Morphological and Biochemical Characters of some Palmyra Palm Trees Grown Ex-Situ Condition at Bangladesh Sugarcrop Research Institute (BSRI)

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ABSTRACT

Juice quality, height, width, growth rate and green leaves were examined for some palmyra palm genotypes grown under ex-situ conditions at Bangladesh Sugarcrop Research Institute. Some of them were twenty and some were thirteen years old. Twenty years old plant showed comparatively higher growth rate per year than the thirteen years old plant. Among the twenty years old genotypes the 9th number showed highest green leaves followed by 1st genotype. The highest base width were observed at 9th genotype and highest top width were in 1st, 9th, 11th, 21th and 28th and middle width were observed in 1st genotype. Highest amount of juice was produced by 21th number. of plant at 2 May 2017 while 28th and 9th genotypes showed highest Brix percent (12.4, 12.3) and highest pol percent (7.89) was observed in 9th genotype. Our results indicate that genotype 28th and 9th performed better ex-situ conditions than other genotypes for selecting an ideal Palmyra palm variety.

Key words: Palmyra palm, green leaves, growth rate, juice quality

INTRODUCTION

Palms are believed to be among the oldest flowering plants in the world (Redhead 1989). For centuries, many palm species have been tapped throughout the tropical world in order to produce fresh juice (sweet toddy), fermented drinks (toddy, wine, arak), syrup (honey), brown sugar (jaggery) or refined sugar. One of mankind's first sources of sugar was probably *Arenga pinnata* (Redhead,1989). Evidence of the use of *Borassus flabellifer* (Palmyra palm) sugar in India has been reported by the Greek historian Megasthenes, ambassador to the court of Chandragupta, in the 4 th century. Hindus knew how to extract it about 4,000 years ago (Ferguson,1888, cited by Fox 1977). Jaggery and treacle extracted from *Caryota urens* sap in Sri Lanka has been an important source of sugar from antiquity (Dissanayake,1977). Greek historian Megasthenes, ambassador to the court of Chandragupta, in the 4 th century. Hindus knew how to extract it about 4,000 years ago (Ferguson, 1888, cited by Fox 1977). Jaggery and treacle extracted from *Caryota urens* sap in Sri Lanka has been an important source of sugar from antiquity (Dissanayake,1977). In Africa, the main traditional use of palm sap is for wine production. It has been reported in Egypt (Date

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palm) long before the birth of Christ (Barreveld, 1993) and on the Guinea coast by early navigators in the 15th century (Sodah Ayernor and Matthews, 1971).

The weather, climate and soils of Bangladesh are very suitable for crop production. Main profession of this country is agriculture. Sugarcane is one of the cash crop in Bangladesh. Sugarcane is the main crop for production of sugar and goor (Jaggery). A large quantity of goor is also produced from date palm. Besides there are palmyra palm and golpata (*Nypa fruticans*) which also produces small quantity of goor. Sugar and goor produced in Bangladesh is not sufficient for fulfillment of demand. According to FAO (1982) 13kg sugar or 17 kg goor is required for each personper year. Accordingly, present requirement of sugar for 160 million populations in Bangladesh is about 20.8 million tons.

Sugarcane is cultivated in1.8 lakh hectare land. Every year 4.0-4.4 million ton goor and 1.4-1.8 million ton sugar is produced from 73.75 million ton sugarcane. At present yield capacity is only 50 t ha^{-1}. So, to produce 1.8 million ton sugar and goor we have to produce 180 million ton of sugarcane. Through using BSRI bred varieties and technologies yield in mill zone is 52 t ha^{-1} but in non mill zone is poor due to lack of BSRI bred varieties and technologies.In Bangladesh shortage of sugar and goor is around 13 lakh ton which can't met up through production of sugar and goor from sugarcane. We can meet up our requirement through production of goor from date palm, palmyra palm and golpata. Sugars from palm trees such as *Phoenix sylvestris* and *Borassus flabellifer* are reported to be more nutritious than cane sugar (Rangaswami,1977 cited by Morton 1988). Some medicinal value is also often reported: it is the case for the sugar from *Borassus flabellifer* (Rangaswami, 1977). In Madagascar, *Cocos nucifera* sap is used against nephritis and bladder infections.

