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EFFECT OF IRRIGATION WITH SALINE WATER ON BARLEY PRODUCTION

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This Thesis is Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Plant Production, Faculty of Graduate Studies, An-Najah National University, Nablus - Palestine.

2022

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Dedication

I dedicate this thesis

To my secret support, my power…… Mom & Dad

To my soulmate…… Isehaq

To my little angle….. Mira

To my family, teachers, friends

And

all for your help and support…

Acknowledgments

Praise be to Allah, the lord of the worlds peace and blessings of Allah be upon the noblest of the Prophets and Messengers, our Prophet Mohammad.

I would like to Thank Dr. Hassan Abu Qaoud & Dr. Munqez Shtaya

for supervision.

Many thanks to Middle East Desalination Research Center (MEDRC) for their foundation and give me an opportunity to work on this topic through the Palestinian Water Authority whom our thanks go as well to them for their follow up the project.

Finally, my thanks to everyone who helped me in my work from the laboratory supervisors and the staff in the university farm.

Declaration

I, the undersigned, declare that I submitted the thesis entitled:

EFFECT OF IRRIGATION WITH SALINE WATER ON BARLEY PRODUCTION

I declare that the work provided in this thesis, unless otherwise referenced, is the researcher's own work, and has not been submitted elsewhere for any other degree or qualification.

Student's Name: شيماء طيطي

Signature:

Date: 23/02/2022

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Abstract

Background: Barley *(Hordeum vulgare L.)* is known to be one of the most salt-tolerant crops. Barley is used as feed and human food, because of its ability to grow and produce in drought and salinity conditions.

Aims: This research aimed to test the seed germination and the behavior of barley landraces at various salt levels.

Materials and methods: The experiments were conducted at both lab and experimental farm of the Faculty of Agriculture, An-Najah National University, Tulkarm/ Palestine. For the germination experiment, seeds of 20 barley landraces collected from farmers in different regions in the West Bank-Palestine were used, the seeds were planted under four concentrations of salinity (control,100, 200, and 300 mM), in this study. Based on the results of the germination experiment, 4 landraces that exhibited the higher germination rate under salt treatments were selected for the field experiment (HV17, HV18, HV19 and HV20). The four landraces were planted on 2018/2019 growing season in a sand clay soil. The landraces were irrigated with different levels of NaCl (Control 100, 200 & 300 mM).

Results: The field experiment showed that chlorophyll content, length and tiller number were reduced with increasing salinity levels. The seeds and straw yield were also reduced with higher salt level, straw yield at (Control, 100, 200 and 300 mM) were (478, 305, 283 and 250 Kg/du) respectively, however, grain yield at control (338 kg/du), 100mM (238 kg/du) was significantly higher than both at 200mM and 300mM (180 and 133 kg/du) respectively, no significant difference among the landraces was observed however, grain yield for HV-19 and HV-17 was the best (247 and 237 kg/du) respectively, as well as with straw yield (375 and 358 kg/du) respectively. Electrical conductivity (EC), Sodium and Chloride concentration were increased with increasing salinity levels.

Conclusion: the current study demonstrated the ability of barley landraces to grow under saline water. Landraces HV-8, HV-16, HV-17, HV-18, HV-19 and HV-20 are they highest germination percentage. The HV-19 and HV-17 landraces are the best result in grain and straw yield.

Keywords: Barley (*Hordeum vulgare L.*), saline water, landraces, germination experiment, grain yield.

Chapter One

Introduction

1.1 Background

Palestine is located in one of the most agricultural and water shortage areas in the world; this puts the agricultural and water sectors at great risk, as a result, to suffer the most limited of renewable water resources due to political and natural conditions. The main sources for water supply in Palestine are groundwater. In Palestine there are four main groundwater basins (three in the *West Bank (WB)* and another one in the *Gaza Strip (GS)*). There are also valleys and streams and the Jordan River basin, in spite of the availability of groundwater basins and that annual renewable extraction of the groundwater basins is more than 700 *million Cubic Meters* (mcm), the rate of groundwater extraction that is allowed to the Palestinians by the Israelis is under 150 mcm per years (PWA, 2018).

Agriculture consumes the most water, accounting for seventy percentage of total water availability supplies according to the World Bank, the quantity of water actually used for irrigation is about 141 mcm/ year to irrigate about 200,000 du in the WB and GS, where 55 mcm/year of water is used in the WB and 86 mcm/ year in the GS. Furthermore. Agriculture is one of the most significant influences economic factor in the Palestine, however, agriculture only contributes to about 12% of Palestinian GDP (PWA, 2018).

Water shortage in the West Bank becomes more pronounced, with the continuous population growth leading to increased demand for food and water, whether used for domestic consumption or the agricultural sector [Alhaj Hussein, 2001].

The water demand is increasing and the gap between the demand and the supply is highly noticed which will be the main challenges that water sector will be facing in the next few years. The demand on water is increasing due to: the natural growth of the population, increase in the requirements for development and the limitation in the access to the water resources due to Israeli obstacles (PWA, 2018).

1.2 Justifications

Challenges facing local water status are obligating the Palestinians to look for new water resources, as the alternative water resources and more salinity and drought tolerant crops. Such issues are becoming crucial steps in water and salinity management. Furthermore, alternative resource such as brackish water, treated wastewater and rainfall-runoff water harvesting has to be used in agriculture, they are gaining increasing importance to integrated water management [Brooks and Trottier, 2010]. Salinity is one of the very significant abiotic factors influences on agricultural productivity because most crop plants are sensitive to salinity caused by excessive salts concentrations in the soil (Shrivastava & Kumar, 2015).

1.3 Problem

Salinity problem will increase Saline water as water resource is the water that consists of high amount or concentration of dissolved salt, this salt known as NaCl. The unit of salt concentration (by weight) is a part per million “ppm”. The index of salinity is *electrical conductivity (EC),* expressed in units of *deciSiemen per metre (dS/m)* (Water Science School, 2018).

During the salt content of irrigation water is increased, negatively effects on growth of plant and productivity in some crops. High concentrations of salt content in irrigation water decline the availability of water for uptake by plants during reducing soil water potential in the root zone. One of the choices to manage salinity is to choose plants or cultivars are salinity tolerant.

Leaf burn and dead tissue around the outside edges of leave are indication of high concentrations from sodium. On the other hand, the high concentrations of chloride occur initially at the extreme leaf tip. Irrigation water with high sodium content can reduce the availability of some elements in soil such as calcium and potassium. Chloride toxicity symptoms are in some crops occur leaf bronzing and necrotic patches. In some woody species can lose their leaves due to salinity and plants respond to salinity in variety of ways due of variances in their ability to adjust osmotically, allowing them to take extract water from saline soil condition (prince, 2019).

1.4 Solutions

The control of salinity is used some practices to management this problem that suffering in salt affected land and regions that suffering salinization water, during Firstly, source control through the irrigated water use efficiency and water application should be minimized and decrease deep percolation, Secondly, intercepted of the unavoidable, isolated drainage water and reused to irrigation of the salt tolerance plant such as halophytes plant, conserve on the water and reducing in pollution during reduce in drainage water. Third, should be use of saline groundwater with surface water to minimize water table elevation. Fourth, unusable final drainage water effluent should be disposal or reclaim. To achieve salinity management should be combined practices and approaches, thus independent on some factors such as economic, climatic, social, as well as edaphic and hydrogeological situations (Rhoades, Kandiah, & Mashali, 1992).

The wise and proper used of high salt content of water, as well as the recycling of drainage waters for irrigation, could increase water availability for irrigation. Various countries across the world include Australia, Egypt, India, Israel, Pakistan and the Untied Stat of America; have significant supplies of such water. With better farming and management procedures, water that is typically classed as unsuitable for irrigation may be effectively used to grow crops without causing long-term harm to crops or soils. The development of salt tolerance crops and the implementation of novel crop and water management practices would improve and will further enhance and aperient the use of saline waters for irrigation and agricultural production while preventing excessive soil salinity. Reusing drainage waters for irrigation will also assist to preserve water and to reduce irrigation is harmful impacts of on the environment (Rhoades, Kandiah, & Mashali, 1992).

The example on the usage of salinity water in Jordan valley (Jericho city), which is irrigated by moderately\ saline groundwater (EC = 6 dS/m) taken from a known well in Jericho. Some plants can be irrigation with moderately salty water: barley *(Hordeum vulgare)*, Mustard *(Brassica nigra)*, great millet *(Sorghum vulgare*), pearl millet (*Pennisetum glaucum*), and beet (*Beta vulgaris*) (Barghouthi, 2009).

The example on the usage of salty water in Israel, irrigated by salty ground waters the EC range between 2 and 8 dS/m about 1200 to 5600 mg/1 in TDS. Diluting the saline water before use, that because irrigation some crops by sprinkler methods. According to Israeli general recommendations, may be irrigation with any salty water within of the salinity tolerance range of the plant and light- and medium- heavy textured soils, saline waters having EC values of up 3.5 to 5.5 dS/m if artificial drainage is provided (add of gypsum are advised for salty waters). Field crops and cotton are successfully produced commercially in the Israel (Nahal Oz) with saline groundwater of 5 dS/m in EC and 26 of sodium adsorption ration (Frenkel & Shainberg, 1975). Tunisia, India and Israel have all reported using of saline GW. Sugar beet is produced in the Israel center Negev with salty GW with an EC = 4.4 dS/m under sprinkler irrigation (De-Malach, Pasternak, Twersky, & Borovic, 1978).

Barley (Hordeum vulgare L.) is one among the world's earliest cultivated grain crop. Between 9500 and 8400 years ago it was first cultivated [Azhaguvel and Komatsuda, 2007]. The Fertile Crescent, specifically Palestine- Jordan region are where barley originated [Badr et al., 2000; Preece et al., 2016]. Many research reported that barley varieties were domesticated in the Near East from their wild relative, wild barley *(Hordeum spontaneum)* [Harlan and Zohary, 1966; Badr et al., 2000]. Hordeum spontaneum and H. vulgare are morphologically similar, with the cultivated form having broader leaves, shorter stems and awns, tough ear rachis, a shorter and thicker spike, and larger grains (Badr, et al., 2000).

The production of barley in the West Bank is concentrated in Jenin, Hebron, Tubas, Dora, Yatta and Ramallah. Barley is the second major cultivated field crop in Palestine after wheat with 9280 ha of cultivation area with 16380 tons of production. Its cultivated area is about 22.1% of the total area cultivated with field crops. Ninety-seven percent (97%) of cultivated barley is under rain-fed system (Ministry of Agriculture (MOA), 2016).

During the drought season in Palestine, 84 percent of the farmers planted barley as a feed for their animals. Barley is associated with most common crop-livestock agricultural systems. Due to the high use of the machine and technology, the old agricultural system is changing towards intensive production methods, mostly for land preparation, sowing, harvesting and fertilizer. As a result, barley production becomes more intense, and it accounts for a bigger part of agricultural output (Abu- Alrub, ALajoma, Jorgen, & Christanse, 2004).

Barley *(Hordeum vulgare L.)* is a versatile cereal grain and that ranks fifth in the world for dry matter production among all crops. Furthermore, in many region of the world it is an essential food source [Gupta et al., 2010]. (Gupta, Abu-Ghannam, & Gallaghar, 2010). Barley *(Hordeum vulgare L.)* is the fourth most significant cereal after wheat, rice and maize. Barley is used as feed and human food, because of its ability to grow and produce in drought and salinity conditions [Baum et al., 2004]. It is known to be one of the most salt-tolerant crops [Shannon, 1984], having a high level of variability tolerance among cultivars [Srivastava and Jana, 1984]. However, barley is consider as salt resistant among crop plants, ionic and osmotic stresses in salt-affected soils have a significant impact on its growth and development (Mahmood, 2011).

1.5 Objectives

The objectives of this study are:

1. To evaluate the effect of different salinity levels on the germination of barley seeds.
2. To evaluate the behavior of barley landraces under different salinity levels.
3. Select suitable barely that tolerate salinity for the local condition in the West Bank.

Chapter Two

Literature Review

2.1 Water resources

Water Resources are sources of water that are useful. Includes uses water agricultural, industrial, domestic, recreational and environmental these all activities for water uses. The consist percent of *fresh water* (FW) in earth 97% divide to salt water and only 3% is freshwater; over 2/3 of this is ice. Groundwater is the remaining unfrozen fresh water. FW is a renewable resource; however, the world's supply of groundwater gradually decline, with decline occurring most clearly in North America and Asia, also it is still unclear how much natural renewal balances this usage, and whether ecosystems are threat. The mechanism for assigning water resources to water users is known as water rights (where such a framework exists) (Perlman & Evans, 2014).

Rainfall is the main sources of the water wealth in West Bank. The estimated of amount of water available in the West Bank from all groundwater sources, rivers, streams and wells at about 925 million cubic meters [Shehadeh, 1989]. The water sources divided into: first rainfall is the only source of all water resources in the Palestinian West Bank and Gaza Strip. In the West Bank differ the rate of rainfall from year to year and in the amount of rainfall that fall annually [Maan, 2007]. Second the surface water divided into valleys is the only source of surface water; the Palestinians are deprived of using their water rights in the Jordan River. The amount of water available in these valleys is estimated at about 136 mcm, divided into 64 mcm. The eastern valleys, that is, heading east towards the Jordan River and 72 mcm it is found in the western valleys heading towards the Mediterranean. The Jordan River constitutes the eastern border of the West Bank, as it extends for a length of 70 km along its side, and the width of the valley of the West Bank is (1 km-12 km). Thus, large areas of arable land are located on the Bank of the river. However, Israel's control completely of the river the Palestinians not benefiting from this water source [Al-Hawash et al., 1992]. Third groundwater It is the infiltration of water through the layers of the earth into its interior, and when this water reaches impermeable rocks, then it gathers to form underground water reservoirs. It is the leakage of water through the layers of the earth into its interior, and when this water reaches impermeable rocks, then it gathers to form underground water reservoirs, and this water can be recovered and benefited during natural methods by emanation by gravity and exiting to the surface of the earth to form springs, or by artificial methods by digging artesian wells, accessing them and pumping them to the surface of the earth. [Abdul Salam, 1990].

The shortage of water resources in Palestine is mostly due to Israel's control in the *West Bank (WB)*on the fully available water resources (surface and *ground waters (GW)*) this is owing to inequitable and unjust water distribution. One of the topics that must be handled to resolve through the final peace discussions is the water use distribution and availability of common water resources. The West Bank (WB) is a mountainous region with heights ranging from 423 meters below sea level in the Jordan valley to 1000 meters above sea level in the central hills. The principle recharge zones of the WB aquifer systems are represented by these hills. The Western GW aquifer basin, the Northeastern and the Eastern aquifers are the most important aquifers in the WB, from which present water supplies are sourced. The WB Mountain Aquifers recharge areas are mostly within the WB, but the pumping areas of the Western and Northeastern basins are split between Israel and the WB areas. The three groundwater basins are directly recharge by rainwater on the outcropping geologic formation in the WB Mountains, while the greatest part of the storage areas is located in the confined portions. Around 679 *million cubic meter (mcm)* (PWA, 2010) of the annual rainfall on WB is estimated to infiltrate the surface layers of the fractured formations recharging the groundwater aquifers (Alharithi, 2009).

