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Effect of potassium humate on yield and yield components of different potato varieties as a second crop after barley harvest in Ardabil region, Iran

Jalil Ajalli[1*], Saeid Vazan[2], Farzad Paknejad[2], Mohammad Reza Ardekani[3] and Ali Kashani[3]

Department of Agronomy and Plant Breeding, Faculty of Agriculture and Natural Resources, Karaj Branch, Islamic Azad University, Karaj, Iran

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ABSTRACT

The effect of different concentrations of Potassium Humate organic matter was investigated on yield and yield components of five potato varieties as a second crop after barley harvest in Ardabil region, northwest Iran. Experiment was carried out as split plot based on a randomized complete block design with three replications during 2010 and 2011 growing seasons. Potassium Humate was considered as the main factor at three levels (0, 250 and 300 mL.ha^{-1} in 300 liter water) and six potato varieties including Agria, Savalan, Kaizer, Markiz and Lota were allocated to subplots. Traits including plant height, number of stems, number and weight of tubers per plant, total tuber yield and marketable tuber yield were measured during growing season and after harvesting. Results revealed significant effect of potassium Humate, variety and interaction of potassium Humate and variety on the studied traits. Savalan and Agria produced the most stem numbers per plant when 300 mL.ha^{-1} Potassium Humate was used. Kaizer and Agria also produced higher plants, whereas the shortest ones were observed in Markiz. Application of 250 and 300 mL.ha^{-1} Potassium Humate increased plant height significantly. It also led to an increment of 24.8 g tuber weight per plant in average. The highest tuber number per plant was produced by Lota and Savalan at 250 and 300 mL.ha^{-1} Potassium Humate application rate. Lota produced the highest tuber weight per plant, total yield and marketable tuber yield when 250 mL.ha^{-1} Potassium Humate was applied. In conclution, planting Lota as a second crop after barley harvest with application of 250 mL.ha^{-1} Potassium Humate could be recommended in Ardabil region climatic condition.

Key words: potato, Potassium Humate, organic matter, yield, yield components, second cropping.

INTRODUCTION

Cultivation of the potato as a second crop after barley harvest is important in Ardabil region, northwest of Iran, due to its suitable soil and climatic condition, long-term growth period, for growing potato. According to Majnoon Hosseini (1996), planting a proper second crop in rotation with the first one has beneficial effects and reduces soil erosion in some areas. He also stated that if conditions allow, second cropping is efficient for farmers economically and it increases their incomes as well as national income [22].

Nassiri (2008) planted potato, cabbage, canola, clover, lettuce, garlic, beans and peas as second crops after rice

harvest and concluded that planting of all above mentioned crops has an important role in reducing rice pests without any soil fertility reduction. According to Hassan Panah *et al*. (2007) pigweed, *Amaranthus retroflexus* L. and lambsquarters, *Chenopodium album* cause serious problems in spring potato cropping in Ardabil region duo to their intense competition with potato during its vegetative growth. They also are problem making in potato harvest in the late summer. They reported that planting potato (cv. Santeh) as a second crop after other crops reduced production cost through suppressing weed growth without implementation of weed management strategies [12]. They also pointed that second cropping of Santeh potato cultivar was beneficial because plants escaped from mildew and Colorado beetle, *Leptinotarsa decemlineata* L. (Col.: Chrysomelidae) and they also produced relatively healthy seed tubers duo to low activity of virus carrier insects like aphids. In planting potato as a second crop in Ardabil plain, synchronization of potato plant's growth and tuber formation with appropriate climate (short days and long nights) was considered as the main reason for physiological maturity of early autumn harvested tubers [12].

Potato is one of the most sensitive crops to nutrition and drought stress due to its low volume root system, and so it requires high amounts of fertilizers to produce reasonable yield [23]. Potato has relatively high potassium requirement in comparison to other vegetables, and so potassium containing fertilizers should be applied in potato fields for high yield production. Adequate potassium fertilizer application can be useful because it makes potato plants adapted to the environmental stresses and may lead to increased resistance of potato to some pests [2].

