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LAIBI, SAMI RESHAK

GROWTH AND MORPHOLOGICAL CHANGES OF PEPPERS (CAPSICUM ANNUUM L.)
WITH VARIOUS MULCHES AT HIGH TEMPERATURES

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GROWTH AND MORPHOLOGICAL CHANGES OF PEPPERS (*Capsicum annuum* L.) WITH VARIOUS MULCHES AT HIGH TEMPERATURES

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Sami Reshak Laibi

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SIGNED: Sami R. Laibi

APPROVAL BY THESIS DIRECTOR

This thesis has been approved in the date shown below:

Norman F. Oebker
N. F. OEBKER
Professor of Plant Science

1/7/83
Date

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ABSTRACT

Growth and morphological changes of green bell and chili peppers (*Capsicum annuum* L.) with different mulching treatments were studied at high temperatures of Southern Arizona.

The cultivar 'Yolo Wonder' was used as green bell and cultivar 'New Mexico 6-4' as chili with aluminum and black mulches. Both treatments were compared to bare soil with drip and to a furrow treatment. The crop response was significantly greater for mulched treatments as indicated by number of flowers and fruits, yield and fresh and dry weights. Chili responded less to mulch than green bell.

Defective fruits were associated more with bare soil except with sunburn fruits which appeared more in green bell on aluminum mulch. The favorable response to aluminum appears to be a result of a favorable microclimate around the plant brought about by water conservation, soil temperature modification and light redistribution.

INTRODUCTION

The bell pepper (*Capsicum annuum* L.) is a potential crop for Arizona. If adverse conditions such as temperature extremes and poor water relationships could be minimized, this vegetable could become an important source of income in Arizona at certain seasons of the year. The chili type (*Capsicum annuum* L.) is already grown extensively in some areas, however production of this type also needs improvements. New cultural practices for these peppers need attention and a better understanding of pepper growth needs to be developed.

Peppers are rich in vitamins C and A which are important nutrients in the daily diet. Green peppers are considered as a salad vegetable. Chili is used for flavoring foods and for pickling.

Mulching is one of the approaches used to modify the microclimate around the plant to fit the crop. The use of plastic for mulching in vegetable production has been used for many years and much information and data are available. Data from trials using plastic mulch indicate mulching is beneficial in a variety of ways. Mulching can increase the yield, enhance earliness, improve quality and modify soil temperatures. There is a reduction in the disturbance of plant roots by eliminating cultivation for weed control and loss of some plant nutrients from the soil by leaching. It has also been observed that aluminum mulches often control virus diseases by repelling aphids which are vectors for these problems. Disposing of the mulch after the growing season is one of the principle drawbacks in using plastic mulches. Another limitation is the cost of labor involved in applying the plastic sheets.

The purpose of this study is to measure the growth and some of the morphological changes in green bell peppers and chilies, including the number of flowers per plant, height of plant, number of fruits per plant, marketable yield, defects and fresh and dry weights as affected by using aluminum and black plastic mulches with different irrigation systems (furrow and drip).

The objective was to find cultural techniques for improving production of these vegetables under high temperature conditions as found in Arizona and other desert areas.

REVIEW OF LITERATURE

Mulching vegetables with materials such as aluminum foil, black polyethylene, paper and other materials has long been a practice in fields and gardens to increase production, promote earlier yields and to improve quality. Beneficial crop response from mulching has been reviewed by many researchers. In mulched vegetables, earlier and greater yields and improved quality are generally due to an improvement in the microclimate generated by mulching. A covering of the soil around the plants conserves soil moisture by reducing evaporation, reflects light into the leaf canopy, modifies soil and air temperature, and controls weeds. All of these situations can affect the morphology and growth patterns of the mulched plants. The following is a review of research relating to this subject.

Microclimate Modification

The selection and application of plastic mulches help create a microclimate advantageous for a particular crop in a particular growing situation by causing different morphological changes in the plant. Many workers have reviewed the effect of mulches on the microclimate, such as soil temperature and compaction, water conservation and air around the plant (Hopen 1965 and Oebker, Harper and Halderman 1973).

Thompson (1932) discovered that soil temperature under paper mulch was higher than in cultivated plots and that mulched plots conserved more water than cultivated plots.

Downes, Heslip and Honma (1959) observed that the soil temperature was 3 - 5^{o}F higher under black and aluminum plastic than in adjacent cultivated plots. This work was confirmed by Fritschen and Shaw (1960) in their comparison between black polyethylene and bare soil.

Other researchers have indicated different results. Honma, McArdle, Carew and Dewey (1959) reported that under mulch treatments the soil temperature was lower during the day and higher during the night compared to bare soil when they used black polyethylene, white surfaced black polyethylene and aluminum-colored polyethylene mulches. Also, they added that air temperature at half the height of plants above mulch was no higher than above bare soil.

The above work regarding black polyethylene was confirmed by Takatori, Lippert and Whiting (1964) when they compared black polyehtylene with petroleum asphalt and clear mulch, but during the night black polyethylene retained more soil heat. Similar results were obtained by Burga-Mendoza and Pollack (1973) when they mentioned that under black polyethylene soil temperature was lower than that of bare soil during the day.

Sheldrake (1963) found that mulching improved soil temperature and moisture content, soil tilth, and increased CO_2 level in the canopy. That contributed to an increase in yield and maturity. He added that CO_2 concentration in the canipy increased four-fold due to build-up under the mulches which was emitted through the holes made for the plants. Schales and Sheldrake (1962) and Giddens (1964) showed also that soil temperature and water content under clear polyethylene was higher than under white plastic.

In a comparative study between clear plastic and black polyethylene, soil temperature under clear polyethylene was higher than under black polyethylene (Shadbolt 1962 and Smith 1964). Shadbolt (1962) also mentioned that soil under black polyethylene and clear plastic was warmer than unumlched plots, but Smith (1964) cited no significant difference between soil temperatures under black polyethylene and bare soil. However, soil temperature under clear polyethylene has a higher temperature than black polyethylene and bare soil.

Liptay and Tiessen (1970) investigated the effectiveness of the polyethylene-coated paper mulches on the soil environment. They observed soil temperature changes at a one inch depth and soil moisture changes between 1 to 4 inches under the treatments. Their results showed higher soil moisture and temperature under clear polyethylene and black paper mulches. Under these mulches, the moister soil stayed warmer longer than the bare but dryer soil.

Hopen (1975) mentioned that under transparent polyethylene, soil temperature was higher than under black polyethylene and was lower under black polyethylene at 2 to 6 inches depth than either transparent polyethylene or unmulched soil.

Moore (1969) compared plain foil (aluminum), black plastic, black paper and check. He announced that during the day the soil temperature was lowest under the plain foil and maintained the lowest 24 hour soil temperature. Also, it registered the most uniform maximum and minimum temperature.

Oebker et al. (1973) found that soil temperature was 5 to 7^{o}F higher under black mulch than under aluminum mulch or bare soil during the day. They added that soil temperature under the aluminum mulch was the same as under the bare soil or slightly higher. In contrast, Moore's (1969) findings were measured in the shade and after irrigation and by using paper instead of foil. Oebker et al. (1963 and 1974) also observed less water used under mulch treatments compared to bare soil.

Due to prolonged maintenance of soil moisture, soil compaction under mulch treatments was less than with bare soil (Edmund 1929, Magrudar 1930, Smith 1931 and Emmert 1957).

Growth

Cochran (1936) studied peppers under different greenhouse temperatures with high soil fertility and moisture. Judged by a final average height and fresh weight, the maximum growth was achieved under temperatures of 70 - 80^{o}F. As temperature was raised to 90 - 100^{o}F, there was little plant growth. This, he explained, was due to higher respiration which reduced carbohydrate content and increased loss of water from transpiration from smaller root system.

Smith (1973) showed that peppers (cv. 'Yolo Wonder') survived on reflective foil mulh forming a bush with increased branching resulting in greater yield compared to bare soil. Dornald and Went (1947) found that the optimum temperature for stem elongation gradually decreased from 30^{o}C to 8.5^{o}C as the plants progressed to maturity. They also mentioned that under night temperature of 26^{o}C and day temperature of 27^{o}C the plants grew larger than those grown at 26^{o}C day temperature and night temperature of 8.5^{o}C.

Wolfenbarger and Moore (1967) used different mulch materials (aluminum on paper, white surface on black plastic, and black plastic) to compare with bare check plots. They found that the average fruit weight was not significatnly different between mulch treatments, but all mulch treatments individually were higher than check plots. The latter was confirmed by Vandenburg and Tiessen (1972) when they found similar results by using black kraft paper coated with clear was, natural paper laminated with polyethylene film.

Rylski (1972) reported that increasing the temperature of the soil increased growth, fresh and dry weights of the plant.

Robert and Wiggans (1981) found stem diameter and fresh and dry weights of plants were the same for mulched and non-mulched treatments.

Flowering and Fruit Set

Cochran (1936) concluded that high temperatures under field conditions resulted in the failure of many blossoms to set fruit. He added also that plants grown under medium or high soil moisture produced high numbers of blossoms and also set a higher percentage of them than did plants grown under low soil moisture conditions.

Dornald et al. (1947) have noticed that the total number of flower buds formed was larger in plants grown at higher temperatures.

Rylski and Kempler (1972) studied fruit set due to the effects of PVC (polyvinyl chloride) and PE (polyehtylene) tunnels as well as tunnels combined with black bitumen mulch and PE film. Mulch and tunnels improved yield and fruit set due to maintaining higher soil moisture and temperature. Vandenburg et al. (1972) observed that mulching increased the number of clusters, flowers and fruits per plant in peppers.

