Indian Journal of Ecology (2025) 52(6): 1477-1482
DOI: https://doi.org/10.55362/IJE/2025/4678

Manuscript Number: 4678
NAAS Rating: 5.38

Screening of Muskmelon Genotypes (*Cucumis melo* L.) for Drought Tolerance

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Abstract: Drought is one of the major environmental stress (abiotic) which interrupts growth and development of plant and its productivity, so screening of genotypes that exhibit drought tolerance in muskmelon crop may help to develop resilient that can withstand the period of water scarcity. Fifteen muskmelon genotypes collected from different sources sown in polybags containing potting mixture of soil: sand: farm yard manure in the ratio of 2:1:1 and were maintained under polyhouse condition. As treatment, water stress was imposed after 30 days after sowing by withholding irrigation for next 15 days and growth parameters are recorded. Among genotypes, Chamarajnagar Local, Muskmelon Round and Kerala 2 gave better response to drought and these genotypes can be further used to test under field conditions and can also be used in breeding programmes for drought tolerance.

Keywords: Drought, Genotypes, Muskmelon, Stress tolerance

Muskmelon botanically called as *Cucumis melo* L. belongs to the family Cucurbitaceae with diploid chromosome number of 24 and Asia is considered as the center of origin of melons. Melons are rich source of antioxidants, protein, lipid, carbohydrate, vitamins and minerals. Additionally, they contain beneficial omega-3 and omega-6 fatty acids. As they are source of minerals, they are crucial for proper body functioning and a healthy immune system and also contain vitamin K, which is essential for blood clotting, making melons beneficial in preventing cardiovascular diseases (Manchali and Murthy 2020). Seeds of melon are also rich source of nutrients which include carbohydrate, protein, fat and dietary fiber (Mehra et al., 2015). Melons are cultivated worldwide and which have wider adaptability and in India they are cultivated in an area of 68.7 thousand hectares with a production of 1518.5 metric tons (Anonymous 2023).

Understanding the response of plants to changing climate conditions is crucial for mitigating global warming concerns, as drought has been the most deleterious aspects of environmental stress that is responsible for the low crop yield which affects agricultural production. It rapidly induces an osmotic imbalance in crops, resulting in several physiological and biochemical dysfunction (Chaves and Oliveira 2004). Depleted water sources or lack of sufficient moisture affects healthy plant development and fruit production. During the vegetative stage, melons require consistent moisture to support leaf growth, root development and overall plant establishment. Insufficient water during this phase can lead to stunted growth and poor plant vigor. As the plants enter the reproductive stage, which includes flowering and fruit formation, water requirements increase further. Inadequate watering during this phase can result in reduced fruit size, blossom end rot or even fruit drop (Sharma et al., 2014). This study favors to select genotypes that exhibit promising drought tolerant traits. Selected genotypes as drought tolerant through this screening can be introduced in drought prone areas and also can be used in breeding Programme to develop drought tolerant varieties/hybrids.

MATERIAL AND METHODS

The experiment was carried out at Department of Horticulture, University of Agricultural Sciences, Bangalore. The experimental material consists of fifteen muskmelon genotypes collected from various sources; Puttikaayi, Dharwad 1, Gadag Local, Kerala 1, Kashi Madhu, Alpur Green, Giriyal Green, Chamarajnagar Local, Banaspathre, Sirsi Local, Bagalkot Local, Muskmelon Round, Muskmelon Local, Kekkarike and Kerala 2. Seeds of fifteen genotypes were sown in polybags containing potting mixture of soil: sand: farm yard manure (2:1:1) and were kept under polyhouse condition. Three replications for both control and treatment were maintained. The observations like shoot length, root length, number of leaves, plant height stress tolerant index, root length stress tolerant index, fresh weight, dry weight and chlorophyll content were recorded. Shoot and root lengths were measured in centimeters at 45 days after sowing (DAS) using a measuring scale. Number of leaves per plant was counted under both control and stress conditions. Fresh and dry weights of seedlings were recorded using a digital balance, with dry weight taken after oven-drying at 60 °C for 72 hours. Chlorophyll content was estimated using a SPAD meter. Stress tolerance indices for plant height and root length were calculated as per Ashraf et al. (2006). The experiment was laid out in a factorial completely randomized design (FCRD), and data were analyzed using ANOVA at 1% significance level.