There are four types of palm trees grows in Bangladesh. They are coconut, date palm, palmyra palm and golpata (*Nipa fruticans*) which plays an important role in village economy, poverty elevation, create employment opportunities and environment development. Date palm and palmyra palm grows in Bangladesh without any care. They can survive for a long period without water. Besides they do not die in waterlog and prolong drought condition. For this reason date palm and palmyra palm grows in Rajshahi and greater part of Jessore and Chuadanga district. These palms grow scattered all over Bangladesh. During 2013-14 and 2014-15 year area of date palm plant is about 1661 and 1805 acre and palmyra palm is about 363 and 349 acre. If we consider 150 date palm/acre and 100 palmyra palm /acre, total number of date palm plant is approximately 2.5-3.0 lakh and palmyra palm is approximately 50 thousand (BBS, 2015). Therefore, to keep the present production sustainable as well as to expand the cultivation area both vertical and horizontal expansions are required which may not be achieved from sugarcane because area of sugarcane is decreasing gradually due to increasing demand for food, vegetable and other cereal crops and utilization of crop lands for houses, roads, industries etc. Vertical expansion can be achieved to some extent through development of high yielding varieties of sugarcane. While horizontal expansion can be achieved through cultivation of other sweetening crops like date palm, palmyra palm, and golpata. Main objective of this study was to find out the suitable genotypes of palmyra palm for expansion of cultivation in different areas of Bangladesh.

MATERIALS AND METHODS

An experiment was carried out to screen suitable palmyra palm genotypes during the 2017 cropping season. Palmyra palm trees grown under ex-situ conditions at BSRI were selected for this purpose. Some of them were twenty years and some were thirteen years old. Data on green leaves number, trunk height, width of base, middle and top were taken at the same time. Amount of sap per plant per day were also determined from the selected genotypes of twenty years old from March to May. Among the selected genotypes one (1^{st} number) plant is female and the others are male. Laboratory analysis of sap was done. Soluble solids (^{0}Brix) was determined by Brix hydrometer standardized at 20°C and Horne's dry lead method was used for sucrose determination using an automatic polarimeter (Bellingham and Stanley ADP-220®). Sap purity was calculated as the ratio of the sucrose content and corrected Brix reading. Reducing sugars were determined by the method described in Queensland Laboratory Manual [Bureau Sugar Experiment Stations (BSES), 1970].

Statistical analysis was performed and means values were compared using LSD test at 5% level of significance [Gomez and Gomez, 1984]

RESULTS AND DISCUSSION

Morphological characters of some selected palmyra palm trees

Different genotypes showed different types of morphology. Among the nine twenty years old genotypes highest height was observed at 1^{st} number of plant followed by 21th number. Highest base width was observed at 9^{th} number followed by 19^{th} number. Highest middle width was observed at 1^{st} number plant. Highest top width was observed at 1^{st}, 9^{th}, 11^{th}, 21^{th} and 28^{th} number plant. 9^{th} number plant showed highest number of green leaves followed by 1^{st} number plant.

Table 1. Morphological characters of some palmyra palm trees at BSRI garden (Twenty years old)

Plant no.	Plant Height (m)	Growth rate (cm/year)	Width (m)			No. of green leaves
			Base	Middle	Top	
1	10.70	0.54	2.30	1.00	1.00	35
8	9.10	0.46	2.22	0.95	0.96	27
9	9.95	0.48	2.70	0.95	1.00	39
10	10.15	0.51	2.42	0.90	0.95	34
11	10.33	0.52	2.20	0.85	1.00	21
12	8.73	0.44	2.40	0.85	0.90	28
19	9.5	0.48	2.50	0.90	0.95	34
21	10.62	0.53	2.15	0.95	1.00	33
28	10.40	0.52	2.22	0.95	1.00	33

Table 2. Morphological characters of some palmyra palm trees at BSRI garden (Thirteen years old)

