Evaluation of *Jatropha curcas* and *Moringa oleifera* Seedlings in Two Different Ecological Regions Cultivated on Different Distances

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ABSTRACT

***Jatropha curcas* L., a multipurpose shrub, planting in a marginal soil, it has gained lot of importance for the production of biodiesel. *Moringa oleifera* Lam., is a highly valued plant, it has an impressive range of medicinal uses with high nutritional value. The field experiment was carried out at Ismailia and Alexandria governorates, at east and west of Egypt, respectively. Jatropha and Moringa were cultivated from May 2013 to October 2015 under different ecological regions and two plant spacing (0.5m*0.5m and 1.0m*1.0m), to evaluate the productivity.**

The results revealed that there was high significant different of the most of growth parameters of Jatropha and Moringa shrubs in Ismailia region as compared with Alexandria region. It was clear that, the amount of fruits, seeds and oil yield (kg ha^{-1}) of Moringa were increased in 2015 as compared with 2014. Jatropha started to give fruits at 2015 in the both two regions, but it did not give fruits with wide spacing in Alexandria. The results also revealed that the highest values of fruits, seeds and oil yield were 2111, 621 and 82 kg ha^{-1}, respectively for Moringa with 0.5m* 0.5m spacing in Ismailia region. While, the lowest values of fruits, seeds and oil yield were 552, 142 and 13 kg ha^{-1}, respectively for Moringa with 1.0m*1.0m spacing in Alexandria. Also, the highest values of fruits and seeds yield were 191 and 105 kg ha^{-1}, respectively of Jatropha in Ismailia, while the highest value of squeeze oil percentage was 17.23% for jatropha with narrow spacing in Alexandria followed by Ismailia region.

It could be concluded that Ismailia region more suitable for planting Jatropha and Moringa especially with narrow spacing to give the highest amount of fruits, seeds and oil yield, but Alexandria region gave the highest oil percentage with Jatropha under narrow spacing.

***Keywords: Jatropha curcas*, *Moringa oleifera*, biodiesel, different ecological regions, spacing, oil yield**

INTRODUCTION

Jatropha curcas:

Jatropha curcas belongs to the genus *Jatropha* which contain approximately 170 known species, family Euphorbiaceae. *Jatropha curcas,* is a shrub of up to 5m tall, originates in Central America and Mexico, and has been naturalized in a number of other tropical and sub-tropical countries in Asia, Africa and Latin America, with the total plantation area estimated at 900,000 ha in 2008. It is a perennial shrub which resists a high degree of aridity and which can grow in most kinds of soils, even in desert and depleted soils thereby avoiding competition with food production, while at the same time helping in soil regeneration and erosion prevention (Jongschaap *et al*., 2007; Achten *et al*., 2008; IFAD-FAO, 2010; FAO, 2011).

Jatropha curcas is an oil seed producing species which has generated much interest due to its potential for bio-diesel production (IFAD-FAO, 2010), where, its production is positive in comparison to the use of fossil fuels (Silitonga *et al.,* 2011). Seed yield and oil production of Jatropha can be related to a variety of factors such as climate, site quality, genetic and physiological quality of the seed used, the size of the plants used in the establishment phase and the intensity of management of the plantations. Jatropha plantations produce two seed crops annually, the first in spring (between April and May) and the second in autumn (between September and October). Seed production will be maintained over 30 - 50 years, FAO (2011); Heller (1996) and Tewari (2007).

Egypt has already cultivated Jatropha using treated wastewater at more than 400 hectare of margin lands (Ministry of Agriculture and land Reclamation Under secretariat for Afforestation & Environment, 2009).

Moringa oleifera:

Moringa oleifera, a woody plant or shrub, offers opportunities for use in marginal lands. The species has low nutrient needs and requires little or no fertilizers, and also needs few or no pesticides when cultivated (Tilman *et al.,* 2006). Moringa belongs to the family of Moringaceae which contains 13 species. The most widely known and used species is *Moringa oleifera*. The tree's height is up to 5 meters tall which is originates in the Himalayas in northwestern India. The species has been planted in tropical and subtropical climates throughout the tropics.

Moringa oleifera grows quickly in many types of environments, a highly drought-resistant, with minimum annual rainfall requirements estimated at 250 mm. The species tolerates a wide variety of soils, with pH between 4.5 and 9.0; however, it prefers neutral to

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slightly acidic soils (pH 6.3–7.0). The species is not frost tolerant (FAO, 2011). Where's *Moringa oleifera* do not need much watering, the trees will flower and produce pods whenever there is sufficient water available. If rainfall is continuous throughout the year, *M. oleifera* will have a nearly continuous yield. In arid conditions, flowering can be induced through irrigation. Temperature preferred by *M. oleifera* ranges between 25-35 degrees celsius (Ramachandran *et al.,* 1980).

Biodiesel derived from Moringa oil is an acceptable substitute for petrodiesel when compared to biodiesel fuels derived from other vegetable oils (Rashid *et al.,* 2008). *Moringa oleifera* is also widely known as coagulants within the scientific community, thus it can be utilized as a chemical coagulation/flocculation agent that treats wastewaters (Verma, 2012).

Ecological requirements for Jatropha and Moringa

Trees in natural populations usually exhibit large variation in growth (Harper, 1977). Understanding this variation in growth is central to forest ecology because of its significance to forest structure and biomass.

