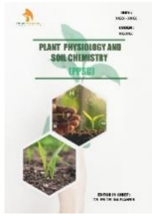
ZIBELINE INTERNATIONAL™ PUBLISHING

ISSN: 2805-5063 (Online)
CODEN: PPSCCU

Plant Physiology and Soil Chemistry (PPSC)

DOI: http://doi.org/10.26480/ppsc.01.2024.01.14



RESEARCH ARTICLE

ALTERNATIVE OPPORTUNITIES OF SAVING WATER BY APPLYING ORGANIC MULCH TYPES AND IRRIGATION INTERVALS ON CHILI PEPPER

Ihab I. Sadek*, Fatma S. Moursy, Mohamed S. M. Ahmed, Z. Y. Maharik, S. H. Ahmed and M. A. M. Heggi

Central Laboratory for Agricultural Climate (CLAC), Agricultural Research Central (ARC), Giza, Egypt.
****Corresponding Author Email: dr.ihabsadek@yahoo.com***

ARTICLE DETAILS

Article History:

Received 13 September 2022
Revised 16 October 2023
Accepted 19 November 2023
Available online 28 November 2023

ABSTRACT

Saving water, sustain soil fertility and adjust rhizosphere microclimate the main targets to obtain, which, considered as main factors herein investigation. Current investigation was conducted under modified greenhouse to indicate the effect of two main factors on growth, productivity and saving amount of water irrigation of chili pepper (*Capsicum annuum* L. Bima F1). The first is three types of organic mulch i.e., rice straw, bagasse and plant compost compared to bare soil (as control). When, the second is three irrigation intervals (every day "as a control", every two days and every three days). Finally, interaction between both studied factors was considered. Seedlings were transplanted on 1st February during both growing seasons in 2021and 2022. Experiment was held on at a private farm located at Kilo No. 80 Cairo Ismailia road in split plot design with three replications. Compost soil mulching significantly increased studied characteristics related to vegetative growth and/or crop yield and its components. Another significant enhancement resulted from irrigation every two days. Contrasting, interaction between compost mulching and three days irrigation interval presented superior enhancement through all studied characteristics. Amount of saved water were estimated by (81.276 and 112.032) and (89.292 and 123.072) cubic meters under every two days and every three days irrigation intervals; during first and second season respectively. Financial study proved the compost mulch + irrigation every three days treatment achieved the highest values from revenues, net return, percentage of net return on the invested pound and net return per feddan.

KEYWORDS

Saving water, Irrigation intervals, Organic mulch, Chili pepper, Economic feasibility.

1. INTRODUCTION

For facing the critical stressful situation concerning produce sufficient food for covering rapid rate of increase population. Extend agriculture area and saving water become persevering necessitude and major target, globally and domestically. Under Egyptian condition newly reclaimed area located in desert and characterized with sandy soil with high infiltration rate. Agriculture sector have to find innovative balanced solution for limited water available for cultivate poor soil with high infiltration rate to produce maximum amount of crops with high quality.

Concept of mulching using agricultural by-product presented for the first time during the mid of 1900s. Later on, other inorganic material was introduced as soil mulch material at 1957 (Iqbal et al., 2020). Since this time, soil mulching is used in agriculture farming worldwide for its multi-function and benefits. Mulching soils presented in two main categories i.e., organic degradable mulch and non-degradable inorganic mulch (Adhikari et al., 2016; Kader et al., 2017 a). On the year 2019, Kader *et al.*, strongly recommended application of soil mulching in commercially cultivated lands within hot and dry regions for obtaining advantages and handling both concepts of water deficiency and weed control (Schahbazian and Iran-Nejad, 2006).

To mulch soil using the organic materials reflected positively on the cultivated crop and the final yield that, crops under soil mulch conditions are mainly being without competition for water resources. Such conclusion was given by Downer and Hodel, 2001. In addition, application of organic soil mulch at arid lands and during hot seasons creates cool soil conditions (Kader et al., 2019). In other words, the organic mulch builds a defense wall for the root system against the extreme heat waves in hot areas. That is very beneficial for the plants especially during the early stage of growth (Chalker-Scott, 2007). In this context, not all types of organic mulch have the same effect regarding conditioning soil temperature; some types have higher ability to solar absorption compared to others (Montague and Kjelgren, 2004). For example, using leaves of plants as mulch affected the soil temperature more optimistic than compost (Tilander and Bonzi, 1997). Where is the less, organic soil mulch have a better ability to create suitable soil temperature for the roots in comparison with non-organic materials (Montague and Kjelgren, 2004).

As a reported that, organic mulch provide maximum yield without high input resources, that refers to its ability to decomposed and enrich soil with nutrient elements (Downer and Hodel, 2001; Chalker-Scott, 2007; Ahmed et al., 2013; Kwambe et al., 2015; Kader et al., 2019).

Organic matter especially organic carbon, as well as, other nutrient elements i.e., nitrogen, phosphorus and potassium are considered as essential needs for both crop yield and soil fertility (Cheng and Zhou, 2019). This nutrient elements and organic matter can be saved throughout using the organic mulch, where, it provide strong protection from both of water erosion and wind as well as create low soil compaction conditions. That allows better growth conditions for the root system and promotes growth and development of the crops (Tanavud et al., 2001). Both of cereal residue, grasses and legumes are used as soil mulch to reduce soil erosion. Speed of water is broken by organic soil mulch that is allowed to increase the rate water infiltration (Chalker-Scott, 2007).

Available soil moisture play very essential role concerning both of plants

Quick Response Code	Access this article online	
	Website: www.ppsc.org.my	**DOI:** 10.26480/ppsc.01.2024.01.14

Cite The Article: Ihab I. Sadek, Fatma S. Moursy, Mohamed S. M. Ahmed, Z. Y. Maharik, S. H. Ahmed and M. A. M. Heggi (2024). Alternative Opportunities of Saving Water by Applying Organic Mulch Types and Irrigation Intervals on Chili Pepper. *Plant Physiology and Soil Chemistry, 4(1): 01-14.*

growth rate and development throughout facilitate nutrients adsorption from soil to plants (Li et al., 2020). Under conditions of enough irrigation water absorption of nutrient elements as well as, the rate of photosynthesis appears to be in the optimum level (Ritawati et al., 2015). Numbers of factors are considered as sources for soil moisture losses and responsible about transformation of the soil to dry lands. One of those factors is weed, that factor is estimated to be responsible about 25% of soil moisture loss because of evapotranspiration (Harris et al., 2004). One of the earliest recommendation of using straw as soil mulching basically depending on its ability to reduce evaporation by 35% was done by (Russell, 1939). In addition, mentioned the ability of organic soil mulch to elevate level of percolation as well as enhancing the water retention of soil (Iqbal et al., 2020). Also, organic mulch play essential role in retain irrigation water where, it locked the runoff and save water to the cultivated crop when it needed. Such situation leads to lower the runoff by 43% and reduce irrigation water as a direct result (Smith, 2000).

Thus, a combined application of appropriate irrigation scheduling and mulching technology represents effective soil and water conservation for crop production in arid and semi-arid regions (Li et al., 2018; Adekaldu et al., 2021).

Vegetable crops are very essential for human being, because of its nutritive value. Globaly, chili pepper (*Capsicum annuum* L.) considered as major commercial vegetables rich in essential vitamin C, capsaicin, beta-carotene, calcium, phosphorus, antioxidant activity, high phenol and capsaicinoid. However, Utami, 2011 indicate benefits of chili for health depending on its content. Moreover, chili pepper can be cultivated in different climatic and ecological zones (Ashrafuzzaman et al., 2011; Nagre et al., 2018). It can be cultivated in open field and at the same time, is highly adapted to cultivation under protected cultivation different structure (Nagy et al., 2015; Loizzo et al., 2015; Faridaha et al., 2019). Also, chili consumed fresh as well as, used in in both of pharmaceuticals and food industrial sector as a raw material. The consuming of chili is continuously increased with the rapid increase in number of population.

Economically, chili pepper presents a unique model of significance, where it's marketing in high prices but, also this high process is acceptable and suitable for the household. This model allow the chili to share in partially protect farmers from the inflation (Fahrurrozi and Ganefianti, 2019).

Under circumstances of limited water it becomes so hard to increase crop productivity, but adjustable scheduling of irrigation together with using water conservation practices like mulching can help to achieve targeted increments (Khurshid et al., 2006). So, combination between soil mulching and irrigation scheduling create high conservation efficiency for both of water and soil. That reflected positively on the level of crop productivity in arid and semi-arid regions (Li et al., 2018; Adekaldu et al., 2021). Currently, mixing between scheduling the irrigation and soil mulching has a great attention especially for vegetable production (Reddy et al., 2016).

So, this study aims to evaluate the chili pepper productivity and saving amount of water irrigation under different tested irrigation intervals and organic soil mulching.

2. Materials and Methods

Impact of three different organic soil mulch as well as, three treatments of irrigation intervals, and there interaction were investigated on productivity and quality of chili pepper throughout seasons of 2021and 2022. The investigation was held on at a private farm located at Kilo No. 80 Cairo Ismailia road.

2.1 Description for Experiment Layout

Modified atmosphere white shade net house was used for cultivate and distribute the experimental treatments. Greenhouse dimensions were 9 meter width and 40 meter long with total area of 360 m^2. The total area was divided into equal five ridges; each one is 1 meter width and 40 meter long. 75 cm were kept apart between each two ridges. However, 50cm distances were kept between both of first and last ridges and the greenhouse sides. Each ridge containing of double drip irrigation lines, considering free10 cm as a guard distance from each side of the ridge, and 80 cm between both irrigation lines. 50 cm between each followed two fixed GR dripper was used (also its considered as a cultivation distance between each followed plants).

2.2 Crop Plant Material

Chili pepper (Bima F1 hybrid) was the chosen plant material for this investigation. After transfer seedlings from the nursery at 1st February to the greenhouse on both growing seasons 2021 and 2022, it were first acclimated to the net house atmosphere by let it rest inside the same net house for five hours. Seedlings were cultivated later on after the acclimation.

2.3 Application of Treatments

Two main factors were studied in this study. The first factor was organic soil mulching; however, the second studied factor was intervals of irrigation. Both of studied factors were presented in three levels and control treatment for each one of them. Types of organic mulch were rice straw, baggas, compost with a 3 cm thickness (chemical and physical properties of each type shown in "Table 1") and bare soil as control treatments. Moreover, add irrigation requirements every day, every two days and every three days were the studied levels of irrigation interval factor. Interaction between the two studied factors was put in consideration during data analyzing and results discussion.

Table 1: Chemical and Physical Properties of Each Type of Organic Mulch.

Properties	Organic mulch types		
	Rice straw	Bagasse	Compost
Moisture (%)	8.4	11	25
EC dS/m	2.3	-----	3.7
pH	-----	0.5	7.2
Ash (%)	19.3	3.7	-----
C/N ratio	61.3	66.5	8.5
N%	0.8	0.51	2.4
P%	0.6	0.1	0.75
K%	0.4	0.04	1.3
Total carbon	49	33.9	20.5
Cellulose	35	42.5	-----
Lignin	12.2	23	-----

2.4 Calculation of Irrigation Amounts

Central Laboratory for Agricultural Climate "CLAC" has provided the historical data for Class-A pan evaporation (ETp) values to calculate the irrigation amounts needs for chili pepper plants through two tested growing seasons.

