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Shortening Transplantation Periods of Potato Plantlets by Use of Potassium Humate and Kadostim and Their Effects on Mini-tuber Production

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Abstract: Plantlets produced from meristem culture of six advanced cultivars (Agria, Advanced clone 397007-9, Marfona, Sante, Satina and Ceaser) propagated by single node cuttings arranged in a RCBD base factorial design with ten replications. Factor A was plantlets produced from meristem culture of advanced cultivars and factor B was seven treatments (four concentrations of potassium humate as 0.5, 1, 1.5 and 2 mL, one concentrations of kadostim as 1 mL, compound concentration of potassium humate and kadostim as 1 ml L^{-1} MS media culture and without them as control). Produced plantlets transplanted into the planting beds of Pitmass (Biolan) with punce (1:1 v/v) in the greenhouse. Some of traits measured such as average weight and number of mini-tuber per plant after harvesting. Results of analysis of variances showed the significant differences between effects of kadostim and potassium humate on advanced cultivars, for transplantation into the greenhouse, stem solidity and rhizo-genesis characters. So transplantation days decreased from 30 to 13 days in MS media culture with compound of potassium humate + kadostim by concentration of 1 ml L^{-1} MS media culture, also decreased to 15 days in MS media culture with kadostim by concentration of 1 ml L^{-1} MS media culture and also decreased to 22 days in MS culture with potassium humate by concentration of 1 and 1.5 ml L^{-1} MS media culture and plantlets had the highest stem solidity and better rhizo-genesis in all of treatments. Agria, Sante and Marfona transplanted earlier and Ceaser transplanted later than others to the greenhouse. Compound concentration of potassium humate and kadostim 1 ml L^{-1} MS media culture had the highest number of mini-tubers per plant and potassium humate 0.5 ml L^{-1} MS and Kadostim 1 ml L^{-1} MS had the highest mini-tuber weight per plant and average of mini-tuber weight per plant. Agria had the highest number and average of weight of mini-tubers per plant. Potassium humate 0.5 ml L^{-1} MS in satina, kadostim 1 ml L^{-1} MS in marfona and potassium humate + kadostim 1 ml L^{-1} MS in Agria had the highest number of mini-tubers per plant. Increasing rate of weight and number of mini-tubers per plant with potassium humate and kadostim in all of advanced cultivars were more than control.

Key words: Meristem culture, mini-tuber, MS media culture, single node cutting

INTRODUCTION

Ardabil province is one of the most suitable areas for potato cultivation in Iran. So regards to weather conditions, have about 28,000 ha under cultivation area and production over 800,000 ton. Mini-tubers are small tubers of potato that produced from plantlets in greenhouse that were cultured *in vitro* (Lommen and Struik, 1992, 1994). Producers of potato mini-tubers need for decreasing time of transplantation from *in vitro* to the greenhouse, powered stem strength and better rhizo-genesis for increasing production rate of mini-tuber per plant and decrease of production cost until farmers could buy cheaper mini-tubers.

Kadostim is an organic cell pathway synthesized bio-stimulator that enhancing potassium leaf nutrient complex characteristics such as liquid formula with free amino acids and biologically active oligo-peptides developed for use in the post flowering stage and ripening of fruits. Products like as bio-stimulators and bio-fertilizers have effects and benefits for plants growth and development such as enhancing the process of seed germination, activating the formation of root system, stimulating the assimilation of micronutrients, accelerating the formation

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Table 1: Potassium humate and kadostim compounds

