# Response Of Paspalum And Ryegrass Plants

# To Sea Water


**By:**

***Wafa Abdalhamed Ali Alawami***

**Supervised by:**

***Mohamed S. Hamoda***

**Co-supervisor:**

***Dr. Salem A. El Shatshat***


**This Thesis was submitted in Partial Fulfillment of the**

**Requirements for Master's Degree of Science in Botany**


**University of Benghazi**

**Faculty of science**


**2017**

**This Thesis: (Response Of Paspalum And Ryegrass Plants To Sea Water) was Successfully Defended and Approved**

**By:**

**Wafa Abdalhamid Ali Alawami**

**Supervisor:**

**Dr.Mohamed S. Hamouda** …..………………………………..

**Co-supervisor:**

**Dr. Salem A. El Shatshat** …………………………………..

**<u>Examination Committee:</u>**

**Internal examiner:**

**Dr. Ali Mohamed El-Bakkosh** .…………………………………

**External examiner:**

**Dr. Ahmed Salem Buhedma** …………………………………..

**Countersigned by:**

**Dr. Houssein M. Eltaguri** (Head, Botany Department)

**Dr. Hussein M. El-Baraasi** (Dean, Faculty of Science)

بسم الله الرحمن الرحيم

﴿أَمَّنْ هُوَ قَانِتٌ آنَاءَ اللَّيْلِ سَاجِداً وَقَائِماً يَحْذَرُ الآخِرَةَ وَيَرْجُو رَحْمَةَ رَبِّهِ قُلْ هَلْ يَسْتَوِي الَّذِينَ يَعْلَمُونَ وَالَّذِينَ لا يَعْلَمُونَ إِنَّمَا يَتَذَكَّرُ أُولُوا الأَلْبَابِ﴾.

صدق الله العظيم

**سورة الزمر آية (9)**

# Acknowledgement

I humbly begin my gratefulness to Allah whose blessing upon me are beyond recognition. My sincere gratitude to my supervisor Dr. Mohamed Hamoda and co-supervisor Dr. Salem Elshatshat . I would like to express my appreciation tomy department and its staff members (The Botany Department) and to my university (Benghazi University). My special thanks and profound gratitude to Mr. mohannad ferjany whose unlimited help and support were one of the main contributing factors for the success and production of this work in its finest presentation. To my father and my mother whose love and care nourished my soul, whose help and support shaped my life, and whose encouragement and trust made me believe that impossible is just a word in a dictionary. To them I express my deepest thanks, sincere gratitude and absolute appreciation. To the man who stood by me, believed in me and dedicated all of his time and love to me and our kids, to this man, my husband and my refuge Ahmad I extend my honest and profound appreciation and gratitude. I also would like to thank to all those who showed even the slightest interest and support to my work, for that I wish them all the best and hope they achieve what they aim for.

# Dedication

I Dedicate My Work To My Parents, My Husband And My Two Children And To My Brothers And Sisters, This Dedication Is Also Extended To All Those Who Hopefully Will Benefit From This Humble Research.

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## List of abbreviations

| | |
|---|---|
| ABA | Applied Behavior Analysis |
| APX | Ascorbate Peroxidase |
| °C | Centigrade |
| $Ca^{++}$ | Calcium Ion |
| CAT | Catalase Enzyme |
| $Cl^{-}$ | Chloride Ion |
| Cm | Centimeter |
| dS/m | Decisiemens Per Metre |
| DW | Dry Weight |
| EC | Electrical Conductivity |
| ETC | Electron Transport Chains |
| FAO | Food And Agriculture Organization |
| FW | Fresh Weight |
| G | Gram |
| GPX | Glutathione peroxidase |
| GR | Glutathione Reductase |
| $HCO_3$ | Carbonate Ion |
| $K^{+}$ | Potassium Ion |
| KM | Kilometers |
| L | Liter |
| LWC | Leaf Water Content |

| | |
|---|---|
| MGR | Mean Germination Time |
| MGT | Mean Germination Time |
| ML | Milliliter |
| Mm | Mili Mole |
| $Na^+$ | Natritum Ion |
| NaCl | Sodium Chloride |
| NO | Nitric Oxide |
| PEG | Polyethylene Glycol |
| PH | Hydrogen Concentration |
| Ros | Reactive Oxygen Species |
| $SO_4^{-2}$ | Phosphate Ion |
| SOD | Superoxide Dismutase |
| SVI | Seedling Vigor Index |
| V/V | Volume By Volume |
| V-ATPase | Vacuolar Adenosine Triphosphatase |
| V-PPase | Vacuolar Pyrophosphatase |
| WSC | Water-Soluble Carbohydrate Concentration |

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# Abstract

Salinity refers to the occurrence of various salts in soil or water in concentration that may interfere with the growth of plants, Turfgrass species and cultivars differ in their responses to salinity, a number of researches were conducted to determine the effect of salinity on growth and development of turfgrass, this study was conducted to examine the effect of different sea water concentration on seed germination and development of *Perennial Ryegrass* (*LoliumPerenne* L.) and Knotgrass (*Paspalum Distichum*), for seed germination study of Perennial Ryegrass(*Lolium Perenne* L.), seeds were grown in petridishes lined with filter paper moisten with saline water in different concentrations (0%, 1%, 2%, 5%, 10% and 20%) irrigated with same solutions for two weeks. Parameters like seed germination, mean germination time, shoot and root lengths were measured in 3 replicated pattern, for Knotgrass (*Paspalum Distichum*) development study, seeds of Knotgrass (*Paspalum Distichum*) were grown in pots and irrigated with saline water in the same concentrations and parameters like fresh and dry weights of shoot and root system, in addition to leaf water contents were measured. The results of seed germination study revealed that germination of Perennial Ryegrass (*Lolium Perenne*L.), decreased with increased salinity,

mean germination time delayed with increased salinity level, shoots and roots weights decreased with increased salinity and the differences in the means of roots and shoots lengths was significant compared with the control treatments. The results of seed development study of Knotgrass (*Paspalum Distichum*) revealed that, there was no correlation between salinity and leaf water content and the differences in the mean of leaf water content was not significant (p-value 0.036), effect of salinity on fresh and dry weight of shoot system was significant(p-value 0.008 0.015) respectively but fresh and dry weights of root and shoot systems was not significant (p- value 0.083, 0.095) respectively. The results of seed germination showed that Perennial Ryegrass (*Lolium Perenne* L.) tolerate salinity very well it can tolerate salinity to (10% and 20%). While the Knotgrass (*Paspalum Distichum*) showed very weak tolerance to salinity.

# Chapter One

# 1. Introduction.

Potable water is essential for human survival. With the progression of climate change and unpredictable weather conditions, the United States has experienced significant areas of drought over the last decade (Schiavon *et al*. 2013). One of the most urgent problems in many of the arid and semi-arid countries is the scarcity of water and Libya is among these countries. Finding enough water to support the food needs and other demands is a priority to all governments. Availability of good quality irrigation water is always a constraint in the arid regions and the water desalination is an expensive alternative. In addition, due to the increased pumping of saline water from the deep wells, the level of total salinity in the soils has increased.

Libya is one of the driest countries in the world with significant changes recorded in temperature and precipitation during the last couple of decades, within which roughly 90.8% of the area is hyper-arid, 7.4% arid, 1.5% semi-arid and 0.3% is classified as sub-humid (Ben-Mahmoud, 1993); with the sub-humid region located in northeast. Libya as an arid nation accounts for 94.5% areas as desert with perpetually scarce freshwater except for a narrow strip along the northern coast, which has a Mediterranean climate. Barely 5% of the country receives more than 100 mm of rain each year. Libya since long relies on groundwater reserves to meet its needs. However, surging demand is stressing supply, and many coastal groundwater aquifers are becoming brackish with an influx of seawater. Thus a major environmental concern in Libya is the depletion of underground water as a result of overuse mainly in agricultural developments, causing salinity and sea-water penetration into the coastal aquifers (Bindra *et al*., 2013).

## 1.1. Green fields turfgrasses and their importance:

In modern urban living , turfgrasses play significant role in enhancing quality of life. They have aesthetic, economic and functional values , turfgrasses play an important role in land stabilization and animal nutrition due to their protein, carbohydrates, fats, fibers and mineral contents, soil protection against water and wind erosion, sand dune fixation, water purification, air purification, temperature modification, energy and cost saving, oxygen generation and carbon sequestration.

The turfgrass industry is considered to be a billion dollars industry which has an impact on the environment as well. A lush green turf is a dream for every green keeper. Establishing and maintaining quality turf requires ensured supply of quality irrigation water which is the most important challenge worldwide. Turfgrasses are among the most important plant groups that are used extensively in the landscape of new cities, coastal resorts and touristic villages. Most of these communities are built in desert areas where irrigation depends primarily on relatively saline water from wells or desalination units (Sakr, 2009). Most commonly used turfgrasses used for this purpose are warm season turfgrasses like Bermuda grass (*Cynodon Dactylon*), Tifway Bermuda grass (*Cynodon Dactylon* x T*ransvaalensis*), Seashore Paspalum grass (*Paspalum Vaginatum),* Knotgrass (*Paspalum Distichum*) and cool season Turfgrasses like perennial Ryegrass (*Lolium Perenne),* Dollarweed (*Hydrocotyle* spp.), Florida pusley (*Richardia Scabra* L.), Virginia Buttonweed (*Diodia Virginiana* L.), Goosegrass, southern Crabgrass (*Digitaria Ciliaris* (Retz.) Koel.), common Bermudagrass, Tropical Signalgrass (*Urochloa Subquadripara* [Trin.] R. Webster), Torpedograss (*Panicum Repens* L.), and purple nutsedge (*Cyperus Rotundus* L.). The need for salt tolerant turfgrass has increased (Harivandi *et al*., 1992) because of salt accumulation in soils (Hoos, 1981), increased restrictions on the use of potable water for landscape irrigation (Devitt *et al*., 2004; Marcum, 2006; Lockett *et al*., 2008), and saltwater intrusion in the groundwater (Murdoch, 1987; McCarty and Dudeck, 1993).

## 1.2. Effect of salinity on turf grass:

As turfgrass on lawns, golf courses and athletic fields is a major user of water for irrigation, minimizing that use is of great importance in an effort to conserve water resources. Turfgrass species and cultivars differ in their responses to salinity (Fu *et al*., 2005; Miyamoto and Chacon, 2006; Lockett *et al*., 2008; Shahba, 2010). In response to salinity, some plants can adjust osmotically to maintain growth and turgot. Osmotic adjustment under saline conditions can occur in plants by the uptake of inorganic ions from the medium, compartmentalizing ions in the cell vacuole, and balancing osmotic potential in vacuoles by the synthesis of compatible organic solutes in the cytoplasm (Ashraf and Harris, 2004; Qian and Fu., 2005; Abdel-Latef *et al*., 2009). The main effects of salinity on turfgrass growth include osmotic stress, ion toxicity, nutritional disturbances (Greenway and Munns, 1980; Cheeseman, 1988), damage to photosynthetic systems by excessive energy (Brugnoli and Bjorkman,1992), and structural disorganization (Flowers *et al*., 1985).

## Study objectives:

To examine the response of Ryegrass (*Lolium Perenne* L.) and Knotgrass (*Paspalum Distichum*) germination to different concentrations of seawater compared with a control treatment and to find out which concentration can be used as optimum one in irrigation systems.

# Chapter Two

# 2. Literature review

## 2.1. Background:

According to the FAO Land and Plant Nutrition Management Service in 2010, over 6% of the world's land, or over 400 million ha, are salt-affected, which means affected by either salinity or sodicity and contain sufficient concentrations of soluble salts to reduce the growth of most plant species (Tester and Davenport, 2003). Much of the world’s land is not cultivated, but a significant proportion of cultivated land is salt-affected. There are more than 65 million hectares of such soil in Africa (Aubert, 1977), 50 million hectares in Europe (Kovda *et al*., 1973; Szaboles, 1979), 17.4 million hectares in Australia, and 77.5 million hectares in North, Central, and South America (Massoud, 1974). Of the current 230 million hectares of irrigated land, 45 million hectares are salt-affected (19.5 %) and of the 1,500 million hectares under dry land agriculture, 32 million are salt-affected to varying degrees (Abbas *et al*., 1994). Much of the arid west of North America is salt-affected, particularly in Utah, Arizona, Texas, New Mexico, Nevada, and California (Szaboles, 1989). When annual rainfall is less than 15 inches (380 mm), salt affected soils are most prevalent because insufficient leaching occurs to remove salts that accumulate due to weathering of minerals and ground water (Pitman and Läuchli 2002). The most common salts in arid and semi-arid climates are sodium and sulfate salts such as $Na_2SO_4$, $K_2SO_4$, $CaSO_4$ and $MgSO_4$. Irrigation water is another source of salts. Irrigation contributes to increased soil salinity through high evapotranspiration rates coupled with inadequate leaching, low quality irrigation water, and rising water tables that receive salts leached from the plant root (Carrow and Duncan, 1998). Saline soils also exist near sea coasts due to the tidal action and airborne salt deposition, or where water tables are shallow and highly saline (Harivandli *et al*., 1992).

In the past decades researches were focused on the use of salt water for irrigation. The development of seawater agriculture has taken two directions. Some investigators have focus on breeding salt tolerance plant such as barley and wheat. The second approach deals with the physiological part of the plant that changes the basic physiology of the plant from salt-sensitive to salt tolerant plant. In general plants are classified according to their capacity to grow on high salt medium, classified as glycophytes or halophytes. Most plants are glycophytes that cannot tolerate salt stress (Sairam and Tyagi, 2004).

## 2.2. **Irrigation water and salinity:**

It is well documented that the amount and quality of irrigation water available in many of the arid and semiarid regions of the world are the main limiting factors to the extension of agriculture (Beck, 1984; Munns, 2002).

Salinity refers to the occurrence of various salts in soil or water in concentration that may interfere with the growth of plants. It comprises chloride, sulfates and bicarbonates of sodium, calcium, magnesium and potassium. Saline-sodic irrigation water, coupled with the low annual rainfall and high evaporation and transpiration in the arid and semi-arid regions, resulted in accumulation of soluble salts in the soil solution and of cations (especially sodium ions) on exchange sites, can alter the structure and, consequently, affect the soil hydraulic conductivity (Sameni and Morshedi, 2000 and Parida, 2005). High Soil salinity level can be a major environmental constraint to crop productivity and negatively affects soil fertility and limits plant production (Richards, 1954). Most crops are susceptible to salt stress and either die or have a yield reduction (Scholberg and Loccascio, 1999). In many crops, seed germination and early seedling growth are most sensitive stages to environmental stresses (Jones, 1986). Most salinity problems in agriculture result directly from the salts carried in the irrigation water. Saline soils occupy 7% of the earth’s land surface (Ruiz-Lozano *et al*., 2001). At present, out of 1.5 billion hectare of cultivated land around the world, about 77 million (5%) is affected by excess salt content (Sheng *et al*., 2008). More than 831 million hectares of land worldwide is salt-affected (Martinez-Beltran and Manzur, 2005) and this area is likely to increase in the future because of secondary Salinization due to irrigation (Pessarakali and Szabolcs, 1999; Pannell and Ewing, 2006), at least 20% of the irrigated agricultural land worldwide (Sudhur and Murthy, 2004).

## 2.3. **Mechanism of salinity effect on plants:**

Salinity of the soil environment is connected with an excessive quality of soluble ions in the soil solution, especially those of $Na^{+}$, $Cl^{-}$, $SO_4^{-2}$, $HCO_3$ and rarely $K^{+}$,$Ca^{+2}$, $Mg^{+2}$, $NO_3$ This leads to the appearance of the phenomenon of physiological drought. Hence, the seeds at germination are most susceptible to salinity stress (Horst and Dunning 1989). Excessive amounts of salts have adverse effects on soil properties and therefore alterations induced in plant growth, yield and quality. Salt stress causes initial water-deficit and ion-specific stresses resulting from changes in the $K^{+}/Na^{+}$ ratio. Thus, it leads to increased $Na^{+}$ and $Cl^{-}$ concentrations that decrease plant growth and productivity by disrupting physiological processes (Shu *et al*., 2012). The factors affecting plant growth under salinity can be divided into three groups, namely: i) water stress, ii) ion toxicity, and iii) problems in nutrient uptake and translocation to green plants' parts, and, as a result, disorders in cells due to disruption of ionic balances such as in the case of $K^{+}$ and $Ca^{++}$. Under salt stress, physiological drought may play an important role by limiting water uptake from the soil. On the other hand, excessive salt uptake by plants disrupts cellular functions and damages their physiological processes such as photosynthesis and respiration (Leopold and Willing, 1984).

## 2.4. **Mechanisms of salinity tolerance:**

Plants on the basis of adaptive evolution can be classified roughly into two major types: the halophytes (that can withstand salinity) and the glycophytes (that cannot withstand salinity and eventually die). Majority of major crop species belong to this second category. Irrespective of their nature, both halophytes and glycophytes cannot tolerate high salt concentration in their cytoplasm, Thus salinity is one of the most brutal environmental stresses that hamper crop productivity worldwide (Flowers, 2004; Munns and Tester 2008). Principle mechanisms include, but are not limited to, ion homeostasis and compartmentalization, ion transport and uptake, biosynthesis of osmoprotectants and compatible solutes, activation of antioxidant enzyme and synthesis of antioxidant compounds, synthesis of polyamines, generation of nitric oxide (NO), and hormone modulation.