Irrigation amounts for chili pepper were calculated depend on crop evapotranspiration (ETo) and the evapotranspiration under modified greenhouse conditions according to (Abou-Hadid and El-Beltagy, 1992). As follow:

$ET_{GH} = 0.7 \times ETo$

Where:

ET_{GH} = the evapotranspiration under modified greenhouse conditions

ETo = the evapotranspiration in the open field conditions

Drip irrigation system was used for irrigation which applied following the evapotranspiration (ETc) method according to soil water balance (Doorenbos and Pruitt, 1977) as follows:

$ETc = ET_{GH} \times Kc$

Where:

ETc = the water requirements for chili pepper plant under greenhouse conditions

ET_{GH} = the evapotranspiration under modified greenhouse conditions

Kc = the crop coefficient for chili pepper plant

The irrigation amounts of chili pepper plants (Kc) were determined using (Allen *et al*., 1998). Kc values increased from 0.5 (initial stage) to 1.06 (middle stage) from transplanting to the start of harvest, and then decreased from 1.06 to 0.7 at the end of the growing season. From 1st of February till the conclusion of the growing season, drip irrigation was applied.

Furthermore, water productivity (WP) was calculated by dividing yield by the total amount of water applied, which is represented as $Kg/m^2/m^3$ as follow:

$$WP = \frac{Total\ yield\ (Kg/m^2)}{Total\ amount\ of\ water\ irrigation\ added\ (m^3)}$$

Recorded data:

Regarding evaluating the vegetative growth, plant height and number of leaves were measured after 75 days from transplanting. However, number of flowers, number of fruits per plant, and total fruit weight/plant were used for evaluate productivity (total yield/plant).

Soil moisture was measured by using the gravimetric method. A known mass of wet soil sample was dried at 105 ∘C in an oven. After weighing the container, wet soil, and dry soil, the percentage of moisture in each was computed as follows:

$$Soil\ moisture\ content\ (\%) = \frac{(Y - Z)}{(Z - X)} \times 100$$

Which is X= Weight of empty moisture box (g),

Y= Wet soil weight with box (g),

Z= Weight of dry soil (g),

(Y-Z)= Moisture content in soil and

(Z-X)= Weight of oven dried soil.

2.5 Experimental Design and Data Analysis

Studied factors were spread inside the net house in split plot design with three replications. Organic soil mulching was arranged in the main plots, moreover, intervals of irrigation was arranged in the sub-main plots. Duncan's multiple range tests at 5% level of probability were used to compare means of the treatments (SAS, 2005).

2.6 Economic Feasibility Study

The economic feasibility of cultivating chili pepper crop in greenhouse (360 m²) should be determinate through growing period, which is almost five months. This financial analysis have depends on operating costs, which, including the rental value and cost of the transaction used, as well as, the quantities of production and revenues for the various transactions in kilograms in order to identify the net return and the rate of return. On the invested pound to compare its value and determine the savings achieved on water and energy. As well as the financial analysis in the case of cultivation of 1 feddan which equal 9 greenhouses.

3. Results

3.1 Plant Height

Data in Table (2) shown effect of different types of organic mulch and three irrigation intervals as well as them interaction on chili pepper plant height. Regarding effect of organic mulch, it positively promoted plant height. It was noticeable that, plants grown under compost mulch conditions presented the highest significant value of plant height, followed by those grown under rice straw and bagasse mulch circumstances without any significant different between last mentioned two types. Contrary, the lowest significant plant height was observed in plants grown in bare soil (control). The same trend of results was observed during the second season.

Concerning effect of irrigation intervals, it was noticed that plants irrigated every two days was significantly the tallest compared to other tested irrigation intervals. Moreover, irrigation every three days recorded the second highest significant plant height. Finally, plants that irrigated every day were significantly the shortest plant height. Trend of obtained results was repeated during both studied seasons.

In addition, interaction between tested types of organic mulch and three irrigation intervals affected significantly on chili plant height. Highest significant plants were found in plants under conditions of interaction between compost mulch and irrigation every three days followed by those under interaction between compost and irrigation every two days. However, interaction between rice straw and irrigation every two days ranked third highest significant plant height. On another hand, lowest significant plant height was detected in interaction between bare soil (control) and irrigation every three days, followed by interaction between control and irrigation every two days and without significant difference between them. Trend of obtained results was repeated typically during both studied seasons.

Table 2: Response of Chili Pepper Plant Height (Cm) to Organic Mulch Types, Irrigation Intervals and Their Interaction During Seasons 2021 And 2022.

Mulching types	Irrigation Intervals			Mean
	Every day	Every two days	Every three days	
	First season			
Rice straw	82.55f	105.25c	93.36de	93.72B
Bagasse	89.33ef	110.86bc	97.58de	99.26B
Compost	102.65cd	116.25b	129.47a	116.12A
Control	77.38g	71.88gh	66.52h	71.93C
Mean	87.98C	101.06A	96.73B	
	Second season			
Rice straw	80.90f	103.15c	91.49de	91.85B
Bagasse	87.54ef	108.64bc	95.63de	97.27B
Compost	100.60cd	113.93b	126.88a	113.80A
Control	75.83g	70.44gh	65.19h	70.49C
Mean	86.22C	99.04A	94.80B	

3.2 Number of Leaves

Illustrated data in Table (3) provide the significant effect for both of organic mulch types and irrigation intervals as well as their interaction on chili pepper number of leaves. Organic mulch affected significantly number of leaves of chili pepper, highest significant no. of leaves was detected due to use of compost as soil mulch. Both of bagasse and rice straw soil mulches ranked second and third highest significant number of leaves. Where the less, control treatment (without mulch) significantly ranked the last order concern number of leaves. Similar trend of results was obtained during both studied seasons.

Regarding to response of chili pepper to different irrigation intervals, number of leaves increased significantly when irrigated once/2 days, followed by those irrigated once/3 days without any significant difference between both treatments. However, the daily irrigation due to lowest found significant number of leaves throughout tested intervals. This trend repeated through both studied seasons.

In addition, interaction between both of soil organic mulch and irrigation intervals led to significant impact on number of leaves. Interaction between compost and irrigation once/3 days enhanced number of leaves significantly to record highest significant value. Moreover, chili pepper plants under conditions of interaction between compost and irrigation once/2 days recorded second highest significant number of leaves. Contrary, interaction between bare soil (control) and irrigation once/3 days recorded the lowest significant number of leaves. Second lowest significant number of leaves was found in plants cultivated in bare soil (control) and irrigation every two days. Last mentioned trend of results was found in the second seasons.

Mulching types	Irrigation Intervals			Mean
	Every day	Every two days	Every three days	
	First season			
Rice straw	66.52e	73.53cd	70.80d	70.28B
Bagasse	70.40d	76.87bc	73.80cd	73.69B
Compost	72.94cd	79.57b	86.29a	79.60A
Control	64.32e	57.19f	51.44g	57.65C
Mean	66.52e	73.53cd	70.80d	
	Second season			
Rice straw	64.58e	71.39cd	68.74d	68.24B
Bagasse	68.35d	74.63bc	71.65cd	71.54B
Compost	70.82cd	77.25b	83.78a	77.28A
Control	62.45e	55.52f	49.94g	55.97C
Mean	66.55B	69.70A	68.53A	

3.3 Average of Flowers

Average number of flowers was significantly affected by types of organic soil mulching and irrigation intervals, as well as interaction between their (Table 4). Regarding effect of organic soil mulching, it was found that, average number of flowers increased significantly as using compost for mulching the soil. Such increment was enough to put plants under this treatment in the first order compared to other tested organic soil mulches. In addition, applied rice straw and bagasse were also have a significant impact on average number of flowers, whereas they occupied second and third order without significant different between them. Contradictory, control treatment (without soil mulch) significantly decreased average number of flowers to record the lowest significant value. The same order of significant effect was appear during the both studied seasons.

Nevertheless, three tested irrigation intervals reflected a significant impact on average number of flowers, highest significant value was obtained when plants irrigated every two days. In addition, irrigation every day ranked the second highest value considering no significant different between the two intervals. Irrigation in every three days lead to obtaining the lowest significant average of flowers, respecting a non-significant different between this treatment and irrigation every two days. Same trend and same order was detected during second studied season.

Furthermore, studied characteristic reflected a significant response to interaction between both of soil organic mulch and irrigation intervals as shown in table (4). The highest significant interaction was compost and irrigation every three days, that was reflected the highest significant average number of flowers. Second highest significant value was obtained when compost soil mulching interacting with irrigation every two days. The third highest significant average number of flowers was detected under interaction of rice straw soil mulch with irrigation every two days considering no significant different between this interaction and the last discussed interaction (compost and irrigation every two days). Focusing on the lowest significant effect, it was noticed in interaction between control and irrigation every three days followed by interaction between control and irrigation every two days. The same significant effect was noticed in the second season.

Table 4: Response of Chili Pepper Number of Flowers/Plant to Organic Mulch Types, Irrigation Intervals and Their Interaction During Seasons 2021 and 2022.

Mulching types	Irrigation Intervals			Mean
	Every day	Every two days	Every three days	
	First season			
Rice straw	80.43de	84.24bc	78.54fg	81.07B
Bagasse	79.21ef	86.65cd	77.48g	81.11B
Compost	80.80de	85.63b	91.22a	85.88A
Control	70.54h	69.85i	69.07j	69.82C
Mean	77.74AB	81.59A	79.07B	
	Second season			
Rice straw	78.81de	80.55bc	77.00fg	78.79B
Bagasse	77.64ef	79.98cd	75.98g	77.87B
Compost	79.17de	81.88b	85.33a	82.13A
Control	73.16h	70.58i	67.91j	70.55C
Mean	77.20AB	78.25A	76.55B	

3.4 Number of Fruits /Plant

In Table (5) noticed that, the significant effect of soil organic mulching and irrigation intervals and their interaction on number of fruits/plant during seasons of 2012 and 2022.

Highlighting on effect of organic soil mulching, mulching soil using compost led to a significant increase in number of fruits per plant, where it significantly ranked the first highest significant value. Moreover, both of rice straw and bagasse soil mulching ranked significantly at second and third order respecting significant different between them. At the last order was control treatment (bare soil) significantly the lowest value of number of fruits/plant. Both studied seasons reflected the same trend of results.

In addition, to irrigate chili plants every two days significantly allow plants to record the highest significant number of fruits per plant. Moreover, irrigation every day recorded second highest order after irrigation every two days. Conflicting, the lowest significant value was noticed under conditions of irrigated every three days. The same trend of results was noticeable during both studied seasons.

On other side, interaction between organic mulching and irrigation intervals significantly enhance average number of fruits/plant. The enhancement in studied character followed descending order start from highest value that significantly obtained in interaction between compost and irrigation once/3 days followed by interaction between compost and irrigation once/2 days then interaction between rice straw and every two days interval.

On the other hand, lowest significant value of number of fruits/plant was found in plants grown in control (not mulched soil) and irrigation every day, followed by those grown in control (not mulched soil) and irrigation every two days and those under conditions of interaction between control (not mulched soil) and three days interval between irrigations. The same trend was found during the second season.

3.5 Total Yield/Plant (g)

Illustrated data in table (6) indicated the effect of organic mulch types and irrigation intervals and their interaction on chili pepper total yield/plant. It's obvious that mentioned characteristic affected significantly by different tested organic mulch. However, mulched soil using rice straw, bagasse or control led to a significant increments in total yield compared to bare soil (control). Deep looking inside results of organic mulch, it is noticeable that compost soil mulch recorded the highest significant total yield follower by rice straw and finally bagasse ranked third highest significant total yield. This trend was true during first and second season.

