RECLAMATION OF SALINE SOIL BY BIOLOGICAL METHODS

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DEDICATION

TO MY PARENTS

AND

MY WIFE

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SUMMARY

The main objective of this thesis was to carry out a study on the effect of soaking pea (Pisum Sativum L.) varieties , Meteor , Puget and Sprite , barley (Hordeum Vulgare L.) varieties , Gadmarker , Triumph , Golden Promise , Marko , Igri and Gerbel and Sugar beet (Beta Vulgare L.) varieties , Julia and Kelin Monseet with different inorganic salt solutions , extracts of Onion and Garlic , and phytohormones . Also included in the investigation was different lengths of dry periods after soaking. Forty nine experiments were carried out through chapters 2 , 3 , 4 , and 5 in a growth room , some of them were grown for fourteen days . All experiments were carried out under saline conditions to investigate : -
A - The possibility of using economic crops to remove excessive salts from the soil as a biological approach .
B - To assess which is more tolerant to salt , the germination or the growth stage . C - To assess whether there is any effect when using a soaking and dry period or not .
D - To decide whether it is possible to increase the salt tolerance of field crops .

In chapter one a brief account is given on salts and salinity problems. Firstly the source, formation , origin and type of salts found in Iraq is given. Secondly salinity

problems and their affect on plant growth are discussed . Thirdly the general aim of agricultural reclamation and important methods of salt reclamation and their problems are discussed. Fourthly , reclamation of saline soil by biological methods and lastly the objectives of the thesis are discussed .

In chapter two , ten experiments were carried out to study the effect of presoaking of barley varieties (Golden Promise , Marko and Gerbel) with calcium salts ($CaCl_2$, $CaBr_2$, $Ca(CH_3COO)_2$, $Ca(NO_3)_2$ and $CaSO_4$) and different dry periods on germination and growth under saline conditions. Pretreatment with the calcium salts showed significant effects in increasing germination percentage of barley varieties in experiments 2 , 3 , 4 and 5 . The optimum results for calcium salts and dry period appeared in experiments 6 , 7 , and 8 and were as follows : -

A- For variety Golden Promise a 3 % $Ca(CH_3COO)_2$ pretreatment with 2 and 3 weeks dry periods . B - For variety Marko a 3 % $CaCl_2$ with 2 and 3 weeks dry periods . C - For variety Gerbel a 3 % $Ca(CH_3COO)_2$ with a 2 weeks dry period.

Water alone used as a pretreatment , also showed a significant effect for all dry periods particularly with Golden Promise and Marko with 2 and 3 weeks dry periods . There are some developments in the case of barley varieties with regard to phenologic observations in the pot experiments (NO. 10) .

Marko variety appeared to have higher germination and fresh weight than the other varieties . In addition it showed a response by absorbing more Na than the others. The work in chapter three was a continuation of the discoveris made in chapter two on the significant effect of calcium salts pretreatment and dry period on germination. Fourteen experiments were carried out on pea varieties Meteor , Puget and Sprite . 1 % $Ca(NO_3)_2$ and 0.18 % $CaSO_4$ gave significant increases in germination percentage of the variety Meteor . Puget and Sprite, were responsive only to $CaBr_2$ and $CaSO_4$ at concentrations of 1 % an 0.18 % respectively. Also 0.14 % $CaSO_4$ gave a significant effect , but lower concentrations did not show any effect. All pea varieties did not show any response in terms of dry periods . In a growth experiment , pea varieties showed a slight response in terms of both phenological observations and mineral element contents .

In chapter four, twenty experiments were carried out in 4 parts , which can be broken down as follows : Part A - Growth regulators. Part B - Calcium peroxide and hydrogen peroxide. Part C - Onion and Garlic extract. All experiments , in parts A , B , and C concentrated on the germination stage of barley varieties Gadmarker, Triumph and Igri. Part D - Growth stage experiment . The findings can be summarized as follows : -

Part A - Gibberellic acid at 100 ppm with 17h dry period showed a significant effect for all varieties .

Part B - Calcium peroxide at a concentration of 0.1 g and 1 day dry period gave a significant effect for Gadmarker , and for Triumph and Igri with a 2 week dry period .

Part C - Garlic and Onion experiments did not show any effect.

Part D - Growth experiment. The results showed all barley varieties responded with calcium peroxide and gibberellic acid pretreatments with regard to seedling development and increased sodium absorption with the gibberellic acid treatment .

In chapter five , five experiments were carried out to study the effect of different pretreatment materials (CaO_2 , $Ca(CH_3COO)_2$, H_2O_2 , NaCl , 2.4.D and $[Co(NH_3)_5Cl]Cl_2$ and different dry periods on the germination stage of sugar beet varieties, Julia and Klein Monseet . High germination percentages were recorded in experiment (No.3) with a 17h dry period. Julia was highly responsive to CaO_2 and H_2O_2 throughout all the experiments tested , but Klein Monseet showed a response with CaO_2 only under 2 weeks dry period . Both varieties , Julia and Klein Monseet responded to the complex CO salt $[Co(NH_3)_5Cl]Cl_2$.

In chapter six , twenty plants growing in Central and South Iraq were received from Iraq for analysis in an attempt to identify whether any of them showed promise for biological land reclamation . From the analysis results the following plants appeared to love a high degree of tolerance and a high salt content :-

Gogallah , Qasab , Righailah , Lizzage and Rwaitah. When advantage is taken of the ability of these plant species to remove salts from soil , it should be theoretically possible to remove six times the amount of salt compared with some herb plants and more than two times compared with commerical plants . The above results were under natural germination conditions , and more than this should be removed under cultivation and using the new technique discussed in this thesis presoaking the seeds followed by a dry period which showed substantial beneficial effects in the investigation carried out as part of this thesis .

SUGGESTION

A PROPOSED SCHEME FOR THE RECLAMATION OF SALINE SOILS USING CHEAP SOURCES OF HEAT

The general way to reclaim land at present is to prevent the land from getting saline by washing out the salts , by lowering the ground water , and by carrying off the water . For more details see chapter one.

There are other possibilities like a biological approach as discussed in this thesis . However, another possibility comes to mind which I would like to suggest , which is good and cheap .

Suggested method : Firstly , dig a well in the land which is to be reclaimed. Water should then be pulled from the well to a glasshouse where it is spread on special sheet trays made of metal to absorb high temperatures . Secondly , the water is then evaporated off using heat sources which are available at a cheap price. The precipitated salts are removed either discarded or collected for sale . Meanwhile the steam could be condensed by a condenser as distilled water and pumped to a drip irrigation system (Fig. 1) which is used to irrigate fields which have been already established for the same purpose (contain either holophytes or high tolerance plants) . It is important to determine optimum soaking and dry period treatments for the plants used under these circumstances as discovered in this thesis .

Drip or trickle irrigation should be used because it provides small controlled amounts of irrigation water at frequent intervals to the root systems of plants. In addition to weed control and water 50 to 90 % savings are claimed by the Manufacturers. Also the yields of most , if not all of the vegetable crops should be increased. The water use efficiency with drip irrigation is nearly twice as high as with other methods of water application. Daily irrigation sprinkling on watermelon and round gourd decreased yields from 20 to 32 % when compared with drip irrigation (Singh and Panjab Singh 1978 ; Bernstein and Francois 1973).

Sources of cheap heat :-

1) Solar energy. The climate of Iraq is sub- tropical, continental , arid climate with dry hot summers. The greater part of the country has a desert climate . The highest recorded temperature in Baghdad is 123 °F as observed by Buringh (1960) , Table 1 demonstrates temperatures found in Iraq and Table 2 demonstrates soil temperatures near Baghdad. Evaporation also rises due to the high temperature (see Table 3). Day length is also an important factor , the maximum is 14h and the minimum nearly 12h (see page xvii). However , if the temperature is about 50 °C on the surface outside the glasshouse so , it is reasonable to assume it

can be double that inside the glasshouse and higher if lenses are used.

2) Using heat energy which is produced from the burning of oilfield gases . Most of the oilfields flame spread in the central and south of Iraq where the saline soils are present.

3) Using oil products like : natural gas , black and white oil etc. as a fuel to evaporate the water in the glass - house .

REFERANCES :

1) Bernstein , L. and Francois, L. E. (1973). Comparisons of drip , furrow , and sprinkler irrigation . Soil Sci. 115 , 73 86 .

2) Buringh , P. (1960) . Soils and soil conditions in Iraq . pp. 45 - 46 .

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TABLE 1 : Temperature in two cities in Iraq

City	Temperature °F												
	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.	Year
Baghdad													
Mean	49	53	59	72	83	91	94	93	87	77	64	52	73
Mean Max.	60	64	71	84	97	105	110	110	103	92	77	64	86
Mean Min.	40	42	48	58	68	73	77	76	68	62	52	42	59
Highest Max.	74	86	90	104	111	116	121	120	116	107	94	79	121
Lowest Min.	18	27	28	38	51	58	62	65	51	39	35	20	18
Basra													
Mean	54	58	65	74	86	91	93	92	87	79	68	57	75
Mean Max.	64	68	75	85	96	100	103	106	102	94	80	69	87
Mean Min.	46	48	55	63	76	81	81	78	72	64	57	48	64
Highest Max.	81	87	95	105	112	115	117	120	113	110	98	85	120
Lowest Min.	24	36	39	52	63	71	73	68	58	46	38	29	24

All temperature are measured in the shadow in an open field at a height of 2 metres above ground level.

Data from Buringh (1960) .

TABLE 2 : Soil temperature in °C near Baghdad .

Time	On the surface	Dry soil at a depth of 1 cm.	Wet soil at a depth of 1 cm.
11	50.0	48.3	26.5
12	52.1	49.5	27.2
13	54.2	50.5	29.0
14	54.2	50.8	29.2
15	52.0	50.1	29.4
16	50.6	48.0	30.0
17	46.5	46.0	31.0
18	41.0	43.5	31.2
19	38.3	40.3	31.0

Data from Buringh (1960)

TABLE 3 : Monthly and annual evaporation (in mm) at Abu Dibbs lake 100 Km^2 south Baghdad . And day length period .

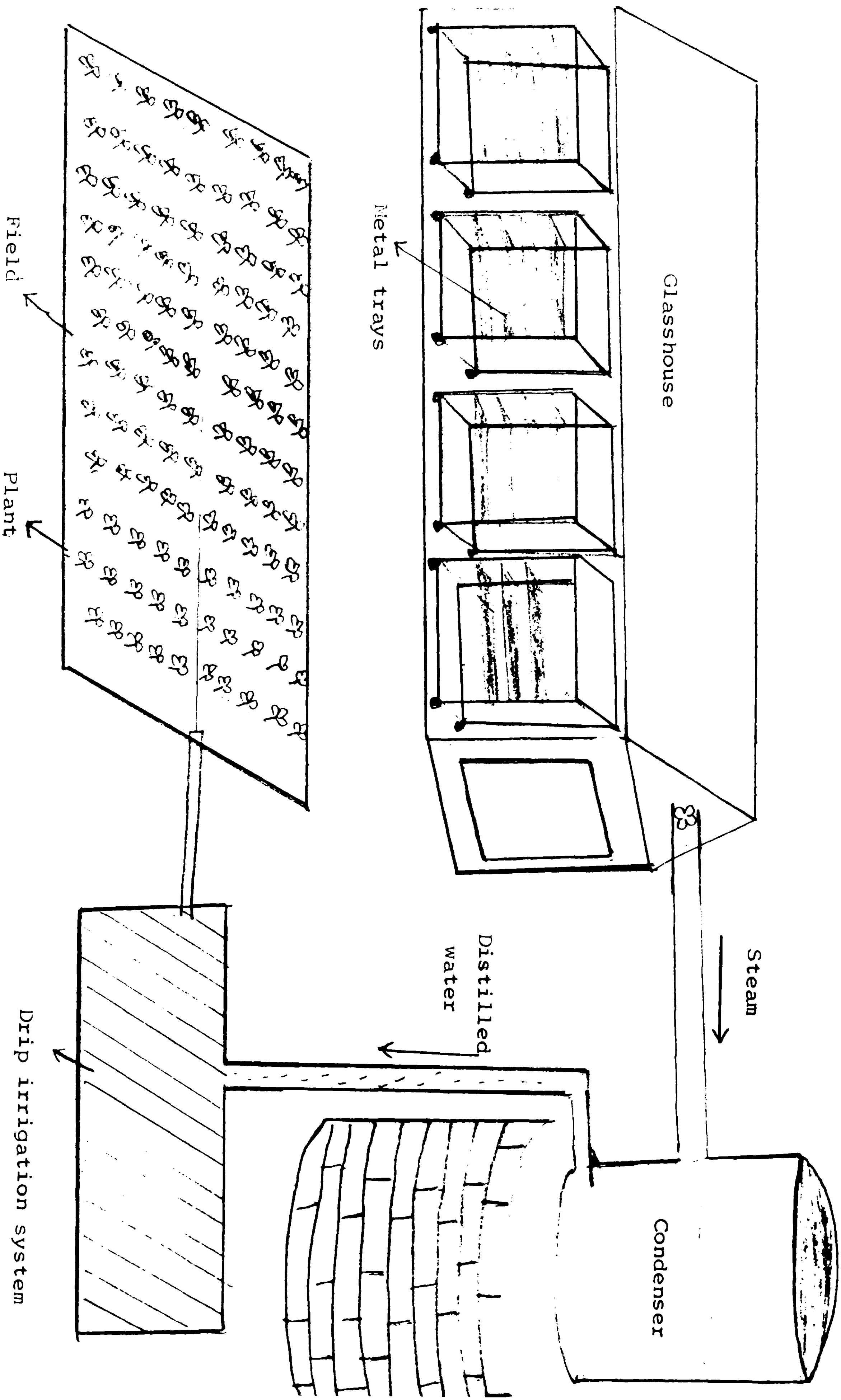
Months	Evaporation (mm)	Percentage
January	103	4.8
February	92	4.3
March	165	7.6
April	130	6.0
May	142	6.5
June	249	11.5
July	318	14.7
August	304	14.0
September	272	12.5
October	93	4.2
November	177	8.2
December	125	5.7
Annual	2.170	100 %

Data from Buringh (1960)

NOTE: The range of day time hours for the months as follows :

January and February		11.0
March and April		12.0
May and June		13.0
July and August		14.0
September = October		13.5
November and December		13.0

Fig. - 1


Glasshouse
Metal trays
Field
Plant
Steam
Distilled water
Condenser
Drip irrigation system

A list of abbreviation for names used in this thesis :

GA	Gibberellic acid
NAA	α - naphthalene acetic acid
IAA	Indole - 3 - acetic acid
2.4 - D	2,4 - dichlorophenoxyacetic acid
S.S	Salt solution
d.p	Dry period
E.S.P	Exchangable sodium percentage
V	Variety
h	Hour
m	Meter
ft	Foot
Km^2	Square kilometer
No	Number
mg	Milligram
ml	Milliliter
cm	Centimetre
ppm	Parts per million

CHAPTER ONE

INTRODUCTION

1.1 SOURCES OF THE SALTS

The source of the salts in natural saline soils is usually the ground-water which is enriched with salts from two sources. Part, sometimes all, is derived from the weathering of rocks in the upper reaches of the river and part is sometimes derived from salt deposits laid down in early geological periods in strata through which the ground-water moves. Saline soils have also been produced artifically by faulty irrigation. Irrigation always involves putting salts on the land as well as water.

An important factor in the transport of the salt from the upper to the lower plain in Iraq is the river. There are two rivers which pass from North to South. One is called the Tigris and the other the Euphrates. Where they pass through various rocks they pick up salts

1.2 SALT FORMATION FACTORS

The formation of salt in the soil depends upon many factors :- arid climate, intensive sunshine, dry wind, low rainfall, high evaporation, the texture of the soil, and poor drainage. All these factors influence soluble salt accumulation in the surface of soils whenever the ground water comes within a few feet of the surface. Also some soils are covered with an efflorescence, or salt crust in humid regions where swamp, marsh or other ill-drained soil is found.

1.3 ORIGIN OF SALT PRESENT IN THE SOILS OF IRAQ

Salts present in the soils of Iraq have different origins :-

A. Salts from the ground water. Most of the ground water is saline even strongly saline. In Southern Iraq ground water depth varies from 7ft - 14ft (2.1m - 4.2m) and sometimes even less.

B. Salts from the sea water contribute to soil salinity in the Southern-most part of Iraq where soils consist of sea deposits or where they are regularly flooded by sea water.

C. Salts from irrigation water. Irrigation waters contribute greatly to the salinization of soils. During irrigation, in which part of the land is irrigated and part is left fallow, more salt is brought in and salinization of the irrigated land becomes extremely important particularly, when drainage is poor. So, along with the progress of irrigation, the problem of salinity arises.

D. By using fertilizer. Farmers in Iraq unaware of soil husbandry problems especially before the 1970's either used too much fertilizer or less than usual.

E. Transported by winds. Crystalline salts can be transported by wind action from one area to another. These salts are mostly deposited on neighbouring land which is already saline.

1.4 TYPE OF SALTS

The most common salts found in Iraq are :

A, SALINE SOILS

Saline soil, a non alkali soil that contains soluble salts in such quantities that they interfere with the growth of most crop plants. The conductivity of the saturation extract is greater than 4 millimhos per-centimeter (at $25^{o}C$) , the exchangeable - sodium-percentage is less than 15% and the pH of the saturated soil is usually less than 8.5 . Saline soils are those which contain sufficient soluble salts to adversely affect growth. The humus is low because the natural vegetation cannot make much annual growth. It normally shows no change of structure down the profile.

Saline soils may contain over 100 tons per acre of salts in the top four feet of soil. The salts may constitute over 1 percent by weight of the soil. (Russell, 1961). This soil displays the presence of a white crust of salt on the surface and is generally flocculated. The permeability is equal or greater than normal soil. Most evidence indicates that accumulations of neutral salts in the substrate inhibit plant growth primarily as a consequence of the increase in osmotic pressure of the soil solution and the accompanying decrease in the physiological availability of water.

The ions which may accumulate in saline soils are :

Na^{+}, Ca^{++}, Mg^{++}, K^{+}, Cl^{-}, SO_4^{--}, HCO_3^{-} .

B, ALKALI SOILS

Alkali soil - A soil that contains sufficient exchangeable sodium to interfere with the growth of most crop plants, either with or without appreciable quantities of soluble salts.

For an alkali soil the exchangeable sodium percentage (E.S.P.) is higher than 15% , the pH of the saturated soil is higher than pH 8.5 , and the electrical conductivity of the saturation extract is less than 4 mmhos./cm. at $25^{\circ}C$.

The alkali soils are generally dark brown or black coloured as there is a dispersion of organic matter, which is dissolved by sodium carbonate through the upper part of the soil forming a dark coating on the soil particles and structural elements. The fine clay colloids are dispersed too and they move downwards and accumulate in the subsoil. Real black alkali soils have not been observed in Iraq.

High alkalinity and low salt content lead to the clay and organic matter particles becoming deflocculated and water unstable. The resulting, soil structure has smooth surfaces, very hard dark coloured, prismatic units. The soil is plastic and sticky when wet and forms hard compact clods when dry,

C, NON SALINE - ALKALI SOIL

This soil is different from alkali soil because it does not contain appreciable quantities of soluble salts. It contains sufficient exchangeable sodium to interfere with the growth of most crop plants. The exchangeable sodium percentage is more than 15%, the conductivity of the saturation extract is less than 4 mmhos per cm. and the pH of the saturated soil media usually ranges between 8.5 and 10 .

D, SABAKH SOILS

This is a local name used by Iraqi farmers for soils which are recognized by the high percentage of deliquescent salts and magnesium sulphate in the always moist surface layers which have a dark colour. These soils are common in Central and Southern Iraq where the ground water is at a low depth.

Sabakh soils occur in irregular patterns, generally in silty or loamy textured material in areas where the surface is still in intimate contact with the ground water by capillary action , at least during the greater part of the year. These soils are common in the silty irrigation deposits along old and present-day irrigation canals and ditches particularly in uncultivated land . Buringh , (1960) divided Sabakh soils into three important layers:

a. An upper layer of about 50 cm; consisting of dark brown to brown coloured material , which is typical

Sabakh with a high calcium chloride and magnesium chloride content. The upper layer is usually somewhat darker than the underlying layer.

b. A middle layer of about 60 cm. which shows a white salt efflorescence on the profile wall after a few days. This salt is mainly sodium chloride.

c. A lower layer which is always wet (full capillary zone) and which grades into the soil below the ground water level.

The dark brown colour of the Sabakh soils is related to a specific depth of the ground water at least for the greater part of the year. The colour is light brown or dark brown in areas where this relationship only lasts for a part of the year and the content of deliquescent salts is less. Some of these lighter coloured spots have sometimes disappeared at the end of the summer and they are covered by a thin dust layer when dry. When the rains start in November strips and spots appear again when at once, a very large area consists of Sabakh soils. The salts are leached from the surface layer with increasing rainfall, so in spring the areas of Sabakh soils seem much smaller. It is very easy to see the wet surface layers during the morning in the middle and south of Iraq and in any dry hot country. Salts are easily washed from Sabakh soils but much water is needed for leaching. There has not been much work carried out on Sabakh soil, so more study is clearly needed on this soil type .

The upper layer is the most charcteristic part of a Sabakh soil (Fig. 1) . This layer has a brittle crust of nearly 2 mm , with bubbles of size 1 to 4 cm in diameter. There is open space under the bubbles the size of which is 0.5 to 1 cm in depth. The crust is greyish in colour as there are many salt crystals present. The next layer consists of a dark brown silty loam, about 2 cm. in depth.

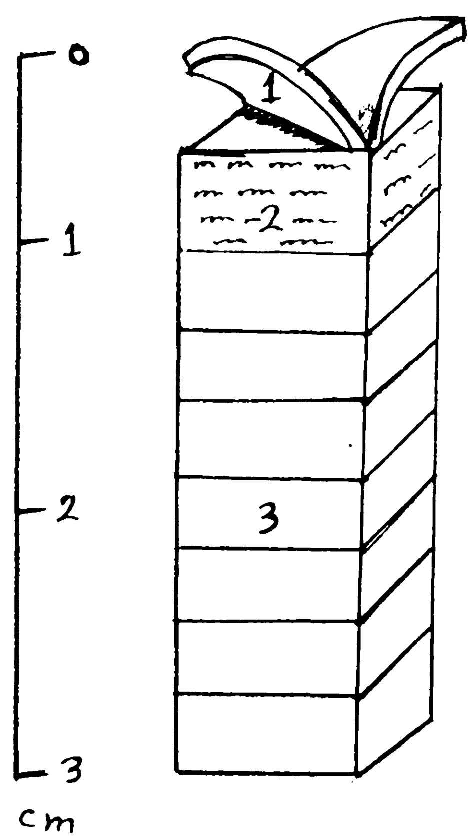


Fig. - 1 -
The upper section of a Sabakh soil. 1. bubble; 2. greyish coloured soil with abundant crystals of sodium sulphate ; 3. Dark brown layer with a platy structure.

E, GYPSUM SOILS

Gypsum is a salt easy to find in many Iraq soils, it does not influence plant growth because its solubility is very low in water. So the osmotic pressure of the solution does not increase above 0.5 atmospheres. When NaCl and $MgCl_2$ are present in the solution the solubility of gypsum is increased. Gypsum is present in Iraq as :

1- Gypsum, which is hydrated Calcium sulphate ($CaSO_4 . 2H_2O$)

2- Anhydrite, which is anhydrous sulphate of lime ($CaSO_4$)

3- Alabaster, which is a fine grained, light coloured, compact, non-crystalline form of gypsum.

4- Secondary or detrital which is reprecipitated gypsum.

The presence of gypsum in saline soils prevents these soils from becoming alkali soils.

Although it is technically possible to reclaim most saline- alkali and alkali soils, it will not always be economic. In some countries alkali soils are successfully reclaimed by adding gypsum or sulphur and by washing and efficient drainage.

1.5 SALINITY

1.5.1 SALINITY PROBLEMS

Salinity is a serious threat to plant growth on irrigated land. It is an obvious factor limiting plant growth. Therefore it was decided to study this effect more closely .

Salinity effects on plants may vary depending on the stage of their development. Sensitivity to salt varies depending on the stage of growth of the crop

The presence of excessive concentrations of soluble salts in the root area of plants can have two types of effect on the growing plant. Specific effects due to particular ions they contain being harmful to the crop and general effects due to them raising the osmotic pressure of the solution around the roots of the crop. Hayward (1943) for instance confirmed that an increase in the osmotic pressure of saline soil solution tends to restrict the uptake of water by plant roots.

All plants are subject to this influence although sensitivity to this effect various widely with plant species. Plants also absorb the constituent ions of the saline solution to varying degrees. This may result in some cases in toxic accumulations of a particular ion or in decreased absorption of some essential nutrient.

Recently much attention has been given to the problem of salinity as one of the major external factors which effect mineral metabolism. A number of investigators (Black, 1956; Greenway, 1962; Kaddah and Ghowail, 1964; Long, 1943; Ratner, 1935) have demonstrated that nutrient uptake by certain plant species is curtailed by salinization. On the other hand, under certain experimental conditions salinization results in a promotion rather than an inhibition of nutrient uptake (Asana and Kale, 1965; Francois and Bernstein, 1964; Mehrotra, 1971; Cavazza, 1968; Chapman, 1968; Cointepas, 1968; Lopez, 1968. The general effects on flat ground of a high salt content in the soil is to give a dwarfed, stunted plant. A reduction in yield of the crop can be due to salts without salt damage being apparent to the farmer. When the salt content becomes higher the stunting becomes more noticeable, the leaves of the plant become dull coloured and often bluish green and they become coated with a waxy deposit.

1.5.2 SALINITY EFFECTING AGRICULTURE IN IRAQ

Iraq has an area of 112.000.000 acres (453.000 Km^2). The prevailing texture of the soils is silty clay loam or silty clay and is in general calcareous. Iraq is by nature an agricultural country with a year-round sunny climate, two great rivers (Tigris and Euphrates), an abundance of workers and money. These treasures are seldom found in such favourable proporations as in the Mesopotamia valley. So there is the foundation for an agricultural economy based on resources that can support the Iraqi to a high standard of living. Unfortunately inspite of these good conditions Iraq is suffering from poor progress in agriculture due to the wrong use of these resources. Uneducated farmers along with the progress of irrigation and the improper use of irrigation and fertilizers, leads to the problem of salinity, particularly in Central and Southern Iraq. Up to 1980 more than 25% of the cultivated land has been abandoned and yields, on other land, have declined between 20% and 50% as a result of salinization (Al-Layla, 1978). The general salinization map of Iraq, (see Fig.2.) indicates the areas in which salinization is a real problem in the soil. Small parts of the river (levees) and estuary (levees) are free from salinization. These areas are too small to indicate in Fig. 2. Alkalinization occurs locally, mainly in the depression areas (Buringh, 1960). Most of the soils have become saline or alkaline due to continuous accumulation of salt from irrigation water caused by the lack of drainage. Reclamation and drainage are the main hopes for restoring these lands to their once fertile and productive state, thus improving production and increasing yield and thereby developing the economy of the country.

The concentration of salts in both rivers has increased with the Euphrates averaging - 800 mg/L, and the Tigris - 500 mg/L.

Increased salinity of the irrigation water leads to reclamation by leaching the salts from the soil. Unfortunately the drainage water is discharged to the rivers , and in this way there is a real problem with regard to river water quality. The main control is to collect drainage water and discharge it in the South, in the special canals to the sea by the Arabic Gulf. This way will improve the river water quality and more care should be taken to demonstrate this on farms to educate the farmers and show them the benefits of the proper use of fertilizers and good irrigation practice to obtain maximum benefit from the use of land and water resources.

1.5.3 HOW SALINE & ALKALI SOILS AFFECT PLANT GROWTH

Saline soil effects plant growth in two distinct ways:

(a) The physiological availability of water to the plant is decreased when the osmotic pressure of the solution increases.

(b) The concertrated soil solution may be conducive to the accumulation of toxic quantities of various ions within the plant. Salt-affected plants usually appear normal, although they are stunted and may have darker green leaves which are sometimes thicker and are more succulent. The plant growth is generally stunted by salinity effects. Particularly in high concentration both the growth rate and ultimate size of most plant species progressively decrease (SHARPLES and Johnston, 1977). Alkali soil affects plant growth in three distinct ways :

(a) The relatively high percentage of adsorbed alkali cations on the exchange complex of these soils may effectively depress the availability of calcium and magnesium.

(b) The activity of the hydroxyl ion may be sufficently high to be toxic to the plant.

(c) The accumulation of adsorbed Na on the exchange complex may have a dispersive effect on the soil and thereby bring about a puddled condition which may seriously curtail permeability to water and air.

1.6 RECLAMATION

1.6.1 GENERAL AIM OF AGRICULTURE RECLAMATION

Reclamation of agriculture land includes the preparation of the land for cultivation or for receiving irrigation water efficiently and removal of excess salts from the root zone and below resulting in the restoration of the natural distribution of salts in the soil profile which was disturbed by irrigation, and subsequent agricultural operations. Of course in the begining it is necessary to remove all scrub jungle and bushes, etc. if present on the land and level the fields to allow irrigation water to spread only over the area. The main point in reclaiming saline soils is to insure good drainage. Soil drainage is most important and the salts have to be washed out by excess irrigation water. Irrigation, drainage and reclamation must be regarded as complementary processes.

1.6.2 IMPORTANT METHODS OF SALT RECLAMATION

Methods of reclamation of saline & alkali soil:

1- Physical amelioration

Several method have been used to improve saline & alkali soils e.g mechanical treatment, deep ploughing, subsoiling , sanding , and profile inversion . The first three treatments are to increase permeability by mixing fine and course textured layers and to obtain more uniform soil by breaking up impermeable layers and by incorporating sand into a fine textured soil. Profile inversion results in the covering of an undesirable soil layer with good material from a lower layer.

2- Biological amelioration

Living and dead organic matter has a good beneficial effect on reclamation of saline and alkali soil by improving soil permeability, and by releasing carbon dioxide during respiration and decomposition. Also the shadow effect of plants reduces evaporation from the soil surface and in an indirect way prevents salt movement upward to the surface. Also the manure addition improves surface soil permeability in saline and alkali soil, and increases carbon dioxide when the manure decomposes and it proves to be a benefit to calcareous alkali soils.

In addition to that mentioned above there is another kind of biological amelioration by using the plants (Halophytes) themselves to reduce the salts present (see 1.9. for more detials) .

3- Chemical amelioration

Chemical amendments are used to neutralise the soil reaction , to react with free soda and to replace exchangeable sodium by calcium. Gypsum is the most common amendment for alkali soil reclamation. Calcium chloride is highly soluble and would be a satisfactory soil amendment, especially when added to the irrigation water. Limestone, the solubility of which is the alkaline medium is very low, is not effective for reclamation of alkali soils when used alone but when added with large amount of manure, it has some beneficial effect, because calcium bicarbonate is formed from manure decomposition and releases carbon dioxide to react with the lime.

