parameters of this study. Moreover, increasing salinity levels decreased significantly the root purity parameters and increased impurity parameters of sugar beet. The DS-9004 cultivar gave the highest values of all studied parameters compared with the LP-15 cultivar under different salinity levels with tryptophan (2.5 mM). Chlorophyll a content and chlorophyll a/b ratio, as well as carotenoids content, were highest in DS-9004 cultivar, while chlorophyll b content was highest in LP-15 cultivar at 75 days.

Conclusions: Salinity level up to 320 ppm positively affected the growth yield of sugar beet while the highest significant reduction was associated with increasing salinity up to 8000 ppm. Thus, pre-soaking in tryptophan (2.5 mM) has a promotive effect on increasing sugar beet yield under water salinity conditions.

Keywords: Salinity, Sugar beet, Pre-soaking, Tryptophan, Growth, Yield, Root quality

**Background**

Sugar beet (*Beta vulgaris* L.) family Chenopodiaceae is one of the world’s leading sugar crops. It is the second main source of sugar after sugar cane, it contains sucrose up to 21% (Memon et al., 2004). Worldwide, the area of sugar beet cultivated, total production (ton) and average root yield (ton ha\(^{-1}\)) reached to 4.47 million ha, 266.8 million tons, and 59.6 ton ha\(^{-1}\) (FAOSTAT, 2016). Sugar beet has stronger salt-tolerant characteristics than other crops.

It is a dicotyledonous plant with high economic value in many countries. In Egypt, the sugar industry depends mainly on sugar cane and sugar beet crops. The total production of sugar beet in 2016 was about 13,323,369 tons with an area of 254,991 ha with an average root yield of 52.3 ton/ha\(^{-1}\) (ha = 2.38 fed). Sugar beet produced 1.25 million tons of sugar represented about 50% of the local production (FAOSTAT, 2016).

Salinity stress is a major limitation of global crop production. Soil salinity is adversely affecting physiological and metabolic processes, finally diminishing growth and yield (Hozayn et al., 2019). Excessive salts injure plants by disturbing the uptake of water into roots and interfering with the uptake of competitive nutrients (Franzen,
Reduction in plant growth has also been attributed to reduce water absorption and osmotic effect, nutritional deficiency on account of ionic imbalance and decrease in many metabolic activities (Rezaee et al., 2012). Several studies have reported that salinity hurts hormones hence germination (Debez et al., 2001).

Amino acids play an important role in plant tolerance to salinity conditions, amino acids act as antioxidants or activators of phytohormones which increases the productivity and quality of sugar beet (El-Gamal et al., 2016). Many previous studies which reported that tryptophan is one of the amino acids that play a vital role for improving plant growth (El-Bassiouny, 2005) through the availability of nutrients and tryptophan (Abbas et al., 2013) protects plants (Hussein et al., 2014) regulating ion transport and remove toxic substances of heavy metals (Rai, 2002). Spraying plant leaves with tryptophan stimulate growth regulators and photosynthesis that reflected improves plant growth (Bakry et al., 2016). As the performance of pre-soaked seeds in tryptophan is much better than untreated under salinity conditions (Saranya, 2017). Therefore, this study aimed to use the pre-soaking with tryptophan to alleviate the negative effects of salinity stress conditions and improve sugar beet yield and quality.

Materials and methods
A pot experiment was performed at the screen greenhouse of Field Crops Research Department, National Research Centre, Dokki, Giza, Egypt, to study the effect of pre-soaking of two cultivars (DS-9004 and LP-15) sugar beet seeds (Table 1) in different concentrations of tryptophan (0.0, 2.5, and 5.0 mM) on growth, yield, and root quality of sugar beet plants grown under different salinity levels (320, 2000, 4000, 6000, and 8000 ppm). Sugar beet seeds were soaked in different tryptophan concentrations for 6 h before sowing. The treatments were arranged in a split-plot in CRD design where salinity levels and tryptophan concentrations were allocated in the main and sub-plot, respectively. The sugar beet soaked seeds were sown in pots (50 cm in diameter) containing equal amounts of sand and clay (1:1) soil. Each treatment consisted of 4 replicates. The pots were irrigated with equal volumes of the various salinity levels after 21 days from sowing. Irrigation was run as follows 3 times with saline solutions and one with tap water. NPK fertilization was done as the recommended rate. After 15 days from sowing, thinning was carried out, so as two uniform seedlings were left in each pot for studying the effect of different treatments on the yield and quality of sugar beet cultivars under different treatments.