Table 5: Response of Chili Pepper Number of Fruits/Plant to Organic Mulch Types, Irrigation Intervals and Their Interaction During Seasons 2021 And 2022.

Mulching types	Irrigation Intervals			Mean
	Every day	Every two days	Every three days	
	First season			
Rice straw	79.36d	82.64bc	73.76f	78.59B
Bagasse	77.98e	81.71c	71.25f	76.98C
Compost	79.47d	84.19b	89.11a	84.25A
Control	67.37g	63.27h	58.88i	63.17D
Mean	76.05B	77.95A	73.25C	
	Second season			
Rice straw	77.08d	80.23bc	71.69f	76.33B
Bagasse	75.75e	79.34c	69.28f	74.79C
Compost	77.18d	81.72b	86.45a	81.78A
Control	65.55g	61.61h	57.38i	61.51D
Mean	73.89B	75.73A	71.20C	

Table 6: Response of Chili Pepper Total Yield/Plant (G) to Organic Mulch Types, Irrigation Intervals And Their Interaction During Seasons 2021 And 2022.

Mulching types	Irrigation Intervals			Mean
	Every day	Every two days	Every three days	
	First season			
Rice straw	595.85ef	620.48bc	589.65f	601.99B
Bagasse	590.71ef	610.54cd	586.83f	596.03B
Compost	607.24de	624.63b	650.45a	627.44A
Control	535.47g	516.78h	504.96i	519.07C
Mean	582.32B	593.11A	582.97B	
	Second season			
Rice straw	592.89ef	617.28bc	586.75f	598.97B
Bagasse	587.80ef	607.43cd	583.96f	593.07B
Compost	604.17de	621.38b	646.95a	624.17A
Control	533.12g	514.61h	502.91i	516.88C
Mean	579.49B	590.18A	580.14B	

Moving to effect of tested irrigation intervals on chili pepper total yield/plant, it's clear from data in table (6) that, all tested intervals due to significant enhancement in the studied characteristic. Highest obtained significant increment was detected in plants irrigated every two days. Moreover, second and third highest significant effect was found in plants irrigated every day followed by those irrigated every three days; without significant different between them. The same trend was repeated during both studied seasons.

Focusing on the effect of interaction between both of organic soil mulch and irrigation intervals, it's apparently the significant effect of such mentioned interaction on enhanced the chili pepper total yield (Table 6). Depictive data in Table (6) reflected the highest significant effect of the interaction between compost soil mulch and irrigation once every three days followed in descending order by interaction between compost mulch and irrigation once every two days with significant difference between them. Although, least significant effect was obtained in plants under condition of interaction between bare soil (control) and irrigation interval once/day followed by those under the circumstances of interaction between control and irrigation once every two days and those under the circumstances of interaction between control and irrigation once every three days considering the significant difference between them. Similar trend was repeated twice, once during first season and again during the second season.

3.6 Amount of Calculated Irrigation Water

Data in Figure (1) present different calculated and applied amount of irrigation water to chili pepper plants during both growing seasons 2021 and 2022. Calculation was done by the rate of 100% from evapotranspiration (ETo). So, plants had been taken maximum amount of irrigation water during the growing season.

It was noticed that, lowest amount of irrigation water had been taken during February and the highest one was during May in the both seasons.

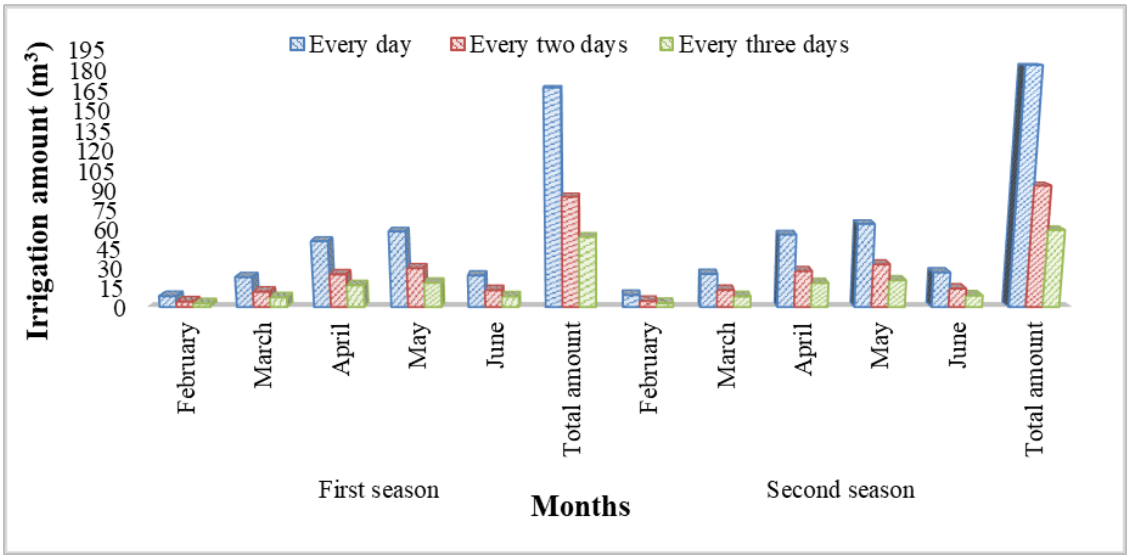


Figure 1: Total amount of applied irrigation water m³/greenhouse (360 m²) during both growing seasons 2021 and 2022.

3.7 Amount of Calculated Saved Irrigation Water

Table (7) obtained the amount of saved irrigation water in different intervals treatments comparing to every day application (control). Values cleared that there were plenty of saved irrigation water in the both intervals treatments. The highest values of saved water amount were in May, because it's the peak of plant growth stage during the both growing seasons which were (28.380 and 31.164 m^3), for irrigation once every two days and (39.756 and 43.656 m^3) for irrigation once every three days in first and second seasons, respectively. The lowest amount of saved irrigation water was in February because it`s the beginning of growing season and the plant still small. On the other hand, Irrigation every two and three days saved well-nigh as much as (33 and 64%) and (49 and 67%) of the quantity of water adding on a daily irrigation on first and second tested seasons, respectively. Meanwhile, Irrigation every three days saved up to 64% in both seasons rather than irrigation every two days.

3.8 Variation of Total Amount of Irrigated Water (m^3/greenhouse)

Figure (2) presented that, the variation of total amount of irrigated water (m^3/greenhouse) among different irrigation intervals treatments during the first and the second season. As aforementioned results there was a variation among the amount of consumed irrigation water. The highest amount of applied water resulted from using irrigation every day but the lowest amount of irrigation water obtained from using three days interval treatment in the both growing season. February was the lowest month in amount of irrigation water but May was the highest one. On the contrary, the highest amount of water saving in chili pepper plants irrigation was the irrigation interval every three days followed by the interval every two days comparing to irrigation every day (control treatment).

3.9 Irrigation Curve of Intervals Irrigation Treatments

Figure (3) reflected that, the irrigation curve of different irrigation treatments during the first and the second growing seasons of chili pepper plants. The curve of applied water is the same curve of chili pepper plants growth that because it represents the growth rate of different stages of plant growth as well as different water requirements. Besides, these curves like crop coefficient curve (K_C) which depends on the growth stage (vegetative, flowering and fruiting) of pepper plant. KC is fraction between crop evapotranspiration (ETc) and reference evapotranspiration (ETo). So, when reducing the amount of irrigation water (ETc) under the same values of evapotranspiration (ETo) lead to decrease the values of K_C in the different irrigation intervals (after two or three days) comparing to every day irrigation. Although, the amount of irrigation decreased but the proportion among different stages still static because of this curve represent the growth rate in different plant stages. The lowest point in the curve was in the beginning of the season (February) and the curve was somewhat stable in the middle of growing season (April to May), after that the curve of applied water was decreasing until the end of growing season.

Table 7: Total Amount of Saved Irrigation Water M^3/Greenhouse Comparing With Every Day Application Treatment During Two Growing Seasons 2121 And 2022.

Irrigation Intervals	February	March	April	May	June	Total amount
	Frist season					
Every day	0	0	0	0	0	0
Every two days	4.284	11.352	25.752	28.380	11.508	81.276
Every three days	5.784	15.852	34.200	39.756	16.440	112.032
	Second season					
Every day	0	0	0	0	0	0
Every two days	4.704	12.540	28.284	31.164	12.600	89.292
Every three days	6.348	17.508	37.560	43.656	18.000	123.072

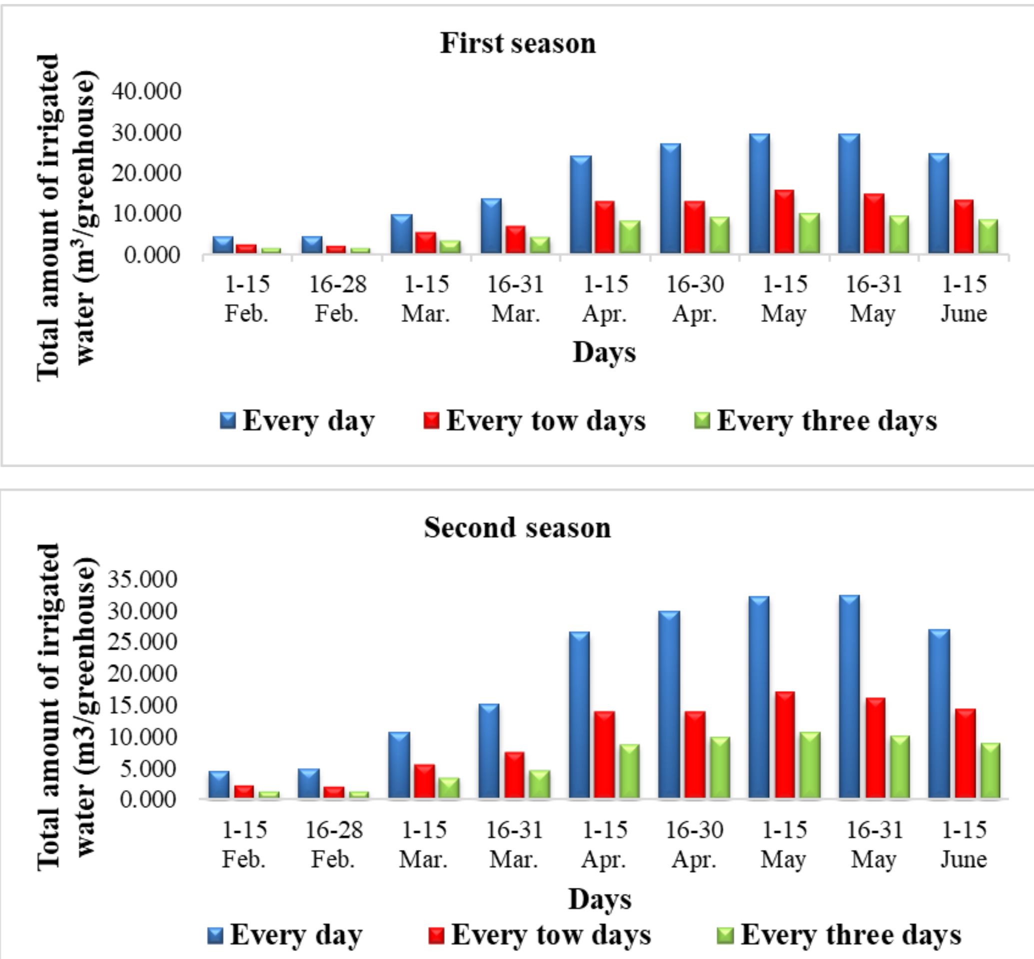


Figure 2: Total amount of irrigated water (m^3/greenhouse) through different development days in 2021 and 2022 seasons.

