INTRODUCTION

Maize (*Zea mays* L.) is considered the third cereal crop after rice and wheat allover the world for production and consumption. In Egypt, it is grow in about 1.773 million feddans which produce about 6.106 million tons of grains with an average yield of 24.6 ardab / Feddan **(Central Administration of Economic, Ministry of Agriculture, Egypt, 2003)**. In addition to its use as a human food, it is also utilized as a poultry and livestock feed and also as a fodder.

Excessive soil and water salinity are environmental stress factors that inhibit the growth and yield of glycophytic crop plants in many regions of the world **(Epstein, 1985 and Cheeseman, 1988)**. The precise mechanisms by which excessive salinity inhibits the growth of crop plants are still not fully understood, but many include osmotic effect as well as the direct toxicity caused by certain ions **(Cheeseman, 1988)**. Salinity affects plants at all stages of development, but sensitivity varies from one growth stage to another **(Mass *et al*., 1986)**.

Maize is classified as a salt-sensitive crop plant **(Mass and Hoffman, 1977)**. The response of maize to salinity varies depending on the stage of development **(Kaddah and Ghowail, 1964; Mass et al, 1983; Pasternak *et al*., 1985)**. Vegetative growth appears to be most sensitive to salinity, while plants are much less affected at later stages **(Cramer, 1994)**. Vegetative growth of maize is severely impaired even at rather low salt concentrations **(Mass and Hoffman, 1983; Hashem, 2000)**. Studies on the relative salt

tolerance of maize cultivars during different stages of growth have show that there is a difference in their response to salinity **(Drew *et al*., 1988; Lewis, et *al*., 1989 and Frederick *et al*., 1990)**.

Salt restricts the growth of plants over larger areas of the earth than does any other inhibitory substance in the natural environment. Sodium and chloride are the most prominent potentially toxic ions of saline substrate. Salinity causes growth reduction primary due to the low osmotic potential of the medium and by specific ion effect as a secondary cause **(Bernstein and Hayward, 1958; Osawa, 1963)**.

The study of the plant response to salt stress has been a central feature for environmental physiologists attempting to understand how plants function in their natural environments and in particular to explain patterns of plant distribution and their performance along environmental gradients **(Jones and Jones, 1989)**. NaCl inhibite water absorption by plants especially with the rise of it's concentration **(Hashem, 2000 and Zaki, 2005)**.

Plants growing in saline environments exploit various strategies at both the whole plant and cell level that allow them to overcome the salinity stress, The problems posed to higher plants by a saline environment results from osmotic stress due to the difficulty in absorbing water from soil of unusually high osmotic pressure, and ionic stress resulting from high concentrations of potentially toxic salt ions which lie above the limit to which plants are adapted for optimum growth during evolution. Both components of salt stress affect a growing plant by causing changes in membrane chemistry, cell and plant water status, enzymes activity, protein synthesis and

gene expression **(Leopold and Willing, 1984; Chapin, 1991 and Blomberg and Alder, 1992)**.

Plant adaptation to increase soil salinity could be obtained through osmotic adjustment, e.g., by ion accumulation. Therefore accumulator species can be expected to be tolerant ones. This adjustment could be achieved by raising of intercellular solute concentration, either by ion uptake from root bathing solution and/or by internal production of osmotically active solutes **(Hsiao *et al.*, 1976 and Jefferies, 1981)**.

Higher plant species differ widely in their tolerance to salinity, which depends primarily on morphological features of the plant, uptake and transport of salt, physiological and metabolic events at the cellular level **(Winicov, 1993)**. **Brugnoli and Lauteri (1991)** reported that plant growth, leaf area development and stomatal conductance were strongly reduced by salinity. **Pessaraki (1991)** found that water uptake decreased with increasing salinity and added that this effect was found to depend on the stage of growth.

