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NV Soni
B.A. College of Agriculture, Anand Agricultural University, Anand, Gujarat, India

HL Dhaduk
B.A. College of Agriculture, Anand Agricultural University, Anand, Gujarat, India

CK Desai
B.A. College of Agriculture, Anand Agricultural University, Anand, Gujarat, India

JR Patel
B.A. College of Agriculture, Anand Agricultural University, Anand, Gujarat, India

Correspondence
NV Soni
B.A. College of Agriculture, Anand Agricultural University, Anand, Gujarat, India

Comparative response of *Zea mays* (L.) genotypes to moisture stress regimes

NV Soni, HL Dhaduk, CK Desai and JR Patel

Abstract
Knowledge of the mechanisms of stress tolerance, its inheritance and efficient techniques of screening germplasms for moisture stress can facilitate utilization for crop improvement and isolating stress resilient genotypes. The present study aimed to identify the suitable donors for generating moisture stress tolerant genotypes to mitigate the problem in areas affected by water limiting conditions. Nineteen maize inbreds were evaluated under field conditions for normal irrigation and by withholding irrigation at flowering stage in split plot design with three replications during 2013-14. The results revealed that stress conditions leads to increase in days to flower but on other hand it leads to force maturity. Leaf rolling and senescence were higher in stress block as compared to normal irrigation in most of the genotypes. The genotype, CM 140 resulted in shorter anthesis silking interval (4.3 days),least leaf senescence (2.3), least yield penalty (23.3 %) with highest increase in leaf proline content under stress (2.5 fold) followed by IL 111 (4.7 days, 2.4, 23.9 %and 2.3 fold) over normal irrigation, respectively. Overall two genotypes were found to be stress tolerant, four showed moderate response and thirteen revealed susceptible response to stress. Hence, the study indicated that the identified genotypes may be used asgenetic resources for maize improvement programme in future.

Keywords: *Zea mays*, genotypes, moisture stress regimes

Introduction
Maize (*Zea mays* L.) together with rice and wheat is one of the three cereal crops that provides 60 per cent of the world's food energy intake. It is the native to Central America (Watson & Dallwitz, 1992) [24] having 2n = 2x = 20 chromosomes. It belongs to *Poaceae* family commonly known as family of grasses. The crop has tremendous genetic variability, which enables it to grow in tropical, subtropical and temperate climates (Anonymous, 2012) [2]. The global maize production during 2016-17 was 1068.79 million tonnes from an area of about 183.57 million hectare with productivity of 5.82 tonne/ha (Anonymous, 2017) [3]. It is grown throughout the year in India, where it gets suitable agro-ecological conditions. It contributes ~9 per cent of total food grain production in India. It is predominantly a rainfed crop with 85 per cent of the area under cultivation in the monsoon season. The change in climatic conditions along with seasonal inconsistency for weather parameters resulted in unpredictable maize production under rainfed and drought conditions (Lobell *et al.*, 2011) [14]. It has been estimated that nearly 29 per cent of the total land affected by drought stress (Nouri & Komatsu, 2013) [20]. The occurrence of moisture stress two weeks either side of flowering can severely affect fertilization; seed set and eventually kernel yield in maize (Bänziger *et al.*, 2000) [4]. The moisture stress increases Anthesis-Silking Interval (ASI) resulted in non-synchronization of flowering that resulted in yield losses in maize (Sain *et al.*, 2001, Adamu *et al.*, 2014) [21, 1]. Genotypes have been found to vary with respect to their response to moisture stress. The crop requires 500-800 mm of water during life cycle of 80 to 110 days (Critchley and Klaus, 1991) [6]. The water requirement of maize increases under dry windy conditions. Under such circumstances evolution of high yielding, water stress tolerant maize varieties are reliable option to cope with the menace of water shortage. Therefore, effective maize breeding programme is required to evolve high yielding and well adapted hybrids/varieties for moisture deficit conditions. However, the progress in developing crop cultivar for tolerance to abiotic stress particularly moisture stress has been slow, because of lack of knowledge of the mechanism of tolerance, poor understanding of inheritance of tolerance, low heritability and lack of efficient techniques for screening germplasm (Khush, 2006) [13]. Agronomical interventions have also their importance, since genetic solutions are unlikely to close more than 30 per cent of the gap between potential and realized yield under water stress (Edmeades *et al.*, 2006) [9]. The problem of water stress can be solved either by providing supplemental irrigation to crop in stress areas or by developing tolerant genotypes.

