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Effect of Plastic Mulch Color on Growth and Productivity of Different Summer Squash Varieties Grown Off-Season

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Abstract

The current study describes the effect of coloured plastic mulch, clear and black polyethylene (PE), on growth and productivity of different summer squash varieties grown on February "off-season". A field experiment was carried out during 2012 and 2013 seasons at the Experimental Farm of Faculty of Agriculture, Assiut University, Assiut, Egypt. The performance of different parameters studied for plant received different mulch treatments was superior to the control (bare soil) treatment. The genotypic differences among squash varieties investigated were found significant for all the studied parameters. Clear PE mulch was significantly more effective than the black PE mulch in this respect. Plants of cvs sown on clear PE flowered earlier than those sown on black PE or bare soil.Total fruit yield (ton/fed) was significantly increased by using clear PE (total fruit yield was 12.61 and 12.94 ton/fed in the 1 st and 2 nd seasons, respectively; corresponding values for the bare soil were 7.61 and 7.74 ton/fed). Plants of 'Eskandrany' produced using clear PE were significantly the earliest to flower and gave the highest early and total fruit yield. It is concluded that mulching, especially clear PE, can be usefully utilized to enhance the summer squash production when grown off-season.

Keywords*: cucurbita pepo, off-season, plastic mulch, production technology.*

Introduction

Summer squash is amongst the most important vegetable crops in Egypt as well as tropical and subtropical regions of the world. It can be produced the year round but grows better in warm weather. Under Egyptian growing conditions especially, early (off-season; late winter or early summer) production of such crop is faced with environmental limitations (prevailing low temperature). Mulching as one of the soil management techniques has been suggested by several authors to improve crop growth and productivity through enhancing soil warming and consequent water and nutrient uptake. The response of vegetable crops to mulch materials in terms of early maturity, better fruit quality and higher yield of tomato has been reported (Hussein *et al*., 2006; Bhella, 1988; West and Pierce, 1988). Black plastic mulch as a soil cover increased okra and squash vegetative growth and yield under rain-fed con-ditionsas compared with bare soil. (Mahadeen, 2014). In addition, plastic mulch increased soil temperature, e.g. in eggplant (Farghali, 1994), okra (Incalcatera *et al.*, 2000), in pepper and okra (Abdel-Rahman, 2007).Black polyethylene (BPE) or clear polyethylene (CPE) mulch is preferred for winter production, because of their ability to transmit more solar energy and the ability of black PE to absorb more heat (Al-Masoum *et al*. 1998). Also, polyethylene (PE) film used in mulching play a great role in modifying soil moisture (VanDerWarken and Wilcox-Lee, 1988). Thus, the objective of this study was to investigate the effect of clear and black PE mulches on growth and productivity of summer squash cvs grown on February "off-season".

Materials and Methods

This study was carried out at the Experimental Farm of Faculty of Agriculture, Assiut University, Assiut, Egypt, during 2012 and 2013 seasons.

Plant material: Four summer squash *(Cucurbita pepo* L.) varieties viz. Eskandrany (1 and 2) produced by Misr for agricultureal development Co., Hybrid cv 'Amjad F1' and Hybrid cv 'New Eskandrany F1' produced by Misr hytech seed international Co., were investigated for their productivity under plastic mulch.

Mulch type: Black polyethylene (BPE) and clear transparent polyethylene (CPE) plastic films each

of 50 µm thickness were used as soil mulch applied prior to planting. Average temperature recorded,˚C at 10 cm depth in soil covered with black or clear polyethylene (PE) mulch or bare soil for the 4 summer squash cultivars grown on February during 2012 and 2013 seasons are presented in Table (1).

Expermental design: Experiment was laid out as split-plot in randomized complete-block design with three replicates. The summer squash cvs were in the main plots, while mulch treatments were randomly distributed to the sub-plots. After 10 days from irrigated the field, plots were completely and tightly covered with the plastic film, bare soil plots were included as control. Seeds were soaked in warm water at 40 °C for 12 h and then incubated at 30 °C in an electric incubator for 12 hours till the radical emergence. Germinated seeds were planted in the permanent field on 1 and 5 Feb., in 2012 and 2013 season, respectively.

