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Research Article

EVALUATION OF DROUGHT TOLERANCE IN VARIOUS CLONES OF *CEIBA PENTANDRA* (LINN.) GAERTN: A COMPARATIVE STUDY

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ABSTRACT

This study focuses on the drought tolerance of *Ceiba pentandra* (Kapok tree), an emergent tree of the tropical rainforest, bye valuating 25 different clones collected from Tamil Nadu. The research assessed drought tolerance through Relative Water Content (RWC) and Chlorophyll Stability Index (CSI). Among the clones, MTPCPP15 from Varusanadu demonstrated superior water retention and moderate drought tolerance, making it the most suitable for semi-arid and rain fed regions. The findings suggest that this clone is well-adapted to water-stress conditions, making it a viable option for drought-prone areas.

Keywords: Kapok, Drought, Relative Water Content, Chlorophyll Stability Index, Climate change.

INTRODUCTION

Kapok tree (*Ceiba pentandra* (Linn.) Gaertn is native to the Amazon region. In India, it was named as Semul in Bengali, Katan, Hattian in Hindi, Biliburaga, Buraga in Kannada; mull-ilavu, panji, panjiu in Malayalam, Pandhari, Salmali in Marathi, Sveta Salmali in Sanskrit; llavam panju in Tamil and Kadami, Pur in Telugu (Troup, 1981). It is an important source of food and fodder in the savanna area of Nigeria (Okafor, 1980). The kapok tree is an emergent tree of the tropical rainforests and is often described as majestic. It can grow to a height of more than 150 feet, towering other trees in the rain forest. Kapok is dry deciduous and sheds leaves during tropical dry season. It is widely spread around the world and occupies an important niche in the ecosystem of the rain forest. It can also be grown as a plantation as well as is suitable for integration in agroforestry.

Ceiba pentandra requires abundant rainfall during the growing season and a dry period from the time of flowering till the pods ripen. Rainfall in its natural range of occurrence is 750-3000 mm, the optimum being 1500-2000 mm, and the temperature range between 18-38°C (Luna, 1996). Fruit set fails, when night temperature is below 15°C. (Gupta, 1993). A well drained soil is necessary for its growth as it thrives well on deep, porous, sandy loam, or alluvial soils. Kapok is a fast growing tree. In the West Coast, it was reported to reach a height of 9 m at the end of 3-4 years. Height growth culminates at the age of about 50 years. Yield of floss per tree varies with age. A full grown tree of about 15 years yields about 2.7 to 4.0 kg of floss. In Java, a full grown plantation of kapok yields about 2000 - 4000 kg per hectare of floss annually (Luna, 1996).

The most important product of the tree is the floss which is obtained from the inner wall of the capsule. These cotton like fibres carry 30 times of their own weight in water and have a high degree of buoyancy (about 5 times of Cork), and therefore, excellently suited for making life-jackets, life-belts, life-buoys and other naval safety apparatus. Being a good sound absorber, it is also used for acoustic insulation and is indispensable in hospitals for stuffing mattresses as it can be sterilized without losing original quality (Luna, 1996). India produces about 3000 tonnes of kapok floss annually against the estimated world production of about 95,000 tonnes (Anon, 1976). Almost the entire production is consumed internally. Kapok seed is a by product of fibre production which is a rich source of oil and protein. Oil content is around 25 per cent. It is used in soap industries. The pressed cake is used as a cattle feed which contains around 26 per cent protein. The leaves are relished by sheep, goats, and cattle. Feeding to bullocks

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revealed that it contained 26.33 per cent dry crude protein, (Sahai and Kumar, 1968). On account of the multifarious uses of kapok, cultivation of kapok under agroforestry has become widespread. Indeed, the area under kapok is also on the rise under farm condition because of absentee landlordism. Increase in the size of holding has also resulted in an increased allocation of land for tree crops particularly kapok (Sekar and Pillai, 1992).

MATERIAL AND METHODS

Study area

The experiments were conducted at Forest College and Research Institute, Mettupalayam, Coimbatore district, located at 11°19″ N latitude and 77°56″ E longitude located at an altitude of 300 m above MSL. The samples needed for the experiment were collected from Samanaickenpalayam, Coimbatore district located at 11°17″N latitude and 76°97″E longitude and at an altitude of 298 m above MSL. It is situated in the foothills of the Western Ghats and spread over an area of 2.19 acres. The climate is semi-arid, tropical with hot summer and cold winter. The dry season starts from early February and continues upto mid-June and the wet season from mid-August to early November. The number of treatments(clones) about 25 and total number of replication is 2. Therefore the number of replication per tree is 6 with an spacing of 5.4m x 5.4 m and the total area is 2.19 acres.

Clones

Leaf samples used for our study were collected from the assemblage of 25 clones of *Ceiba pentandra* collected from various parts of Tamil Nadu. (Table 1)

Sample selection

Samples were collected randomly from all the 25 clones (10-12 leaves). The leaf samples were collected from the middle branch of the tree and the time of collection was during the early morning or late evening.

