International Journal of Agriculture Innovations and Research
Volume 3, Issue 5, ISSN (Online) 2319-1473
Manuscript Processing Details (dd/mm/yyyy) :
Received : 08/02/2015 | Accepted on : 17/02/2015 | Published : 07/03/2015

Study of Safflower (Carthamus Tinctorius L.) Cultivation Under the Jordanian (Mediterranean) Conditions

Dr. Talal Thalji and Dr. Bassam Alqarallah
Horticulture and crop science department, Faculty of Agriculture University of Jordan, Amman -Jordan.
Corresponding Author email: tthalji@yahoo.com

Abstract: **In Jordan, increased cropping intensity imposes a need for diversity to manage the economic risks. Safflower (*Carthamus tinctorius* L.) has been a minor crop in Jordan for many years. An experiment was undertaken to identify the proper variety of cultivating different varieties of safflowers under the Jordanian conditions using four replicates for each treatment for the two local and two imported varieties (Sirothora and Sironaria),The other two were local (Rajeb 1 and Ajlun 1 were considered in biomass weight; number of branches per plant; plant height; number of flower heads per plant; seed numbers per flower; seed yield per plant;harvesting index rate. of seeds to the weight of plants and seed production rate for square meter. there is highly significant differences between dates and the height of the plant (p<0001) for the four varieties under Jordan conditions. Results revealed that local variety Rajeb 1 got the highest result for the total biomass, highest plant , no of flowers and the number of seeds for the planting date 4 i.e. February.**

Keywords: **Safflower, Jordan, Sirothora, Sironaria, Rajeb, Ajlun 1.**

1. INTRODUCTION

Safflower (*Carthamus tinctorius* L.) is considered one of the oldest and important crops for producing oil. It is drought tolerant crop and can grow successfully inmild climate conditions[1]. The crop's seeds need a warm climate to get ripe and reedy. Safflower crop is considered one of the main sources for producingoil for consumption all around the world [2]; mainly in the USA and Germany [3]. The main purpose of growing safflower crop in many countries around the world is fro producing high quality oil reliable for human consumption. The percentage of the oil in the safflower seeds is ranging between 14.8% - 25.9% [4]. The safflower oil contains high percentage of unsaturated oils such as lilolik and lolik acids [5]. In addition a red coloring with (Carthamin) can be produced from its flowersto be used for beauty productions. Moreover the petals can be used as a natural coloring for human food and clothes, they are also contained (Saffranin) which can be used for medicine production and food reservation. The by product which remains after producing oil from the seeds it is very nutritional as an animal and birds feedings, it contains about 25% protein and carbohydrate as a source for energy[6]. The crop can be used as hay and/or silage for feeding cows and for producing bibful.

Simplicity and lack of agricultural tasks requirements in addition to iscorynebacterium roots safflower crop took an important place in the agricultural rotation [7], [8]. The crop is very similar to the feeding legumes and corns [9].Moisture and temperature are the most important factors affecting crop production. Under arid and semiarid Mediterranean conditions prevailing in Karaj, weather condition is favorable during vegetative growth so that high oil yield, oil content, protein yield and linoleic content could be achieved [10].Istanbulluoglu et al. [11] reported that the highest yield was observed in the fully irrigated control, and the highest total water use efficiency was obtained in the treatment irrigated only at the vegetative stage, while the lowest value was observed when the crop was irrigated only at the yield stage. Biological fertilizer (Biosulfur) accelerates oxidation of granular organic sulphur, changing the pH of the soil and providing ideal conditions for different plants to uptake micro and macro nutrients in calcareous and alkaline soils. Ashrafi and Razmjoo reported that a proper irrigation regime throughout the life of the plant may cause small reduction in the total oil content, but it dramatically increases the quality of the oil composition of safflower seeds [12].Safflower can also be grown successfully on soil with poor fertility and in areas with relatively low temperatures [13].

The objectives of this study are to determine the proper variety and the appropriate date for planting and to determine the effect of the planting date on: Biomass weight; number of branches per plant; plant height; number of the flower heads per plant; seed numbers per flower; seed yield per plant;harvesting index rate of seeds to the weight of plants and seed production rate per square meter.