FAO Ecocrop (2011) summarized the Ecological requirements of *Jatropha curcas* and *Moringa oleifera* as follows: optimal rainfall (mm) for both plants are 500- 1500 and 700- 2200, respectively, while absolute range are 300- 2000 and 400- 2600, respectively. Optimal temperature (°C) range are 11- 28 and 20 -35, respectively when absolute range are 7- 36 and 7- 48 for Jatropha and Moringa. For soil pH the optimal rang are 5.5- 7.5, 5.5- 7 and absolute range are 5- 8, 5- 8.5. While, optimal and absolute soil salinity ranges (dS/m) are less than 4, for both plants, respectively. Also, (Palada and Changl, 2003; Amaglo, 2006; Da Amaglo *et al.*, 2006; Schio, 2010) mentioned the similar environmental characteristics for both species. Therefore, both of *J. curcas* and *M. oleifera* are consume a little water compared to other crops used as biofuel feedstocks (WRC, 2008; Palada and Changl, 2003; Rashid *et al.,* 2008; Radovich, 2009; Eijck, 2007) hence not expected to affect the soil water budget. So, the main objective of this study is to evaluate the growth and the productivity of *J. curcas* and *M. oleifera* in Alexandria and Ismailia regions with different plant spacing.

MATERIALS AND METHODS

1. Location and description of study sites

This study was carried out in two geographical sites during two seasons from 2013 to 2015.

1.1. Alexandria site:

Part of this study was carried out At Horticulture Research Institute (HRI) in Antoniades gardens which is located at the Southeastern of Alexandria city bounded by latitude 30° 10' 17.48 N , and longitude 29° 56' 15.83 E, with a total area of about 120 feddans.

1.2. Ismailia Site:

Second part of the study was carried out at Ismailia Agriculture Research Station (IARS) that located in Ismailia governorate in the eastern parts of Arab Republic of Egypt (ARE) at the middle part of Suez Canal at latitudes 30° 36' 15 N and longitudes 32° 16' 20 E, with a total area of about 205 feddans.

2. Soil properties:

Soil analysis presented in Table (1) for Alexandria and Ismailia sites.

3. Meteorology characterizes:

Ismailia climate is characterized with 3 forms: cold warm winter for a long time, intermediate with light rains, moderate summer with some humidity, in general it is a moderate climate all over the year. The maximum monthly average for temperature is 35.1 °C in July and August. However, it is 19.9 °C in January. During night the temperature decreases and the minimum average limit is 7.1°C in January and 20.6 °C in August. While, Alexandria has a semi-arid Mediterranean climate - subtropical characterized by mild, variably rainy winters and hot, dry summers. January and February are the coldest months with daily maximum temperatures typically ranging from 12°C to 18°C. Alexandria experiences violent storms, rain and sometimes hail during the cooler months. July and August are the hottest and most humid months of the year with an average daily maximum temperature of 30°C. Autumn and spring have temperatures average about 22°C. (World Meteorological Organization (UN) 27-09-2009. Meteorology characterizes for both sites presented in Table (2).

Table 1. The physical and chemical properties of the used mixture soil for the two regions

Soil / sample	pH	EC ds/m	Cations (meq/l)				Anions (meq/l)			Texture
			Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCO_3^{-}	Cl^{-}	SO_4^{--}	
Ismailia	7.92	0.178	0.6	0.4	0.31	0.16	0.75	0.5	0.22	Sandy soil
Alexandria	8.10	3.53	13.22	11.20	13.91	4.49	7.23	11.90	17.15	Clay sandy loam

Table 2. Mean of the meteorological data at Central Laboratory of Agricultural Climate (CLAC) under the circumstances of Alexandria and Ismailia through the experiment from 2013 to 2015

Months	Alexandria		Ismailia	
	Mean temperature (ºC)	Mean Humidity (%)	Mean temperature (ºC)	Mean Humidity (%)
January	13.15	74.35	13.25	60.85
February	14.10	71.35	14.40	57.75
March	16.65	66.20	17.30	52.25
April	19.35	64.30	21.60	45.95
May	23.10	67.60	26.00	47.15
June	25.65	69.55	27.60	53.95
July	27.40	71.70	28.55	58.30
August	28.15	71.15	29.40	53.60
September	26.15	68.40	26.95	56.80
October	23.35	69.50	23.70	58.80
November	20.45	73.95	20.90	61.55
December	15.35	72.60	15.30	58.60

4. Experimental treatments description:

Seeds of two shrubs species *Jatropha curcas* and *Moringa oleifera* were sowed in the nursery at two geographical sites (Alexandria & Ismailia) government in May 2013 then planted in land in September 2013, at two plant spacing treatment. Treatment (0.5m * 0.5m) planted in area (24 m^2) for both species and (1m * 1m) treatment planted in area of (40 m^2) for each species; Plants were distributed at three replicates. Plants were surface irrigated with fresh water three times a week in summer and twice a week in winter.

2.5. Data recorded:

2.5.1. Vegetative growth parameters:

Plant height (cm), stem diameter (cm) was measured three times per season in June, September and December of all planted area; data were used for growth curve. While, the data at three periods (2013, 2014 and 2015) were used for statistical analysis.

Three plants of each species and treatment were selected randomly for calculating fresh and dry weight of leaves, stem, root, fruits and total plant weight (gm) at the end of each season (2014 , 2015).

2.5.2. The percentage of fruiting Shrubs:

The percentage of fruiting Shrubs determined by the following equation:

The percentage of fruiting Shrubs=(the number of fruiting shrubs/total number of shrubs)x100

Fruits collected in September of 2014 and 2015 seasons.

2.5.3. Squeezed oil yield:

The shrub seeds were squeezed by a compressor (KT23-100EL). Oil percentage per (100 g) seeds was measured and then calculated per hectare.

2.6. Data analysis:

Experimental layout design was split- split plot with three replicates. Ten plants were chosen randomly from each replicate for data analysis. The main plots were sites, sub plots were tree species, while sub- sub plots were plant spacing. Means of the individual factors and their interaction were compared by L.S.D test at 5% level of probability according to Snedecor and Cochran (1989).

