African Journal of Agricultural Research Vol. 7(31), pp.4432-4439,14 August, 2012
Available online at http://www.academicjournals.org/AJAR
DOI: 10.5897/AJAR11.1048
ISSN 1991-637X ©2012 Academic Journals

Full Length Research Paper

Effects of different concentrations of Humi-Fert Ultra organic matter on mini-tuber production of potato cultivars under *in vivo* condition

Davoud Hassanpanah* and Jafar Azimi

Islamic Azad University, Ardabil Branch, Ardabil, Iran.

Accepted 2 May, 2012

This study was conducted to evaluate the Humi-Fert Ultra organic matter effects on mini-tuber production of potato cultivars during 2010 and 2011. Seedlings of Agria, Savalan, Marfona and Sprit cultivars were raised using single node cuttings under optimum light intensity and temperature for two months. Then, seedlings were propagated by single node cuttings. Experiment design was factorial based on completely randomized design with three replications of two factors, where the first factor included three levels of Humi-Fert Ultra (0, 2 and 3 ml in 300 L of water) and second factor included four potato cultivars (Agria, Savalan, Marfona and Sprit). The seedlings were planted with 10 cm distances between rows and 10 cm between plantlets in planting beds of Mikskaar peat mass with punce (1:1 v/v) in greenhouse. The Humi-Fert Ultra was used in three germinations, tuberaztion and bulking stages. Analysis of variance showed significant differences between different levels of Humi-Fert Ultra, cultivars and their interaction as traits mini-tuber number and weight per square meter; mini-tuber size average, mini-tuber number < 3 g, between 3 and 7 g and >7 g had significant differences. Maximum mini-tuber number and weight per square meter, mini-tuber size average and mini-tuber number between 3 and 7 g was relative to Savalan cultivar in Humi-Fert Ultra with 2 ml per 300 L of water. In this experiment, Humi-Fert Ultra organic matter increased mini-tuber number per square meter in Savalan cultivar with about 420 numbers.

Key words: Mini-tuber, potato, Humi-Fert Ultra, organic matter.

INTRODUCTION

Potato (*Solanum tuberosum* L.) is grown and eaten in more countries than some other crops (Jackson, 1999). It grows mainly under climates with cool temperature and full sunlight, moderate daily temperatures and cool nights. Short days generally induce potatoes tubers, although many modern cultivars can initiate tuberization in long days of north temperate regions (Tarn et al., 1992). Among the most important crops in the world (Fernie and Willmitzer, 2001) and in Iran (FAO, 2011), potato is ranked in the fourth grade between annual (FAO, 2011). Production after the cereal species rice, wheat and barley. Iran is the world's 12th potato producer and the third biggest producer in Asia, after China and India (FAO, 2011). Mini-tubers are small potato tubers produced after being acclimatized under *in vitro* condition and planted at high density in the glasshouse on planting beds or containers using different substrate mixtures. Mini-tubers can be produced throughout the year and are principally used for producing pre-basic or basic seed by direct field planting (Lommen, 1999; Pal and Sengupta, 1985). There are many factors that affect the transferred plantlets under greenhouse conditions; they include cultivar, planting density, planting bed, lighting, nutrient, and irrigation (Ahmad and Machado, 1995).

Humates are carbonic materials that are created by biological and chemical analysis of plants and animals' remains processes (Linchan, 1978). Humic acids cause increased yield. They also cause decreased negative effects of fertilizers and some chemical materials of soil (Salman et al., 2005). These negative effects of chemical fertilizers have led to the usage of nitrogen sources such

*Corresponding author. E-mail: D_Hassanpanah@yahoo.com.

as organic fertilizers in nutrient management (Abou-Hussein et al., 2003; Ashwini and Sridhar, 2006). Organic fertilizers such as cattle manure, contain large amount of nutrients and influence plant's growth and production by improving chemical, physical and biological fertility (Benke et al., 2009; Füleky and Benedek, 2010). Other researches showed that leaf area index, (LAI), shoots weight, plant's height and tuber yield can be increased by the application of organic fertilizer (Stoner et al., 1996; Abou-Hussein et al., 2003). The importance and positive effects of humic acid have been reported by other researchers on plant's growth (Pal and Sengupta, 1985; Hartwigson and Evans, 2000).

Potassium humate is one of the organic matters that causes increase in production quality, plant's tolerant to drought, salinity, hot and cold stress (Gadimov et al., 2007).Hassanpanah et al. (2008a) reported that potassium humate caused increase in tuber yield by 11 ton per ha^{-1} under drought stress condition. Gadimov et al. (2007) also reported potassium humate caused increase in pea number from 14.4 to 52.6 and weight from 12 to 36 g under salinity stress condition.

Also potassium humate causes decrease in the amount of nitrate in leaf, root and tuber of potato (Hassanpanah et al., 2008c).

