Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Vol 2 (8) July 2013: 41-47

Online ISSN 2277-1808
Journal's URL:http://www.bepls.com

ORIGINAL ARTICLE

Safflower Different Varieties Grouping Under Non-Stress and Moisture Stress Conditions

Younes Rameshknia, Tahmasebpoor Behnam* , Elnaz Sabbagh Tazeh
Higher Educational Institute of Rab-Rashid, Tabriz, Iran.
Department of Agronomy and Plant breeding ,Faculty of Agricultural Engineering and Technology , Collage of Agriculture and Natural resources, University of Tabriz , Tabriz , Islamic republic or Iran .
Islamic Azad University ,Tabriz Branch, Iran

ABSTRACT
Due to the growing demand for edible oils, oilseed crop development is very important. Safflower (Carthamus tinctorius L) is a native of Iran oil seed. This crop is compatible with the environmental conditions in the country as well; this is especially true in areas exposed to non-biological stresses such as drought and salinity. Since the recognition of stress-resistant varieties and grouping them is important for correct planning in plant breeding programs, this study was conducted in order to grouping safflower varieties in three irrigation regimes of stress (six and five irrigation, respectively) and free stress (seven irrigation) conditions. This research was in split- plot form with completely random block designs about 26 varieties of safflower. The safflower varieties were grouped in 7 clusters according to the studied traits via cluster analysis and Ward method. The sixth cluster was consisted of N51016, the most dwarf variety with shorter vegetative and reproductive duration. In this research, the traits like the grain number per boll, 1000 grain weight, oil content and the plant yield were evaluated more than the variety mean. In stress conditions, Zaragan local IV and Mianeh local I were the most sensitive varieties regarding the stress tolerance (STI). Finally, among 26 varieties of spring safflower, N51016 was the most tolerant item to the water stress. Also, it had the most plant performance. The cluster analysis results showed that there is adequate genetic diversity for the studied traits and we can use these diversities for the improvement and correction of spring safflower genotypes.
Key words: *safflower, drought stress, stress tolerance index, cluster analysis*

Received 09/05/2013 Accepted 24/06/2013

INTRODUCTION

The major portion of the oil supply is from external sources and regarding the growth of population and per capita consumption of oil in the country, increasing the area under cultivation and production of oilseeds is of utmost importance. Safflower is a versatile traditional plant and is cultivated as a pigment from long ago [22,24]. But nowadays is cultivated more as an oilseed crop that contains 25-45% oil and 12-24% proteins. Based on genotype, safflower has two different kinds of oil with different quality. Some genotypes with high linoleic acid oils have cooking or industrial usage and can be used in the production of soft margarine. Some genotypes oil is consisted of very high oleic acid and is the same as olive oil and thus they show a very high nutrient quality [20,22]. Safflower is compatible with the environmental conditions in the country as well; this is especially true in areas exposed to non-biological stresses such as drought and salinity. Because of the high adaptability to stress, relative resistance to drought, cold and salinity and low fertilizer requirement is planted in most countries [2,8]. Survey conducted on some oilseed crops (soybean, canola, safflower and sunflower) showed more capacity and more effective crop roots of safflower to penetrate the soil and water extraction from lower soil [14]. Conducted experiments have shown that to obtain good performance, 400 mm water and for maximum yield, 600 mm water is needed [8]. Sundge et.al [21] showed that the timing of irrigation based on principles of phonological development is more beneficial than timing based on evaporation and transpiration. According to Zaman [24] the most critical period for safflower irrigation is aggregation and flowering. The common error of the water safflower is the earlier final irrigation. In the final stages of development, when soil moisture is not large, the product decreases and despite the normal appearance the grain may be null [8]. Haby et.al [10] announced that in safflower like other agricultural crops, the effect of water stress on grain yield and plant life in the early reproductive growth stages is more than the others. The survey that Chinese Academy of Science conducted on 2625 populations from 28 countries verified that the height of the bush in the foot changed in the range of the 13 to 251 cm and the tallest bush was from Iran and the shortest

one from India [11]. Yazdi Samadi and Abde Mishani [23] studied 1858 Iranian and foreign lines in irrigation free condition in Karaj announced that the plant height is so changeable and its changing range is from 20 to 90 cm. Also they found out that Iranian lines are the shortest samples.