Relative water content

The concept of relative water content as a measure of water deficit in leaves has been found useful in water stress experiments.

$$RWC = \frac{Fw - Dw}{Tw - Dw} \times 100$$

where,

Fw - Fresh weight of leaf sample
Tw-Turgid weight of leaf sample
Dw - Dry weight of leaf sample

Chlorophyll stability index

The Chlorophyll Stability Index (CSI) is an indicator used to judge the tolerance of plants against stress. A high CSI value indicates that stress has a low effect on the chlorophyll contents of plants.

$$\text{Total Chlorophyll} = \frac{OD\ @\ 652\ nm \times 1000}{34.5} \times \frac{V}{1000 \times W}$$

The chlorophyll stability index is the ratio of total chlorophyll content of the treated sample to the untreated sample and expressing in percentage.

$$\text{Chlorophyll Stability Index} = \frac{\text{Total Chlorophyll content (treated)}}{\text{Total Chlorophyll content (control)}} \times 100$$

RESULT AND DISCUSSION

Results obtained in the present study aimed at estimating drought tolerance in 25 clones of kapok through relative water content are as follows. .35%, 77.6% and 76.87% respectively. It was observed that the clones susceptible to drought are MTPCPP1, MTPCPP18 and MTPCPP5 which recorded values of 37.94%, 39.42% and 48.62% respectively and it was observed that relative water content was higher in MTPCPP2, MTPCPP7 and MTPCPP15 with the values of 71.12%, 69.96% and 68.09 %respectively. Clones that are susceptible to drought are MTPCPP3, MTPCPP19 and MTPCPP1 with the values of 42.94%, 42.98% and 44.39% respectively.

Table 2. Relative Water Content of Kapok clones ((Replication 1 & 2).

S.No.	Clone	Average	Average
1	MTPCPP10	52.26	47.93
2	MTPCP18	59.915	63.29
3	MTPCPP6	45.355	46.93
4	MTPCPP2	48.845	71.12
5	MTPCPP21	76.875	50.33
6	MTPCPP12	50.395	56.94

7	MTPCPP17	67.01	57.53
8	MTPCPP3	56.835	42.94
9	MTPCPP14	76.73	56.60
10	MTPCPP5	48.625	60.01
11	MTPCPP13	61.45	57.05
12	MTPCPP9	62.54	48.82
13	MTPCP23	55.195	50.12
14	MTPCPP20	64.725	55.07
15	MTPCPP19	54.86	42.98
16	MTPCPP8	73.415	50.70
17	MTPCPP16	54.16	58.82
18	**MTPCPP15**	**80.355**	68.09
19	MTPCP37	57.155	64.57
20	MTPCPP22	67.25	62.17
21	MTPCPP1	37.945	44.39
22	MTPCPP18	39.42	63.29
23	MTPCPP7	58.16	64.57
24	MTPCPP4	49.865	53.34
25	MTPCPP11	77.6	48.72

Table 2 indicated that relative water content was maximum in MTPCPP15,MTPCPP11 and MTPCPP21 with the values of 80 The results obtained upon evaluation of drought tolerance in 25 clones of kapok through chlorophyll stability index are presented in table 4.

Table 3. Chlorophyll Stability Index criteria.

S. No.	CSI	DROUGHT TOLERANT CAPACITY
1.	>85%	Highly tolerant
2.	75-85%	Moderately tolerant
3.	65-75%	Susceptible to drought
4.	<65%	Can’t survive drought

Table 4. Chlorophyll Stability Index (%) of Kapok clones (Replication 1 & 2).

S.No.	Clone	Average	Average
1	MTPCPP5	66.9	62.00
2	MTPCPP16	59.50	49.05
3	MTPCP37	66.89	64.00
4	MTPCPP20	68.40	52.75
5	MTPCPP7	51.05	65.25
6	MTPCPP19	38.57	61.00
7	MTPCPP9	65.50	56.5
8	MTPCPP11	48.25	74.35
9	MTPCPP23	62.80	65.95
10	MTPCPP14	56.86	59.70
11	MTPCPP8	50.34	60.45
12	MTPCPP15	83.45	66.40
13	MTPCPP1	51.75	55.85
14	MTPCPP22	60.40	51.1
15	MTPCPP4	36.84	52.80
16	MTPCPP18	59.59	61.35

17	MTPCPP13	44.85	49.6
18	MTPCPP3	56.30	56.60
19	MTPCP18	56.50	70.30
20	MTPCPP21	70.25	58.25
21	MTPCPP2	73.85	55.35
22	MTPCPP6	74.45	58.75
23	MTPCPP12	78.43	38.85
24	MTPCPP10	71.55	76.85
25	MTPCPP17	60.19	53.00

From the Table 5, it was observed that chlorophyll stability index in replication 1 was found to be higher in MTPCPP15, MTPCPP12 with the values of 83.45% and 78.43% respectively while clones MTPCPP4, MTPCPP19 and MTPCPP13 were observed to have low values for CSI which indicated their susceptibility to drought/water stress. In replication 2, it was observed that chlorophyll stability index was higher in MTPCPP10 and MTPCPP11 with values of 76.85% and 74.35% respectively which indicated that the above clones were moderately tolerant to drought. However, clones MTPCPP12, MTPCPP16 and MTPCPP13 which recorded low values for Chlorophyll Stability Index indicated their susceptibility to water stress.

