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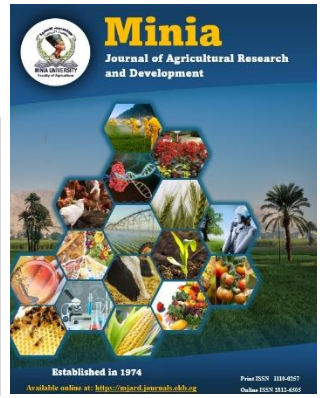

STEVIA SEED GERMINATION BEHAVIOR UNDER SALINITY STRESS CONDATION IN DIFFERENT S0IL TYPES

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ABSTRACT

Two experiments were conducted at the Agricultural Research Center in Giza, Egypt, the first one was done in nursery during 2022, while, the second one was undertaken in the greenhouse in 2023 to compare the germination rate of stevia (*Stevia rebaudiana*, Bertoni) seeds under salinity stress conditions. The first experiment was conducted to evaluate three varieties (Spanti, China1 and Egy1) of stevia under salinity levels of 0, 600 and 1200 ppm, NaCl which was realized from Cynor Laboratories in factorial experiment (3x3) using completely randomized design (C.R.D.) with three replicates. The second experiment was conducted under normal conditions of green house, including three different types of soil i.e., [peat moss, peat moss + compost (1:1) v/v) and peat moss + compost + sand (1:1:1 v/v/v)], three varieties (Spanti, China1 and Egy1) and three levels of salinity 0, 600 and 1200 ppm, NaCl. Randomized complete block design in split-split plot design arrangement with three replicates was used. Soil media occupied the main plots, while, varieties occupied the sub-plots and salinity occupied the sub-sub-plots.

Spanti variety recorded the highest germination rate index (GRI) of stevia seeds at the lowest salinity level (0.0 ppm). On the other hand, Egy1 variety showed the lowest GRI under salinity level of 0.0 ppm salinity level.

Generally, the highest value of number of seedlings was recorded for Spanti variety with mixture peat moss + compost sown in under salinity level of 600 ppm., while the lowest one was obtained for Egy1 variety peat moss with under salinity level of 1200 ppm.

The highest value of seedling length was recorded for Spanti variety sown in peat moss + compost under 600 ppm salinity level, but the highest value of seedling root fresh weight was recorded for Spanti variety sown in peat moss + compost under 0.0 ppm salinity level, While, the highest value of seedling stem fresh weight was recorded for Spanti variety sown in peat moss under 0.0 ppm salinity level.

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INTRODUCTION

Stevia (*Stevia rebaudiana* Bertoni) is a small, herbaceous, semi-bushy, tropical perennial. It is one of the 154 members of the genus Stevia which belongs to Asteraceae family and the herb native to South America **(Singh *et al*., 2017)**, produces in its leaves intercurrent diterpenoid glycosides, which are steviol glycosides, which have zero calories; it is considered the world's natural sweetness plant. It is a small seasonal plant up to 30-60 cm high that has leaves oblong grow along the stems and line up opposite each other **Brandle (1998).** The leaves of the Stevia are the source of the diterpenoid glycosides (stevioside and rebaudioside). Three compounds are 250-300 sweeter than sucrose with zero calories **(Jain *et al*., 2009)**.

Therefore, salt stress tolerance is a widely required trait in agricultural and medicinal plants in order to expand their cultivation in saline and water-deficient areas. The plant itself appears to be involved in establishing resistance mechanisms to many environmental stressors **(Mutlu *et al*., 2016; Shakirova *et al*., 2016; Sharma *et al*., 2018; Batista *et al*., 2019)**. Seed growth, development, and its various levels, as well as seed germination rates, were significantly damaged by salt stress **(Acosta-Motoset *et al*., 2015; Wu 2018)**.

Stevia rebaudiana Bertoni is a plant that is attracting a lot of interest nowadays because of its high sweetening power and non-caloricity (**Samuel *et al*., 2018)**. It is considered one of the most important plants of economic interest in the world. The leaves of the plant contain diterpene-glycosides (steviosides and rebaudiosides), which are widely used as an aural non-caloric sweetener especially for diabetics **(Shivanna *et al*., 2013)**. According to several researchers, this plant is very water demanding and is very sensitive to the salinization of irrigation water **(Zeng *et al*., 2013; Cantabella *et al*., 2017; Gerami *et al*., 2020)**. Its cultivation in regions with semi-arid and arid climates, which are characterized by saline water, requires control of the plant's responses to saline stress.

Stevia ribodiana bertoni is a plant that is attracting a lot of attention nowadays due to its high sweetening power and zero calories **(Samuel *et al*., 2018)**. It is considered one of the most important plants of economic importance in the world. Especially for diabetics **(Shivanna *et al*., 2013)**. According to many researchers, this plant is very demanding of water and very sensitive to salinization of irrigation water **(Zeng *et al*.2013; Cantabella *et al*.2017; Gerami *et al*.2020)**.

The growth, productivity and quality of Stevia seeds are not only affected by genetic factors, but are also affected by environmental factors that affect the growth of Stevia plants, such as; salinity and environments. Salinity plays an important role in controlling plant growth.

Therefore, this study aimed to determine germination traits of stevia varieties under salinity levels in nursery , in addition to soil types and salinity levels under greenhouse conditions in Agricultural Research Center in Giza.