The provision of supplemental irrigation is not feasible under moisture stress. Therefore, development of moisture stress tolerant genotypes seems to be the best alternative to get optimum grain yield in stress conditions.

Materials and Methods

Nineteen maize inbreds listed in Table 2 were assessed using split plot experimental design in three replications under normal irrigation (S_1) and moisture stress at flowering (S_2) for agro-morphological and biochemical traits. The research was conducted at the Agronomy farm, B.A. College of Agriculture, Anand Agricultural University, Anand (22°-35'N latitude and 72°-55'E longitude with an altitude of 45.11 metre above mean sea level) during dry season of 2013-14. The soil of experimental field was sandy loam, deep and well drained alluvial in origin and has fairly good moisture holding capacity. The crop was sown in two rows of 4.0 m length for each test entry with spacing of 60 cm between two rows and 20 cm between two plants. The moisture stress was imparted by withholding irrigation particularly at flowering stage. Life saving irrigation was given 10 days after grain filling stage in 50per cent plots. The data were recorded for days to 50 per cent tasseling (DFT), days to 50 per cent silking (DFS), anthesis-silking interval (ASI), days to 75 per cent maturity (DM), leaf rolling(LR), leaf senescence (LS), number of ears per plant (NEP), shelling percentage (%) (SH), kernel yield per plant (g) (KYP) and proline content (mg g^{-1} FW) (PC). The traits viz., DFT, DFS, ASI, DM, LR and LS were be recorded on population basis of each experimental unit. Leaf rolling and leaf senescence were measured by giving score on a scale from 1 to 5 and 0 to 10, respectively as per the procedure of Banziger *et al*., 2000 [8]. The data generated on different aspects were subjected to statistical analysis as per the method suggested by Snedecor and Cochran, 1967. Based on per se performance of genotypes, response of these genotypes towards moisture stress at flowering period was assessed as per the procedure of Dubey *et al*., 2009 [7].

Results and Discussion

Effect of moisture stress

The effect of moisture stress on individual traits were studied and results (Table 1) revealed that different treatments of moisture stress recorded significant effect on different flowering and maturity traits (days to 50% tasseling, days to 50 % silking, anthesis silking interval and days to 75% maturity), Yield attributes and yield (number of ear per plant, shelling percentage and grain yield per plant) and leaf characters (leaf rolling, leaf senescence and proline content) in maize inbred lines. Magnitude of earliest days to 50% tasseling, days to 50 % silking and anthesis silking interval in moisture stress treatment (Normal irrigation) was to the tune of 5.67, 10.91 and 55.66 percent as compared to moisture stress at flowering, respectively. Whereas, earliest maturity was observed when moisture stress at flowering stage (108.54 days) as compared to moisture stress treatment (Normal irrigation) (113.07 days). Moisture stress at flowering conditions resulted in force maturity. Similar results were also found by Kuchanur (2010) and Adamu *et al.* (2014) [1]. In general, the aforesaid results of normal irrigation and moisture stress may be attributed to the uneven soil water-air relationships which lead to reduction in the rate of photosynthetic activity and unbalanced relationships between plant hormones and biological processes in the whole plant organs (Mehasenand, 2010).

The magnitude of the lower scoring of leaf rolling and leaf senescence in moisture stress treatment (Normal irrigation) was to the tune of 32.20 and 46.36 percent as compared to moisture stress at flowering, respectively. Whereas, proline content raised 2.5 fold in stress condition (2.05 mg g^{-1} Fresh Weight of leaf to 5.38 mgg^{-1} Fresh Weight of leaf). The performances of genotypes are affected by the stress and without stress conditions. Proline is one of the important osmolytes which has important role to play under stress conditions in plants which reduced damage to plant cells in stress conditions. Therefore, increased level of proline content under stress is beneficial for plant. Normal irrigation resulted in significantly increased kernel yield per plant, number of ears per plant and shelling percentage as compared to moisture stress at flowering stage was to the tune of 100.89, 32.94 and 7.65 percent, respectively.