Hassanpanah et al. (2008d), by evaluating the effect of Kadostim and potassium humate on potato cultivars seedling, stated that treatment of Kadostim and potassium humate of 1 ml ratio per one liter of MS decreased the time of removing seedling to greenhouse. Hassanpanah et al. (2008b) stated that potassium humate caused increase in tuber yield with about 5.78 ton per ha^{-1} by evaluating the potassium humate effects on second cultivation.

The purpose of this investigation was to evaluate the different concentration of Humi-Fert Ultra organic matter effects on the mini-tuber production of potato cultivars under greenhouse condition.

MATERIALS AND METHODS

This study was conducted to evaluate the Humi-Fert Ultra organic material effects on mini-tuber production of potato cultivars in biotechnology laboratory and greenhouse of "Potato Seed Production Company of Vilkij Ardabil, Iran" during 2010 and 2011. Seedlings of Agria, Savalan, Marfona and Sprit cultivars were raised by using single node cuttings under optimum light intensity and temperature for two months. Then, seedlings were propagated by single node cuttings. Experiment design was factorial based on completely randomized design with three replications of two factors. First factor included three levels of Humi-Fert Ultra (0, 2 and 3 ml per 300 L water) and second factor included four potato cultivars (Agria, Savalan, Marfona and Sprit). The seedlings were planted with 10 cm distances between rows and 10 cm between plantlets in planting beds of Mikskaar peat-mass with punce (1:1 v/v) in greenhouse. The Humi-Fert Ultra was used in three germination, tuberaztion and bulking stages. These materials included K by 3%, fulvic acid by 3% and humic acid by 12%. All of practices such as irrigation and control of weeds, pests and diseases were done regularly during growth period. Controlling of the pests and fungus diseases were done respectively by using 250 ml ha^{-1} Confidor and 400 g ha^{-1} Equation-pro. Seedlings were grown under 22 to 25°C and at 16 h photoperiod with 5000 light intensity (lux). Mini-tubers were harvested after three months. During growth period and after harvesting, traits were measured such as plant's height, main stem number per plant, mini-tuber number and weight per plant and square meter, mini-tuber size average, mini-tuber number and weight smaller than 3 g, between 3 and 7 g and bigger than 7 g. Analysis of variance and mean comparisons with Duncan test were done by MSTATC software, and linear correlation coefficients between traits was done by SPSS software.

RESULTS AND DISCUSSION

Analysis of variance of the studied parameters showed that the different levels of Humi-Fert Ultra, cultivars and their interaction as traits mini-tuber number and weight per square meter, mini-tuber size average, mini-tuber number smaller than 3 g, between 3 and 7 g and bigger than 7 g had significant different (Table 1).

Maximum mini-tuber number per square meter was relative to Savalan, Marfona and Sprit cultivars in Humi-Fert Ultra with 2 ml per 300 L water (Figure 1). Different mini-tuber number per square meter of Savalan, Marfona and Sprit cultivars in Humi-Fert Ultra with 2 ml per 300 L water compared with the control were 420, 405 and 275 numbers, respectively.

The mini-tuber number per square meter in Humi-Fert Ultra with 2 ml per 300 liter water recorded in this experiment was very high. Hassanpanah et al. (2008a, b, c), Ezati et al. (2011) and Kiumarci et al. (2011) reported that to increase the number of tuber, Humi-Fert Ultra and potassium should be used; while Hassanpanah and Azimi (2011) stated that Humi-Fert Ultra should be used to increase mini-tuber number per square meter. Savalan cultivar had the highest mini-tuber weight per square meter in Humi-Fert Ultra with 2 ml per 300 L water (Figure 2). Difference in mini-tuber weight per square meter of Savalan cultivar in Humi-Fert Ultra with 2 ml per 300 L water compared with the control was 7740 g. Yarahmadi (2008), Hassanpanah et al. (2008a, b, c), Hoseni et al. (2010), Ezati et al. (2011), Kiumarci et al. (2011), Hassanpanah and Azimi (2011) and Irani (2010) reported that Humi-Fert Ultra and potassium humate increased tuber and mini-tuber weight.

The highest mini-tuber size average was produced in Savalan cultivar in Humi-Fert Ultra with 2 ml per 300 L water (Figure 3). Maximum mini-tuber number smaller than 3 g was relative to Agria cultivar in Humi-Fert Ultra with 2 ml per 300 L water and Sprit cultivar in control (Figure 4).

The highest mini-tuber number between 3 and 7 g was produced in Savalan cultivar in Humi-Fert Ultra with 2 to 3 ml per 300 L water (Figure 5). Marfona cultivar had the highest mini-tuber number bigger than 7 g in Humi-Fert Ultra with 2 ml per 300 L water (Figure 6).

