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Performance of exotic date palm (*Phoenix dactylifera*) genotypes in Bangladesh

Faruquei M.A.B., Saha A., Nasim M., Khatun A., Ibrahim M., Harun Ar Rashid, Dewan M.M.R., Quais M.K., Mondal S., Pramanik S., Parvin N., Islam A.B.M.J., Asad Uz Zaman M., Shirazy B.J., Mostafizur A.B.M., Khatun L., Eftekhar Uddin M., Chakrobarty T. and Shahidullah S.M.*

BAU, Mymensingh. All other authors from Rice Farming Systems Division, BRRI, Gazipur 1701, BANGLADESH

*shahidullah4567@gmail.com

Abstract

Date (*Phoenix dactylifera*) is a noble fruit cultivated mainly in dry and hot area of the globe. Wild relative of date palm (*Phoenix sylvestris*) is frequently grown all over Bangladesh. A long-term study had been initiated in 2013 with the seeds of 10 famous date cultivars collected from the International Centre for Biosaline Agriculture (ICBA), United Arab Emirates (UAE). Aim of the current study was to assess the adaptability of exotic date fruit in Bangladesh. Segregated population of the cultivars is growing in the historical Mujibnagar Complex, Meherpur, Bangladesh. This vast population of the species is being established as a germplasm centre. Vegetative growth and flowering response of all the varieties were found encouraging. Among the cultivars the highest percentage of female plants (14%) was recorded in Deglet noor.

Though this ratio is too small but not discouraging. In this population there are vast number of plants with diversified nature. Better genotype and best adapted plant might be selected from the current population. This effort would help us to release appropriate date palm cultivars for Bangladesh environment.

Keywords: Date, Fruit, Genotype, Adaptation, Bangladesh.

Introduction

Date is the unique fruit in the world that can be considered as a complete balanced food for mankind.¹ It is estimated that 37 thousand tons of dates of different grades and varieties have been imported from Pakistan, Tunisia, Algeria and other countries to Bangladesh costing about 22 million US\$ per year of foreign currency.⁸ Mesopotamia (in southern Iraq) is believed to be the centre of origin of date palm cultivation.^{24,26} Now its distribution is widespread over the world.

The United States in the north hemisphere and Australia in south hemisphere are also successfully growing date fruits.^{16,23} Extreme latitude limits range from 39°N at Turkmenistan and Spain to 34°S at Petra Bore in Australia.^{15,28} In consideration of climate and soil, Bangladesh is also suitable for date palm cultivation. The north-western part of the country is comparatively dry. This region holds a tremendous potentiality for it.

In botanical classification, date palm belongs to *Phoenix* genus having several species.^{27,29} Among them, *Phoenix dactylifera* is the most important elite species that is commercially cultivated for fruit production.²² *Phoenix sylvestris* is a wild species and obviously it is one of the closest relatives of *Phoenix dactylifera*.^{2,10} *Phoenix sylvestris* is readily available in Bangladesh, and is grown for juice and gur production. Abundance of wild relatives of a plant species indicates the possibility of its well adaptation.

The canopy structure of date palm is of eco-friendly type which marginally affects the growth and yield of field crops. That is why it is frequently grown on the perimeter of crop field as a component of agro-forestry system. It is also preferred for roadside plantation as well as for the homestead agro-forestry.¹⁹

However, the appropriate plantation density of date palm for system productivity needs to be investigated. Plantation of local date palm (*P. sylvestris*) is seriously decreasing day by day.⁷ Our young generation of farmers is not interested to pay so much hard labour to extract its juice. Furthermore, its lower economic profitability discourages people in commercial plantation. So, it is the time to think over the replacement of local date palm with elite ones.

Changing climate is a vital issue all over the world. The north-western part of Bangladesh is under the prediction of desertification where groundwater is in declining trend.^{9,12-14} In future dry season rice cultivation using groundwater may not be possible in many areas of the country. In the prevailing situation, agroforestry with drought tolerant species like date palm may be better option for the dry area of Bangladesh. In the meantime, some individuals are trying to grow date palm from their personal initiatives.²¹ However, without research and without institutional support, it may not touch the expected goal.