Rylski (1972) reported that as air temperature dropped, the time interval between emergence and flowering increased. She added that the plants developed an equal or greater number of leaves before the first flower under low temperatures. She also found that night temperatures of 20^{o}C brought about the greatest effect on flowering and a delay of about 10 days occured as compared with those at 25^{o}C night temperature in flowering.

Dafault and Wiggens (1981) studied the response of sweet peppers to solar reflectors and reflective mulches. They announced that mulched plants initiated 2.5 times as many flowers as unmulched plants.

Rylski and Spigelman (1982) investigated fruit set in sweet peppers as affected by dirunal temperature combinations. High fruit set was obtained under the lowest night temperature of $15^{o}C$, but the highest night temperature caused considerable blossom drop. The highest tested day temperature did not cause increased blossom drop. The number of fruits per plant was higher under low night temperatures than high night temperatures. Seedless fruit was higher under low temperatures than high temperatures and deformed fruits were found also under low night temperatures. Fruit set, number of fruits per plant under all day temperatures ($22^{o}C$, $25^{o}C$, and $28^{o}C$) were similar.

Yield

Many researchers have agreed that aluminum plastic has greater effect than other types of plastic and unmulched soil in increasing the yield of peppers.

Oebker et al. (1973) have found that aluminum paper mulch had the highest yield compared to black polyethylene paper mulch and unmulched plots. They added that unmulched plots had less mulched plots up to harvest. Similar results were reported by Moore (1969). Smith's results (1973) showed that aluminum foil mulch increased the yields and in some cases doubled it as compared to bare soil. He cited an early increase in yield and the fruits that averaged 10 per plant on the foil, compared to 7.3 on the bare ground.

Thompson and Platenius (1932) showed 57% greater early yield obtained by using paper mulch compared to cultivated plots. Downes et al. (1959) conducted experiments in two Michigan locations - Sodus and East Lansing. He announced in the first location that mulch treatments (black polyethylene and aluminum covered polyethylene) had no effect on total marketable yield, but on the second location, peppers ('Yolo Wonder A' cv.) were not significantly increased by mulching. On the other hand, the total marketable yields were increased 41% over cultivation by using 4 foot strips of plastic in which twin rows were planted 2 inches apart. They explained the results of the first experiment that mulching promoted the vegetative growth at the expense of early fruiting. They added there was no evidence that in 2 inch strips there was any difference between aluminum covered polyethylene and plastic polyethylene. Kanrel and Tiessen (1966) compared black plastic, clear plastic and aluminum foil mulches for vegetable production. They pointed out that aluminum foil was not better for any crop than black plastic, nevertheless, summer squash on plots covered with black plastic containing aluminum laminated surface performed best.

Pollack, Smith and Cialone (1969) used clear PE, black PE, clear degradable, silver degradable and black paper as mulch materials and check soil. They found the lowest yield from bare ground and the highest yield from black PE, silver degradable film and black paper.

Bible (1970 and 1971) used pepper cultivars 'Canape' and 'Earline' and mulch materials black and clear PE plastic, black kraft paper, aluminum foil, double layer (clear on black PE), and double layer (clear PE on aluminum foil). His results showed that all mulch treatments increased the yield of marketable fruits per plant. He reported an increase of 50 - 60% over the control.

Bible (1972 and 1973) carried out other trials. His results showed that cultivars 'Canape', 'Bell Boy' and 'Lincoln Bell' of the sweet peppers increased 13% in marketable yield due to clear plastic and 17% due to black plastic.

Albregts and Howard (1973) studied the effect of strip and full bed black paper coated on both sides as a mulch on (Capsicum annuum L. cr. 'Yolo Wonder L.'). He reported an increase in pepper yield related to both average fruit weight and number of fruits per plant in peppers compared to bare soil.

Mosley (1975) stated that "pepper's yield responded positively to drip irrigation and black mulching and the latest increased the marketable yield compared to bare soil".

Robert and Wiggans (1981) found that the total marketable yield of fruits in the mulched plots were significantly higher than non-mulched treatments.

Porter and Etzel (1979) studied the effect of aluminum painted and black polyethylene mulches on bell pepper. They reported that there was no significant difference on average fruit weights between treatments. They added that the yield produced by using sliver reflective plastic was higher than the plots grown on plastic mulch or from bare ground plots. They explained that the probable increase in yield by using aluminum painted polyethylene was due to increased light photosynthetic active radiation(PAR) reflected by the aluminum painted polyethylene.

MATERIAL AND METHODS

Pepper (Capsicum annuum L.) cultivars 'Yolo Wonder' as green bell pepper and 'New Mexico 6-4' as chili pepper were selected for this study. The seeds were sown on Febryary 2, 1982 in polystyrene trays containing 50:50 peat moss and vermiculite in the greenhouse. Adequate moisture was applied to the trays. The plants were fertilized frequently with 14.8 milliliters of 20:20:20 fertilizer in 7.46 liters of water. The seedlings were hardened before transplanting into the field by reducing the amount of water.

The field was on the Marana Experiment Station situated in the Avra Valley 39 kilometers northwest of Tucson, on the west side of Interstate Highway 10. Its elevation is 600 meters above sea level. The climate is characterized by a low annual rainfall of 250 mm about equally partitioned between summer and winter. A high temperature of 44^{o}C in summer and a low temperature of -14^{o}C in winter has been recorded by the United States Weather Station at The University of Arizona in Tucson. The dominant soil type is Pima clay loam; however, the soil type at (A-1), the site of the experiment, is Grabe loam (Percina 1971).

While the seedlings were hardening, the field soil was plowed, disked, leveled, the drip system and mulch materials were laid out and one furrow was traced. Planting was done by hand 66 days from seeding on April 6 - 7, 1982.

'Yolo Wonder', the cultivar used for green bell pepper, is characterized by fruit setting over a longer picking period and less concentrated near the crown of the plant when compared to 'California Wonder', the usual standard. It is also characterized by its vigorous, medium height, heavy dark foliage, and its resistance to tobacco mosaic virus. Fruits are pendant, dark green, blocky and heavy.

'New Mexico 6-4', used as the chili is characterized by its pods which averaged about six to seven inches in length and about two inches at widest points. Pods are thick fleshed and smooth with well-rounded shoulders tapering to a blunt point at the blossom end. Its yield is about 8 to 12 metric tons of fresh green chili per acre. An average of seven to eight fresh green pods make 1.1 kg. Plants range between 50 and 75 cm high and are upright. Leaves are medium sized and smooth.

Two mulch treatments were compared to the bare soil treatment with a drip irrigation system and a furrow treatment to determine the growth and development and the morphological changes for both peppers. The mulches used were aluminum coated and black PE 1.5 mil thickness. A 90 cm wide mulch was secured over the soil of each treatment row. Twenty two plants (11 of each variety) were transplanted through the mulch, bare, and furrow treatments in each plot. The treatments were replicated 4 times in a randomized complete block design.

Field planting was done on April 6 - 7, 1982 with plants spaced 45 cm apart for the chilis and 30 cm for the green bell peppers and 120 cm between rows which ran north and south. The length of the plot was 9.6 meters.

Fertilizer of 182 kg 11-48-0/ha was applied during land preparation. During planting, a starter solution was applied using (3 pounds of 20:20:20 Peter's brand at 55 gallons water) to provide adequate fertilizer to the plants.

Water was applied through the drip irrigation system for the bare and mulch treatment plots.

Tri-wall (Chapin brand) tubing was used 5 cm underneath the soil next to plant row. An additional twin-wall tubing was laid down on the bare soil in an attempt to maintain a moisture level close to that under mulch treatments. Water was applied to all treatments as needed; the amount was determined by observing plants and soil. The amount of water applied was calculated as 18.1 inches (46 cm) for the mulch and 33.1 inches (84 cm) for the bare soil and 50 inches (127 cm) for the furrow by estimating consumptive use (CU) of water for the plant (Erie, French and Bucks

(1981). Plants were attended to many times. The first time was on May 25, 1982 to record the number of flowers per plant. Additional dates were 6/7, 6/14, 6/23, 6/28, 7/9, 7/21, 7/28, 8/12 and 9/16, to record the number of fruits per plant and the height of plants in cm. Plants were harvested based on fruit firmness on dates 6/28, 7/21, 7/28, 8/12 and 9/6.

Peppers were graded into marketable and unmarketable. Defects included blossom end rot, misshapen, sunburned, and small. The number of fruits were counted and the weight was measured for each class.

The experiment was terminated on September 8, 1982. Five plants without the fruits from each plot were selected to determine fresh weight and then were placed in a dryer for 72 hours at 12.77°C to reach constant dry weight.

Meterological Conditions

The distribution and amounts of rainfall at the Marana Farm (Tucson, Arizona) are shown in Figure 1. In April, May, June, July and August 1982 (0, .51, 0, 2.29 and 4.32 cm or 0, .2, 0, .9 and 1.7 in) were recorded, respectively. These months represent the major part of the growing season involved. Thus, in the absence of irrigation, there was substantial water deficiency in the field.