Mini-tubers' distribution size is influenced by the number

Table 1. ANOVA of traits measurement in different levels of Humi-Fert Ultra and potato cultivars.

S.O.V	d.f	M.S					
		Mini-tuber number per square meter	Mini-tuber weight per square meter	Mini-tuber size average	Mini-tuber number smaller than 3 g	Mini-tuber number between 3 to 7 g	Mini-tuber number bigger than 7 g
Humi-Fert ultra (A)	2	7.99**	2894.0**	41.81**	3.57**	5.69**	6.80**
Cultivar (B)	3	23.15**	1261.64**	9.504**	6.63**	11.0**	13.43**
A×B	6	10.26**	905.52**	6.995**	2.08**	5.05**	9.033**
Error	24	1.69	61.44	0.051	0.083	0.194	0.33
C.V.		15.85	13.33	3.12	17.01	14.89	16.26

**: Significant at 1% level of probability.

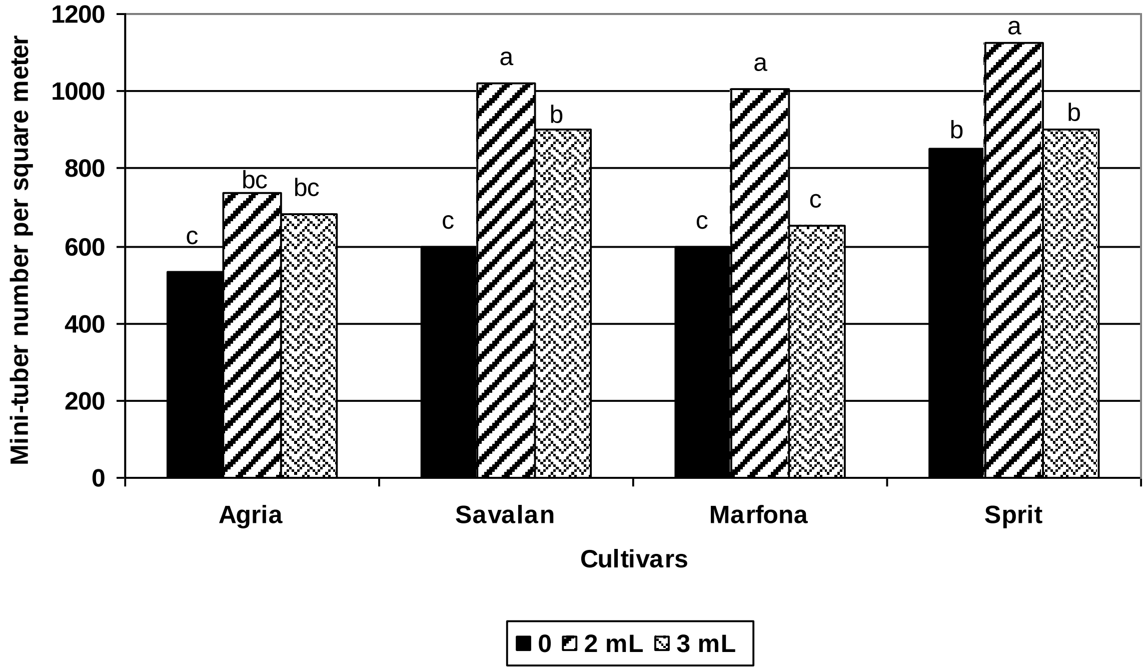

Figure 1. Mean of mini-tuber number per square meter in potato cultivars and different levels of Humi-Fert Ultra.

of produced tubers and tuber yield. Small tubers production may not be sufficient. As a result, small mini- tubers have more waste than the bigger tubers during storage period (Lommen, 1993) and small tubers have weak yield in the field cultivation (Lommen and Struik, 1995; Khalafalla, 2000).

