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Effect of humic acid on different cultivars of potato tubers (*Solanum tuberosum*)

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Abstract

To evaluate the effect of humic acid fertilizer on the yield of potato cultivars in the climatic conditions of Damavand, a factorial experiment based on randomized complete block design with three replications was conducted. Treatments included a humic acid at three levels (non-use, single-and double-consumer) and the three levels (Agria, Sante and potato), respectively. Number of leaves, chlorophyll A and B, carotenoids, wet bulb and dry bulb and tuber yield per plant was measured. Between cultivars in tuber yield per plant was significant at the 1% difference and Agria had the highest yield and the lowest Sante. The humic acid levels in terms of tuber yield differences were observed in the 1% significance level, the highest yield of humic acid was consumed twice. Interaction effect showed the highest yield for the treatment of humic acid is consumed twice Agria. Research results indicate that the performance by the use of humic acid and humic acid no significant difference between once-and twice the performance of Agria tubers than the usual is no longer in Islamabad.

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Introduction

Potato (Solanum tuberosum L.) is the fourth most important food crop after crop of wheat, rice and corn in the world and in the human diet is a special place where the United Nations and FAO in 2008 as the "International Year of Potato 'Name established (Korea *et al,* 2009). In traditional systems, mainly the production and multiplication of seed potato tubers are using. This amplification method has disadvantages, such as low speed and a high risk of contamination replicate tubers pathogens, such as fungi, bacteria and viruses (Struik and Wiersema, 1999). Mini-tubers are small glands that produce seed potatoes of seedlings under High density culture conditions in vitro and in greenhouses for the production of pre-basic and basic seed production.

Indiscriminate use of chemical fertilizers and without the use of organic fertilizers in recent years, Iran has been a notable decline in soil organic matter (Latifi and MohmmadDost, 1998). The use of organic fertilizers is increasing nowadays. Humic substances contain a mixture of different organic compounds that come from the remains of plants and animals (sacrificed *et al*, 2010). Farazandeh research on various quantities of humic acid was planted, it was determined that the crop planted on 25 May and 3 kg per hectare consumption of humic acid, the largest amount of grain weight of the (Farazandeh, and the *et al*., 2011). Ghasemi, the research found that the application of humic acid increased by 10% to 28% increase in the number of leaves and dry weight of underground organs were potatoes (Ghassemi *Et al*, 2012). Study on the effect of racial and cultivated potatoes in Damavand is of special importance. Humic acid from various sources such as soil, humus, peat, and brown coal oxidized coal mined (Sebahattin, and Necdet, 2005). Humic acid decomposition of organic materials, particularly materials of plant origin engenders a stable, insoluble complex with molecular weight 30000-300000 results in the formation of the micro-elements (Mackowiak *Et al,* 2001).

Materials and methods

Experiments in Islamabad Village (a suburb city of Damavand) to latitude 35 degrees 48 minutes north and longitude 52 degrees 5 minutes east of the height of 1880 meters above sea level was carried out. This study is a factorial experiment in a randomized complete block design with two factors was performed in triplicate. The first factor consists of different varieties of potatoes (Agria, potato, Sante) and the second factor comprises several times taking humic acid (non-use, disposable (1.5 kg per ha), two-time (3 kg per hectare) was applied. Ground the test and plow moldboard plowing to a depth of 30 cm per second with the drive is ready. Each plot consisted of four row lengths of 5 meters and a row spacing of 75 cm and a bed. Gap between plants were placed in rows 15 cm. between main plots one meter and 2 meter spacing between adjacent blocks was approved. Seed tubers with a row spacing of 75 cm and 15 cm between plants in the row manually and by placing seed tubers tracks and 5 cm of soil in the bottom of the tumor was done by Bill. Treatments were first factor cultivar (Agria and Sante and potato) is when planting was done according to the scheme. The second factor, which includes various levels of fertilizer and humic acid (non-use, disposable 1.5 kg per hectare, twice the consumption of 3 kg per hectare) in the soil surface feeding on the soil of the plants (one month after planting) and the two consumption in half, and then the soil before flowering (approximately 2 months after planting) was soluble in water. Leaf number, chlorophyll A and B, carotenoids, wet bulb and dry bulb and tuber yield per plant was measured. The data obtained using software MSTATC analysis of variance was performed using Duncan's multiple range test, 1%, treatment means were compared.

Results and discussion

Before performing the analysis of variance, analysis of variance test for normality to comply assumptions were made on the data and the results showed that the data were normally distributed. The analysis of variance was performed comparing the different traits.

Number of Leaves

The results showed that the treatment effect of humic acid on leaf number was significant at the 1% level and the interaction of fertilizer had no significant effect on the number of leaves (Table 1). By comparison leaves out the largest number of Agria (66/59 digits) and the lowest in cultivar Sante (11/38 samples) and the potato cultivar Sante and do not show significant differences (Table 2). Humic acid consumption has also increased the number of leaves to control the maximum number of leaves (88/43 digits) and the lowest consumption of humic acid treated twice (50/52 pcs) (Table 3). The figure shows the effect of decreasing the interaction of humic acid fertilizer on the yield and Agria and two humic acid consumed the highest number of leaves (62.33 ounce), and the Sante taking humic acid, the lowest number of leaves (number 66/26) to respectively (Figure 4). Research Ghasemi *et al* (2012), which corresponded with the results on potato mini-tubers showed a significant effect on leaf humic acid at 1% compared to the non-application and application of humic acid caused a gain of leaves per plant and higher leaf chlorophyll content was to increase the amount of photosynthesis, plants, among others.

