

# Influence of mulching materials on pepper (*Capsicum annuum* L. ssp. *macrocarpum* var. *longum*) characteristics

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## Abstract

The experiment was conducted in order to determine the influence of different mulching materials on some parameters of pepper kapiya type grown in an open field. This type of pepper is widely grown in North Macedonia in open field. It is specifically used for processing with more than half of raw materials volume. The experiment was carried out in the village of Kutretino near Demir Hisar, during the season of 2018. The treatments were as follows: no mulch (bare soil) – as control treatment, straw mulch, black film mulch, white on black (double face) film mulch and red film mulch. A single experimental plot was 15 m<sup>2</sup> with density of 100 plants per plot organized in complete randomized block design in four replications. During the vegetation period the plant height (cm), number of marketable fruits per plant, fruit length (cm), fruit diameter (cm), fruit mass (g) and total yield (t ha<sup>-1</sup>) were measured. According to the results the highest plants (58.8 cm), the highest number of marketable fruits per plant (8.45), the longest and widest fruits (16.00 and 8.25 cm, respectively), the highest fruit mass (113.79 g) and the highest yield (63.15 t ha<sup>-1</sup>) were obtained from plants grown with black foil as mulching material. Taking into consideration the results, it can be concluded that mulching with black film gave the best results for the most of the examined parameters and can be widely used for pepper kapiya type production in open fields.

**Keywords:** open field production, kapiya, straw mulch, plastic films mulch, yield

## INTRODUCTION

Mulching aims to cover soils and forms a physical barrier in order to limit soil water evaporation, to control weeds, to maintain a good soil structure, to improve soil temperature and even to keep the fresh products clean from soil impurities (Awasthi et al., 2006; Siwek et al., 2007; Liang et al., 2011; Kumar and Lal, 2012; Campiglia et al., 2012; Bhardwaj, 2013; Yordanova and Gerasimova, 2015; Kader et al., 2017). The usage of plastic materials for mulching has a dramatic increase worldwide. It is reported that in China the volume of plastic film mulch has a 200-fold increase in the last three decades (Changrong et al., 2014) with a steadily positive annual trend. Kasirajan and Ngouajio (2012) in their detailed review on the advantages and disadvantages of plastic film mulches, express environmental concerns and propose alternative mulches – organic and biodegradable. There are findings that indicate positive influence of paper biodegradable mulch in cultivation of cucumbers (Haapala et al., 2015) and use of different types of straw for cultivation of broccoli and tomato (Kosterna, 2014). When it comes to vegetable mulches, they are mainly used for soil-cultivated crops in open field production as there are plenty of reports detailing the advantages of watermelon mulching (Dadheech et al., 2018) and other cucurbits. There is also information about different mulches enhancing not only the yield but also improving the quality of vegetable crops that are typically grown indoors. Thus, it has been indicated that Agrotexil mulch had a positive effect on the reduction of nitrate in lettuce (Tošić et al.,

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2016). There are fewer studies made on pepper crop and mulching and they mainly refer to hot peppers and bell peppers (Romic et al., 2003; Ashrafuzzaman et al., 2011; Belel, 2012; Mochiah et al., 2012; Komla, 2013; Musie et al., 2015; Edgar et al., 2016; Canul-Tun et al., 2017).

In the Republic of North Macedonia pepper kapiya type is one of the leading vegetable crops by its economic importance. The generic name for this type of peppers is derived from the Turkish word for “gate” because of the large flat fruits with thick pericarp. It represents indispensable raw material for the processing industry with the largest share of almost 63% of processed vegetables (Martinovska Stojcheska et al., 2019). Due to the extensive open field practices the yields get lower by season causing serious losses for the growers. Therefore we propose mulching as a possible improvement of the current agricultural practices. The objective of this trial was to determine the influence of different mulching materials on growth and yield of pepper kapiya type produced in open fields.

## **MATERIALS AND METHODS**

The research was carried out in 2018 on a pepper kapiya type originating from Turkey (Bursa Tohum Seed Production Company) in the vicinity of the village Kutretino, near Demir Hisar (41.22°N, 21.20°E, altitude 700 m). Climatic parameters were within the 10-years average for this region.