MATERIALS AND METHODS

Two experiments were conducted at the Agricultural Research Center in Giza, Egypt; the first experiment was done in nursery during 2022 and the second experiment was undertaken in the greenhouse during 2023. This is to compare the germination rate of stevia (*Stevia rebaudiana*, Bertoni) seeds under different soil types and salinity stress conditions.

Experimental details:

The First experiment

This experiment was conducted in June 2022 in the nursery of the agricultural research laboratory. The germination conditions were at a temperature of 27 degrees Celsius. The seeds are exposed to light for two hours daily. Petri dishes (10 cm in size) and soil media of peat moss + compost were used. Each dish contains 50 seeds. The experiment was conducted to evaluate three varieties (Spanti, China1 and Egy1) of stevia under salinity levels (0, 600 and 1200 ppm, NaCl) which was realized from Cynor Laboratories. Stevia seeds were obtained from the Sugar Research Institute of the Agricultural Research Center in Giza.

Table (A): Physical and chemical analysis of the used compost in experiments:

Properties	value	Properties	value
Organic carbon %	27.9	Total P (%)	0.6
Humidity (%)	23	Total K (%)	1.11
Organic matter (%)	48	Fe (ppm)	610
C / N ratio	15.5	Zn (ppm)	53
PH (1: 2.5)	8.2	Mn (ppm)	115
E. c. (mmhos /cm.)	5.2	Cu (ppm)	190
Total N %	1.8	------	---------

Table (B): Physical and chemical analysis of the used pat moss in experiments:

Specification	Exchange Capacity
PH (H_2O) 3.5	100-150 mval / 100g. org. matter (dry)
Organic matter (%) 95-99 weight (dry)	Volume weight relation: 60- 90 g / 1 (dry)
Total N % 1 weight (dry)	Without an organic fertilizers
Ash 1-5 weight %	Moisture 40 - 50 % approx.
Water H. Capacity 45-55 vol. %	------------
Degree of decomposition H2 – H5	-------------

Treatments under study in this investigation will be described in details as follows:

1- The First factor (Salinity):
   A_1: Control (zero ppm NaCl). A_2: 600 ppm, NaCl. A_3: 1200 ppm, NaCl.

2-The Second factor (varieties):
   B_1: Spanti. B_2: China1. B_3: Egy1.

The experiment was arranged in a factorial completely randomized design (C.R.D.) with three replicates (3 x 3 x 3) which contain 1350 seeds. The salinity treatments were ended by germination the seeds in each salinized water (irrigated with 5 ml distilled water, daily). Seed germination was taken daily for 21 days started after one week form the first day of seed incubation (13th June until 30th June).

The studied characters:

1- Germination percentage: **(**at the end, germination % was calculated by dividing the germinated seedlings on the total number of seeds planted multiplying by 100).

$$\text{Germination (\%)} = \frac{\text{Total number of germinated seeds}}{\text{Total of initial number of seeds}} \times 100$$

2- Germination rate index: was determined according to Bartlet equation, reported by **Hartmann and Kester (1983)**, as follows:

$$\text{Germination rate index} = \frac{A + (A+B) + (A+B+C) + \ldots \text{ etc.}}{N (A + B + C + \ldots \text{ etc.})} \times 100$$

Where: A, B, C, etc.: are number of germinated seeds counted at different intervals.

N: is the number of intervals at which the germinated seeds were counted.

3- Germination velocity, in days: (the mean number of days from sowing date till the emergence on the plume of the first seed in the treatment).

4- Mean germination rate, in days: was calculated as follows: mean number of days to attain 50% of the total germination, as described by **Odetola (1987)**.

The second experiment

This experiment was conducted in the greenhouse of the Agricultural Research Center in January 2023. The experiment was conducted under normal conditions of temperature and lighting. Three different types of soil were used [peat moss, peat moss + compost (1:1 v/v) and peat moss + compost + sand (1:1:1 v/v/v)]. One gram of seeds from each variety (Spanti, China1 and Egy1) was distributed into trays (53x28x4.5 cm) filled with 5.194 cm^3 of each media under irrigation water of salinity levels (0, 600 and 1200 ppm, NaCl).

Treatments under study in this investigation will be described in details as follows:

1- The First factor (soil of types):
A_1: peat moss A_2: peat moss + compost. A_3: peat moss + compost + sand

2- The Second factor (varieties):
B_1: Spanti. B_2: China1. B_3: Egy1.

3- The Third factor (Salinity):
C_1: Control (zero ppm NaCl). C_2: 600 ppm, NaCl. C_3: 1200 ppm, NaCl.

The experimental was design in split-split plot arrangement with three replications. Soil media occupied the main plot, while varieties occupied the sub-plots and salinity levels occupied the sub-sub-plots. Irrigation was done daily with the knak from the planting date until 45 days. The germination signs appeared after ten days.

The studied characters:

In each tray, the following assessments of the studied readings were recorded 6 times under greenhouse experiments:

1- Number of Seedlings Emerged after 8, 15, 21, 28, 35, 42 days from planting.

The following reading was taken on the seedling:

2- Seedling length (cm). 2- Seedling Root Fresh Weight (g/ plant).

