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Study of stress susceptibility indices for yield and component traits in groundnut (*Arachis hypogaea* L.) under drought stress conditions in Rajasthan

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Abstract

Groundnut is an important legume crop both in subsistence and marketable farming in arid and semi-arid regions of the world. The irregular rainfall in the rainfed conditions has been denoted as a most significant climatic factor affecting groundnut production in the arid and semi-arid regions among the numerous abiotic stresses. Tailoring groundnut varieties with tolerance to drought and efficient in water use offers the best long term and cost-effective solution to encounter the uncertainty of monsoon and shrinking availability of irrigation water in country. Hence, a set of sixty groundnut genotypes were evaluated for their drought tolerance towards limited moister availability in rainfed conditions on the basis of three stress susceptibility indices; drought susceptibility index (DSI), drought tolerance efficiency (DTE) and stress tolerance index (STI). These indices have been calculated for eight yield related morpho-physiological traits, which depicted their relative performance under drought stressed conditions in comparison with fully irrigated conditions. On the basis of average ranking RG-559-3, RG-510, RG-425, MH-1, RG-562, GG-14, DGR-7, ICGV-6052 were identified as promising drought tolerant genotypes owing to their lower DSI (<0.80), higher DTE (>80%) and STI (>45) values. A higher amount of transgressive segregants can be obtained by using these cultivars in purposeful hybridization for drought tolerance traits, hence these cultivars further can be used in tailoring drought tolerance in putative groundnut genotypes to mitigate the limited moisture stress conditions.

Keywords: Groundnut, drought, tolerance, rainfed

1. Introduction

Groundnut (*Arachis hypogaea* L.) is an important legume crop both in subsistence and marketable farming in arid and semi-arid regions of the world (Izge *et al*., 2005) [6]. It is commercially cultivated in about 114 countries in tropical and warm temperate regions of the world. Major groundnut producing countries of the World are China, India, USA, Nigeria, Myanmar and Sudan. India ranks first in area and second in production. Nationwide, it covers a total area of about 4.81 MHa with an annual production of 10 MT. In India, the three major groundnut producing states are Gujarat, Rajasthan and Tamil Nadu. Particularly, In Rajasthan, it occupies an area of 0.64 MHa with an annual production of 1.93 MT (Directorate of Economic & Statistics, Department of Agriculture, Cooperation and Farmers Welfare: 2019-20).

India, though has the largest peanut area (4.81 MHa) in the world, but its average productivity is only around 2063 kg ha^{-1} (Directorate of Economic & Statistics, Department of Agriculture, Cooperation and Farmers Welfare: 2019-20). Many researchers concluded that this low productivity may be attributed to cultivation of crop predominantly under marginal and submarginal lands (mainly in rainfed conditions), biotic and abiotic stresses and many socio-economic factors (Hampannavar and Khan 2019) [5]. The irregular rainfall in the rainfed conditions (having major cultivation of groundnut) has been denoted as a most significant climatic factor affecting groundnut production in the arid and semi-arid regions among the numerous abiotic stresses. Groundnut yield in rainfed areas has been limited by the drought stress. Pod yield and other growth parameters have been severely affected (Pimratch *et al.*, 2008, Nautiyal *et al.*, 2002, Reddy *et al.*, 2003) [11, 9, 12]. Yield losses have been estimated up to 56-85% depending on crop growth stage when it was exposed to drought (Reddy *et al.*, 2003) [12], drought intensity and drought duration (Nautiyal *et al.*, 2002) [9].

Tailoring groundnut varieties with tolerance to drought and efficient in water use offers the best long term and cost-effective solution to encounter the uncertainty of monsoon and shrinking availability of irrigation water in country. Selection of tolerant genotypes will help to further transfer this tolerance in high yielding varieties by various breeding methods. In breeding programs, yield is the primary trait for selection under drought prone conditions. However, identification of drought tolerant and drought susceptible genotypes based on yield under stress alone is compounded by the genotype's yield potential and phenology. To remove the effect of variation in phenology and yield potential, Fisher and Maurer (1978) [4] developed a method to assess drought tolerance using drought susceptibility index (DSI), Fisher and Wood, (1981) [3] developed drought tolerance efficiency (DTE) and Fernandez, (1992) [2] developed stress susceptibility Index (SSI) (Pavithradevi *et al*. 2015) [10]. These characteristic is used in many reports for identifying the genotypes with yield stability under water limited conditions. The stress susceptibility index measures the yield stability that apprehends the changes in both potential and actual yield in variable environments (Fisher and Maurer, 1978) [4]. The basic advantage in selecting yield as the selection criteria is that it integrates all the additive traits of many underlying mechanisms of drought tolerance (Kambiranda *et al.* 2011) [7]. Notably, a very few studies have been attempted to get reliable information concerning drought tolerance in groundnut, which still requires some more work. Thus, an effective breeding strategy can be developed for breeding high yielding drought tolerant groundnut genotypes. Hence, in the present investigation an effort has been made to understand the response of groundnut genotypes to drought tolerance towards terminal drought stress conditions.

