International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
www.chemijournal.com
IJCS 2021; 9(5): 08-14

Received: 05-07-2021
Accepted: 12-08-2021

Mahammed Faizan
Department of Genetics and Plant Breeding, College of Horticulture, Mudigere, University of Agricultural and Horticultural Sciences, Shivamogga, Karnataka, India

Harish Babu BN
Zonal Agricultural and Horticultural Research Station, Hiriyur, University of Agricultural and Horticultural Sciences, Shivamogga, Karnataka, India

Lakshmana D
Department of Genetics and Plant Breeding, College of Horticulture, Mudigere, University of Agricultural and Horticultural Sciences, Shivamogga, Karnataka, India

Ganapathi M
Department of Genetics and Plant Breeding, College of Horticulture, Mudigere, University of Agricultural and Horticultural Sciences, Shivamogga, Karnataka, India

Rakshith M
Department of Genetics and Plant Breeding, College of Horticulture, Mudigere, University of Agricultural and Horticultural Sciences, Shivamogga, Karnataka, India

Corresponding Author:
Mahammed Faizan
Department of Genetics and Plant Breeding, College of Horticulture, Mudigere, University of Agricultural and Horticultural Sciences, Shivamogga, Karnataka, India

Investigation on response of growth and yield characters of eggplant over moistures stress and dissection of genetic parameters

Mahammed Faizan, Harish Babu BN, Lakshmana D, Ganapathi M and Rakshith M

Abstract
Eggplant, as a hardy solanaceous crop it's very difficult to develop superior drought tolerant hybrids due lack of gene pool. Present study was conducted in a factorial CRD design with three replication over fifty different eggplant genotypes with two drought level. The experimentation resulted highly significant differences ($P \leq 0.01$) among the genotypes in different levels of drought treatment except numbers days for flower initiation. Genetic variability analysis shown observed traits had high GCV, PCV, broad sense heritability coupled with high genetic advance under moisture stress and normal moisture condition. Except, traits like plant height and total plant length as well as number of days for flowering resulted moderate PCV and GCV under both the conditions. The overall mean performance exposed that genotypes like M17, Very Green Long, IIHR-7, *Solanum Indicum*, IC354597-Round, Swarna Mani, IC99676-Round and Jawahar Brinjal-69 are best drought tolerance genotypes in comparison with yield.

Keywords: ANOVA, genetic parameter, fruit length, PCV, GCV, GAM

Introduction
Brinjal commonly known eggplants or aubergine as in English and baigan in Hindi and different names in versatile languages. Eggplant belongs to family solanaceous and consist with diploid chromosome number of 2n=24. Eggplant is valuable in tropical and subtropical areas of world for it shiny and bright colored fruits. The freshly harvested fruits are appreciated in Indian cuisines like baigan bartha and bitter fruits of eggplant are utilized in medicinal drugs preparation (Chadha and Mndiga 2007) [9]. Leaves of spineless cultivars are consumed as cooked vegetable or used in sauce preparation besides this intake of leaves can reduces chronic diseases including diabetes (Kwon *et al*., 2008) [19]. In account to these indigenous eggplant cultivars are major source for macro and micro nutrients, vitamins, minerals, anti-oxidants and secondary metabolites.
According to FAO statistics eggplant ranked as 6th major vegetable after tomatoes, watermelons, onions, cucumbers, and cabbages in total global vegetable production and it comes under top 35 most important food crops for global food security and mentioned in Annex. 1 of the International Treaty on Plant Genetic Resources for Food and Agriculture (Fowler *et al*., 2003) [14]. Being an important food crop and there have been challenges faced like biotic and abiotic stresses. Many of areas where brinjal is major grown already tackling with vivid adaptation in the current agricultural weather disturbance, which will exaggerate in the future, due to the ongoing climate change (Anwar *et al*., 2013) [3].
Even though eggplant was deliberated to be drought tolerant, it has shown profound susceptibility towards moisture stress due to adverse gene pool. In eggplant it is found to be decrease in total fruit yield up to 60% when water deficits enhanced from 20% to 40% of the field capacity (Karam *et al*., 2011) [17]. There have been many studies reported upon increase in moisture stress would make plant to modify physiological, morphological and root traits (Faizan *et al*., 2021b; Plazas *et al*., 2019) [13, 25] and more over molecular changes will also occurs (Faizan *et al*., 2021a) [12]. as, the plant modify itself for exhibiting tolerance against drought will make plant to show lesser macro and micro-elements absorption and transport in plant results in loss of eggplant yield and productivity over area.
Since eggplant is originated in India, being multi-ecological zoned country there might be a presence of versatile variability for drought stress in eggplant population for plant morphology, biochemical constituents, molecular constitution and specially for fruit characters.

With these contextual challenges we aimed to study effect of moisture deficiency stress on growth and yield components. Furthermore, investigation on presence of genetic variability for these components.

Material and Methods

Plant material and Experimental design

Around 50 different eggplant genotypes seeds were sown in portray by treating with Bavastin® at concentration of 3g per kg of seeds and etiolation was done 3 days. After 30 days saplings were transplanted in pots consisting of single seedling. Experiment was designed into factorial CRD which include two factor *i.e.*, drought conditions (Factor A: Normal moisture condition/control & moisture stress condition) and effect upon 50 eggplant genotypes (Factor C) replicated into three times.