### 2.4.1. **Ion homeostasis and salt tolerance:**

Maintaining ion homeostasis by ion uptake and compartmentalization is not only crucial for normal plant growth but is also an essential process for growth during salt stress (Xiaomu *et al.,* 1995; Hasegawa, 2013). Irrespective of their nature, both glycophytes and halophytes cannot tolerate high salt concentration in their cytoplasm. Hence, the excess salt is either transported to the vacuole or sequestered in older tissues which eventually are sacrificed, thereby protecting the plant from salinity stress (Reddy *et al*., 1992; Zhu, 2003). $Na^+$ ion that enters the cytoplasm is then transported to the vacuole via $Na^+/H^+$ antiporter. Two types of $H^+$ pumps are present in the vacuolar membrane: vacuolar type $H^+$-ATPase (V-ATPase) and the vacuolar pyrophosphatase (V-PPase) (Dietz *et al*., 2001; Wang *et al*., 2001). Under stressed condition, the survivability of the plant depends upon the activity of V-ATPase (Dietz *et al*., 2001). V-ATPase activity was up regulated and V-PPase played a minor role (Wang *et al*., 2001).

### 2.4.2. **Compatible solute accumulation and osmotic protection:**

Compatible solutes, also known as compatible osmolytes, are a group of chemically diverse organic compounds that are uncharged, polar, and soluble in nature and do not interfere with the cellular metabolism even at high concentrations. They mainly include proline (Hoque *et al*.,2007; Ahmad *et al*., 2010; Hossain *et al*., 2011; Nounjan *et al*., 2012; Tahir *et al*., 2012), glycine betaine (Khan *et al*., 2000; Wang and Nii, 2000), sugar (Bohnert *et al*., 1995; Kerepesi and Galiba, 2000), and polyols (Ford, 1984; Dopp *et al*., 1985; Ashraf and M. R. Foolad, 2007; Saxena *et al*., 2013) . Organic osmolytes are synthesised and accumulated in varying amounts amongst different plant species. The concentration of compatible solutes within the cell is maintained either by irreversible synthesis of the compounds or by a combination of synthesis and degradation. The biochemical pathways and genes involved in these processes have been thoroughly studied. As their accumulation is proportional to the external osmolarity, the major functions of these osmolytes are to protect the structure and to maintain osmotic balance within the cell via continuous water influx.

### 2.4.3. **Antioxidant regulation of salinity tolerance:**

Abiotic and biotic stress in living organisms, including plants, can cause overflow, deregulation, or even disruption of electron transport chains (ETC) in chloroplasts and mitochondria . Under these conditions molecular oxygen ($O_2$) acts as an electron acceptor, giving rise to the accumulation of ROS . Singlet oxygen ($^1O_2$), the hydroxyl radical ($OH^-$), the superoxide radical ($O_2^-$), and hydrogen peroxide ($H_2O_2$) are all strongly oxidizing compounds and therefore potentially harmful for cell integrity (Groß *et al*., 2013) . Antioxidant metabolism, including antioxidant enzymes and nonenzymatic compounds, play acritical role in detoxifying ROS induced by salinity stress. Salinity tolerance is positively correlated with the activity of antioxidant enzymes, such as superoxide dismutase (SOD), catalase (CAT), glutathione peroxidise (GPX), ascorbate peroxidase (APX), and glutathione reductase (GR) and with the accumulation of nonenzymatic antioxidant compounds (Asada, 1999; Gupta *et al*., 2005).

### 2.4.4. **Roles of polyamines in salinity tolerance:**

Polyamines (PA) are small, low molecular weight, ubiquitous, polycationic aliphatic molecules widely distributed throughout the plant kingdom. Polyamines play a variety of roles in normal growth and development such as regulation of cell proliferation, somatic embryogenesis, differentiation and morphogenesis, dormancy breaking of tubers and seed germination, development of flowers and fruit, and senescence (Galston *et al*., 1997; Panicot *et al*., 2002; Knott *et al*., 2007; Gupta *et al*., 2013). They also play a crucial role in abiotic stress tolerance including salinity and increases in the level of polyamines which are correlated with stress tolerance in plants (Yang *et al*., 2007; Groppa and Benavides, 2008, Kovács *et al*., 2010). The most common polyamines that are found within the plant system are diamine putrescine (PUT), triamine spermidine (SPD), and tetra-amine spermine (SPM) (Martin-Tanguy, 2001; Kuznetsov and Shevyakova, 2007).

### 2.4.5. **Roles of nitric oxide in salinity tolerance:**

Nitric oxide (NO) is a small volatile gaseous molecule, which is involved in the regulation of various plant growth and developmental processes, such as root growth, respiration, stomata closure, flowering, cell death, seed germination and stress responses, as well as a stress signaling molecule (Delledonne *et al*., 1998). NO directly or indirectly triggers expression of many redox-regulated genes. NO reacts with lipid radicals thus preventing lipid oxidation, exerting a protective effect by scavenging superoxide radical and formation of peroxynitrite that can be neutralized by other cellular processes. It also helps in the activation of antioxidant enzymes (SOD, CAT, GPX, APX, and GR) (Bajgu, 2014).

### 2.4.6. **Hormone regulation of salinity tolerance:**

ABA is an important phytohormone whose application to plant ameliorates the effect of stress conditions. It has long been recognized as a hormone which is upregulated due to soil water deficit around the root. Salinity stress causes osmotic stress and water deficit, increasing the production of ABA in shoot and root (He and Cramer, 1996; Cramer and Quarrie, 2002; Cabot *et al*., 2009). The accumulation of ABA can mitigate the inhibitory effect of salinity on photosynthesis, growth, and translocation of assimilates (Popova *et al*., 1995). The positive relationship between ABA accumulation and salinity tolerance has been at least partially attributed to the accumulation of $K^+$, $Ca^{2+}$ and compatible solutes, such as proline and sugars, in vacuoles of roots, which counteract with the uptake of $Na^+$ and $Cl^-$ (Chen *et al*., 2001).

## 2.5. **Knotgrass (*Paspalum Distichum*)*:***

Knotgrass (*Paspalum Distichum*) is a warm-season species of turfgrass perennial grass that grows in clumps or creeping along the soil surface. Knotgrass (*Paspalum Distichum*) is also adapted to areas with high salinity that once established can be irrigated with brackish water. Its use could augment water conservation efforts in drought prone parts of the country and minimize potable water use in other areas.

Knotgrass (*Paspalum Distichum* ) also known as salt-water couch (eastern Australia), Sea-Shore Paspalum (United States, Western Australia), Grama Bobo, Grama Salada (Peru), Water Couch Grass (Malaysia), Grama de mar (Cuba). Is a summer-growing perennial, with long creeping rhizomes and stolons; culms erect, from 15 to 60 cm. Leaves stiff, narrow, about 15 cm long; racemes usually two; spikelets elliptical, 3.5-4 mm long. It differs from P. paspaloides in that the upper glume is glabrous with the mid-nerve sometimes suppressed; the leaf-blades are usually narrower, up to 4 mm wide, often less, folded and with enrolled margins; racemes up to 4 cm long, often less, usually spreading horizontally or deflexed; lower glume absent (Chippendall, 1955). Knotgrass (*Paspalum Distichum*) is native to Africa and the Americas; now widely distributed throughout the tropics, It needs good summer rain, but persists during the dry season. Adapted to marshy, brackish conditions and saline soils which are moist in summer. Once it is established it is virtually impossible to graze it out (Malcolm and Laing, 1976). Its adaptability to saline land, provids soil stabilization and beach protection.

## 2.6. **Ryegrass (*Lolium Perenne* L .).**

Ryegrass (*Lolium Perenne* L.) is a cool-season perennial bunchgrass native in Europe, Middle Asia, and North Africa. Ryegrass (*Lolium Perenne* L.) plays an important role in forage/livestock systems. Its high palatability and digestibility make this species highly valued for dairy and sheep forage systems. Ryegrass (*Lolium Perenne* L.) is adapted to medium textured soils with a pH between 5.1 and 8.4. It requires a minimum of 18 to 25 inches of precipitation annually, at least half of which should be received as rain. Also known as English Ryegrass; Italian Ryegrass; Perennial Rye Grass (English), Ballico Perenne; Raigras Ingles; Vallico (Spanish), Ivraie Vivace; Ray-Grass Anglais (French), Azevem-Vivaz; Gazao (Portuguese), Gazun (Arabic).

Several subspecies and a large number of varieties exist for *Lolium Perenne* L. , including L. *Perenne*subsp. *Multiflorum,* L. *Perenne*subsp. *Remotum* and L. *Perenne*var. *Cristatum,* L. *Perenne*itself shows considerable variation in growth form, from erect, few-tillered individuals to prostrate compact cushions with many vegetative shoot. (Beddows, 1967) describes several forms with abnormal inflorescences and abnormal spikelet development. L. *Perenne*has also been intensively bred for many years in different countries and many improved varieties of both diploid and tetraploid forms are now available for pasture or turf. L. *Perenne*freely crosses with *Lolium Multiflorum* (Italian Ryegrass); producing fertile hybrids (*L. x Hybridum*) with intermediate characteristics. It also forms hybrids with species of *Schedonorus* (formerly *Festuca)* such as *S. Arundinaceus, S. Giganteus* and *S. Pratensis* . L. *Perenne*does not produce stolons or rhizomes, its shoot buds arise at or near the soil level in young plants but may develop from higher nodes in large single plants. The nodal roots are variable, and may be white, thick, glossy, straight, unbranched and covered with root hairs or more slender and soon becoming fibrous (Beddows, 1967). The initial stem within the germinating seed is about 2 mm long and 2.8 mm in diameter and all the leaves, tillers and roots originate from this. Primary and adventitious roots arise from the base of the embryo (Soper and Mitchell, 1956). (Beddows and Jones,1958) describ L. *Perenne* as a hemicryptophyte with a semi-rosette form before head emergence.

## 2.7. **Review of previous studies:**

A number of studies to investigate salt tolerance in turfgrasses and the mechanisms affecting salt tolerance have been undertaken. (Younger *et al*.,1967) observed significant variation in the salt tolerance of creeping bentgrass (Agrostis Spp.) varieties. The main effect of high salinity was the reduction in top growth; the old variety 'Seaside' had the highest salt tolerance and 'Penncross' the lowest. It was noted that 'Seaside' had high variation between individual plants and Engelke (pers. comm.) has selected new varieties (e.g. 'Mariner') with improved salt tolerance and turf quality based on this variation.

McCarty and Dudeck (1993) reported that when germinating bentgrasses in high-salt solutions, 'Streaker' red top and 'Seaside' creeping bentgrass were the most salt-tolerant. 'Kingston' velvet, 'Exeter' colonial and 'Highland' colonial had intermediate tolerance while 'Pennlinks', 'Penncross' and 'Penneagle' creeping bentgrass were the most salt-sensitive.

Marcum (2000) has studied the salt tolerance in the modern bentgrass varieties. He tested 35 bentgrass cultivars, with increasing salinity concentrations from 1 decisiemans/metre/day up to 8 decisiemans/meter/day at which time data were collected.

The most salt tolerant cultivars were Mariner, Seaside II, Grand Prix, Seaside, 18th Green and Century. The least tolerant cultivars suffered complete death after ten weeks exposure and they included Avalon (velvet bent) Ambrosia (colonial bent) as well as Regent, Putter, Penncross and Penn G-6.

Dudeck and Peacock (1993) carried out a study on warm season grasses and demonstrated that 'Emerald' zoysiagrass (Zoysia Spp.), FSP-3 Seashore paspalum (*Paspalum Distichum*) and 'Tifway' couchgrass (*Cynodon Dactylon* × C. Transvaalensis) were the most salt-tolerant. 'Floralawn' St Augustinegrass (*Stenotaphrum Secundatum*), 'Tifway II' couchgrass (*Cynodon Dactylon* × C. Transvaalensis) and 'FSP-1' Seashore paspalum had intermediate salt tolerance while Centipedegrass (*Eremochloa Ophiuroides*) and Bahiagrass (*Paspalum Notatum)* were very salt-sensitive. Dudeck and Peacock (1993) also demonstrated that as salinity increased, plant K levels decrease and to a lesser degree there is a decrease in Ca, Mg and P.

Amareh *et al*., (2015) conducted an experiment based on a randomized complete block design with 3 replications in Bushehr, Iran. to investigate the feasibility of the *Paspalum Notatum* lawngrass, irrigation by sea water in coastline region. Treatments consisted of 6 levels of saline and fresh water at 0, 20, 40, 60, 80 and 100% concentrations, respectively. The overall evaluation of experimental traits revealed that, there were no differences between the growth of *Paspalum Notatum* lawngrass was observed at 20 to 80 seawater irrigation compared with control treat. Growth of *Paspalum Notatum* lawngrass with 100% seawater irrigation had decreased, In general, it can conclude that gradual irrigation with 80% seawater was proper treatment for maintenance of *Paspalum Notatum* lawngrass.

Mohammad ( 2015) conducted as study on Bermudagrass (*Cynodon Dactylon* L.) in a greenhouse experiment to evaluate its growth responses in terms of shoot and root lengths, shoot and root fresh and dry weights and percentage of grass visual green cover under control and salt stress conditions viz., sodium chloride (NaCl). Plants were grown under control (distilled water) and four levels of salt (75, 150, 225 and 300 mM NaCl equivalent to 4.38, 8.77, 13.15 and 17.53 g L sodium chloride, respectively), using a hydroponics system. Results showed that the adverse effect of salinity on the root length started to appear from the third harvest, generally at the higher levels of salinity and it was more pronounced as the exposure time to salinity progressed. Shoot length was more severely affected under salt stress compared to root length. The effect of salinity on shoot length was shown from the first harvest. The root fresh and dry weights were decreased under salinity stress compared with the control treatment, while there was no significant difference detected between the root fresh or dry weights of different salinity treatments. Bermudagrass proved to have a satisfactory growth under the salinity levels of the experiment higher than the soil salinity of the harsh desert conditions. This indicates that Bermudagrass can effectively be used for cultivation under desert saline soils. Therefore, this grass could be recommended for sustainable production under harsh desert conditions with high soil salinity levels, limited water resources and drought conditions and effectively combating desertification processes.

Couillard and Wiecko (1998) evaluated saltwater tolerance on bermudagrass, and seashore paspalum. The turf was treated with ocean water at three concentrations: pure ocean water (54 dS/m), 2/3 ocean water (37 dS/m) + 1/3 potable water, and 1/3 ocean water (19 dS/m) + 2/3 potable water. The watering schedule was twice daily for two different periods: 3 days (d) or 6 d. Following the saltwater stress periods, potable irrigation was applied to evaluate the recovery potential of seashore paspalum and bermudagrass over a period of 32 d after the salt-stress treatments began. Injury was observed on all plant species tested at all three ocean water concentrations.

Uddin *et al*., (2011) experimented seawater of different salinity levels (0, 24, 48, and 72 dSm-1) on 16 turfgrass species grown in plastic pots filled with a mixture of sand and peat (9:1v/v). Chlorophyll concentration decreased significantly with increasing salinity. *P. Vaginatum* and *Z. Japonica* maintained greater amount of total chlorophyll than the others turfgrass species under salt stress. Increasing salinity also decreased K, Ca, Mg content and K/Na ratio but increased Na content in the shoot tissue. The K, Ca, Mg content reduction was the lowest in the species of *Paspalum Vaginatum*, *Zoysia japonica* and *Zoysia Matrella* while the highest K reduction was in the species of *Digitaria Didactyla* at all salinity levels followed by *Axonopus Affinis*, *Cynodon Dactylon* 'Tifdwarf', *Cynodon Dactylon* 'Greenlesspark' and *Axonopus Compressus* (pearl blue). Other species were the intermediate. The overall, shoot K/Na ratio was the highest in *Paspalum Vaginatum* followed by *Zoysia japonica,* whilst the lowest K/Na ratio was in *Axonopus Compressus* (pearl blue) followed by *C. Dactylon* 'Greenless park'. The results revealed that K, Ca and Mg ions uptake and their distribution to shoot tissues under salinity stress may be relevant issues for salt ($Na^+$) exclusion studies and for plant nutrition as well.

Noaman and El-Haddad (2000) exposed established seashore Paspalum to three levels of salinity: 10 g/L (16 dS/m), 20 g/L (32 dS/m), and 40 g/L (64 dS/m). A reduction in plant height with increased salt concentration was apparent after 4 weeks (wk) and continued to decrease until the end of the experiment at 10 wk. Similarly, as salt concentration increased from 16 dS/m to 64 dS/m, plant biomass decreased by 70%.

Marcum and Murdoch (1994) subjected seashore paspalum and five other warm-season turfgrasses [manilagrass (*Zoisia Matrella* (L.) Merr.), St. Augustinegrass (*Stenotaphrum Secundatum* (Walt.) Ktze.), Tifway Bermudagrass, Japanese lawngrass (*Zoisia Japonica* Steud.), and Centipedegrass] to five saltwater concentrations: 1 mM (1 dS/m), 100 mM (9 dS/m), 200 mM (17 dS/m), 300 mM (26 dS/m), and 400 mM (34 dS/m). Seashore Paspalum growth rates were higher than the other turfgrass species at 34 dS/m. Seashore Paspalum quality ratings were also higher than the other turfgrasses at all saltwater concentrations.

Yiwei *et al*., (2012) conducted a study to examine the growth and physiological responses of diverse perennial Ryegrass accessions to increasing salinity, ten diverse accessions of perennial Ryegrass (*Lolium Perenne* L.) were grown in sand culture and exposed to a half-Hoagland solution amended with 0 (control), 50-, 100-, 150-, 200-, and 300 mM NaCl. Across all accessions, they observed that decreased plant height, K+ concentration and K+/Na+ and increased concentrations of fructan and Na+ were observed at ≥ 50 mM NaCl, while decreased leaf fresh and dry weight (DW), leaf water content (LWC), chlorophyll fluorescence (Fv/Fm), and increased water-soluble carbohydrate concentration (WSC) occurred at ≥ 150 mM NaCl. The maximum separations of salinity tolerance of accessions occurred at 200 to 300 mM NaCl. The results indicated that DW, LWC, Fv/Fm and Na+ could be associated with variability in tolerance of diverse perennial Ryegrasses to high salinity stress.( Yiwei *et al*., 2012).