2. Material and Methods

The present investigation was carried out during *kharif* 2019 at Research Farm, Rajasthan Agricultural Research Institute (Sri Karan Narendra Agriculture University, Jobner), Durgapura, Jaipur (Rajasthan). In these field experiment, 60 genotypes of groundnut belongs to different geographical sources and different growth habits were evaluated for their performance under field conditions for drought stress. These genotypes were grown in field conditions in randomized block design (RBD) with three replications each having two rows of 4m (R×R = 45cm, P×P = 15cm) under two different environments: Drought stress condition, Fully irrigated conditions as Control. All recommended agronomical package of practices were adopted to raise good crop. Observations were recorded for eight morpho-physiological traits like pod yield/plant, kernel yield/plant, 100-kernel weight, pods/plant, shelling%, haulm yield/plant, sound mature kernel (SMK%) and harvest index.

Differences in drought susceptibility index (DSI) and drought tolerance efficiency (DTE) as well as stress tolerance index (STI) among genotypes were analyzed for all the traits. Drought susceptibility index was calculated by using the formulas as suggested by Fisher and Maurer (1978) [4].

$$SSI = [l-YD/YP]/D$$

Where;

YD = Mean of the genotype in stress environment (drought).
YP = Mean of the genotype under non-stress environment.
D = 1-[mean YD of all genotypes/mean YP of all genotypes].

Drought tolerance efficiency was calculated by using the formulas as suggested by Fischer and Wood (1981) [3] and Stress tolerance index was calculated by using the formulas as suggested by Fernandez (1992) [2].

3. Results and Discussion

The stress susceptibility index measures the yield stability that apprehends the changes in both potential and actual yield in variable environments (Fisher and Maurer, 1978) [4]. The basic advantage in selecting yield as the selection criteria is that it integrates all the additive traits of many underlying mechanisms of drought tolerance (Kambiranda *et al.* 2011) [7]. The drought tolerant genotypes should have high drought tolerant efficiency and stress tolerance index and least drought susceptibility index (Arunachalam and Kanan 2013) [1]. In general, most of the genotypes showed high DSI value (>1) as well as low DTE value (> 60%). Hence, we can say that, all the phenological, morpho-physiological, yield and related traits were adversely affected under drought stress as compared to normal irrigated environment. Notably, the stress tolerance index (STI) is used to identify genotypes that produce high yield under both stressed and non-stress conditions (Fernandez, 1992) [2]

The DSI values of the 60 groundnut genotypes for eight important traits varied from 0.19 to 3.19 (Table 1), likewise the DTE value ranged from 50.91% to 96.96% (Table 1). Including all the eight traits viz., pod yield/plant, kernel yield/plant, 100-kernel weight, pods/plant, shelling%, haulm yield/plant, sound mature kernel (SMK%) and harvest index, the overall mean DSI and DTE values for all the genotypes were 1.00 and 83.23% respectively. Similar work done by Arunachalam and Kanan (2013) [1] in twenty groundnut genotypes and recorded average DSI value (0.82), DTE (57.06%).

Overall minimum average DSI value was recorded in genotype RG-559-3 (0.59) followed by RG-510 (0.62). Similarly, overall average maximum DTE value was recorded in genotype RG-559-3 (91.60%) followed by Girnar-2 (91.04%). The other genotypes having lowest DSI and Maximum DTE in comparison to remaining genotypes were MH-1, DGR-7, Girnar-2, RG-425, RG-562 and GG-14 (Table 3) indicating their higher drought tolerance than other genotypes. The average DSI and DTE value of these promising genotypes were low (<0.80 for DSI and >80% for DTE) due to their low DSI value and high DTE value for yield and other drought related morpho-physiological traits. These promising genotypes also showed less reduction (<20%) for kernel yield under field conditions, thereby indicating that these genotypes were drought tolerant.

On the contrary, maximum overall average DSI value was observed in genotype HNG-123 (1.54) followed by RG-606 (1.51). Similarly, minimum overall average DTE value was observed in genotype HNG-123 (73.70%) followed by TPG-41 (74.40%) depicting their susceptibility towards drought stress conditions.

Among different traits the mean DSI and DTE values for pod yield/plant were 1.03 and 75.18%, for kernel yield/plant 1.02 and 76.64%, for shelling% 1.01 and 89.49%, for SMK% 1.01 and 91.85%, for haulm yield/plant 1.01 and 82.68%, for 100-kernel weight 0.98 and 83.42%, for pods/plant 1.00 and 76.02% and for harvest index 0.97 and 90.53% respectively.