Treatment induction

Drought level was scrutinized with the help of tensiometer. These tensiometers were mounted 15 cm apart from the base of plant and irrigated when soil moisture reaches to 50 centibars. As per schedule, all the pots were irrigated until flower initiation stage. Then, the moisture stress was imposed in the treatment pots for 15 days (on the 7th day of water stress, soil moisture tension in tensiometer reached the maximum level of 85 centibars). And, similar step was followed during fruit initiation stage of eggplant.

Record of observation

Flowering data like (a) number of days taken for flower initiation was recorded and Upon fruit picking stage growth traits like (b) plant height, measured from base to shoot tip; (c) Total Plant Length, calculated by adding plant height and root length upon harvesting and coined in terms of centimeters; (d) Number of primary branches per plants. Fruit traits like, (e) Fruit length, measured in centimeters from pedicel attachment to its apex; (f) Fruit circumference, expressed in centimeter and measured using thread; (g) Average fruit weight, weighed in grams; (h) Number of fruits per plant; and final trait *i.e.*, (i) Fruit yield per plant, expressed in terms of kilograms were recorded after harvest.

Biometric analysis

Statistical analysis like Analysis of Variance, descriptive statistics and genetic parameter estimations were done using online statistical tool *i.e.*, WINDOWSTAT *V.7.2.* and other comparative mean performance dissection was done in MS office Excel.

Results and discussion

Analysis of variance for growth and yield parameters:

Analysis of variance was showed that, there exist significant genotypic differences or variability for all the growth and yield traits under the study ($p<0.01$). Highly significant variation was observed due to different moisture stress levels (moisture stress and normal moisture) for all the characters except for the number of days for flower initiation. Further, the interaction effects due to genotypes x moisture stress levels were also found to be highly significant for all the traits ($p<0.01$). This designates that variation exists among the genotypes for drought tolerance through various growth and yield traits (Table 1).

Table 1: Analysis of variance for growth and yield parameters

S. O. V	d.f.	Plant height at harvesting stage (cm)	Total plant length at harvesting stage	Number of days for flower initiation	Number of primary branches/plants	Fruit length (cm)	Fruit circumference (cm)	Average fruit weight (g)	Number of fruits per plant	Fruit yield/plant (g)
Factor A	1	10838.310**	9767.760**	1.430^{NS}	285.032**	105.875**	124.344**	3947.119**	316.172**	667852.70**
Factor C	49	233.579**	545.473**	360.704**	20.541**	25.602**	55.183**	712.890**	69.376**	33347.93**
A x C	49	115.623**	242.118**	43.919**	5.347**	6.144**	7.202**	158.944**	10.703**	12645.17**
Error C	200	6.121	13.805	6.180	0.116	0.077	0.268	2.279	0.055	66.510
Total	299	97.570	170.973	70.448	5.273	5.608	10.819	157.601	14.217	9815.438
General mean		57.109	89.416	43.771	7.830	6.177	11.678	34.225	5.253	159.515
C.V. (%)		4.332	4.155	5.679	4.352	4.502	4.435	4.411	4.452	5.113
S. Em ±.										
Factor A		0.202	0.303	0.203	0.028	0.023	0.042	0.123	0.019	0.666
Factor C		1.010	1.517	1.015	0.139	0.114	0.211	0.616	0.096	3.329
A x C		1.428	2.145	1.435	0.197	0.161	0.299	0.872	0.135	4.709
C.D. @ 5%										
Factor A		0.563	0.846	0.566	0.078	0.063	0.118	0.344	0.053	1.857
Factor C		2.817	4.230	2.830	0.388	0.317	0.590	1.719	0.266	9.285
A x C		3.983	5.982	4.002	0.549	0.448	0.834	2.431	0.377	13.131
C. D @ 1%										
Factor A		0.743	1.116	0.747	0.102	0.083	0.156	0.453	0.070	2.449
Factor C		0.743	5.579	3.733	0.512	0.417	0.777	2.267	0.351	12.245
A x C		5.253	7.890	5.278	0.724	0.590	1.100	3.206	0.497	17.317

S.O.V.- Source of Variation, d. f. - Degrees of freedom, Factor A- Level of moisture stress (Moisture stress and normal moisture), Factor C- Number of genotypes