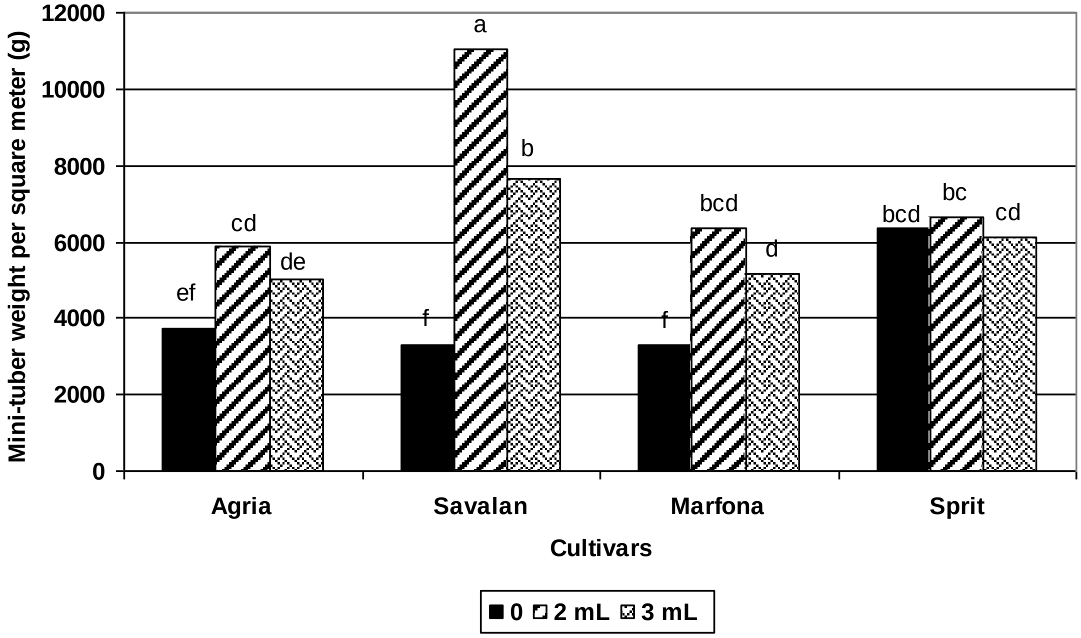

Figure 2. Mean of mini-tuber weight per square meter in potato cultivars and different levels of Humi-Fert Ultra.

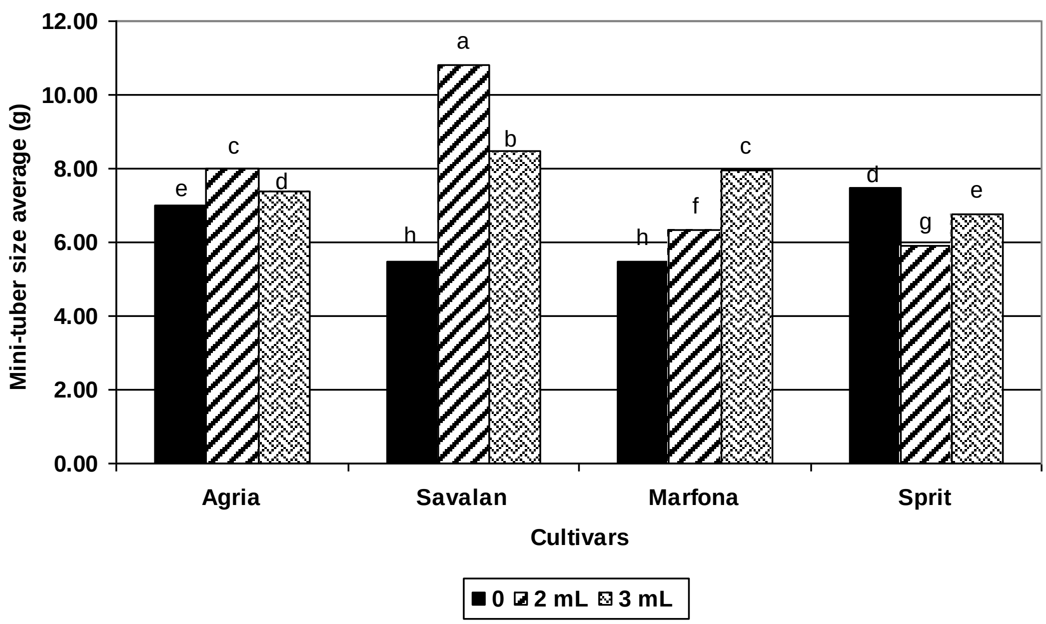

Figure 3. Mean of mini-tuber average size in potato cultivars and different levels of Humi-Fert Ultra.

So, bigger tubers production is preferred. Georgekis et al. (2002) reported that mini- tubers of 4 to 32 g are sufficient for cultivation. Although min-tubers cutting decreases costs, it increases diseases. Bases on the results of this experiment and due to the importance of mini-tuber number and using weights of 3 to 7 g and bigger than 7 g to produce, Humi-Fert Ultra with 2 ml per 300 L water is suggested as sufficient treatment for producers.