Farming Systems working group of Bangladesh Rice Research Institute initiated a research task with date palm (*Phoenix dactylifera*) as a component technology of holistic farming systems. This journey had been started in 2013 at Mujibnagar in Meherpur district characterized by drought prone weather and well-drained light soil.

Among the series of activities the present piece of task addresses the following research questions: Is Bangladesh suitable for growing date palm (*Phoenix dactylifera*)? Will this species produce fruits successfully?

Material and Methods

Geography of the location of experiment: The work was carried out at the historical Mujibnagar Complex, Meherpur, Bangladesh. Geographically the experimental area is located at 23°39' N latitude and 88°36' E longitude. It belongs to High Ganges River Floodplain recognized as Agro-ecological zone 11 (AEZ 11). Texture of topsoil is silty loam to silty clay loam. In respect of pH, the soil is very close to neutral in reaction. Mujibnagar lies on 22m above sea level. The summers are much rainier than the winters. The average annual temperature is 26.2 °C.

Monthly mean maximum temperature is 37°C in April. The coolest month is January where mean minimum temperature falls to 11°C. The rainfall here averages 1422 mm. The driest month is December with 3 mm of rainfall. The greatest amount of precipitation occurs in July with an average of 300 mm.

Description of the materials: Seeds of 10 famous date palm cultivars were collected from the International Centre for Biosaline Agriculture (ICBA) in the United Arab Emirates (UAE). Fruits were harvested and seeds were extracted in October 2012. The cultivars are Azwah, Ambar, Barhee, Deglet Noor, Helali, Lu-Lu, Mabrum, Medjool, Sukkari and Zahidi. Three hundred seeds of each cultivar were used for seedling raising in four phases (Table 1).

Management of the experiment: There were 300 seeds for each cultivar. This bulk was divided into equal four parts where 75 seeds were in each part. Each part was assigned for each planting time. Twenty-five seeds were allotted for each replication. Sufficient number of poly bags of 18 cm × 10 cm size were made ready for sowing the seeds. The poly bags were filled with a homogeneous mixture of soil and vermicompost.

Seeds were soaked with water for 72 hours and incubated in a seed germinator at 30°C.³ Within 12-14 days, seeds got sprouted. Then those sprouted seeds were sown into polybag. One seed was sown in each bag at 2-3 cm depth. The experiment was laid out in a factorial completely randomized design (CRD) with three replications.

Thus, there were 120 units (ten genotypes × four planting times × three replications) of experiment with 25 poly bags in each unit. The four planting times were fixed as four aging limit of seeds and that were 6, 12, 18 and 24 months after harvest (MAH). Seedlings were nurtured in the polybag and all the seedlings at 6-month age were transplanted in the

main field at 2 m × 6 m spacing. Seeding time, transplanting time and number of transplanted seedlings are listed in the table 1.

Data collection and analyses: Seedlings were counted and converted to Percentage of Emergence. All data were subject to Analyses of Variance (ANOVA) using STAR (Statistical Tool for Agricultural Research) for Windows version 2.0.1 which uses R language (IRRI, 2014). Microsoft Excel 2016 was used for computing the descriptive statistics. The comparisons of treatment means were made using Tukey's HSD (Honest significant difference) at 5% level of probability ($p = 0.05$).

Total number of live plants were recorded in March 2019. Then male plants and female plants were identified and all the counts were used for various calculations. Total number of suckers were also counted for each and every set of planting stock at the same time. A plant normally starts its sucker production at the age of three years after seeding.¹¹ Thus, the sucker production rate was calculated using the following formula.

$$\text{Sucker production rate (no./plant/year)} = \frac{1}{T} \times \frac{S}{P}$$

where T=Age of the plant (No. of years) – 3, S = Total number of suckers and P = Total number of plants raised from seedling.

Results and Discussion

Seedling emergence and survival: In the first phase of seed sowing, seedling emergence was excellent in all cultivars. Around 97-99% seedling emergence was recorded. There was no significant difference among the cultivars for seedling emergence. The ranges of seedling emergence were 95-97% in second phase, 91-95% in third phase and finally 76-80% in fourth phase of seed sowing (Table 2).