1.6.3 RECLAMATION OF SALINE SOIL IN IRAQ & ITS PROBLEMS

General experience has confirmed the effectiveness of drainage and leaching as suitable ways to reclaim saline soil everywhere. It is planned as far as possible to keep the upper 5 feet of soil free of excess salt. Where it is not easy to maintain the water table below 5 feet, another approach must be taken to prevent the upward movement of salt into the root zone. Sometimes this can be done by using over irrigation. In the meantime attempts should be made to prevent the water table rising more than 3 feet below the surface.

A good time for effective leaching of saline soil under the conditions found in the middle east is in the autumn or winter when the ground water level is deep and the soil moisture is low. General points for the reclamation of saline soil are :

1. Halophyte shrubs which cover the saline soil should be cleared before leaching.
2. The soil should be surveyed to study soil texture and soil structure.
3. The plans should be include the use of heavy machines.
4. A drainage canal net work should be constructed .
5. An irrigation canal net work should be constructed .
6. The area should be ploughed to depth .
7. The land should be divided into leaching plots and separated from the others by ridges. The size of

the plots will depend on many things such as: soil permeability , size of field, distance between drainage canals , structure and texture of the soil etc.

8. The land should be flooded by leaching water.

The leaching should begin on the lower areas before the higher areas and the water should be added gradually not all at once . For removal of salt from the field , each water application should be given time to soak in before the next is applied. During the leaching the amounts of salts washed out must be checked .

The methods which are mentioned above need workers , abundant water , heavy investment and time. As well as leaching out the soluble salts from the root zone , some other factors for correcting saline soils have to be taken into account .

1. Evaporation losses should be reduced
2. The water table should be lowered
3. Amendments should be added to the soil
4. Salt tolerant plants should be used like :

   Low tolerance : Beans, Pear, Apple, Apricot, Peach, Lemon .

   Medium tolerance: Wheat, Rice, Corn, Sunflower, Pomegranate, Fig, Olive, Grape.

High tolerance: Barley, Sugarbeet, Cotton, Beet, Spinach, Date palms .

After the washing out of the salts has taken place the physical and chemical conditions of the soils will have changed. This often results in a decreasing soil permeability and in a lower gypsum and plant nutrient content. Therefore, most soils will require the application of chemical fertilizers, particularly phosphate and nitrogen. Using irrigation sometimes results in the surface soil becoming silted so, water penetration becomes very difficult. This can partly be avoided by ploughing.

Reclamation projects will never become a success and there will be no increase in crop production if the farmer does not know how to make use of and to maintain the higher productivity of the soil. Demonstration farms will prove very effective in educating the farmers and showing them how maintain land reclamation from resalinty , fertilizers used and good irrigation practice. To obtain maximum benefit from the use of reclaimed land the problems of irrigation, drainage , control of river water quality, and education of farmers must be tackled as a whole and not separately . Lastly all farm management practices have to be improved.

1.7 RECLAMATION OF NON-SALINE ALKALI SOILS

Different chemical compounds have been tried for the improvement of this type of soil like gypsum , limestone, calcium chloride, sulphuric acid etc.)
The following chemical equations are given as examples for the improvement of alkalinity :

$$\text{Gypsum} + Na_2CO_3 \rightleftharpoons CaCO_3 + Na_2SO_4$$

Elementary sulphur: Microbial Oxidation : $2S + 3O_2 \rightarrow 2SO_3$

$$SO_3 + H_2O = H_2SO_4$$

$$H_2SO_4 + 2CaCO_3 \leftrightarrows CaSO_4 + Ca(HCO_3)_2$$

$$Na_2CO_3 + CaSO_4 \rightleftharpoons CaCO_3 + Na_2SO_4$$

The amount of the above chemical substances which are used for soil improvement depends on the quantity of exchangeable sodium to be removed. The comparative effectiveness of the different amendments used for soil improvement is usually assessed on the basis of improvements in the experimental crop yield, like the degree of desalinisation of the soil profile and the degree of de-alkalisation of the soil. Reclamation of alkali soil is as follows :

1) Add suitable amendements to the soil slowly step by step when ploughing the soil .

2) Flood the soil provided an adequate drainage system exists to allow the amendment to wash down slowly and replace the exchangable sodium percentage (E.S.P.)

3) Increase the permeability by deep ploughing .

4) Establish a crop on the land for the plant roots will continue the task of increasing permibility of the subsoil . Rice is an ideal crop. The first crop to be taken is ploughed in as a green manure. Its decom-position will also slowly set free plant nutrients such as P, Fe, Zn, Mn which are very unavailable in alkali soil.

5) A green crop rotation should be used to build up the structure of soil and bring about its improvement.

1.8 RECLAMATION OF SALINE SOIL BY BIOLOGICAL METHODS

Salinity is a serious threat to crop production on the irrigation lands. Reclaiming these soils is very important. The present method of reclaiming saline soils in the arid regions consists of flooding and leaching the top soil. This method has many problems mentioned earliar (1.6.3.). So it seems highly desirable for all arid regions to consider the method of reclaiming saline soils by biological reduction of salts wherever possible.

A number of investigators tried soaking the seeds with many materials, in different conditions and used medium salt levels to increase plant salt tolerance or drought tolerance. Some of them used a dry period after soaking and others used temperature as follows-

The effect of repeated soaking and drying of seeds on an increased consecutive drought and salt tolerance was reported in the literature as early as the late eighties of the previous century as cited in Shannon, and Francois (1977). Russian investigators claimed an increase in yield, as well as in drought and salt tolerance of various crop plants following an early soaking & drying of the seedlings.

The positive effect of soaking and subsequent drying of seeds before sowing on the drought resistance of the emerging plants has been reported by many investigators. Martyanova , (1960) confirmed the effectiveness of this method on seeds hardened by soaking in dilute boric acid solution. Martyanova , Gabanova and Zhurikin , (1962) claimed that alternate soaking and drying of the seeds before planting doubled the yield under drought conditions. Cynaikov and Tocctokhina, (1970) studied the influence of pregrowing seeds treated with sodium pyrophosphate alone and with boron , Benzoamidezol alone and with boron, on the production of sugarbeet in the laboratory and field. They found higher production, long size, higher fixation of N and more resistence to drought. Woodruff, (1975) reported that the grain yield increase was attributable to presowing drought hardening. Parija and Pillay, (1944) confirmed pre-sowing treatment induces resistance against drought in summer paddy rice.

This technique was applied to increase salt tolerance by pretreating seeds in salt solution (Chaudhri and Wiebe , 1964 , 1968) phytohormones (Togawa Bonner, 1957. Sankhla and Mathur, 1968. Darra, Jain and Singh, 1969. Dave and Gaur, 1970. Singh and Darra, 1971 . Darra, Seth, Singh and Mendiratta, 1973). Pre-sowing soaking treatments or hardening of seeds with water or chemical salts induces good germination and development (Chaudhri and Wiebe , 1968 . Idris and Aslam, 1975) and more active coleoptile growth (Salim and Todd, 1968) . Complex Co and Cr salts pretreatments promoted the germination of sugar beet roots and seeds (Petérfi and Brugovitzky , 1961) and good germination by the effect of sodium nitrate and sodium chloride as presowing treatments (Yapparov and Iskhakov , 1974) .

Chaudhri, Shah, Nagvi and Mallick, (1964) did some very interesting work whereby they discovered that it is possible to reduce salt uptake by the plants themselves. They chose Suaeda Fruticosa Forsk as a pioneer specis which is a common plant found in the highly saline and alkaline soils in Pakistan. It is amuch branched perennial shrub two to four feet in height . The stem is woody and the leaves are succulent . The leaves vary in size from 0.2 to 0.6 inches in length and 0.05 to 0.15 inches in thickness. Each plant had 935.0g of fresh leaves, 232.0g of stem, and 161.0g of roots. Calculated on this basis it seems theoretically possible to remove 2,406 pounds of salts from one acre. Under cultivation, the growth of Suaeda Fruticosa is much better and the yield of salts is estimated to be at least 3 times higher than this, theyby removal of the aerial parts for two or three years is enough to reclaim saline soil .

Based on the above, the following aspects were selected as being the most appropriate lines to develop in an attempt to overcome the problems associated with growing plants under the saline soil conditions which can exist in parts of Iraq, the intention being to try and stabilize the farming system so that good crop yields can be excepted over many years.

Consideration will be given in this work to seed treatments as a technique for increasing the salt tolerance of crops. The crops selected for the study are barley peas and sugar beet. Several varieties of each are included in as attempt to look for intervarietal differences. The main aspects under consideration are :

1) The choice of pretreatment solution eg. calcium salts, peroxide , growth regulators etc.
2) The length of the dry period prior to planting.

Particular emphases is given to the germination stage as this was considered to be a particularly critical part of the growth cycle for some plants

The possibility of utilising native salt loving shrubs to desalinate the soil is also included in the study. A brief breakdown of the chapters is as follows :

Chapter One , gives the background to the study and includes information on the type of soils found in Iraq as well as information on the practices employed at present to combat saline conditions .

Chapter Two , gives the effect of presoaking with calcium salts on germination and growth barley varieties under saline conditions .

Chapter Three , gives the influence of growth regulators , calcium peroxide , hydrogen peroxide garlic , and onion extracts pretreatments on germination and growth stage of barley varieties on saline media .

Chapter Four , gives influence of calcium salts pretreatments on peas varieties germinated on saline media .

Chapter Five , gives influence of different materials eg. NaCl , CaO_2 , H_2O_2 , Ca (CH_3COO $)_2$, 2.4 -dichlorophenoxy acetic acid and (Co $(NH_3)_5$ Cl) Cl_2 pretreatments and dry periods on germination of sugar beet on saline media .

Chapter Six , gives analysis of twenty Iraqi plants some of which were halophytes .

1.9 THESIS OBJECTIVE

The objectives of this thesis were to study the effect of soaking three pea varieties , six barley varieties, and two sugar beet varieties with different inorganic salt compounds , extracts of onion and garlic, and phytohormones Different drying periods after soaking were also investigated. These experiments were carried out in a growth cabinet and some of them grown for fourteen days under saline conditions to investigate : -

1- Is it possible to use field crops as a method of biological reclamation by removing excessive amount of salt from the soils ?

2- Is the germination or growth stage more tolerant to salts for the crops which have been used ?

3- Is there any effect when using soaking and dry period ?

4- Is it possible to increase the salt tolerance of field crops ?

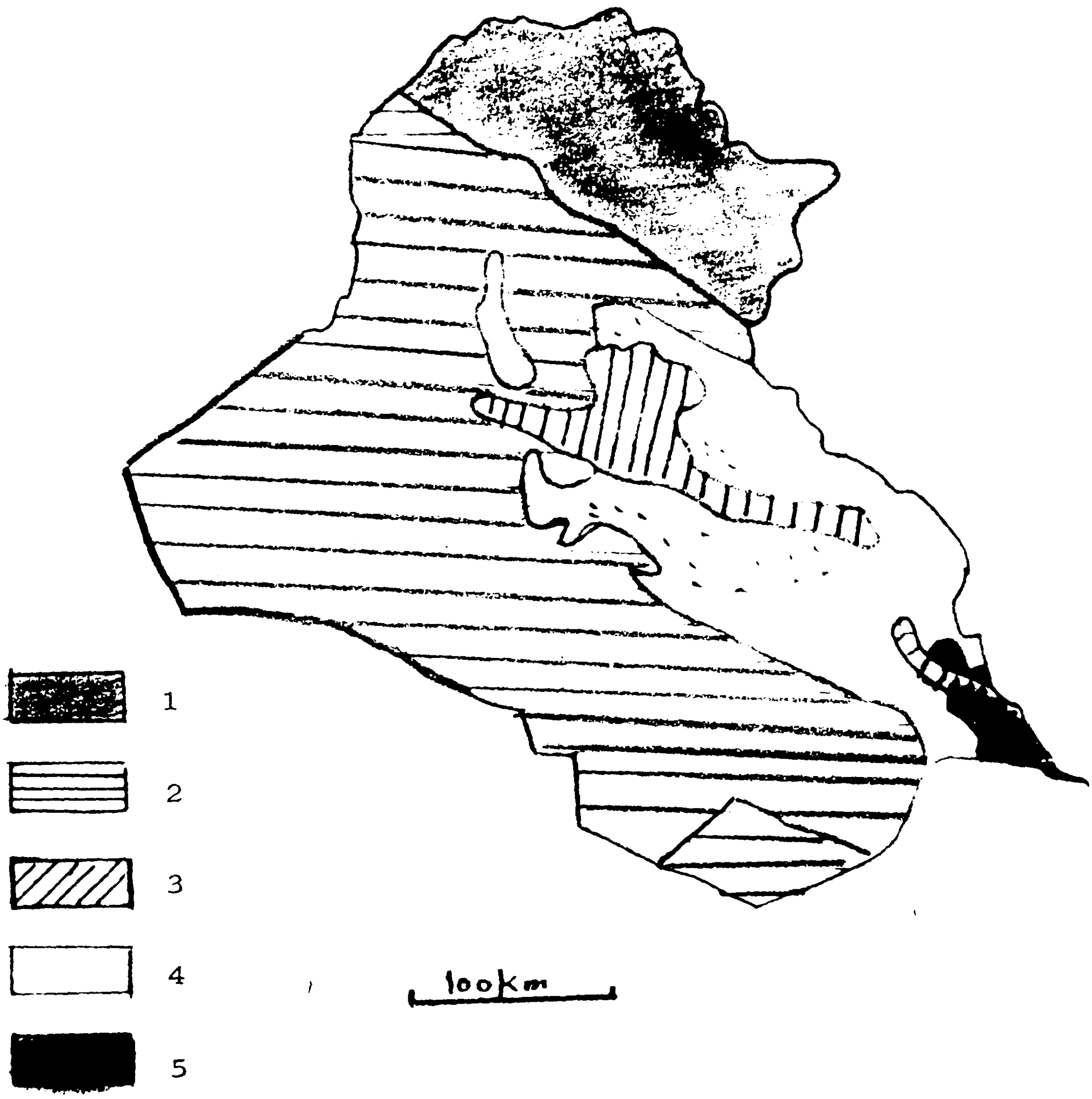


Fig. 2 Schematic map of salinization in soils of Iraq. 1. Soil without salinization; 2. Deserts and soil with some salinization locally; 3. Soils with moderate salinization; 4. Soils with severe salinization ; 5. (And black dots) soils with salinization and solonization .

CHAPTER TWO

EFFECT OF PRESOAKING WITH CALCIUM SALTS ON GERMINATION AND GROWTH OF BARLEY VARIETIES UNDER SALINE CONDITIONS

2.1 INTRODUCTION

2.1 (I) GENERAL SALINITY EFFECT ON BARLEY GROWTH

Barley has been grown on all the Iraqi plains. It is a major winter crop , cultivated in all regions of the world. It is the predominant crop because it can thrive in severe weather conditions and saline soils. It has been particularly satisfactory as one of the early crops planted in the process of reclamation of saline lands and it is more salt tolerant than most other crops during germination as well as in the later stages of the growth cycle. Some investigators have worked on barley under saline conditions . Ayers (1953) tested 30 varieties of barley in salinized soil cultures and observed that there were some significant differences among varieties with respect to their salt tolerance at the germination stage. Singh (1955) related the greater salt tolerance of barley compared with wheat to the larger number and the smaller size of the stomata and to the smaller epidermal cells of the barley leaf compared to the wheat leaf.

The increased yield of presoaking material was emphasized in barley by Martyanova (1961) ; and Martyanova , Gubanova, and Zhuriking (1962) who claimed that Henkel's presowing method doubled the yield under drought conditions .

2.1 (II) CALCIUM EFFECT ON PLANT GROWTH

Calcium is essential to the growth of a plant , particularly the growth of meristems. In very acid soil calcium deficiency can occur. Calcium deficiency has two effects on the plant. The first effect is direct leading to stunting of the root system and the second effect is indirect allowing some substances to accumulate in the plant tissues , so these either lower the plant vigour or harm the plant. The presence of calcium helps to neutralise the undesirable effects in the soil and helps the plant to take up other compounds. When calcium is present at a high level, it depresses the uptake of potassium and magnesium.

The beneficial effects of calcium for improving germination , seedling growth and yield have been investigated by several workers. Albrecht (1941) stated that higher seedling emergence fo tomatoes occurred when planted in calcium chloride and observed injury of the seedlings by using fertilizers alone. When calcium was added to the substrate , the injury which was caused by the fertilizers was offset. Different plants were grown by True (1921) in a water solution containing different ions to study ion uptake by seedlings. He confirmed that calcium added affected the absorption of other important ions such as phosphorus and potassium. When seeds of cotton were treated with calcium sulphate prior to planting in the greenhouse beneficial effects on seedlings were observed (Wiles, 1959). It was also found that the calcium treated seed germinated more rapidly and the seedlings were more vigorous than seedlings of untreated seeds . In addition it was found that cotton seedlings which were deficient in calcium had necrotic and chlorotic cotyledons and dead radicles. The production of healthy radicles was observed by Metzer, et al. (1961) , when calcium salts were added to water observed by cotton seedlings. They found adequate calcium was essential during the early growth stages to produce seedlings with healthy radicles. Also they found that seedlings of cotton untreated lots were smaller in size and less advanced than those lots treated with calcium. Chaudhuri and Wiebe (1964 ; 1968) stated that wheat pretreatment with calcium salts induced a significant increase in germination on high NaCl media.

Bernstein and Ayers (1951 ; 1953) found that presoaking with high concentrations of calcium salts lead to poor yields with bean plants and five varieties of carrots. Calcium delays ripening , reduces storage rots, extends storage life (Sharples and Johnson , 1977) , increases firmness (Bangerth , Dilley and Dewey , 1972 ; Cooper and Bangerth , 1976) and reduces respiration of apples (Bangerth et , al. 1972 ; Bramlage, et al. 1974) . The corking disorders of fruit , bitter pit in apples (Faust and Shear 1968) and blossom end rot of tomatoes (Gerard and Hipp, 1968) have been correlated with a low calcium content and their severity can be lessened by the use of sprays containing this element. Therefore , an understanding of the mechanism of calcium transport and distribution may be dependent upon regulating calcium movement into the affected areas. Knavel (1968) confirmed that calcium translocates into apples mainly at the begining of fruit growth suggesting that young tissue may act as a centre of attraction. Calcium ascent in the stems of herbaceous bean plants (Bell and Biddulph 1963) and in apple trees (Faust and Shear 1968) is based on an exchange process and only in part on mass flow.

Many investigators stated that water and transpiration play a role in supplying the different plant tissues with calcium. Irregular or shortage of water supply causes reduced calcium translocation into plant organs. Wiersum

(1966) stated calcium movement into storage tissue is related to the mode of water supply and its relative movement in the xylem and phloem. Guardiola and Sutcliffe (1972) found that up to 26 percentage of the total cotyledonary calcium was transported to the axis after 4 weeks germination of *Pisum Sativum* seedlings in distilled water.

2.1 (III) EEFECT OF CALCIUM ON THE ABSORPTION OF Mg, Na, K

This effect has been studied by many investigators. Ranter (1935) found increasing levels of exchangeable sodium in the soil resulted in decreased absorption of calcium and attributed the nutritional component of growth inhibition primarily to this factor. In excised barley roots the presence of either calcium or magnesium reduced the additional amount of sodium taken up within the first few hours after immersion in a sodium solution , presumably by blocking the free penetration of sodium through the outer cell barrier (Bange and Schaminne 1968). The effects of calcium in reducing sodium uptake has been reported previously by Viets (1944). Chaudhuri and Wiebe (1968) claimed that Marschner presented evidence that calcium was necessary to maintain the integrity of protoplasmic membranes, which reduced sodium uptake , and also reduced loss of potasium from the cells. In his view, excess sodium is harmful because it induces loss of potassium.

Calcium maintains the membrane , thereby reducing potassium loss or exchange with sodium ions. Hayward and Wadleigh (1949) stated that an excessive concentration of magnesium may be toxic because of excessive absorption of magnesium accompanied by greatly decreased absorption of calcium and potassium. Such an effect is usually eliminated by the simultaneous presence of moderately high concentrations of calcium along with magnesium.

Interrelationships between potassium and calcium in absorption by barley roots were investigated by Overstreet, Jacobson and Handley (1952). They demonstrated that a given concentration of calcium exerts both a depressing and a stimulating effect on the absorption of potassium and that the effects are related to the concentrations of potassium in the external media. The depressing effect has been interpreted as the result of competition for a metobolically produced binding compound. In order to explain the stimulating effect, it is neccessary to postulate that calcium functions as a co-factor in the utilization of the potassium complex during absorption. Kahn and Hanson (1957) stated that the maximum potassium accumulation was reduced in the presence of calcium more in soybeans than in maize.

Magnesium content of safflower and sunflower decreased with salinity according to Heikal (1977) and this is in agreement with the results obtained by El- Shourbagy and Missak (1975) with three varieties of castor bean plants. The reduction in magnesium content was associated with an increase in calcium content and this may be due to high levels of calcium in the saline nutrient solutions. Calcium content app :ciably increased with increasing salinity. This was shown by George (1967) with some cereal crops. The rate of potassium absorption declined with time in the absence of calcium at a pH value of 5.3. This was stated by Hooymans (1964) .

Although calcium plays a special role in the absorption of other ions by plant roots (Jacobson et al 1960), its own nature of uptake is still in doubt. The low order of accumulation of calcium by root tissues observed in conventional excised root experiments has been ascribed to a low permeability of the plasmalemma to calcium (Moore , Jacobson and Overstreet , 1961) but other explanations are possible . One of them is that the movement of calcium across the membrane may be a rate limiting step , but once inside the calcium is readily transported basally and retained only in small amounts by the cell.

Calcium can move into the root xylem of tomato plants by an active transport process - uptake of calcium ion by the cells of the root system itself was not studied, however , it is generally believed that somewhat similar processes probably are involved in ion accumulation in both the root cell vacuoles and root xylem (Lopushinsky 1964).

The aims of the study in this chapter are to see the effect of calcium salts and dry periods on barley varieties covering the germination and seedling stage under high salt conditions. The reasons for the choice of calcium salts for presoaking are : Firstly , no attempt has been made in the past to study the soaking effect of these salts and the dry period on the seeds of different barley varieties under saline conditions. Secondly , calcium ions have been shown to be essential to maintain integrity of the protoplasmic membranes , which are selective in the absorption of individual elements such as sodium and other like effects on enzymes etc.

PART (A) GERMINATION STAGE EXPERIMENTS

2.2 EXPERIMENTAL

2.2.1 MATERIALS AND METHODS

Seeds of barley (Hordeum Vulgare L.) , varieties Golden promise (V_3) , Marko (V_4) and Gerbel (V_6) , were used throughout these nine experiments, except for experiment No.1 which was conducted to determine the salt tolerance of different varieties. A typical pretreatment and treatment schedule was as follow :

1- Pretreatment of seeds with calcium salts.

A.	$CaCl_2 \cdot 2H_2O$	10.000	p.p.m =	1 %
B.	$CaBr_2 \cdot 2H_2O$	=	=	=
C.	$Ca\ (CH_3COO)_2$	=	=	=
D.	$Ca\ (NO_3)_2 \cdot 4H_2O$	=	=	=
E.	$CaSO_4 \cdot 2H_2O$	=	=	=

The control treatment was with distilled water.

2- Pretreatment 7 hours at 19 $\pm$ 2°C in 100 ml beaker containing 50 ml of pre-treatment salt.

3- Each experiment consisted of four replicates in a random design.

4- The pretreatment seeds were rinsed in two changes of distilled water, blotted to remove excess water for about one minute, then the seeds were surface dried on a filter paper.

5- Four dry periods were used after soaking : (0 and 17 hours and 1 and 2 weeks) at room temperature viz. 19 $\pm$ 2°C.

6- Thirty seeds were selected at random from each treatment, placed on double layers of Whatman No. 1 filter paper , moistened with 3 ml of the appropriate solution in a standard 9 cm diameter petridish.

7- The concentration of salt solution used as normal medium was 15.000 p.p.m (1.5 %).

8- The germination period was 6 days , the germination percentage was recorded twice, once after 3 days and the ...

other after 6 days.

9- Seeds were germinated in a darkened growth cabined at $23 \pm 2^{\circ}C$ and were checked daily.

10- The data were statistically analysed , means and standard deviations are presented in the following Tables. It is the mathematically most satisfactory measure of dispersion. The formula adapted was : -

$$S = \frac{(X - \bar{X})^2}{N} \quad \text{or} \quad \frac{X^2}{N} \left(\frac{X}{N}\right)^2$$

Where :

N is the number of individuals

$\bar{X}$. mean of individuals

$X-\bar{X}$ deviation of each observation from mean standard

$$\text{error of mean} = \frac{\text{standard deviation}}{N}$$

95 % confidence limits are : mean $\pm$ t X S.F

T test was used with results where these was a need to show variation

The salt solution which was used as medium for all the following experiments was prepared in the laboratory. The composition was as follows : -

1-	NaCl	27.0 g / L
2-	$CaCl_2 . 2H_2O$	1.0 g / L
3-	$MgSO_4 . 7H_2O$	1.0 g / L
4-	KCl	0.5 g / L
5-	$NaHCO_3$	0.5 g / L
		30.0 g / L

2.3 Results

Experiment 1 demonstrated the influence of different concentrations of salt solution (0, 1, 1.5 , 2 , 2.5 , and 3 %) as a medium for the germination of barley varieties V_3 , V_4 and V_6 . The seeds used were without pretreatment. The data showed a normal germination percentage with distilled water (control) . Germination decreased when the salt medium increased particularly above 2 % concentration (Table 1). V_4 showed a higher tolerance than the others.

Experiment 2 demonstrated the effect of calcium salts as a pretreatment on the germination of barley varieties under 1.5 % salt solution and a zero dry period (seeds planted directly after soaking) . The figures obtained in this experiment (Table 2) showed V_3 and V_4 responded to $CaCl_2$, Ca (CH_3COO $)_2$ and Ca (NO_3 $)_2$ and did not show a response to the calcium bromide and calcium sulphate. V_6

TABLE 1

Influence of different concentrations of salt solution on the germination of three varieties of barley .

Concentration of Salt %	Germination % V_3	Germination % V_4	Germination % V_6
0 % Water	94.9 ± 2.8	94.2 ± 4.3	93.3 ± 2.3
1 % salt solution	88.3 ± 3.7	77.3 ± 3.7	73.3 ± 4.1
1.5 % = =	72.4 ± 4.9	74.9 ± 5.0	69.1 ± 4.9
2.0 % = =	24.1 ± 1.4	40.8 ± 3.6	18.3 ± 3.7
2.5 % = =	3.3 ± 2.3	12.5 ± 4.3	3.3 ± 3.3
3.0 % = =	Zero	1.7 ± 1.7	1.7 ± 1.7

Percentage germination ± standard deviation :

Average of 4 replications .

TABLE 2

The effect of pretreament with various calcium salts on the germination of 3 varieties of barley in 1.5 % salt solution. Dry period 0 .

Pretreatment % \ Varieties	Germination % V_3	Germination % V_4	Germination % V_6
0 % Water	53.3 ± 2.3	44.9 ± 3.7	50.8 ± 4.3
1 % $CaCl_2 \cdot 2H_2O$	72.5 ± 3.6*	71.2 ± 3.7*	65.8 ± 4.3*
1 % $CaBr_2 \cdot 2H_2O$	60.0 ± 4.1	43.3 ± 3.3	44.2 ± 3.6
1 % $Ca(CH_3COO)_2$	65.8 ± 2.7*	69.2 ± 3.6*	69.2 ± 1.5*
1 % $Ca(NO_3)_2 \cdot 4H_2O$	71.6 ± 5.5*	63.3 ± 4.1*	55.8 ± 4.3
0.18 % $CaSO4 \cdot 2H_2O$	53.3 ± 4.1	49.9 ± 4.1	37.5 ± 4.3

Percentage germination ± standard deviation average of 4 replications .

showed a response to $CaCl_2$ and $Ca(CH_3COO)_2$, but did not show a response with the other pretreatments.

<u>NOTE :</u> Experiments 3 , 4 and 5 had the same conditions as were mentioned in experiments 2, except that the dry period was different.

Experiment 3 used a 17 hour dry period. General results in this experiment (Table 3) showed an overall increase in germination percentage compared with experiment 2 (Zero dry period) . The reason for the increase was due to the dry period effect. V_3 gave a large increase with $CaBr_2$. V_4 showed a higher benefit with all pretreatments except the $CaSO_4$ pretreatment where there was a slight increase. V_6 appeared to respond only to $CaCl_2$ and $Ca(CH_3COO)_2$. In experiment 4 there was not a marked difference between this experiment (1 week dry period) and experiment 3 (17 hours dry period) as a general comparison. V_3 showed no significant response with all pretreatment. V_4 showed a significant response with $CaCl_2$, $Ca(CH_3COO)_2$ and $Ca(NO_3)_2$. V_6 showed a response only with $CaCl_2$ and $Ca(CH_3COO)_2$. The data for all varieties were compared with their controls (Table 4) .

In experiment 5 , there was a very clear effect of two weeks dry period in increasing germination percentage (Table 5) for all varieties in comparison to the previous experiment. V_3 showed a significant effect with $Ca(CH_3COO)_2$,

TABLE 3

The effect of pretreatment with various calcium salts on the germination of 3 varieties of barley in 1.5 % salt medium. Dry period 17 hours .

Pretreatment %	Germination % V3	Germination % V4	Germination % V6
0 % Water	70.8 ± 3.5	63.3 ± 4.1	63.3 ± 4.1
1 % $CaCl_2 \cdot 2H_2O$	75.8 ± 4.9	85.8 ± 4.9*	74.1 ± 1.4*
1 % $CaBr_2 \cdot 2H_2O$	87.5 ± 4.3*	84.1 ± 3.6*	73.3 ± 4.1
1 % $Ca(CH_3COO)_2$	70.8 ± 3.6	87.5 ± 3.6*	79.9 ± 4.1*
1 % $Ca(NO_3)_2 \cdot 4H_2O$	71.6 ± 5.0	82.5 ± 4.3*	71.6 ± 4.9
0.18 % $CaSO4 \cdot 2H_2O$	69.1 ± 4.9	75.8 ± 2.8*	64.1 ± 4.9

Percentage germination ± standard deviation average of 4 replications .

TABLE 4

The effect of pretreatment with various calcium salts on the germination of 3 varieties of barley in 1.5 % salt medium. Dry period 1 week .

Pretreatment %	Varieties	Germination % V3	Germination % V4	Germination % V6
0.%	Water	73.3 ± 2.3	66.6 ± 4.7	64.9 ± 3.7
1 %	$CaCl_2 \cdot 2H_2O$	72.5 ± 1.4	84.1 ± 2.7*	80.8 ± 2.8*
1 %	$CaBr_2 \cdot 2H_2O$	77.5 ± 4.3	79.2 ± 3.6	72.5 ± 4.3
1 %	$Ca(CH_3COO)_2$	80.8 ± 3.6	90.8 ± 1.4*	78.3 ± 3.7*
1 %	$Ca(No_3)_2 \cdot 4H_2O$	63.3 ± 4.1	84.2 ± 3.6*	72.5 ± 2.7
0.18 %	$CaSO4 \cdot 2H_2O$	74.9 ± 3.7	77.5 ± 2.9	71.7 ± 2.9

Percentage germination ± standard deviation average of 4 replications .

