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Identification of pearl millet genotypes for drought and high temperature condition in arid and semi-arid regions

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Abstract
An experiment was conducted at All India Coordinated Research Project on pearl millet, Mandor during summer 2019-20 in Randomized Block Design (RBD) with three replications under normal and moisture stress conditions. Ten (10) randomly selected genotypes were sown with recommended cultivation practices of the region. The suitability of the genotypes was judged in terms of grain yield, stover yield, drought susceptibility index (DSI), drought tolerance efficiency (DTE), grain reduction percentage (GRP), threshing percentage (TP) and harvest index (HI). The maximum stover yield was recorded by inbred J-2563 (11115 kg/ha) under irrigated condition whereas JMSB-20172 recorded the maximum stover yield (7604 kg/ha) under terminal stress condition. The lowest drought susceptibility index (DSI) was observed in JMSB-20101 (0.38) which indicated better adaptability of the genotype under terminal stress and high temperature condition.

Keywords: Stress, drought, pearl millet, yield, drought susceptibility index, drought tolerance efficiency

Introduction
Pearl millet is the most important millet crop for human as well as animal feeding. It is grown in arid and semi-arid region occupying fourth position among the cereals next to rice, wheat and sorghum, both in term of area (7.41 mha) and in production (10.30 mt) with an average productivity of 1391 kg/ha [1]. Drought is the most severe abiotic stress reducing pearl millet yield in rainfed drought areas. It is known that pearl millet thrives well under drought prone condition but variant in intensity and severity of drought from season to season and place to place requires cultivation of such varieties of pearl millet which have different level of drought tolerance in different areas. Nevertheless, there is a greater variability for yield performance of different pearl millet genotypes under drought situation. Effort to measure the degree of tolerance with a single parameter has limited value because of the multiplicity of the factors and their interactive condition. Different workers used different methods to evaluate genetic differences in drought tolerance [2]. One of the greatest challenges in drought is to sow a seed type that has the capacity to produce abundant biomass and can mature in a short period of time [3]. The objective of the present study was to identify genotypic differences in adaptation of ten pearl millet genotypes to drought and high temperature conditions under arid and semiarid areas. For breeding such cultivars, it will require parents having sufficient tolerance/ resistance power against moisture stress situations. Hence, it becomes necessary to breed a variety which can fit well in varied moisture stress condition. The present experiment was therefore conducted to find out genotypes for drought and high temperature tolerance to reduce risk of yield loss in drought condition.

Material and Methods
Ten genotypes (J-2526, J-2552, J-2563, J-2584, J-2592, JMSB-101, JMSB-20101, JMSB-20151, JMSB-20155 and JMSB-20172) of pearl millet received from Main Pearl millet Research Station, Junagadh Agricultural University, Jamnagar were evaluated during summer season of 2019-20 at research Farm of ACIRP on pearl millet, Mandor, Agricultural University, Jodhpur under moisture stress (I_a) and irrigated (I_b) conditions in two sets of randomized block design with three replications. Each entry represented by two rows of 4 m length with the row to row and plant to plant spacing of 60 x 10 cm, respectively. One set of experiment was sown under rainfed situation with sufficient soil moisture condition ensuring

good germination. Additional irrigations were given to plots of irrigated experiment only at flowering stage of the crop. The meteorological data at research Farm of ACIRP on pearl millet Mandor (Agricultural University, Jodhpur) during summer, 2019-20 is presented in Table 1.

Drought susceptibility index (DSI) was calculated by the formula given [4].

$$DSI = (1-Y_a / Y_b) / D$$

Where,

Y_a= Grain yield of the genotype under moisture stress condition.

Y_b= Grain yield of the genotypes under irrigated condition

$$D = \frac{\text{Mean grain yield of all strains under moisture stress condition}}{\text{Mean grain yield of all strains under irrigated condition}}$$

Drought tolerance efficiency (DTE) was estimated by using formula given [5].

$$DTE\ \% = \frac{\text{Yield under stress condition}}{\text{Yield under non-stress condition}} \text{ x100}$$

The threshing index and harvest index were calculated using following formula;

$$\text{Threshing index (\%)} = \frac{\text{Grain yield(kg)}}{\text{Dry ear head weight (kg)}} X100$$

$$\text{Harvest index (\%)} = \frac{\text{Econimic yield}}{\text{Biological yield}} X100$$

Results and Discussion

Among ten genotypes, JMSB-20101 showed maximum grain yield levels under moisture stress (1385 kg/ha) and J-2526 in irrigated condition (3144 kg/ha). The ability of genotype JMSB-20101 to produce more biomass under stress condition shows its ability to produce more seed yield. Further, it has highest drought tolerance efficiency (62.44%), least drought susceptibility index (0.38) and minimum reduction in seed yield (37.56%) due to moisture stress and high temperature. More importantly, it maintained highest values of harvest index under moisture stress (17.5%) as well as irrigated (19.4%) condition as compared to other genotypes (Table 2). It was reported that the drought resistant genotype had highest drought tolerance efficiency, minimum drought susceptible index and minimum reduction in grain yield due to moisture stress [6]. They also reported that it maintained highest harvest index and very low values of membrane injury index under rainfed as well as irrigated condition. It also maintained the highest harvest index (HI) and have high threshing percentage (Fig. 1) under moisture stress condition which indicated that the genotype JMSB-20101 may be rated as high temperature and drought tolerant genotype for moisture stress condition and heat stress. It was also reported that in pearl millet, co-mapping of the harvest index and panicle harvest index with grain yield revealed greater drought tolerance by greater partitioning of dry matter from stover to grains [7]. In the present study grain reduction percentage and harvest index under irrigated condition as well as in terminal stress condition was recorded by inbred JMSB-20101(2219 kg/ha and 1385 kg/ha, respectively). The lowest drought susceptibility index (DSI) was observed in JMSB-20101 (0.38) followed by JMSB-101(0.42) which showed better adaptability of the genotypes under high temperature condition.