3- Stem Fresh Weight (g/ plant).

B- Statistical analysis:

All data recorded in each experiment were subjected to proper statistical analysis according to procedures outlined by **Snedecor and Cochran (1981).** The differences among treatment means were compared using Least Significant Differences test (L.S.D) at level of 5% probability.

RESULTS AND DISCUSSION

I – Nursery experiment

Data presented in **Tables (1, 2, 3 and 4)** showed significant effect of salinity (NaCl), stevia varieties and their interaction on germination percentage %, germination rate index, germination velocity (in day) and mean germination rate (mean number of days to attain 50% of the total germination) under growth chamber conditions.

Concerning the effect of application of salinity (NaCl) in growth chamber condition**,** the data presented in **Tables (1, 2, 3 and 4)** indicates that germination percentage, germination rate index, germination velocity and mean germination rate under growth chamber conditions were significantly affected by different salinity levels. The highest values for these traits were recorded under the control treatment (0.0 ppm NaCl), while the lowest ones occurred under salinity level of 1200 ppm treatment, confirming that increased salinity reduces green enation trait**.** These results show that increasing salinity stress negatively affects the previous traits. The reduction in germination traits under salinity stress may be attributed to osmotic stress and ion toxicity which interfere with water uptake and enzymatic activities during germination. These results are in general agreement with those obtained by **Alamgir and Ali (2006), Jamil, *et al.* (2006), Bakhsh and Akram (2011**), **El-Bassiouny and Sadak (2015)**, **Al-Saleh and Shabana (2019)**, **Abou El-Yazied, *et al.* (2019) and El-Khateeb, *et al.* (2019),** who found that increasing salinity levels significantly, reduced germination in stevia.

The results in **Tables (1, 2, 3 and 4)** showed that the effect of the varietal differences, the highest values of germination traits were obtained from the Egy1 variety, followed by the China1 variety, while the lowest values were recorded for the Spanti variety, expect germination rate index which recorded the highest value for obtained from the China1variety, followed by the Egy1 variety, while the lowest values were recorded for the Spanti variety. The superiority of the Spanti variety under salinity stress may be attributed to its enhanced osmotic adjustment and ion homeostasis mechanisms, allowing better germination performance even under higher salt concentrations **(Bakhsh *et al*., 2011)**. The ability of China1 variety to maintain higher GRI under salt stress suggests stronger and possibly better osmotic adjustment mechanisms. This is consistent with findings reported by **Jamil *et al.* (2007)**. This suggests a significant genotypic variation in salt tolerance. This may be due to different growth habits that are governed by genetic factors in these three stevia varieties. These results are in general agreement with those obtained by by **Alamgir and Ali (2006), Bakhsh and Akram (2011**), **Abou El-Yazied, *et al.* (2019) and Al-Saleh and Shabana (2019)**

The effect of interaction between salinity levels and stevia varieties was significant on germination traits as shown in **Tables (1,2,3 and 4) ,** The highest germination percentage was recorded for Egy1 variety under control treatment (0.0 ppm), while the lowest ones was observed for Spanti variety under the 1200 ppm salinity level. Spanti variety recorded the highest germination rate index of stevia seeds under the lowest salinity level (0.0 ppm). On the other hand, Egy1 variety showed the lowest GRI under highest salinity level (1200 ppm). The results showed that sowing China1 variety under salinity level of 0.0 ppm obtained the highest germination velocity, while the Spanti variety under under salinity level of 1200 ppm obtained the lowest value for this trait. The combination of Egy1 variety under salinity level of 600 ppm showed the highest mean germination rate, while the lowest ones was recorded for Spanti variety under salinity level of 1200 ppm.

Table (1): Effect of salinity, varieties and their interaction on germination percentage (%) under incubation chamber condition.

Varieties (B)	Salinity treatments (ppm) (A)			Mean (B)
	0.0	600	1200	
Spanti	34.00	32.00	23.33	**29.77**
China1	53.33	35.33	34.00	**40.89**
Egy1	54.67	44.00	43.33	**47.33**
Mean (A)	**47.33**	**37.11**	**33.55**	**39.33**
LSD at 5%	**A: 12.35**	**B: 15.37**	**AB: 20.50**	

Table (2): Effect of salinity, varieties and their interaction on germination rate index (GRI) under incubation chamber condition.

Varieties (B)	Salinity treatments (ppm) (A)			Mean (B)
	0.0	600	1200	
Spanti	21.87	15.38	15.19	**17.48**
China1	21.68	20.82	20.42	**20.97**
Egy1	21.25	18.48	15.10	**18.28**
Mean (A)	**21.60**	**18.20**	**16.90**	**18.91**
LSD at 5%	**A:4.20**	**B:2.50**	**AB:7.27**	

Table (3): Effect of salinity and varieties on germination velocity under incubation chamber condition.

Varieties (B)	Salinity treatments (ppm) (A)			Mean (B)
	0.0	600	1200	
Spanti	1.33	1.00	0.66	**0.99**
China1	6.00	1.33	1.00	**2.77**
Egy1	4.00	3.66	1.00	**2.88**
Mean (A)	**3.77**	**1.99**	**0.88**	**2.21**
LSD at 5%	**A:1.81**	**B:1.36**	**AB:4.9**	

Table (4): Effect of salinity, varieties and their interaction on Mean germination rate 50% under incubation chamber condition.

