



Physiological Characterization of Banana Germplasm of North East India for Tolerance against Moisture Deficit

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ABSTRACT

Background: Water deficit stress is a serious environmental constrain to banana productivity in north east (NE) India. A field experiment was conducted to appraise the performance of 29 banana germplasm of NE India under moisture deficit condition of Assam that naturally prevails due to deficit rainfall every year during November to January.

Methods: Randomized block design with five replications was the experimental design used. Irrigation was not applied during the crop growing season. Various physio-chemical parameters were measured in the main crop on 7th and 9th months after planting (MAP) that coincided with November and January.

Result: Significant variations were observed in leaf relative water content, leaf area plant⁻¹, leaf area index, total chlorophyll content, leaf proline content, lipid peroxidation, hands bunch⁻¹ and bunch weight amongst germplasm studied. During moisture deficit period, germplasm Barjahaji, Bhimkal, Athiya and Bogimonahar could maintained better values in the physio-chemical traits studied except lipid peroxidation. The germplasm that showed superior values in the physio-chemical traits and lower value for lipid peroxidation registered the higher bunch weight. Significant positive correlation of bunch weight with leaf area (0.42 and 0.45 respectively for 7th and 9th MAP) and relative leaf water content (0.38 respectively for both 7th and 9th MAP) and significant negative correlation with lipid peroxidation (-0.45 and -0.49 respectively for 7th and 9th MAP) were observed at 5 per cent level of significant. Significant strong positive correlation between leaf chlorophyll content and proline content in leaf (0.85) was observed at 9th MAP. Germplasm Barjahaji, Bhimkal, Bogimanohar and Athiya are considered physiologically more tolerant to moisture deficit which can be used for future breeding programs and the physio-chemical parameters viz., leaf area, chlorophyll content, relative leaf water content and proline content can be considered as physiological indices for drought tolerance.

Key words: Banana, Chlorophyll, Moisture stress, Proline, Relative leaf water, Yield.

INTRODUCTION

Banana (*Musa* spp.) is one of the most important commercial fruit crops of tropical and subtropical regions of India. The most suitable climatic condition for the crop is moist warm climate and even rainfall during the growing season without strong wind. Banana requires about 150-167 mm of rainfall per month with an annual rainfall of about 1800-2000 mm (Sharma and Kispotta, 2016). Banana plant is considered stressful when the soil moisture content falls below 50% of field capacity (Blum and Ebercon, 1976). In Assam one of the NE states of India, banana is mainly cultivated as rainfed crop. The productivity of banana in Assam is 17.20 t ha⁻¹ which is far below the national average of 34.86 t ha⁻¹ (Anonymous, 2018). In north east India, the rainfall is scanty during the period between November to January that normally causes depletion of soil moisture content far below 50% of the field capacity. The depletion of soil moisture due to deficit rainfall during the period between November to January and lack of drought tolerant germplasm may be largely responsible for the lower banana productivity in Assam (NE India) although the production potential is high. Drought causes yield loss of banana up to 65% globally (Nansamba *et al.*, 2020). Inadequate soil moisture can hinder the metabolic activities of the plants leading to stunted growth and finally yield. Moisture deficit stress reduced stomatal conductance, leaf size, photosynthetic pigments and growth

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in banana (Kallarackal *et al.*, 1990; Pooja *et al.*, 2019a; 2020; Dhansu *et al.*, 2021). Water deficit stress disrupts the photosynthetic process and consequently the fruit yield in banana (Widiyanto *et al.*, 2023). Nevertheless, the tolerance capacity to drought in banana crop vary from genotype to genotype (Ravi *et al.*, 2013). Therefore, it seems feasible to upsurge the productivity of banana in Assam (NE India) by growing germplasm that can withstand moisture deficit stress. Hence, it becomes indispensable to screen germplasm that are tolerant to moisture deficit stress for advanced breeding programs. In view of the importance of

above mentioned points the current experiment was designed to assess the banana germplasm tolerant to moisture deficit stress based on physio-chemical characters.