Table 1. Analysis of variance.

Mean-square							df	Sources of Change
Tuber yield per plant	Tuber dry matter	Wet bulb	Carotenoids	Chlorophyll B	Chlorophyll A	Number of leaves		
45389/73*	2584/65**	7128/45**	ns0/12	ns0/04	ns0/52	ns223/69	2	Repeat
198843/64*	9817/96*	27446/85*	0/21**	ns0/09	ns0/31	3102/86*	2	type
165178/33*	6590/05*	ns4820/08	ns0/006	ns0/07	ns0/32	ns39/69	2	Humic acid
10671/52ns	ns545/35	ns556/96	ns0/02	ns0/05	ns0/33	ns298/72	4	Interaction
5003/49	685/64	1904/48	0/05	0/03	0/19	114/64	16	Error

ns, * and ** respectively indicate no significant difference, the difference is statistically significant at the 1% and 5% are the

Chlorophyll A

Analysis of variance showed that the effect of the interaction of humic acid fertilizer on the yield of chlorophyll A in the leaves was not significant (Table 1). Comparison of the data obtained revealed that the three cultivars for this trait were not significantly different (Table 2). The use of humic acid did not significantly influence the trait (Table 3). Interaction of fertilizer consumption in double digits shown that humic acid Agria highest chlorophyll A (76/1) to have the lowest impact on the consumption of potato and two humic acid (65/0) (Table 4). Emadi research (2002), a result consistent and not statistically significant genotype effect Chlorophyll A and Chlorophyll A potato cultivar Agria has more. Hosseini *et al* (2011), with research on the potato, thus siding with the results of the According adjective derived from chlorophyll A study of variety and fertilizer had no significant effect The reason it is concluded that physiological traits such as chlorophyll a small amount is very sensitive, so little effect factors such as amounts of manure, herbicides, crop and the is a poison.

Table 2. Comparison of characteristics of potato cultivars.

Mean							
Tuber yield per plant	Tuber dry matter	Wet bulb	Carotenoids	Chlorophyll B	Chlorophyll A	Number of leaves	type
517/15a	104a	173/9a	0/68a	0/45a	1/32a	59/66a	Agria
225/45b	40/46b	68/39b	0/46a	0/3a	1/12a	38/11b	Sante
321/67b	56/74b	92/95b	0/38a	0/26a	0/94a	49/22b	Marfona

Posts that shared at least one letter in each column are not significantly different.

Chlorophyll B

The results showed that the cultivars and varieties humic acid and fertilizer interaction was significant on leaf chlorophyll B, (Table 1). B Mean comparisons revealed that chlorophyll in leaves of potato cultivars were not significantly different from each other (Table 2). Also taking humic acid with control (non-smoking) and no significant differences were at the same level (Table 3). Interaction effects of fertilization on Agria cultivar showed the highest chlorophyll B in two-consumes Humic acid (53/0) is obtained and the lowest amount of chlorophyll B cultivar Sante and lack of humic acid (18/0) is. Consumption and disposable two cultivars of potato and Sante were very small and not significant (Table 4). The research Emadi (2002), the impacts of the chlorophyll B was not significant and Marfona chlorophyll B than Agria and also the effect of the acid more Trpvnyk the property at 5% level meaningful, and chlorophyll B Marfona above Agria was and the results were non-aligned. Research Hosseini *et al* (2011) showed that chlorophyll B genotype effect was not significant and the effect of acid humic this trait is significant at 5% level and has a high range is in line with the results.

Table 3. Comparison of the effect of humic acid on the yield of potatoes.

Mean							Humic acid
Tuber yield per plant	Tuber matter	dry Wet bulb	Carotenoids	Chlorophyll B	Chlorophyll A	Number of leaves	
b204/82	b37/3	a86/09	a0/51	a0/26	a0/92	88/43b	Consumption.
a391/08	ab73/79	a118/1	a0/53	a0/43	a1/3	61/50a	Disposable
a468/37	a90/16	a131	a0/48	a0/32	a1/16	5/52a	Double take

Posts that shared at least one letter in each column are not significantly different.