Varieties (B)	Salinity treatments (ppm) (A)			Mean (B)
	0.0	600	1200	
Spanti	**13.00**	**11.66**	**9.66**	**11.44**
China1	**11.66**	**10.67**	**9.67**	**10.66**
Egy1	**12.00**	**13.66**	**11.00**	**12.22**
Mean (A)	**12.22**	**11.99**	**10.11**	**11.44**
LSD at 5%	**A:1.81**	**B:1.51**	**AB:3.13**	

II -Greenhouse experiment:

1- Number of Seedlings Emerged after 8, 15, 21, 28, 35, 42 days from planting.

The results presented in **Tables (5, 6, 7, 8, 9 and 10)** showed the effect of soil of types, stevia varieties, salinity and their interactions on number of seedlings emerged after **8, 15, 21, 28, 35 and 42** days from planting under Greenhouse conditions.

The effect of soil of types (Peat moss, Peat moss + compost, Peat moss + compost + sand) on number of seedlings emerged after **8, 15, 21, 28, 35 and 42** days from planting under greenhouse conditions was significant. **Tables (5, 6, 7, 8, 9 and 10)** At 8 and 35 days the mixture from peat moss + compost + sand produced the highest average seedling emergence, followed by the mixture from peat moss + compost), and peat moss alone. On the other hand, at 15 days (peat moss + compost) supported the best emergence, followed by (peat moss), while (Peat moss + compost + sand) had the lowest performance. At 21, 28 and 42 days after sowing, mixture at peat moss + compost recoded the best performance seedlings emergence, followed by peat moss + compost + sand, while peat moss alone resulted in the lowest ones. These results are in general agreement with those obtained by **Ghoulam, *et al*. (2002). Al-Saleh and Shabana (2019)** and **El-Khashab, *et al.* (2021)**.

Regarding the impact of varietal differences of stevia on number of seedlings emerged after **8, 15, 21, 28, 35 and 42** days under greenhouse conditions, data presented in **Tables (5 – 10)** reported that the varieties exhibited noticeable and significant differences in performance of seedling emergence. Spanti variety recorded the highest average seedling emergence followed by China1 variety, while Egy1 variety performed the lowest at all tested dates except at 15 days. On the other hand, at 15 days China1 variety recorded the highest average seedling emergence followed by Spanti variety, while Egy1 variety performed the lowest. This highlights Spanti variety as the only promising variety in this setup. The genotype Spanti variety is different from the genotypes China1 variety that make them respond to salinity in different ways although they have a common parent. These results are in general agreement with those obtained by **Alamgir and Ali (2006), Bakhsh and Akram (2011**), **Abou El-Yazied, *et al.* (2019) and Al-Saleh and Shabana (2019)**

Concerning the effect of application of salinity (NaCl) on number of seedlings emerged after **8, 15, 21, 28, 35 and 42** days from planting under greenhouse conditions. It would observed that salinity had a clear negative impact on this trait in all reading ages. **After 8 and 21 days**, the results in **Table (5 and 7)** showed that the average number of seedlings was highest under 600 ppm (32.9 and 29.9) respectively, followed by at 1200 and 0.0 ppm. **After 15 days**, the results in **Table (6)** showed 600 ppm treatment recorded the highest average germination (33.9), followed by 0.0 ppm (27.9), while 1200 ppm recorded the lowest average emergence (25.5). **After 28 days**, the data in **Table (8)** cleared that the salinity level (600 ppm) resulted in an average seedling emergence of 20.3, while levels of 0.0 ppm and 1200 ppm led to decreased averages of this trait, 12.3 and 13.8, respectively. **After 35 days**, data in **Table (9)** reported that interestingly, the best average result was observed under salinity level of 600 ppm (14.2), followed by 0.0 ppm (9.4). However, **after 42 days** data in **Table (10)** showed that the average performance was highest at 0.0 ppm (8.9), dropped at 600 ppm (4.8), and became minimal under salinity level of 1200 ppm (1.5). This demonstrates a clear reduction in emergence with increasing salt concentration. This suggests that moderate salinity had the most negative effect, while certain cultivars tolerated high salinity better. These results are in general agreement with those obtained by **Ashraf and Foolad (2005). Alamgir and Ali (2006), Bakhsh and Akram (2011**), **Abou El-Yazied,** ***et al.*** **(2019). Al-Saleh and Shabana (2019)**,

Concerning the interaction effect among the three factors studied, data in **Tables (5, 6, 7, 8, 9 and 10)** indicated that the highest value of number of seedlings was recorded for Spanti variety sown in mixture pat moss + compost with 600 ppm salinity level, while the lowest ones was obtained from peat moss with Egy1 variety under 1200 ppm after 8,15 and 21 days. **After 28 days**, the highest value of number of seedlings was recorded from mixture peat moss + compost with Spanti variety under 600 ppm., while the lowest ones was obtained from using peat moss with Egy1 and china 1 varieties under 1200 ppm. On the hand **after 35 days**, the highest value of number of seedlings (39.0) was recorded from mixture peat moss + compost with Spanti variety under 0.0 ppm., while the lowest ones was obtained from all types of soil with Egy1 variety with sown under all concentration of NaCl. While, **at 42 days** the best performance was recorded for mixture peat moss + compost with Spanti variety under control. The lowest values for this trait were recorded almost in all soil types with Egy1 variety under different levels of salinity.