The minimum DSI and maximum DTE value for pod yield/plant was recorded in genotype RG-425 (0.35 and 91.58%) followed by RG-559-3 (0.38 and 90.78%), for kernel yield/plant was recorded in genotype RG-559-3 (0.38 and 91.33%) and Girnar-2 (0.38) followed by RG-562 (0.41 and 91.25%), for shelling% was recorded in genotype RG-703 (0.40 and 95.81%), for sound mature kernel % was recorded in genotype ICG-115-1 (0.38) and RG-625 (96.96%) followed by RG-704 and RG-583 (0.53) ICG-115-1 (96.89%), for haulm yield/plant was recorded in genotype RG-425 (0.19 and 96.67%) followed by GG-20 (0.32) and Girnar-2 (96.15%), for 100-kernel weight was recorded in genotype RG-559-3 (0.46 and 92.22%) followed by RG-425 (0.58 and 90.07%), for pods/plant the minimum DSI and maximum DTE value was recorded in genotype UTKARSH (0.27 and 93.55%) followed by Girnar-2 (0.41 and 90.22%). Likewise, for harvest index, the minimum DSI and maximum DTE values for harvest index was recorded in genotype GG-14 (0.32 and 96.89) followed by RG-559-3 (0.35 and 96.57%). Similar findings were observed for hundred mini core entries of groundnut by Mamadou *et al.* (2017) reporting higher DTI values (>.60) for pod yield. They found the range of DTI from 0.51 to 2.18 for pod yield. In another work, Sanogo *et al.* (2020) [14] observed STI (0.20 to 1.40) and DTI (0.25 to 0.94) values for ninety-six groundnut genotypes for pod yield.

Analogously, all the 60 groundnut genotypes also showed significant diversity for stress tolerance index (STI) observed for all the eight traits. It showed the range between 17.41 to 54.66 (Table 2) for all the traits and all the genotypes. These findings were in consensus with the results of Arunachalam and Kanan (2013) [1] reported average STI of 15 in twenty peanut genotypes.

The maximum overall average STI value was recorded in the genotype RG-559-3 (59.54) followed by Girnar-2 (59.26). The other genotypes having the overall average highest STI value (>45) were; DGR-7, RG-425 and RG-510 (Table 3). These higher values of average STI value of these promising drought tolerant genotypes were attributed to their high STI value for yield and other drought related morpho-physiological characters. These genotypes recorded higher pod yield/plant in both stress and non-stress conditions as well as these promising genotypes also showed less reduction (<20%) for kernel yield under field conditions, thereby indicating that these genotypes were drought tolerant.

Among different traits the average STI value were recorded for pod yield/plant was 18.37, for kernel yield/plant (15.28), for shelling% (53.53), for sound mature kernel % (76.91), for haulm yield/plant (66.28), for 100-kernel weight (39.78), for pods/plant (21.11) and for harvest index (28.04). Likewise, the maximum STI value for pod yield/plant was recorded in genotype RG-559-3 (46.27) followed by Girnar-2 (45.80), for kernel yield/plant was recorded in genotype RG-559-3 (40.11) followed by RG-425 (37.61), for shelling % was recorded in genotype ICG-6022 (87.86) followed by RG-575 (75.29), for SMK% was recorded in genotype RG-704 (98.54) followed by DGR-7 (97.34), for haulm yield/plant was recorded in genotype RG-425 (125.00) followed by RG-702 (120.26), for 100-kernel weight was recorded in genotype RG-559-3 (71.20) followed by RG-578 (66.84), for pods/plant was recorded in genotype Girnar-2 (54.87) followed by RG-510 (49.53) and for harvest index, the maximum STI value was recorded in genotype ICGV-6052 (54.66) followed by RG-559-3 (54.08) indicating the stability response of these genotypes towards selection for particular traits. Similar findings of stress susceptibility index and stress tolerance index were also recorded by Shrief *et al.* (2020) [13] using forty-nine peanut genotypes.

Table 1: DSI and DTE for yield and its contributing traits in drought stressed conditions in comparison to fully irrigated environment

