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Classification of maize hybrids under normal and drought stress conditions

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ABSTRACT

Drought stress isone of themost important factors limiting the growth of crops. Toevaluate the changes in grain yield and its components, a field research was conducted on maize hybrids in terms of tolerance to dehydration by using the split plot based on randomized complete block design during2013 and 2014 at the Research Station Agriculture, Islamic Azad University of Tabriz, Iran. The main factorwas two levels of irrigation (optimum irrigation was once every 7 days and Limited irrigation was every 14 days at the beginning of the Tasseling) and sub-factor was 18maizehybrids and4maize varieties. Combined analysis in two years showed that hybrid × waterstress interaction had significant difference for all of measured traits. Under stress condition, the minimum loss of hybrid was obtained for L10 × A679 and in normal condition the maximum loss of hybrid was obtained for L2 × K1263 / 1. Hybrid L3 × A679 showed the highest yield under stress condition. Cluster analysis divided hybridsin normal conditions into three groups and also divided into two groupsin stress condition.Under normal condition the main componentsdivided into 3main component that Justifies 81% of all changes and under stress conditionthe main components divided into 4 main components that Justifies 86% of all changes.

Key Words: Cluster analysis, Hybrid, Maize, Principal component analysis, Stress conditions.

INTRODUCTION

Corn crop (*Zea mays L.*) is a monocots, allogamus and diploid (20x=2n=2) grain crop. maize have high water and energy efficiency and because of C4 photosynthetic cycle has high yield among the cereal and it will be used as food, feed and industrial uses (Yazdi Samadi, 2010). Water deficient is the most important factor limiting agricultural production. In all cases which are essential for plant life, water is needed much more than other materials for crops. Growth Loss due to the drought is the main reason for the yield

decline not only drought stress has negative impact on yield, but also it's affecting the quality of products (Graciano *et al.*, 2005, Hlavinka *et al.*, 2009). Several studies have shown that irrigation greatly increases the yield of the crop; therefore it's the most extensive limiting factor for corn production throughout the world (Kanga *et al.*, 2010; Feng *et al.*, 2009). The irrigation of maize is important due to high variability of economic yield of the biomass in response to lack of water (Adamtey *et al.*, 2010). Mays is too sensitive to drought during the growth process and is very vulnerable to dry soil during flowering and grain filling stages, and it is expected that the effects of drought in the future will be even more common (Ping *et al*, 2006). However, the selection of appropriate genotypes can reduce the impact of drought on crop yield (Hosseini *et al.*, 2013). Setter *et al* (2001) reported that water deficient for five days before pollination and fertilization can reduce the aggregation process in the bottom of the ear. Shoa Hosseini *et al.* (2008) showed on corn that the number of ears per crop, number of kernel rows per ear, number of kernels per row can be used to choose drought tolerant cultivars. Emam and Ranjbar (2001) by using drought stress on corn reported that tension had a significant reduction on crop height, number of leaves, leaf length. In order to Stability and enhance the global corn production Synchronous with the increase in world population, development of drought tolerant hybrids of the most important issues to be considered (Camacho, 2004). The aim of this study was to determine the effect of water deficit on yield and yield components of maize hybrids.

MATERIAL AND METHODS

The Experiment was conducted at the Agricultural Research Station, Islamic Azad University of Tabriz during 2013-2014 in split plot based on randomized complete block design with three replications. The main factor was two levels of irrigation (optimum irrigation was once every 7 days and Limited irrigation was every 14 days at the beginning of the Tasseling) and sub-factor was 22 corn hybrids Consist of 18 Hybrid with four hybrids Control Medium plant NS540, NS640 KSC704 and KSC400 (Dehghan). Hybrids derived from crosses of Two parental inbred lines named k1263/1 (early-mature inbred lines) and A679 (late- mature inbred lines) as raster 'sand nine inbred lines as testing (maternal parents) are from six generations of self-fertilization of foreign trade compound Varieties such as Bosnia, Croatia, Hungary, etc. that Obtained line× tester cross and has been named the L1 up to L 9. 18 hybrids and cultivars KSC400 dehgan have been prepared from the Center of Khorasan Research and 3 control cultivars medium and late varieties, NS540, NS640 and KSC704 have been prepared from Miandoab city. The plot was made of three rows of 4 m length with the distance between rows and hills of 75 and 20 cm, respectively. After crop establishment weeds control was done in the same plots. Harvest was done after the arrival of the corn crop. After harvest some traits such as height, LAI, harvest index, grain length, grain yield, 100 Grain weight, biomass, number of grains per ear, number of kernels per row was measured. The Mstatc, SPSS, and Excel software were used for analyzing data and drawing diagrams.