The data in **Tables (11, 12 and 13)** indicated that the effect of soil types on seedling length (cm.), seedling root fresh weight (gm.) and seedling stem fresh weight(gm.) under greenhouse conditions. In general, peat moss + compost gave the highest values followed by Peat moss + compost + sand and the lowest ones were attained from peat moss alone. These results might be due to the role of mixture soil in enhancing some physiological and biochemical aspects or increasing N, P, K and Ca content, activity in antioxidant enzymes and glutathione content, which revealed increasing in growth rate. These results are in general agreement with those obtained by **Ghoulam,** ***et al*****. (2002), Fageria (2009), Al-Saleh and Shabana (2019**) **and El-Khashab,** ***et al.*** **(2021)**.

Data presented in the same **Tables** found that varieties altered the growth pattern of stevia seedlings, particularly in terms of length and weight. The varied responses among varieties suggest genetic differences in salinity tolerance. Spanti variety had the highest mean performance of seedling length (cm.) and seedling root fresh weight (gm.), whereas varieties China1 and Egy1 variety had the lowest meen performance for these traits. While, the highest mean of seedling stem fresh weight (gm.) obtained with China1 variety and the lowest one was attained from Egy1 variety**.** These results are in general agreement with those obtained by **Alamgir and Ali (2006), Bakhsh and Akram (2011**), **Cantabella,** ***et al*****. (2017) Singh and Rao (2017), Abou El-Yazied,** ***et al.*** **(2019) and Al-Saleh and Shabana (2019)**

Concerning the effect of application salinity (zero, 600 and 1200 ppm NaCl) on seedling length (cm.), seedling root fresh weight (gm.) and seedling stem fresh weight(gm.) under greenhouse conditions, the salinity levels had a substantial impact on these traits. Data in **Tables (11, 12 and 13)** showed that the highest seedling length was recorded under (600 ppm) salinity, while increasing salinity levels to 1200 ppm resulted in reduction in seedling length.

While, the highest root fresh weight was recorded under control (0.0 ppm) salinity, and increasing salinity levels up to 1200 ppm resulted in gradual reductions in root fresh weight. A decrease in total seedling root fresh weight due to the vital role of salinity for growth of plants such as stevia plants under soil salinity. As well as, the highest seedling stem fresh weight was recorded under salinity level of 600 ppm, while increasing salinity level up to 1200 ppm resulted in reduction in stem fresh weight. Decreases in seedling stem fresh weight may be due to the vital role of salinity for growth of plants such as stevia seedling under soil salinity. These results are harmony with those findings reported by **Rastgoo *et al*. (2019); Shirkhanitabar *et al*. (2020) and Sahin (2023).** The reduction in root fresh weight and stem fresh weight under salinity stress can be attributed to osmotic stress and ion toxicity that inhibit root cell elongation and division (**Munns and Tester, 2008**). These results are consistent with the findings of **El-Khashab *et al*. (2021)**, who observed improved root growth of stevia in compost-rich soils under salinity. Similarly, **Ahmed *et al.* (2019)** reported that organic matter in soil helps mitigate salt stress by improving water retention and ion buffering capacity.

These results are in general agreement with those obtained by **Kaya, *et al.* (2006), Misra & Dwivedi (2015), El-Bassiony, *et al.* (2018), Sharma, *et al.* (2018)**, **Abou El-Yazied, *et al.* (2019 Gerami, *et al.* (2020). Hassan, *et al.* (2020), El-Khashab, *et al.* (2021) and El-Khashab, *et al.* (2022) and shabin (2023).**

Concerning the interaction effect among the three factors studied, on seedling length (cm.), seedling root fresh weight (gm.) and seedling stem fresh weight, data indicated that the highest value of seedling length was recorded for Spanti variety with peat moss + compost under salinity level of 600 ppm, while the lowest value was obtained for Egy1 variety with peat moss under of 1200 ppm salinity level. But, the highest value of seedling root fresh weight was recorded for Spanti variety peat moss + compost + sand under salinity level of 0.0 ppm, while the lowest value was obtained for Egy1 variety with peat moss under 1200 ppm. salinity level. However, the highest value of seedling stem fresh weight was recorded for Spanti variety with peat moss under salinity level 0.0 ppm or with peat moss + compost under 600 ppm salinity level, but the lowest one was recoded for Egy1 variety with peat moss under salinity level of 1200 ppm.

Table (5): Effect of Media, varieties, salinity and their interactions on Number of Seedlings Emerged after 8 days from planting under Greenhouse conditions.

