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Effect of foliar spraying with algae suspension on leaf and fruit quality parameters of apple varieties

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Summary: Foliar nutrition experiment was made to investigate the effect of algae products on fruit quality of apples (*Malus domestica Borkh.*).
The study was conducted in 2011 at Siófok in West-Hungary on cv. 'Jonagored' and 'Idared' grafted on M9 rootstock.
In our trial leaf diagnostic and fruit quality measurements were made to study the effectiveness of applied products. Relative leaf chlorophyll content was determined by a portable chlorophyll meter. Fruit weight and shape index were measured. Fruit inner qualifying parameters like titratable acid content and Brix value were also determined.
It can be stated that the used products had traceable effect on investigated fruit parameters. Although, leaf N content was not effected by treatments significantly, relative leaf chlorophyll content significantly increased by both treatments.
Used products significantly increased the fruit weight and shape index. Applied treatments significantly decreased the pH of pulp. Treatments increased the acid contents (fumaric, citric, malic) of apples and decreased the amount of monosaccharides. It means that the applied treatments pushed out the ratio of acid/sugar.

Key words: *Malus domestica Borkh.,* biostimulators, fruit quality

Introduction

At present, the growing interest in ecological methods of fruit production, as well as decreasing number of synthetic chemical products allowed for use in the orchards, motivate to search for new biological formulations to replace the chemical agents (*Rademacher* 2004). Therefore, the role and impact of biostimulators are increasing all over the world. In recent years biostimulators are used frequently not only in crop production but in horticulture as well.

Biostimulators are natural growth regulators or chemicals, most of them contain plant hormones as auxin, gibberellic acid, cytokinins and aminoacids. Some of them contain additive macro and micro nutrients.

Effects of these components increase physiological activities in plants, first of all protein synthesis. Biostimulators help plants surviving stresses. These are used for protect fruit plants from spring frost damage.

According to *Basak and Mikos-Bielak* (2008) biostimulators cause development of unusually strong flowers on apple trees. Their application result in production of large fruits in the year of application and in the abundant flowering in the following year.

At pear, *Błlaszczyk,* 2008 pointed out that the biostimulator used had beneficial influence on some internal fruit quality traits, as fruit firmness and titratable acidity, during the storage and maturation.

Seaweed is commonly used as biostimulator due to its beneficial effects.

The application of seaweed extract for different crops was a great importance due to contain high levels of organic matter, micro elements, vitamins and fatty acids and also rich in growth regulators such as auxins, cytokinin and gibberellins (*Crouch and Van Staden,* 1994).

Seaweed extracts, containing naturally occurring auxins, cytokinins, and gibberellic acids, increase root mass and the root:shoot ratio in several horticultural crops (*Featonby – Smith and Van Staden,* 1983; Finnie and Van Staden, 1985; *Nelson and Van Staden,* 1984).

Application of seaweed extract increased chlorophyll content (*Whapham et al*., 1993; Thirumaran *et al*., 2009). Turan and Köse (2004) observed increases in yield as well as N, P and K with application of seaweed extract on grapevine.

Abdel *Mawgoud et al.* (2010) cleared that application of seaweed extract at concentrations of 1, 2 and 3 g/L increased the response of all growth parameters and yield of watermelon.

Table 1: Nutrient concentrations in NP2

	N	P2O5	K2O	MgO	Fe	Zn	Mn	B	Cu	Mo	Co
	w/w %										
NP2-B	0.06	0.03	0.14	0.029	0.004	0.007	0.005	0.081	0.002	2.E-07	1.E-07
NP2-Ca	0.13	0.03	0.14	0.029	0.004	0.007	0.005	0.005	0.002	2.E-07	1.E-07
NP2-K	0.2	0.03	0.61	0.029	0.004	0.007	0.005	0.005	0.002	2.E-07	1.E-07
NP2-Zn	0.06	0.03	0.14	0.029	0.004	0.061	0.005	0.005	0.002	2.E-07	1.E-07

The beneficial effect of seaweed extract application is as a result of many components that may work synergistically at different concentrations, although the mode of action still remains unknown (Fornes *et al*., 2002).

The objective of this study was to determine the influence of foliar applications of biostimulator material (Natur Plasma – algae suspension) on chlorophyll and N content of leaves and fruit parameters like weight, shape index, skin colour, acid and sugar content of apples.

Materials and methods

The study was conducted in an apple orchard (*Malus domestica Borkh.*) in 2011 at Siófok in West-Hungary on cv. 'Jonagored' and 'Idared' grafted on M9 rootstock. Trees were planted in the spring of 1999. Trees spaced 4 × 1 m, and growing in a calcareous chernozem soil. For the purpose of the experiment, 2 ha areas were randomly selected from the orchard.

For treating, 'Natur Plasma' microbiological products were used, coded as NP1 and NP2.

The composition of NP1 was the following: base material: Chlorella vulgaris algae concentrate in water suspension with 0.3 (m/m%) dry matter content at least. The total number of algae was 3×10^7(db/mL) at least. The pH of NP1 was 6.7 ± 0.5.

The composition of NP2 was: NP1 base solution with additional macro and micronutrient contents *(Table 1.)*

The applied foliar applications are presented in Table 2.

The treatments were made before blooming time and then every 2–3 week till the harvest time *(Table 2.)* The control treatment was the basic treatment without products of Natur Agro Hungária Ltd.

In our trial leaf diagnostic and fruit quality measurements were made to study the effectiveness of applied products.

