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The Effects of Aluminum and Phosphorous on *Brassica napus*

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Abstract: Aluminum (Al) is one of the major constituents of soil. In acidic soils, Solubilized Aluminum can be absorbed via roots and affect plant growth. In this study the effect of Aluminum (40 µmol) and different levels of Phosphorous (0, 40, 80, 320 µmol) in one cultivar of *Brassica napus* (SLM46) were investigated. Results showed in plants that treated with Aluminum, shoot length, dry weight, fresh weight, phenolics compound content significantly decreased but lipid per oxidation and Malondialdehyde (MDA) content significantly increased. On the other hand, in plants that treated with Phosphorous and Aluminum decreased growth parameters and phenolics compound moderated against plants that treated with Aluminum and MDA content was decreased. From these results we suggested that Phosphorous treatment reduced the harmful effect of Aluminum toxicity in this cultivar of canola.

Key words: Aluminum · Phosphorous · *Brassica napus*

INTRODUCTION

Aluminum is of those elements which its toxic effect on living creatures has been proved vividly, though its compounds such as Aluminum Soleplate used to purify water (as sedimentary) but food is the main source for Aluminum to be exposed to human. Environmental toxicity of Aluminum caused various neural (Alzheimer), pulmonary and nephric diseases. Recently EPA organization has started researches about Aluminum toxicity on human and finds out that those suffered from heart and kidney disorders are more sensitive in dealing with Aluminum. [1]. One of the environmental Aluminum toxicity factors is *acidic rains* that free it in soil so it can be so toxic for plants of such regions. The source of freed Aluminum is from Aluminum Hydroxide compound. Aluminum will be free in soil when pH is lower than 5 and causes high toxicity for the plant [2]. Its toxicity depends on various factors and these factors cause this toxic element to infiltrate into the environment (soil, water, farm products and human body). Among important factors cause toxicity of Aluminum in environment we can name: increased raining in proportion to soil vaporization and transpiration, oxidation of pyrite and Sulphide of soil, acidic soil and reaction of clay particles in soil with Hydrogen ion. The mentioned factors free Aluminum ion from soil particles and increase its concentration in the environment. Thus, recognizing and studying main factors of Aluminum toxicity in each region is essential [3, 4].

Acid soils prevent growing of many living creature in soil. Acidity environment of plants root causes imbalance in absorbing many of nutrient and lead to plant abnormal growth; that is some of nutrient absorbed lesser and some like Aluminum absorbed more than natural. Therefore, acidity environment around the root can cause secondary toxicity of some elements. Aluminum is of those important non-heavy elements that its toxicity on plants emerges in low acidity. So, in most of acid soils, Aluminum toxicity can be observed. In farming, Aluminum toxicity causes decrease in growth and products of the plants; moreover, concentration of Aluminum in plants lead to its transfer and concentration in human body and therefore possibility of environmental problems in human life will be increased.Plants grow under the stress of Aluminum and other heavy metals in nature, along with the permanent existence of toxic ions and experience damage caused by concentrative toxicity. Different intoxication symptoms are a symbol of various levels and degrees of adjustment with a stressful environment. Aluminum as a multi-capacity cat ion under the acidic condition is absorbed by negative Ç in free space of Donnas inside the cell in the way of root

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ape pelast. These materials have more negative loads than free carboxylic groups and pectics materials.Two kinds of mechanisms may create resistance against toxicity of metallic ions. One of them is avoidance which is including several methods to prevent toxic ions reaching their joints; the other one is tolerance for metallic ions which are entering intercellular space. Under special conditions, one mechanism may emerge with high degree.

MATERIALS AND METHODS

The sample plant in this study was *Brassica napus.* This plant belongs to *Brassicaceae* family. It is an important plant economically due to its oil seeds. SLM.46 seeds were disinfected by Sodium Hypochlorite 0/1%.Then they were washed by distilled water and were put in it for an hour. To grow the plant in a flower pot, seeding bed was chosen of prelate. This bed is almost lack of any ion and its cat ion exchange capacity is ignorable. After several washing with distilled water, finally sterilized by autoclave and then was used in flower pot. The pots with seeds inside were moved to greenhouse. Greenhouse conditions: light mixture of sodium halide lamp and halogen lamp with 800 Lox, 16 hours light period, 8 hours darkness, 23$\pm$1° C. During the first week after seeding in flower pot, irrigation was with distilled water. Irrigation was twice a day and each one with 80 ml. After a week of irrigation with distilled water, irrigation was started with Long Ashton perfect nutritional solution once a day for two weeks. Making the nutritional solution repeated twice a week and used. Two weeks after irrigation with the nutrition solution lacking Aluminum ion, irrigation started with nutrition solutions contain 0, 20, 40 and 60 concentration of micro molar Aluminum Chloride ($AlCl_3$) to some of the pots and with nutrition solutions contain 0, 40, 80 and 320 concentration of micro molar Potassium Hydroxide phosphate (KH_2PO_4) along with fix concentration of 40 micro molar Aluminum Chloride ($AlCl_3$) to other pots done daily within 3 weeks.

