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COMPARISON STRAWBERRY FIELD PRODUCTION AND OCCURRENCE OF GREY MOULD AT STRAWBERRY GROWING ON SYSTEM WITH ADDITION OF APPLE TREE WOODY CHIPS

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Abstract

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In the years 2014 to 2016 the influence of apple tree wood chips and composted apple tree wood chips in which oyster mushroom grew and yielded which were supplemented into soil on strawberry field production and occurrence of grey mould at strawberry (cv. 'Sonata') was evaluated. Average weight and number of fruits per plant, average fruit weight, average weight and number of fruits affected by *Botrytis cinerea* per plant, percentage of weight and number of fruits affected by *Botrytis cinerea* was calculated. There were recorded differences concerning strawberry yield among the investigated variants of plots, but mainly there were not statistically significant. In 2015 and 2016 the highest average weight of yield and the highest number of fruits was reached at plants cultivated on plots with apple tree wood chips. Average weight of yield on plots with apple tree wood chips was 663.72 g and 822.41 g in 2015 and 2016, respectively. Number of fruits per plant on plots with apple tree wood chips was 67.88 pieces and 65.29 pieces in 2015 and 2016, respectively. Occurrence of grey mould caused by *Botrytis cinerea* on all variants of plots was similar and small differences was found out only but statistically significant difference was among the years. Grey mould was the most frequently found out in the year 2016. *B. cinerea* affected 48.27, 56.89 and 55.94 grams of fruits per plant from plots with composted apple tree wood chips, plots with apple tree wood chips and control plots in 2016, respectively.

Keywords: strawberry, *Fragaria*, apple trees, wood chips, *Malus domestica*, *Pleurotus ostreatus*, *Botrytis cinerea*, grey mould

INTRODUCTION

Strawberry (*Fragaria × ananassa* Duch) is the important small fruit planted in the Czech Republic and they are cultivated on more than 1600 ha. Summary yield is more than 9500 tons (Buchtová 2016). They are grown in many systems. They can be cultivated in both open fields and greenhouses. Straw and black plastic sheet are the most frequently applied mulching treatments in strawberry cultivation. Each way has advantages and disadvantages (Muñoza *et al.* 2017). Strawberry crops have high nutrient demand and potential for the use of organic compost in planting. There are searching the additives, which enhance yield and quality of

strawberry production and decrease infestation by harmful organisms (Fründ *et al.* 2006, Roveda *et al.* 2016).

Various phytopathogenic fungi infect strawberries and these fungi cause diseases, which reduce yield directly. Fruits are attacked especially by *Botrytis cinerea* and *Phytophthora cactorum*. Foliar diseases are cause by the most frequently *Podosphaera aphanis*, *Mycosphaerella fragariae* and *Diplocarpon earliana* and roots are damaged mainly by *Phytophthora cactorum* and *Phytophthora fragariae* (Maas 1998).

Botryotinia fuckeliana (anam. *Botrytis cinerea*) is important pathogen of many plant species including strawberry and later turn to saprotrophic organism. It belong the most harmful fungi which damage strawberry. This fungus causes grey mould (on fruits) and leaf spot of strawberry. It lives asymptomatically in leaves and flower parts for longer time and colonizes. There is variation in resistance among strawberry cultivars to *Botrytis cinerea*, but high rainfall and humidity support expansion of *Botrytis* (Elad *et al.* 2004).

Apple trees are the most important fruit trees in the Czech Republic and they are cultivated on 7000 hectare (Buchtová 2016). Apple trees harbour, a lot of fungal species including phytopathogenic taxa, which can cause disease of apple trees. Among such taxa belong e.g. species from genera *Neofabraea*, *Nectria*. Therefore removing waste wood (mostly parts of branches) which arise after apple tree pruning from orchard is recommended (Jones et Aldwinckle 1990). Possible amount of pruned biomass of apple trees from intensive farming areas is 0.8–2.3 kg per tree (= 2,640–5,560 kg ha^{-1}) (Bilandzija *et al.* 2012, Radojevic *et al.* 2007, Burg *et al.* 2007).

Fresh wood chips used as mulch are decomposed longer time and there are frequently colonised by saprotrophic and phytopathogenic fungi. pH value of soil is decreasing when wood chips are mulched (Eugenio *et al.* 2008).

Oyster mushroom (*Pleurotus ostreatus*) occurs frequently in forest (especially on trunks and branches of beech, willow, poplar) in the Czech Republic and it is very important edible mushroom in the Europe, including Czech Republic. It is cultivated on wheat straw in commercial farms now, but it can be cultivated on many different plant materials, including wood of fruit trees. At the beginning of commercial cultivation, oyster mushroom was cultivated on logs of poplar and beech, but the colonization of the logs is slower than on straw and therefore the cultivation on logs is way which is not more used in commercial production (Jablonský et Šašek 2006).

The goal of our research was to evaluate the potential of apple wood chips and apple wood chips colonised by oyster mushroom to increase yield of strawberry and reduce occurrence of grey mould.

MATERIALS AND METHODS

The study was conducted in Crop Research Institute Praha-Ruzyně (Czech Republic) in the years 2014–2016. The locality is situated in Central Bohemia and is characterized by loamy soils classified as Haplic Luvisols. Altitude is 340 m, mean year temperature 9.7 °C, mean year precipitation 545 mm (Fig. 1, Fig. 2).

