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Research Paper

Relationship of Morphology Characters and Yield under Drought Tolerance of Maize Genotypes using Line Source Sprinkler Irrigation Technique

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ABSTRACT

Forty maize genotypes were studied for influence of moisture stress on yield and yield characters using line source sprinkler irrigation technique during *rabi*-summer, 2016-17 and 2017-2018 using line source sprinkler irrigation technique. The genotypes, G32-DMIL 50, G16-DMIL 13, G39- DMIDS 28, G4-DMIL 78, G28-DMIT 01, G38-DMIDS 15, G15-DMIL 23, G21-DMIL 47, G24-DMIL 84 and G37-DMIDS recorded higher yield compared to other genotypes. The genotype G32- DMIL 50 found promising under various moisture regimes. The genotype G39- DMIDS 28 (148.93 cm) recorded significantly higher plant height followed by G28- DMIT 01 (147.15 cm), G16- DMIL 13 (146.79 cm), G15- DMIL 23 (144.01 cm), G32- DMIL 50 (142.90 cm) and G38- DMIDS 15 (142.06 cm). whereas, the genotype G32- DMIL 50 (310.07g) recorded significantly higher total dry matter. The mean total dry matter at harvest was significantly lower in G2- DMIL 29 (61.73 g) and G23- DMID 05 (67.23 g). The genotypes G5- DMIL 150 (58.25 dm^2), G37- DMIDS 10 (57.41 dm^2) and G31- DMIT 110 (56.55 dm^2) recorded significantly higher leaf area.

***Key words*:** Maize, Drought tolerance, Yield, Plant height, Leaf area, Total dry matter

Maize (*Zea mays* L.) being a C_4 plant belongs to family *Poaceae* and is popularly known as "Queen of cereals" because of its high production potential and wider adoptability. Maize is the important cereal crop occupying 144 m ha area with a production of 695 mt in the world. In India, it is grown in an area of 8.26 m ha with a production of 19.31 mt [1]. The productivity of maize in India is very low (2337 kg/ha) compared to the world average (4815 kg/ha). This is because nearly 79 per cent of the maize area is under rainfed situation, where the crop experiences soil moisture stress which leads to decreased yield. In Karnataka, the crop is grown in 1.17 m ha area with a production and productivity of 3.58 m t and 3060 kg/ha, respectively [1]. About 42 per cent of the maize area is under irrigation and 58 per cent of the area is under rainfed situation in Karnataka.

The economic losses in crop production due to drought are quite substantial and will undoubtedly further increase with the expected climate changes. To prepare for these changes, various new agricultural technologies are tried and utilized [2]. Low water availability is one of the major causes for crop yield reductions affecting the majority of the farmed regions around the world. As water resources for agronomic uses become more limiting, the development of drought-tolerant lines becomes increasingly more important [3]. Drought is a natural phenomenon caused by the combinations of hydrological, climatic, and environmental forces that result in insufficient precipitation for agricultural production over a prolonged duration [4]. With the increasing human population and depleting water resources, the development of drought-resistant crops is of prime importance to preventing crop yield losses from drought stress [5].

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MATERIALS AND METHODS

The line source sprinkler irrigation technique was laid out following the method developed by [6] in Main Agricultural Research Station, Dharwad, which is situated in agro-ecological northern transition zone (Zone 8) of Karnataka. Soil was red sandy loam in texture containing 5.50% coarse sand, 11.00% fine sand, 29.20% silt and 54.30% clay with pH of 7.65. The field experiment was conducted with 40 genotypes of maize. The seeds were sown in furrows by dibbling at a distance of 60 cm between the rows and 20 cm between the plants across the line source layout. Two to three seeds were dibbled per hill. At the time of dibbling care was taken to place the seeds at uniform depth. Thinning was done to retain one seedling per hill at 15 days after sowing. Recommended dose of fertilizer for irrigated condition 150:75:37.5 kg N: P: K per ha was applied. In moisture stress situation the entire dose of recommended fertilizer was applied as basal dose. While in case of irrigated condition the 50% of recommended dose of fertilizer and entire dose P_2O_5 and K_2O were applied as a basal dose. The remaining 50% of N was applied in two splits at 30 and 60 DAS. The field was irrigated through line source kept at 7.5 m interval daily to provide uniform irrigation to the plot up to 20 days after sowing. The treatment of water gradient levels was imposed on 21st day after sowing. Plant protection against pest and diseases was provided as per the package of practices and crop was maintained weed free throughout the season. Each genotype was raised in a two row of 7.5m length with a spacing of 60cm × 20 cm perpendicular to the line source on either side of the LS system with randomization. Each row was divided into 5 parts (M_1, M_2, M_3, M_4 and M_5 moisture regimes) each of 1.4m length which consisted of 7 plants. The water catch cans were placed perpendicular to LS system between rows in the middle of each part (moisture level) in line with sprinkler heads to estimate receipt of moisture levels. The water applied to each subplot was determined by measuring the water collected in plastic container (catch can) in different subplots at convenient locations (Fig 1).

