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Effect of different types of mulches on 'Newton' tomato yields and fruit cracking under plastic greenhouse conditions

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Abstract: This study was conducted at Al-Balqa` Applied University research station to investigate the effect of different types of mulches on 'Newton' tomato yields and fruit cracking incidence under greenhouse conditions. The experiment consisted of seven treatments (black plastic, tuff gravel, clear plastic, compost, crushed stone, shredded wood, and the control); a randomized complete block design with three replicates was used. Different mulch types showed significant effects on early, medium, late, and total yields/ha of the tomato fruits. Higher early and medium yields were obtained using black and clear plastic. Compost resulted with the highest total yield. Results of this study clearly showed that mulching improves total tomato yields under greenhouse conditions. In addition, larger fruits were obtained by applying mulching. Tomato cracking was also slightly affected by the mulch types used in this study.

1. Introduction

Tomato is the leading vegetable crop grown throughout the world and it is also the number one vegetable crop in Jordan. The statistics of the Ministry of Agriculture (MOA, 2012) reveal that the total tomato area cultivated is 12344.5 ha producing an average of 73.4 tons per hectare. In addition, the statistics indicate that the total number of plastic houses is extensively increasing. In Jordan, the use of various types of mulches has become a well-established practice over recent years.

It is well known that mulching helps to maintain healthy vegetable crops. The benefits of using several types of mulches have been extensively studied and recognized. However, with the global call for organic agricultural production and reduction of pesticide and fertilizer use, mulches will continue to be used.

Peet (1992) summarized the environmental, cultural, and anatomical factors that can increase the incidence of cracking as: irregular watering, high temperatures and light, fruit anatomy, excessive rapid fruit growth, genetical differences among cultivars, high differences between day and night temperatures, and high humidity. Peet and Willits (1995) concluded that growers should reduce watering tomato cultivars that are crack-prone, particularly when yielding from the upper clusters. The cuticular membrane in the outer epidermal periclinal walls of both resistant and intermediate cultivars was thicker when compared to cultivars that exhibit cracking (Matas *et al*., 2004). Cracking is mainly caused by extreme changes in fruit growth rate caused by moisture fluctuations (Swiader *et al*., 1992). Thus, the growth rate is affected by mulching material by means of manipulating the microclimate (Bender *et al*., 2008; Abubaker, 2013). Differences in the microclimate, depending on the mulch material, will influence the growth rate and hence could affect fruit cracking incidence. Therefore, the objective of this study was to investigate the effect of different types of mulches on 'Newton' tomato yield and fruit cracking incidence under plastic house conditions.

2. Materials and Methods

The research was conducted at Al-Balqa' Applied University Research Station during the 2011/2012 growing season under a green plastic house (25 m long, 9 m wide, and with a height of 2.7 m) covered with a single glaze of 200 micron clear polyethylene film. During the summer season 2011, soil solarization was applied against soil borne pests. Soil was then disked and prepared for laying the types of mulches used in the study. Seven types of mulches were used: black plastic, tuff gravel (thickness of covering 6-7 cm), clear plastic, compost (thickness of covering 6-7 cm), crushed stone (thickness of covering 6-7 cm), shredded wood (thickness of covering 6-7 cm), and the control (no

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mulch). These were arranged in a randomized complete block design with three replicates for each mulch type. Five- to six-week-old seedlings of the commercial indeterminate tomato (*Lycopersicon esculentum* M. var. 'Newton'), with an average of 12 cm height, were transplanted in December 2011. Each experimental unit consisted of a 3 m row length, with a 1 m space between every two rows. Seedling distances were 30 cm between plants with ten plants per plot. The soil surface was covered with the designated type of mulch just before transplanting and it remained covered until the end of the growing season. Tomato plants were then trained to one stem by continuous removal of auxiliary shoots. Soil moisture content was monitored using a MPKIT-160 soil moisture meter. A drip irrigation system was employed to irrigate and fertilize the plants according to local commercial tomato, plastic-house grower practices. Weeds were removed by hand and pest management control practices were applied throughout the study. Growth parameters (plant height, stem diameter, total number of leaves, and dry matter) were recorded (Abubaker, 2013). Total yield of ripe fruits was determined by recording the consecutive weights of 24 hand-harvested fruits from 6 March to 10 June 2012. Total yield was subdivided into three categories: early, medium, and late yields consisting of eight harvests each. The total number of cracked fruits and the percentages were recorded for the three harvest dates. All statistical analyses were performed using SAS/STAT Version 9.2 and Analysis of Variance was conducted by the PROC GLIMMIX procedure. Means were separated following the Fisher's Protected Least Significant Difference (LSD) Test.

