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Evaluation of chilli (*Capsicum annuum* L.) and its wild relatives for yield and drought tolerance

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Abstract
Chilli (*Capsicum annuum* L.), one of the most important vegetable cum spice crops belongs to the family Solanaceae. Drought is an important abiotic stress that causes reduction in plant growth and yield and also leads to decline in several physiological and biochemical characters. The plants imposed with 100% FC recorded higher average plant height of 86.97 cm than 50% field capacity plants (64.07cm). The results revealed that genotypes AVPP9813 recorded 81.20 days for first flowering followed by EC-320525 (81.60 days). For number of fruits per plant at 100% FC the more number of fruits per plant of 110.40 was noticed in IC-119233 and the lowest was recorded in VI047102 (14.60). The highest green fruit yield per plant of 404.06 g was exhibited by IC-119233 while the least value of 48.66 g was noted in the genotype VI059328 at control. The highest relative water content was exhibited by Arka Lohit (72.24 *per cent*) followed by EC-362917 (72.19 *per cent*) while IC-119233 reported the lowest value of 62.09 *per cent* in 100% FC. However, 50% FC treatment, EC-362917 recorded highest relative water content of 71.48 per cent. For chlorophyll stability index IC-119231 recorded the highest value (71.04 *per cent*) and the lowest was registered by IC-119234 (55.46 *per cent*).

Keywords: Chilli (*Capsicum annuum* L.), yield and drought tolerance

Introduction
Chilli (*Capsicum annuum* L.) is a most important spice in every Indian cuisine because of its pungency, spicy taste, appealing colour and flavour. Chillies are very sensitive to various biotic and abiotic stresses. Drought is an abiotic stress that causes reduction in plant growth and yield and also leads to decline in several physiological and biochemical characters. Water stress leads to the loss of cell turgidity, stomatal closure which in turn affects the leaf gas exchange, increase in foliage temperature and decrease chlorophyll stability index (Sivakumar *et al*. 2014) [5]. Drought causes decline in stomatal conductance, net photosynthesis and leaf chlorophyll content (Gladden *et al*. 2012) [2]. Water deficit conditions also leads to a decreased Fv/Fm ratio due to protein deactivation in chlorophyll structure. Plants tolerate moisture stress through mechanisms like maintenance of cell membrane integrity, high relative water content (RWC), high chlorophyll stability index (CSI) and osmotic adjustment with proline, glycine betaine. Exposure of capsicum plant to water stress treatment reported to have reduced transpiration rate as an outcome of the increased stomatal conductance. High sensitivity of nitrate reductase and anti - oxidant enzymes to drought stress serves as an excellent tool to assess drought tolerant capacity in crop plants (Zakaria, 2020) [10]. However, different cultivars of chilli respond to drought differently. There is a need to select high yielding, drought tolerant chilli genotypes under rainfed conditions and hence the present investigation was carried out to screen chilli genotypes for drought tolerance.

Materials and Methods
The pot culture experiment was conducted at the College Orchard, Department of Vegetable Science, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore. The experimental material for the study comprised twenty-three chilli genotypes selected as best during the laboratory condition were raised during, February – September, 2018 under pot culture conditions inside the poly house to further screen for drought tolerance. The seedlings of each genotype were raised in portrays and was transplanted into pots

45 days after sowing. The experiment was laid in a factorial completely randomized block design (FCRD) comprising of two treatments (100 per cent field capacity (FC) and 50 per cent field capacity (FC)) with three replications each where the seedlings of the genotypes were planted in pots of uniform size of 50 x 30 $m^{2.}$ Uniform sized pots were filled with 20 kg of soil and the weight was recorded. The pots were then saturated with water and kept for 24 hours for attainment of moisture saturation level and the weight was recorded once again. The field capacity was calculated by weighing and watering each pot at regular intervals. Forty-five days old seedlings were then transplanted into the pots by maintaining one seedling in each pot. After 25 days of transplanting, drought was imposed to the plants Treatment II (50 per cent field capacity) while 100 per cent field capacity was maintained for control pots. The cultivation and management operations of chilli were followed including the application of recommended dose of fertilizers and plant protection measures as per the recommended package of practices of Tamil Nadu Agricultural University, Coimbatore.