The water collected in each plastic container is computed using:

$$\text{Water applied (cm)} = \frac{\text{Water collected in each plastic container in } M_1 \text{ (cm}^3\text{)}}{\text{Area of the plastic container (cm}^2\text{)}}$$

The amount of water applied to each subplot is accumulated over the duration of the treatment. Any rainfall during the imposition of drought treatments is added to water input to all subplots (Table 1).

Water deficit thus created was calculated relative to the open pan evaporation that occurs during the treatment period.

Water deficit created relative to the open pan evaporation that occurred during the treatment period was calculated using the formula:

$$\text{Water deficit (\%)} = \frac{X_1 - X_2}{X_1} \times 100$$

Where,

X_1 = Cumulative open pan evaporation during the experimental period (cm)

X_2 = Cumulative amount of water applied (including rain) during the experimental period (cm).

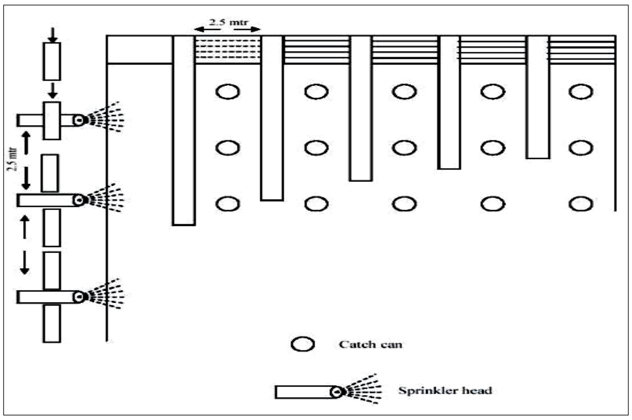

Fig 1 The line source sprinkler irrigation system and field arrangement of genotypes and catch cans used to establish a gradient of soil moisture

Table 1 Particulars of water used in line source sprinkler irrigation technique

Particulars	M_1	M_2	M_3	M_4	M_5
Amount of water supplied (ml)	42703.07	37424.12	26911.88	16335.31	10826.70
Amount of water received through rain (ml)	1786.00	1786.00	1786.00	1786.00	1786.00
Total amount of water (ml)	44489.07	39210.12	28697.88	18121.31	12612.70
Amount of water in (kg) (1ml=0.997g)	44355.61	39092.49	28611.79	18066.94	12574.86
Amount of water in cm (area of container 38.46 cm^2)	67.14	59.18	43.31	27.35	19.04
Moisture deficit (%)	11.17	-2.02	-28.29	-54.72	-68.48

Cumulative pan evaporation during the experimentation = 60.40 cm

RESULTS AND DISCUSSION

Morphological characters

Morphological characters play an important role in drought tolerance and the inclusion of these parameters is of immense interest in screening large number of genotypes due to their simplicity. Genetic improvement for drought tolerance is a long-term solution. The identification of markers which are associated with drought tolerance is useful in crop improvement programmes.

Plant height (cm)

Plant height is one of the important characters of growth and development of the canopy in maize. The genotypes selected as relatively tolerant in LST have maintained plant height with relatively lower per cent reduction under different moisture deficits. Similar results have been reported by [7] and [8] in cotton that plant height, number of leaves, buds and bolls were decreased with an increase in depletion of available soil moisture. Plant height is a major concern to plant breeder since yield has positively correlated with plant height in maize [9].