Application of organic fertilizers is taken into consideration all over the world during the last two decades, because of its importance in food safety and environmental health. Organic fertilizers contain components that can increase product quality, plant tolerance to disease and pests and environmental stresses such as heat, cold and drought as well as root system development [5]. Organic fertilizers are obtained from plant and animal materials decomposition which are relatively stable and their application can cause better plant nutrition and soil fertility improvement as well as a reduced water requirement of plants [16].

Potassium Humate is considered as an organic fertilizer. It contains 5% nitrogen, 2.8% phosphorus, 10% potassium and some micronutrients including molybdenum, copper, zinc, cobalt and magnesium [6]. Potassium Humate increases product quality and plant tolerance to drought stress, salinity, heat, cold, disease and pests [6, 8, 18].

Application of Potassium Humate increased potato tuber yield [13, 18], mean mini- tuber size and weight, and mini-tuber number per plant [9]. It also reduced potato seedlings transfer time from laboratory to greenhouse under water stress condition [9].

The present study was carried out to investigate the effect of different concentrations of Potassium Humate on yield and yield components of five potato varieties as a second crop after barley harvest in Ardabil region.

MATERIALS AND METHODS

Experiment was carried out as split plot based on a randomized complete block design with three replications during 2010 and 2011 growing seasons in Ardabil region, northwest Iran. Potassium Humate was considered as the main factor at three levels (0, 250 and 300 mL.ha^{-1} in 300 liter water) and five potato varieties including Agria, Savalan, Kaizer, Markiz and Lota were allocated to subplots. Plants in the control treatment were treated only with water.

Potato was planted after barley harvest on 15th July. Before the experiment, chemical and physical characteristics of soil were measured. Phosphate fertilizer was applied to the amount of 150 kg.ha^{-1} at two times (50% at planting time and 50% at tuber formation stage). 250 kg.ha^{-1} nitrogen fertilizer was also applied at three times (25% at planting, 50% at plant emergence and 25% immediately after tuber formation stages). Besides, 300 kg.ha^{-1} Potassium fertilizers were also applied at planting time, based on the soil test results.

Operations such as weeding and pest and disease control were done uniformly in all plots, if necessary. During growth period and after harvest, 10 plants were selected randomly in each plot to measure the traits of plant height, number of stems per plant, number and weight of tubers per plant. Besides, total tubers of plots weighted and total tuber yield and marketable tuber yield were calculated after harvest.

SAS software was used for variance analysis by GLM procedure and means were compared by Duncan's Multiple Range Test.

RESULTS

Analysis of variance results showed that the effects of Potassium Humate, variety and interaction effects of variety and Potassium Humate were significant on the studied traits at 5% of probability level.

Number of stems per plant

Savalan and Agria produced the most main stems per plant and the least number of stems per plant was observed in Satina and Lota. In total, Savalan and Agria produced the highest number of main stems per plant when 300 mL. ha^{-1} Potassium Humate was applied (Figure 1).

Plant height

Figure (2) represents plant height of the potato varieties planted after barley harvest as affected by Potassium Humate. Based on the results, the maximum plant height was belong to Kaizer and Agria, whereas Markiz produced the shortest plants. Agria and Kaizer produced higher plants when 250 and 300 $mL.ha^{-1}$ Potassium Humate were applied.

Number of tubers per plant

There was no significant difference among Potassium Humate levels in tuber number per plant. The highest number of tubers per plant was observed in Lota and Savalan varieties when 250 and 300 $mL.ha^{-1}$ Potassium Humate were applied.

