



**International Journal of Biology, Pharmacy
and Allied Sciences (IJBPAS)**

'A Bridge Between Laboratory and Reader'

www.ijbpas.com

**STUDY ON DROUGHT STRESS EFFECTS IN SOME OF SOYBEAN GENOTYPES
BASED ON STRESS TOLERANCE INDEX**

ANAHITA FARAHBAKHSH

M. Sc. Student, Science and Research Branch, Islamic Azad University, Tehran, IRAN

E Mail: anahita_farahbakhsh65@yahoo.com

ABSTRACT

In order to identify the characteristics affecting the performance and determine the best index of drought resistance on the 10 soybean genotypes, an experiment based on randomized complete block design with three replications in 2014 in Iran, Gorgan, was done. In two separate experiments, the genotypes were grown without stress and drought stress. Results analysis of traits variance showed high genetic diversity among varieties. Stress causes a reduction in the majority of attributes and was the largest decline in yield trait. Evaluation in drought resistance, stress tolerance (STI), geometric mean of productivity (GMP) and mean productivity (MP) highly correlated with yield potential (Yp) and yield stress conditions (Ys), and were recognized as the best index. The results of the STI index of other indicators appear more favorable. The average grain yield of the genotypes studied in normal conditions respectively 6820 kg per hectare and stress condition was 4218 kg per hectare, which indicates that this genotype in both conditions had a higher yield than other genotypes of studied. The results of the STI index than other indicators appear more favorable. Also genotypes No. 1 (L.83-570) that has lowest STI with 0.28 with average yield in both normal conditions (5418 kg) and stress condition is respectively (1528) kg. Genotype No. 3 (L75-6114) have acceptable potential and superior in both normal and drought conditions and can be used in breeding programs to be considered as superior genotypes. Genotype No. 8 (Williams) was considered as control genotypes. Have good potential in normal conditions and potential in drought conditions is unfavorable. Therefore, this

cultivar can be as useful genetic resource for breeding proceeding with plans to produce drought tolerant genotypes is used.

Keywords: Drought stress, yield, stress tolerance, Soybean

INTRODUCTION

Basically, water is the most important factor limiting plant growth and the fact that much of an arid and semi-arid lands to determine the relative tolerance to drought, the crops, including soybean genotypes is important in the assessment than each plant under drought conditions are able to provide a relatively acceptable yield, the more they can safely be planted in arid and semi-arid (Kargar et al., 2004). Soybean (*Glycine max* L.) is a plant than breed of Fabaceae, whose main product is in terms of producing oil and protein throughout the world. Value of this product because of much oil and high protein its seed that includes 20 and 40 percent than grain weight (Imam, 2007). The plant is because of genetic diversity and broad compatibility, in a wide range of latitudes is planted in seeds and oil production is allocated to its first place. Soybean with having 15 to 25 percent oil is one of the important oil seed and has the highest cultured area of oilseed crops in the world. (Sarvy, 2012) Fernandez (1992) Index (STI) And GMP as indicators of resistance to drought was introduced. Fernandez (1992), the response of genotypes based on their performance in the

environments of stress and non-stress divided into four groups: group A of genotypes that in both environments have high performance; Group B genotypes with high yield in conditions are normal; Group C includes genotypes that have good yield under stress; And Group D genotypes with low yield in both environments. He believes the most appropriate criteria for the stress measure that is capable of detecting group A than other groups. Rozył and Hombil (2002) Tolerance Index (TOL) and mean productivity (MP) have presented. High levels of tolerance, representing more sensitive of genotypes to drought and whatever this index is lower, will be better. Rozył and Hombil (1984) Tolerance indicators (TOL) and mean productivity (MP) used to select drought tolerant cultivars. TOL index is better only be used when enhanced performance is desired in terms of stress. If the rise in yield in both stress and non-stress environments is concerned, it is better to use the MP index. MP is not able to separate cluster A, B and selection is done based on high levels of MP. Fisher and Maurer (1987), stress

susceptibility index (SSI) drought tolerant cultivars offered for evaluation. Selection based on this index, causes the genotypes with low performance in normal conditions, but the high yield under drought stress. This index is not able to separating group A from C. Fernandez (1992), stress tolerance indicators (STI) provided. High levels of STI index for each genotype, indicating higher stress tolerance Most of the potential yield is genotypes. This index is able to separate the Group A from the groups of C and B. He presented other indicators as geometric mean of GMP which is less sensitive to performance in normal and stress conditions. GMP in comparison with MP has higher power in separating the group of A from other groups. According to Fernandez (1992), Indicators in both normal and stress conditions are highly correlated with yield, as the best indicator are introduced. Jalilijan and Khodabande (1998) found that under stress conditions during flowering and pod filling, reduced traits that caused the most damage to seed yield loss as the flowers, and then reduced seed weight, the stress in process of filling pod, was significant. Ghoreishi *et al* (1971) in investigating Effects of drought stress on photosynthesis isoclines of in soybean pod in the case of tension had been found that the apparent