Severe drought stress in early growing stage affects the length of internodes [10] and reduction of plant height under drought stress was reported by [11]. Reduction in ear length was also reported in maize when subjected to drought [12-13]. The results of present study revealed that plant height among the genotypes, G39- DMIDS 28 (148.93 cm) recorded significantly higher plant height followed by G28- DMIT 01 (147.15 cm), G16- DMIL 13 (146.79 cm), G15- DMIL 23 (144.01 cm), G32- DMIL 50 (142.90 cm) and G38- DMIDS 15 (142.06 cm). The mean plant height at harvest was significantly lower in G2- DMIL 29 (82.36 cm) followed by G6- DMIT 30 (83.69 cm), G23- DMID 05 (85.92 cm) and G25- DMIL 99 (90.73 cm) (Table 2).

Significant amount of variability among long and short stature maize populations for ear and plant height [14]. Genetic diversity of maize plays a key role in maize breeding [15]. Similarly, [16] reported that plant height was the major contributor towards divergence, while studying on forage maize. These results are similar to those of [17-19] who also observed differences among the genotypes in plant height under stress conditions. The grain yield and its components also reduced when height was reduced due to drought stress indicating that height has strong positive relation with yield.

Number of leaves

Another important morphological parameter which has relevance to the performance of a genotype in terms of productivity is the number of leaves as they serve as a photosynthetically active source and considered as an important functional unit of plant which contributes to the growth and yield. The number of leaves was maximum at 85 DAS and declined later due to shedding, among the genotypes G28- DMIT 01 (12), recorded, significantly higher number of leaves followed by G16- DMIL 13 (11.7), G32- DMIL 50 (11.4), G15- DMIL 23 (11.2), G39- DMIDS 28 (11.2) and G38- DMIDS 15 (11). The number of leaves were significantly lower in G2- DMIL 29 (6.4), G6- DMIT 30 (6.8), G23- DMID 05 (7.2), G25- DMIL 99 (7.3), G5- DMIL 150 (7.4) and G19- DMID 16 (7.7) (Table 3). This may be attributed to the fact that growth and development of leaves was curtailed by water stress. These results are in conformity with the findings of [20-22] who also observed differences in number of leaves among the maize genotypes under varied moisture stress situations.

Table 2 Plant height (cm) of maize genotypes as influenced by different moisture regimes at harvest