Results and Discussion

The plants imposed with 100% FC recorded higher average plant height of 86.97 cm than 50% field capacity plants (64.07cm). Among the genotypes, IC-119230 was significantly taller (113.16 cm) which is followed by IC-119221 (106.50 cm) and SNTV-88 (103.30 cm) in control. Number of branches per plant imposed with 100% FC recorded highest branches per plant of 5.50 than 50% field capacity plants (4.17). In the genotypes, IC-119233 recorded 11.20 followed by IC-045986 (10.60) whereas at 50% FC, IC-045986 (8.00) showed highest number of branches followed by IC-119233 (7.60) while VI047102 recorded lowest number of branches (1.20). Similarly, Smitha (2006) [6] concluded that maximum number of branches was observed in the genotype G11 (48.27) and minimum number of branches reported in genotype G7 (28.53) at 150 DAT.

In 100% FC delayed flowering was recorded with a mean value of 82.89 days than 50% field capacity plants (76.48 days). The results revealed that the genotype EC- 320525 recorded 74.00 days of flowering followed by EC-388996. The genotype AVPP-9813 recorded the least number of days (75.40 days) taken for first flowering at control. For the character days taken to first flowering the plants imposed with 100% FC recorded with a mean value of 91.20 days than 50% field capacity plants (85.70 days). The results revealed that genotypes AVPP9813 recorded 81.20 days for first flowering followed by EC-320525 (81.60 days). Similarly Sreenivas *et al*. (2019) [7] stated that out of 45 chilli genotypes the minimum days to 50% flowering was observed in germplasm Banihari (34.42 days) followed by Shitari-Shitari (36.12 days), IC-342465 (37.73 days).

For number of fruits per plant at 100% FC the more number of fruits per plant of 110.40 was noticed in IC-119233 and the lowest was recorded in VI047102 (14.60). Whereas under stress treatment, the same genotype IC-119233 (80.80) recorded highest number of fruits per plant and the lowest was recorded in VI047102 (7.60). At 50% FC, the overall mean performance recorded was 42.01 and at 100% FC, it was 56.37. The highest individual green fruit weight of 9.38 g was exhibited by AVPP9905 while the least value of 1.54 g was noted in the genotype ST-13837 at control. At 50% FC, AVPP9905 recorded highest individual fruit weight of 7.36 g and the lowest was noted in VI059328 (1.02 g). Sreenivas *et al*. (2019) [7] reported that fresh fruit weight varied from 0.87 g to 8.33 g. The maximum fresh fruit weight was observed in Srinagar (8.33 g) followed by 2016-CHI Var-1 (4.21 g). The lowest fruit weight was observed in Blue chilli (0.87 g).

The highest green fruit yield per plant was recorded in IC-119233 (404.06g) at 100% FC followed by IC-045986 (397.57 g) and the lowest fruit green yield per plant was observed in accession VI059328 (48.66). (Fig 1.) However at 50% FC, EC-554803 attained the highest green fruit yield per plant of 220.32 g followed by IC-119230 (215.76g) and the lowest was obtained by accession VI059328 (23.26g) and SNTV-88 (24.45g).

The highest relative water content was exhibited by Arka Lohit (72.24 *per cent*) followed by EC-362917 (72.19 *per cent*) while IC-119233 reported the lowest value of 62.09 *per cent* in 100% FC. However, 50% FC treatment, EC-362917 recorded highest relative water content of 71.48 per cent. While the lowest relative water content was observed by EC-554803 (54.12 *per cent*).

The general mean performance for chlorophyll stability index among various genotypes recorded were 65.13 *per cent* and 60.60 *per cent* at 100% FC and 50% FC respectively. Results showed that in control, IC-119231 recorded the highest value (71.04 *per cent*) and the lowest was registered by IC-119234 (55.46 *per cent*). Gladen, 2012 found that function of temperature is inversely related to the degree of stress conditions imposed on the plants. So the stability of chlorophyll pigments can be correlated with drought tolerance.