Table1: List of studied maize hybrids

Number	Hybrid name	number	Hybrid name
1	L2×K1263/1	12	L29× A679
2	L29×K1263/1	13	L3× K1263/1
3	L31×A679	14	L10× K1263/1
4	L2× A679	15	L31× K1263/1
5	L24× K1263/1	16	L5× K1263/1
6	L3× A679	17	L5× A679
7	L24× A679	18	L10× A679
8	L9× A679	19	NS640
9	L9× K1263/1	20	NS540
10	L26× K1263/1	21	KSC400 (Dehghan)
11	L26× A679	22	KAC704

RESULTS AND DISCUSSION

In this study, analysis of variance assumptions are retrieved and their establishment was approved. The results of two year Combined analysis of variance showed that the effect of water stress on seed weight, harvest index, biomass, leaf area index, number of grains per ear, grain in rows at 1%, And the length of the ear in the 5% Was significant. Significant differences were among hybrids at 1% for all the studied traits except ear length observed. Hybrid ×water stress interaction for all traits at 1% for biomass and height at 5% that indicate different hybrid reaction under normal and stress conditions were observed (Table2). Results of this experiment accommodated with the results of Ahmadi *et al* which demonstrated that there is interaction between different levels of irrigation× hybrid. Results of mean comparison showed that, hybrid L2× K1263/1, L26×K1263/1 had the highest number of kernels per row under normal conditions and under stress conditions hybrids L3×A679, L26×K1263/1 had the highest number of kernels per row. Under stress conditions hybrid L29×K1263/1, L10×A679, NS640 the least reduction showed. Under stress conditions hybrid L2×K1263/1 with a 42% reduction the maximum decline showed. The main reason for reducing the number of kernels per row can be

attributed to the delay of peak appearance under stress conditions. In this way the peak appeared when pollination was done and there weren't living pollen for inoculation of female flowers. The majority of eggs remained not inoculated and the result is that the number of seeds per row reduced (Ahmadi *et al*, 2000). Kalamian *et al* (2005) the ovary floret sterility under stress conditions to decline in the number of kernels per row attributed. Hybrid's Height has been reduced under water deficit than normal condition. Maximum height is of hybrids L3 ×K1263/1, NS640, KSC704 under normal conditions and under water stress conditions maximum amount is of hybrids L2×K1263/1, NS640, KSC704 and a minimum height reduction of water stress on hybrids is of L31×K1263/1, NS640 and hybrids L3×K1263/1, L10×A679 showed the most reduction of the stress conditions. Asch *et al* (2001) reported that in drought stress condition the turgor pressure of stem cells that are being elongated Reduced and on the other hand Production of photosynthesis reduced. Therefore stem inter node length and crop height was affected by stress conditions reduced. Lack of adequate water supply, although has no direct effect on grain yield, but it affected crop establishment and growth of stemand reduces the accumulation of substances in the body (Payero *et al*, 2009). Water stress the number of grains per ear than normal condition reduced. So that the hybrid L2×K1263/1 and L26×K1263/1the highest number of grains per ear under normal conditions showed. Hybrids L3×A679 and L26×K1263/11the highest number of grains per ear under water stress showed. And hybrid L29×K1263/1 and L10×A679 and 640 minimal reductions in the number of grains per ear under normal and stress conditions showed. And under water stress condition hybrid L2×K1263/1 with 42 percent reductionthe maximum reduction in the number of grains per ear among hybrids showed. This reduction in the number of grains per ear can be attributed tothe stress on the sterility of eggs in the corn cob (Cakir, 2004). Significant differences among studied hybrids in terms of the number of grain per ear that indicated the inadequate assimilate in flowering time or previously were observed (Payero *et al.*, 2009). Reduction of grain number due to the reduction of physiological destination capacity has direct effect on grain yield (Emam and Ranjbar, 2001). In this study, Hybrid hadn't significant difference in corn length and most hybrids were in one group. And corn length of hybrid L2×K1263/1 under water stress condition with 49 percent reduction the maximum reduction among hybrids showed and hybrids L2×A679, L26×A679, L5×K1263/1 minimum reduction of both the normal and water stress conditions showed. It seems that drought stress at the stage of silk appearance, because of tube leaves the supply of assimilate to ear and thus had a negative impact on the cob reduced. The research results matches with Rafi (2010) and Rashid (2006) that showed the negative impact of water deficit on maize corn. The effect of water stress on leaf photosynthetic reduce assimilate production, cell growth and ear length (Pessarakli, 2001). Under normal condition hybrids L2×K1263 /1, L9×A679, L9×K1263/1, L10×K1263/1 and under stress condition hybrids L2× K1263/1, L9×A679, L3×A679 were found to be the highest 100grain weight hybrids respectively. Under stress condition hybrids L29×A679, L31× K1263/1, L29×K1263/1 showed the lowest100 grain weight reduction among hybrids studied. And under stress condition hybrid L9×A679 with 11% reduction the highest100 grain weight reduction showed. Drought stress can greatly reduce the amount of assimilate by affecting the opening degree of stomata, reducing calvin cycle enzyme activity and in this way directly reducing grainweight (physiological target capacity) (Seilsepoor *et al*, 2006, Pessarakli, 2001). Plavsic (2006) reported 100 grain weight in corn reduces in stress condition; 100 grain weight reduction in water can be attributed to rising wrinkled grain with less weight. Hybrids L2×K1263/1 and L3×A679 the highest grain yield under normal condition showed and L31×A679 and L3×A679 the highest grain yield under stress condition showed and hybrids L10×A679 L3×A679, the lowest grain yield by L24×A679 showed under stress condition than normal condition In addition, a number of hybrids hadn't significant difference with this hybrids. The results showed that the grain yield under drought stress than normal condition reduced. Researchers have been attributed the yield reduction to the reduction of photosynthesis efficiency and shortening of growing season (Earl and Davis, 2003). Research has shown that drought can severely influence the yield of crops during pollination (Moser*et al*, 2006). Under normal conditions hybrid L29× K1263/1 and L24×K1263/1 maximum biomass among studied hybrids showed. Increasing biomass in normal condition, Due to more extension and higher duration of green leaves that cause a larger Physiological source (Paolo and Rinaldi, 2008). Under water stress condition hybrids L2×A679, L9× K1263/1 and L26×K1263/1 Maximum biomasses showed. Kalamian *et al.* (2005) by studying six hybrid corns reported that the water deficit reduce the biomass. In this research biomass of hybrids decreased under drought stress conditions than normal. Hybrids L10×A679, L26×A679 and NS640 the least biomass reductions showed. Hong and Yun (2007) reported that drought stress the biomass of roots, stems and leaves corn reduced. Under normal condition hybrids L3 ×K1263/1, KSC704 and under water stress condition hybrids L29×A679 and L5×K1263/ 1showed the maximum amount of leaf area index, respectively. Drought stress the leaf area index reduced. Among hybrids L26× K1263/1, KSC400 (Dehghan) showed the least leaf area index reduction under water stress than normal condition. Drought stress reduces cell division and development so it reduced leaf area incorn (Paolo and Rinaldi, 2008). Hua*et al* (2007) reported that drought stress reduces leaf deveolment