The Israeli depletion of Palestinian water has led to a huge decrease in the aquifer's water. The annual deficit in the aquifer has been estimated at 40 and 50 mcm in the West Bank and Gaza Strip, respectively, and this would threaten animal and plant life and increase soil salinity. In addition to the daily suffering that the Palestinian population will face. Also, Israel's appropriation of the waters of the Jordan River, including the rights of the Palestinians, had serious effects on the environmental conditions in this region, as the Dead Sea began to decline due to the shortage of water from the Jordan River, which now threatens it with depletion and drought to turn into a salt marsh.

The water shortage in Palestinian communities becomes more dangerous in the summer season, and the Israeli company mekorot has even threatened to stop supplying water to the cities of Hebron, Bethlehem and Jenin due to the lack of water in the aquifer, according to the report of the Israeli coordinator for water affairs in the West Bank.

Indeed, Many Palestinian cities in Jenin, Bethlehem, Hebron, Tubas, Tulkarm, and the Gaza Strip are suffering from a water shortage. At a time when Israel drains Palestinian water (Barakat & heackock, 2013).

Groundwater supplies are under increased pressure as the Palestinians are difficult access to the Jordan River. Surface water (Jordan River) and the GW as well as captures rainwater, are the main sources of water in the WB & GS.

1. Palestine suffers from a lack and scarcity of water, due to its arid and semi-arid climatic condition as well as dramatic rainfall oscillations and secondly the long conflict that has lasted for decades. Until a sensible solution to the dispute is found, the Palestinians should find out how to deal with their daily water problem on their own. Appling novel water reuse, recycling, harvesting techniques and reducing water losses from distribution network is the most efficient way –but not the only way face the water supply shortages problems, for domestic, industrial and agricultural purposes.
2. For all purposes, the average per capita water consumption in the OPT is 65 I/c/d in the West Bank and 84 I/c/d in Gaza Strip. As a result, the average water consumption in Palestine is much below WHO recommended the minimum standard of 120 I/c/d by (Alharithi, 2009).

Also, another challenge that facing shortage in water status like Palestinian internal causes such as

1. The high percentage of losses for water: the annual percentage of losses from main lines and internal distribution networks ranges between 30% and 50%. There are two main reasons this large amount of water is lost due to oldest pips and Infringements on water networks during carried out either by illegal connections on the main lines, or by tampering with meters, or by operating water wells without the presence of water meters.
2. Pollution and high salinity: Despite the presence of large quantities of water in some Palestinian areas, this water suffers from a high percentage of pollution or/and salinity due to unregulated use of fertilizers and pesticides.
3. Limit of the pumped water only one or two days a week which helps to accumulate rust in the networks even if these networks were modern, which increases the percentage of salt in the water.

4. Lack of water sources or insufficient sources: Some communities suffer from the lack of a private source to supply water to its networks. Despite the availability of the necessary capabilities to establish water networks, the main obstacle in the lack of the necessary source to feed the network with water [PWA, 2004].

Due to both natural and artificial constraints, Palestine has one of the world's most limited renewable water resources, with only 65 I/c/d available for municipal use in the West Bank [PWA, 2010]. At the moment, the gap between water demand and the available water supply. Artificial non-economic factors have a significant impact on the available supply. Due to population increase, rising living standards, the need to expand irrigated agriculture, industrialization, and Israeli control of water resources, the gap between supply and demand is widening. The Palestinian water demand refers to the amount of water required for the state to survive and meet the need of the sectors, including domestic, public, industrial, and agricultural. A number of assumptions must be made in order to make an estimate and prognosis for these demands. Because current water consumption data is repressed in the OPT, these assumptions will not be totally based on current water consumption is suppressed. Nevertheless, data on current water consumption is required and it's provided for three sectors: municipal, industrial and agricultural. Domestic, commercial, touristic and public consumption are all included in municipal consumption. Agricultural consume the most water accounting for 70% of total available water supply. Furthermore, agricultural production has been the mainstay of the Palestinian economy, accounting for over 30% of 0 from 1968-1992, and for 13% from 1992-1998. Estimates of future agricultural water needs are influenced by different factors. Furthermore, there is technological and environmental consideration. Theses requirement are also influence by Social, economic, political and cultural variables. The Current irrigation water supply in WB and GS is around 172 mcm/yr through 89 mcm is utilized in WB. It's vital to understand that an agricultural water supply comes from either shallow, old wells or natural springs. Natural springs have a high degree of discharge unpredictability, making them unreliable sources. Although these springs have an average flow about 49 mcm/yr, this discharge is modest in drought years and high in wet years. Large volumes of water are lost in wet years due to a lack of storage structure. So the real average amount used from springs is sustainability lower than the arithmetic mean of spring discharge (Alharithi, 2009).

2.1.1 Saline water as a resource

Concept of saline water is the water that consists of high amount or concentration of dissolved salt, this salt known as NaCl. The unit of salt concentration (by weight) is a part per million “ppm”. This means that water with a dissolved salts concentration of 10,000 has 1% weight contributed by the salt content. The parameters salinity in fresh water less than 1000 ppm, 1000 to 3000 ppm in slightly salty water, 3000 to 10000 ppm in moderately salty water, highly saline water 10000 to 35000 ppm, in ocean water contain 35000 ppm from salts. The table (2.1) explains classification of saline water (Water Science school, 2018).

Table 2.1

Classification of saline water

Water classification	Electrical conductivity ds/m	Salt concentration mg/l	Type of water
Non-saline	< 0.7	<500	Drinking and irrigation water
Slightly saline	0.7-2	500-1500	Irrigation water
Moderately saline	2-10	1500- 7000	Primary drainage water and groundwater
Highly saline	10-25	7000- 15000	Secondary drainage water and groundwater
Very highly saline	25-45	15000- 35000	Very saline groundwater
Brine	>45	>35000	seawater

In New Mexico, about 75% of GW is very saline without treatment; there is an extensive amount of very salty water in the ground [Reynolds, 1962]. Causes of increased salinity in ground water due to occur during infiltrates for rainfall downward into the ground, the contain of ground on rocks that consist on highly soluble minerals it can increase in salinity for GW, due to accumulate of salt for long term this significantly increases of salinity for become as ocean water. The decreasing in water level of the lake is clearly shown by the white-colored and parallel lines lake deposits ringing the shore. The decline in water level at a rate of about 1 m/ year (Water Science school, 2018).

Salinity of can be made of human or natural. In most areas, fresh and saline subsurface waters exist in close proximity. Seawater intrusion is the when pumped of FW hydraulic that connect in by seawater. The resulting from change in gradients pumping in a flow of salt water from the sea towards the well. The cause's salinity of the natural. some researcher documented the in sediments rock with increasing in depth the salinity is significantly increasing. These layers is rich in general by Sulphate in the surface, bicarbonate water at an intermediary layer and in greater depth is rich by chloride water [Craig, 1980].

In drought condition may be source of surface water became very saline resulting they have influence in tidal of the sea especially in coastal regions, As the high tide approaches the shore, saltwater flows inland through streams and drainage canals. The quality of water in impacted streams and drainage canals is considerably altered by this upstream migration of seawater (Rhoades, Kandiah, & Mashali, 1992).

Many of things we require water for such as drinking, irrigation, and many industrial applications, cannot be used with saline water. Slightly saline water is occasionally utilized in the same way that irrigating crops for example, requires water having up to 2,500 ppm of salt content. Normally, though, moderate to high saline water has limited use. On the other hand, cannot used of this water to drink or domestic use, farmers don't usually irrigate with moderate and high salty water. Salty water is useful for some water-use purposes, and salty water can be conserved into FW, for which we have many uses. However, it necessary to conserve on fresh water in some area that suffering of shortage. With continuous population growth leading to increased demand for fresh water, whether used for domestic consumption or the agricultural and industrial sector (Water Science school, 2018).

2.1.2 Saline water and agricultural

Salt-affected land has long been thought to be unusable. However, after much but as a research and years of testing, a viable answer was discovered: saline agriculture. It is extremely possible to grow crops on salt-affected land if the appropriate (salt tolerant) cultivars are utilized, as well as alternate irrigation, fertilization and water management strategies. With saline agriculture, food is grown on salt-affected soils and irrigated with salt or brackish water in saline agricultural. Saline agriculture increase and improves food security while reducing the demand on already scarce fresh water supplies. Fresh water is used for irrigation in traditional farming system, putting a strain on the world's already restricted fresh water reserves. In actuality, fresh water makes up only 1% of the world's total water supply, with 70% of that being used for agriculture. So, if saline water can be used as a resource, it can help agriculture use less fresh water and decrease water stress in many locations (Knowledge center by salt farm foundation, 2017).

The judicious and proper use of saline water, as well as the recycling of drainage waters for irrigation, could increase Water availability for irrigation. Some countries around the world, including Australia, Egypt, India, Israel, Pakistan and the USA, have significant supplies of such water. With improved farming and management procedure, water that is typically classed as unsuitable for irrigation can be successfully used to grow crops without causing long-term harm to crops or soils. The development of salt tolerance crops and the implementation of novel crop and water management practices would improve and enable the use of saline waters for irrigation and crop production, while preventing excessive soil salinity. Reusing drainage waters for irrigation will also assist to conserve water and to decline irrigation harmful effect on the environment (Rhoades, Kandiah, & Mashali, 1992).

In saline agriculture, Irrigation is crucial. Fresh or brackish water can be used for irrigation. It is critical to irrigate regularly in both circumstances because salts accumulate in the soil when the amount of water available reduces due to evapotranspiration (example the sum of evaporation and transpiration through the plant leaves). As a result, it's critical to maintain a consistent level of soil moisture. It's also vital to irrigate adequately with brackish water so that salts don't accumulate in the top layers and are discharged to deeper soil layers or, preferably, a drainage system. Only sandy soils or loamy sandy soils are appropriate for irrigation with brackish water. Irrigating clay soils with brackish water will cause structural issues with the soil. This in turn impacts soil permeability and the aeration both of which have a negative impact on crop performance (Knowledge center by salt farm foundation, 2017).

2.1.3 Example of usage of saline water in irrigation in Israel

Considerable use has been made of saline waters for irrigation in Israel. The majority of the saline ground waters range between 2 and 8 dS/m in EC (about 1200 to 5600 mg/1 in TDS). The salty water is diluted before usage by introduced into the national carrier system. Because the majority of the crops are watered by sprinkler methods, certain crops suffer poor emergence due to crusting. As a result, they are sometimes furrow irrigation is occasionally used to get them started. Extra water (equivalent to about 25 to 30 percent more than evapotranspiration) is usually provided for leaching. Light- and medium-textured soils can be irrigated with any salty water in the range of the crop salinity tolerance, whereas heavy soils can be irrigation with waters having values of EC up 3.5 to 5.5 dS/m when artificial drainage is provided (add the gypsum is advised for such waters), according to Israeli general standard. Cotton can be grown commercially successfully in the Israel (Nahal Oz region) with salty groundwater of 5 dS/m in EC and 26 of sodium adsorption ratio SAR. If the silty clay soil is treated periodically with gypsum application and national carrier water is used to raise the soil to field capacity during a depth of 150 to 180 cm before to planting (typically during the winter). (Frenkel & Shainberg, 1975).

India, Tunisia and Israel have all reported using the brackish groundwater to irrigation. In The Israel central (Negev area) sugar beet is produced with salty groundwater has EC = 4.4 dS/m under sprinkler irrigation (De-Malach, Pasternak, Twersky, & Borovic, 1978).

2.1.4 Example of usage of saline water in irrigation in the Jordan Valley

Salt tolerance plants it can be irrigation with moderately salty water such as example on management of salinity for saline water this practice is suit to the environment. The implementation research project both of Palestinian Ministry of **a**griculture and National Agricultural Research Center (NARC) under address (Saving freshwater resources with salt tolerant forage production in marginal areas of WANA region). The objective of the project is to facilitating cooperation between some countries (WANA) region, North

Africa and West Asia for increase incomes of the rural poor. Another objective provides the plants for animal feed as forage and other agricultural products under saline water of irrigation. The investigation in Palestine conducted in the Jordan Valley (Jericho city) where they planted crops and irrigation with moderately saline groundwater (EC = 6 dS/m) extracted from a known well in Jericho for four years. The resulting from this experiment shows that these crops can be irrigated with moderately saline water and can be considered as salt-tolerant: barley (Hordeum vulgare), Mustard (Brassica nigra), great millet (Sorghum vulgare), pearl millet (Pennisetum glaucum), and beet (Beta vulgaris). (Barghouthi, 2009)

2.2 Salinity problem

Salinity is one of the main problems that facing agriculture in different areas of the world. Millions of hectares of land became nonproductive because of salinity problems. Salt accumulations in agricultural land are usually confined to arid and semiarid regions where rainfall is not sufficient to transport salts away from the plant root zone. Some of the salt ions accumulate in the soil such as sodium (Na^+), chlorine (Cl–), calcium (Ca^{2+}), magnesium (Mg^{2+}), sulfate (S), and bicarbonate (HCO3–), resulting in an increase of salinity and affecting plant growth and development [Lewis, 1984].

Salinity problem in Palestine especially in Jericho and Al-Gaurs consider as the food basket of Palestine. This region that depends in main groundwater water resource of Jordan valley, this water considers is of poor quality due to highly salinity specifically chloride concentration in water (Da'as & Walraevens, 2010).

Electrical conductivity is the concentration of total dissolved salt and ions is highly in Jericho springs water. This springs unsuitable to irrigate some crops and lands in this region due to impact on productivity [Khayat, et al., 2006]. Reason of salinity of these springs due to: domestic sewage, agricultural return- flow or as a result of over extraction from deep subsurface brine aquifers and fresh water aquifers containing salt-bearing rocks (Khayat, Hötzl, Geyer, & Ali, 2006).

2.3 Water and soil salinity problem

Because the parent rock from which the soil was created includes salts. The soil may be salty. Because most irrigation water contains salts, Water is categorized as the primary source of salt in irrigated soils. The water given to the soil after irrigation is either consumed by the crop or evaporates immediately from the moist soil and leaving the salt behind in the soil. These salts will accumulate in the soil and will lead to what is called salinization. Saline groundwater may also play and important role in soil salinization. When the water table rises the saline groundwater may reach the upper soil layers leading to the salinization of the root zone ((FAO), 1985).