After 75 days from sowing, one plant was taken from each pot to determine root length and diameter (cm), fresh and dry weight (g). Photosynthetic pigments in leaves were determined using a spectrophotometer. At harvest, a sample of fresh roots was taken from each treatment and sent to the Beet Laboratory at Nubaria Sugar Factory to determine root quality. Alpha-amino nitrogen (α-amino-N), sodium (Na), and potassium (K) concentrations were estimated according to the procedure of Sugar Company by Auto Analyzer described by Cooke and Scott (1993). TSS and sucrose percentage estimated in fresh samples of sugar beetroot by using a saccharometer according to the method described by AOAC (1995). Sugar loss was calculated using the following formula: Sugar loss % = 0.29 + 0.343 (K + Na) + 0.094 α-amino-N, Sugar recovery % was calculated using the following equation: Sugar recovery (%) = sucrose (%) − sugar loss (%) (Cooke and Scott, 1993). Recoverable sugar yield (g plant\(^{-1}\)) was calculated using the following equation of Mohamed (2002): Recoverable sugar yield = root yield (g plant\(^{-1}\) × sugar recovery. Quality index was calculated as (sugar recovery (%) × 100)/sucrose (%). Gross sugar yield (g plant^{-1}) = root yield (g plant\(^{-1}\) × sucrose (%). Sugar loss yield was computed as root yield (g plant\(^{-1}\) × sugar loss.

The values of all parameters were statistically analyzed to find out the level of significance using MSTAT-C package program (MSTAT-C, 1983). The mean differences were compared by the least significant difference test (LSD) at 5% level of significance.

Results
Effect of pre-soaking with tryptophan on root parameters of sugar beet at 75 days after sowing under different salinity levels
Data in Table 2 clearly indicated that pre-soaking sugar beet seeds with tryptophan (2.5 mM) under different salinity levels increased significantly sugar beetroot parameters, i.e., root length and diameter (cm), root fresh and dry weight (g) at 75 days after sowing as compared with tryptophan 0.0 and 5.0 mM. On the other hand, with an increase in the salinity of irrigation water up to 8000 ppm, there was a decrease in the values of all these parameters. In all the cases, the increment in root parameters in DS-9004 cultivar was more than LP-15 cultivar as roots length (18.77 cm), root diameter (6.10 cm), and root fresh weight (9.83 g) with tryptophan (2.5 mM) under salinity level at 320 ppm. Whilst, LP-15 cultivar was suppressed in root dry weight (2.99 g) with tryptophan

| Table 1 | Origin and sources of sugar beet (Beta vulgaris L) cultivars used in this study |
|---------|-------------------------------------|
| Cultivars | DS-9004 | LP-15 |
| Seeds | Multigerm | Multigerm |
| Origin | Denmark | France |
| Source | *SCRI | *SCRI |

*Sugar Crops Research Institute, Agricultural Research Centre, Ministry of Agriculture, Giza, Egypt
(2.5 mM) under salinity level at 320 ppm. Maximal root parameters were recorded with tryptophan (2.5 mM) under salinity level at 320 ppm for DS-9004 cultivar.

Effect of pre-soaking with tryptophan on photosynthetic pigment contents under different salinity levels at 75 days after sowing

**Photosynthetic pigment**

The results in Table 3 indicated the pre-soaking in tryptophan (2.5 mM) had increased significantly each of chlorophyll a, b, and carotenoids contents compared with other treatments (tryptophan 0.0 and 5.0 mM) at 75 days after sowing under salinity level at 320 ppm. Therefore, the highest value of chlorophyll a (15.62 mg/g f.w.) was obtained with tryptophan (2.5 mM) for DS-9004 cultivar. While the highest value of chlorophyll b (7.04 mg/g f.w.) with tryptophan (2.5 mM) for LP-15 cultivar. On the other hand, chlorophyll a/b ratio insignificantly affected by the pre-soaking treatments under different salinity levels.
levels. Accordingly, the greatest chlorophyll a/b ratio (2.94 mg/g f.w.) was recorded without tryptophan (0.0 mM) under salinity level at 8000 ppm for DS-9004 cultivar. While, the lowest chlorophyll a/b ratio (1.81 mg/g f.w.) was obtained with tryptophan (2.5 mM) under salinity level at 320 ppm for LP-15 cultivar. Tryptophan treatment at 2.5 mM was the most pronounced treatment and caused the highest significant increase in carotenoids content (4.64 mg/100 g f.w.) under salinity level at 320 ppm for DS-9004 cultivar.

