EFFECT OF GAMMA RAYS AND SALINITY ON GROWTH AND CHEMICAL COMPOSITION OF *Ambrosia maritima* L. PLANT

BY

AHMED MOHAMED EL-HEFNY MOEMEN
B.Sc. Agric.Sci. (Soil Science), Fac. Agric., Cairo Univ., 2002

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In

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<tr>
<td>Cm</td>
<td>Centimeter</td>
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<tr>
<td>Cv</td>
<td>Cultivar</td>
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<tr>
<td>g</td>
<td>Gram</td>
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<tr>
<td>mg</td>
<td>milligram</td>
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<tr>
<td>Kr</td>
<td>Kilo rad = 1000 rad</td>
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<tr>
<td>r</td>
<td>Rad</td>
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<tr>
<td>$\gamma$-rays</td>
<td>Gamma rays</td>
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<td>Gy</td>
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<tr>
<td>$^{60}$Co</td>
<td>Cobalt 60</td>
</tr>
<tr>
<td>O.M</td>
<td>Organic matter</td>
</tr>
<tr>
<td>Ec</td>
<td>Electrical conductivity</td>
</tr>
<tr>
<td>LSD</td>
<td>Least significant difference</td>
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<td>Chl</td>
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**Degree:** (M.Sc.)  
**Title of Thesis:** Effect of Gamma Rays and Salinity on Growth and Chemical Composition of *Ambrosia maritima* L. Plant.  
**Supervisors:** Dr. Ahmed Hussien Hanafy Ahmed  
Dr. Abdel Rahman Morsi Ghallab  
Dr. Omaima Said Hussein Mahmoud  
**Department:** Agricultural Botany.  
**Branch:** Plant Physiology.  
**Approval:** 28/3/2012

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**ABSTRACT**

This work achieved to study the effects of, mixture of salt 2:2:1 (Na Cl-CaCl$_2$ and Mg SO$_4$), concentration of (0, 2000, 4000 and 6000 ppm). on growth characters, some chemical components and some active ingredients in shoots of *Ambrosia maritima* plants, at different stages of growth, during two seasons. Pots 30 cm in diameter were filled of sand-loamy soils in appropriate concentration, all pots were irrigated with tap water. The exposed damsisa seeds to gamma rays, doses (0, 20, 40, and 80 Gy) before sowing together with control non irradiated seeds were sown in saline soils (0, 2000, 4000 and 6000 ppm). Soil salinity treatments caused a decrease in plant height, number of leaves, content of damsin, and an increase in fresh weigh, dry weight, total sugars, total chlorophyll, amino acids and ambrosine content. Also, Gamma rays caused an increase in most of growth parameters and most of chemical composition. It was observed that 40 or 80 Gy was more effective. We investigated the combined effect of levels of salinity and doses of radiation used, this interference improve growth parameters and chemical composition in *ambrosia maritima* plants and caused ascertain the role of gamma irradiation in plants tolerance to soil salinity and alleviation their harmful effect on plants.  

**Key words:** *Ambrosia maritima*, salinity, gamma ray, ambrosin, damsin, growth parameters, photosynthetic pigments, total soluble sugars, total soluble phenols, protein, amino acids, minerals.
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INTRODUCTION

Damsisa (*Ambrosia maritima* L), is a perennial plant richly branched, gray herb with finely dissected fragrant leaves, (Tuckholm, 1974). Damsisa in Egypt is considered wild herb growing all over the season, on the banks, canals and river Nile as a common weed (Bedevian, 1936). Damsisa is used in Egyptian folk medicine in many purposes, as a remedy of rheumatic pains, decoction of plant for asthma bilharzias, in diabetes and to expel kidney stones. From the active ingredients of this plant, ambrosin and damsin that shown to be toxic to the snails representing the intermediate host of schistosomiasis and fascioliasis found in canals, (Piceman *et al.*, 1986).

Soil salinity is one of the main problems for world agriculture Ahloowalia *et al.* (2004). Reduction in the crop productivity under the salt stress has been revealed in various plant species and often associated with a decrease in the photosynthetic capacity, Baek *et al.* (2005). Agricultural productivity is severely affected by soil salinity because salt levels that are harmful to plant growth affect large terrestrial areas of the world. The damaging effects of salt accumulation in agricultural soils had influenced ancient and modern civilizations. It is estimated that 20% of the irrigated land in the world is presently affected by salinity, Yeo (1999).

