



Annual Research & Review in Biology

28(3): 1-11, 2018; Article no.ARRB.41665
ISSN: 2347-565X, NLM ID: 101632869

Jojoba Seed Yield Response to Water Stress under Circumstances of Sinai

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Authors' contributions

This work was carried out in collaboration between both authors. Author EAK designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author GAA managed the analyses of the study. Both authors read and approved the final manuscript and this work is a part from project number 11030125.

Article Information

DOI: 10.9734/ARRB/2018/41665

Editor(s):

(1) George Perry, Dean and Professor of Biology, University of Texas at San Antonio, USA.

Reviewers:

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(2) Masmoudi-Charfi Chiraz, Olive Tree Institute, Carnoy, Tunisia.

Complete Peer review History: <http://www.sciencedomain.org/review-history/25975>

Original Research Article

Received 19th March 2018
Accepted 23rd May 2018
Published 23rd August 2018

ABSTRACT

Aims: This study aims to evaluate the five clones of jojoba plant under the influence of irrigation intervals and the impact on growth and yield of chemical content.

Study Design: Two field experiments were carried out for five clones (S-L, S-610, S-700, S-B and S-G), to study the effect of irrigation intervals; one week (control), two weeks and three weeks) on jojoba plants at aged three and thirteen years from planting to investigation growth, yield characters and content seed from oil and some chemical contents.

Place and Duration of Study: Almaghara Research and Production Station (latitude: 30,717993"N, longitude: 33, 329103 E) which follow Desert Research Center, Agriculture Ministry, Egypt, at 2015/2016 and 2016/2017 respectively.

Methodology: The experimental rows (5 plants) were assigned for each clone in three replications. The farming distances were 4 x 2 meters. Mixed seedlings of both females and males were planted at a rate of one male seedling for every six female seedlings to allow cross-fertilization of each clone.

All clones were treatment at three times (October, March and April). The plants were collected on 22nd April to determine the growth, yield characters and some chemical content.

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Statistical analyses and mean comparisons were conducted using MSTATC software.

Results: The jojoba plant was affected by increased irrigation interval, and it was clear in all clones. Irrigation every three weeks had an impact of irrigation every week. The effect of irrigation interval varied from one clone to another and the lowest was s-700. The older seedlings are less affected by irrigation interval than small seedlings. The best results were category s-700 at the age of thirteen years and irrigation every two weeks.

Conclusion: All variable of studied confirmed that clones of jojoba had a significant effect with irrigation interval at one week but decrease value at three weeks. Jojoba plants tolerance to water stress but irrigation interval every week increased seed yield.

Keywords: Interval irrigation; growth and yield characters; oil; jojoba; Sinai.

1. INTRODUCTION

Jojoba (*Simmondsia chinensis* [link] Schneider) is an evergreen shrub plant grown for the purpose of obtaining oil. It adapts in arid and semi-arid areas to tolerate high temperature (about 50°C) and also tolerates water stress. Jojoba is a separate male and female shrub (dioecious) plant Jojoba is considered a high economic crop for the high demand for Jojoba oil. Jojoba plant has a better chance than traditional crops for soil and climate competition, [1,2]. Jojoba oil is used in the manufacture of cosmetics and lubricants instead of whale liver oil. Currently, farmers have turned to commercial cultivated after confirming the properties of the oil extracted from Jojoba, [3]. Jojoba is slow-growing perennial wooden plants and evergreens and deeply rooted and the high temperature so called tree desert, [4], and it's a relatively new crop that is adapted to hot, dry climates. It is a new industrial crop being grown commercially in hot arid and semiarid regions, [5].

Where the plant Jojoba is tolerance of water stress, but it has been proved that irrigate processes is an actual significant element and affect the development seed yield of plants, affects the content of oil yield and oil composition. The increasing scarcity of water competitions sustainable improvement and increase of cultivated area to facing the growing nutrition needs of the world's population. Therefore, the major challenge for countries is to increase crop productivity for the water unit [6].