** - Significance @ 1%, * - Significance @ 5%, NS- Non-Significant.

Table 2: Mean performance of eggplant genotypes for growth and yield parameters

Genotypes	Plant height at harvesting stage (cm)		Total plant length at harvesting stage (cm)		Number of days for flower initiation		Number of primary branches		Fruit length (cm)	
	Normal moisture	Moisture stress	Normal moisture	Moisture stress	Normal moisture	Moisture stress	Normal moisture	Moisture stress	Normal moisture	Moisture stress
Suvarna GP098	63.00	49.92	86.00	84.42	34.00	39.20	11.00	10.13	6.00	4.70
Pusa Upkar	39.00	44.55	57.00	68.05	35.00	41.53	10.33	12.14	9.50	7.15
Vijaya ARBH98	56.00	49.44	72.00	73.44	37.00	41.53	6.00	6.30	6.20	4.70
Arka Kranti	49.00	49.98	69.50	74.48	45.00	44.52	8.02	9.66	6.50	5.70
Bhagyamati	48.00	58.14	82.00	78.64	44.00	35.88	6.40	11.07	7.00	5.20
IIHR-322	68.00	60.32	89.00	88.82	47.00	43.19	7.03	9.28	8.00	7.70
Rampur Local	72.00	49.49	98.00	78.99	48.00	43.52	7.07	7.64	6.00	5.70
Pusa Ankur	63.00	37.83	96.00	66.33	52.00	44.52	7.07	10.00	5.60	4.90
R-2580	47.00	47.52	77.00	84.52	37.00	36.21	5.31	5.66	18.00	4.37
R-2594	49.00	49.04	87.00	66.94	37.00	36.21	3.62	9.40	5.80	5.78
R-2591	68.00	52.47	114.00	83.97	37.00	37.21	6.17	8.31	4.20	4.00
IC354140	65.00	56.43	122.00	102.93	43.00	40.20	6.32	7.00	5.90	4.83
Early Round Market	63.00	57.42	95.00	84.92	31.00	35.88	5.65	8.67	8.30	5.73
M4	59.00	57.42	85.00	83.42	44.00	46.84	6.00	4.00	8.30	7.80
M21	80.00	56.43	113.00	85.93	47.00	42.86	5.00	4.90	7.40	7.90
M17	49.00	48.51	84.00	78.68	40.00	42.19	6.00	5.50	9.10	8.95
Pusa Bindu	52.00	49.50	80.00	83.00	47.00	47.84	7.03	7.36	7.00	5.80
Mattigulla	75.00	44.55	114.00	74.05	53.00	49.50	6.35	9.00	7.00	6.30
Ramdurga	56.00	41.58	114.00	73.08	35.00	38.87	4.00	5.00	7.40	5.15
Malapur Local	71.00	57.42	98.50	79.67	37.00	39.20	6.03	10.59	5.70	4.70
Pant Samrat	62.00	46.53	86.00	75.92	47.00	43.52	5.00	8.00	6.00	5.60
IC90785	60.00	39.60	86.00	76.10	44.00	40.53	7.03	10.21	5.70	4.90
IC99676- Long	63.00	48.51	95.00	84.01	37.00	37.21	6.50	8.90	8.30	7.20
IIHR-7	67.00	40.59	95.00	73.59	47.00	43.52	3.38	10.26	5.40	4.50
Punjab Sadabahar	65.00	57.42	93.00	84.92	32.00	35.55	8.25	9.00	7.40	5.60
L-2232	58.00	48.51	88.00	89.01	41.00	43.52	5.00	8.34	6.20	6.05
IC99676- Round	60.00	47.52	86.00	80.02	29.00	33.55	6.00	7.89	4.70	4.65
Aruna	62.00	48.51	90.00	73.76	46.00	52.49	6.70	10.64	7.10	5.37
Shobha	63.00	49.47	98.00	89.47	47.00	40.86	7.00	8.30	6.80	7.00
Long Green	70.00	56.43	105.00	97.43	46.00	42.19	10.28	8.67	4.90	4.65
Swarna Manjari	73.00	63.73	113.00	93.23	40.00	42.86	8.10	10.28	10.20	5.70
Melavanki	68.00	59.25	97.00	92.75	41.00	40.20	6.00	8.50	5.30	4.90
Hebbal Gulla	67.00	51.48	92.00	83.98	45.00	45.18	10.00	13.00	5.30	4.10
R-2581	74.00	55.44	104.00	96.44	32.00	43.19	6.52	9.03	8.10	5.90
Swarna Pratibha	68.00	48.82	101.00	90.32	45.00	43.19	7.32	8.67	6.50	5.97
Round Green	66.00	54.45	93.00	91.90	40.00	40.86	9.17	7.67	15.00	12.07
L-2230	59.00	52.47	88.00	86.97	57.00	59.47	4.00	7.66	4.80	4.40
M19	68.00	40.59	98.00	67.75	43.00	50.17	7.00	7.10	10.80	8.70
CH-215	67.00	63.59	102.00	83.09	44.00	51.16	6.40	5.97	7.40	6.55
Jawahar Brinjal-8	58.00	45.54	111.00	69.98	46.00	27.24	6.25	8.64	4.70	3.90
Swarna Mani	59.00	48.51	99.00	85.76	40.00	48.50	6.00	7.30	7.00	6.85
IC90691	62.00	45.54	96.00	72.04	34.00	37.87	10.00	11.20	6.40	5.17
Jawahar Brinjal-69	60.00	49.50	89.00	87.00	40.00	47.18	10.07	11.39	5.20	4.47
Very Green Long	58.00	47.52	87.00	88.02	50.00	44.52	4.03	9.64	8.10	6.85
IC354597-Round	59.00	51.24	91.00	100.71	52.00	44.19	6.68	9.34	5.00	4.90
CO-2	72.00	49.50	102.00	87.50	40.00	43.52	5.65	8.64	5.40	4.65
Solanum macrocarpon	68.00	51.48	105.00	89.23	80.00	72.09	4.00	5.60	3.50	3.20
Solanum indicum	80.00	59.40	115.00	100.69	57.00	55.81	10.00	12.30	0.90	0.90
Solanum torvum	76.00	49.50	113.00	93.00	53.00	51.16	9.00	13.50	1.80	1.60
Solanum mammosum	72.00	66.33	105.00	106.61	60.00	63.79	11.00	13.00	5.70	5.80