If not managed properly, irrigation with saline water is risky since it will reduce plant growth and production. Salts transported in the water can build up in the root zone to levels high enough to impact crop development. Because soluble salts do not leach as easily in fine-textured soils as they do in sandy soils; therefore, adding enough water to fulfill crop water requirements is crucial. Plant roots absorb water through membranes in root cells a process known as osmosis. Osmosis is a natural process in which water travels through from a solution of low of dissolved salts concentration to one with greater salt concentrations by passing through a semi permeable membrane. This mechanism permits water to travels from a solution with low salts concentration (the irrigation water) to a solution of relatively high salt concentration (plant root cells) in an attempt to bring the two solutions into equilibrium. This process is repeated until the plant cells are turgid or full [Keith et al., 2003].

When plants are irrigated with moderately salty water, they must work harder to absorb water from the soil, however when extremely salty irrigation water is utilized, the osmosis process may be reversed. Water will migrate from the root cells into the surrounding solution if the fluid outside the plant roots has a greater salt content than that of the root cells. As a result of the loss of moisture, the plant becomes stressed. This is why high salt damage has symptoms that are comparable to high salt moisture stress (Department of primary industries (DPI), 2001).

Despite the fact salinity-related issues in irrigated areas in arid and semiarid lands are unavoidable, there are ways to prevent or mitigation them. However, problems remain in many locations and river basins where farmers use high amount of irrigation water (Qureshi, Cornick, Qadir, & Aslam, 2008).

Water quality continues to worsen as a result of continued irrigation without proper salt and drainage management, and agricultural land steadily declines as salt levels rise (Oster, Letey, Vaughan, Wu, & Qadir , 2012).

Most irrigation systems have a problem in reducing drainage volume and disposing of salt-laden drainage fluids, which are a result of irrigation at the system level. This saline water is frequently sent to evaporation ponds without being reused, wasting a precious resource. While this water is frequently considered as a ‘problem’, it is claimed that adding value to it and its constituents might turn it into a opportunity. The same is turn for salt-affected lands since those with high levels of salts are always abandoned, resulting in the relocation of population over time (Qadir, Noble, Karajeh, & George, 2014).

2.4 Impact of salinity on plant

High levels from sodium and chloride ions can cause toxicity to plants. These ions can be absorbed through the roots or by direct contact with the leaves. Direct absorption via the leaves causes more harm. A decrease in the rate and amount of water that plant roots can absorb from the soil occurs (prince, 2019).

Leaf burn, dead tissue around the outer margins of leaves is indications of Sodium toxicity symptoms. On the other hand, the chloride toxicity symptoms show itself first near the leaves extreme tip. High amount of sodium in irrigation water can be minimizing the availability of some elements in soil such as calcium and potassium. are leaf bronzing and necrotic spots being indication symptoms of chloride toxicity in several cultivars. Some woody species can lose their leaves due to salt, while agricultural plants respond to salinity in variety of ways due to variances in their ability to adapt osmotically, allowing them to take extract water from saline soil solutions (prince, 2019).

The effect of salts on plant can be general and specific effects especially influence on growth and productivity of crop. Also salts may have impact on physical and chemical characteristics as well for soil such as influence on the suitability of the soil as a medium for plant development and growth. Alkalinity and Sodium ion is increased may be promote the slaking of aggregates and the swelling and dispersion of clays, resulting in compaction for soil, loss of porosity and decline in permeability, particularly when rapid desalinization occurs after rainfall or the irrigated with of low-salinity waters. Salts have general impact on plants, followed by reducing plant stand and growth rate. As for sensitive crops, particularly woody perennials, chloride, sodium and boron may have unique toxicity effects. Salt tolerance plants varies, but many are tolerances to salts especially after seedling establishment, to yield well when watered with salty waters, particularly typical drainage waters, if suitable cultural management practices are followed (Rhoades, Kandiah, & Mashali, 1992).

Salinity hinders water absorption and thus reduces the availability of water to crops lead to decreasing the total water potential in the soil. Salinity has an impact on plant physiology and on the productivity, the yields reduction with increasing salinity concentration in irrigation water [Haman Dorota Z., 2008]. Most cultivated plants reduce yield and production when exposure to stress, even at threshold levels lower than amount at electrical conductivity is equal 4 ds/ m [Maas, 1990]. When salt-sensitive crops are exposed to salt for few days, their growth rate is reduced with little noticeable effects. However salt-tolerant crops may able to grow and development during growth season under moderate salinity, but blooming or florets production decreasing may occur (Munns, 2002).

Some crops considers as tolerant to salinity because to can grow under high concentration salinity such as (barley, sugar beet and cotton) range of 6.9 to 8.0 dS m -1 (77-88 mM salinity) in table (2.3) shown classification some crop to sensitive and tolerant to salinity [Maas and Hoffman, 1977]. *Beta vulgaris* and *Hordeum vulgaris* are very sensitive to salinity during germination stage, although they are very tolerant during the development stages (Maas, 1990).

Table 2.3

Tolerance threshold values of some crops to saline soils [Brady & Weil, 2008].

Sensitives (0-4 ds m-1)	**Moderately tolerance (4-6 ds m-1)**	**Tolerance (6-8 ds m-1)**	**Highly tolerance (8-12 ds m-1)**
Almond	Corn	Fig	Barley
Bean	Grain sorghum	Oats	Cotton
Clover	Lettuce	Pomegranate	Olive
Onion	Soybean	Sunflower	Rye
Potato	Tomato	Wheat	Wheat grass

Germination percentage and seedling growth are decline at high level from salinity resulting to decline the osmotic stress that makes to inhibition absorb of some nutrient such as calcium, potassium and nitrate and accumulate of Na + and Cl to toxic level inside cells and root zone. Low osmotic potential of soil solution makes is negatively effect on different development growth stages (Kalaji & Pietkiewicz, 1993).

Water-deficit stress is described as a condition in which the water potential and turgor of plant are lowered to the point where they interfere with normal activities. Water stress is defined as a modest loss of water that causes stomata to close and gas exchange to be limited. Desiccation is a significantly larger loss of water that can cause major disruptions in metabolism and cell structure, as well as the eventual cessation of enzyme catalyzing activities. Reduced water content, turgor, total water potential, wilting, stomata closure, and cell expansion, enlargement and growth are all signs of water stress. Severe water stress can cause photosynthesis to stop, metabolism to be disrupted, and eventually death (de Oliveira, Mendes, Alencar, & Gomes-Filho, 2013).

2.5 Saline water management

The effect of salinity conceded on saline seeps in upper area of soil, should be used the some practice in long term solutions to this problem, and applied some strategies to use of land changes in objective to restore the hydrological state, and restore the hydrologic equilibrium, in the salt effected lands is required to restore their productivity and fertility (Department of primary industries (DPI), 2001).

The control of salinity is used some practices to management this problem that suffering in salt affected land and regions that suffering salinization water during Firstly, source control through the irrigated water use efficiency and practices should be minimize water application and decrease deep percolation, Secondly, intercepted of the unavoidable, isolated drainage water and reused to irrigation of the salt tolerance plant such as halophytes plant, conserve on the water and reducing in pollution during reduce in drainage water. Third, should be use of saline groundwater with surface water to minimize water table elevation. Fourth, unusable final drainage water effluent should be disposal or reclaim. To achieve salinity management should be combined practices and approaches, thus independent on some factors such as economic, climatic, social, as well as edaphic and hydrogeological factors (Rhoades, Kandiah, & Mashali, 1992).

Some strategies that to mitigation in saline seeps and increase water use in the recharge area.

Practices for the recharge area:

1. Intensive cropping: this methods used to reducing salinity problem. Long fallows are eliminated, resulting in greater water usage in the recharge region, and reduced seepage flow.
2. Growing deep rooted perennials Crops: differ significantly in their rooting depth and seasonal water use. Practical experiments were carried out by some researchers such as Brown and Miller, (1978) the researchers used alfalfa as a deep-rooted crop and studied how this crop contributes to control of saline seep. The alfalfa has a deep root system may its root reach up to six meters (6.10 m) and has exhausted the highest amount of soil water (787 mm). These researches examined the impact of six years of alfalfa cultivation on a saline seep recharge discharge region. In 1971, the water table in the outflow region was 0.30 m below the soil surface, whereas in the recharge area it was 6.2 meters. The water table has lowered by 2.9 meters in the discharge region and 2.0 meters in the recharge region after six years. Several additional crops and cropping sequences are also being tested in connection to saline seep management.

3. Drainage Surface in the recharge area, natural and man-made ponds have good surface drainage, useful and often economical means of regulating surplus water in the seepage region. Ponded water should be drained in the recharge area rather than in the seep area. Additional issue like as saline effluents disposal, a lake of suitable outlets, and so on are experienced in the latter. While surface drainage may be sufficient for removing extra water from the recharge zones, subsurface drainage is sometimes required in the discharge areas which is a costly proposition.

Practices for the discharge areas:

1. Cropping in the same way that intensively cropping with perennial and deep rooted plants such as alfalfa with high water use assist to keeping the water table at greater depths and prevents salinization in the recharge area.
2. Drainage: drainage in the discharge zone has the goal of lowering the water table and desalinizing the root zone through leaching. In dry land situation, artificial subsurface drainage and leaching by applied water are often not cost effective. Despite this, in limited areas drainage works have been installed in a few localities with varying results. Sommerfeldt et al., (1978) experimented with mole drains, which are created by using a mole plough to pull a bullet shaped device through the soil. It is essentially made up of a beam with downward- extending perpendicular blade. The bullet shaped item at the end of the blade creates a channel. Some disadvantage include the drains are easily installed and have a cheap installation cost. Mole drains work best in soils that have enough clay to be cohesive and that are moist enough to be plastic. The restricted depth (60 to 70 cm) to which these mole drains can be created, as well as their relatively short life span (2 to 3 years).

   subsurface drainage of most saline seep discharge areas is unfeasible due to extremely low permeability of soils caused by high montmorillonite clay content and often high sodium adsorption ratio of the soil solution, waste disposal issues, poor accessibility for heavy drainage equipment and difficulty in locating saline seep focal points. In addition the cost of materials and installation is sometimes higher than the land price. Based on these considerations, it would be preferable to provide drainage and implement excess water management measures in the recharge area rather than control the water table in the drainage in the discharge areas acxordung to Van der Pluym (1978) and Miller et al,. (1981).

3. Salt-tolerant crops: although attempts are being made to ameliorate saline seeps, growing salt-tolerant plants is an effective way of reaping some economic rewards (FAO, 2013)

Desalinization

Desalinization for saline waters is technically conceivable, but its application is limited by expense (initial capital cost expenditures of the equipment, as well as and high operation and maintenance costs) and the challenge of disposing of the residual saline concentrate (Department of primary industries (DPI), 2001).

Some challenges that facing at use desalinization treatments include:

1. To destroy microorganism like bacteria, pre-treatment of the water may include sand filtration, micro-filtration, and ultraviolet treatment.

2. It is tough to purify water that's containing on high iron, silica or manganese.

3. It takes 2-3 days to sanitize the membranes properly.

4. Membranes work under high pressure, and have a three year lifespan (Department of primary industries (DPI), 2001).

The example on desalinization experiment in Khan-Youns in Gaza strip. However, The salinity of water in the Gaza Strip in general and agricultural areas in particular, is one of the most important reasons that negatively affected the diversity of crops, which made farmers turn to planting specific varieties that tolerate salinity. The percentage of total salts in west of Khan Yunis governorate reached (3000 ppm) as this percentage is considered very high for most vegetable crops. Once of the successful experiments to solve the problem of water salinity through the establishment of a desalination plant to reduce the salinity in the irrigation water, where the experiment succeeded in reducing the percentage of salinity from 400 - 3000 ppm with a production capacity of 8 cups per hour. During mixing the water by 70%-30% with saline water, thus the salt content after mixing reaches 1100 ppm, considering that this ratio is suitable for most crops. The low percentage of salt in the water treated at the desalination plant, had a significant positive impact on the diversity of crops such as cucumbers and sweet peppers, which are well grown in waters that contain a low percentage of salt (MOA, 2019).

2.6 Salt tolerant plants “Halophytes"

A halophyte is a plant that can grow in high salt concentrations (more than 200 mM NaCl). They are plants that have evolved to thrive in salinized condition. To deal with salinity, they use specific approaches. However, most crop cultivars are salt sensitive – Glycophytes: (a plant that can only develop and reproduce at relatively low salt concentrations), therefore improving and optimizing them to produce more salt-tolerant plants is a technique for to increasing crop production on salinized agricultural land (Van Zelm, Zhang, & Testerink, 2020).

Interaction with beneficial soil microorganisms, such as symbiotic nitrogen-fixing bacteria and mycorrhizal fungi, to increase salinity tolerance in crops can have a big influence on plant tolerance to stress of salt. According to studies, mycorrhizal colonization can decline chloride ions absorption while blocking Na^+ translocation to shoot tissues in salinity [Evelin et al., 2009].

Plant has some methods (or mechanisms) to handle salinity tolerance such as reducing osmotic stress plant decrease leaf area and stomatal conductance, another mechanism exclusion of the Na+ by roots to prevention accumulation to toxic concentration, and the final mechanisms the tissue tolerance that consists in accumulation Na+ and Cl^- by compartmentalization. Various plants have different salt tolerance system. Under salt stress, sodium ion and chloride ion are typically maintained in the roots of barley, wheat, maize and sorghum [Peng et al., 2016].

While attempts are being made to restore the saline seeps, cultivation salt-tolerant plants is an excellent strategy to provide some economic rewards (FAO, 2013).

Proline and glycine they are organic solute produced by plant that tolerant to salinity, this making to maintain water balance and physiological function, during salt stress, they maintain osmotic and membranes stabilization, constitutive proteins and enzymes, scavenging free radicals, and buffering cellular redox potential (Ashraf & Foolad , 2007).

(Munns, 2002) Documented that the impacts of salt on plants have two stages growth response concept: first stage, osmotic is of short duration and reduce development owing to water stress caused by salt in the root. The second phase, known as ion-specific phase takes longer to develop and it is caused by the extra levels of salt accumulation in cell vacuoles of transpiring leaves which results in a decrease in the growth of younger leaves due to a shortage of carbohydrates supply to developing cells.

2.7 Barley

Barley *(Hordeum vulgare)* is one of the world's five major crop species, growing thought the Fertile Crescent at various locations (Palestine, Jordan, south Turkey, Iraqi Kurdistan, and southwestern Iran). According to FAO, barley *(Hordeum vulgare L.)* is one of the world´s most widely farmed crops, with the European Union as its leading producer. In the cold temperate zone, it can adapt to a broad range of environments. It was domesticated from its wild relative around 8000 B.C. *Hordeum spontaneous*, *H. Spontaneum* and *H. Vulgare* share similar morphological characteristics, such as cultivated form version having wider leaves, short awns, short stem, tough ear rachis, bigger grains, and a shorter and thicker spike (Eshghi, et al., 2012)

Taxonomy and Classification of Barley: Barley is a self-pollinating plant. It is an annual cereal and it is a member of the grass family that belongs to the order Poales, genus *Hordeum* which contains many species that could be classified according to the chromosomes number and morphological characteristics (Zohary, Hopi, & Weiss, 2000).