S. No.	Genotypes	Plant height (cm) Moisture regimes					Mean
		M_1	M_2	M_3	M_4	M_5	
1	G1: DMIL 281	136.90	120.17	111.02	87.66	70.90	105.33
2	G2: DMIL 29	106.72	94.32	86.86	68.65	55.27	82.36
3	G3: NMI 15	139.88	123.49	113.99	89.84	72.16	107.87
4	G4: DMIL 78	179.46	159.50	144.45	115.81	91.15	138.07
5	G5: DMIL 150	121.67	106.92	99.15	78.51	62.53	93.76
6	G6: DMIT 30	108.58	96.51	87.40	69.85	56.12	83.69
7	G7: DMIL 112	128.92	113.94	105.06	81.90	66.77	99.32
8	G8: DMIT 11	166.82	147.94	135.95	106.98	84.73	128.48
9	G9: DMIL 132	156.75	138.85	126.17	100.99	79.46	120.44
10	G10: DMIT 27	166.32	147.83	133.71	107.33	84.47	127.93
11	G11: DMIL 77	144.45	128.39	116.99	91.77	74.81	111.28
12	G12: DMIL 58	124.98	110.83	101.10	79.27	64.73	96.18
13	G13: DMID 35	158.00	138.85	128.76	100.38	81.83	121.56
14	G14: DMIL 117	164.89	145.89	132.72	106.40	83.75	126.73
15	G15: DMIL 23	186.25	165.35	151.78	120.19	96.46	144.01
16	G16: DMIL 13	190.79	169.57	154.53	121.21	97.86	146.79
17	G17: DMIL 52	136.81	120.23	111.22	86.78	70.58	105.12
18	G18: DMIL 41	136.92	120.19	111.17	87.67	70.50	105.29
19	G19: DMID 16	125.20	110.03	102.03	80.04	64.84	96.43
20	G20: DMID 09	144.48	128.41	117.74	93.23	74.83	111.74
21	G21: DMIL 47	170.52	151.56	138.62	108.33	87.97	131.40
22	G22: DMID 147	164.69	144.73	132.56	106.27	83.65	126.38
23	G23: DMID 05	111.47	99.07	90.39	71.37	57.28	85.92
24	G24: DMIL 84	174.42	155.02	141.97	112.20	90.16	134.75
25	G25: DMIL 99	117.56	103.90	95.80	75.51	60.88	90.73
26	G26: DMIL 63	162.87	144.43	131.10	105.10	82.72	125.24
27	G27: DMIT 65	160.48	142.15	129.01	103.56	81.35	123.31
28	G28: DMIT 01	191.36	170.08	154.03	123.10	97.19	147.15
29	G29: DMID 02	159.57	141.83	130.04	101.37	82.64	123.09
30	G30: DMIL 97	155.17	137.60	126.45	99.51	80.36	119.82
31	G31: DMIT 110	154.12	135.44	125.60	99.30	78.28	118.55
32	G32: DMIL 50	185.98	164.56	149.70	120.01	94.27	142.90
33	G33: DMIDS 12	148.18	131.55	120.76	94.14	76.00	114.13
34	G34: DMIDS 03	143.29	127.36	116.05	90.89	73.35	110.19
35	G35: DMIDS 21	145.78	128.11	118.51	92.61	75.50	112.10
36	G36: DMIDS 33	154.10	135.27	125.12	99.44	78.27	118.44
37	G37: DMIDS 10	169.55	149.00	138.17	109.41	87.81	130.79
38	G38: DMIDS 15	183.92	163.47	149.88	118.68	94.33	142.06
39	G39: DMIDS 28	193.27	171.78	157.11	122.78	99.71	148.93
40	G40: DMIDS 07	143.66	126.25	115.64	92.70	73.97	110.44
	Mean	152.87	135.26	123.96	98.02	78.49	
	For comparison of	S.Em. ±			CD @ 0.05		
	Moisture regimes (M)	1.33			3.93		
	Genotypes (G)	3.76			11.12		
	M x G	8.40			24.86		