Table 2: Treatments of the experiment

Time of applications	Treatment		Dose
11. IV.2011.	NP1	NP2-B	10L /1000L water/ha
30. IV. 2011.	NP1	NP2-B	
23. V. 2011.	NP1	NP2-Ca	
10. VI. 2011.	NP1	NP2-Ca	
27. VI. 2011.	NP1	NP2-Ca	
18. VII. 2011.	NP1	NP2-Ca	
1. VIII. 2011.	NP1	NP2-B/K	

As the chlorophyll content of leaves is linked to nitrogen content and chlorophyll measurement may provide information on the plant physiological state hence, to photosynthesis in our investigation relative leaf chlorophyll content was determined by a portable chlorophyll meter (SPAD 502+, Minolta, Japan) and leaf N by Kjeldahl method.

For measuring leaf N and chlorophyll content healthy, fully developed leaves were collected from the mid-third portion of current season extension shoots. Leaf samples were collected 100 days after full bloom, from uniform trees. The mean of five readings from the chlorophyll meter was obtained for each leaf (10 developed leaves). For leaf N measuring dried, homogenized samples were used.

Fruit inner qualifying parameters like titrable acid content and Brix value were also determined. Titrable acid content was measured by potentiometric titration according to Hungarian standard (MSZ EN 12147:1998). Brix values were measured by hand refractometer (ATAGO PAL series).

Data of leaf and fruit analysis were subjected to analysis of variance (ANOVA) and means were separated by Duncan's significant difference test at $P<0.05$.

Results and discussion

Results of field observations

Visual field survey was held to estimate the growing experiences in the vegetation period, directly before the harvest (22. September 2011).

Our observations were the following:

1. Spraying of used products was made separately. Spraying problems (precipitation, phase separation, inhomogenity) were not observed during the spraying. Corrosion or clogging in the sprinkler head was not observed.
2. Leaf burning symptoms were not observed after foliar application.
3. Adsorption of the products was excellent on the leaf surface.
4. Absorption of the products was satisfactory.
5. The leaf colour was greener, healthier and brighter at treated trees compared to the control leaves of trees.
6. Skin colour of treated apples was more intensive and completed than control apples *(Photos 1–6).*

Photo 1. 'Idared' control

Photo 2. 'Idared' treatment NP1

Photo 3. 'Idared' treatment NP2

Photo 4. 'Jonagored' control

Photo 5. 'Jonagored' treatment NP1

Photo 6. 'Jonagored' treatment NP2

Results of leaf analysis

Results of leaf N and chlorophyll measurements were presented in *Table 3*.

From the results it was evident that the value of SPAD was depended on variety. Moreover, applied treatments also had significant effect on SPAD values. Both treatments increased the relative chlorophyll content of leaves. This result is correlation with field observations. Obtained result may be explained by the positive effect of 'Chlorella vulgaris' algae suspension on chlorophyll developing, by improving working of cloroplastis.

Table 3. Effect of treatments on leaf relative chlorophyll contents

Variety / Treatments	N%	Relative chlorophyll content (SPAD)
Idared / Control	2,14a	55,2a
Idared / NP1	2,27a	59,8b
Idared / NP2	2,25a	62,2b
Jonagored / Control	2,11a	51,5a
Jonagored / NP1	2,14a	53,4b
Jonagored / NP2	2,15a	53,9b

In each column, means followed by the same letter are not significantly different ($P<0.05$).

It seems that applied products help photosynthetic process and improves plant metabolism. Although, leaf N content was not effected by treatments significantly it can be state that applied products increased leaf N content at both varieties. Our finding confirm previous research using SPAD to estimate N availability in apple (Neilsen et al., 1995) showed a significant relationship between N rate and SPAD measurements for four varieties of apple.

Results of fruit analysis

Results of fruit analysis are presented in *Table 4*.

It can be state that both used products significantly increased the fruit weight. The fruit weight development was varied by variety and treatment. The degree of increment varied between 3.8–5.4% at 'Idared' and 10.8–18.3% at 'Jonagored'. It seems that the products improved the cell division and nutrients incorporation.

Our results pointed out that the shape index of apples was increased by both treatments. This finding is correlated with the weight-development of apples.

Applied treatments significantly decreased the pH of pulp except of NP2 treatment at 'Idared'. According to this, the titrable acid content of apples was increased by the treatments except of NP2 treatment at 'Idared'.

Table 4. Results of fruit analysis

	Weight (g)*	Weight-development (%)**	Si*** (mm/mm)	pH	Titrable acid content (%)	Brix°
Idared Control	179.78a	–	55.0/60.5	3.35b	0.58a	14.2b
Idared NP1	186.72b	3.8	50.5/67	3.00a	0.70b	14.3b
Idared NP2	189.55b	5.4	57.8/66.5	3.34b	0.49a	13.4a
Jonagored Control	194.26a	–	60.2/66.3	3.70b	0.41a	15.5b
Jonagored NP1	215.20b	10.8	64.4/71.7	3.28a	0.49b	14.3a
Jonagored NP2	229.90b	18.3	64.8/71.8	3.25a	0.48b	14.5a

In each column, means followed by the same letter are not significantly different (P<0.05).
*weight is presented as mean weight of ten fruits
**weight development is expressed as increment % compared to control
***shape index is expressed as the ratio of height/width

Soluble solid content of apples was decreased by treatments, except except of NP1 treatment at 'Idared'. Summarized our results it can be stated that the used products had traceable effect on investigated fruit parameters. Treatments increased the acid contents (fumaric, citric, malic) of apples and decreased the amount of monosaccharides. It means that the applied treatments pushed out the ratio of acid/sugar.

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