Chips from apple tree branches (cultivar Golden Delicious) were used for the experiment. Branches were 1–3 old, length of the chips was 5–30 mm. C:N ratio of the chips was 52.87 (Vario MACRO cube – Elementar Analysensysteme, GmbH, Germany). Chips were chemically treated with solution of liquid surfactant Empigen OB (lauramine oxide supplied by Hunzsman) in concentration 0.16%. Chips were agitated 12 hours with the Empigen OB solution and then decanted, mixed with 4% of the grain spawn of *Pleurotus ostreatus* (strain HK35). 10 kg of inoculated chips was filled to plastic bags. After 30 days was substrate completely colonized by mycelium and fruitbodies started to grow. Oyster mushroom was grown for 70 days and spent substrate was subsequently used as a supplement to earthworms compost colonised by *Eisenia fetida*. After 90 days of composting, the material was applied on a strawberry culture as an organic fertilizer.

A pulse cereal mixture had been grown to improve soil conditions before strawberries were set to grow. The strawberries were planted in five beds that were divided into 3 parts of each one. These parts were separated vertically through a plastic divider dipped to 60 cm of depth. The first part was assigned like a control variant without adding any organic substance into the soil. In the second part were 60 litres of apple tree wood chips mixed into the soil (5% chips in the soil volume). In the third part were added 60 l composted apple tree wood chips in which oyster mushroom had grown and yield (fructificated). The rank of the variants was changed on the each bed. Composition of microbial community was not analysed before the study.

The strawberry plants were planted in the end of March 2014 and two weeks after the soil preparation. The distance between plants in row was 20 cm and 70 cm between the rows. There were two rows on each bed. The cultivar 'Sonata' from frigo planting stock were used. A drop-irrigation was built and used during dry weather periods. Wheat straw mulch was laid before the flowering of the strawberries to suppress weeds and prevent from fruit contact with the soil. The strawberries were fertilized with 30 g ammonium nitrate with a limestone/m^2 in May and 20 g/m^2 NPK in August after the harvest. None fungicide was used during the study.

The yield parameters very evaluated at 30 plants in each variant. Both healthy mature fruits and fruits affected by grey mould were picked up 14th time during June and the beginning of July 3 times

I: *Strawberry yields comparison 2014–2016 in three variants of plots.*

Variant	Average weight of yield per plant (g)			Average number of fruits per plant (pcs)			Average fruit weight (g)		
	2014	2015	2016	2014	2015	2016	2014	2015	2016
Plot with composted apple tree wood chips in which oyster mushroom grew and yielded	71.17a	584.59a	712.63a	9.43ab	60.69a	51.74a	5.75a	8.42a	**12.76a**
Plot with apple tree wood	57.56a	**663.72a**	**822.41a**	8.26a	**67.88a**	**65.29b**	6.05a	**8.80a**	12.01a
Control plot – without additives	**80.54**a	573.26a	725.45a	**10.22**b	61.47a	54.49ba	**6.32**a	7.95a	12.05a

Different letters among rows indicate statistically significant difference P ≤ 0.05 (Tukey test)

II: *Occurrence of grey mould caused by fungal species Botrytis cinerea 2014–2016 in three variants of plots.*

Variant	Average weight of fruits affected by *Botrytis cinerea* (g) per plant			Average number of fruits affected by *Botrytis cinerea* per plant			Percentage of weight of fruits affected by *Botrytis cinerea* (%)			Percentage number of fruits affected by *Botrytis cinerea* (%)		
	2014	2015	2016	2014	2015	2016	2014	2015	2016	2014	2015	2016
Plot with composted apple tree wood chips in which oyster mushroom grew and yielded	0.03a	22.36a	48.27a	0.02ab	3.24a	5.96a	0.04a	3.82a	6.77a	0.21a	**5.34**a	**11.52**a
Plot with apple tree wood chips	0.12a	**22.57**a	**56.89**a	0.01a	**3.29**a	**7.16**a	0.20a	3.40a	6.92a	0.12a	4.85a	10.97a
Control plot – without additives	**0.38**a	21.98a	55.94a	**0.06**b	3.11a	5.48a	**0.47**a	**3.83**a	**7.71**a	**0.59**a	5.06a	10.06a

Different letters among rows indicate statistically significant difference P ≤ 0.05 (Tukey test)

III: *Strawberry yields comparison 2014–2016.*

Year	Average weight of yield per plant (g)			Average number of fruits per plant (pcs)			Average fruit weight (g)		
	Plot with composted apple tree wood chips	Plot with apple tree wood chips	Control plot	Plot with composted apple tree wood chips	Plot with apple tree wood chips	Control plot	Plot with composted apple tree wood chips	Plot with apple tree wood chips	Control plot
2014	71.17a	57.56a	80.54a	9.43a	8.26a	10.22a	5.75a	6.05a	6.32a
2015	584.59b	663.72b	573.26b	**60.69**b	**67.88**b	**61.47**b	8.42b	8.80b	7.95b
2016	**712.63**b	**822.41**c	**725.45**c	51.74b	65.29b	54.49b	**12.76**c	**12.01**c	**12.05**c

Different letters among rows indicate statistically significant difference P ≤ 0.05 (Tukey test)

IV: *Occurrence of grey mould caused by fungal species Botrytis cinerea 2014–2016.*

Year	Average weight of fruits affected by *Botrytis cinerea* (g) per plant			Average number of fruits affected by *Botrytis cinerea* per plant			Percentage of weight of fruits affected by *Botrytis cinerea* (%)			Percentage number of fruits affected by *Botrytis cinerea* (%)		
	Plot with composted apple tree wood chips	Plot with apple tree wood chips	Control plot	Plot with composted apple tree wood chips	Plot with apple tree wood chips	Control plot	Plot with composted apple tree wood chips	Plot with apple tree wood chips	Control plot	Plot with composted apple tree wood chips	Plot with apple tree wood chips	Control plot
2014	0.03a	0.12a	0.38a	0.02a	0.01a	0.06a	0.04a	0.20a	0.47a	0.21a	0.12a	0.59a
2015	22.36b	22.57b	21.98a	3.24b	3.29b	3.11b	3.82b	3.40b	3.83ab	5.34b	4.85a	5.06a
2016	**48.27**c	**56.89**c	**55.94**b	**5.96**c	**7.16**c	**5.48**c	**6.77**c	**6.92**c	**7.71**b	**11.52**c	**10.97**b	**10.06**a

Different letters among rows indicate statistically significant difference $P \leq 0.05$ (Tukey test)

per week and this fruits were weighted and counted immediately on the field. The leaves of strawberries were cut to reduce the occurrence of leaf disease and pests in the end of July. The straw mulch was dipped into the soil in the autumn.