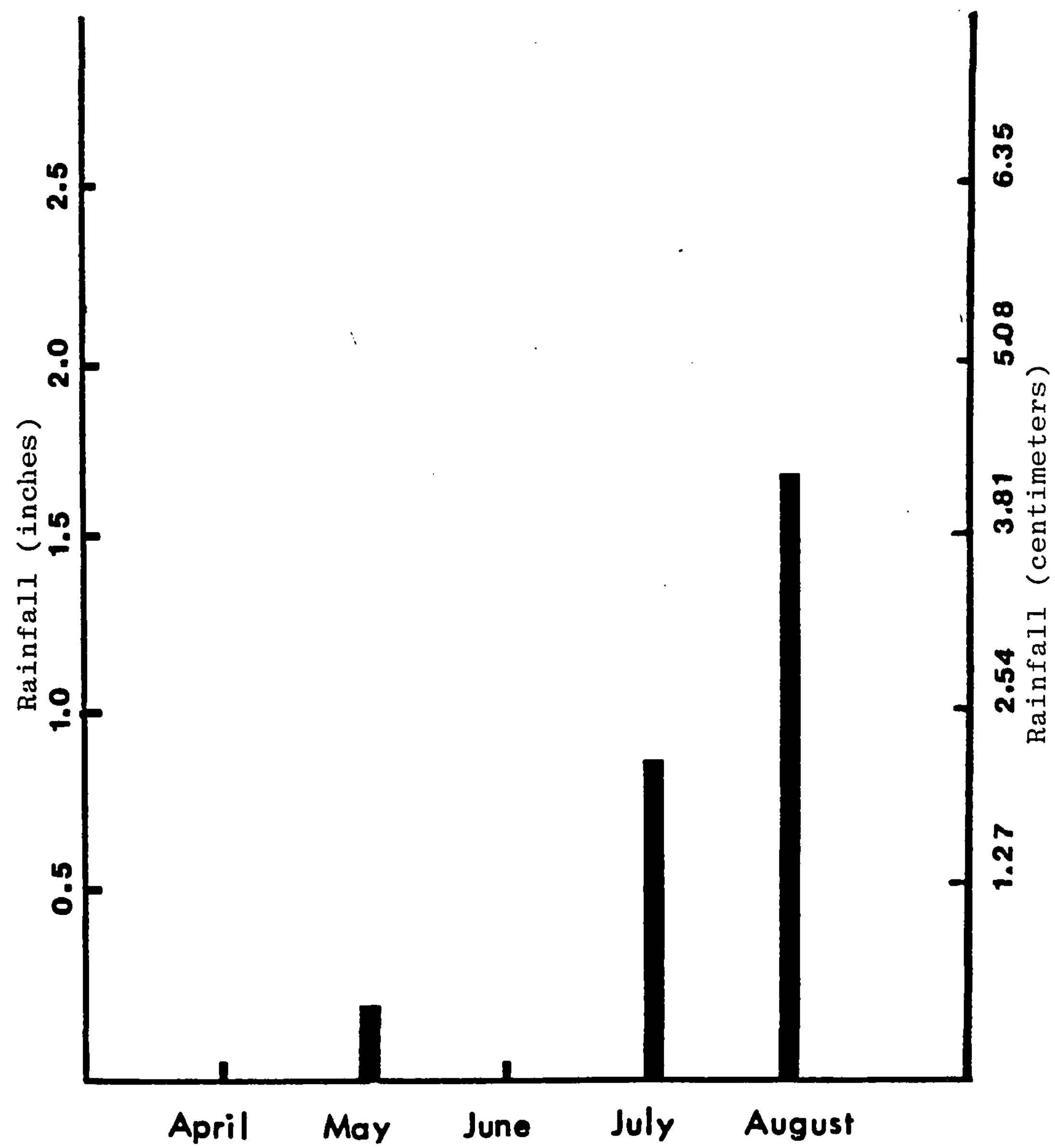

Figure 1. Mean Rainfall Distribution at University of Arizona Marana Experimental Station during April-August, 1982.

Mean maximum temperature is reported in Figure 2. June, July and August were the hottest months during the growing season (April to August, 1982).

The analysis of variance (ANOVA) was done with the assistance of the University Agricultural Experiment Station, Quantitative Studies Center using the Statistical Package for Social Sciences (SPSS). Treatment means were compared using the least significant difference (LSD).

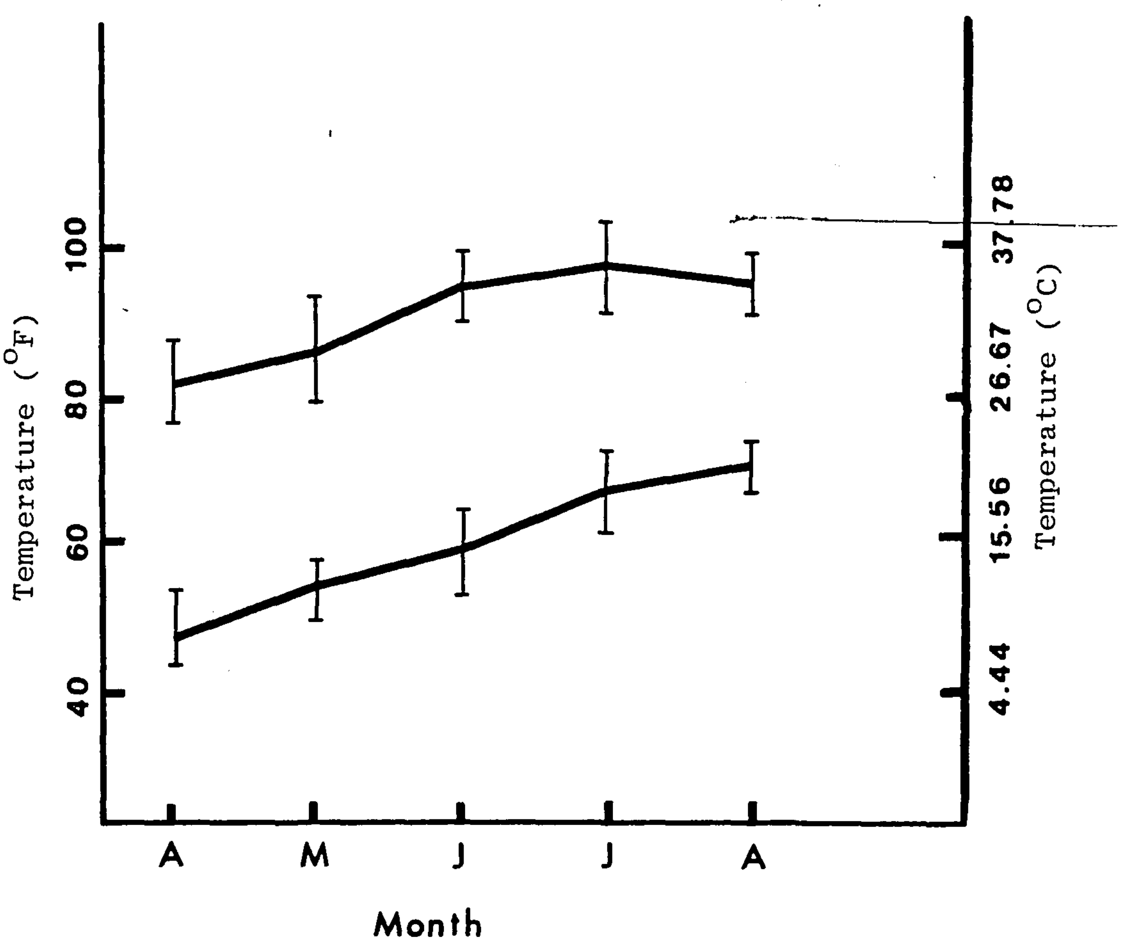

Figure 2. Mean Maximum-Minimum Temperature of the University of Arizona Marana Experiment Station during April-August, 1982.

RESULTS

This experiment was conducted to study the influence of aluminum and black polyethylene (PE) mulches under drip irrigation on the morphological changes and yields of both green bell and chili peppers using bare soil and furrow irrigated plots as control treatments. The results will be presented in different parts: (1) flowering, (2) number of fruits per plant, (3) height of plant, (4) number of harvested fruits and weight per plant over the growing season for different classes (a) marketable and (b) unmarketable, including: blossom end rot, misshapen fruits, small fruits, and sunburned fruits, and (5) fresh weight and dry weight.

Flowering

From the analysis of variance of number of flowers per plant which were recorded on May 25, 1982 (Table 1), we can see there is significant difference between treatments for both green bell and chili peppers. The LSD (.05) for number of flowers per plant (Table 2) shows that aluminum mulch plots had more flowers than other treatments in green bell peppers. There was no significant difference between black PE, bare soil, and furrow irrigated treatments. In

Table 1. Flower Number Variance of Bell and Chili Peppers as Influenced by Mulching Treatments.

Source of Variation	Sum of Squares	DF	Mean Square	F
	- - - - - Bell Peppers - - - - -			
Total	2181.3	15	145.4	
Block	651.5	3	217.2	4.50
Treatment	1095.4	3	365.1	7.57
Residual	434.4	9	48.3	
	- - - - - Chili Peppers - - - -			
Total	1199.9	15	80.0	
Block	256.2	3	85.4	8.58
Treatment	854.2	3	284.7	28.61
Residual	89.6	9	10.0	

Table 2. Flower Number of Green Bell and Chili Peppers as Affected by Mulching 50 Days after Transplanting at Marana, 1982.

Treatments	Number of Flowers[z]	
	Green Bell	Chili
Aluminum	36.0[a]	37.3[a]
Black	24.0[b]	34.0[ab]
Bare	20.4[b]	31.0[b]
Furrow	13.1[b]	18.0[c]

[z]values in columns followed by the same letter are not significantly different (.05) by LSD.

chili pepper there was no significant difference between aluminum and black PE mulches, but both mulches resulted in a higher number of flowers per plant as compared to bare soil, followed by the furrow treatment. It seems there is a combination of soil moisture and temperature contributing to these results.