TABLE 5

The effect of pretreatment with various calcium salt on the germination of 3 varieties of barley in 1.5 % salt medium. Dry period 2 weeks.

Pretreatment % \ Varieties	Germination % V3	Germination % V4	Germination % V6
0 % Water	79.2 ± 1.5	81.6 ± 3.7	70.0 ± 2.4
1 % $CaCl_2 \cdot 2H_2O$	84.1 ± 2.7	94.1 ± 1.4*	77.5 ± 3.6
1 % $CaBr_2 \cdot 2H_2O$	80.8 ± 2.8	85.0 ± 3.7	75.9 ± 3.7
1 % $Ca(CH_3COO)_2$	90.0 ± 2.4*	90.8 ± 3.6	85.9 ± 1.7*
1 % $Ca(NO_3)_2 \cdot 4H_2O$	81.7 ± 1.7	90.8 ± 1.4*	77.5 ± 3.6
0.18 % $CaSO_4 \cdot 2H_2O$	81.7 ± 2.9	81.7 ± 1.7	75.8 ± 2.8

Percentage germination ± standard deviation average of 4 replications.

V_4 showed a significant effect with $CaCl_2$ and $Ca(NO_3)_2$. And V_6 showed a significant effect only with $Ca(CH_3COO)_2$ (Table 5).

In all previous experiments 2 , 3 , 4 and 5 there appeared to be a very clear effect of pretreatment and dry period leading to increased germination of barley varieties under saline conditions. The data showed (Table 5) maximum germination for V_3 and V_6 was with 1 % $Ca(CH_3COO)_2$ and for V_4 was with 1 % $CaCl_2$ and with 2 weeks dry period. From these results it was decided to investigate the optimum concentrations of calcium chloride and calcium acetate on germination, also dry periods beyond 2 weeks.

Water pretreatments showed respectively increasing germination through the same experiments mentioned above , therefore, it was worthwhile to study in more detail this effect on all varieties . Four experiments 6 , 7 , 8 and 9 were carried out as follows :-

<u>Experiment Six , Seven , Eight</u>

Four concentrations of pretreatment (1 , 2 , 3 and 4 %) and five dry periods (0 , 1 , 2 , 3 and 4 weeks) were used for all varieties. In experiment six , V_3 was tested with $Ca(CH_3COO)_2$. The data (Table 6) showed a high percentage germination with the 3 % concentration and 2 and 3 weeks dry period. In experiment 7 , V_4 was tested with $CaCl_2$. (Table 7) which also responded with the 3 % concentration and 2 and 3 weeks dry period. In experiment 8 , V_6 was tested with Ca (CH_3COO)$_2$ and showed a high response with the 3 % concentration and 2 weeks dry period . Also a high response was demonstrated with the 2 % concentration and 3 weeks dry period (Table 8) . In experiment nine , the varieties V_3 , V_4 and V_6 were tested with water alone under five dry periods including zero days as a control. All dry periods were significant but V_3 , and V_4 gave high increases with 2 and 3 weeks dry period. V_6 demonstrated a high response with a 4 weeks dry period.

TABLE 6 : Effect of different dry periods for V3 with different concentrations of Ca $(CH_3COO)_2$.

Conc. of $Ca(CH_3COO)_2$ \ Dry period	0 Day	1 Week	2 Weeks	3 Weeks	4 Weeks
1 %	65.8 ± 4.9	80.8 ± 3.6	88.3 ± 1.7	85.0 ± 3.7	88.3 ± 1.7
2 %	61.6 ± 3.7	88.3 ± 3.7	85.8 ± 4.9	88.3 ± 1.7	78.5 ± 2.7
3 %	63.3 ± 4.7	85.0 ± 3.7	94.1 ± 1.4*	93.3 ± 0.0*	81.6 ± 3.7
4 %	68.3 ± 3.7	84.2 ± 4.3	86.6 ± 2.4	88.3 ± 1.7	89.1 ± 2.9

Percentage germination ± standard deviation of 4 replications.

TABLE 7 : Effect of different dry periods for V4 with different concentration of $CaCl_2 \cdot 2H_2O$

Dry period / Conc. of $CaCl_2 \cdot 2H_2O$	0 Day	1 Week	2 Weeks	3 Weeks	4 Weeks
1 %	72.5 ± 2.7	82.5 ± 4.3	90.0 ± 0.0	81.7 ± 2.9	85.8 ± 2.8
2 %	76.6 ± 4.1	80.0 ± 2.4	90.8 ± 2.8	84.2 ± 3.6	85.8 ± 4.3
3 %	70.8 ± 2.7	84.1 ± 1.4	94.1 ± 1.4*	93.3 ± 2.3*	83.3 ± 4.1
4 %	70.0 ± 4.7	78.3 ± 3.7	88.3 ± 3.7	84.2 ± 1.5	88.3 ± 1.7

Percentage germination ± standard deviation of 4 replications .

TABLE 8 : Effect of different dry period for V6 with different concentration of Ca $(CH_3COO)_2$.

Dry period / Conc. of Ca $(CH_3COO)_2$	0 Day	1 Week	2 Weeks	3 Weeks	4 Weeks
1 %	56.6 ± 2.4	81.6 ± 3.7	82.5 ± 2.7	76.6 ± 4.1	88.3 ± 1.7
2 %	76.7 ± 4.1	81.7 ± 2.9	84.2 ± 4.3	95.0 ± 1.7*	86.6 ± 4.1
3 %	70.0 ± 2.4	85.8 ± 3.6	89.2 ± 1.5*	87.5 ± 2.8	87.5 ± 1.5
4 %	64.2 ± 4.3	85.8 ± 2.8	84.2 ± 3.6	90.0 ± 4.1	89.2 ± 1.5

Percentage germination ± standard deviation of 4 replications .

TABLE 9 : Effect of dry period for barley varieties after Pretreatment with water .

Varieties \ Dry period	0 Day	1 Week	2 Weeks	3 Weeks	4 Weeks
V_3	50.0 ± 5.0	70.0 ± 4.1*	78.3 ± 3.7*	85.0 ± 2.9*	68.3 ± 5.0*
V_4	46.7 ± 3.4	68.3 ± 3.7*	79.1 ± 2.8*	74.1 ± 2.7*	68.3 ± 2.9*
V_6	52.5 ± 1.4	66.6 ± 4.1*	68.3 ± 3.7*	67.5 ± 1.8*	74.1 ± 2.7*

Percentage of germination grain ± standard deviation of 4 replications .

PART (B) GROWTH STAGE EXPERIMENT

2.4 EXPERIMENTAL

2.4.1 MATERIALS AND METHODS

Seeds of barley (Hordeum Vulgare L.) varieties Golden promise (V_3) , Marko (V_4) and Gerbel (V_6) which were used in previous experiments (part A , germination stage) were used here in this experiment after the optimum dry period and pretreatment salt concentrations were discovered . A typical pretreatment and treatment regime was as follows : -

Pretreatment of seeds (omitting V_6) in different salt solutions was as follows :-

T_1 - Distilled water and 2 weeks dry period

T_2 - 3 % $CaCl_2.2H_2O$ = = = = =

T_3 - 3 % $Ca(CH_3OO)_2$ = = = = =

T_4 - Distilled water = 3 weeks = =

T_5 - 3 % $CaCl_2.2H_2O$ = = = = =

T_6 - 3 % $Ca(CH_3OO)_2$ = = = = =

Seeds were soaked in about 50 % of their own weight of water or pretreatment solution in 100 ml glass beakers. The seeds were kept in a dark place at a temperature of 19 $\pm$ 2^{o}C for 7 hours. At the end of the soaking period, the seeds were rinsed in two changes of distilled water and spread out to air dry at room temperature on filter paper. After complete drying the seeds were stored in labelled paper packages until they were used (2 and 3 weeks) . After the treatment, 20 seeds were chosen at random and sown in 10 cm diameter flower pots, each filled with vermiculite. All pots were moistened initially with 1.5 % salt solution to field capacity (115 ml each pot) and watered daily with nutrient solution to maintain field capacity. Composition of nutrient solution in the experiment was replicated three times , placed in growth cabinets at 22 $\pm$ 3^{o}C , relative humidity 55 - 60 % and light period 12 hours . At the time of harvest after 14 days, germination percentages , height of plants, fresh weight of shoots, dry weight of shoots and length of roots were recorded . Analyses was carried out to estimate sodium , potassium , calcium and magnesium percentages. The procedure of preparation of plant tissue samples for analysis was as follows:

The procedure used involved the removal of the plants (aerial parts) from pots, then drying the tissue overnight at 100^{o}C in porcelain basins in the oven. The dried plant material was then ground in an agate morter and 0.1 g weighed for subsequent anlyses. Some samples weighed less than 0.1 g and in these cases all the material was used.

The dried samples were transferred to 100 cm^3 conical flasks and 10 cm^3 . Analar nitric acid added. Samples were digested at 100 °C on hot plates in a fume cupboard until the initial reaction subsided, then the flasks were covered with watchglasses and the temperature increased to allow the mixture to boil for approximatly 1 hour. The solutions were subsequently cooled, filtered into 50 cm^3 volumetric flasks and diluted to the mark with distilled water. The concentrations of calcium and magnesium in the solutions were determined by atomic absorption spectrophotometry as follows : A dilute sample was prepared from the stock solution and 10 ml releasing reagent added (Dissolved 60 g of strontium chloride $SrCl_2 \cdot 6H_2O$ in 100 ml). The atomic absorption spectrophotometer was adjusted until the zero was steady and the maximum reading was obtained with the solutions containing 0 and 5 mg / ml of calcium or 0 and 1 mg / ml of magnesium. Results were then calculated from the graph.

The concentrations of potassium and sodium in the dilute solutions were determined by flame photometry . A dilute sample was prepared from the stock solution and 0.1 % releasing reagent added. The flame photometer was used according to the manufactures instructions to measure potassium or sodium emission. The controls were adjusted until the zero was steady and maximum readings were obtained from standard solutions. The normal working ranges are :

Na - 0 ______ 2 p.p.m

K - 0 ______ 5 p.p.m

2.5 RESULTS

Germination

The efffect of different dry periods and pre-treatments on seed germination of varieties Golden Promise (V_3) and Marko (V_4) are presented in Table 10 . Both of them showed significant effects in increasing germination with T_3 , T_5 and T_6 compared with their controls T_1 and T_4 respectively and did not show any response to T_2 . Variety Marko appeared to give a higher germination percentage than Golden Promise.

Shoot growth

The average height of 14 day old shoots showed a benefit response for both varieties V_3 and V_4 to treatment T_2 and T_3 respectively. No effect was noted for T_5. For T_6 only variety Marko showed a significant effect on the average height (Table 10) . All were compared with their controls.

Fresh weight

Variety Golden Promise did not show any response for all treatments studied. Variety Marko showed a significant effect with regard to fresh weight only with T_6 and did not show any response with the others (Table 10).

Dry weight and root length

Variety Golden Promise did not show any response to any of the treatments tried either based on dry weight or root length. But variety Marko showed a significant increase in average dry weight (T_3) and did not show anything with the other (Table 10).

Mineral elements

No significant effect on calcium content in the variety Golden Promise at all pretreatments was observed. But variety Marko showed a slight increase with T_5 compared with its control (T_4). Also Magnesium and potassium contents did not show any increase over controls for both varieties Golden Promise and Marko. Sodium content in contrast to magnesium and potassium was significantly increased with T_6 for variety Golden Promise and T_2 , T_5 and T_6 for variety Marko (Table 11) .

TABLE 10 : Phenologic observations on barley development Golden Promise (V3)

Treatment	Germination %	Average height cm.	Average fresh wt. g	Average dry wt. g	Average root length cm.
Soaking in water, 2 weeks dry period as a control T1	78.3 ± 2.4	8.00 ± 0.0	1.01 ± 0.08	0.09 ± 0.009	6.05 ± 0.06
Soaking in 3 % $CaCl_2 . 2H_2O$, 2 weeks dry period T2	83.3 ± 4.71	10.43 ±* 0.76	1.05 ± 0.05	0.1 ± 0.01	5.83 ± 0.19
Soaking in 3 % $Ca(CH_3COO)_2$, 2 weeks dry period T3	91.0 ±* 2.35	9.07 ±* 0.05	1.01 ± 0.05	0.09 ± 0.008	5.14 ± 0.16
Soaking in water, 3 weeks dry period as a control T4	70.0 ± 4.0	10.27 ± 0.39	1.02 ± 0.07	0.09 ± 0.009	5.43 ± 0.25
Soaking in 3 % $CaCl_2 . 2H_2O$, 3 weeks dry period T5	86.7 ±* 2.35	10.3 ± 0.57	1.18 ± 0.02	0.10 ± 0.01	6.02 ± 0.06
Soaking in 3 % $Ca(CH_3COO)_2$, 3 weeks dry period	86.7 ±* 2.4	9.4 ± 0.45	1.02 ± 0.1	0.07 ± 0.009	5.56 ± 0.31

Standard deviation of 3 replicates

Contd.

TABLE 10 : Phenologic observations on barley development Marko (V4)

Treatment	Germination %	Average height cm.	Average fresh wt. g	Average dry wt. g	Average root length cm.
Soaking in water, 2 weeks dry period as a control T1	83.3 ± 2.4	11.66 ± 0.47	1.44 ± 0.08	0.14 ± 0.004	4.69 ± 0.29
Soaking in 3 % $CaCl_2 \cdot 2H_2O$, 2 weeks dry period T2	90.0 ± 4.1	13.91 ±* 0.05	1.66 ± 0.06	0.15 ± 0.008	5.28 ± 0.51
Soaking in 3 % $Ca(CH_3OO)_2$, 2 weeks dry period T3	93.33 ±* 0.0	13.7 ±* 0.13	1.71 ± 0.06	0.17 ±* 0.004	5.53 ± 0.37
Soaking in water, 3 weeks dry period as a control T4	78.3 ± 2.4	12.57 ± 0.24	1.47 ± 0.09	0.15 ± 0.009	5.4 ± 0.14
Soaking in 3 % $CaCl_2 \cdot 2H_2O$, 3 weeks dry period T5	91.0 ±* 2.35	12.93 ± 0.13	1.62 ± 0.05	0.14 ± 0.014	4.85 ± 0.15
Soaking in 3 % $Ca(CH_3COO)_2$, 3 weeks dry period T6	93.33 ±* 2.36	14.13 ±* 0.4	1.89 ±* 0.04	0.18 ± 0.004	5.81 ± 0.03

Standard deviation of 3 replicates

TABLE 11 : Effect of soaking on contents of some mineral elements in the seedlings of barley under 1.5 % salt medium (Data expressed as %) Golden Promise (V3) .

Treatment	Ca %	Mg %	Na %	K %
T1 Soaking in water, 2 weeks dry period as a control	0.16 ± 0.003	3.57 ± 0.38	2.67 ± 0.24	4.94 ± 0.08
T2 Soaking in 3 % $CaCl_2 . 2H_2O$, 2 weeks dry period	0.16 ± 0.008	3.03 ± 0.15	1.95 ± 0.15	4.9 ± 0.07
T3 Soaking in 3 % $Ca(CH_3COO)_2$, 2 weeks dry period	0.17 ± 0.005	3.29 ± 0.26	1.96 ± 0.1	5.05 ± 0.14
T4 Soaking in water, 3 weeks dry period as a control	0.17 ± 0.005	3.37 ± 0.24	1.93 ± 0.09	5.55 ± 0.07
T5 Soaking in 3 % $CaCl_2 . 2H_2O$, 3 weeks dry period	0.19 ± 0.011	3.35 ± 0.14	2.18 ± 0.14	5.71 ± 0.19
T6 Soaking in 3 % $Ca(CH_3COO)_2$, 3 weeks	0.17 ± 0.012	3.14 ± 0.13	2.93 ±* 0.13	5.51 ± 0.26

Standard deviation of 3 replicates

Contd.

TABLE 11 : Variety Marko (V4)

Treatment	Ca %	Mg %	Na %	K %
T1 Soaking in water, 2 weeks dry period as a control	0.1 ± 0.004	2.49 ± 0.04	1.77 ± 0.14	3.86 ± 0.1
T2 Soaking in 3 % $CaCl_2 \cdot 2H_2O$, 2 weeks dry period	0.11 ± 0.005	2.47 ± 0.15	2.95 ± 0.14 *	4.06 ± 0.11
T3 Soaking in 3 % $Ca(CH_3COO)_2$, 2 weeks dry period	0.1 ± 0.003	2.24 ± 0.15	1.73 ± 0.2	3.82 ± 0.16
T4 Soaking in water, 3 weeks dry period as a control	0.1 ± 0.006	2.51 ± 0.11	1.71 ± 0.05	3.9 ± 0.15
T5 Soaking in 3 % $CaCl_2 \cdot 2H_2O$, 3 weeks dry period	0.13 ± 0.005 *	2.54 ± 0.15	2.53 ± 0.09 *	4.19 ± 0.22
T6 Soaking in 3 % $Ca(CH_3COO)_2$, 3 weeks dry period	0.1 ± 0.002	2.2 ± 0.1	2.89 ± 0.04 *	3.73 ± 0.18

Standard deviation of 3 replicates

2.6 Discussion

From the results of the previous experiments carried out in part A , experiment 1 was conducted to determine the effect of various levels of salt solutions on the germination of barley varieties Golden Promise , Marko , and Gerbel under controlled conditions . The data showed a reduction in the germination percentage with the progressive increase of salt concentration as a result of outer toxicity or high osmotic pressure. The varieties differed in tolerance. Marko had a higher germination percentage than the others. The results were similar to those of Ayers (1953). From this experiment 1.5 % concentration was selected as a suitable level to use in subsequent experiments as a germination medium.

In experiments 3 , 4 and 5 pretreatments and dry periods were included. The data showed that the effect of the dry period was very clear and gave a distinct increase in germination percentage compared with experiment 2 (Zero time dry period) and the results in experiment 5 (2 weeks dry period) recorded more germination than the other. Chauduri and Weibe (1968) confirmed beneficial effects of the dry period with wheat and Shannon and Francois (1977) with cotton. The varieties showed different responses. However, Marko gave the best response in terms of increased germination percentage compared with the others.

In all experiments , $CaCl_2$ and $Ca(CH_3COO)_2$ pretreatments gave good effects on increasing germination , $Ca(NO_3)_2$ was low, and $CaBr_2$ and $CaSO_4$ were lower still. Pretreatment with distilled water alone significantly increased germination. From all the above results, four experiments were carried out viz 6 , 7 , 8 and 9 to investigate the best results. The results showed that : -

1- 3 % $Ca(CH_3COO)_2$ with a 2 and 3 weeks dry period was optimum for the Golden Promise variety
2- 3 % $CaCl_2$ with a 2 and 3 weeks dry period was optimum for the Marko variety .
3- 3 % $Ca(CH_3COO)_2$ with a 2 weeks dry period was optimum for the Gerbel variety .
4- The water pretreatment effect on varieties showed a significant increase with a 2 and 3 weeks dry period for Golden Promise and Marko but Gerbel had a higher response with a 4 weeks dry period (Table 9) .

It may be concluded that pretreatment of barley seeds with different calcium salts may be beneficial to growth under saline conditions (1.5 %) . This result is in agreement with Albrecht (1941) . The beneficial effects may be attributed to more vigorous plants (Wiles 1959) or healthy radicles (Leonard 1948) .

Viets (1944) reported previously the effect of calcium in reducing sodium uptake. Also Chaudhuri and Wiebe (1968) confirmed that during the pretreatment phase with wheat grains probably small amounts of calcium absorbed are able to partly counteract the harmful effects of sodium in the germination medium. Also they stated that the stimulation was by the cation and not the anion, as nitrate or chloride pretreatment in combination with either sodium or potassium gave much poorer results. But I also expect there is an effect. It could be predicted that from the anion as well as at least there are some interactions between cation and anion and other factors such as temperature, dry period etc., because calcium bromide and calcium sulphate did not show any effect throughout the previous experiments.

Part B pots experiments

With regard to the phenologic observations on the development of barley varieties, the data represented in Table 10 did not show a high response. Germination for Golden Promise and Marko was generally enhanced with all pretreatments except T2 . Marko generally had a higher germination response relative to Golden Promise. Judged by the height of the plants more response was noted with Marko than with Golden Promise.

Average of fresh weights, average of dry weights and average of root lengths did not show any increase with any of the pretreatments except Marko which showed a significant increase in fresh weight with 3 % $Ca(CH_3COO)_2$ and a 3 weeks dry period .

In the case of mineral elements , the rate of uptake of an ion by a root is dependant upon the ion supply at the root surface and the amount of ion supplied to the root depends upon the size of the soluble and exchangeable ion. The data represented in Table 11 showed the sodium content in the plant to be relatively high, particulary in the variety Marko , the reason probably being due to the high NaCL contents in the medium. The results confirm the finding of Lunin et al. (1964) . Calcium content did not show an increase with Golden Promise but in Marko a slight increase appeared with T5 . Magnisium and potassium did not show an increase, which is in accord with Lehr and Wybenga (1955) with flax seeds and El - Shourbagy and Missak (1975) with castor bean varieties.

In spite of the results in this chapter not being as very highly significant as expected , however , it was decided to try in the next chapter to see the effect of the same calcium salts as pretreatments on pea varieties under the same conditions to see if the same type of effects could occur with other crops species (barley varieties).

CHAPTER THREE

EFFECT OF PRESOAKING WITH CALCIUM SALTS ON GERMINATION AND GROWTH OF PEA VARIETIES UNDER SALINE CONDITIONS

3.1 INTRODUCTION

Many investigators studied calcium effects in plants in different ways as well as its distribution and uptake within the plant. Calcium received considerable attention in recent years because of its desirable effects and relationship to physiological processes.

Some investigators working with the pea crop like Nance (1973) stated that the swelling of decapitated pea epicotyls, induced by kinetin and calcium was correlated with the development of walls rich in pectic substances, particularly pectic uronic acid. Mondal and Nance (1975) suggested that kinetin and calcium promote swelling of pea stems through a mechanism independent of the production of ethylene. Pea epicotyls enlarge excessively in the transverse direction in response to kinetin.

The object of this chapter is to study the calcium effect as a pretreatment on several varieties of pea seeds, including the dry period effect selected from the last chapter.

These treatments showed significant effects on germination percentages with barley varieties and also showed some beneficial effects to the growth stage (see chapter two). The reasons for the choice of peas in this study were because there are some varieties of legumes resistant to salinity and alkalinity ,(Dahiya and Singh 1976) and are useful crops to grow under saline conditions.

PART A GERMINATION STAGE

3.2 Experimental

3.2.1 Materials and methods

Pea (pisum sativum L.) varieties , Meteor (V_1) Puget (V_2) and Sprite (V_3) were used throughout these experiments. In experiments 1 and 6 non pretreated pea seeds of different varieties were tested for salt tolerance by germination in different salt concentrations just to select a suitable level to use in the subsequent experiments . The seeds in all experiments except 1 and 6 were soaked in 100 ml beakers containing 50 ml of pretreatment solution. The soaking solution was as aqueous solution of :-

A- $CaCl_2 \cdot 2H_2O$

B- $CaBr_2 \cdot 2H_2O$

C- $Ca(CH_3COO)_2$

D- $Ca(NO_3) . 4H_2O$

E- $CaSO_4 . 2H_2O$

The control treatments contained distilled water. The soaking period was 7 hours at 16 $\pm$ 2°C . Rinsing of the pretreated grains by two changes of distilled water was carried out followed by blotting to remove excess water for about one minute. The dry periods after soaking were zero, 17h, 24h , 1 and 2 weeks at room temperature (16 $\pm$ 2°C) . The germination period was 6 days and measurements of germination percentage were carried out twice, one after 3 days and the other after 6 days. The influence of the different treatments on germination was tested by placing 20 seeds in a petridish. The dishes were placed in darke growth cabinets at 23 $\pm$ 2°C (for more details see 2. 2. 1). There were some modifications in concentrations of some pretreatments depending upon the experimented design. The number of experiments carried out was five, replications were eight and the concentrations of the salt medium were 1, 1.5 and 2.0% for variety Meteor. But for Puget and Sprite varieties the number of experiments was eight, replications were four and the concentration of the salt medium was 1.5 %.

3.3 RESULTS

Experiments 1 was a general test to check the salt tolerance of variety Meteor (V_1) and experiment 6 was a test for Puget (V_2) and Sprite (V_3) varieties. The results obtained in these experiments are summarised in Tables 1 and 6 respectively. In these experiments different salt solutions were used (0, 0.5, 1, 1.5, 2 and 2.5 %). Germination percentage decreased with increasing salinity . After the 1.5% salt level there was a very clear reduction in germination.

In experiment 2 the pretreatment was with five calcium salts and distilled water served as the control. Zero dry period and three levels of salt media (1, 1.5 and 2%) were used. The data in Table 2 showed a response for (V_1) with caclium nitrate and calcium sulphate under both levels (1 and 1.5 %) . But relatively, the results under 1.5 % salt solution were better than the 1 % level comparing both with their control. Meanwhile the 2 % salt solution appeared to have no effect.

TABLE 1

Influence of different concentrations of salt solution on the germination of pea (Meteor).

Concentration of salt %	Germination % pea (Meteor)
0 % water	95.0 ± 4.3
0.5% salt solution	88.1 ± 3.4
1.0 % = =	73.1 ± 3.4
1.5 % = =	47.5 ± 3.5
2.0 % = =	10.6 ± 2.9
2.5 % = =	Zero

Percentage germination ± standard deviation average of 8 replications .

TABLE 2

The effect of Zero dry period and different calcium salts pretreatment on the germination of pea (Meteor) under different salt solution .

Pre-treatment ppm	Germination % under 1% salt solution	Germination % under 1.5 % salt solution	Germination % under 2.0 % salt solution
0 ppm water	82.5 ± 3.5	66.9 ± 3.5	23.1 ± 3.4
10.000 pmm $CaCl_2 \cdot 2H_2O$	86.8 ± 2.4	65.0 ± 4.3	21.9 ± 2.4
10.000 pmm $CaBr_2 \cdot 2H_2O$	87.5 ± 2.5	70.6 ± 5.8	21.3 ± 2.2
10.000 pmm $Ca(CH_3COO)_2$	79.4 ± 3.0	59.4 ± 3.9	18.3 ± 2.4
10.000 pmm $Ca(NO_3)_2 \cdot 4H_2O$	89.4 ± 4.6*	77.5 ± 2.5*	19.4 ± 3.0
1.800 pmm $CaSO_4 \cdot 2H_2O$	88.8 ± 3.3*	76.3 ± 3.3*	18.1 ± 2.4

Percentage germination ± standard deviation average of 8 replications .

In experiment 3 , the data (Table 3) showed no effect for a 17 hour dry period for treatments with all salt levels. As results in experiment 2 showed promise , further studies were carried out in experiments 4 and 5 to discover the effect of calcium nitrate and calcium sulphate respectively, on germination percentage when different concentrations were used than those mentioned in Table 2 under 1.5 % salt solution. So the data in Tables 4 and 5 showed no significant increase in germination percentage.

In experiment 7 , the data (Table 7) showed calcium bromide and calcium sulphate had a beneficial effect on germination percentage compared to the other treatments for both pea varieties Puget and Sprite under zero dry period. Meanwhile, dry periods 17 h , 24h , 1 and 2 weeks in experiments 8 , 9 , 10 and 11 respectively did not show any response (Table 8, 9 , 10 and 11) .

As results in experiment 7 showed promise, further studies were carried out in experiments 12 and 13 to discover the effect of calcium bromide and calcium sulphate on the germination percentage. Germination data in Table 12 showed no response with either low or high caclium bromide concentrations compared to the 10.000 ppm used previously. But calcium sulphate appeared to have an effect under 1.4 and 1.8 ppm and did not show any effect with lower concentrations (Table 13) .

TABLE 3

The effect of 17h dry period and different calcium salt pretreatments on the germination of pea (Meteor) with different salt solutions .

Pre-treatment ppm	germination % under 1 % salt solution	germination % under 1.5 % salt solution	germination % under 2.0 % salt solution
0 ppm water	80.0 ± 2.5	58.2 ± 2.4	20.0 ± 2.5
10.000 ppm $CaCl_2 \cdot 2H_2O$	80.0 ± 3.5	59.4 ± 3.9	16.3 ± 4.3
10.000 ppm $CaBr_2 \cdot 2H_2O$	81.3 ± 2.2	60.0 ± 3.5	17.5 ± 3.5
10.000 ppm $Ca(CH_3COO)_2$	81.9 ± 2.4	56.8 ± 2.4	16.3 ± 4.1
10.000 ppm $Ca(NO_3)_2 \cdot 4H_2O$	76.3 ± 3.3	60.6 ± 2.9	17.5 ± 3.5
1.800 ppm $CaSO_4 \cdot 2H_2O$	85.0 ± 4.3	58.8 ± 2.2	19.4 ± 3.0

Percentage germination ± standard deviation average of 8 replications.

TABLE 4

The effect of different $Ca(NO_3)_2 \cdot 4H_2O$ conc. as a pre-treat. on pea (Meteor variety) germination with 1.5 % salt solution and zero dry period .

Concentration of $Ca(NO_3)_2 \cdot 4H_2O$	Germination %
0 ppm water	70.6 ± 5.3
10.000 ppm	75.8 ± 4.6
15.000 ppm	67.5 ± 4.3
20.000 ppm	75.6 ± 3.9
25.000 ppm	35.0 ± 5.6
30.000 ppm	36.9 ± 4.2

Percentage germination ± standard deviation average of 8 replications.

TABLE 5

The effect of different $CaSO_4 \cdot 2H_2O$ conc. as a pretreatment on pea (Meteor variety) germin. with 1.5 % salt solution and zero dry period .

Concentration of $CaSO_4 \cdot 2H_2O$	Germination %
0 ppm water	66.9 ± 4.3
500 ppm	58.2 ± 4.2
1000 ppm	57.5 ± 2.5
1400 ppm	72.5 ± 4.3
1800 ppm	74.3 ± 4.6

Percentage germination ± standard deviation average of 8 replications.

TABLE 6

Influence of different concentrations of salt solution on the germination of two pea varieties, Puget (V_2) and Sprite (V_3) .

Concentration of salt %	Germination % V_2	Germination % V_3
0 % water	93.8 ± 4.1	92.5 ± 2.5
0.5 %	95.0 ± 3.5	93.8 ± 4.2
1.0 %	80.0 ± 3.5	82.5 ± 2.5
1.5 %	76.3 ± 4.1	40.0 ± 3.5
2.0 %	21.3 ± 2.1	22.5 ± 2.5
2.5 %	3.8 ± 4.2	3.8 ± 4.2

Percentage germination ± standard deviation :
Average of 4 replications .

TABLE 7

The effect of pre- treatment with various calcium salts on the germination of two pea varieties with 1.5 % salt solution and zero dry period .

Varieties / Pre-treat.	Germination % V_2	Germination % V_3
0 ppm water	80.0 ± 0.0	71.3 ± 4.2
10.000 ppm $CaCl_2 \cdot 2H_2O$	75.0 ± 3.5	58.8 ± 4.1
10.000 ppm $CaBr_2 \cdot 2H_2O$	88.8 ± 4.2 *	82.5 ± 2.5 *
10.000 ppm $Ca(CH_3COO)_2$	72.5 ± 4.3	57.5 ± 2.5
10.000 ppm $Ca(NO_3)_2 \cdot 4H_2O$	77.5 ± 4.3	56.3 ± 4.2
1.800 ppm $CaSO_4 \cdot 2H_2O$	83.8 ± 2.2 *	82.5 ± 2.5 *

Percentage germination ± standard deviation average of 4 replications.