photosynthesis to drought stress during pod is more sensitive than the flowering stage. Daneshian *et al.*, (2002) reported that as a result of drought stress in soybean yield were decreased that due to decline of number of seeds per plant and thousand grain weights. They also found that the amount of oil seed and grain protein content was decreased with increasing tensions, but ultimately due to decrease in yield stress has a negative effect in oil yield and seed protein. This research was to evaluate and select drought tolerant genotypes were determined by using multi-parameter.

MATERIALS AND METHODS

To identify traits and drought tolerant genotypes, an experiment in a randomized complete block design with 10 genotype of (Table 1) with three replications in 2012 was done. Design in the form of two separate experiments was carried out with no stress and drought stress. In order to germinate uniformly cultivated of genotypes, as moist on rows 60 cm interval and on the rows 6-4 cm and was done at a depth of 3-1 cm. Based on soil test of 120 kg. Per hectare of phosphorus fertilizer and 95 kg per hectare of nitrogen fertilizer (50% in land preparation and 50% for road jointing stage) were used. All agricultural operations in the area during stages of procedure until harvest were done.

Table1. Soybean genotypes under studied

number	Cultivar	number	Cultivar
1	L.83-570	6	Ks4895
2	DARBY	7	NE.3399
3	L75-6141	8	Williams
4	Apollo	9	K1410
5	L.17	10	Hobbit*D.P.X

To determine drought tolerant genotypes, indicators of mean productivity (MP), the geometric mean of (GMP), Stress Tolerance Index (STI), tolerance index (TOL), stress

susceptibility index (SSI) and stress tolerance index change shaped (MSTI) was calculated by using the following formula:

$$MP = (Y_{Pi} + Y_{Si}) / 2 \quad GMP = \sqrt{Y_{Pi} \times Y_{Si}} \quad STI = (Y_{Pi} \times Y_{Si}) / Y_p^2$$

$$TOL = (Y_{Pi} - Y_{Si}) / Y_p \quad SSI = (1 - (Y_{Si} / Y_{Pi})) / SI; \quad SI = 1 - (Y_s / Y_p)$$

The above relations Y_{Pi} seed yield of each genotype under normal conditions; Y_{Si} seed yield in stress conditions; Y_S average yield genotypes in drought conditions and Y_P average yield of genotypes is in optimum condition. Then simple correlation between these indicators, calculated and cluster analysis to the minimum variance method of ward based on standardized average drought tolerance indicators were performed. Statistical analysis by using softwares of

SPSS-22, Minitab-15, Snagit-8 and was used of excel for charts.

RESULTS AND DISCUSSIONS

Simple analysis of variance of measured traits in both normal and stress conditions showed (Table 2) between the genotype of soybean grain yield there was significant at 5% level. This suggests that a significant difference between genotypes and shows that power of genetic of genotypes in incidence seed yield has been difference.

Table 2: Analysis of simple variance performance of soybean genotypes in drought stress and drought conditions

Resource change	Degrees of freedom	average of squares	
		Drought stress	Without stress
Repeat	2	149549.32	2026519.8
genotype	9	2030231.5**	18282191*
Wrong	20	758087.6	1055323.4
Coefficient of variation		16.19	12.07

*, **: significant 5, 1% probability levels, respectively.

Drought resistance indices:

Table 3, Mean indices of drought tolerance and grain yield in normal and drought conditions shows. In order to better identify and determine of genotypes and grouping of response to drought stress by using average

yields each test in normal and drought indices, STI, SSI, MP, GMP, TOL was measured and calculated. Based on the STI index and opinion of Fernandez STI index can be, Provide better classification than other indices. Based on the STI index it was

found that genotypes No. 3 (L75-6141) with STI (1.04) in both environments stress and non-stress have the highest performance. In investigating the average seed yield of this genotype in normal conditions 6820 kg per hectare respectively and stress conditions is 4218 kg per hectare, which indicates that these genotypes in both conditions had a higher yield than other genotypes under studied. The results of STI index from other indicators appear more favorable. Also genotypes No. 1 (L.83-570) that lowest of STI with 0.28 with an average yield in both normal conditions (5418 kg) and stress

conditions is respectively (1528) kg genotype No. 3 (L75-6114) have acceptable and superior potential in both normal and drought conditions and can be used in breeding programs to be considered as superior genotypes. Genotype No. 8 (Williams) was considered as control genotypes. With good potential in normal conditions and potential for drought conditions are unfavorable. Therefore, this cultivar cannot as useful genetic resource for breeding programs were used in the production of drought tolerant genotypes.