The surface of the aluminum mulch reflected more heat into the plant canopy; this could have been a cause of the increase in the number of flowers per plant. Mulch treatments conserved soil moisture and aided in providing adequate moisture to the plants.

Number of Fruits per Plant

There was no significant difference in the number of fruits per plant in bell pepper during the first 78 days following transplanting to the field (Table 3, Figure 3). Chili pepper showed no significant difference between mulch treatments up to day 106 following field transplanting (Table 4, Figure 4). This suggests the climatic conditions were equally favorable up to this time for the production of fruits in all treatments.

in green bell peppers, there were differences in the number of fruits per plant at the latter dates (83, 94, 106, 113, 128, and 143) from transplanting. In chili peppers, there was a difference in the number of fruits per plant at the last days (113 and 128) from transplanting, but the last date (143) shows no difference between treatments. In green pepper, aluminum and black mulch treatments were quite similar at the last dates for the production of fruits, but both were superior to the bare soil and furrow treatments. In chili peppers, day 113 from transplanting showed that aluminum mulch increased fruit production as compared to other treatments. Day 128 showed bare soil had the lowest number of fruits compared to the other treatments which did not differ significantly.

It appears that mulch treatments offer better growing conditions than unmulched treatments. The probable reason for less fruit production in the bare soil treatment was

Table 3. Number of Fruits per Green Bell Pepper Plant at Progressive Intervals as Affected by Mulches at Marana, 1982.

Days after Transplanting	Treatment^{z}			
	Aluminum	Bare	Black	Furrow
62	1.26^{a}	.20^{a}	.97^{a}	.30^{a}
69	1.35^{a}	.32^{a}	1.47^{a}	.38^{a}
78	2.74^{a}	1.56^{a}	2.36^{a}	1.03^{a}
83	4.33^{b}	2.39^{ab}	3.87^{ab}	1.42^{a}
94	5.87^{c}	2.04^{ab}	4.06^{bc}	1.20^{a}
106	16.52^{c}	9.38^{b}	16.18^{c}	6.83^{a}
113	23.80^{b}	11.20^{a}	21.60^{b}	10.23^{a}
128	20.21^{b}	10.83^{a}	19.04^{b}	12.18^{a}
143	17.55^{b}	9.92^{a}	17.63^{b}	11.26^{a}

^{z}values in rows followed by the same letter are not significantly different (.05) by LSD.

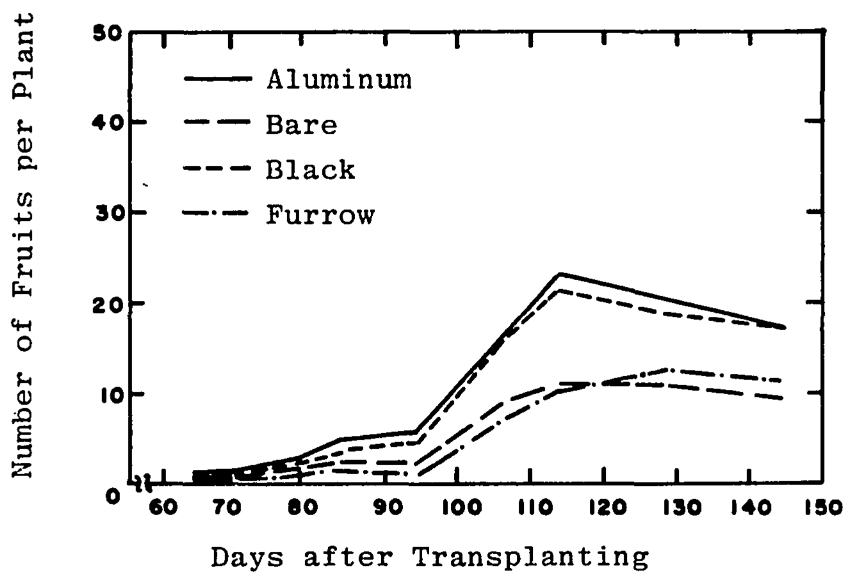

Figure 3. Number of Fruits per Green Bell Pepper Plant at Progressive Intervals as Affected by Mulches at Marana, 1982.

Table 4. Number of Fruits per Chili Pepper Plant at Progressive Intervals as Affected by Mulches at Marana, 1982.

Days after Transplanting	Treatment[z]			
	Aluminum	Bare	Black	Furrow
62	.30[a]	.16[a]	.22[a]	.16[a]
69	.59[a]	.18[a]	.52[a]	.20[a]
78	.65[a]	.41[a]	.53[a]	.47[a]
83	1.42[a]	.86[a]	1.26[a]	.91[a]
94	4.30[a]	1.77[a]	3.12[a]	2.36[a]
106	21.01[a]	11.87[a]	11.07[a]	14.12[a]
113	29.83[b]	11.91[a]	16.69[a]	30.88[ab]
128	41.01[b]	28.39[a]	32.79[ab]	30.88[ab]
143	45.14[a]	37.70[a]	37.64[a]	38.40[a]

[z]values in rows followed by the same letter are not significantly different (.05) by LSD.

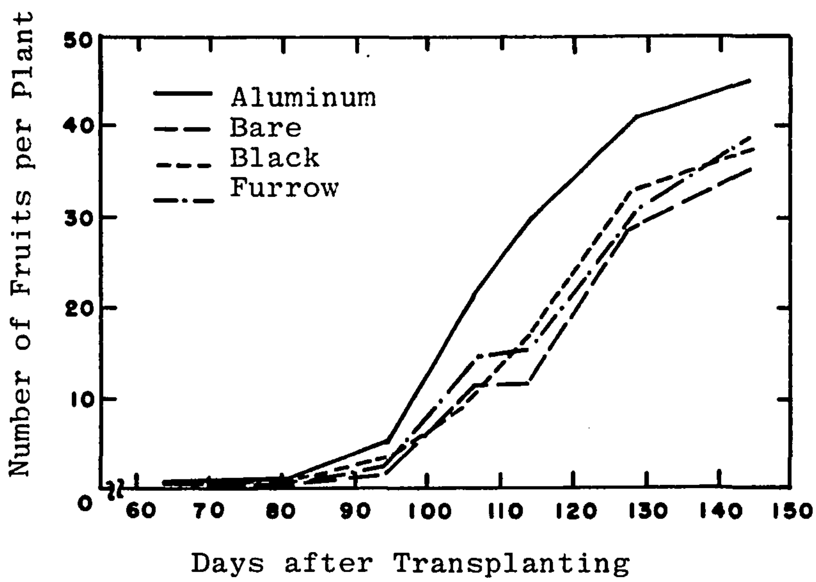

Figure 4. Number of Fruits per Chili Pepper Plant at Progressive Intervals as Affected by Mulches at Marana, 1982.

that the plants were exposed to greater drought stress even though more water was applied.

Height of Plant

Generally a slight difference between treatments in the height of the plants was observed. In green bell pepper (Table 5, Figure 5), the early time periods after transplanting showed inconsistent results, but it is always in the favor of aluminum and black mulch up to day 94 from transplanting when black mulch and furrow treatments have taller plants than aluminum and bare soil treatments. At day 106 from transplanting, the aluminum mulch plants resume their height to be in the same category with black mulch. Both mulches produced taller plants than bare soil and furrow treatments. The latter days (113, 128 and 143) from transplanting showed no difference among treatments.

In chili pepper (Table 6, Figure 6), there are only three time periods (69, 94 and 128 days) from transplanting which showed differences between treatments. At the time period (94 days from transplanting) the plants mulched with plastic and furrow treatments, plants were taller than those mulched with aluminum and bare soil. At day 128, the furrow treatment plants were taller than those from black and bare treatments, but they were not different from aluminum mulch plants.

Table 5. Height of Green Bell Pepper Plant in cm at Intervals at Marana, 1982.

Days after Transplanting	Treatment[z]			
	Aluminum	Bare	Black	Furrow
62	33.18[ab]	28.89[a]	34.86[b]	29.59[a]
69	39.96[b]	29.32[a]	39.55[b]	36.55[b]
78	40.93[ab]	37.30[a]	54.13[b]	39.30[a]
83	41.33[ab]	38.58[ab]	43.40[b]	36.98[a]
94	44.58[a]	44.08[a]	51.00[b]	47.91[ab]
106	51.51[a]	56.67[a]	56.26[a]	56.34[a]
113	53.20[ab]	50.48[a]	55.99[b]	50.25[a]
128	57.95[a]	57.94[a]	58.80[a]	56.46[a]
143	58.27[a]	57.66[a]	58.00[a]	55.66[a]

[z]values in rows followed by the same letter are not significantly different (.05) by LSD.

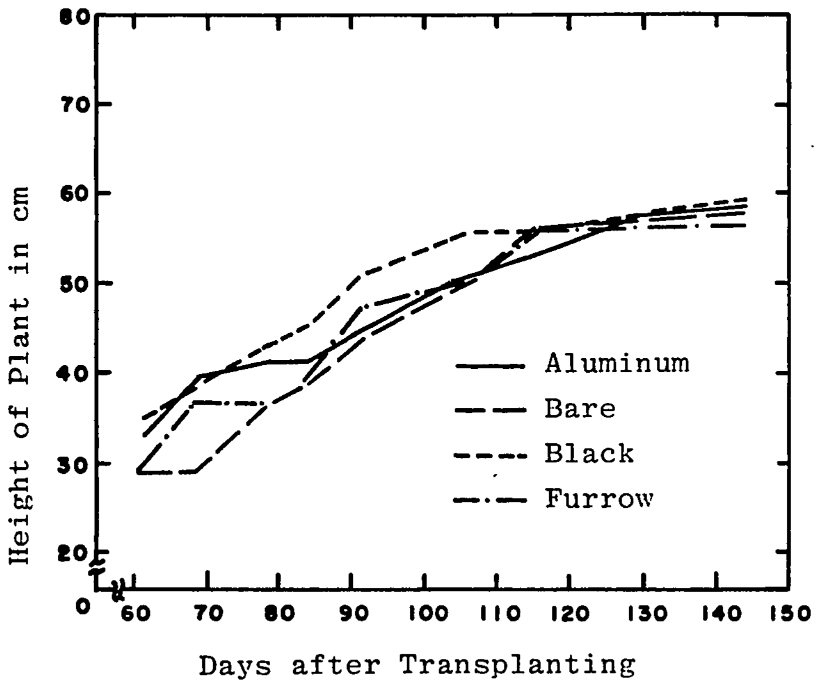

Figure 5. Height of Green Bell Pepper Plant in cm at Intervals at Marana, 1982.