2. MATERIALS AND METHODS

Two experiments were conducted in two different locations, during the 2009/2010 and2010/2011 growing seasons, prospectively; one was conducted on farmer's field in village Rajeb, District Ajlun, north of Jordan Capital, Amman, and the second trail was conducted on the Jordan University premises in Amman.

Four varieties cultivars were used in this trail, two were from Australia (Sirothora and Sironaria), the other two were local (Rajeb 1 and Ajlun 1). A split-plot design was applied for this trial, with three sequences for each treatment. Four planting dates were designated for the treatment on the two locations as follow 1, 2, 3 and 4 as November, December, January and February, respectively, the first after the rain fall on 3/11/2009 and 5/11/2010; the

second on1/12/2009 and 4/12/2010; the third on 2/1/2010 and 5/1/2011; and the fourth date on 3/2/2010 and 4/2/2011.The main plot area was 8x8 meters and subplots within the main plot 2x2metres. The subplots and the rows within were randomly selected for the treatments, four treatments with four replicates for each treatment for the two local and two imported varieties. During the harvesting task a half meter was left as boarder effect to be avoided. A weekly visit was made to monitor the treatments and to collect needed data for the height of the plants, number of branches, number of flower heads and seed numbers per flower. After harvesting, the biomass weight, seed yield per plant, harvesting index and seeds production per square meter were calculated. Microsoft Excel was used to calculate the statistical average for the row data collected for the above mentioned variables for the four varieties during the two Seasons. A SAS software vergin 9.0 was used for analyzing calculated statistical data "Table 1".

Table 1: Univariate Analysis of Variance, Tests of between-Subjects Effects, Dependent Variable: wt

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	2.129E6	6	354901.7	37.36	.000
Intercept	5.833E7	1	5.833E7	6141	.000
rep	124797.7	3	41599.2	4.38	.007
date	2004612.9	3	668204.3	70.34	.000
Error	693380.6	73	9498.3		
Total	6.115E7	80			
Corrected Total	2822791.2	79			

a. R^2 = .754 (Adjusted R^2 = 0.734)

3. Safflower Seed Separation Techniques

A power thresher consists of a feeding chute, fully enclosed threshing cylinder with 36 studs bitter provided with winnowing blower for cleaning of seeds grains; powers transferred by mean of V-belt type "Table 2". In order to prevent cracking of the seed, the combine with 22- inch cylinder set at peripheral speed at 500 rpm with a concave clearance 5/8 inch at the front and 1/2 inch at the back. An oscillating sieve oscillated by spring shock up without any extra vibration with double screen are provided for cleaning grain in order to avoid machine clogging, fixed screen at bottom & removable screen were used in separation. Arrangement for draw bar and axle are provided for easy transportation. Grain spout made as galvanized metal sheet. Safety guards provided on transmission system were used After the most of the leaves have turned brown and the flower bracts show a green tint. Stems were dried and seeds were rub free of the least mature heads. The seed should have a moisture content of 8 percent or less for safe storage. Safflower is harvested with a small-grain combine. To prevent cracking of the seed, the combine cylinder should not exceed a peripheral speed of 3,000 feet per minute. This will be about 500 rpm for a 22-inch cylinder. The suggested concave clearance is 5/8 inch at the front and 1/2 inch at the back. Shaker speeds greater than those used for small grains are required to keep the machine from clogging. Shattering is not usually a problem, but safflower should be harvested when it is mature to minimize sprouting in the heads if a fall rain occurs. Bird damage to mature standing fields has not been a problem. Safflowers were harvested through a thresher which consists of a feeding chute, fully enclosed threshing cylinder with 36 studs bitter.

Table 2: Safflower power thresherspecifications

Type	spike tooth
Feeding system	Hoper
Concave	interchangeable for different crop types
Flywheel	single
Winnowing blower	available
Aspiratory Blower	available
Cylinder	fully enclosed with 36 studs bitter
RPM	750
Drive	V-belt
Length (mm)	1520
Breadth (mm)	1120
Height (mm)	1700
Weight (kg)	350
Safely guard	available

Oscillating sieve with double screening arrangement, a fixed top concave & interchangeable bottom concave (for different crop types), blower for winnowing & heavy fly wheel. All these are mounted on heavy & attractive steel frame chassis. Our thresher is perfect for multi-crop threshing, easy, smooth & simple operation, winnowing blower provided for cleaning of seeds grains. Oscillating sieve oscillated by spring shock up without any extra vibration. Double screen are provided for cleaning grain, fixed screen at bottom & removable screen provided for different types of seeds. Arrangement for draw bar and axle are provided for easy transportation. Grain spout made as galvanized metal sheet. Safety guards provided ontransmission system.