Statistical analysis

Analysis of variance was done by Statistica 12 (StatSoft Analytical Software for Windows). Analysis of variance (ANOVA) was used to determine the effects of supplement (wood chips, wood chips in which oyster mushroom grew and yielded) and year on yield strawberry and *Botrytis cinerea*. Tukey HSD comparison method was used to separate means after ANOVA at P Ľ 0.05. The test of normality was done.

RESULTS

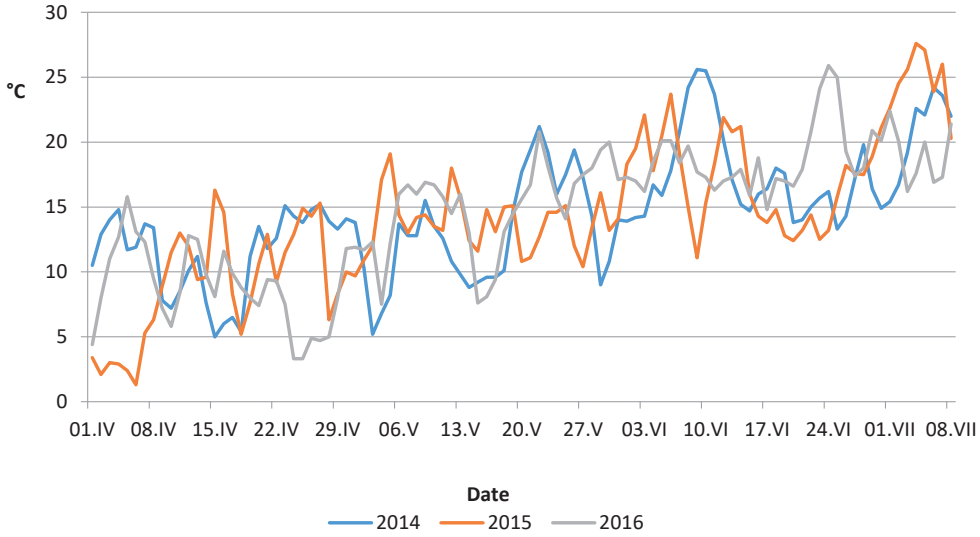
During the harvest of fruits was carried out for five weeks at 2–3 day intervals. The first harvest was on June, 12, June 5, June 6 and the last one on July, 15, July 8, July 7 in 2014, 2015 and 2016 respectively.

Strawberry yield

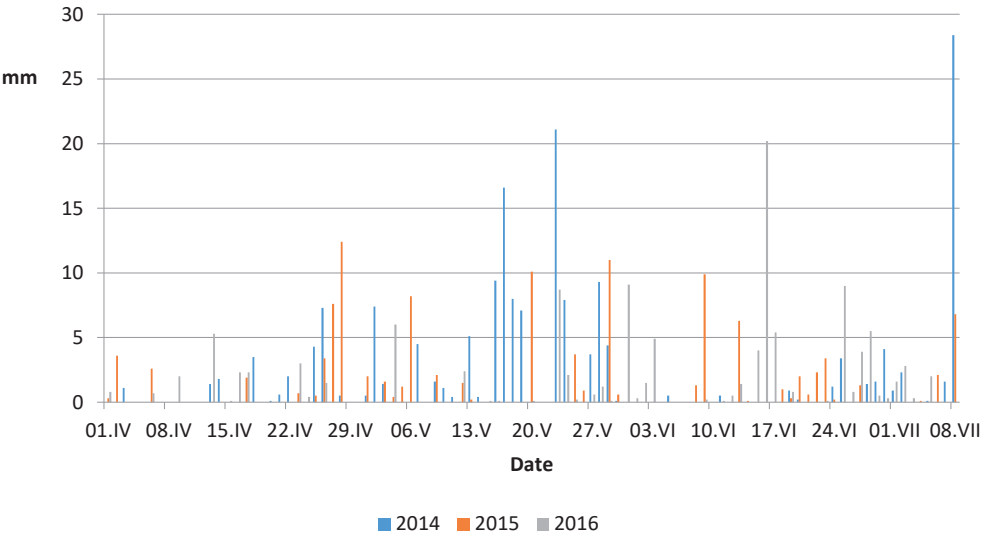
The differences in yield on three variants of strawberry among the first (2014) and two following years (2015 and 2016) were recorded. In 2015 and 2016 the highest average weight of yield and the highest number of fruits was reached at plants cultivated on plots with apple tree wood chips.