[7] reported that jojoba plant resist to water stress because of some morphological changes such as decrease leaf area and increase the thickness of the leaf and weight of the leaf and thus control the drought [8]. So, development of

jojoba plants is affected by many agriculture climatic factors e.g., water. Several studies on growth and yield characters of jojoba conformed that as, [9]. This study aims to evaluate the five clones of jojoba plant under the influence of irrigation intervals and the impact on growth and yield of chemical content.

2. MATERIALS AND METHODS

Jojoba plants were cultivated in Almaghara Research and Production Station (latitude: 30,717993"N, longitude : 33, 329103 E) which follow Desert Research Center, Agriculture Ministry, Egypt at 2015/2016 and 2016/2017 respectively. Two field experiments were carried out for five clones (S-L, S-610, S- 700, S-B and S-G), to study the effect of irrigation intervals; one week (control), two weeks and three weeks on jojoba plants at aged three and thirteen years from planting to investigate growth, yield characters and content seed from oil and some chemical contents.

The experimental rows (5 plants) were assigned for each clone in three replications. The farming distances were 4 x 2 meters. Mixed seedlings of both females and males were planted at a rate of one male seedling for every six female seedlings to allow cross-fertilization of each clone.

A row has been planted on the border around each replicates to ensure homogeneity. The field is equipped with weed removal, drip irrigation system installation and fertilizer use within the recommended limits of the Ministry of Agriculture. All clones were treatment at three times (October, March and April). The plants were collected on 22nd April to determine the growth, yield characters and some chemicals contents.

Growth characteristics: Shrub characteristics (height, diameter and circumference) were recorded prior to harvest from three shrubs randomly selected in each experimental plot once a year. The shoot characters as plant height (cm), a number of main branches/plant, stem diameter (cm), shoot weight (fresh & dry) and number of nodes/stem. Data record concerning leaf number of leaves/plant, leaf width, length (cm) and its area (cm²). Leaf area (cm²) was estimated from the following equation: Leaf area = 0.717 X – 0.095, which X is the product of length by width [10,11].

Yield characteristics: Data on fruiting and terminal branches from each the field trials recorded from the inner three plants in the middle row of each experimental plot. Data included a total number of branches, nodes, leaves, floral buds and developing or mature fruits per a 50 cm the terminal fruitful branch during the first week of December, February and April to coincide with the active reproductive stage of joboba. Seeds harvested from three individual plants in each experimental plot by hand at full maturity. They will clean, drying and weight. Individual seed weight (100 seed weight) and oil content of the seeds were recorded after harvest on a plot basis.

Chlorophyll Content: Randomly samples of fresh leaves taken by the end of October from the middle part of the stem for chlorophyll determination. Chlorophyll content was determined according to [12] by using a spectrophotometer. Total carbohydrates percentages determine in leaf samples taken the same way and in the meantime of chlorophyll samples. The leaf samples dried in an electric oven at 70°C for 24 hours according to [13]. Leaf Mineral Content: Nitrogen, phosphorus, potassium, iron, zinc, copper and magnesium were determined in dried leaf samples, digested using sulphuric and perchloric acids method as mentioned by [14], according to the methods described by [15,16].

Statistical analyses and mean comparisons were conducted using MSTATC software [17].

3. RESULTS AND DISCUSSION

All data in (Table 1a, b) showed that the increase irrigation intervals lead to a decrease of all growth characters as plant height (cm), number of main branches/plant, stem diameter (cm), number of nodes/stem, length of node (mm),

number of leaves/plant, leaf width (mm), leaf length (mm) and leaf area (cm²).