RESULTS

Treatment with both Aluminum and Phosphorus had a significant effect on dry weight of aerial parts of *Brassica napus*. The most effect is seen in 80 and 320 micro molar concentration levels of Phosphorus, while Aluminum treatment alone had no effect on dry weight of the plant aerial parts. But according to the charts (Figs1-1 and 1-2), dry weight of plant aerial parts

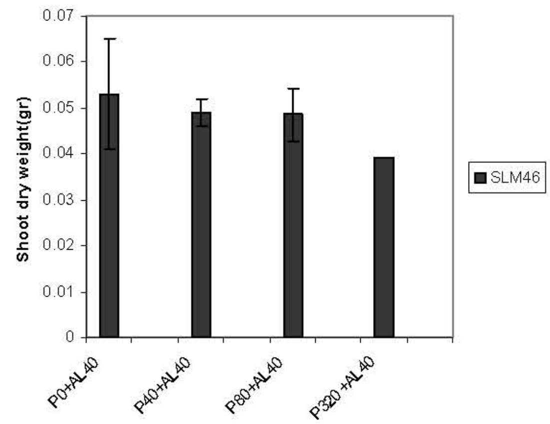

Fig. 1-1: The effect of Aluminum and Phosphorus concentrations on dry weight of canola aerial parts

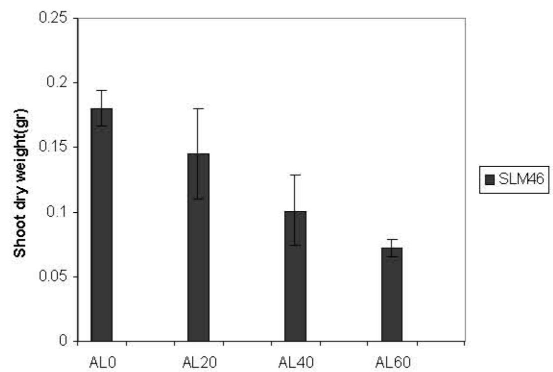

Fig. 2-1: The effect of Aluminum concentrations on dry weight of canola aerial parts

was decreased remarkably via Aluminum treatment; while using Phosphorus concentrations, weight losing became more balanced and there is no noticeable difference with marker plant.

Also, treatment with both Aluminum and Phosphorus had a significant effect on longitudinal growth of root and shoot. The most effect is seen in 80 and 320 micro molar concentration levels of Phosphorus in which treatments of both of them were significant. Aluminum treatment alone had a significant effect on longitudinal growth of root especially in 40 and 60 micro molar concentrations of Aluminum that is very significant. But about longitudinal growth of shoot, Aluminum had no significant effect alone. According to the charts also (Figs 3-1, 4-1, 5-1 and 6-1), treatment with Aluminum alone caused longitudinal decrease of root and shoot growth, while using Phosphorus treatments caused remarkable longitudinal growth of root and shoot.

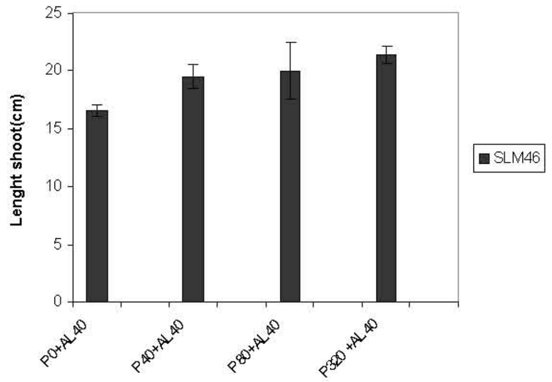

Fig. 3-1: The effect of Aluminum and Phosphorus concentrations on shoot length of canola plants