First year (2014) the highest average weight of yield per plant (80.55 g) and the highest number of fruits (10.22 per plant) was reached at plants cultivated on control plots. The lowest average weight of fruits (58.82 g) per plant and the lowest number of fruits (8.26 per plant) were found out at plants cultivated on plots with apple tree wood chips. Average fruit weight was the highest on plants from control plots (6.32 g per plant) and the lowest was on plots with composted apple tree wood chips in which oyster mushroom grew and yielded (5.75 g per plant). None statistically significant differences among three variants of plots were in average weight of yield per plant and average fruit weight. The statistically significant difference was found in average number of fruits per plant between control plots and plots with apple tree wood chips (Tab. I). The highest yield was reached in first week of harvest. The weight of fruits per plant yield and number of fruits in following weeks were constantly descending. The average of weight of one fruit was in following weeks was constantly descend except last week. Number of fruits lowers slower than decrease of weight of fruits. Average weight of fruits was still smaller and smaller except last week (Fig. 3, 4 and 5).

Second year (2015) the highest average weight of yield per plant (663.72 g) and the highest number of fruits (67.88 per plant) was reached at plants cultivated on plots with apple tree wood chips. The lowest average weight of yield (573.26 g) per plant was observed at plants cultivated on control plots. The lowest number of fruits (60.69 per plant) was found out at plants cultivated on plots with



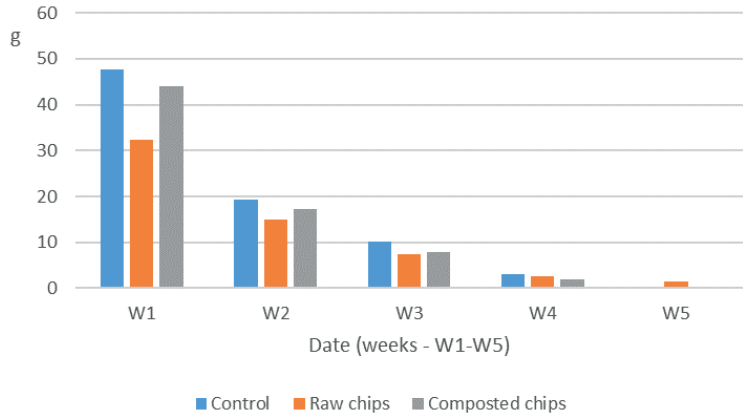
1: *Temperature during April to July 2014–2016 in Praha – Ruzyně*



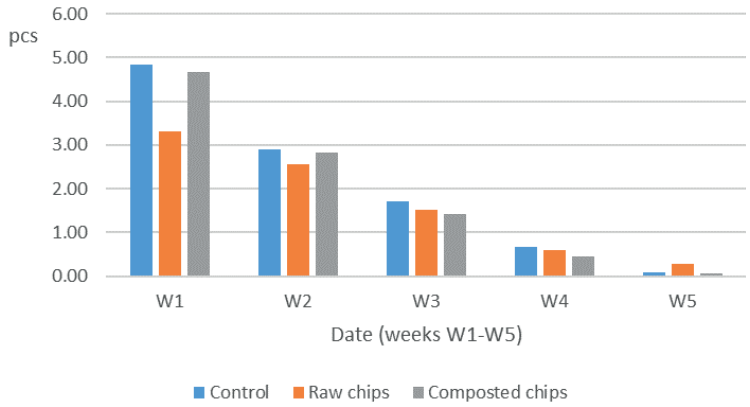
2: *Precipitation during April to July 2014–2016 in Praha – Ruzyně*

composted apple tree wood chips. Average fruit weight was the highest on plots with apple tree wood chips (8.80 g) and the lowest was on control plots (7.95 g) and control plots (7.66 g) (Tab. I). The highest yield and number of fruits was reached in the second week of harvest. The weight of fruits per plant yield and number of fruits in following weeks were constantly descending. The average fruit weight was the highest first week and in following weeks was constantly descending except last week. None statistically significant differences among three variants of plots were recorded in any evaluated parameter (Tab. I, Fig. 8, 9 and 10).

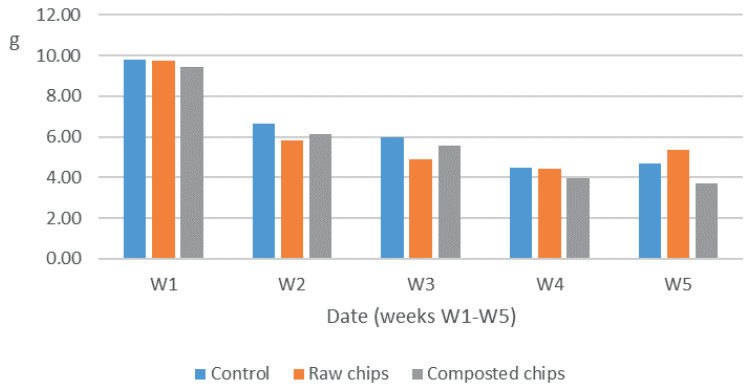
In the year 2016 the highest average weight of yield per plant (822.41 g) and the highest number of fruits (65.29 per plant) was reached at plants cultivated on plots with apple tree wood chips. The lowest average weight of yield (712.63 g) and number of fruits (51.74 per plant) were observed at plants from plots with composted apple tree wood chips in which oyster mushroom grew and yielded. Average fruit weight was the highest on plots with composted apple tree wood chips in which oyster mushroom grew and yielded (12.76 g) and the lowest was on plots with apple tree wood (12.01 g) (Tab. I). The highest yield and number of fruits was reached in second week of harvest. The weight of fruits per plant yield and number of fruits in following weeks was constantly descended. The average fruit weight was the highest first week and fruit weight was constantly descended except in following weeks, but the change was slower than in the year 2015. The statistically significant difference was found in average number of fruits per plant between plots with composted apple tree wood chips in which oyster mushroom grew and yielded and plots with apple tree wood chips (Tab. I, Fig. 13, 14 and 15).