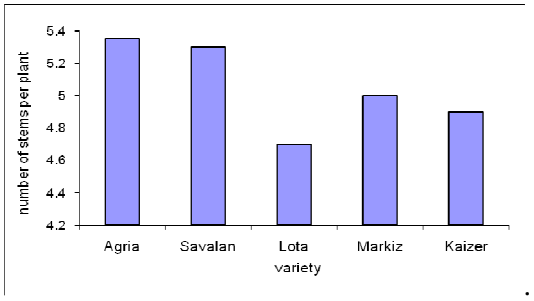

Figure 1. Number of stems per plant in the studied potato varieties

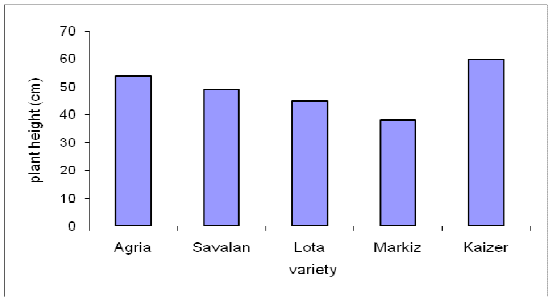

Figure 2. Plant height of the studied potato varieties

Tuber weight per plant

Lota and Kaizer varieties produced higher tuber weight in cultivation after barley harvest (Figure 3). Application of Potassium Humate on Lota variety increased its tuber weight per plant up to 24.8 gram. Maximum tuber weight per plant was obtained by planting Lota with 250 $mL.ha^{-1}$ Potassium Humate application rate. However, there was no significant difference between control and 300 $mL.ha^{-1}$ Potassium Humate treatments in this trait.

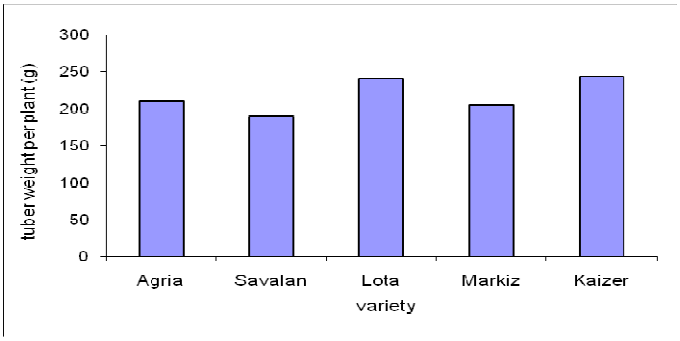

Figure 3. Tuber weight per plant in the studied potato varieties

Total tuber yield and marketable tuber yield

Tuber yield was higher in Lota than the other studied potato varieties (Figures 4 and 5). The highest total tuber yield and marketable tuber yield traits were obtained by planting Lota as 250 mL.ha^{-1} Potassium Humate was applied.

Potassium Humate application increased total and marketable tuber yield of the studied potato varieties in comparison to the control (Fig. 6, 7). As shown in Figures (6) and (7), 250 mL.ha^{-1} Potassium Humate was more effective than 300 mL.ha^{-1}, so that it resulted in the highest values for both total and marketable tuber yields.

