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Mulch and planting method on quantitative traits of cucumber

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Abstract

Water deficiency and broomrape (*Orobanche* spp.) infestation are important limitations for cucumber (*Cucumis sativus* L.) production in Iran. Effects of mulch type (clear polyethylene mulch, black polyethylene mulch, hydro flume mulch, and no mulch), and planting method (seeded and transplanted) were tested to determine effects on cucumber, cv. Super Dominus. The interaction between mulch and planting method affected the number of days to flowering, plant length, number of days to harvest, and earliness. Early yield and yield per plant was highest (186.42 and 183.12 g/plant, respectively) when transplanting was with clear and black polyethylene mulch. Black mulch produced the highest total yield, 1671.75 g per plant. Clear mulch was most effective in controlling broomrape. Using polyethylene mulch (black and clear), and transplanting produced the highest early yield and mulch alone produced the highest yield and control of broomrape.

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Introduction

Cucumber (*Cucumis sativus* L.) is one of the most important cucurbit crops in the world (FAO, 2010). However, its cultivated land has decreased to in some regions due to drought and infestation of the weed broomrape (*Orobanch*e spp.). Transplants can establish cucumber, but roots disrupted during transplanting will hinder growth.

Hassandokht *et al.* (2010) reported that the number of fruit per plant in tomato using dark polyethylene was 79.43% more than control. Earliness using clear and dark polyethylene was reported to be 140.4 and 113%, respectively, more than control. The average fruit weight was 13.27% and the total yield in dark and clear mulch was 105 and 98% more than control. Kashi *et al.* (2004) reported that using dark polyethylene mulch increases watermelon plant wet weight twice as much as the control. Also, the total yield in dark polyethylene mulch treatment increased to 85%. The number of fruit per plant and the average fruit weight increased comparing with control. Earliness in dark polyethylene treatment was 32.6% of the total yield. Farias-Larios and Orozoco-Santos (2010) reported that watermelon marketable yield in treatment with polyethylene mulch (dark, clear and white) was 48.3, 43.2 and 38.3 t/h respectively, and 22.8 t/h in control.

Fonseca *et al.* (2003) stated that clear and dark polyethylene mulch produced the most female flower in cucumber. Polyethylene mulches had the most fruit and fruit per plant. Nesmith (1999) reported that earliness in transplanted watermelon was better than seeded one, although total yield and the average fruit was not statistically significant. Liptay *et al.* (1982) reported that the total yield in tomato was not significantly different with regard to transplanting and seeding, although earliness performance was 19.8, and 34.2 t/h in seeding and transplanting, respectively.

Use of transplants is beneficial in establishment of some vegetables (Liptay *et al.*, 1982; Nesmith, 1999). Broomrape is a parasitic plant that affecting cultivated crops (Elahinia, 2009; Roostai, 2010). Broomrape seed germinate 5 to 6 weeks after the host is established. Up to 50 stems may emerge from roots of each host plant (Elahinia, 2009). Because of prolific seed production and duration in soil broomrape cane be a large problem if rotation planting is not used (Roostai, 2010). Some species of broomrape seed can survive for 14 years, but exposures to light reduces broomrape germination (Roustai, 2010). This project was undertaken to evaluate effect of mulch types on cucumber earliness, total yield, compare seeding and transplanting and control of broomrape.

Materials and methods

Description of Experimental Site and Design

The research was conducted under field conditions in Beiranshar, Khorramabad, Lorestan Province (33° 41' N / 48° 33' E), Iran, at 1600 m above the sea level in 2011. The soil was comprised of 50% clay, 46% silt and 4% sand with 1.14% organic carbon. Environmental conditions were determined from a weather station that was 2 kilometers from the field.

The factorial experiment was arranged in a randomized complete block design, with 4 replications.

Treatments were mulch type (clear polyethylene: B1, black polyethylene: B2, hydro flume: B3 no mulch: B0) and planting method (seeding: A1, transplanting A2). Hydro flume is a type of flexible polyethylene pipe valve with 50 cm diameter used for irrigation. After using hydro flume for many times, it can be used as much as a recycling material. This type of mulch can retain moisture and heat around roots more than other type of mulch because of it thickness.

Cultural Practices

Cucumber, cv. Super Dominus (Peto Seed, Parma, Italy) transplants were produced. Two seeds were planted in a plastic pot, 10×10 cm, containing a growing medium composed of 50% soil and 50% soft sand a sand (a sand with a smaller than normal grain size). Pots were irrigated and transferred to a growth chamber temperature 25-30°C. Plants were exposed

to 25 fluorescent lamps (40 w) model T10 (Pars Company, Mashhad, Iran) in parallel. The distance from lamps to pot surface was 50 cm. Plants were irrigated once for two days using 5 or 6 L water for 220 pots in each application. After 12 days one-true-leaf, hardened (plants transferred out of growth chamber with deficit irrigation and exposed to alternating sun and shade) transplants were transferred to the prepared field soil.