Effect of genotypes

Result also showed (Table 4.2) that different genotypes exhibited significant effect on DFT and DFS in maize inbred lines. The genotype CM140 recorded significantly earliest tasseling (54.00 days) which was at par with IL103 (54.50 days). Similarly CM140 also recorded significantly earliest silking (57.50 days). The genotype CM140 recorded lowest ASI (3.50 days) which was at par with IL111 (3.83 days). For DM genotype CM140 recorded significantly earliest maturity (101.67 days) which was at par with IL103 (104.17 days). However, the genotype GYL7 showed late maturity (120.67 days). The lowest leaf rolling score was exhibited by genotype IL111(1.58) which was at par with IL102, IL10, IL104, IL105, IL106, IL107, IL110, GYL6, CLQ47, HKI-193-1 and CM140. Similarly for leaf senescence scoring lowest scores was observed in the genotype CM140 (2.17) which was at par with IL111 (2.28). The high value of leaf rolling and leaf senescence was observed in the genotypes IL113 (3.25) and I-07-575 (5.62). For proline content, genotype CM140 depicted significantly highest value of 5.03 mg g^{-1} Fresh Weight of leaf (FW) which was at par with IL109 (4.89 mg g^{-1} FW). The lowest value for proline content was obtained in IL105 (2.62mg g^{-1} FW). The genotype IL104 recorded significantly highest kernel yield per plant (96.7 g) which was at par with IL111 (92.93 g) and CM140 (90.43 g). For ears per plant, genotype IL111 depicted significantly highest value (1.33) which was at par with GYL6. The shelling percentage was significantly highest in genotype CM140 (76.96%) which was at par with I-07-575, HKI-193-1, IL111, IL114 and IL101 (77.67 days).

Interaction effect

The data in the Table 2 showed that the combination S_1G_{19} recorded significantly earliest tasseling (51.67 days), which was at par with combinations S_1G_3. Significantly the late tasseling (73.00 days) was recorded with combination S_2G_{13} and S_2G_{15} it was at par with combination $S_2G_{11.}$ So it is concluded that stress condition at flowering resulted in increasing the days to 50 per cent tasseling in genotypes. Some earlier workers (Kuchanur, 2010 and Adamu *et al.*, 2014) [1] also reported increase in days to 50 per cent tasseling under stress condition as compared to normal irrigation. The combination S_1G_{19} recorded significantly earliest silking (54.33 days), which was at par with combinations S_1G_3. Treatment combination S_2G_{13} recorded significantly late silking (81.00 days) which was at par with combinations S_2G_{11} and$S_2G_{15.}$ Thus moisture stress prolonged the period of days to 50 per cent silking. These results accord with the results obtained by Zaidi *et al.*, 2008 [25], Kuchanur 2010 and

Adamu *et al.*, 2014 [1]. The treatment combination S_1G_{19} depicted significantly lowest ASI period (2.67 days), which was at par with all the combinations *viz.*, S_1G_1, S_1G_2, S_1G_3, S_1G_4, S_1G_5, S_1G_6, S_1G_7, S_1G_8, S_1G_9, S_1G_{10}, S_1G_{11}, S_1G_{12}, S_1G_{13}, S_1G_{14}, S_1G_{15}, S_1G_{16}, S_1G_{17}, S_1G_{18}. Whereas combinations, S_2G_8 and S_2G_{11} recorded significantly highest ASI period of 9.33 days which was at par with combinations S_2G_1, S_2G_3, S_2G_6 and S_2G_{12}. The increased in ASI period under moisture stress was also reported by Sain *et al.*, 2001 [12], Magorokoshi *et al.*, 2003 [16], Zaidi *et al.*, 2008 [25], Kuchanur 2010 and Adamu *et al.*, 2014 [1]. The combination S_2G_{19} exhibited significantly earliest maturity of (98.33 days), which was at par with all the combinations S_2G_1, S_2G_3 and S_2G_{10}. Whereas combinations S_1G_{11} recorded significantly late maturity of 121.67 days which was at par with combinations S_1G_5, S_1G_9 and S_1G_{13}. The moisture stress condition resulted in early maturity of genotypes as compared to normal irrigation condition. These results are in conformation with earlier reports of Kuchanur 2010. In general, the aforesaid results of normal irrigation and moisture stress may be attributed to the uneven soil water-air relationships which lead to reduction in the rate of photosynthetic activity and unbalanced relationships between plant hormones and biological processes in the whole plant organs (Mehasen and El-Gizawy, 2010) [17].