4. Results and Discussion

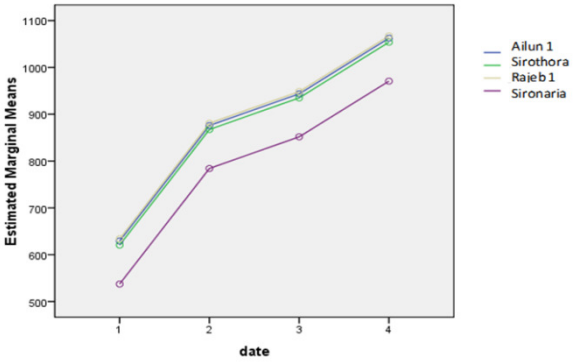
"Fig. 1" shows the means of total biomass weight of plant for Safflower varieties in gm for the local varieties i.e. Rajeb 1 and Ajlun 1 had the biggest weight comparing with the other introduced verities (Sirothora and Sironaria); under four different dates as Rajeb 1 variety for the 4th planting date i.e. February. there is highly significant differences between different dates 1, 2, 3 and 4 as November, December, January and February, respectively and the weight of the plant ($p<0.001$), Student Newman Kulles was applied to test the difference between each date, the weight of the plant increases significantly by date means for date 4 (1038.55±93.37), for date 3 919.70(161.61), for date 2 852.05(63.01), and for date 1 as 605.30(59.10). which is considered the best date for Safflower cultivation the reason is that in this date the weeds were eliminated through tillage and availability of water requirement. "Fig.2" shows that the means for Safflower varieties height in cm under four different dates; it reveals that same local varieties i.e Rajeb 1 had the

International Journal of Agriculture Innovations and Research
Volume 3, Issue 5, ISSN (Online) 2319-1473

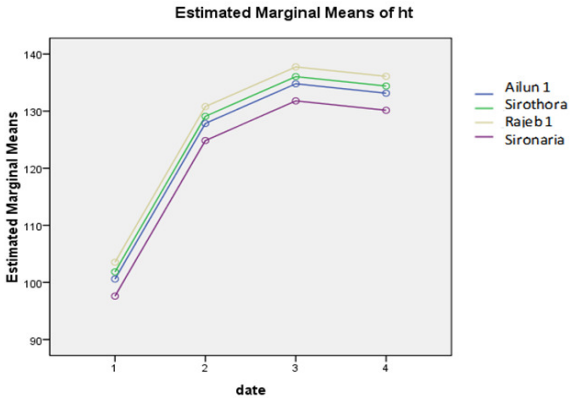
highest growing height around 137 cm under the planting dates 3 and 4 i.e. January and February respectively ; compared with the other varieties ; There is highly significant differences between dates and the height of the plant for Rajeb 1 ($p<0.001$), Student Newman Kulles was applied to test the difference between each date according to means of plant height it is significantly for date 4 (133.45±7.93) and date 3 (135.10±6.94) than date two means (128.15±7.97) and date one (100.90±6.66). "Fig.3" shows that Rajeb 1 got the most numbers of flowers around 22 flowers under the planting date 3 and 4 i.e. January and February respectively.

As There is highly significant differences between dates and the plant number of flowers ($p<0.001$) for the Safflower varieties, Student Newman Kulles was applied to test the difference between each date according to means of number of flowers; it is significantly higher for all date 4 (21.45±1.76) and date 3 (21.65±1.98) than date two means (20.70±2.25) compared with first date (11.75±1.33).