The soil was irrigated 48 hours before planting. Plots were 2.5 m in length and 1.5 m in width. Phosphorus (168 $kg{\cdot}ha^{-1}$) as triple-super phosphate spread in furrows and covered with soil. Mulch was spread after the soil was irrigated to field capacity. Planting was on 13 June. Twelve seed, or transplants, were placed in each plot at distances of 1.5 m and 30 cm between rows and plants, respectively. There were two rows in each plot. Before planting the mulches were spread.
Four plants in each plot were randomly selected and marked with colored ribbons. Data were taken from the same plant.

Marketable fruit was a minimum 75 g in weight, 13.5 cm in length, and 2.5 cm in diameter. The early yield was sum of the first two harvests was determined.

Data Collection and Analysis

Data collected included Earliness and total yield, number of fruit per plant and average fruit weight were determined. Broomrape infestation was determined in each plot and infestation ratio calculated. Data were subjected to ANOVA in SPSS (ver. 16 IBM. Armonk. New York). If the interaction was significant, it was used to explain results. If the interaction was not significant means were separated with Duncan's multiple range test.

Results and discussion

Minimum and maximum temperature during planting, plant development and harvesting were 12 and 37°C, respectively. Mulch affected number of days to flowering, plant length, number of days to the first harvest, number of fruit per plant, average fruit weight, early yield, total yield and broomrape infestation percent. Planting method affected the number of days to flowering, plant length, number of days to harvesting and early yield. The mulch by planting method interaction affected number of days to flowering, plant length, number of days to harvesting and early yield (Table 1).

Table 1. Analysis of variance for traits measured on cucumber, cv. Super Dominus.

		Mean Square							
Source of variation	df	Plant length	Days to flowering	Days to 1st harvest	No. fruit / plant	Average fruit weight	Early yield	Total yield	Broom rape infestation
Replication	3	28.40	5.65	0.22	0.02	15.77	0.11	0.10	0.11
Mulch (M)	3	21.38**z	66.50**	355.99**	0.78**	64.93**	51.37**	1.83**	4.13**
Planting method (P)	1	487**	654.15**	32.97**	0.01ns	0.42ns	78.34**	0.08ns	0.53ns
M × P	3	631**	40.85**	2.03**	0.02ns	5.81ns	0.40**	0.16ns	0.12ns
Error	21	48	1.32	0.21	0.04	6.72	0.03	0.27	0.28

Effect of mulch on number of fruit per plant

The fewest number of fruit per plant was with no mulch (Table 2). Use of mulch produced the longest plants. Longer plants will produce more fruit per plant. Number of fruit per plant was similar with all mulches, and all were higher than the control. Grass mulch increased numbers of fruit per plant by 242% compare to no mulch (Ibeawuchi *et al.*, 2007). Farias-Larios *et al.* (1994) reported that plastic mulch (clear and black) increased number of fruit per plant in cucumber compare to a no mulch control. Using black and clear polyethylene mulches in melon increased the numbers of fruit per plant compared to control (Ekinci and Dursun, 2009). Clear mulch increased numbers of fruit per plant by 59.12% over their studies. Fonseca *et al.* (2003) stated that black polyethylene mulch in cucumber increased numbers of fruit per plant compared to no mulch. Black mulch increased numbers of fruit per plant by 21% over current study.

Effect of mulch on average fruit weight

The highest, and lowest average fruit weight was for hydro flume and control (Table 2). Average fruit weight was higher with use of clear or black polyethylene and hydro flume mulches compared to control. It may be due to absorption and nutrient uptake in short time. Average fruit weight was similar for all mulches, clear, hydro flume mulches had heavier fruit than the control, but black, and no mulch weights were similar.

Table 2. Effect of mulch type on some traits of cucumber cv. Super Dominus.

Mulch type	Days to flowering[z]	Plant length (cm)	Days to 1 st harvest	No. fruit /plant	Average fruit weight (g)	Early yield (g/plant)	Total yield (g/plant)	Broom rape infestation(%)
Clear mulch	17.90^{c}	114.56^{a}	40.25^{a}	19.88^{a}	78.12^{a}	127.37^{a}	1561.00^{a}	6.25^{c}
Dark mulch	19.75^{b}	115.12^{a}	44^{c}	21.50^{a}	77.64^{ab}	122.25^{a}	1677.78^{a}	16.25^{bc}
Hydro flume mulch	19.39^{b}	105.68^{a}	46.50^{b}	18.62^{a}	80.17^{a}	40.77^{b}	1491.16^{a}	28.75^{b}
Control	24.75^{a}	79.31^{b}	56^{a}	10.69^{b}	72.90^{b}	20.62^{b}	724.00^{b}	62.50^{a}

[z]Means in each column having similar letters are not significantly different using Duncan's multiple range test at 1% level.