MATERIALS AND METHODS

The current experiment was carried out at the experimental field of Department of Horticulture and Department of Crop Physiology, Assam Agricultural University, Jorhat (Assam), India during the period of 2017-18. The monthly meteorological data during the period of experimentation recorded at meteorological observatory of AAU, Jorhat, India is being depicted in Fig 1a and 1b. Twenty-nine (29) banana germplasm of numerous genomic groups were collected for the experiment (Table 1). Randomized block design (RBD) was the statistical designed used. Five replications were maintained for the study. Uniform and healthy sword suckers of three months old were used as planting material weighing about 2 kg from healthy mother plants. For dwarf germplasm 1.8 m×1.8 m, for medium tall 2.1 m×2.1 m and for tall germplasm 2.4 m×2.4 m (row to row and plant to

plant) spacing were maintained. A total of 145 pits of 45 cm³ were dug in the month of April, 2017. Well rotten farm yard manure @12 kg pit⁻¹ was applied before planting. The corms were treated with furadan 3G @40 g sucker⁻¹ before planting as a preventive measure against insect pest attack. The planting of suckers was done on 2nd May, 2017 in pits prepared in the month of April. At 3rd MAP, recommended dose of $\frac{1}{2}$ N and $\frac{1}{2}$ K₂O along with full dose of P₂O₅ fertilizers were applied in each pit. The remaining $\frac{1}{2}$ N and $\frac{1}{2}$ K₂O fertilizers were applied at 5th MAP. No irrigation was provided throughout the crop growing season. The observations for various physio-chemical parameters were recorded at first week of 7th and 9th MAP and yield parameters were recorded at harvest. The leaf area (LA plant⁻¹) was measured employing the length and breadth method suggested by Hewitt (1955) with the constant factor of 0.83 for banana. The methods suggested by Williams (1946) for leaf area index (LAI), Barrs and Weatherly (1962) for relative leaf water content (RLWC), Bates *et al.* (1973) for leaf proline content (LPC) and Hiscox and Israelstam (1979) non-maceration method using dimethyl sulphoxide (DMSO) for total leaf chlorophyll content

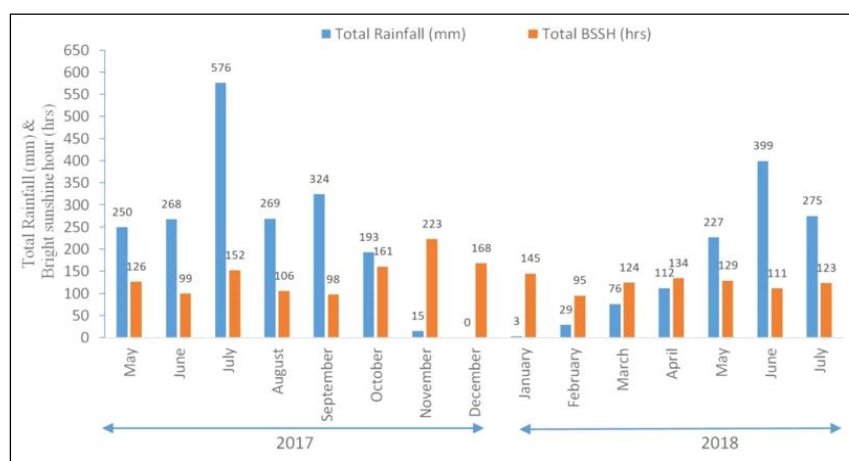


Fig 1a: Monthly total rainfall and bright sunshine hour during crop growing season of 2017-18.