Increasing salinity level (more than 6000 ppm) decreased significantly photosynthetic pigment contents of all pre-soaking treatments.

Effect of pre-soaking with tryptophan on root parameters of sugar beet under different salinity levels at harvest (180 days after sowing)

Table 4 indicated that pre-soaking with tryptophan (2.5 mM) was the most pronounced treatment and caused the highest significant increase in root

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### Table 3: Effect of pre-soaking two sugar beet seed cultivars with tryptophan and irrigated with different salinity levels on photosynthetic pigment contents (mg/100 g fresh weight) at 75 days after sowing

| Treatments | Photosynthetic pigment (mg/100 g fresh weight) |
|------------|-----------------------------------------------|
| Salinity (ppm) | Chl. A | Chl. B | Chl. A/B | Carotenoids |
| DS-9004 | LP-15 | DS-9004 | LP-15 | DS-9004 | LP-15 | DS-9004 | LP-15 |
| 320 | 0.0 | 11.90 | 11.67 | 5.26 | 6.29 | 2.26 | 1.85 | 3.87 | 3.35 |
| | 2.5 | 15.62 | 12.74 | 6.36 | 7.04 | 2.45 | 1.81 | 4.64 | 4.24 |
| | 5.0 | 15.33 | 12.55 | 5.93 | 6.43 | 2.59 | 1.95 | 4.41 | 4.06 |
| 2000 | 0.0 | 11.66 | 10.99 | 5.13 | 5.75 | 2.27 | 1.91 | 3.43 | 2.82 |
| | 2.5 | 14.85 | 12.15 | 6.09 | 6.17 | 2.44 | 1.97 | 4.46 | 3.89 |
| | 5.0 | 14.48 | 11.58 | 5.86 | 6.09 | 2.47 | 1.90 | 3.95 | 3.28 |
| 4000 | 0.0 | 9.80 | 10.76 | 4.08 | 5.38 | 2.40 | 2.00 | 3.11 | 2.31 |
| | 2.5 | 12.85 | 11.91 | 5.92 | 5.87 | 2.17 | 2.03 | 4.23 | 3.62 |
| | 5.0 | 12.66 | 11.48 | 5.83 | 5.70 | 2.17 | 2.01 | 3.87 | 2.73 |
| 6000 | 0.0 | 9.20 | 10.35 | 4.20 | 4.70 | 2.19 | 2.20 | 3.07 | 2.27 |
| | 2.5 | 12.55 | 11.75 | 5.78 | 5.49 | 2.17 | 2.14 | 4.23 | 3.19 |
| | 5.0 | 12.37 | 10.84 | 5.72 | 5.31 | 2.16 | 2.04 | 3.34 | 2.72 |
| 8000 | 0.0 | 8.92 | 8.21 | 3.03 | 3.97 | 2.94 | 2.07 | 2.95 | 2.03 |
| | 2.5 | 10.98 | 10.16 | 5.72 | 4.49 | 1.92 | 2.27 | 3.60 | 2.95 |
| | 5.0 | 10.31 | 9.66 | 5.29 | 4.38 | 1.95 | 2.21 | 3.26 | 2.50 |

LSD₅%

| Variety | DS-9004 | LP-15 |
|---------|---------|-------|
| Mean of main effects |
| Variety | DS-9004 | 12.23 | 5.35 | 2.30 | 3.76 |
| | LP-15 | 11.12 | 5.54 | 2.02 | 3.06 |
| Mean of main effects |
| Salinity (ppm) | 320.0 | 13.30 | 6.22 | 2.15 | 4.10 |
| | 2000.0 | 12.62 | 5.85 | 2.16 | 3.64 |
| | 4000.0 | 11.58 | 5.46 | 2.13 | 3.31 |
| | 6000.0 | 11.18 | 5.20 | 2.15 | 3.14 |
| | 8000.0 | 9.71 | 4.48 | 2.23 | 2.88 |

LSD₅%

| Variety | DS-9004 | LP-15 |
|---------|---------|-------|
| Try. (mM) |
| 0.0 | 8.62 | 3.98 | 1.84 | 2.43 |
| 2.5 | 10.46 | 4.91 | 1.78 | 3.25 |
| 5.0 | 10.10 | 4.71 | 1.79 | 2.84 |