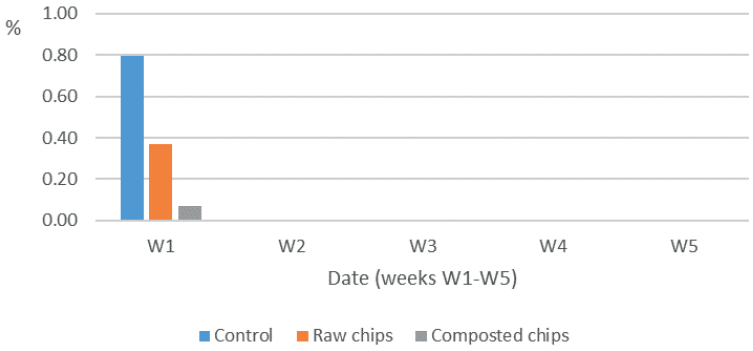
3: *Average weight of yield per plant in 2014*



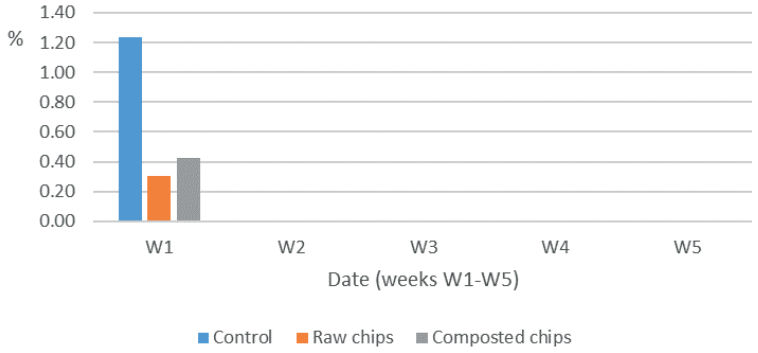
4: *Average number of fruits per plant in 2014*



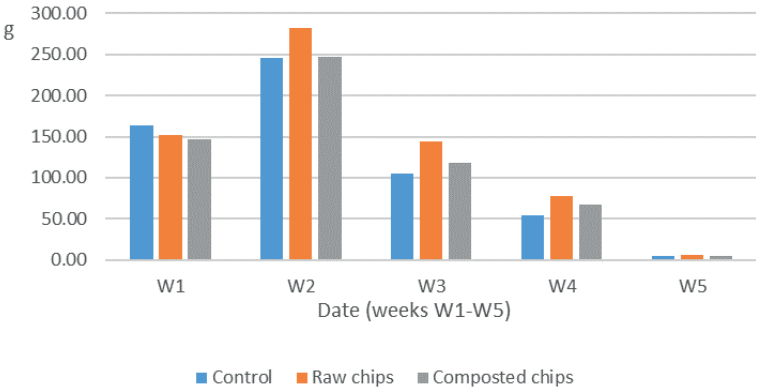
5: *Average fruit weight in 2014*



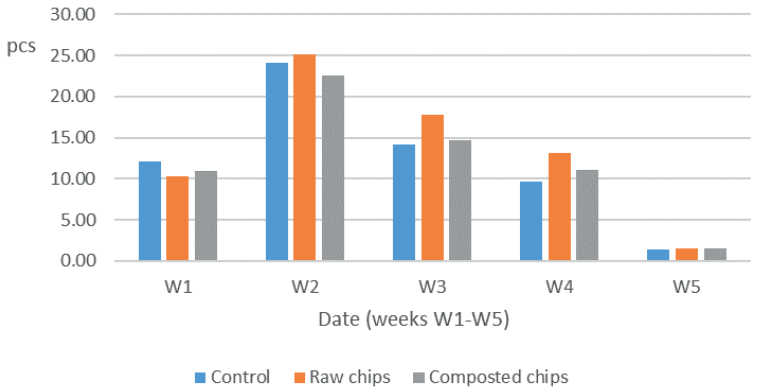
6: *Percentage of weight of fruits affected by Botrytis cinerea in 2014*



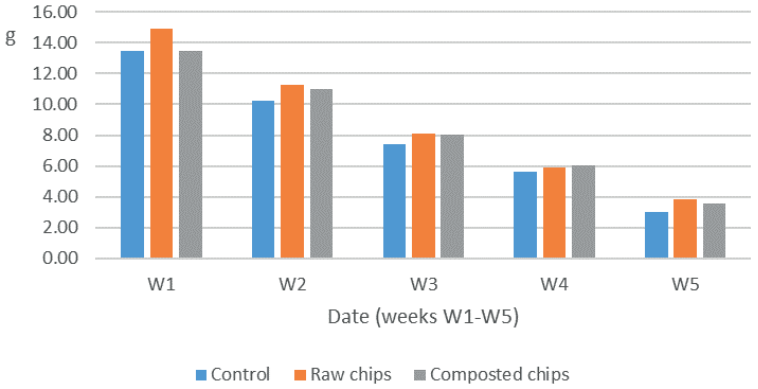
7: *Percentage number of fruits affected by Botrytis cinerea in 2014*



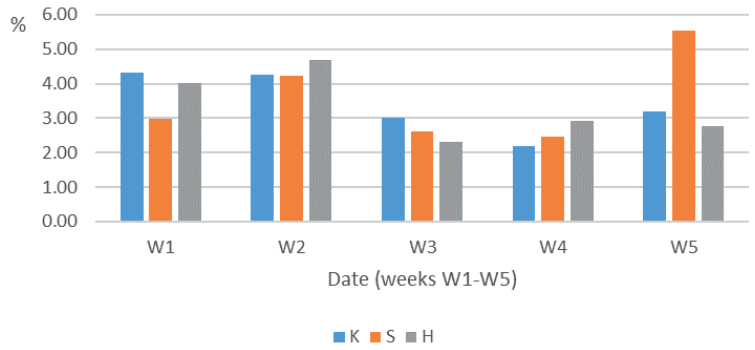
8: *Average weight of yield per plant in 2015*