Interaction effect between moisture stress and genotypes was found to be significant for leaf senescence and proline content but non-significant for leaf rolling in maize. The results indicated that the combination S_1G_{19} recorded significantly lowest leaf senescence scoring (2.00), which was at par with eleven different combinations. The two treatment combinations, S_2G_{19} and S_2G_8 of moisture stress conditions also showed at par results with the normal irrigated conditions. So it is concluded that the genotypes having less leaf rolling under stress conditions was considered ideal. The most of the genotypes showed increased leaf rolling under moisture stress conditions. Increased leaf rolling under stress conditions was observed which is similar with the results obtained by Munyiri *et al.*, 2010 [19]. Proline is one of the important osmolytes which has important role to play under stress conditions in plants which reduced damage to plant cells in stress conditions. Therefore, increased level of proline content under stress is beneficial for plant. For proline content combination S_2G_{19} recorded significantly highest value of 7.82 mg g^{-1} FW, which was at par with the combinations S_2G_8 (7.44 mg g^{-1} FW). But lowest value was obtained in the combinations, S_1G_{16} (1.81 mg g^{-1} FW). Our results forhigh accumulation of proline in all maize genotypeswere in agreement with a number ofpast studies including some cited here such as Moussa and Abdel-Aziz 2008, Spoljarevic *et al.*, 2011, Tarighaleslami *et al.*, 2012, Hassan, *et al.*, 2013, Jabeen *et al.*, 2008 and Mafakheri *et al.*, 2010. Thus, proline accumulation is not just a sign of cellular injury resulting in response to water shortage but is a marker of stress tolerance having a definite osmoregulatory role in plants subjected to stressful conditions.

The results in the table represented that the combination S_1G_{14} recorded significantly highest kernel yield per plant (118.8 g), which was at par with combinations S_1G_4 (117.9 g), S_1G_6 (108.3 g), S_1G_{18} (107.1 g), S_1G_{17} (106.1 g), S_1G_{10} (105.5 g) and S_1G_3 (103.9 g). The kernel yield per plant was reduced in moisture stress conditions as compared to normal irrigation. The same results were also obtained by group of researchers working on maize (Khan *et al.*, 2001, Zaidi *et al.*, 2008, Hussain 2009, Godawat *et al.*, 2010, Kuchanur 2010, Mehasen and El-Gizawy, 2010, Munyiri *et al.*, 2010; Cairns *et al.*, 2013 and Adamu *et al.*, 2014) [1, 25, 17, 9]. For shelling percentage combination S_1G_{10} recorded significantly highest value of 81.20%, which was at par with all the combinations S_1G_{17} (80.80%), S_1G_{19} (80.20%), S_1G_{18} (79.80%) and S_1G_5 (78.20%). The stress conditions in the reduction of shelling percentage as compared to normal irrigation condition as reported by Kuchanur 2010 and Mehasen and El-Gizawy 2010 [17].

Table 1: Effect of moisture stress on flowering and maturity traits, leaf characters, proline content, yield attributes and yield of maize inbred lines

Treatments	Flowering and maturity traits				Leaf characters		Proline Content (mg g^{-1} FW)	yield and yield attributing		
	Days to 50 % tasseling	Days to 50 % silking	Anthesis Silking Interval	Days to 75 % maturity	Leaf rolling	Leaf senescence		Kernel yield per plant (g)	Number of ear per plant	Shelling percentage (%)
Moisture Stress (S)										
S_1	59.39	62.63	3.25	113.07	1.81	2.73	2.05	94.48	1.13	77.25
S_2	62.96	70.30	7.33	108.54	2.67	5.09	5.38	47.03	0.85	71.76
S.Em.±	0.42	0.38	0.07	0.52	0.02	0.02	0.06	1.32	0.01	0.71
C.D. (P=0.05)	2.57	2.29	0.40	3.15	0.14	0.15	0.37	8.06	0.07	4.33
CV %	5.22	4.27	9.37	3.52	7.56	9.80	12.19	14.13	8.50	7.21
Genotypes (G)										
G_1: IL101	56.67	62.50	5.83	105.83	2.42	3.75	3.74	66.07	0.87	75.19
G_2:IL102	60.00	65.00	5.00	108.17	1.83	2.97	3.90	60.63	0.83	74.59
G_3: IL103	54.50	60.17	5.67	104.17	1.83	4.61	3.05	71.80	0.93	74.82
G_4: IL104	60.83	66.17	5.33	113.00	2.08	3.29	4.17	96.70	1.07	74.38
G_5: IL105	64.00	68.67	4.67	112.67	2.00	5.04	2.62	56.53	0.93	74.21
G_6: IL106	59.00	65.17	6.17	107.50	2.50	3.50	3.14	81.23	1.00	73.67
G_7: IL107	59.33	64.00	4.67	110.00	2.17	4.18	4.17	63.17	0.97	73.32
G_8: IL108	59.17	65.33	6.17	110.67	2.83	3.74	4.89	67.43	0.87	73.68
G_9: IL109	67.83	72.83	5.00	117.17	2.00	3.46	4.14	58.97	0.97	73.72
G_{10}: IL111	55.83	59.67	3.83	107.00	1.58	2.28	4.54	92.93	1.33	75.95
G_{11}: IL112	69.83	76.17	6.33	119.33	2.42	3.47	3.47	58.27	0.80	72.59
G_{12}: IL113	65.67	71.50	5.83	114.17	3.25	5.01	3.65	60.13	1.02	73.57
G_{13}: IL114	70.17	75.83	5.67	117.67	2.42	5.02	3.06	60.60	1.13	75.40
G_{14}: GYL6	56.17	61.33	5.17	106.33	2.25	4.68	3.45	79.83	1.27	74.25
G_{15}: GYL7	70.67	76.00	5.33	120.67	2.50	3.90	2.69	59.13	0.73	72.41
G_{16}: CLQ47	58.83	63.67	4.83	109.33	2.00	4.79	3.67	71.07	1.07	74.15
G_{17}: I-07-575	56.83	63.17	6.33	107.33	3.00	5.62	3.83	72.00	1.07	76.79