Type of soil (A)	Varieties (B)	Salinity treatments (C)			
		c_1	c_2	c_3	Mean of A
		2023			
Peat moss	**Spanti**	38.0	11.0	41.0	28.3
	China1	20.0	29.0	35.0	28.0
	Egy1	21.0	20	5.0	11.0
Mean		**26.3**	**20.0**	**27.0**	**22.4**
Peat moss + compost	**Spanti**	36.0	47.0	22.0	35.0
	China1	25.0	25.0	24.0	24.6
	Egy1	16.0	40.0	26.0	27.3
Mean		**25.6**	**37.3**	**24.0**	**28.9**
Peat moss + compost + sand	**Spanti**	28.0	41.0	45.0	38.0
	China1	37.0	47.0	39.0	41.0
	Egy1	10.0	35.0	31.0	25.3
Mean		**25.0**	**41.0**	**38.3**	**38.7**
Mean of c		**25.6**	**32.9**	**29.7**	**29.4**
Mean of (B)	**Spanti**	34.0	33.0	36.0	34.3
	China1	27.3	33.6	32.6	31.12
	Egy1	15.6	31.7	20.7	22.7
LSD 5%	**A**	0,4			
	B	0.5			
	C	0.4			
	AB	0.8			
	AC	0.9			
	BC	0.8			
	ABC	1.6			

Table (6): Effect of Media, varieties, salinity and their interactions on Number of Seedlings Emerged after 15 days from planting under Greenhouse conditions.

Type of soil (A)	Varieties (B)	Salinity treatments (C)			
		c_1	c_2	c_3	Mean of A
		2023			
Peat moss	**Spanti**	37.0	34.0	36.0	35.7
	China1	40.0	34.0	41.0	38.3
	Egy1	20.0	9.0	1.0	10.0
Mean		**32.3**	**25.7**	**26.0**	**28.0**
Peat moss + compost	**Spanti**	41.0	49.0	26.0	38.7
	China1	27.0	35.0	31.0	31.0
	Egy1	15.0	35.0	23.0	24.3
Mean		**27.6**	**39.7**	**26.7**	**31.3**
Peat moss + compost + sand	**Spanti**	36.0	39.0	7.0	27.3
	China1	28.0	41.0	35.0	34.7
	Egy1	7.0	29.0	29.0	21.7
Mean		**23.7**	**36.3**	**23.6**	**27.9**
Mean of c		**27.9**	**33.9**	**25.5**	29.1
Mean of (B)	**Spanti**	38.0	40.7	23.0	**33.9**
	China1	31.7	36.7	35.7	**34.7**
	Egy1	14.0	24.3	17.7	**18.7**
LSD 5%	**A**	0.5			
	B	0.4			
	C	0.5			
	AB	0.5			
	AC	0.6			
	BC	0.4			
	ABC	1.7			

Table (7): Effect of Media, varieties, salinity and their interactions on Number of Seedlings Emerged after 21 days from planting under Greenhouse conditions.

Type of soil (A)	Varieties (B)	Salinity treatments (C)			
		c_1	c_2	c_3	Mean of A
		2023			
Peat moss	**Spanti**	34.0	13.0	31.0	26.0
	China1	16.0	40.0	14.0	23.3
	Egy1	5.0	7.0	1.0	4.3
Mean		**18.3**	**20.0**	**15.3**	**17.8**
Peat moss + compost	**Spanti**	41.0	47.0	37.0	41.6
	China1	13.0	35.0	32.0	26.7
	Egy1	1.0	29.0	20.0	16.6
Mean		**18.3**	**37.0**	**29.7**	**28.3**
Peat moss + compost + sand	**Spanti**	38.0	34.0	7.0	26.3
	China1	28.0	39.0	31.0	32.7
	Egy1	1.0	25.0	20.0	15.3
Mean		**22.3**	**32.7**	**19.3**	**24.7**
Mean of c		19.6	29.9	21.4	**23.6**
Mean of (B)	**Spanti**	37.7	31.3	25.0	**31.3**
	China1	19.0	38.0	25.7	**27.6**
	Egy1	2.3	20.3	13.7	**12.1**
LSD 5%	**A**	0.5			
	B	0.3			
	C	0.5			
	AB	0.7			
	AC	0.9			
	BC	0.7			
	ABC	0.8			

Table (8): Effect of Media, varieties, salinity and their interactions on Number of Seedlings Emerged after 28 days from planting under Greenhouse conditions.

Type of soil (A)	Varieties (B)	Salinity treatments (C)			
		c_1	c_2	c_3	Mean of A
		2023			
Peat moss	**Spanti**	33.0	12.0	16.0	20.3
	China1	3.0	2.0	1.0	2.0
	Egy1	1.0	3.0	1.0	1.6
Mean		**12.3**	**5.6**	**6.0**	**7.9**
Peat moss + compost	**Spanti**	40.0	45.0	15.0	33.3
	China1	1.0	29.0	25.0	18.3
	Egy1	1.0	21.0	14.0	12.0
Mean		**14.0**	**31.7**	**18.0**	**21.2**
Peat moss + compost + sand	**Spanti**	30.0	33.0	7.0	23.3
	China1	1.0	37.0	26.0	21.3
	Egy1	1.0	1.0	19.0	7.0
Mean		**10.7**	**23.7**	**17.3**	**17.2**
Mean of c		**12.3**	**20.3**	**13.8**	**15.5**
Mean of (B)	**Spanti**	34.3	30.0	12.7	**25.7**
	China1	1.7	22.7	17.3	**13.9**
	Egy1	1.0	8.3	11.3	**6.9**
LSD 5%	**A**	0.5			
	B	0.4			
	C	0.5			
	AB	0.7			
	AC	0.9			
	BC	0.7			
	ABC	1.8			

Table (9): Effect of Media, varieties, salinity and their interactions on Number of Seedlings Emerged after 35 days from planting under Greenhouse conditions.