There was positive significant correlation between number of mini-tubers per square meter with number and weight of mini-tubers between 3 and 7 g and bigger than 7 g; and weight of mini-tubers per square meter and weight of mini-tubers per square meter with mini-tubers

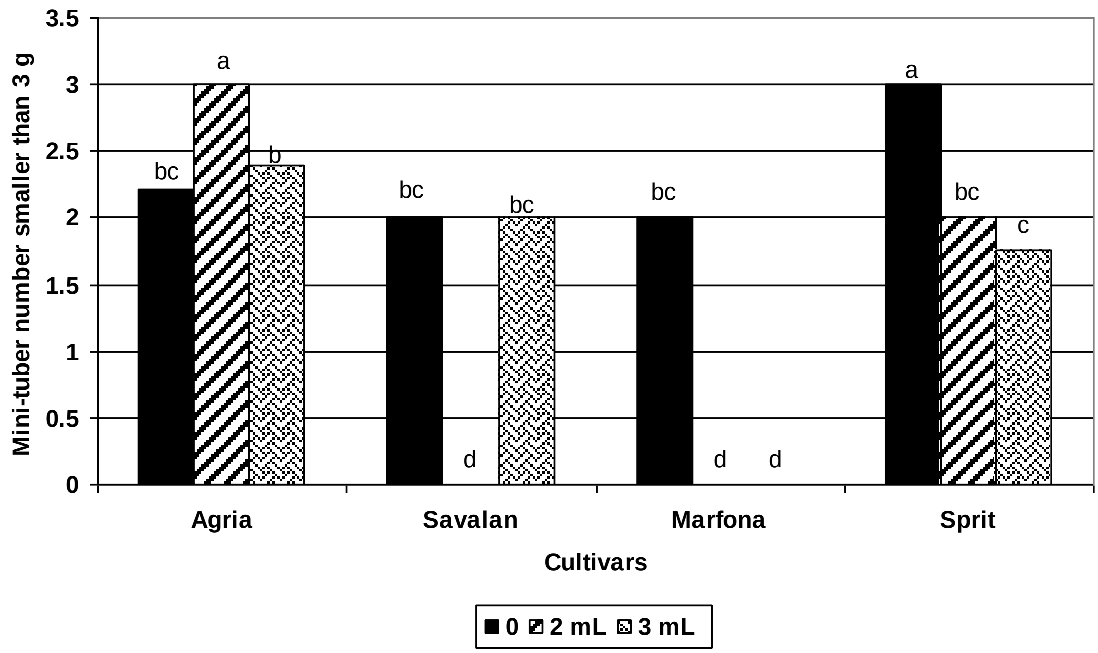

Figure 4. Mean of mini-tuber number smaller than 3 g in potato cultivars and different levels of Humi-Fert Ultra.

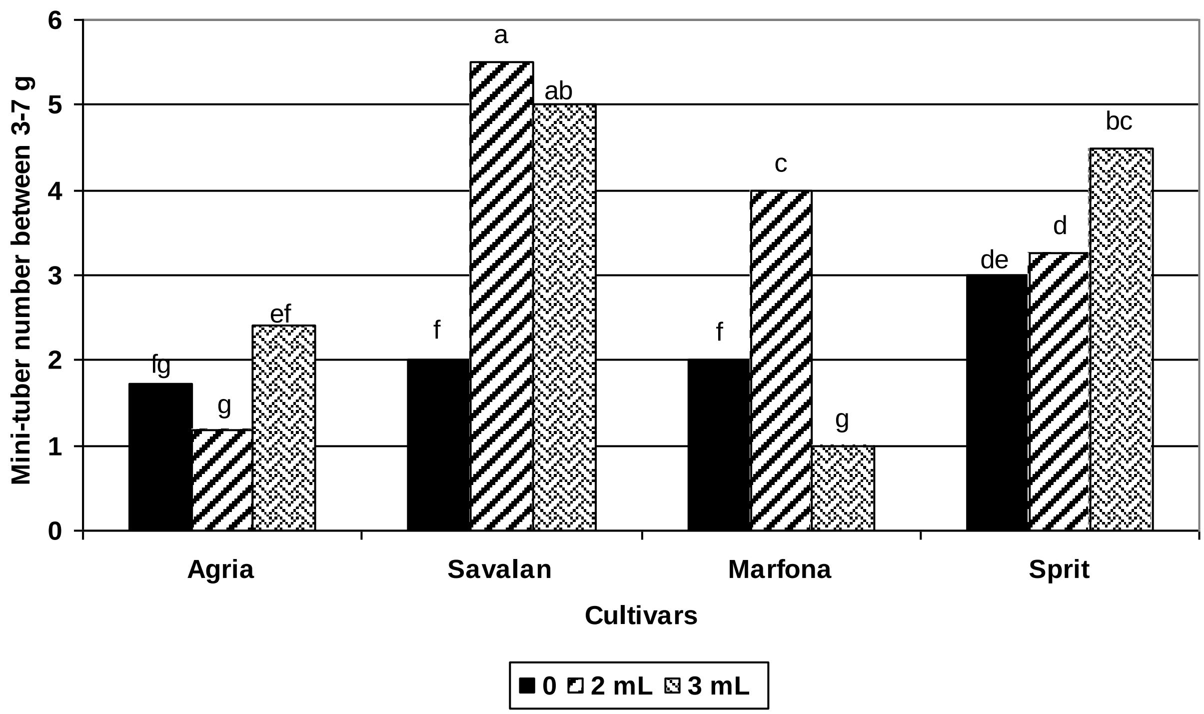

Figure 5. Mean of mini-tuber number between 3 and 7 g in potato cultivars and different levels of Humi-Fert Ultra.

number between 3 and 7 g, and mini-tubers weight between 3 and 7 g and bigger than 7 g (Table 2). These results are in accordance with that of Vanaei et al. (2008), Hassanpanah and Azimi (2010) and Hassanpanah et al. (2011).