Classification according to chromosomes number [Chapman and Carter, 1976]:

1- Dipoide Group (2n=14) this group includes Hordeum disticum, Hordeum vulgare, Hordeum irregular and Hordeum agriocrithum.
2- Tetraploid Group (2n=28) this group includes the following wild type Hordeum bulbosum, Hordeum murium and Hordeum jubatum.
3- Hexaploid Group (2n=42) this group contains Hordeum nodosum.

Classification according to morphological characteristics (Kumar et al., 2012):

1- Two-rowed barley with shattering spikes (wild barley) is classified as Hordeum spontaneum.
2- Two-rowed barley with nonshattering spikes is classified as Hordeum distichum L.
3- Six-row with shattering spikes as Hordeum agriocrithon.

Six-row barley with nonshattering spikes as Hordeum vulgare L. (or Hordeum hexastichum L.).

Barley (*Hordeum vulgare* L.) is one of classified as the fourth most significant cereal grain crops after rice, wheat and maize. Barley is one of the world's earliest domesticated grain crops. It was first cultivated between 9500 and 8400 years ago [Azhaguvel and Komatsuda, 2007]. The Fertile Crescent, notably the Palestine- Jordan region is where barley originated [Badr et al., 2000; Preece et al., 2016]. Many researchers reported that barley varieties were domesticated in the Near East from their wild relative, *Hordeum spontaneum* [Harlan and Zohary, 1966; Badr et al., 2000].

The cultivation of barley, wheat and legumes is one of the main agricultural sectors in Palestine. It plays a central role through its contribution to the Gross Domestic Product (GDP) and employment. Furthermore, agriculture is a crucial driving force for other economic sectors, and a foundational pillar for preserving the environment [MOA, 2014–2016].

Barley cultivation in Palestine is Barley is a winter crop, as it is grown in most temperate regions, and it tolerates drought conditions more than wheat; It succeeds cultivation in the lands where the rainfall rate is 250-300 mm annually. The importance of barley is widely used in animal feed, as a concentrated vital food in the case of using grains, or green grazing. Barley grains contain 65% carbohydrates, 12% protein, 11% water, 2% fat, and 6% fiber. Barley is grown in a double or triple cropping cycle, and the best cycle for cultivation as fodder legumes especially if fodder legumes are planted for grazing or green harvest. Barley can be planted early in the autumn due to its dependence on rainfall; they are usually planting in October and sometimes in November. Seedlings germinate quickly if watered with rainwater or irrigation water, and the barley plant does not require cultural practice; It is sufficient to fertilize and eliminate weeds by controlling them manually, or spraying them with agricultural pesticides. The yield of barley is 125 kg per du depending on the area, and in the irrigated areas, the production may reach 300-500 kg / du. The crop is harvested May manually or using the harvester, if the land is leveling and the barley is long, then threshed by thresher , and stored in bags or and silos. Appropriate storage conditions must be provided to avoid attacked pests, and spoilage due to moisture. The most common varieties: Baladi, Nayomi 531, Root, Ma'alit. [MOA, 2014– 2016].

Barley is associated with the most common crop livestock agricultural system. During the drought season In Palestine, 84% of the farmers planted barley as a feed for their animals. Due to growing technology, the old agricultural system is changing towards intensive production methods, mostly for land preparation, planting, harvesting and fertilizer. As a result, barley production becomes more intense and it accounts for a bigger part of agricultural al., output (Abu- Alrub, ALajoma, Jorgen, & Christanse, 2004).

The production of barley in the West Bank is concentrated in Jenin, Hebron, Tubas, Dora, Yatta and Ramallah. Barley is the second major cultivated field crop in Palestine after wheat with 9280 ha of cultivation area with 16380 tons of production. Its cultivated area is about 22.1% of the total area cultivated with field crops. Ninety-seven percent (97%) of cultivated barley is under rain-fed system [PCBs, 2010; FAO, 2013; MOA, 2016].

Table 2.7

Statistics of barley production in west bank during 2015-2016 growing season

Site	Cultivated area (ha)	Total grain production (Ton)	Total straw production (Ton)
Yatta	3790	9475	7580
Dora	1600	4800	4800
Ramallah	850	1360	2550
Hebron	760	1900	3800
Jenin	500	1865	200
Tubas	500	700	400

Most of the farmers are still planting old traditional varieties (landraces) which are known to show a high level of resistance to biotic and abiotic stress factors. Landraces are common to farmers and they are adapted to local environmental conditions [FAO, 2013; ICARDA, 2016].

The principle cultivated field crops in the Jericho district are wheat and barley, which cover 106.5 hectares. Jericho has high saline soils and high pollination vulnerability. Soil salinity is resulting by two main factors. The salt can be applied to the soil during saline water since the irrigation water is of low quality. Groundwater that is too near to the surface might produce salinity. When water is applied to the soil, capillary action causes the ground water to rise. When water evaporates, salts are left behind, which can be form a crust on the soil [ARIJ, 1996].

Climate requirement for barley cultivation: the optimum temperature for barley growth varies according to the growth stage. It can grow at relatively low temperatures (4°C) and higher temperatures (30°C) especially during spike formation, but the optimum temperature during the growing period is (20°C). It can adapt to any ecological situation, but most species do not thrive in the humid tropics. Barley is classified as a sensitive crop to frost. Frost damage during the blooming stage has a significant influence on crop output. Also drought conditions is suitable to cultivation of barley also barley has a very good tolerance to dry season [Reddy, 2015].

Soil condition for barley planting: barley crops can be growth in different types of soils including saline, sodic & lighter soils. Moreover, Loam soil is the most suitable soil for growing barley with a pH of 7–8. Barley cultivation is not successfully in acidic soils [Reddy, 2015].

Harvesting in barley cultivation: in mid of May to June harvesting barley crop to obtain on straw and grain. The harvest at the right time is very important to avoid over ripening lead to breaking of spikes [Reddy, 2015].

Nutritional value of barley: B vitamins such as niacin, thiamin, and pyridoxine (vitamin B-6) are abundant in barley; beta-glucans and fiber are also present in barley. Some nutrients can help protect of the body from many problems and the response of heart health, maintain blood pressure, lack of cholesterol and control of its level such as vitamins and minerals [Nanak Chand et al., 2008]. Barley also has advantages for bone health, cancer, inflammation, digestion, weight control, and satiety. It also aids in the absorption of fat, helps maintain the structure of cellular membranes, and aids in the transmission of nerve impulses [Ware, 2019].

2.8 Barley and salinity

Zhang et al., [2010] reported that the seeds can germinated in saline condition at lower osmotic potentials than those germinated in iso-osmotic *Polyethylene- glycol* (PEG) solutions and generally germinated faster. In this research was found that a positive correlation between seed salt content and external salinity in the saline condition. Dry mass and germination percentage were decreased with increasing in germination index and Na+ concentration at higher temperature.

Jamshidi and Javanmard, [2017] reported that evaluation of barley genotype for salinity tolerance under stress indices. His study uses 26 barley genotypes. The stress indicators identified the 10 most tolerant barley genotypes including 4Shur, Torkman, Makouei, Karoon, 5Shur, Bahman, Sahra, Torsh, Reihan and Goharjo. The stress indicators varied, indicating that Nimruz was the most sensitive barley genotype under stress.

Chang et al., [2014] documented that barley is the salinity tolerant of field crops, that tolerant to higher than 250mM NaCl concentration, consequently. The barley crop may be suitable to be used in salt remediation of salt impacted soils.

Mahmood, [2011] examined the development and growth for three barley cultivars under different concentrations from K+/ Na+, NaCl and NaHCO3. In this research was found that increasing biomass yields in control and 100 mM NaCl treatment. However, in NAHCO3 treatment was adversely affected on the growth of three cultivars even at a low or negligible concentration (10 mM). Addition of potassium ion on the saline medium contribute to increase K+ uptake and growth even less tolerant barley cultivars.

Degl'Innocenti et al., [2009] reported that both salinity and potassium deficiency caused a reduction in biomass production in wild barley (*Hordeum maritimum* L.) and cultivated barley. Also, they reported that deficit in K+ may affected on roots more than shoots, whereas, for salinity the reverse occurred. Typically, K+ absorb was more affected in *(Hordeum maritimum L.)* than in cultivated barley.

Katerji et al. [2006] reported that varietal salt tolerance affects the salt tolerance barley classification and the water use efficiency. Variety Melusine performed best due to its high production and salt tolerance. However, in non-saline and saline condition, variety ISABON3, a particularly salt-tolerant landrace, produced more grain and straw.

Hamdy et al. [2005] found that the saline water in supplemental irrigation (with brackish water EC 3- 9 ds/m) of barley and wheat under rain-fed agriculture, were investigating the potential to secure substantial yields, with mean yield decreases of only 21% in barley and 25% in wheat when compared to the fully irrigated with fresh water as a control. The response of barley to water stress at various development stages and soil salinity levels.

The interaction between water stress and salinity was significant. Shoot dry weights reducing when exposed to high salinity treatment and water stress. in comparison to low salinity, proportional reductions in shoot dry weights attributable to salt during the vegetative development stage were 33% and 46% for medium and high salinity concentration, respectively,. the dry weights of the roots differed considerably across treatments. When the plant in vegetative growth stage was exposed in water and salinity stress led to reduction in root dry weights [Al-Khafaf et al., 1990].

Khosh Kholgh et al., [2013] reported that the effect of NaCl levels on germination percentage% and threshold of *Hordum valugari L.* germplasms. In experiment one: 23 barley germplasms divide to (17 accessions and 6 improved barely cultivars), uses four treatment of NaCl treatment (0, 100, 200, 300Mm NaCl), to investigation germination index. They measured some variables such as germination percent, root length, shoot length, root fresh weight, root dry weight, shoot fresh weight, shoot dry weight, Na+ root content, K+ root content, Na+ shoot content, K+ shoot content. In experiment two: they uses the threshold salinity of 7 germplasms that selected from the first experiment were analyzed in five treatments (1.3, 5, 10, 15 and 20 ds.m-1). They measured some variables both shoot length, dry and fresh weight, Na+ and K+ content. They found that increasing in salt concentrations lead to decreased germination index, some of germplasms showed high tolerance to salinity. Also, the wild cultivars (accessions) showed that a highest tolerance with compared to the other cultivars that is likely contain genes for resistance to salt stress.

Salahat, [2013] examined that marginal water resource such as saline water and treated wastewater as an alternative water resource, these water consist of high salt concentration. In this study used three level from salinity level were S1 (1080 ppm), S2 (3240 ppm) and S3 (9720 ppm), and used treated wastewater the total dissolved solid (1200 ppm) and addition to fresh water as control (442 ppm). The aims of this study evaluate the productivity and behavior five barley varieties under different salinity level. Found that straw and seed yield varieties (1 and 4) are the highest yield. At the high concentration of salinity level decreasing the straw and seeds yield. In treated wastewater treatment showed the higher values of another treatment.

Al- Busaidi, [2006] reported that the effect of salinity on barley in different growth condition in growth chamber, glass house and greenhouse, used two NaCl level were (3 ds/m and 13 ds/m) in each growth condition. In 13 ds/m (high level of salinity) found that reduction in yield in different growth condition.

Al – Shammary, [1998] documented that effect of different salinity level on four barley varieties (Gusto, Alkharji, Qatifi and Haili), and used five level of saline water ranging 2.85ds/m to 15.95 ds/m. The found in this study with increased in salinity level reducing significantly in the production of straw and seed yield and height of plants.

Arshad Ullah et al., [2019] reported that evaluate of the salinity tolerance in five different varieties of barley under different salinity levels and sodicity levels and find best variety can be salt tolerant. In this experiment used treatment as follow salinity level (S0 = 3.78 ds/m + 14.78 (mmol/ L) and S1= 12.34 ds/m+29.87 (mmol/L)), barley varieties is (PK-30046, PK-30163, RD-2508, BH-924 and Shahara). The result of this experiment RD-2508 and BH-924 varieties are the best salt tolerant in other varieties. The seeds yield the highest value in Shahara at S0 and S1 treatments. The amount of K^+/ Na^+ decreasing in S0 treatment.

Hamad, [2014] presented research about the use of groundwater that high salinity to irrigated plant in Jericho area. the used of salinity water contain up to (10000 mg/l) to irrigated the barley plant after treating its seeds with certain types of bacteria, compared it with untreated seeds irrigated with fresh water. The study showed that plants treated and irrigated with saline water grew better than those irrigated with fresh water, and the vegetative mass of them produced about three times what was produced by untreated seeds irrigated with fresh water. This research would launch a revolution in the world of agriculture and the use of salty water in irrigation plantings.

Chapter Three
Materials and Methods

During the 2018/2019 growing season, the experiment was done in sand-clay soil, in the laboratories and experimental farm of the Faculty of Agriculture and Veterinary Medicine, An-Najah National University, Tulkarm, Palestine (32.31519º N, 35.02033º W and altitude of 75 m) during the in a. The regions climate is hot humid in the summer and warm in winter with an average annual rainfall of 600 mm.

3.1 Plant Material

This study employed seeds from twenty different barley landraces obtained from farmers in different regions in the West Bank-Palestine were used in this research (Table 3.1). Grain samples were collected as a mixed bag from farmers who had been growing the same landrace from generation to generation.