Plant no.	Plant Height (m)	Growth rate (cm/year)	Width (m)			No. of green leaves
			Base	Middle	Top	
47	3.36	0.26	2.10	1.30	1.15	36
50	3.50	0.27	2.00	1.30	1.12	32
51	3.60	0.29	2.17	1.29	1.17	36
54	4.23	0.34	2.10	1.45	1.40	38
55	3.90	0.30	2.20	1.35	1.20	33
59	4.75	0.37	2.25	1.40	1.25	46

On the contrary, among the thirteen years old genotypes highest height was observed at 59th number of plant followed by 54th number. Highest base width was observed at 9th number followed by 19th number. Highest middle width was observed at 59th number plant. Highest top width was observed at 54th number plant. 59th number plant showed highest number of green leaves followed by 54th number plant.

From the above tables we found that twenty years old plant showed comparatively higher growth rate per year than the thirteen years old plant. Because of, in earlier stage palmyra palm seedling growth rate is negligible for two to three years.

Amount of sap per day per plant were determined in different times from the twenty years old selected genotypes (Table 3). Highest amount of juice was produced from plant number 19th at 2 May 2017. Highest brix percentage was obtained from 9th number plant. From the table we observed that juice flow decreases as the brix percentage increases. Sap flow is higher during cool night which is simillar to this findings and the study which was conducted in Cambodia, on *Borassus flabellifer* where they showed that there was no significant differences between days in the yield of juice and its brix value, but differences for these two parameters were highly significant between farms, months and sex of the palm tree (for the brix between male and female, the difference is significant instead of highly significant) Khieu Borin(1996).

Table 3. Amount of juice collected from selected palmyra palm genotypes (Twenty years old) at BSRI garden in different days

Plant no.	20 May 2017		23 May 2017		25 May 2017		27 May 2017		02 June 2017	
	Amount of juice (L/plt/d)	Brix (%)	Amount of juice (L/plt/d)	Brix (%)	Amount of juice (L/plt/d)	Brix (%)	Amount of juice (L/plt/d)	Brix (%)	Amount of juice (L/plt/d)	Brix (%)
1	3.6	10.6	5.02	10.16	5.9	10.75	7.0	10.24	8.8	10.30
8	6.4	8.8	6.08	9.07	6.6	8.9	5.7	9.28	5.6	11.95
9	5.16	11.7	6.74	11.56	7.1	11.65	4.05	13.0	7.7	12.30
10	6.09	9.3	6.92	10.0	6.28	9.4	3.58	10.38	6.3	9.26
11	8.88	8.8	8.55	8.52	8.2	9.7	8.0	9.93	8.9	10.20
12	4.8	9.0	4.49	9.5	4.40	9.7	4.1	10.0	4.6	10.05
19	8.2	10.42	7.49	10.0	8.00	10.0	6.66	10.23	10.3	10.30
21	8.92	9.96	9.22	9.44	10.6	9.1	5.65	10.06	10.4	9.20
28	8.68	8.39	5.77	9.86	6.35	10.2	7.0	9.4	5.2	9.08

Biochemical characters of palmyra palm sap

Biochemical characters of palmyra palm sap which was indicated by brix percentage, purity percentage, pol percentage and reducing sugar (Table 4). Twenty years old genotypes showed significant difference on brix, pol percentage purity percentage and reducing sugar. Genotypes 28th and 9th number plant produced highest brix percentage (12.4, 12.3) while highest pol percentage (7.89) was observed in 9th number plant. 1st number plant showed highest purity percentage (90.73) and lowest reducing sugar was observed in 8th, 10th, 12th and 28th number of plant.

Table 4. Chemical analysis of palm sap collected from some palmyra palm trees (Twenty years old) at BSRI yard at 02.May 2017

Plant number	Brix (%)	Pol (%)	Purity (%)	Reducing Sugar
1	10.3f	7.38 c	90.73 a	0.18 ab
8	12.1b	7.38 c	77.23 i	0.09 b
9	12.3a	7.89 a	81.19 d	0.15 ab
10	9.8 h	6.52 f	84.21 b	0.08 b
11	10.1 g	6.29 g	78.80 h	0.14 ab
12	10.1 g	6.34 g	79.40 g	0.08 b
19	10.3 f	6.82 e	83.78 c	0.14 ab
21	9.2 i	5.81 h	79.91 g	0.20 a
28	12.4 a	7.21 b	80.11 f	0.09 b

From the above results it may be concluded that the genotypes which showed better performance under natural condition can be selected as an ideal genotypes for dissemination in different areas in Bangladesh. The 28th and 9th number plant produced higher brix and pol than others. So, considering the production of goor we can say that the genotypes (28th and 9th) are better for cultivation in different location to meet up the demand of goor to supplement sugar required for the country.

