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Evaluation of small cardamom accessions for moisture stress

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Abstract

High biomass and high yielding cardamom genotypes viz., Green gold, Mysore-2, APG 277, Malabar-18, Compound panicle 7 (CP 7) and Hybrid 36 were screened for moisture stress tolerance. Clonally propagated seedlings were planted in cement pots and grown for one and a half year with recommended package of practices under rainout shelter with three replications and two treatments (control and moisture stress). Moisture stress was imposed by withholding irrigation for two months. Data on morphological and physiological parameters related to drought tolerance were recorded at the initiation, middle and end of stress. Plant height and number of leaves per clump did not record significant variation among the accessions at the initiation of stress. Number of dried leaves increased under stress in all genotypes at the middle of stress. Compound panicle 7 recorded higher reduction in biomass at end of stress period compared to all other accessions. Variation in relative water content between the treatments was non significant. Chlorophyll florescence yield reduced significantly under moisture stress treatment compared to control. Results indicate that genotypes Mysore 2, Green gold and Malabar 18 have better adaptability to drought conditions.

Key words: biomass, cardamom, moisture stress, chlorophyll fluorescence, plant height, relative water content

Cardamom (*Elettaria cardamomum* Maton) is generally grown as a rainfed crop and soil moisture is one of the limiting factors in augmenting the productivity. Moisture stress affects growth and development of crop plants at different stages. Morphological characters such as leaf area, plant height and root growth are severely affected in many crop plants (Blum, 1996; Sulikeri, 1986). Though cardamom crop is grown in Western Ghats that receive an annual rainfall of 2500-4000 mm, the rainfall is not evenly distributed. The crop experiences moisture stress during December - May (Rajendra Hegde and Korikanthimath 1996). Significant yield differences were observed among the twelve cardamom clones planted under regulated natural shade and moisture levels. Clones P3 and P6 were superior compared to other clones (Gurumurthy *et al.* 1996). Maintenance of leaf area, plant height and biomass are better morphological traits for drought indexing in cardamom. Physiological parameters such as relative water content and

Table 1. Effect of moisture stress on growth parameters (per clump) at the initiation of stress.

Treatment	Plant height (cm)	No. of tillers/ clump	No. leaves per clump
Control			
Green gold	139.9	11.83	67.5
Mysore 2	135.5	12.75	74.4
APG 277	158.4	12.16	76.2
Malabar 18	145.1	11.58	63.5
CP 7	131.7	13.58	68.0
Hybrid 36	139.1	13.58	68.0
Mean	141.7	12.36	69.2
Stress			
Green gold	136.7	15.0	95.1
Mysore 2	134.7	22.58	73.3
APG 277	142.5	12.9	54.3
Malabar 18	150.2	14.4	98.9
CP 7	146.2	12.4	82.0
Hybrid 36	154.6	17.5	79.4
Mean	144.2	15.8	80.5
CD at 5 %			
Moisture stress	NS	1.53	NS
Genotypes	NS	NS	NS
Interaction	NS	NS	NS

membrane stability can be used for characterization of cardamom germplasm for drought/moisture stress (Ankegowda and Krishnamurthy 1998). In this study, six genotypes with high biomass and good yield characters were selected to assess their moisture stress tolerance capacity.

Six accessions namely Green gold, Mysore-2, APG 277, Malabar 18, Compound Panicle 7 (CP 7) and Hybrid 36 with high biomass and yield characters were selected for the study. These genotypes were multiplied clonally and planted in cement pots of 2.5 ft x 2 ft diameter filled with soil, sand and farm yard mixture under rainout shelter with 4 plants for each treatment in three replicates. Treatments included control and moisture stress. Plants were grown for 18 months in cement pot and moisture stress was imposed by with holding irrigation for two months. The physiological and morphological parameters were recorded at the initiation of stress, middle of stress (two months) and at the end of stress (3 months). Plant height, number of tillers/clump and number of leaves per clump were recorded at the initiation of stress and middle of stress. Relative water content was also recorded at initiation of stress and middle of stress as per Sullivan leaf disc test. Chlorophyll fluorescence yield was recorded with chlorophyll fluorescence meter. Number of dry leaves was recorded at the middle of stress and at the end of stress. Biomass characters such as dry weight of tillers, leaves, roots and total dry weight (g/ clump) were recorded at end of stress after uprooting the plants from the pots. Data were analyzed statistically by using Mstatc package.

Growth parameters at the initiation of stress:

Data recorded on plant height, number of tillers per clump and number of leaves per clump at the initiation of stress is presented in Table 1. Plant height and number of leaves per clump did not show significant variation among the accessions. APG 277 recorded maximum plant height (158.4 cm) and Compound panicle 7 recorded minimum (131.7 cm) in control and in stress treatment, Hybrid 36 recorded maximum plant height (154.6 cm) while Mysore 2 recorded the minimum (134.7cm). Mysore 2 (22.6) had maximum number of clumps per tiller under stress while the minimum was noticed in Malabar 18 (11.58). Malabar 18 (98.9) recorded maximum number of leaves per clump under stress treatment and under control, Green gold recorded the lowest.

Growth parameters at the middle of stress:

Data on growth and relative water content is presented in Table 2. Plant height did not record significant variation among the accessions. Number of tillers and dry leaves per clump recorded significant variation between control and stress treatments. Moisture stress increased the number of dry

Table 2. Effect of moisture stress on growth parameters (per clump) at the middle of stress.