Table 3: Estimated sensitivity tolerant genotypes by various indicators of drought tolerance

number	genotype	YP	YS	STI	SSI	MP	GMP	TOL
1	L.83-570	5418	1528	0.28	1.35	3473	2877	3890
2	DARBY	6822	3015	0.74	1.05	4918	4535	3870
3	L75-6141	6820	4218	1.04	0.72	5519	5363	3602
4	Apollo	5908	2218	0.47	1.18	4063	3619	3690
5	L.17	3985	2538	0.37	0.68	3261	3180	1447
6	Ks4895	4128	1985	0.29	0.98	3056	2862	2143
7	NE.3399	4028	1922	0.28	0.99	2975	2782	2106
8	Williams	5018	1902	0.35	1.17	3460	3089	3116
9	K1410	5925	3485	0.75	0.78	4705	4544	2440
10	Hobbit*D.P.X	4528	1808	0.29	1.13	3168	2861	2720

Yp: Yield in normal condition

SSI : Stress Susceptibility Index

TOL : Tolerance

GMP : Geometric Mean Productivity

Ys: Yield in stress condition

STI :Stress Tolerance Index

MP : Mean Productivity

To determine the best indicators selected criteria for choosing those which have a high correlation with the performance of two environments. According to the results presented in Table 4 Indicators of MP, GMP and STI positive and significant correlation with Ys and Yp While the SSI indicators is

negative and significant correlation with Ys and Yp have a negative correlation. These results correspond with the findings of some researchers (Molla Sadeghy et al., 2011 a, b). Cluster analysis (Figure 2) 10 genotypes of under the study is located in two groups. For better understanding these indicators on

the performance of genotypes and determine the best genotype, the indexes into two principal components analyze (Table 5 and Figure 3) evaluated genetic by using SSI index experimental materials Just based on the classification of the resistance and susceptibility to stress in other words, using this indicators, can be sensitive and tolerant genotypes were identified regardless of their yield potential (rare, et al., 2000). Stress susceptibility index based on ratio the performance of each cultivar under stress conditions to normal conditions in

comparison with the ratio of the total the measured cultivars. Therefore two varieties with high or low performance in both environments can have the same SSI amount; Thus selection based on these indices, reformers mistakenly throws (Naimi et al., 2008). Moghadam and Hadi Zadeh (2000) conducted in researches that on the corn plant between average productivity indicators and yield under stress positive correlation did not observe that this is inconsistent with the results obtained in this investigation.

Table 4: Simple correlation coefficients between the Indicators of tolerance and performance in two conditions

	YP	YS	STI	SSI	MP	GMP
Ys	0.674*	1				
STI	0.842**	0.963**	1			
SSI	-0.012	-0.737**	-0.531	1		
MP	0.935**	0.892**	0.977**	-0.361	1	
GMP	0.86**	0.956**	0.997**	-0.513	0.985**	1
TOL	0.631	0.148	0.115	0.758*	0.315	0.148

* and ** Significantly at $p < 0.05$ and < 0.01 , respectively

The first component with justification 69.724 percent of variance changes in the data matrix, has highly correlated with Yp, MP, GMP and STI These components for better performance should have the higher levels. Hence could be named as a component of yield potential and stress tolerance. These component genotypes with high yield potential and drought tolerance separate from genotypes with low yield mean and sensitive. The second component 29.971 percent of the total variance explained and had highly correlated with the SSI and

TOL indicators. So the second component can be as sensitive component called to stress. These indicators positively correlated with the second component having smaller amounts are due to more resistant genotypes should be selected numerical values. Because this component of genotypes with low yield in stress condition and high rates of SSI and TOL separates. These results are consistent with findings of Rozył and Hombil (2002), Rose et al. (2006) and Molla Sadeghy et al (2011 c) correspond. Fernandez (1992) in a three-year study in normal conditions and

water stress Found that between the stress susceptibility indicators and seed yield there is significant correlation. The results of this study with findings of Nurman Moayed and et al (2001) are consistent. Their correlation with GMP and STI indices reported positive and significant wheat yield. Haghparast (1995), Nikkhah (1999) and Shafa Zadeh et al (2004) also examined wheat genotypes, highly significant positive correlation

between stress condition and yield in indices of MP, GMP and STI and Also a significant and positive correlation between the performance in non-stress environment and all tolerance indices and susceptibility to drought report. They stated that significant and positive correlation between indices and performance in both stress and non-stress conditions show the suitability of these indicators to assess drought tolerance.