RESULTS AND DISCUSSIONS

1. Growth parameters

1.1. Plant height

Trends for height growth of *J. curcas* and *M. oleifera* for Ismailia and Alexandria regions are shown in figure (1-A and B). At 2013, 2014 and 2015 periods, the results indicated a high increase in the growth with high significant variation in height between the two species at all assessment, as shown in table (3). However, at the end of the experiment in 2015, no significant variation in plant height was observed for the two regions and plant spacing. Also, there was a highly significant difference for the two regions, species and spacing interaction. The mean Moringa height was 219.16 cm and 319.63 cm for Alexandria region for wide and narrow spacing, respectively. Hence, the mean height of Jatropha was 93.7 cm for Alexandria and 138.4 cm for Ismailia with wide spacing.

It is interesting to note that at many assessment in both sites, Ismailia region showed superiority in height growth (50.99, 160.77 and196.11 for 2013, 2014 and 2015, respectively) as compared with Alexandria region (27.21, 54.64 and 187.43, respectively). *M. oleifera* species gave the highest significant values 51.97, 151.68 and 267.54 cm, respectively through 2013, 2014 and 2015, respectively as compared with *J. curcas* 26.24, 63.73 and 115.99, respectively.

Generally, the significant differences in the height growth of shrubs at Ismailia site specially, at 2013 and 2014 could be attributable to provenance difference in tolerance to arid/semiarid conditions of study site (Edward *et al.*, 2006). The excellent performance of Ismailia site is an indication of better adaptation to region condition for both of the two species. In addition the low salinity of the soil in Ismailia region as compared with Alexandria region as indicated in table (1).

On the other side, the data in figure (1-A and B) and table (3) indicated that closer plant spacing resulted into higher plant height (199.36 cm) than wider plant spacing (184.17 cm) due to the competition for the light, this results correlated with the finding of Kalannaver *et al.*(2009), Ghosh *et al.*(2006) and Fagam *et al.*(2012). Results elsewhere indicated that the growth and development of Jatropha is significantly affected by plant spacing (Evangelista, 2009).

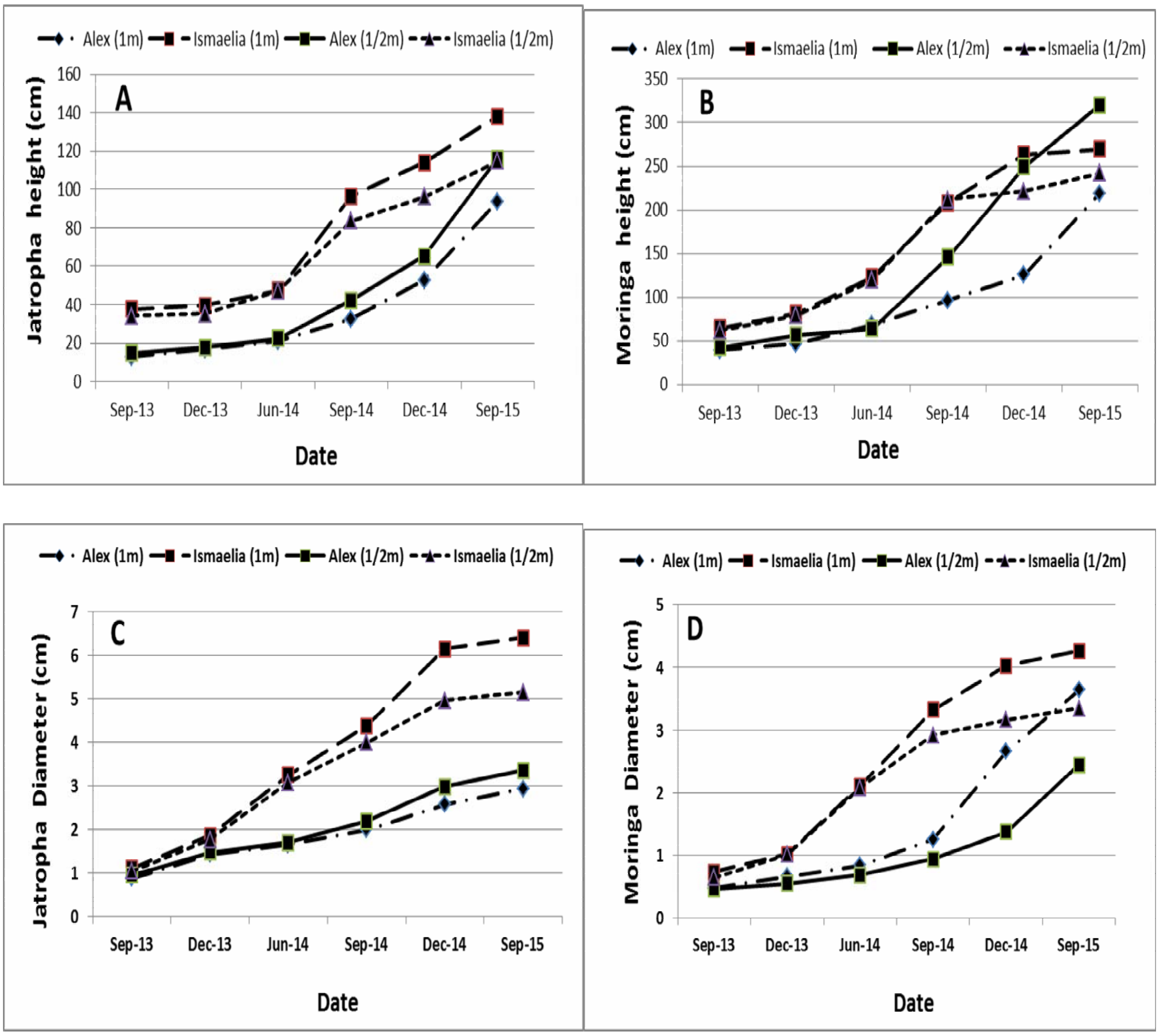

Figure 1. Growth of of *Jatropha curcas* and *Moringa oleifera* affected by different regions and different plant spacing from 2013 till 2015

1.2. Stem diameter

Data in figure (1, C and D) and table (3) showed the behaviour of stem diameter (cm) during the study period. At 2013 and 2014 periods a gradual increase and a significant difference can be seen in diameter especially for the two regions and species. While, there was no significant differences in diameter at 2013 and 2014 due to spacing. These results approved with the results of Fagam *et al.* (2012), which indicated that the effect of plant spacing on the canopy diameter of *J. curcas* was not significant. Although, the results at 2015 indicated that there was a significant differences between the regions, species, and plant spacing and the interaction between them. On the other side, the superior stem diameter was 6.40 cm for *J. curcas* in Ismailia region with wide spacing. While, the lowest stem diameter was 2.44 cm for *M. oleifera* in Alexandria region with narrow spacing (Table 3).

