Available online at www.sciencedirect.com

ScienceDirect

journal homepage: http://ees.elsevier.com/ejbas/default.asp

Involvement of spermine and spermidine in the control of productivity and biochemical aspects of yielded grains of wheat plants irrigated with waste water

*Heshmat Aldesuquy**, *Samia Haroun*, *Samy Abo-Hamed*, *Abdel-Whab El-Saied*

Department of Botany, Faculty of Science, Mansoura University, P.O. Box 35516, Mansoura, Egypt

ARTICLE INFO

Article history:
Received 27 September 2013
Received in revised form
26 December 2013
Accepted 27 December 2013
Available online 5 February 2014

Keywords:
Heavy metals
Spermine
Spermidine
Waste water
Wheat
Yield

ABSTRACT

A pot experiment was conducted to evaluate the beneficial effect of grain presoaking in spermine (0.15 mM), spermidine (0.3 mM) and their interaction with waste water (25%, 50%, 100%) polluted with heavy metals on yield and biochemical aspects of yielded grains of wheat plants (*Triticum aestivum* L.) variety Sakha 94. Irrigation of wheat plants with waste water decreased significantly all yield components (100 kernel weight, grain yield/plant, straw yield/plant, mobilization and crop indices) and water use efficiency. On the other hand, polyamines appeared to ameliorate the harmful disordered of heavy metals of waste water on yield components as well as water use efficiency. The effect was more pronounced with Spm + Spd treatment. In the majority of cases, carbohydrates, protein, phosphorus, ions content and growth promoters in yielded grains were decreased in response to waste water stress in wheat plants, meanwhile, chloride, heavy metals content and abscisic acid level were increased in yielded grains of wheat plants. Application of spermine, spermidine or their interaction appeared to mitigate the deleterious effects of waste water on the above biochemical aspects of yielded grains of wheat plants. Protein banding pattern in yielded grains showed induction of proteins with molecular weights 73, 70, 24, 20 and 15 kDa in response to waste water application. Furthermore, spermidine treatment caused appearance of new proteins with molecular weights 73, 70, 57, 24, 23 and 17 kDa in yielded grains. Grain yield of wheat plants was negatively correlated with chloride, heavy metals and ABA.

Abbreviations: ABA, abscisic acid; Spm, spermine; Spd, spermidine; WW, waste water.

* *Corresponding author*. Tel.: +20 1006573700; fax: +20 50 2246254.
E-mail addresses: heshmat-aldesuquy@hotmail.com, Aboneel@yahoo.com (H. Aldesuquy).

Peer review under responsibility of Mansoura University

Production and hosting by Elsevier

http://dx.doi.org/10.1016/j.ejbas.2013.12.001

1. Introduction

The use of waste water for irrigation may serve as an additional source of water with fertilizing properties after appropriate dilution. Irrigation water quality not only affects the growth of crops, but also have long term effects on soil health, grain quality, fodder quality and health of consumers [1]. The waste waters of (paper, automobile, textile and food industry mills) are alkaline in nature with variable concentrations of different chemical species. Application of these untreated effluents altered the physicochemical properties of the soil and rate of seed germination in plants [2]. In suburban areas, the use of municipal and industrial waste water is common practice in many parts of the world [3]. Waste water carry appreciable amount of toxic heavy metals and concentrations of heavy metals in waste waters vary from city to city [4]. Important sources of heavy metals in waste water are urban and industrial effluents. Heavy metals are extremely persistent in the environment and accumulate to toxic levels [5]. High concentrations of heavy metals affect mobilization and balanced distribution of the elements in plant organs via the competitive uptake [6].

Extensive irrigation by the effluents released from a paper mill have led to the accumulation of heavy metals (Cu, Zn, Pb, Co, Cd, Cr, and Ni) in the soil and different parts of the paddy crops [7]. Wheat is one of several crops that tend to accumulate relatively high concentrations of heavy metals specially cadmium in plant tissues when grown in soils that contain elevated levels of that toxic metal. Because cadmium (Cd) represents a potential health threat to consumers, international trade organizations have sought to limit the acceptable concentration of Cd in edible crops sold in international markets. In this respect, Sutapa and Bhattacharyya [8] have proposed maximum levels of 0.2 mg Cd/kg for wheat grain.