Munns (1993) has proposed a biphasic model of growth response to salinity. According to this model, growth is at first reduced by a decrease in the soil water potential, this phase of growth reduction is a water stress effect and may be regulated by inhibitory signals from the roots. The growth reduction in the first phase is an effect of salt outside rather than inside the plant and genotypes differing in salt tolerance respond identically in this first phase. In the second phase, the concentration of toxic ions increases rapidly, especially in old leaves, which die as a result of a fast

increase of the salt concentration in the cell wall or cytoplasm when vacuoles can no longer contain incoming salts. In this second phase, genotypes which vary in salt tolerance may respond differently as a result of their different abilities to exclude toxic ions or to sequester them in the vacuoles.

Salinity stress has been reported to disturb the integrity of wheat and barley cell membrane resulting in increased membrane permeability **(Mansour *et al*., 1993)**. Maintenance of membrane integrity and selective uptake of essential minerals are the parts that confer salt tolerance **(Schroppel-Meier and Kaiser, 1988)**. **Ismail (2003)** reported that under salt stress, membrane permeability was higher in maize (Less-salt tolerant) than that of sorghum (More-salt tolerant).

Under salt stress, shoot and root lengths, fresh and dry masses, water and pigment contents were slightly decreased by increasing salinity level up to 60 mM NaCl, hereafter the values of these parameters decreased significantly **(Azooz *et al*., 2002)**. However, broad bean tolerated NaCl salinity up to 240 mM NaCl and lupin to 200 mM NaCl. The length of root and shoots and their water content, as well as dry matter yield, remained more or less unchanged up to the level of 80 mM NaCl **(Shaddad *et al*., 1990)**.

Salinity significantly reduced growth of stems and root and resulted in lateral rolling of leaf lobules, reduction in leaf size and necrosis of older leaves of sweet potatoes plant **(Villafane, 1997)**. Salinity also caused a reduction in the seedlings water content which was proportional to stress level and was more pronounced in the

shoot than root organs **(Hamed and Al Wakeel., 1994)**. **Abd El-Samad *et al*. (2004)** showed that the lack of a negative response to increasing NaCl concentration for water content, dry matter yield and leaf area of Cv. 324 up to a concentratin of -0.6 MPa indicated salt tolerance.

Pessaraki *et al.* (1989) evaluated the effects of NaCl salinity on growth of corn in terms of dry matter production and nitrogen and water uptake. They found that any level of NaCl in the root medium is detrimental to corn growth and resulted in marked decreases in shoot, root and total dry matter production**. Mishra *et al*. (1994)** studied the effect of salt stress on the growth of 15 day-old seedlings of maize. They observed that increasing salinity levels decreased shoot and root length, shoot: root ratio, specific leaf weight and total leaf area compared to the unstressed control plants.

Qing and Guo (1999) showed that with the increase of NaCl concentration, the number of chloroplasts of sweet potato leaves decreased, chlorophyll a and b synthesis were inhibited by high salinity treatments **(Khan *et al.*, 1998)**. In the leaves of *Cressa cretica* L., the total nitrogen content, chlorophyll content and RNA: DNA ratio decreased **(Liu-wei *et al*., 1998)**.

The contents of Chl a, Chl.b carotenoids and consequently total pigments were slightly decreased by increasing the level of NaCl up to 60 mM, while pronounced decrease was observed at high levels of salinity **(Ball *et al*., 1987 and Azooz *et al*., 2002)**. **Ashraf (1989)** also demonstrated the physiological basis of salt tolerance of two cultivars of black gram (*Vigna mungo* L. cv. Candhai Mash and

cv Mash 654) in salinized sand culture at the flowering stage and found that increasing NaCl level in the rooting medium significantly reduced the chlorophyll a, chlorophyll b, leaf water potential, leaf solute potential and leaf turgor potential in the cultivars. At the high salinities, cv Candhari Mash (relatively salt tolerant) had significantly large amounts of the above measurements than cv Mash 654 (salt sensitive).

The hydroponic technique was applied by **Ahmed *et al.* (1977)** to study the effect of different salinity levels on pigment contents and photosynthetic activities of safflower and maize plants, it was found that while safflower plant could tolerate salinization treatments up to the highest level used (0.1 M NaCl), exhibiting higher pigment contents and photosynthetic activity, maize plants were highly sensitive to any salinization level investigated exhibiting markedly lower pigment contents and photosynthetic activity.