Farias-Larios and Orozco-Santos (1997) stated that average fruit weight of water melon (*Citrullus lanatus* (Thunb.) Matsum & Nakai) increased using black and clear polyethylene mulches. Kashi *et al.* (2004) reported that average fruit weight in watermelon, cv. Charleston Gray, increased using black polyethylene mulch. Ekinci and Dursun (2009) reported that average fruit weight of melon (*Cucumis melo* L.) increased for using black and clear polyethylene mulches.

Effect of mulch on Total yield

Total yield was similar for all mulches, which were higher than with no mulch. (Table 2). Mulching increased yield due to increased plant length and number of fruit per plant (Table 2). Kashi *et al.* (2004) reported that total yield in watermelon using black polyethylene increased compared to treatment without mulch, due to higher soil temperature, sufficient moisture and weed control. El-Nemr (2006) reported that black and clear polyethylene mulches increased total yield of cucumber. Sari *et al.* (1994) reported that using clear plastic mulch increased total yield of cucumber compared to no mulch. According to Ekinci and Dursun (2009) melon total yield increased using black or clear polyethylene mulches compared to no mulch control. Farias-Larios and Orozco-Santos (1997) reported that total watermelon yield using black and clear polyethylene increased compared to no mulch. Ibarra-Jimenez *et al.* (2008) and Salman *et al.* (1990) reported an increase in total cucumber yield using black polyethylene mulch compared to no mulch. Increased total yield due to mulch is due to increasing soil temperature around roots, which enhances water and food absorption and early and total yield (El-Nemr 2006).

Effect of mulch on broomrape infestation

The highest and lowest broomrape infestation was for no mulch and clear polyethylene mulch, respectively (Table 2). Black polyethylene and hydro flume mulches were intermediate. In black polyethylene and hydro flume mulches, broomrape wilted after they had grown for 4-5 cm, due to high temperature under the mulch. In clear polyethylene mulch, broomrape was desiccated.

Effect of mulch and planting method on plant length

The longest cucumber plants occurred using black mulch and transplanting and the shortest plant was without mulch and transplanting (Table 3). Using mulch influences the microclimate around the plants, maintain humid and heating the soil and using transplant with sufficient roots for absorption and nutrient uptake produced the longest plants. Ekinci and Dursun (2009) reported that black and clear polyethylene mulches increased muskmelon plant length 19 and 42.4%, respectively, compared to no mulch

Table 3. Effect of mulch type and planting method on some traits of cucumber cv. Super Dominus.

Mulch x Planting method	Days to flowering[z]	Plant length (cm)	Days to 1 st harvest	No. fruit /plant	Average fruit weight (g)	Total yield (g/plant)	Broom rape infestation (%)
Clear mulch×seeding	23.8^{a}	114.75^{ab}	45^{d}	21.20^{a}	78.84^{a}	1677.81^{a}	0^{d}
Dark mulch×seeding	25.5^{a}	113.50^{ab}	48^{c}	20.50^{a}	76.63^{ab}	1565.75^{a}	12.50^{cd}
Hydro flume mulch×seeding	24.78^{a}	105.43^{bc}	48^{c}	19^{a}	79.96^{a}	1516.05^{a}	10^{cd}
No mulch×seeding	26^{a}	69.12^{c}	58^{a}	11^{b}	72.86^{ab}	692^{b}	55^{ab}
Clear mulch×transplanting	12^{d}	114.73^{ab}	35^{f}	18.50^{a}	77.58^{ab}	1444.25^{a}	27.50^{bc}
Dark mulch×transplanting	14^{c}	116.75^{a}	40^{e}	22.50^{a}	78.92^{a}	1777.80^{a}	22.50^{cd}
Hydroflume mulch×transplanting	14^{c}	105.93^{abc}	45^{d}	25.18^{a}	80.39^{a}	1466^{a}	30^{bc}
No mulch×transplanting	23.50^{b}	62.50^{d}	54^{b}	10.38^{b}	72.93^{b}	756.75^{b}	70^{a}

[z]Means in each column having similar letters are not significantly different using Duncan's multiple range test at 1% level.

Effect of mulch and planting method on flowering

The longest time to flowering was for no mulch and establishment from seed and the least number was for clear mulch and establishment by transplanting (Table 3). Using 12-day-old transplants and clear mulch increased soil temperature around roots, and enhanced water and food absorption, and decreased time to flowering. Farias-Larios *et al.* (1994) reported that using plastic mulch decreased number of days to flowering in cucumber compared to no mulch, due to increasing soil temperature and plant growth.