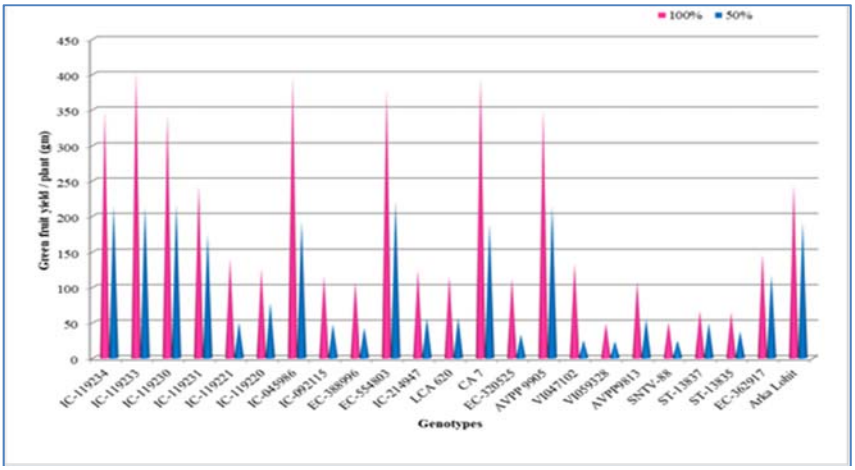

Fig 1: Mean performance for green fruit yield per plant (gm) at100% FC and 50% FC of chilli genotypes

Conclusion

From this above experiment it is concluded that the genotypes viz., IC-119233 and IC-045986 were recorded highest for most of the growth and yield characters in chilli. Arka Lohit had recorded the highest relative water content whereas IC 119231 had recorded the highest chlorophyll stability index. Hence, these well performed four genotypes alone can be used as a parent for hybridization programme.

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Table 1: Mean performance for plant height, number of branches per plant and days to first flowering under non-stress and drought stress conditions of chilli genotypes

S. No	Genotypes	Plant height			Number of branches per plant			Days to first flowering		
		100%	50%	100%	100%	100%	Mean	100%	50%	Mean
1	IC-119234	91.46	65.46	78.46	5.60	3.80	4.70	82.40	71.60	77.00
2	IC-119233	92.80	74.56	83.68	11.20	7.60	9.40	77.00	70.40	73.70
3	IC-119230	113.16	82.58	97.87	8.60	6.60	7.60	86.80	81.00	83.90
4	IC-119231	87.20	82.68	84.94	7.60	6.60	7.10	78.40	71.00	74.70
5	IC-119221	106.50	62.56	84.53	5.20	3.60	4.40	76.20	72.20	74.20
6	IC-119220	93.64	58.68	76.16	4.60	3.60	4.10	83.00	76.00	79.50
7	IC-045986	89.04	71.42	80.23	10.60	8.00	9.30	85.00	78.40	81.70
8	IC-092115	86.90	53.60	70.25	4.40	3.60	4.00	76.20	71.20	73.70
9	EC-388996	54.94	43.18	49.06	3.00	1.80	2.40	75.40	70.60	73.00
10	EC-554803	98.78	72.44	85.61	8.00	6.60	7.30	80.00	74.80	77.40
11	IC-214947	99.84	58.10	78.97	3.60	3.40	3.50	84.40	76.40	80.40
12	LCA 620	94.42	64.40	79.41	3.40	2.00	2.70	76.80	71.80	74.30
13	CA 7	68.82	59.34	64.08	8.40	6.20	7.30	76.60	71.80	74.20
14	EC-320525	97.76	55.28	76.52	3.00	1.60	2.30	74.00	70.40	72.20
15	AVPP 9905	64.32	60.76	62.54	4.80	3.80	4.30	81.60	76.20	78.90
16	VI047102	54.02	40.20	47.11	2.00	1.20	1.60	75.80	72.20	74.00
17	VI059328	80.96	55.70	68.33	3.00	2.00	2.50	82.40	77.40	79.90
18	AVPP9813	92.52	57.60	75.06	4.00	2.80	3.40	75.40	72.80	74.10
19	SNTV-88	103.30	69.66	86.48	3.40	2.00	2.70	94.80	89.20	92.00
20	ST-13837	49.38	46.96	48.17	6.00	5.60	5.80	95.20	92.00	93.60
21	ST-13835	86.32	67.66	76.99	3.00	2.60	2.80	99.20	93.80	96.50
22	EC-362917	94.18	83.20	88.69	5.60	4.80	5.20	86.60	82.80	84.70
23	Arka Lohit	100.16	87.60	93.88	7.60	6.00	6.80	80.20	75.00	77.60
	Mean	86.97	64.07	75.52	5.50	4.17	4.83	81.89	76.48	79.18
		SE d	CD (0.05)	CD (0.01)	SE d	CD (0.05)	CD (0.01)	SE d	CD(0.05)	CD(0.01)
	G	1.08	2.15	2.85	0.09	0.18	0.23	1.17	2.33	3.08
	T	0.32	0.63	0.84	0.03	0.05	0.07	0.35	0.69	0.91
	GXT	1.53	3.04	4.03	0.12	0.25	0.33	1.66	3.29	4.36