In the area of carbohydrate metabolism, stress induced reduction in chlorophyll content **(Longstreth, *et al.*, 1984; Chavan and Karadge, 1986)** and accumulation in soluble sugars which accompanied by a reduction in the level of starch **(Ford and Wilson, 1981; Vyas *et al.*, 1985). Rathert (1983) and Spryopoulose (1986)** described sucrose as being the compatible osmotic solute to maintain the stressed tissues in a more negative water potential. **Hawker and Walker (1978)** found that growth of leaves, invertase activity and concentrations of reducing sugars were lower at the higher concentrations of NaCl in bean and maize leaves. Under the higher salinity levels, in lupen the losses in carbohydrate

were accompanied by increase in soluble protein **(Shaddad *et al.*, 1990)**.

Salinity stress was found to induce profound changes in the components of carbohydrates **(Todd and Basler, 1965)**. In this respect, some authors **(El-Shahaby, 1978; Fayez, 1984 and Ahmed *et al.*, 1989)** have reported that carbohydrates were variously accumulated in various plants under salinity conditions. **Bernstein 1961; El-Shahaby, 1978 and 1981; Gaber, 1981)** found that at low and moderate salinity levels the production of sugar and consequently the total carbohydrates were reduced. **Hashem (2000), Azooz *et al.* (2002)** found that salinity induced inhibitory effects on the biosynthesis of carbohydrate and free amino acids, but opposite effects were observed on the biosynthesis of protein and proline in *Zea mays* and respectively. **Abd El-Samad, *et al*. (2004)** showed that in the tolerant *Zea mays cv*. 324, total carbohydrate and soluble protein in shoot and total protein in roots increased with salinity stress.

Many plants accumulate a considerable amount of free proline in response to salt stress **(Dhingra and Varghese, 1985; Irigoyen *et al.*, 1992)**. The most common interpretation of proline accumulation is that it acts as a cytoplasmic osmotic solute and as a source of energy and nitrogen **(Stewart and Lee, 1974; Aspinall and Paleg, 1981; Ford and Wilson, 1981)**. Leaf proline content increases proportionately faster than other amino acids in soybean and sorghum under water stress **(Bates *et al*., 1973)**. **Cavalieri and Huang, (1979),** Studied the Proline accumulation by eight major

species of salt marsh halophytes under growth chamber and field conditions. They found that the significance of proline accumulation in halophytes in the salt marsh environment should be viewed as a species-specific phenomenon related to the salinities encountered in the field. It has been suggested that stress enhanced the production of proline, which may cause osmotic adjustment **(Steward and Lee, 1974 and Treichel, 1975)**. Proline accumulation as a response to salinity is in agreement with the earlier findings of **Weimberg *et al.* (1982)** on sorghum. The accumulation of free proline increased in the leaves in response to increasing salinity **(Al-Bahrany, 1994, Hashem, 2000 and Zaki, 2005)**.

The proline and glycine betaine contents increased with increasing salinity up to 500 mM NaCl the accumulation of proline and glycine betain might play a role in the alleviation of salt stress **(Venkatesan and Chellappan, 1998)**. Proline accumulation was higher and detected earlier at a lower salinity concentration in the salt sensitive of maize plant cv. 323 compared to the salt tolerant cv. 324 **(Abd El-Samad *et al*. 2004)**.

On the other side some works dealt with proline accumulation in plants treated with some stress counteracting substances (growth-promoting substances). It is found that while water stress markedly increased the accumulation of proline the counteracting substances significantly reduced its accumulation **(Azooz, 1990; Abd El-Samed; 1991, Verma, *et al*., 1991 and Singh *et al*., 1994)**. These authors concluded that these substances (Phytohormones,

amino acids or vitamins) could alleviate the adverse effects of water stress at least on the test plants.