Table 1. Average temperature (°C) recorded at 10 cm depth in soil under black and clear polyethylene (PE) mulch or bare soil for 4 summer squash cultivars grown on February during 2012 and 2013 seasons.

Cultivars[(a)]	Plastic Mulch ColorTreatments											
	Bare soil (control)				Black				Clear			
	E1	E2	A	NE	E1	E2	A	NE	E1	E2	A	NE
2012												
February	15.9	16.8	17.0	15.6	20.0	20.8	21.0	19.6	24.7	25.4	25.6	24.2
March	18.5	19.3	19.5	18.2	22.2	23.1	23.3	21.8	26.6	27.3	27.5	26.1
April	21.4	22.4	22.6	21.0	25.7	26.8	27.0	25.2	28.6	29.3	29.6	28.0
May	24.8	26.1	26.3	24.3	28.2	29.3	29.6	27.7	31.2	32.1	32.4	30.6
2013												
February	15.4	16.0	16.1	15.1	22.2	23.0	23.2	21.8	26.3	27.6	27.9	25.8
March	17.2	18.0	18.2	16.9	23.9	24.8	25.0	23.4	27.7	28.8	29.1	27.2
April	21.3	22.3	22.5	20.9	26.7	27.6	27.9	26.2	29.3	30.6	30.9	28.7
May	24.0	24.9	25.1	23.5	27.9	28.7	29.0	27.4	30.2	31.8	32.1	29.6

(a) Cultivars are: E1= Eskandrany 1, E2= Eskandrany 2, A= 'Amjad F1' Hybrid cv and NE= 'New Eskandrany F1' Hybrid cv.

Planting was done 40 cm apart on the nouthern side of the ridge. Three ridges (70 cm apart and 3 m long) were included in each plot. The plants were fertilized with 300 kg/fed ammonium nitrate (33.5% N), 200 kg/fed calcium superphosphate (15.5% P_2O_5) and 200 kg/fed potassium sulfate (48% K_2O). Half of these fertilizers amount was added during soil preparation. Other agricultural practices of irrigation, pest control…, etc, were applied as recommended for summer squash production (Hassan, 1991).

Data collection and analysis: Data were recorded on the following traits: 1) average fruits weight (g) per plant, total fruits yield (ton/feddan), fruit dry matter (%), femininity tendency (%) (female/male and female flower×100) and days to the anthesis of first female flower. Data were subjected to analysis of variance according to Snedecor and Cochran (1980). Means of the treatments were compared using the Least Significant Difference (LSD) test or Duncan's Multiple Range Test (DMRT) where appropriate at 0.05 propability level.

Results

Effect of plastic mulch

The tested mulch treatments showed an obvious effect on elevation of the soil temperature during cool weather as compared to the control (bare soil) and hence rapid warming of the soil (Table1). In 2012 season for all periods of growing season, the average bare soil temperature at 10 cm depth in the Eskandrany 1 plots ranged from 17°C to 26.3° C while from 25.6° C to 32.4° C as a result of using the clear polyethylene (PE) mulch (6.1° C - 8.6° C higher than those of control). The black PE showed 3° C - 4° C higher than those of control.

Mulch treatments showed a significant effect on average fruit weight per plant, total fruits yield and percentage of fruit dry matter (Table 2). Mulching produced higher fruits weight per plant than control. The highest yield of fruits per plant was recorded for clear PE mulch (728.7 and 747.9 g, respectively) followed by black plastic mulch in both seasons. The control showed the lowest fruit weight per plant (462.8 and 470.4 g in first and second seasons, respectively). Observation on the femininity tendency followed a closely similar trend to average fruits weight per plant and total fruits yield (Table 3). Control treatment produced lowest fruits yield in both seasons (7.611 and 7.737 tons, respectively). Clear PE mulch performance better than black PE mulch

and showed highest total fruits yield per feddan, which recorded 12.606 and 12.938 tons in first and second season, respectively. Also, it is obvious that fruit dry matter was increased under mulching than control. Moreover, higher fruit dry weight percentage (7.0 %, in both seasons) recorded with clear PE mulch compared to black PE mulch (5.8 and 5.9 %, in both seasons) and control (4.9 and 5.0 %).