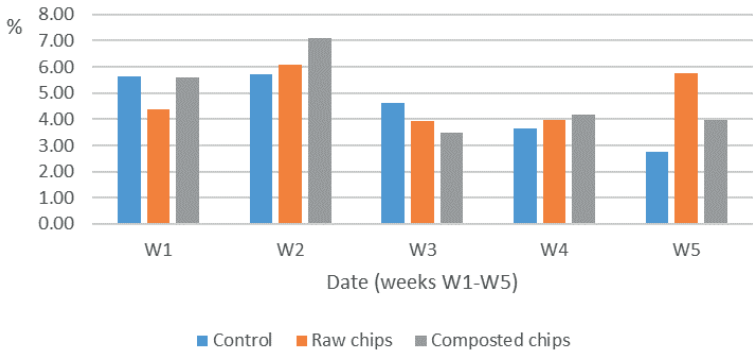
9: *Average number of fruits per plant in 2015*



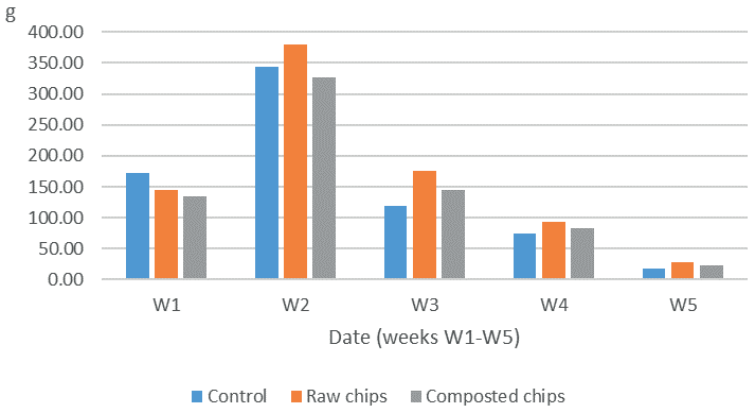
10: *Average fruit weight in 2015*



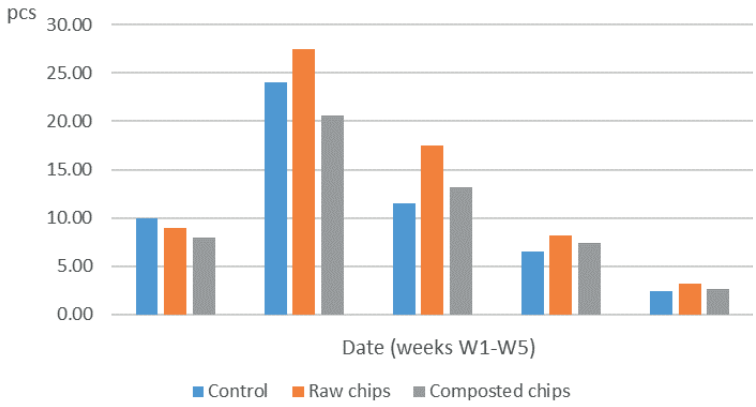
11: *Percentage of weight of fruits affected by Botrytis cinerea in 2015*



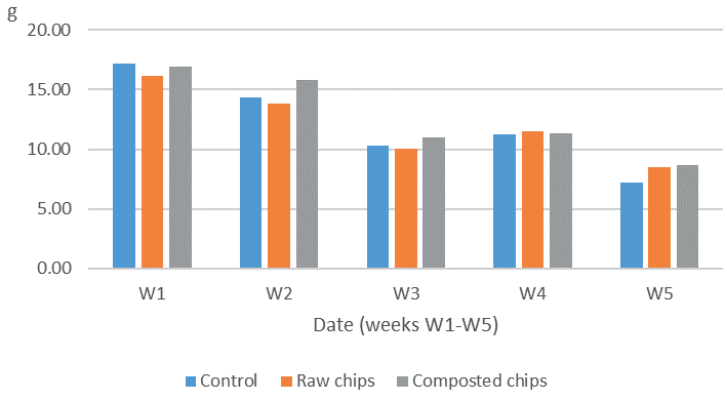
12: *Percentage number of fruits affected by Botrytis cinerea in 2015*



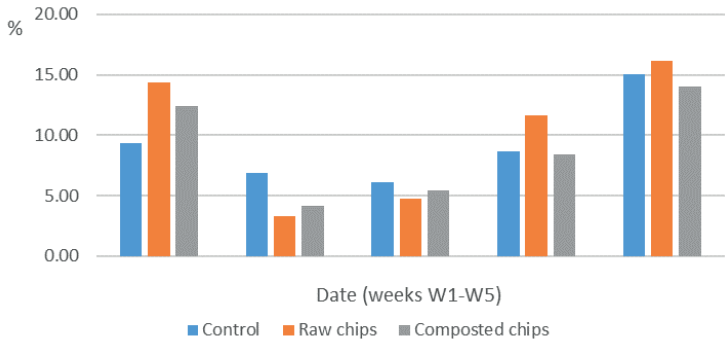
13: *Average weight of yield per plant in 2016*