M_1 = +11.17 M_2 = -2.02 M_3 = -28.29 M_4 = -54.72 M_5 = -68.48

The genotypes differed significantly for number of leaves at all the growth stages during the period from 45 DAS to harvest. The number of leaves varied from 6-12 in all the genotypes. At M_5 moisture regime, the genotypes G16-DMIL 13 (9.5), G28-DMIT 01 (9.5), G15- DMIL 23 (9), G32- DMIL 50 (9), G39- DMIDS 28 (9) and G4 DMIL 78 (8.5) recorded significantly higher values compared to other genotypes. Similar results have been reported by [23] in cotton that, number of leaves was decreased with an increase in deficit of available soil moisture.

Table 3 Number of leaves per plant of maize genotypes as influenced by different moisture regimes at 85 DAS

S. No.	Genotypes	Number of leaves per plant / Moisture regimes					Mean
		M_1	M_2	M_3	M_4	M_5	
1	G1: DMIL 281	11.50	9.00	8.00	7.00	5.50	8.20
2	G2: DMIL 29	10.00	7.00	6.00	5.00	4.00	6.40
3	G3: NMI 15	11.50	9.50	8.50	7.00	6.00	8.50
4	G4: DMIL 78	13.50	11.50	10.50	9.50	8.50	10.70
5	G5: DMIL 150	11.00	8.00	7.00	6.00	5.00	7.40
6	G6: DMIT 30	10.00	7.50	6.50	5.50	4.50	6.80
7	G7: DMIL 112	11.50	9.00	8.00	6.50	5.00	8.00
8	G8: DMIT 11	13.00	11.50	10.00	9.00	8.00	10.30
9	G9: DMIL 132	12.50	10.50	9.50	8.50	7.00	9.60
10	G10: DMIT 27	13.00	11.00	10.00	9.00	8.00	10.20
11	G11: DMIL 77	12.00	9.50	8.50	7.50	6.50	8.80
12	G12: DMIL 58	11.00	9.00	8.00	6.50	5.00	7.90
13	G13: DMID 35	12.50	11.00	9.50	8.50	7.50	9.80
14	G14: DMIL 117	13.00	11.00	10.00	9.00	8.00	10.20
15	G15: DMIL 23	14.00	12.00	11.00	10.00	9.00	11.20
16	G16: DMIL 13	14.50	12.50	11.50	10.50	9.50	11.70
17	G17: DMIL 52	11.50	9.00	8.00	7.00	5.50	8.20
18	G18: DMIL 41	11.50	9.50	8.50	7.00	6.00	8.50
19	G19: DMID 16	11.00	8.50	7.50	6.50	5.00	7.70
20	G20: DMID 09	12.00	10.00	8.50	7.50	6.50	8.90
21	G21: DMIL 47	13.00	11.50	10.50	9.50	8.50	10.60
22	G22: DMID 147	13.00	11.00	10.00	9.00	8.00	10.20
23	G23: DMID 05	10.50	8.00	7.00	6.00	4.50	7.20
24	G24: DMIL 84	13.50	11.50	10.50	9.50	8.50	10.70
25	G25: DMIL 99	11.00	8.00	7.00	6.00	4.50	7.30
26	G26: DMIL 63	13.00	11.00	10.00	9.00	8.00	10.20
27	G27: DMIT 65	13.00	11.00	10.00	9.00	7.50	10.10
28	G28: DMIT 01	15.50	13.00	11.50	10.50	9.50	12.00
29	G29: DMID 02	12.50	11.00	9.50	8.50	7.50	9.80
30	G30: DMIL 97	12.50	10.50	9.50	8.00	7.00	9.50
31	G31: DMIT 110	12.50	10.50	9.00	8.00	7.00	9.40
32	G32: DMIL 50	14.50	12.50	11.00	10.00	9.00	11.40
33	G33: DMIDS 12	12.00	9.50	8.50	7.50	6.00	8.70
34	G34: DMIDS 03	12.50	10.50	9.00	7.50	6.50	9.20
35	G35: DMIDS 21	12.50	10.00	8.50	7.50	6.50	9.00
36	G36: DMIDS 33	12.50	10.50	9.00	7.50	6.50	9.20
37	G37: DMIDS 10	13.00	11.50	10.50	9.00	8.00	10.40
38	G38: DMIDS 15	14.00	12.00	11.00	9.50	8.50	11.00
39	G39: DMIDS 28	14.00	12.00	11.00	10.00	9.00	11.20
40	G40: DMIDS 07	12.00	9.50	8.50	7.00	6.00	8.60
	Mean	12.44	10.29	9.16	8.04	6.91	