The analysis of variance for number of days lapsed to first female flower appearance of four squash cvs grown under plastic mulch exhibited significant effects (Table 3). Due to using mulch, days to first female flower decreased compared to control in both season. Less number of days to first female flower was recorded with clear plastic mulch in both seasons (29.6 and 29.4 days, respectively). It seemed that clear PE was performance better than black PE.

Varieties performance and their interaction with soil mulch treatments

Results in Table (2 and 3) indicate that cultivar Amjad F1 scored highest average fruits yield per plant, total fruits yield and femininity tendency in both season while cv Eskandrany 1 gave the highest value for average dry matter percentage in fruits and number of days to first female flower anthesis.

Eskandrany-1 under clear PE mulch exhibited the highest fruits yield per plant (760.4 and 782.3 g in both seasons, respectively) compared to control (254.2 and 259.9 g in both seasons, respectively). Also, variety Eskandrany-1 gave the highest total yield of fruits in both seasons, which recorded 13.154 and 13.533 tons per feddan compared to control (4.321 and 4.417 tons). Maximum percentage of fruits dry metter was recorded in variety Eskandrany-1, which was 8.5 and 8.1 % in first and second seasons, respectively. The control gave 5.1 and 5.3 % of fruit dry weight in both seasons, respectively.

Results in Table (3) indicate that the highest value of femininity tendency was recorded in variety Amjad F1 in the two seasons (30.8 and 31.1) under clear PE compared to control (21.8 and 22.3, in both seasons). Also, variety of New Eskandrany F1 scored less number of dats to first female flower in frist and second season (27.7 days in both seasons) as compared to control (36.2 and 35 days, respectively).

Discussion

In the present work, records of temperature for the tested mulch treatments showed an obvious effect in elevation of the soil temperature as

compared to the control (bare soil). Use of clear plastic was superior to the black one in this regard. The present findings are in harmony with previous reports of Mashingaidze *et al.*(1996) who indicated that mean weekly soil temperature was the higest under clear plastic mulch and generally lowest under the black plastic covers. Furthermore, Wolfe *et al*. (1989) found that clear mulch increased soil temperatures more than black mulch. Also, Frank and Heineman (1987) found that the warmest temperatures were noted under the clear plastic cover and the coolest under the black plastic cover. Gabriel *et al*. (1994) indicated that clear PE mulch showed the highest soil temperature and white/black film the lowest.

Earlier plant growth and earlier crop production are two of the primary benefits of using black and clear plastic mulches (Lamont, 1993). Earlier crop production generally results in higher market prices and higher yields. Color affects the surface temperature of the mulch and the underlying soil temperature. Ham *et al.* (1993) indicated that if the clear plastic had been placed loosely on the surface, so that an insulating air gap would have been established then greater heat storage or less heat loss might have occurred. Black mulch absorbs most ultra-violet (UV), visible, and infrared wavelengths (IR) of incoming solar radiation and re-radiates absorbed energy in the form of thermal radiation or long-wavelength infrared radiation. Much of the solar energy absorbed by black plastic mulch is lost to the atmosphere through radiation and forced convection. In contrast, clear plastic mulch absorbs little solar radiation but transmits 85% to 95%, with relative transmission depending on the thickness and degree of opacity of the polyethylene. The under surface of clear plastic mulch usually is covered with condensed water droplets. This water is transparent to incoming shortwave radiation but is opaque to outgoing longwave infrared radiation; so much of the heat lost to the atmosphere from a bare soil by infrared radiation is retained by clear plastic mulch. Thus, daytime soil temperatures under clear plastic mulch are generally 8 to 14° F higher at a 2-inch depth and 6 to 9° F higher at a 4-inch depth compared to those of bare soil.