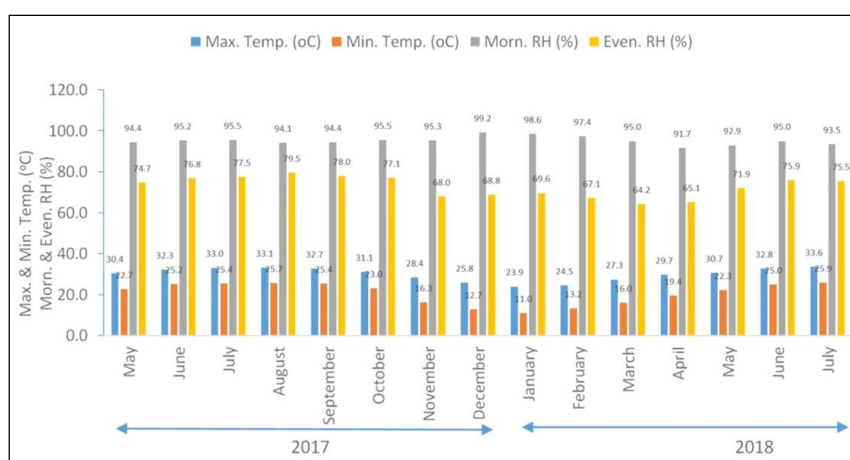


Fig 1b: Monthly temperature and relative humidity during crop growing season of 2017-18.

(TLCC) were used for estimation. The method of Heath and Packer (1968) was adopted for measuring the level of lipid peroxidation (LP) in terms of malondialdehyde content (MDA). Fully developed number of hands bunch⁻¹ were counted at harvest from each plant. The bunch weight was recorded using electronic weighing balance. All data were statistically analyzed following Yates method as described by Gupta and Kapoor (2009) and the results are discussed.

RESULTS AND DISCUSSION

The twenty-nine (29) banana germplasm exhibited significant variation in the physiological characters viz., LA plant⁻¹, LAI and RLWC (Table 2). The germplasm Bhimkal followed by Simolu Manohar, Athiya and Barjahaji recorded the highest LA plant⁻¹ at 7th MAP. The LA plant⁻¹ decreased at 9th MAP as compared to that of LA plant⁻¹ value at 7th MAP. The germplasm Bhimkal followed by Simolu Manohar,

Table 1: The twenty-nine (29) banana germplasm selected for the experiment.

Dwarf	Medium tall	Tall
Dwarf Jahaji	Barjahaji	Athiya
Suti Jahaji	Chenichampa	Manohar
Dwarf Cavendish	Malbhog	Jatikal
Odil	Agnisagar	Kachkal (white)
Thengransu	Digjowa	Kachkal (green)
	Gobin Tulchi	Bhimkal
	Bogimonohar	Lesari Manohar
	Sahabkal	Simolu Manohar
	Man Jahaji	Bhat Manohar
	Amrit Sagar	Fesa Manohar
	Doodhsagar	Honda
	Grand Naine	
	Ketchulepa	

Table 2: Physiological parameters of banana germplasm at moisture deficit 7th and 9th MAP.