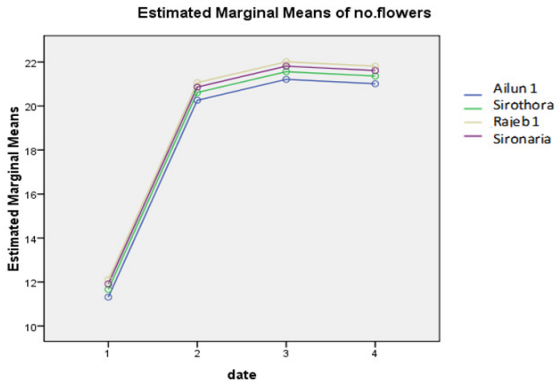
While the most teller numbers belong to Sironaria variety under the planting date 3 i.e. January as shown in "Fig.4". As There is highly significant differences between dates and the plant number of tellers ($p<0.001$) for the Safflower varieties, Student Newman Kulles was applied to test the difference between each date according to means of number of tellers; it is significantly higher for the planting date 3 (11.00±0.35) and planting date 2 (11.00±0.19) than date 4 means (10.21±0.05) compared with first date (6.01±0.14); as Increase in planting density increased number of branches per square meter, but reduced number of heads per branch and per plant, seed yield per plant and harvest index [14] . "Fig.5"shows the number of seeds per one plant for Safflower varieties under 4 different planting date ; it revealed that local safflower variety Rajeb 1 and introduced Safflower variety Sironaria got the most seed numbers per plant under the planting date 4 i.e. February. As there is highly significant differences between dates and the number of seeds ($p<0.001$), Student Newman Kulles was applied to test the difference between each date according to means of number of seeds shows that number of seeds are significantly higher for all date 4 (46.10±3.34) and date 3(45.90±4.29) than date two means (44.70±6.09) and date one (24.30±3.50).



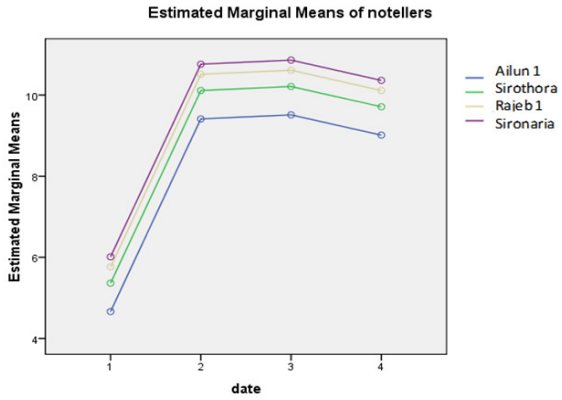
"Fig. 1": Estimated Marginal Means of weights in gm per square meter for Safflower under 4 different cultivation dates.



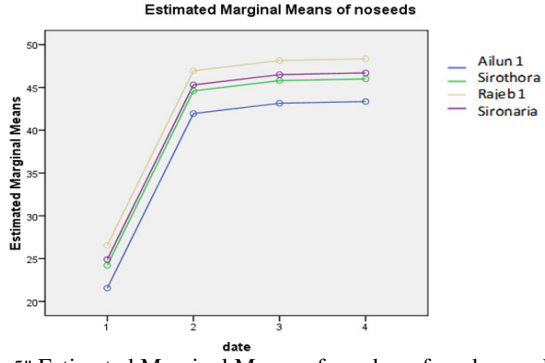
"Fig. 2": Estimated Marginal Means of heights (cm)for Safflower under 4 different cultivation dates.



"Fig. 3": Estimated Marginal Means of number offlowers for Safflower under 4 different cultivation dates.



"Fig. 4":Estimated Marginal Means of number of tellers for Safflower under 4 different cultivation dates.



"Fig. 5":Estimated Marginal Means of number of seeds per plant for Safflower varietiesunder 4 different cultivation dates

5. CONCLUSIONS

Different Safflowers varieties were cultivated according to Jordan conditions; varieties were as follow local varieties i.e. Rajeb 1 and Ajlun 1, while the introduced varieties were Sironaria and Sirothora under 1, 2,3 and 4 different planted dates i.e. November , December , January and February respectively. The experiment data shows that Rajeb 1 as local variety got the best results for total biomass weight; means of height; number of flowers , number of tellers and number of seeds; as shown in "Fig. 1, 2, 3 and 5". For safflower harvesting, ordinary grain combine are quite suitable for harvesting safflower, provided certain basic differences between the crops are appreciated. Safflower provided certain basic differences between the crops are appreciated. Safflower cannot be threshed as fast as wheat or barely, and both the forward speed of the machine and the threshing speed of the cylinder must be reduced. Speed of working willdepend on weather the crop is being harvested, for oil or seed. Combine, with spike-tooth, single bar cylinders are all satisfactory for Safflower harvesting.