Table 2. Combined analysis for evaluated traits of maize hybrids in two years

Source of variation	df	Number of kernels per row	Height	number of grains per ear	length corn
year	1	7.93^{*}	32.84^{**}	9.8^{*}	0.539^{ns}
/yearReplication	4	2.82^{ns}	1.002^{ns}	4.231^{ns}	1.25^{ns}
water stress	1	40267.09^{**}	54.38^{ns}	90864.18^{**}	1072.50^{*}
year×water stress	1	0.069^{ns}	21.66^{**}	0.044^{ns}	0.15^{ns}
main error	4	2.391	155.84	495.35	20.39^{**}
Hybrid	21	20.42^{**}	7.49^{**}	18.75^{**}	6.41^{ns}
year× Hybrid	21	0.37^{ns}	0.430^{ns}	0.478^{ns}	1.063^{ns}
water stress× Hybrid	21	5.65^{**}	2.43^{*}	4.288^{**}	7.33^{**}
year×water stress× Hybrid	21	0.71^{ns}	0.53^{ns}	0.802^{ns}	0.64^{ns}
Minor error	168	7.73	946.58	1656.54	18.99
Coefficient of Variation		9.66	13.99	9.73	18.05

Continued Table 2

Source of variation	df	100grainweight	grain yield(kg)	biomass	leaf area index	harvest index
year	1	0.001^{ns}	4.26^{ns}	3.70^{**}	5.71^{ns}	20.13^{*}
/year Replication	4	2^{ns}	5.54^{ns}	0.80^{ns}	2.42^{ns}	3.48^{n}s
water stress	1	7023.14^{**}	1097.73^{**}	483.14^{**}	967.78^{**}	3189.89^{**}
year×water stress	1	0.104^{ns}	2.65^{ns}	4.27^{ns}	0.63^{ns}	0.111^{ns}
Main error	4	11.68	0.111	0.210	0.149	4.026
Hybrid	21	35.58^{**}	13.37^{**}	12.28^{**}	10.27^{**}	20.10^{**}
year× Hybrid	21	0.456^{ns}	0.57^{ns}	0.54^{ns}	0.532^{ns}	0.45^{ns}
water stress × Hybrid	21	4.22^{**}	5.20^{**}	2.21^{*}	1.92^{**}	8.5^{**}
year×water stress× Hybrid	21	0.532^{ns}	0.74^{ns}	0.51^{ns}	0.95^{ns}	0.37^{ns}
Minor error	168	0.289	0.311	1.38	0.368	11.48
Coefficient of Variation		3.20	13.52	14.41	15.56	8.59

ns ,*,** respectively, not significant, significant at levels of 5 and 1%.