LSD₅%

| Variety | DS-9004 | LP-15 |
|---------|---------|-------|
| ns non significant |
| aSignificant |

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parameters under different salinity levels. Whereas, the highest value of root length (26.00 cm) were observed with tryptophan (2.5 mM) under two salinity levels (320 and 4000 ppm) for DS-9004 cultivar. The highest value of root diameter (20.00 cm) with tryptophan (2.5 mM) under salinity level at 320 ppm for DS-9004 and LP-15 cultivars, while the significant highest root fresh weight (208.00 g/plant) was exhibited with tryptophan (2.5 mM) under level 320 ppm of salinity for LP-15 cultivar. Furthermore, sugar beet was significantly affected by the high level of salinity (8000 ppm) that was significantly decreased in root parameters with all pre-soaking treatments.

**Effect of pre-soaking with tryptophan on shoot parameters of sugar beet under different salinity levels at harvest (180 days after sowing)**

Table 5 showed that pre-soaking with tryptophan (2.5 mM) significantly increased sugar beet shoot parameters of sugar beet at 180 days after sowing as compared with

| Treatments | Root parameters at harvest | | | |
|------------|--------------------------|---|---|---|
| Salinity (ppm) | Try. (mM) | DS-9004 | LP-15 | DS-9004 | LP-15 | DS-9004 | LP-15 |
| 320 0.0 | 24.00 | 21.50 | 16.00 | 15.00 | 145.00 | 174.00 | 2.5 | 26.00 | 24.00 | 20.00 | 20.00 | 207.00 | 208.00 | 5.0 | 25.00 | 20.00 | 19.00 | 18.00 | 181.00 | 193.00 |
| 2000 0.0 | 22.00 | 18.50 | 15.00 | 14.00 | 107.00 | 145.00 | 2.5 | 25.00 | 22.00 | 18.00 | 18.00 | 185.00 | 187.00 | 5.0 | 24.00 | 20.00 | 17.00 | 16.00 | 163.00 | 175.00 |
| 4000 0.0 | 20.00 | 18.00 | 15.00 | 12.00 | 126.00 | 124.00 | 2.5 | 26.00 | 20.00 | 19.00 | 17.00 | 183.00 | 172.00 | 5.0 | 23.00 | 19.00 | 16.00 | 15.00 | 156.00 | 159.00 |
| 6000 0.0 | 19.00 | 18.00 | 13.00 | 12.00 | 95.00 | 120.00 | 2.5 | 24.00 | 19.00 | 16.00 | 16.00 | 151.00 | 165.00 | 5.0 | 21.00 | 18.00 | 14.00 | 14.00 | 141.00 | 147.00 |
| 8000 0.0 | 15.00 | 14.00 | 10.00 | 10.00 | 113.00 | 105.00 | 2.5 | 22.00 | 16.00 | 12.00 | 14.00 | 144.00 | 135.00 | 5.0 | 18.50 | 15.00 | 11.00 | 12.00 | 136.00 | 133.00 |

**LSD<sub>5%</sub>**

| 1.77 | 0.15 | 5.79 |

**Mean of main effects**

| Variety | DS-9004 | LP-15 |
|---------|---------|-------|
| 22.30 | 15.40 | 148.87 |
| 18.87 | 14.87 | 156.13 |

**F sig.**

| Salinity (ppm) | 320.0 | 2000.0 | 4000.0 | 6000.0 | 8000.0 |
|----------------|-------|--------|--------|--------|--------|
| DS-9004 | 23.42 | 21.92 | 21.00 | 19.83 | 16.75 |
| LP-15 | 18.00 | 16.33 | 15.67 | 14.17 | 11.50 |

**LSD<sub>5%</sub>**

| 1.29 | 0.11 | 4.23 |

**Try.(mM)**

| 0.0 | 2.5 | 5.0 |
|-----|-----|-----|
| 15.83 | 18.67 | 16.96 |
| 11.00 | 14.17 | 12.67 |

**LSD<sub>5%</sub>**

| 0.97 | 0.08 | 3.17 |

*ns non significant
*aSignificant
other treatment (tryptophan 0.0 and 5.0 mM) under the different salinity levels. The highest values of shoot length (32.00 cm), shoot fresh weight (299.00 g/plant) were revealed with tryptophan (2.5 mM) under salinity level at 320 ppm for LP-15 and DS-9004 cultivars, respectively. Concerning the effect of different salinity levels, increasing salinity levels (more than 320 ppm) caused a significant reduction in shoot parameters of all pre-soaking treatments.