Table 3.1

Barley (Hordeum vulgare L.) landraces obtained from different regions in Palestine

Code	Collection site	Province	Latitude	Longitude
HV-1	Ras Atya	Qalqilya	32º9'33.35"N	34º59'30.20"E
HV-2	Imatin	Qalqilya	32º11'34.53"N	53º9'34.25"E
HV-3	Bayt Iba	Nablus	32º14'24.10"N	35º12'43.66"E
HV-4	Beta	Nablus	32º8'17.54"N	35º17'1.09"E
HV-5	Tayasir	Tubas	32º20'33.24"N	35º23'47.42"E
HV-6	Jayus	Qalqilya	32º12'2.29"N	35º2'2.71"E
HV-7	Sinjil	Ramallah	32º2'7.02"N	35º15'52.19"E
HV-8	Qabatiya	Jenin	32º24'42.83"N	35º16'48.41"E
HV-9	Silat Al-Dahr	Jenin	32º19'1.32"N	35º11'21.53"E
HV-10	Shuweka	Tulkarm	32º20'8.52"N	35º2'6.19"E
HV-11	Tubas	Tubas	32º19'21.30"N	35º22'6.44"E
HV-12	Azun	Qalqilua	32º10'38.25"N	35º3'19.96"E
HV-13	Anabta	Tulkarm	32º18'29.01"N	35º7'11.44"E
HV-14	Tel Albeida	Tubas	32º22'53.33"N	35º30'22.71"E
HV-15	Ni'lin	Ramallah	31º56'57.36"N	35º1'16.37"E
HV-16	Dura	Hebron	31°30'17.1"N	35°01'21.9"E
HV-17	Bet Ula	Hebron	31°35'46.7"N	35°01'30.8"E
HV-18	Halhul	Hebron	31°34'54.9"N	35°05'54.4"E
HV-19	Beit Qad	Jenin	32°28'24.6"N	35°21'25.0"E
HV-20	Al-Auja	Jericho	31°94'68.69"N	35°46'99.03"E

3.2 Experiment 1: Germination experiment

The experiment done in the incubator chamber of the Faculty of Agriculture and Veterinary Medicine, in Tulkarm. The germination experiment was conducted in serval stages, which are as follows:

1. For each cultivar, 350 hand-selected seeds of uniform size will be surface sterilized with 1% sodium hypochlorite for 15 min and then rinsed with sterile deionized water for three times (each time for 5 minutes) under a laminar airflow cabinet.
2. These seeds will be then transferred to sterile Petri dishes (10 seeds per Petri dish) containing two Whatman No. 1 filter paper moistened with 10 ml of Hoagland solution NaCl (control).
2. NaCl will be used in three concentrations of 100, 200, and 300 mM equivalent (10, 20, 30 ds/m) and DW was used as control. Three replicates of 50 seeds will be used in each treatment.
3. Seeds will be allowed to germinate and were incubated in darkness in a in a growth chamber at 20-25 °C under a 12 h photoperiod (120 µmol m-2 s-1) fluorescent; germination percentages will be recorded after 6 days.
4. Take five seedlings from each treatment will be randomly picked for recording of observations on the following seedling characters:

- Coleoptile length (cm): The length of the coleoptile was recorded in centimeters from the seed to the coleoptile tip.
- Root length (cm): was measured in centimeter from the base of the root to root tip in 4days old seedlings.
- Shoot length (cm): Shoot length was measured in centimeters from the base of the shoot to the leaf tip.
- Root to shoot length ratio: The ratio between root length to shoot length was calculated.

Figure1

Germination stage for barley seeds.

3.3 Experiment 2: Field experiment

Based on the results of the first experiment, 4 landraces were selected for the field experiment (HV17, HV18, HV19 and HV20). The experiment was conducted in a shelter house. Fifteen pre-germinated seeds per landrace per replicate were sown in plastic pots (35*45*25 cm) filled with a mixture of peat moss and sandy soil 1:1 (v/v), in (Figure 2) shows some picture for field experimental.

After sowing, pots were irrigated with tap water for 4 weeks, then the application of NaCl treatments started. The same concentrations used in experiment 1 were used in experiment 2.

Figure 2

The field experiment.

3.3.1 Experiment layout

The salinity treatments (control, 100, 200, and 300 mM NaCl). A total of 48 pots was be used for 4 landraces (HV 17, HV 18, HV 19 and HV 20) with three replicates for each treatment. was be used The Randomized Complete Design "RCD". Colors presented as well as White (control), pink (100mM), yellow (200mM), green (300mM) Nacl as shown in table (3.2).

Table 3.3

illustrates the distribution of the pots as designed

Treatment	Replicat one	Replicat two	Raplicat three
Treatment 1	HV 18- 0	HV 17- 0	HV 19- 0
Treatment 2	HV 19- 0	HV 19- 100	HV 19- 100
Treatment 3	HV 17- 200	HV 20- 200	HV 17- 200
Treatment 4	HV 18- 200	HV 17- 300	HV 17- 300
Treatment 5	HV 19- 200	HV 19- 200	HV 18- 0
Treatment 6	HV 18- 100	HV 18- 100	HV 18- 100
Treatment 7	HV 20- 100	HV 20- 300	HV 18- 200
Treatment 8	HV 18- 300	HV 18- 300	HV 18- 300
Treatment 9	HV 17- 100	HV 19- 0	HV 17- 0
Treatment 10	HV 20- 300	HV 18- 0	HV 17- 100
Treatment 11	HV 17- 0	HV 17- 100	HV 19- 200
Treatment 12	HV 19- 300	HV 20- 100	HV 19- 300
Treatment 13	HV 20- 0	HV 20- 0	HV 20- 0
Treatment 14	HV 17- 300	HV 19- 300	HV 20- 100
Treatment 15	HV 20- 200	HV 17- 200	HV 20- 200
Treatment 16	HV 19- 100	HV 18- 200	HV 20- 300

3.3.2 Cultural practices

Irrigation: Irrigation requirement was calculated using CROPWAT software that used to determine the modified FAO Penman–montieth equation, based on the average climatic factors of Tulkarm area that Estimated needs 300000L, in the experiment was applied as seasonal amount 60L, plants were irrigated every four day from 28\ 11\ 2018 until 28\ 4\ 2019.

prepare saline solution depend on this 100mM needs to (5.85g\L), 200mM (11.700g\L) and 300mM needs to (17.55g\L).

Fertilization: Plants were fertilized with Liquid fertilizer (Shafer) 5-3-8 (N-P-K).
Disease & pest control: Plants were sprayed with fungicides and insecticides as needed.

3.3.3 Data collection:

During the growing season, days to heading (the number of days from sowing the seeds until 90% of the plants per landraces flowering) were kept track of during the experiment.

Five randomly selected plants from each landrace middle rows were harvested at maturity, and the following measurements were taken (the average of the five plants was used for statistical analysis):

Plant Height: The height was taken from the soil surface to the upper side of the main spike.

Tiller Number: The total number of fertile and unfertile tillers was counted.
Total Grain Yield: Spikes were threshed using a threshing machine and then all the seeds for each landraces were weighted.

Straw yield: Straws were cutting from button of plant then all the straws for each landraces were weighted.

Chlorophyll content: Chlorophyll meter “SPAD-502” was used to measure leaf chlorophyll content. The chlorophyll content was taken averaged measured in three different stages GS30-39 (stem elongation), GS40-49 (Booting), GS60-69 (flowering).

1. Calibration device according to the attached catalog.
2. Device driver and make sure the scanner in contact with collectors with each other because to make sure calibration process.
4. Measurement Total Chlorophyll Content on the plant directly on the leaf and then another leaf from the same plant sample (3 readings are taken on the same sample)
4 pressing the average button and score the reading.
5. Records take in the early morning before each irrigation.
6.

3.4 Chemical analysis in laboratory

Chemical analysis has been used for determining the Na+ and Cl^{-} (in soil extraction, grain and straw), soil EC for each landrace at each concentration, these tests were performed at An-Najah National University Laboratories.

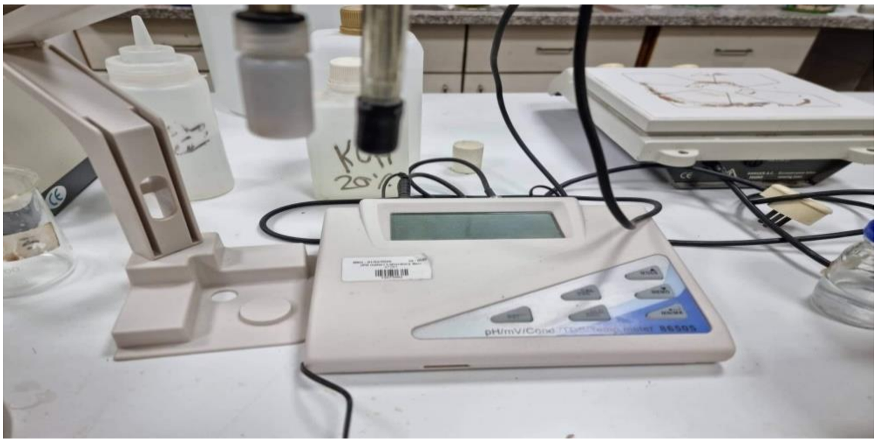
3.4.1 Electrical conductivity (EC) for soil

Electrical conductivity (EC) was measured using an EC meter see figure (3) according to ICARDA [2013]. In this experiment we use EC meter to take the reading for soil using this procedure.

1. Weigh 20 g of dry soil aerobically.
2. Placed in a 250 ml Erlenmeyer flask.
3. Add 100 ml of distilled water to the soil and mix well on the shaker for 30 minutes and leave it for 30 minutes and then mixed manually for half a minute and let it to infiltrate
4. Make filtration using filter paper and then appoint filtrate degree heat (extraction).
2. Adjusted EC meters and make a calibration according to the instructions cataloged for each device using potassium chloride solution (0.01 mohs\cm).
3. Wash the electrode with distilled water and then immersed in the (soil extract) and measure the degree of Electrical Conductivity (EC) mohs\cm.
4. Always saves the electrode in distilled water after the end of measurements to maintain.

Figure 3

Electrical conductivity meter use to measure EC.



3.4.2 Na+

Sodium-ion was analyzed in soil, seeds and soil extraction using Photoelectric flame photometry where the so-called standard curve is made, which represents the relationship between concentration and Flame reading, from which the sodium concentration can be calculated in any sample [ICARDA, 2013].

3.4.2.1 Na+ for straw

To determine the Na^+ content in the straw:

1. one g of straw per replicate per treatment was burned at 550°C for 3 hours, to obtain the ash of straw.
2. Dissolve the ash with a few parts of distilled water in a volumetric flask (100 ml), then complete with distilled water until reach 100 ml.
3. Take 10 ml of the sample by pip (in the 2nd step) in a 100ml flask and complete with distilled water. Measure control concentration and record reading.
4. In the salinity high concentrations (100, 200 and 300 mM) are diluted by taking 10 ml from the sample (third step) and putting it in a volumetric flask (50 ml) and adding distilled water.
5. Put the sample in Flame photometer device after calibration (Na 100 ppm and blank for distilled water 0.00), then record reading that taken from the device.

Note: the control concentration was not diluted because include a range of device 410 nm.

3.4.2.2 Na+ for seeds

1. one g of seeds per replicate per treatment was burned at 550 °C for 3 hours, to obtain the ash of seeds.
2. Dissolve ash of seeds with a few parts of distilled water in a volumetric flask (100 ml), then complete with distilled water until reach 100 ml.
3. Put the sample in Flame photometer device after calibration (Na 100 ppm and blank for distilled water 0.00), then record reading that taken from the device.

3.4.2.3 Na+ for soil extraction

1. After preparing soil extraction for each treatment, was taken 1 ml from sample extract by pipe digital, and then added in 100 ml distilled water.
2. Put the sample in Flame photometer device after calibration, then record reading that taken from the device.

3.4.3 Cl^{-}

The method for chloride ion determination is Mohr`s method, this method is based on the formation of insoluble silver salts when calibration of silver nitrate chloride using potassium chromate index.

Take a known volume of sample (soil extract or seed ash extract or straw ash extract) in a flask and add four drops of potassium chromate as an indicator. Add silver nitrate as titrants to the sample record the volume of silver nitrate consumed until access to the end point (appearance red color) [ICARDA, 2013].

3.4.3.1 Cl^{-} for straw and seeds

1. One g of straw or seeds per replicate per treatment was burned at 550 ℃ for 3 hours, to obtain ash.
2. Dissolve ash of seeds or straw with a few parts of distilled water in a volumetric flask (100 ml), then complete with distilled water until reach 100 ml.
3. Take 1 ml from the sample (in 2^{nd} step) by pipe digital and put in volumetric flask 100ml and well mixing, then complete with distilled water.
4. Take 10 ml from mixing (3^{rd} step) by pipe then emptied in the flask, and added 3 drops of potassium chromate K_2CrO_4 as an indicator.
5. Add silver nitrate $AgNO_3$ as titrant on the flask by titration, then calculate how much consume of $AgNO_3$, record net amount taken until access to the end point (appearance red color).
6. Depended on the following equation, the amount of Cl^{-} in seeds or straw is calculated.

Chloride Ion Concentration (mg/L) = (A×N ×35.45) *1000 / V sample

Where: A = volume of titrant used, N is the normality of silver nitrate (here we used N/71 or 0.0141 N), and V sample is the volume of sample used (ml) [ICARDA, 2013].

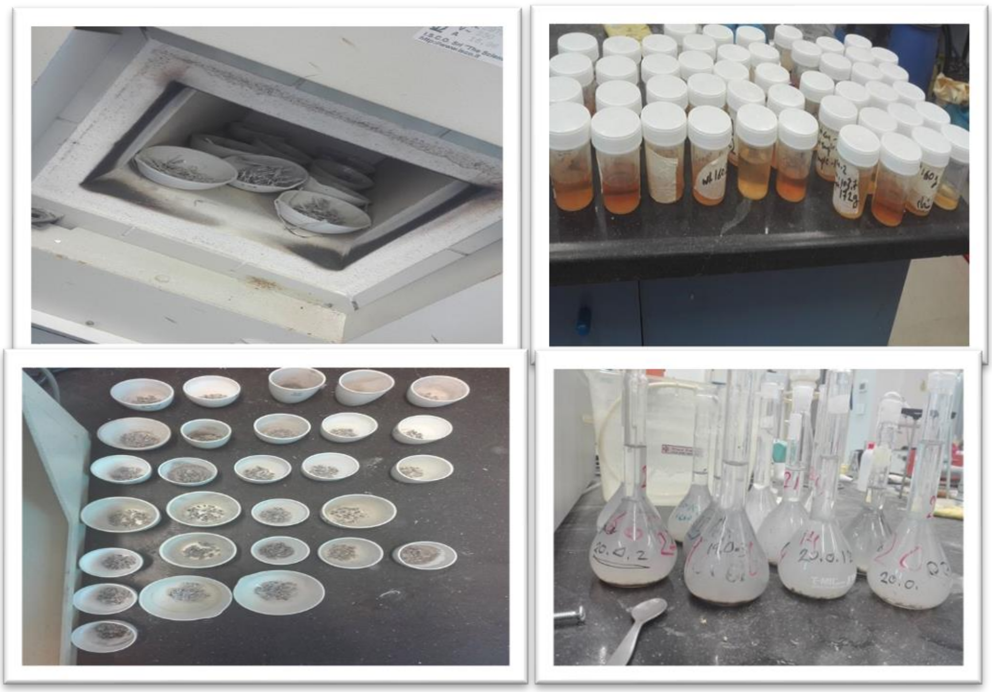
3.4.3.2 Cl^{-} for soil extraction

1. After preparing soil extraction for each treatment, was taken 1 ml from sample extract by pipe digital, and then added in a volumetric flask(100 ml) containing a few parts from distilled water and mixing then complete with distilled water until access to 100 ml.
2. Take 10 ml from mixing (1st step) by pipe then empty in a flask, and add 3 drops of potassium chromate $K2CrO_4$ as an indicator.
3. Add silver nitrate $AgNO_3$ as titrant on the flask by titration, then calculate how much consume of $AgNO_3$, record net amount taken until access to the end point (appearance red color).
4. Depended on the following equation, the amount of Cl^{-} in the extract is calculated [ICARIA, 2013].

