EFFECT OF PHOSPHORUS, SULPHUR AND SOME BIOSTIMULANTS ON PRODUCTIVITY OF POTATO

By

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ABSTRACT

Sami Hosni Mahmoud Ibrahim: Effect of phosphorus, sulphur and some Bio-stimulants on Productivity of Potato. Unpublished Ph.D Thesis, Department of Horticulture, Faculty of Agriculture, Ain Shams University, 2015.

Two field experiments were carried out during the two successive growth seasons of 2012/2013 and 2013/2014 in a sandy soil at Sadat City, Taba Farm, EL-Menofyia Governorate to study the effect of phosphorus sources, seaweed rates, sulphur rates and some bio-stimulants (amino acids, chitosan and potassium silicate) on potato productivity. First experiment: This experiment included 9 treatments which were the simple combinations between three phosphorous fertilizer sources ,i.e. single super phosphate "SSP", Mono-Ammonium Phosphate (MAP) and Di-Ammonium Phosphate (DAP), with foliar application of three levels of seaweed extract (0, 2.5 and 5 cm^3/L). Second experiment: this experiment included 12 treatments which were the simple interactions between three levels of agricultural sulphur (0, 150 and 300 kg/fed) and spraying with three bio-stimulant substances, i.e. amino acids (2.5 cm^3/L), chitosan (5 cm^3/L) and potassium silicate (2 cm^3/L), in addition to tap water as a control treatment. The obtained results indicated that to increase the total tuber yield and its components, it is favorable to supply potato plants with phosphorus in the form of DAP or MAP, where they caused significant vigorous plant growth (plant height, number of leaves/ plant, number of shoots/plant, fresh and dry weight of leaves and shoots, leaf area, leaf area index, relative growth rate and net assimilation rate). The highest values of total photosynthetic pigments and its fractions were determined in plants supplied with phosphorus fertilizer in DAP form. Using either MAP or DAP caused an increase in total tuber yield and its components, if compared with using the traditional super-phosphate. Potato plants which received DAP as phosphorus fertilizer source gained the best nutritional values if compared with the other phosphorus sources. Seaweed extracts had a favorable effect on plant growth parameters and

total tuber yield as foliar spraying at rate of 2.5 or 5.0 cm^3/L. The foliar spraying of seaweed caused an enhancement in all physical properties and nutritional value of potato tubers if compared with that plants sprayed with tap-water (control). The addition of sulphur resulted in a superiority in most the vegetative growth measurements, moreover increasing level of sulphur caused a gradual increase in the estimated parameters. Particular within 150 up 300 kg/fed., gained the highest total and marketable yield and the lowest un-marketable yield. The best physical and chemical constituents of tubers were recorded with potato plants received sulphur at a rate of 150 or 300 Kg/fed. Also, the obtained data reveal that there were no significant differences between amino acid and chitosan. The foliar spraying by amino acid mixture gave the highest values of fresh and dry weight of whole plant, The heaviest total and marketable tuber yield and the lowest value of un-marketable yield. The values of starch, total carbohydrates, total sugar, dry matter, N, P, K, Ca, Fe, Mn, Zn and Cu, were increased with spraying by the bio-simulative substances if compared with plants treated by tap-water.

Key words: Potato, phosphorus, seaweed, chitosan, potassium silicate, and yield.

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1. INTRODUCTION

Potato (*Solanum tuberosum* L.) is recognized as one of the most important vegetable crops for local consumption and exportation.

In Egypt, potato occupies about 405.840 feddans produced about 4.8 million tons with an average of 11.8 tons/fed., according to **FAOSTAT (2013)**. Globally, Egypt is ranked as number twelfth among potato producers. The total exported quantities were 420 thousand tons in 2013 compared to the 289 thousand tons in 2012; the exported Egyptian potato is mainly produced from winter plantation.

