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ASSESSMENT OF DROUGHT TOLERANCE IN FEW CLONES OF NATURAL RUBBER (*Hevea brasiliensis*) UNDER DRY HOT CLIMATE OF ODISHA, INDIA

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KEYWORDS

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ABSTRACT

A preliminary study was conducted to assess the drought tolerance at the early stages of growth in different clones of natural rubber (*Hevea brasiliensis*) at the Regional Research Station of Rubber Research Institute of India at Kadalipal, Dhenkanal, Odisha in eastern region of India. Poly bag plants of five clones RR11 430, RR11 105, RR11 600, RR11 208 and IRCA 111 were assessed for the drought tolerance and compared drought injury indices status with same clones growing naturally in the adjoining field. Results of drought injury indicated scorching, leaf yellowing, drying and leaf fall at regular intervals, since imposition of drought stress conditions. Among various tested clones RR11 600 and RR11 430 have comparatively higher drought tolerant. Plants under field condition showed drought injury symptoms much later than the poly bag plants. Drought indices, tolerance of drought of different clones and possible reasons have been also discussed.

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1 Introduction

The Para rubber tree (*Hevea brasiliensis*) is a tropical tree native to hot and humid Amazon region. Tree is commercially cultivated in south Asian countries, where the agro climatic conditions are suitable for its growth and productivity. Annual rainfall varying from 2000 to 4000 mm, which is well distributed throughout the year, warm and sunny days with a temperature range of 21° C to 35° C and atmospheric relative humidity of 80 percent or above are considered to be best (Verhey, 2010). Further, fairly deep soils with slight to moderate acidic pH are also ideal for the growth of the tree (Rao & Vijayakumar, 1992; Krishnakumar, 1993). Traditional rubber belt (8° – 12° N) encompasses the southern tips of the peninsula in the country provides most appropriate environment conditions.

The shrinkage in the availability of cultivable land in the traditional region (8° – 12° N) and ever growing demand for natural rubber has necessitated considering other areas of diverse agro-climate zone for the extension of rubber. The Odisha state (17° – 22° N) located in eastern region of India was consequently identified as possible potential nontraditional region (Hajra & Potty, 1986; Sethuraj et al., 1989).

The state experiences low and erratic rainfall, high temperature and low atmospheric relative humidity for about five to six months in a year (Gupta et al., 2002; Krishan, 2013). It is well quoted that these environmental conditions inhibits the growth and productivity of natural rubber (Chandrashekar et al., 1990; Mohankrishna et al., 1991). The needs of successful productive cultivation of rubber under less congeal area as of Odisha and other regions have necessitated screening and evolving clones for the drought prone conditions. The present early assessment of drought tolerance of few promising clones of rubber is a preliminary attempt towards the direction.

2 Materials and Methods

A preliminary study to assess the drought tolerance of five clones of natural rubber (*H. brasiliensis*) was carried out at the Rubber Board, Regional Research Station at Kadalipal, Dhenkanal, Odisha (20°49' N; 85° 30' E; 100 m MSL). The study was conducted during March to April 2010. Nine months aged brown budded poly bag plants with equal representation of twelve seedlings of five clones viz. RR11 430, RR11 105, RR11 208, RR11 600 and IRCA 111 were undertaken for the study and also assessed the natural growth performance of same clones of twelve month age growing in the adjoining field. The field had plain terrain with acidic soil classified as loamy sand in texture and lateritic in nature. The weather parameters viz. maximum, minimum temperature and rainfall have recorded from meteorology observatory in Regional Research Station, kadalipal, Dhenkanal.

The entire experimental poly bag plants were provided with same cultural practices and environment. Further Poly bag

were also filled with same field soil as acidic and loamy sand texture and of lateritic in nature. The plants of each clone were provided with shade and watering twice a week prior to impose drought stress conditions. Drought was imposed by discontinuing irrigation from the month of March 2010 onwards. Visual observations on drought injury parameters in leaves, as scorching, yellowing, drying and leaf fall were recorded at regular intervals, using the self calibrated of the four indices which are more suitable for monitoring and expressed in percentage. Similar observations were also recorded for same clones of twelve month stage growing naturally in adjacent field. The field plants were provided uniform standard cultural practices of rubber growing as described by Rubber Board (2009). The performance of poly bag and field plants with relevance to drought injury indices was assessed.