Muhammad *et al*.,( 2012) conducted a study on four Bermuda grass cultivars Tifway, Tifdwarf, Dacca and Khabbal (local ecotype) to examine their salinity tolerance using half-strength Hoagland's solution culture system under greenhouse conditions. The cultivars were exposed to five salinity levels viz., 2.4 (control) 50, 100, 150 and 200 mM NaCl). They found that, increasing salt concentration in the nutrient media caused: (a) a reduction in number of stolons plug, number of roots/plug, length of shoot, dry weights of root and shoot, turf quality, and potassium content in stolons, (b) increase in sodium and chloride content in stolons. They concluded that, Tifway was found to be the most tolerant to salinity while Khabbal the most sensitive, among all four grass cultivars.

Mane *et al*., (2011) carried out a study in India to examine the alterations in the growth characteristics of a grass species *Pennisetum Alopecuroides* under the influence of sodium chloride (NaCl) salinity. They found that shoot length of *Pennisetum Alopecuroides* was increased by 13.17% at 100 mM NaCl concentration while the root length was observed to be increased at 50 mM NaCl concentration by 26.93%. Maximum height of the plant was observed by 18.23% at 50 mM while shoot to root ratio was higher at 300 Mm concentrations by 29.17% increase over the control. Moreover, the maximum percent increase in leaf area was recorded as 11.17% (100 mM). Fresh weight was increased by 50.92 % at 100 mM while dry weight of the experimental grass was increased by 33.64 % at the same concentration of salt to the rooting medium while moisture percentage was increased to a maximum by 24.61% at 50 mM. It appears that the grass species studied exhibit a moderate salinity tolerance as far as linear growth of plant is concerned. Salt stress induced alteration in growth characteristics of *Pennisetum Alopecuroides* grass.

Baig *et al*., (2015) conducted a study in Pakistan to examine the effect of salinity on three imported seeds i.e. *Trifolium Repens*, *Dactylis Glomerata* and *Medicago sativa*. Experiments were conducted in salinity induced soils. Seed germination and speed of germination were recorded. Study showed in higher salinity exhibit no germination. In garden soil *Trifolium Repens* showed highest percentage of germination i.e. 56.66% ±1.55 while percentage of germination of *Medicago sativa* and *Dactylis Glomerata* was 50% ±1.00 and 37% ± 1.155 respectively. They also observed that *Dactylis Glomerata* was highly salinity sensitive in comparison to other two species.

Borowski (2008) conducted a study to examine the effect of sodium chloride salinity on the germination of 4 species of grasses i.e. *Lolium Perenne*, *Festuca Rubra*, *Agrostis Capillaris*, *Poa Pratensis*. The grass seeds germinated in Petri dishes, in darkness, at the temperature of 24°C. Besides the control, 3 levels of salinity were used in the studies:100, 200 and 300 mM NaCl. The obtained results demonstrated that the growing level of salinity in the environment significantly decreased the germinating speed, the number of the produced roots, the length of the longest root, and the length of the coleoptiles in the seedlings of all studied grass species. *Lolium Perenne*seeds tolerated salinity the best, and next in a diminishing sequence those were the seeds of *Festuca Rubra*, *Agrostis Capillaris* and *Poa Pratensis*.

Zulkaliph *et al*., (2013). studied about 16 turfgrass species for salt tolerance from Peninsular of Malaysia under sand culture system. Irrigation seawater of different salinity levels (0, 24, 48, and 72 dS m-1) were applied to turfgrass species grown in a plastic pots filled with a mixture of sand and peat (9:1). Their study revealed that, the most salt tolerant turf species was *P. Vaginatum*, *P.*, *Z. Matrella*, *Z. Japonica*, *C. Dactylon* 'satiri' , *C. Dactylon* (Kuala Muda), while the least tolerant group were *E. Ophiuroides*, (UPM), *P. Notatum* (UPM), *A. Compressus* 'cowgrass' (UPM), *A. Affinis* (UPM), and *A. Compressus* 'pearl blue'. (Zulkaliph *et al*., 2013).

Wiecko (2003) exposed seashore Paspalum, bermudagrass, St. Augustinegrass, and Centipedegrass to three different salinity levels (54, 37, and 19 dS/m) over two short term salt stress durations (3 and 6 d). Seashore Paspalum showed excellent salinity tolerance compared to all other plants tested with the maximum injury of 18% at 54 dS/m after the 6 d salt stress duration. Bermuda grass injury was 30% at 54 dS/m after the 6 d salt stress duration and only minor injury at lower salt concentrations. St. Augustinegrass showed up to 60% injury under the 6 d duration of 54 dS/m and centipedegrass showed complete necrosis.

Dai *et al*., (2008) conducted to determine relative salinity tolerance of greens-type *Poa Annua* L. compared with other cool-season turfgrass species. ffects of increasing salinity stress on final germination percentage (FGP), germination rate (GR), clipping yield dry weight (CYD), verdure dry weight (VD), root dry weight (RD), and the longest root length (LRL) were evaluated for nine experimental lines of greens-type *P. Annua*, two cultivars of Kentucky bluegrass (*P. Pratensis* L.), three cultivars of creeping bentgrass (*Agrostis Stolonifera* L.), and one cultivar of perennial Ryegrass (*Lolium Perenne* L.)they found that, FGP, GR , CYD , VD , and RD declined with increasing salinity; LRL increased at lower salinity levels but decreased at higher levels . Perennial Ryegrass (*Lolium Perenne* L.) 'Charger II' and creeping bent grass 'Mariner' exhibited the most salinity tolerance while Kentucky bluegrass cultivars exhibited the least. Salinity tolerance of greens-type *P. Annua* was intermediate; however, some experimental lines exhibited nearly equal salinity tolerance to that of Mariner.

# Chapter Three

## 3. Materials and methods

### 3.1. Study location and plant materials:

This study was conducted at Benghazi city. This study was conducted during spring-summer 2016 in Benghazi university laboratory. Plant materials used in this study are described in the following table and figures.

**Tab. (3-1): Plant species used in the study.**

| Common name | Scientific name | Family |
|---|---|---|
| Ryegrass | *Lolium Perenne* L. | Poaceae |
| Knotgrass | *Paspalum Distichum* | Poaceae |

**Fig (3-1): Perennial Ryegrass (*Lolium Perenne* L.).**

**Figure(3-2): Knotgrass (*Paspalum Distichum*).**

## 3.2. Experimentation seawater concentration effect on of Ryegrass (*Lolium Perenne* L. ):

This experiment was conducted during spring time March/2016.

### 3.2.1. Seed germination experiment:

1. Seeds of Ryegrass selected with similar shape and size, were obtained from the local market of Benghazi. They were surface-sterilized with 2% sodium hypochlorite solution NaOCl for 12 minutes and rinsed with sterile distilled water several times then blotted using sterile paper towels.
2. Seawater was obtained from Sedi khalifa area 17 Km in North of Benghazi, five concentrations of seawater were prepared 1%, 2%, 5%, 10%, 20% (v/v) , for preparation of 1% concentration in a measuring cylinder 1ml of seawater was diluted with distilled water to complete the volume to 100ml, the same procedure was performed for the other concentrations as shown in table (3-2), 0% concentration was a pure distilled water which was used as a control.

**Tab. (3-2): Preparation of different concentration of seawater.**

| Concentration | Seawater | Distilled water |
|---|---|---|
| 0% Control | 0 | Pure distilled water |
| 1% | 1ml | 99 ml |
| 2% | 2ml | 98 ml |
| 5% | 5ml | 95ml |
| 10% | 10ml | 90ml |
| 20% | 20ml | 80 ml |

4. In sterile 9 cm Petri dishes lined with double layer whatmann filter paper moisten with 5 ml of each seawater concentration, Seeds were plated on Petri dishes under aseptic conditions. Each Petri dish contained 10 seeds of one inbred-line, plates were kept at room temperature 25° C, this process was in 3 replicates for each concentration , the total number of plates were 18 plates.
5. Plates were watered as needed with 5 ml of each concentration for 10 days. Every day from the beginning of germination, the number of germinated seeds was determined.
6. Germinated seeds were counted daily for the calculations of daily and final germination percentages and mean germination time (MGT).seeds were considered germinated when the radical had protruded 2 mm according to the following formulas:

- % Germination (G%) = $\frac{\text{No.of seeds with extened radicals}}{\text{Total number of seeds}} \times 100$
- Mean germination time (MGR)= ∑(T1*n1 + T2*n2 +…+ Tk*nk)/∑(n1 + n2 +…+nk)

  where (N)= No. of new germinated seed, T= time from the beginning of the experiment.

- **Seedling Vigor Index (SVI):**

The seedling vigor index was calculated by using Abdul-Baki and Anderson (1973) formulae.

**SVI** = (Shoot length+ Root length) × Germination percentage.

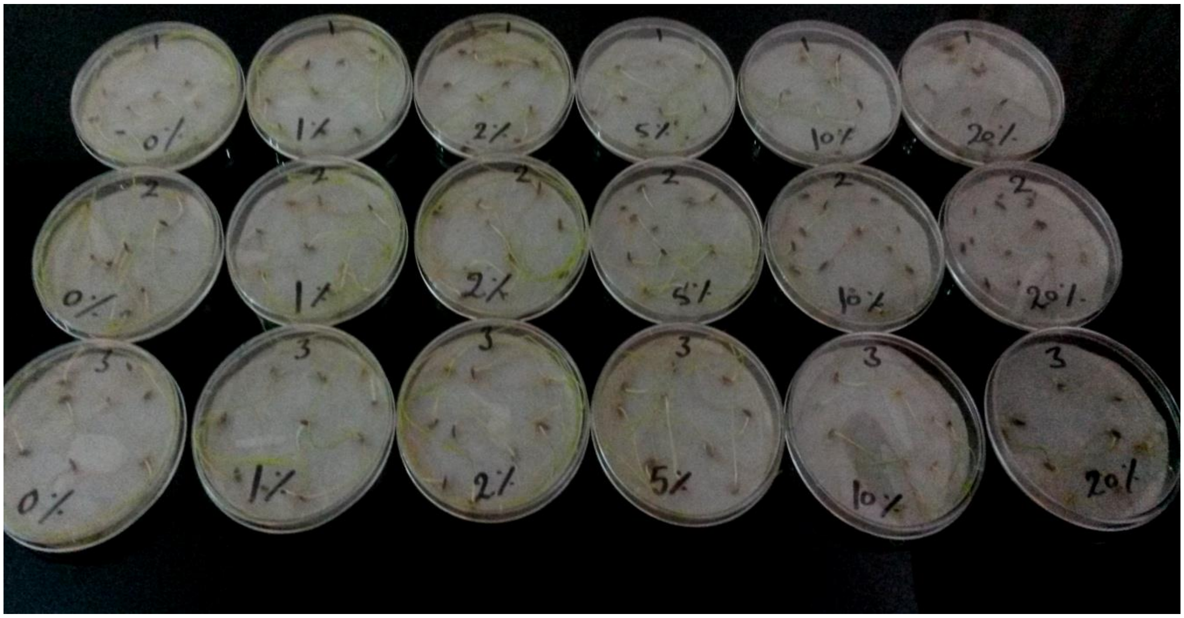


**Figure (3-3) : Seed germination of Perennial Ryegrass (*Lolium Perenne* L.).**

## 3.2.2. Seedling development study:

Germinated seeds were allowed to develop and grow the seedlings under the same conditions. At the end of the growth period in this study, root length, shoot length, fresh and dry weight of the grown Ryegrass (*Lolium Perenne* L.) were measured. Fresh weight were measured directly by sensitive balance, dry weight were taken after drying of the plant in an oven at 65° C for 24 hours.

## 3.2.3. Measurements of both electro conductivity and PH:

Electrical conductivities EC and pH of each sea water concentration were measured by EC and pH meter (HANNA, Germany).

**Table (3-3): Measurement of electro conductivity and PH.**

| Concentration | 0% | 1% | 2% | 5% | 10% | 20% |
|---|---|---|---|---|---|---|
| E.C | 2 | 820 | 1552 | 3635 | 3999 | Above 3999 |
| PH | 7.80 | 6.40 | 6.43 | 6.47 | 7.63 | 7.67 |

## 3.3. Experimentation of seawater concentrations effect on development of Knotgrass (*Paspalum Distichum*):

This experiment was conducted in May/ 2016 in an opened space, exposed to natural air and sunlight.

1. Eighteen Knotgrass (*Paspalum Distichum*) transplants provided in ordinary condition were cultivated in plastic pots with diameter and deepness of 30 cm (3 pots for each concentration) filled with agricultural soil obtained from Sedi Khalifa area.
2. Knotgrass (*Paspalum Distichum*) pots were treated with urea solution 0.4% as a fertilizer prepared by adding 40g of urea to 10L of water.
3. Seawater was obtained from Sedi khalifa area, five concentrations of seawater were prepared 1%, 2%, 5%, 10% and 20% (v/v) , 0% distilled water was used as a control treatment.
4. The pots were irrigated with the different concentration of seawater for 2 weeks, then the shoot parts were clipped, the clipped shoot were measured by sensitive balance to obtain the fresh weight, dry weight were obtained after drying of the clipped shoot in an oven of temperature about 65 ° C for 24 hours. This procedure was repeated 2 times on shoot part. After six weeks, the same procedure was applied to the root part.
5. Shoot system water content ,was measured 2 weeks after seawater concentrations treatments were imposed. To determine shoot system water content, Shoot system was cut from plants and quickly placed in a clean, dry glass vial and capped. After determining fresh weight , Shoot system was dried in an oven at 65°C for 24 h to determine dry weight.

**Figure (3-4): Development of Knotgrass (*Paspalum Distichum*).**

## 3.4. Statistical analysis:

Data of seed germination and seedling development experiments on Ryegrass *(Lolium Perenne* L.) (germination percentage, mean germination time, root length, shoot length, dry weight and fresh weight) in addition to the data collected from seawater concentrations effect on development of Knotgrass experiment (fresh and dry weights of clipped shoot) summarized in SPSS (social package statistic software, version 18) and analyzed by Anova test to estimate the differences in the response to verities of seawater concentrations significance was accepted at *P*-values below 0.05 the confidence interval was set at 95%.

# Chapter Four

## 4. Results.

### 4.1. Experimentation of seawater concentrations effect on germination and development of Ryegrass (*Lolium Perenne* L. ):

#### 4.1.1. Mean germination time (MGT) of Ryegrass (*Lolium Perenne* L.):

Higher reduction of germination was recorded in seeds irrigated with sea water 1%, seed germination was delayed at the other concentrations compared with the control, which recorded higher value at concentration of 20% ( 4.17 days).

**Table (4-1): Mean germination time of Ryegrass (*Lolium Perenne* L.).**

| Seawater % | MGT |
|---|---|
| 0% | 3.37 |
| 1% | 2.93 |
| 2% | 3.4 |
| 5% | 3.53 |
| 10% | 3.51 |
| 20% | 4.17 |

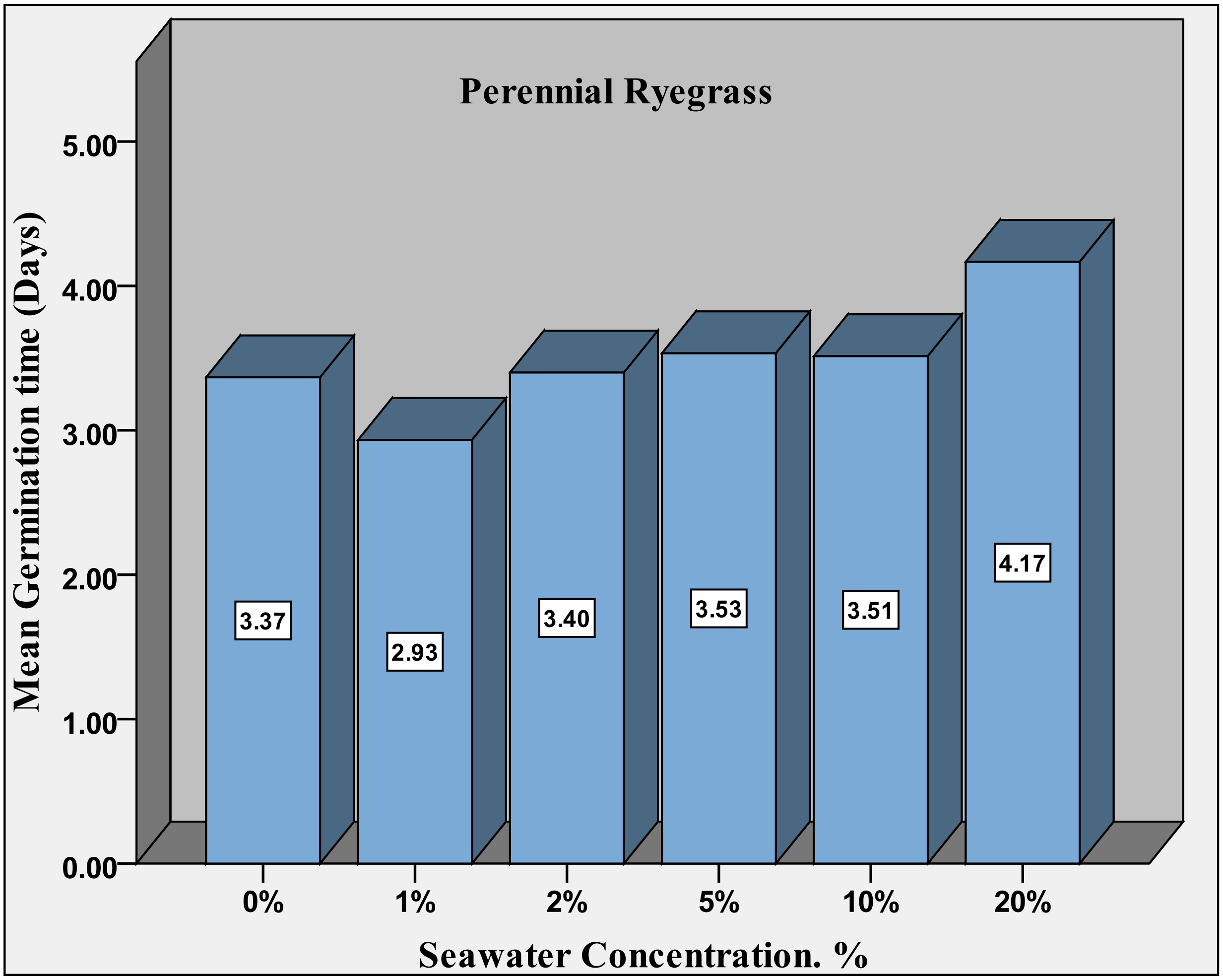


**Figure (4-1): Mean germination time of Ryegrass (*Lolium Perenne* L.).**

### 4.1.2. Seed germination percentage of perennial Ryegrass (*Lolium Perenne* L .):

Final seed germination of Ryegrass (*Lolium Perenne* L.) showed significant decrease at higher concentrations of sea water (10% and 20%). So increased seawater concentrations affect both mean germination time and final germination percentage.