S. No	Genotype	Pod yield/plant		Kernel yield/plant		Shelling%		SMK%		Haulm yield/plant		100-KW		Pods/plant		Harvest Index	
		DSI	DTE	DSI	DTE	DSI	DTE	DSI	DTE	DSI	DTE	DSI	DTE	DSI	DTE	DSI	DTE
1.	RG-623	1.06	74.48	1.19	72.52	0.77	91.92	1.65	86.67	1.32	77.27	0.71	87.97	1.07	74.42	0.37	96.39
2.	RG-625	1.17	72.03	1.24	71.54	0.94	90.12	0.38	96.96	0.92	84.21	0.83	85.95	1.26	69.76	1.48	85.53
3.	CSMG-9510	1.10	73.62	1.42	67.29	0.99	89.70	0.56	95.47	0.97	83.33	0.87	85.14	0.98	76.58	1.20	88.34
4.	RG-703	1.10	73.65	0.64	85.34	0.40	95.81	0.56	95.47	1.29	77.78	1.06	81.95	0.95	77.25	0.54	94.69
5.	Punjab-1	0.82	80.43	0.74	83.04	0.87	90.91	1.30	89.52	0.86	85.19	1.16	80.26	1.02	75.54	0.57	94.42
6.	RG-704	1.33	68.18	1.21	72.22	1.51	84.16	0.53	95.68	1.57	73.08	0.78	86.79	1.32	68.22	0.69	93.30
7.	ICG 115-1	1.23	70.52	0.71	83.57	0.88	90.84	0.38	96.89	1.41	75.86	0.80	86.44	1.47	64.79	0.72	92.95
8.	TMV-10	1.14	72.68	1.21	72.22	0.80	91.67	0.94	92.37	0.92	84.21	1.16	80.28	1.31	68.50	1.40	86.30
9.	DGR-7	0.51	87.77	0.65	85.05	0.51	94.63	0.54	95.65	1.77	69.56	0.98	83.33	0.57	86.35	0.63	93.89
10.	RG-615	1.12	73.16	1.00	77.08	1.03	89.26	1.57	87.29	1.06	81.82	1.09	81.43	1.15	72.46	1.09	89.41
11.	Girnar-2	0.39	90.73	0.38	91.25	0.53	94.42	1.90	84.68	0.22	96.15	0.79	86.50	0.41	90.22	0.58	94.36
12.	ICGV-44	0.95	77.08	0.86	80.17	0.98	89.70	0.75	93.91	0.70	88.00	0.86	85.33	1.20	71.29	1.27	87.59
13.	NRCG-12177	1.28	69.29	1.17	73.04	1.23	87.13	1.12	90.99	1.16	80.00	0.85	85.62	1.16	72.11	1.37	86.61
14.	RG-614	1.19	71.39	1.37	68.57	1.19	87.60	1.18	90.43	1.01	82.61	0.77	86.96	1.08	73.98	1.39	86.42
15.	RG-633	1.15	72.48	0.83	80.99	1.14	88.12	1.14	90.83	0.80	86.21	0.99	83.20	1.18	71.79	1.63	84.07
16.	RG-702	0.71	82.91	0.44	89.80	1.08	88.73	1.16	90.63	0.75	87.10	0.89	84.85	1.07	74.42	0.49	95.19
17.	GG-21	0.99	76.25	1.16	73.33	1.26	86.77	0.77	93.80	0.83	85.71	1.05	82.20	0.80	80.69	1.13	88.96
18.	RG-562	0.91	78.07	0.41	90.48	1.10	88.54	1.45	88.26	1.04	82.14	0.89	84.85	0.57	86.43	0.51	95.04
19.	RG-628	1.61	61.43	0.51	88.33	1.33	86.08	1.42	88.56	0.90	84.62	1.08	81.67	0.71	82.94	2.81	72.60
20.	RG-586	1.42	65.96	1.32	69.74	0.88	90.79	0.99	92.00	1.84	68.42	0.89	84.89	0.63	85.00	0.37	96.40
21.	ICGV-7247	0.85	79.61	0.81	81.30	0.94	90.22	0.62	94.98	0.97	83.33	1.07	81.82	0.72	82.70	0.46	95.53
22.	NRCG-95195	1.10	73.60	1.50	65.49	1.01	89.46	0.92	92.60	1.32	77.27	1.14	80.60	0.80	80.92	0.49	95.24
23.	RG-559-3	0.38	90.78	0.38	91.33	0.77	91.92	1.49	87.93	0.35	94.00	0.46	92.22	0.50	88.08	0.35	96.57
24.	RG-584	1.14	72.53	0.84	80.59	1.41	85.21	1.13	90.91	1.16	80.00	1.18	80.00	0.91	78.21	0.96	90.66
25.	ICGV-7038	0.72	82.69	0.82	81.10	0.90	90.55	0.87	92.99	0.55	90.48	0.88	84.97	0.90	78.30	0.88	91.40
26.	ICG-3746	1.06	74.55	1.14	73.77	1.04	89.16	0.99	91.96	1.06	81.82	1.06	82.05	0.99	76.29	0.91	91.11
27.	TG-22	0.85	79.50	1.72	60.50	1.04	89.16	0.80	93.58	0.87	85.00	1.18	80.00	0.59	85.75	0.66	93.52
28.	TPG-41	1.70	59.11	1.65	62.16	1.32	86.23	1.00	91.89	2.15	63.16	0.77	86.84	1.99	52.23	0.66	93.59
29.	RG-425	0.35	91.58	0.83	80.90	0.85	91.09	0.90	92.73	0.19	96.67	0.58	90.07	0.94	77.50	0.54	94.74
30.	T-28	1.15	72.37	0.80	81.51	0.80	91.58	1.19	90.35	0.97	83.33	1.16	80.22	0.65	84.41	1.35	86.84