3 Results and discussion

The region experiences stressful drought for five to six months every year concomitant with high intensities of solar radiation and high temperature with an annual average rainfall of 1200.0 mm mainly confined mid June to September. The distribution of rainfall is far from the required amount for rubber cultivation which results in long dry spells extending from November to May causing drought conditions. The summer months, February to May exhibited severe soil moisture deficit. During the study average maximum temperature was exceeds than 35°C, occasionally it rising beyond 44° C during the day in the summer months. Evaporation was low during July to September while it was higher during summer months (Gupta et al., 2002; Krishan, 2013). The mean temperature and rainfall of the study site during the experimental period has been given in Table 1.

The drought symptoms in leaves were visually observed at regular intervals. The scorching symptoms were first noticed in RR11 600 among the clones. The scorching symptom was observed during the initial stage of drought stress, between seven days after withholding of watering (Table 2). The early scorching in the clones seems to be mainly due to the high light intensity causing bleaching of chlorophyll. Further water stress which reduces the transpiration rate and increases leaf temperature may also results in leaf scorching (Jacob et al., 1999; Mohammadin et al., 2005).

Further leaf yellowing was noticed after twenty one days of water stress in the entire clones. Among the clones, RR11 600 and IRCA 111 showed comparatively less yellowing (Table 2). Yellowing of leaves in all clones mainly attributed to water deficit in leave, creating an imbalance causing increase in ratio of carotenoids to chlorophyll (Serge & Leonar, 2004). The better performance of few clones namely RR11 600, IRCA 111 and RR11 430 may be due to comparatively efficient maintenance of leaf water potential and stomata conductance during the stress period (Chandrashekar et al., 1994).

Table 1 Meteorological parameter of the study site.

Month/Period	Temperature(°c)		Rainfall (mm)
	Max	Min	
19.03.10 to 25.03.10	40.2 (39.0 – 41.5)	21.7 (20.5 – 24.0)	0
26.03.10 to 01.04.10	40.1 (38.0 – 42.5)	24.4 (25.5 – 25.0)	0
02.04.10 to 08.04.10	41.8 (40.0 – 42.5)	24.3 (23.0 – 26.0)	0
09.04.10 to 15.04.10	43.1 (41.0 – 44.0)	25.2 (23.0 – 27.5)	0
16.04.10 to 22.04.10	43.2 (40.5 – 45.0)	25.9 (25.5 – 27.5)	0
23.04.10 to 29.04.10	42.0 (41.5 – 43.5)	25.7 (24.5 – 26.5)	0

Table 2 Drought induced leaf symptoms of *H. brasiliensis* clones under polybag condition.

SCORCHING (%)							
Clone	Days after introduction of drought stress						
	4	7	10	14	18	21	25
RRII 430	-	-	15	15	-	-	-
RRII 105	-	20	20	-	-	-	-
RRII 208	-	-	-	-	-	-	-
RRIM 600	-	15	-	-	-	-	-
IRCA 111	-	-	-	-	-	-	-
SE	-	4.35	4.36	3.10	-	1.22	-
CV	-	1.24	1.25	2.01	-	1.18	-
YELLOWING (%)							
RRII 430	-	-	-	10	-	-	45
RRII 105	-	-	-	-	-	15	25
RRII 208	-	-	-	10	-	50	-
RRIM 600	-	-	-	-	5	-	-
IRCA 111	-	-	-	5	-	-	-
SE	-	-	-	2.23	1.01	9.69	9.13
CV	-	-	-	0.89	1.98	1.49	1.30
DRYING (%)							
RRII 430	-	-	-	-	10	15	15
RRII 105	-	-	-	-	15	45	45
RRII 208	-	-	-	-	20	35	75
RRIM 600	-	-	-	-	-	20	35
IRCA 111	-	-	-	10	-	15	15
SE	-	-	-	2.44	4.01	6.10	10.95
CV	-	-	-	1.20	0.88	0.47	0.61
LEAF FALL (%)							
RRII 430	-	-	-	-	5	-	15
RRII 105	-	-	-	-	-	-	25
RRII 208	-	-	-	-	-	-	55
RRIM 600	-	-	-	-	-	-	10
IRCA 111	-	-	-	-	-	-	15
SE	-	-	-	-	0.47	-	8.10
CV	-	-	-	-	1.95	-	0.68