The differences in diameter development could be attributed to variations in adoptability among the regions, but Ismailia region showed low soil salinity and good climatic conditions for both the two species (Table 1& 2).

2. The productivity

2.1. Fruit weight

Results in table (3) show the variation between the amount of fruits per shrubs through 2014 and 2015 seasons. It was clear that, *M. oleifera* was fast growth shrubs in Ismailia region because; it started to give fruits at 2014 season. While, the same species started to give fruits at 2015 season in Alexandria region. In the opposite, *J. curcas* started to give fruits in 2015 season in the two regions, but it did not give fruits with wide spacing in Alexandria. Considering, the amount of fruit was highly significant variations between the two species. Hence, at 2015 season, the highest amount of fruits (138.33 gm/ shrub) was of *M. oleifera* with wide spacing in Ismailia. While, the lowest amount of fruits (8.46 gm/ shrub) was of *J. curcas* with narrow spacing in Alexandria. De Avila (1949) found that distance (2.7 by 2.7m) may be more desirable for commercial cultivation of *J. curcas* because wider spacing is reported to increase crop yield by increasing fruit size. While, Silva *et al.* (2011) claimed that, as plant adapt to environmental conditions, the number of fruits will increase and, therefore, the productivity will also increase.

2.2. Hundred seed weight

The data in Table (3) showed significant effect due to region, species and spacing in the weight of hundred seeds and the interaction between the three previous factors is highly significant. Also, the data indicated that *Jatropha curcus* cultivated in Alexandria with narrow space recorded the highest mean value of hundred seeds weight (62.58 g). Whereas, *Moringa oleifera* cultivated in Ismailia with wide space recorded the lowest mean weight for hundred seeds weight (35.18 g) with significant difference between the two values. In addition, the data showed that *J. curcus* cultivated in Ismailia with narrow and wide space recorded 53.96 and 54.94 g for hundred seeds weight, respectively, while *M. oleifera* cultivated in the same region with narrow space recorded 35.58 g.

For Alexandria region, *M. oleifera* recorded 40.78 g. and 40.38 g for narrow and wide space respectively. Whereas, *J. curcus* with wide space did not give any seeds in the same region.

The previous results showed that Alexandria region is more suitable for hundred seeds weight for the two species than Ismailia region. So, this may be due to increase in photosynthetic activity that increases accumulation of metabolic substances, which directed impact on seed weight (Reddy *et al.* 1996). However, Shams *et al.* (1967) and Ögütçü (1980) reported that lesser thousand seed weight in Castor bean plant may be due to different plant material and environmental conditions. Terren *et al.* (2012) found that Jatropha seeds are often small and poorly filled. Also, Achten *et al.* (2010) showed that the weight of 1000 seeds rarely exceeds 500 g. These results agree with our results because we get mean values of 42.87 and 37.98 g for Jatropha and Moringa respectively (table 3).

2.3. Squeezed oil percentage

According to the analysis of variance (Table 3) the squeezed crude oil percentage responded significantly to the effect of the regions, species and spacing. Also, the interaction between these three parameters is highly significant. *Jatropha curcus* planted in Alexandria with narrow space recorded the highest mean value of squeezed oil percent (17.27%) followed by *Moringa oleifera* cultivated in Ismailia with narrow and wide space (13.19%), followed by *Jatropha curcus* cultivated in the same region with narrow space (12.89%) and wide space (12.88%). In addition, *Moringa oleifera* in Alexandria with wide space give mean value of (9.10%). Whereas, the same species with narrow space in the same region give the lowest mean value of squeezed oil percent (6.1%). Deng *et al.* (2010) and Heller (1996) reported that Jatropha seeds contain 25-40% oil by weight. The average Jatropha oil content is 35% frequently quoted in the literature of Achten *et al.* (2008). While, Amouri *et al.* (2012) found that Moringa seeds contain 33-41% oil.

Table 3. Mean values of seedlings height(cm), stem diameter(cm), fruit weight(gm/shrub), 100 seed weight(gm) and oil percentage(%) of *Jatropha curcas* and *Moringa oleifera* affected by different regions and different plant spacing