31.	HNG-10	1.25	70.00	1.10	74.63	1.19	87.56	1.10	91.10	1.50	74.19	0.82	86.08	0.91	78.09	0.58	94.35
32.	GNL-469	0.61	85.27	0.57	86.81	1.25	86.90	1.28	89.66	0.58	90.00	1.18	80.00	0.56	86.58	0.54	94.74
33.	RG-571	0.91	78.22	0.95	78.22	0.96	90.00	1.46	88.24	0.73	87.50	0.74	87.50	0.64	84.55	1.09	89.39
34.	RG-574	1.15	72.35	1.18	72.85	0.97	89.82	1.11	91.00	1.11	80.95	1.03	82.46	1.34	67.92	1.09	89.38
35.	RG-438	1.09	73.76	1.03	76.34	1.06	88.87	0.67	94.59	1.21	79.31	0.91	84.48	1.19	71.55	0.72	93.00
36.	RG-510	0.47	88.60	0.63	85.63	1.01	89.42	0.82	93.36	0.43	92.59	0.69	88.24	0.43	89.57	0.44	95.69
37.	RG-420	0.75	82.03	1.13	74.07	1.04	89.12	0.97	92.17	0.65	88.89	1.02	82.61	0.69	83.33	0.79	92.29
38.	GG-14	0.68	83.67	0.57	86.87	1.33	86.13	0.54	95.61	0.79	86.36	1.09	81.53	0.58	86.19	0.32	96.89
39.	NRCG-12312	0.72	82.60	0.43	90.09	0.97	89.89	0.61	95.09	0.78	86.54	0.87	85.22	0.97	76.62	0.47	95.45
40.	TG 37A	0.84	79.73	1.20	72.38	0.97	89.83	0.67	94.61	0.97	83.33	1.15	80.49	1.09	73.73	0.44	95.68
41.	RG-575	1.24	70.25	1.30	70.07	0.78	91.87	0.57	95.43	1.57	73.08	0.63	89.33	0.96	77.00	0.40	96.14
42.	RG-583	1.37	67.16	1.50	65.52	1.00	89.57	0.53	95.73	0.97	83.33	1.12	80.88	1.33	68.09	1.99	80.60
43.	RG-561	0.93	77.75	0.95	78.26	0.84	91.21	0.81	93.43	0.86	85.19	1.11	81.06	2.05	50.91	0.90	91.27
44.	ICG-350	1.19	71.53	1.13	74.11	1.06	88.96	1.72	86.10	1.51	74.07	1.16	80.22	0.76	81.68	0.35	96.57
45.	RG-631	1.00	76.06	1.10	74.64	1.02	89.29	1.20	90.29	0.61	89.47	1.09	81.41	0.51	87.67	1.54	85.00
46.	ICGV-6052	1.49	64.24	0.97	77.68	1.42	85.12	0.66	94.64	1.37	76.47	0.99	83.19	0.96	76.99	1.64	84.00
47.	NRCG-4775	0.84	79.76	0.81	81.45	1.28	86.63	0.82	93.39	0.79	86.36	1.07	81.74	1.23	70.58	0.78	92.36
48.	SG-99	1.28	69.20	1.48	65.87	0.78	91.85	1.40	88.68	0.87	85.00	1.13	80.87	2.04	51.11	1.91	81.41
49.	RG-606	1.69	59.51	1.31	69.86	1.30	86.42	0.74	94.05	0.79	86.36	1.17	80.17	1.91	54.23	3.19	68.90
50.	ICGV-6119	1.49	64.32	1.49	65.64	0.89	90.67	0.77	93.81	1.94	66.67	1.13	80.87	1.18	71.67	0.36	96.48
51.	ICGV-86590	1.63	61.00	1.52	65.06	0.82	91.45	1.10	91.15	2.04	65.00	1.07	81.75	0.86	79.41	0.63	93.85
52.	GG-20	0.49	88.19	0.88	79.86	0.90	90.56	1.02	91.79	0.32	94.44	1.18	80.00	1.85	55.55	0.68	93.38
53.	MH-1	0.67	84.02	0.49	88.74	0.82	91.45	2.06	83.40	0.67	88.46	1.15	80.50	0.45	89.29	0.51	94.98
54.	RG-382	0.99	76.23	1.57	63.89	1.14	88.12	1.21	90.27	0.87	85.00	0.61	89.66	0.98	76.49	1.06	89.68
55.	RG-578	1.08	74.16	1.32	69.72	1.66	82.60	0.51	95.91	0.97	83.33	1.16	80.21	1.22	70.65	1.13	88.99
56.	HNG-123	1.81	56.64	1.50	65.52	0.96	89.96	0.99	92.04	1.39	76.19	1.14	80.70	1.91	54.17	2.63	74.34
57.	UTKARSH	0.67	83.82	1.10	74.70	1.13	88.17	1.51	87.83	0.62	89.29	1.18	80.00	0.27	93.55	0.63	93.88
58.	HNG-69	1.43	65.58	0.84	80.59	0.89	90.65	1.17	90.54	0.92	84.21	0.89	84.89	0.51	87.78	2.27	77.88
59.	CSMG 2003-19	0.68	83.79	0.92	78.86	0.81	91.57	1.36	89.03	0.49	91.67	1.16	80.25	0.60	85.59	0.88	91.41
60.	ICG-6022	1.13	72.92	1.03	76.27	0.56	94.17	0.97	92.20	1.21	79.17	0.91	84.56	1.10	73.66	0.81	92.11