The interesting point in Table 2 is that there is a significant

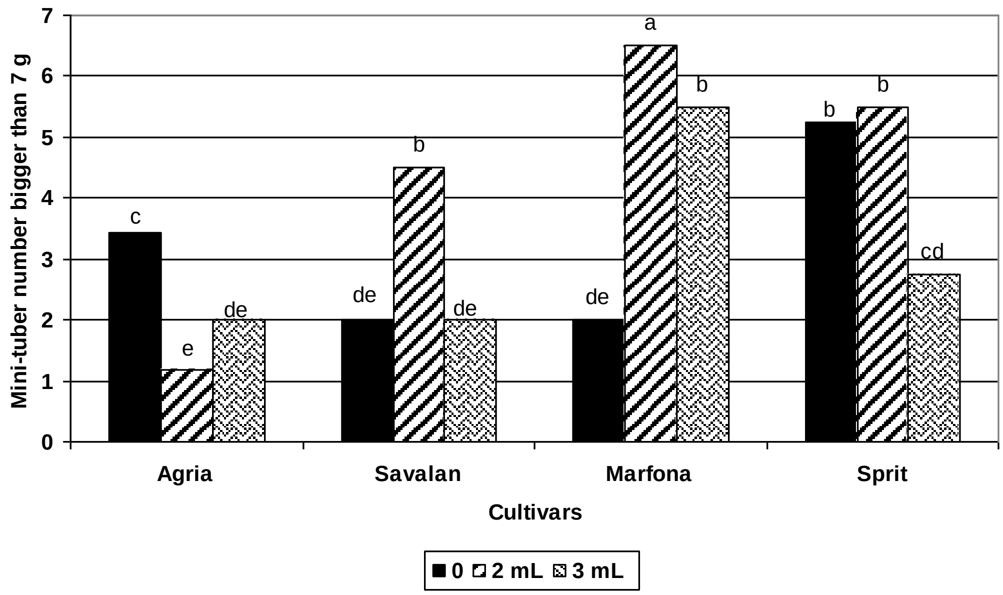

Figure 6. Mean of mini-tuber number bigger than 7 g in potato cultivars and different levels of Humi-Fert Ultra.

Table 2. Correlation between attributes for potato cultivars.

Parameter	Mini-tuber number			Mini-tuber weight			Mini-tuber number per m²	Mini-tuber weight per m²
	<3 g	3-7 g	>7 g	<3 g	3-7 g	>7 g		
Mini-tuber number (3-7 g)	-0.32							
Mini-tuber number (> 7 g)	-0.59*	0.21						
Mini-tuber weight (< 3 g)	0.85**	0.03	-0.63*					
Mini-tuber weight (3-7 g)	-0.62*	0.86**	0.35	-0.22				
Mini-tuber weight (> 7 g)	-0.76**	0.48	0.72**	-0.49	0.80**			
Mini-tuber number per m^2	-0.22	0.72**	0.69*	-0.08	0.89**	0.56*		
Mini-tuber weight per m^2	-0.16	0.77**	0.11	0.31	0.84**	0.61*	0.56*	
Mini-tuber size average	0.02	0.28	-0.39	0.43	0.49	0.30	-0.13	0.73**

* and **: Significant at 5 and 1% level of probability, respectively.

positive correlation between mini-tubers per square meter with weight of mini-tubers per square meter ($p<0.05$) ($r = 0.56$). These results are in accordance with that of Vanaei et al. (2008), Hassanpanah and Khodadadi (2009), Hassanpanah and Azimi (2010) and Hassanpanah et al. (2011).

The highest correlation coefficient ($r = 0.89$) belongs to the mini-tubers per square meter and mini-tubers weight between 3 and 7 g followed by between mini-tubers number and weight of 3 to 7 g ($r = 0.86$). Hassanpanah et al. (2011) reported significant positive correlation between mini-tubers per square meter with weight of mini-tubers per square.

There was positive significant correlation between mini-tuber weight per square meter with mini-tuber average size ($p<0.01$) ($r = 0.73$). These results are in accordance with that of Gopal et al. (2002).