**Table (4-2): Seed germination percentage of Ryegrass (*Lolium Perenne* L.).**

| Seed germination % | | | |
|---|---|---|---|
| **Concentration %** | **Mean** | **SD. Deviation** | **SD. Error of Mean** |
| 0% | 73.25 | 6.65 | 3.33 |
| 1% | 76.75 | 3.86 | 1.93 |
| 2% | 76.5 | 3.11 | 1.55 |
| 5% | 71.25 | 6.19 | 3.09 |
| 10% | 64.0 | 8.37 | 4.18 |
| 20% | 59.0 | 12.0 | 6.0 |

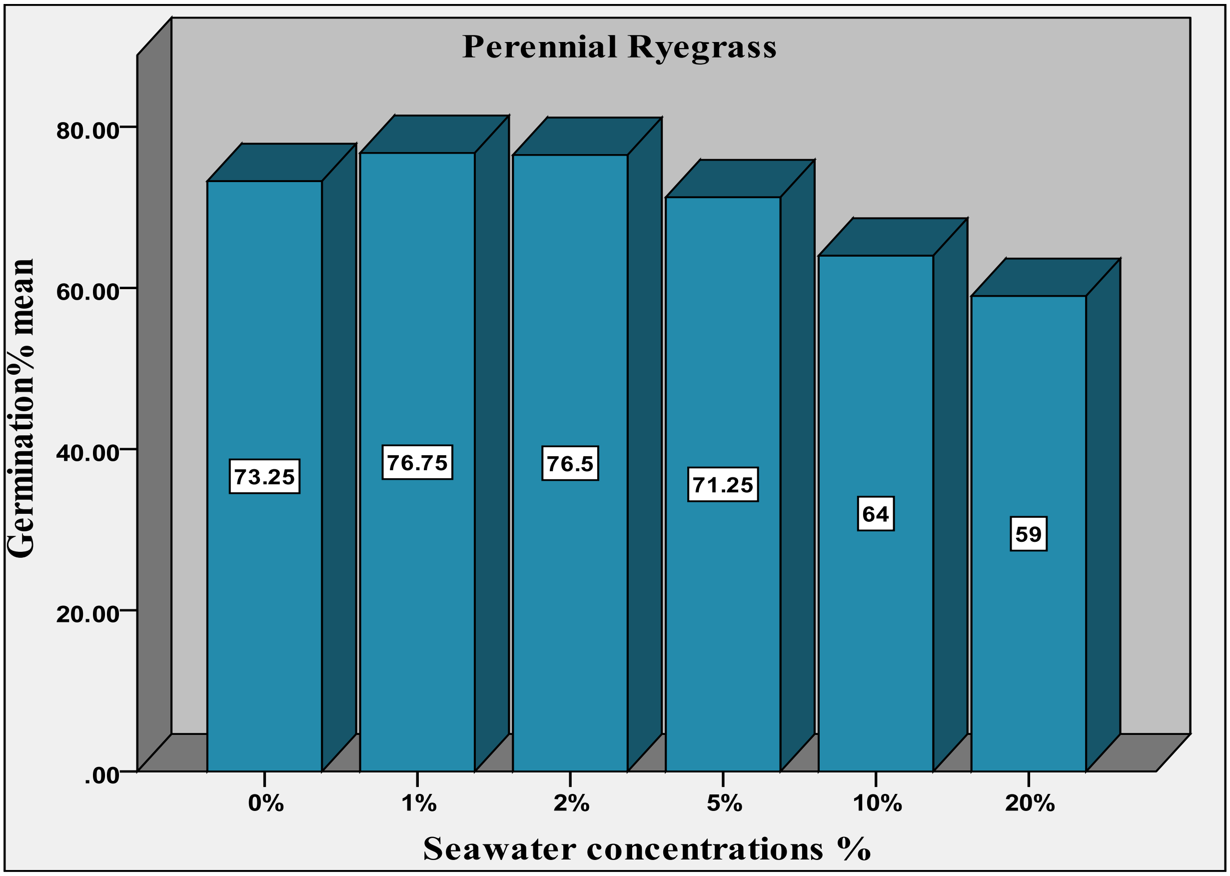


**Figure (4-2): Germination percentage of Ryegrass (*Lolium Perenne* L.) .**

### 4.1.3. Effect of seawater concentrations on Ryegrass (*Lolium Perenne* L.) shoot and root length:

The effect of seawater concentrations increase showed highly significant decrease in mean of both shoot and root lengths of Ryegrass (*Lolium Perenne* L.) compared with the control especially at high concentrations (p-value=000). Post hoc multiple comparison revealed that this significant effect had related to the higher concentration of sea water 5%, 10% and 20%, (p-value= 0.007, 0.00, 0.00) respectively as described in table (4-3) and figures (4-3), (4-4). Both shoot and root lengths of Ryegrass were negatively affected by seawater concentrations, their lengths decreased with increased seawater concentrations level, but the sensitivity of shoot to seawater concentrations were more than that of root as shown in the figure (4-5).

**Table (4-3): Effect of seawater concentrations on Ryegrass (*Lolium Perenne* L.) shoot and root length.**

| Parameters | Descriptive | | | | Anova |
|---|---|---|---|---|---|
| | **Conc. %** | **Mean** | **S.D±** | **S. error** | **p- value** |
| **Shoot** | 0% | 9.50 | 2.70 | 0.43 | 0.000** |
| | 1% | 9.21 | 2.15 | 0.34 | |
| | 2% | 9.15 | 1.93 | 0.31 | |
| | 5% | 7.83 | 2.79 | 0.44 | |
| | 10% | 5.37 | 2.76 | 0.44 | |
| | 20% | 1.32 | 1.24 | 0.20 | |
| **Root** | 0% | 9.29 | 2.70 | 0.43 | 0.000** |
| | 1% | 10.44 | 3.22 | 0.51 | |
| | 2% | 10.01 | 2.56 | 0.40 | |
| | 5% | 8.19 | 3.03 | 0.48 | |
| | 10% | 7.14 | 3.34 | 0.53 | |
| | 20% | 2.16 | 1.58 | 0.25 | |

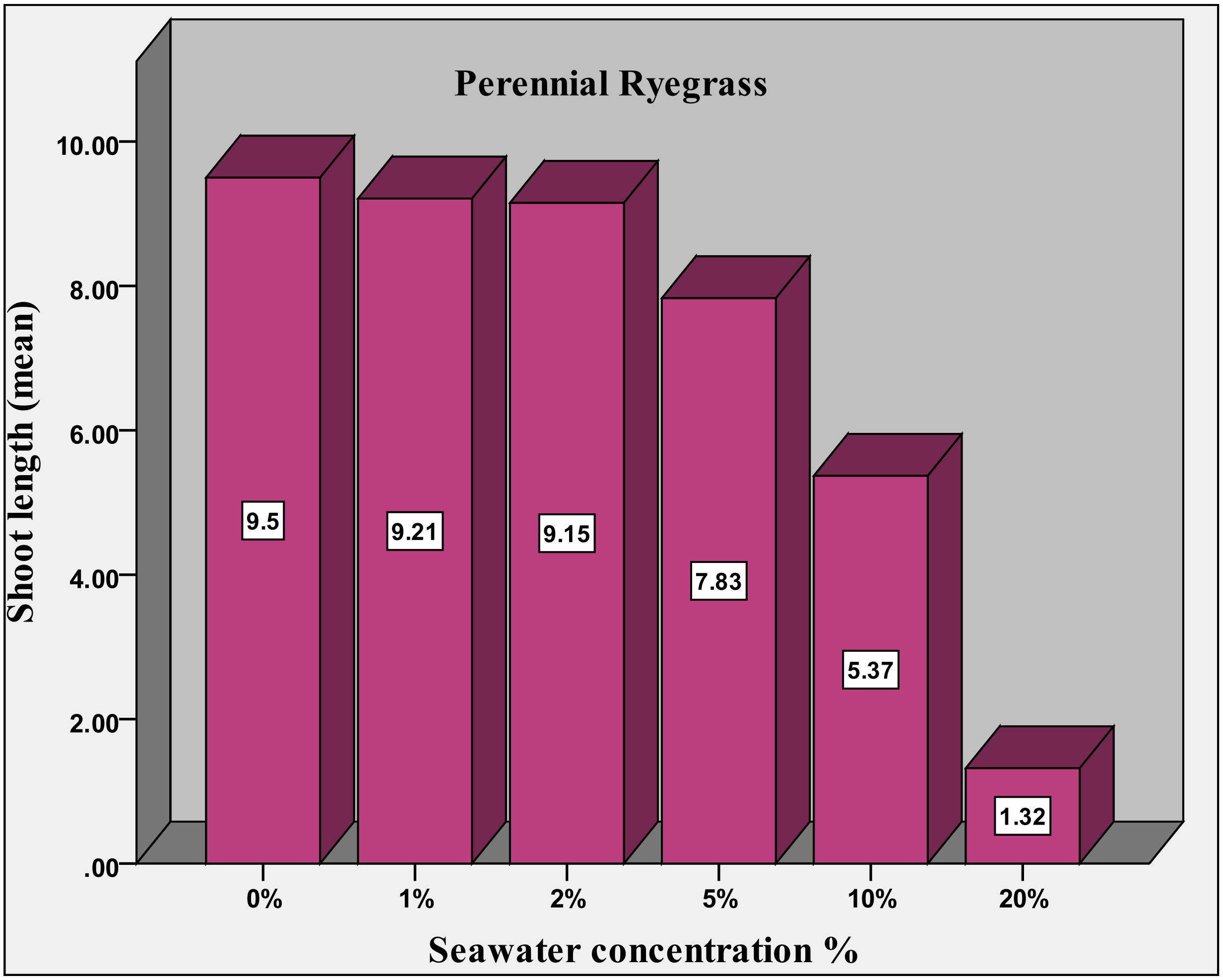


**Figure (4-3): Effect of seawater concentrations on Ryegrass (*Lolium Perenne* L.) shoot length.**

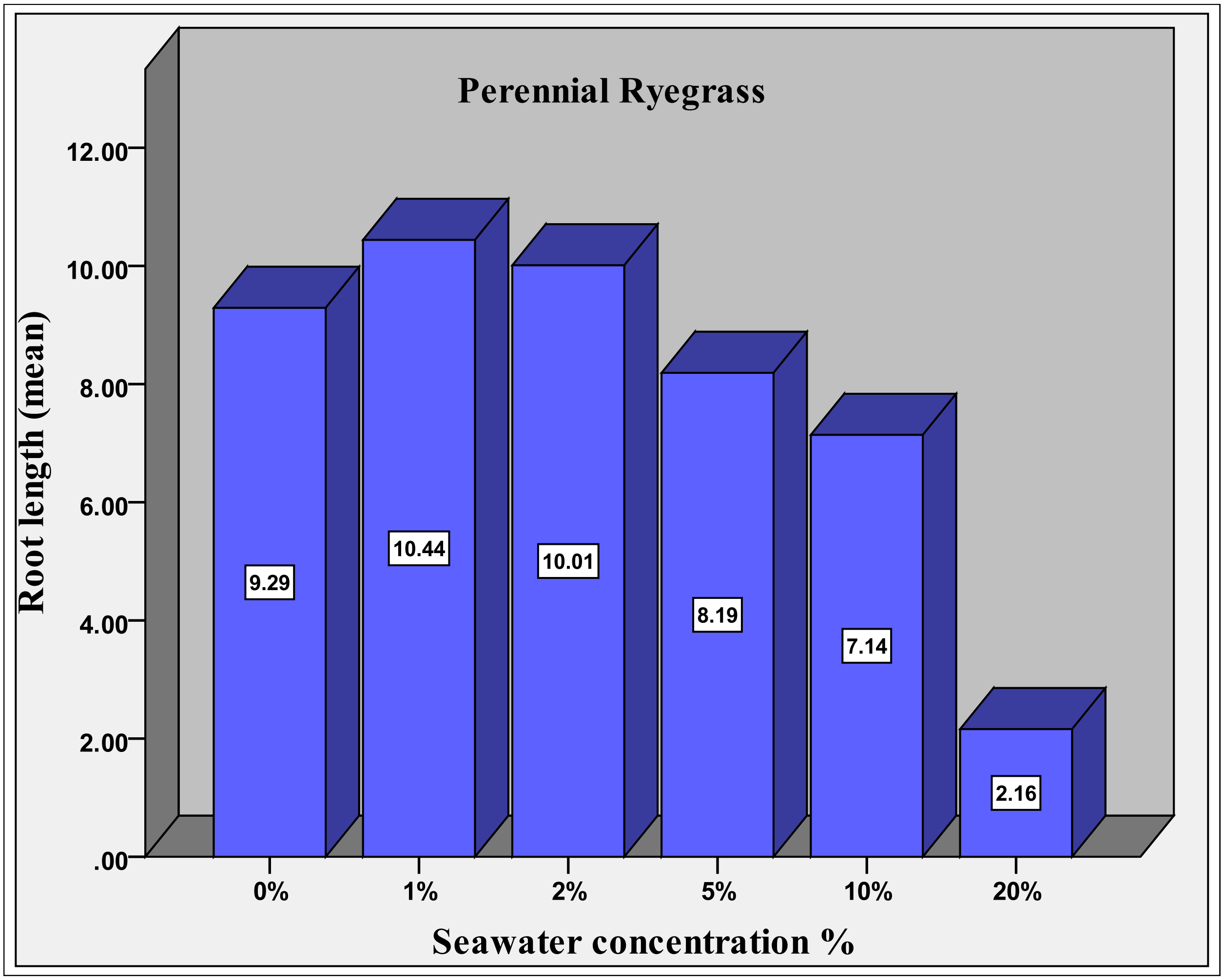


**Figure (4-4): Effect of seawater concentrations on Ryegrass (*Lolium Perenne* L.) root length.**

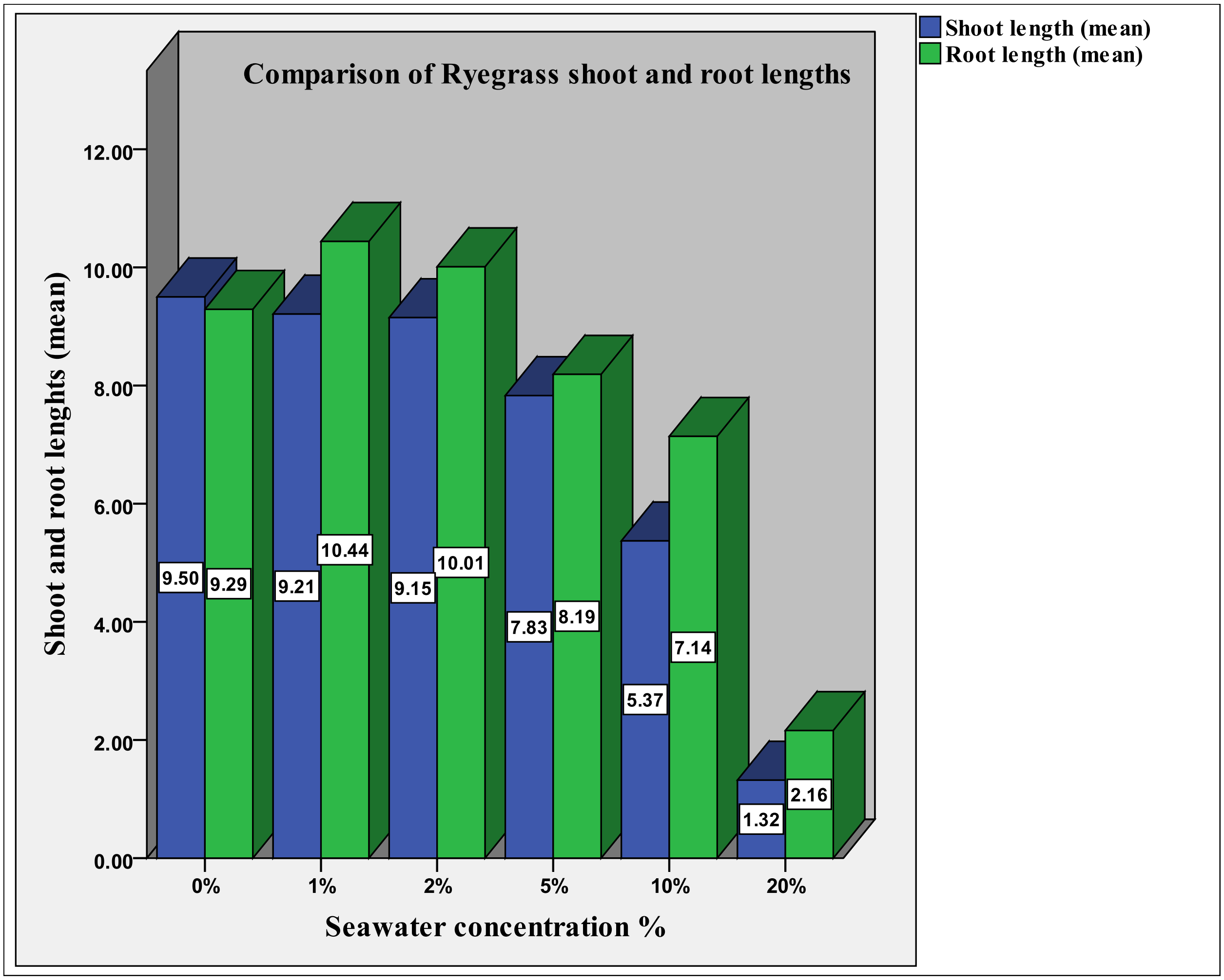


**Figure (4-5):Comparing response of Ryegrass (*Lolium Perenne* L.) shoot and root length to seawater concentrations.**

### 4.1.4. Effect of seawater on seedling vigor index (SVI) of perennial Ryegrass (*Lolium Perenne* L.):

Seedling vigor index of perennial Ryegrass (*Lolium Perenne* L.) showed significant decrease in the value with increased seawater concentrations, compared with the control treatment the highest seedling vigor index value was observed at sea water concentration of 1%, while the lowest seedling vigor index was recorded at sea water concentration of 20%.