Treatment	Plant height (cm)	No. of tillers/ clump	No. leaves/ clump	No. of dry leaves/ clump	Relative water content (%)	Chlorophyll fluorescence yield
Control						
Green gold	156.8	12.16	63.9	21.0	93.7	0.72
Mysore 2	157.2	12.75	53.8	14.6	92.6	0.73
APG 277	182.6	12.75	51.4	12.3	94.5	0.74
Malabar 18	175.2	10.38	46.1	16.7	94.7	0.74
CP 7	150.6	11.41	65.3	16.7	96.6	0.71
Hybrid 36	165.1	14.58	66.0	22.1	94.7	0.74
Mean	164.6	12.34	57.8	17.3	93.8	0.73
Stress						
Green gold	170.3	13.4	64.9	26.1	91.7	0.63
Mysore 2	162.6	18.9	52.5	55.3	90.5	0.65
APG 277	168.1	13.0	42.2	25.7	92.5	0.65
Malabar 18	179.7	14.7	65.3	29.7	92.2	0.64
CP 7	178.5	12.7	66.1	33.7	93.4	0.60
Hybrid 36	164.0	17.0	51.6	29.3	93.7	0.65
Mean	170.6	14.96	57.1	33.33	93.1	0.64
CD at 5%						
Moisture stress	NS	1.45	NS	1.73	NS	0.02
Genotypes	NS	NS	2.47	1.99	1.23	NS
Interaction	NS	NS	2.94	2.36	0.71	NS

Table 3. Effect of moisture stress on growth parameters (per clump) at end of stress.

Treatment	Plant height (cm)	No. of tillers/ clump	No. leaves / clump	No. of dry leaves/clump
Control				
Green gold	155.0	10.9	50.8	19.7
Mysore 2	145.8	13.7	57.8	15.7
APG 277	160.6	10.7	57.9	23.4
Malabar 18	166.7	11.8	56.1	22.9
CP 7	151.1	10.6	48.8	24.4
Hybrid 36	158.2	12.5	57.9	27.9
Mean	156.3	11.7	54.9	22.3
Stress				
Green gold	136.2	12.4	11.1	65.0
Mysore 2	139.5	19.2	19.4	108.7
APG 277	147.9	11.6	14.8	57.8
Malabar 18	166.1	11.1	16.9	82.3
CP 7	154.3	10.0	33.4	51.0
Hybrid 36	135.3	13.5	18.2	82.7
Mean	146.5	12.9	18.9	74.6
CD at 5%				
Moisture stress	NS	0.97	1.73	2.95
Genotypes	NS	1.18	2.70	2.48
Interaction	NS	0.95	7.62	2.95

Table 4. Effect of moisture stress on dry matter partitioning (per clump) at end of stress.

Treatment	Dry weight of tillers (g/clump	Dry weight of leaves (g/clump)	Dry weight of roots (g/clump)	Totay dry weight (g/clump)
Control				
Green gold	1401.6	136.6	205.0	1743.2
Mysore 2	1566.6	356.6	197.0	2120.2
APG 277	1658.3	290.0	178.3	2126.6
Malabar 18	1260.0	336.6	148.3	1744.9
CP 7	613.3	193.3	113.3	919.9
Hybrid 36	756.7	265.0	135.0	1156.7
Mean	1209.4	263.0	162.8	1635.2
Stress				
Green gold	215.6	126.9	52.6	395.1
Mysore 2	285.1	166.7	37.0	488.8
APG 277	216.0	86.62	51.6	354.1
Malabar 18	228.6	151.2	34.32	414.1
CP 7	173.5	84.3	27.01	284.8
Hybrid 36	241.1	111.1	46.9	399.1
Mean	226.68	121.3	41.5	389.4
CD at 5%				
Moisture stress	8.15	6.98	4.09	9.06
Genotypes	14.11	8.46	6.70	16.83
Interaction	16.78	10.06	NS	20.01

leaves to reduce active leaf area for transpiration. Mysore 2 recorded highest dry leaves followed by Hybrid 36 and Compound panicle 7. Relative water content did not show significant variation between stress and control treatments due to rhizomatous nature of the crop. Significant variation was recorded among genotypes for relative water content. Chlorophyll fluorescence yield recorded at the middle of stress showed significant variation between the treatments. Compound panicle 7 had the lowest value. Fluorescence yield was lower in stress treatment which indicates the lower efficiency of electron transport under stress than control. Soil moisture content decreased under stress.

Growth and biomass characters at end of stress:

Growth and biomass characters recorded at end of stress are presented in Tables 3 and 4. Plant height did not record significant variation between the treatments. Number of tillers per clump recorded significant variation among genotypes. Number of green leaves reduced significantly under stress compared to control. Reduction in the number of green leaves was less in Compound panicle 7 and APG 277 compared to other genotypes. Mysore 2 recorded highest dried leaves. Dry weight of tillers per clump recorded significant variation between treatments and was reduced under stress. Mysore 2 and Hybrid 36 recorded higher dry weight of tillers compared to other genotypes. Dry weight of leaves per clump also recorded significant variation among treatments. Moisture stress reduced dry weight of leaves (Ankegowda & Krishnamurthy 1998). Mysore 2, Malabar 18 and Green gold recorded higher number of green leaves in stress compared to other genotypes. Significant variation was also recorded for

dry weight of roots per clump. Green gold, APG 277 and Hybrid 36 recorded higher root weight under stress compared to other genotypes. Significant variation was recorded for total dry weight between the treatments. Green gold, Mysore 2 and APG 277 maintained higher total dry weight in control. Mysore 2, Malabar 18, hybrid 36 and Green gold maintained higher dry weight than APG 277 and Compound panicle 7 under stress. The tested genotypes are high biomass types with good yield. The results of the study showed that these genotypes maintained good biomass under moisture stress also. Data indicate that Mysore 2, Hybrid 36 and Green gold have better adaptability under drought conditions due to the maintenance of more leaf area, tillers and total dry weight.

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