genotypes	fruit circumference (cm)		Average fruit weight (g)		Number of fruits per plant		Fruit yield (g/plant)	
	Normal moisture	Moisture stress	Normal moisture	Moisture stress	Normal moisture	Moisture stress	Normal moisture	Moisture stress
Suvarna GP098	12.20	13.57	32.74	25.44	6.00	4.33	196.46	107.66
Pusa Upkar	19.40	18.04	56.00	38.32	6.00	4.67	336.00	172.72
Vijaya ARBH98	14.30	11.45	41.91	32.49	8.00	4.67	335.24	157.33
Arka Kranti	12.30	12.00	34.40	36.27	10.00	4.33	344.00	154.30
Bhagyamati	13.00	10.08	38.44	28.68	18.00	7.00	691.86	188.01
IIHR-322	10.50	10.90	39.65	31.00	6.00	4.33	237.92	126.00
Rampur Local	11.90	13.40	40.45	34.78	6.00	3.67	242.72	127.33
Pusa Ankur	15.00	14.23	56.40	48.17	5.00	3.33	282.00	156.67
R-2580	14.20	8.40	37.09	29.37	11.00	6.33	408.00	184.67
R-2594	5.01	5.09	44.50	40.56	4.00	2.67	178.00	106.67

R-2591	11.30	11.10	32.84	36.33	6.00	2.67	197.02	88.67
IC354140	12.40	10.07	30.51	25.71	13.00	6.67	396.62	177.67
Early Round Market	8.10	8.53	25.00	17.57	6.00	5.67	150.00	97.05
M4	8.70	7.05	18.65	31.26	14.00	5.00	261.10	153.33
M21	8.70	10.50	28.67	30.56	6.00	3.00	172.00	90.00
M17	10.00	8.05	30.00	32.04	5.00	4.67	150.00	142.67
Pusa Bindu	10.70	8.65	48.00	21.18	2.00	3.33	96.00	75.33
Mattigulla	13.30	16.10	42.00	27.23	5.00	3.33	210.00	112.00
Ramdurga	15.60	15.85	43.33	36.86	3.00	4.00	130.00	139.89
Malapur Local	11.30	12.65	31.50	30.28	6.00	3.33	189.00	93.67
Pant Samrat	16.20	8.93	40.75	33.64	8.00	6.00	326.00	190.79
IC90785	13.90	13.80	56.50	40.33	2.00	2.33	113.00	94.33
IC99676- Long	7.20	7.80	28.93	29.16	14.00	6.33	405.00	169.34
IIHR-7	19.50	14.55	71.00	40.67	2.00	2.67	142.00	108.67
Punjab Sadabahar	15.60	15.50	74.00	35.00	2.00	1.33	148.00	51.67
L-2232	11.50	10.25	20.50	27.56	4.00	2.00	82.00	52.33
IC99676- Round	11.50	10.75	31.00	27.83	2.00	6.33	62.00	172.67
Aruna	10.30	10.83	28.75	28.03	8.00	3.67	230.00	102.33
Shobha	15.70	10.50	28.88	31.58	7.00	3.33	202.15	105.67
Long Green	16.10	12.30	40.67	30.22	3.00	2.33	122.00	72.00
Swarna Manjari	15.50	12.60	81.33	46.00	3.00	2.00	244.00	92.00
Melavanki	15.20	12.90	34.40	30.94	5.00	3.67	172.00	113.51
Hebbal Gulla	11.50	10.00	44.73	39.61	6.00	3.00	268.40	115.67
R-2581	9.10	10.15	28.87	22.11	3.00	2.33	86.61	57.00
Swarna Pratibha	13.70	12.53	36.80	40.22	5.00	3.33	184.00	134.67
Round Green	11.00	10.87	47.50	27.67	4.00	3.33	190.00	91.67
L-2230	13.20	10.90	36.00	31.95	4.00	3.67	144.00	97.00
M19	8.20	9.73	31.00	21.80	12.00	5.67	372.00	118.22
CH-215	15.00	12.40	42.67	26.17	6.00	3.33	256.00	88.67
Jawahar Brinjal-8	12.90	11.20	34.00	27.50	4.00	2.33	136.00	59.33
Swarna Mani	12.90	6.85	27.17	27.65	6.00	4.67	163.00	126.72
IC90691	12.30	12.53	32.80	28.49	5.00	4.67	164.00	132.00
Jawahar Brinjal-69	12.30	11.27	31.00	24.50	4.00	4.00	124.00	97.45
Very Green Long	13.40	9.30	56.67	34.23	3.00	3.67	170.00	118.00
IC354597-Round	10.10	9.80	30.00	36.22	5.00	2.33	150.00	76.00
CO-2	16.50	13.35	43.93	37.53	4.00	3.67	175.72	132.00
Solanum macrocarpon	16.90	13.80	50.00	43.50	2.00	2.00	100.00	75.29
Solanum indicum	3.10	3.00	0.83	0.68	24.00	21.67	20.00	14.33
Solanum torvum	4.20	3.80	10.50	7.40	6.00	4.33	63.00	32.00
Solanum mammosum	13.62	13.78	19.33	17.57	5.00	4.33	116.00	73.67

Response of egg-plant genotypes for drought stress on growth and yield traits

Plant height at harvesting stage

In normal moisture condition, plant height ranged between 39.00 to 80.00 cm with a mean of 63.12 cm. However, under moisture stress condition, the plant height was in the range of 37.83 to 66.33 cm with a mean of 51.10 cm (Table 4). Mean reduction for plant height at harvesting stage at moisture stress condition was about 17.84 per cent as compared to normal moisture condition (Table 3 & Figure 1). The variation in overall mean reduction of plant height over normal condition could be due to prolonged drought imposture for 15 days to same plant which resulted in drying of shoot tip. Similar results were reported by Kirnak *et al.* (2001) [18] and Ebrahim *et al.* (2012) [10].