Type of soil (A)	Varieties (B)	Salinity treatments (C)			
		c1	c2	c3	Mean of A
		2023			
Peat moss	**Spanti**	9.0	5.0	12.0	8.6
	China1	3.0	1.0	1.0	1.6
	Egy1	1.0	1.0	1.0	1.0
Mean		**4.3**	**2.3**	**4.7**	**3.8**
Peat moss + compost	**Spanti**	39.0	22.0	15.0	25.3
	China1	1.0	27.0	1.0	9.6
	Egy1	1.0	7.0	1.0	3.0
Mean		**13.7**	**18.7**	**5.7**	**12.7**
Peat moss + compost + sand	**Spanti**	29.0	29.0	7.0	21.7
	China1	1.0	35.0	24.0	20.0
	Egy1	1.0	1.0	1.0	1.0
Mean		**10.3**	**21.7**	**10.7**	**14.2**
Mean of c		**9.4**	**14.2**	**7.0**	**10.2**
Mean of (B)	**Spanti**	25.7	18.7	11.3	**18.6**
	China1	1.7	21.0	8.7	**10.5**
	Egy1	1.1	3.0	1.0	**1.7**
LSD 5%	**A**	0.3			
	B	0.6			
	C	0.4			
	AB	0.8			
	AC	0.8			
	BC	0.6			
	ABC	1,2			

Table (10): Effect of Media, varieties, salinity and their interactions on Number of Seedlings Emerged after 42 days from planting under Greenhouse conditions.

Type of soil (A)	Varieties (B)	Salinity treatments (C)			
		c_1	c_2	c_3	Mean of A
		2023			
Peat moss	**Spanti**	8.0	4.0	5.0	5.6
	China1	3.0	1.0	1.0	1.6
	Egy1	1.0	1.0	1.0	1.0
Mean		**4.0**	**2.0**	**2.3**	**2.7**
Peat moss + compost	**Spanti**	39.0	15.0	1.0	18.3
	China1	1.0	1.0	1.0	1.0
	Egy1	1.0	2.0	1.0	1.3
Mean		**13.6**	**6.0**	**1.0**	**6.8**
Peat moss + compost + sand	**Spanti**	26.0	18.0	2.0	15.3
	China1	1.0	1.0	1.0	1.0
	Egy1	1.0	1.0	1.0	1.0
Mean		**9.3**	**6.6**	**1.3**	**5.7**
Mean of c		**8.9**	**4.8**	**1.5**	**5.0**
Mean of (B)	**Spanti**	24.3	12.3	2.6	**13.0**
	China1	1.6	1.1	1.1	**1.2**
	Egy1	1.1	1.3	1.0	**1.1**
LSD 5%	**A**	0.5			
	B	0.4			
	C	0.5			
	AB	0.7			
	AC	0.7			
	BC	0.5			
	ABC	1.0			

Table (11): Effect of type of soil, stevia varieties, salinity and their interactions on seedling length (cm.) under greenhouse conditions.

Type of soil (A)	Varieties (B)	Salinity treatments (C)			
		c_1	c_2	c_3	Mean of A
		2023			
Peat moss	Spanti	4.2	4.8	5.0	4.6
	China1	4.9	4.5	3.7	4.4
	Egy1	2.8	3.1	2.3	2.7
Mean		**4.0**	**4.1**	**3.7**	**3.8**
Peat moss + compost	Spanti	4.5	5.1	4.7	4.7
	China1	4.0	4.3	5.0	4.4
	Egy1	3.0	2.9	3.2	3.0
Mean		**3.8**	**4.0**	**4.3**	**4.0**
Peat moss + compost + sand	Spanti	4.6	4.4	4.8	4.6
	China1	3.8	4.2	4.6	4.2
	Egy1	2.5	3.3	3.1	3.0
Mean		**3.6**	**4.0**	**4.2**	**3.9**
Mean of c		**3.8**	**4.1**	**4.0**	**3.9**
Mean of (B)	Spanti	4.4	4.8	4.7	**4.6**
	China1	4.2	4.3	4.4	**4.3**
	Egy1	2.8	3.1	2.9	**2.9**
LSD 5%	A	**0.1**			
	B	**0.6**			
	C	**0.2**			
	AB	**0.5**			
	AC	**0.6**			
	BC	**0.4**			
	ABC	**0.9**			

Table (12): Effect of type of soil, varieties, salinity and their interactions on seedling root fresh weight (g) under Greenhouse conditions.