Yazdi Samadi and Abde Mishani [23] investigated the Iranian and foreign lines under irrigation free conditions in Karaj and found out that the oil content changes from 16% to 40%. Also, Iranian lines have high oil content. They conducted another experiment under drought stress and reported that Varamin line with one irrigation produce good crop under drought stress comparing to irrigation free conditions.

Abel [1] showed the significance reduction of the grain yield with the irrigation after 90% discharge but when there was 60 – 70% moisture discharge, the irrigation had no much effect on the yield. Hang and Ivans [12]) investigated the irrigation effects on the grain yield in 2 years and announced that in these two years, the irrigation increases the grain yield.

Omidi Tabrizi, et al [16] investigated the winter safflower varieties and lines and concluded that there is a significant difference between the studied varieties and lines regarding the grain yield and the oil. The results of the evaluation of top seed and oil yield of safflower varieties and lines of winter in Karaj, Isfahan and Fars showed L.R.V51/51 was the superior genotype with high environmental adaption in all conditions regarding the grain yield and oil [16]. Ehdaei and Noor Mohammadi [5] investigated Nebraska 10 and Arak local 28110 and found a positive and significant correlation between the grain yield with the grain number per head, 1000 grain weight and the grain oil content. Omidi Tabrizi, et al [15] investigates spring safflower 100 varieties and found a significant difference between them regarding the yield and yield components. Gajendra [9] conducted an experiment in Delhi on the winter safflowers and announced that the most yields among the irrigation levels was about the irrigation in two stages of the Rosette and flowering ending. Behalra, et al [3] tested the irrigation treatments including irrigation free condition and different postures of the irrigation in the stages of rosette, branching, flowering and the grain development on the behima variety and announced that the irrigation in four stages of rosette, branching, flowering and the grain development increase the grain yield to 71/4%, but an irrigation in the grain stage increases it to 5/3%. Pawar et al [18] investigated the effect of irrigation timing program on the safflower varieties yield and announced that 3 irrigations in the time of planting, branching and flowering make the achievement of 1/64 tons per hectare and 2 irrigations in the stages of planting and branching, respectively results in 1/24 and 1/49 tons per hectare. Yield stability in dryad and irrigation safflower was studied by Patil, et al [17]. They announced that the genotype differences and its interaction in the environment are significant regarding the grain yield. They reported that SSF21 is the most tolerant genotype in the variable environmental conditions; Bhima and JLSF88 are the most desired genotypes for the favorable and irrigated circumstances and JISF19A and NRS209 are the best genotypes for the favorable circumstances.

One of the critical issues in evaluating cultivars for drought resistance is a quantitative measurement criterion of these varieties [4]. In semi-arid areas where rainfall distribution is not appropriate, high yield stress is not considered the best measure of drought resistance but yield stability (compared to normal and stressful conditions yield) is considered as a better indicator of genotype response to stress [20]. Rozveil and Humblein [19] introduced tolerance index (TOL) and mean productivity (MP). The high TOL shows the relative high sensitivity of the genotype to the stress. Fisher and Morrer [7] offered stress susceptibility (SSI). The low SSI shows the little changes of a genotype yield in favored and stress conditions with the most tolerance to the stress. Fernandez [6] offered stress tolerance index (STI). The more tolerant genotypes according to this index have higher STI. He offered another index: geometric mean productivity (GMP) that is the geometric yield mean of a genotype in favored and stress conditions. This index has a very high correlation with STI [6].

This experiment was conducted to select the superior varieties regarding studied different traits under the drought stress and to group the varieties according to the measured traits.