Treatments	Plant height (cm)			Stem diameter (cm)			F. w (gm/shrub)		100 S. w. (gm)	Oil (%)
	2013	2014	2015	2013	2014	2015	2014	2015	2015	2015
Regions										
Ismailia	50.99	160.77	196.11	0.88	3.67	4.91	47.2	64.94	44.91	13.03
Alexandria	27.21	54.64	187.43	0.69	1.59	3.09	0	43.62	35.93	8.87
F.test	**	**	N.S	*	**	**	**	N.S	**	**
L.S.D 5%	0.61	32.43	—	0.15	0.54	0.72	11.83	—	1.51	0.07
Shrubs species										
Jatropha curcas	26.24	63.73	115.99	1.002	3.14	4.46	0	10.39	42.87	10.76
Moringa oleifera	51.97	151.68	267.54	0.57	2.12	3.55	47.2	98.17	37.98	11.14
F.test	**	**	**	**	**	*	**	**	**	**
L.S.D 5%	3.32	28.56	39.47	0.103	0.48	1.33	7.64	52.44	0.65	0.05
Plant spacing										
0.5m * 0.5m	39.09	95.71	199.36	0.77	2.51	3.58	21.48	45.48	48.22	13.11
1m * 1m	39.12	119.7	184.17	0.80	2.75	4.42	25.71	63.08	32.62	8.79
F.test	N.S	**	N.S	N.S	N.S	**	N.S	N.S	**	**
L.S.D 5%	—	14.01	—	—	—	0.233	—	—	0.23	0.05
Interaction										
Reg.1XSh.1	38.86	90.10	126.53	1.08	4.18	5.76	0	16.54	54.45	12.88
Reg.1XSh.2	63.13	231.44	265.68	0.68	3.15	4.06	94.4	113.33	35.38	13.19
Reg.2XSh.1	13.61	37.36	105.46	0.91	2.09	3.15	0	4.23	31.29	8.63
Reg.2XSh.2	40.81	71.93	269.4	0.47	1.09	3.04	0	83.01	40.58	9.1
F.test	N.S	**	N.S	N.S	N.S	*	**	N.S	**	**
L.S.D 5%	—	40.39	—	—	—	1.89	10.8	—	0.92	0.08
Reg.1XSp.1	49.75	146.57	180.33	0.84	3.46	4.27	0	49.73	44.77	13.04
Reg.1XSp.2	52.24	174.97	211.89	0.92	3.87	5.55	0	80.14	45.06	13.03
Reg.2XSp.1	28.43	44.86	218.39	0.7	1.56	2.9	42.97	41.22	51.68	13.18
Reg.2XSp.2	26	64.43	156.46	0.68	1.62	3.29	51.42	46.01	20.19	4.55
F.test	N.S	N.S	**	N.S	N.S	**	N.S	N.S	**	**
L.S.D 5%	—	—	25.92	—	—	0.329	—	—	0.32	0.077
Sh.1XSp. 1	26.33	62.93	115.9	1.002	3.09	4.24	0	9.8	58.27	15.08
Sh.1XSp. 2	26.14	64.53	116.09	1.001	3.18	4.67	0	10.97	27.47	6.44
Sh.2XSp. 1	51.84	128.50	282.82	0.55	1.93	2.93	42.97	81.15	38.18	11.14
Sh.2XSp. 2	52.09	174.87	252.26	0.603	2.31	4.17	51.42	115.18	37.78	11.14
F.test	N.S	**	N.S	N.S	N.S	**	N.S	N.S	**	**
L.S.D 5%	—	19.82	—	—	—	0.32	—	—	0.32	0.07
Reg.1XSh.1XSp.1	38.07	83.67	114.64	1.05	3.99	5.13	0	11.14	53.96	12.89
Reg.1XSh.1XSp.2	39.65	96.53	138.42	1.12	4.38	6.40	0	21.95	54.94	12.88
Reg.1XSh.2XSp.1	61.43	209.47	246.01	0.64	2.93	3.42	85.95	88.33	35.58	13.19
Reg.1XSh.2XSp.2	64.83	253.41	285.36	0.73	3.36	4.71	102.85	138.33	35.18	13.19
Reg.2XSh.1XSp.1	14.60	42.20	117.16	0.95	2.19	3.36	0	8.46	62.58	17.27
Reg.2XSh.1XSp.2	12.63	32.53	93.76	0.88	1.99	2.94	0	0	0	0
Reg.2XSh.2XSp.1	42.26	47.52	319.63	0.46	0.94	2.44	0	73.98	40.78	6.1
Reg.2XSh.2XSp.2	39.36	96.33	219.16	0.47	1.25	3.64	0	92.03	40.38	9.1
F.test	N.S	N.S	**	N.S	N.S	**	N.S	N.S	**	**
L.S.D 5%	—	—	36.66	—	—	0.46	—	—	0.46	0.109

** Highly significant * Significant NS- Non significant

Regions: Reg. 1: Ismailia Reg. 2: Alexandria Shrubs species: Sh. 1: *Jatropha curcas* Sh. 2: *Moranga oleifera* Plant spacing: Sp. 1: 0.5m*0.5m Sp. 2: 1m*1m

These highly percent of oil than our results perhaps due to the sample age of our young shrubs we used in our study. In general, narrow spacing increased oil content as compared with wide spacing.

3. Biomass

3.1. Fresh weight

The analysis of variance for leaves, stem, root, fruits and total fresh weight is shown in table (4). Regions, species and plant spacing effected on leaves, stem, root, fruits and total fresh weight significantly, especially at the first season (2014). Also, there was a significant effect for species and plant spacing interaction on leaves, stem, fruits, roots and total fresh weight. However, at the end of the experiment in 2015, there was no significant variation in leaves, root, fruits and total fresh weight due to the interaction between region, species and plant spacing. On the other side, the total fresh weight gave superior values (3078.5, 3025.8 and 3057.3 gm) at Ismailia, *M. oleifera* and wide plant spacing, respectively. Hence, the superior value of total fresh weight was in Ismailia, with *M. oleifera* and wide plant spacing interaction in the first and second seasons (3332.5 and 4722.7, respectively).

