# Impact of supplementary plant preparations and organic fertilizers on yield of organic strawberries cv. 'Elkat' and 'Symphony'

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**Abstract**

*In 2011 the field experiments with organic strawberries cv. 'Elkat' and 'Symphony' were conducted. We evaluated the effects of product category supplementary plant preparations Lignohumate B and Synergin® and liquid organic fertilizers Prev-B2 and Hungavit A® on yield and other harvest data. The highest total and marketable yield was achieved in both varieties after Lignohumate B application. Lignohumate B also increased mean fruit weight. 'Elkat' had significantly higher yield and mean fruit weight compared to 'Symphony'. Prev-B2 significantly reduced the number of grey mould diseased fruits of 'Symphony'.*

**Keywords:** Strawberry, organic fertilizers, humates, yield, *Botrytis cinerea*

## Introduction

Traditional way to provide crops by nutrients in organic farming is application of voluminous organic fertilizers such as manure, compost or green manure in soil before planting. Because of relatively quick mineralization of raw organic material and thus potential risk of nutrients losses by washout during winter time (Gaskell *et al.*, 2009), some crops including strawberries may meet nutritional problems during restricted periods of the growth cycle (Neri *et al.*, 2002). Foliar application of organic fertilizers based on humic acid substances, derived mainly from vermicomposts, seems to be perspective way to provide plants with suitable forms of nutrients during prolonged period (Singh *et al.* 2010). In addition vermicomposts contain humic acids and plant growth regulators like auxins, gibberellins and cytokinins, which support plant growth (Atiyeh *et al.*, 2002). Plant nutrition can be more efficient using supplementary plant preparations, which are not registered as fertilizers due to low nutrient content. Some of them together with organic fertilizers contain valuable biologically active components such as humic acids or plant growth regulators, others can help to protect crops from pests and disease incidence. Synergistic effect of humic acids and plant growth regulators are discussed (Arancon *et al.,* 2004, Verlinden *et al.*, 2009).

The aim of the present study was to prove the effect of two commercial supplementary plant preparation Lignohumate B (humate) and Synergin® (organic plant growth regulator) and two foliar fertilizers Hungavit A® (vermicompost) and Prev-B2 (boron fertilizer) on yield and quality of organic strawberries.

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**Material and Methods**

Experiments were carried out at Faculty of Horticulture in Lednice (Mendel University in Brno). The locality is situated in Southern Moravia (above sea level 180 m, average temperature 9 °C, average year precipitation 517 mm, silty soils). The soil was thoroughly prepared for two years according to the rules of organic agriculture using 3 types of green manure every year – phacelia, white mustard and mixture of field pea with oat, respectively. Young plants of cv. 'Elkat' and 'Symphony' were planted in September 2010. Double row planting system on ridges covered by black polypropylene plastic mulch (non-woven fabric) was used. The distance of double rows was 0.8 m, spacing of plants 0.35×0.25 m. The experimental plots were set as randomized block design with 3 replications per treatment (60 plants). Drop irrigation was installed above the plastic mulch. In spring 2011 the space between the ridges were mulched with wheat straw.

Four treatments were used consisting of different fertilizers and supplementary plant preparations, respectively. All of them were applied on the leaves with hand sprinkler five times in 7 day intervals:

1th application: 15. 4. 2011 (BBCH 55 – first flowers at the bottom of the rosette).
2nd application: 22. 4. 2011 (BBCH 58 – early balloon stage).
3th application: 10. 5. 2011 (BBCH 67 – flowers fading: majority of petals fallen).
4th application: 17. 5. 2011 (7 days after the end of flowering).
5th application: 4. 7. 2011 (7 days after the end of harvesting).

Treatments were following:

1. Lignohumate B.

Lignohumate B is a mixture of salts of humic substances (12 %) with a high content of fulvic acids component. It is an environmental-friendly supplementary plant preparation made from technical lignosulfonate during paper manufacturing (Amagro Ltd., Czech Republic). Foliar applications were applied at a dose 1.0 l of Lignohumate B in 600 l of water per hectar.

2. Synergin®.

Synergin® is a synergistic bioregulator of plant growth, which contains a number of physiologically active substances, namely the natural cytokinin and auxin precursors of organic origin produced from food raw materials (Juwital Ltd., Czech Republic). Synergin® was applied by spraying in recommended dose 2 l per hectare (spray liquid volume 600 $l.ha^{-1}$).