METHODS AND MATERIALS

This experiment was conducted in Azerbaijan-e-Shargi Agricultural and investigation centre as spring, in 1379. The area is located at an altitude of 1350 meters above sea level. In this study 26 spring varieties of safflower were investigated in split- plot form with completely random block designs: . ،MIAEL.1 ، MARAND L.1 ،MIANE L.2 ،MARAND L.2 ،MARAND L.3 ،LANGARMAHAN L. ،ZARGHAN L.2 ،ZARGHAN L.3 ، ZARGHAN L.4 ،ZARAND.KERMAN 1 ،ZARAND.KERMAN 2 ،KORDESTAN 2 ،ESFAHAN L. ،BROOJERD L. ، NISHABOOR L. ،N974051 ،N51016 ،V-51-242 ،NEBRASKA825 ،A-1 ،TOMJIC ،N.5 ،3151 ،24-1 و D51-361.

The preparing of the ground was done as: plow, disc, tabulation and stack atmosphere in spring and winter. All operations were performed in a mechanical way to deal with weeds and for a farm pest; the spraying was done three times. So that the first time was with Thrips, the second with Desis and the third one was with DinoKarp spraying pesticides. During the harvesting, in a3 irrigation level, seven times, a2:

six times and a1, five times irrigation had been done. Seven irrigations in a3 were: after planting, germination, the stalk rapid growth, branching, 50% budding, 50% flowering and water grain. The studied traits were: the planting days to germination, planting to stalk appearance, planting to 50% budding, planting to 50% flowering, planting to 100% flowering, the bush height, the boll number per bush, the grain number per boll, 1000 grain weight, the plant performance and oil content.

After making sure of the assumptions of analysis of variance, data were analyzed and the mean values were compared by LSD test in 1 and 5% probability. To determine the sensitivity or tolerance to drought stress tolerance index, STI was as follows:

$$STI = \frac{Y_p . Y_s}{\left(\overline{Y}_p\right)^2}$$

Yp: stress free yield

Ys: under stress yield

Yp: the mean yield of all genotypes under stress free conditions

To group the varieties regarding the measured traits, cluster analysis was done by Ward. SPSS and MSTAT-C software were used to statistical analysis.

RESULTS AND DISCUSSION

Genetic diversity of the crop has been the subject of researches in the world (13). To study the genetic diversity of cultivars for traits measured cluster analysis was performed. The same genotypes were grouped in a cluster (figure 1).

Cluster No.1: Bonab local, Marand local I, Marand local II, Mianeh local I

Cluster No.2: Zargan local II, Zargan local IV, and Neishaboor local

Cluster No.3: Mianeh local II, Isfahan local, 3151 and Marand local III

Cluster No.4: Langar Mahan local, 24-1, V-51-242, Zargan local III, Zarand Kerman I, Zarand Kerman II, N974051, Kordestan II, Booroojerd local, D51-361 and N.5

Cluster No.5: TOMJIC

Cluster No.6: N51016

Cluster No.7: Nebraska and A-1

In table 1 you can see the mean of each cluster's safflower varieties and mean deviation of the overall clusters for studied traits. In first cluster, there are varieties with more grains per boll. The second cluster composed of 3 varieties and the mean boll number was more than entire mean. The third cluster varieties had shorter growing period, longer producing period and superior boll number per bush, grain number per boll, oil percentage and the plant performance. The 11 varieties of fourth cluster showed longer growing period and shorter producing period, relatively dwarf and more 1000 grain weight more than entire mean. The fifth cluster composed of dwarf TOMJIC with longer growing period and shorter production; this variety had more mean value of boll number per bush, oil content and plant performance compared studied varieties. The sixth cluster composed of the most dwarf one: N51016 with shorter growing and production period. It had grain number per boll, 1000 grain weight, oil content and plant performance more than the entire mean value. Moreover, the number of grain per boll and the plant performance in this cluster assessed more than the others. Cluster no.7 composed of 2 dwarf verities with shorter growing and producing period and more boll number per bush, 1000 grain weight, oil content and plant performance. The most 1000 grain weight belonged to this cluster. We can consider the cluster no.6 as the best cluster regarding important and needed traits.