Kadostim			
Aminogram distribution (%)		Potassium humate	
Glycine	1.80	Nitrogen	2.8%
Valine	5.10	Humid	5.0%
Proline	8.40	Phosphorus	0.4%
Alanine	13.21	Potassium	10.0%
Aspartic acid	4.50	pH = 8.2	
Arginine	8.40	$N\text{-}NH_4$	460.0 mg L^{-1}
Glutamic acid	0.90	$N\text{-}NO_3$	890.0 mg L^{-1}
Lysine	5.10	P_2O_5	890.0 mg L^{-1}
Leucine	16.51	K_2O	8600.0 mg L^{-1}
Isoleucine	4.50	MgO	620.0 mg L^{-1}
Phenilalanine	5.10	Cu	4.5 mg L^{-1}
Methionine	4.20	Zn	11.5 mg L^{-1}
Serine	3.90	S	400.0 mg L^{-1}
Threonine	3.00	Fe	15.0 mg L^{-1}
Histidine	3.00	Mn	10.0 mg L^{-1}
Glycocoll	9.60	B	2.0 mg L^{-1}
Tyrosine	1.50	Mo	2.0 mg L^{-1}
Glutamine	0.90	Co	1.0 mg L^{-1}
Cystine	0.30		
Other	0.08		
Total nitrogen (N)	5.00% w/w		
Ammoniac nitrogen	1.60% w/w		
Nitric nitrogen	3.10% w/w		
Organic nitrogen	0.30% w/w		
Organic matter	2.00% w/w		
K_2O (soluble in water)	6.00% w/w		
Free amino acids	3750 mg L^{-1}		

and growth of leaves, impacts over leaf stoma to control and regulate moisture, light, temperature, salinity and gas, activating the photosynthesis process of nutritional and substances and reserves, favors the formation of flowers, their capacity of fecundates, reducing the effects of stress and shock by transplantation, adverse weather (frost, drought and hailstorm) and chemical agents, facilitating the regeneration of damaged tissues, improving the absorption of all agrochemical products, stimulating the acquired immunology, increasing the resistance of the plants and yield and enhancing size, sorting and quality of the fruit, increasing the yield and fruit shelf life after harvest (Anonymous, 2007a) (Table 1).

Humates are widespread carbonic matters being formed in the processes of biological and chemical decomposition of plant and animal residues. Humates present the complex of high molecular polyfunctional nitrogenic organic compounds with cyclic structure and specific physical, chemical and biological characteristics (Lopez-Fernandez *et al*., 1992). Humic acid causes to increase yield in watermelon, cabbage and potatoes (Salman *et al*., 2005). Humic acid is used to remove or decrease the negative effects of chemical fertilizers and some chemicals from the soil. The major effect of humic acid on plant growth has long been reported by Lee and Bartlette (1976), Linchan (1978), Pal and Sengupta (1985), David *et al*. (1994) and Hartwigson and Evans (2000).

Potassium humate is an active hormone with natural origin that extracts from plants and animal remains exist in the bottom of marshes (Table 1). This material is formed from N, P, K and microelements namely Mo, Cu, Zn, B, Co, Mg (Gadimov *et al*., 2007). Potassium humate increases accumulation of chlorophyll, sugar, amino acids and more improves the efficiency of nitrogen utilization, allowing for reduced fertilizer rates, the plant's ability to withstand the stresses of heat, drought, cold, disease, insect and other types of environmental or cultural pressures and also increases general plant productivity, in terms of yield, as well as plant stem strength (Anonymous, 2008). Using of potassium humate increased root system, tuber yield, tuber number per plant (Anonymous, 2007b), root number (Baraldi, 1991) and pea numbers from 14.4 to 52.6 and its weight from 12 to 36 g in condition of saline stress by application of 250 mL ha^{-1} potassium humate in stage of 3-6 weeks after planting as spraying and decreased nitrate amounts in leaves and roots (Gadimov *et al*., 2007) and decreased nitrate accumulation in potato tubers (Hassanpanah *et al*., 2007).

This experiment was conducted for evaluation of effect of two biological complexes namely kadostim and potassium humate on meristem culture of potatoes.

MATERIALS AND METHODS

Experiment was done in biotechnology laboratory and greenhouse of Villkej Company in Ardabil Province, Iran in 2007. In this experiment, plantlets produced from meristem culture of six advanced cultivars (Agria, Advanced Clone 397007-9, Marfona, Sante, Satina and Ceaser) propagated by single node cuttings (Lommen and Struik, 1995; Ahmed *et al*., 1995). Experimental design was factorial on the basis of complete randomized block design in ten replications. Factor A was plantlets produced from meristem culture of six advanced cultivars (Agria, Marfona, Sante, Satina, Ceaser and Advanced Clone 397007-9) and factor B was seven treatments (four concentrations of potassium humate as 0.5, 1, 1.5 and 2 mL, one concentrations of kadostim as 1 mL, compound concentration of potassium humate and kadostim as 1 ml L^{-1} MS medium (Murashige and Skoog, 1962) and without them as control). After planting, plantlets reached to enough growth after about 30 days in 18-22 centigrade temperature and 16/8 photoperiod (Dobranzki *et al*., 1999; Lommen and Struik, 1995; Ahmed *et al*., 1995; Yiem *et al*., 1990) with 5000 lux intensity light. The days to transplantation, stem strength and rhizo-genesis measured. Analysis of variance was done and means compared by LSD (Least significant