Under Egyptian soil conditions, P availability is considered one of the major growth-limiting factors for growing plants. The P of the applied fertilizers converts fast to unavailable form for plant absorption by its reaction with the soil constituents (**Dawa *et al.*, 2007)**. This could be explained why the cultivated soils require a high amount of mineral P fertilizers to complete supplies of plants. Yet, the use of large amounts of such fertilizers is responsible for rising production cost, as well as leads to the crisis of environmental pollution, particularly water and soil **(Zarei *et al.*, 2012)**. The most commonly used phosphorus fertilizer sources are di ammonium phosphate (DAP), mono ammonium phosphate (MAP). These Phosphorus fertilizer sources are highly water soluble (>80 %) thus dissolves quickly in soil to release plant-available phosphate and ammonium. Potato has high P requirement for optimum growth and yield; thus, when grown on P deficient soils, considerable yield losses are found. Now MAP and DAP are widely used as sources of P fertilizer, and are popular in most locations in Europe countries due to their high P nutrient content and its excellent physical properties. **(Rosen *et al.*, 2014).**

Seaweed extracts contain various micro elements (Cu, Zn, Mo, B, Co) in addition to macro elements and contain auxins, gibberellins' and cytokinins, when seaweed was sprayed on plants it led to significant increase in root growth ability and stem thickness and growth (**Jensen,**

2004 ; Thirumaran *et al*., 2009). Numerous studies have revealed a wide range of beneficial effects of seaweed extract applications on plants, such as early seed germination and establishment, improved crop performance and yield, elevated resistance to biotic and abiotic stress, and enhanced postharvest shelf-life of perishable products **(Norrie and Keathley, 2006; Khan *et al*., 2009)**.

Sulphur is one of sixteen essential nutrient elements and is the fourth major nutrient after N, P and K required by plants for proper growth and yield as it is known to take part in many reactions in all living cells **(Sud and Sharma, 2002)**.

Amino acids and chitosan are considered as precursors and constituents of proteins, which are important for stimulation of cell growth and help to maintain favorable pH value within the plant cell **(Pospieszny *et al*., 1991; Rai, 2002).** Amino acids can directly or indirectly influence the physiological activities of the plant (**Kowalczyk and Zielony, 2008)**.

Chitosan and chitin are those of the most abundant polysaccharide compounds found in the nature and they were reported to affect on improving the growth of several crops **(Khin *et al*. 2006)**.

Nowadays, silicon is considered an agronomically essential element because the beneficial effects of Si, including enhanced growth and quality, photosynthesis stimulation, transpiration reduction, and increased plant resistance to abiotic and biotic stresses, in several agricultural crops **(Kamenidou and Cavins, 2008).**

The present investigation was therefore, undertaken to find out maximizing the beneficial effect of different phosphorous fertilizer sources (MAP and DAP) and investigate the effect of foliar application of seaweed on the productivity of potato plants. Also studied the effect of adding agricultural sulphur in addition to foliar spraying of amino acids, chitosan and potassium silicate to increase the productivity and quality of potatoes.

2. REVIEW OF LITERATURE

In order to have a wide view on the effect of phosphorus, sulphur and some bio stimulants on productivity of potato, the review of literature will be divided in to the following items:

2.1. Effect of phosphorus fertilizer sources on plant growth, yield and its components and chemical contents.

2.2. Effect of seaweed extract on plant growth, yield and its components and chemical contents.

2.3. Effect of sulphur rates on plant growth, yield and its components and chemical contents.

2.4. Effect of some bio stimulants (amino acid, chitosan and potassium silicate) on plant growth, yield and its components and chemical contents.

2.1. Effect of phosphorous fertilizer sources

2.1.1. Plant growth

A large number of scientists have found the relationships between phosphorus availability and potato growth but relatively little has been published on the mechanisms by which phosphorus supply influences growth processes and yield formation **(Johnston *et al.* 1986)**. Their results indicated that the response of potato growth to freshly applied super phosphate widened the range of soluble phosphorus values to 3–67 mg p/kg**.** Relationships between these soluble P values and vegetative growth of potatoes were assessed and found that the best vegetative growth and associated soluble phosphorus values was 25 mg P/kg.

It is essential to understand the effect of applied and residual P in relation to growth characteristics of potato in commercial production. The importance of understanding P fertilization is highlighted by the fact that this crop receives more applied phosphorus than any other vegetable crop species **(Allison *et al.*, 2001)**. An adequate supply of phosphorus is