The genotypes investigation according to STI

This index was used to study of the varieties resistance against water stress conditions. Usually by this index are selected cultivars that are resistant to drought, but they also have a high yield. STI was configured in this experiment on a1 and a2 comparing to a3 (table2 and 2, 3 figures). In a1, N51016, TOMJIK, N974051, A-1, V-51-242 and 3151 were respectively the most tolerant genotypes to water stress and had high yield. In contrast, Mianeh local I, Zaragan local IV and N.5 were respectively the most sensitive genotypes to water stress.

In a2, N51016, Marand local III and Mianeh local II were the most tolerant genotypes to water stress and S51361, Zaragan local IV and Mianeh local I were the most sensitive genotypes to water stress. Finally, N51016 was the most tolerant variety to water stress among 26 varieties of spring safflower with high yield. Zaragan local IV and Mianeh local I was more sensitive than the others to water stress.

Table1. Clusters and their average deviation from the mean of all varieties for the traits in safflower

cluster No	trait	Germination days	Stalk days	50%budding days	50%flowering days	100% f days	Bush height	Boll per bush	Grain per boll	1000grain weight	Oil percentage	Plant yield
Cluster 1	mean	9.25	32.54	63.42	80.13	84.42	77.62	12.53	39.29	32.39	26.79	15.78
	Deviation from total mean	-0.08	1.4	3.2	2.26	1.4	7.18	-2.66	6.57	-3.2	-2.38	-1.12
Cluster2	mean	9.17	34.22	65.83	85.11	90.56	78.89	18.37	27.74	30.63	29.58	15.25
	Deviation from total mean	-0.16	3.08	5.61	7.24	7.54	8.45	3.18	-4.98	-4.96	0.41	-1.65
Cluster3	mean	9.63	30.96	59.88	79.58	84.33	75.96	17.03	33.05	32.15	29.55	17.95
	Deviation from total mean	0.30	-0.18	-0.34	1.71	1.31	5.52	1.84	0.33	-3.44	0.38	1.05
Cluster4	mean	9/14	30.39	58.49	76.08	81.53	67.15	14.77	31.84	36.01	29.05	16.07
	Deviation from total mean	-0.19	-0.75	-1.73	-1.79	-1.49	-3.29	-0.42	-0.88	0.42	-0.12	-0.20
Cluster5	mean	9.17	30.27	58.83	74.33	80.83	68.17	17.30	32.23	34.78	35.37	19.27
	Deviation from total mean	-0.16	-0.87	-1.39	-3.54	-2.19	-2.27	2.11	-0.49	-0.81	6.2	2.37
Cluster6	mean	9.83	29.33	57	72.22	77.33	56.67	9.67	49.47	43.42	29.29	20.57
	Deviation from total mean	0/50	-1.81	-3.22	-5.65	-5.69	-13.77	-5.52	16.75	7.83	0.12	3.67
Cluster7	mean	10.09	29.59	57.09	73.50	78.5	58.50	16.05	23.13	50.49	29.89	17.57
	Deviation from total mean	0.76	-1.55	-3.13	-4.37	-4.52	-11.94	0.84	-9.59	14.9	0.72	0.67

Table2. STI values for a1 and a2

No.	Varity	Level	
		a1	a2
1	Bonab local	0/713	0/879
2	Mianeh local 1	0/460	0/693
3	Marand local 1	0/782	0/799
4	Mianeh local 2	0/855	1/118
5	Marand local 2	0/935	0/885
6	Marand local 3	1/020	1/176
7	Langar Mahan	0/971	0/946
8	Zaragan local 2	0/626	0/764
9	Zaragan local 3	1/016	0/891
10	Zaragan local 4	0/483	0/671
11	Zarand Kerman 1	0/728	0/749
12	Zarand Kerman 2	0/710	0/853
13	Kordestan local 2	0/744	0/887
14	Isfahan local	0/748	1/022
15	Booroojerd local	0/811	0/746
16	Neishaboor local	0/963	0/918
17	N974051	1/135	0/995
18	V-51-242	1/078	0/873
19	N51016	1/205	1/245
20	NEBRASKA	0/761	0/826
21	A-1	1/126	1/014
22	TOMJIK	1/205	1/049
23	N.5	0/584	0/712
24	3151	1/077	0/947
25	D51-361	0/721	0/557
26	24-1	0/906	0/965