TABLE 8

The effect of pre-treatment with various calcium salts on the germination of two pea varieties with 1.5 % S.S. and 17h dry period .

Varieties / pre-treat.	Germination % V_2	Germination % V_3
0 ppm water	78.8 ± 2.2	70.0 ± 3.5
10.000 ppm $CaCl_2 . 2H_2O$	70.0 ± 5.0	51.3 ± 2.2
10.000 ppm $CaBr_2 . 2H_2O$	73.8 ± 4.1	45.0 ± 3.5
10.000 ppm $Ca(CH_3COO)_2$	62.5 ± 2.5	57.5 ± 2.5
10.000 ppm $Ca(NO_3)_2 . 4H_2O$	63.8 ± 2.2	71.3 ± 2.2
1.800 ppm $CaSO_4 . 2H_2O$	82.5 ± 2.5	76.3 ± 4.2

Percentage germination ± standard deviation average of 4 replications.

TABLE 9

The effect of pre-treatment with various calcium salts on the germination of two pea varieties with 1.5 % S.S. and 24h dry period .

pre-treat. \ Varieties	Germination % V_2	Germination % V_3
0 ppm water	76.3 ± 4.2	51.3 ± 5.4
10.000 ppm $CaCl_2 . 2H_2O$	62.5 ± 2.5	42.5 ± 2.5
10.000 ppm $CaBr_2 . 2H_2O$	73.8 ± 4.2	47.5 ± 2.5
10.000 ppm $Ca(CH_3COO)_2$	57.5 ± 4.3	46.3 ± 6.0
10.000 ppm $Ca(NO_3)_2 . 4H_2O$	48.8 ± 4.2	57.5 ± 2.5
1.800 ppm $CaSO_4 . 2H_2O$	75.0 ± 3.5	57.5 ± 2.5

Percentage germination ± standard deviation average of 4 replications.

TABLE 10

The effect of pre-treatment with various calcium salts on the germination of two pea varieties with 1.5 % S.S. and 1 week dry period.

Varieties / pre-treat.	Germination % V_2	Germination % V_3
0 ppm water	22.5 ± 2.5	21.3 ± 2.2
10.000 ppm $CaCl_2 . 2H_2O$	17.5 ± 2.5	15.0 ± 5.0
10.000 ppm $CaBr_2 . 2H_2O$	15.0 ± 3.5	22.5 ± 2.5
10.000 ppm $Ca(CH_3COO)_2$	13.8 ± 4.1	26.3 ± 2.2
10.000 ppm $Ca(NO_3)_2 . 4H_2O$	15.0 ± 3.5	18.8 ± 2.2
1.800 ppm $CaSO_4 . 2H_2O$	15.0 ± 5.0	21.3 ± 2.2

Percentage germination ± standard deviation average of 4 replications.

TABLE 11

The effect of pre-treatment with various calcium salts on the germination of two pea varieties with 1.5 % S.S. and 2 weeks dry period.

Varieties / pre-treat.	Germination % V_2	Germination % V_3
0 ppm water	18.8 ± 2.2	16.3 ± 4.2
10.000 ppm $CaCl_2 \cdot 2H_2O$	15.0 ± 3.5	16.3 ± 2.2
10.000 ppm $CaBr_2 \cdot 2H_2O$	16.3 ± 4.2	17.5 ± 2.5
10.000 ppm $Ca(CH_3COO)_2$	11.3 ± 2.2	17.5 ± 4.3
10.000 ppm $Ca(NO_3)_2 \cdot 4H_2O$	12.5 ± 4.3	11.3 ± 2.2
1.800 ppm $CaSO_4 \cdot 2H_2O$	15.0 ± 5.0	18.8 ± 4.2

percentage germination ± standard deviation average of 4 replications.

TABLE 12

Effect of different $CaBr_2 \cdot 2H_2O$ concentration on pea varieties germination under saline media (1.5 %) with zero dry period.

Conc. of pre-treat. \ Varieties	Germination % V_2	Germination % V_3
0 ppm water	76.3 ± 4.2	67.5 ± 5.5
5.000 ppm	81.3 ± 2.2	72.5 ± 7.5
10.000 ppm	90.0 ± 5.0 *	*85.0 ± 3.5
20.000 ppm	83.8 ± 4.2	78.8 ± 2.2
30.000 ppm	80.0 ± 0.0	73.8 ± 4.2

Percentage germination ± standard deviation average of 4 replications .

TABLE 13

Effect of different $CaSO_4 \cdot 2H_2O$ concentration on pea varieties germination under saline media (1.5 %) with zero dry period .

Conc. of pre-treat. \ Varieties	Germination % V_2	Germination % V_3
0 ppm water	77.5 ± 4.3	71.3 ± 2.2
5.00 ppm	68.8 ± 4.2	72.5 ± 4.3
1.000 ppm	75.0 ± 5.0	71.3 ± 4.2
1.400 ppm	85.0 ± 3.5*	*86.3 ± 4.2
1.800 ppm	82.5 ± 4.3*	*81.3 ± 2.2

Percentage germination ± standard deviation average of 4 replications.

PART B GROWTH STAGE

3.4 EXPERIMENTAIL

3.4.1 MATERIALS AND METHODS

Pea (pisum sativum L.) varieties (Meteor V_1 was missing) , Puget (V_2) and Sprite (V_3) were used in this experiment (growth stage) also used optimum pre-treatment materials and dry periods which were determined from previous experiments (part A germination stage) . Pretreatment and treatment regimes were as follows : -

T_1 - Soaking in water, and zero dry period

T_2 - Soaking in 1 % $CaBr_2 \cdot 2H_2O$ = =

T_3 - Soaking in 0.14 % $CaSO_4 \cdot 2H_2O$ dry period

T_4 - Soaking in 0.18 % $CaSO_4 \cdot 2H_2O$ = =

Seeds were soaked in about 50 % of their weight of water or pretreatment solution in 100 ml glass beakers (for more details see 2.4.1) .

3.5 RESULTS

The beneficial effect of $CaBr_2$ and $CaSO_4$ presowing treatments on phenological observation of the pea varieties with zero dry period are presented in Table 14 and 15 .

Variety Puget showed a response in germination percentage under treatment two (T_2) Calcium bromide also showed a benefit with respect to avarage fresh weight under the same treatment and did not show any response for any other phenologic observations made (Table 14) .

Variety Sprite showed a significant increase in germination percentage for all treatments and also showed a response for average height only with treatment two (T_2), and did not show any response for all other phenologic observations made (Table 15).

The effect of soaking on contents of some mineral elements in the seedling of pea varieties are presented in Tables 16 and 17 .

Calcium and sodium contents were significantly greater in pea seedlings (variety Puget) under treatments two and three . Magnesium content was significantly greater under treatment three (T_3). Meanwhile potassium did not show any response (Table 16) .

Variety Sprite did not show any response for all elements, except that the sodium content was significantly greater under treatment two (T_2) as demonstrated in Table 17 .

TABLE 14 Phenologic observations on pea development (V_2)

Treatment	Germination %	Average height cm.	Average fresh wt.g.	Average dry wt. g.	Average root length cm.
Soaking in water, zero dry period	79.2 ±	7.4 ±	3.65 ±	0.36 ±	7.52 ±
T_1	4.2	0.19	0.3	0.03	0.3
Soaking in 1 % $CaBr_2 \cdot 2H_2O$ = =	95.9 ± *	7.08 ±	4.96 ±*	0.4 ±	7.2 ±
T_2	4.2	0.26	0.04	0.02±	0.27
Soaking in 0.14 % $CaSO_4 \cdot 2H_2O$ = =	89.6 ±	6.1 ±	3.23 ±	0.32 ±	6.22 ±
T_3	3.6	0.16	0.19	0.05	0.2
Soaking in 0.18 % $CaSO_4 \cdot 2H_2O$ = =	85.4 ±	6.4 ±	3.41 ±	0.41 ±	7.5 ±
T_4	3.6	0.16	0.38	0.05	0.39

Standard deviation average of 4 replications.

Cont.

TABLE 15 Phenologic observation on pea development (V_3)

Treatment	Germination %	Average height cm.	Average fresh wt. g.	Average dry wt. g.	Average root length cm.
Soaking in water, zero dry period	70.9 ±	8.3 ±	4.28 ±	0.39 ±	5.5 ±
T_1	3.2	0.23	0.16	0.01	0.37
Soaking in 1 % $CaBr_2 \cdot 2H_2O$ = =	89.6 ± *	9.27 ±*	3.03 ±	0.29 ±	6.0 ±
T_2	3.6	0.29	0.14	0.03	0.35
Soaking in 0.14% $CaSO_4 \cdot 2H_2O$ = =	87.5 ±*	8.41 ±	4.08 ±	0.38 ±	5.45 ±
T_3	4.2	0.26	0.3	0.04	0.14
Soaking in 0.18% $CaSO_4 \cdot 2H_2O$ = =	85.4 ± *	8.07 ±	4.5 ±	0.44 ±	6.45 ±
T_4	3.6	0.16	0.12	0.03	0.2

Standard deviation average of 4 replications .

TABLE 16 Effect of soaking on contents of some mineral elements in the seedling of Puget (V_2) under 1.5 % salt medium (Data expressed as %)

Treatment	Ca %	Mg %	Na %	K %
Soaking in water, zero dry period	0.146 ±	1.0 ±	1.0 ±	2.74 ±
T_1	0.01	0.09	0.23	0.26
Soaking in 1% $CaBr_2 \cdot 2H_2O$ = =	0.289 ±	1.37 ±	1.5 ±	3.42 ±
T_2	0.04 *	0.11 *	0.06 *	0.37
Soaking in 0.14% $CaSO_4 \cdot 2H_2O$ = =	0.234 ±	1.32 ±	1.26 ±	2.81 ±
T_3	0.02 *	0.09 *	0.07 *	0.2
Soaking in 0.18% $CaSO_4 \cdot 2H_2O$ = =	0.24 ±	1.18 ±	1.38 ±	2.82 ±
T_4	0.15	0.09	0.11	0.21

Standard deviation average of 4 replications.

Cont.

TABLE 17 : Effect of soaking on contents of some mineral elements in the seedling of Sprite (V_3) under 1.5 % salt medium (Data expressed as %)

Treatment	Ca %	Mg %	Na %	K %
Soaking in water, zero dry period	0.16 ±	1.19 ±	1.15 ±	3.15 ±
T_1	0.02	0.23	0.09	0.13
Soaking in 1% $CaBr_2 . 2H_2O$ = =	0.18 ±	1.02 ±	1.11 ±	2.5 ±
T_2	0.02	0.11	0.03 *	0.11
Soaking in 0.14% $CaSO_4 . 2H_2O$ = =	0.2 ±	1.208 ±	0.95 ±	3.18 ±
T_3	0.02	0.06	0.08	0.18
Soaking in 0.18% $CaSO_4 . 2H_2O$ = =	0.2 ±	1.283 ±	1.2 ±	2.96 ±
T_4	0.02	0.05	0.14	0.17

Standard deviation average of 4 replications.

3.6 Disussion

Before starting pretreatments in this chapter a general check on salt tolerance for pea varieties was made to determine the optimum salt level which could be used in subsequent experiments. Different concentrations of salt were used. Germination percentage decreased with high salt concentration, Corespondingly more seeds suffered from irreversible salt effects either through toxicity or predisposal to other deteremintal effects in their enviroment. A suitable salt level was 1,5 % for all varieties. Five calcium salts and different dry periods were also included as treatments. The first time, variety Meteor was used, it showed a response in germination percentage when soaked in 10,000 p.p.m of $Ca(NO_3)_2$ and 1,800 ppm of $CaSO_4$ (Table 2). Due to their beneficial effects additional studies have been made to determine optimum pretreatment concentrations but the results showed no effect (Table 4 and 5).

Unfortunately the variety Meteor was not available for this further work. Another two pea varieties, Puget and Sprite, were used to continue the research. They consistantly responded only to $CaBr_2$ and $CaSO_4$ concentrations of 10,000 and 1,800 ppm respectively. The promotive effect of $CaSO_4$ on germination percentage shown earlier with variety Meteor was confirmed in these experiment. All pea varieties did not show any response in terms of dry periods. Inspection of the experimental data indicated that the $CaSO_4$ 1,800 ppm was more conducive than the other to increase germination percentage for pea varieties. Also the 1,400 ppm concentration benefited both varieties whereas low concentrations did not show any beneficial effect. All experiments were under saline conditions. A pot experiment was carried out to develop this work using the optimum calcium salt and suitable concentrations which were determined previously. The data showed that the plants as stated responded only slightly both in terms of phenological observations and in mineral element contents (Tables 14, 15 , 16 and 17). Despite these results which were not too encouraging, it was felt that this work should be developed further by including different factors such as changing the tempreature of soaking , the different soaking period and different varieties etc.

CHAPTER FOUR

INFLUENCE OF GROWTH REGULATORS, CALCIUM, PEROXIDE AND HYDROGEN PEROXIDE AND GARLIC, AND ONION EXTRACT PRETREATMENTS ON GERMINATION AND GROWTH STAGE OF BARLEY VARIETIES UNDER SALINE CONDITIONS

PART (A) INFLUENCE OF GROWTH REGULATORS (GERMINATION STAGE)

4.1. (i) INTRODUCTION

It is now accepted that there are at least three major classes of growth promoting hormones- auxins, gibberellins and cytokinins. In addition, other classes of plant hormones exist, particularly the growth inhibitors such as abscisic acid (ABA) but also including a gas, ethylene, which is involved in many growth phenomena. Growth hormones are translocated within the plant, and influence the growth and differentiation of the tissues and organs with which they come in contact.

It has been reported that spraying spurshoots of apricot with gibberellin (GA) stimulates combial activity and leads to increased xylem development (Bradley and Crane, 1957). On the other hand, it is well known that indole - acetic acid stimulates cambial activity.

Leopold and Thimann (1949) pointed out that winter barley responded to very low concentrations of α- naphthalene acetic acid (NAA) by a distinct increase in the number of flower Primordia over the controls. At 0.01 µg / L. this promotion was as high as 35 % . Higher concentrations had the opposite effect inhibiting flower formation more and more strongly as the concentration increased. Brian, Hemming and Radley (1955) reported that gibberellin (GA) increased extension growth of wheat coleoptile sections. It elicited a maximum response at a concentration of 0.01 ug/ml. A further increase in concentration to 100 ug/ml did not significant increase activily than indole acetic acid (IAA) at the same concentration. Optimum concentration of IAA (10 ug/ ml) induced a much greater response than GA. The effect of GA was more than IAA in inducing extension of pea stem sections , but an increase in concentration of GA above 0.1 ug/ ml. did not increase or decrease response. GA did not increase water uptake by potato tuber tissue. Marth, Audia and Mitchell (1956) reported that increases in stem length of a number of woody perennials followed application of GA. Brian and Hemming (1958) stated that the GA induced extension of green pea - stem sections in light only if an auxin was also present and they said excised internodes from plants pre - treated with GA extended appreciably faster in vitro than those from untreated plants only if an auxin was supplied in the incubation medium .

Many investigators have reported beneficial results by the application of various synthetic hormones in the development of the cotton plant and the yield of seed cotton (Eaton, 1950) . It has been found that the plant hormones enhance flowering and reduce boll shedding , thereby increasing the yield to some extent . Munshi and Lyengar (1967) indicated that a water spray containing 10 ppm of α - NAA treatments was beneficial with respect to this property at the flowering stage or when plants have 4 to 5 leaves . But higher doses of 20 ppm did not give a significant increase in mean fiber length over the control and physical properties of 320 F cotton on the whole were not significantly influenced by α - NAA treatments .

Digby and Wareing (1966) showed that the applied IAA and GA stimulated division in the intact cambium and also that IAA promoted cell enlargement . Also they stated that there was an increase in cell number of the culture with increase in IAA concentration the optimum being between 1 and 2.5 ppm . At higher concentrations there is significant inhibition of cell division . They also showed an increase in mean cell size with increase in IAA concentration and GA alone increased the rate of cell division of the cambial cells in suspension culture . Unlike IAA , it did not inhibit at higer hormone concentrations. With IAA and GA in combination there is a slight increase in cell number as compared with the treatment using GA alone. But there is a marked decrease in mean cell size with increase in hormone concentration when GA was used alone which is associated with , but opposite to the increase in cell number . They also showed that each of the three hormones promotes some cell division when applied alone .

Nieman and Bernsten (1959) reported that the GA when applied as a spray to primary leaves of dwarf red kidney bean plants, in concentration of 10 and 100 ppm increased the stem length fresh and dry weight of both the top and the roots , the yield of green beans , area per leaf , and the total leaf area per plant . Arney and Mancinell (1965) suggest that the primary effect of GA is to stimulate cell division in the apical and subapical meristems in the Meteor pea stems and they said the increased cell elongation which also results from applications of GA is probably a secondary effect mediated through increased auxin production resulting from the increased cell division , or in the case of the pith, a purely passive stretching imposed by the increased growth of the outer tissues.

4.1.(ii) Effect of hormone presoaking on emergence and growth of some plants

The effects of different concentrations of phyto-hormones as a presowing treatment on seed germination and growth have been discovered by many workers. Henkel (1954), Bhardwaj and Rao (1955), Gandhi and Bhatnagar (1961) and Sankhla and Muthur (1968) reported that the germination , growth and yields of a few crops can be enhanced by soaking seed for 24 hours in the phytohormones at different concentrations and with inorganic salts. Asana, Mani and Prakash (1955) , Dave, and Gaur (1970), Singh and Dara (1971) showed significant effects on growth and yield of some crop species grown under saline conditions when pre-soaking seeds with optimal concentrations of phytohormones. Sankhla and Mathur (1968) reported that the percentage germination of cumin seed after treatment by the growth regulating substances IAA, NAA and GA had beneficial effects under 25, 50 and 100 ppm Shannan and Francois (1977) reported that the hormones GA, IAA, Kinetin, β furfuylaminopurine and adenosine when used as pretreatments in cotton seed did not significantly increase germination rate.

The high accumulation of salts in the root zone disturbs the equilibrium between the soil moisture and cell sap of the seed, thereby decreasing the physiological availability of water needed for optimum germination and plant growth and leads to poor gemination of seeds (Eaton 1942, 1944 ; Richards 1954 ; Hayward and Bernstein 1958). Also Shah and Loomis (1965) confirm that the major effect of salinity in the root enviroment may be attributed to a reduced hormone delivery from root to leaves, which inhibits crop growth. Wheat seeds treated with GA or an auxin may be beneficial for seedling development at higher osmotic pressure levels where seed emergence and seedling growth usually get a setback, (Darra, Seth, Singh and Mendiratta, 1973). For a particular set of conditions, however, the benefits may depend upon the selection of the optimum hormone concentration. The beneficial effects of growth promoters under high osmotic pressure situations may be produced by increased physiological availability of water and nutrients. Darra, Jain and Singh (1969) reported that the soaking of wheat variety S 227 with growth regulators, (GA , IAA , IBA , NAA) and salts (sodium chloride and potassium dihydrogen phosphate) had significant effects on the germination , which increased up to 75 percent , whereas by soaking the seeds with salts the germination increased up to 77 percentage. The net increase in the percentage of germination over unsoaked seeds under various growth-regulators and salts was from 21 to 47 percentage under different sets of conditions.

Bird and Ergle (1961) found that cotton cultivars varied in response to GA. They suggested that this variation may account for varying degrees of success by others who have used this chemical. GA has been shown to be effective for increasing germination of several weed species (Holm and Miller 1972). Cole and Wheeler (1974) evaluated the effect of pre- conditioning seed, which was soaked in GA solutions or water, on germination of G. Barbadense Pima S.4 . Both seed treatments reduced chilling injury during early periods of germination.

Therefore, in this study an attempt was made to discover the effect of soaking and dry period on the seeds of three barley varieties with two concentration levels, 50 and 100 ppm of three phytohormones NAA, IAA and GA upon their germination and subsequent growth under saline media.

4.2 EXPERIMENTAL

4.2.1 MATERIALS AND METHODS

Three barley varieties (Hordeum vulgare L.) Godmarker (V_1), Triumph (V_2), and Igri (V_5) were used throughout these five experiments. Seeds soaked for 7 hour at 19 $\pm$ 2^{o}C in 100 ml beakers containing 50 ml of growth regulator solution. Growth regulators used for pre - soaking were at two levels, 50 and 100 ppm from α- naphthalene acetic acid (NAA) , 3 - indole acetic acid (IAA) and gibberellic acid (GA). Seeds soaked in distilled water served as the control, (for more details see 2.2.1) .

One more experiment (No. 6) was carried out to cover the effect of GA between 17 hour and one week , because the results under 17 hour dry period were beneficial. The dry periods chosen were 1 , 2, 3 and 4 days. Also one more level of GA was included .

4.3 Results

Experiment one was a general test on barley varieties (Gadmarker , Triumph , Igri) to assess their tolerance to different salt concentration treatments. The data in Table 1 showed a progressive increase in suppressed germination as shown by the declining values for all growth, particularly the sharp fall after 2.0 % . Variety Igri was more sensitive than the other varieties to the salt.

In experiment two, the data showed that both levels of gibberellic acid (GA) increased germination percentage more than the other auxins. This was true for all varieties, but the 100 ppm level gave a higher increase than 50 ppm

Variety Triumph showed some response under 100 ppm NAA and both levels of IAA. Variety Igri was less responsive than the other varieties to the growth regulators (see Table 2) .

In experiment three the results showed (Table 3) under 17 hours dry period, an overall increase in germination percentage compared with previous experiments (No. 2) . Gibberellic acid showed a clearer effect than the other growth regulators, particularly under 100 ppm which was higher than the 50 ppm concentration. Variety Igri was less responsive than the other varieties to the growth regulators as shown in experiment two .

In experiment four, the results generally showed (Table 4) an overall decrease in germination compared with a 17 hours dry period . Significant increases were show by NAA and IAA in germination percentage for Gadmarker. Varieties Gadmarker and Triumph, both gave relatively high responses to NAA and IAA for all concentrations compared with experiment three. Variety Igri did not show any response.

In experiment five the data (Table 5) did not show any increase in germination over the previous experiment , therefore no more work on extending the dry period was carried out .

In experiment six the data (Table 6) did not show any increase in germination percentage with all barley varieties tested with dry period beyond 17 hours and GA concentrations beyond 100 ppm.

4.4 Discussion

The results mentioned in experiments (2 - 6) suggest that the soaking of the seeds of 3 barley varieties with gibberellic acid and an auxin were beneficial for germination under salt conditions where seed emergence usually decreased. Seed germination was reduced when high concentrations were used, possibly due to their toxic effects. This type of result was also observed by Bhardwaj (1962) and Salim and Todd (1968). The treatment with 100 ppm GA and a 17 hours dry period was more effective than the others. This result is also in agreement with foundings in chapter two.

The beneficial effects of growth regulators depend upon many factors like length of soaking, length of dry period after soaking, selection of the optimum hormone, temperature of soaking, light intensity etc. The reason for beneficial effects of hormones is probably due to increased physiological availability of water and nutrients.

TABLE 1

Influence of different concentrationsof salt solution on the germination of three varieties of barley grains

Concentration of salt %	Germination % V_1	Germination % V_2	Germination % V_5
0 % water	96.6 ± 2.4	97.5 ± 2.8	96.7 ± 3.4
1 % salt solution	65.8 ± 2.8	74.2 ± 3.6	60.8 ± 4.9
1.5 % salt solution	55.0 ± 3.7	61.6 ± 3.7	28.3 ± 2.9
2.0 % salt solution	36.6 ± 4.6	25.0 ± 3.7	7.5 ± 2.8
2.5 % salt solution	13.3 ± 3.3	9.2 ± 2.8	1.7 ± 1.7
3.0 % salt solution	0.0	0.0	0.0

Percentage germination ± standard deviation.

Average of 4 replications.

TABLE 2

The effect of zero time dry period and different concentrations of growth hormones on germination of barley varieties in 1.5 % salt media .

Pre-treatment \ Varieties	Germination % V_1	Germination % V_2	Germination % V_5
Control water 0 p.p.m	50.8 ± 2.7	40.8 ± 2.8	26.6 ± 2.4
NAA 100 p.p.m	35.8 ± 1.4	52.5 ± 2.7*	34.9 ± 3.0
NAA 50 p.p.m	36.7 ± 2.3	41.7 ± 1.7	30.8 ± 2.8
IAA 100 p.p.m	56.6 ± 2.4	55.0 ± 3.7*	33.3 ± 3.3
IAA 50 p.p.m	49.1 ± 2.7	55.0 ± 1.7*	32.5 ± 2.7
GA 100 p.p.m	77.5 ± 2.8*	62.5 ± 2.7*	43.3 ± 3.3*
GA 50 p.p.m	62.5 ± 3.3*	54.1 ± 2.7*	36.6 ± 2.4*

Percentage germination ± standard deviation .

Average of 4 replications .

TABLE 3

The effect of 17 hours dry period and different concentrations of growth hormones on germination of barley varieties in 1.5 % salt medium .

Varieties / Pre-treat.	Germination % V_1	Germination % V_2	Germination % V_5
Control 0 p.p.m water	73.3 ± 2.3	75.8 ± 3.6	66.6 ± 2.4
NAA 100 p.p.m	66.6 ± 2.3	77.5 ± 1.5	61.6 ± 2.7
NAA 50 p.p.m	67.5 ± 2.8	75.8 ± 2.8	54.1 ± 2.7
IAA 100 p.p.m	65.8 ± 2.8	67.5 ± 2.8	62.5 ± 2.7
IAA 50 p.p.m	67.5 ± 2.7	64.2 ± 4.3	56.6 ± 2.4
GA 100 p.p.m	95.8 ± 1.4*	95.0 ± 2.8*	87.5 ± 1.4*
GA 50 p.p.m	76.6 ± 24	78.3 ± 3.8	68.3 ± 2.9

Percentage germination ± standard deviation.

Average of 4 replications.

TABLE 4

The effect of 1 week dry period and different concentrations of growth hormones on germination of barley varieties in 1.5 % salt medium .

Varieties / Pretreatment	Germination % V_1	Germination % V_2	Germination % V_5
Control 0 p.p.m water	67.5 ± 1.5	74.1 ± 2.7	55.0 ± 3.7
NAA 100 p.p.m	75.8 ± 1.4*	78.3 ± 1.7	52.5 ± 2.7
NAA 50 p.p.m	75.0 ± 1.7*	78.3 ± 2.9	53.3 ± 2.3
IAA 100 p.p.m	75.8 ± 1.4*	73.3 ± 4.1	58.3 ± 1.7
IAA 50 p.p.m	79.1 ± 4.2*	75.8 ± 2.7	52.5 ± 4.3
GA 100 p.p.m	71.7 ± 1.7	80.0 ± 4.1*	50.8 ± 4.3
GA 50 p.p.m	69.1 ± 2.8	64.1 ± 2.7	49.1 ± 4.3

Percentage germination ± standard deviation.

Average of 4 replications.

TABLE 5

The effect of 2 weeks dry period and different concentrations of growth hormones on germination of barley varieties in 1.5 % salt medium .

Pretreatment \ Varieties	Germination % V_1	Germination % V_2	Germination % V_5
Control 0 p.p.m water	59.1 ± 2.7	75.0 ± 2.9	53.3 ± 4.1
NAA 100 p.p.m	67.5 ± 4.3	52.5 ± 2.7	31.7 ± 1.7
NAA 50 p.p.m	64.1 ± 2.7	61.7 ± 1.7	56.6 ± 2.4
IAA 100 p.p.m	66.6 ± 4.1	53.3 ± 3.3	53.3 ± 3.3
IAA 50 p.p.m	62.5 ± 2.7	55.0 ± 5.0	44.1 ± 2.7
GA 100 p.p.m	64.1 ± 2.7	78.3 ± 3.7	43.3 ± 4.1
GA 50 p.p.m	65.8 ± 2.8	72.5 ± 2.7	50.0 ± 3.4

Percentage germination ± standard deviation.

Average of 4 replications.

TABLE 6

The effect of different dry periods and concentrations of GA on germination of barley varieties .

	conc. Pre-treat. \ Dry Period	1 day	2 day	3 day	4 day
V_1	0 p.p.m control	85.0 ± 3.7	85.0 ± 1.7	79.1 ± 2.8	73.3 ± 4.0
	GA 100 p.p.m	91.6 ± 3.7	85.8 ± 2.8	79.2 ± 1.5	74.1 ± 2.7
	GA 150 p.p.m	84.1 ± 2.7	78.3 ± 1.7	78.3 ± 1.7	71.7 ± 1.7
V_2	0 water control	85.8 ± 1.4	85.0 ± 3.7	85.8 ± 1.4	81.6 ± 5.0
	GA 100 p.p.m	93.3 ± 2.3	90.0 ± 5.7	85.0 ± 5.0	85.0 ± 1.7
	GA 150 p.p.m	81.7 ± 1.7	79.2 ± 1.5	71.7 ± 1.7	66.6 ± 2.3
V_5	0 water control	82.5 ± 1.4	83.3 ± 3.3	79.2 ± 3.6	80.8 ± 5.0
	GA 100 p.p.m	85.0 ± 1.7	81.7 ± 1.7	73.3 ± 4.1	75.8 ± 4.3
	GA 150 p.p.m	80.8 ± 4.3	77.5 ± 6.3	80.8 ± 1.4	63.3 ± 2.7

Percentage germination ± standard deviation. Average of 4 replications .

PART (B) CALCIUM AND HYDROGEN PEROXIDE EFFECTS ON THE GERMINATION STAGE

4.5 INTRODUCTION

Peroxide is used in domestic detergents, and is also very widely used in industry, for example used for paper pulp manufacture and for bleaching cotton. Hydrogen peroxide (H_2O_2) has long been known to be effective for seed sterilization (Riffle and Spring Field, 1968 ; Trappe, 1961) . Increased temperatures have led to legume injury with a 10 - 15 % hydrogen peroxide treatment for 30 minutes (Walter and Erdman, 1926) . Beneficial effects other than seed sterilization have been observed with hydrogen peroxide; eg, dilute solutions 1 % or less have increased germination rates for seeds of Pinus (Ching and Parker, 1958 ; Migita and Takahashi, 1956) , Acre seeds (Trappe, 1961) , Abies seeds (Ching and Park, 1958), Cryptomeria seeds (Migita and Takahashi, 1956) and Pseudotsuga (Ching and Park, 1958 ; Shearer and Tackle, 1960). However, harsh treatment with 30 % hydrogen peroxide for 30 minutes (Riffle and spring field, 1968) and 35 % for 60 minutes (Trappe, 1961) have also increased germination of seeds of various trees and shrubs.

Soaking Phaseolus vulgaris seeds in dilute hydrogen peroxide for up to 24 hours before, during, or after soaking in water prevented the usual water soaking injury (reduced germination and growth of survivors) and was slightly stimulatory to subsequent growth (Orphanos and Heydecker , 1968).