**Table (4-4): Effect of seawater on seedling vigor index of perennial Ryegrass (*Lolium Perenne* L.).**

| Seawater concentration % | SVI |
|---|---|
| 0% | 1376.40 |
| 1% | 1508.14 |
| 2% | 1465.74 |
| 5% | 1141.43 |
| 10% | 800.64 |
| 20% | 205.32 |

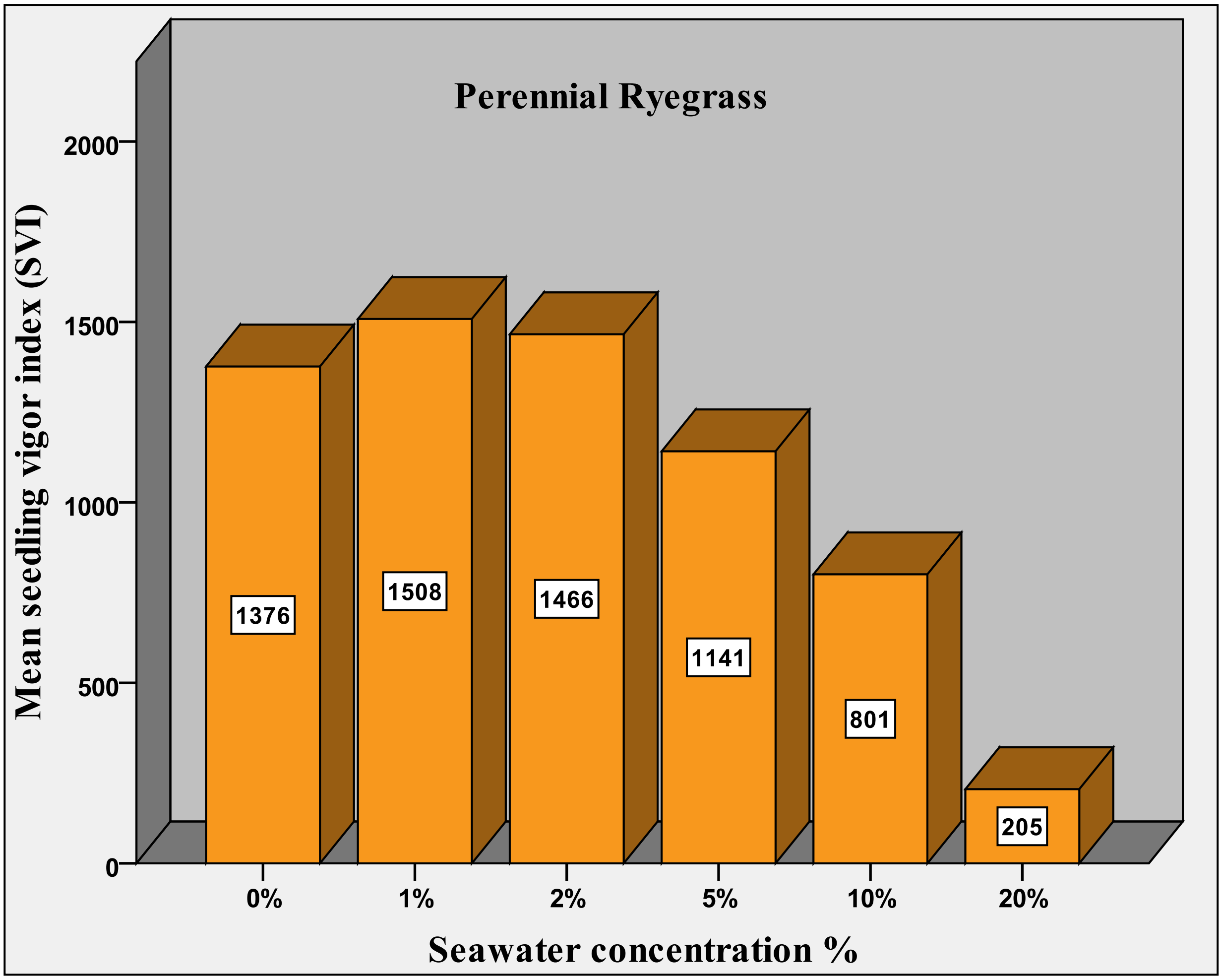


**Figure (4-6): Effect of seawater on seedling vigor index of perennial Ryegrass (*Lolium Perenne* L.).**

## 4.2. Experimentation of seawater concentrations effect on development of Knotgrass *(Paspalum Distichum)*:

### 4.2.1. Effect of seawater concentrations on Knotgrass (*Paspalum Distichum*) shoot system water content:

As described in the table (4-5) and figure (4-7), there was very weak correlation between seawater concentrations and leaf water content (pearson correlation =0.111). Seawater concentrations level did not affect leaf water content, the differences in the means of leaf water content were not significant compared with the control (p-value= 0.063).

**Table (4-5): Effect of seawater concentrations on Knotgrass (*Paspalum Distichum*) shoot system water content.**

| Seawater concentrations | Mean | N | STD |
|---|---|---|---|
| 0% | 53.00 | 3.00 | 1.73 |
| 1% | 52.33 | 3.00 | 2.08 |
| 2% | 57.33 | 3.00 | 2.08 |
| 5% | 54.00 | 3.00 | 1.73 |
| 10% | 56.67 | 3.00 | 3.21 |
| 20% | 55.00 | 3.00 | 0.00 |
| **Pearson correlation** | 0.11` | | |
| **Anova** | 0.064 | | |

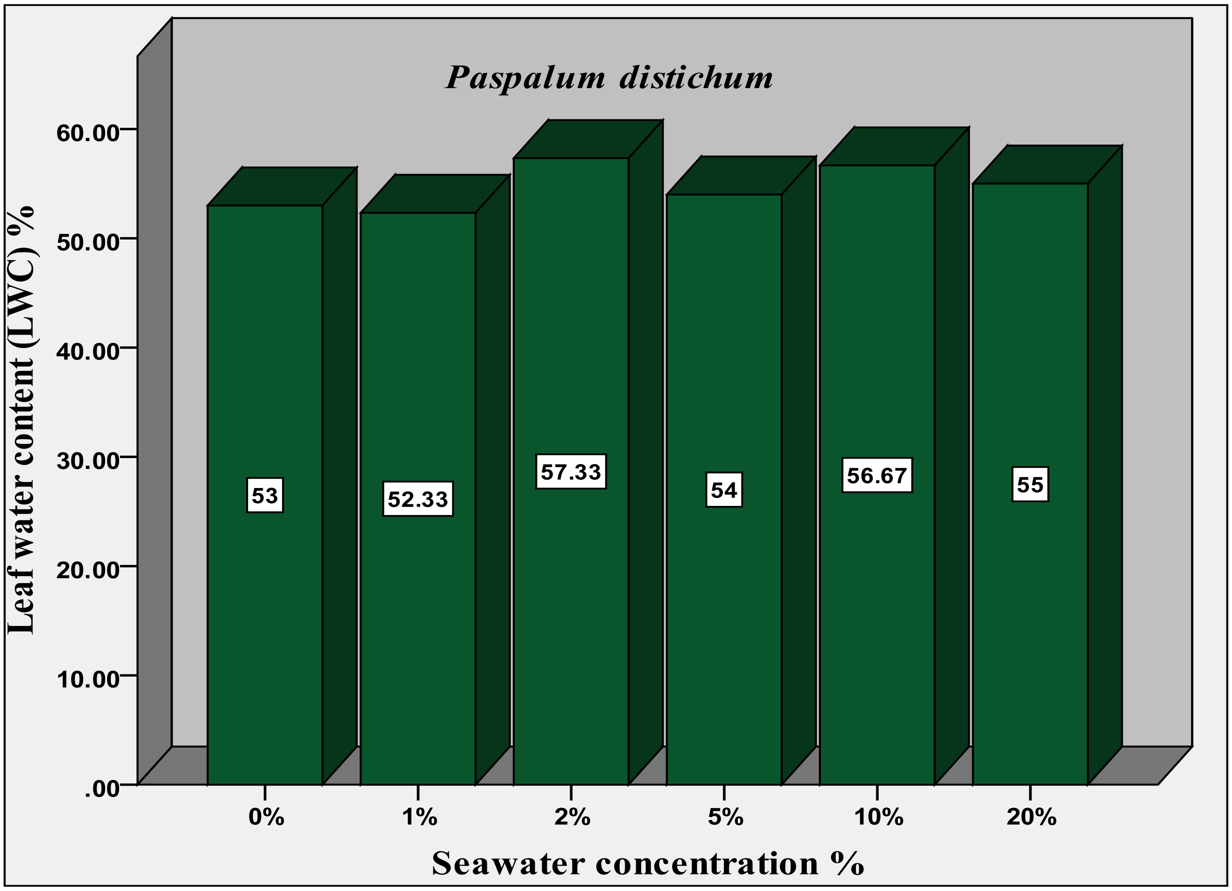


**Figure (4-7): Effect of seawater concentrations on Knotgrass *(Paspalum Distichum*) shoot system water content.**

### 4.2.2. Effect of seawater concentrations on Knotgrass (*Paspalum Distichum*) shoot fresh and dry weights:

Effect of seawater concentrations on the means of Knotgrass (*Paspalum Distichum*) fresh and dry weights showed significant differences (P- value 0.008, 0.015) respectively. Compared with their control treatments both fresh and dry weights of shoot system showed increased value at seawater concentrations (1 and 5%), then showed decreased value with increased seawater concentrations, maximum reduction in shoot dry and fresh weight were seen at higher concentrations (10% and 20%).

**Table (4-6): Fresh and dry weights of Knotgrass (*Paspalum Distichum*) shoot system.**

| Seawater concentrations % | Descriptive | Fresh weight | Dry weight |
|---|---|---|---|
| 0% | **Mean** | 65.93 | 31.16 |
| | **SD. Deviation** | 15.01 | 7.67 |
| | **SD. Error of Mean** | 5.00 | 2.56 |
| 1% | **Mean** | 72.68 | 34.79 |
| | **SD. Deviation** | 13.11 | 8.18 |
| | **SD. Error of Mean** | 4.37 | 2.73 |
| 2% | **Mean** | 59.05 | 25.06 |
| | **SD. Deviation** | 6.68 | 4.68 |
| | **SD. Error of Mean** | 2.23 | 1.56 |
| 5% | **Mean** | 65.46 | 30.29 |
| | **SD. Deviation** | 13.09 | 7.51 |
| | **SD. Error of Mean** | 4.36 | 2.50 |
| 10% | **Mean** | 51.94 | 22.55 |
| | **SD. Deviation** | 10.25 | 5.04 |
| | **SD. Error of Mean** | 3.42 | 1.68 |
| 20% | **Mean** | 54.47 | 24.54 |
| | **SD. Deviation** | 7.41 | 3.27 |
| | **SD. Error of Mean** | 2.47 | 1.09 |
| **Anova** | | 0.008 | 0.015 |

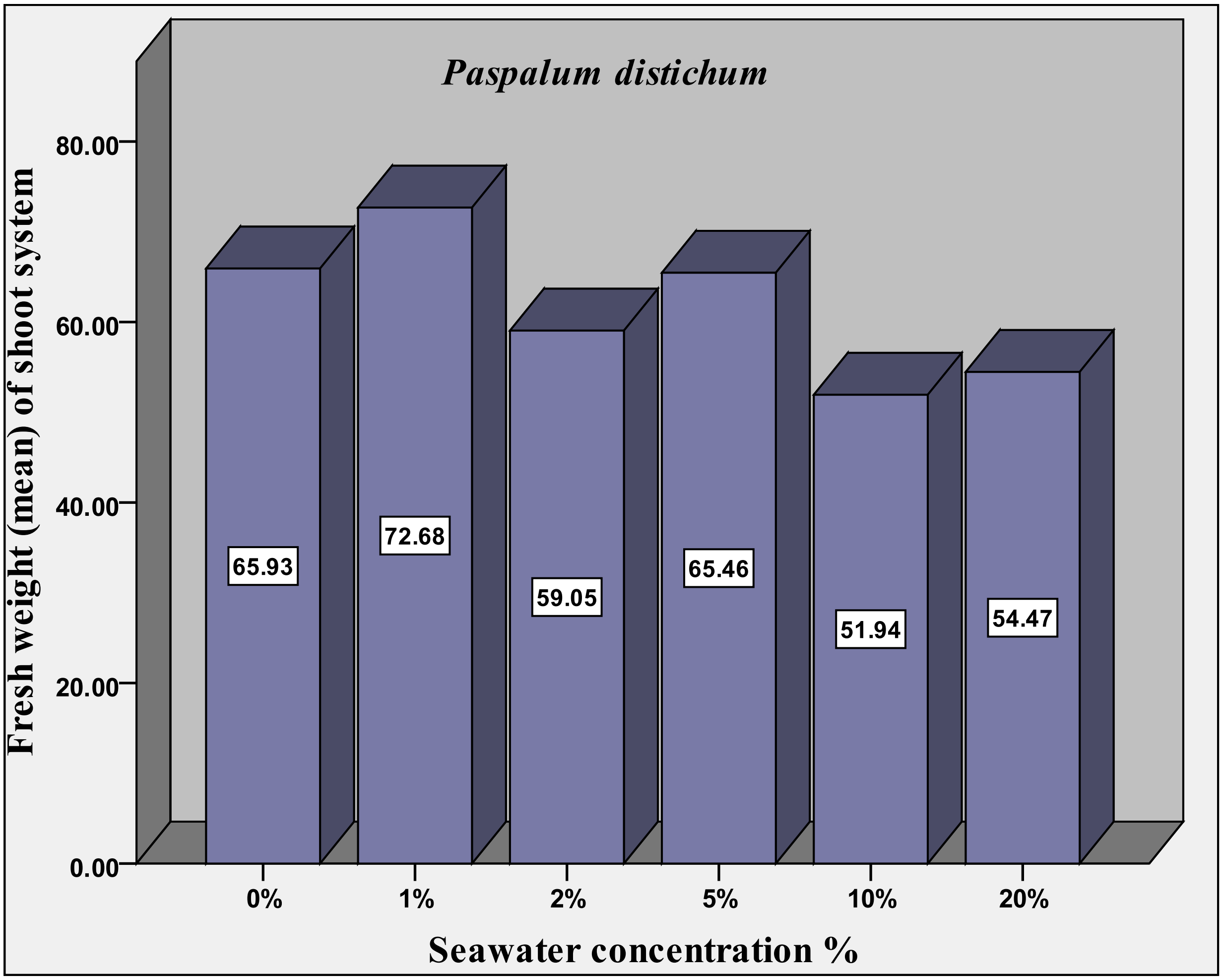


**Figure (4-8): Effect of seawater concentrations on the Fresh weight of Knotgrass (*Paspalum Distichum*). shoot system.**