3. Lignohumate B + Hungavit A®.

Hungavit A® is a liquid fertilizer based on vermicompost extract (BioLife Ltd. Hungary). It contains following nutrients ($mg.l^{-1}$): N 140, K 650, Mg 7000, B 4950, Ca 83, P 290, Fe 7.7, Cu 0.2 and Zn 0.41 (Gaspar, 2002). Strawberry plants were treated with tank mix of Lignohumate B (1.0 $l.ha^{-1}$) and Hungavit A® – first two applications at a dose 7.7 $l.ha^{-1}$ followed by three apllication at dose 8.8 $l.ha^{-1}$ (spray liquid volume 600 $l.ha^{-1}$)

4. Prev B2®

Prev B2® is as boron liquid fertilizer and conditioner (Biofa AG, Germany). It contains 2.1% of boron, 4.2% of cold-pressed orange oil and 0.4% of fatty alcohol ethoxylate. The recommended dose 1.8 $l.ha^{-1}$ (spray liquid volume 600 $l.ha^{-1}$) was used.

5. Control

Untreated, free of any preparations.

During the harvest time we assessed the yield and quality of production. Data were recorded on all harvest dates, berries were picked twice a week. Mid-season ripening cv. 'Elkat' showed 8 harvests, the first one 26th May, the last one 22nd June. Late season

ripening cv. 'Symphony' was harvested during 2nd June and 27th June (total 7 harvests). Fruits were weighed and sorted into following qualitative classes according to the marketing standards of the European Union (commission regulation /EC/ no 843/2002): Extra class (regular shape and colour, diameter >25 mm), Class I (slight defect of shape, a white patch max 1/10 of the surface, diameter 18–25 mm) and Class II. class (defect of shape, a white patch max 1/5 of the surface), respectively.

The marketable yield consisted of berries assigned to the previous classes. Berries with smaller diameter, with malformations or other disorders, as well as those ones damaged by grey mould or other rots, formed unmarketable yield. Numbers of fruits infected by grey mould were calculated separately to determine the level of infestation (%) by *Botrytis cinerea* Pers. Mean fruit weight was calculated from weights of all berries. Collected data of different parameters were averaged and statistically processed by ANOVA and LSD test ($P<0.05$) using software Unistat version 5.1. Number of fruits diseased by grey mould (in percentage units) was analysed by using software UPAVplus, ver. 1.06 (Czech Phytosanitary Administration) taking into account arcsin data transformation.

## Results

Yield parameters were negatively influenced by late spring frosts. During flowering temperature dropped bellow 0 °C in four subsequent days. Critical temperatures were recorded 6th May, when it fell to -4.1 °C. It caused significant fruit set reduction and resulted in higher number of deformed berries taking part in unmarketable yield at both cultivars (Figure 1 and Figure 2). Cv. 'Elkat' had total yield 103.4 g per plant, while total yield of cv. 'Symphony' was only 42.9 g per plant.

Application of Lignohumate B produced highest total yield at both cultivars. In the case of 'Elkat', application of Lignohumate B significantly increased total yield not only compared to control but to all other treatments (Figure 1). Further, application of Lignohumate B significantly increased the weight of fruits sorted in Extra class, II. class, but also unmarketable portion of total yield. Application of other preparations slightly increased yield parameters compared to control, but the differences were not significant.