Germination and emergence were improved for sugar beet (Beta vulgaris US H_2O) , soybean (Glycine max corsoy), and navy bean (phaseolus vulgaris seafarer) when seeds were soaked in as little as 0.25 % hydrogen peroxide for four hours unless the seeds were dried befor planting , in which case cracking and reduced germination occurred (Smucker and Leep , 1975). Helton and Dilbeck (1982) treated two groups of seeds of Pisum Sativum, - Alaska and Garfield with different concentrations of hydrogen peroxide and different soaking periods. Although most treatments enhanced plant performance for both cultivars there were substantial differences for the various types of growth measured . Considering all measurement categories collectively , the single treatment that was as good or better than other treatments for both cultivars was immersion of seeds in 30 % hydrogen peroxide for 45 minutes.

It has been found that peroxides in a newly devised technique , can increase the germination and improve seedling vigour for farm crops in recent years. ADAS soil scientist Vaidyanathan (1980) found that soaking of commercial sugar beet seeds always increased germination percentage compared with untreated seeds. When he worked with seedbed salts, he knew that there was a lot of nitrate salts to be found in sugar beet seedbeds . These salts impede germination. There is also a suggestion that the germination is disturbed when oxygen is lacking therefore more oxygen is needed . Beet seeds contain germination inhibitors which are water soluble. So he thought that if he could apply extra oxygen and change the inhibtor whilst at the same time washing off, or sterilising the seeds , then germination would be increased. However, he found in the laboratory that hydrogen peroxide gave significant results as well as in the field.

In 1976 Vaidyanathan obtained good results with commercially availble seed of three varieties for both roots and sugar yield, when treated with hydrogen peroxide compared with the control. Also in 1976 and 1977 the biggest responses to hydrogen peroxide were seen. He found an average 38 % increase in sugar dry weight . In 1978 he worked with calcium and magnesium peroxides in the pellet. Early figures showed increases in germination were obtained. He found 8 % advantage in using the hydrogen peroxide with Amono sugar beet variety in 1979 at 21 days after drilling and 23 % when the seed was treated with magnesium peroxide and there was a 27 % boost when the calcium peroxide was used.

The object of this part of chapter four was to determine the soaking effect on barley varieties of different concentrations of calcium and hydrogen peroxide and different dry periods under saline media to choose good germination percentage conditions for subsequent growth stage experiments in pots.

4.6 Experimental

4.6.1 Materials and methods

The same barley varieties which were mentioned in previous experiments in this chapter have been used. Seven experiments were carried out , each one was replicated four times . Two levels of calcium and hydrogen peroxide (0.1 and 0.2 %) , four dry periods (0, 17 hours, 1 and 2 weeks) for experiments 1 , 2 , 3 , and 4 were used. Experiment 5 was a further study using the variety Godmarker with four levels of calcium peroxide concentrations and four different dry periods (1 , 2 , 3 and 4 days) .

Four levels of calcium peroxide (0.1, 0.2 , 0.3, and 0.4 %) and four different dry periods (1, 2, 3 and 4 weeks) were used for varieties Triumph and Igri each one in separate experiments No. 6 and 7 respectivly .

Seeds were soaked for seven hour at 16 $\pm$ 2 °C in 100 ml beakers containing 50 ml of pretreatment materials (for more details see 2.2.1) .

4.7 Results

In experiment one as a general rule the results showed low germination percentage (Table 1) . It seems that the effect of soaking for all pretreatments with zero dry period was not significant except for varieties Triumph and Igri which showed a response with 0.1 and 0.2 % calcium peroxide (CaO_2).

In experiment two the data (Table 2) showed on overall increase in germination percentage compared with experiment one. Variety Igri showed a lower response than the other varieties to the pretreatment . All varieties showed more response to CaO_2 than H_2O_2.

In experiment three, the results obtained in Table 3 showed that no further improvement in the germination percentage of Gadmarker variety was obtained by prolonging the dry period. In contrast the varieties Triumph and Igri showed a relative increase in germination compared with experiment two under 0.1 and 0.2 % CaO_2 . Hydrogen peroxide did not show any improvment for all varieties.

In experiment four, the data in Table 4 showed all varieties responded to the calcium peroxide but not all responded to hydrogen peroxide. Generally the results were lower than a one week dry period effect. With respect to the results which had been obtained from previous experiments, variety Gadmarker showed a high response under 0.1

and 0.2 % CaO_2 pretreatment effect and 17 hours dry period. No more effect beyond one week dry period was observed, therefore, it seems more study is needed to discover the effect between one and four day dry periods. However in varieties Triumph and Igri , germination appeared to increase in parallel to increasing dry period until 2 weeks. So, more study is needed to fix the optimum dry period and calcium peroxide concentration . Therefore three more experiments have been carried out - 5 , 6 and 7 .

In experiment five the results for Gadmarker variety (Table 5) appeared to give a significant effect on increased germination with all dry periods tested (1 - 4 day) , particularly with 0.1 calcium peroxide . But the optimum result was for treatment 1 day dry period and 0.1 % calcium peroxide concentration .

In experiment six , the data for Triumph variety was significant with all calcium peroxide concentrations with a 4 weeks dry period. But treatment 0.1 % CaO_2 concentration and 2 weeks dry period was very highly responsive (Table 6)

In experiment seven , the same thing applied for Igri variety . It was responsive to all dry periods (1 - 4 weeks) but the optimum effect was with treatment 0.1 % calcium peroxide and a 2 weeks dry period (Table 7) .

TABLE 1

The effect of zero dry period and different concentrations of calcium and hydrogen peroxide pretreatment on germination of 3 varieties of barley in 1.5 % salt medium .

Varieties / Pre-treatment %	Germination % V_1	Germination % V_2	Germination % V_5
Soaking with 0.0 water	49.1 ± 4.3	35.0 ± 3.7	20.0 ± 2.4
Soaking with 0.1 CaO_2	47.5 ± 2.8	67.5 ± 3.6*	41.6 ± 5.0*
Soaking with 0.2 CaO_2	58.3 ± 5.0	66.7 ± 3.4*	51.6 ± 3.7*
Soaking with 0.1 H_2O_2	30.0 ± 2.4	25.0 ± 3.7	31.6 ± 3.7
Soaking with 0.2 H_2O_2	29.2 ± 3.6	30.0 ± 3.4	29.1 ± 2.8

Percentage germination ± standard deviation.

Average of 4 replications .

TABLE 2

The effect of 17h dry period and different concentrations of calcium and hydrogen peroxide pretreatments on germination of 3 varieties of barley in 1.5 % salt medium

Varieties / pre-treatment %	Germination % V_1	Germination % V_2	Germination % V_5
Soaking with 0.0 water	71.6 ± 3.7	74.1 ± 2.7	60.0 ± 4.1
Soaking with 0.1 CaO_2	83.7 ± 1.7*	80.8 ± 2.8	76.7 ± 3.4*
Soaking with 0.2 CaO_2	81.6 ± 2.9*	80.0 ± 3.6	75.8 ± 2.8*
Soaking with 0.1 H_2O_2	65.0 ± 3.7	64.1 ± 3.6	49.1 ± 2.8
Soaking with 0.2 H_2O_2	65.8 ± 2.8	57.5 ± 4.3	32.5 ± 1.4

Percentage germination ± standard deviation.

Average of 4 replications.

TABLE 3

The effect of 1 week dry period and different concentrations of calcium & hydrogen peroxide pretreatments on germination of 3 varieties of barley in 1.5% salt medium

Varieties / pre-treatment %	Germination % V_1	Germination % V_2	Germination % V_5
Soaking with 0.0 water	65.0 ± 3.7	75.8 ± 3.6	65.7 ± 3.4
Soaking with 0.1 CaO_2	80.8 ± 2.8*	88.3 ± 3.7*	80.0 ± 2.4*
Soaking with 0.2 CaO_2	78.3 ± 2.9*	86.7 ± 3.4*	77.2 ± 1.5*
Soaking with 0.1 H_2O_2	43.3 ± 4.0	63.3 ± 2.3	55.8 ± 3.6
Soaking with 0.2 H_2O_2	55.0 ± 3.7	60.0 ± 2.4	54.2 ± 4.3

Percentage germination ± standard deviation.

Average of 4 replications .

TABLE 4

The effect of 2 weeks dry period and different concentrations of calcium and hydrogen peroxide pretreatment on germination of 3 varieties of barley in 1.5 % salt medium .

Pre-treatment % \ Varieties	Germination % V_1	Germination % V_2	Germination % V_5
Soaking with 0.0 water	56.6 ± 4.1	74.1 ± 2.7	58.3 ± 2.9
Soaking with 0.1 CaO_2	80.0 ± 2.4*	91.6 ± 3.7*	83.8 ± 2.6*
Soaking with 0.2 CaO_2	75.8 ± 3.6*	88.3 ± 3.7*	79.6 ± 2.3*
Soaking with 0.1 H_2O_2	48.3 ± 2.9	58.3 ± 3.7	45.0 ± 3.7
Soaking with 0.2 H_2O_2	49.1 ± 4.3	65.8 ± 3.6	44.2 ± 3.6

Percentage germination ± standard deviation.

Average of 4 replications .

TABLE 5

The effect of different dry periods and concentrations of calcium peroxide on germination of barley variety (Gadmarker (V_1))

Dry period / pre-treat. %	1 day	2 day	3 day	4 day
0 water	65.0 ± 3.7	58.3 ± 3.7	55.0 ± 3.7	41.6 ± 3.7
0.1 CaO_2	87.5 ± 2.7*	76.6 ± 2.4*	75.8 ± 2.8*	77.5 ± 1.5*
0.2 CaO_2	75.8 ± 2.8	78.3 ± 3.7*	75.0 ± 2.9*	78.3 ± 1.7*
0.3 CaO_2	58.3 ± 3.7	65.8 ± 3.6	72.5 ± 2.7*	69.1 ± 2.8*
0.4 CaO_2	57.5 ± 2.8	61.6 ± 3.7	62.5 ± 2.7	64.1 ± 2.7*

Percentage germination ± standard deviation .

Average of 4 replications .

TABLE 6

The effect of different dry periods and concentrations of calcium peroxide on germination of barley variety (Triumph (V_2)).

Conc. pretreat. % \ Dry Period	1 week	2 week	3 week	4 week
0 water	76.7 ± 5.3	78.3 ± 3.7	79.2 ± 3.6	64.9 ± 3.7
0.1 CaO_2	85.8 ± 2.8	95.0 ± 2.8*	86.6 ± 2.4	85.0 ± 2.9*
0.2 CaO_2	85.0 ± 2.9	86.6 ± 2.0	85.0 ± 2.9	80.8 ± 3.6*
0.3 CaO_2	75.8 ± 3.6	85.8 ± 2.8	85.8 ± 3.6	80.8 ± 2.8*
0.4 CaO_2	77.5 ± 4.3	83.3 ± 4.1	81.7 ± 2.9	78.3 ± 3.7*

Percentrage germination ± standard deviation.

Average of 4 replications .

TABLE 7

The effect of different dry periods and concentrations of calcium peroxide on germination of barley variety (Igri (V_5)) .

D. P. / conc. pretreat. %	1 week	2 week	3 week	4 week
0 water	54.1 ± 2.7	57.5 ± 2.8	46.6 ± 2.4	34.1 ± 2.7
0.1 CaO_2	79.2 ± 1.4*	84.1 ± 1.4*	71.6 ± 3.7*	70.8 ± 3.6*
0.2 CaO_2	76.7 ± 4.1*	78.3 ± 3.7*	73.3 ± 3.3*	70.0 ± 4.1*
0.3 CaO_2	65.0 ± 3.7	78.3 ± 1.7*	61.6 ± 3.7*	60.8 ± 2.8*
0.4 CaO_2	64.1 ± 2.7	62.5 ± 2.7	60.0 ± 2.4*	52.5 ± 2.7*

Percentage germination ± standard deviation.

Average of 4 replications .

4.8 Discussion

Results of experiments (1 - 7) indicate that barley varieties do not respond to zero time and beyond 2 week dry period with regard to increased germination. This conclusion conforms with the work discussed in chapter two. Calcium peroxide pretreatments (0.1 % with 1 day and 2 weeks dry period) gave much better germination subsequently in 1.5 % salt solution in the dark compared with hydrogen peroxide pretreatment. Although hydrogen peroxide was highly effective in Vaidyanathan's experiments with sugar beet it did not show any effect here in the barley varieties experiments, in contrast to calcium peroxide which showed a significant effect as Vaidyanathan found in his work . In this laboratory study it was shown that 0.1 % calcium peroxide and a 2 weeks dry period gave a beneficial effect for all varieties and looked very promising indeed as a pretreatment for barley varieties intended to be grown under saline conditions.

PART (C) ONION AND GARLIC EXTRACTS EFFECT ON GERMINATION STAGE

4.9 INTRODUCTION

Plant growth substances are present in most plants either in seeds or in the plants themselves , (Khan, et al; 1976) . Many people work on this subject identifying these substances by chromotography . Lenton and Saunders (1971) used new techniques to identify abscisic acid (ABA) in plant extracts (dry ungerminated seed) by gas chromotography. Also abscisic acid (ABA) has been shown by Milborrow (1967) to be present in the inhibitor B zone which occurs on paper chromotograms of many plant extracts (Bennett , Clark and Kefford , 1953) . However, the extracts have been studied by many workers. Shuck (1935) confirmed an inhibitory substance could be leached from lettuce seeds. He found that the water in which dormant seeds was kept was inhibitory to the subsequent germination of the same seeds. Since that time there have been other descriptions of inhibitory substances isolated from lettuce seeds. Speer and Tupper (1975) stated that lettuce seeds (Lactuca Sativa var. Grand Rapids and Great lakes) were found to contain inhibitory substances, one of which is probably abscisic acid. Extracts from seeds were characterized by gas liquid chromotography, and peaks coincident with abscisic acid were found. They found that the unpurified methanol extracts of both Grand Rapids and Great Lakes lettuce seeds inhibit germination when tested on these seeds. In both varieties the inhibitory substance is present, it is lost on dialysis and is effective on both varieties. Also Grand Rapids seeds germinate more in the presence of the inhibitor than do Great Lakes seeds.

Wareing and Foda (1956) described two separate zones from paper chromatograms of lettuce seed extracts that inhibited subsquent seed germination,

The effects of naturally - occuring inhibitors in seeds in controlling germination have received intensive attention . Evenari (1949) . Crocker and Barton (1953). Tool et al. (1957) , Mayer and Mayber (1963) have made many stúdies on the germination inhibitors and their possible role in the seed effecting germination. Fendall and Cande (1971) extracted growth inhibitors from seeds of dormant orchardgrass (Dactylis Glomerata L.) and found one - third of the inhibitors to be present in the lemma and palea and the remainder in the Caryopsis .

Salim and Tood (1968) used garlic extract with eight other dilute solutions as a presowing drought hardening treatment in wheat and barley seedling . The extracts did not showing beneficial effects. Kheradnam and Bassiri (1980) studied the effect of safflower seed extracts of two varieties Wild Safflower (WS) and Cultivated Safflower (CS) with the same seeds of varietães . WS seeds were quite sensitive to their own leachate and even the lowest concentration of the leachate caused significant reductions in their germination. Also WS seed leachate did not produce any significant effect on the germination of CS seeds. CS seed extract was used full - strength on WS and CS and was shown to decrease seed germination and seedling growth .

It seemed desirable , therefore to determine the effect of such garlic and onion extracts as presoaking treatments , on three barley varieties under saline conditions. Also it was decided to assess the effect of dry period, because not much work seems to have been done on this subject and some success had seemed with some crop pretreatmentsin previous chapters .

4.10 EXPERIMENTAL

4.10.1 Materials and methods

Garlic and onion extracts were prepared from one garlic lobe and onion piece weighing 2.5 gram. Both of them were crushed separated in distilled water and filtered. The filtrate was made up to 250 ml. Two levels of concentration from each one was carried out. The original concentration was 1 % , the other more dilute one was 0.5 % .

Six experiments were conducted to discover the Garlic and Onion extracts pre - treatment effect on three barley varieties . Pretreatment 7 hours at 19 $\pm$ 2 C^{o} in 100 ml. beakers containing 50 ml. of extract (for more details see 2.2.1) except for experiments 5 and 6 where the conditions differed only slightly. Different dry periods were used (1, 2, 3, and4 days) and different Onion extracts. The concentration levels used were 0.5 , 1 , 1.5 and 2 %

4.11 Results

Garlic and Onion extract pre - treatments did not show any significant increase in germination percentage for all barley varieties tested compared with their controls (Tables 1 , 2 , 3 and 4) . Throughout , four experiments were carried out (1 , 2 , 3 and 4). There are some effects for dry period. These were very clear and showed an increase in germination paralleled to an increase in dry period except for the 2 weeks dry period where a decline was noted . Inspite of the fact that the results were not significant , varieties Gadmarker and Triuumph showed high responses to onion extract with a 17 hours dry period compared with the others. So , it is worth while to study more about this increase and to discover whether this is a response . For this reason another two experiments were set up (5 and 6) . Neither experiment appeared to give significant results .

4.12 Discussion

Most but not all seed plant extracts have inhibitor growth hormones present and should be expected to show some beneficial effects either by using optimum concentrations or by the presence of growth promotion hormones. However, in this study, soaking of barley varieties for seven hours different dry periods and four levels of Garlic and Onion extracts (0.5 , 1 , 1.5 and 2 %) have been used. No beneficial effects were shown. The reason for these results was probably that the extracts in these experiments contained toxic substances which exerted their effects due to their high concentration in the extracts.

TABLE 1

The effect of zero dry period and different concentration pre - treatment of Garlic and Onion extracts on germination of barley varieties under 1.5 % salt medium .

Varieties / pre-treatment	germin. % V_1	germin. % V_2	germin. % V_5
Soaking with water as a control	45.0 ± 2.9	35.8 ± 4.3	20.8 ± 3.6
Soaking with 1 % Garlic extract	35.0 ± 3.7	30.8 ± 2.8	21.6 ± 3.7
Soaking with 0.5 % Garlic extract	35.8 ± 1.4	34.1 ± 2.7	22.5 ± 2.7
Soaking with 1 % Onion extract	36.6 ± 2.3	44.2 ± 4.3	25.8 ± 2.8
Soaking with 0.5 % Onion extract	48.3 ± 3.7	45.0 ± 3.7	27.5 ± 1.5

Percentage germination ± standard deviation .

Average of 4 replications .

TABLE 2

The effect of 17 hours dry period and different concentration pre- treatment of Garlic and Onion extract on germination of barley varities under 1.5 % salt medium .

Varieties / pre-treatment	germin. % V_1	germin. % V_2	germin. % V_5
Soaking with water as a control	68.3 ± 3.7	70.8 ± 2.8	60.8 ± 4.8
Soaking with 1 % Garlic extract	60.8 ± 3.6	45.8 ± 2.8	50.0 ± 2.4
Soaking with 0.5 % Garlic extract	55.8 ± 2.8	40.0 ± 3.4	40.0 ± 2.4
Soaking with 1 % Onion extract	55.0 ± 3.7	56.6 ± 2.4	67.5 ± 2.8
Soaking with 0.5 % Onion extract	55.3 ± 4.1	50.0 ± 2.4	60.0 ± 4.7

Percentage germination ± standard deviation .

Average of 4 replications .

TABLE 3

The effect of one week dry period and different concentration pre- treatment of Garlic and Onion extract on germination of barley varieties under 1.5 % salt medium .

Varieties / pre-treatment	germin. % V_1	germin. % V_2	germin % V_5
Soaking with water as a control	66.6 ± 2.4	70.0 ± 2.3	55.0 ± 1.7
Soaking with 1 % Garlic extract	65.8 ± 2.8	65.8 ± 4.9	49.1 ± 4.9
Soaking with 0.5 % Galric extract	62.5 ± 4.3	60.8 ± 3.6	41.6 ± 3.7
Soaking with 1 % Onion extract	70.8 ± 3.6	77.5 ± 2.8	57.5 ± 1.5
Soaking with 0.5 % Onion extract	66.7 ± 3.3	73.3 ± 3.3	57.5 ± 3.6

Percentage germination ± standard deviation .

Average of 4 replications.

TABLE 4

The effect of two weeks dry period and different concentration pre- treatment of Garlic and Onion extract on germination of barley varieties under 1.5 % salt medium .

Varieties / pre-treatment	germin. % V_1	germin % V_2	germin % V_5
Soaking with water as a control	55.8 ± 3.6	72.5 ± 1.4	53.3 ± 2.3
Soaking with 1 % Garlic extract	55.0 ± 3.7	55.0 ± 2.9	46.6 ± 5.7
Soaking with 0.5 % Garlic extract	50.8 ± 3.5	56.6 ± 2.4	45.8 ± 4.3
Soaking with 1 % Onion extract	61.6 ± 3.7	71.6 ± 5.0	55.8 ± 3.6
Soaking with 0.5 % Onion extract	60.8 ± 4.9	72.5 ± 3.6	50.0 ± 4.1

Percentage germination ± standard deviation .

Average of 4 replications.

TABLE 5

The effect of different dry period and pre-treatment concentration of Onion extract on germination of barley variety Gadmarker (V_1) under 1.5 % salt medium .

pre-treatment	1 day	2 day	3 day	4 day
Water 0 Control	65.0 ± 3.7	66.6 ± 2.4	68.3 ± 5.0	67.5 ± 4.9
0.5 %	60.8 ± 1.4	63.3 ± 4.1	66.6 ± 3.4	65.8 ± 2.7
1 %	69.1 ± 2.8	67.5 ± 1.5	72.5 ± 2.7	70.8 ± 2.8
1.5 %	70.8 ± 3.6	67.5 ± 1.5	62.5 ± 2.7	63.3 ± 3.3
2.0 %	58.3 ± 1.7	50.8 ± 4.9	55.0 ± 5.0	55.8 ± 4.3

Percentage germination ± standard deviation .

Average of 4 replications .

TABLE 6

The effect of different dry period and pre - treatment concentration of Onion extract on germination of barley variety Triumph (V_2) under 1.5 % salt medium .

Dry period / Concentration	1 day	2 day	3 day	4 day
Water as a control	71.6 ± 3.7	73.3 ± 3.3	65.8 ± 1.4	63.3 ± 3.3
0.5 %	75.8 ± 4.9	73.3 ± 3.3	71.6 ± 3.7	72.5 ± 1.4
1 %	75.0 ± 1.7	77.5 ± 2.8	69.2 ± 5.5	57.5 ± 2.8
1.5 %	62.5 ± 2.7	75.8 ± 2.8	56.6 ± 2.4	51.6 ± 5.0
2.0 %	61.6 ± 3.7	75.8 ± 2.8	54.1 ± 2.7	41.7 ± 2.9

Percentage germination ± standard deviation .

Average of 4 replication .

PART (D) GROWTH STAGE EXPERIMENT

4.13 EXPERIMENTAL

4.13.1 Materials and Methods

Barley grains (Hordeum vulgare L.) varieties Gadmarker (V_1) , Triumph (V_2) and Igri (V_5) which were used in previous experiment parts A , B , C (germination stage were used here in this growth experiment which was carried out in pots after optimum pretreatment material and dry period had been determined. The pretreatment and treament regime was as follows : -

T_1-	Soaking in	distilled water and 1 day dry period						
T_2-	=	=	0.1 g CaO_2	=	=	=	=	=
T_3-	=	=	distilled	=	= 17 hours	=	=	
T_4-	=	=	100 p p m GA	=	=	=	=	=
T_5-	=	=	distilled water	=	2 weeks	=	=	
T_6-	=	=	0.1g CaO_2 and	=	=	=	=	=
T_7-	=	=	distilled water	=	17 hours	=	=	
T_8-	=	=	100 p p m GA and	=	=	=	=	=
T_9-	=	=	distilled water	=	2 weeks	=	=	
T_{10}-	=	=	0.1g CaO_2 and	=	=	=	=	=

T_{11}- Soaking distilled water and 17 hours dry period

T_{12}- = 100 p p m GA = = = = =

Seeds were soaked in about 50 % of their weight of water or pretreatment solution in 100 ml glass beakers. The seeds were kept in a dark place at a temperature of 19 $\pm$ 2 ^{o}C for the required time as shown in the treatments. At the end of the soaking period, the seeds were rinsed in two changes of distilled water and spread out to air dry at room temperature. For more detailed see 2.4.1 .

4.14 RESULTS

The effect of different dry periods, GA and CaO_2 as presowing treatments on phenological properties of the barley varieties are presented in Table 1 .

Germination : Variety Gadmarker showed significant increase in germination percentage under CaO_2 and GA (T_2 and T_4) compared with the controls. Variety Triumph appeared to respond to CaO_2 as is clearly shown under T_6 and did not show an increase with GA. Variety Igri showed a significant increase with GA pretreatment T_{12} but did not show the same response with CaO_2 (T_{10}).

Plant Height : The average height of the plants for all varieties were increased significantly by GA (T_4, T_8 and T_{12}) whereas CaO_2 did not appear to have any effect, except variety Triumph (T_6).

Fresh and dry weight : No increase was effected for all varieties tested except CaO_2 (T_6).

Root length : Gibberellic acid showed a significant effect for all varieties with (T_4 , T_8 and T_{12}) and no effect was noted with the calcium peroxide treatment.

The effect of soaking on contents of some mineral elements in the seedling of barley are presented in Table 2.

Potassium , calcium and magnisum did not show any significant increase over the control, for all varieties under all pretreatments. However sodium showed a significant increase for all varieties with GA (T_4 , T_8 and T_{12}) whereas calcium peroxide did not show any effect on the concentrations of the elements in the plant .

4.15 Discussion

Sufficient experimental evidence (throughout 19 experiments) has been presented to show some dry periods, some chemical materials and some growth regulators stimulate the germination of the three barley varieties tested. Gibberelic acid at 100 ppm under 17 hours dry period had a significant effect for all varieties tested in part (A) and calcium peroxide (0.1 g) also had a significant effect for Gadmarker under 1 day dry period and for Triumph and Igri under 2 weeks dry period in part (B). However, in part (C) Garlic and Onion extracts did not show any effect.

Under growth stage experiment (Part D) the optimum results obtained from parts A and B in this chapter were employed . The data showed that treatments of barley varieties with calcium peroxide and Gibberellic acid (Table 1) were beneficial for seedling development (Phenologic observations) and increased sodium absorption under gibberelic acid (Table 2) , at high salt media where seed emergence and seedling growth usually had a setback. For a particular set of conditions, however , the benefit may depend upon the selection of the optimum GA and CaO_2 concentrations as well as length of dry period. As a general role the significant effects for all of them under salt media may be produced by increased physiological availability of water and nutrients. It is also possible that under high salt concentrations naturally present hormones may be suppressed and that the presoaking treatment supplies sufficient hormones for normal growth (Tagawa and Bonner 1957 ; Kessler 1961 ; Shah and Loomis 1965).

Thus, the determintal effects of high salts on barley seedling may be reduced to some extract by treating the seeds with the proper concentration of a suitable hormone or other chemical, and a good dry period. Lastly the response of these varieties to various pretreatments under salt condition requires further investigation before the full benefits of seed treatments can be appreciated .

TABLE 1 : Phenologic observation on barley development

Pre-treatment / Phenologic	V_1 Gadmarker				V_2 Triumph				V_5 Igri			
	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}	T_{11}	T_{12}
	control 1 day d.p	0.1 % CaO_2 1 day d.p	control 17 h d.p	100p.p.m GA 17h d.p	control 2 weeks d.p	0.1 % CaO_2 2 weeks d.p	control 17h d.p	100p.p.m GA 17h d.p	control 2 weeks d.p	0.1 % CaO_2 2 weeks d.p	control 17h d.p	100p.p.m. GA 17h d.p
Germination %	71.6 ± 2.4	88.3 ±* 2.4	88.3 ± 2.4	95.0 ±* 0.0	80.0 ± 0.0	93.3 ±* 2.4	91.6 ± 2.4	96.7 ± 2.4	80.0 ± 4.1	86.7 ± 2.4	78.3 ± 2.4	90.0 ±* 0.0
High average	9.1 ± 0.09	10.3 ± 0.4	9.3 ± 0.2	13.1 ±* 0.2	12.8 ± 0.1	14.4 ±* 0.3	13.8 ± 0.1	18.4 ±* 0.4	13.0 ± 0.07	14.1 ± 0.3	13.7 ± 0.3	16.7 ±* 0.2
Fresh wt. average	0.87 ± 0.05	0.91 ± 0.05	0.88 ± 0.05	0.99 ± 0.08	0.25 ± 0.01	1.7 ±* 0.01	1.71± 0.08	1.8 ± 0.16	2.07 ± 0.03	2.19 ± 0.12	2.04 ± 0.13	2.16 ± 0.009
Dry wt. average	0.12 ± 0.004	0.12 ± 0.01	0.11 ± 0.004	0.12 ± 0.004	0.13 ± 0.009	0.156±* 0.004	0.15 ± 0.004	0.16 ± 0.004	0.17 ± 0.004	0.2 ± 0.008	0.19 ± 0.01	0.20 ± 0.004
Root Long average	4.75 ± 0.18	5.23± 0.20	5.20 ± 0.15	5.95 ±* 0.09	5.31 ± 0.08	6.29 ± 0.31	6.04 ± 0.02	6.47 ±* 0.04	5.89 ± 0.21	5.87 ± 0.12	5.66 ± 0.02	6.19 ±* 0.5

Standard deviation of 3 replicates

TABLE 2 : Effect of soaking on contents of some mineral elements in the seeedling of barley under 1.5% salt medium (Data expressed as %)

Pre-treatment / Elements	V_1 Gadmarker				V_2 Triumph				V_5 Igri			
	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}	T_{11}	T_{12}
	control 1 day d.p	0.1 CaO_2 1 day d.p	control 17h d.p	100 ppm 17h d.p	control 2 weeks d.p	0.1 CaO_2 2 weeks d.p	control 17h d.p	100 ppm GA 17h d.p	control 2 weeks d.p	0.1 CaO_2 2 weeks d.p	control 17h d.p	100 ppm GA d.p
K %	3.83 ± 0.26	4.37 ± 0.36	3.96 ± 0.25	3.95 ± 0.21	4.43 ± 0.29	4.75 ± 0.01	4.36 ± 0.17	5.01 ± 0.2	4.11 ± 0.16	3.68 ± 0.32	4.13 0.21	3.88 ± 0.25
Na %	1.01 ± 0.17	1.32 ± 0.21	1.05 ± 0.02	1.68 ±* 0.08	1.44 ± 0.04	1.51 ± 0.1	1.55 ± 0.06	1.93 ±* 0.05	1.45 ± 0.01	1.08 ± 0.21	1.08 ± 0.1	1.29 ±* 0.004
Ca %	0.07 ± 0.002	0.07 ± 0.004	0.08 ± 0.001	0.07 ± 0.005	0.05 ± 0.001	0.06 ± 0.002	0.05 ± 0.004	0.07 ± 0.004	0.07 ± 0.002	0.06 ± 0.002	0.05 ± 0.004	0.05 ± 0.005
Mg %	0.4 ± 0.02	0.38 ± 0.05	0.04 ± 0.02	0.43 ± 0.008	0.39 ± 0.02	0.4 ± 0.02	0.4 ± 0.01	0.45 ± 0.03	0.33 ± 0.01	0.3 ± 0.01	0.29 ± 0.02	0.32 ± 0.02

Standard deviation of 3 replicatės . .