Total plant length at harvesting stage

Under moisture stress, the mean total plant length at harvesting stage ranged between of 66.33 to 106.61 cm with a mean of 83.71 cm. Nevertheless, in normal moisture condition, total plant length at harvesting stage was in the range of 57.00 to 122.00 cm with a mean of 95.12 cm. Under moisture stress, total plant length at harvesting stage showed 10.83 per cent decreased rate as compared to normal moisture condition due to decreased shoot length after drought imposture at fruit initiation stage. Reduced total plant length results in reduction of total plant biomass which ultimately reduces the fruit dry matter (Birhanu and Tilahun, 2010) [7].

Number of days for flower initiation

The average number of days for flower initiation under moisture stress condition was 43.84 days with a range of 27.24 to 72.09 days. However, under normal moisture condition, the mean number of days for flower initiation was 43.70 days and it ranged from 29 to 80 days. It had shown marginally increased 1.57 per cent overall mean under moisture stress as compared to normal moisture condition. This may be due to reduction in the overall plant growth at a very early stage upon drought imposed on flower initiation stage. Generally, it is common that, the plants under stress enters flowering stage or reproductive stage earlier than the normal plants.

Number of primary branches per plant

The mean number of primary branches per plant under normal moisture condition was 6.85 branches with a range of 3.38 to 11.00 branches. Conversely, under moisture stress condition, the mean number of primary branches per plant was 8.80 and it ranged from 4.00 to 13.50 branches. Overall mean reduction for moisture stressed condition increased by 34.92 per-cent as compared to normal moisture condition. The results are in agreement with the findings of Byari and AL-Rabighi (1996) [8]. The reason behind increase in number of primary branches was due to decreased shoot length (drying of shoot tip) over prolonged drought imposture.

Table 3: Comparative overall mean performance of eggplant genotypes for various traits

Sl. No.	Characters	Normal moisture condition	Moisture stress condition	Changes in mean value under moisture stress condition compared to normal moisture	Change in *per cent* mean under moisture stress condition compared to normal moisture
Growth and yield related characters					
1	Plant height at harvesting stage (cm)	63.12	51.099	-12.02	-17.84
2	Total plant length at harvesting stage (cm)	95.12	83.71	-11.41	-10.83
3	Number of days for flower initiation	43.70	43.84	+0.140	+1.57
4	Number of primary branches/plants	6.85	8.81	+1.95	+34.92
5	Fruit length (cm)	6.77	5.58	-1.18	-14.22
6	Fruit circumference (cm)	12.32	11.03	-1.28	-8.57
7	Average fruit weight (g)	37.85	30.59	-7.25	-14.61
8	Number of fruits per plant	6.28	4.22	-2.05	-21.35
9	Fruit yield (g/plant)	206.70	112.33	-94.36	-37.22

'+'Sign indicates increase in mean value of the concerned trait in moisture stress condition over normal moisture condition.
'- 'Sign indicates decrease in mean value of the concerned trait in moisture stress condition over normal moisture condition.

Fruit length

The mean fruit length under moisture stress was in the range of 0.90 to 12.07 cm with a mean of 5.58 cm. However, under normal moisture condition, the mean fruit length was 6.77 cm and it ranged from 0.90 to 18.00 cm. Fruit length in moisture stressed plants showed 14.22 per cent reduction as compared to normal moisture condition. This observation in the present study is in agreement with the findings obtained by Abd-El-Aal *et al*. (2008) [1], Gobu (2015) [18] and Ebrahim *et al*. (2012) [10].

Fruit circumference

In moisture stress condition, the mean fruit circumference was in the range of 3.00 to 18.04 cm with a mean of 11.03 cm. On the other hand, under normal moisture condition, fruit circumference was in the range of 3.10 to 19.50 cm with a mean of 12.32 cm. Fruit circumference showed 8.57 per cent reduction in moisture stress condition as compared to normal moisture condition. Findings of Abd-El-Aal *et al*. (2008) [1], Ebrahim *et al*. (2012) [10] and Gobu (2015) [18] are in support of our results.

Average fruit weight

The average fruit weight under normal moisture condition was 37.85 g and it ranges from 0.83 to 81.33 g. Though, the average fruit weight under moisture stress was 30.60 g with a range of 0.68 to 48.17 g. Average fruit weight in moisture stressed condition showed 14.61 per cent reduction as compared to normal moisture condition. Similar results were found by Smittle *et al*. (1994) [29] in bell pepper and by Patane and Cosentino (2010) [24] in tomato. The reduction of average fruit weight was due to reduction in fruit length and fruit circumference.

Number of fruits per plant

The mean number of fruits per plant under normal moisture was 6.28 and it ranged from 2.00 to 24.00. However, the mean number of fruits per plant under moisture stress condition was 4.23 with a range of 1.33 to 21.67. Number of fruits per plant showed 21.35 per cent reduction due to the imposed moisture stress as compared to normal moisture condition. This result is in accordance with the findings of Ebrahim *et al*. (2012) [10], Bafeel and Moftah (2008) [4] and Shamim *et al*. (2014) [27] who suggested that the negative effect of drought stress on the yield and its components may be related to the decrease in vegetative growth. However, El-Hady and Doklega (2017) [11] reported increased number of fruits per plant under moisture stress.