$$\text{Plant height stress tolerance index} = \frac{\text{Plant height of stressed plants (cm)}}{\text{Plant height of control plants (cm)}} \times 100$$

$$\text{Root height stress tolerance index} = \frac{\text{Root height of stressed plants (cm)}}{\text{Root height of control plants (cm)}} \times 100$$

RESULTS AND DISCUSSION

The shoot length of fifteen selected muskmelon genotypes was measured under control and water stress conditions at 45 days after sowing. Among the treatments, shoot length under water stress conditions was lower than that of control (Table 2). Among the genotypes, Dharward 1 recorded maximum shoot length of 88.83 cm and minimum was recorded in Puttikaayi (34.75 cm). The lower mean reduction in shoot length was observed in Dharward 1 (15.57 %), which in on par with Chamarajnagar Local (17.75 %) and Muskmelon Round (18.85 %), while highest reduction noticed in the genotype Muskmelon Local (53.61 %). In the study, reduction in shoot length was observed under moisture stress condition, Drought stress decline water potential and turgor in plant leaves, which leads to a slowed growth rate and impacting various biological processes within the plant (Hussain et al., 2018). Moisture stress also impacts the availability of stem reserves, reduces internodal length and lowers water potential, all of which contribute to decreased plant height. This aligns with the findings, of Salvadora et al. (2017) in tomato and Ansari et al. (2019) and Rehman et al. (2023) in melons, where decreased plant height was observed under stress condition. The effect water stress on root length of selected genotypes was recorded at 45th day after sowing. In moisture stress condition, root length got decreased as compared to control (Table 1). An increase in the root length can be seen in genotypes like Puttikaayi, Kerala 1, Bagalkot Local and Muskmelon Round compared to control, in which highest percentage increase was recorded in genotype Muskmelon Round (22.76 %). All other genotypes showed a decrease in root length under water stress conditions. Where, Alpur Green had maximum root length (32.17 cm) with 5.06 per cent reduction, while Giriyal Green shown minimum root length of 23.19 cm with only 1.06 per cent reduction of root length compared to control and genotype Kekkarike showed highest percentage reduction (26.75 %) under water stress condition.

In this study, drought stress is imposed in polybags which restricts the growth of roots, here both increase and decrease in root length is recorded. Drought stress often leads to changes in soil structure, such as increased compaction or reduced moisture, which can inhibit root growth. Under water deficit plant adopt themselves to preside over water stress condition by changing in physiological traits, i.e. root and shoot length (Kusvuran and Dasgan 2017) in tomato (Pandey et al., 2018) muskmelon. Number of leaves per plant of genotypes was recorded (Table 1). Under moisture stress conditions, the number of leaves per plant was consistently lowered compared to the control. Among genotypes, the higher number of leave s was recorded in Giriyal Green (18.67) and lower in Alpur Green (10.17) and the lower mean reduction in number of leaves observed in Kerala 2 (2.32 %), which in on par with Kashi Madhu (8.33 %) and highest reduction were noticed in the genotype Puttikaayi (36.74 %). Water stress conditions lead to fewer leaves as the plant adapts by reducing its surface area to limit water evaporation and optimize survival. Munne-Bosch and Alegre (2004) reported that decrease in leaf number under moisture stress is a controlled physiological adaptation that helps the plant survives in adverse climatic conditions. Water scarcity reduces leaf size, longevity and the number of leaves per plant in tomato (Shao et al., 2008).