Doheem and Sharaf (1983) and Sharaf and Youssef (1987) found that salinity caused increases in the contents of both soluble nitrogen and free amino acid of the grain yield of wheat and seed yield of broad bean. **Kamel *et al.* (1987)** observed that salinity caused increases in the total amino acid concentration and most of the individual amino acids especially threonine, aspartic, glutamic, phenylalanine and tyrosine in the grain yield of rice. Working on guar, **Kriem *et al.* (1986)** found that salinity (3000 and 6000 ppm NaCl) decreased the nitrate nitrogen in the seed yield.

Concerning the effect of salinity on the contents of proteins in the seed yield, many studies showed that salinity was of inhibitory effects. In this respect, **Doheem and Sharaf (1983)**, working on wheat; **Ragab *et al.* (1985)**, working on pea; **Abd El-Rahim *et al.*, (1985)** working on soybean; **Sharaf and Youssef (1987)** working on broad bean; **Hassanein (2000)** Working on rice; all observed that protein contents of the seed or grain yield were reduced in response to salinity conditions.

Levels of protein, nucleic acids and carbohydrates in plants growing under saline stress are affected by salt-induced alteration in the activities of synthetic and hydrolytic enzymes **(Nieman and Poulsen 1964; Prisco and O'Leary 1972; Dubey, 1982, 1985)**. Activities of the enzymes protease, amino peptidase and carboxypeptidase were determined in seedlings of rice cultivars with different salt tolerances raised under increasing levels of NaCl

salinity. Salinity caused a marked increase in protease activity in root as well as shoots **(Dubey and Rani, 1990)**. The breakdown of proteins in germinating seeds as well as in various parts of the plant is accomplished by the activities of protease and peptidase **(Mikkonnen, 1986)**. Germinating rice grains with different salt tolerances show varying behaviours of amylases, phosphotase, nucleases and proteases **(Dubey, 1983, 1985; Dubey and Rani, 1987)**.

Uperty and Sarin (1975), Sheoran and Garg (1978), Hassanein (2000) and Kasim and Hamada (2003) observed a reduced protein synthesis and an enhanced protease activity in pea plants, leaves of mung been, rice seedlings and *Eruca sativa* seedlings grown under saline conditions.

The localization of antioxidant enzymes between the mesophyll and bundle sheath cells were determined in sorghum (*Sorghum vulgare* L.) leaves. The activity of antioxidant enzymes like superoxide dismutase (SOD), catalase (CAT), guaiacol peroxidase (POD), ascorbate peroxidase (APX) and glutathione reductase (GR) were assayed in whole leaf, mesophyll and bundle sheath fractions of sorghum leaves subjected to water-limited conditions. GR was mostly localized in mesophyll fraction, while SOD, APX and peroxidase were located in bundle sheath cells. Catalase was found to be equally distributed between the two cell types. Under water stress conditions, most of the SOD activity was found in the bundle sheath tissues. Little or no activity of the enzyme CAT, APX, or POD was found in the mesophyll extracts

when exposed to water stress, GR activity increased when exposed to low water regimes **(Duarisundar *et al*., 2004, Hashem, 2006)**.

The SOD is the first enzyme involved in the antioxidative processs. The increase of its activity in plant tissues under salt stress was signaled in several reports **(Lee *et al*., 2001; Rubio *et al*., 2002)**. This enzyme converts superoxide radical to hydrogen peroxide (H_2O_2) and molecular oxygen (O_2). However, H_2O_2 is itself a cellular toxic product that is scavenged by other antioxidant enzymes, mainly CAT which, decomposes H_2O_2 to water and O_2 without consuming reductants and, thus, may provide plant cells with an energy-efficient mechanism to remove H_2O_2 **(Scandalios *et al*., 1997)**.

The enhanced production of reactive oxygen species by environmental stress may result in a significant damage to cellular constituents and even cell death if protective mechanisms fail to detoxify the reactive oxygen species by antoxidative systems **(Paolacci *et al*., 1997; Hassanein, 1999)**. It is well known that peroxidases are important component of this defence system **(Polle, 1995).** Salt stress preferentially enhanced the content of H_2O_2 as well as the activities of the superoxide dismutase (SOD), ascorbate peroxidase (APX), and peroxidase specific to guaiacol, whereas it induced the decrease of catalase activity. On other hand, salt stress had little effect on the activity levels of glutathione reductase (GR) **(Lee *et al*., 2001)**.