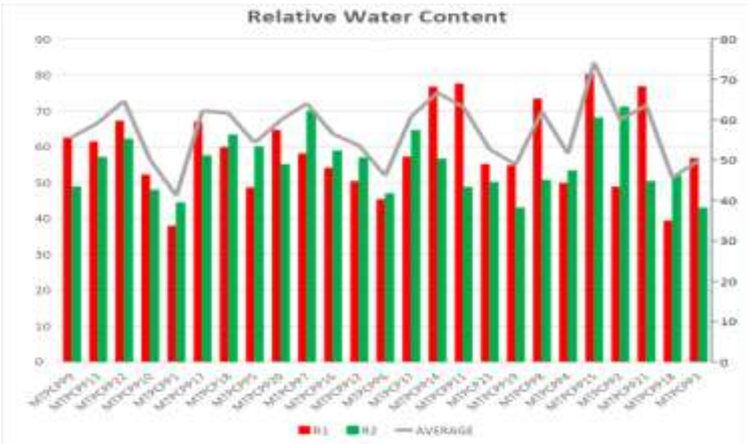

Figure 1. From the graph it is clearly shown that MTPCPP15 has good drought tolerant capacity among the 25 clones followed by MTPCPP14.

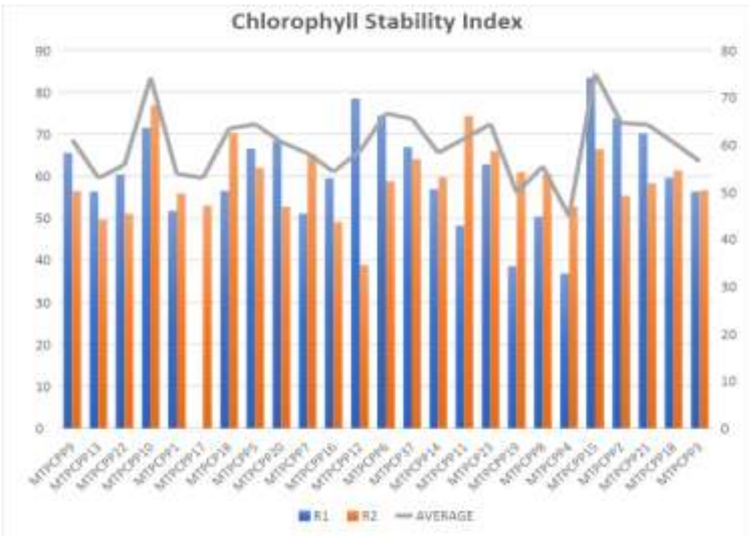

Figure 2. From the graph it is clearly evident that MTPCPP15 possessed good drought tolerant capacity among the 25 clones followed by MTPCPP10.

CONCLUSION

Kapok tree (*Ceiba pentandra* (Linn.) Gaertn native to the Amazon region requires abundant rainfall during the growing season and a dry period from the time of flowering till the pods ripen. The rainfall in its natural range of occurrence is 750-3000 mm, the optimum being 1500-2000 mm, and the temperature range between 18-38°C. Fruit set fails, when night temperature is below 15°C. A well-drained soil is necessary for its growth the kapok tree is an emergent tree of the tropical rainforest and is adapted to the tropical conditions after its introduction. *Ceiba pentandra* by nature had some drought resistance and is suitable for studying its drought tolerance. Drought Tolerance can be divided into two parts including drought avoidance and dehydration tolerance. Drought avoidance includes root depth, reasonable use of available water by plants, and changes in plants' lifestyle to use rainfall. Dehydration tolerance consists of plants' capability to partially dehydrate and grow again when rainfall continues. Adaption of plants to drought stress is a vital issue to develop new improve methods for increasing stress tolerant plants the study aimed to assess drought tolerance in *Ceiba pentandra* using Relative Water Content (RWC) and Chlorophyll Stability Index (CSI) as evaluation methods. Conducted at the AICRPAF trial site, 25 clones of *Ceiba pentandra* were collected from various regions in Tamil Nadu and tested over an area of 2.19 acres, with the trial being two years old. Leaf samples were randomly collected to measure RWC and CSI. In the first replication, clone MTPCPP15 from Varusanadu exhibited the lowest water deficit, while in the second replication, clone MTPCPP2 from Vathalakundu showed high RWC. When averaging both replications, MTPCPP15 demonstrated superior water retention, making it well-suited to areas with water stress. In terms of CSI, MTPCPP15 showed moderate chlorophyll stability, indicating a better tolerance to drought compared to other clones. Overall, the study concludes that MTPCPP15 from Varusanadu possesses high water retention ability and moderate drought tolerance, making it a promising candidate for semi-arid and rainfed regions.

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