Chloride Ion Concentration (mg/L) = (A×N ×35.45) *1000 / V sample Where: A = volume of titrant used, N is the normality of silver nitrate (here we used N/71 or 0.0141 N), and V sample is the volume of sample used (ml) [ICARDA, 2013].

Figure 4

During Na+ and Cl- test in laboratory.



3.5 Experimental design and data analysis

Both experiments used a factorial treatment design for both components (Landraces and salt concentrations), with the combined treatment being entirely randomized in a completely randomized design. Following data collection, a two-way analysis of variance was performed, followed by a mean separation of the significant components at a probability of 0.05 using LSD test. The software Minitab was used.

Chapter Four

Results

4.1 Experiment1: germination of barley landraces

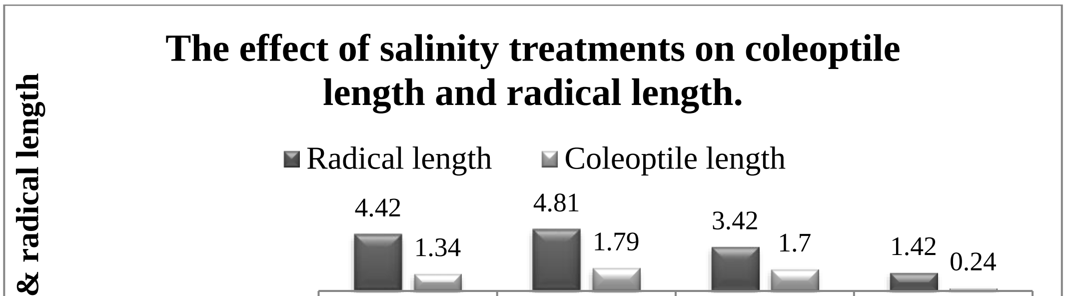
4.1.1 Effect of salinity on germination percent%

The effect of salinity treatments on coleoptile length and radical length. There were significant differences between barley landraces and salinity level is shown in (fig.5). No significant interaction in coleoptile length was observed between landraces and salt level. Coleoptile length was reduced significantly with increasing salinity level. Significant differences in length were observed between landraces.

No significant interaction was observed in radical length between landraces and salt level. Radical length was reduced significantly with increasing salinity level. Significant differences in length were observed between landraces.

Figure 5

The effect of salinity treatments on coleoptile length and radical length.



	0	100	200	300
Radical length	4.42	4.81	3.42	1.42
Coleoptile length	1.34	1.79	1.7	0.24

Significant differences in germination percent% were observed in (Table 4.1.1.2) between landraces. Landraces HV-16, HV-17, HV-18, HV-19 and HV-20 showed the highest germination percent% after 4 days from germination, but after 6 days HV-8, HV-16, HV-17, HV-18, HV-19 and HV-20 it highest germination percent%.

Table 4.1

The effect of NaCl treatments on germination percent (%).

Landraces	Germination %				
	Control	100mM	200mM	300mM (4days)	300mM (6days)
HV-1	48.3^{ef}	56.6^{abc}	51.6^{efg}	0.0^{b}	0.0^{f}
HV-2	90.0^{abc}	83.3^{a}	83.3^{ab}	1.6^{b}	10.0^{def}
HV-3	76.6^{abcdef}	58.3^{abc}	65.0^{bcde}	0.0^{b}	0.0^{f}
HV-4	91.6^{ab}	45.0^{bc}	33.3^{g}	0.0^{b}	0.0^{f}
HV-5	96.6^{a}	83.3^{a}	78.3^{abcd}	1.6^{b}	1.6^{f}
HV-6	55.0^{def}	50.0^{abc}	66.6^{bcde}	0.0^{b}	0.0^{f}
HV-7	70.0^{abcdef}	73.3^{ab}	80.0^{abc}	0.0^{b}	0.0^{f}
HV-8	85.0^{abcd}	80.0^{ab}	58.3^{ef}	0.0^{b}	81.6^{a}
HV-9	66.6^{abcdef}	63.3^{abc}	50.0^{efg}	0.0^{b}	1.6^{f}
HV-10	56.6^{cdef}	66.6^{ab}	65.0^{bcde}	0.0^{b}	5.0^{ef}
HV-11	56.6^{cdef}	58.3^{abc}	58.3^{ef}	0.0^{b}	0.0^{f}
HV-12	46.6^{ef}	28.3^{c}	63.3^{cde}	0.0^{b}	1.6^{f}
HV-13	80.0^{abcd}	65.0^{abc}	88.3^{a}	0.0^{b}	0.0^{f}
HV-14	60.0^{bcdef}	63.3^{abc}	60.0^{de}	1.6^{b}	10.0^{def}
HV-15	43.3^{f}	81.6^{ab}	40.0^{fg}	0.0^{b}	0.0^{f}
HV-16	66.6^{abcdef}	81.6^{ab}	33.3^{g}	15.0^{ab}	20.0^{cd}
HV-17	80.0^{abcde}	76.6^{ab}	58.3^{ef}	15.0^{ab}	15.0^{cde}
HV-18	73.3^{abcdef}	83.3^{a}	36.6^{g}	21.6^{a}	21.6^{cd}
HV-19	83.3^{abcde}	70.0^{ab}	61.6^{cde}	20.0^{a}	23.3^{c}
HV-20	75.0^{abcdef}	73.3^{ab}	51.6^{efg}	11.6^{ab}	45.0^{b}
L94	98.3^{a}	80.0^{ab}	91.6^{a}	15.0^{ab}	48.3^{b}

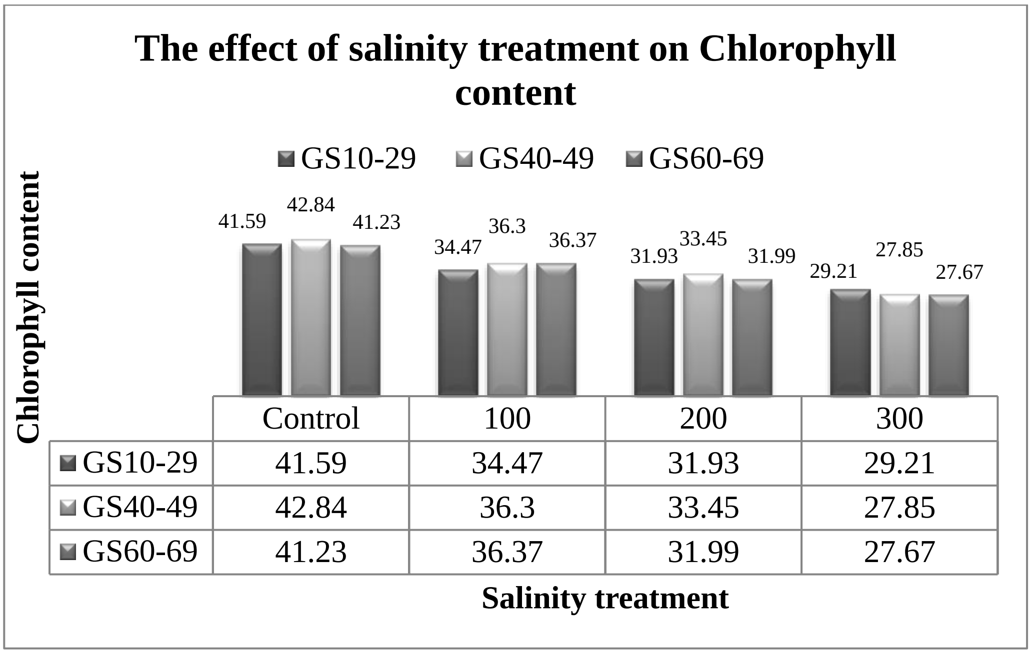
4.2 Experiment 2: Field experiment

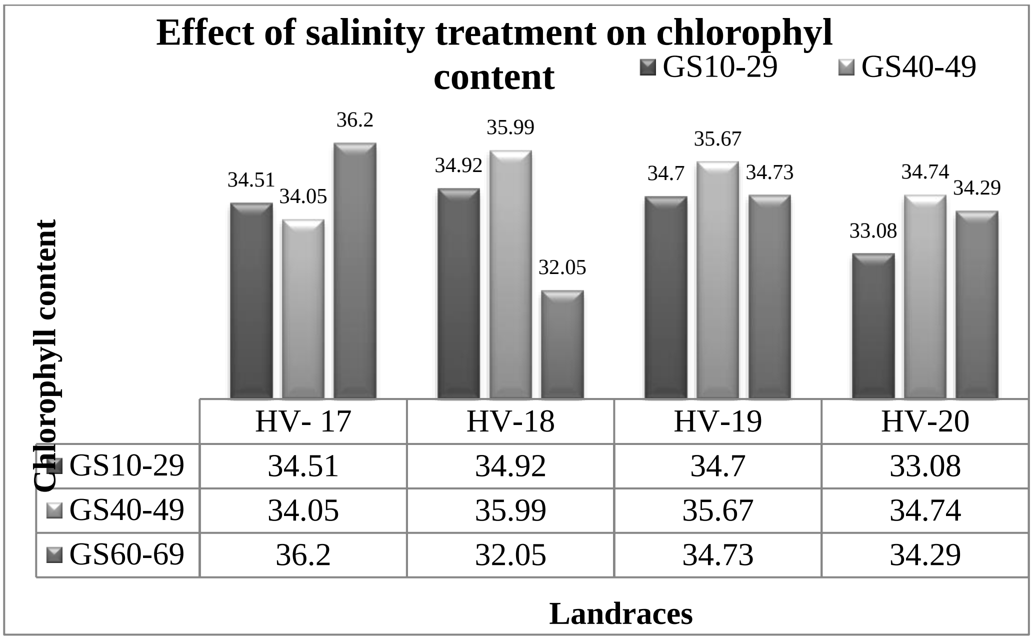
4.2.1 Effect of salinity on chlorophyll content

The effect of salinity on chlorophyll content of different barley landraces is shown in (fig. 6). Chlorophyll content was reduced significantly with increasing salinity concentration. There was no significant interaction between barley landraces and salinity concentration. Significant differences in chlorophyll content were observed between landraces at both growth stages. Landraces HV-17 and HV-19 showed the highest chlorophyll content at full flowering (36.2 and 34.4 respectively).

Figure 6

The effect of salinity level on chlorophyll content in four barley landraces.



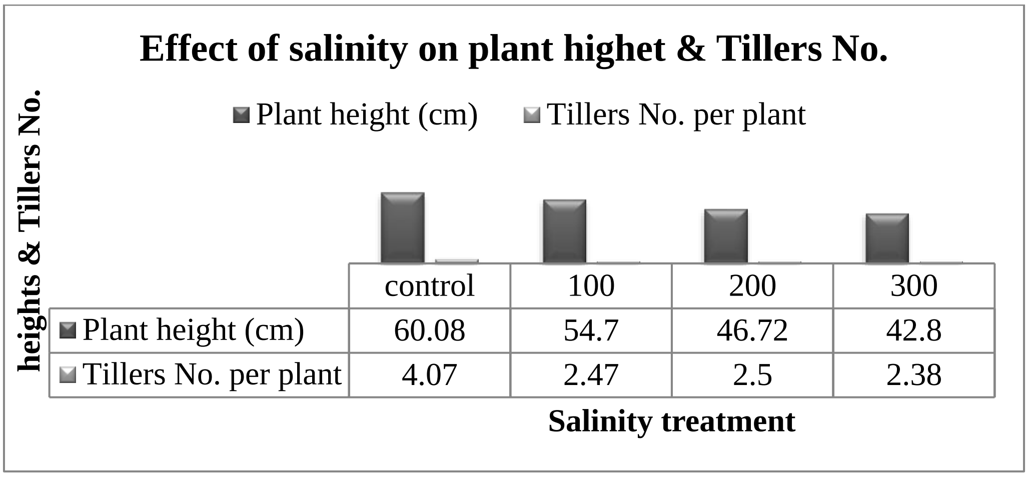


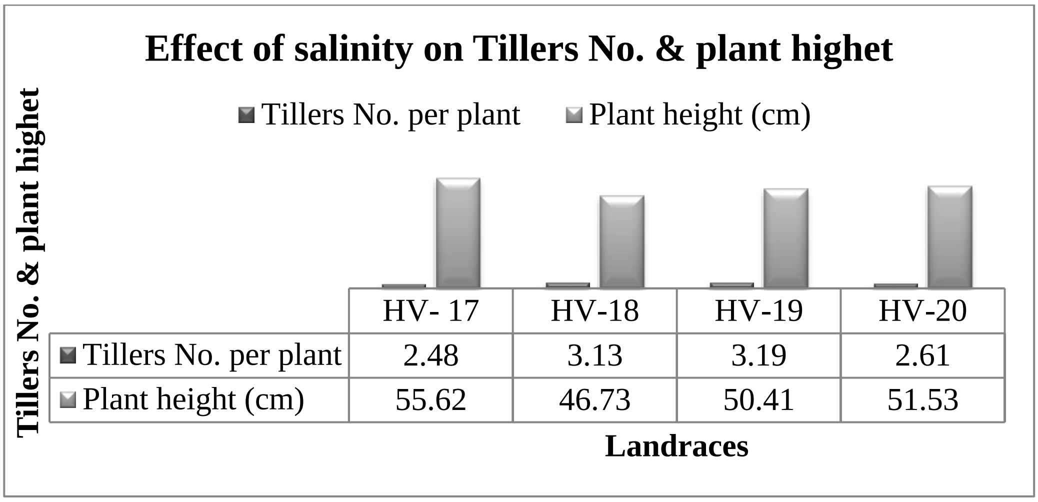
4.2.2 The effect of salinity treatments on plant height and number of tillers

The number of tillers was significantly reduced by salinity whereas no significant difference was observed between different salinity level. Significant differences were observed between landraces in tiller number. Plant height was significantly reduced by salinity. Significant differences were observed between landraces in Plant height.

Figure 7

The effect of salinity treatments on the number of tillers and Plant height in four barley landraces.