In this parameter, the varietal response was statistically similar for a particular age of seed. However, a significant difference was observed among the four age groups of seeds. In the fourth phase the seeds were sown after 24 months of harvesting. Seedling emergence was significantly lower in fourth phase in all the cultivars. No interaction effect was observed among the seed age and date palm cultivars. Several authors reported negative relationship of seed viability and seedling vigour with seed aging.^{4,18,25} In the present study, the seeds were stored in room temperature. Longer duration of storage might cause the decrease of seed viability and/or seedling vigour.

Table 1
Description on the treatments of the experiment.

	1 st planting	2 nd planting	3 rd planting	4 th planting
Age of seeds after harvest	6 months	12 months	18 months	24 months
Time of seed sowing	March 2013	October 2013	March 2014	October 2014
Age of seedling	6 months	6 months	6 months	6 months
Time of transplanting	October 2013	March 2014	October 2014	March 2015

Table 2
Seedling emergence (%) of exotic date palm (*Phoenix dactylifera*) cultivars as affected by aging.

Cultivar	1 st seeding (6 MAH)	2 nd seeding (12 MAH)	3 rd seeding (18 MAH)	4 th seeding (24 MAH)
01.Azwah	97.33aA	94.67aA	90.67aA	78.67aB
02.Ambar	98.67aA	96.00aA	93.33aA	80.00aB
03.Barhee	98.67aA	96.00aA	92.00aA	77.33aB
04.Deglet Noor	97.33aA	97.33aA	94.67aA	76.00aB
05.Helali	97.33aA	96.00aA	94.67aA	80.00aB
06.Lu-lu	97.33aA	97.33aA	93.33aA	78.67aB
07.Mabrum	97.33aA	97.33aA	93.33aA	77.33aB
08.Medjool	98.67aA	96.00aA	92.00aA	78.67aB
09.Sukkari	98.67aA	94.67aA	90.67aA	80.00aB
10.Zahidi	97.33aA	94.67aA	92.00aA	76.00aB

HSD_{0.05} = 11.07; MAH = month after harvest.

Note: Figures in the table have been calculated on the basis of data presented in Appendix 1.

Figures with same small letter in a column do not differ significantly.

Figures with same capital letter in a row do not differ significantly.

The survival of seedlings after transplanting was recorded for all the seedlings of all four phases (Table 3). In the first set, the survival of transplanted seedling was in the range of 34-80%. Significant variation was observed among the cultivars for seedling survival. The highest survival rate was 80% for for the progenies of Barhee and Sukkari. The performance of Azwah, Ambar, Helali, Lu-lu, Mabrum and Zahidi was statistically similar. In the contrast, Medjool and Deglet noor showed significantly lower rate of survival. In the other sets of seeding, the survival of transplanted seedlings showed the similar trend.

In all the cases, worse performance was observed for these two cultivars viz. Deglet noor and Medjool. In consideration of a specific cultivar, there was no significant difference among the four phase of seeding. Hence, it is clear that there was no effect of seed aging on seedling survival or transplanting shock. Data in the table 3 also indicates that there was no interaction effect between cultivar and seed aging or storage period of seed.

Offshoot generation: Offshoot generation i.e. sucker production features of different date palm cultivars are presented in table 4. A date palm normally starts its offshoot blooming at 3 years of seeding. Hence, active offshoot generation duration was 36 months for 1st planting and those durations were 30, 24 and 18 months for 2nd, 3rd and 4th planting respectively.

From the data presented in the table, it is clear that there was an interaction between the date cultivars and plant age. Offshoot generation rate was influenced by cultivar and also by growth phase of plant. Increasing trend of offshoot generation was not similar for all the cultivars.

Sucker production rate was statistically identical for all the cultivars up to 30 months. There was an exception among the plant groups which had 36 months duration. Here only

one cultivar Mabrum showed significantly lower rate in offshoot generation than the others.

In case of growth phases, six cultivars viz. Barhee, Degletnoor, Lu-lu, Mabrum, Medjool and Sukkari expressed their alike nature. For these cultivars there was no significant difference in offshoot generation rate among the age groups. Hence, it is clear that offshoot generation rate was very similar in younger and older plants. In case of Azwah and Ambar, sucker production rate was lower up to 18 months and after that age, this rate increased significantly and had been going with similar trend.