Data in the (Table 1a) showed that the lowest irrigation interval (one week) led to increased vegetative growth such as shoot characters (plant height, number of main branches/plant, stem diameter, number of nodes/stem and length of node 77.88, 2.999, 1.571, 16.774 and 12.506) respectively, and leaf characters (number of leaves/plant, leaf width, length and leaf area 103.468, 28.54, 37.812 and 8.2084) respectively, compared to highest irrigation interval (three weeks) led to decrease vegetative growth such as shoot characters (plant height, number of main branches/plant, stem diameter, number of nodes/stem and length of node 71.56, 2.4194, 1.2668, 14.806 and 11.056) respectively, and leaf characters (number of leaves/plant, leaf width, length and leaf area 86.24, 26.55, 36.56 and 7.385) respectively.

Data presented that the clones have high statistically significant between them led to increased vegetative growth. Data appears that the S-700 clone is superior in vegetative growth such as shoot characters (plant height, number of main branches/plant, stem diameter, number of nodes/stem and length of node 76.35, 2.73, 1.43, 16.22 and 12.12) respectively, and leaf characters (number of leaves/plant, leaf width, length and leaf area 99.37, 28.09, 37.10 and 7.97) respectively, compared to all clones especially S-L clone have decreased vegetative growth such as shoot characters (plant height, number of main branches/plant, stem diameter, number of nodes/stem and length of node 73.30, 2.57, 1.35, 15.49 and 11.55) respectively, and leaf characters (number of leaves/plant, leaf width, length and leaf area 89.87, 27.19, 37.12 and 7.64) respectively.

Data point to that lowest interval irrigation (one week) interaction with clone s-700 led to increase growth characters (plant height, number of main branches/plant, stem diameter, number of nodes/stem, length of node, number of leaves/plant, leaf width, length and leaf area 79.49, 3.083, 1.615, 17.47, 13.04, 109.28, 28.83, 37.79 and 8.331) respectively, while interaction between clone S-L and irrigation (three weeks) led to decrease growth characters (plant height, number of main branches/plant, stem diameter, number of nodes/stem, length of node, number of leaves/plant, leaf width, length and leaf area 70.08, 2.344, 1.227, 14.37, 10.72, 83.71, 26.5, 36.49 and 7.322) respectively.

Table 1a. Effect of irrigation intervals and clones of jojoba plants on growth characters at three years

Clones treatments	Shoot characters					Leaves characters				
	Plant height (cm)	Number of main branches/plant	Stem diameter (cm)	Number of nodes/stem	Length of node (mm)	Number of leaves/plant	Leaf width (mm)	Length (mm)	Leaf area (cm ²)	
S-L	0	76.33	2.906	1.522	16.31	12.14	97.26	27.56	38.14	7.959
	2 weeks	73.49	2.459	1.288	15.79	11.78	88.64	27.50	36.72	7.648
	3 weeks	70.08	2.344	1.227	14.37	10.72	83.71	26.50	36.49	7.322
S-610	0	77.85	2.993	1.567	16.57	12.37	105.87	28.77	37.71	8.248
	2 weeks	75.01	2.533	1.326	16.05	12.01	97.26	27.56	36.79	7.710
	3 weeks	71.58	2.414	1.264	14.89	11.11	86.18	26.55	36.56	7.381
S-700	0	79.49	3.083	1.615	17.47	13.04	109.28	28.83	37.79	8.331
	2 weeks	76.56	2.609	1.366	16.05	12.01	100.00	28.83	36.87	8.128
	3 weeks	72.99	2.487	1.302	15.14	11.31	88.83	26.61	36.63	7.455
S-B	0	78.63	3.053	1.599	17.08	12.73	103.98	28.80	37.75	8.289
	2 weeks	75.80	2.583	1.352	16.18	12.07	96.03	27.59	36.83	7.747
	3 weeks	72.30	2.462	1.289	15.01	11.19	87.56	26.58	36.59	7.418
S-G	0	77.14	2.964	1.552	16.44	12.25	100.95	28.74	37.67	8.215
	2 weeks	74.31	2.509	1.313	15.92	11.89	93.56	27.53	36.76	7.678
	3 weeks	70.85	2.390	1.252	14.62	10.95	84.95	26.53	36.53	7.352
LSD C	9.1377	0.30897	0.04217	4.6737	2.0334	10.3346	6.2617	7.4735	0.23284	
LSD T	10.909	0.51579	0.05504	4.8222	3.0927	11.2315	8.3536	9.3406	0.64280	
LSD C x T	12.038	0.91179	0.09365	2.2779	3.2125	11.9908	12.420	10.217	0.94881	