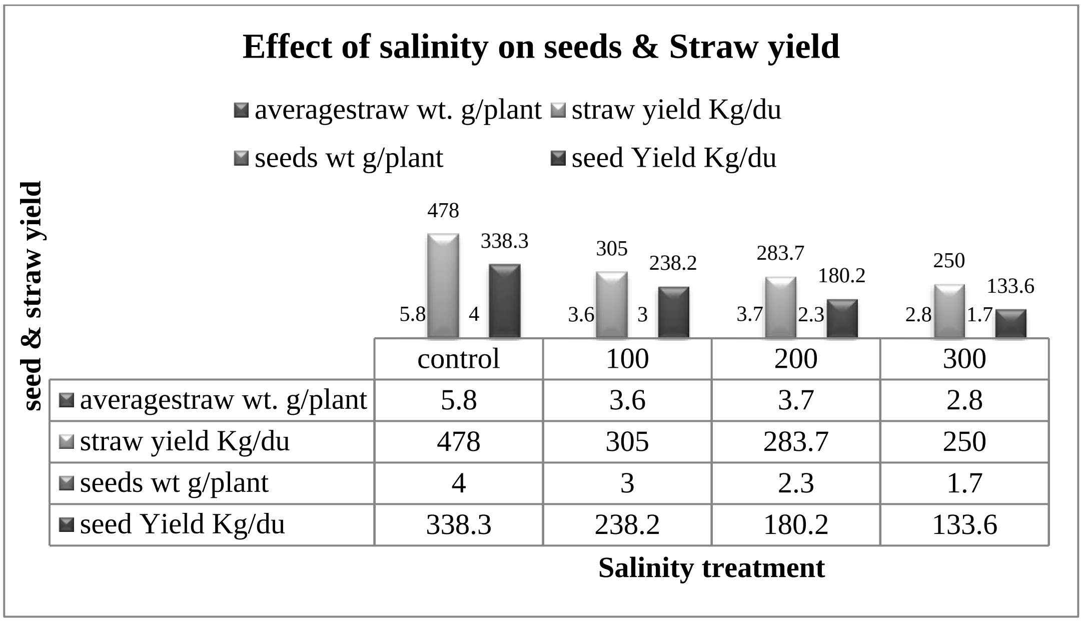
4.3 The effect of salinity treatment on straw & seeds yield in barley landraces

The effect of salinity level on the yield of different barley landraces is shown in (fig 8). The straw yield was reduced significantly when salinity concentration increased as follows as (478, 305, 283 and 250 Kg/donum) respectively (control, 100, 200, 300 mM). Average straw weight in different salinity concentrations was observed reduced with salinity increasing, in control (5.8 g/plant), at 300 mM (2.8 g/plant) but in 200 mM was observed (3.7 g/plant) and at 100 mM (3.6 g/plant). The result showed no significant difference among the landraces, however, the straw yield in HV-19 and HV-17 was the best recorded (375 and 358 kg/donum) respectively.

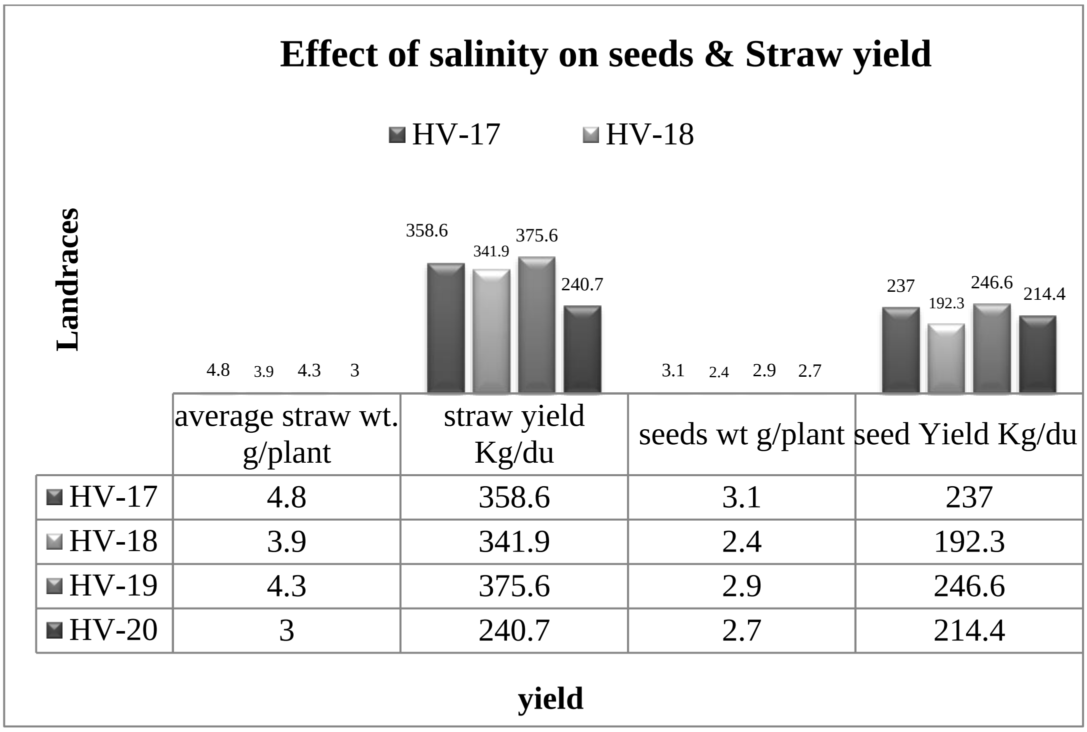
The seed yield was reduced significantly when salinity concentration increased. The seeds yield at control (338 Kg/du), at 100 mM (238 kg/du) there was observed the best from both 200 mM (180 kg/du) and 300 mM (133 kg/du). No significant interaction between barley landraces and salinity. The result showed no significant difference among the landraces.

Figure 8

The effect of salinity treatments on straw & seeds yield.



	control	100	200	300
averagestraw wt. g/plant	5.8	3.6	3.7	2.8
straw yield Kg/du	478	305	283.7	250
seeds wt g/plant	4	3	2.3	1.7
seed Yield Kg/du	338.3	238.2	180.2	133.6



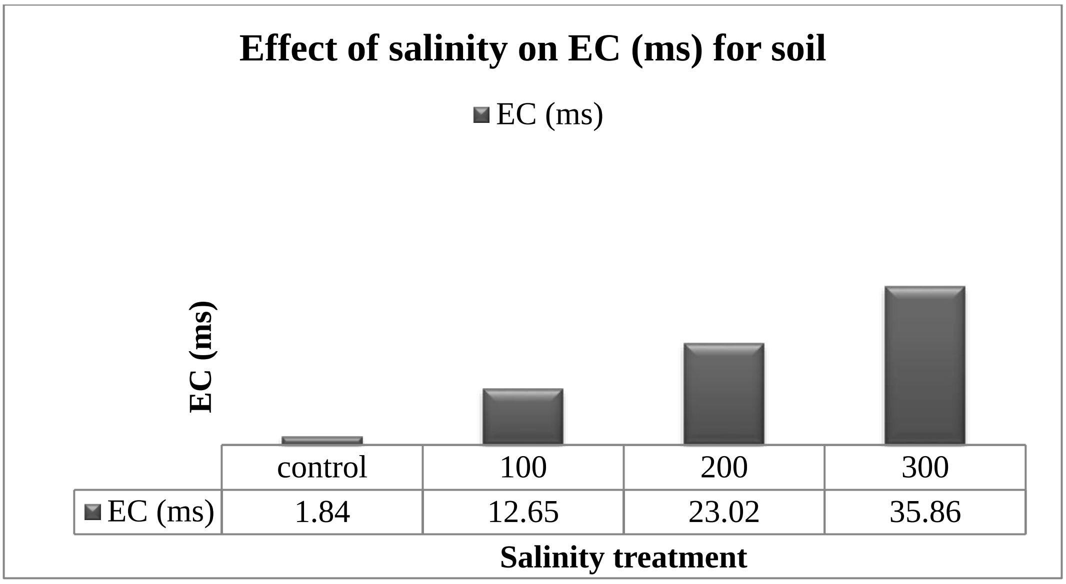
	average straw wt. g/plant	straw yield Kg/du	seeds wt g/plant	seed Yield Kg/du
HV-17	4.8	358.6	3.1	237
HV-18	3.9	341.9	2.4	192.3
HV-19	4.3	375.6	2.9	246.6
HV-20	3	240.7	2.7	214.4

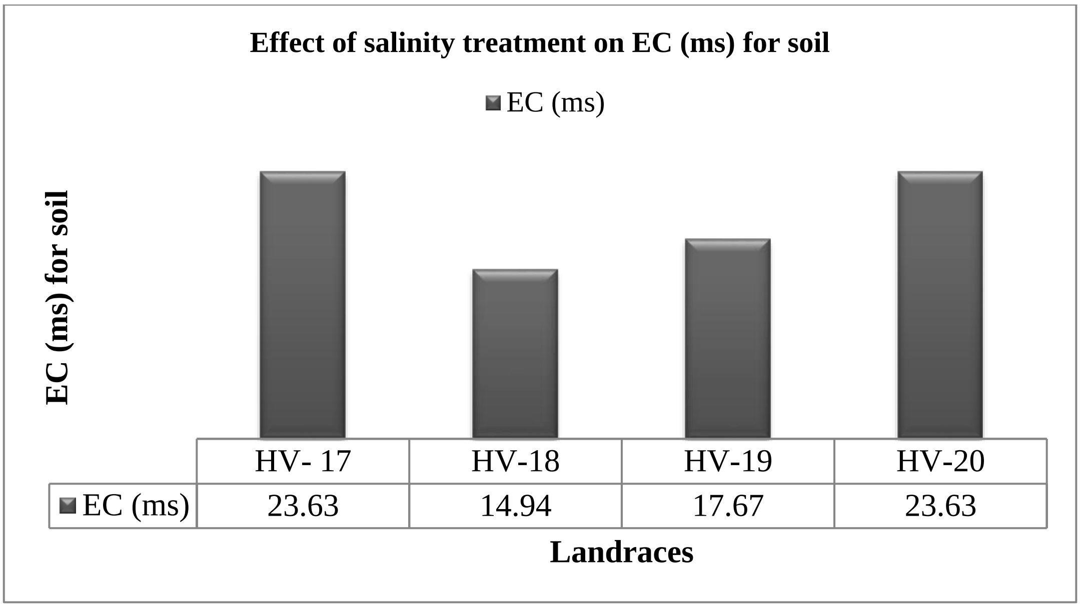
4.4 The effect of salinity treatment on EC for soil

Electrical conductivity EC (ms) was increased significantly with increasing in salinity concentration.

Figure 9

The effect of salinity on EC (ms) on barley landraces.





4.5 Amount of Na^+ and Cl^- in (Soil extraction, seeds and straw) at different concentrations of salinity in barley landraces

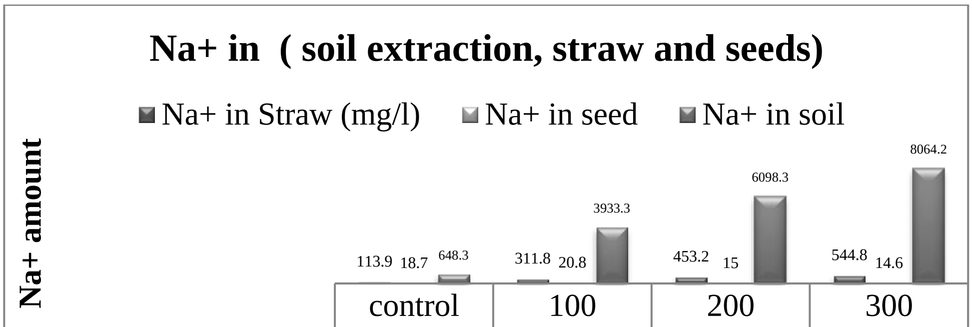
The effect of salinity on the amount of Na^+ and Cl^- in (Soil extraction, seeds and straw) in barley landraces there were shown in (fig 10).

The Na^+ accumulation in soil extraction was increased gradually with increasing salinity, control (648 mg/L), 100 mM (3933 mg/L), 200 mM (6098 mg/L) and 300 mM (8064 mg/L). However, in the seeds, Na^+ accumulation is less value registered versus soil extraction and straw, at increasing the salinity was increased significantly in Na^+ amount. In contrast, the Na^+ concentration in straw also increased with increasing salinity concentration at control, 100, 200 and 300 mM (11.3, 311, 453 and 544 mg/L) respectively.

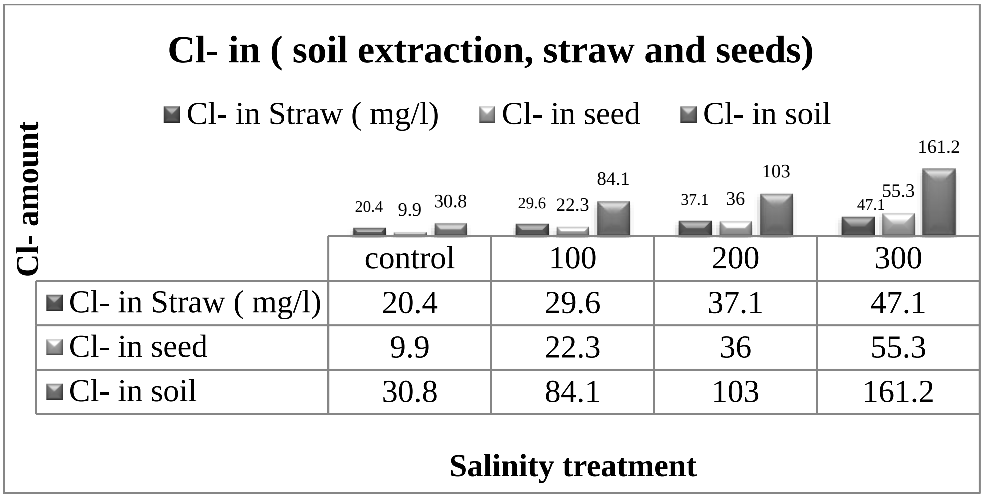
The Chloride ion concentration was increased significantly with increasing in salinity level, however, the Cl^- concentration in soil extraction significantly increased at control, 100, 200 and 300 mM (31, 84, 103 and 161 mg/L respectively). The same result in seeds and straw was significantly increased with increasing salinity levels. No significant interaction between barley landraces and salinity was observed.

Figure 10

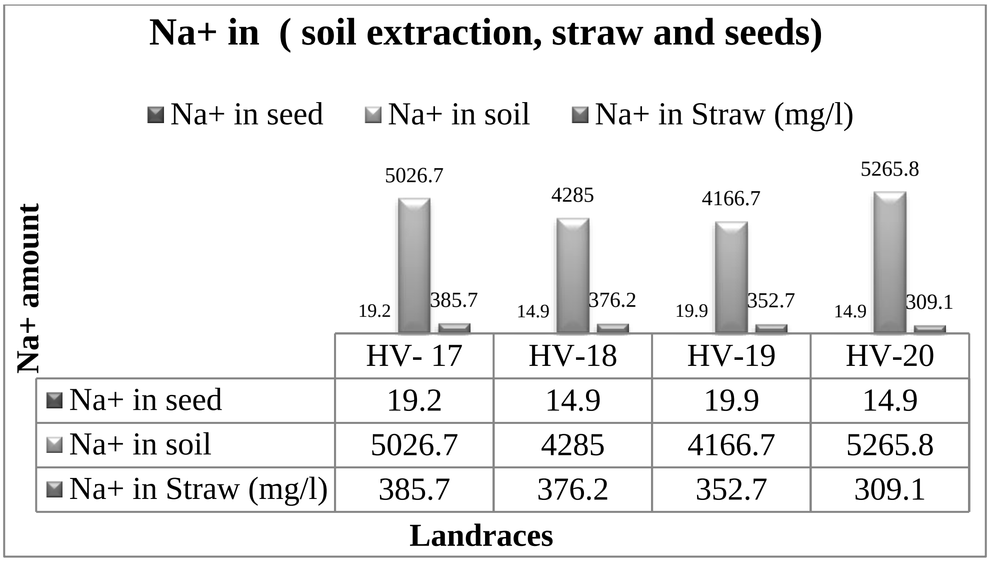
The effect of salinity treatments on Na+ and Cl- content in soil extraction, barley seeds and straw of four barley landraces.