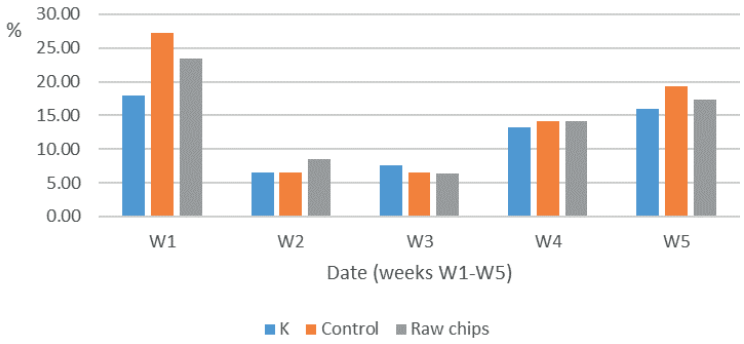
14: *Average number of fruits per plant in 2016*



15: *Average fruit weight in 2016*



16: *Percentage of weight of fruits affected by Botrytis cinerea in 2016*



17: *Percentage number of fruits affected by Botrytis cinerea in 2016*

Occurrence of grey mould caused by *Botrytis cinerea*

The differences in occurrence of grey mold on three variants of strawberry among all years were observed. Occurrence of grey mould caused by *Botrytis cinerea* on all variants of plots was similar during all years and small differences was found out only but statistically significant difference was among the years. Grey mould was the most frequently found out in the year 2016.

First year (2014) frequency of occurrence of grey mould caused by *Botrytis cinerea* was very low. Average percentage of weight of fruits affected by *B. cinerea* per plant was the smallest on plots with composted apple tree wood chips in which oyster mushroom grew and yielded and the highest at plants from control plots (0.04%) and the highest on plots with apple tree wood chips (0.47%). Average percentage number of fruits affected by *B. cinerea* was the highest on control plot (0.59%) and the lowest on plots with apple tree wood chips: (0.12%) (Tab. II). Statistically significant difference were recorded in average number of fruits affected by *Botrytis cinerea* per plant between control plot (0.06 fruit) and Plot with apple tree wood chips (0.01 fruit) only. Occurrence of grey mould was observed first week of harvest only (Tab. II, Fig. 6 and 7).

Second year (2015) average percentage of weight and number of fruits affected by *Botrytis cinerea* were 8 to 95 times higher than in the year 2014. Average percentage of weight of fruits affected by *Botrytis cinerea* was almost the same at all variants of plots (between 3.40–3.83% weight of fruits) and average percentage of number of fruits affected by *Botrytis*

cinerea was similar at all variants of plots (between 4.85 to 5.34% number of fruits). Occurrence of grey mould was observed in all week of harvest. None statistically significant differences among three variants of plots were recorded in any evaluated parameter concerning *Botrytis cinerea* (Tab. II, Fig. 11 and 12).

In the year 2016 average percentage of weight and number of fruits affected by *Botrytis cinerea* were 16 to 169 times higher than in the year 2014 and 1.8 to 2.3 times higher than in 2015. Average percentage number of fruits affected by *Botrytis cinerea* was the lowest on control (10.06% number of fruits) and the highest on plots with composted apple tree wood chips in which oyster mushroom grew and yielded (12.31% number of fruits). Average percentage of weight of fruits affected by *Botrytis cinerea* per plant was the smallest on plots with composted apple tree wood chips in which oyster mushroom grew and yielded (6.77% weight of fruits) and the highest at plants from control plots (7.71% weight of fruits). Occurrence of grey mould was observed in all week of harvest. None statistically significant differences among three variants of plots were recorded in any evaluated parameter concerning *Botrytis cinerea* (Tab. II, Fig. 16 and 17).

There were found out statistically significant differences in many parameters among all study years. The highest average weight of yield (712.63–822.41 g) and average fruit weight (12.01–12.76 g) were recorded in 2016 but the highest average number of fruits (60.69–67.88) was observed in the year 2015. The highest weight (48.27–56.89 g), number (5.48–7.16), percentage of weight (6.77–7.71%) and percentage of number (10.06–11.52%) of fruits affected by *Botrytis cinerea* were calculated in the year 2016 (Tab. II and IV).

During the study leaf spot of strawberry caused by *Mycosphaerella fragaria* was recorded on small number of leaves after harvest only. The leaves were each year after the harvest cut back and remove out of field. It was not found out the difference among the variants. Any other diseases caused by fungi or fungi-like organisms were observed.

DISCUSSION

There were evaluated yield of strawberries which were planted in March 2014 and the plants were developing during the year 2014. Therefore, results obtained in the year 2014 will not be discussed in next paragraphs. First year yield and occurrence of grey mould were statistically significant lower than in second (2015) and third (2016) year.

Until now, nobody investigated influence of composted apple tree wood chips in which oyster mushroom grew and yielded raw or apple tree wood chips on strawberry yield and frequency of grey mould on strawberry fruits.

In present study yield from plots with composted apple tree wood chips in which oyster mushroom grew and yielded almost same (±1.5%) as from control plots but average fruit weight was in these plots higher by 5.9%. Yield from plots with apple tree wood chips was higher by 13.3% than from control plots. Average fruit weight recorded on plots with apple tree wood chips in 2016 was by 0.3% lighter than from control plots and in 2016 by 10.7% heavier than from control plots. On plots with composted apple tree wood chips in which oyster mushroom grew and yielded (51.74 per plant) were observed higher number of fruits than on control plots (54.49 per plant). On plots with apple tree wood chips were picked up the highest number of fruit, but farmers prefer yield based on less amount number but heavier fruit than on higher number of lighter fruits. Apple tree wood chips started to be decomposed in 2014 and their decomposition enhanced of content of nutrient in soil and it caused higher yields in 2015 and 2016.