Table 1b. Effect of irrigation intervals and clones of jojoba plants on growth characters at thirteen years

Clones treatments		Shoot characters			Leaves characters			
		Height	Diameter	Circumference m ²	Number of leaves/branch	Leaf width (mm)	Length (mm)	Leaf area (cm ²)
S-L	0	209.88	2.37	8.643	101.67	24.77	44.65	8.011
	2 weeks	202.06	2.006	7.876	92.66	24.72	43	7.699
	3 weeks	192.65	1.912	7.439	87.52	23.82	42.72	7.37
S-610	0	214.04	2.441	9.408	110.68	25.86	44.14	8.27
	2 weeks	206.22	2.066	8.643	101.67	24.77	43.07	7.729
	3 weeks	196.81	1.968	7.658	90.09	23.87	42.81	7.401
S-700	0	218.59	2.515	9.711	114.25	25.91	44.23	8.303
	2 weeks	210.47	2.128	8.886	104.54	25.91	43.16	8.101
	3 weeks	200.67	2.028	7.893	92.86	23.92	42.89	7.43
S-B	0	216.22	2.49	9.24	108.7	25.89	44.19	8.286
	2 weeks	208.4	2.107	8.533	100.39	24.8	43.11	7.745
	3 weeks	198.79	2.008	7.78	91.54	23.9	42.84	7.415
S-G	0	212.06	2.417	8.97	105.53	25.84	44.1	8.254
	2 weeks	204.34	2.045	8.314	97.81	24.75	43.04	7.715
	3 weeks	194.83	1.949	7.549	88.8	23.84	42.76	7.385
LSD C		55.1014	0.241	1.0467	12.3146	5.3851	6.5875	0.758
LSD T		41.7146	0.4022	1.4596	17.1716	7.5494	7.6893	1.1203
LSD C x T		29.2436	0.7111	1.9449	22.8809	6.7211	8.909	1.9137

Data in (Table 1b) investigation that the increase irrigation intervals lead to a decrease of growth characters as shoot characters (height, diameter and circumference m²) and leaves characters (number of leaves/branch, leaf width (mm), length (mm) and leaf area cm²). Growth and physiological characters presented in (Table 1b) show that jojoba plants were considerably affected by the irrigation periods treatments (7 days) irrigation interval increased all growth characters.

On the other hand, irrigation interval (15 days) decrease growth characters at thirteen years old for jojoba plants.

The general increase in growth characters lead to irrigated at short intervals is in agreement with the findings of [18]. The different clone treatments had a significant positive effect on the height plants. Intervals irrigation were Statistically significant taller than the control plants, with the low period being the most effective intervals treatment is in agreement with the findings of [19] who found that short period irrigation increased plant height. A significant interaction was detected in the data between the effects of irrigation periods and clones treatments on the plant height 1week irrigation interval in plants 7 days irrigation interval and clones in all seasons.

Leaf area was gradually decreased and recorded the smaller area at the highest irrigation interval led to decrease in all vegetative growth according to [20].

All data in (Table 3a, b) showed that the irrigation intervals lead to increase some chemical contents in leaves as Chlorophyll content (chl. A, Chl. B and carotene), total Carbohydrates, nitrogen%, phosphorus%, Potassium%, Fe ppm, Zn ppm, Cu ppm and Mg ppm. All characters affected by increase period irrigation. Data presented in Table 3 show that the irrigation interval had statistically significant stimulatory effect on elements and chlorophyll contents and carbohydrates of jojoba plants under irrigation stress.