Generally, Ashworth and Harrison (1983) showed that plastic mulches are used to modify environmental condition and improve crop yield throughout the increase of soil temperature. Our observations suggested that differences

between the two tested mulch treatments regarding soil temperatures were more obvious early in the growing season, while became close to each other as plants progressed in age. It is noticeable that records of temperature in plots of cv Amjad F1 were, generally, higher than their respective values recorded in plots of other cvs. The most obvious differences in temperatures (ranging from 1.3°C - 1.4°C) were obtained during earlier stages of growth. Results of present work revealed that cv Amjad F1 exhibited enhanced flowering and promoted earlier crop yield.

Table 2. Average fruits yield/plant (g), total fruits yield (ton/fed) and average fruit dry matter (%) for 4 summer squash cultivars grown on February during 2012 and 2013 seasons as affected by soil mulch under Assiut conditions [1].

Soil mulch (B) / Cultivar (A)	Control (Bare soil)	Black PE	Clear PE	Mean	Control (Bare soil)	Black PE	Clear PE	Mean
	A- Average fruit yield/plant (g) [2]							
	2012				2013			
Eskandrany1	254.2d	553.7d	760.4a	**522.7**	259.9d	566.1d	782.3a	**536.1**
Eskandrany2	536.7b	627.0b	719.8b	**627.8**	537.2b	641.1b	736.0b	**638.1**
Amjad F1	551.0a	664.2a	756.5a	**657.2**	563.5a	679.2a	779.7a	**674.1**
New Eskandrany F1	509.4c	590.8c	678.2c	**592.8**	520.9c	604.2c	693.4c	**606.2**
Mean	**462.8**	**608.9**	**728.7**	**600.1**	**470.4**	**622.6**	**747.9**	**613.6**
$LSD_{0.05}$ [3]	**11.9**				**17.2**			
	B- Total fruit yield (ton/ feddan) [2]							
	2012				2013			
Eskandrany1	4.321c	9.578d	13.154a	**9.017**	4.417c	9.794d	13.533a	**9.248**
Eskandrany2	8.587b	10.847b	12.452c	**10.628**	8.594b	11.090b	12.733b	**10.806**
Amjad F1	8.981a	11.490a	13.087b	**11.186**	9.184a	11.749a	13.489a	**11.474**
New Eskandrany F1	8.557b	10.221c	11.731d	**10.170**	8.751b	10.452c	11.996c	**10.400**
Mean	**7.611**	**10.534**	**12.606**	**10.250**	**7.737**	**10.771**	**12.938**	**10.482**
$LSD_{0.05}$ [3]	**0.215**				**0.302**			
	C- Average fruit dry matter (%) [2]							
	2012				2013			
Eskandrany1	5.1a	6.3a	8.5a	**6.6**	5.3a	6.5a	8.1a	**6.6**
Eskandrany2	4.9b	5.6c	6.5c	**5.7**	4.9b	5.8c	6.8c	**5.8**
Amjad F1	4.9b	5.9b	6.9b	**5.9**	5.2a	6.0b	7.0b	**6.1**
New Eskandrany F1	4.6c	5.3d	6.2d	**5.3**	4.7c	5.5d	6.3d	**5.5**
Mean	**4.9**	**5.8**	**7.0**	**5.9**	**5.0**	**5.9**	**7.0**	**6.0**
$LSD_{0.05}$ [3]	**0.1**				**0.1**			

[1] variance of soil mulch treatments x cultivars x year interaction was significant.
[2] means within column followed by same letter(s) are not significantly different at 0.05 level of probability using the Duncan Multiple range Test (DMRT).
[3] to compare soil mulch treatments for the same cultivar.