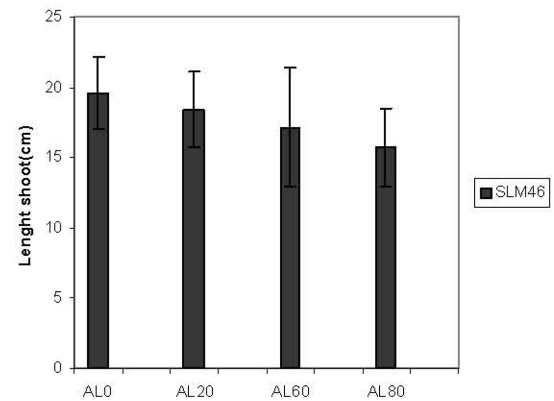

Fig. 4-1: The effect of Aluminum concentrations on shoot length of canola plants

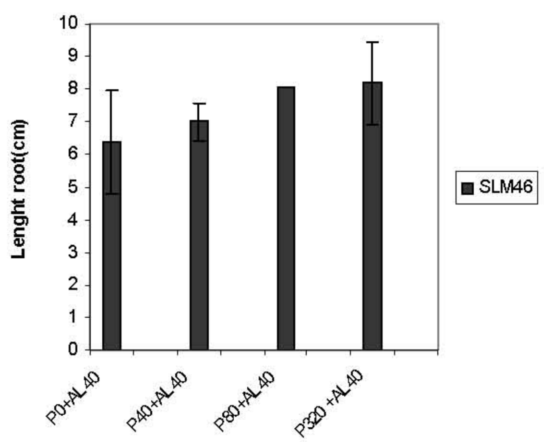

Fig. 5-1: The effect of Aluminum and Phosphorus concentrations on root length of canola plants.

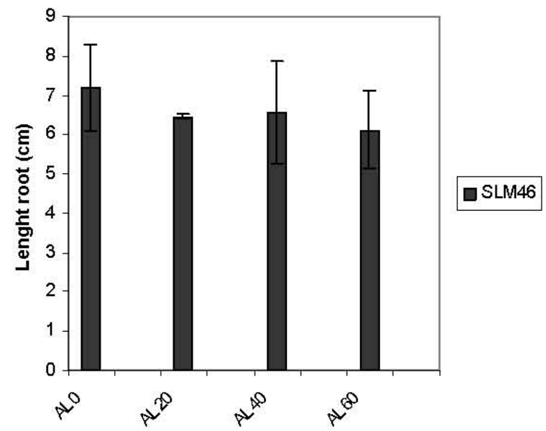

Fig. 6-1: The effect of Aluminum concentrations on root length of canola plants

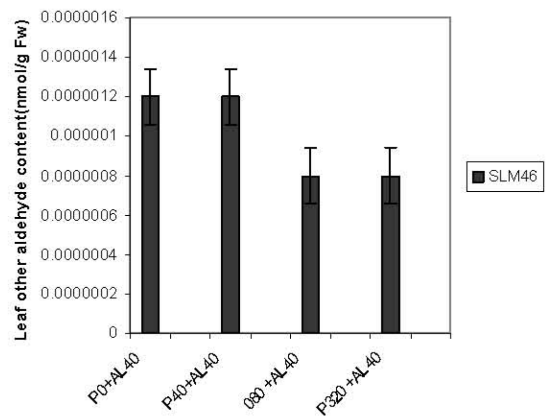

Fig. 7-1: The effect of Aluminum and Phosphorus concentrations on other membrane Aldehydes concentrations

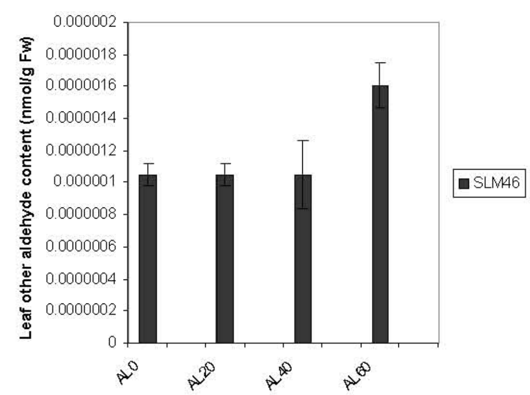

Chart 8-1: the effect of Aluminum different concentrations on other membrane Aldehydes concentrations.