| Treatment | Salinity (ppm) | Try. (mM) | Shoot parameters at harvest |
|-----------|----------------|-----------|-----------------------------|
|            |                |           | Length (cm) | Fresh wt. (g) |
| DS-9004   | 320            | 0.0       | 26.00       | 222.00        |
|           |                | 2.5       | 29.00       | 299.00        |
|           |                | 5.0       | 28.00       | 279.00        |
| LP-15     | 2000           | 0.0       | 24.00       | 217.00        |
|           |                | 2.5       | 29.00       | 273.00        |
|           |                | 5.0       | 28.00       | 260.00        |
| DS-9004   | 4000           | 0.0       | 24.00       | 194.00        |
|           |                | 2.5       | 28.00       | 268.00        |
|           |                | 5.0       | 27.00       | 256.00        |
| LP-15     | 6000           | 0.0       | 23.00       | 189.00        |
|           |                | 2.5       | 25.00       | 230.00        |
|           |                | 5.0       | 24.00       | 223.00        |
| DS-9004   | 8000           | 0.0       | 20.00       | 183.00        |
|           |                | 2.5       | 23.00       | 218.00        |
|           |                | 5.0       | 21.00       | 195.00        |

**LSD5%**

| Variety | DS-9004 | LP-15 |
|---------|---------|-------|
| Salinity (ppm) | 25.27 | 25.13 |
| F sig. | a | a |
| Salinity (ppm) | 29.33 | 27.33 |
| F sig. | a | a |
| Salinity (ppm) | 26.00 | 16.00 |
| F sig. | a | a |
| Salinity (ppm) | 23.17 | 18.17 |
| F sig. | a | a |
| Salinity (ppm) | 20.17 | 16.00 |
| F sig. | a | a |

**LSD5%**

| Try. (mM) | 0.0 | 2.5 | 5.0 |
|-----------|-----|-----|-----|
| DS-9004   | 19.08 | 22.92 | 21.00 |
| LP-15     | 149.83 | 182.50 | 171.33 |

**LSD5%**

| ns non significant | Significant |

**Discussion**

The above results revealed that the highest root parameters were obtained with tryptophan (2.5 mM) under salinity level at 320 ppm, but the lowest significant increments were noticed when sugar beet plants were subjected to a high level of salinity (8000 ppm). This reduction in plant growth caused by high salinity due to the osmotic effect and adversely affecting physiological and metabolic processes (Hozayn et al., 2019). These results are consistent with that obtained by Hajiboland et al. (2009) which found that sugar beet had a significant growth under moderate salinity levels. The previous studies showed that pre-soaking in tryptophan has increased the growth of many crops like snap bean plants (El-Awadi et al., 2011); chickpea (Abbas et al., 2013); wheat (Mohite, 2013), and quinoa (Bakry et al., 2016). Regarding photosynthetic pigment, results indicated that the pre-soaking treatments had a significant effect on photosynthetic pigment under different salinity levels at 75 days after sowing as compared with control (tryptophan 0.0 mM). Also, Kandil et al. (2001) revealed that
photosynthetic pigments content in sugar beet leaves after 90 days from sowing, significantly affected by varieties. Otherwise, with increasing salinity levels more than 6000 ppm, there was a decrease in values of all these parameters. These results are in agreement with Khan et al. (2006) and El-Tantawy et al. (2006) who found that chlorophyll a, b, and carotenoids were reduced by 6000, 10,000, and 14,000 ppm. Dadkhah (2011) who found that photosynthesis of leaves was decreased in two cultivars with increasing salinity. Bakry et al. (2016) mentioned that foliar application of tryptophan under water deficit (skipping irrigation) enhanced the growth by stimulating growth regulators level (IAA) and protecting the photosynthetic apparatus. El-Awadi et al. (2017) who found that chlorophyll a, b, and carotenoids were increased under the effect of IAA, tryptophan as seed priming.