difference) test. Then, plantlets cultured in planting beds of Pitmass (Biolan) with punce (1:1 v/v) in a greenhouse. Experimental design was factorial on the basis of complete randomized block design in three replications. The plantlets were planted with distances 10 cm between rows and 10 cm between plantlets (Regand *et al*., 1995). All of plantlets irrigated after planting by normal water. Macro and micro nutrients were used to provide for nutrition of plantlets. All of practices such as irrigation and control of weeds, pests and diseases were done regularly during growth period. Control of pests and fungus diseases were done, respectively by use of 250^{cc} per ha Confidor and 400 g ha^{-1} Equation-Pro. Mini-tubers harvested after about two months. Then some of traits measured such as average weight and number of mini-tuber per plant. Analysis of variance was done and means compared by LSD test.

RESULTS AND DISCUSSION

Results of analysis of variance showed significant differences between effect of kadostim and potassium humate and advanced cultivars for transplantation to greenhouse, stem solidity and rhizo-genesis.

Transplantation days of plantlets from *in vitro* to the greenhouse decreased from 30 days (control) to 13 days in MS media culture with compound of potassium humate + kadostim by concentration of 1 ml L^{-1} MS culture, to 15 days in MS media culture with kadostim by concentration of 1 ml L^{-1} MS culture and to 22 days in MS culture with potassium humate by concentration of 1 and 1.5 ml L^{-1} MS media culture and plantlets had the highest stem solidity and better rhizo-genesis in all of treatments. Agria, Sante and Marfona transplanted to the greenhouse earlier and Ceaser later than others (Fig. 1).

Results of Analysis of variance in the greenhouse showed the significant differences between effects of kadostim and potassium humate on advanced cultivars on average of mini-tuber weight per plant and number and weight of mini-tuber per plant.

Compound concentration of potassium humate and kadostim with 1 ml L^{-1} MS media culture had the highest number of mini-tubers per plant (2.56 tubers). Potassium humate 0.5 ml L^{-1} MS and kadostim 1 ml L^{-1} MS had the highest mini-tuber weight per plant (3.09 and 2.89 g) and average of mini-tuber weight per plant (1.74 and 1.62 g) (Table 2).

Agria had the highest number (2.84 tubers) and average weight of mini-tubers per plant (4.87 g) (Table 3). Potassium humate 0.5 ml L^{-1} MS on Satina, kadostim 1 ml L^{-1} MS on Marfona and potassium humate + kadostim 1 ml L^{-1} MS on Agria produced the highest number of mini-tubers per plant (Fig. 2). Increasing rate of weight and number of mini-tubers per plant with potassium humate and kadostim in all of advanced cultivars were more than control.

Correlation between weight of mini-tuber per plant with average weight of mini-tuber per plant was positively significant at probability levels of 5% (r = 0.85) and with number of mini-tuber per plant was negatively non-significant (r = - 0.35). Gopal *et al*. (2002) resulted the same correlation coefficient (r = 0.86) between tuber yield and average tuber weight.