3.10 Water Productivity (WP)

From Table (8) and Fig. (4), indicated the irrigation interval every three days gave the greats values of water productivity (WP) compared with other irrigation interval treatments. The highest value of WP was indicated with irrigation every three days + compost mulch treatment followed with irrigation every three days + rice straw mulch and irrigation every three days + bagasse mulch treatments on second and third places, respectively. When irrigation every three days + bar soil (control) treatment paced the last place. Moreover, the same trend was noticed with irrigation every two days and irrigation every day, respectively. Generally, applied irrigation every three days + compost mulch treatment recorded the best value from WP, when, irrigation every day + bar soil (control) treatment reduced it. This result was harmony with (Costa and Gianquinto, 2002; Ertek et al., 2007; Sezen et al., 2011) demonstrated that water productivity declines when irrigation amount increases in capsicum. In contrast, discovered that increasing irrigation frequency enhances water productivity (Sezen et al., 2011). This might be because to differences in treatment intervals, soil, meteorological circumstances, and protective structure (Kumar et al., 2016).

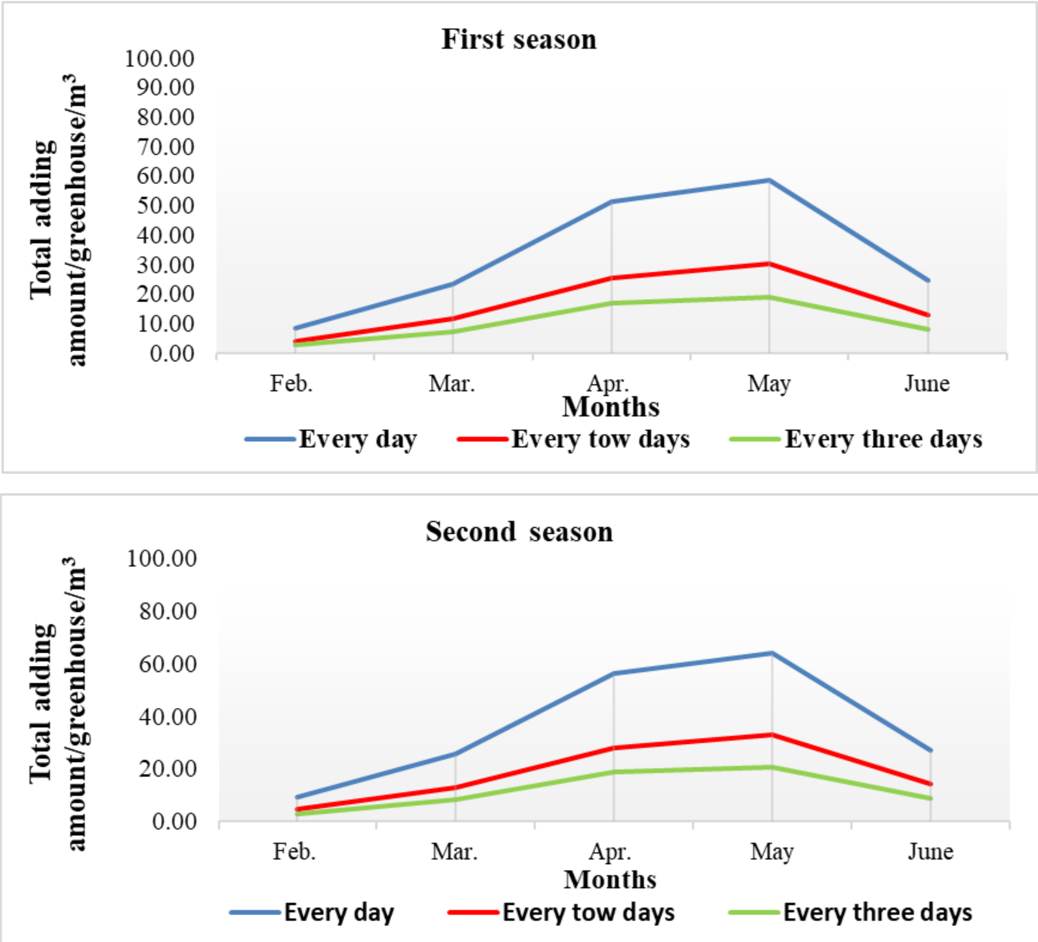


Figure 3: Irrigation curve of intervals irrigation treatments during both growing seasons 2021 and 2022.

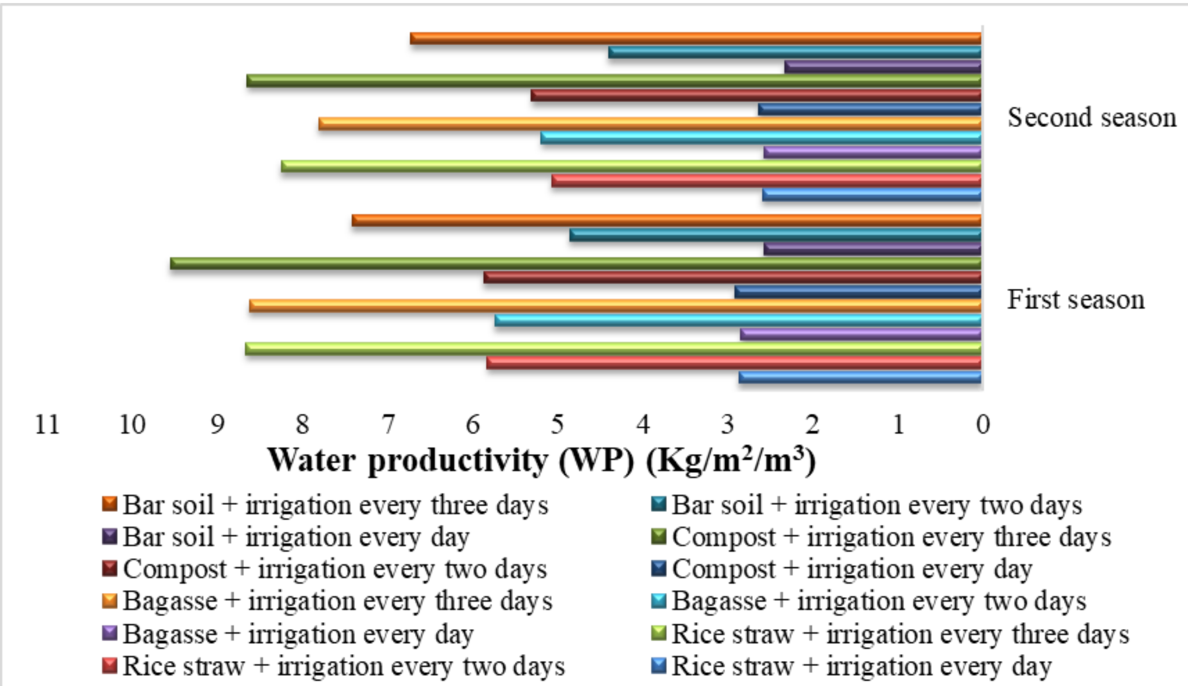


Figure 4: Effect of mulching types, irrigation intervals and their interaction on water productivity "WP" ($Kg/m^2/m^3$) in 2021 and 2022 seasons.

Table 8: Effect of Mulching Types, Irrigation Intervals and Their Interaction on Water Productivity "WP" (Kg/M^2/M^3) And Soil Moisture (%) Through 2021 And 2022 Seasons.

Treatments		No. of Irrigations	Water adding (m^3/m^2)	Yield (Kg/m^2)	WP	Soil moisture (%) 0-15 cm
Mulch types	Irrigation intervals					
Frist season						
Rice straw	Every day	135	0.833	3.575	4.29	20.78^{c}
	Every two days	69	0.426	3.723	8.73	19.21^{d}
	Every three days	44	0.273	3.538	12.98	18.92^{e}
Bagasse	Every day	135	0.833	3.544	4.26	20.66^{c}
	Every two days	69	0.426	3.663	8.59	19.12^{d}
	Every three days	44	0.273	3.521	12.92	18.83^{e}
Compost	Every day	135	0.833	3.643	4.38	21.32^{a}
	Every two days	69	0.426	3.748	8.79	20.94^{b}
	Every three days	44	0.273	3.903	14.32	20.80^{bc}
Bar soil (control)	Every day	135	0.833	3.213	3.86	18.63^{f}
	Every two days	69	0.426	3.101	7.27	15.89^{g}
	Every three days	44	0.273	3.030	11.12	12.00^{h}
Second season						
Rice straw	Every day	135	0.915	3.557	3.89	20.16^{c}
	Every two days	69	0.468	3.557	7.60	18.63^{d}
	Every three days	44	0.299	3.704	12.37	18.35^{e}
Bagasse	Every day	135	0.915	3.527	3.86	20.04^{c}
	Every two days	69	0.468	3.645	7.78	18.55^{d}
	Every three days	44	0.299	3.504	11.70	18.27^{e}
Compost	Every day	135	0.915	3.625	3.96	20.89^{a}
	Every two days	69	0.468	3.728	7.96	20.52^{b}
	Every three days	44	0.299	3.882	12.97	20.38^{bc}
Bar soil (control)	Every day	135	0.915	3.199	3.50	18.07^{f}
	Every two days	69	0.468	3.088	6.59	15.41^{g}
	Every three days	44	0.299	3.017	10.08	11.64^{h}

3.11 Soil Moisture

Regarding to soil moisture in Table (8), indicated that, applied compost mulch lead to increase soil moisture content with all irrigation interval treatments. The higher soil moisture content was observed with compost mulch + irrigation every day, when, compost mulch + irrigation every day and compost mulch + irrigation every day placed on order second and third place, respectively, without significant between second and third place. In contrast, control treatment (bar soil) obtained reduction in soil moisture content with all irrigation interval treatments. The greater reduction was found with control treatment + irrigation every three days. This is related to water management is critical in capsicum at all phases of plant growth because it influences stand formation, fruit set, and quality (Costa and Gianquinto, 2002). A sufficient water supply and reasonably homogeneous soil moisture are essential for greater yields throughout the growth season (Sezen et al., 2011). Furthermore, (Sezen et al., 2011) discovered that soil water content remained relatively high in high frequency plots compared to low frequency plots.

The current findings demonstrated that both excess and deficit of water inhibited crop growth, and greater yields were achieved with the irrigation every three days + compost mulch treatment, which, had suitable concentrations of soil moisture throughout all phases of crop development.

3.12 Economic Feasibility

Economic study in Figure (5) presented that, using different mulch types treatments leads to increase the operating costs rather than control treatment (bar soil). The highest operating costs were obtained with compost mulch type (6267.0 L. E.) followed by bagasse (6243.2 L. E.), rice straw (6088.0 L. E.) and bar soil (5544.0 L. E.), respectively. That is mean applied mulch treatments increasing operating costs by 13% more than control treatment. Contrary, applied irrigation intervals reduced the operating costs by 2-3 % compared to daily irrigation. The greatest reduction was indicated by irrigation every three days (5366.4 L. E.) followed by irrigation every two days (5415.2 L. E.). Generally, total operating costs increased by 7-10 % by applied mulch types with irrigation intervals more than bar soil + daily irrigation treatment (control).