Table 2: Stress Tolerance Index (STI) for yield and its contributing traits in drought stressed conditions in comparison to fully irrigated environment

S. No	Genotype	Pod yield/plant	Kernel yield/plant	Shelling%	SMK%	Haulm yield/plant	100-KW	Pods/plant	Harvest Index
1.	RG-623	18.81	18.26	67.61	66.69	53.74	52.33	23.02	34.53
2.	RG-625	10.85	9.67	48.10	89.59	43.68	29.99	13.02	24.51
3.	CSMG-9510	13.02	11.30	45.82	89.33	68.97	44.43	16.88	18.62
4.	RG-703	19.38	16.85	65.58	89.56	81.47	34.54	18.46	23.47
5.	Punjab-1	18.40	15.28	52.83	73.55	89.22	44.19	17.11	20.34
6.	RG-704	14.27	12.36	64.43	98.54	70.98	52.28	17.09	19.83
7.	ICG 115-1	20.61	17.56	54.20	85.71	91.67	28.68	18.13	22.18
8.	TMV-10	12.22	12.36	46.26	68.73	43.68	38.57	18.33	27.61
9.	DGR-7	37.26	35.78	74.62	97.34	52.87	64.34	46.77	51.74
10.	RG-615	11.22	10.42	48.78	64.94	56.90	38.03	13.52	19.46
11.	Girnar-2	45.80	34.28	73.00	69.57	93.39	54.76	54.87	48.38
12.	ICGV-44	19.20	15.83	67.77	93.95	79.02	45.75	32.12	23.97
13.	NRCG-12177	16.31	14.18	66.70	59.91	71.84	47.76	28.26	22.40
14.	RG-614	13.83	11.09	45.65	63.91	62.79	39.46	19.90	21.73
15.	RG-633	18.39	14.03	53.15	83.08	104.17	30.98	18.27	17.41
16.	RG-702	24.86	19.29	59.68	60.74	120.26	35.23	23.02	20.39
17.	GG-21	6.93	6.05	58.15	76.65	24.14	27.27	16.25	28.33
18.	RG-562	21.66	16.66	61.24	62.37	92.53	35.23	20.66	23.10
19.	RG-628	7.68	4.67	40.32	74.34	20.55	28.02	6.18	36.86
20.	RG-586	6.85	5.91	39.35	84.57	35.49	39.08	6.88	19.05
21.	ICGV-7247	22.09	18.05	57.31	85.11	107.76	33.97	21.36	20.22
22.	NRCG-95195	15.25	12.27	47.19	87.30	53.74	34.48	18.03	28.00
23.	RG-559-3	46.27	40.11	67.61	63.22	84.41	71.20	49.39	54.08
24.	RG-584	12.82	9.79	45.66	84.64	45.98	25.21	19.90	27.52
25.	ICGV-7038	24.17	23.10	68.63	91.23	57.33	47.39	24.22	41.60
26.	ICG-3746	10.83	9.56	46.09	61.64	56.90	26.76	15.63	18.79
27.	TG-22	16.98	12.57	46.09	59.41	48.85	25.21	23.76	34.29
28.	TPG-41	13.00	11.24	45.12	82.34	32.76	47.81	11.77	39.17
29.	RG-425	44.89	37.61	69.73	59.95	125.00	48.93	39.36	35.43
30.	T-28	20.08	16.94	64.67	62.74	107.76	63.32	20.71	18.39
31.	HNG-10	24.30	20.06	66.37	67.78	102.44	51.20	31.75	23.40
32.	GNL-469	11.58	10.55	46.02	64.46	51.72	25.21	20.91	22.09
33.	RG-571	14.45	11.71	54.71	80.09	72.41	30.02	16.83	19.68
34.	RG-574	11.16	10.06	47.00	81.76	51.29	25.53	18.18	21.47