Conclusions

In this research, Humi-Fert Ultra with 2 ml per 300 L water in Savalan, Marfona and Sprit cultivars increased mini-tuber number per square meter by nearly 420, 405 and 275 numbers, respectively. Humi-Fert Ultra organic matter included K by 3%, fulvic acid by 3% and humic acid by 12%. Its material helped to aggregate and improve soil structure. In sandy soils, it led to increase in cationic exchange capacity, further spread of root system, and adjustment of salinity and alkalinity root environment (rhizosphere). By stimulating plants physiological activities it led to increase in absorption rate of materials by the soil, increased speed transfer of food from the root to the leaves and fruits. As a source of energy, it is consumed by soil organisms, and magnifier population raises it in the soil. In this experiment, Humi-Fert Ultra increased mini-tuber number per square meter in Savalan cultivar by 420 numbers. In Iran, each mini-tuber was close to $ 0.25 during 2011. Based on this result, the cost was $ 105, an additional income for producers. In addition to the economic incomes, progressive farmers will get low production cost and lower prices of mini-tubers.

ACKNOWLEDGEMENTS

All stages of this research were done in biotechnology laboratory and greenhouse belonging to Villkej Company of Ardabil Province, Iran. We would like to thank Mr. Latif Fathii manager of this company and his colleges. We appreciate Islamic Azad University, Ardabil Branch, Iran management for financial assistance this project.

REFERENCES

Abou-Hussein SD, El-Shorbagy T, Abou-Hadid AF, El-Behairy U (2003). Effect of cattle and chicken manure with or without mineral fertilizers on tuber quality and yield of potato crops. ISHS, Acta Hortic. 608:95-100.

Ahmad Ali SMM, Machado VS (1995). Potato mini-tuber production from nodal cutting compared to whole *in vitro* plantlets using low volume media in a greenhouse. Potato Res. 38:69-75. DOI: 10.1007/BF02358071.

Ashwini KM, Sridhar KR (2006). Evaluation of pill millipede (*Arthrosphaera magna*) composit on plant growth and dry matter yield. J. Environ. Agric. Food Chem. 5:1323-1329.

Benke MB, Hao X, Chang C (2009). Effects of long-term cattle manure applications on soil, water, and crops: Implications for animal and human health. In: G.S. Bañuelos and Z.Q. Lin (eds). Development and uses of biofortified agricultural products. Boca Raton, Florida: CRC Press. pp. 135-153.

Ezati A, Sharokhi SH, Hassanpanah D (2011). The effect of some organic fertilizers different levels on quantitative and qualitative characteristics of Agria and Savalan potato cultivars in Ardabil region. Islamic Azad University, Ardabil Branch. p. 90.

FAO (2011). International year of the potato 2008. www.potato2008.org

Fernie AR, Willmitzer L (2001). Molecular and biochemical triggers of tuber development. Plant Physiol. 127:1459-1465. www.plantphysiol.org/cgi/doi/10.1104/pp.010764.

Füleky G, Benedek S (2010). Composting to recycle biowaste. In: E. Lichtfouse (ed). Sociology, organic farming, climate change and soil science, Sustainable Agriculture Reviews. Dordrecht, Netherlands: Springer Science Business Media B.V. pp. 41-76.

Gadimov AG, Ahmaedova AN, Alieva RC (2007). Symbiosis nodules bacteria *Rhizobium legumosarum* with Peas (*Pisum Sativum*) nitrate reductase, salinification and potassium humus. Azarbayjan National Academy of Science.

Georgekis DN, Fyllidis K, Staropuolos DI, Nianiou NI, Vezyroglou EX (2002). Effect of planting density and size of potato seed mini-tubers on the size of the produced potato seed tubers. Available on the: http://www.act.hort.org.

Gopal J, Kumar R, Kang GS (2002). The effectiveness of using a mini-tuber crop for selection of agronomic characters in potato breeding programmes. Potato Res. 45(2-4):145-151. DOI: 10.1007/BF02736110

Hartwigson JA, Evans MR (2000). Humic acid seed and substrate treatments promote seedling root development. Hortic. Sci. 35:1231-1233. HortScience ISSN 0018-5345 CODEN HJHSAR; 2000, vol. 35, no7, pp. 1231-1233 (15 ref.) INIST-CNRS, Cote INIST : 13300, 35400009387318.0100 Nº notice refdoc (ud4) : 876098

Hassanpanah D, Azimi J (2010). Study of potato different cultivars mini-tubers potential and production in repeated and conventional harvesting under *in vivo* condition. Int. Symp. Agron. Physiol. Potato 20-24 September 2010, Nevsehir, Turkey.

Hassanpanah D, Azimi J (2011). Study of different concentrations effects of organic material on mini-tuber production of potato cultivars under *in vivo* condition. Islamic Azad University, Ardabil Branch. p. 58.

Hassanpanah D, Khodadadi M (2009). Study the plantlet age effect and planting beds on Agria potato mini-tuber production under *in vivo* condition. J. Biol. Sci. 9(3):243-248.