Table 6. Height of Chili Pepper Plant in cm at Intervals at Marana, 1982.

Days after Transplanting	Treatments[z]			
	Aluminum	Bare	Black	Furrow
62	43.88[a]	38.93[a]	43.94[a]	39.75[a]
69	44.28[ab]	41.33[a]	47.53[b]	40.80[a]
78	48.65[a]	48.00[a]	51.23[a]	51.65[a]
83	50.80[a]	48.57[a]	52.13[a]	52.80[a]
94	54.16[a]	55.50[a]	61.08[b]	60.91[b]
106	62.98[a]	61.48[a]	63.57[a]	64.33[a]
113	65.67[a]	62.50[a]	63.75[a]	71.00[a]
128	70.83[ab]	67.08[a]	66.25[a]	73.75[b]
143	73.06[a]	71.59[a]	68.01[a]	75.81[a]

[z]values in rows followed by the same letter are not significantly different (.05) by LSD.

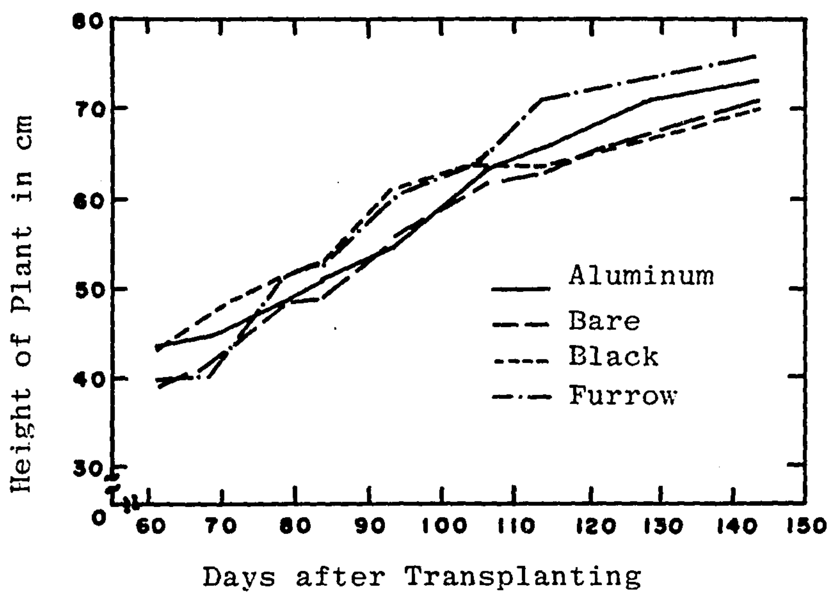

Figure 6. Height of Chili Pepper Plant in cm at Intervals at Marana, 1982.

Marketable Yield

In all cases, mulch treatments were superior to non-mulched treatments. Aluminum mulch showed substantial increase in the marketable yield both in the number and weight of harvested fruits.

In green peppers, the analysis of variance of the number of harvested fruits and the weight of harvested fruits (Table 7 and 8) showed a significant difference between treatments at different time periods. The same pattern followed in chili peppers (Tables 9 and 10). Aluminum mulched green pepper plants (Table 11, Figures 7 and 8) showed a higher number of harvested fruits and weighed more than other treatments except at the first harvest date (83 days from transplanting) when there was no significance between treatments. Black mulch followed aluminum mulch in favoring potential fruit yield. At day 106 the black mulch was not significantly different from bare soil on furrow treatments, but at day 113 it had higher yields both in the number and weight of harvested fruits over the bare and furrow treatments. At day 128, black and furrow treatments became similar in yield, but both had higher yields than bare soil. At last harvest date black and furrow treatments were not significantly different but both had higher yields in the number of harvested fruits over bare soil. The weight of harvested fruits was higher in the furrow when compared to black and bare soil treatments.

Table 7. Marketable Yield Variance (Number of Harvested Fruits per Plant) of Green Peppers as Affected by Mulching.

Source of Variation	Sum of Squares	DF	Mean Square	F
Residual	3.6	48	.1	
Block	1.3	3	.4	5.79
Time	43.0	4	10.76	144.01
Time by Treatment	13.0	12	1.08	14.49
Error 1	3.3	9	.36	
Treatment	25.2	3	8.9	23.00

Table 8. Marketable Yield Variance (Weight of Harvested Fruits per Plant) of Green Peppers as Affected by Mulching.

Source of Variation	Sum of Squares	DF	Mean Square	F
Residual	9317.1	48	194.1	
Block	4048.9	3	1349.6	6.95
Time	129017.8	4	32254.5	166.17
Time by Treatment	44956.6	12	3746.4	19.30
Error 1	7152.8	9	794.8	
Treatment	60035.2	3	20011.7	25.18

Table 9. Marketable Yield Variance (Number of Harvested Fruits per Plant) of Chili Pepper as Affected by Mulching.

Source of Variation	Sum of Squares	DF	Mean Square	F
Residual	5.5	48	.1	
Block	.5	3	.2	.132
Time	310.0	4	77.5	676.38
Time by Treatment	131.1	12	10.9	95.35
Error 1	5.7	9	.6	
Treatment	126.4	3	42.1	66.81

Table 10. Marketable Yield Variance (Weight of Harvested Fruits per Plant) of Chili Pepper as Affected by Mulching.

Source of Variation	Sum of Squares	DF	Mean Square	F
Residual	1810.7	48	37.7	
Block	91.7	3	30.6	.81
Time	88522.9	4	22130.7	586.66
Time by Treatment	33126.9	12	2760.6	73.18
Error 1	1510.6	9	167.8	
Treatment	48410.2	3	16136.7	96.14

Table 11. Marketable Yield of Green Bell Peppers at Marana, 1982. (Number of Harvested Fruits and Weight in g/plant).

Days after Transplanting	Treatments[z]			
	Aluminum	Bare	Black	Furrow
83				
Number	.39[a]	.12[a]	.03[a]	.02[a]
Weight	11.42[a]	8.93[a]	3.60[a]	2.38[a]
106				
Number	.78[a]	.22[b]	.10[b]	.12[b]
Weight	41.37[b]	17.95[a]	5.75[a]	7.20[a]
113				
Number	2.67[c]	1.12[a]	2.10[b]	.82[a]
Weight	147.25[c]	62.87[a]	115.00[b]	46.90[a]
128				
Number	3.50[c]	.70[a]	1.79[b]	1.75[b]
Weight	180.67[c]	32.70[a]	100.89[b]	103.63[b]
143				
Number	2.75[c]	.43[a]	1.05[b]	1.50[b]
Weight	138.70[d]	19.00[a]	60.63[b]	100.18[c]

[z]Values in rows followed by the same letter are not significantly different (.05) by LSD.

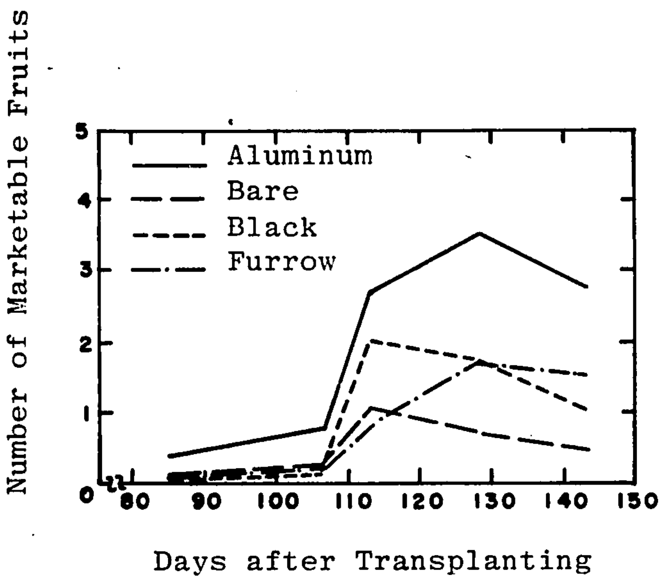

Figure 7. Marketable Yield of Green Bell Peppers at Marana, 1982. (Number of harvested fruits per plant.)