Germplasm	Leaf area (LA)m ² plant ⁻¹			Leaf area index (LAI)			Relative leaf water content (RLWC)%		
	7 th	9 th	Mean	7 th	9 th	Mean	7 th	9 th	Mean
Dwarf Jahaji	7.5	7.2	7.35	2.36	2.08	2.22	66.91	64.84	65.88
Suti Jahaji	7.6	7.4	7.50	1.39	1.22	1.31	68.24	65.98	67.11
Dwarf Cavendish	6.7	6.2	6.45	1.21	1.13	1.17	65.37	63.78	64.58
Odil	2.5	1.9	2.20	0.77	0.73	0.75	63.58	61.87	62.73
Thengransu	2.2	2.0	2.10	0.62	0.59	0.61	60.14	58.45	59.30
Barjahaji	8.4	8.1	8.25	2.44	1.89	2.17	78.78	76.89	77.84
Chenichampa	5.6	5.1	5.35	0.68	0.63	0.66	62.39	60.91	61.65
Malbhog	5.2	4.7	4.95	0.72	0.65	0.69	64.87	62.64	63.76
Agnisagar	6.5	6.3	6.40	1.25	1.22	1.24	71.37	69.40	70.39
Digjowa	4.8	4.4	4.60	0.97	0.94	0.96	64.42	63.75	64.09
Gobin Tulchi	4.1	3.8	3.95	1.23	1.21	1.22	69.33	67.38	68.36
Bogimanohar	7.9	7.1	7.50	0.65	0.62	0.64	74.24	72.25	73.25
Sahabkal	5.4	4.8	5.10	0.94	0.85	0.90	66.37	64.11	65.24
Man Jahaji	6.1	5.7	5.90	1.31	1.27	1.29	67.53	65.15	66.34
Amrit Sagar	5.7	5.4	5.55	1.24	1.10	1.17	72.62	70.18	71.40
Doodhsagar	4.7	4.5	4.60	1.16	1.12	1.14	63.27	60.85	62.06
Grand Naine	5.8	5.5	5.65	1.44	1.29	1.37	68.91	66.74	67.83
Ketchulepa	3.2	3.0	3.10	0.88	0.73	0.81	65.17	63.76	64.47
Athiya	8.6	8.4	8.50	2.18	2.04	2.11	78.54	76.59	77.57
Manohar	7.8	7.3	7.55	2.13	1.95	2.04	67.48	65.30	66.39
Jatikal	5.4	5.0	5.20	1.23	1.17	1.20	67.49	65.18	66.34
Kachkal (White)	2.8	2.6	2.70	0.58	0.52	0.55	54.63	52.76	53.70
Kachkal (Green)	2.7	2.6	2.65	0.55	0.51	0.53	54.18	52.41	53.30
Bhimkal	12.2	9.5	10.85	2.83	2.56	2.70	79.16	77.56	78.36
Lesari Manohar	6.6	6.2	6.40	1.97	1.64	1.81	67.51	66.64	67.08
Simolu Manohar	11.9	9.1	10.50	2.25	1.87	2.06	77.33	75.15	76.24
Bhat Manohar	6.3	5.6	5.95	0.81	0.75	0.78	68.96	66.97	67.97
Fesa Manohar	7.3	6.4	6.85	0.76	0.73	0.75	67.63	66.39	67.01
Honda	4.4	4.3	4.35	1.36	1.31	1.34	64.75	63.40	64.08
Mean	6.1	5.5		1.31	1.18		67.63	65.77	
S.Ed(±)	0.152	0.141		0.033	0.024		0.91	0.88	
CD-5%	0.271	0.259		0.078	0.039		1.81	1.77	
CV (%)	4.96	5.22		8.74	9.21		10.57	10.71	

Athiya and Barjahaji maintained similar trends at 9th MAP in terms of LA plant⁻¹ as that of 7th MAP. Averaging over the two samplings at 7th and 9th MAP, the highest LA plant⁻¹ was observed in the germplasm Bhimkal; whereas the lowest LA plant⁻¹ was recorded in Thengrangs. The LAI also declined gradually from 7th MAP towards 9th MAP. The highest LAI at 7th MAP was found in the germplasm Bhimkal followed by Barjahaji, Dwarf Jahaji and Simolu Manohar. The value for LAI also declined at 9th MAP as compared to that of 7th MAP and the highest LAI was registered by the germplasm Bhimkal followed by Dwarf Jahaji, Athiya and Manohar. On an average among the 29 germplasm, the germplasm Bhimkal showed the highest LAI and lowest value for LAI was found in Kachkal green. From the mean value of germplasm, it was found that LAI was 9.92% lower at 9th MAP than at 7th MAP. The germplasm Bhimkal followed

by Barjahaji, Athiya and Simolu Monohar showed higher value for RLWC both at 7th and 9th MAP. On an average the germplasm Bhimkal recorded 31.98% higher RLWC over lowest performing germplasm Kachkal green.