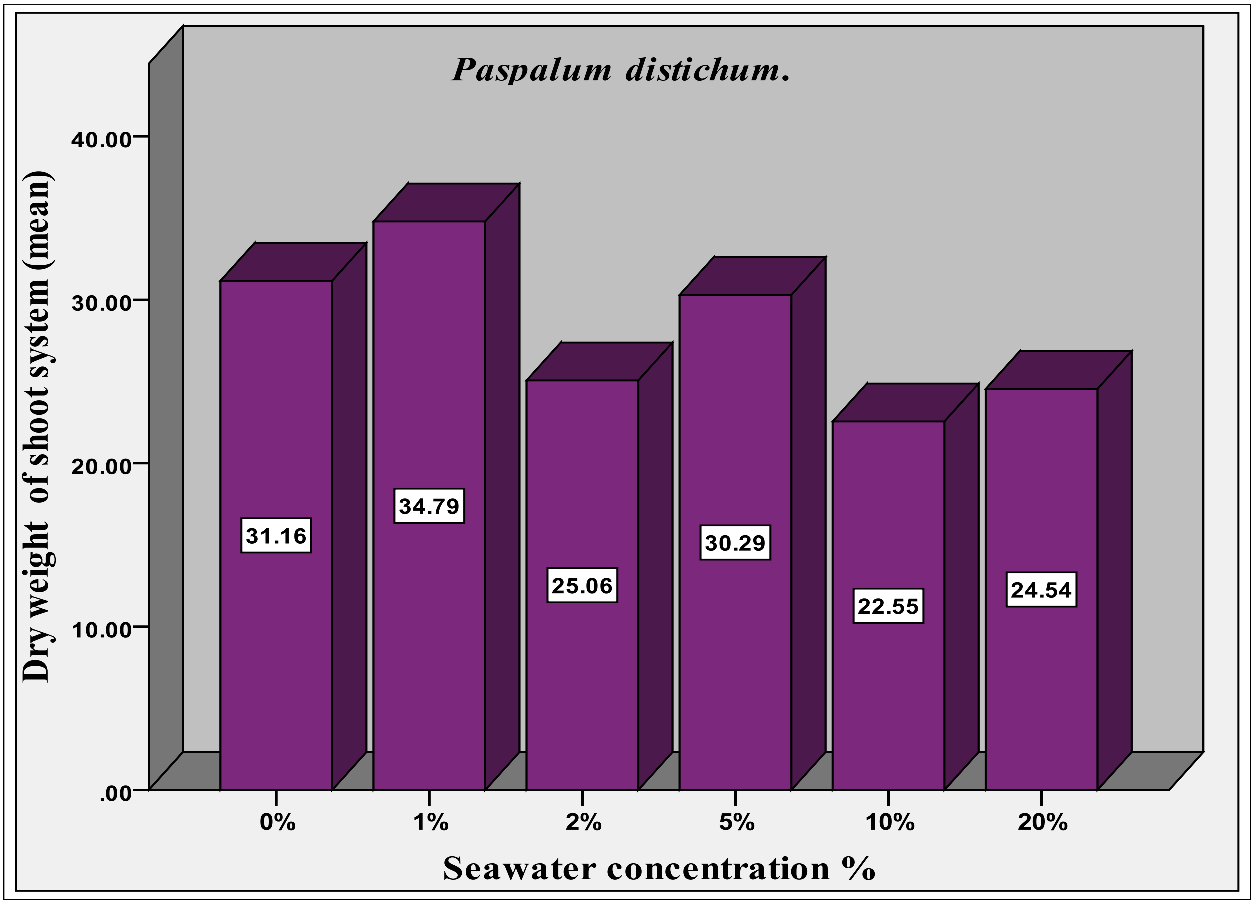


**Figure (4-9): Effect of seawater concentrations on the dry weight of Knotgrass (*Paspalum Distichum*). shoot system.**

### 4.2.3. Effect of seawater concentrations on Knotgrass (*Paspalum Distichum* ) root fresh and dry weights:

Effect of seawater concentrations on the means of Knotgrass *(Paspalum Distichum*) roots fresh and dry weights showed no significant differences (P- value 0.083, 0.095) respectively. Compared with their control treatments both fresh and dry weights of root system showed decreased value with increased seawater concentrations, but this reduction in root system weight was not significant.

**Table (4-7): Fresh and dry weights of Knotgrass (*Paspalum Distichum*) root system.**

| Seawater concentrations % | Descriptive | Fresh weight | Dry weight |
|---|---|---|---|
| 0% | **Mean** | 242.68 | 127.99 |
| | **SD. Deviation** | 80.822 | 35.3 |
| | **SD. Error of Mean** | 46.663 | 20.38 |
| 1% | **Mean** | 289.94 | 142.48 |
| | **SD. Deviation** | 40.652 | 17.731 |
| | **SD. Error of Mean** | 23.47 | 10.237 |
| 2% | **Mean** | 188.03 | 97.327 |
| | **SD. Deviation** | 1.8864 | 1.6855 |
| | **SD. Error of Mean** | 1.0891 | 0.9731 |
| 5% | **Mean** | 193.4 | 100.77 |
| | **SD. Deviation** | 12.627 | 8.6384 |
| | **SD. Error of Mean** | 7.29 | 4.9874 |
| 10% | **Mean** | 178.03 | 90.743 |
| | **SD. Deviation** | 11.583 | 7.1754 |
| | **SD. Error of Mean** | 6.6876 | 4.1427 |
| 20% | **Mean** | 212.76 | 110.44 |
| | **SD. Deviation** | 62.858 | 35.068 |
| | **SD. Error of Mean** | 36.291 | 20.246 |
| **ANOVA** | | 0.083** | 0.095** |

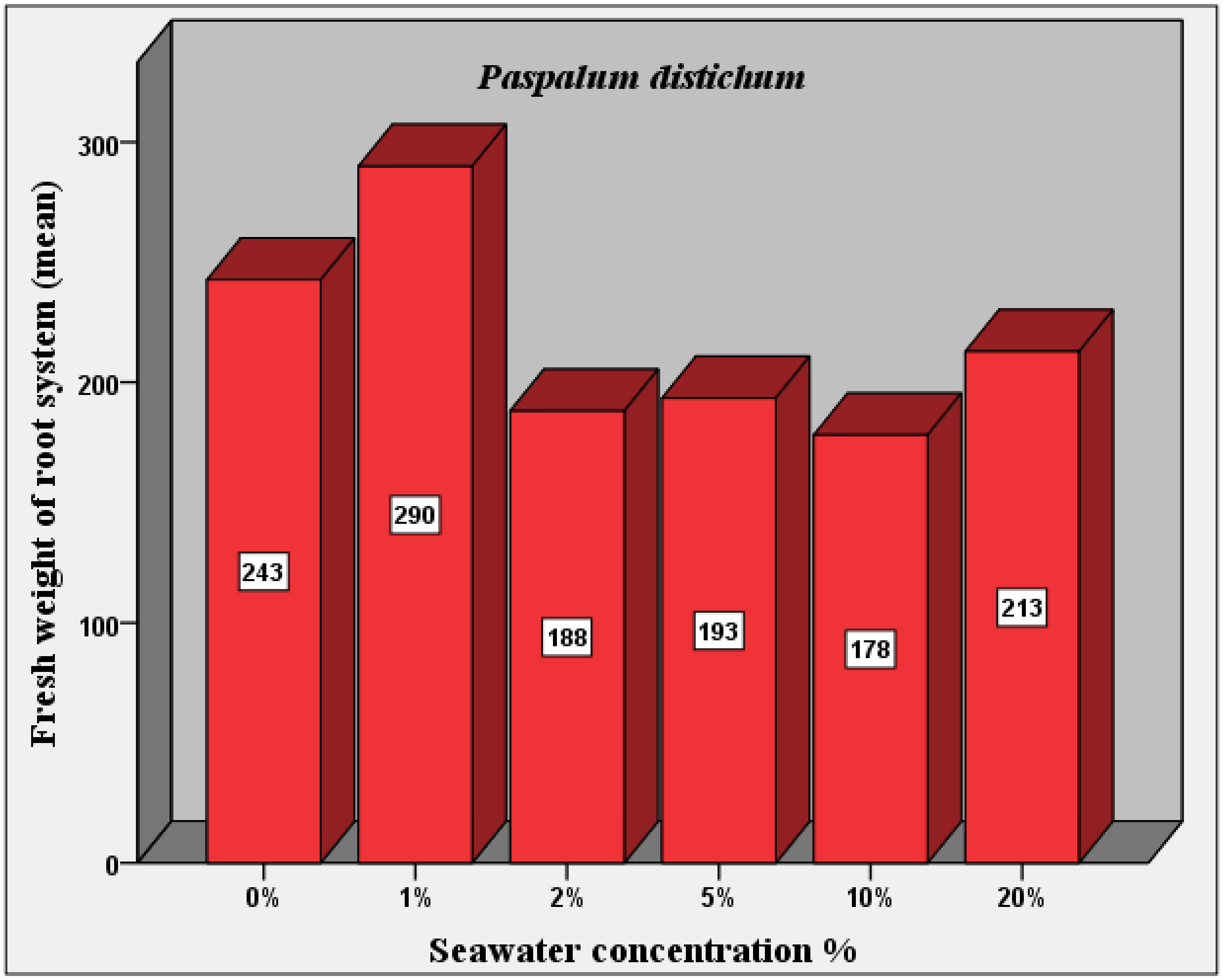


**Figure (4-10): Effect of seawater concentrations on the fresh weight of Knotgrass (*Paspalum Distichum*) root system.**

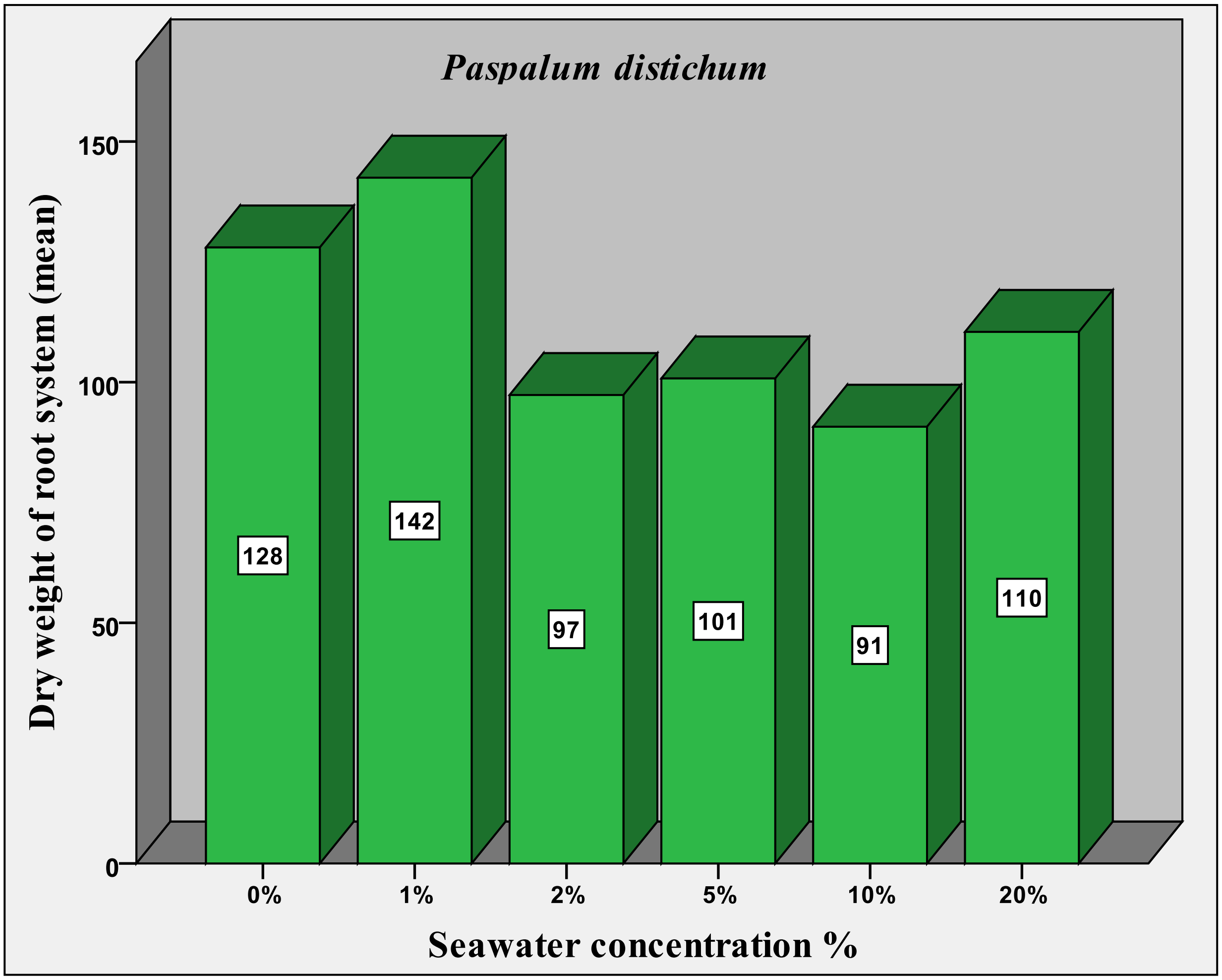


**Figure (4-11): Effect of seawater concentrations on the dry weight Knotgrass (*Paspalum Distichum*) root system.**

# Chapter Five

# 5. Discussion.

## 5.1. Effect of seawater concentrations on Ryegrass (*Lolium Perenne* L.) germination:

Germination is a most salt-sensitive plant growth stage and severely inhibited with increasing seawater concentrations in both glycophytes and halophyte**.** The results demonstrated that Ryegrass (*Lolium Perenne* L.) seeds germinated the fastest at the seawater concentrations level 1% concentration (2.93days) which was faster than the control treatment (3.37 days). With the seawater concentrations level 2%, the germinating speed of Ryegrass (*Lolium Perenne* L.) seeds started to decreas in relation to the control by which then reached to the slowest value at seawater concentrations level 20%. (Borowski, 2008) demonstrated that Ryegrass (*Lolium Perenne* L.) seeds germinated the fastest in the control conditions then the germinating speed of Ryegrass (*Lolium Perenne* L.) seeds which decreased in relation to the control.

Increased seawater concentrations of the environment delayed the beginning time of germination of the examined grass species and extended its period, which is also confirmed in the studies on Ryegrass (*Lolium Perenne* L.) by (Horst and Dunning, 1989). Increased seawater concentrations up to 20% caused further dramatic drop of the root growth, compared to the control in Ryegrass (*Lolium Perenne* L.) .The inhibiting effect of NaCl on seed germination and the seedling growth may result from the decrease of the chemical potential of water around the seeds and the consequent problems regarding its intake by the seeds as well as from the excess of $Na^{+}$ and $Cl^{-}$ ions in the environment. The studies by Myers ad Couper (1989), conducted on the seeds of Ryegrass (*Lolium Perenne* L.) with the use of isoosmotic solutions of different salts as well as PEG and mannitol point mainly to the osmotic effect. The studies showed clear differentiation in tolerance to seawater concentrations of turfgrass species; Ryegrass (*Lolium Perenne* L.). proved to be the most resistant, the data from literature confirm the fact that within the group of lawn grasses, Ryegrass (*Lolium Perenne* L.) tolerates seawater concentrations relatively well (Ashraf *et al*, 1986; Wysocki, 1994; Xiaofang *et al*., 2000; Hujun, 2001; Yongqin *et al*., 2003; Stawicka *et al*., 2006). Inhibition of Ryegrass (*Lolium Perenne* L.). growth in the seawater concentrations conditions was also observed by (Yongqin *et al.,* (2003). The degree of tolerance of the studied cultivars to NaCl seawater concentrations resulted from differentiated accumulation of sodium and chloride ions as well as free proline in the tissues. Tolerant cultivars contained less of the enumerated osmotically active compounds in the tissues.

## 5.2. Effect of seawater concentration on Mean germination time :

Mean germination time of perennial Ryegrass (*Lolium Perenne* L.) was significantly influenced by seawater. Increasing seawater levels increased mean germination time of perennial Ryegrass (*Lolium Perenne* L.). At 20 % seawater concentration, Ryegrass (*Lolium Perenne* L.) had the longest mean germination time as 4 days. Whereas, seeds of perennial Ryegrass germinated approximately in 2 days at 1% seawater concentration. Germination time was 1 day longer at 20% concentrations than the control. It is obvious that germination time of perennial Ryegrass *(Lolium Perenne* L.) elongates with increasing seawater concentrations. Seed of Ryegrass*(Lolium Perenne* L.) germinated in a short time because of higher water uptake at the low salinity concentrations. The delay and prevention of water absorption also delayed the germination. Delayed germination causes both increased irrigation cost, and irregular and weak seedling growth in the establishment of perennial Ryegrass. The same results were reached at by, some researchers who claimed that as a result of increasing osmotic pressure, water uptake is delayed and, so germination time is elongated and germination rate is decreased (Quila, 1992; Gunjaca and Sarcevic, 2000; Almansouri *et al*., 2001).

## 5.3. Effect of seawater concentration on Ryegrass (*Lolium Perenne* L.) shoot and root:

Growth parameters such as shoot and root growth are also considered to be excellent criteria for determining seawater concentrations tolerance of turf grasses (Marcum and Murdoch, 1990a; Dean *et al*., 1996; Marcum, 1999; Uddin *et al*., 2011a; Uddin and Juraimi, 2012). Rather than comparing absolute growth under stress, seawater concentrations tolerance is better expressed as relative (to control) growth reduction, an indication of plant vigor under stress (Uddin and Juraimi, 2012). Our study revealed that both shoot and root lengths was negatively affected by seawater concentrations, shoot were more sensitive to seawater concentrations than roots.

## 5.4. Effect of seawater concentrations on Knotgrass (*Paspalum Distichum*) shoot system water content:

The results of the study revealed that there was very weak correlation between seawater concentrations and shoot system water content (Pearson correlation =0.111). Seawater concentrations level did not affect shoot system water content, the differences in the means of shoot system water content were not significant compared to the control (p-value= 0.063), indicating that seawater concentrations tolerance may, in part, be attributed to the ability of plants to maintain a desired tissue hydration level.