35.	RG-438	17.61	13.89	57.48	84.54	95.83	27.09	19.44	18.13
36.	RG-510	39.64	32.17	46.79	88.24	96.98	38.89	49.53	40.32
37.	RG-420	16.14	12.68	62.28	65.14	41.38	37.49	21.20	38.49
38.	GG-14	17.16	13.79	47.07	85.24	60.06	47.89	18.89	28.19
39.	NRCG-12312	20.48	16.29	53.43	93.75	84.05	26.85	19.00	24.03
40.	TG 37A	13.79	11.71	52.80	85.22	68.97	51.58	18.00	19.73
41.	RG-575	21.06	19.30	75.29	92.70	70.98	47.89	32.20	29.28
42.	RG-583	14.49	12.94	44.65	84.68	38.79	35.65	22.55	36.84
43.	RG-561	17.36	15.19	45.47	86.99	89.22	33.66	11.66	19.19
44.	ICG-350	16.13	13.64	39.58	70.17	77.59	63.32	19.94	20.51
45.	RG-631	18.42	13.98	47.28	84.27	46.41	47.21	19.54	39.16
46.	ICGV-6052	17.59	14.30	45.07	63.44	31.75	28.07	21.65	54.66
47.	NRCG-4775	19.68	13.43	56.84	85.86	60.06	25.76	18.14	32.34
48.	SG-99	17.48	14.86	48.44	83.19	48.85	25.48	12.02	35.29
49.	RG-606	15.87	13.56	42.55	79.78	60.06	25.71	12.76	26.07
50.	ICGV-6119	10.04	9.06	38.27	64.00	31.03	25.48	10.29	31.92
51.	ICGV-86590	7.33	6.58	39.64	62.19	37.36	36.56	15.36	19.35
52.	GG-20	12.20	10.06	46.82	90.72	43.97	42.89	12.04	27.38
53.	MH-1	37.98	29.69	39.64	74.73	85.92	48.50	16.86	43.61
54.	RG-382	13.63	10.94	50.06	61.59	48.85	28.75	17.52	27.52
55.	RG-578	14.82	12.16	47.10	87.28	68.97	66.84	16.00	21.20
56.	HNG-123	13.91	12.94	46.51	62.80	48.28	24.99	11.74	28.43
57.	UTKARSH	18.62	13.42	50.47	62.06	100.57	48.80	15.04	18.27
58.	HNG-69	11.92	9.44	47.82	59.61	43.68	39.08	19.03	26.92
59.	CSMG 2003-19	15.31	10.01	47.34	79.37	75.86	50.18	19.60	19.91
60.	ICG-6022	18.16	15.58	87.86	92.01	65.52	44.74	36.33	27.35

Table 3: Average DSI, DTE and STI of genotypes with their relative rank for yield and its contributing traits in drought stressed conditions in comparison to fully irrigated environment

S. No.	Genotype	Average DSI	Rank	Average DTE	Rank	Average STI	Rank
1.	RG-623	1.02	33	82.71	33	41.87	20
2.	RG-625	1.03	34	82.01	39	33.68	46
3.	CSMG-9510	1.01	30	82.43	35	38.55	34
4.	RG-703	0.82	10	85.24	18	43.66	16
5.	Punjab-1	0.92	19	84.91	19	41.37	24
6.	RG-704	1.12	46	80.20	53	43.72	15
7.	ICG 115-1	0.95	24	82.73	32	42.34	18
8.	TMV-10	1.11	44	81.03	46	33.47	47
9.	DGR-7	0.77	7	87.03	9	57.59	4
10.	RG-615	1.14	49	81.49	44	32.91	50
11.	Girnar-2	0.65	4	91.04	2	59.26	2
12.	ICGV-44	0.95	23	84.14	22	47.20	10
13.	NRCG-12177	1.17	52	80.60	51	40.92	25
14.	RG-614	1.15	50	81.00	47	34.80	42
15.	RG-633	1.11	42	82.21	38	42.43	17
16.	RG-702	0.82	12	86.70	11	45.43	14
17.	GG-21	1.00	29	83.47	26	30.47	56
18.	RG-562	0.86	14	86.73	10	41.68	23
19.	RG-628	1.29	56	80.78	49	27.33	60
20.	RG-586	1.04	37	81.65	43	29.65	57
21.	ICGV-7247	0.80	8	86.18	15	45.73	13
22.	NRCG-95195	1.03	36	81.90	41	37.03	36
23.	RG-559-3	0.59	1	91.60	1	59.54	1
24.	RG-584	1.09	41	82.26	37	33.94	45
25.	ICGV-7038	0.82	9	86.56	12	47.21	9
26.	ICG-3746	1.03	35	82.59	34	30.78	55
27.	TG-22	0.96	26	83.38	27	33.39	48
28.	TPG-41	1.40	58	74.40	59	35.40	41
29.	RG-425	0.65	3	89.41	4	57.61	3
30.	T-28	1.01	32	83.83	24	46.83	12
31.	HNG-10	1.06	40	82.00	40	48.41	8
32.	GNL-469	0.82	11	87.49	8	31.57	53
33.	RG-571	0.93	22	85.45	17	37.49	35
34.	RG-574	1.12	47	80.84	48	33.31	49
35.	RG-438	0.98	28	82.74	31	41.75	22
36.	RG-510	0.62	2	90.39	3	54.07	5
37.	RG-420	0.88	16	85.56	16	36.85	37
38.	GG-14	0.74	6	87.91	5	39.79	30

