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INDUCTIONOF THE GROWTH AND INCREASE THE PRODUCTIVITY OF POTATO CAUSED BY SOIL SALINITY STRESS

By

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SUMMARY

Induction of the growth and increasing the productivity of potato caused by soil salinity stress

The investment of saline soils whose areas amount to more than one billion hectares in the world and the application of soil amendments such as organic fertilizers, agricultural gypsum, humic acids and sulfur to improve the soil and increase its fertility, as well as the use of foliar sprays with osmoprotectants, i.e., essential oils, proline, ascorbic acid and silicon dioxide to increase growth and the plants' tolerance to soil stresses are among the recent trends. In addition, the renewal of non-traditional water management methods (groundwater and saline water), hope to achieve water and food security, as well as the need to think about integrated and sustainable programs for the application of local agriculture in arid and semi-arid environments in order to transfer saline farming techniques, especially in light of climate changes that will negatively affect all parts of the Arab world as a whole in general and Egypt in particular.

The study was conducted in consecutive experiments as follows:

Pots experiment

Pots experiment was carried out during the season of 2013 to evaluate six levels of salinity, i.e., 0.5 (control), 1.5, 3, 4.5, 6 and 7.5 dSm^{-1} on growth and yield of potato cv. Spunta. The sand culture technique was used in this experiment. In this experiment 144 plastic pots of 40 cm in diameter were used.

The experiment was designed with four replications and each experimental unit contained 6 pots. A marked decrease in plant length, foliage fresh, chlorophylls and tuber yield per plant and DM were observed when the crop was irrigated with the more saline water (7.5 dSm^{-1}) compared to the control, whereas, there were no significant differences among treatments in tuber number. These results encourage planting potato in salt-affected soils up to 6.0 dSm^{-1} with using soil conditioners and osmoprotectants to modulate salinity stress.

Preliminary experiment

During its life cycle, the potato has to cope with a number of abiotic stresses including salinity stress. Salinity influences growth and entire metabolism. Antioxidants and osmoprotectants a potential tool for crop improvement have to enable plants to beat such stresses. Therefore, effects of certain soil amendments (FYM, $CaSO_4$, S, HA, and FA) and bio-agents (VAM, *Bacillus subtilis*, *Trichoderma* sp.) applied singly in a separate experiment and foliar application with osmoprotectants in another experiment, i.e., calcium chloride, sodium selenite, ascorbic acid (AsA), citric acid, salicylic acid (SA), plant extract, kinetin Kin, glutathione (GSH), silicon dioxide (SiO_2), mannitol, proline, yeast extract, Se + Vit. E, arginine (Arg) and spermidine (Spd) polyamines, glycine betaine (GB), essential oils (EOs), and nitric oxide (NO) on potato productivity were investigated under soil saline stress in sandy loam clayey soil (EC 5.4 dSm^{-1}), during the growing summer season of 2014. The experimental design used was randomized complete block for both experiments.

FYM, HA, S, and GYP is an ideal soil conditioner for better growth and yield of potato plants. Foliar spray with antioxidants and osmoprotectants (Pro, EOs, SiO_2 and AsA) gave the best results on the productivity of potato.

Field trails

Potato growth, yield, yield quality, photosynthetic pigments, proline, total phenols, and enzymatic activity under salt-affected soil and their responses to soil amendments and osmoprotectants as foliar application were evaluated in 2015 and 2016 summer growing seasons. A field experiment was conducted using potato (*Solanum tuberosum* L. cv. Spunta) grown in the Experimental Farm of Horticulture Research Department, Faculty of Agriculture, Damietta University, New Damietta, Egypt. A split-plot design was used with soil conditioners (FYM, HA, S, and GYP) as main plots, Pro, EOs, SiO_2, and AsA as osmoregulators and antioxidants randomly distributed within sub-plots. Each treatment was repeated three times.

1. Effect of soil amendments, osmoprotectants foliar application, and their interaction on vegetative growth characters of potato plants.

The combined interaction of soil amendments and osmoprotectants had significant effects on plant length, plant foliage fresh and dry weights and leaves area per plant, tubers forming efficiency TFE, relative growth rate RGR and net assimilation rate NAR, in potato plants in both seasons of study. No significant differences among all tested treatments were found in a number of main stems per plant in both seasons. Application potato plants with FYM at 30 ton.fed^{-1} as

soil conditioner and foliar application with proline Pro (10 mM) exhibited significant positive effects on all mentioned studied parameters.

Application of FYM recorded the highest significant values of growth studied parameters except for a number of main stems.

Foliar application with Pro had significant effects in all vegetative growth studied parameters as compared to other treatments and non-adding one.

2. Effect of soil amendments. osmoprotectants foliar application, and their interaction on yield and yield components of potato plants.

Amendments with FYM (30 ton.fed^{-1}) as well as foliar application with Pro (10 mM) and FYM x EOs (5 ml.L^{-1} for each) had significant effects of the number of tubers, total tuber yield and yield components (30: 60 mm and over 60 mm) of potato, in comparison with other treatments, in both seasons. However, under-salinity condition without application of any treatment had an increase value of tuber weight <30 mm.

Application potato with FYM@30 ton.fed^{-1} had significant effects on the number of tubers, total tuber yield and tuber yield components parameters (30: 60 mm and over 60 mm) with significant differences among all treatments (GYP, S and HA) and control in two seasons.

Folia application with Pro (10 mM) had increased values of the number of tubers, tuber yield and tuber grading (30: 60 and over 60 mm) over two seasons of study compared with EOs, AsA and SiO_2.

3. Effect of soil amendments, osmoprotectants foliar application, and their interaction on tuber quality and photosynthetic pigments of potato plants.

The interaction treatments between osmoprotectants (Pro, EOs, AsA and SiO2) and soil conditioners, i.e., FYM, S, HA and GYP had significant effects on tuber quality parameters (vitamin C, dry matter and specific gravity) and photosynthetic pigments (chlorophylls and carotenoids) in both seasons.

The integrated application of FYM (30 ton.fed^{-1}) and Pro (10 mM) had significant effects on vitamin C, dry matter and specific gravity, chlorophylls and carotenoids.

4. Effect of soil amendments. osmoprotectants foliar application, and their interactions on physiological characters and enzymatic activity of potatoes.

Combined treatment of both FYM and Pro was more effective than other treatments in total phenolic compounds, and enzymatic activity (CAT, and POD) and decrease significantly content of proline and POD, in both seasons.

Application of single factor (p=0.05) increased significantly total phenols, CAT, and POD, in addition decreased significantly proline content and PPO in the both seasons.