Helali expressed a little bit different mode where this rate was lower up to 24 months and higher afterward. The cultivar Zahidi produced its suckers in significantly lower rate up to 30 months and then started its higher production rate. Several authors documented the offshoot production nature of date palm. Offshoots are mainly produced in a limited number (20 to 30 at most) during the early life of the palm (10 to 15 years from the date of its planting) depending on the variety and cultural mangement.^{16,17}

Flowering behavior and sex ratio: Flowering data were recorded in March 2019 (Appendix 4). About 15-36% plants started their flowering in the population of the youngest age i.e. 54 month after seeding (Fig. 1). The highest rate was observed in Zahidi followed by Helali. The lowest flowering rate was recorded for Azwah and Sukkari. About 40-67% flowering plants were counted in the oldest sets of 72 months. In this oldest population, the highest flowering rate was documented in Zahidi followed by Helali and the lowest was in Deglet noor and Medjool.

It is notable that Zahidi and Helali stood as top-two in flowering response for both ages viz. youngest and oldest populations. Zahidi proved its best performance also in case of flower increasing trend and that was about 11%. This

trend was 10.27% in Azwah followed by Sukkari with 10.26%. The lowest rate 8% was observed in Medjool. Several experts and authors documented their experiences about the flowering age of date palm orchard. In a vast population derived from seed/sexual propagation, some exceptional plants show its flowering expression at a very early stage like three years. Majority of plant population flowers by seven years. However, the whole orchard gets its full flowering at maximum 10 years of seeding.^{5,6,20}

Among the flowering plants, male and female plants were recorded separately (Appendix 5). The highest percentage of female plants were counted in the segregated population of Degletnoor cultivar and that was about 14% (Fig. 2). On the

contrary, the lowest percentage of female (7.35%) was observed in that of Lu-lu. Several authors predicted the 50:50 ratio of male-female plants in the segregated population of date palm.²⁸

However, in our current study, the result in Bangladesh environment says that this ratio does not exceed 14:86. Though this ratio is too small but not discouraging. In this population, there are vast number of plants with diversified nature. Better genotype and best adapted plant might be selected from the current population. This effort would help us to release appropriate date palm cultivars for Bangladesh environment.

Table 3
Plant survival (%) after transplanting of seedlings of different date palm cultivars produced from different ages of seeds.

Cultivar	1 st set	2 nd set	3 rd set	4 th set
01.Azwah	76.71aA	71.83aA	73.53aA	69.49aA
02.Ambar	77.03aA	75.00aA	75.71aA	75.00aA
03.Barhee	79.73aA	76.39aA	76.81aA	79.31aA
04.Deglet Noor	47.95bA	50.68bA	49.30bA	43.86bA
05.Helali	78.08aA	77.78aA	77.46aA	75.00aA
06.Lu-lu	75.34aA	76.71aA	81.43aA	77.97aA
07.Mabrum	78.08aA	75.34aA	78.57aA	77.59aA
08.Medjool	33.78bA	34.72bA	37.68bA	27.12bA
09.Sukkari	79.73aA	71.83aA	73.53aA	68.33aA
10.Zahidi	78.08aA	76.06aA	76.81aA	78.95aA

HSD_{0.05} = 16.39

Note: Figures in the table have been calculated on the basis of data presented in Appendix 2.

Figures with same small letter in a column do not differ significantly.

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Table 4
Sucker (off-shoot) production rate (no./plant/year) for the segregated population of different date cultivars in Bangladesh environment.

Genotype	Duration of sucker production (Started from 3-years age)			
	1 st planting (36 months)	2 nd planting (30 months)	3 rd planting (24 months)	4 th planting (18 months)
01.Azwah	0.59aA	0.47aA	0.45aA	0.37aB
02.Ambar	0.50aA	0.40aA	0.40aA	0.30aB
03.Barhee	0.51aA	0.39aA	0.39aA	0.38aA
04.Deglet Noor	0.50aA	0.38aA	0.40aA	0.40aA
05.Helali	0.60aA	0.47aA	0.41aB	0.44aB
06.Lu-lu	0.48aA	0.34aA	0.35aA	0.38aA
07.Mabrum	0.39bA	0.40aA	0.39aA	0.37aA
08.Medjool	0.53aA	0.34aA	0.42aA	0.42aA
09.Sukkari	0.51aA	0.40aA	0.40aA	0.37aA
10.Zahidi	0.60aA	0.42aB	0.42aB	0.37aB

HSD_{0.05} = 0.15

Note: Figures in the table have been calculated on the basis of data presented in Appendix 3.