Table 3. Femininity tendency and number of days to first female flower anthesis for for 4 summer squash cultivars grown on February during 2012 and 2013 seasons as affected by soil mulch under Assiut conditions [1]

Soil mulche (B) / Cultivar (A)	Control (Bare soil)	Black PE	Clear PE	Mean	Control (Bare soil)	Black PE	Clear PE	Mean
	A- Femininty tendency(female/male and female flower)×100[2]							
	2012				2013			
Eskandrany1	10.3d	21.9d	30.4a	**20.9**	10.6d	22.2d	25.7d	**19.5**
Eskandrany2	21.2b	25.6b	28.5b	**25.1**	21.8b	25.2b	29.5b	**25.5**
Amjad F1	21.8a	26.1a	30.8a	**26.2**	22.3a	27.2a	31.1a	**26.8**
New Eskandrany F1	20.6c	23.4c	27.7c	**23.9**	20.6c	24.0c	27.5c	**24.0**
Mean	**18.5**	**24.2**	**29.3**	**24.0**	**18.8**	**24.6**	**28.4**	**23.9**
$LSD_{0.05}$[3]	**0.5**				**0.3**			
	B- Number of days to first female flower anthesis[2]							
	2012				2013			
Eskandrany1	42.3d	33.7c	31.0c	**35.7**	43.2d	34.1c	30.3c	**35.8**
Eskandrany2	36.9b	33.1b	28.8b	**32.9**	37.4b	32.9b	28.5b	**32.9**
Amjad F1	37.4c	33.6c	20.8c	**33.9**	38.0c	35.5d	31.2d	**34.9**
New Eskandrany F1	36.2a	30.4a	27.7a	**31.4**	35.0a	31.1a	27.7a	**31.3**
Mean	**38.2**	**32.7**	**29.6**	**33.5**	**38.4**	**33.4**	**29.4**	**33.7**
$LSD_{0.05}$[3]	**0.3**				**0. 2**			

[1] variance of soil mulch treatments x cultivars x year interaction was significant.
[2] means within column followed by same letter(s) are not significantly different at 0.05 level of probability by using the Duncan Multiple Range Test (DMRT).
[3] to compare soil mulch treatments for the same cultivar.

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تأثير لون اغطية التربة البلاستيكية على النمو والانتاجية فى اصناف الكوسة المختلفة المزروعة فى غير الموسم

شرين يعقوب عطاالله

قسم الخضر – كلية الزراعة– جامعة اسيوط

الملخص

اجريت هذة الدراسة بمزرعة التجارب البحثية – كلية الزراعة – جامعة اسيوط وذلك خلال موسيمين زراعيين ، واستخدمت فى هذة الدراسة لونان من اغشية البولى ايثلين سمك ٥٠ ميكرون وهى الشفاف والاسود لتغطية التربة ، بالاضافة الى معاملة عدم التغطية (معاملة المقارنة) وكذلك استخدمت ٤ اصناف من الكوسة وهى اسكندرانى ١،اسكندرانى ٢، هجين امجد اف١، نيو اسكندرانى هجين اف١ وتمت الزراعة فى فبراير من عامى ٢٠١٢ و ٢٠١٣.

دللت النتائج المتحصل عليها ان البلاستيك الشفاف كان اكثر فاعلية من البلاستيك الاسود فى هذة الدراسة، حيث ادى استخدام البلاستيك الشفاف الى الازهار المبكر للنباتات مقارنة باستخدام البلاستيك الاسود او معاملة الكنترول (بدون اغطية). كانت هناك زيادة معنوية فى المحصول الكلى للثمار باستخدام البلاستيك الشفاف حيث انه تم الحصول على ١٢،٦٠٦ ، ١٢،٩٣٨ طن/للفدان فى الموسم الاول والثانى على التوالى مقارنة بمعاملة الكنترول (بدون تغطية) والتى سجلت ٧،٦١١ ، ٧،٧٣٧ طن/للفدان. كانت نباتات الصنف الاسكندرانى ١ مع استخدام البلاستيك الشفاف هى المعاملة الاكثر تبكيرا فى الازهار وكذلك الاعلى فى المحصول الكلى ، ويتبين من هذة الدراسة ان اغطية التربة وخاصة استخدام البلاستيك الشفاف تعتبر طريقة فعالة لزيادة انتاجية محصول الكوسة عند الزراعة المبكرة.