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THE EFFECT OF ANIMAL PROTEIN HYDROLYSATE ON QUANTITY AND QUALITY OF STRAWBERRY DAUGHTER PLANTS CV. 'ELSANTA'

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Abstract. The studies were carried out in the years 2006–2007 in an unheated glasshouse. Strawberry mother plants cv. 'Elsanta' were grown in polypropylene bags filled with peat-based substrate (3 plants per bag). The bags with plants were placed on gutters in the glasshouse at the height of 165 cm. The distance between the gutters was 120 cm. The experiment was established in a split-block design in 4 replications of 3 plants each. The aim of this work was to evaluate the influence of biostimulant based on animal protein hydrolysate on number, length and diameter of runners and number of strawberry daughter plants as well as their crown diameter, fresh weight and number of leaves. The application of biostimulant did not have a beneficial influence on number of runners, their length and diameter. Applied biostimulant did not also affect quantity of strawberry daughter plants, their crown diameter as well as number of leaves. Significant decreased in weight of daughter plants after biostimulant application was found. The quantity and quality of runners as well as daughter plants in compared years of the experiment were significantly different. These differences were probably caused by powdery mildew.

Keywords: *Fragaria* × *ananassa*, biostimulant, propagation

INTRODUCTION

In the last decade, a number of products referred to generically as biostimulants have appeared on the market for application to crops [Boehme et al. 2005].

Biostimulants are defined as non-fertilizer products which have a beneficial effect on plant growth. Many of these materials are natural products that contain no added chemicals or synthetic plant growth regulators [Russo and Berlyn 1990].

In the recent years, the use of biostimulants has been increasing and their using is becoming a common practice in the sustainable agriculture. The main effect of these

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products is to reduce fertilizers application and other chemical compound in agriculture [Russo and Berlyn 1990].

Sanderson and Jameson [1986] and Crouch et al. [1992] classified biostimulants generally into three major groups on the basis of their source and content. These groups include humic substances, hormone containing products, and amino acid containing products.

Biostimulants are, in general, made of a mix of humic acids, marine algae extracts, mycorrhizal fungi, vitamins, and other compounds – which can vary according to the producer [Ferrini and Nicese 2002]. There are also biostimulants composed of peptides, amino acids, polysaccharides, and/or phytohormones, etc. [Parrado et al. 2008] as well as plant extracts [Prokkola et al. 2003, Laugale et al. 2006, Laugale and Daugavietis 2009].

Biostimulants have been reported to increase overall plant growth of a number of agricultural and horticultural crops [Russo and Berlyn 1990, Boehme et al. 2005]. They have also been shown to enhance the soil microbial activity and nitrogen dynamics [Chen et al. 2002], nutrient uptake [Eşítken and Pirlak 2002], seed germination [Poincelot 1993, Yildrim et al. 2002], resistance to biotic and abiotic stress [Boehme 1999, Boehme et al. 2005, 2008, Polo et al. 2006, Botta et al. 2009, Marfà et al. 2009], chlorophyll content [Russo and Berlyn 1990, Blunden et al. 1997, Neri et al. 2002], and plant defence against pest and diseases [Washington et al. 1999, Prokkola et al. 2003, Anttonen et al. 2003]. The use of biostimulants has also been affected earliness [Botta et al. 2009, Marfà et al. 2009] and fruit quality [Cholewiński 1998, Neri et al. 2002, Masny et al. 2004, Sarli et al. 2009, Abdel-Mawgoud 2010].