During water stress triggered in plants by salt stress, the generation of active oxygen species, including superoxide

($O^{\cdot}_2$),hydroxyl radicals (OH), hydrogen peroxide (H_2O_2), and singlet oxygen (O_2), are thought to play an important role in inhibiting plant growth and further, the active oxygen species need to be scavenged for maintenance of normal growth **(Lee *et al*., 2001)**.

Active oxygen species act both as toxic compounds in the cell and as mediators for the induction of stress tolerance. To detoxify the toxicity of active oxygen species, a highly efficient antioxidant defense system is present in plant cells. Antioxidants can be divided into two classes: non enzymic constituents including lipid-soluble and membrane-associated tocopherols, water-soluble reductants; ascorbic acid and glutathione, and enzymic constituents including SOD, catalase, peroxidase, APX and GR **(Foyer, 1993).**

The primary scavenger in the detoxification of active oxygen species in plants is SOD, which is a group of metallo enzymes that converts superoxide to H_2O and O_2 and offers protecting cell, against superoxide induced oxidative stress **(Asada and Kiso, 1973; Fridovich, 1986)**. Catalase can also reduce H_2O_2 to water, but it has a very low affinity for H_2O_2 **(Graham and Patterson, 1982)**.

Stresses inhibit growth through their effects on the hormonal balance **(Lerner and Amazallag, 1994)**. The decrease in growth promoting substances concomitantly with an increase in ABA content in response to salinity stress were observed by **Haroun (1985)** working on *Pisum sativum* plant, **Foda *et al*. (1991)** working on *Lupinus termis* plant and **Abd El-Kader (1991)** working on *Cucurbita pepo* seeds, **Hassanein (1999)** working on rice plant, **El-Khawas (1999)** working on *Trigonella Poenum graecum* plants,

Hashem (2000) on *Zea mays* plants. Moreover, it was reported by many authors that the exposure of the plants to salinity was rapidly followed by decreases in cytokinin production by tomato roots **(Walker and Dumbroff, 1981)** and by temporary accumulation of ABA in rice plant **(Moons *et al*., 1995)**.

Stress tolerance is dependent upon the genetic and biochemical characteristics of the species. Therefore, attempts have been made by certain investigators to differentiate stress-tolerant and stress-sensitive genotypes of crops on the basis of profiles or levels of soluble proteins and proteolytic enzymes which exist in the sets of genotypes differing in stress tolerance **(Dubey and Rani, 1987 and 1990)**.

Ericson and Alfinito (1984) reported that two protein bands (20 and 32 KD) were unique on SDS polyacrylamide gels of cells adapted to grow on NaCl, and **Singh *et al*. (1985)** found that eight protein bands increased, including the 26 KD polypeptide and that four protein bands decreased in the salt adapted cells, the 26 KD polypeptide increased in the greatest amount and constituted about 10 % of the total cellular protein. **Sadka *et al.* (1991)** and **Fisher *et al.* (1994)** found that the amount of 150 and 60 KD proteins respectively were greatly increased with an increase in salinity levels in *Dunaliella Salina*. Moreover, **Muthuchelian *et al*. (1996)** found that 100 and 250 mM NaCl led to a specific loss in the contents of 55, 43, 33, 25, 23 and 20 KD polypeptides.

Environmental stresses cause important modification in gene expression **(Soussi *et al*., 2001)**. Gene expression is manifested by

the appearance of new proteins, which are not present before the stimulation. Salinity promotes the synthesis of salt stress-specific proteins **(Ben-Hayyin *et al.*, 1989, Hashem, 2000)**, many of these proteins were suggested to protect the cell against the adverse effect of salt stress. Accumulation of 26 KD protein (osmotin) is a common response to salt stress **(Guerrier, 1998 and Hashem, 2000)**. Salinity stress led to the appearance of 67 and 26 KD polypeptide (in cv. Dorado) and 45 KD sorghum (in cv. Hagen shandawil) **(Azooz, 2004)**.