The main two effects of salt stress on plant growth and development are osmotic (water stress) and ionic effects. Osmotic influence of salinity results as a consequence of salt-induced decrease in soil water potential. Also, the growth habits and physiological properties of plant may different markedly under different condition
such as drought, salinity, light deficiency and irradiation (Miflin, 2000). In plants, the antioxidant enzymes activity and the photosynthetic capacity are known to positively affected by the low dose of $\gamma$-irradiation (Lee et al., 2002 and 2003), which can improve the stress tolerance in plants subjected to salt stress. Also, Chinusamy et al. (2005) reported that soil type and environmental factors, such as vapor pressure deficit, radiation, and temperature might further alter salt tolerance. Reduction in the crop productivity under the salt stress has been revealed in various plant species and often associated with a decrease in the photosynthetic capacity.

Gamma rays belong to ionizing radiation and interact with atoms or molecules to produce free radicals in cell. These radicals can damage or modify important components of plant cells. $\gamma$-rays have been reported to affect differentially the morphology; anatomy, biochemistry, and physiology of plant depending on the irradiation level. This effect include change in plant cellular structure and metabolism, e.g. dilution of thylakoid membranes, alteration in photosynthesis, modulation of antioxidant system, and accumulation of phenolic compounds (Kim et al., 2004, Kovacs and Keresztes, 2002 and Wi et al., 2005). This work was assigned to investigate:

1- Improve of *Ambrosia maritima* L plant growth by using low doses of $\gamma$- radiation and evaluating their stimulatory response on plants.

2- Alleviate salt stress and improve plant growth through interaction of $\gamma$- radiation with salinity.
3-Estimate the active ingredients (ambrosin and damsin) in damsisa plants during flowering stage as affected by radiation treatments, salinity levels and both of them.
REVIEW OF LITERATURE

The results of some previous investigations concerning different levels of salinity, as well as different doses of radiation and their interactions are summarized in the following:

1. Effect of salinity

   a. Effect of salinity on growth parameters

   Many researchers were studied the effect of salinity on vegetative growth of several plant species. Everardo et al. (1974) proposed three theories for explanation the effect of salinity on plants: First, soluble salts in soil decrease the free energy of the soil water, thereby, decreasing the availability of water to plants. The second is that growth is inhibited by an excess of salts taken up by plants from saline media as energy spent by plants to maintain turgor pressure in an expense of the growth, finally, salts may exert detrimental effects on plant growth through toxicity of one or more specific ions present in higher relative concentration. On the other hand, Marschner, (1995) reported that there are three major constraints for plant growth on saline substrates:

   1. Water deficit "drought stress" arising form low (more negative) water potential of the rooting medium.

   2. Ion toxicity associated with the excessive uptake mainly of Cl\textsuperscript- and Na\textsuperscript+.

   3. Nutrient imbalance by depression in uptake and/or shoot transport and impaired internal distribution of mineral nutrients, and calcium in particular. It is often not possible to assess the relative
contribution of these three major constraints to growth inhibition at high salinity, as many factors are involved.

Zidan and Alzahrani (1994) stated that in seed and seedling of *Ocimum basilicum* L. exposed to salinity of up to 120 mM NaCl, germination was affected at salinities 60 mM NaCl, however, seedling growth and dry matters (DM) production were reduced by NaCl concentration 40 mM NaCl.

Kotb and El-Gamal. (1994) stated that the fresh and dry weights of *Nigella sativa* L plant organs were highly significant decreased by increasing salinity levels up to 0.3%, such decrease might be attributed, either to the decrease in plant height or the decrease in branching.

EL-Sherbeny (1995) concluded that, using saline water containing sodium and calcium chloride (1:1) in different levels as 1000, 2000, or 3000ppm caused reduction in plant height and fresh and dry weight of leaves, stems and roots of *Tagetes erecta* plant.

Khan and Ahmed (1998) established that *Indigofolia forsk* seed germination and shoot growth were reduced by increasing salinity using 10-30% sea water for irrigation (EC-iw: 4.5-14.0 dS.m-1).

Morales *et al.* (1998) found that in *Argyranthemum coronopifolium* plant exposed to 70 mM NaCl nutrient solution at 45 days after sowing for, 15 days, salinity reduced the relative growth rate, net assimilation rate and leaf area ratio. Leaf water potential deceased significantly in treated plant while leaf turgor potential increased due to osmotic adjustment.

Marcelis and Van, (1999) studied the effect of five salinity levels 1, 2, 4, 9 and 13 dSm-1 on growth of radish (*Raphinus sativus*
.L). It was found that the reduction in plant weight by an increase in ECs level was more pronounced in terms of fresh weight than of dry weight.