Table 3. Means of hybrids for evaluated traits under normal and stress condition in two years

Hybrid name	Number of kernels per row		Height		number of grains per ear		length corn	
	normal	water stress	normal	water stress	normal	water stress	normal	water stress
L2×K1263/1	39.73	24.28	256.8	212.5	581.4	336.9	30.42	15.48
L29×K1263/	30.35	26.27	255.9	179.4	456.8	372.8	25.12	15.50
L31×A679	34.50	22.8	239	202.5	501.2	304.3	27.37	15.85
L2× A679	34.78	25.77	259.9	182.5	511.6	354.9	26.48	15.13
L24× K1263/1	34.07	23.50	262.2	191.1	503.8	326.4	28.18	15.58
L3× A679	36.10	27.27	217.6	176.6	557.1	388.5	31.12	26.27
L24× A679	35.98	24.68	255.9	206.8	561.1	364.7	32.65	27.22
L9× A679	35.02	23.33	222.7	175.6	525.5	326.4	29.37	26.38
L9× K1263/1	35.53	21.93	252.9	189.7	517.3	302	27.33	29.53
L26× K1263/1	39.30	29.55	251.3	211	604	425.5	32.88	27.27
L26× A679	37.02	22.25	233.8	177	535.7	297.1	24.32	23.57
L29× A679	27.29	19.18	238.8	193.5	435.1	269.3	23.82	26.78
L3× K1263/1	31.10	22.37	268.5	170.9	462.5	310.6	29.62	24.08
L10× K1263/1	32.62	20.50	255.9	200.5	509.3	296.2	23.92	21.62
L31× K1263/1	33.17	24.48	225.5	218.4	494.8	342.9	28.88	25.18
L5× K1263/1	29.68	20.82	214.8	160.4	446.1	292.7	21.33	21.57
L5× A679	33.02	24.98	230.9	192.9	469.1	366.6	31.03	18.02
L10× A679	31.72	26.87	261.3	177.6	484.7	373.1	27.40	15.27
NS640	31.12	26.25	278.3	221.4	463.5	356	28.50	15.43
540NS	35.20	20.20	249.4	183.7	511.8	280	27.68	15.57
DEHGHAN	33.22	20.93	229	210.1	504.7	298	26.12	15.53
704KSC	31.33	24.88	278.1	223.4	472	337	26.53	15.48
LSD5./.	4.18		35.07		61.22		6.55	

Continued Table 3

Hybrid name	100 grain weight		grain yield		biomass		leaf area index		Harvest index	
	normal	water stress	normal	water stress	normal	water stress	normal	water stress	normal	water stress
L2×K1263/1	18.3	16.8	6.38	3.10	9.81	7.08	4.26	2.90	45.33	37.42
L29×K1263/1	17.2	16.7	4.87	3.62	11	6.98	3.73	2.93	36.28	40.52
L31×A679	16.4	15.55	4.96	2.39	8.79	5.41	4.36	3.43	42.08	38.18
L2× A679	17.3	15.82	5.20	3.22	10.78	8.26	4.75	3.16	39.05	34.48
L24× K1263/1	16	15.57	4.75	3.05	10.95	7.70	4.85	2.90	36.55	34.15
L3× A679	18.2	16.87	6.21	3.82	7.64	6.12	4.30	3.41	50.4	44.57
L24× A679	17.2	16.37	5.76	3.46	9.67	8.07	4.21	3.30	43.40	36.27
L9× A679	18.9	16.82	6.17	3.22	9.87	6.27	4.90	3.28	44.22	40.10
L9× K1263/1	18.3	16.63	5.57	2.73	9.57	8.32	4.11	2.38	43.18	31.42
L26× K1263/1	16.7	15.57	6.09	3.58	10.82	8.10	4.23	3.48	42.42	37.50
L26× A679	17.8	16.33	5.82	2.63	9.49	6.76	3.95	3.08	43.92	34.88
L29× A679	17	16.4	4.34	2.42	8.76	6.89	5.11	4.06	39.47	32.67
L3× K1263/1	16.8	15.53	4.32	2.75	9.60	7.20	4.28	3.15	37.82	33.97
L10× K1263/1	18.4	16.7	5.78	2.88	8.79	6.60	5.76	3.68	45.40	36.60
L31× K1263/1	17.05	16.75	5.17	3.01	9.30	6.73	3.78	2.86	41.63	38.08
L5× K1263/1	16.52	15.55	4.46	2.63	7.97	6.04	4.81	4.03	41.80	36.55
L5× A679	17.13	15.68	4.77	2.98	9.40	6.48	4.41	3.96	39.93	38.03
L10× A679	16.63	15.67	4.62	3.57	9.01	7.15	4.11	2.73	40.28	39.08
640	17.93	16.75	4.78	3.37	7.74	5.26	4.95	3.21	44.40	45.28
540	17.38	16.97	5.24	2.52	8.81	5.17	4.66	3.66	43.45	39.75
DEHGHAN	16.48	15.57	5.07	2.43	9.33	6.80	3.98	3.60	41.08	33.52
704	16.98	15.78	4.73	2.93	10.43	7.75	5.21	3.56	37.57	34.15
LSD5./.	0.808		0.83		1.33		0.912		5.09	