Fruit yield/plant

In moisture stress condition, the mean fruit yield per plant was in the range of 14.33 to 190.79 g with a mean of 112.33 g. Nevertheless, in normal moisture condition, fruit yield per plant was in the range of 20.00 to 691.86 g with a mean of 206.70 g. Fruit yield per plant in moisture stressed condition decreased by 37.22 per cent as compared to normal moisture condition due to decrease in fruit length, fruit circumference, average fruit weight and number of fruits per plant. These results were in line with the findings of Tan (1995) in tomato, Kirnak *et al*. (2001) [18], Abd-El-Aal *et al*. (2008) [1] and Ebrahim *et al*. (2012) [10] in eggplant.

Estimate of genetic variability for physiological and root traits

The traits like number of primary branches, fruit length, fruit circumference, average fruit weight, Fruit yield per plant and number of fruits per plant had shown high PCV (Phenotypic coefficient of variation) along high GCV (Genotypic coefficient of variation) under moisture stress and normal moisture condition. whereas, other traits like plant height and total plant length at harvesting stage as well as number of days for flower initiation resulted moderate PCV and GCV. But number of days for flower initiation showed high PCV under normal moisture condition (Table 4). The traits exhibiting high GCV value over PCV values represents the presence of variation is mainly due to genetic composition and which is heritable. The maximum percentage of GCV and PCV value contribute maximum towards greater diversity.

All the observed character exhibited high broad sense heritability (h) coupled with high genetic advance over mean. The characters having extreme heritability would benefit in selection of exclusive genotypes from diverse eggplant population for drought tolerance. In order to improve efficacy of selection heritability tied with genetic advance over mean which explains the traits having high broad sense heritability coupled with high genetic advance over mean might be governed by additive gene action and have a great scope for direct selection of drought tolerant eggplant genotype (Gobu *et al*.,2017) [16]. The acquired results exposed that the use of aforementioned trait would have sufficient scope for choice of genotype for drought tolerance. The extracted results are parallel with experiments conducted by Mahaveer *et al*. (2004) [20]; Singh and Kumar, 2005 [28]; Birhanu and Tilahun, 2010 [7]; Balaji *et al*. (2013) [5]; Nayak and Nagre (2013) [22]; Pallavi and Sanjay (2014) [23]; Mili *et al*. (2014) [21]; Solaimana *et al*. (2015) [30]; Gobu (2015) [16]; Akpan *et al*. (2016) [2]; Samlindsujin *et al*. (2017) [26] and Banerjee *et al*. (2018) [6].

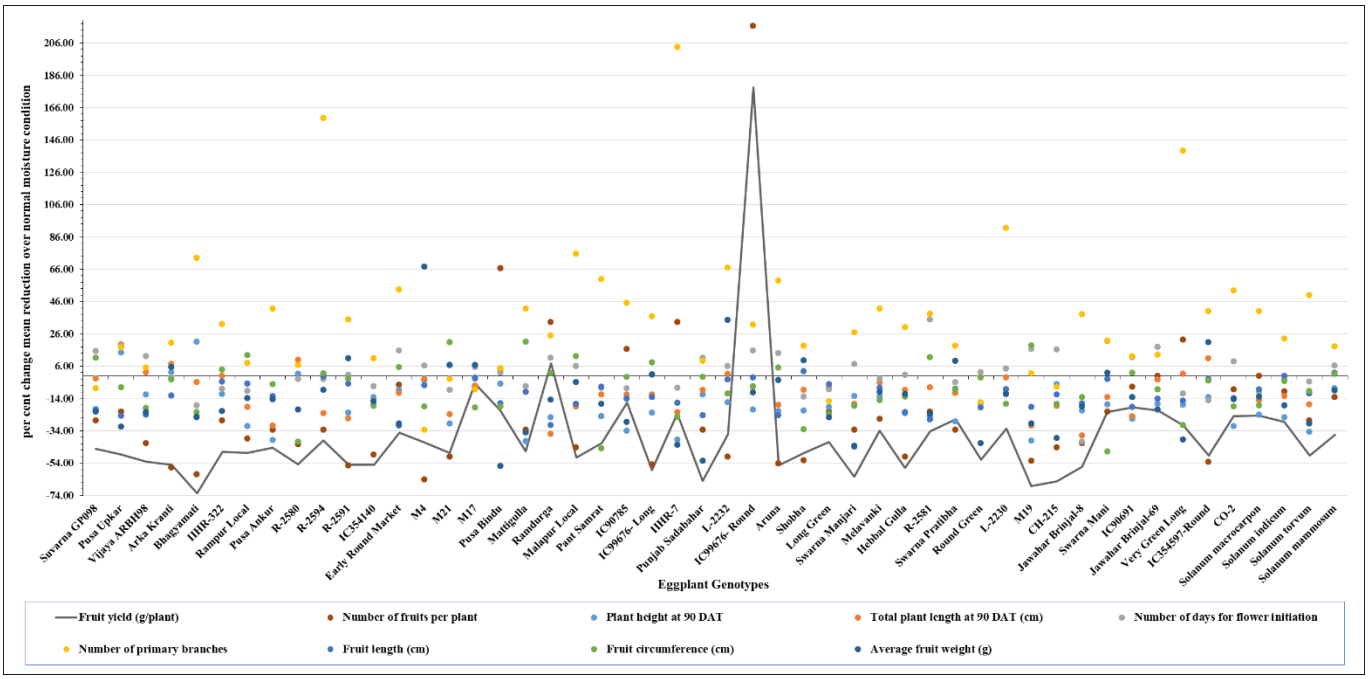

Fig 1: Per-cent change mean reduction over normal moisture condition for eggplant genotypes recorded during flower initiation stage