3. Results and Discussion

The different mulch types showed significant effects on early, medium, late, and total yields (t/ha) of the tomato fruits (Table 1). Tomato plants grown under black, clear plastic, and shredded wood mulches resulted in the highest early yields, which were significantly higher than that of the control (Table 1). However, tuff gravel, crushed stone, and the plants grown using compost resulted in higher early yields compared to the control but they were not significantly different. Swiader *et al*. (1992) mentioned that black, gray, and transparent mulches raise soil temperatures. Thus, the rate of growth for plants grown under those mulches will increase. The mean yields showed fewer differences between the various types of mulches (Table 1). Black and clear plastic resulted in higher mean yields, however they were not significantly different from that of the control. Compost also resulted in higher mean yields that were not significantly different from the control and the slow release of nutrients from the organic material early in the season may be a possible explanation. Tomato plants that were grown using shredded wood and tuff gravel as a mulches recorded the lowest mean yields: 56.1 and 57.4 t/ha, respectively (Table 1). However, these yields were not significantly different compared to the control. Late yields showed less difference among the various types of mulches (Table 1), although the highest were recorded with tuff gravel (60. 2 t/ha) and compost (59.7 t/ha). These yields were significantly different compared to the yields of plants growing without mulch. Shredded wood also resulted in higher late yields that were significantly compared to the control. In addition, the control yields (48.1 t/ha) showed higher late yields but they were not significantly different compared to the clear plastic (46.4 t/ha), black plastic (43.5 t/ha), and crushed stone (43.3 t/ha). The highest overall yields were obtained using compost (Table 1). The descending order from highest to lowest total yields was found to be: compost, black plastic, clear plastic, tuff gravel, shredded wood, control, and finally crushed stones. The total yields of plants grown under compost, black plastic, clear plastic, and tuff gravel were significantly different compared to the control but were not significantly different compared to the shredded wood mulch. Crushed stone mulch gave the lowest total yields (144.2 t/ha), which were not significantly different compared to the control and shredded wood much. The soil temperature-increasing effect of black mulch and the late season release of organic material from the compost explain the ability of such mulches to give superior production compared to the other types. Our results coincide with Kayum *et al*. (2008) and Bay (2011). Both researchers showed that

Table 1 - Yield (early, medium, late, and total) and average fruit weight of greenhouse tomato 'Newton' under different types of mulches

Mulch type	Early yield (t/ha)	Medium yield (t/ha)	Late yield (t/ha)	Total yield (t/ha)	Fruit weight (g)
Black plastic	46.5 a	70.1 a	43.5 b	160.1 a	173.4 ab
Tuff gravel	38.7 bc	57.4 b	60.2 a	156.3 a	169.5 abc
Clear plastic	45.2 a	66.3 a	46.4 b	157.9 a	174.7 a
Compost	36.7 c	66.0 a	59.7 a	162.4 a	175.1 a
Crushed stone	37.7 bc	62.2 ab	43.3 b	144.2 b	150.5 d
Shredded wood	43.3 ab	56.1 b	56.2 a	155.6 ab	160.8 bcd
Control	33.2 c	63.3 ab	48.1 b	144.6 b	160.2 cd
LSD 0.05	6.29	8.11	7.45	11.48	13.15

Different letters in a column indicate significant differences at $P \leq 0.05$ according to Fisher's Protected LSD.

mulching significantly affected yield components, increased yield, and improved fruit quality.

Regarding fruit weight, the largest fruits were obtained using compost, clear and black plastic with average weights of 175.1, 174.7, and 173.4 g/fruit (Table 1). These weights were not significantly different compared to tuff gravel. The lowest fruit weights were achieved when crushed stone was used, followed by the control and shredded wood. There were no significant differences with regard to the lowest fruit weights.

Dry matter contents of leaves and stems were significantly affected by mulch types (Table 2). Tomato dry matter was highest when grown using the compost as a mulching material (19.4%); differences with crushed stone (18.8%) and black plastic (18.3%) were not significant. Abubaker (2013) attributed similar findings to the higher amounts of available minerals released from the compost which also manifested favorable effects on available water content during the growing season, directly affecting vegetative growth.

Table 2 - Dry matter percentages of 'Newton' tomato leaves and stems grown under different types of mulches

Mulch type	Dry matter of leaves and stems (%)
Black plastic	18.3 ab
Tuff gravel	17.8 b
Clear plastic	17.6 b
Compost	19.4 a
Crushed stone	18.8 ab
Shredded wood	17.7 b
Control	17.6 b
LSD 0.05	1.30

Different letters in a column indicate significant differences at $P \leq 0.05$ according to Fisher's Protected LSD.