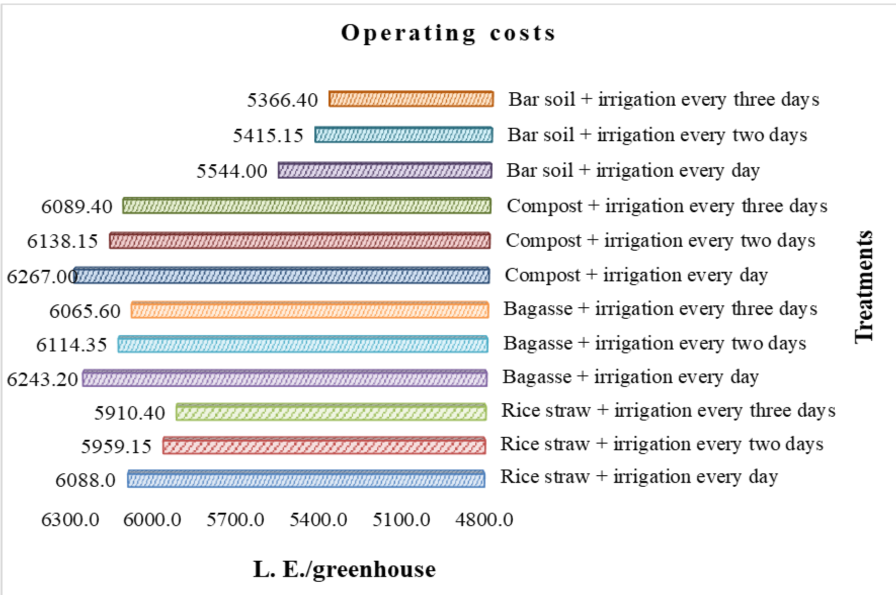


Figure 5: Effect of mulching types, irrigation intervals and their interaction on operating costs (L. E.)/greenhouse for both growing seasons 2021 and 2022.

Illustrated data in Table (9) reflected the effect of applying mulching types, irrigation intervals and their interaction on revenues (L. E.), net return (L. E.), percentage of net return on the invested pound (%) and net return per feddan (L. E.). The positive effect was obtained with compost mulch + irrigation every three days, which achieved (7784.4, 1695.0, 27.8 and 15255.0) on revenues (L. E.), net return (L. E.), percentage of net return on the invested pound (%) and net return per feddan (L. E.), respectively rather than control treatment (bar soil + daily irrigation), which, gave (6411.5, 867.5, 13.5 and 7807.5), respectively. That is referees to increase on revenues, net return, percentage of net return on the invested pound and net return per feddan by (21, 95, 106 and 95 %), respectively, when applied compost mulch + irrigation every three days treatment compared to bar soil + daily irrigation as control treatment.

On the other hand, compost mulch + irrigation every two days, rice straw mulch + irrigation every two days and bagasse mulch + irrigation every two days treatments placed the second, third and fourth places, respectively after compost mulch + irrigation every three days treatment. While, bar soil + irrigation every three days treatment occupied the last place in all tested items.

Table 9: Effect of Mulching Types, Irrigation Intervals and Their Interaction on Revenues (L. E.)/Greenhouse, Net Return (L. E.)/Greenhouse, Net Return on The Invested Pound (%)/Greenhouse and Net Return Per Feddan (L. E.) For Both Growing Seasons 2021 And 2022.

Mulch types	Irrigation Intervals		
	Every day	Every two days	Every three days
	Revenues*		
Rice straw	7132.4	7425.6	7058.4
Bagasse	7071.1	7307.8	7024.7
Compost	7268.5	7476.1	7784.4
Control	6411.5	6188.3	6047.2
	Net return**		
Rice straw	1044.4	1466.4	1148.0
Bagasse	827.9	1193.4	959.1
Compost	1001.5	1337.9	1695.0
Control	867.5	772.8	680.8
	Net return on the invested pound***		
Rice straw	14.6	24.6	19.4
Bagasse	11.7	19.5	15.8
Compost	13.8	21.8	27.8
Control	13.5	14.3	12.7
	Net return per feddan****		
Rice straw	9399.6	13198.0	10332.0
Bagasse	7451.1	10741.0	8631.9
Compost	9013.5	12041.5	15255.0
Control	7807.5	6955.6	6127.2

*Revenues = Quantity of production (Kg) × Price, which is 10 L. E. per kg

**Net return = Revenues - Total costs

***Net return on the invested pound (%) = $\frac{\text{Net return}}{\text{Operating costs}}$

1 feddan = 9 greenhouses ($360m^2$)

****Net return/feddan = Net return/greenhouse ($360m^2$) × 9

3.13 Alternative Opportunities

As mentioned before in Table (7) applied compost mulch + irrigation every three days treatment lead to save about 123 m^3 of water in both growing seasons. This amount can use for cultivating other crops or increasing the cultivating area by chili pepper.

Table (10) presented the alternative opportunities to use saving water amounts, which, achieved by applying compost mulch + irrigation every three days for cultivating three important crops i.e., cucumber, squash and common bean at the same time of cultivation of chili pepper.

Data obtained that, each crop (cucumber, squash and common bean) need to irrigate per season by (194.590, 153.640 and 120 m^3) of water, respectively. When, total amount from saving water is 123 m^3. That is mean to complete all summer growing season for cucumber and squash crops need to supplementary amount of water by (71.590 and 30.640 m^3) of water, respectively. When, common bean crop has more sufficient irrigation water for complete growing season.

In the same way, intervals irrigation have indirect positive role on reducing the operating hours of irrigation pumping, that is mean saving the pumping power (electricity), that lead to save money, this role was clear in Table (11). The highest hours of operating irrigation pump observed with daily irrigation (41.63 and 45.74 hr.) in first and second seasons, respectively, when, irrigation every two and three days have (21.32 and 13.63) in first season and (23.41 and 14.97 hr.), in second season, respectively. So, irrigation every three days reduced operating hours by 33 % (28 and 31 hr.), on both growing seasons, respectively.

Table 10: Using Saving Water to Cultivate Other Crops I.E., Cucumber, Squash and Common Bean.

Crops	Total amount of irrigation (m^3)	Saving amount of water (m^3)	Supplemental amount of water (m^3)
Cucumber	194.590	123	71.590
Squash	153.640	123	30.640
Common bean	120.000	123	-3.000

Table 11: Effect of Irrigation Intervals on Operating Hours/Greenhouse, Power Consumption (K/Watt/Hr.)/Greenhouse and Power Price/Greenhouse (L. E.) During 2021 and 2022 Seasons.

Irrigation intervals	Operating hours	Power consumption	Price
	First season		
Irrigation every day	41.63	31.06	37.27
Irrigation every two days	21.32	15.90	19.08
Irrigation every three days	13.63	10.16	12.20
	Second season		
Irrigation every day	45.74	34.12	40.94
Irrigation every two days	23.41	17.47	20.96
Irrigation every three days	14.97	11.17	13.40

Table 12: Effect of Irrigation Intervals on Saving Operating Hours/Greenhouse, Saving Power Consumption (K/Watt/Hr.)/Greenhouse, Saving Power Price/Greenhouse (L. E.) And Saving Power Price/Feddan (L. E.) During 2021 And 2022 Seasons.				
Irrigation intervals	**Saving power/hr.**	**Saving K/watt**	**Saving price/G.H.**	**Saving price/feddan**
	First season			
Irrigation every day	0	0	0	0
Irrigation every two days	20	15.16	18.19	163.71
Irrigation every three days	28	20.89	25.07	225.65
	Second season			
Irrigation every day	0	0	0	0
Irrigation every two days	22	16.65	19.98	179.85
Irrigation every three days	31	22.95	27.54	247.89

Table 13: Using Saving Operating Hours to Irrigate Other Crops I.E., Cucumber, Squash and Common Bean.			
Crops	**Operating hours**	**Saving operating hours**	**Supplemental operating hours**
Cucumber	48.65	30	18.65
Squash	38.41	30	8.41
Common bean	30.00	30	0

During the time, irrigation every three days (Table 12) saved 21 and 23 k/watt/greenhouse (360m^2) in first and second season, respectively, that is lead to save 25 and 28 L. E./greenhouse in first and second season, respectively, and saving 226 and 248 L. E./feddan in first and second season, respectively. This saving directly reduces operating costs of crop. Furthermore, as a positive role of applied irrigation every three days electricity power was saved as a direct effect and reducing the maintenance times for water pumping, which means reducing maintenance expenses and increasing the lifespan of the pump as an indirect effect. Also, as a positive direct effect the lower amount of water was detected and increasing grow income as an indirect effect.

Data in Table (13), indicate that, the operating hours for each crop (cucumber, squash and common bean) to irrigate per season is (48.65, 38.41 and 30 hr.), respectively. When, total saving operating hours is (30 hr.). That is mean to complete irrigation season for cucumber and squash crops need to supplementary operating hours by (18.65 and 8.41 hr.), respectively. When, common bean crop has not needed any or more supplemental operating hours to complete irrigation season.

5. Discussion

Saving water is a global goal everyone goes on to achieve it especially under climate change. So, leads to provide alternative opportunities to use those water for growing other crops, which, approaches maximizing water use.

Obtained results herein highlighted tested factors (i) mulching types, (ii) irrigation intervals and their interaction were a touchable reasons for a significant impact on all measured characteristics i. e., plant height, number of leaves, average number of flowers/plant, number of fruits/plant and total yield/plant.

Generally, all chili plants which applied by compost mulching or irrigated every two days were enhanced compared to those grown in bar soil and irrigated every day. Concerning interaction between studied factors, the greatest improvement in all studied parameters was significantly enhanced under the interaction between compost soil mulching and irrigation every three days. In this context, Kadarso, 2008 insure that chili plants and crop was better than the same plants cultivated in non-mulched soil. Author clarifies mulches white color mulches reflect radiation and increase photosynthesis, compared to mulches with dark color. However, soil with dark color under mulch will keep temperature low and provides good results for plant growth. In contrast, rice straw mulch reduced soil temperature through its interactive effects of high solar radiation reflectance, low thermal conductivity and low heat capacity of the straw layer (Kader et al., 2017 a and b). The significant difference in soil temperature recorded between the mulching treatments and the no mulch plots could be due to the mulch materials providing soil cover hence reducing evapotranspiration.

Investigating effect of mulch on the same crop was done by Barus, 2006, and reported that both of plant height, stem diameter, number of branches as well as, the crop productivity were significantly enhanced by application of soil mulching. Likewise, certified that water availability in the rooting zone profoundly influenced chili pepper growth and development, including flowering (Techawongstein et al., 1992; Christopher et al., 2011). Enhancing the crop productivity was explained by both of on basis of low soil temperature under different materials of organic soil mulches where, it allows for high rate of fruit set and number of fruits (Fahrurrozi and Ganefianti, 2019; Yordanova and Gerasimova, 2015). Addition to mentioned effect of low soil temperature on crop productivity both of mentioned the capableness of organic soil mulch to save moisture content and avoiding the compaction of the soil (Yordanova and Gerasimova, 2015; Teame et al., 2017). The same explanation was adopted by Decoteau, 2000, who, use the fact that, chili pepper are very sensitive to water deficit during flowering to prevent the ability of application soil mulching improve the states of soil moisture.