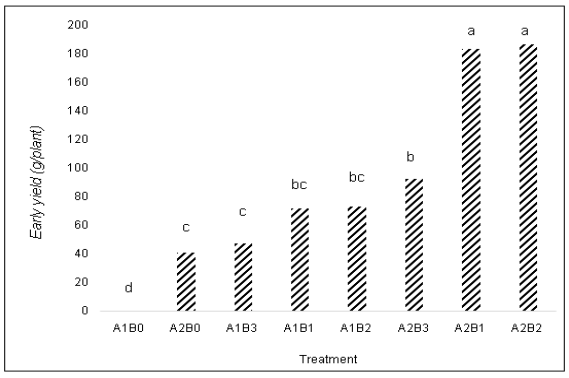

Fig. 1. Interaction of mulch type and planting method on early yield of cucumber cv. Super Dominus.

Ekinci and Dursun (2009) reported that clear or black polyethylene mulches decreased number of days to flowering in melon (*Cucumis melo* L.) compared to no mulch treatment. They reported the numbers of days to first flower due to treatment with no mulch, black and clear polyethylene mulch were 46.55, 41.33, and 39.63 days, respectively which were 21.9, 21,58 and 21.73 more than reported here.

Effect of mulch and planting method on first harvest

The longest time to the first harvest was due to no mulch and seeding the shortest time was for clear mulch and transplanting (Table 3). Mulch and transplanting reduced time to flowering, when it reduced, the time to first harvest will reduced. Fonseca *et al.* (2003) reported that using black polyethylene mulch reduced numbers of days to harvest, because of increasing soil temperature and plant growth. Farias-Larios *et al.* (1994) reported that plastic mulches (clear and black) in cucumber reduced numbers of days to first harvest.

Cucumber transplanting reduced time to first harvest than use of seeding. Moghadam (2011) reported that transplanting cucumber decreased number of days to flowering by 9 days than for seeding. Using mulch and transplanting reduced time to first harvest.

Effect of mulch and planting method on early yield

Early yield increased using mulches (black and clear) and transplanting, the highest and lowest amount of earliness was for clear and black mulches and transplanting and the no mulch and seeding (Table 3). Increased early yield may be due to soil heating with mulches and increasing plant growth. El-Nemr (2006) reported that earliness in cucumber increased whit use of clear and black polyethylene mulches, compared to no mulch. In his work, early yield was 0.96 and 0.93 kg/m^2 for clear and black mulch, respectively, but early yield in this current study was 0.28 and 0.27 kg/m^2 for clear and black mulch, respectively. This work was under unheated plastic

house with mulch only without planting method, but this work was in field condition with planting method. Ibarra-Jimenez *et al.* (2008) reported that earliness in cucumber with black polyethylene mulch increased compared to a no mulch control. Early yield for black mulch was 26.5 t ha $^{-1}$, but early yield in current study for black mulch was 2.72 t ha $^{-1}$. Salman *et al.* (1990) reported that early yield in cucumber using black and clear polyethylene mulches increased compared to treatment without mulch. Early yield for clear and black mulch was 3.15 and 3.46 kg/m^2, respectively, but early yield in current study was 0.28 and 0.27 kg/m^2 for clear and black mulch,

respectively. Their work was in unheated plastic tunnels. Early yield in watermelon using black polyethylene mulch was higher than without mulch (Kashi *et al.*, 2004).

The interaction between mulch and planting method on early yield indicated clear or black mulch and transplanting were best (Fig. 1).

Effect of mulch and planting method on broomrape infestation

Seeding cucumber and use of clear mulch resulted in no broomrape infestation (Table 3). Clear plastic decreases weed growth by increasing soil temperature. Absence of light using black plastic mulch prevents photosynthesis hindering weed growth (El-Nemr, 2006). Average temperature was 29 ^{o}C, six weeks after seeding, with soil temperature being 3 to 4 ^{o}C warmer than air temperature, using clear mulch causes light to pass through and heat the soil (5-6 ^{o}C). According to Ekinci and Dursun (2009) average mean soil temperature under clear mulch was 5-8 ^{o}C higher compare to the control. Farias-Larios and Orozco-Santos (1997) stated that the highest soil temperature under clear polyethylene mulch reached 38.5 ^{o}C, which is more than what was reported for black polyethylene and the no mulch treatment. The average temperature around the roots was 37-39 ^{o}C and temperature seems to prevent broomrape germinating. But it is unclear for us that this prevent is because of high temperature (37- 39^{o}C) around root host or producing allelopatic materials from root host which need for broomrape germination which needs further investigation.

Transplants and mulch can be used to obtain early yield and using clear and black mulches can be used for controlling broomrape.

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