ACKNOWLEDGEMENT

Authors would like to express their indeed thankful for the university of Jordan i.e. Deanship of Academic research for supporting and funding this research study.

REFERENCES

[1]. Arnon, I., "*Crop Production in Dry Areas*", Systematic Treatment of the Principal Crops. vol. II: Leonard Hill, London. 1972.
[2]. Kaffka, S.R., T.E. Kearney, P.D. 2001. Knowles and M.D. Miller. Safflower production in California.[Online]. Available: http://agric. ucdavis.edu/crop/oilseed/saff2oil.htm.
[3]. Robbelen, G., Development of new industrial oil crops. Fat Sci. Technol. 1987.vol.89:pp.563-570.
[4]. Elfadl, E.Y., Reinbrecht, C., Frick, C., von Witzke-Ehbrecht, S., Rudolphi, S.,Claupein, W., Genotype by environment interaction in safflower (*Carthamus tinctorius* L.) grown under organic farming system in Central Europe. In: Esendal, E. (Ed.), Proceedings of the 6th International Safflower Conference, Istanbul, Turkey, June 6-10. 2005. pp.: 39-43.
[5]. Velasco, L., Fernandez-Martinez, J.M., Progress in breeding modified to copherol content and composition in safflower. Sesame Safflower Newsletter. 2002. vol.17, pp.98-101.
[6]. Hume, D.E., Lyons, T.B., Hay, R.J.M., Evaluation of Grasslands Punachickory (*Cichoriumintybus*L.) in various grass mixtures under sheep grazing. N.Z. J. Agric. 1995. vol. 38,pp. 317–328.
[7]. Francois, L.E., Berstein, L., Salt tolerance of safflower. Agron.1964.J. 56,pp. 38-40.
[8]. Bassil, E.S. and Kaffka, S.R. Response of safflower (*Charthamus tinctorius* L.) to saline soils and irrigation II. Crop response to salinity.Agricultural Water Management.2002. vol.54: pp.81-92.
[9]. Vonghia, G., Pinto, F., Ciruzzi, B., Montemurro, O., ''In vivo'' digestibility and nutritive value of safflower utilized as fodder crop cultivated in Southern Italy. In: Guessous, F., Kabbali, A., Narjisse, H. (Eds.), Livestock in the Mediterranean Cereal Production Systems. PUDOC, Wageningen. 1992. pp. 127-129.
[10]. Mirshekari, M., Majnounhosseini, N., Amiri, R., Moslehi, A., Zandvakili, O., R., Effects of Sowing Date and Irrigation Treatment on Safflower Seed Quality. J. Agr. Sci. Tech. 2013 vol. 15: 505-515
[11]. Istanbulluoglu A., Gocmen E., Gezer E., Pasa C., and Konukcu F., Effects of water stress at different development stages on yield and water productivity of winter and summer safflower (Carthamustinctorius L.). Agric. Water Manag., 2009. vol.96, pp.1429-1434.
[12]. Ashrafi E. and Razmjoo K., Effect of irrigation regimes on oil content and composition of safflower (Carthamustinctorius L.) cultivars. J. Am. Oil Chem Soc., 2010.vol. 87,pp. 499-506.
[13]. Koutroubas, S.D., Papadoska, D.K., 2005. Adaptation, grain yield and oil content of safflower in Greece. VIth International Safflower Conference, Istanbul. 6-10 June 2005, pp.161-167.
[14]. Azari, A. and Khajehpour, M.R. Effects of Planting Pattern on Growth,Development, Yield Components and Seed Yield of Safflower, Local Variety of Isfahan, Koseh, in Spring Planting. Journal of Science and Technology of Agricultural and Natural Resources. 2005.vol. 7(1): pp.167-155.

AUTHOR'S PROFILE

Dr. Talal Thalji born in Jordan 1949, faculty members at University of Jordan - Faculty of Agriculture/ Department of horticure and crop science.
email: tthalji@yahoo.com

Dr. Bassam Qarallah born in Jordan is faculty members at University of Jordan - Faculty of Agriculture/ Department of horticure and crop science.