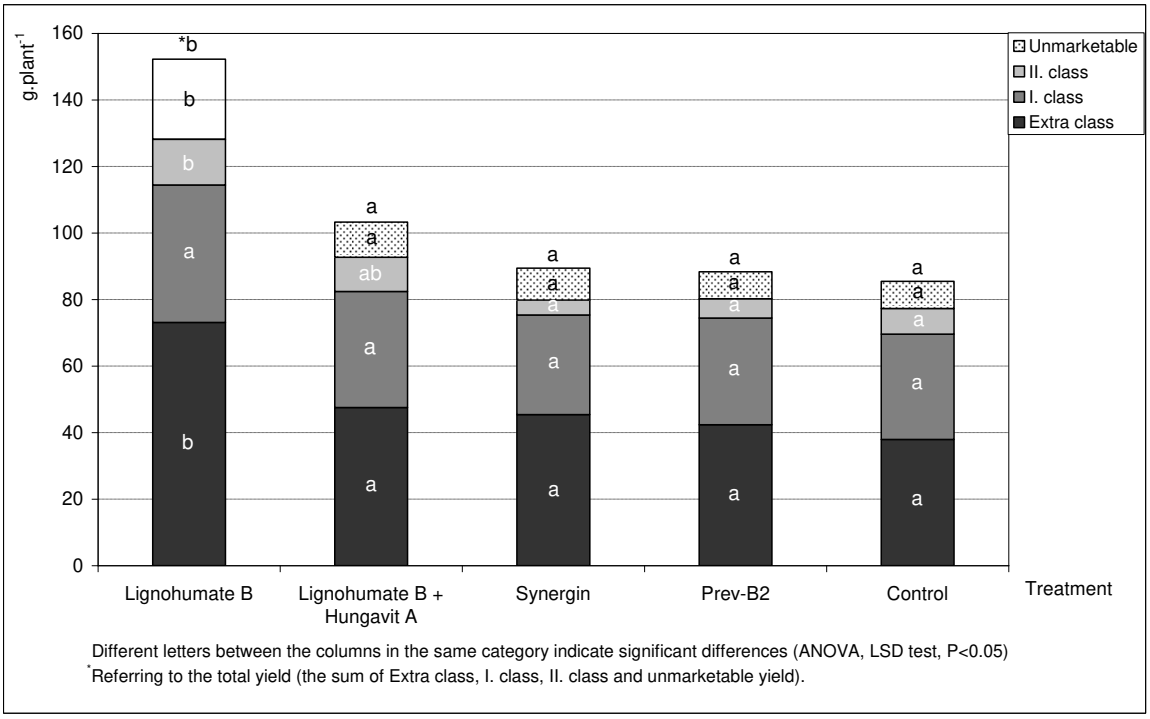


Figure 1: Harvest data for 'Elkat'

'Symphony' showed lower portion of fruits in Extra class and higher number of fruits especially in class II, compared to 'Elkat'. Treatment by Lignohumate B resulted in the best yields as well, while it significantly increased total yield compared to control (Figure 2). All other treatments increased yields non-significantly. Combined application of Lignohumate B and Hungavit A® produced the highest number of fruits in Extra class.

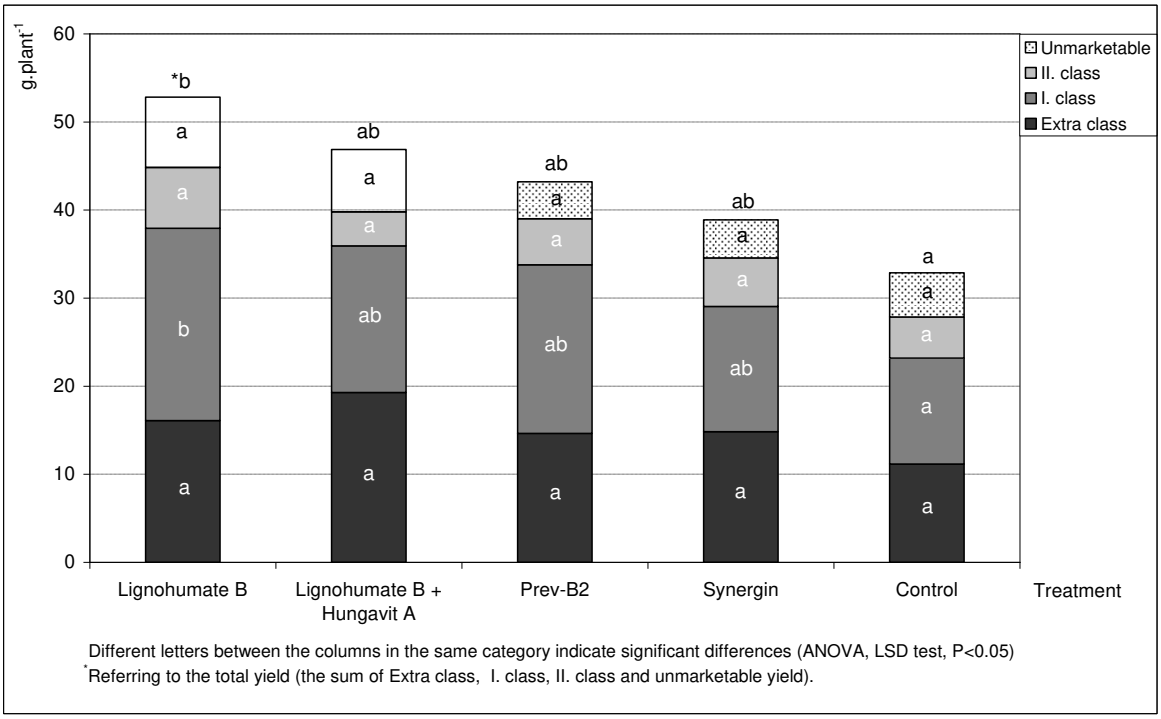


Figure 2: Harvest data for 'Symphony'

Table 1 submits economically important yield parameters like marketable yield and fruit size (expressed as mean fruit weight), respectively. All preparations increased marketable yield and fruit weight in both observed cultivars. Greater effect was found at cv. 'Elkat', when Lignohumate B produced significantly higher (65%) marketable yield compared to control. Spraying tank mix from humate (Lignohumate B) and vermicompost (Hungavit A®) resulted in 20% higher marketable yield. We cannot confirm significantly positive effect of variants on 'Symphony' yields, even though strawberries harvested from plots treated by Lignohumate B provided 60.5% higher marketable yield compared to control (Table 1).

'Elkat' showed to be more productive cultivar. It reached more than double, significantly higher marketable yield compared to 'Symphony'.