The Plant height stress tolerance index (PHSTI) values for fifteen genotypes assessed were analyzed (Table 2). Among genotypes, Dharward 1 (92.21) obtained maximum PHSTI which was on par with Chamarajanagar Local (91.13) and Muskmelon Round (90.57), while minimum was obtained at Muskmelon Local (73.20) and Banaspathre (74.71). The plant height stress tolerance index can indicate adaptation of genotypes to drought conditions based on their shoot growth responses. In the present study, the shoot length found to be decreased under water stress there by reduced PHSTI compared to control. Saensee *et al* (2012) in sunflower and Faizan, (2020) in brinjal reported that stress tolerance index can be used effectively for selecting genotypes which are tolerant to moisture stress. The Root length stress tolerance index (RLSTI) of fifteen genotypes was computed analysed data were presented in Table 2. Among genotypes, Muskmelon Round (111.40) showed maximum RLSTI, followed by Kerala 1 (108.06), whereas Kekkarike (86 .63) and Banaspathre (88.43) recorded minimum. The root length stress tolerance index can indicate adaptation of genotypes to drought conditions based on their root growth responses. Genotypes have a higher root stress tolerance index, indicating their greater resilience to stress, whereas lower index, reflecting their susceptibility to stress. It can be used effectively used for selecting genotypes which are tolerant to moisture stress (Saensee et al., 2012) in sunflower and (Gobu et al., 2014) brinjal.

Plant fresh weights of genotypes were measured at 45th day after sowing. The recorded data is illustrated in Figure 1. Among the genotypes, the minimum mean reduction was found in Chamarajnagar Local (38.50 %) followed by Puttikaayi (42.28 %). The highest mean reduction percentage was recorded in Kashi Madhu (79.86 %), which is on par with Giriyal Green (74.39 %). While the Giriyal Green recorded maximum plant fresh weight (33.92 g), which also had higher mean reduction of 74.39 per cent. Muskmelon Round recorded minimum fresh weight (16.05), while interaction effect showed maximum fresh weight in Kerala 2 (18.00 g) and minimum was in Kashi Madhu (7.97 g) under water stress condition (Fig. 2). Higher plant fresh weights under moisture deficit environments are desirable characters with respective to drought tolerance. A common adverse effect of water stress on crop plants is the reduction in fresh and dry biomass production Zhao *et al.* (2006) and Farooq *et al.* (2009). Under moisture deficit conditions, plant height, leaf number, size and stem diameter typically decrease, which finally lead to decreased biomass production causing reduced fresh weight of the seedlings.

The dry weights of genotypes were taken at 45th day after sowing. The data is illustrated in Figure 3. The genotype Giriyal Green recorded maximum dry weight (10.70 g), which also shown highest mean reduction of 70.54 per cent. While Banaspathre recorded minimum dry weight of plant (3.52 g) with lowest mean reduction of 11.53 per cent. Among genotype and treatment interaction, maximum dry weight is

Table 1. Effect of water stress on shoot length, root length and number of leaves of muskmelon genotypes at 45th day after sowing

Genotypes	Shoot length (cm)				Root length (cm)				Number of leaves			
	Control	Treatment	Mean	Mean reduction (%)	Control	Treatment	Mean	Mean reduction (%)	Control	Treatment	Mean	Mean reduction (%)
Puttikaayi	43.67	25.83	34.75	40.85	23.67	25.67	24.67	-8.45	16.33	10.33	13.33	36.74
Dharwad 1	96.33	81.33	88.83	15.57	29.27	27.17	28.22	7.17	18.67	12.33	15.50	33.96
Gadag Local	86.00	51.67	68.83	39.92	29.93	25.00	27.47	16.47	17.33	12.00	14.67	30.76
Kerala 1	72.33	45.33	58.83	37.33	26.98	31.33	29.16	-16.12	13.33	9.33	11.33	30.01
Kashi Madhu	96.67	57.33	77.00	40.70	32.47	27.95	30.21	13.92	12.00	11.00	11.50	8.33
Alpur Green	75.67	49.67	62.67	34.36	33.00	31.33	32.17	5.06	12.00	8.33	10.17	30.58
Giriyal Green	67.33	50.17	58.75	25.49	23.38	23.00	23.19	1.63	22.00	15.33	18.67	30.32
Chamarajnagar Local	77.00	63.33	70.17	17.75	26.67	25.00	25.83	6.26	13.33	11.00	12.17	17.48
Banaspathre	57.33	28.33	42.83	50.58	30.37	23.33	26.85	23.18	13.00	10.33	11.67	20.54
Sirsi Local	65.67	40.33	53.00	38.59	31.33	27.00	29.17	13.82	17.00	11.33	14.17	33.35
Bagalkot Local	62.67	49.33	56.00	21.29	28.83	30.33	29.58	-5.20	19.67	13.00	16.33	33.91
Muskmelon Round	61.00	49.50	55.25	18.85	22.67	27.83	25.25	-22.76	13.33	10.67	12.00	19.95
Muskmelon Local	74.00	34.33	54.17	53.61	30.73	24.00	27.37	21.90	15.00	10.67	12.83	28.87
Kekkarike	84.00	60.50	72.25	27.98	28.67	21.00	24.83	26.75	14.33	11.67	13.00	18.56
Kerala 2	47.33	39.33	43.33	16.90	27.33	23.67	25.50	13.39	14.67	14.33	14.50	2.32
Mean	71.13	48.42	59.77	31.98	28.35	26.24	27.29	7.44	15.47	11.44	13.45	26.05
		CD (1%)				CD (1%)				CD (1%)		
Genotype (G)		14.42 *				3.92*				2.52*		
Treatment (T)		5.27 *				1.43*				0.92*		
G×T		NS				5.55*				3.56*		