The effect of Aluminum treatments on concentration of MDA resulted from membrane lipid per oxidation was very significant especially in 40 and 60 micro molar concentrations of Aluminum; and as seen in Fig. 10-1, there is a noticeable increase on MDA concentration. Also, both Aluminum and Phosphorus treatment had a very significant effect on MDA concentration that most of the effect is seen in 80 and 320 micro molar

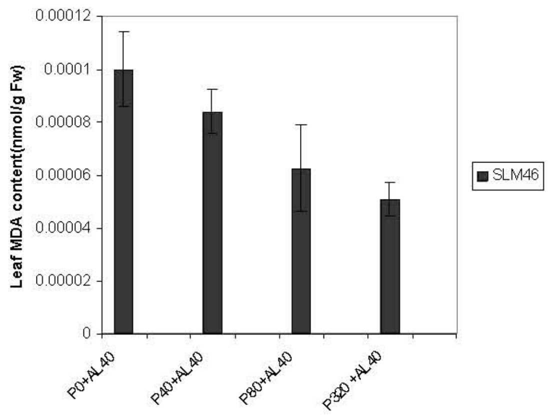

Chart 9-1: The effect of Aluminum and Phosphor different concentrations on membrane MDA concentration

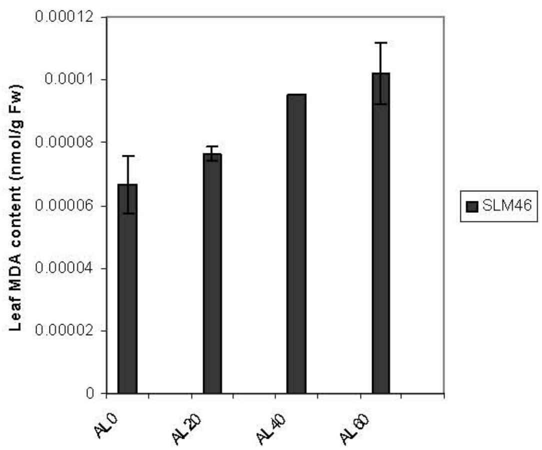

Fig. 10-1: The effect of Aluminum concentrations on membrane MDA concentration

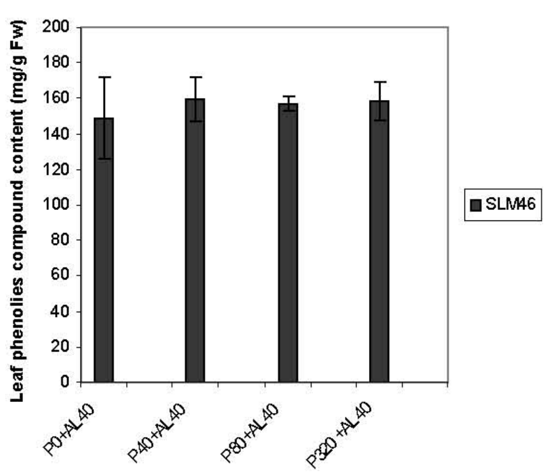

Fig. 11-1: The effect of Aluminum and Phosphorus different concentrations on the plant Phenol compounds

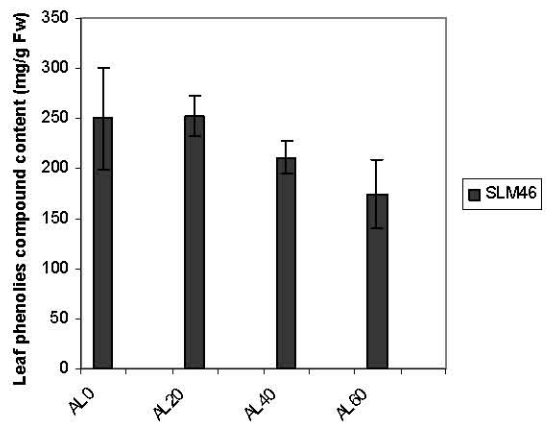

Fig. 12-1: The effect of Aluminum concentrations on the plant Phenol compounds

concentrations of Phosphorus; this case is shown in Fig 9-1 as high decrease in concentration of this Aldehyde. For other Aldehydes of membrane, Aluminum treatments and both Aluminum and Phosphorus treatments had no significant effect, but there was a significant effect in 80 and 320 micro molar concentrations of Phosphor and also in 60 micro molar concentration of Aluminum; according to Figs 7-1 and 8-1 also concentration of other Aldehydes of membrane like Ethan increased by Aluminum treatments, but treatment with both of them caused decrease in membrane lipids per oxidation and led to decrease in concentration of Aldehydes like Ethan.