Some researchers have observed that biostimulants have not always shown improved plant growth and yielding. For example, Albregts et al. [1988] found no increase in the fruiting of strawberry after application of several types of biostimulants. A study by Csizinszky [1990], using two cultivars of bell peppers, demonstrated that biostimulants had no influence on yields or nutrient content of the peppers. Heckman [1995] noticed that the yield of cabbage was not increased over controls with biostimulants. Kelting et al. [1997] observed no beneficial effects on the growth of biostimulant-treated turkish hazelnut trees. None of the biocontrol treatments applied by Washington et al. [1999] increased strawberry yield. The research by Neri et al. [2002] showed that biostimulants did not increase the yield of strawberries. However, fruit quality was improved. Several biological sprays, compared by Prokkola et al. [2003], did not affect strawberry yield, fruit shelf life and incidence of grey mould. Biostimulants applied by Łyszkowska et al. [2008] in lettuce growing did not increased significantly total and marketable yield and weight of head. In studies conducted by Gajc-Wolska et al. [2009] biostimulants did not influence on physical and sensorial traits of tomato fruit.

According to Morales-Payan and Stall [2003], organic amino acid and peptide complex have been found to increase yield in various crops. They are natural biostimulants, comprising oligo- and polypeptides, and free amino acids, which can be obtained through chemical and/or enzymatic hydrolysis of organic matrix from plant or animal sources. The first biostimulant product, based on amino acids and short chain peptides, was born in Italy more than 35 years ago [Maini 2006]. According to Cambri et al. [2008], plants treated with amino acid biostimulant (Aminoplant®) stimulates, at molecular level, endogenous plant defence response to biotic and abiotic stress factors.

Morales-Payan and Stall [2004a], comparing different biostimulants (gibberellic acid, acetylthioproline, a mixture amino acids and short-chain peptides), reported the highest yield of scallion treated with a mixture amino acids and short-chain peptides. In another studies conducted by those researchers a complex of amino acids and short-chain peptides reduced the time from seedling emergence to the adequate transplanting stage of passion fruit [Morales-Payan and Stall 2004b], Research by Polo et al. [2006] showed that biostimulant based on porcine hemoglobin hydrolysate lessened the harmful effects caused by the intense cold and heat treatment in lettuce. Kowalczyk et al. [2008] found that Aminoplant – organic fertilizer which contains aminoacids and short peptide chains, positively affected the yield of lettuce plants grown on rockwool. These results were not confirmed under field conditions [Łyszkowska et al. 2008]. Ertani et al. [2009], using two biostimulants based on protein hydrolysates, observed positive effect on root and leaf growth and also on nitrogen metabolism of maize seedlings. In the study conducted by Botta et al. [2009], natural product based on characterized peptides of low molecular weight enhanced earliness and quantity as well as quality of strawberry yielding. Marfà et al. [2009], using as a biostimulant an animal protein hydrolysate, found that strawberry plants produced more biomass of newly formed roots and also showed early flowering and fruiting.

Results of several experiments have shown that the action of biostimulators depends on doses and frequency of application as well as strawberry cultivar [Rohloff et al. 2002, Masny et al. 2004, Żurawicz et al. 2004, Laugale et al. 2006, Sas-Paszt et al. 2008, Botta et al. 2009, Sarli et al. 2009].

The effect of biostimulants to promote strawberry plant growth and yielding have been studied by many researchers [Albregts et al. 1988, Cholewiński 1998, Washington et al. 1999, Eşítken and Pirlak 2002, Neri et al. 2002, Rohloff et al. 2002, Prokkola et al. 2003, Masny et al. 2004, Żurawicz et al. 2004, Laugale et al. 2006, Sas-Paszt et al. 2008, Botta et al. 2009, Marfà et al. 2009, Roussos et al. 2009, Sarli et al. 2009, Abdel-Mawgoud et al. 2010].

In fact, relatively little research has been done to document the effect (or non-effect) of biostimulants on strawberry mother plants growth and productivity. Therefore, the purpose of this study was to determine the effects of biostimulant based on animal protein hydrolysate on the quantity and quality of runners (length and diameter) and strawberry daughter plants (crown diameter, fresh weight and number of leaves).

MATERIAL AND METHODS

The studies were conducted in the years 2006–2007 at the Marcelin, experimental station of Poznań University of Life Sciences. They were consisted of two one-factor experiments established in an unheated glasshouse.