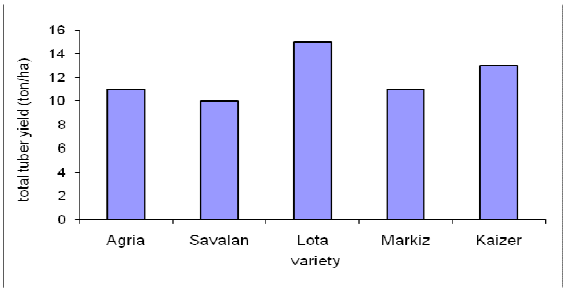

Figure 4. Total tuber yield of the studied potato varieties

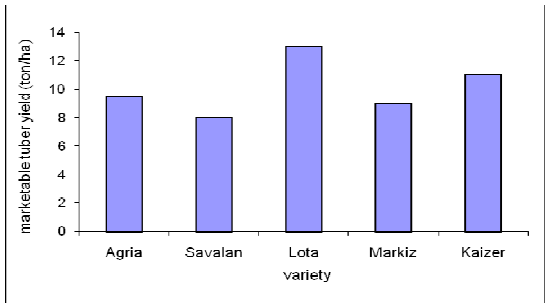

Figure 5. Marketable tuber yield of the studied potato varieties

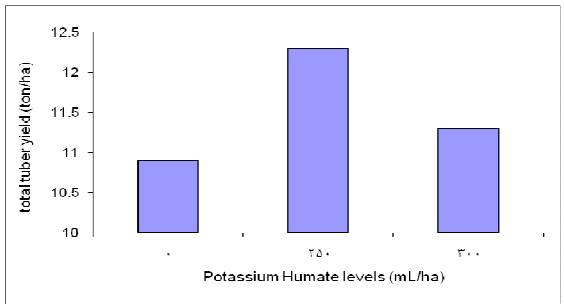

Figure 6. Total tuber yield of potato varieties at different Potassium Humate levels

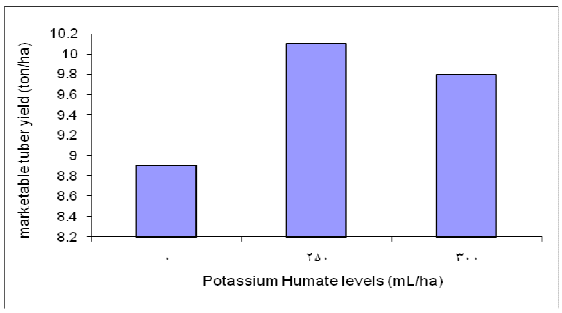

Figure 7. Marketable tuber yield of potato varieties at different Potassium Humate levels

DISCUSSION

According to results of the present study, planting potato as a second crop after barley harvest in 15th June reduced tuber yield up to three tons per hectare in comparison to spring cultivation. Jones and Allen (1989) showed that planting date was effective on potato performance through its effects on leaf area index and the amount of radiation absorbed by plants. Acosta-Gallegos *et al.* (1996) also showed that potato tuber yield was higher in spring cultivation, because plants grew and tubers formed in a suitable climatic condition. According to them, the most suitable temperatures for potato planting and tuber enlargement are 10-15°^{C} and 20-30°^{C} [1], respectively.

Although potato yield was reduced a little in comparison to its planting in spring, results of the present study were in consistent with findings of other researches and revealed the possibility of planting potato varieties after barley harvest in Ardabil region. In order to increase farmers' income in second cropping, planting Lota with application rate of 250 mL.ha^{-1} Potassium Humate was recommended. Nassiri (2010) also reported higher performance of Savalan and Lota potato varieties in spring cultivation and second cropping. Hassan Panah *et al.* (2008) reported 35 tons per hectare potato tuber yield for Santeh variety in the second cropping of potato. Hassan Panah *et al.* (2009) also showed the possibility of planting Savalan potato variety as a second crop in Ardabil region. According to Hassan Panah (2010) Agria and Savalan varieties produced the highest total tuber yield in second cropping. Different results for performance of potato varieties may pertain to differences between the studied climatic conditions.

In the present study, application of Potassium Humate increased both total tuber yield and marketable tuber yield traits that were consistent with results of other researchers. Results of a research showed that seed treatment with

Potassium Humate before potato planting and also spraying it at the germination stage created strong root system for the plant [3]. Potato tubers treated with Potassium Humate before planting and spraying it on sprouts increased root system volume and so caused an increment of up to 22% in tuber yield [4]. The potato tubers treated with a solution of 0.01% and 0.02% Potassium Humate for 24 hours before sowing, increased yield up to 23%, improved quality of produced tubers and reduced nitrate accumulation in tubers from 47 mg to 18.5 mg per hectare [3]. Application of Potassium Humate solution before sprouting increased potato yield [4]. Potassium Humate application increased potato tuber yield and number and weight of tubers per plant under water stress condition [9, 18]. It also reduced nitrate accumulation in the tubers [14].

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