In the year 2016 higher occurrence of grey mould (10.0 to 11.5% of fruits) than in the year 2015 (4.8–5.3% of fruits) was recorded. The differences were statistically significant. The age of strawberry culture could be reason (accumulation of plant debris which was colonised by *Botrytis cinerea* and it was not decomposed), but probably the weather was main reason. Average temperature and precipitation during harvest and one month before were higher in the year 2016 (17.38 °C, 1.44 mm per day) than in 2015 (16.68 °C, 1.08 mm per day). Higher temperature and humidity are suitable for spread of *Botrytis cinerea*.

Pištěková (2015) did not recorded any significant positive effect of commercial products Alginure, Prev-B2 and Trifender WP on strawberry yield. Kremláčková *et al.* (2010) studied influence of Lignohumat B and Synergin® on yield two strawberry cultivars (Honeoye and Symphony). They did not found out statistically significant differences among the investigated variants (including control). Their results were more varying than in the present study. In the present study, the highest yield and number of fruits were observed on plots with apple tree wood chips, but Kremlačková *et al.* (2010) did not found out any trend in results.

Bissuti *et al.* (2017) investigated influence of commercial products Trichostar® (based on *Trichoderma harzianum* T58; Gerlach GmbH & Co. KG, Germany) and RhizoVital® (based on *Bacillus amyloliquefaciens* FZB42; Abitep GmbH, Germany) on strawberry yield and yield increase was at least by 6%. If would be apple tree wood chips with oyster mushroom living culture or with Trichoderma living culture instead of composted apple tree wood chips in which oyster mushroom grew and yielded could *Pleurotus* or *Trichoderma* added in soil enhance, quality of soil and the strawberry could be higher.

Porras *et al.* (2007) found out positive effect of solarisation, *Trichoderma* applications (Tusals®, Newbiotechic, S.A. Paseo de Bollullos de la Mitacio'n, 6 Parque Industrial A-49, PIBO, 41110 Bollullos de la Mitacio' n, Seville, Spain) and combination of solarisation with *Trichoderma* applications on strawberry yield. If would be apple

tree wood chips added before solarisation and *Trichoderma* applications after it could bring higher positive effect on strawberry yield.

In the present study, either on plots with composted apple tree wood chips in which oyster mushroom grew and yielded nor on plots with apple tree wood chips were not calculated statistically significant lower occurrence of grey mould than on control plot. The obtained results from all variants were similar. Boček *et al.* (2012) used commercial products Alginure (Tilco Biochemie GmBH, Germany), Myco-Sin® VIN (Dr. Schaette AG, Germany) and Polyversum® (Biopreparaty Ltd., Czech Republic) and they observed lower occurrence of grey mould in majority variants in comparison with control. Using of apple tree wood chips for support of development microbial community in soil and plant debris, which could decrease level of occurrence of grey mould does not give positive results at least similar as give above-mentioned commercial products.

Botrytis cinerea is frequently recorded in different plant from leaves, flowers, fruits, buds and stems. (Elad *et al.* 2004). It is not typical soil borne fungi and it is associated with plant residues in superficial layers soil and it can utilize cellulose (Domsch *et al.* 2007) but rarely is isolated from woody parts of plants. The apple tree wood chips is not suitable source of nutrient for B. cinerea and therefore it is small probability that wood chips could be reservoir of this fungus. Wood chips in which oyster mushroom grew and yielded were utilized by *Pleurotus ostreatus* and composted. *B. cinerea* does not have enough of nutrients for utilization. Therefore it is small probability that substrate could be reservoir of *B. cinerea*.

Spore germination and infection *Botrytis cinerea* optimum temperatures are between 9 and 21 °C (Shtienberg and Elad 1997). Yunis *et al.* (1994) found out outbreaks of gray mold occurred if free moisture was longer than 7 hours and temperature exceeded 12–18 °C. During our study the distribution of precipitation during April to June was each year different (Fig. 2). Sum precipitation in April was 22.6 mm, 33 mm and 18.4 mm in 2014, 2015 and 2016, respectively. Sum precipitation in May was 110 mm, 43.5 mm and 30.7 mm in 2014, 2015 and 2016, respectively. Sum precipitation in June was 13.8 mm, 28.75 mm and 59.4 mm in 2014, 2015 and 2016, respectively (Fig. 2). In May (14.8 °C) and June (18.7 °C) 2016 the highest average temperature against 2014 (in May 13.0 °C, in June 17.3 °C) and 2015 (in May 13.7 °C, in June 17.0 °C) was recorded. The highest percentage of weight and number of fruits affected by *Botrytis cinerea* was taken in 2016 (Fig. 1). The higher precipitation in June and higher temperature in May and June in 2016 give better conditions for outbreaks of gray mold.

CONCLUSION

From obtained the results, it is evident that are limited differences in yield among strawberry plants cultivated on soil in which were composted apple tree wood chips in which oyster mushroom grew and yielded added, soil in which were apple tree wood chips added and spoil without additives. The highest average weight of yield was and the highest average number of fruits were found out at plants growing on soil with apple tree wood. Average weight of yield on plots with apple tree wood chips was 663.72 g and 822.41 g in 2015 and 2016, respectively. Number of fruits per plant on plots with apple tree wood chips was 67.88 pieces and 65.29 pieces in 2015 and 2016, respectively. The highest average fruit weight was recorded at plants cultivated on soil with composted apple tree wood chips in which oyster mushroom grew and yielded. Fruits from all study variants were infested by grey mould caused by *Botrytis cinerea* with similar frequency. There was statistically significant difference in average number of fruits per plant were second a third year, but there were difference in average weight of yield per plant and average fruit weight (third year were higher).

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