For comparison of	S.Em. ±	CD @ 0.05
Moisture regimes (M)	0.11	0.33
Genotypes (G)	0.30	0.89
M x G	0.67	1.98

M_1 = +11.17 M_2 = -2.02 M_3 = -28.29 M_4 = -54.72 M_5 = -68.48

Total dry matter production (g/plant)

Dry matter production is an important yield contributing character, particularly under water limited situation, since the basic vegetative phase is essential for initiation of anthesis and silking. Drought stress reduces the rate of dry matter production and its partitioning thus affects the seed yield adversely. In the present study among the genotypes, G32- DMIL 50 (310.07g) recorded significantly higher total dry matter. The mean total dry matter at harvest was significantly lower in G2- DMIL 29 (61.73 g) and G23-DMID 05 (67.23 g) (Table 4).

The present study revealed the significant differences in dry matter production among the different genotypes. The high yielding genotypes, G32- DMIL 50 (310.07 g) had maximum total dry weight which indicates efficient translocation of photosynthates towards the maximum dry matter production thereby indicating the importance of moisture [24-28].

Table 4 Total dry matter (g/plant) of maize genotypes as influenced by different moisture regimes at harvest

S. No.	Genotypes	Total dry matter (g/plant) Moisture regimes M_1	M_2	M_3	M_4	M_5	Mean
1	G1: DMIL 281	189.16	165.20	141.09	113.02	93.83	140.46
2	G2: DMIL 29	82.86	72.61	61.80	50.00	41.35	61.73
3	G3: NMI 15	207.62	181.74	154.45	125.09	103.81	154.54
4	G4: DMIL 78	312.61	274.58	230.05	190.22	153.19	232.13
5	G5: DMIL 150	171.62	150.74	127.32	102.71	85.81	127.64
6	G6: DMIT 30	119.5	104.72	89.01	72.71	58.56	88.90
7	G7: DMIL 112	188.21	163.43	140.38	113.58	94.11	139.94
8	G8: DMIT 11	298.8	261.25	219.88	181.21	149.41	222.11
9	G9: DMIL 132	260.35	228.41	191.33	157.64	127.58	193.06
10	G10: DMIT 27	291.8	256.30	214.73	177.55	142.70	216.62
11	G11: DMIL 77	220.69	191.63	164.61	134.28	109.25	164.09
12	G12: DMIL 58	175.69	152.38	131.04	106.55	86.79	130.49
13	G13: DMID 35	260.7	226.38	194.45	156.02	130.36	193.58
14	G14: DMIL 117	289.92	254.65	213.35	175.25	142.07	215.05
15	G15: DMIL 23	336.77	295.80	251.19	204.58	168.39	251.35
16	G16: DMIL 13	385.97	335.15	285.96	234.85	191.06	286.60
17	G17: DMIL 52	199.37	172.92	148.31	119.32	99.29	147.84
18	G18: DMIL 41	201.94	176.36	150.02	120.65	100.37	149.87
19	G19: DMID 16	172.45	150.43	128.63	103.21	86.23	128.19
20	G20: DMID 09	239.24	210.13	178.45	145.57	119.63	178.60
21	G21: DMIL 47	295.07	256.22	219.50	179.54	146.95	219.46
22	G22: DMID 147	269.24	236.48	198.13	161.13	131.93	199.38
23	G23: DMID 05	90.37	78.92	67.04	54.99	44.83	67.23
24	G24: DMIL 84	311.79	273.23	232.25	189.72	155.59	232.52
25	G25: DMIL 99	164.27	143.79	122.53	99.13	82.14	122.37
26	G26: DMIL 63	273.53	240.25	201.29	165.89	134.04	203.00
27	G27: DMIT 65	272.31	239.18	200.12	164.88	133.17	201.93
28	G28: DMIT 01	361.44	316.74	265.98	219.93	177.11	268.24
29	G29: DMID 02	272.56	236.67	203.30	165.85	136.29	202.93
30	G30: DMIL 97	256.41	224.19	191.25	155.51	128.21	191.11
31	G31: DMIT 110	250.51	219.78	184.35	149.92	125.26	185.96
32	G32: DMIL 50	418.14	367.27	307.29	252.75	204.90	310.07
33	G33: DMIDS 12	234.62	203.73	173.83	142.53	117.31	174.40
34	G34: DMIDS 03	216.01	187.35	159.82	131.44	106.93	160.31
35	G35: DMIDS 21	240.12	208.51	179.10	143.71	119.58	178.20
36	G36: DMIDS 33	243.78	214.12	179.39	145.65	121.16	180.82
37	G37: DMIDS 10	307.82	270.37	229.60	184.22	153.92	229.19
38	G38: DMIDS 15	316.29	277.81	234.34	192.45	158.15	235.81
39	G39: DMIDS 28	327.8	284.64	243.85	199.46	163.25	243.80
40	G40: DMIDS 07	214.06	188.02	159.02	128.11	104.89	158.82
	Mean	248.53	217.30	184.20	150.27	123.23	

For comparison of	S.Em. ±	CD @ 0.05
Moisture regimes (M)	2.26	6.68
Genotypes (G)	6.39	18.90
M x G	14.28	42.27

M_1 = +11.17 M_2 = -2.02 M_3 = -28.29 M_4 = -54.72 M_5 = -68.48

Leaf area (dm^2 $plant^{-1}$)

Growth analysis is a physiological probe on the development of the crop in chronological sequence to elucidate and account the causes for differences in yield through the events that have occurred earlier in the growth. Variation in leaf area was a main cause of differences in yield but variation in net assimilation rate (NAR) was of minor importance [29].

In present study, among the genotypes G5- DMIL 150 (58.25 dm^2), G37- DMIDS 10 (57.41 dm^2) and G31- DMIT 110 (56.55 dm^2) recorded significantly higher leaf area. The Leaf area was significantly lower in G20- DMID 09 (21.80 dm^2), G2- DMIL 29 (22.16 dm^2), G30- DMIL 97 (24.08 dm^2) and G32- DMIL 50 (24.47 dm^2) (Table 5). Similarly, leaf expression growth is often the first detectable response to water stress [30].

Table 5 Leaf area (dm^2 $plant^{-1}$) of maize genotypes as influenced by different moisture regimes at harvest