Table 4. Discriminant function analysis for verification of hybrids grouping under normal condition

Number of group	wilks Lambda statistic	Chi-square test	df	Probability Level
2	0.027	52.12	27	0.03
3	0.127	29.90	16	0.019
4	0.478	10.71	7	0.152

Table 5. Discriminant function analysis for verification of hybrids grouping under stress condition

Number of group	Wilks Lambda statistic	Chi-square test	df	Probability Level
2	0.048	43.92	20	0.002
3	0.31	16.97	9	0.049

in corn. Paolo and Rinaldi (2008) reported that on maize with 50 percent reduction in the amount of water needed during the growth period caused reduction in leaf area index of product. Under water deficit condition harvest index showed 12% increase in hybrid L29×K1263/1 and showed 19 %decrease in hybrid L10× K1263/1. Grain yield is one of the components of the harvest index, harvest index changes dependents on changes in grain yield, if drought stress occurred harvest index will be reduced. This subject has also been reported by other researchers (Setter *et al* 2001). Researchers demonstrated that the sensitivity of corn to drought caused this reduction (Kicker, 2004). Under normal condition, the highest harvest index was obtained for hybrid L3×A679 and under water stress condition maximum amount was obtained for hybrids are L3×A679 and NS640. Hlavynka *et al* (2009) reported that the less assimilate allocation to economic crop sectors causes reduction in harvest index under water stress condition. Setter*et al* (2001) stated that water shortage is one of the factors limiting crop growth. In addition to the reduction in dry matter production disturbance share carbohydrates in seeds and as a result reducing the harvest index. The results of mean comparison

showed that in addition to the fore mentioned hybrids among the studied traits, there are other hybrids that showed no significant difference with fore mentioned hybrids.

Cluster analysis

Cluster analysis (ward's method) was done based on two year average using standardized data for grouping studied hybrids under both irrigation conditions. In normal condition there were three cluster, the first cluster included hybrids 3, 4, 5, 13, 15, 17, 18, 21 and 22. The second cluster included hybrids 12,14,16,19 and The third cluster included hybrids 1, 6, 7, 8, 9, 10, 11 and 20 under stress condition there were two clusters, The first cluster included hybrids 3, 9, 11, 12, 13, 14, 16, 17, 20, 21, 22 and hybrids 1, 2, 4, 5, 6, 7, 8, 10, 15, 18 and 19 were in the second cluster (Fig1and 2). Discrimination function analysis confirmed the conducted grouping in both condition (Tables 4 and 5). A research was conducted on farm data that classified Corn genotypes into 5 groups and the discrimination function analysis showed that the classification is correct (Jaynes *et al*, 2003). Arithmetic mean and standard Deviations are shown in each cluster for both experimental conditions in Tables 6, 7. In normal conditions (Table 6). The first cluster hybrids In terms of height, biomass attributes were worth more than the total average, so the positive attributes of the hybrids can be used in breeding projects. Hybrids in second cluster in terms of the harvest index, area Leaf index were more valuable than the total average. Hybrids in the third cluster of height, number of seeds per row, number of grains per ear, HI, ear length, grain weight, biomass, grain yield were more valuable than the total average. Although some characteristics of groups 1 and 2 are superior to the total average, but this group of hybrids had lower grain yield than the total average. Hybrids in the third cluster from normal condition were found to be the most suitable because they had higher values for most studied traits. In accordance with the cluster analysis (Table 7) under water stress condition, The first cluster which includes hybrids 3, 9, 11, 12, 13, 14, 16, 17, 20, 21 and 22 in terms of ear length, ear weight with cover, LAI had higher value of total average and hybrids 2, 4, 5, 6, 7, 8, 10, 15, 18 and 19 were in the second cluster, which in terms of the height, number of kernels per row, number of grains per ear, harvest index, grain weight, biomass, grain yield had higher value than total average. Hybrids in the second cluster from water deficit condition were found to be the most suitable because they had higher values than total average. In accordance with the cluster