Hassanpanah D, Gurbanov E, Gadimov A, Shahriari R (2008a). Shortening transplantation periods of potato plantlets by use of potassium humate and kadostim and their effects on mini-tuber production. Pak. J. Biol. Sci. 11(10):1370-1374. DOI: 10.3923/pjbs.2008.1370.1374; URL: http://scialert.net/abstract/?doi=pjbs.2008.1370.1374

Hassanpanah D, Gurbanov E, Gadimov A, Shahriari R (2008b). Use of Potassium Humate and for the second cultivation of Sante potato cultivar in Ardabil. IHSS 14, Moscow – St. Petersburg, Russia.

Hassanpanah D, Gurbanov E, Gadimov A, Shahriari R (2008c). Reduction of nitrate accumulation in potato by use of Potassium Humate for human safety. Iran Biomed. J. 11(1):416.

Hassanpanah D, Gurbanov E, Gadimov A, Shahriari R (2008d). Determination of yield stability in advanced potato cultivars as affected by water deficit and Potassium Humate in Ardabil region, Iran. Pak. J. Biol. Sci. 11(10):1354-1359. PMID: 18817268 [PubMed - indexed for MEDLINE].

Hassanpanah D, Azimi J, Azizi SH (2011). Effect of planting bed composition on mini-tuber production of potato cultivars under greenhouse condition. J. Food Agric. Environ. 9(1):384-388.

Hoseni AH, Khorshidi MB, Hassanpanah D, Meirshekari B, Ajali J (2010). Potassium Humate effect on yield of three potato cultivars in Ardabil region under normal and deficit water conditions. Agric. Sci. J. 3(11):15-26.

Irani P (2010). Effect of amino acid sprayed on quality and quantity yield of barley seed. Available on the: http://agri-iran.mihanblog.com/post/160, Accessed 20 Sep 2010.

Jackson SD (1999). Multiple signaling pathways control tuber induction in potato. Plant Physiol. 119:1-8. www.plantphysiol.org/content/119/1/1.full

Khalafalla AM (2000). Effect of plant density and seed size on growth and yield of potato in Khartoum, Sudan. Fifth Triennial Congress of the African Potato Association. 28 May-2 June. Kampala, Uganda.

Kiumarci A, Ajali J, Hassanpanah D (2011). Evaluation of different concentrations of Potassium Humate effects on yield and yield components of potato different cultivars under spring cultivation and after barley harvest in Ardabil area. Islamic Azad University, Meaneh Branch. p. 79.

Linchan DJ (1978). Humic acid and nutrient uptake by plants. Plant Soil 50:663-670.

Lommen WJM (1993). Post-harvest characteristics of potato mini-tubers with different fresh weights and from different harvests. II. Losses during storage. Potato Res. 36:273-282.

Lommen WJM (1999). Causes for low tuber yields of transplants from *in vitro* potato plantlets of early cultivars after field planting. J. Agric. Sci. 133:275-284. http://library.wur.nl/WebQuery/wurpubs/62225

Lommen WJM, Struik PC (1995). Field performance of potato mini-tubers with different fresh weights and conventional seed tubers: Multiplicati on factors and progeny yield variation. Potato Res. 38:159-169.

Pal S, Sengupta MB (1985). Nature and properties of humic acid prepared from different sources and its effect on nutrient availability. Plant Soil 88:91-95. DOI: 10.1007/BF02140667

Salman SR, Abou-hussein SD, Abdel-Mawgoud AMR, El-Nemr MA

(2005). Fruit yield and quality of watermelon as affected by hybrids and humic acid application. J. Appl. Sci. Res. 1:51-58. http://www.aensionline.com/jasr/jasr/51-58.pdf

Stoner KA, Ferrandino FJ, Gent MPN, Elmer WH, La Mondia JA (1996). Effects of straw mulch spent mushroom compost, and fumigation on the density of Colorado potato beetle (*Coleoptera: Chrysomelidae*) in potatoes. J. Econ. Entomol. 89:1267-1280.

Tarn RT, Tai GCC, De Jong H, Murphy AM, Seabrook JEA (1992). Breeding potatoes for long-day, temperate climates. Plant Breed. Rev. 9:217-332. DOI 10.1111/j.1439-0523.2004.tb02133.x

Vanaei H, Kahrizi D, Chaichi M, Shabani G, Zarafshani K (2008). Effect of genotype, substrate combination and pot size on minituber yield in potato (*Solanum tuberosum* L.). Am. Eurasian J. Agric. Environ. Sci. 3(6):818-821.

Yarahmadi Z (2008). Effects of biological fertilizers on physiological characteristics, yield and yield components of maize seed Maxima cultivar under drought stress condition. The First National Conference on Water Crisis, Zabol University, 4-6 February, 2008.