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 (64.07 cm). 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) [3]. 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 cm². 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 (64.07 cm). 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 V1047102 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 V1047102 (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 V1047102 (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 V1059328 (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 (404.06 g) at 100% FC followed by IC-045986 (397.57 g) and the lowest fruit green yield per plant was observed in accession V1059328 (48.66). However at 50% FC, IC-342465 attained the highest green fruit yield per plant of 220.32 g followed by IC-119230 (215.76 g) and the lowest was obtained by accession V1059328 (23.26 g) and SNTV-88 (24.45 g).

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.
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% 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 5.20 3.60 4.10 | 76.20 72.20 74.20 |
| 5     | IC-119220   | 93.64 58.68 76.16 4.60 3.60 4.10 | 83.00 76.00 79.50 |
| 6     | IC-045986   | 89.04 71.42 80.23 10.60 8.00 9.30 | 85.00 78.40 81.70 |
| 7     | IC-092115   | 86.90 55.60 71.80 4.40 3.60 4.10 | 83.00 76.00 79.50 |
| 8     | EC-388996   | 54.94 43.18 49.06 3.00 1.80 2.40 | 75.40 70.60 73.00 |
| 9     | EC-554803   | 98.78 72.44 85.61 8.00 6.60 7.30 | 80.00 74.80 77.40 |
| 10    | LCA 620     | 94.42 82.58 97.87 3.40 2.00 2.70 | 76.80 71.80 74.30 |
| 11    | CA 7        | 84.20 62.56 84.53 5.20 3.60 4.40 | 86.80 78.40 81.70 |
| 12    | Arka Lohit   | 93.64 58.68 76.16 4.60 3.60 4.10 | 83.00 76.00 79.50 |

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 | 4.00 3.00 3.80 | 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 57.80 68.40 19.68 | 3.28 2.92 3.10 | 10.98 |
| 5     | IC-119220   | 59.00 37.80 48.40 35.93 | 3.26 3.12 3.14 | 45.07 |
| 6     | IC-119221   | 60.40 46.20 53.30 23.51 | 2.08 1.68 1.88 | 29.33 |
| 7     | IC-045986   | 104.60 75.20 97.50 21.87 | 4.30 3.40 3.85 | 20.93 |
| 8     | IC-092115   | 92.50 67.80 80.90 24.51 | 3.72 3.10 3.41 | 16.67 |
| 9     | EC-388996   | 33.80 22.00 31.40 14.20 | 3.66 2.62 3.14 | 28.42 |
| 10    | AVPP9905    | 64.32 40.20 51.70 19.68 | 3.28 2.92 3.10 | 10.98 |
| 11    | AVPP9905    | 42.00 30.00 36.00 14.20 | 3.28 2.92 3.10 | 10.98 |
| 12    | LCA 620     | 52.00 32.00 42.00 14.20 | 3.28 2.92 3.10 | 10.98 |
| 13    | CA 7        | 42.00 30.00 36.00 14.20 | 3.28 2.92 3.10 | 10.98 |
| 14    | Arka Lohit   | 29.20 20.00 24.60 14.20 | 3.28 2.92 3.10 | 10.98 |
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 66.68 68.16     | 68.84 66.18 67.51         |
| 9     | EC-388996     | 107.57 42.62 75.10       | 66.47 61.12 63.80     | 60.17 54.23 57.20         |
| 10    | EC-554803     | 124.32 55.87 90.10       | 67.19 60.17 63.68     | 65.18 59.87 62.53         |
| 11    | LCA 620       | 115.44 56.20 85.82       | 66.47 61.12 63.80     | 60.17 54.23 57.20         |
| 12    | CA 7          | 395.43 187.92 291.67     | 69.64 66.68 68.16     | 68.84 66.18 67.51         |
| 13    | EC-320525     | 112.80 33.06 72.93       | 70.47 65.23 67.85     | 62.47 54.18 58.33         |
| 14    | AVPP 9905     | 348.94 213.44 281.19     | 65.81 61.79 63.80     | 62.66 57.45 60.06         |
| 15    | VLR 47102     | 133.15 24.90 79.03       | 68.47 65.23 66.85     | 69.19 64.84 67.02         |
| 16    | VLR 59328     | 48.66 23.26 35.96        | 62.66 57.45 60.06     | 63.35 56.48 59.92         |
| 17    | AVPP 9813     | 107.99 54.35 81.17       | 67.43 62.79 65.11     | 64.48 60.97 62.73         |
| 18    | SNTV-88       | 35.39 24.45 37.42        | 67.61 61.07 64.34     | 63.24 59.96 61.60         |
| 19    | ST-13837      | 66.22 49.28 57.75        | 64.89 63.75 64.32     | 65.68 64.47 65.08         |
| 20    | ST-13835      | 64.15 37.44 50.30        | 70.05 69.17 69.61     | 70.15 64.59 67.37         |
| 21    | EC-362917     | 146.88 117.00 131.94     | 72.19 71.48 71.84     | 69.47 68.74 69.11         |
| 22    | Arka Lohit    | 244.58 190.34 217.46     | 72.24 70.91 71.58     | 68.66 67.19 67.93         |
| Mean  |              | 198.30 139.35 153.83     | 65.10 63.14 65.12     | 65.13 60.60 62.87         |

|       |               | SED CD(0.05) CD(0.01)    | SED CD(0.05) CD(0.01) |
|-------|---------------|--------------------------|------------------------|
| G     | 0.72          | 1.42 1.88                | 0.05 0.10              |
| T     | 0.21          | 0.42 0.55                | 0.01 0.03              |
| GXT   | 1.01          | 2.01 2.66                | 0.07 0.14              |

G – Genotype, T – Treatment
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