The experiment included four treatments compared to the control – no mulch: treatment 1 – wheat straw mulch (thickness of layer 5 cm); treatment 2 – black film mulch (20 µm thickness); treatment 3 – white on black film mulch (20 µm thickness); and treatment 4 – red film mulch (20 µm thickness). Distance between the rows was 60cm and 25cm between the plants. Each experimental plot had 100 plants on a surface of 15 m<sup>2</sup>. The plots were organized into a complete randomized block system with 4 replications, or 20 experimental plots in total (300 m<sup>2</sup>). The plants were grown from seedlings. The transplantation date was 30<sup>th</sup> of May, 60 days from emerging. During the vegetation, custom agricultural practices were applied such as: drip irrigation, fertilization and plant protection.

The plant height and number of marketable fruits per plant were measured on 10 plants from each experimental plot, while the fruit morphological characteristics, such as fruit length (cm), fruit diameter (cm) and fruit mass (g) were recorded on 20 fruits from each experimental plot. Fruit mass was measured by electronic balance with a precision to second decimal, while fruit length and diameter were measured by a digital caliper. In order to calculate the total yield 50 plants of each experimental plot randomly selected were harvested weekly, starting from the last week of August. Obtained data were statistically processed by analysis of variance (ANOVA). The sample means among treatments were compared by least significant difference (LSD) tested at 1 and 5% probability level.

## **RESULTS AND DISCUSSION**

According to the trial results, the black film mulch had a very good influence on the plant height with an average value of 58.8 cm as presented in Table 1a. There is a significant statistical difference at the level of 0.01 among all tested treatments and the control. Locher et al. (2005) examining the influence of colored mulches (clear, violet and light green) on soil temperature and yield of sweet pepper found that height and stem diameter in mulched treatments had shown significantly stronger vegetative growth than the un-mulched treatment. Strong vegetative growth is especially important for the kapiya type pepper as the plant produces relatively heavy fruits that might cause collapse of the stem. In a similar experimental design, Dhaliwal et al. (2017) confirm that pepper plants grown on black film mulch were the highest ones compared to other types of mulch.

Ashrafuzzaman et al. (2011) found a higher number of fruits in mulching plants compared to the ones grown on bare soil to be a result of the positive influences of mulching on flower fertilization. In the same paper, the highest number of fruits was reported for plants grown on black film mulch, followed by blue film and transparent film. Consistent to these results, in our study we have observed on average 8.45 fruits per plant (Table 1b.), with a significant difference between this and the other treatments. However, there was no

significant difference among the other treatments and the control.

Table 1. Comparison between treatments for the examined plant traits.

