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Content and Uptake of Nutrients with Plant Biomass of Potatoes Depending on Potassium Fertilization

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Abstract

The influence of potassium fertilizer source and the increasing potassium fertilization levels (0, 200, 400 and 600 mg K_2O/kg soil) supplied either as K_2SO4 or KCl at equal nitrogen and phosphorus fertilizer background (200 mg N/kg and 150 mg P_2O_5/kg soil) on the content and the uptake of nutrient elements from the soil in potato plant parts was studied. Pot experiment was carried out. The fertilization with K_2SO_4 decreased N content in roots from 2.91% at level K_{200} to 2.52% at level K_{600} and increased N content in aboveground biomass compared to the control and variants fertilized with KCl. The increasing KCl rates led to decreasing of N content in aboveground biomass from 4.03% at K_{200} to 2.34% at potassium level K_{400}. Nitrogen content in tubers at variants fertilized with K decreased compared to the control. Potassium fertilization did not influence considerably P content in the plant parts. The K content in plant parts at variants fertilized with KCl was higher than the plants fertilized with K_2SO_4. Approximately 74% of absorbed nitrogen from the soil was allocated in the above ground biomass. The rest of the nitrogen was distributed between roots (17%) and tubers (9%). The highest P uptake was determined in control plants. The quantity of the uptaken K allocated in aboveground biomass was the highest (83%). The rest of K was distributed between roots (11%) and tubers (6%).

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Keywords: potatoes, potassium fertilization, uptake of nitrogen, phosphorus and potassium.

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1. Introduction

Potatoes (*Solanum tuberosum* L.) are widely grown crop in the mountain regions in Bulgaria. Their tubers are a good source of starch, proteins, vitamins, sugars, minerals and other useful substances (Blagoeva et al., 2004). The healthy development of potato tubers requires, among other agricultural practices, proper fertilization. Potato crops require large amounts of nutrients and therefore a large amount of fertilizers are applied for their production (Luz et al., 2013). The fertilization rates should be considered with the content of available nutrients in the soil, the requirements of the grown varieties (early or late), as well as direction of production (for fresh consumption or processing) (Nikolova, 2010). Nitrogen fertilization increases tuber and dry matter yield and the nitrogen content in potato plants (Sharifi et al., 2007; Neshev et al., 2014). Application of nitrogen and potassium depressed dry matter content at the deficiency of phosphorus. Potassium and nitrogen fertilization is required for maximum potato production. Both elements and source of potassium (KCl, K_2SO_4) affect yield and quality of potatoes (Berger et al., 1961; Manolov et al., 2015). Potassium sulfate is the preferred source of potassium for potatoes compared to potassium chloride. It improves quality parameters of potatoes (Herlihy and Carroll, 1969; Manolov et al., 2015).

The aim of the study was to determine the influence of the source of potassium fertilizer and increased potassium fertilization rates on the uptake of N, P and K and their allocation in the different plant parts.

2. Materials and Methods

The study was carried out with variety „Picasso" in conditions of pot experiment. Plants were grown in 15-liter pots containing 14.5 kg soil with pH 5.35. The soil contained 21.58 mg/ kg mineral nitrogen, 38.8 mg P_2O_5/100 g and 50 mg K_2O/100 g before the beginning of the experiment. The experiment was designed to evaluate potato responsiveness to increasing rates of K (0, 200, 400 and 600 mg K_2O/ kg soil) supplied either as K_2SO_4 or KCl. Ammonium nitrate and triple superphosphate were applied to all variants (including to the control) to provide 200 mg/kg N and 150 mg/kg P_2O_5 respectively. All treatments were replicated 5 times. To calculate the content and uptake of nutrient elements, whole plants were analyzed at the end of the vegetation. The plant samples were dried at 60^{o}C, weighted and milled. They were mineralized with concentrated H_2SO_4 using H_2O_2 as a catalyst. The total nitrogen content was determined according to Kjeldahl method by distillation in apparatus of Parnas-Wagner (Tomov et al., 2009). Phosphorus was determined colorimetrically (spectrophotometer Camspec M105) (Tomov et al., 2009) and potassium photometrically (flame photometer PFP-7) (Ivanov and Krastev, 2005).

For statistical analyses of collected data, Duncan's multiple range test (1955) of SPSS program was used. Statistical differences were considered significant at $p < 0.05$.

3. Results and Discussions

Significant increase of concentration of nitrogen in the roots with increasing rates of KCl was observed (2.78 % K_{200} – 3.20 % K_{600}) (Table 1). The increasing potassium rates applied as K_2SO_4 led to slight decreasing of N content in roots and tubers (Table 1). Potassium fertilization increased potassium content in roots compare to the control. The increase was more considerable at variants fertilized with KCl (Table 1). Application of K_2SO_4 increased N content in aboveground biomass compare to control. The highest KCl rates (K_{400} and K_{600}) decreased N content in aboveground biomass considerably (Approximately 2 % lower in comparison with other treatments) (Table 1). Potassium fertilization had a significant influence on K content in these plant parts of potatoes, compared to the control. Higher rates of KCl increased K content up to 6.54 % at K_{600} (Table 1).

The K fertilization and type of K fertilizer did not influence considerably N content in tubers, which was almost equal at all variants. An exception was observed at K_{600}-KCl where the content N in tubers (3.04%) exceeded N content in the control sample (2.61%) (Table 1). The studded fertilizing rates applied as K_2SO_4 did not influenced K content in tubers (Table 1).

Increasing KCl rates led to an increase of K content in the tubers from 1.79% at variant K_{200} to 2.15% at variant K_{600}. Potassium fertilization did not influence phosphorus content in roots, aboveground biomass and tubers (Table 1).