That acts on the imbalance of internal hormones, thus inhibiting plant growth (Younis et al., 2003). Results indicate that the pre-soaking treatments were significantly to alleviate the harmful effect of salinity stress on root and shoot parameters at 180 days after sowing as compared with control (tryptophan 0.0 mM). It was noticed that a significant decrease has existed in root and shoot parameters with increasing salinity levels. These results agreed with those reported by Jamil and Rha (2007) who indicated that sugar beet plants grown under salinity stress exhibited decreased significantly in root and shoot dry weight with the increase in salt concentration. Khayamim et al. (2014) reported that salinity stress decreased root yield. With regard to the effect of amino acids, El-Desouky et al. (2011) and Abd El-Aal (2012) showed that the amino acids treatment significantly increased growth parameters as diameter and stem length,

### Table 6: Effect of soaking two sugar beet seed cultivars with tryptophan and irrigated with different salinity levels on root quality parameters at harvest (180 days after sowing)

| Treatments   | Root purity | Impurity parameters |
|--------------|-------------|---------------------|
|              | Sugar %     | Purity              | K     | Na     | Alfa Amino-N |
|              | DS-9004     | DS-9004             | DS-9004 | LP-15  | DS-9004     | LP-15  | DS-9004 | LP-15  | DS-9004 | LP-15  | DS-9004 | LP-15  |
| Salinity (ppm) | Try. (mM) |            |            |            |            |            |            |            |            |            |            |            |            |
| 320          | 0.0        | 16.15         | 14.41      | 74.69      | 74.00      | 3.27       | 2.52       | 5.82       | 7.02       | 3.42       | 4.02       |
|              |            | 17.71         | 14.96      | 81.92      | 85.30      | 2.04       | 1.91       | 2.16       | 1.91       | 2.25       | 2.17       |
|              |            | 16.77         | 14.48      | 80.95      | 80.99      | 2.20       | 2.59       | 3.31       | 3.23       | 3.89       | 2.94       |
|              | 2.5        | 16.13         | 13.10      | 74.03      | 72.14      | 3.48       | 2.52       | 6.74       | 7.83       | 3.56       | 4.29       |
|              |            | 17.25         | 14.95      | 80.67      | 80.97      | 2.22       | 2.19       | 2.44       | 1.99       | 2.39       | 3.00       |
|              |            | 16.15         | 13.81      | 79.34      | 80.28      | 2.57       | 2.47       | 3.69       | 3.30       | 3.07       | 3.08       |
| 2000         | 0.0        | 15.25         | 12.31      | 71.83      | 69.83      | 3.79       | 3.19       | 7.12       | 8.51       | 3.58       | 4.61       |
|              |            | 15.92         | 13.98      | 78.45      | 80.20      | 2.27       | 2.22       | 3.70       | 3.20       | 3.42       | 3.08       |
|              |            | 15.59         | 13.12      | 78.13      | 76.99      | 2.63       | 2.70       | 3.94       | 3.62       | 3.56       | 3.20       |
|              | 2.5        | 14.75         | 12.25      | 64.81      | 65.29      | 4.21       | 3.21       | 8.19       | 9.26       | 3.91       | 5.77       |
|              |            | 15.25         | 13.12      | 76.46      | 76.21      | 2.45       | 2.65       | 4.07       | 3.38       | 3.64       | 3.83       |
|              |            | 14.96         | 12.08      | 76.42      | 75.69      | 2.81       | 3.02       | 4.68       | 3.65       | 3.93       | 4.05       |
| 4000         | 0.0        | 13.62         | 11.58      | 64.00      | 64.16      | 4.64       | 3.82       | 8.32       | 9.59       | 4.67       | 5.83       |
|              |            | 15.23         | 11.98      | 74.19      | 76.19      | 2.66       | 4.00       | 5.76       | 3.41       | 3.75       | 4.45       |
|              | 2.5        | 14.46         | 11.71      | 67.38      | 71.59      | 3.10       | 4.03       | 6.27       | 3.97       | 4.28       | 5.21       |
| Mean of main effects | |            |            |            |            |            |            |            |            |            |            |            |
| Variety      | DS-9004    | 15.68         | 74.88      | 2.96       | 5.08       | 3.55       |
|              | LP-15      | 13.19         | 75.32      | 2.87       | 4.92       | 3.97       |
| Salinity (ppm) | 320.0     | 15.75         | 79.64      | 2.42       | 3.91       | 3.12       |
|              | 2000.0     | 15.23         | 77.91      | 2.58       | 4.33       | 3.23       |
|              | 4000.0     | 14.36         | 75.91      | 2.80       | 5.02       | 3.58       |
|              | 6000.0     | 13.74         | 72.48      | 3.06       | 5.54       | 4.19       |
|              | 8000.0     | 13.10         | 69.59      | 3.71       | 6.22       | 4.70       |
| Try. (mM)   | 0.0        | 11.63         | 57.90      | 2.89       | 6.53       | 3.64       |
|             | 2.5        | 12.53         | 65.88      | 2.05       | 2.67       | 2.67       |
|             | 5.0        | 11.93         | 63.98      | 2.34       | 3.31       | 3.10       |
number of branches and leaves/plant, fresh and dry weight of stems and leaves, total leaf area/plant, and specific leaf weight. Abdelraouf (2017) found that increasing salt concentration decreased significantly the growth of the root and shoot of sugar beet seedlings with all pre-soaking treatments. However, the interaction between salinity and pre-soaking treatments had a significant effect on roots growth.