Table 5. Temperature and rainfall pattern during the sap collection period

Day	April		May	
	Average Temp.(^{0}C)	Rainfall (mm)	Average Temp.(^{0}C)	Rainfall (mm)
1	20.99	-	27.83	-
2	24.16	-	27.83	-
3	26.83	-	26.33	-
4	27.0	-	27.32	-
5	27.17	-	30.16	-
6	26.16	-	28.67	-
7	27.33	-	28.16	-
8	27.16	-	26.5	-
9	28.67	-	27.66	19.09
10	27.19	-	28.5	-
11	28.18	-	26.16	-
12	28.33	-	26.5	-
13	24.33	-	26.66	-
14	24.5	-	26.33	-
15	27.84	-	23.83	20.68
16	29.08	-	29.0	25.45
17	28.67	-	27.0	-
18	29.84	-	27.67	-
19	29.98	-	27.49	-
20	27.34	-	29.5	-
21	28.84	-	27.49	-
22	28.84	-	28.83	-
23	28.84	-	24.71	-
24	27.16	-	30.16	-
25	29.16	-	28.16	-
26	30.66	-	26.17	-
27	30.66	-	28.82	-
28	28.33	-	27.0	-
29	29.5	-	27.61	-
30	30.33	-	27.84	-

REFERENCES

Bureau Sugar Experiment Stations (BSES) (1970). Laboratory Manual for Queensland Sugar Mills (5th Ed.), Division of Mill technology, Brisbane, Queensland, Australia, **5 (95-98):** 113-114.

Barreveld, W. H. 1993. Date palms products. FAO Agricultural Services, Bulletin No 101. FAO, Rome. pp. 262.

Dissanayake, B. W. 1977. Use of *Caryota urens* in Sri Lanka. In: First International Sago Symposium. The Equatorial Swamp as a Natural Resource. Ed. Tan K. Sarawak, East Malaysia, Kuching 1976. Kuala Lumpur. pp. 84-90.

Fox, J. F. 1977. Harvest of the Palm, Ecological Change in Eastern Indonesia. Harvard University Press, Cambridge, Massachusets, and London, England. pp. 290.

Gomez, K.A. and Gomez, A.A. 1984. Statistical procedures for agricultural research (2nd Ed.). A Wiley Interscience Publication, NY, USA Pp. 680.

Khieu Borin and Preston, T. R. 1995. Conserving biodiversity and the environment and improving the wellbeing of poor farmers in Cambodia by promoting pig feeding systems using the juice of the sugar palm tree (Borassus flabellifer). Livestock Research for Rural Developement (7) 2: http://www.cipav.org.co/lrrd/lrrd7/2/5.htm

Khieu Borin, B.1996. A study on the use of the sugar palm tree (*Borassus flabellifer*) for different purposes in Cambodia. M.Sc. Thesis Swedish University of Agricultural Sciences, Uppsala. pp. 67.

Morton, J. F. 1988. Notes on Distribution, Propagation, and Products of *Borassus* Palms (Arecaceae). Economic Botany, **42(3):** 420-441.

Redhead, J.1989. Utilization of tropical foods: trees. In: FAO Food and Nutrition Paper 47: 3. FAO, Rome, pp. 52.

Rangaswami , G. 1977. Palm tree crops in India. Outlook-on-Agriculture (UK). 9(4): 167-173.

Sodah Ayernor, G. K.; and Matthews, J. S. 1971. The Sap of the Palm *Elaeis guineensis* Jacq. as Raw Material for Alcoholic Fermentation in Ghana. Tropical Science. XIII(1): 71-83.