Another theory was presented depending on increasing accumulated amounts of soil organic matter that lead to enhance number and fruit weight of chili pepper by (Khandaker et al., 2017). Addition to organic matter level, Also, Mahadeen, 2014 stated that mulch is able to modify the balancing of soil nutrient and water required by crops and enhance the organic matter containing also slows down soil surface run off allowing longer infiltration time therefore water infiltration rate is increase and soil moisture will be higher.

Those attributes due to positive benefits of mulch, that's, summarized at the potential of mulches to improve soil structure, increase organic matter, and establish patterns of nutrient cycling more similar to natural ecosystems has been recognized (Abubaker, 2013). In addition, soil mulching play essential role concerning water retention and also lowering the harmful effect on soil surface by velocity of wind (Kay, 1998). Regarding soil moisture reported that, organic mulches presented great help in saving soil moisture content for long time compared to bare soil (Ghosh et al., 2006). Later on, confirmed the ability of soil mulches materials on lowering the evaporation from soil and save about 15-20% of soil moisture because of finding a physical barrier to soil water evaporation (Liu et al., 2013 and Mahmoud et al., 2021). Such stability in level of soil moisture is very important for chili production, where both of mentioned the positive correlation between amount of irrigation water and fresh and dry weight of chili plants (Cafer et al., 2006; Yuniati and Sarfuddin, 2019). In addition, organic soil mulching perform as insulating interphase between the soil and the atmosphere, which trapped evaporating soil moisture that eventually condensed back onto the soil surface (Tariq et al., 2016). Another summery was presented where it refer to its low heat conductivity, less heat goes through to the soil hence, less water is lost through evaporation by (Döring et al., 2005). Conducive conditions created under the organic mulch also enhance microbial activities, which improve aeration and infiltration and hence reduce soil temperature. The bare nature of the no mulch plots exposed the soils to the atmosphere and hence received direct sun rays, thereby increasing evaporation. Thus, high soil moisture recorded for the organic mulch treatment compared to the no mulch treatment could be attributed to the reduction in evapotranspiration from the soil surface and weed density

Moreover, pointed to important role for both of slow and rapid decomposition of organic mulch on richening soil by nutrients elements (Cherr et al., 2006). In this context, insure the positive role of organic mulch in elevates levels of phosphorus and potassium in mulched soil (Sønsteby et al., 2004; Cadavid et al., 1998). Furthermore, pointed to the creating a balanced situation between nutrients elements and water, that enhance growth of root system (Idaryani et al., 2021).

Additionally, composts are used in agriculture to improve soil fertility and quality because they can increase organic matter content, especially in sandy soils, which have low water and nutrient holding capacity. Soil fertility can be further increased by the addition of nutrients from compost (Lakhdar et al., 2009). According to Römheld and Neumann (2006), the improvement of nutrient uptake particularly of micronutrients was important to increasing plant resistance to biotic and a biotic stresses. Compost is used to provide essential nutrients (such as N, P and K) to rebuild soil physic-chemical properties, and re-establish microbial populations and activities (Lakhdar et al., 2009).

Potassium (K), sulfur (S), and boron (Br) are three of the essential nutrients that need special mention with regards to production of quality vegetables. One way to reduce K leaching is to add organic matter such as compost to the soil (Giller, 2002). Sulfur is especially important because this nutrient forms organic compounds in the plant. It can be used to decrease the pH level if soils are too alkaline and good sources of sulfur include compost (Heckman *et al.*, 2009). The improvements in plant growth and increases in fruit yields due to organic amendments could also related to production of hormones or humates in the composts which may acting as plant-growth regulators in addition to the nutrient supply (Arancon *et al*., 2003; Tu *et al.*, 2006). Barker and Bryson (2006) suggested that compost might be more beneficial for increasing plant growth when the compost is enriched with nutrients. Ghosh *et al*. (2006) found more moisture content in organic mulch than without mulch under field condition. To reported increased photosynthesis in chilies with application of mulch, and in okra leaves under control due to higher retention of soil moisture for longer period that increased rate of transpiration (Thakur et al., 2000; Thakur and Kumar 2020; Bhadauria and Vijay, 2006).

The use of mulch can improve the physical, chemical and biological properties of the soil which will positively impact on the supplying of nutrients to plants for fruit formation and development (Wahocho et al., 2016). Moreover, through increasing the organic content of the soil, biological activity can be enhanced and water and nutrient holding capacity can be improved in soils (Darlington, 2003). Organic matter application and, consequently, the humus soil distribution decreased soil Na, EC and pH which can be accounted for by high supplies of Ca, Mg and K. These mineral elements kept the cation-exchange sites on soil particles, minimizing adsorption of Na, and so enhancing Na leaching losses during precipitation (Ouni et al., 2014). Biologically, compost increases soil microbial populations and can be used to suppress plant disease (Wallace et al., 2008).

On the other side, accurate irrigation however quantity or intervals between followed irrigation, considered as the back bone for maintaining a strong growth for any crop, especially by reducing humidity in soil that, responsible for a 60 to 80% crop loss (El-Sayed et al., 2019). Disclose, stated, both of less and excess water supply lead to reduce number of fruits per plants, contrary, organized irrigation lead to produce a greater number of fruits per plant (Kumar et al., 2016). In this regard, revealed crop yield of sweet pepper reduced because of the up and down rate of respiration and photosynthesis and limitation of leaf area expansion by temporary of wilting or by early leaf senescence (Xianshi et al., 1998). In addition, water supply in the critical stages of development and high sensitivity of sweet peppers to water stress are of the importance of immunity. Whereas, water is important for maintaining the turgidity of plants (Rasheed and Rahman, 2013). Furthermore, stated that the water factor is essential because it will affect the growth process (Nugraha et al., 2014). The need for water will increase along with the increasing age of the plant. The highest water requirements occur during the flowering period. The appropriate amount of water accelerates the growth to the formation of fruit size. When the amount of water supplied increases, the excess water becomes useless or inefficient. This is because the provision of water in the right amount according to their needs will result in optimal plant growth and increase the efficiency of providing water to plants (Nikita et al., 2014).

Specifically, chili plants needs urgently to regular irrigation with accurate intervals, especially during flowering and fruit development, where plants became very sensitive to water shortage (González-Dugo et al., 2007). Aside from, earlier study by showed that, extra amount and near intervals lead to decrease the crop yield of chili plants (Wankhede and Morey, 1984). Following this hypothesis, emphasize on efficiency of watering every 4 days to increase significantly plant dry matter and produce the maximum crop yield (Khan et al., 2008). Related to last mentioned, stated that, fifteen days interval between each followed watering lead to enhancement for both of vegetative and crop yield component characteristics (El-Sayed et al., 2019). Author also presented explanation for the obtained results on basis of providing a moderate water stress and level of soil moisture allows pepper to grow better vegetative and crop production. Moreover, tested the same hypothesis and interpreted that, found enhancements by the stable available water all over the growing season (Jamiez et al., 2000). In contrast, reduce interval between watering to be every 3 days compared to 6 and 9 days (Paul et al., 2013). It was noticeable that, three days interval was the optimum between other tested intervals, where, 6 and 9 days looks like causing more stress on the studied intervals. Nevertheless, on 2013, Paul *et al*., found a noticeable increments and high rate of photosynthesis under conditions of five days irrigation intervals.

Concerning interaction between irrigation intervals and soil mulching, mixing between irrigation and soil mulch lead to significant improvement in soil temperature and water retention that are affected both of vegetative growth and crop yield (Yang et al., 2018). Moreover, reported the good performance of pepper vegetative growth and its relation to combination between 3 days irrigation intervals and compost soil mulching (Rannu et al., 2018). Also authors mentioned to high soil moisture retention that due to enhance the rate vegetative growth. Nonetheless, infiltration, aeration, moisture conservation and nutrient absorption is a direct reasons for the last mentioned enhancements in vegetative growth and yield of pepper under compost soil mulching conditions (Ashrafuzzaman et al., 2011; Li et al., 2018; Bi et al., 2018). Furthermore, indicated that, the chili plant had the highest number of leaves in the application of straw mulch and the frequency of giving water once a day (Idaryani et al., 2021). The number of leaves in straw mulch with the highest frequency of watering once a day because straw mulch can provide a microclimate that supports the activity of microorganisms in the soil and can increase nutrients so that it affects the number of leaves of chili plants. This stated that straw mulch could reduce weed growth and can maintain moisture stability in the soil so that microorganisms are active in decomposing organic matter needed by plants in the growth of plant (Damaiyanti et al., 2013). The available water in these conditions is sufficient for the water needs of the chillies so that their growth is optimal. According to chili plants are sensitive to water deficiency because of their shallow root system (González-Dugo et al., 2007). Several other studies have reported similar situations where soybean yields increased under mulching (Sekhon et al., 2005; Arora et al., 2011). The highest yield obtained from the compost mulch treatment under irrigation every three days could be ascribed to the conducive growth conditions, namely optimum soil temperature, adequate soil moisture, and favorable microclimate for microbial activities. These conditions consequently improved soil aeration and facilitated the decomposition of the rice straw to incorporate nutrients to the soil (Lawal and Rahman, 2007; Ashrafuzzaman et al., 2011; Reddy et al., 2017; Yan et al., 2017). Similar results have been reported in soybean production. Furthermore, the optimum soil moisture contents enhanced root growth and proliferation, and, thus, increased nutrient availability and uptake by the crop roots that eventually improved growth and yield (Sarkar and Singh, 2007; Kader et al., 2017 a, b). The treatment combination of compost mulch and irrigation every three days significantly increased stem girth, plant height, number of branches and leaves per plant, which could have increased the number of active fruit-bearing nodes and photosynthetic rates of crops, and subsequently, fruit yields. High soil temperature is a major cause of flower drop, and hence, low yields in pepper production. The lower yield could be attributed to some extent to the degree of flower drop due to high soil temperatures resulting from the absorption of solar radiation. Addition studies and explanation on this regard were presented, irrigation interval every three days saved water up to 33% and 64% of the water used by every day and every two days, respectively. The increase in the amount of irrigation water saved by the highest performing irrigation every three days compared to the least performing irrigation every day was due to the soil surface cover and protection provided by the mulching materials. The unrestricted and high surface evaporations are the reasons for the lowest soil moisture content and crop water productivity in the no mulch treatment. The much significant influence of compost mulch treatment under irrigation every three days relative to the other treatments could have resulted from its improvement in soil water retention and aeration, reduced evapotranspiration rates and leaching of nutrients, and, regulation of soil temperature for improved growth and development, yield and crop water productivity of pepper (Li et al., 2018; Yang et al., 2018). The findings of this study confirm the studies of who found that increasing water application does not guarantee increased yield (Akinbile and Yusoff, 2011).

6. Conclusion

Applying the organic mulch with irrigation intervals has a positive effect on reducing amount of water irrigation added. So, it's considered as a positive way for saving water especially under limiting of fresh water availability. Moreover, the positive role not stopped on saving water, but also, extends to enhancement the vegetative growth, flowering, yield and increasing net income of growers. All those, benefits obtained with applied compost mulch + irrigation every three days followed descending order by compost mulch + irrigation every two days. Furthermore, achieved the highest values from revenues, net return, percentage of net return on the invested pound and net return per feddan.