* Significant; NS: Non-significant, CD- Critical difference

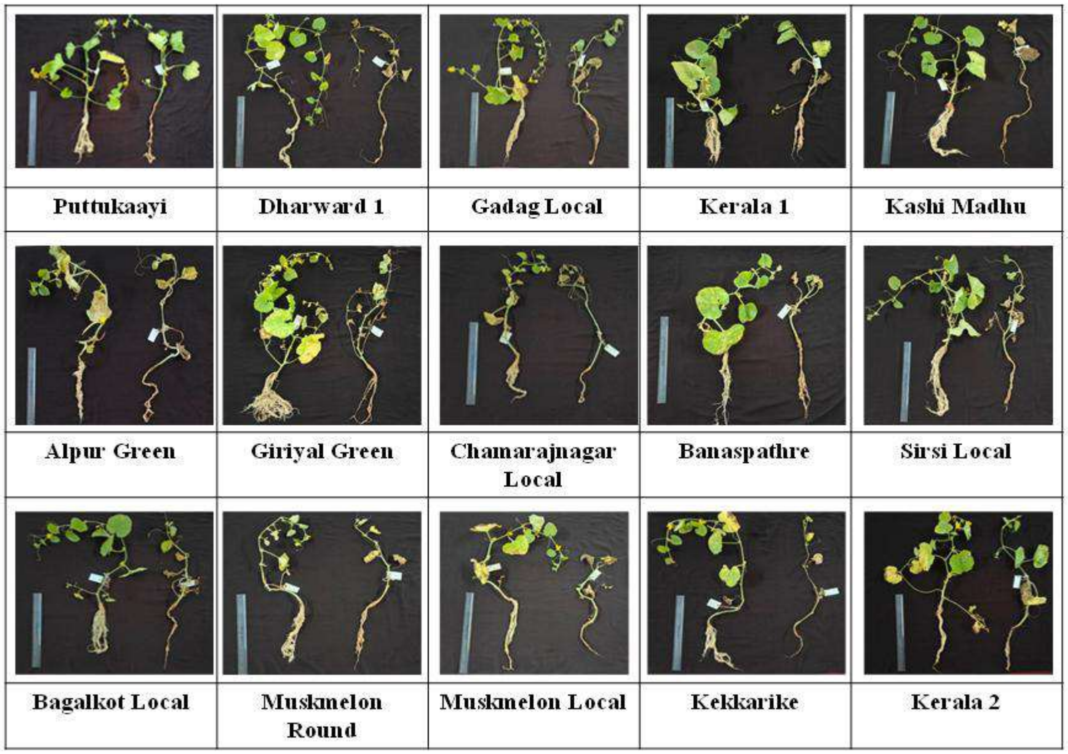

Fig. 1. Effect of water stress on the shoot and root growth of fifteen muskmelon genotypes under control and treatment at 45th day after sowing

Table 2. Effect of water stress on PHSTI and RLSTI of muskmelon genotypes at 45th day after sowing