Strawberry plants cv. ‘Elsanta’ were planted into black polypropylene bags of 20 × 85 cm, filled with 12 dm^3 of peat-based substrate. The bags with plants were placed on gutters in the glasshouse at the height of 165 cm. The distance between the gutters was 120 cm. There were 3 plants in each bag planted 20 cm apart. The soil surface in the glasshouse was covered with white plastic film to take advantage of extra light reflection. The plants were irrigated and fertilized with the use of a system of individual drippers and fertilizer injector Dosatron, controlled by electronic time-controller Nelson. All inflorescences emerging from the mother plants were removed to promote runnering.

Strawberry mother plants were planted in the second decade of April (2006 and 2007) and runners with daughter plants were detached from them at the second decade of August (2006 and 2007). All runners and strawberry daughter plants as well as the number of leaves per daughter plant were counted. The length of runners was measured with a ruler. The measurement of diameter of runners and strawberry daughter plants was made using a caliper. Daughter plant fresh weight was determined with a balance.

In the study commercial biostimulant based on animal hemoglobin hydrolysate (Aminoflor) was applied. Plants were sprayed 6 times with water solution of Aminoflor (1%). The first application was made (after transplanting) to the roots and the next to the plant foliage. A biostimulant-free control was also established.

The experiment was established in a split-block design in 4 replications of 3 plants each. Data were analyzed statistically, using the method of variance analysis, assessing the significance of differences by means of Newman-Keuls test at the 0.05 significance level.

RESULTS AND DISCUSSION

Organic amino acid and peptide complexes have been found to have beneficial effect on various crops [Morales-Payan and Stall 2004, 2004a, Polo et al. 2006, Kowalczyk et al. 2008, Botta et al. 2009, Ertani et al. 2009, Marfà et al. 2009] but these findings were not confirmed in the presented study.

Table 1. Influence of strawberry mother plants (cv. 'Elsanta') treatment with an animal protein hydrolysate on number of runners
Tabela 1. Wpływ traktowania roślin matecznych truskawki (odm. 'Elsanta') hydrolizatem białka zwierzęcego na liczbę rozłogów

Treatment Traktowanie	2006	2007	Mean Średnia
Aminoflor	15.82 a	9.15 b	12.49 a
Control – Kontrola	15.07 a	7.97 b	11.52 a
Mean – Średnia	15.45 a	8.56 b	

Means followed by the same letter do not differ significantly at p = 0.05 according to Newman-Keuls multiple range test
Średnie oznaczone tą samą literą nie różnią się istotnie, wg testu Newman-Keulsa przy p = 0,05

The application of biostimulant based on animal hemoglobin hydrolysate did not influence the number of runners, as well as their length and diameter (tab. 1–4). Neither number of daughter plants, their crown diameter and number of leaves were signify-

Table 2. Influence of strawberry mother plants (cv. 'Elsanta') treatment with an animal protein hydrolysate on number of runners with daughter plants
Tabela 2. Wpływ traktowania roślin matecznych truskawki (odm. 'Elsanta') hydrolizatem białka zwierzęcego na liczbę rozłogów z sadzonkami

Treatment Traktowanie	2006	2007	Mean Średnia
Aminoflor	13.10a	9.08b	11.09a
Control – Kontrola	12.58a	7.98b	10.28a
Mean – Średnia	12.84a	8.52b	

Means followed by the same letter do not differ significantly at p = 0.05 according to Newman Keuls multiple range test
Średnie oznaczone tą samą literą nie różnią się istotnie, wg testu Newman-Keulsa przy p = 0,05

Table 3. Influence of strawberry mother plants (cv. 'Elsanta') treatment with an animal protein hydrolysate on length of runners, cm
Tabela 3. Wpływ traktowania roślin matecznych truskawki (odm. 'Elsanta') hydrolizatem białka zwierzęcego na długość rozłogów, cm

Treatment Traktowanie	2006	2007	Mean Średnia
Aminoflor	110.10a	100.05a	105.08a
Control – Kontrola	110.20a	106.92a	108.56a
Mean – Średnia	110.15a	103.49a	