Table 1: Marketable yield (g.plant$^{-1}$) and mean fruit weight (g)

| Treatment | 'Elkat' | | 'Symphony' | |
|---|---|---|---|---|
| | Marketable yield (g) | Fruit weight (g) | Marketable yield (g.plant$^{-1}$) | Fruit weight (g) |
| Lignohumate B | 128.1 b | 11.1 a | 44.8 a | 8.4 a |
| Synergin® | 79.8 a | 10.9 a | 34.6 a | 8.4 a |
| Lignohumate B + Hungavit A® | 92.7 ab | 10.6 a | 39.8 a | 8.7 a |
| Prev-B2 | 80.2 a | 10.4 a | 39.0 a | 8.7 a |
| Control | 77.3 a | 9.7 a | 27.9 a | 7.5 a |

Different letters between rows indicate significant differences at P<0.05

Looking to the Table 1 we could see all treatments increased mean fruit weight of both cultivars, but none of them significantly. Regarding cv. 'Elkat', application of Lignohumate B gave the best results, when it provided 14.4% higher mean fruit weight compared to untreated control.

Comparing cultivars, 'Elkat' was characterized by bigger fruits. 'Elkat' has significantly higher fruit weight (26.5%) than 'Symphony'.

Further, we evaluated the effects of used preparations on grey mould, caused by *Botrytis cinerea*, on fruits. The results of observations of both varieties are quite different. While Lignohumate B significantly decreased number of infected fruits at 'Symphony', we observed significantly higher number of diseased fruits in plots of cv. 'Elkat' treated with the humate preparation. The best results gave Prev-B2 mainly at 'Symphony', where it significantly reduced the disease development compared to control (Table 2).

Table 2: Number of fruits (%) infected by *Botrytis cinerea*

| Treatment | 'Elkat' | 'Symphony' |
|---|---|---|
| Lignohumate B | 3.0 b | 1.1 a |
| Synergin® | 2.5 b | 1.3 ab |
| Lignohumate B + Hungavit A® | 1.0 a | 2.1 ab |
| Prev-B2 | 1.0 a | 1.0 a |
| Control | 0.4 a | 4.4 b |

Different letters between rows indicate significant differences at $P<0.05$

## Discussion

There are several studies reported the positive effect of vermicomposts to growth, yield and health status of strawberries. Arancon *et al.* (2003, 2004) proved that vermicompost significantly improved growth characteristics and increased yields compared to inorganic fertilizers. They found 35% higher marketable yield compared to control variant. In our study vermicompost (Hungavit A®) together with humate (Lignohumate B) increased marketable yields in both used cultivars 'Elkat' and 'Symphony' by 20,0% and 42,7%, respectively. American authors explained the positive effects of vermicompost not only because of direct supply of macronutrients but also due to hormones or humates in vermicomposts acting as plant-growth regulators independent of nutrient supply**.** Neri *et al.* (2002) and Singh *et al.* (2010) submitted similar conclusions presenting positive effect of foliar humic acid application on fruit quality, reducing the number of malformed and rotten (grey mould) fruits in organic strawberries. They assume an indirect positive physiological effect of humic acids on the whole plants.

Preparation Prev-B2 has a wide range of uses. In the Czech Republic it registered as boron fertilizers containing orange oil. This substance supports spray adhesion to leaves and directly suppresses pests and pathogens attacks. We found the less number of unmarketable strawberry fruits in plots treated by Prev-B2. It could be explained by positive effect both of orange oil and boron. While the first substance showed to be effective to suppress infection of several pathogens (Jamar *et al.*, 2010), the second one could reduce the risk of malformed fruits (Singh *et al.*, 2007). However in our study Prev-B2 proved to decrease grey mould only in cv. 'Symphony'. Jamar *et al.* (2010) found that Prev-B2 spraying effectively reduced scab incidence on fruits of apple trees. In the work of Singh *et al.* (2007) the reduction of number of malformed strawberries was confirmed only when boron was applied together with calcium.

Zahradníček *et al.* (2006) tested biostimulator Synergin® at several field crops and horticultural plants, e.g. vegetables and peaches. They proved positive effect on plant

growth and productivity. Their outputs correspond to a certain extent with our results, although Synergin® did not show significant effect in our study.

Soltani *et al.* (1999) tested Hungavit® fertilizers on tomato, pepper and potato. In accordance with our trial on strawberries, Hungavit® had non-significant effect on total yield of the vegetables and potato. Although there were 55% fewer diseased tomato and pepper fruit in Hungavit® treatments, this was not statistically significant from the control treatments, similarly to our observation.

In conclusion we have to admit that results of our experiments were strongly negatively influenced by unfavourable meteorological conditions during blossom. Late spring frosts caused pronounced reduction of number of evaluated fruits. The experiment will continue in 2012.

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