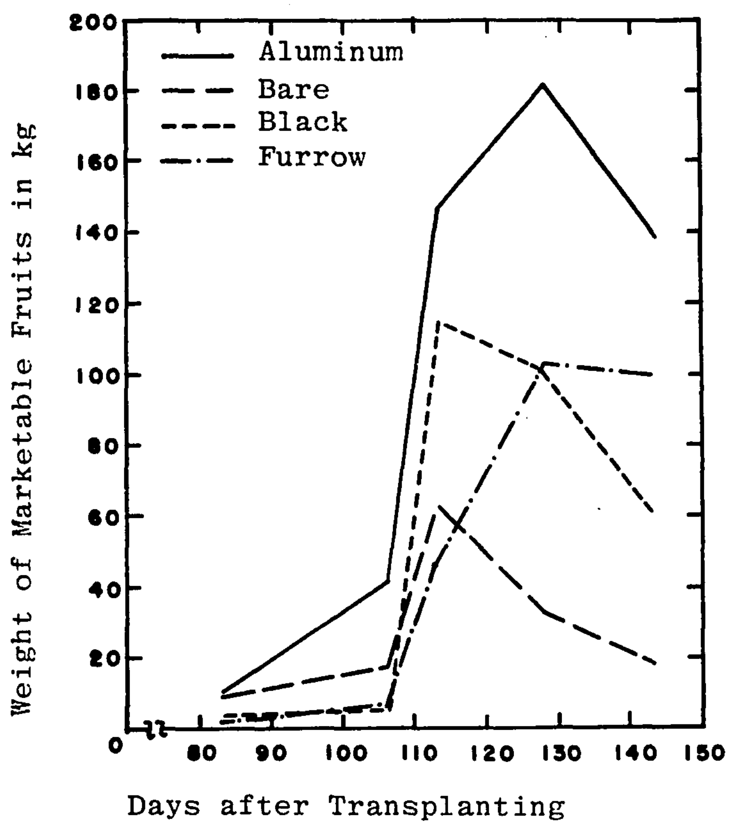

Figure 8. Marketable Yield of Green Bell Peppers at Marana, 1982. (Weight of harvested fruits in g/plant.)

Chili peppers responded differently than green peppers. At the first harvest, day 83 and 106, there was no significant difference between treatments (Table 12, Figures 9 and 10) for chili peppers. At the last two harvests (days 128 and 143), aluminum mulch yields in number of harvested fruits and weight exceeded black mulch. Furrow treatments had higher yields than bare soil in the last two harvests. At 113, the number of harvested fruits was higher at furrow treatments followed by aluminum, then black mulch followed by bare soil. In a measure of the fruit weight at the same date (113 days), aluminum mulch was not different from furrow treatment, which were both higher than black mulch, followed by bare soil.

It was obvious that aluminum mulch provided a favorable condition for the plants to increase yield. The reflection of solar energy by aluminum aided in cooling the soil and provided more light for photosynthetic activity. Also, mulches in general conserved water, which consequently aided in providing good nutrient absorption by plants. Black mulch increased the soil temperature, which caused an adverse effect on the growth, and subsequently the yield during summer at high temperatures.

Unmarketable Yield

There are certain defects which make peppers unmarketable: blossom end rot (BER), misshapen fruits,

Table 12. Marketable Yield of Chili Peppers as Affected by Mulching at Marana, 1982. (Number of Harvested Fruits and Their Weight in g/plant.)

Days after Transplanting	Treatments[z]			
	Aluminum	Bare	Black	Furrow
83				
Number	.08[a]	.01[a]	.08[a]	.06[a]
Weight	1.83[a]	.15[a]	1.13[a]	1.46[a]
106				
Number	.20[a]	.13[a]	.21[a]	.55[a]
Weight	4.71[a]	2.75[a]	4.15[a]	13.36[a]
113				
Number	4.25[c]	2.88[a]	3.48[b]	4.97[d]
Weight	104.68[c]	22.41[a]	60.00[b]	96.13[c]
128				
Number	8.14[d]	.65[a]	3.17[b]	5.25[c]
Weight	138.79[d]	18.67[a]	54.19[b]	84.91[c]
143				
Number	7.90[d]	.55[a]	2.90[b]	5.90[c]
Weight	130.69[d]	14.50[a]	38.90[b]	93.80[c]

[z]Values in rows followed by the same letter are not significantly different (.05) by LSD.

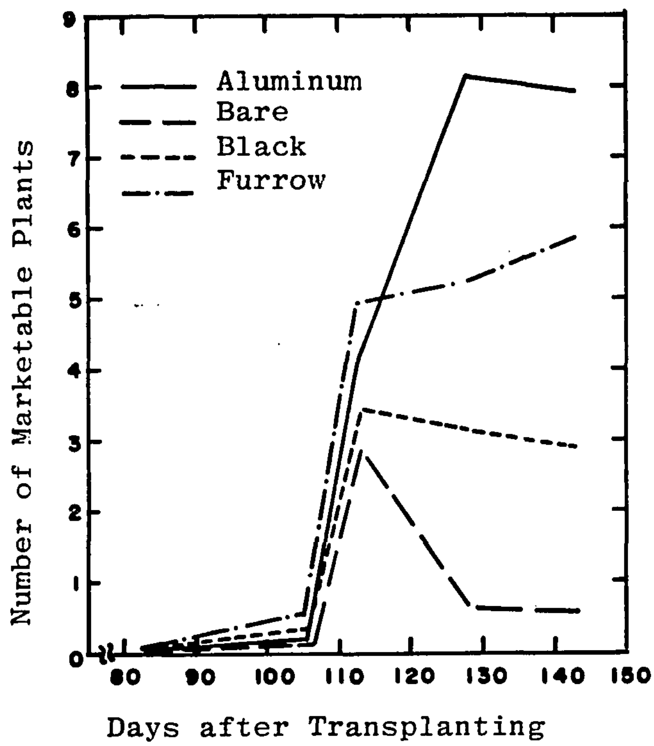

Figure 9. Marketable Yield of Chili Pepper Plants at Marana, 1982. (Number of Harvested Fruits per plant.)

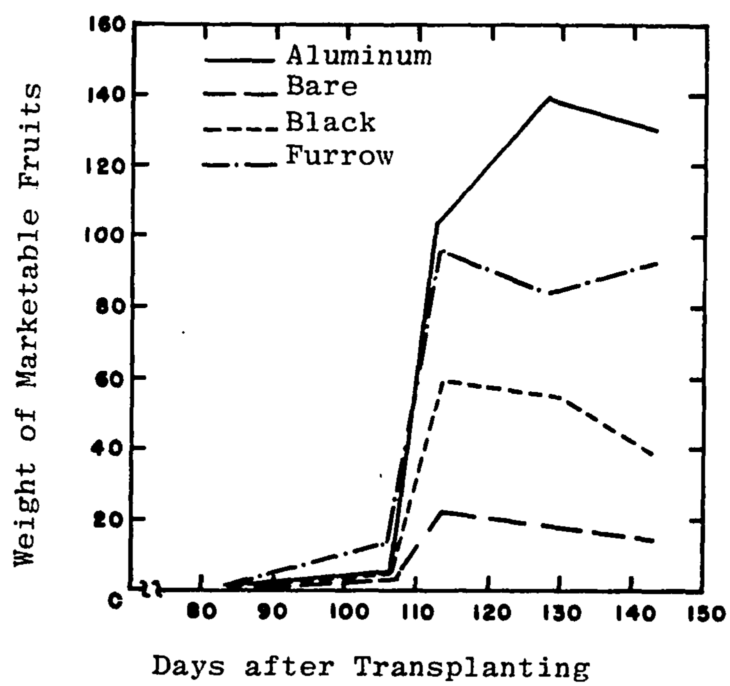

Figure 10. Marketable Yield of Chili Pepper Plants at Marana, 1982. (Weight of Harvested Fruits in g per plant.)

small fruits and sunburned fruits. These defects are presented in the percentage of total yield (Tables 13 and 14).

Generally, the unmarketable fruits were fewer in mulched treatments than unmulched treatments. Again, aluminum mulch is superior to other treatments in reducing the defects except in the case of sunburn in green bell peppers. A higher percentage of sunburned fruits was found in the aluminum mulched plots, which can be explained by added radiation reflected to the plants. The severity of the problem was partially overcome by higher yields with aluminum.

In green bell peppers (Table 13), there was no significant difference in the percent of blossom end rot fruits for both aluminum and black mulch treatments, and both have a lower percent of blossom end rot fruits compared to furrow and bare soil treatments. The percent weight of blossom end rot fruits was the lowest in aluminum mulch treatment followed by black mulch, then the furrow treatment was followed by bare soil.

There was no significant difference between treatments regarding the number of misshapen fruits, but aluminum had lowest percent weight of misshapen fruits, followed by black mulch. The percent weight of misshapen fruits was higher in the furrow treatment than with bare soil. There was the highest percent of small fruits with black

Table 13. Marketable and Defect Percentages of Green Peppers at Marana, 1982.

Classification of the Yield	Treatments[z]			
	Aluminum	Bare	Black	Furrow
Marketable				
Number	26[b]	12[a]	19[a]	22[b]
Weight	40[c]	23[a]	31[b]	38[c]
Blossom End Rot				
Number	15[a]	37[c]	15[a]	28[b]
Weight	9[a]	40[d]	20[b]	24[c]
Misshapen				
Number	24[a]	32[a]	38[a]	31[a]
Weight	18[a]	20[b]	29[d]	24[c]
Small				
Number	10[c]	7[a]	12[d]	8[b]
Weight	9[c]	2[a]	9[c]	5[b]
Sunburn				
Number	24[b]	12[a]	11[a]	10[a]
Weight	24[d]	14[c]	11[b]	9[a]
Total Unmarketable				
Number	73[a]	87[c]	81[b]	78[ab]
Weight	60[a]	77[d]	69[c]	63[b]

[z]Values in rows followed by the same letter are not significantly different (.05) by LSD.

Table 14. Marketable and Defect Percentages of Chili Peppers at Marana, 1982.