Genotypes	PHSTI			RLSTI		
	Control	Treatment	Mean	Control	Treatment	Mean
Puttikaayi	100.00	59.16	79.58	100.00	108.45	104.23
Dharwad 1	100.00	84.43	92.21	100.00	92.83	96.41
Gadag Local	100.00	60.08	80.04	100.00	83.52	91.76
Kerala 1	100.00	62.67	81.34	100.00	116.12	108.06
Kashi Madhu	100.00	59.31	79.66	100.00	86.09	93.04
Alpur Green	100.00	65.64	82.82	100.00	94.95	97.48
Giriyal Green	100.00	74.51	87.25	100.00	98.36	99.18
Chamarajnagar Local	100.00	82.25	91.13	100.00	93.75	96.88
Banaspathre	100.00	49.42	74.71	100.00	76.84	88.42
Sirsi Local	100.00	61.42	80.71	100.00	86.17	93.09
Bagalkot Local	100.00	78.73	89.36	100.00	105.20	102.60
Muskmelon Round	100.00	81.15	90.57	100.00	122.79	111.40
Muskmelon Local	100.00	46.40	73.20	100.00	78.09	89.05
Kekkarike	100.00	72.02	86.01	100.00	73.26	86.63
Kerala 2	100.00	83.10	91.55	100.00	86.59	93.29
Mean	100.00	68.02	84.01	100.00	93.53	96.77
		CD (1%)			CD (1%)	
Genotype (G)		10.91*			8.75*	
Treatment (T)		3.98*			3.20*	
G×T		15.43*			12.38*	

*Significant; PHSTI: Plant Height Stress Tolerant Index; RLSTI: Root Length Stress Tolerant

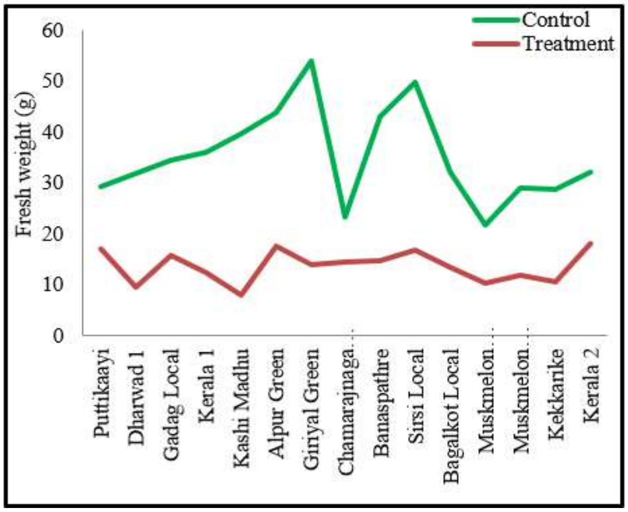

Fig. 2. Effect of water stress on fresh weight (g) of muskmelon genotypes at 45th day after sowing

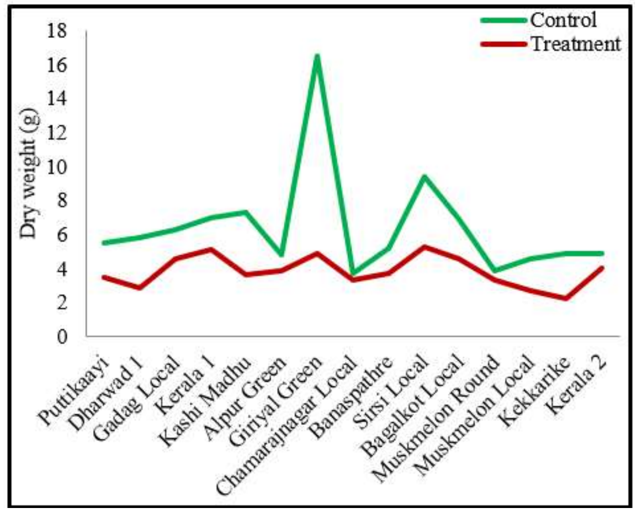

Fig. 3. Effect of water stress on dry weight (g) of muskmelon genotypes at 45th day after sowing