REFERENCES

Abubaker, M. S., 2013. Effect of different types of mulch on performance of tomato (Lycopersicon esculentum Mill.) under plastic house conditions. Al-Balqa Applied Univ., Agric. and Environ., 11(2), Pp. 684-686.

Abou-Hadid, A. F. and El-Beltagy, A.S., 1992. Water balance under plastic house conditions in Egypt. Acta Hort., 303, Pp. 61-72.

Adekaldu, E., Amponsah, W., Tuffour, H. O., Adu, M. O. and Agyare, W. A., 2021. Response of chilli pepper to different irrigation schedules and mulching technologies in semi-arid environments. Journal of Agriculture and Food Research, 6, Pp. 1-10.

Ahmed, M., Baiyeri, K. P. and Echezona, B. C., 2013. Effect of colored polyethylene mulch and harvesting stage on growth and yield of industrial sugarcane in Nigeria. Afric. J. Biotech, 12, Pp. 10–18

Adhikari, R., Bristow, K. L., Casey, P. S., Freischmidt, G., Hornbuckle, J. W. and Adhikari, B., 2016. Preformed and sprayable polymeric mulch film to improve agricultural water use efficiency. Agricultural Water Management, 169, Pp. 1-13.

Akinbile, C. O., and Yusoff, M. S., 2011. Growth, yield and water use pattern of chilli pepper under different irrigation scheduling and management, Asian J. Agricult. Res., 5(2), Pp. 154–163.

Allen, R. G., Pereira, L. S., Raes, D., and Smith, M., 1998. Crop evapotranspiration guidelines for computing crop water requirements. FAO Irrigation and drainage paper 56. Food and Agriculture Organization, Rome.

Arancon, N. Q., Edwards, C. A., Bierman, P., Metzger, J. D., Lee, S. and Welch, C., 2003. Effects of vermin composts on growth and marketable fruits of field-grown tomatoes, peppers and strawberries. Pedobiologia, 47, Pp. 731–735.

Arora, V. K., Singh, C. B., Sidhu, A. S. and Thind, S. S., 2011. Irrigation, tillage and mulching effects on soybean yield and water productivity in relation to soil texture, Agric. Water Manag., 98(4), Pp. 563–568.

Ashrafuzzaman, M., Halim, M. A., Ismail, M. R., Shahidullah, S. M., and Hossain M. A., 2011. Effect of plastic mulch on growth and yield of chilli (capsicum annuum L.), Braz. Arch. Biol. Technol., 54(2), Pp. 321–330.

Barker, A.V., and Bryson, M., 2006. Comparisons of composts with low or high nutrient status for growth of plants in containers. Commun. Soil Sci. Plan., 37, Pp. 1303–1319.

Barus, W. A., 2006. Pertumbuhan dan produksi cabai (*Capsicum annum* L.) dengan penggunaan mulsa dan pemupukan PK. J. Penelitian Bidang Ilmu Pertanian, 4(1), Pp. 41-44.

Bhadauria, H., and Vijay, K., 2006. Effect of mulching on growth and productivity of okra (*Abelmoschus esculentus* L.) moench under saline irrigation condition. American Journal of Plant Physiology, 1(2), Pp. 214-216.

Bi, Y., Qiu, L., Zhakypbek, Y., Jiang, B., Cai, Y., and Sun, H., 2018. Combination of plastic film mulching and AMF inoculation promotes maize growth, yield and water use efficiency in the semiarid region of Northwest China, Agric. Water Manag., 201, Pp. 278–286.

Cadavid, L. F., El–Sharkawys, M. A., Acosta, A., and Sanchez, T., 1998. Long–term effects of mulch, fertilization and tillage on cassava grown in sandy soils in northern Colombia. Field Crop. Res., 57(1), Pp. 45-56.

Cafer, G., Iran, E., Akincik, K., Ucan, S., and Akinci, S. G., 2006. Response of red hot pepper plant (*Capsicum annuum* L.) to the deficit irrigation. Akdeniz Uuniversiteisi Zirrat Fakultesi Dergisi. 19, Pp. 131-138.

Chalker-Scott, L., 2007. Impact of mulches on landscape plants and the environment - a review. J. Environ. Hortic., 25, Pp. 239–249.

Cheng, M., and Zhou, H. P., 2019. Effects of long-term straw returning to the field on soil nutrients, enzyme activity and corn yield in the Loess Plateau. Chinese Journal of Eco Agriculture, 27(10), Pp. 1528-1536.

Cherr, C. M., Scholberg, J. M. S., and Sorley, Mc. R., 2006. Green manure approaches to crop production: a synthesis. Agron. J., 98, Pp. 302–319.

Christopher, O., Akinbile, D., and Yusoff, M. S., 2011. Growth, yield and water use pattern of chilli pepper under different irrigation scheduling and management. Asian J. Agric. Res., 5, Pp. 154-163.

Costa, L. D., and Gianquinto, G., 2002. Water stress and water table depth influence yield, water use efficiency and nitrogen recovery in bell pepper: Lysimeter studies. Australian Journal of Agricultural Research, 53, Pp. 201-210.

Damaiyanti, D. R. R., Aini, N., and Koesriharti, K., 2013. Kajian penggunaan macam mulsa organik pada pertumbuhan dan hasil tanaman cabai besar (*Capsicum annuum* L.). J. Hortikultura, 1(2), Pp. 25-32.

Darlington, W., 2003. Compost – A Guide for evaluating and using compost materials as soil amendment. Consultant Soil and Plant Laboratory, Inc., Orange Office, (714) 282-8777.

Decoteau, D. R., 2000. Vegetable Crops. Prentice Hall. Upper Saddle River, NJ, USA.

Doorenbos, J., and Pruitt, W. O., 1977. Guidelines for predicting crop water requirements. In: Irrigation and Drainage Paper No. 24, FAO, Rome, 179.

Döring, T. F., Brandt, M., Heß, J., Finckh, M. R., and Saucke, H., 2005. Effects of straw mulch on soil nitrate dynamics, weeds, yield and soil erosion in organically grown potatoes, Field Crop. Res., 94, Pp. 238–249.

Downer, J., and Hodel, D., 2001. The effects of mulching on establishment of Syagrus romanzoffiana (Cham.) Becc.,Washingtonia robusta H. Wendl. and Archontophoenix cunninghamiana (H. Wendl.) H. Wendl. and Drude in the landscape. Sci. Hortic., 87, Pp. 85–92

El-Sayed, H. A., Shokr, M. M. B., Elbauome, H. A. A., and Elmorsy, A. K. S. A., 2019. Response of sweet pepper to irrigation intervals and humic acid applicatio. J. Plant Production, Mansoura Univ., 10(1), Pp. 7-16.

Ertek, A., Sensoy, S., Gedik, I., and Kucukyumuk, C., 2007. Irrigation scheduling for green pepper (Capsicum annuum L.) grown in field conditions by using class-A pan evaporation values. American Eurasian Journal of Agriculture and Environment Sciences, 2(4), Pp. 349–358.

Fahrurrozi, F., and Ganefianti, D. W., 2019. Early yield responses of three promising chili pepper hybrids to different mulch types. Asian J. Agric. Biol., 7(4), Pp. 548-554.

Faridaha, S. N., Waris A., and Rahmi, R., 2019. Utilization of soil moisture through furrow irrigation for the growth of chilli pepper. International Journal of Innovative Technology and Exploring Engineering, 8(7), 492-495.

Ghosh, P. K., Dayal, D., Bandyopadhyay, K. K., 2006. Evaluation of straw and polythene mulch for enhancing productivity of irrigated summer groundnut. Field Crops Research, 99(2-3), Pp. 76-86.

Giller, K. E., 2002. Targeting moment of organic resources and mineral fertilizers: Can we match scientist fantasies with farmer's realities. In: Vanlauwe B., Diels, J., Sanginga, N. and Merckx, R. (Eds), Integrated plant nutrient management in sub-Saharan Africa: From concept to practice. CAB International, Wallingford Oxon, UK, Pp. 155-172.

González-Dugo, V., Orgaz, F., and Fereres, E., 2007. Responses of pepper to deficit irrigation for paprika production. Scientia Horticulturae, 114, Pp. 77–82.

Harris, R. W., Clark, J. R., and Matheny, N. P., 2004. Arboriculture: integrated management of landscape trees, shrubs, and vines, 4th edition. Prentice Hall, Inc, Upper Saddle River, NJ.578 pages.

Heckman, J. R., Weil, R., and Magdoff, F., 2009. Practical steps to soil fertility for organic agriculture. In C. Francis (Ed.), Agronomy Monographs 54 Organic Farming: The Ecological System (pp. 139-172). Madison, WI: Alliance of Crop, Soil and Environmental Science Societies.

http://dx.doi.org/10.2134/agronmonogr54.c7

Idaryani, Warda, Suriany and Halil, W., 2021. Effect of mulch application and water frequency on growth and production of chilli (Capsicum annum L). Earth and Environmental Science, 807, Pp. 1-9.

Iqbal, R., Raza, M. A. S., and Valipour, M., 2020. Potential agricultural and environmental benefits of mulches - a review. Bull Natl Res Cent 44, 75.

Jamiez, R. E., Vielma, Rada, F., and Garcia, N. C., 2000. Effect of irrigation frequency on water and carbon relation in three cultivars of sweet pepper. Sci. Hort., 81(3), Pp. 301-308.

Kadarso, 2008, Kajian penggunaan jenis mulsa terhadap hasil tanaman cabai merah varietas red charm. J. Agron. Indonesia**,** 10(2), Pp. 134-139.

Kader, M. A., Senge, M., Mojid, M. A., and Ito, K., 2017 a. Recent advances in mulching materials and methods for modifying soil environment. Soil and Tillage Res., 168, Pp. 155-166.

Kader, M. A., Senge, M., Mojid, M. A., and Nakamura, K., 2017 b. Mulching type-induced soil moisture and temperature regimes and water use efficiency of soybean under rain-fed condition in central Japan, Int. Soil Water Conserv. Res., 5, Pp. 302–308.

Kader, M. A., Singha, A., Begum, M. A., Jewel, A., Khan F. H., and Khan, N. I., 2019. Mulching as water-saving technique in dry land agriculture: review article. Bulletin of the National Research Centre, 43, Pp. 1-6.

Kay, B. L., 1998. Mulching and chemical stabilizers for land reclamation in dry regions. In. Schaller F.W. and Sutten P. (eds).Reclamation of Drastically Distributed Lands. Am. Soc. Agronomy, Madison. WI, Pp. 467-483.

Khan, M. A. I., Farooque, A. M., Haque, M. A., Rahim, M. A., and Hoque, M. A., 2008. Effects of water stress at various growth stages on the physio-morphological characters and yield in chilli. Bangladesh J. Agril. Res., 33(3), Pp. 353-362.

Khandaker, M. M., Rohani, F., Dalorima, T., and Mat, N., 2017. Effects of different organic fertilizers on growth, yield and quality of *Capsicum annuum* L. var. Kulai (red Chilli Kulai). Biosci. Biotech. Res. Asia., 14, Pp. 185-192.

Khurshid, K., Iqbal, M., Arif, M. S. and Nawaz, A., 2006. Effect of tillage and mulch on soil physical properties, and growth of maize. Int. J. Agric. Biol., 5, Pp. 593-596.

Kumar, R., Kumari, P., and Kumar, S., 2016. Effect of irrigation levels and frequencies on yield, quality and water use efficiency of capsicum grown under protected conditions. International Journal of Bio-resource and Stress Management, 7(6), Pp. 1290-1296.