CHAPTER FIVE

INFLUENCE OF DIFFERENT MATERIALS PRETREATMENT AND DRY PERIODS ON GERMINATION STAGE OF SUGAR BEET IN SALINE MEDIA ..

5.1 Introduction

Sugar beet (Beta vulgars L.) is highly salt tolerant (Francois and Goodin, 1972). It is mainly grown in the Mosul city in Iraq, to cover the sugar industry's need there. Its growth and yield respond to irrigation. Few studies have been carried out about it, most of them were fertilizer experiments. Sugar beet seed pre-treatments have not been studied as extensively as that of wheat or barley.

In this chapter, I will be trying to see whether salt absorption from soil is possible by sugar beet or not, when soaking with different materials (NaCl , CaO_2 , H_2O_2 , $Ca(CH_3COO)_2$, 2.4 - Diochlorophenoxy acetic acid and $Co(cH_3)_5Cl)Cl_2$ and different dry periods (0, 17h , one week and two weeks) through the germination and growth stages. But due to a fault in the thermostat and the lighting of the growth room some sugar beet seeds for germination experiments died and for this reason the work was limited to the germination stage only.

The pre - soaking treatment of seeds with different materials could successfully enhance seed emergence , plant growth and root systems in various crop species by inducing salt tolerance and even drought resistance (Asana et al. , 1955 ; Bhardwaj and Rao , 1955; Darra, et al. , 1970).

The reason for the dry periods choisen was due to significant effects in previous work with barley varieties. The reason for pretreatment material chosen was because of significant effects noted by some workers as follow : -

Calcium acetate (Ca $(CH_3COO)_2$) has already shown a significant effect in previous chapter. Lehr (1941) stated that sodium in numerous instances can be applied advantageously to beet. Eaton, (1942) reported that the sugar beet showed a high degree of tolerance to chloride . Milford (1977) and Hunter (1970) reported that NaCl increased plant dry weight, surface area, thickness and succulence of the leaves of sugar beet .

Woolley, (1957) stated that tomato plants showed a 12% increase in dry weight with additions of Na at the rate of one millimole of NaCl per litre of culture solution . Sodium absorbed by the plant accumulated mainly in the leaves and petioles. It increased the water content of the leaves, stem , root and the plant fresh weight.

Lawlor and Milford (1973) and Chaudhuri and Wiebe, (1968) found slight benefits from 1% NaCl pretreatment on germination of wheat, but pretreatment with Ca salts induced significant increases in germination on high NaCl media. Yapparov and Iskhakov, (1974) stated that sugar beet seeds presowing treatment with 10% solution of sodium nitrate and sodium chloride in combination with 0.01% boric acid during 24 hours stimulates germination of the seeds, growth and crop yield of the plant.

The synthetic auxin, 2.4 - Dichlorophenoxy acetic acid (2.4-D) has been extensively used as a herbicide since 1945 when it first became available commercially . Although it has been shown to completely disrupt growth and development of most dicots, the exact mechanism is still unknown. Its influence on plants has been extensively investigated for three decades. This auxin herbicide probably promotes growth and yield when used in optimum concentration.

Peterfi and Brugovitzky , (1961) studied the effect of some complex salts on the germination of sugar beet. They state that stimulation was significant when seeds were soaked 24 hours in 100mg % of (Co $(NH_3)_5Cl$ $)Cl_2$ and 2.4 - Dichlorophenoxy acetic acid....) . A new technique , designed to improve seedling emergence and growth, is being tested on different crops. It has been found that the chemical peroxide can increase the germination and seedling vigour. Vaidynathan , (1980) soaked sugar beet in 0.2 percent hydrogen peroxide(H_2O_2) solution for 12 hours and then dried the seed. Results were very good and both root and sugar yields were increased.

Also Coumans, (1974) stated that the dormancy of sugar beet seeds disappeared by a treatment with hydrogen peroxide .

5.2 EXPERIMENTAL

5.2.1 Materials and methods

Sugar beet seeds (Beta vulgars L.) varieties Julia (V1) , Klein Monseet (V2) were used throughout these five experiments. Experiment No. 1 was carried out to investigate salt tolerance as described in previous chapters. In experiments 2 , 3 , 4 and 5 the seeds were soaked as follow :

1-	Soaking	period	7h	with	water (control)
2-	=	=	=	=	0.2 % CaO_2
3-	=	=	=	=	2.0 % Ca $(CH_3COO)_2$
4-	=	=	12h	=	water (control)
5-	=	=	=	=	0.2 % H_2O_2
6-	=	=	8h	=	water (control)

7- Soaking period 8h with 1 % NaCl

8- = = 24h = water (control)

9- = = = = 1 mg % 2.4-D

10- = = = = = $(Co(NH_3)_5 Cl)Cl_2$

Soaking was at 16 ± 2°C in 100 ml beaker . For more details see chapter 2. 2. 1 except the amount of seeds moisted in the petri dish was 5 ml and germination temperature was 20 ± 2°C .

5.3 Results

In experiment one , sugar beet seeds were irrigated with different concentrations of salt solution (0, 5000 , 10000 , 15000 , 20000 , 25000 ppm) . The data indicate a gradual decrease in germination with increase in salt concentration (Table 1) . Both varieties showed no germination after 15.000 ppm The variety Julia was more tolerant than the variety Klein monoseet.

In experiment two , the seeds were soaked and germinated without dry period . Both varieties demonsrated significant germination under T2 and T10 . Variety Julia was more responsive than the other one to all the pretreatments . It showed an increase under T3 and T5, (Table 2) .

In experiment three , the effect of 17 hour dry period after soaking on the sugar beet seeds was very clearly more germination than the zero d.p. experiment. Julia was responsive to T2 , T3 and T5 . Both varieties also appear to give significant increase in percent germination under treated with complex salt (T10) (Table 3).

In experiment four , the data shows little reduction in germination percentage compared with experiment three. Julia was responsive to T2 , T5 and T10 while Klein Monoseet did not show any response to any of the treatments.

In experiment five , although there are some significant effects for Júlia under T_5 , T_2 and T_{10} and Klein Monoseet under T2 and T10 , the data did not show a high increase in germination compared with the experiment 3(17 d.p). Therefore, the dry period did not seem to bring about an effect after two weeks .

TABLE 1

Influence of different concentrations of salt solution on the germination of two varieties of sugar beet

salt concentration \ Varieties	Germination % V1	Germination % V2
0 ppm water	95.8 ± 1.4	91.7 ± 1.7
5000 ppm	85.0 ± 2.9	76.6 ± 1.5
10000 ppm	62.5 ± 2.7	48.3 ± 1.7
15000 ppm	29.1 ± 2.8	21.7 ± 1.7
20000 ppm	0.8 ± 1.4	0.0
25000 ppm	0.0	0.0

Percentage germination ± standard deviation.

Average of 4 replications.

TABLE 2

Influence of different chemical pre-treatments and dry periods on germination of sugar beet on saline media 1 % . Dry period zero

varieties / pre-treatments	Germination % V1	Germination % V2
T1 control	49.1 ± 2.8	37.5 ± 2.8
T2	64.1 ± 2.7 *	49.1 ± 2.8 *
T3	65.0 ± 1.7 *	34.1 ± 2.7
T4 control	54.1 ± 2.7	32.5 ± 1.4
T5	64.1 ± 2.7 *	31.6 ± 3.7
T6 control	61.7 ± 2.9	35.0 ± 1.7
T7	65.8 ± 3.6	38.3 ± 1.7
T8 control	62.5 ± 1.4	28.3 ± 2.9
T9	41.7 ± 1.7	36.6 ± 4.1
T10	67.5 ± 1.5 *	37.5 ± 1.4 *

Percentage germination ± standard deviation.

Average of 4 replications .

TABLE 3

Influence of different chemical pre-treatments and dry periods on germination of sugar beet on saline media (1%). Dry period 17 hours

pre treatment \ Varieties	Germination % V1	Germination % V2
T1 control	70.8 ± 2.8	61.7 ± 1.7
T_2	83.3 ± 2.3 *	66.6 ± 2.4
T_3	78.3 ± 1.7 *	59.1 ± 2.8
T_4 control	64.1 ± 2.7	56.7 ± 4.1
T_5	72.5 ± 2.7 *	52.5 ± 2.7
T_6 control	75.8 ± 3.6	63.3 ± 2.3
T_7	74.1 ± 2.7	65.8 ± 2.8
T_8 control	79.9 ± 2.3	58.3 ± 1.7
T_9	50.8 ± 3.6	39.1 ± 2.8
T_{10}	89.1 ± 2.8 *	67.5 ± 2.8 *

Percentage germination ± standard deviation.

Average of 4 replications .

TABLE 4

Influence of different chemical pre - treatments and dry periods on germination of sugar beet on saline media (1 %) . Dry period 1 week

Pre treatment \ Varieties	Germination % V1	Germination % V2
T_1 control	67.5 ± 4.3	60.8 ± 3.6
T_2	79.1 ± 2.8 *	65.8 ± 3.6
T_3	68.3 ± 5.0	50.0 ± 4.7
T_4 control	55.0 ± 3.7	45.0 ± 3.7
T_5	68.3 ± 1.7 *	50.8 ± 5.5
T_6 control	73.3 ± 2.3	62.5 ± 2.7
T_7	71.7 ± 1.7	61.7 ± 1.7
T_8 control	60.8 ± 3.6	50.0 ± 4.1
T_9	55.0 ± 5.0	40.8 ± 3.6
T_{10}	72.5 ± 2.7 *	57.5 ± 2.8 *

Percentage germination ± standard deviation.

Average of 4 replications.

TABLE 5

Influence of different chemical pre - treatments and dry periods on germination of sugar beet on saline media (1 %). Dry period 2 weeks

PRE-treatment \ Varieties	Germination % V1	Germination % V2
T_1 control	69.9 ± 2.4	54.1 ± 2.7
T_2	77.5 ± 1.4 *	63.3 ± 2.3 *
T_3	44.1 ± 2.7	32.5 ± 2.7
T_4 control	50.8 ± 1.4	38.3 ± 6.0
T_5	60.0 ± 2.4 *	45.0 ± 3.7
T_6 control	71.7 ± 2.9	62.5 ± 4.3
T_7	68.3 ± 1.7	52.5 ± 2.7
T_8 control	50.8 ± 3.6	34.1 ± 2.7
T_9	50.0 ± 2.4	36.7 ± 4.1
T_{10}	59.1 ± 2.8 *	51.6 ± 3.7 *

Percentage germination ± standard deviation. Average of 4. replications .

5.4 Discussion

The first experiment was a general test for salt tolerance. Decreased germination was measured as a slowing of germination , a lowering of the ultimate germination percentage , or both. Increases in salt solution concentration depressed the two sugar beet varieties to different degrees , but variety Julia showed more tolerance than Klèin Monoseet.

Thus , at high salt concentrations correspondiingly more seeds suffered from irrèversible salt effects either through toxicity or due to the lower salt tolerance of the sugar beet variety. From this experiment 10.000 ppm salt solution was chosen as the best concentration for the media of the pretreatment experiments .

Four pre - treatment experiments have been carried out with different dry periods. The germination rates of pre - treatment seed were compared with seeds pretreated with distilled water (wet controls) .

The maximum seed germination percentage was recorded in experiment three with a 17 hour dry period. Variety Julia was highly responsive to the calcium peroxide (T_2) and hydrogen peroxide (T_5) throughout all the experiments , but variety Klein Monoseet showed a response with calcium peroxide only under two weeks dry period .

This result agrees with Vaidyanathan , (1980) and Coumans , (1974) .

Both varieties Julia and Klein Monoseet showed responses to the complex Co salt ($Co(NH_3)_5Cl)Cl_2$, the results being in agreement with Peterfi and Brugovitzky (1961) . The other pretreatment materials did not show any effect .

Inspite of poor or even decreased germination being observed in some experiments in this study , it may be concluded that pre- soaking treatments of sugar beet seeds with some different materials (as used in this chapter) and the optimum dry period showed a beneficial increase in germination under saline conditions.

CHAPTER SIX

IRAQI PLANT ANALYSIS

6.1 INTRODUCTION

Halophytes are plants which are tolerant of high salt environments and generally contain large amounts of electrolyte .

Their environment is normally dominated by sodium chloride (NaCl) but may also include a variety of other salts e.g. sodium sulphate (Na_2SO_4) , sodium carbonate (Na_2CO_3) , magnesium chloride ($MgCl_2$) calcium sulphate ($CaSO_4$) and potassium chloride (KCl) . The presence of these additional salts has a profound effect on the plants ability to grow in a saline environment .

Generally speaking the presence of sodium ions (Na^+) is considered to be particularly toxic to plant cell membranes leading to the death of the plant . The presence of other cations , notably Ca^{2+} has a strong action protecting the membrane to some extent against the sodium effects. The optimum salt concentration for the growth of halophytes is not very well documented and depends on many factors :

1) Enviromental conditions such as temperature , humidity etc. which in general have not been very carefully controlled .

2) The age of the plant and its tolerance to salt can differ between the germination stage , early development and maturity . Little information is available on this aspect. The distribution of ions within the plant differs between plants but in general terms, more than 90 % of the sodium in halophytes is present in the shoots and at least 80% in the leaves .

There are many halphyte plants growing in Central and South Iraqi areas but little detailed information is available on these in the literature .

As these plants have already colonised the saline areas in question in Iraq it was felt that more information about them in terms of the amount of salt they could take up , their tolerance to salts and their possible yields would be a promising line of research to adopt when considering ways of desalinating high salt soils by biological means. The use of holophytes themselves to desalinate soils has been attempted before . Chauadhri et al. , (1964) employed Suaeda fruticosa forsk as a pioneer species and it grows in abundance in the highly saline and alkaline soils of Pakistan (See chapter one for more details) . From analysis of the plant it was shown that it would be possible to remove 2.406 lb/ acre of salt in one year . Chaudhri felt that this figure could be increased 3 fold by more intensive cultivation . With these points in mind it was decided to study some 20 Iraq plants which were sent from Iraq to Glasgow for analysis (leaves only) where arange of selected cations was studied . Some of these plants were halophytes and the others were herbs which could grow in low salinity soil. By this means it was hoped to identify some plants which showed promise as a means of desalinating soils by biological means. A description of the plants selected for this study is as follows :

1) Shuwail , Cressa cretica L.

It is found in waste land especially where it is damp - saline , present in central and eastern alluvial areas in southern Iraq districts, because of its ability to survive in alkaline soil . It is an alkali weed and a perennial herb reproducing by seeds. This plant is used as an indicator of saline soil . Live-stock graze this herb . It is much branched , hairy , leaves minute , sessile entire , acute , alternate . Stem sub erect. Flowers whitish , terminal spike . (Plate 1) .

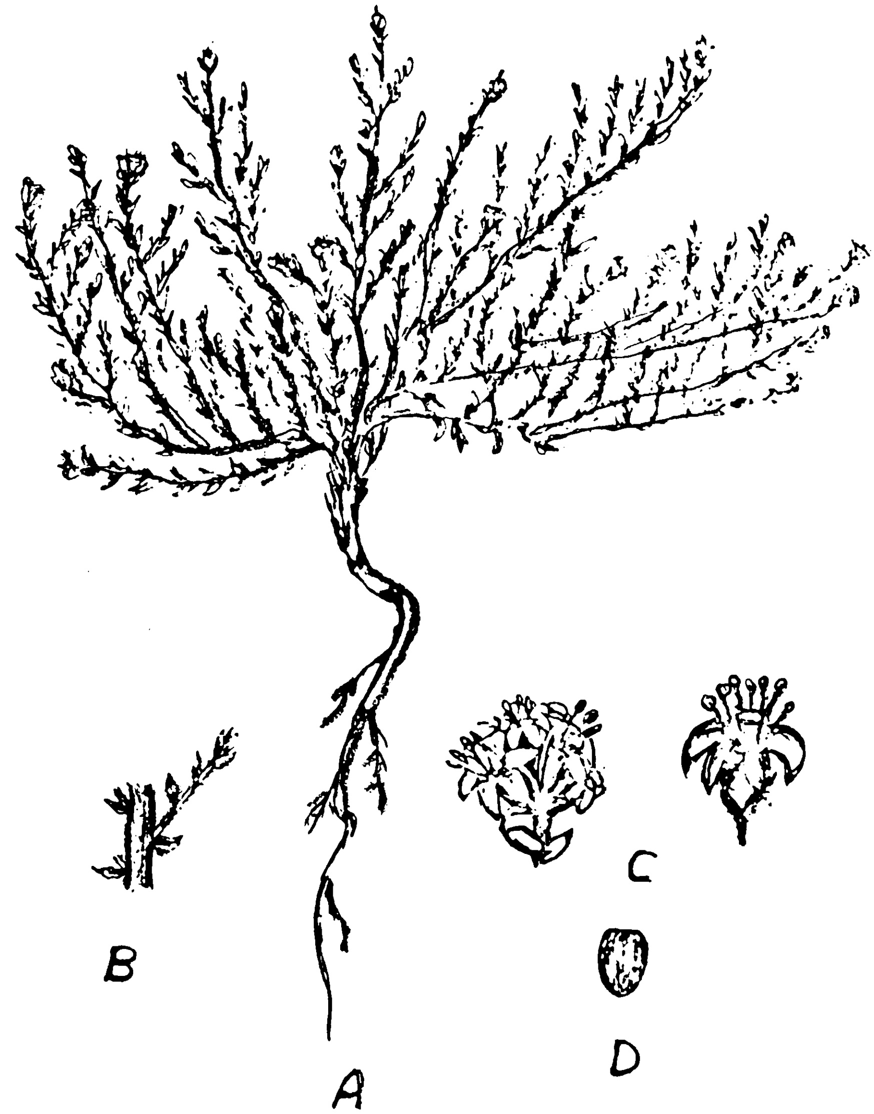
2) Chibchab , Salsola kali L.

It grows in semi saline soils , Jazirah , Central alluvial plains and lower Iraq district . It is an annual , spiny weed reproducing by seeds. It is grazed by livestock. Stem procumbet . Leaves subteret , fleshy with a rigid pungent point (Plate 2) .

3) Ijairbeh , Heliotropium europaeum L.

The plant grows in cultivated fields of summer crops and in the western desert , Sulaimanuya, Kirkuk and in waste land of lower Jazirah. This weed is an annual herb reproducing by seeds. Stem erect, much branched, densely hairy. Spikes a long straight or spirally bent at apex. (Plate 3) .

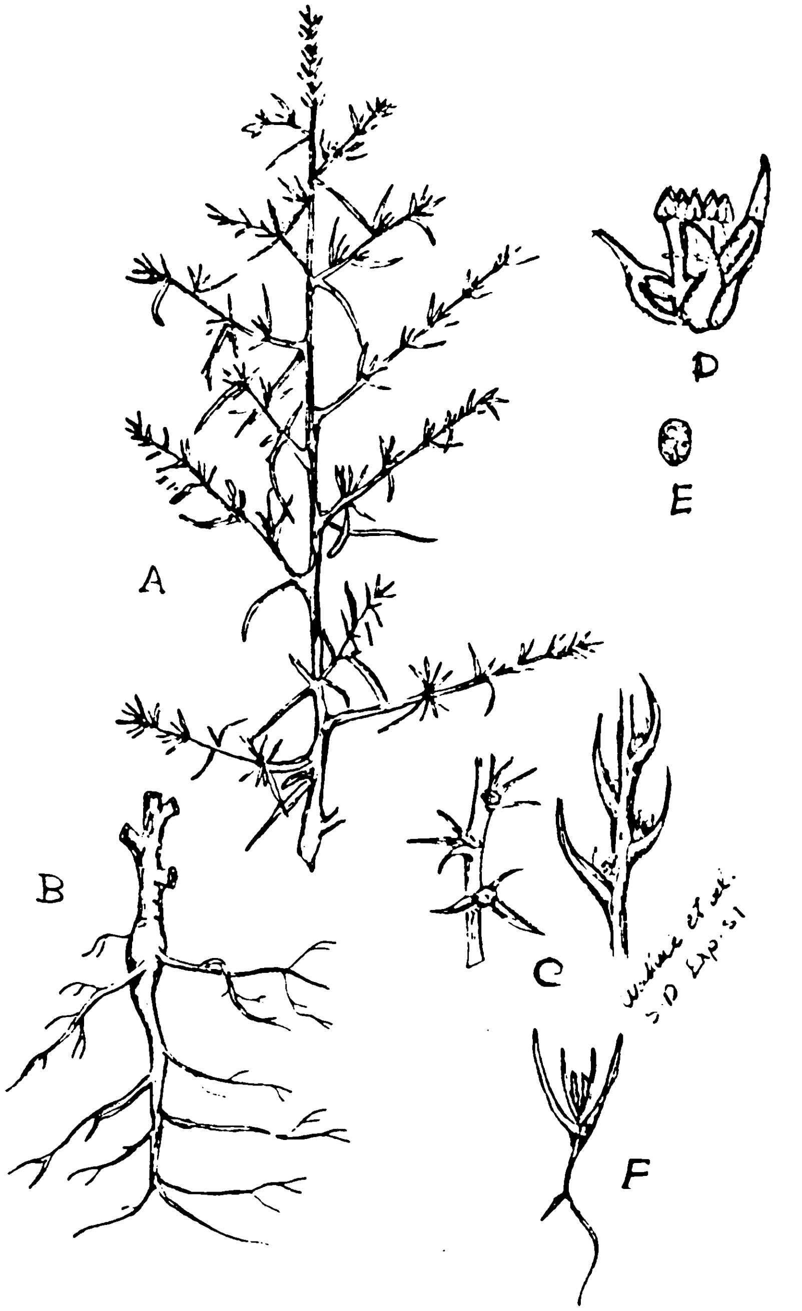
PLATE 1



Cressa cretica L.

A, root; B, branch; C, flower and flower cluster; D, seed.

PLATE 2



Salsola kali L.

A, stem; B, roots; C, Brand, D, flower; E, seed; F, seedling.

PLATE 3

Heliotropium europaeum L.

A, plant; B, inforescence; C, flower; D. seed.

4) Sie'd , Cyperus rotundus L.

It is found in thick stands in moist sandy places especially along river banks , central and eastern alluvial plains and lower Iraq districts . It is a perennial grass which reproduces by tubers and seeds. Stem erect. Rhizomes elongated , creeping with ovate tubers. Spikelets linear, many flowered . (Plate 4) .

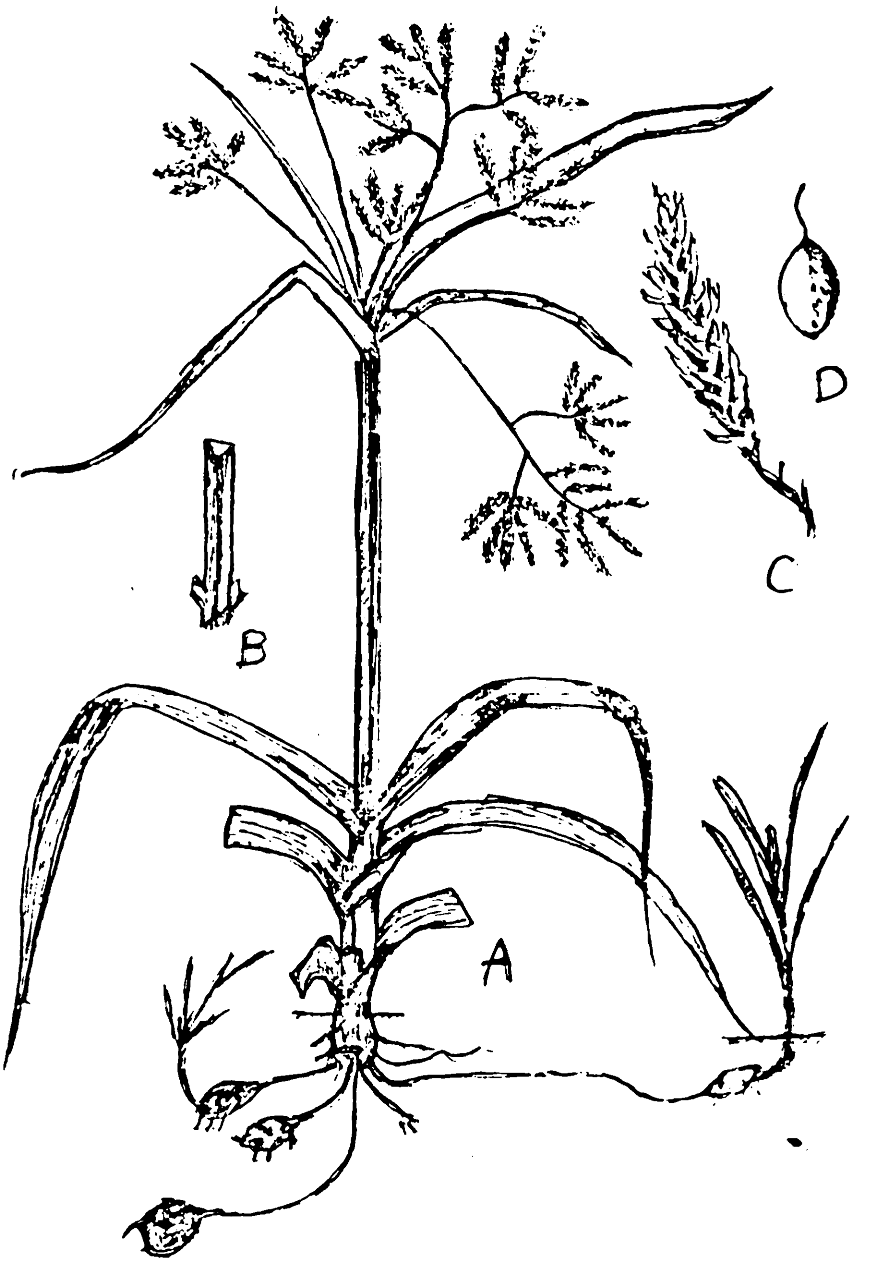
5) Wodaynah , Euphorbia peplus L.

It grows in fields , vegetable gardens , Orchards and central alluvial plains and lower Iraq districts , it is an annual herb reproducing by seeds. Plant 20 - 30 cm high . Stem erect , slender , branched and yellow green . (Plate 5) .

6) Halfa hawliyah , Eragrostis poaeoides P.B

It is found in western desert , central alluvial plains and lower Iraq districts. It is stemmy annual grass reproducing by seeds. Stem flat with long hairs at the base , 5 - 25 cm. long , (Plate 6).

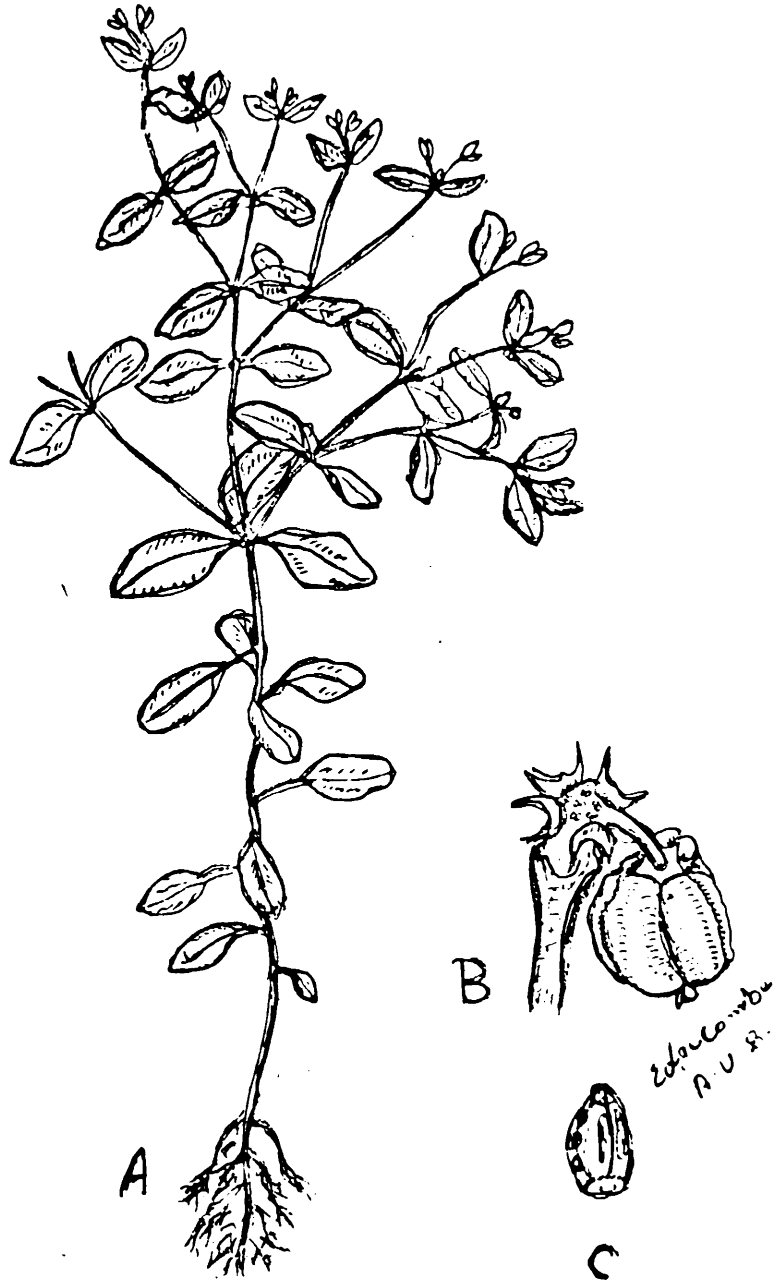
PLATE 4



Cyperus rotundus L.

A, plant; B, segment of stem showing cross section; C, enlarged spikelet; D, seed.

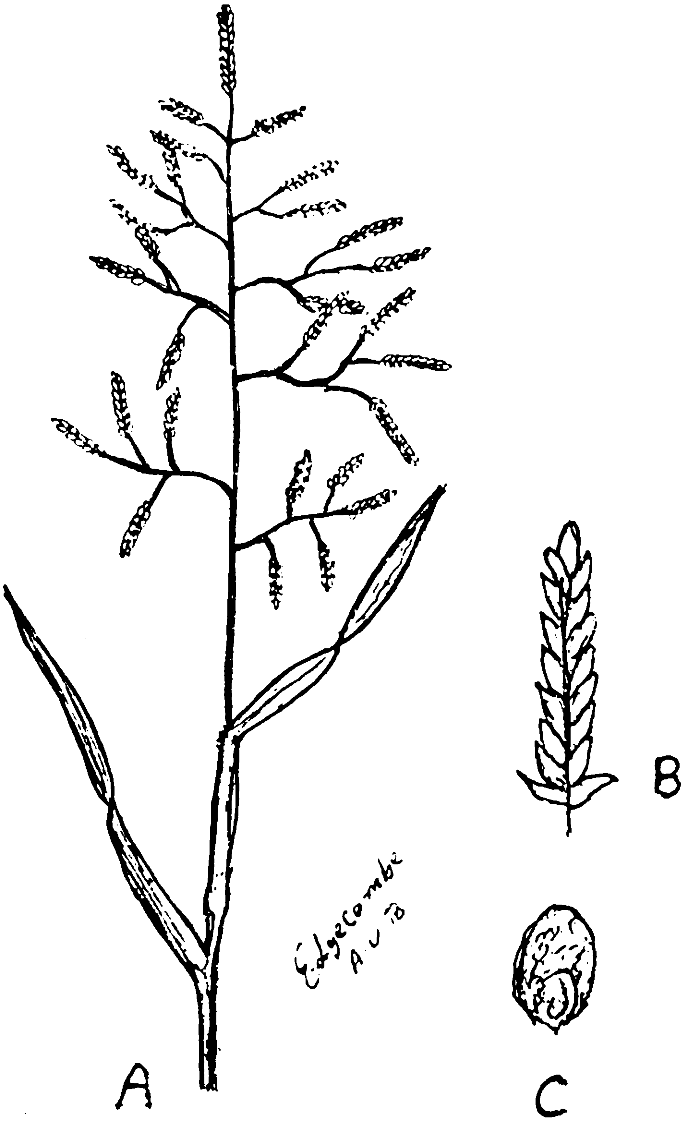
PLATE 5



Euphorbia peplus L.