Similar trends were recorded for plant height and volume in Argentina [21] but highest interval was recorded led to decrease plant height. [22] reported that the plant height has Statistically significant correlated with tree diameter and volume, which directly affected on increase seed yield. Similarly, [21] reported that plant height and plant volume were positively correlated with seed yield. Plant growth, photosynthesis and stomatal aperture may be limited under water deficit, which would be regulated by physical and chemical signals [23].

Table 2a. Effect of rates of irrigation intervals and clones of jojoba plants on yield characters at three years

Clones treatments	Total number of branches	No. leaves	W, Seeds harvest (kg)	Weight (100 seed gm)	Oil content of the seeds %	
S-L	0	9.300	139.0	66.14	79.55	46.78
	2 weeks	7.870	126.7	64.78	68.18	43.28
	3 weeks	7.500	119.7	63.50	64.40	38.16
S-610	0	9.579	151.0	70.09	81.95	48.49
	2 weeks	8.105	139.0	68.65	70.24	44.22
	3 weeks	7.726	123.2	67.27	66.34	39.49
S-700	0	9.866	156.4	74.04	82.03	49.53
	2 weeks	8.349	143.8	72.52	70.31	45.83
	3 weeks	7.957	127.3	71.22	66.40	40.44
S-B	0	9.770	148.8	72.07	81.22	48.87
	2 weeks	8.267	137.5	70.58	69.61	44.60
	3 weeks	7.880	125.8	69.15	65.75	39.68
S-G	0	9.485	144.3	67.13	81.14	47.63
	2 weeks	8.027	133.7	65.75	69.55	43.75
	3 weeks	7.650	121.4	64.43	65.68	38.92
LSD C	4.5983	1.9687	1.7305	7.6709	0.2628	
LSD T	4.43292	1.8318	1.6101	7.2052	0.0082	
LSD C x T	3.19872	1.4536	1.2777	5.8876	0.0018	

Table 2b. Effect of rates of irrigation intervals and clones of jojoba plants on yield characters at thirteen years

Clones treatments		Total number of branches	No. leaves	No. of flowers /meter	No. of fruits/meter	W, Seeds harvest (g)	Weight (100 seed gm)	Oil content of the seeds %
S-L	0	6.4162	79.933	21.196	15.078	5.8083	80.665	47.865
	2 weeks	5.4302	72.854	19.325	13.573	5.6885	69.142	46.148
	3 weeks	5.1747	68.825	17.236	11.207	5.5757	65.3	44.734
S-610	0	6.6092	86.793	21.236	15.107	6.1548	83.546	51.702
	2 weeks	5.5925	79.933	19.364	13.603	6.0281	71.062	47.158
	3 weeks	5.3302	70.839	17.266	11.227	5.9073	67.221	46.148
S- 700	0	6.8072	89.951	21.285	15.137	6.5013	83.546	55.842
	2 weeks	5.7608	82.655	19.404	13.622	6.3687	71.062	49.884
	3 weeks	5.4896	73.181	17.305	11.256	6.2548	67.221	48.167
S-B	0	6.7409	85.541	21.255	15.127	6.3281	82.586	52.106
	2 weeks	5.7044	79.061	19.384	13.613	6.1984	71.062	48.571
	3 weeks	5.4371	72.31	17.285	11.237	6.0727	66.261	47.36
S-G	0	6.5449	82.982	21.216	15.098	5.8955	82.586	50.793
	2 weeks	5.5381	76.883	19.345	13.583	5.7737	70.102	46.653
	3 weeks	5.2777	69.805	17.256	11.217	5.6579	66.261	45.542
LSD C		2.54658	13.08255	4.83853	3.91921	1.82863	13.1137	8.71507
LSD T		2.38451	11.99989	4.53054	3.66973	0.98406	12.5169	8.49846
LSD C x T		1.17483	10.92346	2.23225	1.80814	0.29987	11.6172	7.29689