Classification of the Yield	Treatments[z]			
	Aluminum	Bare	Black	Furrow
<u>Marketable</u>				
Number	51^{c}	18^{a}	38^{b}	50^{c}
Weight	64^{c}	22^{a}	40^{b}	60^{d}
<u>Blossom End Rot</u>				
Number	20^{c}	36^{d}	17^{b}	9^{a}
Weight	10^{a}	29^{c}	12^{b}	10^{a}
<u>Misshapen</u>				
Number	22^{a}	33^{c}	37^{d}	30^{b}
Weight	21^{a}	41^{c}	40^{c}	25^{b}
<u>Small</u>				
Number	6^{a}	12^{d}	11^{c}	7^{b}
Weight	3^{a}	7^{c}	6^{b}	3^{a}
<u>Sunburned</u>				
Number	$.8^{b}$	$.5^{a}$	$.8^{b}$	1^{c}
Weight	$.6^{a}$	$.5^{a}$	1^{a}	1^{a}
<u>Total Unmarketable</u>				
Number	48^{a}	82^{c}	66^{b}	49^{a}
Weight	36^{a}	78^{d}	60^{c}	40^{b}

[z]Values in rows followed by the same letter are not significantly different (.05) by LSD.

mulch, followed by aluminum, but there was no significant difference between them in the percent of weight. Furrow treatment was higher in the percent of small fruits and percent weight over the bare soil. Aluminum mulch recorded the highest percent on the number and weight of sunburned fruits over all treatments. The other three treatments did not show any significant difference between them regarding the percent of number of sunburned fruits; however, bare soil became second in the order in the percent weight followed by black mulch.

BER is associated with fluctuations in the soil moisture; probably that is why we found more BER fruits in the bare soil than mulch plots. In case of mulch treatment, there is an adequate, even moisture supply, which reduces the BER fruits. The pattern of associated defects with chili papper is different than the one with green bell pepper.

In chili pepper (Table 14), bare soil has the highest percent of number of BER fruits and percent weight over the other treatments. Aluminum mulch was higher in the percent of number of BER fruits compared to black mulch and the latest is higher than furrow treatment. Aluminum and furrow treatment were not significantly different in the percent of the weight of BER fruits; however, both were less than black mulch.

The percent of number of misshapen fruits was higher under black mulch than bare soil. Bare soil had a larger percent of misshapen fruits compared to the furrow treatment and the later was higher than aluminum mulch. Aluminum mulch showed the lowest percent of number and percent weight of misshapen fruits. There was no significant difference between black mulch and bare soil in the percent weight of misshapen fruits, but both are higher in the percent of weight compared to furrow treatment. The least percent of small fruits in number and weight were recorded by aluminum mulch. The highest percent of number of small fruits was in bare soil followed by black mulch which are both higher than furrow on the percent number of small fruits. Aluminum and furrow treatments were not significantly different in the percent weight of small fruits. Higher percent weight of small fruits in bare soil compared to black mulch. There is no significant difference between aluminum and black mulch treatment at the percent of number of sunburned fruits but both are higher than bare soil and less than furrow treatments. There is no significant difference in the percent weight of sunburned fruits at all treatments.

Fresh Weight

From the analysis of variance (Tables 15 and 16), there is significant difference in the treatments for the

Table 15. Analysis of Variance of Fresh Weight per Plant in kg of Green Bell Pepper as Affected by Treatments.

Source of Variation	Sum of Squares	DF	Mean Square	F
Block Treatment	.121	3	.040	16.603
Treatment	.078	3	.026	10.755
Residual	.022	9	.002	
TOTAL	.221	15	.015.	

Table 16. Fresh Weight in kg for Chili and Green Pepper Plants. (145 days after transplanting at Marana, 1982).

Treatment[z]	Green Bell	Chili
Aluminum	1.42[a]	1.52[a]
Black	1.33[b]	1.32[b]
Furrow	1.26[cb]	1.31[b]
Bare	1.24[c]	.99[c]

[z]values in columns followed by the same letter are not significantly different (.05) by LSD.

green bell pepper in the fresh weight 145 days after transplanting. Aluminum mulch treated plants were greater in their fresh weight than other treatments (Table 16). Black mulch treated plants differ significantly from bare soil, but it is not different than furrow treatment. Furrow and bare soil provide almost the same fresh plant weights.

The same pattern of significance applies to the chili pepper (Tables 16 and 17) except furrow and black mulch treatments were significantly different from those of bare soil.

Table 17. Analysis of Variance of Fresh Weight per Plant in kg of Chili Pepper as Affected by Treatments.

Source of Variation	Sum of Squares	DF	Mean Square	F
Block Treatment	.142	3	.047	3.160
Treatment	.573	3	.919	12.776
Residual	.135	9	.015	
TOTAL	.850	15	.057	

Dry Weight

There is no significant difference between treatments for the green bell peppers in the dry weight basis 145 days from transplanting (Tables 18 and 19). In chili peppers (Tables 19 and 20), aluminum mulch was not significantly different than furrow treatment, but was significantly different than black mulch and bare soil. However, furrow, black and bare soil treatments were not significantly different from each other. The difference between aluminum mulch treatment and others was probably due to the better microclimate and better light reflection. The more significant differences with fresh weights was probably due to water content.

Table 18. Analysis of Variance of Dry Weight per Plant in kg of Chili Pepper as Affected by Treatments.

Source of Variation	Sum of Squares	DF	Mean Square	F
Block	.005	3	.002	.700
Treatment	.037	3	.012	5.160
Residual	.022	9	.002	
TOTAL	.064	15	.004	

Table 19. Dry Weight in kg for Chili and Green Pepper Plants. (145 days after Transplanting at Marana, 1982.)

Treatment[z]	Green Bell	Chili
Aluminum	.25[a]	.28[a]
Black	.21[a]	.18[b]
Furrow	.21[a]	.23[ab]
Bare	.20[a]	.16[b]

[z]values in columns followed by the same letter are not significantly different (.05) by LSD.

Table 20. Analysis of Variance of Dry Weight per Plant in kg of Green Bell Pepper as Affected by Treatments.

Source of Variation	Sum of Squares	DF	Mean Square	F
Block	.004	3	.001	.183
Treatment	.007	3	.002	.300
Residual	.066	9	.007	
TOTAL	.076	15	.005	

GENERAL DISCUSSION AND CONCLUSION

In general, pepper plants responded better to aluminum coated polyethylene mulch than to black mulch and other treatments.

Green bell peppers responded more than chili peppers to mulch treatments. This may be due to the adaption of chilis to more severe stress conditions at high temperatures. The above means that mulches are more advantageous for plant growth and development in green bell than in chilis.

In most cases, growth as measured by fresh and dry weight was favored by the aluminum mulch although plant height is not significantly different between treatments. Also, regarding the yield, we found that peppers responded positively to mulch treatment.

When looking at unmarketable fruits, we found the percent of blossom end rot was higher in bare plots than other treatments. This could be due to the moisture fluctuation in bare plots. The percentage of misshapen fruits was higher in bare plots and black mulch. It appears that black mulch causes an adverse situation, such as higher soil temperature. Black mulch can absorb heat, which makes more evaporation and fluctuation of the soil moisture; this results in misshapen fruits. Bare plots get high temperatures similar to those of black mulch.

Green bell peppers responded more to mulches than chili peppers. The percentage of sunburned fruits is higher with aluminum mulch than other treatments in green bell. It is probably because of more radiant energy reflected into the canopy, which causes sunburned fruits.

The situation with chili peppers regarding the percentage of sunburned fruits is different than green bells. This can be explained due to two different reasons: first, probably there is some dirt covering the aluminum mulch near the chili plants; second, which is more reasonable, that the response of chili peppers to mulch is less than green bell peppers and more to moisture levels in the soil.

It is very likely in our situation at least one of the following factors contribute to our results. These factors are: water conservation, reflective light and temperature.

Conservation of soil moisture under mulch treatment is considered to be an important contribution by mulch to the plants. This factor can explain the difference between mulch and non-mulched treatments, because under the mulch the soil moisture was more consistent and uniform. Many researchers agreed that adequate moisture under mulch contributes to the increase of flowers and fruit per plant, growth and yield.

Referring to the results that were obtained by Giddens (1964), it is certainly true that reflective characteristics of aluminum are important for redistributing the light into the plant canopy, which contributes to the increase in yield and growth.

The reflective characteristics of aluminum not only redistribute the light, but it also prevents the soil from becoming too hot for plant growth. This is very important in our situation, since the experiment was carried out at high temperatures.

The results of Oebker et al. (1973) showed that soil temperature under aluminum is lower than other treatments.

The final product of photosynthesis is the carbohydrates, which are the main source of food to the plant. The aluminum mulch is more promising in providing the materials for synthesis than other treatments. It redistributes the light into the plant canopy and provides higher soil moisture.

It is probably that black mulch did not do as good as aluminum mulch because black polyethylene absorbs heat and transmits it to the soil, which increases the soil temperature, which in turn provides unfavorable conditions to plant growth and yield.

In conclusion, we believe it is worthwhile to apply aluminum for green bell and chili peppers, since the ultimate goal is the yield. It is obvious that the aluminum mulch increases the yield, but studies need to be continued to find mulches easy to dispose of and inexpensive.

SUMMARY

This research was carried out to measure the growth and some of the morphological changes in green bell and chili peppers (*Capsicum annuum* L.) as affected by mulching at high temperature conditions. This experiment was done at the University of Arizona Marana Experiment Station in the summer of 1982; cv. 'Yolo Wonder' was used as green bell pepper and cv. 'New Mexico 6-4' was used as chili pepper. Aluminum coated polyethylene and black PE mulches were compared to bare soil with drip irrigation system and furrow treatments. The following results were obtained:

1. The number of flowers per plant is higher in aluminum mulch than other treatments.

2. The response of green bell peppers on the mulched treatments as indicated by the number of fruits per plant was significantly greater than the pepper with unmulched treatments. For the chilis there is less significant between treatments.