10 soybean cultivars

Component	Eigen value	% of Variance	YP	YS	STI	SSI	MP	GMP	TOL
1	4/881	69/724	0/905	0/924	0/990	-0/43	0/997	0/995	0/242
2	2/098	29/971	0/423	-0/382	-0/124	0/897	0/076	-0/096	0/968

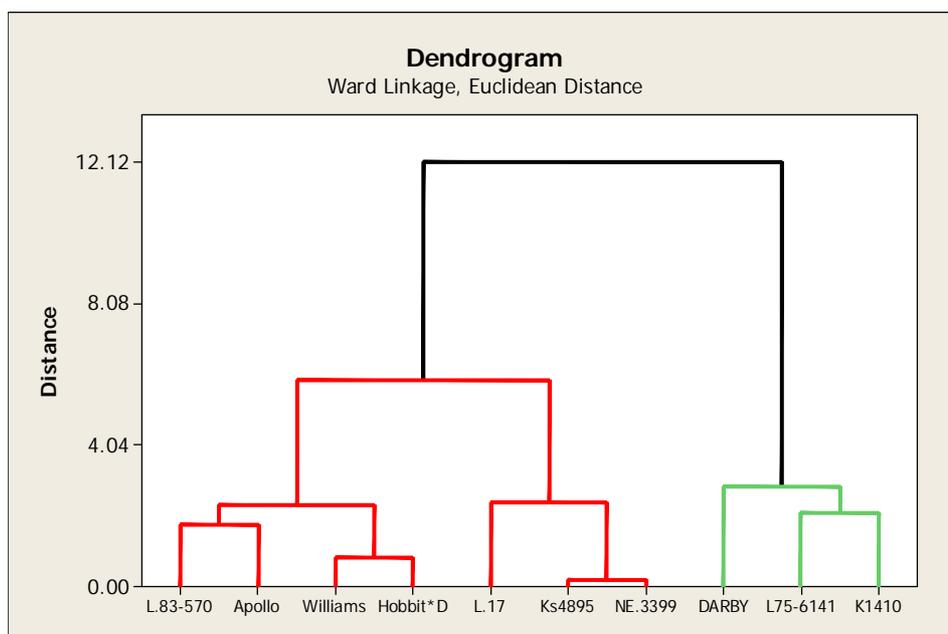


Figure 2- soybean cultivars dendrogram cluster analysis based on indicators of drought tolerance

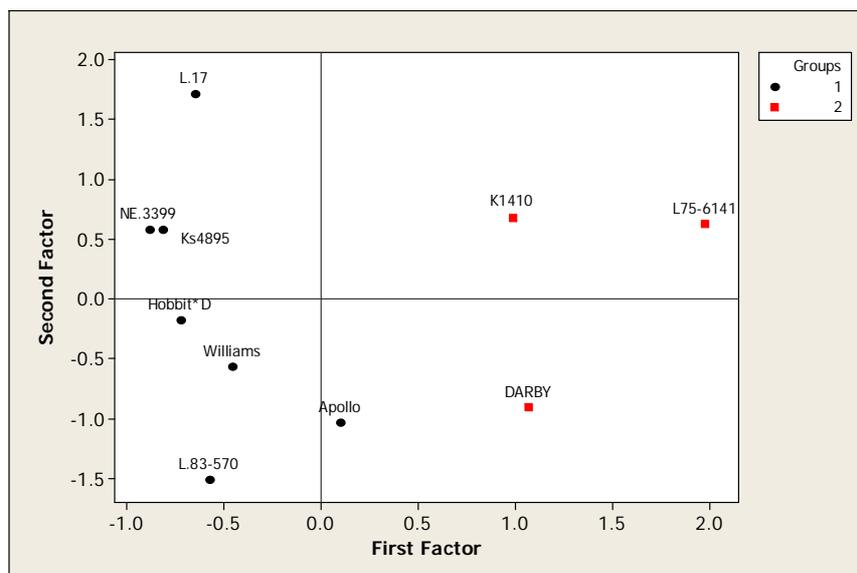


Figure 3: Biplot for five tolerance and susceptibility indices in 10 soybean cultivars on the basis of first and second components