G_{18}: HKI-193-1	63.00	68.17	5.17	112.67	1.77	2.78	3.43	77.43	0.87	75.99
G_{19}: CM140	54.00	57.50	3.50	101.67	1.72	2.17	5.02	90.43	1.12	76.96
S.Em.±	0.62	0.70	0.32	1.30	0.29	0.16	0.11	4.00	0.06	0.75
C.D. (P=0.05)	1.74	1.98	0.90	3.66	0.83	0.44	0.31	11.27	0.17	2.12
CV %	2.47	2.59	14.78	2.87	6.21	4.77	7.25	13.84	7.92	2.47
Interaction										
S X G	Sig.	Sig.	Sig.	Sig.	NS	Sig.	Sig.	Sig.	NS	Sig.

Table 2: Influence of moisture stress on per se performance of flowering, leaf traits, proline content and yield and its attributing characterson maize inbred lines

Genotypes	DFT		DFS		ASI		DM		LS		PC (mg g^{-1} FW)		KYP (g)		SH (%)	
	Moisture Levels															
	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2
IL101	55.00	58.33	58.33	66.67	3.33	8.33	108.67	103.00	2.9	4.6	2.42	5.06	91.0	41.1	78.1	72.3
IL102	59.33	60.67	62.67	67.33	3.33	6.67	112.33	104.00	2.2	3.8	2.03	5.77	76.0	45.3	76.0	73.1
IL103	53.00	56.00	56.00	64.33	3.00	8.33	105.67	102.67	3.5	5.7	1.90	4.19	103.9	39.7	77.0	72.7
IL104	60.33	61.33	64.00	68.33	3.67	7.00	115.67	110.33	2.1	4.5	2.31	6.03	117.9	75.5	77.4	71.4
IL105	63.33	64.67	66.33	71.00	3.00	6.33	117.67	107.67	2.9	7.2	1.90	3.34	76.5	36.6	78.2	70.2
IL106	57.33	60.67	60.67	69.67	3.33	9.00	109.00	106.00	2.4	4.6	2.00	4.27	108.3	54.2	76.7	70.6
IL107	57.67	61.00	61.33	66.67	3.67	5.67	114.67	105.33	3.5	4.8	2.35	5.99	81.7	44.7	74.6	72.1
IL109	56.00	62.33	59.00	71.67	3.00	9.33	110.67	110.67	2.6	4.8	2.35	7.44	93.7	41.2	74.8	72.5
IL110	66.00	69.67	69.33	76.33	3.33	6.67	118.67	115.67	2.6	4.3	2.02	6.26	74.2	43.7	75.2	72.2
IL111	55.00	56.67	58.00	61.33	3.00	4.67	111.33	102.67	2.1	2.4	2.10	6.98	105.5	80.3	81.2	70.7
IL112	68.67	71.00	72.00	80.33	3.33	9.33	121.67	117.00	2.5	4.5	1.86	5.09	81.8	34.7	75.5	69.7
IL113	64.00	67.33	67.00	76.00	3.00	8.67	114.00	114.33	3.2	6.9	2.04	5.25	84.9	35.4	76.5	70.7
IL114	67.33	73.00	70.67	81.00	3.33	8.00	117.00	118.33	2.9	7.2	1.99	4.13	88.0	33.2	77.3	73.5
GYL6	54.33	58.00	57.33	65.33	3.00	7.33	107.33	105.33	3.1	6.3	1.90	5.00	118.8	40.9	77.9	70.6
GYL7	68.33	73.00	72.00	80.00	3.67	7.00	121.00	120.33	2.2	5.6	1.83	3.55	78.5	39.7	73.1	71.8
CMQ47	57.00	60.67	60.33	67.00	3.33	6.33	113.33	105.33	3.4	6.1	1.81	5.52	98.9	43.2	77.4	70.9
I-07-575	54.33	59.33	58.00	68.33	3.67	9.00	110.33	104.33	3.5	7.8	2.06	5.61	106.1	37.9	80.8	72.8
HKI-193-1	59.67	66.33	62.67	73.67	3.00	7.33	114.33	111.00	2.2	3.3	1.93	4.93	107.1	47.7	79.8	72.2
CM140	51.67	56.33	54.33	60.67	2.67	4.33	105.00	98.33	2.0	2.3	2.22	7.82	102.4	78.5	80.2	73.7
S.Em.±	0.87		0.99		0.45		1.83		0.22		0.16		5.65		1.06	
C.D. *	2.46		2.79		1.27		5.17		0.61		0.44		15.94		3.00	