Examined traits by treatments	Treatments				
	No-mulch	Straw	Black foil	White on black foil	Red foil
a. Plant height (cm)	LSD 0.05=1.44 <sup>a</sup> LSD 0.01=2.02 <sup>A</sup>				
No-mulch	<b>47.23</b>	-3.77 <sup>A</sup>	-11.65 <sup>A</sup>	-6.17 <sup>A</sup>	5.50 <sup>A</sup>
Straw	3.77 <sup>A</sup>	<b>51.00</b>	-7.88 <sup>A</sup>	-2.40 <sup>A</sup>	9.27 <sup>A</sup>
Black foil	11.65 <sup>A</sup>	7.88 <sup>A</sup>	<b>58.88</b>	5.48 <sup>A</sup>	17.15 <sup>A</sup>
White on black foil	6.17 <sup>A</sup>	2.40 <sup>A</sup>	-5.48 <sup>A</sup>	<b>53.40</b>	11.67 <sup>A</sup>
Red foil	-5.50 <sup>A</sup>	-9.27 <sup>A</sup>	-17.5 <sup>A</sup>	-11.67 <sup>A</sup>	<b>41.73</b>
b. Number of marketable fruits per plant	LSD 0.05=0.98 <sup>a</sup> LSD 0.01=1.23 <sup>A</sup>				
No-mulch	<b>7.00</b>	0.75	-1.45 <sup>A</sup>	-0.38	1.42 <sup>A</sup>
Straw	-0.75	<b>6.25</b>	-2.20 <sup>A</sup>	-1.13 <sup>a</sup>	0.67
Black foil	1.45 <sup>A</sup>	2.20 <sup>A</sup>	<b>8.45</b>	1.07 <sup>a</sup>	2.87 <sup>A</sup>
White on black foil	0.38	1.13 <sup>a</sup>	-1.07 <sup>a</sup>	<b>7.38</b>	1.80 <sup>A</sup>
Red foil	-1.42 <sup>A</sup>	-0.67 <sup>a</sup>	-2.87 <sup>A</sup>	-1.80 <sup>A</sup>	<b>5.58</b>
c. Fruit length (cm)	LSD 0.05=0.46 <sup>a</sup> LSD 0.01=0.65 <sup>A</sup>				
No-mulch	<b>15.40</b>	-0.30	-0.60 <sup>a</sup>	-0.38	0.12
Straw	0.30	<b>15.70</b>	-0.30	-0.08	0.42
Black foil	0.60 <sup>a</sup>	0.30	<b>16.00</b>	0.22	0.72 <sup>A</sup>
White on black foil	0.38	0.08	-0.22	<b>15.78</b>	0.50 <sup>a</sup>
Red foil	-0.12	-0.42	-0.72 <sup>A</sup>	-0.50 <sup>a</sup>	<b>15.28</b>
d. Fruit diameter (cm)	LSD 0.05=0.32 <sup>a</sup> LSD 0.01=0.44 <sup>A</sup>				
No-mulch	<b>8.00</b>	-0.13	-0.25	-0.13	-0.03
Straw	0.13	<b>8.13</b>	-0.12	0.00	0.10
Black foil	0.25	0.12	<b>8.25</b>	0.12	0.22
White on black foil	0.13	0.00	-0.12	<b>8.13</b>	0.10
Red foil	0.03	-0.10	-0.22	-0.10	<b>8.03</b>
e. Fruit mass (g)	LSD 0.05=10.38 <sup>a</sup> LSD 0.01=12.62 <sup>A</sup>				
No-mulch	<b>105.39</b>	-2.69	-8.40	-6.99	1.90
Straw	2.69	<b>108.08</b>	-5.71	-4.31	4.59
Black foil	8.40	5.71	<b>113.79</b>	1.40	10.30
White on black foil	6.99	4.31	-1.41	<b>112.38</b>	8.89
Red foil	-1.90	-4.59	-10.30	-8.89	<b>103.49</b>

a = significant at 5%, A = highly significant at 1%.

Fruit length and diameter determine the shape of the paper fruit. Kapiya type is characterized by fruit index 2. Although these two traits are stable for a certain cultivar, in this study we have observed a statistically significant difference in the average fruit length among the different treatments, with the longest fruits obtained with black film mulch, averaging 16.00 cm (Table 1c.). Unlike the fruit length, the fruit diameter (Table 1d.) was observed to be rather uniform among treatments, with no significant differences. The highest average value was again recorded in plants grown with black film mulch (8.25 cm), followed by the straw and white on black film with an average width of 8.13 cm, red film with an average width of 8.03 cm and at the end fruits from the control treatment with an average width of 8.00 cm. In a similar trial, but with different pepper cultivars, Belel (2012) found a statistically significant difference ( $p>0.05$ ) in the fruit length of all different mulches compared to the control (4.52 cm). The longest fruit of 7.78 cm in his trial was obtained from black film. Unlike our results, the same author found a significant influence of mulching materials ( $p>0.01$ ) on fruit diameter and number of fruits per plant, which may be a result of

increased number of branches and leaves of plants. In an experiment comparing different organic and inorganic mulches (Edgar et al., 2016) it was concluded that fruit length and diameter had been significantly different ( $P < 0.05$ ) between all the treatments as compared to the control, but among the mulched plots greatest fruit length was observed on the black polythene treatment and the largest fruit diameter of the fruits from the straw mulch. According to Dhaliwal et al. (2017) the superior performance under black polythene mulch can be attributed to improved root zone temperature.