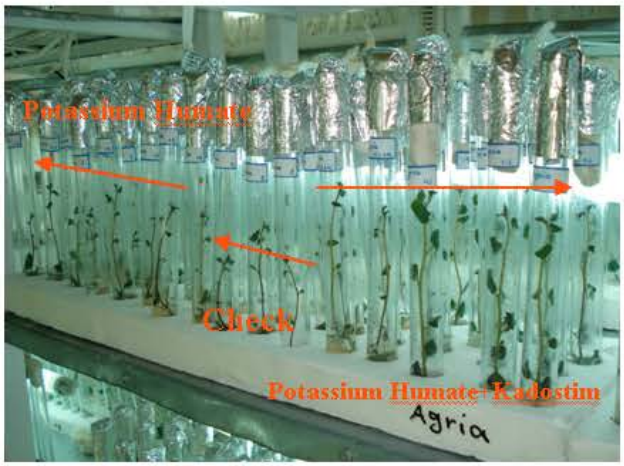

Fig. 1: Planlets of potato cvs. on different levels of potassium humate and kadostim

Table 2: Mean of traits on different levels of Potassium humate and Kadostim in the greenhouse

Treatments	No. of mini-tubers	Weight of mini-tubers (g)	Average weight of mini-tubers (g)
Kadostim 1 ml L^{-1} MS (KA = 0.001)	1.78b	2.89ab	1.62a
Kadostim 1 mL+potassium humate 1 ml L^{-1} MS (KA+PH)	2.56a	2.59ab	1.01b
Potassium humate 2 ml L^{-1} MS (pH = 0.002)	1.50b	2.69ab	1.79a
Potassium humate 1.5 ml L^{-1} MS (pH = 0.0015)	1.67b	2.16b	1.29b
Potassium humate 1 ml L^{-1} MS (pH = 0.001)	2.00ab	2.61ab	1.30b
Potassium humate 0.5 ml L^{-1} MS (pH = 0.0005)	1.78b	3.09a	1.74a
Control (C = 0.0)	1.56b	2.20b	1.41b

MS= Murashige and Skoog media culture; l = L; Values with different letter(s) are significantly at $p<0.05$

Table 3: Mean of traits for different cultivars in the greenhouse

Cultivars	No. of mini-tubers	Weight of mini-tubers (g)	Average weight of mini-tubers
Agria	2.84a	13.810a	4.87a
Satina	2.70a	9.381b	3.47b
Marfona	2.54ab	10.100b	3.98b
Ceaser	2.25b	7.143c	3.17b
Advanced clone	2.67a	10.030b	3.75b
Sante	2.63a	9.524b	3.62b

Values with different letter(s) are significantly different at $p<0.05$

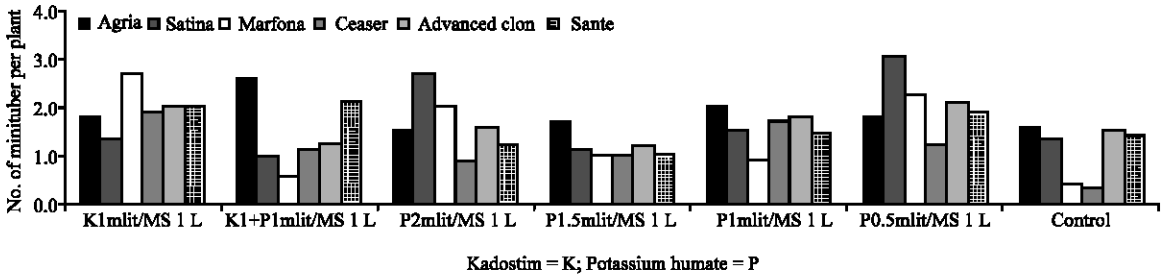

Fig. 2: Mean of mini-tubers number of potato cvs. on different levels of potassium humate and kadostim in the greenhouse

There are 30-35 days numbers to transplantation by mini-tuber producers at present. However, it decreased to 13-22 days related to type and amounts of biological complexes applied in culture media and variety in this experiment. Increasing rate of average weight and number of mini-tubers per plant with potassium humate and kadostim in all of six advanced cultivars were more than control.

The price of one mini-tuber is about 0.25$ in Iran. In this study potassium humate increased the number of mini-tubers per plant (with mean of 1.86 tubers). Therefore about 47$ increased for production of mini-tubers per square meter. Thus potassium humate caused the economic effects pay attention to results of this research. On the other hand, we would like to apply results of this research for increasing production of mini-tuber per plant, so decrease in production cost until farmers could buy cheaper mini-tubers.

CONCLUSIONS

The potassium humate and Kadostim decreased the days to transplantation of plantlets from *in vitro* to the greenhouse from 30 to 13-22 days and increased number and average of mini-tuber weight per plant.

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