* Signicant at 5% level; FW: Fresh weight of leaf ; S_1: Normal irrigation; S_2: Moisture stress at flowering

Table 3: Response of maize inbred lines towards moisture stress conditions at flowering stage

Genotypes	Response to water stress at flowering stage	ASI under stress	Leaf senescence under stress	% decrease in yield	~ fold increase in proline under stress
G_1: IL101	Susceptible	8.3	4.6	54.8	1.1
G_2:IL102	Moderately tolerant	6.7	3.8	40.4	1.8
G_3: IL103	Susceptible	8.3	5.7	61.8	1.2
G_4: IL104	Moderately tolerant	7.0	4.5	36.0	1.6
G_5: IL105	Susceptible	6.3	7.2	52.2	0.8
G_6: IL106	Susceptible	9.0	4.6	50.0	1.1
G_7: IL107	Moderately tolerant	5.7	4.8	45.3	1.5
G_8: IL108	Susceptible	9.3	4.8	56.0	2.2
G_9: IL109	Moderately tolerant	6.7	4.3	41.1	2.1
G_{10}: IL111	Tolerant	4.7	2.4	23.9	2.3
G_{11}: IL112	Susceptible	9.3	4.5	57.6	1.7
G_{12}: IL113	Susceptible	8.7	6.9	58.3	1.6
G_{13}: IL114	Susceptible	8.0	7.2	62.3	1.1
G_{14}: GYL6	Susceptible	7.3	6.3	65.6	1.6
G_{15}: GYL7	Susceptible	7.0	5.6	49.4	0.9
G_{16}: CLQ47	Susceptible	6.3	6.1	56.3	2.0
G_{17}: I-07-575	Susceptible	9.0	7.8	64.3	1.7
G_{18}: HKI-193-1	Susceptible	7.3	3.3	55.5	1.6
G_{19}: CM140	Tolerant	4.3	2.3	23.3	2.5

The genotypes were classified into three classes based on their response towards water stress at flowering stage in maize (Dubey *et al*., 2009) [7]. Out of nineteen inbred lines studied only two inbred lines i.e. IL111 and CM140 were found tolerant to moisture stress. These two lines also showed 2.5 and 2.3 fold increase in proline content under stress conditions in comparison to normal irrigated conditions. Total of four lines showed moderately tolerant response to stress viz., IL102, IL104, IL107 and IL109 based on their *per se* performance in stress and well watered conditions. The genotypes which are susceptible exhibited either long ASI period greater than 8 days or barren plants or/and high leaf senescence ranged from >50-100% dead leaves or/and high kernel yield penalty >50-100% as compared to well watered conditions. These genotypes are considered to have susceptible reaction towards water stress conditions at flowering stage. The following study was useful in selecting parents for hybridization programme intending to develop hybrids with early maturity. Based on the study, a total of ten parents were selected for hybridization. The list of selected parents is given in Table 3 along with the reaction towards moisture stress of the selected genotypes. Out of ten inbred lines six lines were found susceptible, two had tolerant and two had moderately tolerant reaction for moisture stress condition.

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