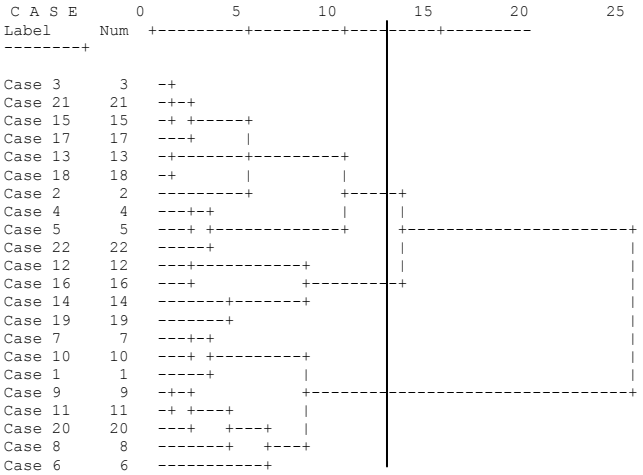

Figure 1. Dendrogram of cluster analysis based on all studied traits in maize hybrids under normal condition

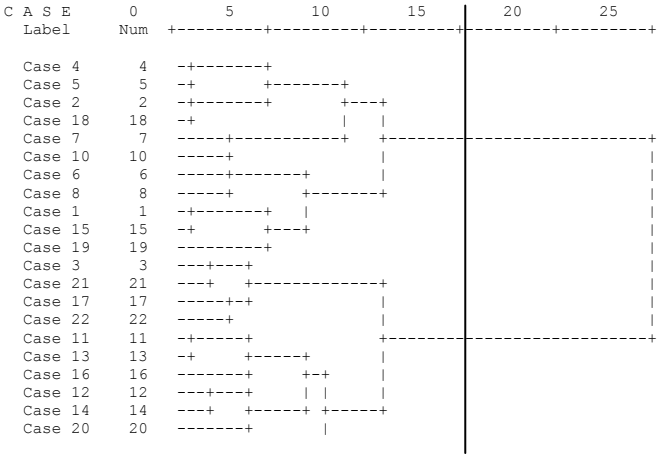

Figure 2. Dendrogram of cluster analysis based on all studied traits in maize hybrids under water stress condition

Table 6. Mean and percent of deviation from total mean for each cluster under normal condition

Cluster	Hybrid		Number of kernels per row	Height	number of grains per ear	length corn
1		Mean	32.95	248.98	488.45	27.67
	2,3,4,5,, 13,15,17,20,21,22	Deviation from total mean	-2.54	1.11	-32.25	−0.20
2	12,14,16,19	Mean	30.02	243.97	448.27	24.55
		Deviation from total mean	−11.20	-0.93	11.23	-11.47
3		Mean	36.95	241.57	554.65	29.73
	1,6,7,8,9,10,11	Deviation from total mean	9.30	-1.90	9.84	7.20
		Total mean	33.81	246.25	504.98	27.73

ContinueTable-6

Cluster	Hybrid		100grain weight	grain yield	biomass	leaf area index	Harvest index
1		Mean	16.89	4.88	9.77	4.38	39.61
	2,3,4,5,,13,15,17 ,20,21,22	Deviation from total mean	-2.60	-6.67	3.49	-2.5	-5.25
2	12,14,16,19	Mean	17.17	4.53	8.16	4.96	41.89
		Deviation from total mean	-0.96	-13.47	-13.48	10.47	0.20
3	1,6,7,8,9,10,11	Mean	17.97	6	9.56	4.28	44.71
		Deviation from total mean	2.63	14.73	1.26	-4.64	6.94
		Total mean	17.34	5.23	9.44	4.49	41.81

Table7- Mean and percent of deviation from total mean for each cluster under stress condition

Cluster	Hybrid		numberof kernels perrow	Height	number of grains per ear	length corn
1		Mean	21.90	191.31	302.17	20.69
	4,5,2,18,7,10,6,8,1,15,19	Deviation from total mean	-7.91	-1.14	-8.84	0.64
2	3,21,17,22,11,13,16,12,14,20,9	Mean	25.66	195.71	360.75	20.43
		Deviation from total mean	7.91	1.14	8.84	-0.64
		Total mean	23.77	193.51	331.45	20.55