The most important factors which affect the productivity and quality of sugar beetroots are the percentage of sugar, purity (Abdel-Mawly and Zanouny, 2004). This increment of sugars in sugar beet with pre-soaking considered a direct result of the obtained vigorous growth that is accompanied by high photosynthesis efficiency and high yield with high quality (Abd El-Aal, 2012). In both cultivars, sugar % was decreased with increasing salinity. A reason for this might be due to the smaller size of cells. It was observed that salt stress increases the level of reducing sugars within the cell several plants belonging to different species (Gupta and Huang, 2014). Under severe salinity stress, sugar percentage was reduced as compared to the control (320 ppm). This reduction could be the result of the depressive effect of high salinity on the process of photosynthesis (Khan et al., 1995). Also, Hajiboland et al. (2009) reported that sugar content of sugar beet increased under mild salinity (EC = 5.5 dS m⁻¹) when compared with the control and high levels of salinity and this due to the fact that the salt leads to higher accumulation of sugars in roots. Similar results were reported by (Razavizadeh and Rostami, 2013) in canola and Khayamim et al. (2014) in sugar beet.

The maximum concentrations of impurity parameters that inhibited plant growth were observed without pre-soaking (tryptophan 0.0 mM) under salinity level at 8000 ppm and minimum concentrations were observed with tryptophan (2.5 mM) under salinity level at 320 ppm. These results are explained previously by Daddkhal (2005) indicated that the white sugar content is affected negatively significant with increasing root impurities as K⁺, Na⁺, and α-amino-N. The accumulation of Na⁺ in plant roots due to the uptake of other anions (Darwesh, 2013 & Wu et al., 2013). Moreover, the purity of sugar beetroots was increased, simultaneously with the reduction of root contents of impurities with pre-soaking in tryptophan treatment. The opposite was true with increasing salinity. Similar trends were observed by Masri et al. (2015) found that sucrose, total soluble solids, and purity of sugar beet juice decreased with salinity stress. Also, El-Tantawy et al. (2006) concluded that salinity stress increased the α-amino-N and Na⁺ concentration in the sugar beet. Also, Hussain et al. (2009) and Khafagy et al. (2009) found that NaCl at 8–15 ds/m reduced growth parameters and chlorophyll contents in Cassia absus L., whereas Na, Cl, and K contents were increased at a high level of NaCl. Meanwhile, pre-soaking of seeds in glycine betaine and ascorbic acid partially counteracted the harmful effect of NaCl on sweet pepper and Sadeghi and Shourijeh (2012) on (Sorghum bicolor L). Feizi et al. (2018) indicated that with higher levels of water salinity molasses sugar, leaf weight, and the concentrations of Na, K, and α-amino-N in sugar beet significantly increased.

Conclusions
The pre-soaking of sugar beet seeds in tryptophan (2.5 mM) is considered one of a simple tool for reducing the negative effect of salinity stress on sugar beet yield. Whereas the studied parameters were recorded the highest values with tryptophan (2.5 mM) under salinity level at 320 ppm for DS-9004 cultivar.

Abbreviations
CRD design: Completely randomized design; TSS: Total soluble solids or sugar; Na: Sodium; K: Potassium; LSD: Least significant difference test

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References
A.O.A.C. Association of Official Analytical Chemists. 16th Edn., Official methods of analysis, Washington, DC. 1995.
Abbas SH, Schall M, Saleem M, Tariq M, Aziz I, Qamar M, Majeed A, Afir M (2013) Effects of L-tryptophan on plant weight and pod weight in chickpea under rain fed conditions. Science, Technology and Development. 32(6):277–280