Salinity stress caused a considerable increase in sodium content, slight decrease in potassium content while a marked decrease in calcium and magnesium in chick pea was observed **(Varshney *et al.*, 1998)**. **Azooz *et al*. (2002)** showed that the content of Ca^{++} decreased significantly under salinity stress while Na+ and K+ contents were intensively accumulated. **Saha and Gupta (1998)** reported that both Na and Cl ions increased while potassium (K^+) ion decreased under salinity leading to decreased K^+/Na^+ ion ratio. **Lynch and Läuchli (1984)** found that excess NaCl inhibited uptake and transport of K^+ to the xylem. Recent experiments have shown that supplemental Ca^{++} alleviates the effect of NaCl salinity on maize **(Mass and Grive, 1987; Evlagon *et al*., 1990; Cramer, 1992)**.

Alfocea *et al*. (1993) worked on five tomato cultivars having different responses to salinity stress, they found that there was an accumulation of Na^+ and maintenance of K^+, Ca^{++} and Mg^{++} contents with increasing salinity, and the cultivars which is greater in salt

tolerance was associated with a higher Na^+ accumulation and lower K^+ content in the shoot than those found in the other cultivars. **Younis *et al*. (1994)** working with *Phaseolus vulgaris* found that, K^+ and Ca^{++} concentrations decreased, whereas those of Na^+ and Cl^- increased in both shoots and roots with increasing NaCl concentration.

Salinity adversely affects the growth of plants and their yield, and the alleviation of these effects on plants can be caused by applying various growth promoting substances such as phytohormones **(Singh, *et al*., 1994; Hassanein and Amin, 1999, Kasim and Dowidar, 2006)**, vitamins **(Polimbetova *et al*., 1964; Azooz, 1990, 2002 and 2004)** and the amino acid proline **(Abdel-Samed, 1987 and Hamed and Alwakeel, 1994)**. All the above authors recorded that the interactive treatments of water stress and these substances exerted mostly positive results in alleviating the adverse effects of water stress on the growth of plants.

Vitamins are organic compounds which are required in trace amounts to maintain normal growth and proper development of organism, these compounds act as coenzyme systems and thus take essential part in the regulation of metabolism. Plant would respond to exogenous supply of the vitamins only if its endogenous vitamins level was low **(Bonner and Green, 1939)**. Normal green plants can grow well without any external vitamin application because they can synthesis their entire requirements of vitamins **(Aberg, 1961)**, but it is of course not excluded that at a particular developmental stages of certain plants or organs may contain slight suboptimal quantities of

these vitamins, and therefore may exhibit stimulated growth by Further additions. Furthermore, it has been shown that vitamins can be considered as limiting factors in the development of plant **(Azooz, 1997)**. Laboratory and field experiments have indicated that seed soaking in vitamin solution; ascorbic acid (vit. C), nicotinamide (Vit. pp), Pyridoxine (Vit. B_6) counteracted the adverse effects of salinity on seed germination, seedling growth, and some relevant metabolic activities **(Shaddad *et al*., 1990; Azooz, 1997; Heikal *et al*., 2000, Ahmed *et al.*, 2001; Azooz *et al.*, 2002)**. Seed pre-soaking in 100 ppm, riboflavin counteracted the adverse effect of salinity on growth parameters, which were accompanied by enhanced biosynthesis of pigments, soluble carbohydrates, soluble protein, total protein, free amino acids and proline. Moreover, riboflavin treatments resulted mostly in a decrease of Na^+ accumulation and an increase of K^+ and Ca^{++} contents as compared with those of the corresponding salinization level **(Azooz *et al.*, 2002)**. Presoaking of seeds with optimal concentration of vitamins has been shown to be beneficial in seedling growth under saline condition by increasing physiological availability of water and nutrient **(Ashfaq *et al*., 1983; Azooz *et al*., 2002; Barakat, 2003; El-Bassiouny and Bekheta, 2001 and 2005)**.