G – Genotype, T – Treatment

Table 2: Mean performance for number of fruits per plant and individual green fruit weight (g) under non-stress and drought stress conditions of chilli genotypes

S. No	Genotypes	Number of fruits per plant				Individual green fruit weight			
		100%	50%	Mean	Reduction (%)	100%	50%	Mean	Reduction (%)
1	IC-119234	81.40	63.60	72.50	21.87	4.30	3.40	3.85	20.93
2	IC-119233	110.40	80.80	95.60	26.81	3.66	2.62	3.14	28.42
3	IC-119230	92.20	69.60	80.90	24.51	3.72	3.10	3.41	16.67
4	IC-119231	74.20	59.60	66.90	19.68	3.28	2.92	3.10	10.98
5	IC-119221	59.00	37.80	48.40	35.93	2.36	1.32	1.84	44.07
6	IC-119220	60.40	46.20	53.30	23.51	2.08	1.68	1.88	19.23
7	IC-045986	104.60	76.80	90.70	26.58	3.82	2.50	3.16	34.55
8	IC-092115	55.00	37.00	46.00	32.73	2.10	1.28	1.69	39.05
9	EC-388996	15.60	8.20	11.90	47.44	6.96	5.32	6.14	23.56
10	EC-554803	68.20	51.00	59.60	25.22	5.54	4.32	4.93	22.02
11	IC-214947	42.00	38.80	40.40	7.62	2.96	1.44	2.20	51.35
12	LCA 620	52.00	44.60	48.30	14.23	2.22	1.26	1.74	43.24
13	CA 7	94.60	54.00	74.30	42.92	4.18	3.48	3.83	16.75
14	EC-320525	33.80	29.00	31.40	14.20	3.37	1.15	2.26	65.88
15	AVPP 9905	37.20	29.00	33.10	22.04	9.38	7.36	8.37	21.54
16	VI047102	14.60	7.60	11.10	47.95	9.12	3.28	6.20	64.04
17	VI059328	31.60	22.80	27.20	27.85	1.54	1.02	1.28	33.77
18	AVPP9813	26.60	17.20	21.90	35.34	4.06	3.16	3.61	22.17
19	SNTV-88	29.20	22.80	26.00	21.92	1.76	1.13	1.45	35.80
20	ST-13837	43.00	35.20	39.10	18.14	1.54	1.40	1.47	9.09