3.2. Dry weight

The results for dry weight of two species under two locations and two plant spacing are presented in table (4). Regions, species and plant spacing affected significantly on leaves, stem, root, fruits and total dry weight especially through 2015 seasons. While, at 2014 season, the interaction between region and species were not differed in stem, root and total dry weight. Also, the interaction between regions and plant spacing were not differed significantly in leaves, stem and total dry weight. At the end of the experiment (2015), it was clear that total dry weight gave the highest values (1151.6, 1011.3 and 1055.7 gm,) at Ismailia region, *M. oleifera* and wide spacing, respectively. However, the interaction between regions, species and plant spacing was not significant in affecting the dry matter production in Jatropha and Moringa in the two seasons. Generally, the two species grown at Ismailia site with wide spacing showed high production of leaves, stem, root, fruits and total dry weight than those grown at Alexandria site (Table 4). This could be due to sufficient availability of growth resources (soil, temperature and humidity Table (1&2)).The highest values in leaves, stem, root, fruits and total dry weight were (85.62, 507.5, 370, 110 and 1151.6 gm, respectively). While, the lowest values in leaves, stem, root, fruits and total dry weight were (27.0, 204.0, 145.6, 26.6 and 403.2 gm, respectively) at Alexandria site. This poor performance could probably be due to poor genetic adaptation influenced by climatic conditions in these areas (Edward *et al.*, 2013). On the other side, the widest plant spacing produced the highest dry matter than the narrow spacing, and there was a highly significant difference between them. On the contrary Edward *et al*. (2013) found that biomass of *Moringa oleifera* decreased with increasing spacing in both study sites. Bernardo *et al.* (1999) also noted that as spacing increase, total biomass production per hectare decrease. Evangelista (2009); Khrishna *et al*.(2008); Saxena *et al*.(2001) reported that the growth parameters like plant height, number of leaves, leaf area and dry matter yield were significantly affected by fertilizer types and levels and plant population.

3.4. The total yield of fruit, seed and oil

The relationship between regions, species and plant spacing and there effects on fruits, seeds and oil yield were take the same trend, and the yield of Moranga fruits, seeds and oil increased in Ismailia as compared with Alexandria of two spacing. Data in table (5) indicated that the highest values of fruits, seeds and oil yield were 2111, 621 and 82 kg $h\bar{a}^{1}$, respectively for Moranga in Ismailia with narrow spacing. On the other side, the amount of Jatropha fruits and seeds were superior in Ismailia as compared with Alexandria region. While, the superior Jatropha oil yield (14 kg $h\bar{a}^{1}$) was recorded for Alexandria followed by Ismailia region (13.3 kg $h\bar{a}^{1}$) with narrow spacing. Generally, decreasing plant spacing led to increasing fruits, seeds and oil yield for the two species in the two regions through the first and second seasons and may be the narrow spacing led to the competition between shrubs caused increased fruits seeds and oil. So, it could expand the cultivation area. Achten *et al.* (2008) found that the seed yield of mature Jatropha ranged between 9.8-12.3 t. $h\bar{a}^{1}$ of dry seed is a reasonable yield estimate for an adequately managed plantation with favourable environment conditions. Amouri *et al.* (2012) showed that the seeds and oil yield of mature *Moringa oleifera* ranged between 3-6(t/ ha) and 0.99-2.46(t/ ha), respectively. However, *Jatropha curcas* seed yield ranged between 0.94- 2.35(t/ ha). While, Terren *et al.* (2012) found that the average seed yield obtained at Senegal after four years of cultivation less than 500 kg $h\bar{a}^{1}$ of dry seed. These results are very high when compared with our results, this may be our shrubs are still young and it did not reach to the maturity age.

3.5. Fruiting Shrubs percentage

There was a high variation in the fruiting shrubs percentage in the first season (2014) as compared with the second season (2015) as shown in table (5).

le 4. Mean values of seedlings fresh and dry weight of leaves, stem, root, fruit and total weight (gm) of *Jatropha curcas and inga oleifera* affected by regions and plant spacing at 2014 and 2015

reatments	Leaves weight (gm)				Stem weight (gm)				Root weight (gm)				Fruits weight (gm)				Total weight (gm)			
	Fresh w.		Dry w.		Fresh w.		Dry w.		Fresh w.		Dry w.		Fresh w.		Dry w.		Fresh w.		Dry w.	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
ons																				
ilia	277.5	330	62.5	85.62	1080	1516.62	453.75	507.5	883.75	1005	312.5	370	71.87	226.87	24.37	110	2313.12	3078.54	853.16	1151.62
andria	91.62	133.9	16.94	27.008	211.29	479.68	69.99	204	204.09	461.48	68.24	145.56	0	227.97	0	26.68	507.004	1718	155.18	403.26
t	*	*	**	*	**	*	**	*	*	**	*	*	**	N.S	**	*	**	N.S	**	*
) 5%	13.76	117.07	12.52	27.49	69.18	653.72	14.204	232.969	593.39	129.71	222.576	436.08	7.76	—	1.55	70.77	666.42	—	247.39	343.86
bs species																				
pha curcas	228.32	342.94	44.13	80.68	547.8	976.25	223.32	308.9	348.11	432.02	116.36	137.75	0	19.525	0	16.24	1124.23	1770.75	383.82	543.57
nga oleifera	140.8	120.95	35.31	31.95	743.49	1020.05	300.416	402.6	739.72	1034.46	264.38	377.81	71.87	435.32	24.37	120.44	1695.89	3025.79	624.53	1011.31
t	**	**	N.S	**	**	N.S	*	*	*	**	*	**	**	**	**	**	*	**	**	**
) 5%	60.67	43.95	—	7.1	110.22	—	66.804	79.45	278.8	53.85	96.3	23.12	5.012	146.001	1.003	48.21	442.61	242.33	177.61	89.43
spacing																				
* 0.5m	133.93	198.87	29.31	48.99	527.65	885.21	222.61	245.01	459.5	535.26	175.83	182.12	28.75	119.9	6.25	32.03	1149.83	1739.25	434.01	499.17
1m	235.18	265.02	50.13	63.64	763.64	1111.09	301.125	466.48	628.34	931.22	204.91	333.44	43.12	334.95	18.12	104.65	1670.29	3057.29	574.34	1055.71
t	**	N.S	*	*	**	*	**	**	**	**	*	*	**	**	**	*	**	**	**	**
) 5%	32.54	—	15.25	12.05	96.27	196.71	40.44	18.22	53.33	233.11	27.28	117.1	5.76	131.02	2.47	57.02	175.39	560.98	62.52	209.6
action																				
1XSh.1	370	565	75	137.5	957.5	1572.5	400	510	605	682.5	207.5	220	0	30	0	25	1932.5	2850	682.5	892.5
1XSh.2	185	95	50	33.75	1202.5	1460.75	507.5	505	1162.5	1327.5	417.5	520	143.75	423.75	48.75	195	2693.75	3307.08	1023.83	1410.75
2XSh.1	86.64	120.88	13.27	23.86	138.1	380.01	46.65	107.8	91.23	181.55	25.22	55.5	0	9.05	0	7.48	315.97	691.5	85.141	194.65
2XSh.2	96.6	146.91	20.62	30.15	284.483	579.35	93.33	300.2	316.95	741.42	111.27	235.63	0	446.9	0	45.89	698.03	2744.5	225.23	611.87
t	**	**	*	**	N.S	*	N.S	*	N.S	N.S	N.S	**	**	N.S	**	**	N.S	**	N.S	N.S
) 5%	85.8	62.16	22.93	10.04	—	134.18	—	112.37	—	—	—	11.77	7.08	—	1.41	68.18	—	342.71	—	—
1XSp.1	210	272.5	47.5	71.25	922.5	1113.25	397.5	377.5	817.5	742.5	330	290	57.5	72.5	12.5	42.5	2200.75	2200.75	787.5	763.25
1XSp.2	345	38.75	77.5	100	1237.5	1920	510	637.5	950	1267.5	295	450	86.25	381.25	36.25	177.5	3956.33	3956.33	918.83	1540
2XSp.1	57.87	125.25	11.12	26.73	132.8	657.18	47.73	112.53	101.54	382.02	21.66	74.25	0	167.3	0	21.57	1277.75	1277.75	80.52	235.09
2XSp.2	125.36	142.55	22.77	27.28	289.78	302.18	92.25	295.46	306.68	594.95	114.83	216.88	0	288.65	0	31.8	2158.25	2158.25	229.85	571.43