Leaf drying is an important drought symptom. Maximum leaf dryness was observed after twenty five days of stress induction in clones RR II 208 and RR II 105. The other clones also showed leaf dryness up to a certain extent. The possible high drought susceptibility was reported in RR II 208 and up to certain extent also reported in RR II 105. This may be due to higher water stress induced early senescence (Table 2). Leaf senescence and shedding also decreases the total leaf hydraulic conductance; following soil drying and root decay adversely affecting the root conductance (Sangsing, 2004). Further, the leaves of rubber trees tends to loss turgidity and expose the effective leaf area to direct sun causing drying of leaves (Chandrashekar et al., 1994). Stress also induced conditions which lead to less leaf area index, resulting in lesser solar radiation interception and plants shows comparatively poor growth (Devkumar et al., 1988). Leaf fall following

commencement of dryness was also most predominant in RR II 208 and RR II 105.

The performance of clones in the field conditions is depicted in table 3. Among the various tested clones, clone RR II 208 followed by RR II 105 and RR II 430 showed higher scorching, yellowing and drying of leaves as compared to other clones. The clone RRIM 600 recorded the comparatively less drought symptoms and thus showed higher tolerance. The response of plants varied to drought in field and polybag conditions. The higher and delayed tolerance to drought injury under the field conditions as compared to the polybag plants seems to be mainly due to high soil volume and soil moisture storage associated with field plants. The present findings are in support with the earlier report under almost similar environmental conditions (Ravichandran et al., 2011).

Table 3 Drought leaf symptoms of *H. brasiliensis* clones under the field condition.

SCORCHING (%)							
Clone	Days after introduction of drought stress						
	4	7	10	14	18	21	25
RR II 430	-	5	-	15	15	15	-
RR II 105	-	-	-	-	5	10	10
RR II 208	-	-	-	10	-	-	-
RRIM 600	-	-	-	-	-	-	-
IRCA 111	-	-	-	5	5	-	-
SE	-	1.00	-	2.91	2.73	3.16	1.95
CV	-	1.97	-	0.97	1.09	1.26	1.98
YELLOWING (%)							
RR II 430	10	10	15	15	-	-	-
RR II 105	-	10	-	25	-	25	25
RR II 208	-	10	-	10	20	25	40
RRIM 600	-	5	-	-	5	10	15
IRCA 111	-	-	5	-	-	10	15
SE	1.95	2.01	2.91	4.74	3.87	4.84	6.59
CV	1.97	0.57	1.45	0.95	1.54	0.69	0.68
DRYING (%)							
RR II 430	-	-	-	10	-	10	-
RR II 105	-	-	5	-	-	20	-
RR II 208	-	20	-	-	35	35	-
RRIM 600	-	-	-	-	-	-	-
IRCA 111	-	-	-	-	-	5	-
SE	-	4.01	1.00	2.00	7.10	6.20	-
CV	-	1.98	2.01	2.00	2.10	6.88	-
LEAF FALL (%)							
RR II 430	-	-	-	-	-	-	-
RR II 105	-	-	-	-	-	-	10
RR II 208	-	-	20	-	-	25	-
RRIM 600	-	-	-	-	-	-	-
IRCA 111	-	-	-	-	-	-	5
SE	-	-	3.98	-	-	4.84	2.01
CV	-	-	2.01	-	-	1.61	1.33

Clonal variation existed in the degree of tolerance of drought as well as in the response to irrigation as also reported by Chandrashekar, (1997). Inherited genetic, anatomical and physiological characters among drought tolerant and susceptible clones might be different and contributed to variability in tolerance (Premakumari et al., 1993). In general, clones RRIM 600 and RR2 430 showed comparatively higher tolerance to drought conditions.

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Conflict of interest

Authors would hereby like to declare that there is no conflict of interests that could possibly arise.

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