Figures with same small letter in a column do not differ significantly.

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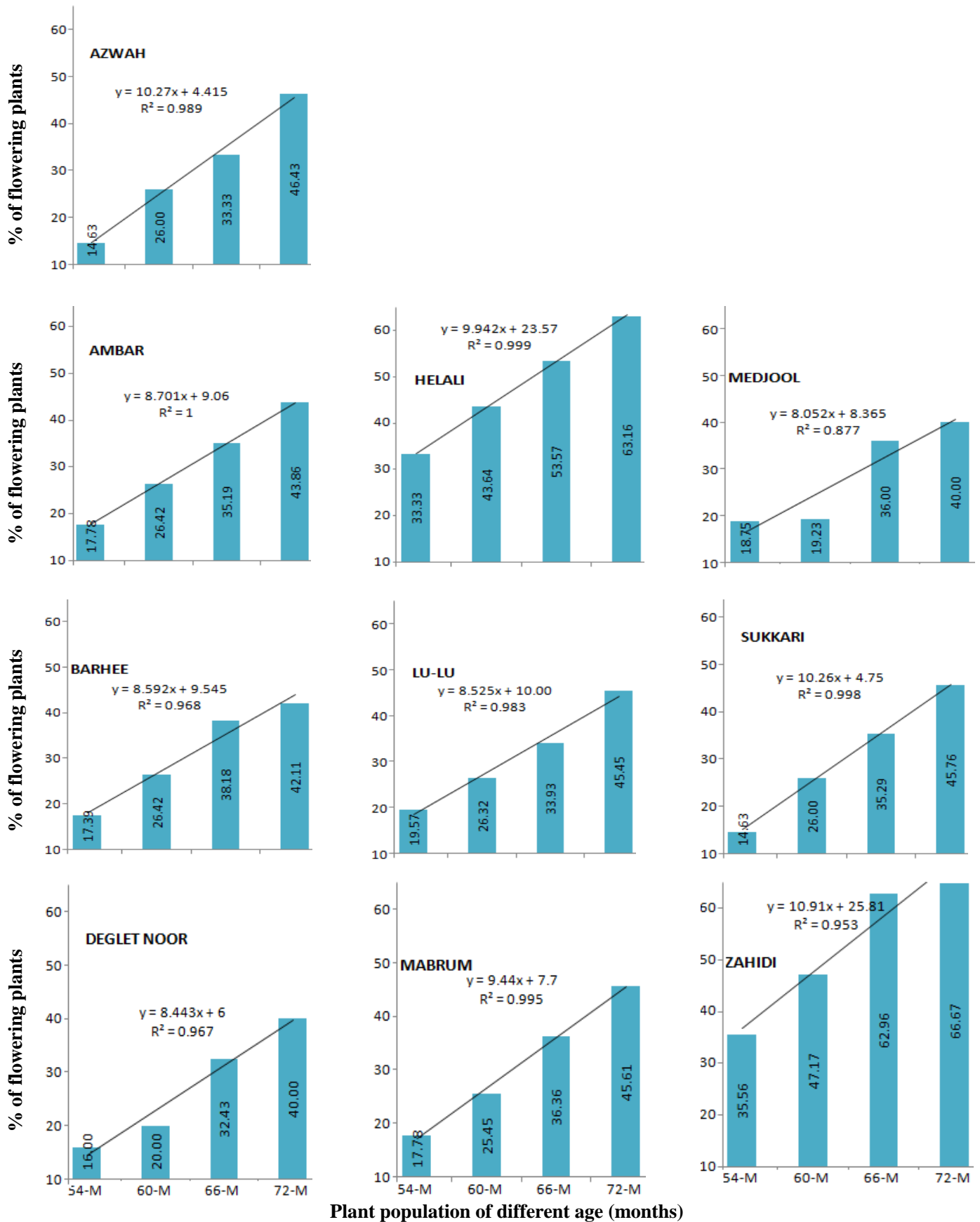