Carotenoids

Analysis of variance showed that the effect was significant at the 5% level as well as the interaction of humic acid fertilizer on the leaves had no significant effect on carotenoid (Table 1). The results showed that the mean differences between three cultivars of leaf carotenoid absent (Table 2). The effect of humic acid on yield was not significant (Table 3). Interaction between manure total carotenoids in leaves No influence on the maximum amount of Agria and taking two humic acid (70/0) and the potato and use the least amount of humic acid (34/0) is capable. Humic consume more than double the effect of acid on Agria disposable but once-and twice on potato cultivars and Sante are not significantly different (Table 4). Research Hosseini *et al* (2011), the impacts of humic acid and fertilizer interaction on carotenoid in the leaves were not significant and is consistent with our results. Research thus far Davoodi *et al* (2012) showed that application of humic acid on chlorophyll a and b is significant at the 1% level. He thinks that, humic acid increases the absorption of water and nutrients, resulting in increased levels of chlorophyll a and b and the carotenoids. Humic acid, water and food by putting more and more suitable for the plant has been able, by making the pigment increases and assimilate in the plant easier to.

Wet bulb

Analysis of variance showed that the treatment effect on this trait was significant at the 1% level and in the treatment of humic acid fertilizer on the yield and interaction effects were not significant (Table 1). Comparison shows that the maximum weight of Agria tubers (9/173 g) is capable of a minimum weight of cultivar Sante (39/68 mg), with no significant difference between potato cultivars (Table 2). The humic acid intake did not differ significantly on these characteristics and use of humic acid twice the maximum weight (131 grams) and consumes minimal weight humic acid (09/86 g) contents (Table 3). Interaction of fertilizer in Agria cultivar showed the greatest weight to the double use of humic acid (8/206 g) and the lowest weight of the cultivar Sante and humic acid intake (g 42/53, respectively) (Table 4). The results of this experiment were consistent

with the results of previous research and testing Parvizi (2006), the effect of cultivar on seed tuber weight was significant at 1%. She praised the research (2009) showed that the effect is significant at 5% level of tuber weight, as compared to the average of the figures show the superiority of Agria potato varieties by about 9%, respectively.

Table 4. Comparison of the effects of fertilization on potato genotype.

Mean-square							Application of type humic acid	
Tuber yield per plant	Tuber dry matter	Wet bulb	Carotenoids	Chlorophyll B	Chlorophyll A	Number of leaves		
cde298/5	cd57/97	abc131/25	0/66ab	0/39abc	b0/81	58/66a	Failure	Agria
b558/29	ab113/27	ab183/77	0/64ab	0/45abc	1/39ab	58bc	Once	
a694/67	a140/88	a206/75	0/75a	0/53ab	1/76a	62/33a	Double	
f126/49	d22/1	c53/42	0/44ab	0/18c	0/98ab	26/66d	Failure	Sante
de257/29	cd45/13	c72/36	0/53ab	0/56a	1/31ab	43/33cd	Once	
cde292/57	cd54/15	c79/38	0/42ab	0/16c	1/08ab	44/33c	Double	
ef189/49	cd31/83	c73/6	0/44ab	0/21bc	0/98ab	46/33bc	Failure	Marfona
cd357/65	cd62/96	c98/29	0/44ab	0/3abc	1/21ab	50/5bc	Once	
c417/86	bc75/43	bc106/96	0/27b	0/28abc	0/65b	50/83c	Double	

Posts that shared at least one letter in each column are not significantly different.

Tuber dry matter

Analysis of variance showed the effect of humic acid on yield was significant at the 1% level in the fertilizer interaction effect on this trait was not significant (Table 1).Mean comparisons revealed that the highest tuber dry matter relating to Agria (104 g) and the lowest was related to the cultivar Sante (46/40 mg) and potato does not show significant differences (Table 2). The consumer survey showed that humic acid and humic acid caused a significant increase twice the highest tuber dry matter intake of humic acid (16/90 g) and the lowest disposable humic acid (30/37 g) were produced (Table 3). The interaction revealed that for all three cultivars increased tuber dry matter've spent most of Agria and two humic acid (9/140 g) and the lowest in cultivar Sante and avoiding the use of humic acid (10/22 G) (Table 4). Research Parvizi (2006), the effect on the dry matter was significant at the 1% and the lowest dry matter content of potato varieties Agria and Sante and has been in the middle of which the results were consistent. The research Farajzadeh *Et al* (2010), the effect was significant at 1% level of tuber dry weight.

Tuber yield per plant: analysis of variance, it showed that the impacts of humic acid on yield of tubers per plant at 1% level meaningful and if the interaction of fertilizer and cultivar on these traits was significant not (Table 1). The comparison shows the maximum performance out of Agria tubers per plant (15/517 g) and lowest for cultivar Sante (45/225 g) (Table 2). The effect of humic acid twice, most (37/468 g) and control (non-use) the least (82/204 mg) once or twice the performance and the use of humic acid, there was no significant difference (Table 3). Interaction of humic acid fertilizer that increases the yield of different varieties and cultivars of once-and twice humic acid test is significant. Maximum performance and twice taking of humic acid Agria (67/694 g) and the lowest yield of tubers per plant cultivar Sante and lack of humic acid (49/126 g) (Table 4). Mortazavi and Amin Poor (2008), found that the effect of seed tuber yield at 5% level of significance The production of seed tubers of potato cultivars were placed in a central position and is consistent with our results. Dehdar research (2004), the effect on tuber yield per plant was significant at the 5% level, and the lowest average yield of tubers per plant in the region, the Magi were relating to Agria.

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