A. plant; B: capsules; C. seed.

PLATE 6



Eragrostis poaeoides P. Beauv.

A, panicle; B, branch of panicle; C, seed.

7) Howairrah , Sisumbrium irio L.

It grows in central alluival plain and lower Iraq districts . It is an annual plant reproducing by seeds. Stem erect, 30 - 60 cm high. (Plate 7).

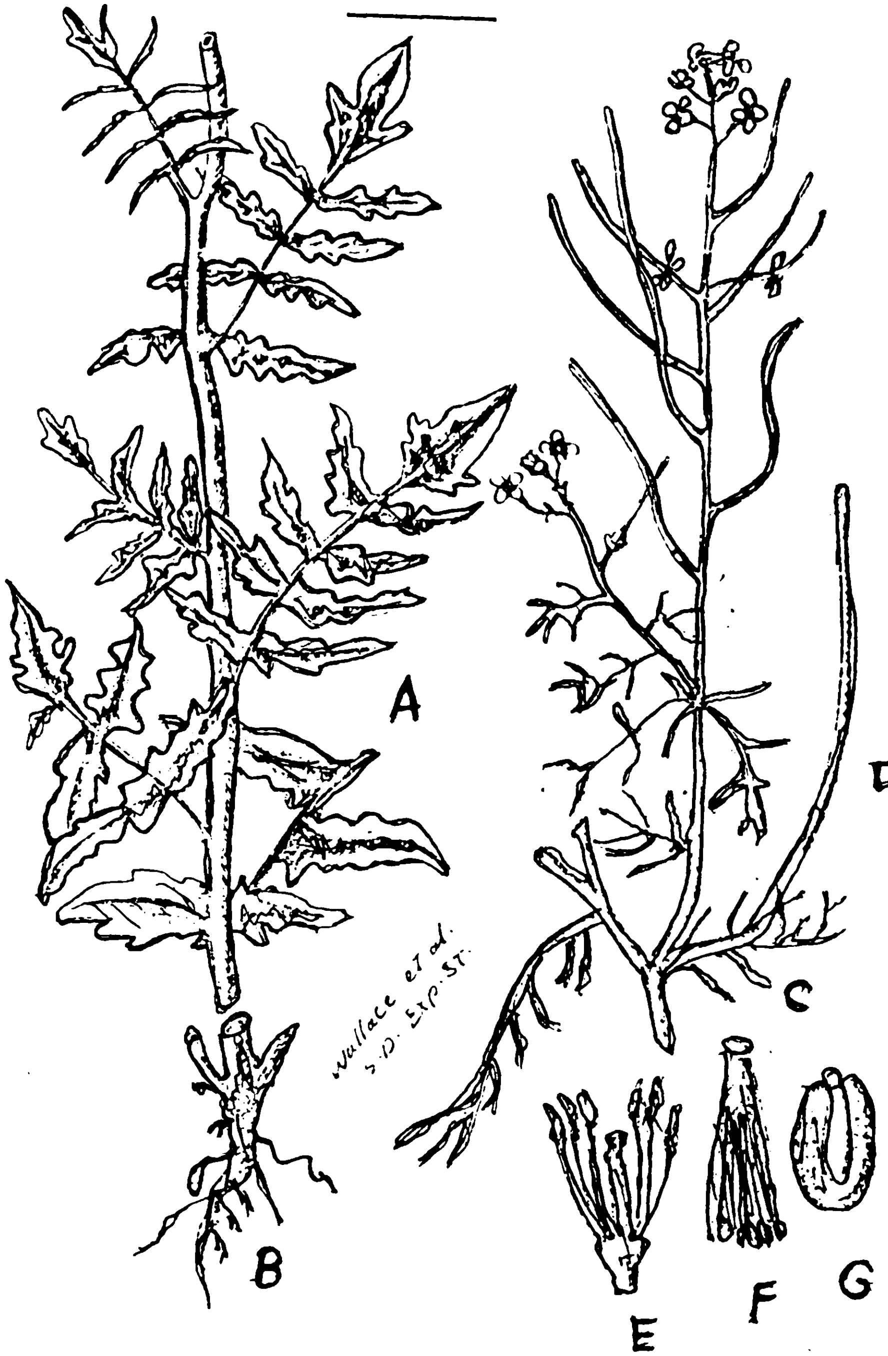
8) A'agool , Alhagi maurorum M.

Reproducing by seeds. It is found in most districts in the country. Prickly alhagi is a shrubby perennial. The shrub is grazed by animals when the young shoots appear. Stem erect with numerous ascending branches. Plant armed with long, pungate spreading spines. (Plate 8) .

9) Hummaith , Rumex dentatus L.

It grows in cultivated fields , waste places and along canals in the central and eastern alluvial plains, Erbil and lower Iraq districts. It is grazed by animals , an annual herb reproducing by seeds. Stem simple or branching from base , 30 - 70 cm. high. See (Plate 9) .

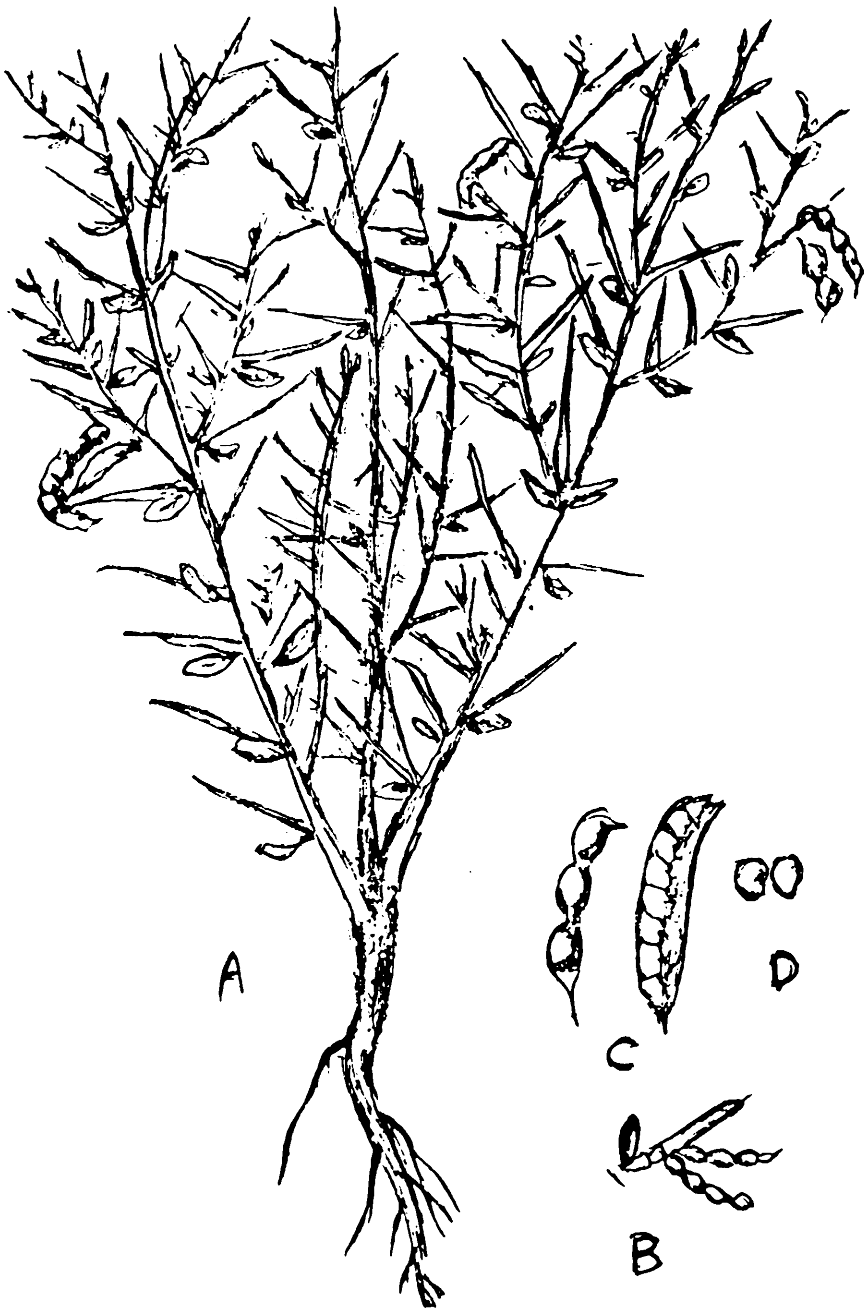
PLATE 7



Sisymbrium irio L.

A, stem; B, root; C, inflorescence; D, pod; E, male and female parts of the flower; F, part of pod showing seeds; G, seed.

PLATE 8



Alhagi maurorum Medir.

A, plant; B, spine with pods; C, pods D, seeds.

PLATE 9

Rumex dentatus L.

A, plant; **B**, inflorescence; C, Fruit; D, seeds.

10) Halfa , Imperata cylindrica L.

It is a very vigorous and wide spreading weed and can be found in very thick stands where water table is high. This grass is a perennial weed reproducing by seeds and long creeping rhizomes. Stem erect, usually surrounded at base by dry sheaths, leaves glabrous, 10 - 100cm. high. (Plate 10).

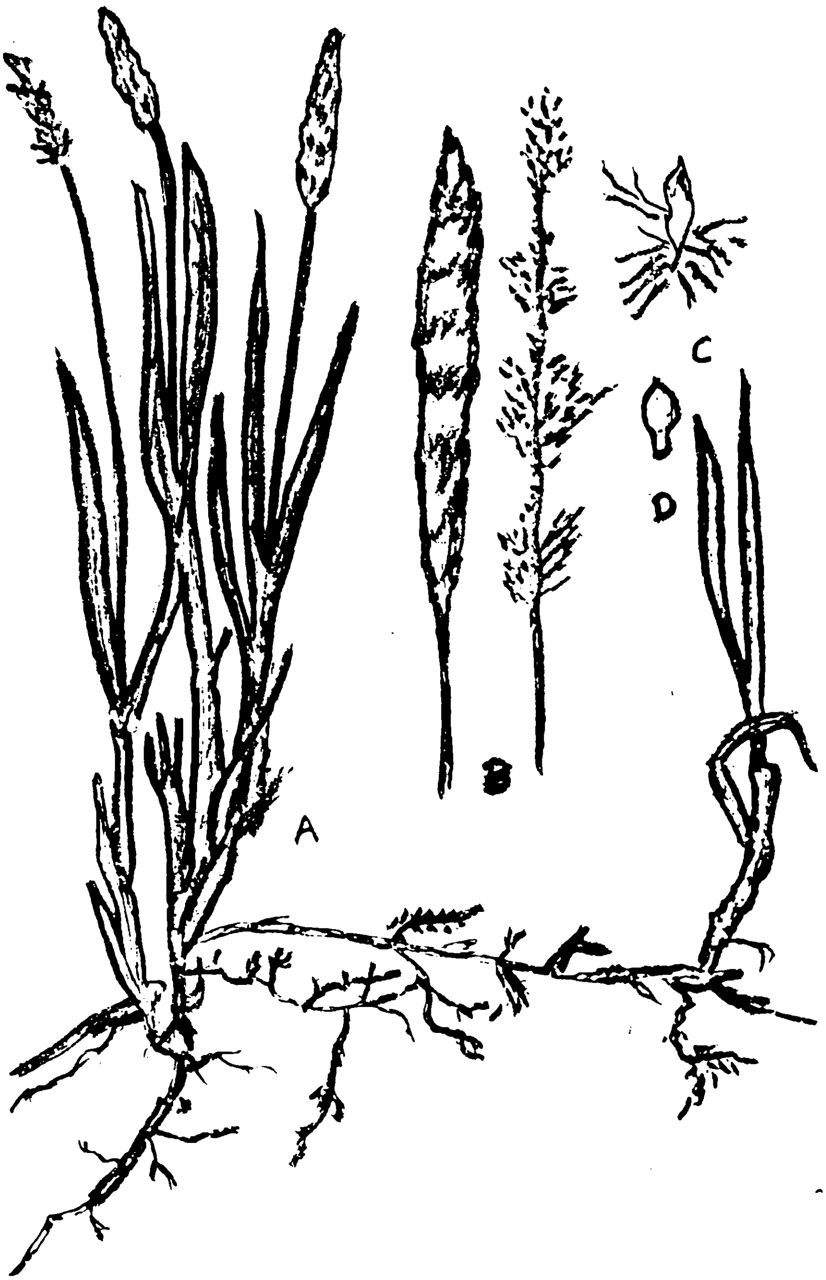
11) Gogallah , Schanginia aegyptiaca

This plant is a bushy annual herb reproducing by seeds. It grows in waste land of the central and eastern alluvial plains and lower Iraq districts. The plant is grazed by animals and collected for fire building by local people. Stem glabrous, lateral branches spreading while the centrel is often erect. 30 - 50 cm.high (Plate 11).

12) Qasab , Phragmites communis Trin

Reproducing by seeds and thick creeping rhizomes. It is found is very thick stands in marshes, and wet grounds in central and eastern alluvial plains, lower Iraq. The plant is tolerant to saline soils and stagnant water. It is grazed by livestock when young and succulent This grass has some industrial uses by local people. Culms erect, many-noded , sheathed , smooth , 2 - 3m. high. Rhizomes creeping (Plate 12).

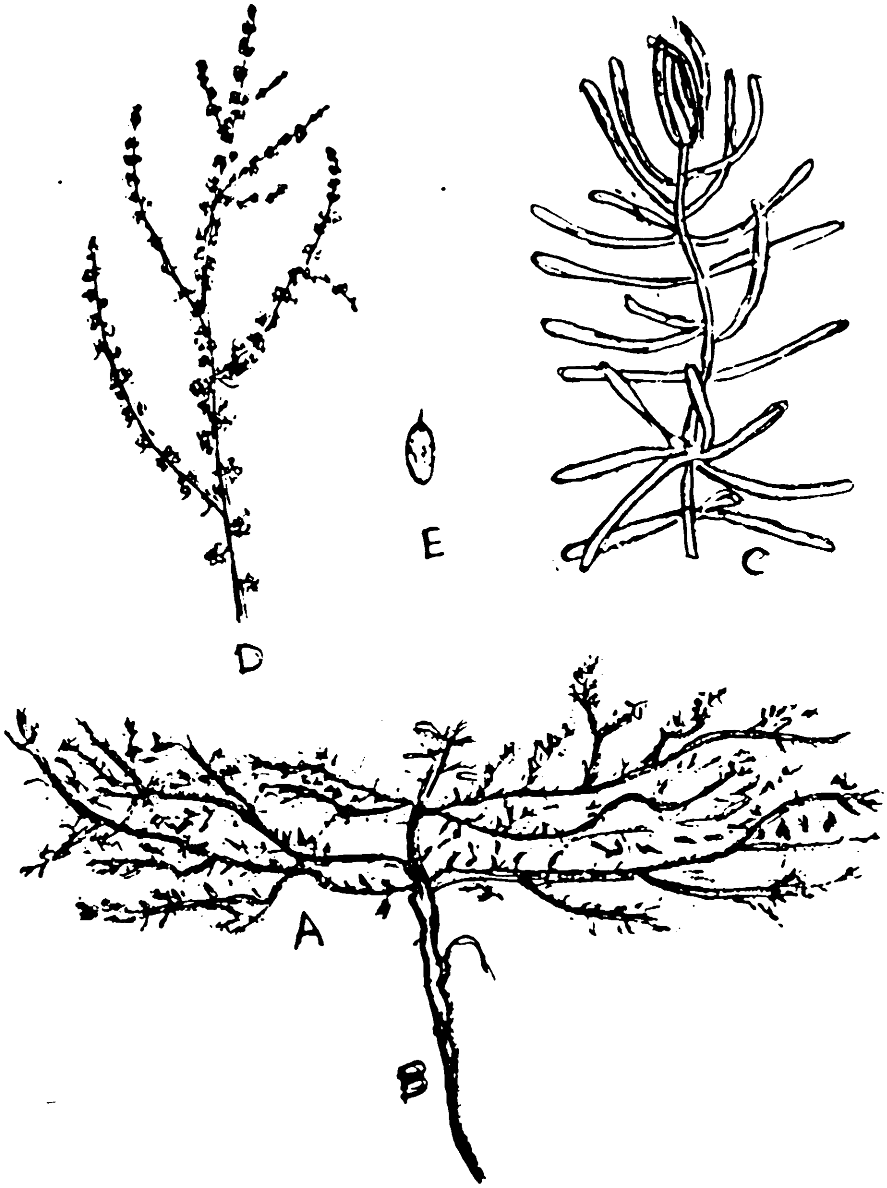
PLATE 10



Imperata cylindrica (L.) P. Beauv.

A, plant; B, panicles; C, spikelet; D, seed.

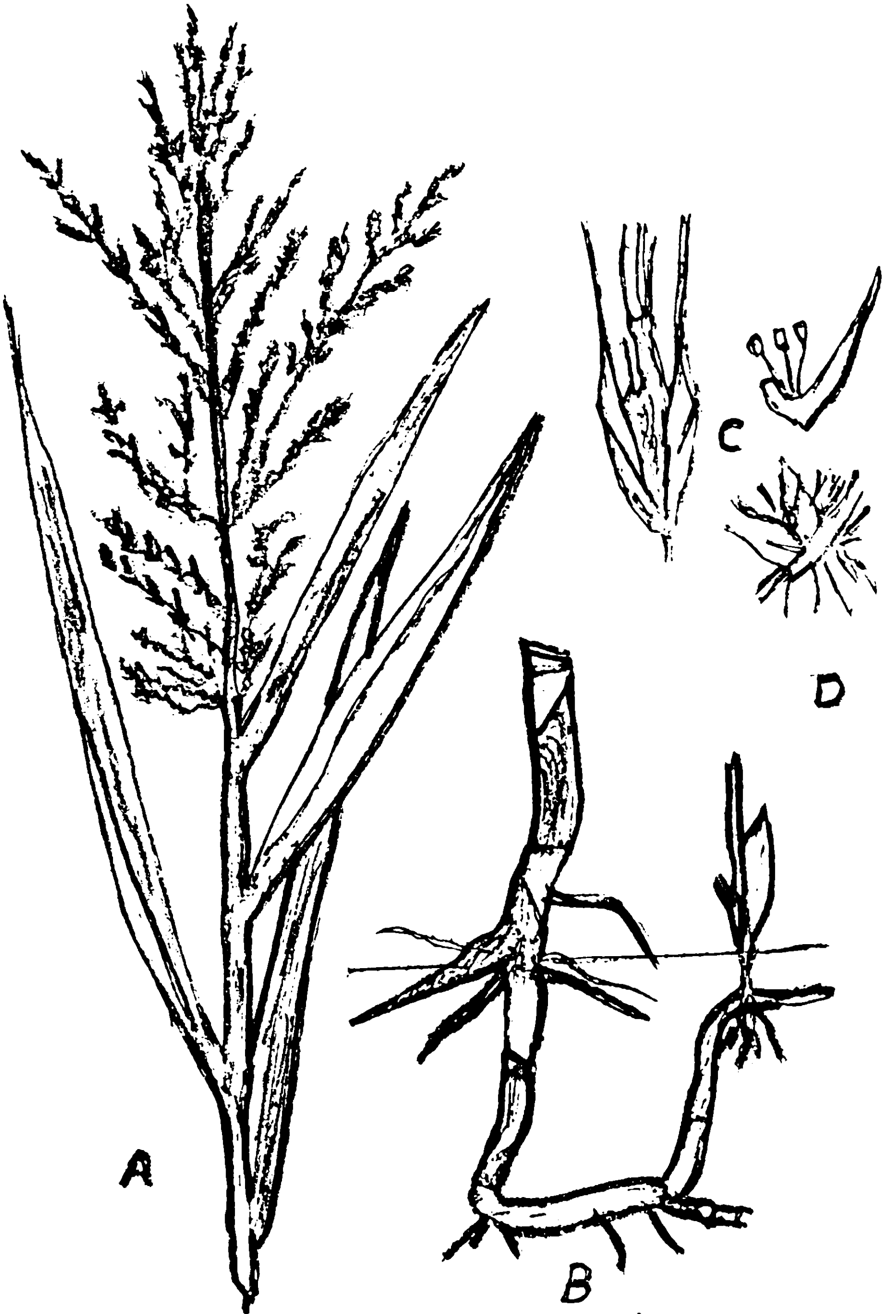
PLATE 11



Schanginia aegyptiaca (Hasxleg.) Aellen

A, branching stem; B, root; C, enlarged branch; D, inflorescence; E, seed.

PLATE 12



Phragmites communis Trin.

A, spike; B, rhizomes; C, spikelet; D, seed.

13) Thayyel , Cynodon L.

It can be found in thick stands in sandy soils, waste places and long irrigation ditches. It is a perennial weed reproducing by creeping rhizomes and seeds. Culms erect or bent at the base , runners prostrate , rooting at the nodes. (Plate 13) .

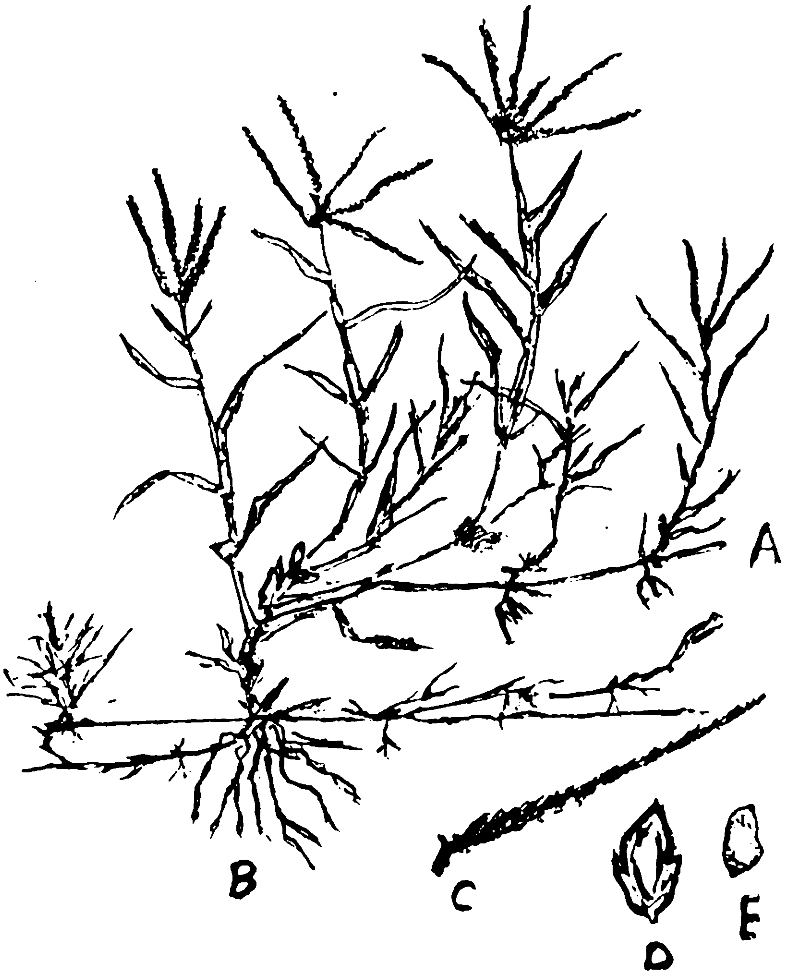
14) Righailah , Chenopodium murale L.

The plant grows in waste land of the central alluvial plains , southern desert districts. It is grazed by livestock. Stem erect or ascending , branching from the base. 30 - 70 cm. high (Plate 14) .

15) Lizzage , Xanthium strumarium L.

It is found in the central and eastern alluvial plains districts. This plant is a bushy annual herb reproducing by seeds (Plate 15) .

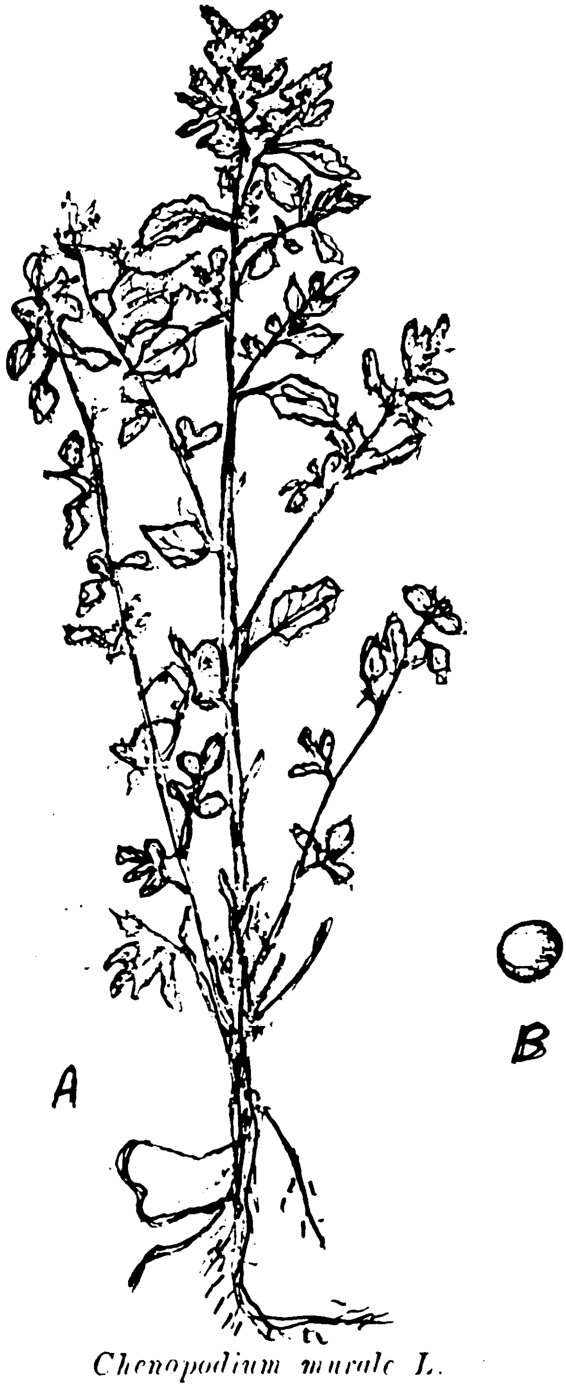
PLATE 13



Cynodon dactylon (L.) Pers.

A, plant; B, roots; C, spike; D, flower; E, seed.

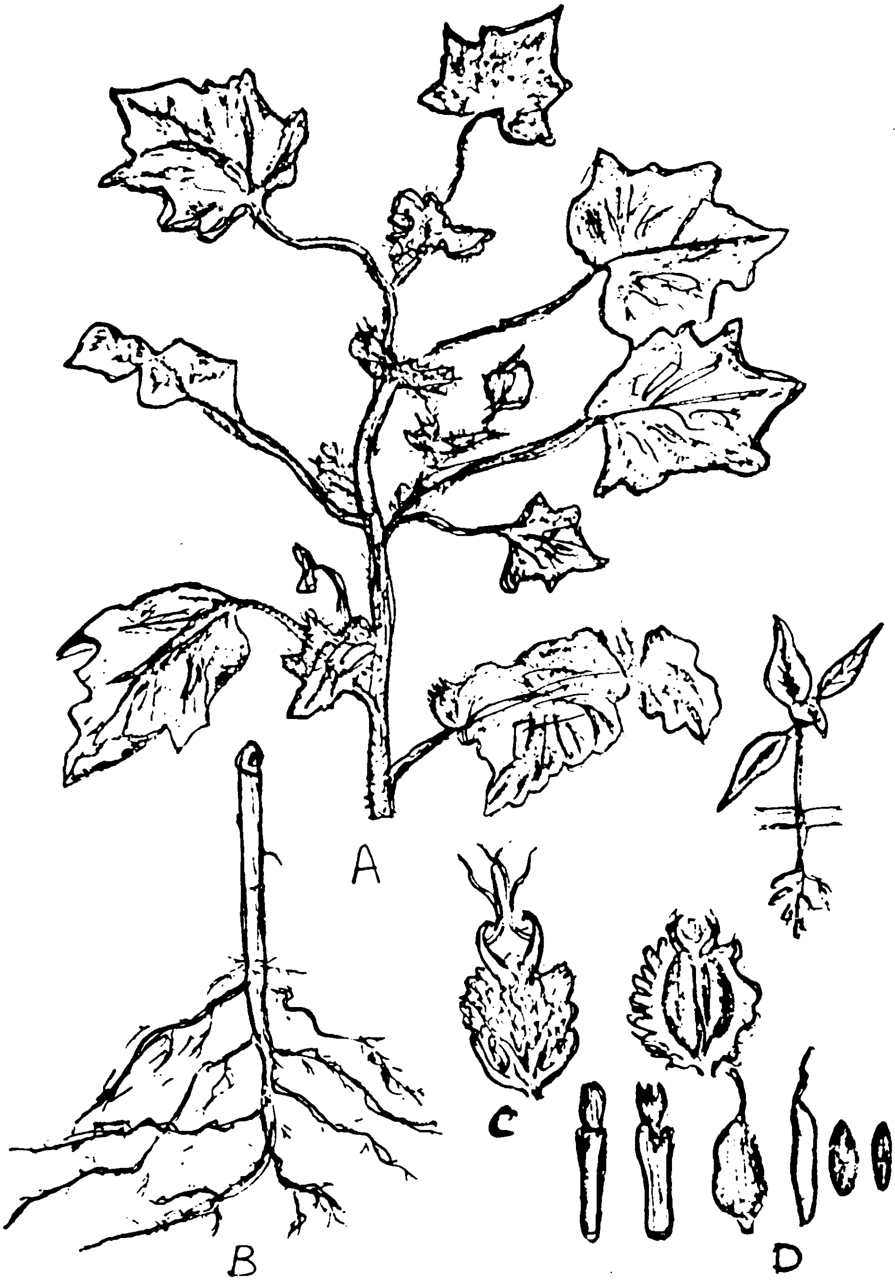
PLATE 14



Chenopodium murale L.

A, plant; B, seed.

PLATE 15



Xanthium strumarium L.

A, stem; B, root; C, inflorescence; D, fruits and seeds.

16) Rwaithah , Lolium tomulentum L.