El-Mogy (1999) showed that, soil salinity treatments significantly decreased the number of branches / plant in *Ambrosia maritima* L. plants comparing to control. The lowest number of branches was obtained from plants grown in soil salinity (0.4%) followed by (0.2%). While the highest number was observed from soil salinity (0.1%) over the control at different stages of growth during two seasons. Also, the increasing in the levels of salinity reduced plant height, number of leaves / plant, and dry weight of herb *Ambrosia maritima* significantly except the lowest level of salinity.

In addition, Khan et al. (1999) reported that when *Halopyrum mucronatum* (a perennial grass found on the coastal dunes of Karachi, Pakistan) is treated with 0, 90, 180, and 360 mM NaCl in sand culture, fresh and dry mass of roots and shoots reach the peaks at 90mM NaCl, a further increase in salinity inhibits plant growth, ultimately resulting in plant death at 360mM NaCl, and maximum succulence is noted at 90mM NaCl.

Also, El-Makawy (1999) stated that, vegetative characters of three medicinal plants (*Calotropis procera* R, *Peganum harmala*,L, and *Marrubium vulgare* L.) were significantly decreased with increasing saline water irrigation. Number of leaves, fresh and dry weight of roots, stem and leaves and seeds/ plant were obtained with low saline water irrigation level of 4000 ppm, followed with 5000,6000 and 7000 ppm which gave the minimum values in this respect on plants.
Chartzoulakis and Klapaki (2000) investigated the effect of salt tolerance of two greenhouse bell pepper hybrids. Salinity treatments were imposed by irrigating with half-strength Hoagland solution containing 0, 10, 25, 50, 100 and 150 mM/1 of NaCl. They noticed that salinities up to 50 mM delayed germination but did not reduce the final germination percentage. It was reduced significantly at 100 and 150 mM NaCl in both hybrids. Plant growth parameters such as plant height, and dry weight were significantly reduced at salinities higher than 25 mM NaCl in both hybrids.

El-Sanafawy (2000) studied the effect of different levels of sodium chloride, calcium chloride (1500, 3000 and 4500 ppm) and their mixtures in the irrigation water on Ambrosia maritima L plants.

The author observed that increasing the level of salinity in irrigation water had an inhibitory effect on plant height, and significantly decreased number of shoot/plant as compared to the control. Also, fresh and dry weights of herb decreased with increasing salinity level of irrigation water. At the high salts levels the injurious effect was more pronounced.

Takemura et al. (2000) examined the effect of different salt levels (0, 125, 250 and 500 mM NaCl) on mangrove plant growth. The results indicated that plant height was greatest in the 125 mM NaCl solution followed by 250 mM. Meanwhile data obtained by Parida et al (2003) on the same plant under the effects of salinity range (0, 100, 200 and 400 mM NaCl) indicated that plant height, fresh and dry weight were maximal in culture treated with 100 mM NaCl and decreased at higher concentrations.
Wang and Nil (2000) stated that in *Amaranthus tricolor*, 300 mM NaCl salt stress results in a considerable decrease in fresh and dry weights of leaves, stems and roots.

Aziz and Khan (2001) found that optimum growth of plants is obtained at 50% seawater and declines with further increases in salinity in *Rhizophora mucronata*.

Kotb *et al.* (2001) stated that salinity treatments significantly increased damsisa plant height and branch number up to 2000 ppm. But at 3000 ppm a significant decrease was observed.

Meloni *et al.* (2001) investigated the effect of salt stress (0, 50, 100, and 200 mol m⁻³) of NaCl, on plant growth of two cultivars of cotton (*Gossypium hirsutum* L). They found that increased NaCl levels resulted in a significant decrease in shoot and leaf growth biomass. Potassium level remained stable in the leaves.

El-Sharnoubi. (2002) studied the effect of gamma irradiation on survival percentage of propagated plants of *Hypericum perforatum* after two and three months of acclimatization, found that it decreased significantly by increasing gamma radiation doses, however, gamma rays at doses less than 40 Gy caused significant decrease in shoot length compared with the control.

Gulzar *et al.* (2003) stated that salinity treatments of *Aeluropus lagopoides* plants grown in non-saline and 200mM NaCl had the greatest fresh and dry weights. Increasing salinity (400 to 1000 mM NaCl) caused a decrease in fresh and dry weights of plants.

Hebbara *et al.* (2003) attributed the effect of high salt concentration on plants to soil solution that bound, to create high