21	ST-13835	39.60	26.00	32.80	34.34	1.62	1.44	1.53	11.11
22	EC-362917	54.00	46.80	50.40	13.33	2.72	2.50	2.61	8.09
23	Arka Lohit	77.40	61.80	69.60	20.16	3.16	3.08	3.12	2.53
	Mean	56.37	42.01	49.19		3.72	2.62	3.17	
		SED	CD(0.05)	CD(0.01)		SED	CD(0.05)	CD(0.01)	
	G	0.72	1.42	1.88		0.05	0.10	0.13	
	T	0.21	0.42	0.55		0.01	0.03	0.04	
	GXT	1.01	2.01	2.66		0.07	0.14	0.19	

G – Genotype, T – Treatment

Table 3: Mean performance for green fruit yield / plant, relative water content (%) and chlorophyll stability index (%) under non-stress and drought stress conditions of chilli genotypes

S. No	Genotypes	Green fruit yield / plant			Relative water content			Chlorophyll stability index		
		100%	50%	Mean	100%	50%	Mean	100%	50%	Mean
1	IC-119234	348.20	215.24	281.72	63.01	60.45	61.73	55.46	51.23	53.35
2	IC-119233	404.06	212.70	308.38	62.09	59.47	60.78	65.12	63.14	64.13
3	IC-119230	342.98	215.76	279.37	71.58	69.12	70.35	69.45	67.24	68.35
4	IC-119231	243.38	174.03	208.70	71.05	70.05	70.55	71.04	70.05	70.55
5	IC-119221	139.24	49.90	94.57	62.58	58.46	60.52	61.14	54.48	57.81
6	IC-119220	125.63	77.62	101.62	64.89	60.04	62.47	63.98	59.17	61.58
7	IC-045986	397.57	192.00	294.79	63.78	61.24	62.51	59.17	54.27	56.72
8	IC-092115	115.50	47.36	81.43	69.45	61.24	65.35	68.74	60.85	64.80
9	EC-388996	107.57	42.62	75.10	66.45	61.14	63.80	68.72	60.81	64.77
10	EC-554803	377.83	220.32	299.07	63.21	54.12	58.67	61.71	53.47	57.59
11	IC-214947	124.32	55.87	90.10	67.19	60.17	63.68	65.18	59.87	62.53
12	LCA 620	115.44	56.20	85.82	66.47	61.12	63.80	60.17	54.23	57.20
13	CA 7	395.43	187.92	291.67	69.64	66.68	68.16	68.84	66.18	67.51
14	EC-320525	112.80	33.06	72.93	70.47	65.23	67.85	62.47	54.18	58.33
15	AVPP 9905	348.94	213.44	281.19	65.81	61.79	63.80	62.66	57.45	60.06
16	VI047102	133.15	24.90	79.03	68.47	65.23	66.85	69.19	64.84	67.02
17	VI059328	48.66	23.26	35.96	62.66	57.45	60.06	63.35	56.48	59.92
18	AVPP9813	107.99	54.35	81.17	67.43	62.79	65.11	64.48	60.97	62.73
19	SNTV-88	50.39	24.45	37.42	67.61	61.07	64.34	63.24	59.96	61.60
20	ST-13837	66.22	49.28	57.75	64.89	63.75	64.32	65.68	64.47	65.08
21	ST-13835	64.15	37.44	50.80	70.05	69.17	69.61	70.15	64.59	67.37
22	EC-362917	146.88	117.00	131.94	72.19	71.48	71.84	69.47	68.74	69.11
23	Arka Lohit	244.58	190.34	217.46	72.24	70.91	71.58	68.66	67.19	67.93
	Mean	198.30	109.35	153.83	67.10	63.14	65.12	65.13	60.60	62.87
		SED	CD(0.05)	CD(0.01)	SED	CD(0.05)	CD(0.01)	SED	CD(0.05)	CD(0.01)
	G	2.65	5.27	6.97	0.88	1.76	2.33	0.95	1.90	2.51
	T	0.78	1.55	2.06	0.26	0.52	0.69	0.28	0.56	0.74
	GXT	3.75	7.45	9.86	1.25	2.48	3.29	1.35	2.68	3.55

G – Genotype, T – Treatment

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