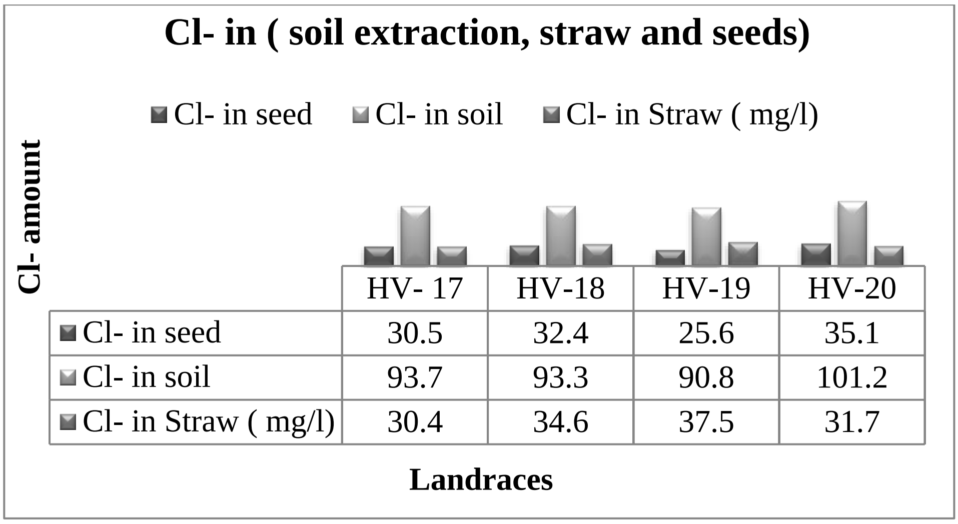
	control	100	200	300
Na+ in Straw (mg/l)	113.9	311.8	453.2	544.8
Na+ in seed	18.7	20.8	15	14.6
Na+ in soil	648.3	3933.3	6098.3	8064.2



	control	100	200	300
Cl- in Straw (mg/l)	20.4	29.6	37.1	47.1
Cl- in seed	9.9	22.3	36	55.3
Cl- in soil	30.8	84.1	103	161.2



	HV- 17	HV-18	HV-19	HV-20
Na+ in seed	19.2	14.9	19.9	14.9
Na+ in soil	5026.7	4285	4166.7	5265.8
Na+ in Straw (mg/l)	385.7	376.2	352.7	309.1



	HV- 17	HV-18	HV-19	HV-20
Cl- in seed	30.5	32.4	25.6	35.1
Cl- in soil	93.7	93.3	90.8	101.2
Cl- in Straw (mg/l)	30.4	34.6	37.5	31.7

Chapter Five

Discussion

5.1 Germination experiment

In our study we found a significant difference between barley landraces and NaCl concentration. The coleoptile and radical lengths were reduced significantly with increasing salinity concentration. The germination percent % was reduced significantly with increasing salinity concentration. Several researchers reported that seed germination reduced with increasing salinity concentration. Germination was reduced at the 300 mM NaCl. The ACSAD1430 the germination rate of this cultivar was greater than that of other cultivars [Othman et al., 2006]. On the other hand, Othman reported that water imbibition can begin seed germination, and any shortage of water can put seedlings under stress. Shokohifard et al., [1989] reported that salt stress harmed seed germination in two ways osmotically through decreased absorption or ionically by the buildup of Na and Cl, resulting in an imbalance in nutrient intake and toxicity effect. Further, Younis et al., [1991] reported that low moisture content under salinity stress led metabolism to stop or hinder specific processes in germination metabolic sequences. On the other hand, salt stress increased the intake of harmful toxic ions, which might affect the seeds enzymatic or hormonal activity during germination.

5.2 Effect of salinity levels on Chlorophyll content in barley landraces

Chlorophyll content reduced with increasing salt content but not significantly affected between barley landraces and salinity. In contrast, other researchers reported there were increasing in chlorophyll content of salt-tolerant plant-like barley. The finding may be because chloroplasts in stressed leaves rise. Moreover, chlorophyll content decreased due to salt stress in plants sensitive to salt stress such as tomato and lettuce [Yarsi et al., 2017]. Irrigation with use of high sodium concentration in water lead to accumulate the sodium ion in the leaves and increased in it and cause toxicity ion, and declines in photosynthetic activity result in lower growth, chlorophyll content and stomatal conductance, as well as, to a lesser extent through a reduce in photosystem II efficiency [Netondo, 2004]. In our experiment, samples were taken from plants in different stages that reached the production stage, however, the low chlorophyll content at higher salinity concentration could be due to lower photosynthesis and salt stress. The same result mention in research by [Ehsan et al., 2011] demonstrated that Na^+ and Cl^- exclusion are distinct processes in barley genotypes and various genotypes displayed varied combinations of the two mechanisms. High quantities of Sodium ion inhibited potassium and calcium absorption, as well stomatal conductance, which lowered photosynthesis. However, high Cl^- levels lowered photosynthetic capability owing to non-stomatal effects: chlorophyll breakdown.

5.3 The effect of salinity treatment on plant height and the number of tillers

The tillers number, spike length, plant length, spike number, biomass per plant and grain yield per plant were all reduced as the salt of sodium and chloride ion concentration increased and causing more damage in barley [Ahmad et al., 2003].

In this research, tillers number and plant height were decreased significantly with highest in salinity concentration. The reduction in tillers numbers is evidence of an adaptive device resulting from water stress. This reduction reduced the transpiration area and hence helps the plant to endure water stress [Saleh and Ismail, 2012].

The same result was demonstrated by Movafegh et al., [2012] in barley during this experiment increasing salinity level reduced in shoot and root length and growth.

5.4 The effect of NaCl treatment on seeds and straw yield in barley landraces

Salinity reduces the total water potential in the soil, limiting the amount of water available to plants. Salinity has an impact on plant physiology and on the production. As salt content rises, yield drops steadily until it reaches zero in the plant sensitive to salinity that cannot grow in saline habitats where salt concentration is more than ~100 mM NaCl [Dorota, 2008]. However, according to tolerance “Halophytes" are salt-tolerant plants. under high salt levels, the plant may grow and reproduce (> 400 mM NaCl) [Greenway and Munns, 1980].

Saline soil contains a high quantity of salts (NaCl) that contribute to the reduction in growth and grain yield in cereal crops (Schilling et al., 2013). Another research has worked in the Mediterranean area the result from this research, the possibility of securing high yields, with mean decreases of only 21% in barley and 25% in wheat when compared to the fully, fresh-water irrigated control [Hamdy et al., 2005].

In this research, the straw yield was reduced significantly when salinity concentration increased as follows as (478, 305, 283 and 250 kg/donum) respectively (control, 100, 200, 300 mM) but in the seed yield in control (338 kg/du), at 100 mM (238 kg/du) there was observed the best from both 200 mM (180 kg/du) and 300 mM (133kg/du).

5.5 The effect of salinity levels on EC for soil

In this research, the quantity of salt in soil is measured by electrical conductivity (EC) of the soil (salinity of soil), highly dependent on the level of soil salinity, it will also rise and fall with soil moisture. The result from this research increased significantly with increasing salinity levels.

5.6 Amount of Na^+ and Cl^- in (Soil extraction, seeds and straw) at different concentrations of salinity in barley landraces

In this research sodium and chloride ions was the major source for salinity; as the resulting, the Na^+ accumulation in soil extraction was increased gradually with increasing salinity levels as shown in (table 4.5). In the straw and seeds Na^+ accumulation was increased significantly with increasing salinity levels. Chloride ion concentration there was increased with increasing salinity level. In contrast, several studies demonstrated that under high salinity levels, some elements such as Na^+, Cl^-, K^+, and Ca^{+2} accumulated considerably in the plant, the chemical content of the soil and the PH affect nutrient uptake [Abdul, 2013].

Increase Sodium accumulation and Chloride may effect on plant enzymes and induce cell swelling, leading to decreased energy production and other physiological activities [Larcher, 1980] and accumulation of Chloride impairs hinders photosynthetic performance by inhibition the nitrate reductase activity [Xu et al., 2000].

Chapter Six

Conclusions and Recommendations

6.1 Conclusions

The primary goal of this study was to evaluate germination percentage, behavior of barley landraces under different water salinity levels, and select suitable barely that tolerate salinity.

1. In the germination experiment is coleoptile and radical lengths were reduced significantly with increasing NaCl concentration. Landraces HV-16, HV-17, HV-18, HV-19 and HV-20 were showed the highest germination percent% after 4 days, but after 6 days HV-8, HV-16, HV-17, HV-18 and HV-19 and HV-20 it highest germination percent%.
2. Chlorophyll content, length, Tillers number, Straw and seed weight, this agronomic trait was reduced affected with increasing salinity levels.
3. The straw and seeds yield were reduced with increasing NaCl levels in straw yield at (0, 100, 200 and 300 mM) were observed (478, 305, 283 and 250 Kg/du) respectively. But in seeds yield at 100 mM (238 kg/du) there was observed the best from both 200 mM (180 kg/du) and 300 mM (133 kg/du). As for landraces HV-19 and HV-17 was the best recorded in straw yield (375 and 358 kg/du), while in seed yield (247 and 237 kg/du) respectively.
4. Electrical conductivity (EC), Sodium and Chloride concentration was increased with increasing salinity levels.

6.2 Recommendations

1. Conducting an experiment similar to this experiment in several locations and years, and using the same salinity concentrations.
2. Using other barley landraces and measuring the same variables that were measured in this experiment
3. Conducting other experiments on the same landraces and other landraces and reaching the best landraces that tolerant the highest salinity concentration.

List of Abbreviations

Abbreviation	Meaning
µmol m^{-2} s^{-1}	Micromoleper second and square meter
$AgNO_3$	Silver nitrate
AMF	Arbuscular Mycorrhizal Fungi
AVP1	Arabidopsis Vascular Pyro-phosphatase
DW	Deionized water
EC	Electrical conductivity
FW	Fresh water
g/l	Gram/Litter
GDP	Gross Domestic Product
GW	Groundwater
HV	*Hordeum vulgare L.*
K_2CrO_4	Potassium chromate
LEA	Late Embryogensis Abundent
MCM/yr	Million Cubic Meters /Year
mM	Millimolar
mmhos/cm	MilliMhos /centimeter
mS/cm	MilliSiemens/centimeter.
No.	Number
NPK	Nitrogen, phosphors and Potassium
PEG	Polyethylene- glycol

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جـامعـــة النجاح الوطنية

كليـــة الدراســـات العليـــا

تأثير الري باستخدام المياه المالحة على انتاج الشعير

إعداد

شيماء جبر علي طيطي

إشراف

أ.د. حسان أبو قاعود

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قدمت هذه الرسالة استكمالا لمتطلبات الحصول على درجة الماجستير في الإنتاج النباتي، من كلية الدراسات العليا، في جامعة النجاح الوطنية، نابلس– فلسطين.

2022

تأثير الري باستخدام المياه المالحة على انتاج الشعير

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الملخص

المقدمة: يعتبر الشعير *(Hordeum vulgare L.)* من أكثر المحاصيل مقاومة للملوحة .يستخدم الشعير كعلف وغذاء للإنسان ، بسبب قدرته على النمو والإنتاج في ظروف الجفاف والملوحة .

الأهداف: يهدف هذا البحث إلى تقييم إنبات بذور الشعير وسلوك أصناف محلية من الشعير تحت مستويات ملوحة مختلفة.

الطريقة والمواد: اجريت هذه التجربه في كلية الزراعه النجاح في طولكرم. في تجربة الانبات، تم استخدام 20 صنف محلي من الشعير جمعت من مزارعين في مناطق مختلفة في الضفة الغربية، تم زراعة هذه البذور تحت اربعة تراكيز ملوحة مختلفة (0(ماء مقطر)، 100، 200 و 300 ملي مولار)، في هذه الدراسة. بالاعتماد على نتائج تجربة الإنبات تم اختيار أربعة أصناف محلية لزراعتها في التجربة الحقلية والتي أظهرت أعلى معدل انبات تحت معاملات الملوحة المختلفة (HV-17, HV-18, HV-19 and HV-20). وتم زراعة هذه الاصناف المحلية في موسم النمو لعام 2018\2019 في تربه رمليه طينيه. تم ري هذه الاصناف المحلية بمستويات ملوحة مختلفة (0(ماء عذب)، 100، 200 و 300 ملي مولار).

النتائج: أظهرت التجربة الحقلية أن محتوى الكلوروفيل ، أطوال النباتات و عدد التفرعات قلت بزيادة مستويات الملوحة.و كذلك انخفضت انتاجية محصول الشعير (الحبوب و القش) مع زيادة مستويات الملوحة, لوحظ ان انتاجيه

المحصول من القش عند تركيز 100 ، 200 و 300 ملي مولار كانت (305 ، 283 ، 250 كغم / دونم) على التوالي. بينما انتاجيه المحصول من الحبوب عند 100 ملي مولار (238 كغم / دونم) لوحظت انها الافضل من 200 ملي مولار و 300 ملي مولار (180 و133 كغم/ دونم) على التوالي، لايوجد فروق معنوية بين الاصناف البلدية كما لوحظ ان افضل قراءة لانتاجية الحبوب في الصنفين HV-19 و17 -HV (247 و237 كغم/دونم)على التوالي، بينما انتاجية المحصول من القش (358 و375 كغم/دونم)على التوالي. وازداد كل من التوصيل الكهربائي (EC)، تركيز الصوديوم والكلوريد مع زيادة مستويات الملوحة.

الخاتمة: هذه الدراسة توثق قدرة محصول الشعير على النمو تحت ظروف الملوحة. أصناف الشعير التالية ,HV-8, HV-16, HV-17, HV-18, HV-19 وHV-20 لهما اعلى نسبة انبات. الصنفانHV-17. HV-19 هما الأفضل في إنتاجية القش والحبوب.

الكلمات المفتاحية: الشعير*(Hordeum vulgare L.)*، المياه المالحة، الأصناف المحلية، تجربة الانبات، إنتاجية الحبوب.