Type of soil (A)	Varieties (B)	Salinity treatments (C)			
		c_1	c_2	c_3	Mean of A
		2023			
Peat moss	**Spanti**	0.6	0.7	0.5	0.6
	China1	0.6	0.8	0.5	0.6
	Egy1	0.9	0.7	0.1	0.5
Mean		**0.7**	**0.7**	**0.4**	**0.6**
Peat moss + compost	**Spanti**	0.9	0.9	0.4	0.7
	China1	0.8	0.8	0.5	0.7
	Egy1	0.6	0.6	0.5	0.6
Mean		**0.8**	**0.7**	**0.5**	**0.7**
Peat moss + compost + sand	**Spanti**	1.0	0.8	0.5	0.8
	China1	0.8	0.7	0.6	0.7
	Egy1	0.6	0.7	0.8	0.7
Mean		**0.7**	**0.7**	**0.6**	**0.6**
Mean of c		**0.8**	**0.7**	**0.5**	**0.7**
Mean of (B)	**Spanti**	0.7	0.8	0.5	**0.7**
	China1	0.7	0.7	0.5	**0.6**
	Egy1	0.7	0.6	0.4	**0.5**
LSD 5%	**A**	0.05			
	B	0.2			
	C	0.2			
	AB	0.4			
	AC	0.1			
	BC	0.1			
	ABC	0.4			

Table (13): Effect of Media, varieties, salinity and their interactions on seedling stem fresh weight (g) under greenhouse conditions.

Type of soil (A)	Varieties (B)	Salinty treatments (C)			
		c_1	c_2	c_3	Mean of A
		2023			
Peat moss	**Spanti**	3.0	2.8	2.3	2.7
	China1	2.9	2.7	2.0	2.5
	Egy1	1.5	1.8	1.2	1.5
Mean		**2.5**	**2.4**	**1.8**	**2.2**
Peat moss + compost	**Spanti**	2.7	3.0	2.5	2.7
	China1	2.6	2.8	2.2	2.5
	Egy1	1.7	1.9	1.4	1.7
Mean		**2.3**	**2.6**	**2.0**	**2.3**
Peat moss + compost + sand	**Spanti**	2.8	2.9	2.6	2.8
	China1	2.5	2.7	2.3	2.5
	Egy1	1.6	1.8	1.3	1.6
Mean		**2.3**	**2.5**	**2.1**	**2.3**
Mean of c		**2.4**	**2.5**	**1.9**	**2.2**
Mean of (B)	**Spanti**	2.8	2.0	2.5	**2.4**
	China1	2.7	2.7	2.2	**2.5**
	Egy1	2.6	1.8	1.3	**1.9**
LSD 5%	**A**	0.05			
	B	0.3			
	C	0.2			
	AB	0.4			
	AC	0.5			
	BC	0.4			
	ABC	0.7			

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الملخص العربى

سلوك إنبات بذور الاستيفيا تحت ظروف الإجهاد الملحي في أنواع مختلفة من التربة

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اجريت تجربتين فى المعمل والصوبة بمركز البحوث الزراعية بالجيزة، تم زراعة التجربة الأولى فى شهر يونيو ٢٠٢٢ تحت ظروف الحضانة بمعمل مركز البحوث الزراعية فى أطباق بترى وتم زراعة ٥٠ بذرة فى كل طبق وكانت البيئة المستخدمة (peat moss + compost) ونفذت التجربة على ثلالث أصناف من ألأستيفيا (Spanti, China1 and Egy1) تحت ثلاث مستويات من الملوحة (0, 600 and 1200 ppm, NaCl) لدراسة نسبة الإنبات وكان التصميم المستخدم فى التجربة هو التام العشوائية فى ثلاث مكررات.

ونفذت التجربة الثانية فى يناير ٢٠٢٣ بصوب مركز البحوث الزراعية – معهد بحوث المحاصيل السكرية فى تصميم القطع المنشقة مرتين فى ثلاث مكررات، وقد وزعت انواع التربة بنسب متساوية عشوائيا على القطع الرئيسية ١- peat moss ٢- peat moss + compost ٣- peat moss + compost + sand ، واصناف الأستيفيا (Spanti, China1 and Egy1) عشوائيا على القطع المنشقة ، وتركيزات الملوحة على القطع التحت شقية (0, 600 and 1200 ppm, NaCl) وذلك لدراسة صفات الإنبات، وتم الحصول على بذور الأصناف المستخدمة فى التجارب من معهد بحوث المحاصيل السكرية بالجيزة.

وتم تلخيص أهم النتائج فيما يلى:

١- أمكن الحصول على أعلى دليل لمعدل الإنبات بزراعة الصنف Spanti تحت ظروف المقارنة(بدون ملوحة)، بينما ادى زراعة الصنف Egy1 تحت مستويات الملوحة الأعلى (١٢٠٠ جزء فى المليون) إلى الحصول على أقل القيم لهذا المقياس.

٢- سجل الصنف Spanti المنزرع فى بيئة مخلوطة من (peat moss + compost) مع استخدام مستوى الملوحة ٦٠٠ جزء فى المليون أعلى عدد للبادرات، بينما أعطى الصنف Egy1 مع بيئة من (peat moss) تحت مستوى الملوحة الأعلى ١٢٠٠ جزء فى المليون أقل القيم لعدد البادرات.

٣- أعطى الصنف Spanti المنزرع فى بيئة من (peat moss + compost) مع استخدام ٦٠٠ جزء فى المليون من الملوحة أعل قيمة لطول البادرة، بينما تم تسجيل أعلى وزن طازج لجذور البادرة من زراعة الصنف Spanti فى بيئة من(peat moss + compost) خالية من الملوحة (الكنترول) وعلاوة على ذلك أمكن الحصول على أعلى قيمة للوزن الطازج لساق البادرة بزراعة الصنف Spanti فى بيئة من peat moss خالية من الملوحة (الكنترول).