Table 3a. Effect of rates of irrigation intervals and clones of jojoba plants on the content of leaves from chemical content at three years

Clones treatments		Chlorophyll 51 content			Total Carbohydrates	Nitrogen%	phosphorus%	Potassium%	Fe ppm	Zn ppm	Cu ppm	Mg ppm
		Chl. A	Chl. B	Carot.								
S-L	0	3.085	1.693	3.325	12.121	3.197	0.246	1.975	1.456	4.772	1.234	0.906
	2 weeks	2.802	1.538	3.022	11.013	2.904	0.224	1.794	1.322	4.335	1.120	0.818
	3 weeks	2.774	1.383	2.629	9.1954	2.286	0.216	1.392	1.121	3.935	1.111	0.688
S-610	0	3.485	1.761	3.370	13.324	3.257	0.275	2.211	1.473	4.792	1.246	0.944
	2 weeks	3.166	1.599	3.057	12.102	2.958	0.250	2.008	1.338	4.352	1.131	0.857
	3 weeks	2.720	1.438	2.830	9.8299	2.513	0.240	1.727	1.134	3.950	1.122	0.720
S-700	0	3.485	1.761	3.370	13.324	3.257	0.275	2.211	1.473	4.792	1.246	0.944
	2 weeks	3.166	1.599	3.057	12.102	2.958	0.250	2.008	1.338	4.352	1.131	0.857
	3 weeks	2.720	1.438	2.830	9.8299	2.513	0.240	1.727	1.134	3.950	1.122	0.720
S-B	0	3.165	1.796	3.452	13.532	3.283	0.287	2.118	1.488	4.806	1.237	0.956
	2 weeks	2.875	1.632	3.139	12.292	2.979	0.261	1.924	1.351	4.365	1.124	0.861
	3 weeks	2.629	1.468	2.839	10.284	2.477	0.251	1.748	1.421	4.781	1.114	0.725
S-G	0	3.135	1.727	3.425	13.229	3.217	0.274	2.057	1.471	4.787	1.225	0.922
	2 weeks	2.848	1.569	3.112	12.017	2.923	0.249	1.868	1.335	4.348	1.113	0.836
	3 weeks	2.602	1.411	2.802	9.5552	2.431	0.220	1.697	1.456	4.772	1.234	0.704
LSD C		0.085	0.022	0.059	4.7383	0.111	0.010	0.123	0.001	0.009	0.188	0.008
LSD T		0.077	0.021	0.093	4.5028	0.099	0.009	0.111	0.001	0.008	0.187	0.008
LSD C x T		0.0027	0.0033	0.128	4.1926	0.100	0.005	0.106	0.001	0.007	2.289	0.009

Table 3b. Effect of rates of irrigation intervals and clones of jojoba plants on the content of leaves from chemical content at thirteen years