Means followed by the same letter do not differ significantly at p = 0.05 according to Newman Keuls multiple range test
Średnie oznaczone tą samą literą nie różnią się istotnie, wg testu Newman-Keulsa przy p = 0,05

Table 4. Influence of strawberry mother plants (cv. 'Elsanta') treatment with an animal protein hydrolysate on runners diameter, mm
Tabela 4. Wpływ traktowania roślin matecznych truskawki (odm. 'Elsanta') hydrolizatem białka zwierzęcego na średnicę rozłogów, mm

Treatment Traktowanie	2006	2007	Mean Średnia
Aminoflor	3.55a	1.82b	2.68a
Control – Kontrola	3.62a	1.82b	2.72a
Mean – Średnia	3.59a	1.82b	

Means followed by the same letter do not differ significantly at p = 0.05 according to Newman Keuls multiple range test
Średnie oznaczone tą samą literą nie różnią się istotnie, wg testu Newman-Keulsa przy p = 0,05

Table 5. Influence of strawberry mother plants (cv. 'Elsanta') treatment with an animal protein hydrolysate on number of daughter plants
Tabela 5. Wpływ traktowania roślin matecznych truskawki (odm. 'Elsanta') hydrolizatem białka zwierzęcego na liczbę sadzonek

Treatment Traktowanie	2006	2007	Mean Średnia
Aminoflor	36.50a	27.00b	31.75a
Control – Kontrola	36.40a	24.90b	30.65a
Mean – Średnia	36.45a	25.95b	

Means followed by the same letter do not differ significantly at p = 0.05 according to Newman Keuls multiple range test
Średnie oznaczone tą samą literą nie różnią się istotnie, wg testu Newman-Keulsa przy p = 0,05

Table 6. Influence of strawberry mother plants (cv. 'Elsanta') treatment with an animal protein hydrolysate on diameter of daughter plants, mm
Tabela 6. Wpływ traktowania roślin matecznych truskawki (odm. 'Elsanta') hydrolizatem białka zwierzęcego na średnicę sadzonek, mm

Treatment Traktowanie	2006	2007	Mean Średnia
Aminoflor	7.40a	6.52a	6.96a
Control – Kontrola	7.42a	6.35a	6.88a
Mean – Średnia	7.41a	6.44b	

Means followed by the same letter do not differ significantly at p = 0.05 according to Newman Keuls multiple range test
Średnie oznaczone tą samą literą nie różnią się istotnie, wg testu Newman-Keulsa przy p = 0,05

Table 7. Influence of strawberry mother plants (cv. 'Elsanta') treatment with an animal protein hydrolysate on number of leaves of daughter plants
Tabela 7. Wpływ traktowania roślin matecznych truskawki (odm. 'Elsanta') hydrolizatem białka zwierzęcego na liczbę liści sadzonek

Treatment Traktowanie	2006	2007	Mean Średnia
Aminoflor	3.32a	3.48a	3.40a
Control – Kontrola	3.42a	3.90a	3.66a
Mean – Średnia	3.38a	3.69a	

Means followed by the same letter do not differ significantly at p = 0.05 according to Newman Keuls multiple range test
Średnie oznaczone tą samą literą nie różnią się istotnie, wg testu Newman-Keulsa przy p = 0,05

cantly different because of biostimulant treatment during two seasons (tab. 5–7). Some researchers, comparing different biostimulants, reported their significant influence on strawberry reproduction. In the research conducted by Żurawicz et al. [2004] plant bioregulators (PBRs) had a beneficial effect on strawberry daughter plants formation and development. In their studies the number of daughter plants increased by almost 300% as compared to the untreated control mother plants. Sas-Paszt et al. [2008] also demonstrated significant influence of bioregulators on the number and size of strawberry runner plants. Aslantas and Güleryüz [2004] confirmed the beneficial influence of biostimulants on the quantity and quality of strawberry runners and daughter plants.