Aluminum treatments and both Aluminum and Phosphorus treatments had no significant effect on the plant phenol compounds; but based on Figs 11-1 and 12-1, concentration of phenol compounds decreased with Aluminum treatment while they increased with both Aluminum and Phosphorus treatments.

DISCUSSION

In environmental conditions, the existing Aluminum stress in soil firstly enters roots and therefore root is the first place which experience Aluminum stress. The results of this study showed that longitudinal growth of the plant (under stress) root decreases significantly in proportion to the sample plant. Barceló *et al.* [5] reported that due to decrease of flexibility in cells wall among under stress (with heavy metals) plants, the longitudinal growth of the roots is prevented.

Many reports showed that decrease of root growth with Aluminum presence is due to the decrease in lengthening rate of the cells; which can be because of irreversible controlling of proton pump, which is responsible for cellular growth, with Aluminum presence [6].

Roots growth is resulted from two mechanisms: cell division on the root tip and cell lengthening in longitudinal growth area. Both mechanisms are influenced with existence of heavy metals, but most of researchers believe that cell lengthening is much more sensitive than cell division [7].

At the time of stress, Aluminum ion enters the roots firstly then after the ion entrance into the root cells, the cell experiences core damage [7].

Possibly, Aluminum controls the growth of the germ root through decreasing RNA synthesis and making change in rib nuclease function. It seems possible core damage and core function in cell division area is of factors decrease *Brassica napus* root growth [8].

Also, it is seen that Aluminum controls growing of aerial part and biomass of plant different parts in addition to decreasing longitudinal growth [3].

Aggregation Aluminum in different parts of plant and disorder in general metabolism of plant considered as the reason of in dry weight and fresh weight decreasing, that is lead to decrease in plant general growth [9].

Probably biomass is decreased due to change in water condition of the plant. Decrease in water absorption or dehydration following the membrane damage is one of the main reasons decreasing plant weight [9].

Membrane of plant cells is commonly the main place of emerging the toxicity of heavy metals like Aluminum. These metals react with ligands that contain sulphor nitrogen and oxygen. Cellular mechanism of Aluminum toxicity in membrane is not recognized perfectly [9].

Phenol compounds especially Hydroxy-Cinamic Acids are very much in epidermis. The existence of these compounds in leaf makes it thicker, removing free radicals and changing the amount of chlorophyll and carotenoid. Aluminum effects on Phenyl Alanine Ammonias Leas, Chaklone Synthesize and other enzymes in Phenyl Propanoid direction. Phenyl Alanine Ammonias Leas enzyme causes Phenyl Alanine change into trans-Cinamic acid and formation of phenol compounds like phelavonoids, Tannins and Lignin [10].

Probably, Aluminum causes decrease in Phenol compounds rate by effecting on the mentioned enzyme [10].

The existence of Phenol compounds like esters of Hydroxy-Cinamic acid in Epidermis cells decreases plant cells tolerance against damages of environmental stresses. Therefore in *Brassica napus,* formation of Phenol compounds under the treatment of Aluminum and Phosphorus increases plant tolerance against Aluminum and increasing the amount of these compounds in plants treated by Phosphorus is probably due to effect of this element on synthesizing enzymes of the compounds in phenyl propanone direction [11]. Fat per oxidation is a process depends on free radicals. Oxygen free radicals, oxygen of hydroxyl radicals and proton zed super oxide anions attack fats especially unsaturated fat acids like (Linoleic Acid); the result of this process is formation of synthesizing products like Aldehydes. This process is used as an index to choose tolerant and sensitive plants against environmental stresses [12]. Usually, fats per oxidation increase are considered as the index of oxidative stress increase. Fats per oxidation increase in Aluminum treatment conditions shows insufficiency of tolerance mechanisms created in plant against oxidative stress; and its decrease in treated plants shows reinforcement of tolerance mechanisms in this plants. In plants, oxygen free radicals or lipid peroxidation reactions damage unsaturated, fat, organic acids; and aggregation Aldehydes, Hydrocarbons and Cross-link products. The amount of lipid peroxidation products like MDA or Ethan become high in plant cells membrane – which is under the environmental stresses – that shows the interference of oxygen free radicals [13].

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