REFERENCES

- [1] Imam, 2007. Cultivation of crops, Third Edition, published by the University of Shiraz.
- [2] Jaliliyan, A., and Khodabande, N., (1998). Effects of water stress during reproductive growth stages on yield and yield components of soybean. Abstract fifth Congress of Crop Science.
- [3] Daneshian, GGH. Nurmohamdy, Junubi, P., 2002. Study the reaction of soybean to drought stress and different amounts of phosphorus. Abstract Crop Science Congress of Iran. Karaj. Seed and Plant Improvement Institute
- [4] Karegar, S.M.A., Ghannadha, M.R., Bozorpour, R., r., Khaje Ahmad Attari, A., and Babai, H.R. 2004. Evaluation of drought tolerance in soybean genotypes number of limited irrigation conditions. Journal of Agricultural Sciences Iran. Volume 35, Issue 1, 142-129.
- [5] Fernandez GCJ. (1992). Effective selection criteria for assessing plant stress tolerance. In Proceeding of the Symposium. Taiwan, 13-16 Aug. Pp. 257-270.
- [6] Fisher RA, Maurer R (1978). Drought resistance in spring wheat cultivars: I. Grown yield responses. Aust. J. Agric. Res. 29: 897-912.
- [7] Ghorashy, SR, JW pandleton, DB Peters, JS Boyer, & JEBeuerlein. 1971. Internol water stress and apparent photosynthesis with

- Soybean differing in pubescence. *Agron. J.* 63: 674-676. 10
- [8] Haghparast, R. 1995. Selection for resistance to drought in wheat. MSc. Thesis, College of Agriculture, University of Tabriz, Iran.
- [9] Moghadam, A., and M.H. Hadizadeh, 2000. Use of plant density in selection of drought tolerance varieties in corn. *Iranian Journal of Crop Sciences* 2 (3): 25-38.
- [10] Mohammadi, R., R. Haghparast., M. Aghaei Sarbarzeh and A. Abdollahi, 2006. Evaluation of drought tolerance rate of advanced genotypes of Durum wheat on the basis of physiologic standards and other related indices. *Iranian agriculture sciences.* 37-1: 561-567.
- [11] Mollasadeghi, V., Y. Momeni Gizilasheg., R. Hazrati Hazejan and H. Mazhabi. 2011(c). Evaluation of 14 winter bread wheat genotypes in normal irrigation and stress conditions after anthesis stage. *African Journal of Biotechnology* Vol. 10 (54), pp. 11188-11195
- [12] Naderi, A., Majidi-Hevan, E., Hashemi-Dezfoli, A., and Nourmohammadi, G. 2000. Efficiency analysis of indices for tolerance to environmental stresses in field crops and introduction of a new index. *Plant and Seed Journal.* 15 (4): 390-402.
- [13] Naeimi, M; Gh. A. Akbari; A. H. hirani Rad; S. A. M. M. Sanavi; S. A. Sadat Noori and H. jabari. 2008. Evaluation drought tolerance in different varieties by evaluation indices of stress in end of growth season. *E-Journal of production of agriculture plants* 1 (3): 83-89.
- [14] Nikkhah, H.R. 1999. Study on heritability of resistance to drought in bread wheat. MSc. Thesis, College of Agriculture, University of Tehran, Iran.
- [15] Nourmand Mo'eid, F; M.A.Rostami and M.R. Ghannadha. 2001. Evaluation of drought tolerance indices in bread wheat. *Iranian agriculture sciences Journal* 32 (4): 795-805.
- [16] Rosielle AA, Hambling J. (1981). Theoretical aspects of selection for yield in stress and non-stress environments. *Crop Sci.* 21: 943-946.
- [17] Shafazadeh, MK, A. Yazdanswpas., A. Amini, and MR Gannadha, 2004. Study of terminal drought tolerance

in promising winter and facultative wheat (*Triticum aestivum* L.) genotypes using stress susceptibility and tolerance indices. *Seed and Plant* 20: 57-71.

- [18] Sio-Se Mardeh, A., Ahmadi, A., Poustini, K., Mohammadi, V., 2006. Evaluation of drought resistance indices under various environmental conditioning. *Field Crop Res.* 98: 222-229.
- [19] V. Mollasadeghi., M. Valizadeh, R. Shahryari and AA Imani, 2011 (a). Evaluation of Drought Tolerance of Bread Wheat Genotypes Using Stress Tolerance Indices at Presence of Potassium umate. *American-Eurasian J. Agric. & Environ. Sci.*, 10 (2): 151-156.
- [20] V. Mollasadeghi, M. Valizadeh, R. Shahryari and AA Imani, 2011 (b). Evaluation of End Drought Tolerance of 12 Wheat Genotypes by Stress Indices. *Middle-East Journal of Scientific Research* 7 (2): 241-247.