a1: the last irrigation in 50% budding
a2: the last irrigation in 50% flowering

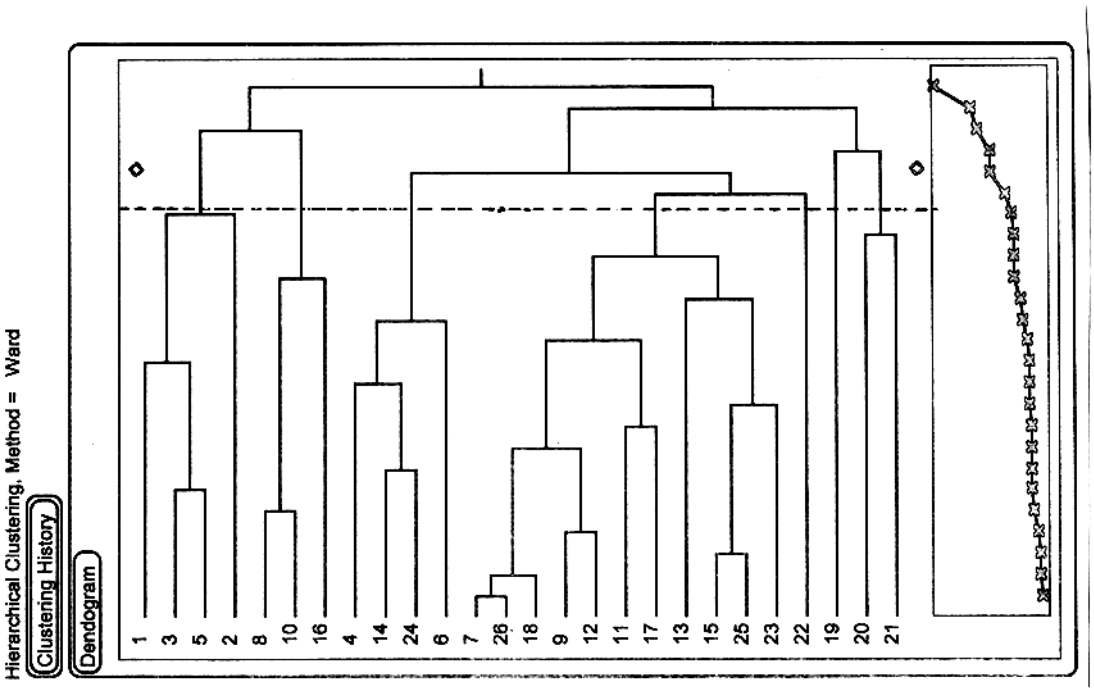

Figure1. Dendrogram of spring safflower 26 varieties cluster analysis

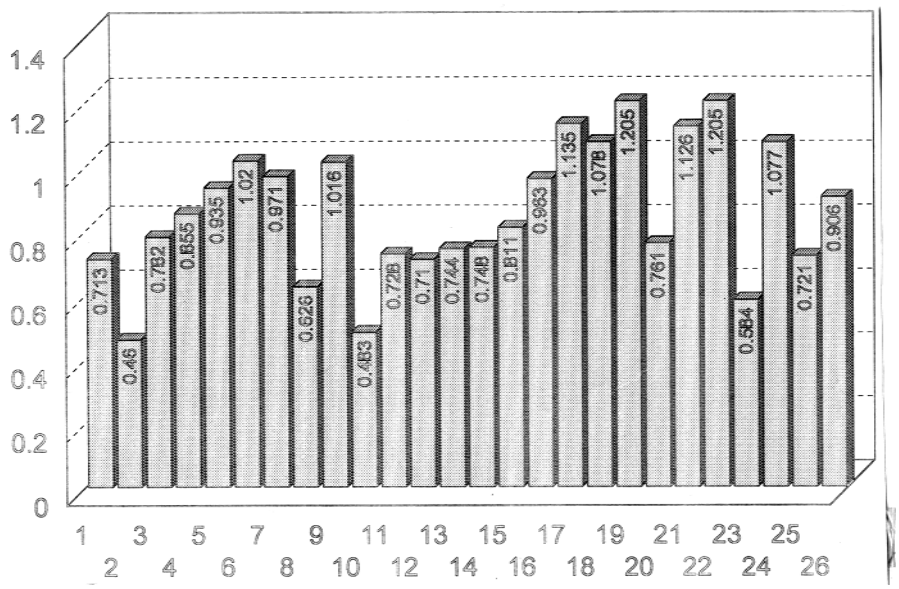

Figure2. STI coefficients in a1 level to a3 level for spring safflower 26 varieties

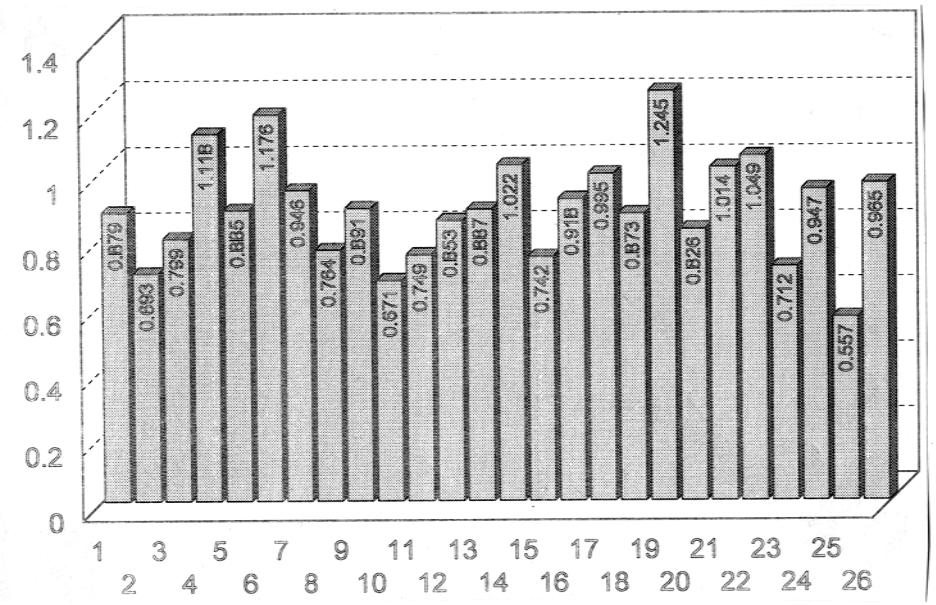

Figure3. STI coefficients in a2 to a3 for spring safflower 26 varieties

REFERENCES

1. Abel, G.H. (1976). Effects of irrigation regimes, Planting dates, nitrogen levels and row spacing on safflower cultivars. Agron. J. 68: 448-451.
2. Alyari, H., Shekari F. and Shekari F. (2000). The oil seeds, Tabriz Amidi publications.
3. Bhalerao. P.D., P.N. Jadhao, and G.R. Fulzele. 1993. Response of late-sown safflower to irrigation. Indian Journal of Agronomy, 38: 1, 150-151.
4. Clarke, J. M., Ronald, M. D., and Towenly-Smith, T.F. (1992). Evaluation of methods for quantification of drought tolerance in wheat. Crop Science, 32: 723-728.
5. Ehdaei, B. and Noor Mohammadi, G. (1984). Effect of planting date on yield and other agronomic traits of two safflower varieties, Journal of Agricultural Faculty of Agriculture, Shahid Chamran University, No. 9. Pp. 41-28.
6. Fernandez, G.C.J. (1996). Effective selection criteria for assessing plant stress tolerance. Adaptation of food crops to temperature and water stress tolerance. Proceeding of an International Symposium. Asian Vegetable Research and Development Center Tiwan. PP 257-270.
7. Fischer, R. A. and R. Maurer. (1978). Drought resistance in spring wheat cultivars. 1. Grain yield response. *Aust. J. Agric. Res*. 29: 897-912.
8. Fooroozan K. (1999). Safflower, Publishing Company oilseeds. TehranGaJendra, Giri. 1995/ Influence of irrigation and nitrogen on safflower. Indian Journal of Agronomy, 40: 2, 356-337.