The accumulation of heavy metals in plant tissues might cause reduction in physiological and biochemical activities of plants resulting lower biomass and yields. Yield thus had significant and negative relationship with the concentrations of Ni^{++}, Cd^{++}, Cu^{++}, Pb^{++}, Zn^{++} and Cr^{+3} in root and shoot [9]. Jonathan et al. [10] proved that, the application of Zn to wheat plant reduced grain biomass and weights. Furthermore, the application of Cd and Zn to young wheat plants affected negatively yield of treated plants [11].

Several investigations showed that, polamines played important role in cell elongation and cell division of different plant species [12]. Polyamines stimulated DNA replication, transcription and translation [13]. In addition to their function in plant development, polyamines may play a role in stress responses because their levels in plant cells increase under a number of environmental stress conditions [14]. Plants respond to pollutants such as lead, producing high levels of polyamines [15]. Putrescine (Put) has been shown to accumulate in the plant cells following many different types of stress (drought, deficient mineral nutrition, acid stress, phytotoxic metals), and therefore it can be considered as a stress marker [16]. In addition to exogenous application of both Spd and Spm effectively reversed the harmful effects of Cu stress in *Nymphoides peltatum* plants [17].

The continuous use of waste water mostly polluted with heavy metals by Egyptian farmers in irrigation of many crops resulted in accumulation of heavy metals in soil and consequently continuous uptake of heavy metals by roots causing toxicity to soil, plants and consumers. Thus, the present work was undertaken to ameliorate the toxicity of heavy metals on yield and biochemical aspects of yielded grains of wheat plants by application of either spd or spm in addition to their interaction.

2. Materials and methods

2.1. Plant material and growth conditions

Homogeneous lot of wheat grains (*Triticum aestivum)* variety Sakha 94 were surface sterilized by soaking in 0.001 M $HgCl_2$ solution for 3 min, then washed thoroughly with distilled water, and divided into four sets which were soaked in distilled water to serve as control, spermine (0.15 mM), spermidine (0.3 mM) or (spermine 0.15 mM + spermidine 0.3 mM) respectively for about 6 h. After soaking, the thoroughly washed grains were planted on 15th November 2005 in plastic pots (15 grains per pot; 25 cm width × 30 cm height) filled with 6 kg mixture of soil (clay and sand = 2:1, v/v). The pots were kept in greenhouse, where the plants subjected to natural day/night conditions (minimum/maximum temperature and relative humidity were: 29.2/33.2 °C and 63/68% respectively, at mid-day) during the experimental period. The plants in all sets were irrigated to field capacity by normal tap water. Fifteen days after planting, the plants were thinned to five/pot. On day 21 from sowing, the pots of each set were subdivided into four groups each one contained 20 pots. The pots of the first group in each set still irrigated with tap water, while 2nd, 3rd and 4th groups in all sets were irrigated with 25%, 50% or 100% waste water respectively. The resulting sixteen treatments were marked as follows:

Treatments	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
WW %	0	25	50	100	0	25	50	100	0	25	50	100	0	25	50	100
Spm (0.15 mM)	−	−	−	−	+	+	+	+	−	−	−	−	−	−	−	−
Spd (0.30 mM)	−	−	−	−	−	−	−	−	+	+	+	+	−	−	−	−
Spm + Spd	−	−	−	−	−	−	−	−	−	−	−	−	+	+	+	+

Data in Table 1 showed analyses of physicochemical characters of standard fresh water and untreated waste water (ppm). These analyses were carried out according to Clescrei et al. [18]. The main source of untreated waste water was the main Aga drain in Dakahliya Province, Egypt.

At tillering stage (i.e. 21 days from planting) and at heading (65 days from planting), the plants received 35 kg N ha^{-1} as urea and 35 kg P ha^{-1} as potassium dihydrogen phosphate as