Regarding fruit cracking, average values are presented in Figure 1 and the average percentage of cracked fruits are presented in Figure 2. The results clearly indicate no significant differences between the seven mulch types used in our study. However, the average number of cracked fruits was highest when compost was used, and it is worth mentioning again that the highest overall yields were obtained using this type of mulch. However, slight differences were observed in the average percentage of cracked fruits with regard to the total number of fruits, particularly between the clear plastic and control treatments but these differences were not significantly different. Our results are in agreement with Suwwan *et al*. (1988) who indicated that seasonal cracking was not affected by the five mulch types they studied (i.e. silver plastic, black plastic, paper, white/black plastic and black/white plastic).

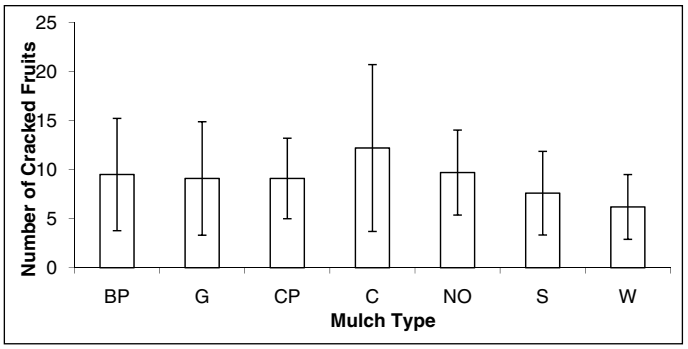

Fig. 1 - The average number of cracked `Newton` tomato fruits for the three harvest dates for each mulch type. BP= black plastic, G= gravel, CP= clear plastic, C= compost, NO= no mulch (control), S= stone, and W= wood.

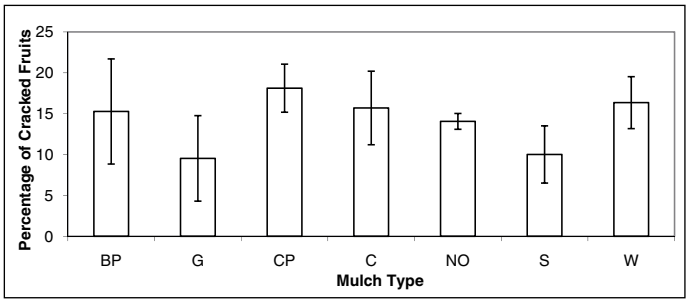

Fig. 2 - The percentage of cracked `Newton` tomato fruits for the three harvest dates for each mulch type. BP= black plastic, G= gravel, CP= clear plastic, C= compost, NO= no mulch (control), S= stone, and W= wood.

4. Conclusions

Mulching improved growth parameters and yields of 'Newton' tomato grown under plastic house conditions. The highest overall yields were obtained using compost followed by black plastic. No significant differences among types of mulches were observed regarding the number of cracked fruits. However slight, though not significant, differences were found when considering the average number of cracked fruits compared to the total number of fruits.

References:

ABUBAKER S., 2013 - *Effect of different types of mulch on performance of tomato (*Lycopersicon esculentum *M.) under plastic house conditions*. - Journal of Food, Agriculture & Environment, 11(2): 132-134.

BAY B., 2011 - *Effect of mulching and amount of water on the yield of tomato under drip irrigation*. - Journal of Horticulture and Forestry, 3(7): 200-206.

BENDER I., RAUDSEPING M., VABRIT S., 2008 - *Effect of organic mulches on the growth of tomato plants and quality of fruits in organic cultivation*. - Acta Horticulturae, 779: 341-346.

KAYUM M.A., ASADUZZAMAN M., HAQUE M., 2008 - *Ef-*

fects of indigenous mulches on growth and yield of tomato. - Journal of Agriculture & Rural Development, 6(1&2): 1-6.

MATAS A.J., COBB E., PAOLILLO D., NIKLAS K., 2004 - *Crack resistance in cherry tomato fruit correlates with cuticular membrane thickness*. - HortScience, 39(6): 1354-1358.

MOA, 2012 - *Annual Report*. - Ministry of Agriculture, Amman, Jordan.

PEET M.M., 1992 - *Fruit cracking in tomato*. - HortTechnology, 2(2): 216-223.

PEET M.M., WILLITS D., 1995 - *Role of excess water in tomato fruit cracking*. - HortScience, 30(1): 65-68.

SUWWAN M., AKKAWI M., AL-MUSA A.M., MANSOUR A., 1988 - *Tomato performance and incidence of tomato yellow leaf curl (TYLC) virus as affected by type of mulch*. - Scientia Horticulturae, 37(1-2): 39-45.

SWIADER J., WARE G., McCOLLUM J., 1992 - *Producing Vegetable Crops*. - Fourth Edition, Interstate Publishers, Inc., Danville, Illinois, USA