## 5.5. Effect of seawater concentration on Knotgrass (*Paspalum Distichum*) dry and fresh weights:

Both fresh and dry weights of Knotgrass (*Paspalum Distichum*) were decreased with increased seawater concentrations level, but this reduction was not significant compared to the control treatment. Such reduction in root fresh weight might be attributed to a decrease in water uptake and osmotic potential under salt stress, which directly affects the growth and development of plants (Terry and Waldron, 1984; Riaz *et al*., 2010). Asimilar trend was observed by (De Costa and Zoysa, 1995) in soybean and rice, but in contrast, (Hameed and Ashraf, 2008) in *Cyndon dactylon* and (Naz *et al*., 2009) in some arid zone grasses related high root dry weight to seawater concentrations tolerance. The overall reduction in dry weight of root was attributed to toxic effect of salt and reduced nutrient availability due to salt stress in growth medium (Qadir and Shams 1997). Shoot dry weight decreased with increase in external NaCl concentration. This decrease in shoot dry weight could be attributed to shrinkage of cellular contents, reduced growth, development, and differentiation of tissues and disturbed avoidance mechanism as described earlier in different plant species under salt stress (Kent and Lauchli, 1985; Suplick-ploense *et al*., 2002; Munns and Tester, 2008). Seawater concentrations effects the growth of plants, which reduces metabolite synthesis and ultimately decreases dry weight of shoot (Cheesman, 1988).

# Conclusion

- Mean germination time of Ryegrass (*Lolium Perenne* L.) delayed with increased seawater concentrations level which reached the maximum delay at seawater concentration of 20% (4 days).
- Germination percentage of Ryegrass (*Lolium Perenne* L.) decreased with increased seawater concentrations, at concentrations of (10% and 20%) germination percentages were (64% and 59%), which revealed that Ryegrass (*Lolium Perenne* L.) tolerates seawater concentrations very well.
- This study reveals that both shoot and root lengths are negatively affected by seawater concentrations, shoot are more sensitive to seawater concentrations than roots.
- Both fresh and dry weights of Knotgrass (*Paspalum Distichum*) shoot systems are decreased significantly with increased seawater concentrations and this decrease was significant.
- Both fresh and dry weights of Knotgrass (*Paspalum Distichum*) root systems are decreased with increased seawater concentrations level, but this reduction is not significant compared to the control treatment.
- Decreased dry weights of roots reveal that Knotgrass (*Paspalum Distichum*) does not tolerate seawater concentrations.
- The relation between seawater concentrations and leaf water content is very weak, and the differences in the mean of leaf water content are not significant compared to the control at all seawater concentrations levels.

Finally based on the results, the best concentration which can be used and recommended is 1%, compared to other concentration, the results of this concentration were the best for Knotgrass (*Paspalum Distichum*) development.

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# Appendices

## 1. Seed germination of Ryegrass (*Lolium Perenne* L.) :

| Conc. | Mean | STD | SD. Error of Mean |
|---|---|---|---|
| 0% | 73.2500 | 6.65207 | 3.32603 |
| 1% | 76.7500 | 3.86221 | 1.93111 |
| 2% | 76.5000 | 3.10913 | 1.55456 |
| 5% | 71.2500 | 6.18466 | 3.09233 |
| 10% | 64.0000 | 8.36660 | 4.18330 |
| 20% | 59.0000 | 12.00000 | 6.00000 |
| Total | 70.1250 | 9.30317 | 1.89900 |

## 2. Seed development for Ryegrass (*Lolium Perenne* L.) :

**One way**

| ANOVA | | | | | | |
|---|---|---|---|---|---|---|
| | | Sum of Squares | Df | Mean Square | F | Sig. |
| L Shoot mean | Between Groups | 205.128 | 5 | 41.026 | 68.567 | .000 |
| | Within Groups | 10.770 | 18 | .598 | | |
| | Total | 215.898 | 23 | | | |
| L Root mean | Between Groups | 185.497 | 5 | 37.099 | 17.476 | .000 |
| | Within Groups | 38.213 | 18 | 2.123 | | |
| | Total | 223.710 | 23 | | | |

**Post Hoc Tests (Multiple Comparisons) of shoot lengths mean:**

| | | | | | | 95% Confidence Interval | |
|---|---|---|---|---|---|---|---|
| Variable | Conc. | Conc. | Mean | STD | Sig | Lower Bound | Upper Bound |
| L Shoot mean | 0% | 1% | 0.30 | 0.55 | 0.59 | -0.85 | 1.45 |
| | | 2% | 0.36 | 0.55 | 0.52 | -0.79 | 1.51 |
| | | 5% | 1.67 | 0.55 | 0.01 | 0.52 | 2.82 |
| | | 10% | 4.13 | 0.55 | 0.00 | 2.98 | 5.28 |
| | | 20% | 8.18 | 0.55 | 0.00 | 7.03 | 9.33 |
| | 1% | 0% | -0.30 | 0.55 | 0.59 | -1.45 | 0.85 |
| | | 2% | 0.06 | 0.55 | 0.91 | -1.09 | 1.21 |
| | | 5% | 1.38 | 0.55 | 0.02 | 0.23 | 2.52 |
| | | 10% | 3.84 | 0.55 | 0.00 | 2.69 | 4.98 |
| | | 20% | 7.88 | 0.55 | 0.00 | 6.73 | 9.03 |
| | 2% | 0% | -0.36 | 0.55 | 0.52 | -1.51 | 0.79 |
| | | 1% | -0.06 | 0.55 | 0.91 | -1.21 | 1.09 |
| | | 5% | 1.32 | 0.55 | 0.03 | 0.17 | 2.46 |
| | | 10% | 3.78 | 0.55 | 0.00 | 2.63 | 4.92 |
| | | 20% | 7.82 | 0.55 | 0.00 | 6.67 | 8.97 |
| | 5% | 0% | -1.67 | 0.55 | 0.01 | -2.82 | -0.52 |
| | | 1% | -1.38 | 0.55 | 0.02 | -2.52 | -0.23 |
| | | 2% | -1.32 | 0.55 | 0.03 | -2.46 | -0.17 |
| | | 10% | 2.46 | 0.55 | 0.00 | 1.31 | 3.61 |
| | | 20% | 6.51 | 0.55 | 0.00 | 5.36 | 7.66 |
| | 10% | 0% | -4.13 | 0.55 | 0.00 | -5.28 | -2.98 |
| | | 1% | -3.84 | 0.55 | 0.00 | -4.98 | -2.69 |
| | | 2% | -3.78 | 0.55 | 0.00 | -4.92 | -2.63 |
| | | 5% | -2.46 | 0.55 | 0.00 | -3.61 | -1.31 |
| | | 20% | 4.05 | 0.55 | 0.00 | 2.90 | 5.20 |
| | 20% | 0% | -8.18 | 0.55 | 0.00 | -9.33 | -7.03 |
| | | 1% | -7.88 | 0.55 | 0.00 | -9.03 | -6.73 |
| | | 2% | -7.82 | 0.55 | 0.00 | -8.97 | -6.67 |
| | | 5% | -6.51 | 0.55 | 0.00 | -7.66 | -5.36 |
| | | 10% | -4.05 | 0.55 | 0.00 | -5.20 | -2.90 |
| *. The mean difference is significant at the 0.05 level. | | | | | | | |

**Post Hoc Tests (Multiple Comparisons) of root lengths mean:**

| Variable | Conc. | Conc. | Mean | STD | Sig | 95% Confidence Interval | |
|---|---|---|---|---|---|---|---|
| | | | | | | Lower Bound | Upper Bound |
| L Root mean | 0% | 1% | -1.15 | 1.03 | 0.28 | -3.31 | 1.01 |
| | | 2% | -0.72 | 1.03 | 0.49 | -2.88 | 1.44 |
| | | 5% | 1.10 | 1.03 | 0.30 | -1.06 | 3.27 |
| | | 10% | 2.15 | 1.03 | 0.05 | -0.02 | 4.31 |
| | | 20% | 7.13 | 1.03 | 0.00 | 4.96 | 9.29 |
| | 1% | 0% | 1.15 | 1.03 | 0.28 | -1.01 | 3.31 |
| | | 2% | 0.43 | 1.03 | 0.68 | -1.73 | 2.59 |
| | | 5% | 2.25 | 1.03 | 0.04 | 0.09 | 4.42 |
| | | 10% | 3.30 | 1.03 | 0.01 | 1.13 | 5.46 |
| | | 20% | 8.28 | 1.03 | 0.00 | 6.11 | 10.44 |
| | 2% | 0% | 0.72 | 1.03 | 0.49 | -1.44 | 2.88 |
| | | 1% | -0.43 | 1.03 | 0.68 | -2.59 | 1.73 |
| | | 5% | 1.82 | 1.03 | 0.09 | -0.34 | 3.99 |
| | | 10% | 2.87 | 1.03 | 0.01 | 0.70 | 5.03 |
| | | 20% | 7.85 | 1.03 | 0.00 | 5.68 | 10.01 |
| | 5% | 0% | -1.10 | 1.03 | 0.30 | -3.27 | 1.06 |
| | | 1% | -2.25 | 1.03 | 0.04 | -4.42 | -0.09 |
| | | 2% | -1.82 | 1.03 | 0.09 | -3.99 | 0.34 |
| | | 10% | 1.04 | 1.03 | 0.33 | -1.12 | 3.21 |
| | | 20% | 6.02 | 1.03 | 0.00 | 3.86 | 8.19 |
| | 10% | 0% | -2.15 | 1.03 | 0.05 | -4.31 | 0.02 |
| | | 1% | -3.30 | 1.03 | 0.01 | -5.46 | -1.13 |
| | | 2% | -2.87 | 1.03 | 0.01 | -5.03 | -0.70 |
| | | 5% | -1.04 | 1.03 | 0.33 | -3.21 | 1.12 |
| | | 20% | 4.98 | 1.03 | 0.00 | 2.82 | 7.14 |
| | 20% | 0% | -7.13 | 1.03 | 0.00 | -9.29 | -4.96 |
| | | 1% | -8.28 | 1.03 | 0.00 | -10.44 | -6.11 |
| | | 2% | -7.85 | 1.03 | 0.00 | -10.01 | -5.68 |
| | | 5% | -6.02 | 1.03 | 0.00 | -8.19 | -3.86 |
| | | 10% | -4.98 | 1.03 | 0.00 | -7.14 | -2.82 |
| *. The mean difference is significant at the 0.05 level. | | | | | | | |

### 3. Fresh and dry weights of Knotgrass (*Paspalum Distichum*) shoot system:

**One way**

| ANOVA | | | | | | |
|---|---|---|---|---|---|---|
| | | Sum of Squares | Df | Mean Square | F | Sig. |
| Wet weight for shoot | Between Groups | 921.193 | 5 | 184.239 | 5.324 | .008** |
| | Within Groups | 415.236 | 12 | 34.603 | | |
| | Total | 1336.429 | 17 | | | |
| Dry weight for shoot | Between Groups | 334.426 | 5 | 66.885 | 4.558 | .015** |
| | Within Groups | 176.108 | 12 | 14.676 | | |
| | Total | 510.534 | 17 | | | |

**Post Hoc Tests (Multiple Comparisons) of Knotgrass (*Paspalum Distichum*) fresh weight (Shoot system):**

| Variable | Conc. | Conc. | Mean | STD | Sig | 95% Confidence Interval | |
|---|---|---|---|---|---|---|---|
| | | | | | | Lower Bound | Upper Bound |
| Wet weight for shoot system (mean) | 0% | 1% | -6.75 | 4.80 | 0.19 | -17.21 | 3.72 |
| | | 2% | 6.88 | 4.80 | 0.18 | -3.59 | 17.34 |
| | | 5% | 0.47 | 4.80 | 0.92 | -10.00 | 10.93 |
| | | 10% | 13.99* | 4.80 | 0.01 | 3.53 | 24.46 |
| | | 20% | 11.46* | 4.80 | 0.03 | 1.00 | 21.93 |
| | 1% | 0% | 6.75 | 4.80 | 0.19 | -3.72 | 17.21 |
| | | 2% | 13.623* | 4.80 | 0.02 | 3.16 | 24.09 |
| | | 5% | 7.22 | 4.80 | 0.16 | -3.25 | 17.68 |
| | | 10% | 20.7389* | 4.80 | 0.00 | 10.27 | 31.20 |
| | | 20% | 18.21* | 4.80 | 0.00 | 7.74 | 28.67 |
| | 2% | 0% | -6.88 | 4.80 | 0.18 | -17.34 | 3.59 |
| | | 1% | -13.62* | 4.80 | 0.02 | -24.09 | -3.16 |
| | | 5% | -6.41 | 4.80 | 0.21 | -16.87 | 4.06 |
| | | 10% | 7.12 | 4.80 | 0.16 | -3.35 | 17.58 |
| | | 20% | 4.59 | 4.80 | 0.36 | -5.88 | 15.05 |
| | 5% | 0% | -0.47 | 4.80 | 0.92 | -10.93 | 10.00 |
| | | 1% | -7.22 | 4.80 | 0.16 | -17.68 | 3.25 |
| | | 2% | 6.41 | 4.80 | 0.21 | -4.06 | 16.87 |
| | | 10% | 13.52* | 4.80 | 0.02 | 3.06 | 23.99 |
| | | 20% | 10.994* | 4.80 | 0.04 | 0.53 | 21.46 |
| | 10% | 0% | 13.99-* | 4.80 | 0.01 | -24.46 | -3.53 |
| | | 1% | -20.74* | 4.80 | 0.00 | -31.20 | -10.27 |
| | | 2% | -7.12 | 4.80 | 0.16 | -17.58 | 3.35 |
| | | 5% | -13.52* | 4.80 | 0.02 | -23.99 | -3.06 |
| | | 20% | -2.53 | 4.80 | 0.61 | -12.99 | 7.94 |
| | 20% | 0% | -11.46* | 4.80 | 0.03 | -21.93 | -1.00 |
| | | 1% | -18.201* | 4.80 | 0.00 | -28.67 | -7.74 |
| | | 2% | -4.59 | 4.80 | 0.36 | -15.05 | 5.88 |
| | | 5% | -10.99* | 4.80 | 0.04 | -21.46 | -0.53 |
| | | 10% | 2.53 | 4.80 | 0.61 | -7.94 | 12.99 |
| *The mean difference is significant at the 0.05 level. | | | | | | | |

**Post Hoc Tests (Multiple Comparisons) of Knotgrass (*Paspalum Distichum*) dry weight (Shoot system):**

| Variable | Conc. | Conc. | Mean | STD | Sig | 95% Confidence Interval | |
|---|---|---|---|---|---|---|---|
| | | | | | | Lower Bound | Upper Bound |
| Dry weight for shoot system (mean) | 0% | 1% | -3.63 | 3.13 | 0.27 | -10.44 | 3.19 |
| | | 2% | 6.09 | 3.13 | 0.08 | -0.72 | 12.91 |
| | | 5% | 0.86 | 3.13 | 0.79 | -5.95 | 7.68 |
| | | 10% | 8.60 | 3.13 | 0.02 | 1.79 | 15.42 |
| | | 20% | 6.61 | 3.13 | 0.06 | -0.20 | 13.43 |
| | 1% | 0% | 3.63 | 3.13 | 0.27 | -3.19 | 10.44 |
| | | 2% | 9.72 | 3.13 | 0.01 | 2.91 | 16.54 |
| | | 5% | 4.49 | 3.13 | 0.18 | -2.32 | 11.31 |
| | | 10% | 12.23 | 3.13 | 0.00 | 5.42 | 19.05 |
| | | 20% | 10.24 | 3.13 | 0.01 | 3.43 | 17.06 |
| | 2% | 0% | -6.09 | 3.13 | 0.08 | -12.91 | 0.72 |
| | | 1% | -9.72 | 3.13 | 0.01 | -16.54 | -2.91 |
| | | 5% | -5.23 | 3.13 | 0.12 | -12.05 | 1.59 |
| | | 10% | 2.51 | 3.13 | 0.44 | -4.30 | 9.33 |
| | | 20% | 0.52 | 3.13 | 0.87 | -6.29 | 7.34 |
| | 5% | 0% | -0.86 | 3.13 | 0.79 | -7.68 | 5.95 |
| | | 1% | -4.49 | 3.13 | 0.18 | -11.31 | 2.32 |
| | | 2% | 5.23 | 3.13 | 0.12 | -1.59 | 12.05 |
| | | 10% | 7.74 | 3.13 | 0.03 | 0.93 | 14.56 |
| | | 20% | 5.75 | 3.13 | 0.09 | -1.06 | 12.57 |
| | 10% | 0% | -8.60 | 3.13 | 0.02 | -15.42 | -1.79 |
| | | 1% | -12.23 | 3.13 | 0.00 | -19.05 | -5.42 |
| | | 2% | -2.51 | 3.13 | 0.44 | -9.33 | 4.30 |
| | | 5% | -7.74 | 3.13 | 0.03 | -14.56 | -0.93 |
| | | 20% | -1.99 | 3.13 | 0.54 | -8.80 | 4.83 |
| | 20% | 0% | -6.61 | 3.13 | 0.06 | -13.43 | 0.20 |
| | | 1% | -10.24 | 3.13 | 0.01 | -17.06 | -3.43 |
| | | 2% | -0.52 | 3.13 | 0.87 | -7.34 | 6.29 |
| | | 5% | -5.75 | 3.13 | 0.09 | -12.57 | 1.06 |
| | | 10% | 1.99 | 3.13 | 0.54 | -4.83 | 8.80 |