It is found in waste land of the central and eastern alluvial plains and Mosul districts. It is an annual grass reproducing by seeds. Leaves green, hairless, culms erect or slightly spreading slender (Plate 16).

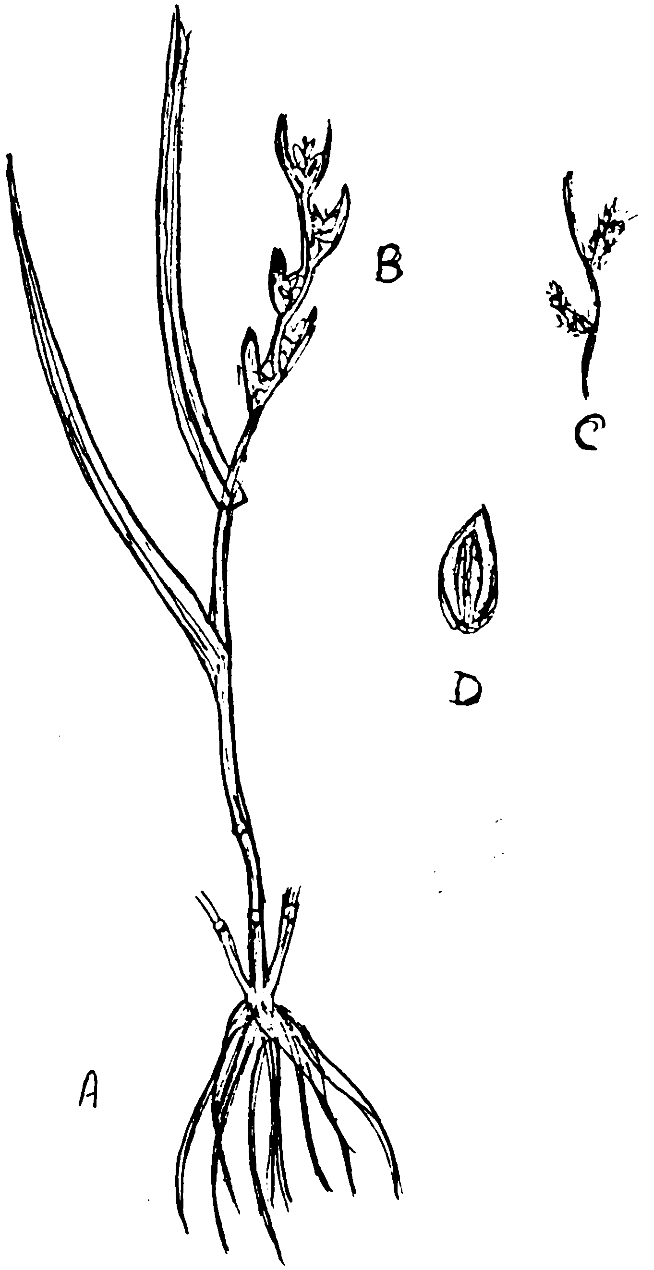
17) Jinnaibrah , Cardaria draba L.

It is found in central and eastern alluvial plains , southern desert , Erbil , Kirkuk and Amadia districts. It is a perennial weed grazed by animals and at times collected by some people and cooked for food. Reproducing by seeds. Leaves simple , stem erect 30 - 50 cm. high (Plate 17) .

18) Shoke or Kharnoob , Lagonychium farctum

This plant is a thorny shrub reproducing by seeds. It is found in southern and western deserts , central and eastern alluvial plains , Erbil , Kirkuk , Mosul , 2.0 meters in height. The plant has very deep taproot. Livestock graze this shrub (Plate 18) .

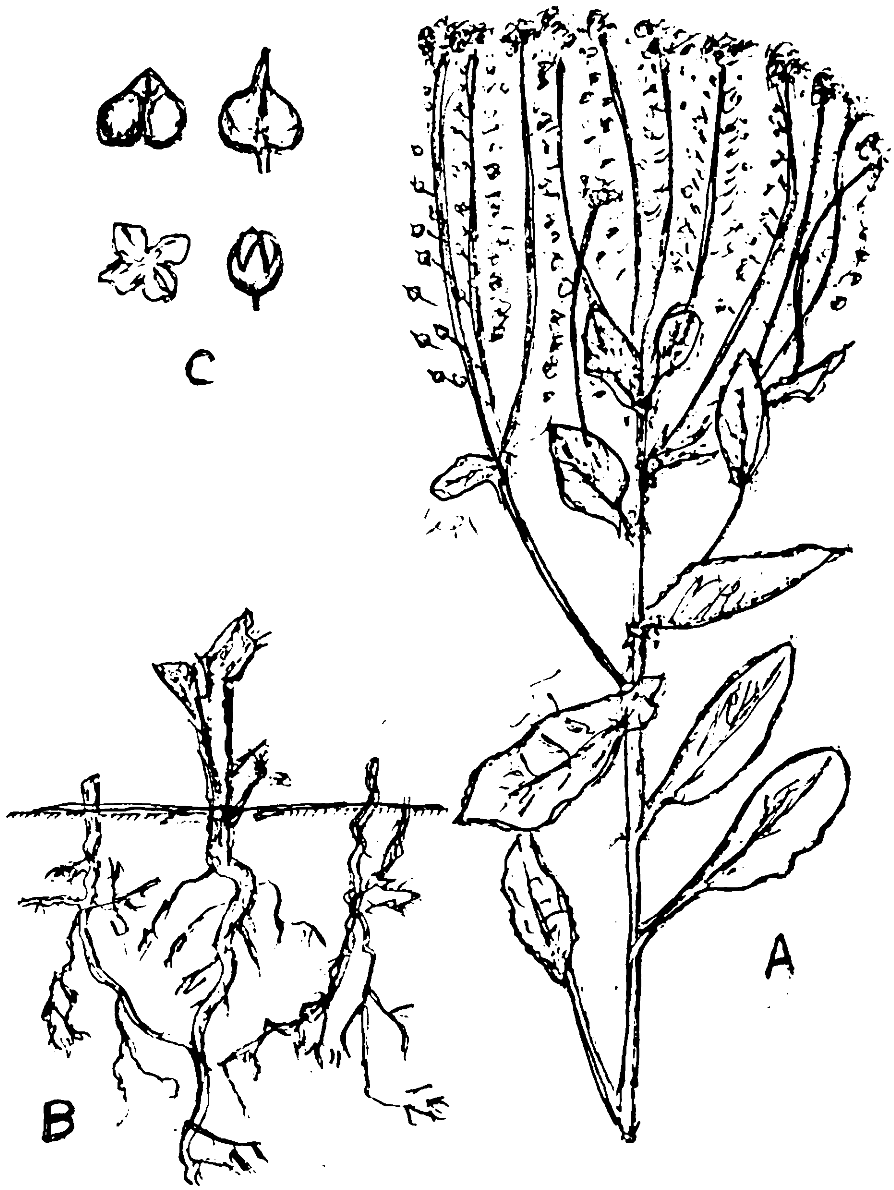
PLATE 16



Lolium temulentum L.

A, plant; B, spike; C, enlarged spikelets; D, seed

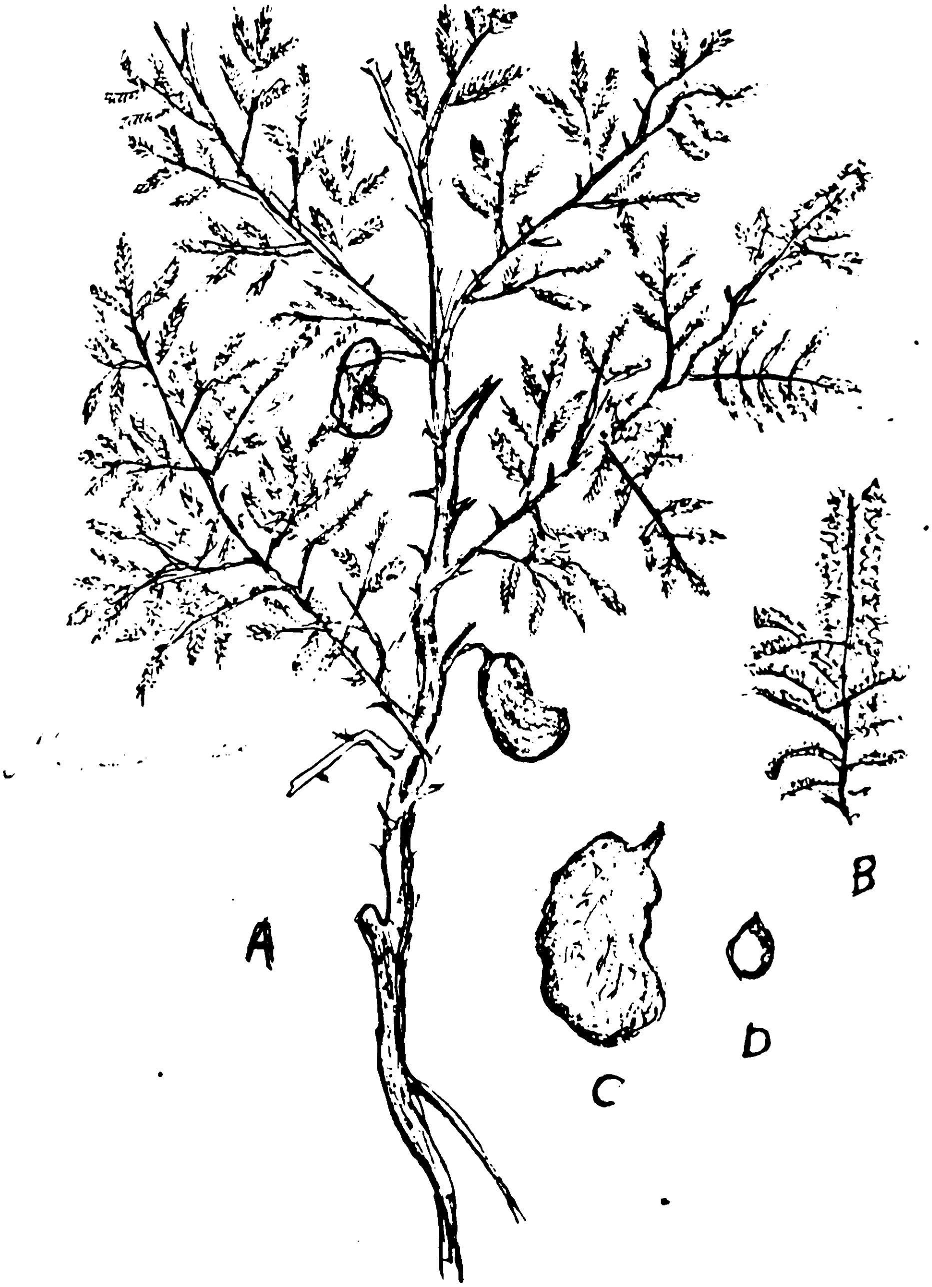
PLATE 17



Cardaria draba (L.) Desv.

A, stem; B, root system; C, flower and fruit.

PLATE 18



Lagonychium farctum (Banks. et Soland.) Bobr.

A plant, B, inflorescence; C, pod; D, seed.

19) Rhailah or Hamedh , Chenopodium album L.

It grows in the central alluvial plains, Erbil , Rawanduz and western desert districts. Reproducing by seeds. Stem erect , greenish , 30 - 80 cm. high . (Plate 19) .

20) Zorraige , Chrozophora verbascifalia

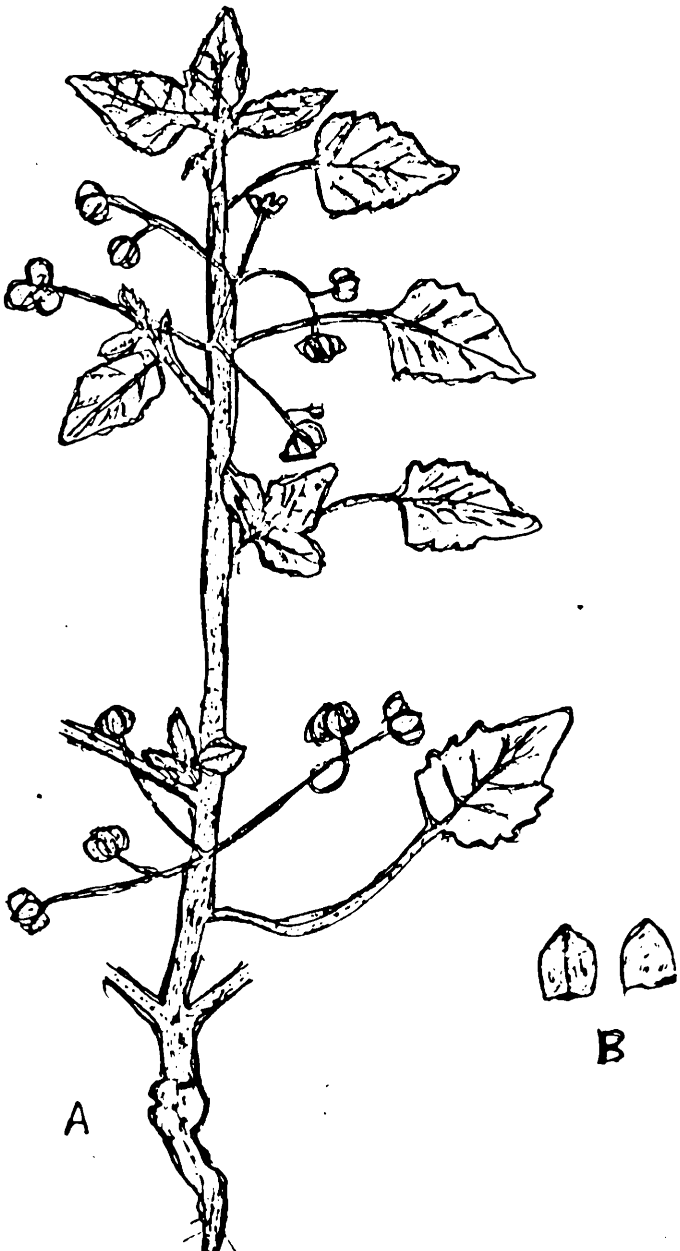
It is an annual plant reproducing by seeds. It is found in the waste land , western desert , Mosul , Erbil , Amadia and central alluvial plains districts. Stem erect , branched 10 - 30 cm. high (Plate 20) .

PLATE 19

Chenopodium album L.

A, stem; B, root; C, fruit.

PLATE 20



Chrozophora Verbascifolia (Wild.) Juss.

A, plant; B, seeds.

6.2 EXPERIMENTAL

6.2.1 Chemical analysis

The dried sample of plant material was ground in an agate morter and 0.1g weighed for subsequent analysis. Forty samples have been taken from twenty plants (two samples from each plant) . The dried samples were transferred to 100 cm^3 conical flasks and 10 cm^3 analar nitric acid added. Samples were digested at 100 $^{\circ}C$ on a hot plate in the fume cupboard until the material reaction subsided and the solution became clear. For more details see chapter 2.4.1 .

6.3 Results and Discussion

As noted in Table 1 most of the 20 plants had salt levels in excess of those generally found in most commerical plants ie, maize , barley , peas , etc.

Plant numbers 11 , 12 , 14 , 15 and 16 respectivly Gogallah , Qasab , Righailah , Lizzage , and Rwaithah , were particularly high in salts so it would appear as if these plants could tolerant high salts and remove large amounts from the growing medium and therefore, would be most suitable for a study on biological desalination.

Taking advantage of the ability of these plant species to remove salts from soil , it should be possible , at least in theory to sow these plants and remove up to six times the amount of salt compared with some herb plants like Fingergrass and more than two times commercial plants like wheat (See Table 2) under natural conditions. Under cultivation and using the new technique of soaking followed by dry period which has been used in previous chapters where the growth would be adapted much better and the yield of salts removed estimated to be considerably higher than the values reached in Table 2 . Obviously much work would be required before this possibility could become a reality but such a study would be very worthwhile .

The adaptation of these plants to saline substrates is related to the ability of the plants physiology to prevent the salts interfering with the metabolic processes. Ahmad , (1968) found mainly salts of Na , K , Ca , and Mg impregrated with some quartz particles in the organic material which renders them insoluble to water. These cells work merely as store houses and do not let minerals interfere in the normal metabolism of the plant. This was considered to be one of the adaptive mechanisms for inducing salt tolerance in the halophytes.

TABLE 1 Inorganic ion analysis of selected Iraqi plants

No.	Latin name	Family name	English name	Colloquial name	Na%	K%	Mg%	Ca%
1	Cressa cretica L.	Convolvulaceae	Alkali weed	Shuwail	1.22	0.9	1.49	2.85
2	Salsola Kali L.	Chenopodiaceae	Russian thistle	Chibchab	4.25	1.12	1.98	0.3
3	Heliotropium europaeum L.	Boraginaceae	European	Ijairbeh	1.85	2.22	1.0	2.45
4	Cyperus rotundus L.	Cyperaceae	Common nut grass	Si'ed	0.49	2.65	0.60	0.68
5	Euphorbia peplus L.	Euphorbiaceae	Petty spurge	Wodaynah	0.80	1.42	0.53	1.18
6	Eragrostis poaeaides P.B.	Gramincae	Spreading love grass	Halfa hawliyah	4.00	2.43	0.5	0.1
7	Sisymbrium irio L.	Crucifera	London rocket	Howairrah	1.23	1.12	1.08	1.58
8	Alhagi maurorum M.	Papilionaceae	Prickly alhagi	A'agool	0.83	0.56	0.82	1.58
9	Rumex dentatus L.	Polygonaceae	Dentated dock	Hummaith	0.48	2.43	0.67	0.5
10	Imperata cylindrica L.	Gramineae	Blody grass	Halfa	6.00	1.52	0.36	0.05

Continued ..

TABLE 1 Inorganic ion analysis of selected Iraqi plants

No.	Latin name	Family name	English name	Colloquial name	Na%	K%	Mg%	Ca%
11	Schanginia aegyptiaca	Chenopodiaceae	Suwad	Gogallah	9.25	1.50	1.85	0.68
12	Phragmites communis Trin	Gramineae	Common reed	Qasab	9.75	1.07	0.29	0.05
13	Cyodon dactylon L.	Gramineae	Finger grass	Thayyel	0.43	1.38	0.31	0.1
14	Chenopodium murale L.	Chenopodiaceae	Sowbane	Righailah	1.80	5.35	1.74	0.78
15	Xanthium strumarium L.	Compositae	Clotbur	Lizzage	1.20	2.06	1.25	3.98
16	Lolium temulentum L.	Gramineae	Darnel	Rwaitah	0.60	6.35	0.39	0.05
17	Cardaria draba L.	Cruciferae	White weed	Jinnaibrah	0.62	2.37	0.61	1.73
18	Lagonychium farctum	Mimosaeae	Prosopis	Shoke	2.10	0.56	0.49	1.68
19	Chenopodium album L.	Chenopodiaceae	Pig weed	Rghailah	0.9	1.27	0.27	0.45
20	Chrozophora verbascifolia	Euphorbiaceae	Mullein	Zorraige	2.7	1.42	0.78	2.5

TABLE 2 A comparison of the inorganic ion concentration of two halophytes (Suwad and common reed), with two herbs (Fingergrass and sowbane)and two commercial plants (alfalfa and wheat)

Elements % / Plants	Na %	K %	Mg %	Ca %	Total
Alfalfa	0.069	2.542	0.389	2.886	5.886
Wheat 5 weeks old	0.146	3.584	0.25	1.095	5.075
Fingergrass	0.43	1.38	0.305	0.1	2.215
Sowbane	0.9	1.27	0.273	0.45	2.893
Suwad Halophytes	9.25	1.5	1.85	0.675	13.275
Common reed Halophytes	9.75	1.07	0.288	0.05	11.158

Wheat (Mexicon super - x) Helkal, (1977)

Alfalfa , Brown Hayward (1956)

Fingergrass and Sowbane from Table 1 .

CHAPTER SEVEN

CONCLUSION

The idea of inducing the plant it self to remove salt from saline soil is a recent discovery. Chaudhuri and et aL (1964) carried out investigattions with Suaeda Fruticosa (halophytes) and showed it can bring about reclamation of saline and alkaline soils in certain parts of Pakistan by absorbing large quantities of salt from the top soil. A theoretical estimate shows that more than 2,400 lbs of salts can be removed from one acre by a single harvest of the aerial parts in the autumn of each year.

The investigations reported here were initiated to find out the possibility of inducing salt absorbtion as a land reclamation method at the germination and seedling stages for two weeks under saline conditions in a growth room (for glyogphytes) . Seeds of barley, peas and sugar beet were used throughout these 49 experiments. Several varieties were used with each crop to give the work additional agronnomic relevance. In addition, there was a separate study with some IRAQI plants to estimate their ability to aid land reclamation.

The first experiments from chapters 2, 3, 4 and 5 were conducted to determine the effect of various levels of salt solution on the germination of different varieties of each crop studied. The data showed a reduction in the germination percentage with the progressive increase of salt concentration as a result of outer toxicity or high osmotic pressure. Based on these results 1.5 % salt solution was selected as the medium to test the effectiveness of the seed pretreatments for barley and pea varieties and 1 % for sugar beet varieties. The salt tolerance data presented in all chapters showed differences between varieties, because salt tolerance differences exist not only between species but also amongst genotypes of a certain species. This latter aspect attracts increasing interest for both biochemical studies on the mechanism of salt tolerance and applied research such as adaptation of crop species to saline soils (Epstein and Norlyn, 1977).

Obviously it is impossible to indicate the precise tolerance of any plant, because the capacity of any plant to endure salt, varies with the physical characteristics of the soil, the kind, amount and character of salt, fertility of the soil, moisture supply, climate, kind of crop and other modifying factors.

Barley varieties showed excellent tolerance of the concentration of 2 % salinity particularly with variety Marko (V4). Higher concentrations induced considerable decreases in the stand and the concentration of 2.5 % induced complete mortality. Significant differences were noted between varieties (Table 1 Chapter 2). These differences agree with the findings of Ayers (1953) who worked with 30 barley varieties. Pea varieties appear less tolerant than barley varieties. The pea variety Puget (V2) stood up to a concentration of 1.5 % and was more tolerant than the other variety tested. Sugar beet was excellent at 1 % and the variety Julia showed more tolerance than the other variety tested.

The major inhibitory effect of salinity upon plant growth has been attributed to either water stress (Magisted 1945 , Bernstein and Hayward 1958) or salt toxicity (Dahiya and Singh 1976). A third alternative exists, namely nutrient inbalance consequent upon the high level of NaCl .

The presoaking and dry period of the seeds (chapter 2, 3, 4, and 5) stimulated the germination process under saline conditions. The reason for the effect could be the result of increased physiological availability of water and nutrients. Also it is possible that under high salt concentration naturally present hormones may be suppressed and that the presoaking treatment supplies sufficient hormones for normal growth (Tagawa and Bonner 1957 ; Kessler 1961 ; Shah and Loomis 1965). Also there are significant differences in total germination between treated seeds. These results conform with work of others workers like Parija and Pillary (1945) May and Milthorpe (1962) and Mortyanova et al(1962).

Dry seeds contain no functional membranes until water enters during the early minutes of hydration (Simon 1974).

During this period, solution containing ions, hormones and even protiens may traverse the nonfunctioning membrane and subseqently affect ensuing metabolic processes. Presoaking seeds with a 4 hours water treatment allows membrane and protein hydration and an initation of processes such as oxidative phosphorylation, R N A synthesis , polysome formation and protein synthesis (Waters, 1966).

From observations carried out as part of this study, the germination started earlier in the seeds soaked in pretreatment solution as compared with the unsoaked seeds under saline conditions. This conclusion agrees with the findings of Chaudhuri and Wiebe (1964 ; 1968), Cocks and Donald (1973) Idris and Aslam (1975) .

Some calcium salts appeared to have a significant effect (chapter 2) in inducing barley varieties to absorb Na. Variety Golden Promise (V3) showed a response to Na absorption under 3 % $Ca(CH_3COO)_2$ and a 3 weeks dry period (Table 11). Variety Marko (V4) showed a higher response than V3 to Na absorption under 3 % $CaCl_2$ with 2 and 3 weeks dry period and 3 % $Ca(CH_3COO)_2$ with 3 weeks dry period. Also this variety showed a slight increase in the content of calcium under $CaCl_2$ with a 3 weeks dry period. Calcium bromide and calcium sulphate pretreatment did not show any effect with the barley varieties, but they appeared to give a slight benefit with the pea varieties at the germination and seedling stages. The Puget variety was much better than sprite at absorbing salt but both of them were less responsive than barley.

As a general rule the considerable difference in the content of mineral elements in leaves of the treated plants was also induced by the salinity level. Sodium and sometimes calcium appeared higher than usual in the leaves of the test plants, probably due to the presoaking treatment and the dry period, additional to the reason of increased Na level in the experimental solution as Lunin et. al. (1964) confirmed with vegetable crops and EL - Shourbagy and Missak (1975) with three varieties of caster bean. They reported that sodium increased progressively with saline irrigation. Also Francois and Bernstein (1964) with sunflower leaves, Asana and Kale (1965) with four varieties of wheat and George (1976) with some cereal crops indicated that the Ca content appreciably increased with increasing salinity.

Potassium content appeared to decrease with all pre-treatments. The reduction may be due to the level of calcium in the culture media as reported by Allison (1964) who noted that high concentrations of Ca may restrict the uptake of K by beans and some carrot varieties .

Magnesium content of all barley and pea varieties except variety Puget decreased and this is in agreement with the results obtained by EL – Shourbagy and Missak (1975) with three varieties of caster bean plant.

Hormones play different roles in relation to salt balance and salt effects in plants (Shannon and Francois 1977). The data shown in chapter 4 Tables 1 and 2 (growth stage) indicate that the varieties Gadmarker, Triumph and Igri absorb more Na than usual due to their significant response with 100 ppm GA and 17 hour dry period under saline conditions. Gibberellic acid has successfully employed in overcoming an osmotic inhibition in the germination of lettuce seed (Kahn et aL. 1957). Also GA showed a significant effect in reducing chilling injury during the early periods of germination of Pima S - 4 (Cole and Wheeler 1974) . But NAA and IAA showed a very slight effect on barley varieties. The reason may be due to stimulation of active Cl^- uptake , although this was not verifield. Active uptake of Cl^- has been stimulated in oat coleoptiles in response to either auxin treatment or low pH (Rubinstein 1974).

Although CaO_2 showed a big effect in increasing germination of varieties V1 , V2 , and V5 particularly with concentration of 0.1 g and 2 week dry period. This treatment did not show a significant effect on the growth stage except when some phenologic effects were observed with the barley plant.

Garlic and Onion extracts unfortunately did not show any effect on barley varieties.

Sugar beet seed varieties in chapter 5 appeared to have a low tolerance compared with barley and pea varieties at the germination stage. A dry period of 17 hours (Table 3) showed a big effect on both varieties. Variety Julia was highly responsive to CaO_2 and H_2O_2 throughout all experiments. Varitey Klein Monoseet showed a response with CaO_2 and a 2 weeks dry period only. The results agree with the findings by Vaidyanathan (1980) and Coumans (1974) . The complex salt ($Co(NH_3)_5Cl)Cl_2$ was highly effective in increasing germination for both varieties. Unfortunately the growth stage was not carried out in this chapter , for the reasons mentioned before. However from these experiments, it does successfully increase salt tolerance particularly with the variety Julia.

Pretreatments with distilled water yield significant increases in germination throughout all experiments in chapter 2 when used as a control. Therefore a separate experiment was carried out (see Table 9) and the results were not better than the best pretreatment results in all the experiments (see Chapters 3, 4 and 5) . For this reason it was decided not to do any more separate experiments.

The decrease in certain cation contents in the test plants especially at high salinity levels may be explained in terms of the opinion of Long (1973) who stated that, salt in the culture solution in contact with membranes of absorbing root cells or accumulated salt within the plant may produce deleterious effects on the protoplasm directly.

Iraqi plant analyses were carried out in chapter 6 to estimate the elements contained in the aerial parts of the plants. Some of these plants (Gogallah , Qasab , Righailah , Lizzage and Rwaitah) were halophytes and showed high salt concentrations. When advantage is taken of these plant species to estimate theoretically their ability to remove salts from soil, it should be possible , at least to increase the value by six times compared with some herb plants like Finger Grass and more than two times with comercial plants like the wheat crop and large increases will result under good conditions of cultivation using optimum soaking and dry period conditions.

Lastly, the results and discussions from all the work carried out so far can answer the thesis objectives as follows : -

1- A) Land reclamation by crop plants is not impossible but a little difficult.

B) Land reclamation by halophyte plants is possible but not easy.

Both of the above points, in addition to the advantages of a soaking pretreatment and a dry period which have already been demonstrated in this thesis, need more work to be carried out under real conditions to optimise the effects and to discover others factors eg. influence of temperature and pH of soaking solution etc.

2 - Germination stage was more tolerant than growth stage for barley and pea varieties.

3 - Soaking and dry period was shown to be a benefit with some pretreatment materials for some varieties.

4 - Most varieties of the crops showed a response to increased salt tolerance after treatment.

ADDENDUM

The following is an attempt to relate the laboratory exercises on seed germination (Chapter 2) and biological desalination (Chapter 6) to the situation which could conceivably exist in the field.

1. Barley seed germination

The critical salt concentration mainly adopted in the petri dish exercises is 15,000 ppm (1.5%). This approximates to half sea water salt concentration which is ~32,000 ppm (3.2%). The conductivity of sea water is ~56 millimoles/cm. The conductivity of the germination medium is ~26 millmoles/cm. In saline soils the top tolerance value for economic barley production is ~10 millimoles/cm.

Accepting the fact that there are many interrelated factors involved, it would nevertheless seem reasonable to assume that the most critical stage in barley production is not the germination stage, although this is not necessarily the case with other plants, e.g. sugar beet.

2. Biological desalination

This calculation assumes that some irrigation water would have to be added to attain a reasonable yield of shrubs/acre to enable an annual harvest to take place.

Amount of salt removed per year - 2,400 lb/acre

~1 ton/acre ~2.5 tonnes/hectare (2,500 kg)

If 10 hectare-cm of irrigation water were employed annually to give reasonable growth this would require

$$10,000 \text{ cm} \times 10,000 \text{ cm} \times 10 \text{ cm} = 1,000,000,000 \text{ cm}^3$$

(1,000,000 litres) of water/hectare.

The amount of salt removed by the shrubs would therefore be -

$$2{,}500 \text{ kg}/1{,}000{,}000 \text{ litres} = \frac{2{,}500{,}000 \text{ g}}{1{,}000{,}000 \text{ litre}}$$

$$= 2.5 \text{ g/litre of water.}$$

Obviously the more salt tolerant the plants, then the less irrigation water would be required, e.g. 1 hectare-cm of irrigation water would lead to the removal of 25 g salt/litre water. However 10 cm of irrigation water would not be considered excessive. Therefore if the shrubs were to have a positive effect on removing salt from saline soil, then the irrigation water would have to contain less that 2.5 g salt/litre of water (0.25%). This should be feasible, bearing in mind that this salt content is approximately $^{1}/_{10}$ sea water concentration and $^{1}/_{5}$ of the critical salt level adopted here for germination studies.

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