Edgar et al. (2016) found that the effect of different plastic mulches on fruit mass per plant was significant at  $P < 0.05$  compared to the control plot. In the same trial the black plastic polythene mulch had the heaviest fruits (924.5 and 649.8 g plant<sup>-1</sup>) which was however insignificantly different from the other mulched plots. In our experiment there was no statistically significant difference in the average fruit mass among the studied treatments (Table 1e.). Peppers grown on black film mulch had the highest average fruit mass (113.79 g), while the lowest average fruit mass had the fruits of red film mulch (103.49 g). Belel (2012) and Mochiah et al. (2012) also found that there was no significant difference in fruit mass between the treatments with different types of mulches.

Locher et al. (2005) report that in case of all treatments with their experiment on clear and colored plastic mulch the yields have been between 4.5 and 6 kg m<sup>-2</sup> as an outstanding result under Hungarian open-field conditions for the examined cultivar and that mulched treatments produced significantly higher yields than the un-mulched treatment. This study demonstrates the positive influence of black film mulch on the total yield, which is not the case with the use of red film mulch. A comparative analysis of the average yield, as presented in Figure 1, showed that there was a statistically significant difference at the level 0.01 between the yield of black foil (63.15 t ha<sup>-1</sup>) and the yield obtained from control, straw and red foil. Many studies showed that black foil had superior positive impact on the yield of pepper (Romic et al., 2003; Ashrafuzzaman et al., 2011; Edgar et al., 2016; Mekonnen and Betewulign, 2014; Canul-Tun et al., 2017). According to Dhaliwal et al. (2017) the superior performance under black polythene mulch can be attributed to improved root zone temperature. Dadheech et al. (2018) add to this findings that soil water loss is reduced under black plastic mulch and that a more uniform soil moisture is maintained, thus the growth of plants on mulch can be twice that of plants in un-mulched soil.

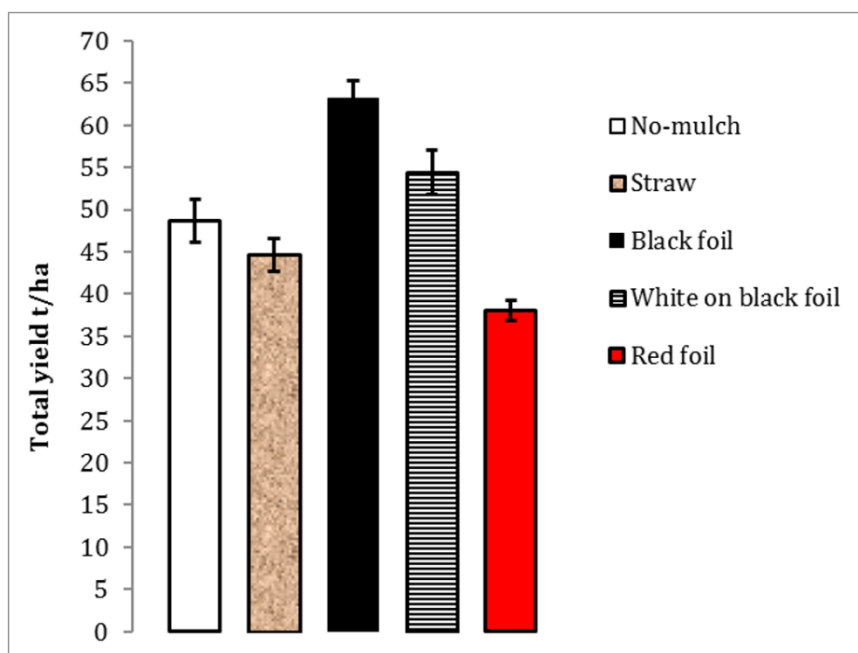


Figure 1. Total yield (t ha<sup>-1</sup>) by treatment.

## CONCLUSIONS

The following conclusions can be drawn from the experiment:

- Mulching had positive effects on growth and yield of pepper kapiya type in open fields.
- Straw wheat mulch and red film were less suitable for pepper kapiya type grown in open fields.
- The black film followed by white on black film can be recommended for pepper kapiya type production in open fields.

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