Table 4: Estimates of genetic parameters for growth and yield parameters in eggplant genotypes

Sl. No.	Characters	MEAN		RANGE		PCV (%)		GCV (%)		h^2 (%)		GAM (%)	
		Moisture stress	Normal moisture	Moisture Stress	Normal moisture	Moisture stress	Normal moisture	Moisture Stress	Normal moisture	Moisture stress	Normal moisture	Moisture stress	Normal moisture
1	Plant Height at harvesting stage (cm)	51.10	63.12	37.83 - 66.33	39.00 - 80.00	13.15	14.12	12.11	13.63	84.74	93.26	22.96	27.12
2	Total plant length at harvesting stage (cm)	83.71	95.12	66.33 - 106.61	57.00 - 122.00	11.96	14.13	11.39	13.40	90.62	89.93	22.33	26.18
3	Number of days for flower initiation	43.84	43.70	27.24 - 72.09	29.00 - 80.00	18.24	20.36	17.00	19.85	86.81	95.05	32.62	39.86
4	Number of primary branches	8.80	6.85	4.00 - 13.50	3.38 - 11.00	24.92	29.06	24.58	28.69	97.27	97.47	49.93	58.35
5	Fruit length (cm)	5.58	6.77	0.90 - 12.07	0.90 - 18.00	31.97	40.45	31.72	40.16	98.43	98.60	64.83	82.16
6	Fruit circumference (cm)	11.03	12.32	3.00 - 18.04	3.10 - 19.50	27.31	28.20	26.99	27.82	97.62	97.33	54.93	56.55
7	Average fruit weight (g)	30.60	37.85	0.68 - 48.17	0.83 - 81.33	28.51	38.97	28.26	38.68	98.28	98.51	57.72	79.08
8	Fruit yield/plant (g)	112.33	206.70	14.33 - 190.79	20.00 - 691.86	36.89	56.63	36.65	56.40	98.70	99.19	75.01	115.72
9	Number of fruits per plant	4.23	6.28	1.33 - 21.67	2.00 - 24.00	67.68	68.64	67.54	68.50	99.59	99.59	138.84	140.83

Where,
PCV–Phenotypic co-efficient of variation, GCV–Genotypic co-efficient of variation,
h^2–Broad sense heritability, GAM–Genetic Advance as *per cent* over Mean.

Conclusion

Finally, we can conclude that the genotypes like M17, Very Green Long, IIHR-7, *Solanum Indicum*, IC354597-Round, Swarna Mani, IC99676- Round and Jawahar Brinjal-69 are best tolerance performing genotypes in comparison with yield under drought stress condition. The comparative overall mean analysis revealed that traits like Plant height at harvesting stage, Total plant length at harvesting stage, Number of primary branches per plants, Fruit length, Fruit circumference, Average fruit weight and Fruit yield per plant were exhibiting common phenomenon upon drought stress induction. In addition to all the traits had shown high GCV, PCV, broad sense heritability coupled with high genetic advance over mean under moisture stress and normal moisture condition. Except, trait like plant height and total plant length at harvesting stage as well as number of days for flower initiation resulted moderate PCV and GCV under both the conditions. The obtained results can be used for further improvement utilization of drought tolerant parents for moisture stress tolerant superior hybrid development.

References

1. Abd-El-Aal FS, Abdel Mouty MM, Ali AH. Combined effect of irrigation intervals and foliar application of some anti-transpirants on eggplant growth, fruits yield and its physical and chemical properties. Research Journal of Agriculture and Biological Sciences 2008;4(5):416-423.
2. Akpan NM, Ogbonna PE, Onyia VN, Okechukwue C, Atugwu IA. Variability studies on ten genotypes of eggplant for growth and yield performance in south eastern Nigeria. Journal of Animal and Plant Sciences 2016;26(4):1034-1041.
3. Anwar MR, Li Liu D, Macadam I, Kelly G. Adapting agriculture to climatechange: a review. Theoretical and Applied Climatology 2013;113:225-245.
4. Bafeel SO, Moftah AE. Physiological response of eggplants grown under different irrigation regimes to anti-transplant treatments. Saudi Journal of Biological Sciences 2008;15(2):259-267.
5. Balaji L, Reddy PS, Reddy RVSK, Sivaraj N. Variability, heritability and genetic advance studies in Brinjal (*Solanum melongena* L.). Electronic Journal Plant Breeding 2013;4(1):1097-1100.
6. Banerjee S, Verma A, Bisht YS, Maurya PK, Jamir I, Mondal S, *et al*., Genetic variability, correlation coefficient and path coefficient analysis in brinjal germplasm. International Journal of Chemical Studies 2018;6(4):3069-3073.
7. Birhanu K, Tilahun K. Fruit yield and quality of drip-irrigated tomato under deficit irrigation. African Journal