Cont. Table 4.

Treatments	Leaves weight (gm)				Stem weight (gm)				Root weight (gm)				Fruits weight (gm)				Total weight (gm)			
	Fresh w.		Dry w.		Fresh w.		Dry w.		Fresh w.		Dry w.		Fresh w.		Dry w.		Fresh w.		Dry w.	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
F.test	*	*	N.S	*	N.S	**	N.S	**	N.S	N.S	**	**	**	N.S	**	*	N.S	N.S	N.S	*
L.S.D 5%	46.03	67.04	—	17.04	—	278.2	—	25.76	—	—	38.585	38.585	8.151	—	3.49	80.64	—	—	—	296.42
Sh.1XSp. 1	194.67	303.85	38.37	75.26	570.25	858.35	237.2	236.83	347.3	352.35	110.26	120.81	0	13.1	0	11.7	1527.65	1527.65	385.83	444.61
Sh.1XSp. 2	261.96	382.03	49.89	86.1	525.35	1094.16	209.45	380.96	348.93	511.7	122.45	154.68	0	25.95	0	20.78	2013.85	2013.85	381.8	642.53
Sh.2XSp. 1	73.2	93.9	20.25	22.72	485.05	912.08	208.03	253.2	571.7	718.17	241.4	243.43	57.5	226.7	12.5	52.37	1950.85	1950.85	482.18	553.72
Sh.2XSp. 2	208.4	148.01	50.37	41.18	1001.93	1128.01	392.8	552	907.75	1350.75	287.37	512.2	86.25	643.95	36.25	188.51	4100.73	4100.73	766.88	1468.9
F.test	*	N.S	N.S	N.S	**	N.S	**	**	**	*	N.S	N.S	**	**	**	*	**	**	**	**
L.S.D 5%	46.03	—	—	—	136.156	—	57.194	25.76	75.424	329.67	—	—	8.15	185.29	3.49	80.64	793.35	793.35	296.42	296.42
Reg.1XSh.1XSp.1	320	515	65	130	1030	1425	430	410	610	560	195	205	0	10	0	10	1960	2510	690	755
Reg.1XSh.1XSp.2	420	615	85	145	885	1720	370	610	600	805	220	235	0	50	0	40	1905	3190	675	1030
Reg.1XSh.2XSp.1	100	30	30	12.51	815	801.5	365	345	1025	925	465	375	115	135	25	75	2055	1891.5	885	771.5
Reg.1XSh.2XSp.2	270	160	70	55	1590	2120	650	665	1300	1730	370	665	172.5	712.5	72.5	315	3332.5	4722.667	1162.66	2050
Reg.2XSh.1XSp.1	69.35	92.7	11.75	20.53	110.5	291.7	44.4	63.66	84.6	144.7	25.52	36.63	0	16.2	0	13.4	264.45	545.3	81.67	134.23
Reg.2XSh.1XSp.2	103.93	149.06	14.79	27.2	165.7	468.33	48.9	151.93	97.866	218.4	24.91	74.36	0	1.9	0	1.56	367.5	837.7	88.61	255.06
Reg.2XSh.2XSp.1	46.4	157.8	10.5	32.93	155.1	1022.66	51.06	161.4	118.4	511.35	17.8	111.86	0	318.4	0	29.75	319.9	2010.2	79.36	335.95
Reg.2XSh.2XSp.2	146.8	136.03	30.75	27.36	413.86	136.03	135.6	439	515.5	971.5	204.75	359.4	0	575.4	0	62.03	1076.16	3478.8	371.1	887.8
F.test	N.S	N.S	N.S	N.S	**	**	**	**	N.S	N.S	**	N.S	**	N.S	**	N.S	N.S	N.S	N.S	N.S
L.S.D 5%	—	—	—	—	192.55	393.43	80.88	36.44	—	—	54.568	—	11.52	—	4.94	—	—	—	—	—