3. The height of plant for all treatments was almost similar throughout the growing season.

4. Aluminum mulch produced significantly more yield in number and weight of harvested fruits than other treatments.

5. Aluminum mulch produced significantly more fresh and dry weight than other treatments.

6. The percent of blossom end rot (BER) fruits is higher in bare plots than other treatments.

7. The percentage of misshapen fruits is higher in bare plots and black mulch.

8. In green bell peppers, the percentage of sunburned fruits is higher with aluminum mulch than other treatments, but in chili pepper, the higher percentage of sunburned fruits was found with furrow treatment.

9. For all parameters, chili peppers responded less to mulch treatments than green bell peppers.

Under high temperatures, as it is in Arizona and other desert areas, aluminum mulch can provide a more favorable condition for plant growth and production.

Conserving soil moisture, modifying soil temperature and redistributing the light into the plant canopy were achieved by using aluminum mulch which contributes to the increase of growth and production.

This study showed that it is an advantage to apply aluminum mulch or similar material for peppers under high temperature conditions to increase the growth and production.

APPENDIX

Table A1. Plant Height Variance of Bell Pepper as Affected by Mulching at Marana, 1982.

Source of Variation	Sum of Squares	DF	Mean Square	F
Residual	1188.0	96	12.4	
Block	179.1	3	59.7	4.82
Time	12116.3	8	1515.5	122.38
Time by Treatment	485.8	24	20.2	1.64
Error 1	290.7	9	32.3	
Treatment	446.0	3	148.7	4.60

Table A2. Plant Height Variance of Chili Pepper as Affected by Mulching at Marana, 1982.

Source of Variation	Sum of Squares	DF	Mean Square	F
Residual	1371.9	96	14.3	
Block	71.5	3	23.8	1.67
Time	15987.4	8	1998.4	139.84
Time by Treatment	603.9	24	25.2	1.76
Error 1	220.3	9	24.5	
Treatment	282.2	3	94.1	3.84

Table A3. Fruit Number Variance of Bell Peppers as Affected by Mulching.

Source of Variation	Sum of Squares	DF	Mean Square	F
Residual	396.9	95	4.2	
Black	79.3	3	26.4	6.32
Time	5969.0	8	746.1	178.57
Time by Treatment	544.1	24	22.7	5.43
Error 1	38.1	9	4.2	
Treatment	846.8	3	282.3	66.68

Table A4. Fruit Number Variance of Chili Peppers as Affected by Mulching.

Source of Variation	Sum of Squares	DF	Mean Square	F
Residual	1229.5	96	12.8	
Block	234.8	3	78.3	6.11
Time	29576.2	8	3697.0	288.67
Time by Treatment	841.5	24	35.1	2.74
Error 1	496.8	9	55.2	
Treatment	715.8	3	328.6	4.32

Table A5. Analysis of Variance of the Percent of Number of Marketable Fruits of Green Pepper as Affected by Treatments.

Source of Variation	Sum of Squares	DF	Mean Square	F
Block	.002	3	.001	.700
Treatment	.066	3	.022	22.380
Residual	.009	9	.001	
TOTAL	.077	15	.005	

Table A6. Analysis of Variance of the Percent of Weight of Marketable Fruits of Green Pepper as Affected by Treatments.

Source of Variation	Sum of Squares	DF	Mean Square	F
Block	.001	3	.000	1.461
Treatment	.082	3	.027	80.774
Residual	.003	9	.000	
TOTAL	.086	15	.006	

Table A7. Analysis of Variance of the Percent of Number of BER Fruits of Green Peppers as Affected by Treatments.

Source of Variation	Sum of Squares	DF	Mean Square	F
Block	.003	3	.001	.771
Treatment	.153	3	.051	36.841
Explained	.156	6	.026	18.806
Residual	.012	9	.001	
TOTAL	.168	15	.011	

Table A8. Analysis of Variance of the Percent of Weight of BER Fruits of Green Pepper as Affected by Treatments.

Source of Variation	Sum of Squares	DF	Mean Square	F
Block	.000	3	.000	1.338
Treatment	.304	3	.10121	21.938
Residual	.000	9	.000	
TOTAL	.305	15	.020	

Table A9. Analysis of Variance of the Percent of Number of Misshapen Fruits of Green Peppers as Affected by Treatments.

Source of Variation	Sum of Squares	DF	Mean Square	F
Block	.016	3	.005	1.317
Treatment	.051	3	.017	4.094
Residual	.037	9	.004	
TOTAL	.105	15	.007	

Table A10. Analysis of Variance of the Percent of Weight of Misshapen Fruits of Green Peppers as Affected by Treatments.

Source of Variation	Sum of Squares	DF	Mean Square	F
Block	.000	3	.000	.373
Treatment	.037	3	.012	59.181
Residual	.002	9	.000	
TOTAL	.040	15	.003	

Table A11. Analysis of Variance of the Percent of Number of Small Fruits of Green Peppers as Affected by Treatments.

Source of Variation	Sum of Squares	DF	Mean Square	F
Block	.001	3	.000	.702
Treatment	.024	3	.008	21.252
Residual	.003	9	.000	
TOTAL	.028	15	.002	

Table A12. Analysis of Variance of the Percent of Weight of Small Fruits of Green Peppers as Affected by Treatments.

Source of Variation	Sum of Squares	DF	Mean Square	F
Block	.000	3	.000	.543
Treatment	.074	3	.025	191.884
Residual	.001	9	.000	
TOTAL	.076	15	.005	

Table A13. Analysis of Variance of Percent of Number of Sunburned Fruits of Green Pepper as Affected by Treatments.

Source of Variation	Sum of Squares	DF	Mean Square	F
Block	.003	3	.001	.978
Treatment	.091	3	.030	33.924
Residual	.008	9	.001	
TOTAL	.101	15	.007	

Table A14. Analysis of Variance of the Percent of Weight of Sunburned Fruits of Green Peppers as Affected by Treatments.

Source of Variation	Sum of Squares	DF	Mean Square	F
Block	.000	3	.000	2.335
Treatment	.090	3	.030	502.635
Residual	.001	9	.000	
TOTAL	.091	15	.006	

Table A15. Analysis of Variance of the Percent of Number of Marketable Fruits of Chili Peppers as Affected by Treatments.

Source of Variation	Sum of Squares	DF	Mean Square	F
Block	.000	3	.000	.698
Treatment	.353	3	.118	707.923
Residual	.001	9	.000	
TOTAL	.355	15	.024	

Table A16. Analysis of Variance of Percent of Weight of Marketable Fruits of Chili Peppers as Affected by Treatments.

Source of Variation	Sum of Squares	DF	Mean Square	F
Block	.000	3	.000	.175
Treatment	.497	3	.1661	749.290
Residual	.001	9	.000	
TOTAL	.498	15		

Table A17. Analysis of Variance of Percent of Number of BER Fruits of Chili Pepper as Affected by Treatments.

Source of Variation	Sum of Squares	DF	Mean Square	F
Block	.000	3	.000	.619
Treatment	.226	3	.075	945.276
Residual	.001	9	.000	
TOTAL	.227	15	.015	

Table A18. Analysis of Variance of Percent of Weight of BER Fruits of Chili Peppers as Affected by Treatments.

Source of Variation	Sum of Squares	DF	Mean Square	F
Block	.000	3	.000	.097
Treatment	.170	3	.057	417.857
Residual	.001	9	.000	
TOTAL	.171	15	.011	

Table A19. Analysis of Variance of Percent of Number of Misshapen Fruits of Chili Pepper as Affected by Treatments.

Source of Variation	Sum of Squares	DF	Mean Square	F
Block	.000	3	.000	.562
Treatment	.066	3	.022	199.513
Residual	.001	9	.000	
TOTAL	.067	15	.004	

Table A20. Analysis of Variance of Percent of Weight of Misshapen Fruit of Chili Peppers as Affected by Treatments.

Source of Variation	Sum of Squares	DF	Mean Square	F
Block	.000	3	.000	.037
Treatment	.146	3	.049	760.109
Residual	.001	9	.000	
TOTAL	.147	15	.010	

Table A21. Analysis of Variance of Percent of Number of Small Fruits of Chili Peppers as Affected by Treatments.

Source of Variation	Sum of Squares	DF	Mean Square	F
Block	.000	3	.000	.322
Treatment	.034	3	.011	384.817
Residual	.000	9	.000	
TOTAL	.034	15	.002	

Table A22. Analysis of Variance of Percent of Weight of Small Fruits of Chili Pepper as Affected by Treatments.

Source of Variation	Sum of Squares	DF	Mean Square	F
Block	.000	3	.000	.047
Treatment	.025	3	.008	375.817
Residual	.000	9	.000	
TOTAL	.025	15	.002	

Table A23. Analysis of Variance of Percent of Number of Sunburned Fruits of Chili Pepper as Affected by Treatments.

Source of Variation	Sum of Squares	DF	Mean Square	F
Block	.002	3	.001	1.162
Treatment	.009	3	.003	6.967
Residual	.004	9	.000	
TOTAL	.015	15	.001	

Table A24. Analysis of Variance of Percent of Weight of Sunburned Fruits of Chili Peppers as Affected by Treatments.

Source of Variation	Sum of Squares	DF	Mean Square	F
Block	.002	3	.001	1.460
Treatment	.002	3	.001	1.563
Residual	.004	9	.000	
TOTAL	.009	15	.001	

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