Effect of iodine containing irrigation water on plant physiological processes of bean and potato cultivated in different soils

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Abstract
Iodine deficiency in humans is a well-known environmental health problem in several regions of the world. Fruits and vegetables have been proven to be an effective way to increase iodine intake for humans by iodine enriched edible plants.
In our study plant physiological processes of potato and bean plants cultivated on three different soils (sandy, silty sand, silt) applying potassium iodide containing irrigation water in concentration of 0.10 and 0.50 mg/L were investigated. After the harvest the plant parts (root, aerial parts and fruits) were dried and their mass were determined. The homogenized plant parts were mineralized by microwave-assisted acidic digestion. Iodine and essential element concentrations were measured by inductively coupled plasma mass spectrometer.
In case of bean fruits the iodine addition (0.50 mg/L) resulted in considerable reduction (20-50%) of biomass, while the relative change of potato mass amounted to only -10% - +10% depending on the soil type. Results showed, that applying 0.50 mg/L iodine concentration in the irrigation water, the highest iodine concentration in edible parts of bean and potato plants were 1.6 mg/kg (silt soil) and 1.8 mg/kg (sandy soil), respectively.
Keywords: bean, potato, iodine deficiency, nutrition

1. Introduction

Iodine is an essential micronutrient present in the human body in minute amounts (15 – 20 mg) almost exclusively in the thyroid gland. The recommended daily iodine intake is 90 μg, 120 μg and 150 μg for the age groups of 0-59 months, 6 – 12 years, adolescents and adults, respectively. During pregnancy and lactation, 250 μg daily intake is recommended (WHO 2004). However, both in the developing and the developed countries, the daily iodine intake of the people is insufficient which leads to iodine deficiency disorders (Delange et al. 2002; Rana and Raghuvanshi 2013; Kaputsa-Duch et al. 2017). The main intervention strategy for iodine deficiency monitoring and prevention is the "universal" salt iodization (Andersson et al. 2007). Due to new policies adopted by many countries to reduce salt consumption by 50% to 5 g/day in order to prevent hypertension and cardiovascular diseases, the indirect iodization of food materials have been receiving a growing attention. One way is the fortification of animal fodder and the iodine content of foods derived from animal sources and the second is the fortification of iodine content of different edible plants applying iodine containing irrigation water. In this paper the uptake and translocation of iodine in bean and potato plants were investigated. The KI containing irrigation water with iodine in concentration of 0.1 and 0.5 mg/L was led to the soil surface. The iodine concentration of different plant parts and the iodine distribution within the plants were investigated by ICP-MS following their microwave-assisted acid digestion.

2. Materials and Methods

2.1 Plant growth

Plant growth was carried out in a greenhouse, the experimental area received natural light and climate data were continuously monitored during the growing period. Bean and potato plants were cultivated in three different soil types (sand, silty sand, silt). Iodine was added to irrigation water as potassium iodide in concentrations of 0.1 and 0.5 mg/L I^-.

2.2 Sample preparation and elemental analysis

Samples were mineralized in a mixture of 7 cm^3 67% HNO_3 and 3 cm^3 30% H_2O_2 using microwave assisted acidic digestion procedure, and elemental concentrations for the different plant parts were determined by inductively-coupled plasma mass spectrometer

3. Results

The addition of iodide to the irrigation water in concentration of 0.5 mg/L, had a relatively high inhibitory effect to bean plants since dry mass was reduced by 20-50%, while the relative change of potato mass amounted

to only -10% - +10% depending on the soil type. Iodine accumulation of different bean (silt soil) and potato (sand soil) plant parts by adding 0.10 mg/L and 0.50 mg/L iodide to the irrigation water are presented in *Figures 1 and 2*. It can be concluded, that iodine content increased in all plant tissues of both plants by increasing iodide concentration in the irrigation water. Results showed that the application of 0.50 mg/L iodine in the irrigation water increased the iodine concentration in edible parts of bean and potato plants, with the highest measured at 1.6 mg/kg (silt soil) and 1.8 mg/kg (sandy soil), respectively.

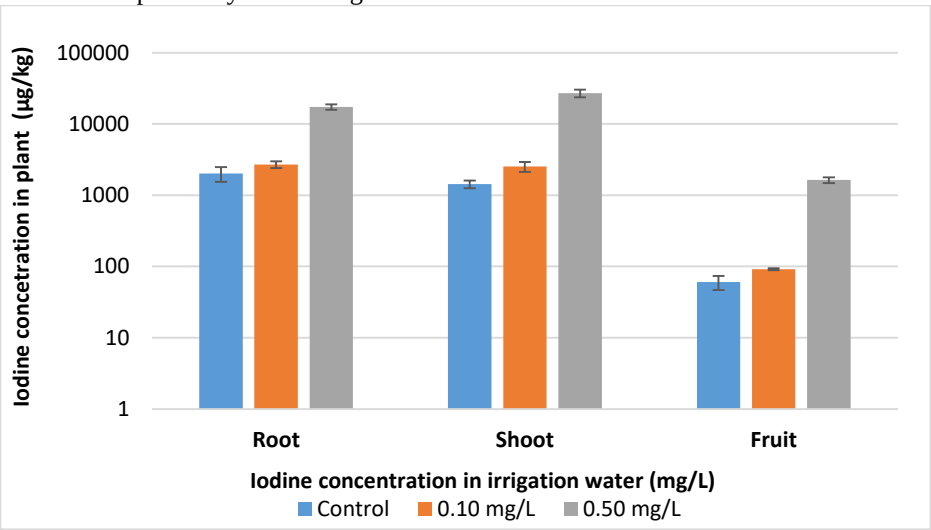

Figure 1. Iodine concentration of bean plant parts

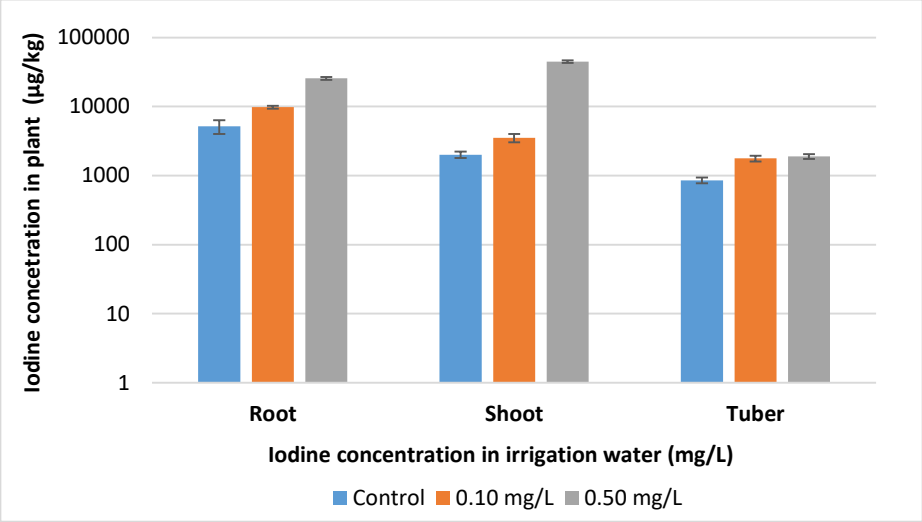

Figure 2. Iodine concentration of potato plant parts

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