39.	NRCG-12312	0.73	5	87.69	6	42.24	19
40.	TG 37A	0.92	20	83.72	25	40.22	27
41.	RG-575	0.93	21	82.90	29	48.59	6
42.	RG-583	1.23	55	78.86	54	36.32	38
43.	RG-561	1.06	39	81.13	45	39.84	29
44.	ICG-350	1.11	43	81.66	42	40.11	28
45.	RG-631	1.01	31	84.23	20	39.53	32
46.	ICGV-6052	1.19	53	80.29	52	34.57	43
47.	NRCG-4775	0.95	25	84.03	23	39.01	33
48.	SG-99	1.36	57	76.75	57	35.70	40
49.	RG-606	1.51	59	74.94	58	34.54	44
50.	ICGV-6119	1.16	51	78.77	55	27.51	59
51.	ICGV-86590	1.21	54	78.58	56	28.04	58
52.	GG-20	0.91	18	84.22	21	35.76	39
53.	MH-1	0.85	13	87.60	7	47.12	11
54	RG-382	1.05	38	82.42	36	32.36	51
55.	RG-578	1.13	48	80.70	50	41.80	21
56.	HNG-123	1.54	60	73.70	60	31.20	54
57	UTKARSH	0.89	17	86.40	14	40.91	26
58.	HNG-69	1.12	45	82.77	30	32.19	52
59.	CSMG 2003-19	0.86	15	86.52	13	39.70	31
60.	ICG-6022	0.96	27	83.13	28	48.44	7

4. Conclusion

On the basis of three stress susceptibility indices RG-559-3, RG-510, RG-425, MH-1, RG-562, GG-14, DGR-7, ICGV-6052 were identified as promising drought tolerant genotypes owing to their lower DSI, higher DTE and STI values. A higher amount of transgressive segregants can be obtained by using these cultivars in purposeful hybridization for drought tolerance traits, hence these cultivars further can be used in tailoring drought tolerance in putative groundnut genotypes to mitigate the limited moisture stress conditions. Breeders should further consider stress susceptibility indices as important criteria for selection of drought tolerant genotypes as these give yield stability of a genotype across environments.

5. References

1. Arunachalam P, Kannan P. Screening for drought tolerant groundnut (*Arachis hypogaea* L.) lines suitable for rainfed. Asian J Agri. Res. 2013;7(1):35-42.
2. Fernandez CGJ. Effective selection criteria for assessing plant stress tolerance Ed. Adaptation of Food Crops to Temperature and Water Stress, Kuo C. G AVRDC, Shanhua, Taiwan, 1992, 257-270.
3. Fischer KS, Wood G. Breeding and Selection for drought tolerance in maize. Proceeding of the Symposium on Principles and Methods in Crop Improvement for Drought Resistance with emphasis on Rice, IRRI, Philippines, 1981 May, 23-25.
4. Fisher RA, Maurer R. Drought resistance in spring wheat cultivars I. Grain yield response. Aust. J Agri. Res. 1978;29:897-912.
5. Hampannavar MR, Khan H. Association Study of Morphological and Physiological Traits with Yield in Groundnut Genotypes under Terminal Drought Condition. Int. J Curr. Microbiol. App. Sci. 2019;8(01):668-678.
6. Izge AU, Abubakar MA, Echekwu CA. Estimation of genetic and environmental variance components in pearl millet (*Pennisetum glaucum* L.) genotypes. Nig. J Appl. Exp. Biol. 2005;6(1):105-114.
7. Kambiranda DM, Vasanthaiah HKN, Katam R, Ananga A, Basha SM, Naik K. Impact of Drought Stress on Peanut (*Arachis hypogaea* L.) Productivity and Food Safety. 2011;10.5772-27917.
8. Mamadou CA, Ntare B, Gracen V, Danquah EY, Ofori K. Evaluation of Groundnut Mini Core to Identify Sources of Tolerance to End of Season Drought in the Sahel, Niger International Journal of Plant Breeding and Genetics. 2017;11(1):31-38.
9. Nautiyal PC, Rao NRC, Joshi YC. Moisture-deficit-induced changes in leaf-water content, leaf carbon exchange rate and biomass production in groundnut cultivars differing in specific leaf area. Field Crops Research. 2002;74:67-79.
10. Pavithradevi S, Manivannan N, Vindhiya Varman P, Ganesamurthy K. Evaluation of groundnut genotypes for late season drought tolerance. Legume Research. 2015;38(6):763-766.
11. Pimratch S, Jogloy S, Vorasoot N, Toomsan B, Patanothai A, Holbrook CC. Relationship between biomass production and nitrogen fixation under drought stress conditions in peanut genotypes with different levels of drought resistance. J Agron. 2008;194:15-25.
12. Reddy TY, Reddy VR, Anbumozhi V. Physiological responses of groundnut (*Arachis hypogea* L.) to drought stress and its amelioration: A critical review. Plant Growth Regulators. 2003;41:75-88.
13. Saied A, Shrief SA, Ashraf A, El-Mohsen A, Lattif HMA, Soda ME, *et al*. Groundnut Improvement: Drought Stress and Water use Efficiency of Some Peanut Genotypes Grown Under Newly Reclaimed Soil Plant Archives. 2020;20:1527-1536.
14. Sanogo O, Tongoona PB, Ofori K, Desmae H. Selection of drought tolerant genotypes in groundnut (*Arachis hypogaea* L.) using indices. 2020;12(2):146-155.