ContinueTable-7

Cluster	Hybrid		100grain weight	grain yield	biomass	leaf area index	Harvest index
1		Mean	16.06	2.67	6.68	3.51	35.43
	2,3,4,5,, 13,15,17,20,21,22	Deviation from total mean	-0.83	-11.63	-2.84	6.09	-4.62
2	12,14,16,19	Mean	16.33	3.37	7.07	3.11	38.86
		Deviation from total mean	0.83	11.63	-2.84	-6.09	4.62
		Total mean	16.19	3.01	6.87	3.31	37.14

Table 8- Eigen values, percentage of variance and cumulative percentage of determined components under normal condition

Component	Eigen value	percentage of variance	Cumulative percentage of variance
1	3.99	44.43	44.43
2	1.97	21.94	66.37
3	1.36	15.18	81.55

Table 9- Coefficients components for evaluated traits under normal condition

	Coefficients		
Traits	1	2	3
Height	-0.138	0.352	0.814
length corn	0.610	0.430	0.049
Number of kernels per row	0.911	0.284	0.012
number of grains per ear	0.931	0.250	0.045
100grainweight	0.603	-0.478	0.293
Harvest index	0.751	0.622	-0.024
Biomass	0.022	0.851	0.151
leaf area index	-0.240	-0.421	0.766
grain yield	0.962	-0.073	0.054

Table10- Eigen values, percentage of variance and cumulative percentage of determined components under stress condition

component	Eigen value	Percentage of variance	Cumulative percentage of variance
1	3.40	37.80	37.80
2	1.97	21.98	59.79
3	1.35	15.02	74.81
4	1.03	11.52	88.34

analysis which demonstrated that hybrids 10, 8,7,6,1 were found to be the most superior, because in both experimental condition they were in a cluster that in terms of traits associated with yield and it's component in corn had higher value than total average, therefore had good potential for use in breeding programs to produce high-yield hybrids.

Principal component analysis

In table 8, and 9 cumulative percentage and Principal component coefficients are provided under normal conditions. Three main independent components justify 81% of all changes. The first component Justifies 44% Of Total changes that, the highest coefficients are related to the number of seeds per row, number of grains per ear and grain yield. However, due to the high coefficient of the characters for the first component, it was named as grain yield component. The second component accounted for 22% of all changes. For these components, harvest index and biomass have high coefficients, however, due to the high coefficient of components for these traits and the role that these traits plays in crop growth and chlorophyll in plant and increase their yield through the process of photosynthesis, This component was named Psychological characteristics. According to the results of cluster analysis which demonstrated that under normal condition hybrids 1, 6, 7, 8, 9, 10, 11 and 20 were in a cluster that in terms of yield and its components were superior to other hybrid (Fig. 3) the bi-plot based on the first and second principal component by grouping hybrids confirmed the cluster analysis result. Results of principal component analysis in water stress conditions (Tables 10 and 11) demonstrated that the four main components Justifies 86% of all changes. The first component Justify 37% of Total changes that, number of seeds per row, number of grains per ear and grain yield showed the highest coefficients. Due to high coefficient of number of rows and number of grains per ear, that will increase the yield, this component, was named yield component. And the second component showed the similar results of the second component under normal conditions; therefore this component was named Psychological characteristics. According to the results of cluster analysis which demonstrated that under normal condition hybrids 1, 2, 4, 5, 6, 7, 8, 10, 15, 18 and 19 was in a cluster that in terms of yield and its components were superior too their hybrid (Fig. 4) the bi-plot based on the first and second principal component by grouping hybrids confirmed the cluster analysis.

Table11- Coefficients components for evaluated traits under stress condition

	coefficients			
Traits	1	2	3	4
Height	0.189	-0.060	-0.311	0.840
length corn	0.001	-0.239	0.767	-0.179
Number of kernels per row	0.955	-0.081	-0.203	-0.081
number of grains per ear	0.966	-0.107	-0.120	-0.103
100grainweight	0.155	0.514	0.688	0.403
Harvest index	0.576	0.807	-0.012	-0.076
Biomass	0.252	0.930	0.103	0.051
leaf area index	-0.435	0.344	-0.341	-0.299
grain yield	0.955	0.033	0.099	-0.150