9. Haby, V.A., A.L. Black, J.W.Bergman, and R.A.Larson. (1982). Nitrogen fertilizer requirements of irrigated safflower in the northern great plains. *Agron, J*. 74: 331-335.
10. Han, Yun Zhou, Yang Jianguo Zangli, Li Dajue, and Wang Zhaoma. (1993). In characterization and evaluation of safflower germplasm. Institute of Botany, *Chinese Academy of Sciences*.
11. Hang, A.N. and D.W.Evans. (1985). Deficit sprinkler irrigation of safflower and safflower. *Agron. J.* 77: 585-592.
12. Johnson, C., P. B. Ghorpade and V. L. Bradley. (2001). Evaluation of the U.S.D.A. core safflower collection for seven quantitative traits.The international safflower conference , U.S.A.
13. Merrill, S. D., D. L. Tanaka, J. M. Krupinsky and R. E. Ries. (2001). Safflower root growth and water use in omparison with other crops . Vth international safflower conference, Williston, N. D., U. S. A. 227-231.
14. Omidi Tabrizi, A.H.M.R. Gannadha, M.R. Ahmadi, V.S.A, Peigambari, .(1999). Agronomic characteristics of spring safflower varieties through multivariate statistical methods, *Journal of Agricultural Sciences*, volume 30 (4): 817-826 pages.
15. Omidi Tabrizi, A.H, M.R. Ahmadi, M.R, Shahsavari, V.S.A, Karimi, .(2000). Stability of seed yield in safflower genotypes of winter. *Seed and Plant Journal*, Vol 16 (2): pp. 145-130.
16. Patil, P.S., A.M. Patil., and A.B.Deolar. (1992). Stability of Yield in rainfed and irrigated safflower. Journal of Maharashtra. *Agric. Univ*. 17: 1, 66-69.
17. Pawar, H.K., B.R.Patil., K. K. Khade., V.D. More., G.K. Nain., and S. H. Shinde. (1987). Effect of irrigation scheduling on Yield of safflower varieties. *Journal on Oilseeds Research*, 4: 2, 162-168.
18. Rosielle, A.A., and J. Hamblin. (1981). Theoretical aspencts of selection for Yield in stress and non-stress environment. Crop Sci. 21: 943-946.
19. Simane, B., Struik, P.C., Nachit, M. M., and Peacock, J. M. (1993). Ontogenetic analysis of Yield components and yields stability of durum wheat in water-limited environments. *Euphytica*, 71: 211-219.
20. Sondge, V.D., R.P.Rodge., and S.J.Quadri. (1987). Irrigation decisions in safflower under constraint conditions. *Journal of Maharashtra Agricultural Universities,* 12: 1, 19-22.
21. Weiss, E. A. (2000).Oil Seed Crops. Blackwell Science Ltd., Oxford, London.
22. Yazdi Samadi, Bahman and Siroos Abde Mishani, (1970). Crop Breeding Center, Tehran University Press.
23. Zaman,. A. (1986). Safflower water management in drought affected region of west Bengal. Seeds end Farms, 12: 8, 6-9.

Citation of this Article
Younes Rameshknia, Tahmasebpoor Behnam, Elnaz Sabbagh Tazeh. Safflower Different Varieties Grouping Under Non-Stress and Moisture Stress Conditions. Bull. Env. Pharmacol. Life Sci., Vol 2 (8) July 2013: 41-47