The biochemical parameters viz., TLCC, LPC and LP also showed significant variations among the germplasm (Table 3). The higher TLCC at 7th MAP was found in germplasm Bogimanohar, Gobin Tulchi, Athiya and Barjahaji. The TLCC decreased at 9th MAP, where the higher value was observed in the germplasm Bogimanohar, Athiya, Gobin Tulchi, Amrit Sagar, Barjahaji and Bhimkal. On an average, among the 29 germplasm, Bogimanohar occupied the first rank followed by Gobin Tulchi, Athiya and Barjahaji in terms of TLCC. As compared to 7th MAP, TLCC value decreased 36% at 9th MAP. The germplasm Bhimkal, Barjahaji, Athiya and Simolu Manohar registered the higher value for LPC

Table 3: Biochemical parameters of banana germplasm at moisture deficit 7th and 9th MAP.

Germplasm	Total leaf chlorophyll content (TLCC) mg g ⁻¹ fw			Leaf proline content (LPC) µg proline g ⁻¹ fw of leaf			Lipid peroxidation (LP) n mol MDA g ⁻¹ fw of leaf		
	7 th	9 th	Mean	7 th	9 th	Mean	7 th	9 th	Mean
Dwarf Jahaji	1.16	0.94	1.05	88.18	93.51	90.85	6.06	6.95	6.51
Suti Jahaji	1.06	0.86	0.96	86.19	90.33	88.26	5.69	6.48	6.09
Dwarf Cavendish	0.73	0.76	0.75	79.11	83.57	81.34	6.22	7.84	7.03
Odil	0.69	0.61	0.65	76.41	81.86	79.14	8.85	9.43	9.14
Thengrangs	0.74	0.63	0.69	77.85	84.12	80.99	8.64	9.11	8.88
Barjahaji	1.19	0.97	1.08	92.19	97.74	94.97	4.94	6.08	5.51
Chenichampa	0.78	0.72	0.75	80.43	85.92	83.18	9.36	9.71	9.54
Malbhog	0.68	0.62	0.65	78.63	83.19	80.91	8.33	9.35	8.84
Agnisagar	1.18	0.92	1.05	90.07	95.68	92.88	6.78	7.55	7.17
Digjowa	0.81	0.73	0.77	84.17	89.94	87.06	7.29	8.37	7.83
Gobin Tulchi	1.23	0.98	1.11	88.32	94.74	91.53	7.38	8.61	8.00
Bogimanohar	1.24	0.99	1.12	87.62	94.33	90.98	6.87	7.25	7.06
Sahabkal	0.78	0.61	0.70	81.29	87.76	84.53	8.11	8.86	8.49
Man Jahaji	0.89	0.88	0.89	84.83	88.87	86.85	5.94	6.55	6.25
Amrit Sagar	1.13	0.98	1.06	90.18	95.61	92.90	7.36	8.04	7.70
Doodhsagar	1.03	0.92	0.98	83.46	88.19	85.83	5.72	6.51	6.12
Grand Naine	0.89	0.91	0.90	88.28	94.53	91.41	6.76	7.97	7.37
Ketchulepa	0.83	0.74	0.79	83.94	87.05	85.50	8.32	9.16	8.74
Athiya	1.22	0.98	1.10	92.09	97.68	94.89	5.10	6.22	5.66
Manohar	1.07	0.71	0.89	81.23	85.46	83.35	7.09	7.88	7.49
Jatikal	0.87	0.76	0.82	84.27	88.44	86.36	5.99	7.04	6.52
Kachkal (White)	0.66	0.58	0.62	74.70	79.66	77.18	9.23	9.86	9.55
Kachkal (Green)	0.68	0.57	0.63	75.29	79.81	77.55	9.59	9.88	9.74
Bhimkal	1.10	0.97	1.04	94.11	98.73	96.42	5.61	6.23	5.92
Lesari Manohar	1.06	0.78	0.92	82.55	88.02	85.29	7.11	8.13	7.62
Simolu Manohar	0.80	0.75	0.78	91.81	97.25	94.53	7.07	8.26	7.67
Bhat Manohar	0.82	0.69	0.76	80.48	87.01	83.75	6.07	6.83	6.45
Fesa Manohar	0.74	0.72	0.73	83.16	88.07	85.62	7.59	8.20	7.90
Honda	0.86	0.82	0.84	84.93	89.07	87.00	6.29	7.03	6.66
Mean	1.25	0.80		84.34	89.52		7.08	7.91	
S.Ed(±)	0.097	0.064		0.89	0.92		0.226	0.239	
CD-5%	0.176	0.152		1.81	1.85		0.274	0.297	
CV (%)	6.93	8.66		9.23	10.86		3.95	4.67	