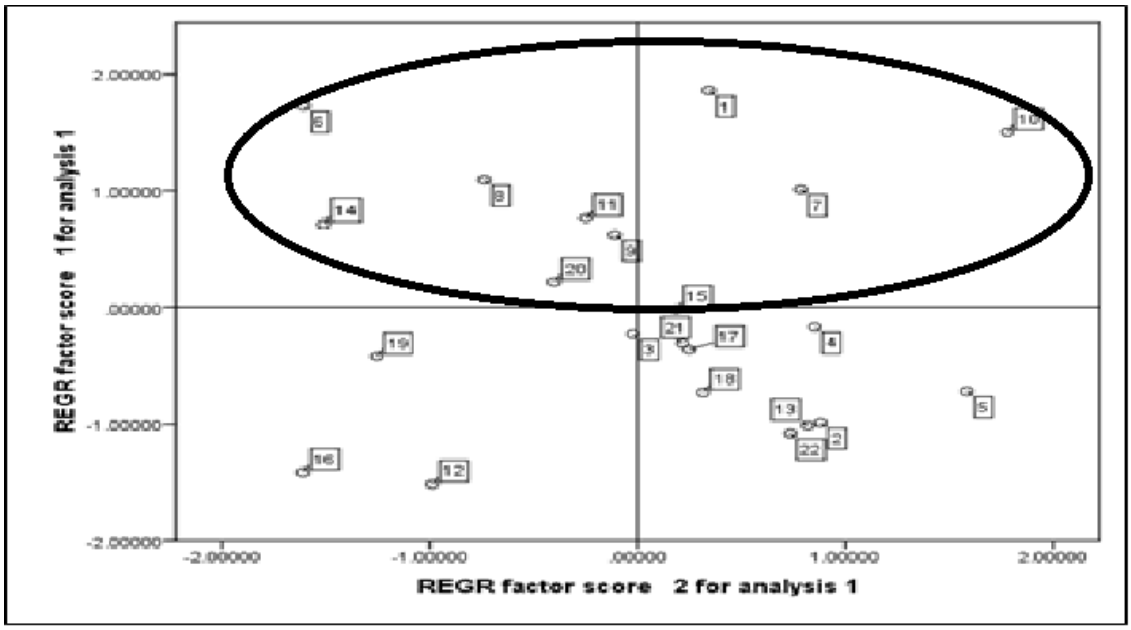

Figure 3. Bi-plot charts based on the first and second principal component under normal condition.

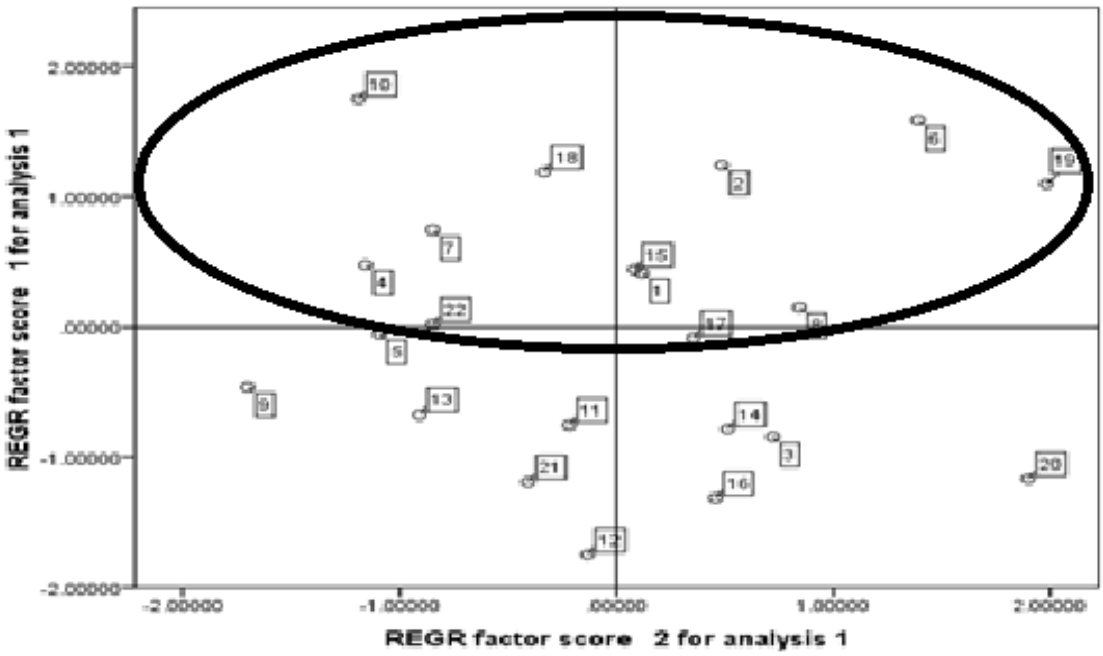

Fig. 4. Bi-plot charts based on the first and second principal component under stress condition.

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