Table 1: Meteorological data of Mandor during Summer 2019-20

Meteorological Month /Week	Temp. in ºC		Rainfall (in mm)	No. Rainy days	Rel. Humidity	
	Min	Max			Min (%)	Max (%)
Jan8-14	9.6	16.9	0	0	42.7	65.3
Jan15-21	11.3	17.1	0	0	48.9	74.1
Jan22-28	11.0	20.4	0	0	29.7	56.0
Jan. 29 - Feb. 04	9.9	19.0	0	0	30.9	56.3
Feb.5-11	10.6	20.3	0	0	28.3	56.6
Feb.12-18	13.9	25.9	0	0	15.9	35.0
Feb.19-25	15.7	23.6	0	0	36.3	63.0
Feb. 26 -Mar. 04	18.0	25.6	0	0	35.6	62.6
Mar5-11	14.9	21.6	0	0	40.6	62.6
Mar12-18	16.1	24.6	0	0	23.6	42.9
Mar19-25	21.4	28.3	0	0	27.7	46.3
March 26 -April 1	20.6	28.1	0	0	31.4	55.4

Table 2: Effect of different high temperature and moisture situations on yield and different parameters

S. No.	Genotypes	Grain Yield (kg/ha)		Fodder Yield (kg/ha)		% reduction	DTE%	DSI%	HI	
		Ia	Ib	Ia	Ib				Ia	Ib
1	J-2526	1103	3144	5135	7701	64.90	35.10	0.65	14.5	23.9
2	J-2552	139	1649	5326	10463	91.58	8.42	0.92	2.2	11.6
3	J-2563	276	810	7243	11115	65.87	34.13	0.66	3.3	6.0
4	J-2584	196	363	3306	5542	46.08	53.92	0.46	4.5	5.3
5	J-2592	165	1939	5764	7903	91.48	8.52	0.91	2.4	16.6
6	JMSB-101	843	1464	4833	7622	42.41	57.59	0.42	12.7	13.5
7	JMSB-20101	1385	2219	4840	7132	37.56	62.44	0.38	17.5	19.4
8	JMSB-20151	319	985	5340	6639	67.56	32.44	0.68	5.0	11.1
9	JMSB-20155	533	945	5153	6875	43.57	56.43	0.44	8.3	9.5
10	JMSB-20172	1058	2920	7604	8590	63.76	36.24	0.64	10.7	20.4
	CD at 5%	121	478	837	1304				1.7	3.9

	CV (%)	12	17	9	10				12.2	16.7

I_a – Moisture stress condition I_b – Irrigated condition

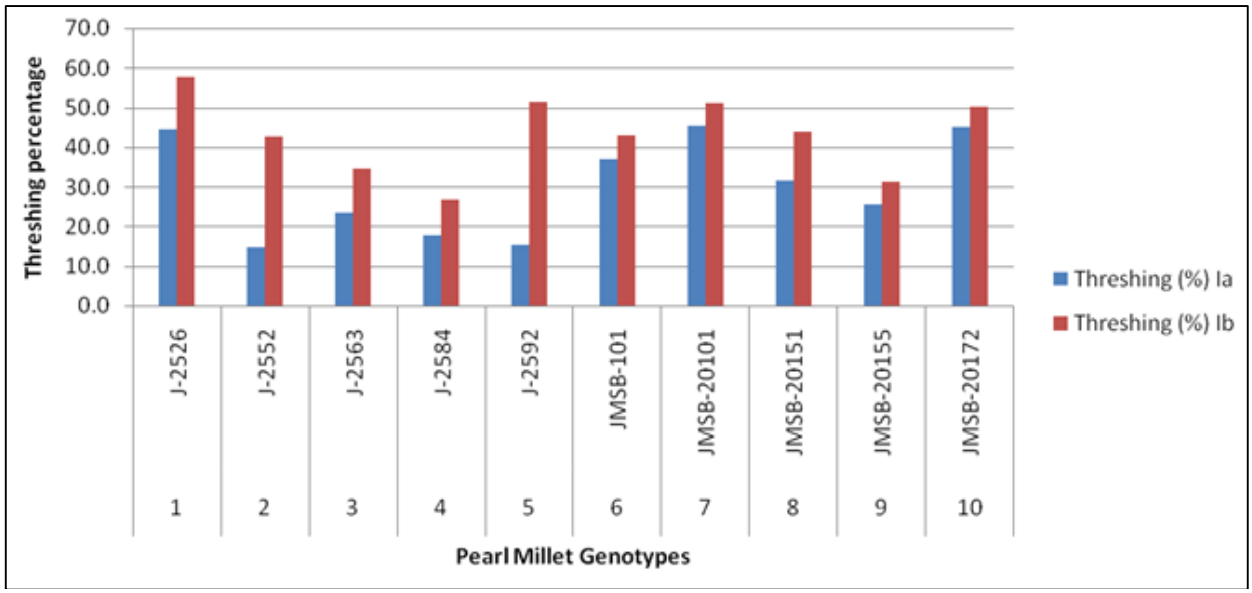

Fig 1: Effect of high temperature and drought stress on threshing percentage of the genotypes

Conclusion

The genotype JMSB-20101 and JMSB-101 may be preferred for developing suitable varieties for moisture stress and high temperature condition.

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Conflict of Interest

Author has no conflict of interest of any type.

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