| Variable | Conc. | Conc. | Mean | STD | Sig | 95% Confidence Interval | |
|---|---|---|---|---|---|---|---|
| | | | | | | Lower Bound | Upper Bound |
| Dry weight for shoot system (mean) | 0% | 1% | -3.63 | 3.13 | 0.27 | -10.44 | 3.19 |
| | | 2% | 6.09 | 3.13 | 0.08 | -0.72 | 12.91 |
| | | 5% | 0.86 | 3.13 | 0.79 | -5.95 | 7.68 |
| | | 10% | 8.60 | 3.13 | 0.02 | 1.79 | 15.42 |
| | | 20% | 6.61 | 3.13 | 0.06 | -0.20 | 13.43 |
| | 1% | 0% | 3.63 | 3.13 | 0.27 | -3.19 | 10.44 |
| | | 2% | 9.72 | 3.13 | 0.01 | 2.91 | 16.54 |
| | | 5% | 4.49 | 3.13 | 0.18 | -2.32 | 11.31 |
| | | 10% | 12.23 | 3.13 | 0.00 | 5.42 | 19.05 |
| | | 20% | 10.24 | 3.13 | 0.01 | 3.43 | 17.06 |
| | 2% | 0% | -6.09 | 3.13 | 0.08 | -12.91 | 0.72 |
| | | 1% | -9.72 | 3.13 | 0.01 | -16.54 | -2.91 |
| | | 5% | -5.23 | 3.13 | 0.12 | -12.05 | 1.59 |
| | | 10% | 2.51 | 3.13 | 0.44 | -4.30 | 9.33 |
| | | 20% | 0.52 | 3.13 | 0.87 | -6.29 | 7.34 |
| | 5% | 0% | -0.86 | 3.13 | 0.79 | -7.68 | 5.95 |
| | | 1% | -4.49 | 3.13 | 0.18 | -11.31 | 2.32 |
| | | 2% | 5.23 | 3.13 | 0.12 | -1.59 | 12.05 |
| | | 10% | 7.74 | 3.13 | 0.03 | 0.93 | 14.56 |
| | | 20% | 5.75 | 3.13 | 0.09 | -1.06 | 12.57 |
| | 10% | 0% | -8.60 | 3.13 | 0.02 | -15.42 | -1.79 |
| | | 1% | -12.23 | 3.13 | 0.00 | -19.05 | -5.42 |
| | | 2% | -2.51 | 3.13 | 0.44 | -9.33 | 4.30 |
| | | 5% | -7.74 | 3.13 | 0.03 | -14.56 | -0.93 |
| | | 20% | -1.99 | 3.13 | 0.54 | -8.80 | 4.83 |
| | 20% | 0% | -6.61 | 3.13 | 0.06 | -13.43 | 0.20 |
| | | 1% | -10.24 | 3.13 | 0.01 | -17.06 | -3.43 |
| | | 2% | -0.52 | 3.13 | 0.87 | -7.34 | 6.29 |
| | | 5% | -5.75 | 3.13 | 0.09 | -12.57 | 1.06 |
| | | 10% | 1.99 | 3.13 | 0.54 | -4.83 | 8.80 |

*The mean difference is significant at the 0.05 level.

**One way**

| ANOVA | | | | | | |
|---|---|---|---|---|---|---|
| | | Sum of Squares | Df | Mean Square | F | Sig. |
| Wet weight for root system | Between Groups | 26734.396 | 5 | 5346.879 | 2.580 | .083 |
| | Within Groups | 24866.036 | 12 | 2072.170 | | |
| | Total | 51600.432 | 17 | | | |
| Dry weight for root system | Between Groups | 5939.181 | 5 | 1187.836 | 2.441 | .095 |
| | Within Groups | 5838.312 | 12 | 486.526 | | |
| | Total | 11777.493 | 17 | | | |

**Post Hoc Tests (Multiple Comparisons) of Knotgrass (*Paspalum Distichum*) fresh weight (Root system)**

| Variable | Conc. | Conc. | Mean | STD | Sig | 95% Confidence Interval | |
|---|---|---|---|---|---|---|---|
| | | | | | | Lower Bound | Upper Bound |
| Wet weight for root system | 0% | 1% | -47.27 | 37.17 | 0.23 | -128.25 | 33.72 |
| | | 2% | 54.65 | 37.17 | 0.17 | -26.34 | 135.63 |
| | | 5% | 49.28 | 37.17 | 0.21 | -31.70 | 130.26 |
| | | 10% | 64.64 | 37.17 | 0.11 | -16.34 | 145.63 |
| | | 20% | 29.92 | 37.17 | 0.44 | -51.06 | 110.90 |
| | 1% | 0% | 47.27 | 37.17 | 0.23 | -33.72 | 128.25 |
| | | 2% | 101.91 | 37.17 | 0.02 | 20.93 | 182.90 |
| | | 5% | 96.55 | 37.17 | 0.02 | 15.57 | 177.53 |
| | | 10% | 111.91 | 37.17 | 0.01 | 30.93 | 192.89 |
| | | 20% | 77.19 | 37.17 | 0.06 | -3.80 | 158.17 |
| | 2% | 0% | -54.65 | 37.17 | 0.17 | -135.63 | 26.34 |
| | | 1% | -101.91 | 37.17 | 0.02 | -182.90 | -20.93 |
| | | 5% | -5.37 | 37.17 | 0.89 | -86.35 | 75.62 |
| | | 10% | 10.00 | 37.17 | 0.79 | -70.99 | 90.98 |
| | | 20% | -24.73 | 37.17 | 0.52 | -105.71 | 56.26 |
| | 5% | 0% | -49.28 | 37.17 | 0.21 | -130.26 | 31.70 |
| | | 1% | -96.55 | 37.17 | 0.02 | -177.53 | -15.57 |
| | | 2% | 5.37 | 37.17 | 0.89 | -75.62 | 86.35 |
| | | 10% | 15.36 | 37.17 | 0.69 | -65.62 | 96.35 |
| | | 20% | -19.36 | 37.17 | 0.61 | -100.34 | 61.62 |
| | 10% | 0% | -64.64 | 37.17 | 0.11 | -145.63 | 16.34 |
| | | 1% | -111.91 | 37.17 | 0.01 | -192.89 | -30.93 |
| | | 2% | -10.00 | 37.17 | 0.79 | -90.98 | 70.99 |
| | | 5% | -15.36 | 37.17 | 0.69 | -96.35 | 65.62 |
| | | 20% | -34.72 | 37.17 | 0.37 | -115.71 | 46.26 |
| | 20% | 0% | -29.92 | 37.17 | 0.44 | -110.90 | 51.06 |
| | | 1% | -77.19 | 37.17 | 0.06 | -158.17 | 3.80 |
| | | 2% | 24.73 | 37.17 | 0.52 | -56.26 | 105.71 |
| | | 5% | 19.36 | 37.17 | 0.61 | -61.62 | 100.34 |
| | | 10% | 34.72 | 37.17 | 0.37 | -46.26 | 115.71 |
| *The mean difference is significant at the 0.05 level. | | | | | | | |

**Post Hoc Tests (Multiple Comparisons) of Knotgrass (*Paspalum Distichum*) dry weight (Root system)**

| Variable | Conc. | Conc. | Mean | STD | Sig | 95% Confidence Interval | |
|---|---|---|---|---|---|---|---|
| | | | | | | Lower Bound | Upper Bound |
| Dry weight for root system | 0% | 1% | -14.50 | 18.01 | 0.44 | -53.74 | 24.74 |
| | | 2% | 30.66 | 18.01 | 0.11 | -8.58 | 69.90 |
| | | 5% | 27.22 | 18.01 | 0.16 | -12.02 | 66.46 |
| | | 10% | 37.24 | 18.01 | 0.06 | -2.00 | 76.48 |
| | | 20% | 17.54 | 18.01 | 0.35 | -21.70 | 56.78 |
| | 1% | 0% | 14.50 | 18.01 | 0.44 | -24.74 | 53.74 |
| | | 2% | 45.16 | 18.01 | 0.03 | 5.92 | 84.40 |
| | | 5% | 41.72 | 18.01 | 0.04 | 2.48 | 80.96 |
| | | 10% | 51.74 | 18.01 | 0.01 | 12.50 | 90.98 |
| | | 20% | 32.04 | 18.01 | 0.10 | -7.20 | 71.28 |
| | 2% | 0% | -30.66 | 18.01 | 0.11 | -69.90 | 8.58 |
| | | 1% | -45.16 | 18.01 | 0.03 | -84.40 | -5.92 |
| | | 5% | -3.44 | 18.01 | 0.85 | -42.68 | 35.80 |
| | | 10% | 6.58 | 18.01 | 0.72 | -32.66 | 45.82 |
| | | 20% | -13.12 | 18.01 | 0.48 | -52.36 | 26.12 |
| | 5% | 0% | -27.22 | 18.01 | 0.16 | -66.46 | 12.02 |
| | | 1% | -41.72 | 18.01 | 0.04 | -80.96 | -2.48 |
| | | 2% | 3.44 | 18.01 | 0.85 | -35.80 | 42.68 |
| | | 10% | 10.02 | 18.01 | 0.59 | -29.22 | 49.26 |
| | | 20% | -9.68 | 18.01 | 0.60 | -48.92 | 29.56 |
| | 10% | 0% | -37.24 | 18.01 | 0.06 | -76.48 | 2.00 |
| | | 1% | -51.74 | 18.01 | 0.01 | -90.98 | -12.50 |
| | | 2% | -6.58 | 18.01 | 0.72 | -45.82 | 32.66 |
| | | 5% | -10.02 | 18.01 | 0.59 | -49.26 | 29.22 |
| | | 20% | -19.70 | 18.01 | 0.30 | -58.94 | 19.54 |
| | 20% | 0% | -17.54 | 18.01 | 0.35 | -56.78 | 21.70 |
| | | 1% | -32.04 | 18.01 | 0.10 | -71.28 | 7.20 |
| | | 2% | 13.12 | 18.01 | 0.48 | -26.12 | 52.36 |
| | | 5% | 9.68 | 18.01 | 0.60 | -29.56 | 48.92 |
| | | 10% | 19.70 | 18.01 | 0.30 | -19.54 | 58.94 |

| Variable | Conc. | Conc. | Mean | STD | Sig | 95% Confidence Interval | |
|---|---|---|---|---|---|---|---|
| | | | | | | Lower Bound | Upper Bound |
| Dry weight for root system | 0% | 1% | -14.50 | 18.01 | 0.44 | -53.74 | 24.74 |
| | | 2% | 30.66 | 18.01 | 0.11 | -8.58 | 69.90 |
| | | 5% | 27.22 | 18.01 | 0.16 | -12.02 | 66.46 |
| | | 10% | 37.24 | 18.01 | 0.06 | -2.00 | 76.48 |
| | | 20% | 17.54 | 18.01 | 0.35 | -21.70 | 56.78 |
| | 1% | 0% | 14.50 | 18.01 | 0.44 | -24.74 | 53.74 |
| | | 2% | 45.16 | 18.01 | 0.03 | 5.92 | 84.40 |
| | | 5% | 41.72 | 18.01 | 0.04 | 2.48 | 80.96 |
| | | 10% | 51.74 | 18.01 | 0.01 | 12.50 | 90.98 |
| | | 20% | 32.04 | 18.01 | 0.10 | -7.20 | 71.28 |
| | 2% | 0% | -30.66 | 18.01 | 0.11 | -69.90 | 8.58 |
| | | 1% | -45.16 | 18.01 | 0.03 | -84.40 | -5.92 |
| | | 5% | -3.44 | 18.01 | 0.85 | -42.68 | 35.80 |
| | | 10% | 6.58 | 18.01 | 0.72 | -32.66 | 45.82 |
| | | 20% | -13.12 | 18.01 | 0.48 | -52.36 | 26.12 |
| | 5% | 0% | -27.22 | 18.01 | 0.16 | -66.46 | 12.02 |
| | | 1% | -41.72 | 18.01 | 0.04 | -80.96 | -2.48 |
| | | 2% | 3.44 | 18.01 | 0.85 | -35.80 | 42.68 |
| | | 10% | 10.02 | 18.01 | 0.59 | -29.22 | 49.26 |
| | | 20% | -9.68 | 18.01 | 0.60 | -48.92 | 29.56 |
| | 10% | 0% | -37.24 | 18.01 | 0.06 | -76.48 | 2.00 |
| | | 1% | -51.74 | 18.01 | 0.01 | -90.98 | -12.50 |
| | | 2% | -6.58 | 18.01 | 0.72 | -45.82 | 32.66 |
| | | 5% | -10.02 | 18.01 | 0.59 | -49.26 | 29.22 |
| | | 20% | -19.70 | 18.01 | 0.30 | -58.94 | 19.54 |
| | 20% | 0% | -17.54 | 18.01 | 0.35 | -56.78 | 21.70 |
| | | 1% | -32.04 | 18.01 | 0.10 | -71.28 | 7.20 |
| | | 2% | 13.12 | 18.01 | 0.48 | -26.12 | 52.36 |
| | | 5% | 9.68 | 18.01 | 0.60 | -29.56 | 48.92 |
| | | 10% | 19.70 | 18.01 | 0.30 | -19.54 | 58.94 |
| *The mean difference is significant at the 0.05 level. | | | | | | | |

## 4. Effect of sea water concentration on leaf water content of Knotgrass (*Paspalum Distichum*)

### One way

| ANOVA | | | | | |
|---|---|---|---|---|---|
| LWC | | | | | |
| | Sum of Squares | df | Mean Square | F | Sig. |
| Between Groups | 59.611 | 5 | 11.922 | 2.861 | 0.063 |
| Within Groups | 50.000 | 12 | 4.167 | | |
| Total | 109.611 | 17 | | | |

**Correlation**

| Correlations | | | |
|---|---|---|---|
| | | Salinity | LWC |
| Salinity | Pearson Correlation | 1 | 0.389 |
| | Sig. (2-tailed) | | 0.111 |
| | N | 18 | 18 |
| LWC | Pearson Correlation | 0.389 | 1 |
| | Sig. (2-tailed) | 0.111 | |
| | N | 18 | 18 |

**استجابة نباتي البسبيلوم والجازون لمياه البحر**

**إعداد**

**وفاء عبدالحميد علي العوامي**

**إشراف**

**د. محمد سالم حموده**

**المشرف المساعد**

**د. سالم عبد العالي الشطشاط**

# ملخص الدراسة


تعتبر الملوحة من أهم العوامل البيئية التي تؤثر سلبا على نمو النبات وتطوره وخاصة في المناطق الصحراوية وشبه الصحراوية ، ومن هنا أتجهت أغلب الدراسات الحديثة لدراسة مدى قابلية بعض النباتات للعيش في بيئة مالحة ، ومن ضمن هذه النباتات أعشاب المسطحات الخضراء التي وجد أنها تستهلك كميات كبيرة من مياه الري ، وقد أجري هذا البحث خلال فصلي الربيع والصيف من العام 2016 لمعرفة تأثير تركيزات مختلفة من مياه البحر على نبات Perennial Ryegrass (*Lolium Perenne L.*) وذلك عن طريق زراعة بذور هذا النبات في أطباق خاصة وريها بكميات مناسبة من محلول ملحي بتراكيز مختلفة (1% ،2% ،5% ،10% و 20%) ، لمدة 10 أيام ومقارنتها بتركيز التحكم (0%) . وقد وجد أن معدل توقيت الإنبات يتأخر كلما إزداد تركيز المحلول مقارنة بأطباق التحكم ، كما أن نسبة الإنبات تقل بزيادة تركيز المحلول ، بالإضافة إلى أن الفرق في متوسطات أطوال الجذور والسيقان لهذا النبات مقارنة بالتحكم كان معنوي ، كما أن السيقان أكثر حساسية للملوحة مقارنة بالجذور، كما نستنتج من هذه الدراسة أن هذا النبات يعتبر من النباتات المقاومة نسبياً للملوحة عند التراكيز (10% و 20%).

كما أجريت دراسة أخرى على نبات Knotgrass (*Paspalum Distichum*) لمعرفة تأثير الملوحة على الوزن الجاف والرطب للمجموع الجذري والخضري للنبات ، بالإضافة إلى تأثير الملوحة على المحتوى المائي للأوراق ، وقد تمت الدراسة من خلال زراعة هذا النبات في أصيصات وريها بنفس التركيزات السالف ذكرها لمدة أسبوعين وقياس وزن كلا من المجموع الجذري والخضري في الحالة الرطبة والجافة بعد تجفيفها في فرن عند درجة حرارة 65 درجة مئوية ومقارنة هذه الأوزان بوزن نبات التحكم ، وقد أثبتت الدراسة بأن هناك فرقا معنوياً في أوزان النبات عند مختلف التركيزات في الحالة الرطبة والجافة للمجموع الخضري ( 0.015،0.008 ) .بينما الفرق في أوزان النبات للمجموع الجذري في الحالة الرطبة والجافة لم يكن معنوياً (0.083, 0.095). بالإضافة إلى أن الفرق في متوسطات المحتوى المائي للأوراق لم يكن معنوياً (0.036) .وهذا يدل على هذا النبات مقاومة للملوحة .

# استجابة نباتي البسبيلوم والجازون لمياه البحر

إعداد

وفاء عبدالحميد علي العوامي

إشراف

د. محمد سالم حموده

المشرف المساعد

د. سالم عبد العالي الشطشاط

قدمت هذه الرسالة استكمالاً لمتطلبات الحصول على درجة الإجازة العالية (الماجستير) في علم النبات

جامعة بنغازي

كلية العلوم

2017