** Highly significant * Significant NS- Non significant

Regions: Reg. 1: Ismailia Reg. 2: Alexandria **Shrubs species:** Sh. 1: *Jatropha curcas* Sh. 2: *Moranga oleifera* **Plant spacing:** Sp. 1: 0.5m*0.5m Sp. 2: 1m*1m

Table 5. The total yield of fruit, seed and oil (kg ha^{-1}) of *Jatropha curcas* and *Moringa oleifera* and the percentage of fruiting shrubs (%) for all treatments at 2014 and 2015

Regions	Treatments		Fruits (kg ha^{-1})		Seeds (kg ha^{-1})		Oil (kg ha^{-1})		The percentage of fruiting shrubs (%)	
	Shrubs species	**Plant spacing**	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
Ismailia	*Jatropha curcas*	0.5m * 0.5m	0	191	0	105	0	13.37	0	43
		1m * 1m	0	169	0	93	0	12	0	77
	Moringa oleifera	0.5m * 0.5m	1821	2111	536	621	70	82	53	60
		1m * 1m	544	829	160	244	21	32	53	60
Alexandria	*Jatropha curcas*	0.5m * 0.5m	0	145	0	80	0	14	0	43
		1m * 1m	0	0	0	0	0	0	0	0
	Moringa oleifera	0.5m * 0.5m	0	1182	0	304	0	28	0	40
		1m * 1m	0	552	0	142	0	13	0	60

It was clear that Moringa was start give fruits at 2014 in Ismailia region with the two plant spacing. While, Jatropha start give fruits at 2015 in the two regions.

Although, Jatropha did not gave fruits with wide spacing in Alexandia region. But, Jatropha had the optimal fruiting shrubs percentage (77%) in Ismailia with wide spacing, followed by Moranga in the two region which it gave (60%) of fruiting shrubs percentage with wide spacing (Table, 5). The wider plant spacing of 1m * 1m exhibits minimum competition for growth factors therefore, did not affect the performance of individual plants (Amaglo *et al.,* 2006). In addition, the ideal ecological characters for fast fruiting and the percentage of fruiting shrubs.

CONCLUSION

The experiment was conducted at two regions, two species and two plant spacing, results showed that Ismailia region had higher values for most of the growth parameters and the yield; therefore, it is ideal for planting and survival of Jatropha and Moringa. It was clear that, *Moringa oleifera* had a high growth parameters and yield as compared with *Jatropha curcas*. On the other side, closer plant spacing (0.5m* 0.5m), produced plants with greater height, fruits, seeds and oil yield, while wider plant spacing (1m* 1m), gave plants with bigger stem diameter, biomass and fruiting shrubs percentage. However, *Jatropha curcas* gave the highest oil percentage in Alexandria region with narrow spacing only, but it gave the superior fruiting shrubs percentage and fruits yield in Ismailia region with narrow and wide spacing.

So, Ismailia region is recommended for planting Jatropha and Moringa to gives better growth, high production and oil percentage.

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الملخص العربي

تقيم لشتلات الجتروفا والمورنجا المنزرعة فى نطاقين بيئين مختلفين على مسافات زراعة مختلفة

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الجاتروفا كركس شجيرة متعددة الأغراض، تزرع فـى الأراضى المهمشة ولها أهمية كبيرة فـى أنتـاج الوقـود الحيوى. المورنجا أوليفيرا شجيرة عالية القيمـة الغذائيـة والطبية معا. لذا أجريت التجربة الحقلية فـى الأسـماعيلية والأسكندرية والتى تقعان شرق وغرب مصر على التوالى. حيث تم زراعة الجاتروفا والمورنجا منذ بداية مايو ٢٠١٣ حتى أكتوبر ٢٠١٥ بتلك النطاقيين البيئين المختلفين وعلـى مسافتيين للزراعـة(٠,٥*٠,٥ متـر)،(١*١ متـر) لتقـيم الأنتاجية.

أظهرت النتائج أختلافات معنوية عالية لمعظم مقـاييس النمو للجاتروفا والمورنجا بمنطقـة الأسـماعيلية مقارنـة بمنطقة الأسكندرية. حيث أنه من الواضـح أن محـصول الثمار والبذور والزيت(بالكجم/ هكتار) للمورنجا أزدادت فى عام ٢٠١٥ مقارنة بعام ٢٠١٤ . بينما الجاتروفا بدأت فـى الأثمار فى عام ٢٠١٥ فى كلى المنطقتين غير أنها لم تنتج ثمار فى المسافات الواسعة بالأسكندرية. النتائج أظهـرت أيضا أن أعلى قيم فى محصول الثمار والبـذور والزيـت (٢١١١، ٦٢١، ٨٢ كجم/ هكتار على التوالى) للمورنجـا للمسافات (٠,٥*٠,٥ متر) فى منطقة الأسـماعيلية. بينمـا كانت أقل قيم لمحصول الثمار والبـذور والزيـت (٥٥٢، ١٤٢، ١٣ كجم/ هكتار على التوالى) للمسافات (١*١ متر) فى منطقة الأسكندرية. أيضا أعلى قيم لمحـصول الثمـار والبذور لشجيرات الجاتروفا كان (١٩١، ١٠٥ كجم/ هكتار على التوالى) فى منطقة الأسماعيلية بينما أعلى قيمة للنسبة المئوية للزيـت المعـصور كانـت 17.23% لـشجيرات الجتروفا النامية فى منطقة الأسـكندرية علـى المـسافات الضيقة تليها منطقة الأسماعيلية.

لذا يمكن أستنتاج أن منطقة الأسماعيلية أكثـر ملائمـة لزراعة الجاتروفا والمورنجا خاصة على المسافات الضيقة لتعطى أعلى محصول للثمـار والبـذور والزيـت ولكـن الأسكندرية أعطت أعلى نـسبة زيـت بالبـذور خاصـة المنزرعة على المسافات الضيقة.