S. No.	Genotypes	Leaf area (dm^2 $plant^{-1}$) Moisture regimes					Mean
		M_1	M_2	M_3	M_4	M_5	
1	G1: DMIL 281	37.54	32.59	28.63	27.95	24.36	30.21
2	G2: DMIL 29	27.45	23.83	21.10	20.52	17.89	22.16
3	G3: NMI 15	49.42	42.81	37.93	37.00	32.17	39.87
4	G4: DMIL 78	34.33	29.46	26.56	25.36	22.45	27.63
5	G5: DMIL 150	72.26	62.45	55.17	54.09	47.25	58.25
6	G6: DMIT 30	35.77	31.02	27.67	26.42	23.32	28.84
7	G7: DMIL 112	34.15	29.65	26.25	25.56	21.99	27.52
8	G8: DMIT 11	41.86	35.93	32.30	31.34	27.20	33.72
9	G9: DMIL 132	35.61	30.53	27.44	26.30	23.25	28.63
10	G10: DMIT 27	34.33	29.46	26.56	25.32	22.45	27.62
11	G11: DMIL 77	36.67	31.84	28.37	27.27	23.61	29.55
12	G12: DMIL 58	59.78	51.90	46.12	44.39	38.43	48.13
13	G13: DMID 35	40.11	34.83	30.63	30.03	25.83	32.28
14	G14: DMIL 117	50.35	43.21	38.75	37.19	32.92	40.48
15	G15: DMIL 23	39.77	34.53	30.72	29.77	26.01	32.16
16	G16: DMIL 13	40.80	35.22	31.56	30.34	26.27	32.84
17	G17: DMIL 52	44.02	38.13	33.61	32.86	28.30	35.39
18	G18: DMIL 41	65.47	56.65	49.92	48.81	42.48	52.67
19	G19: DMID 16	59.76	51.89	45.63	44.74	38.72	48.15
20	G20: DMID 09	26.95	23.40	20.85	20.17	17.62	21.80
21	G21: DMIL 47	39.45	34.17	30.52	29.45	25.40	31.80
22	G22: DMID 147	45.00	38.62	34.36	33.24	29.43	36.13
23	G23: DMID 05	46.28	40.00	35.80	34.46	30.03	37.31
24	G24: DMIL 84	58.10	50.39	44.94	43.43	37.87	46.95
25	G25: DMIL 99	38.08	33.06	29.27	28.51	24.79	30.74
26	G26: DMIL 63	36.58	31.39	28.22	27.02	23.92	29.43
27	G27: DMIT 65	60.39	51.77	46.53	44.54	39.49	48.54
28	G28: DMIT 01	52.28	44.87	40.44	38.61	34.08	42.06
29	G29: DMID 02	42.52	36.92	32.89	31.83	27.38	34.31
30	G30: DMIL 97	29.82	25.89	23.01	22.32	19.38	24.08
31	G31: DMIT 110	70.28	60.32	53.66	52.61	45.89	56.55
32	G32: DMIL 50	30.44	26.09	23.43	22.48	19.90	24.47
33	G33: DMIDS 12	52.92	45.68	40.88	39.62	34.07	42.64
34	G34: DMIDS 03	43.44	37.46	33.60	32.30	27.93	34.95
35	G35: DMIDS 21	36.05	31.30	27.53	26.91	23.21	29.00
36	G36: DMIDS 33	31.83	27.32	24.27	23.73	20.81	25.59
37	G37: DMIDS 10	71.15	61.78	54.33	53.26	46.52	57.41
38	G38: DMIDS 15	34.16	29.49	26.42	25.57	22.34	27.60
39	G39: DMIDS 28	37.56	32.54	29.05	28.04	24.18	30.28
40	G40: DMIDS 07	36.64	31.70	27.98	27.06	23.96	29.47
	Mean	43.98	38.00	33.82	32.76	28.58	

For comparison of	S.Em. ±	CD @ 0.05
Moisture regimes (M)	2.26	6.68
Genotypes (G)	6.39	18.90
M x G	14.28	42.27

M_1 = +11.17 M_2 = -2.02 M_3 = -28.29 M_4 = -54.72 M_5 = -68.48

Grain yield (kg/ha)

Among the moisture regimes, M_1 recorded significantly higher values for maize yields followed by M_2, M_3 and M_4 and these treatments differed significantly among themselves. The treatment M_5 recorded significantly lower maize yield compared to other treatments.

Irrespective of moisture regimes and genotypes G32-DMIL 50 (4764) recorded the highest yield (kg/ha) and lowest yield (kg/ha) was observed in G2- DMIL 29 (1038) (Table 6). The interaction effects between moisture regimes and genotypes were significant. The genotype G32- DMIL 50 (6626), G16- DMIL 13 (6113) and G39- DMIDS 28 (5900) recorded significantly higher yield (kg/ha) at M_1 moisture regime and significantly lower yield (kg/ha) was recorded in genotype G2- DMIL 29 (559), G6- DMIT 30 (1202), G23-DMID 05 (1205) and G25- DMIL 99 (1314) at M5 moisture regime. At M_5 moisture regime genotype G32- DMIL 50 (2518), G16- DMIL 13 (2354), G39- DMIDS 28 (2289), G38- DMIDS 15 (2251), G15- DMIL 23 (2244) and G4- DMIL 78 (2209) recorded significantly higher yield (kg/ha) compared to other genotypes.