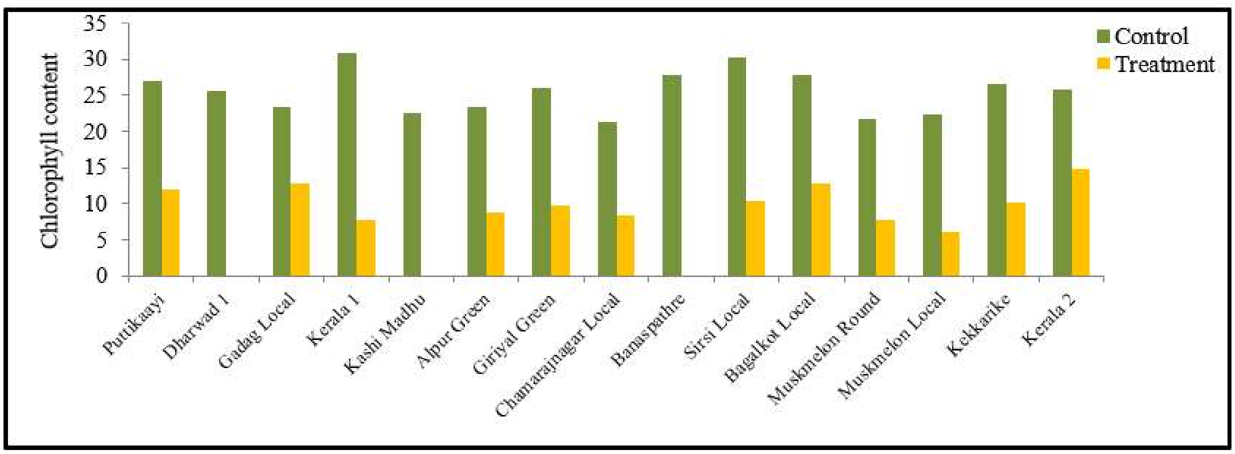

Fig. 4. Effect of water stress on chlorophyll content (SPAD units) of muskmelon genotypes at 45th day after sowing

recorded in Sirsi Local (5.27 g), while minimum was recorded in Kekkarike (2.25 g) followed by Muskmelon Local (2.73 g) in water stress condition (Fig. 3). Due to moisture stress condition, plant growth and development processes gets affected by which leads in reduction in dry matter accumulation. In the present study, total dry weight of muskmelon plants declined under moisture stress. Similar results were observed by Abdalla et al. (2018) and Gonzalez-Orenga et al. (2023) in brinjal; Rezaei et al. (2012) and Mahpara et al. (2018) in tomato.

The chlorophyll content of genotypes was measured using SPAD meter. The chlorophyll content found to be drastically reduced under water stress condition (Fig. 4). Among the genotypes maximum chlorophyll content was recorded in Kerala 2 (20.28) with minimum mean reduction of 42.57. Whereas, plants which are wilted due to water stress (Dharward 1, Kashi Madhu and Banaspathre) showed no chlorophyll content (Fig. 4). Drought stress limits water availability, which affects the plants ability to carry out photosynthesis. As it is crucial for conversion of light energy and into chemical energy, reduced photosynthetic activity often leads to a decrease in chlorophyll content. Rehman *et al* (2023) studies reported the decrease in chlorophyll under drought stress in muskmelon plants. Reduction or no-change in chlorophyll content of plant under drought stress has been observed in different plant species and its intensity depends on stress rate and duration. Drought stress imposed during vegetative growth or anthesis significantly decreased total chlorophyll content in chickpea (Mafakheri et al., 2010).

CONCLUSION

The present study was performed to screen muskmelon genotypes for drought tolerance, where the results showed that there is significant tolerance to drought in the muskmelon genotypes like Chamarajnagar Local, Muskmelon Round and Kerala 2. While, genotype Muskmelon Local along with

Banaspathre and Kekkarike showed susceptible to drought conditions. Therefore, the tolerant genotypes can be further study under field conditions and can be used to develop varieties for drought conditions.

ACKNOWLEDGEMENT

Authors are thankful to Department of Horticulture, University of Agricultural Sciences, GKVK, Bengaluru and College of Horticulture, University of Horticultural Sciences campus, Bangalore.

AUTHOR'S CONTRIBUTION

Kavya S conducted the research and collected the data. Suneetha C was responsible for the initiation and conceptualization of the study. Shivapriya M provided the seed material for the study. Venkatesha Murthy conceptualized the experiment and supervised the overall research work. Bhavani P and Sunitha T.R supervised the experimental work. Yuvaraj S and Praveenakumar R wrote and edited the manuscript. All authors read and approved the final manuscript.

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Received 18 August, 2025; Accepted 25 November, 2025