both at 7th and 9th MAP. Averaging over two samplings, the germplasm Bhimkal accumulated highest and Kachkal white recorded the lowest LPC. The LPC increased 6.14% at 9th MAP than that of 7th MAP which coincided with more deficit rainfall. Peroxidation of lipids in biological membranes is the resultant effect of oxidative stress in plant. In current study, LP in leaf at 9th MAP showed an increase of 11.72% as compared to that of 7th MAP. The lower LP in leaf both at 7th and 9th MAP was recorded in the germplasm Barjahaji, Athiya, Bhimkal and Suti Jahaji; whereas, the germplasm Kachkal green registered highest LP in leaf.

Fig 2 represented that the germplasm Barjahaji, Manohar, Suti Jahaji, Amrit Sagar, Jatikal registered higher hands bunch⁻¹ and the lowest value was found in the germplasm Malbhog. In the present study, the germplasm Barjahaji recorded 37.14% higher hands bunch⁻¹ over Malbhog. The main contributing factor for the ultimate yield of banana is bunch weight. The germplasm Barjahaji, Bhimkal, Bogimanohar and Athiya registered higher bunch weight among the 29 germplasm and Chenichampa showed the lowest bunch weight. The germplasm Barjahaji registered 41.98% higher bunch weight over Chenichampa.

Relative leaf water content is a useful parameter for measuring the water status in plants. It indicates the degree

of cellular water deficit in plants under drought condition (Soltys-Kalina *et al.*, 2016). All the physiological parameters studied showed lower values at 9th MAP as compared to that of 7th MAP which might be due to suffering of plants to more moisture deficit stress. During current study, the rainfall was extremely low in November (15 mm), December (no rainfall) and January (3 mm) of 2017-18 (Fig 1) which might have caused moisture stress to the plants during this period. The decreased in LA plant⁻¹ at 9th MAP might be due to inhibition of cell division and cell elongation, cell turgor, volume and eventually growth as well as senescence and abscission of leaf due to lack of rainfall causing more moisture deficit stress condition (Pooja *et al.*, 2019b; Dhansu *et al.*, 2022). Water stress adversely affects the growth of bananas (Ravi *et al.*, 2013; Kissel *et al.*, 2015). Stevens *et al.* (2020) stated that water deficit stress reduced the canopy cover and leaf area index of banana. Nansamba *et al.* (2022) also reported that water stress significantly reduced the total leaf area, functional leaves, total dry matter and relative leaf water content in banana. Meena *et al.* (2021) reported that water stress significantly decreased shoot length, seedling dry weight, relative water content, membrane stability index and chlorophyll content in pearl millet genotypes. Among twenty-nine (29) germplasm studied, the germplasm