Clones treatments		Chlorophyll 51 content			Total carbohydrates	Nitrogen%	phosphorus%	Potassium%	Fe ppm	Zn Ppm	Cu ppm	Mg ppm
		Chl. A	Chl. B	Carot.								
S-L	0	2.0381	1.5261	2.9016	10.140	2.5220	0.2383	1.5331	1.2369	4.340	1.225	0.759
	2 weeks	3.0924	1.6968	3.3333	12.148	3.2038	0.2474	1.9769	1.4589	4.782	1.235	0.901
	3 weeks	3.8956	1.7571	4.0663	13.453	3.2359	0.2798	2.0501	1.6607	5.232	1.246	0.973
S-610	0	3.0020	1.5874	3.1224	10.843	2.7731	0.2647	1.9056	1.2517	4.357	1.238	0.795
	2 weeks	3.4940	1.7651	3.3735	13.353	3.2641	0.2758	2.2158	1.4763	4.801	1.248	0.945
	3 weeks	4.5381	1.8283	4.9597	13.655	3.3563	0.3002	2.2549	1.6805	5.253	1.259	1.021
S-700	0	3.0020	1.5874	3.1224	10.843	2.7731	0.2647	1.9056	1.2517	4.357	1.238	0.795
	2 weeks	3.4940	1.7651	3.3735	13.353	3.2641	0.2758	2.2158	1.4763	4.801	1.248	0.945
	3 weeks	4.5381	1.8283	4.9597	13.655	3.3563	0.3002	2.2549	1.6805	5.253	1.259	1.021
S-B	0	2.9016	1.6194	3.1325	11.345	2.7339	0.2777	1.9287	1.5678	5.274	1.229	0.800
	2 weeks	3.1727	1.8002	3.4639	13.555	3.2871	0.2880	2.1235	1.4911	4.815	1.240	0.950
	3 weeks	4.3675	1.8645	4.5180	13.755	3.3695	0.3103	2.2489	1.6974	5.269	1.269	1.026
S-G	0	2.8715	1.5563	3.0924	10.543	2.6817	0.2433	1.8725	1.5491	5.252	1.216	0.777
	2 weeks	3.1425	1.7309	3.4337	13.253	3.2249	0.2748	2.0613	1.4734	4.796	1.227	0.922
	3 weeks	4.3273	1.7922	4.4779	13.555	3.3042	0.2880	2.1837	1.6772	5.248	1.257	0.997
LSD C		0.0933	0.0240	0.0700	5.15473	0.1230	0.0112	0.1342	0.0165	0.0992	2.490	0.010
LSD T		0.0837	0.0230	0.0987	4.89856	0.1108	0.0100	0.1208	0.0148	0.0893	0.203	0.009
LSD C x T		0.0030	0.0040	0.1397	4.56115	0.1056	0.0096	0.1151	0.0141	0.0851	0.204	0.008

Data in the (Table 2a, b) investigation that the irrigation intervals lead to a decrease of all growth characters as and so, yield characters as total number of branches, number of leaves, weight of seeds/plant (kg), weight 100 seeds (gm) and oil content of the seeds %. The data presented in (Table 2) show that the yield characters on jojoba plants were considerably affected by the irrigation periods treatments seven days irrigation interval increased all yield characters at three years aged, on the other hand, 15 days irrigation interval decreased branches giving plants that were Statistically significant.

The photosynthetic pigments content (Chl.a, Chl.b, Chl.a/b and carotenoids) were reduced at all levels of treatments as compared to the irrigation interval (one week). Results of total carbohydrates described clear evidence of increasing accumulation of carbohydrates *Simmondsia chinensis* as compared to the control.

The stomatal regulate the rate of transpiration in response to water stress. Thus, the relation between the potential pressure and the water is altered. This results from the accumulation of active substances and the increased flexibility of the cell walls. A number of proteins and genes have been identified that respond to water stress, which activates the mechanisms of defence against oxygen generators to reduce the impact of drought stress, [24].

4. CONCLUSION

The jojoba plant was affected by increased irrigation interval, and it was clear in all clones. Irrigation every three weeks had an impact of irrigation every week. The effect of irrigation interval varied from one clone to another and the lowest was s-700. The older seedlings are less affected by irrigation interval than small seedlings. The best results were category s-700 at the age of thirteen years and irrigation every two weeks.

DISCLAIMER

This manuscript was published in the conference.

Conference name: - ICAAECP 2017: 19th International Conference on Advanced Agricultural Engineering and Crop Production.

Available link: -

<http://waset.org/pdf/books/?id=80001&pageNumber=1>

December 04-05, 2017, Amsterdam, The Netherlands.

World Academy of Science, Engineering and Technology.

International Journal of Agricultural and Biosystems Engineering.

Vol: 11, No: 12, 2017.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
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