Kwambe, X. M., Masarirambi, M. T., Wahome, P. K., and Oseni, T. O., 2015. The effects of organic and inorganic mulches on growth and yield of green bean (*Phaseolus vulgaris* L.) in a semi-arid environment. Agric. Biol. JN Am., 6, Pp. 81–89.

Lakhdar, A., Rabhi, M., Ghnaya, T., Montemurro, F., Jedidi, N., Abdellya, C., 2009. Effectiveness of compost use in salt-affected soil. Journal of Hazardous Materials, 171, 29-37.

Lawal, A. B., and Rahman, S. A., 2007. Effect of irrigation, fertilizer and manure on yield and economic return of okra/pepper intercrops, Trop. Sci., 47(1), Pp. 45-48.

Li, S., Li, Y., Lin, H., Feng, H., and Dyck, M., 2018. Effects of different mulching technologies on evapotranspiration and summer maize growth, Agric. Water Manag., 201, Pp. 309-318.

Li, R., Qinggui, L., Jinjin, Z., Zhongxian, L., Lindong, P., Kai H., and Linqing, Z., 2020. Effects of organic mulch on soil moisture and nutrients in Karst area of south west China. Pol. J. Environ. Stud., 29(6), Pp. 4161-4174.

Liu, Y., Gao, M. S., Wu, W., Tanveer, S. K., Wen, X.X. and Liao, Y. C., 2013. The effects of conservation tillage practices on the soil water-holding capacity of a non-irrigated apple orchard in the Loess Plateau China. Soil Tillage Res., 130, Pp. 7-12.

Loizzo, M. R., Pugliese, A., Bonesi. M., Menichini, F. and Tundis, R., 2015. Evaluation of chemical profile and antioxidant activity of twenty cultivars from *Capsicum annum, Capsicum baccatum, Capsicum chacoense* and *Capsicum chinense*: A comparison between fresh and processed peppers. Food Sci. Tech.**,** 64**,** 623-631.

Mahadeen, A. Y., 2014. American Journal of Agricultural and Biological Sciences, 9(2), Pp. 202-207.

Mahmoud, S. H., EL-Tanahy, A. M. M. and Abou-Hussein, S. D., 2021. Biodegradable mulch for vegetable production. A review. Middle East Journal of Agriculture Research, 10(2), Pp. 637-653.

Montague, T. and Kjelgren, R., 2004. Energy balance of six common landscape surfaces and the influence of surface properties on gas exchange of four containerized tree species. Sci. Hortic., 100, Pp. 229-249

Nagre, P. K., Sonkamble, A. M. and Patil, S. R., 2018. A review on fertigation in capsicum under protected conditions. Int. J. Curr. Microbiol. App. Sci., Special Issue- 6, Pp. 1051-1055.

Nagy, Z., Dadood, H., Ambrozy, Z. and Helyes, L., 2015 Determination of polyphenols, capsaicinoids, and vitamin C in new hybrids of chilli peppers. J. of Analytical Methods in Chemistry, Article ID 102125, p 10.

Nikita, M. D., Aini, N. and Sumarni, T., 2014. Pengaruh frekuensi dan volume pemberian air pada pertumbuhan tanaman *Crotaria Mucronata* Desv. Jurnal Produksi Tanaman, 2(8), Pp. 673-678.

Nugraha, Y. S., Sumarni, T. and Sulistyono, R., 2014 Pengaruh interval waktu dan tingkat pemberian air terhadap pertumbuhan dan hasil tanaman kedelai (*Glycine max* (L) Merril.) Jurnal Produksi Tanaman**,** 2(7), Pp. 552-559.

Ouni, Y., Ghnaya, T., Montemurro, F., Abdelly, C. h. and Lakhdar, A., 2014. The role of humic substances in mitigating the harmful effects of soil salinity and improve plant productivity. International J. of Plant Production, 8, Pp. 354-362.

Paul, J. C., Mishra, J. N., Pradhan, P. L. and Panigrahi, B., 2013. Effect of drip and surface irrigation on yield, water use efficiency of capsicum annuum grown under mulch and non-mulch conditions in eastern coastal India. European J. Sus. Dev., 2(1), Pp. 99-108.

Rannu, R. P., Ahmed, R., Siddiky, A., Ali, A. S. M. Y., Murad, K. F. I. and Sarkar, P. K., 2018. Effect of irrigation and mulch on the yield and water use of strawberry. Int. J. Agron., 2018, Pp. 1-10.

Rasheed, S. M. and Rahman, H. U., 2013. Performance of modified double cross maize hybrids under drought stress. Sarhad J. Agric., 29(2), Pp. 199-203.

Reddy, G. C., Hebber, S. S. and Reddy, G. P. D., 2016. Effect of plastic mulch and non-mulch on growth, yield and quality of red chilli (*Capsicum annum* L.) under drip fertigation. Plant Archives, 16(2), Pp. 563-567.

Reddy, G., Hebbar, S. S., Nair, A. K., Raghupathy, H. B., Gowda, A. M. and Umesha, K., 2017. Growth and yield performance of hybrid hot pepper, chilli (*Capsicum annuum* L.) as influenced by fertigation and polyethylene mulching. J. Hortic. Sci., 11(2), Pp. 151–155.

Ritawati, S., Nurmayulis, N., Firnia, D., Fitriyani, F., 2015. Changes in soil moisture content and yield of several peanut varieties (*Arachis hypogaea* L.) were given drip irrigation in dry land. J. of the Science of Agriculture and Fisheries, 4(2), Pp. 1-15.

Römheld, V. and Neumann, G., 2006. The rhizosphere: contributions of the soil-root interface to sustainable soil systems. In Biological Approaches to Sustainable Soil Systems (N. Uphoff, N. A. S. Ball, E, Fernandes, H. Herren, O. Husson, M. Laing, C. Palm and J. Thies, eds.), pp. 92–107. CRC-Press, Oxford, UK.

Russell, J. C., 1939. The effect of surface cover on soil moisture losses by evaporation. Amer. Soil. Science Society, 4, Pp. 65–70.

Sarkar, S. and Singh, S. R., 2007. Interactive effect of tillage depth and mulch on soil temperature, productivity and water use pattern of rainfed barley (*Hordium vulgare* L.). Soil Tillage Res., 92(1–2), Pp. 79–86.

SAS Institute. The SAS system for Microsoft Windows. Release 9. 1. SAS Inst, Cary, NC; 2005.

Schahbazian, N. and Iran-Nejad, H., 2006. The effects of different mulch types and irrigation intervals on cotton yield. Die. Bodenk, 57, Pp. 765–766.

Sekhon, N. K., Hira, G. S., Sidhu, A. S. and Thind, S. S., 2005. Response of soyabean (*Glycine max* Mer.) to wheat straw mulching in different cropping seasons. Soil Use Manag., 21, Pp. 422–426.

Sezen, S. M., Yazar, A., Tekin, S., Eker, S., Kapur, B., 2011. Yield and quality response of drip irrigated pepper under Mediterranean climatic conditions to various water regimes. African Journal of Biotechnology, 10(8), Pp. 1329–1339.

Smith, M. W., 2000. Cultivar and mulch affect cold injury of young pecan trees. J. Amer. Pomo. Soc., 54, Pp. 29–33.

Sønsteby, A., Nes, A. and Måge F., 2004. Effects of bark mulch and NPK fertilizer on yield, leaf nutrient status and soil mineral nitrogen during three years of strawberry production. Acta Agriculturae Scandinavica, Sec. B - Soil Plant Sci., 54, Pp. 128–34.

Tanavud, C., Kheowvongsri, P., Yongchalermchai, C., Leowarin, W., Densrisereekul, O., Bennui, A., Muraseand, J. and Kimura, M., 2001. Effects of land use patterns on soil and water quality in Khlong U-Taphao Basin. Thai. J. Agric. Sci., 34, Pp. 15-31.

Tariq, M. S., Bano, A. and Qureshi, K. M., 2016. Response of strawberry (*Fragaria annanasa*) cv. Chandler to different mulching materials, Sci. Technol. Dev., 35(3), Pp. 117–122.

Teame, G., Tsegay, A. and Abrha, B., 2017. Effect of mulching on soil moisture, yields and yield contributing component of sesame (*Sesamun indicum* L.). Int. J. Agron., 2017, Pp. 1-6.

Techawongstein, S., Nawata, E. and Shigenaga, S., 1992. Response of chili pepper cultivars to transient water stress. J. Japan Soc. Hort. Sci., 61, Pp. 85-92.

Thakur, P. S., Thakur, A. and Kanaujia, S. P., 2000. Reversal of water stress effects. I. Mulching impacts on the performance of *Capsicum annum* under water stress deficit. Ind. J. Hortic., 57, Pp. 250-254.

Thakur, M. and Kumar, R., 2020. Mulching: Boosting crop productivity and improving soil environment in herbal plants. Journal of Applied Research on Medicinal and Aromatic Plants, 20, Pp. 1-60.

Tilander, Y. and Bonzi, M., 1997. Water and nutrient conservation through the use of agro-forestry mulches, and sorghum yield response. J. Plant. Soil, 197, Pp. 219 -232.

Tu, C., Ristaino, J. B. and Hu, S., 2006. Soil microbial biomass and activity in organic tomato farming systems: Effects of organic inputs and straw mulching, Soil Biol. Biochem., 38, Pp. 247–255.

Utami, S., 2011. Manfaat Kandungan Zat Dalam Cabe (*Capsicum annum* L.) Bagi Kesehatan. Jurnal Kesehatan,

Wahocho, N. A., Ahmed Z., Sheikh, Jogi, Q., Talpur, K. H. and Leghari, S. J., 2016. The Science International (Lahore). 28, Pp. 2.

Wallace, R. W., French-Monar, D. R. and Porter, P., 2008. Growing tomatoes successfully on the Texas high plains. J. App. Ecol., 45, Pp. 1076–1085.

Wankhede, B. N. and Morey, D. K., 1984. Effect of levels of irrigation, nitrogen and potash on the growth and yield of chilli. Punjabrao Krishi Vidyapeeth. Res. J., 8(2), Pp. 22-25.

Xianshi, G., Sinclair, T. R. and Ray, J. D., 1998. Effect of drought history on recovery of transpiration, photosynthesis and leaf area development in maize soil. Crop Sci. Soc. Florida, 57, Pp. 83-86.

Yan, Z., Gao, C., Ren, Y., Zong, R., Ma, Y. and Li, Q., 2017. Effects of pre-sowing irrigation and straw mulching on the grain yield and water use efficiency of summer maize in the North China Plain. Agric. Water Manag., 186, Pp. 21–28.

Yang, Y., Ding, J., Zhang, Y., Wu, J., Zhang, J., Pan, X., Gao, C., Wang, Y. and He, F., 2018. Effects of tillage and mulching measures on soil moisture and temperature, photosynthetic characteristics and yield of winter wheat, Agric. Water Manag., 201, Pp. 299–308.

Yordanova, M. and Gerasimova, N., 2015. Influence of different organic mulches on soil temperature during pepper (*Capsicum annuum* L.) cultivation. Scientific Papers. Series B, Horticulture, 59, Pp. 285-290.

Yuniati, S. and Sarfuddin, 2019. Influence the intensity of watering towards growth and the production of pepper plants (*Capsicun frutescens* L.). Jurnal Produksi Tanaman, 5(2), Pp. 45–52.