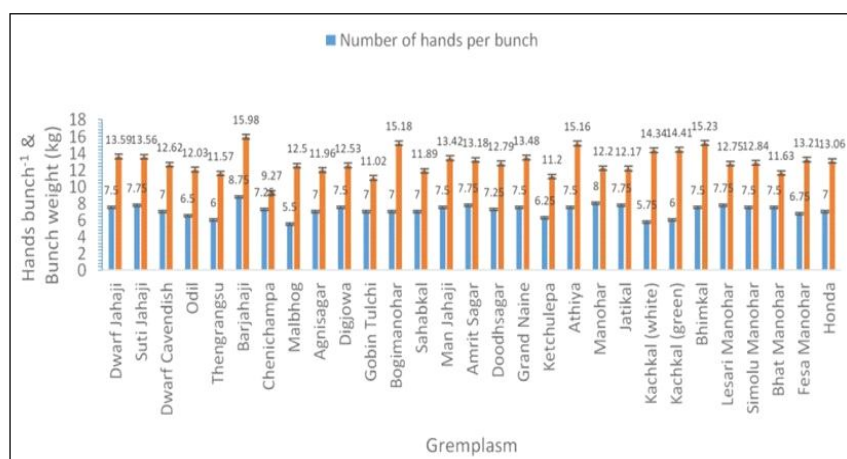


Fig 2: Number of hands per bunch and bunch weight of banana germplasm.

Table 4: Correlation of physio-chemical and yield attributes at moisture deficit 7th and 9th MAP at 5 per cent level of significant.

Parameters	7 th MAP							9 th MAP						
	RLWC	LPC	LA	LAI	TLCC	LP	BW	RLWC	LPC	LA	LAI	TLCC	LP	BW
Relative leaf water content (RLWC)	1							1						
Proline content in leaf (LPC)	0.88	1						0.88	1					
Leaf area (LA)	0.82	0.71	1					0.82	0.72	1				
Leaf area index (LAI)	0.69	0.71	0.76	1				0.69	0.67	0.77	1			
Total leaf chlorophyll content (TLCC)	0.67	0.76	0.47	0.58	1			0.70	0.85	0.58	0.58	1		
Lipid peroxidation in leaf (LP)	-0.69	-0.69	-0.61	-0.66	-0.62	1		-0.65	-0.64	-0.68	-0.65	-0.73	1	
Bunch weight (BW)	0.38	0.38	0.42	0.43	0.35	-0.45	1	0.38	0.36	0.45	0.41	0.39	-0.49	1

Bhimkal, Athiya, Simolu Manohar and Barjahaji could maintain higher values of RLWC, LA plant⁻¹ and LAI during the moisture deficit stress period. Bananuka *et al.* (1999) reported that the banana genotypes that exhibited small reduction in leaf area and maintenance of high relative leaf water content and assimilation rate under moisture deficit condition are more resistance to drought stress. A significant and positive correlation of RLWC was found with LA (0.82, Table 4) and LAI (0.69, Table 4) in the present investigation.

Chlorophyll is the major photosynthetic pigments that plays crucial role in the productivity of crop plants through photosynthesis (Sharma *et al.*, 2021). The moisture deficit induced reduction in TLCC at 9th MAP might be due to deterioration of chloroplast membrane leading to destruction of chloroplast structures and consequently decreased in chlorophyll content in leaf. Surendar *et al.* (2013) reported that moisture deficit significantly reduced the concentration of leaf chlorophyll in banana. Under moisture deficit period the chloroplast proteins and lipids might have oxidatively damaged leading to degradation of leaf chlorophyll and inhibition of photosynthetic process (Rani *et al.*, 2023). Sharma (2015) stated that water deficit stress significantly reduced chlorophyll content in mung bean genotypes hampering growth and yield. Widiyanto *et al.* (2023) reported that water deficit reduced chlorophyll content and caused chlorosis of banana plantlets. Water deficit stress destroyed the PS-II of light reaction of photosynthesis leading to decline in leaf chlorophyll concentration and thereby inhibition of light capturing capacity and photosynthetic rate (Kumar *et al.*, 2016b; Sasi *et al.*, 2018). Jabari *et al.* (2006) reported that reactive oxygen species (ROS) form under moisture stress caused peroxidation of chlorophyll and thereby its breakdown in wheat. Proline is an osmotic solute that helps to maintain tissue water potential as well as acts as a source of carbon and nitrogen under stress condition in higher plants (Lata *et al.*, 2019). In present study the germplasm Barjahaji, Bogimanohar, Athiya, Bhimkal and Gobin Tulchi maintained higher TLCC and LPC and showed lesser peroxidation of lipid during water deficit period. The LPC exhibited significant and positive correlation with TLCC (0.76 and 0.85 respectively for 7th and 9th MAP, Table 4) and negative correlation with LP (-0.69 and -0.64 respectively for 7th and 9th MAP, Table 4). Surendar *et al.* (2015) reported that banana crop accumulated more proline against water deficit stress. They opined that accumulation of more proline and maintenance of leaf chlorophyll concentrations during stress conditions can be considered among the major physiological indices of water deficit stress tolerance. Jiang and Huang (2001) opined that under prolonged water deficit condition lipid peroxidation negatively correlated with leaf relative water content and photosynthetic pigment. Similarly in our current investigation also there were negative correlation of LP with RLWC (-0.69 and -0.65 respectively for 7th and 9th MAP, Table 4) and TLCC (-0.62 and -0.73 respectively for 7th and 9th MAP,