Barbieri (1959) observed that application of vitamin B_6 enhanced height, leaf number, fresh and dry weights of pea, broad bean, beet and wheat in pot culture. The influence of B-vitamins on chlorophyll synthesis has been investigated by **Artimonov (1966), Easley (1969)**. They found that foliar treatment of plant with B-vitamins promoted the chlorophyll synthesis in the treated plants.

Kudrev and Pandev (1967) noted that spraying with pyridoxine accelerated uptake of nitrogen in wheat plants. **Ansari (1986)** reported that soaking lentil seeds for 12h and mung bean seeds for 4h in 0.3 % pyridoxine solution enhanced leaf nitrogen, phosphorus and potassium contents at vegetative flowering and fruiting stages of the two crops. Moreover, foliar spray of 0.2% pyridoxine solution at flowering stage increased the content of these nutrients in leaves of both crops.

In a field trial **Genkel (1970)** investigated the effect of soaking wheat grain for 12h in 0.005, 0.05 and 0.5% nicotinic acid and 0.05 and 0.5 % nicotinamide solution. He found that grain yield was raised by 16.7 q/ha in the control to 21.9, 18.8 and 24.5 q/ha by the application of 0.005 and 0.05% nicotinic acid and 0.5 of nicotinamide treatments, respectively. Further, the produced grains contained 89.2, 100.2, 96.3, 87.0 and 80.3 mg protein/g dry grain, respectively as compared with 82.7 mg in the control. **Ovcharov and Kulieva (1968)** have reported that cotton seedlings contain higher concentration of nitrogen and phoshorus as a result of seed treatment with pyridoxine (Vit B_6) or nicotinamide (Vit. PP) solution.

It has been found that seed soaking of lupin and broad been in either ascorbic acid or pyridoxine counteracted the adverse effects of salinity on germination, seedling growth, photosynthetic pigments, carbohydrate content, total nitrogen, protein, and the contents of K^+, Ca^{++} and Mg^{++} in the different organs of the plants **(Radi *et al*., 1989 and Shaddad *et al*., 1989 and 1990). El-Tayeb (1991)** showed that

seed presowing in/or spraying of shoot of broad bean, cowpea, lupin and sunflower with ascorbic acid and pyridoxine could ameliorate the harmful effects of water deficit on plant growth and metabolic activities.

As far as the literature available there is no information on the role of nicotinamide to alleviate the adverse effects of NaCl on plant. However, nicotinamide is connected to stress metabolism. In this respect, **Berglund *et al.* (1993)** suggested that nicotinamide can be used to increase the yield of radish and outdoor cucumber. Treatment with vit B_2 decreased the relative peroxidase activity which was accompanied with the disappearance of these four isoenzyme forms **(Shaddad *et al.*, 1990; Ahmed *et al*., 1998)**.

Kodandaramaiah (1983) found that vitamin treatments induced a significant alteration in the enzymes related to protein metabolism; which indicate that vitamins might act as activators of protein synthesis. **Azooz (2004)** showed that seed presoaking in vitamin PP generally, resulted in an increase in the intensity of the most polypeptide bands which were already apparent in vitamin PP untreated salinized and non-salinized seedlings.

Vitamins of the B-group, a part from acting as coenzymes, are involved in various physiological processes. Niacin and thiamine have been shown to act as growth promoters **(Thimann, 1965)**. Similarly thiamine and pyridoxine produced by leaves are essential for the growth of roots **(Greulach and Adams, 1963)**. The growth, development, productivity and quality of wheat grains is affected by nicotinic acid and its analogues exert a stimulatory action on the

productivity of spring wheat leaves **(Polimbetova *et al*., 1969)**. Thus a part from their main role as coenzymes, vitamins also probably plays other independent roles in the biochemical processes of plants, repairing the injurious effect of the unfavourable conditions.

AIM OF WORK

As far as the literature surveyed above, only some sporadic works were conducted trying to alleviate the adverse effects of water deficit and/or salinity stress by vitamin treatments. Therefore, in this work, two members of vitamins namely vit. PP (nicotinamide) and vit. C (ascorbic acid) were experimented with trying to alleviate the inhibitory effect of salinity on the growth and metabolic activities of *Zea mays*.