of Food Agriculture Nutrietion and Development 2010;10(2):2139-2151.
8. Byari SH, Al-RabigHI SMS. Yield and growth responses of eggplant cultivars to water deficit. Egyptian Journal of Horticulture 1996;23(1):89-100.
9. Chadha ML. Mndiga HH. African Eggplant - From Underutilized to a Commercially Profitable Venture. In: Proceedings of the 1st International Conference on Indigenous Vegetables and Legumes—Prospectus for Fighting Poverty, Hunger and Malnutrition. Eds. MI. Chadha, G. Kuo, CLL. Gowda. Acta Horticulturalae. International Society for Horticultural Sciences (ISHS), Korbeek-Lo, Belgium 2007, 521-523.
10. Ebrahim A, Ali Ag, Yaser E. Effect of irrigation and nitrogen on yield, yield components and water use efficiency of eggplant. African Journal of Biotechnology 2012;11(13):3070-3079.
11. El-Hady MA, Doklega SMA. Response of two eggplant cultivars to irrigation intervals and foliar application with some anti-transpirants. Journal of Plant Production Mansoura University 2017;8(12):1395-1401.
12. Faizan M, Harish Babu BN, Fakrudin B, Lakshmana D, Rakshith M. In silico identification and annotation of drought responsive candidate genes in Solanaceous plants. International Journal of Creative Research Thoughts 2021a;9(1):2320-2882.
13. Faizan M, Harish Babu BN, Lakshmana D, Ganapathi M, Rakshith M. Physiological and root growth response of eggplant genotypes upon drought stress and assessment of genetic parameters at different developmental stage. International Journal of Ecology and Environmental Sciences 2021b;3(4):22-33.
14. Fowler C, Smale M, Gaiji S. Unequal exchange? Recent transfers of agricultural resources and their implications for developing countries. Development Policy Review 2001;19:181-204.
15. Gobu R, Harish Babu BN, Chandra K, Shankar M, Prakash O. Effect of Moisture stress on Key Physiological traits in Brinjal (*Solanum melongena* L.) Cultivars. Vegetos 2017;30:403-408.
16. Gobu R. Studies on genetic variability in eggplant (*Solanum melongena* L.) genotypes for drought tolerance and yield, M. Sc., Thesis, University of Agricultural and Horticultural Sciences, Shivamogga 2015.
17. Karam F, Saliba R, Skaf S, Breidy J, Rouphael Y, Balendonck J. Yield and water use of eggplants (*Solanum melongena* L.) under full and deficit irrigation regimes. Agricultural Water Management 2011;98:1307-1316.
18. Kirnak H, Cengiz K, Ismail Tas, David H. The influence of water deficit on vegetative growth, physiology, fruit yield and quality in eggplants, Bulgarian Journal of Plant Physiology 2001;27(4):34-46.
19. Kwon YI, Apostolidis E, Shetty K. *In vitro* studies of eggplant (*Solanum melongena*) phenolics as inhibitors of key enzymes relevant for type 2 diabetes and hypertension. Bioresource Technology 2008;99:2981-2988.
20. Mahaveer P, Nandan M, Dikshit SN, Nichal SS. Genetic variability, genetic advance and heritability in brinjal (*Solanum melongena* L.). Orissa Journal of Horticulture 2004;32(2):26-29.
21. Mili C, Bora GC, Das B, Paul SK. Studies on variability heritability and genetic advance in *Solanum melongena* L. (Brinjal) genotypes. Direct Research Journal of Agriculture and Food Science 2014;2(11):192-194.
22. Nayak BR, Nagre PK. Genetic variability and correlation studies in brinjal (*Solanum melongena* L.). International Journal of Applied Biology and Pharmaceutical Technology 2013;4(4):211-215.
23. Pallavi C, Sanjay K. Variability, heritability and genetic advance studies in egg-plant (*Solanum melongena* L.). Plant Archives 2014;14(1):483-486.
24. Patane C, Cosentino SL. Effects of soil water deficit on yield and quality of processing tomato under a Mediterranean climate. Agricultural Water Management 2010;97:131-138.
25. Plazas M, Nguyen HT, González-Orenga S, Fita A, Vicente O, Prohens J, *et al*. Comparative analysis of the responses to water stress in eggplant (*Solanum melongena*) cultivars. Plant Physiology and Biochemistry 2019;143:72-82.
26. Samlindsujin G, Karuppaiah P, Manivannan K. Genetic variability and correlation studies in brinjal (*Solanum melongena* L.). Journal of Plant Sciences 2017;12(1):21-27.
27. Shamim F, Farooq K, Waheed A. Effect of different water regimes on biometric traits of some tolerant and sensitive tomato genotypes. Journal of Animal and Plant Sciences 2014;24(4):1178-1182.
28. Singh O, Kumar J. Variability, heritability and genetic advance in brinjal. Indian Journal of Horticulture 2005;62(3):265-267.
29. Smittle DA, Dickens WL, Stansell JR. Irrigation regimes affect yield and water use by bell pepper. Journal of the American Society for Horticultural Science 1994;119:936-939.
30. Solaimana M, Nishizawa T, Khatun M, Ahmad S. Physio-morphological characterization genetic variability and correlation studies in brinjal genotypes of Bangladesh. Computational and mathematical biology 2015;4(1):364-369.