Table 4). Singh *et al.* (2011) reported that drought tolerant wheat genotypes exhibited less peroxidation of lipid than drought sensitive genotypes. Our current study also revealed that the higher yielder germplasm exhibited lesser reduction in total leaf chlorophyll content, less lipid peroxidation and higher accumulation of proline during water deficit period. Similar findings were put forwarded by Dash *et al.* (2017) and they opined that the drought tolerant lentil genotypes exhibited lower reduction in chlorophyll content, RLWC and accumulated more proline as compared to susceptible ones. Their results suggested that maintenance of higher concentrations of leaf chlorophyll, RLWC and more proline accumulation plays a significant role in tolerance of crop plants to drought stress. Tian *et al.* (2023) reported that proline content in the leaves of soybean increased significantly under drought stress conditions and they opined that increased in proline content reduced damage caused by drought stress.

A significant reduction in yield of banana under water deficit condition was reported by Turner and Thomas (1998). During the crop cycle, a deficit of 100 mm monthly rainfall reduced bunch weight in banana (Van Asten *et al.*, 2011). The higher yield in the germplasm Barjahaji, Bhimkal, Bogimanohar and Athiya under moisture deficit unirrigated condition might be due to the summative effects of higher TLCC, RLWC, LA plant⁻¹, LPC and lower MDA formation. Significant and positive correlation of bunch weight was noted with RLWC (0.38 respectively for both 7th and 9th MAP, Table 4), LA plant⁻¹ (0.42 and 0.45 respectively for 7th and 9th MAP, Table 4) and LPC (0.38 and 0.36 respectively for 7th and 9th MAP, Table 4) and a negative correlation was observed with LP (-0.45 and -0.49 respectively for 7th and 9th MAP, Table 4). Surendar *et al.* (2013) reported that water deficit caused reduction in banana yield; however, the tolerant and moderately tolerant cultivars showed better performance in morphological, physiological, biochemical processes and lesser reduction in yield components. Bordoloi *et al.* (2023) reported that significant genetic variation existed among the blackgram genotypes in terms of proline content, pods per plant, relative leaf water content, chlorophyll content and seed yield per plant under water stress condition.

CONCLUSION

It is concluded that among the 29 germplasm of banana studied Barjahaji, Bhimkal, Bogimanohar and Athiya were found to be the superior yielder under unirrigated moisture deficit situation in Assam, India. These germplasm maintained higher LA plant⁻¹, LAI, RLWC, TLCC and LPC which showed positive correlation with bunch weight and lower value for LP in leaf that showed negative correlation with bunch weight. Hence, these germplasm can be used for future breeding program and the morpho-physiological traits can be used for evaluation of drought tolerant banana genotype.

Conflict of Interest

On behalf of all authors, the corresponding author states that there is no conflict of interest.

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