CONCLUSIONS

Considering all the above parameters under severe moisture stress the genotypes, G32-DMIL 50, G16-DMIL 13, G39- DMIDS 28, G4-DMIL 78, G28-DMIT 01, G38-DMIDS 15, G15-DMIL 23, G21-DMIL 47, G24-DMIL 84 and G37-DMIDS 10 performed well compared to other genotypes. The genotype G32- DMIL 50 found promising under various moisture regimes.

Table 6 Yield (kg/ha) as influenced by different moisture regimes in maize genotypes

S. No.	Genotypes	Yield (kg/ha) Moisture regimes					Mean
		M_1	M_2	M_3	M_4	M_5	
1	G1: DMIL 281	3702	3350	2777	2070	1429	2666
2	G2: DMIL 29	1436	1304	1077	812	559	1038
3	G3: NMI 15	4087	3707	3057	2305	1594	2950
4	G4: DMIL 78	5814	5291	4302	3314	2209	4186
5	G5: DMIL 150	3540	3221	2641	1982	1380	2553
6	G6: DMIT 30	3164	2872	2369	1803	1202	2282
7	G7: DMIL 112	3531	3178	2648	1995	1377	2546
8	G8: DMIT 11	5267	4772	3897	2992	2054	3796
9	G9: DMIL 132	4814	4376	3557	2729	1829	3461
10	G10: DMIT 27	5198	4731	3847	2963	1970	3742
11	G11: DMIL 77	4318	3886	3238	2461	1662	3113
12	G12: DMIL 58	3531	3175	2648	2006	1356	2543
13	G13: DMID 35	4660	4194	3495	2609	1817	3355
14	G14: DMIL 117	4916	4474	3638	2783	1868	3536
15	G15: DMIL 23	5754	5236	4316	3274	2244	4165
16	G16: DMIL 13	6113	5502	4554	3485	2354	4402
17	G17: DMIL 52	3702	3328	2769	2073	1436	2662
18	G18: DMIL 41	3848	3482	2874	2151	1489	2769
19	G19: DMID 16	3540	3200	2655	1982	1380	2551
20	G20: DMID 09	4378	3984	3283	2495	1707	3169
21	G21: DMIL 47	5686	5117	4253	3241	2206	4101
22	G22: DMID 147	4942	4497	3657	2767	1878	3548
23	G23: DMID 05	3121	2824	2328	1779	1205	2251
24	G24: DMIL 84	5575	5062	4175	3178	2169	4032
25	G25: DMIL 99	3369	3055	2527	1903	1314	2434
26	G26: DMIL 63	4968	4520	3676	2822	1888	3575
27	G27: DMIT 65	4856	4419	3589	2754	1841	3492
28	G28: DMIT 01	5814	5279	4302	3314	2209	4184
29	G29: DMID 02	4745	4271	3559	2705	1851	3426
30	G30: DMIL 97	4703	4260	3527	2671	1834	3399
31	G31: DMIT 110	4677	4251	3461	2619	1824	3366
32	G32: DMIL 50	6626	6030	4897	3750	2518	4764
33	G33: DMIDS 12	4514	4063	3363	2569	1761	3254
34	G34: DMIDS 03	4343	3905	3231	2476	1672	3126
35	G35: DMIDS 21	4403	3963	3302	2466	1708	3169
36	G36: DMIDS 33	4660	4240	3448	2605	1803	3351
37	G37: DMIDS 10	5515	5018	4136	3088	2151	3982
38	G38: DMIDS 15	5771	5252	4300	3290	2251	4173
39	G39: DMIDS 28	5900	5310	4413	3363	2289	4255
40	G40: DMIDS 07	4232	3851	3161	2370	1608	3045
	Mean	4593	4161	3424	2600	1772	

For comparison of	S.Em. ±	CD @ 0.05
Moisture regimes (M)	41.10	121.65
Genotypes (G)	116.24	344.07
M x G	259.92	769.37

M_1 = +11.17 M_2 = -2.02 M_3 = -28.29 M_4 = -54.72 M_5 = -68.48

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