In the presented study the applied biostimulator significantly decreased in weight of strawberry daughter plants (tab. 8). Some researchers have also observed that biostimulants have not always shown improved plant growth [Albregts et al. 1988, Csizinszky 1990, Heckman 1995, Kelting et al. 1997, Washington et al. 1999, Neri et al. 2002, Prokkola et al. 2003, Łyszkowska et al. 2008, Gajc-Wolska et al. 2009]. Moreover some investigators observed different reaction of plants on the same biostimulators [Kowalczyk et al. 2008, Laugale and Daugavietis 2006, 2009, Łyszkowska et al. 2008].

Table 8. Influence of strawberry mother plants (cv. 'Elsanta') treatment with an animal protein hydrolysate on weight of daughter plants, g
Tabela 8. Wpływ traktowania roślin matecznych truskawki (odm. 'Elsanta') hydrolizatem białka zwierzęcego na masę sadzonek, g

Treatment Traktowanie	2006	2007	Mean Średnia
Aminoflor	5.38a	4.35b	4.86b
Control – Kontrola	5.58a	5.12b	5.35a
Mean – Średnia	5.48	4.74b	

Means followed by the same letter do not differ significantly at p = 0.05 according to Newman Keuls multiple range test
Średnie oznaczone tą samą literą nie różnią się istotnie, wg testu Newman-Keulsa przy p = 0,05

Significant differences between compared years of studies were found with the exception of length of runners and number of leaves. The lower quantity and quality of runners and daughter plants in 2006 might have been connected with high incidence of powdery mildew.

CONCLUSIONS

1. The applied biostimulant based on animal hemoglobin hydrolysate did not have a beneficial influence on strawberry runners and daughter plants quantity and quality of cv. 'Elsanta'.

2. Weight of strawberry daughter plants treated with the biostimulant was significantly lower than non treated ones.

3. Significant differences, probably caused by high incidence of powdery mildew, between compared years of studies were found with the exception of length of runners and number of leaves.

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WPŁYW HYDROLIZATU BIAŁKA ZWIERZĘCEGO NA LICZBĘ I JAKOŚĆ SADZONEK TRUSKAWKI ODMIANY 'ELSANTA'

Streszczenie. W ostatnich latach obserwuje się rosnące zainteresowanie wykorzystaniem biostymulatorów w uprawach rolniczych i ogrodniczych. Badania nad truskawką dotyczą przede wszystkim określenia wpływu biostymulatorów na wzrost i plonowanie roślin. Niewiele jest natomiast prac dokumentujących wpływ (lub jego brak) na wzrost i produktywność roślin matecznych. Celem prezentowanych badań było określenie wpływu biostymulatora opartego na hydrolizacie białka zwierzęcego na liczbę, długość i średnicę rozłogów oraz na liczbę sadzonek rozłogowych truskawki, średnicę ich korony, świeżą masę oraz liczbę liści. Badania zostały przeprowadzone w latach 2006–2007 w nieogrzewanej szklarni. Rośliny mateczne truskawki odmiany 'Elsanta' były uprawiane w workach polipropylenowych wypełnionych susbstratem torfowym (3 rośliny/worek). Worki z roślinami umieszczono na rynnach na wysokości 165 cm. Odległość między rynnami wynosiła 120 cm. Doświadczenie założono w układzie bloków losowych w czterech powtórzeniach, po trzy rośliny w każdym powtórzeniu. Zastosowanie biostymulatora nie miało istotnego wpływu na liczbę, długość i średnicę rozłogów wytworzonych przez rośliny mateczne truskawki. Zastosowany biostymulator nie wpłynął również na liczbę sadzonek rozłogowych, średnicę ich korony oraz liczbę liści. Istotnie mniejszą świeżą masę sadzonek miały rośliny traktowane biostymulatorem. Stwierdzono istotne różnice w liczbie i jakości rozłogów oraz sadzonek pomiędzy porównywanymi latami badań. Różnice te mogły być spowodowane wystąpieniem mączniaka.

Słowa kluczowe: *Fragaria* × *ananassa*, biostymulator, rozmnażanie

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