Fig. 1: Trend of flowering response in segregated population of different date varieties over time

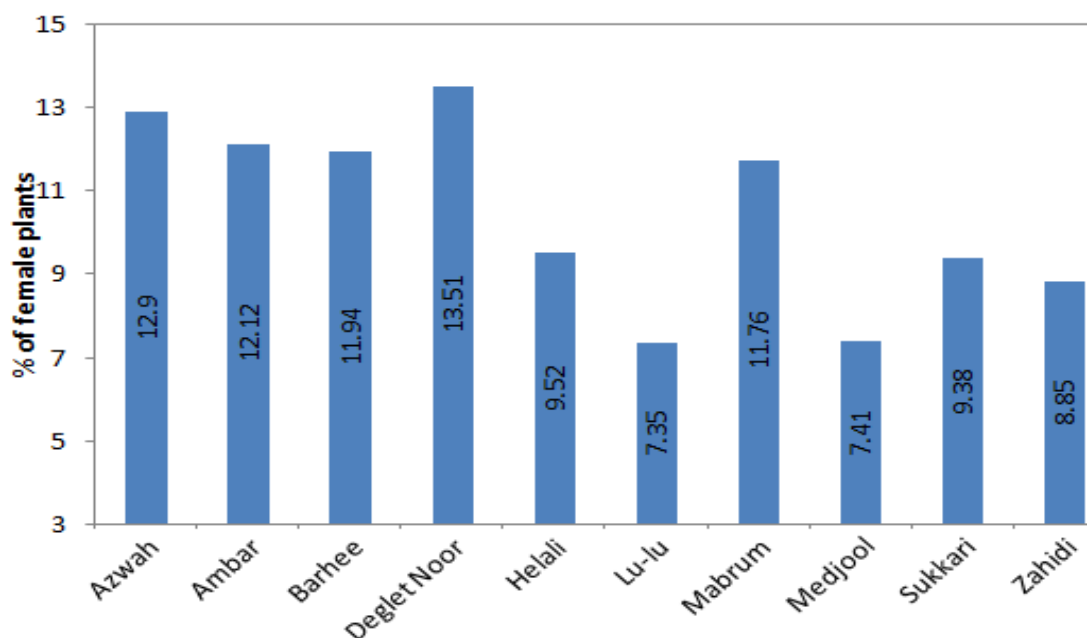


Figure 2: Ratio of female plants in the segregated population of date palm cultivars in Bangladesh environment.

Appendix 1

No. of seeds sown and seedlings emerged of exotic date palm (*Phoenix dactylifera*) cultivars at different ages of seeds.

Cultivar	1 st seeding (6 MAH)		2 nd seeding (12 MAH)		3 rd seeding (18 MAH)		4 th seeding (24 MAH)	
	Seed	Seedling	Seed	Seedling	Seed	Seedling	Seed	Seedling
01.Azwah	75	73	75	71	75	68	75	59
02.Ambar	75	74	75	72	75	70	75	60
03.Barhee	75	74	75	72	75	69	75	58
04.Deglet Noor	75	73	75	73	75	71	75	57
05.Helali	75	73	75	72	75	71	75	60
06.Lu-lu	75	73	75	73	75	70	75	59
07.Mabrum	75	73	75	73	75	70	75	58
08.Medjool	75	74	75	72	75	69	75	59
09.Sukkari	75	74	75	71	75	68	75	60
10.Zahidi	75	73	75	71	75	69	75	57

Appendix 2

Number of seedlings transplanted in the field and number of plants sustained.

Cultivar	1 st set		2 nd set		3 rd set		4 th set	
	Seedlings transplanted	Plants sustained	Seedlings transplanted	Plants sustained	Seedlings transplanted	Plants sustained	Seedlings transplanted	Plants sustained
01.Azwah	73	56	71	51	68	50	59	41
02.Ambar	74	57	72	54	70	53	60	45
03.Barhee	74	59	72	55	69	53	58	45
04.Deglet Noor	73	35	73	37	71	35	57	25
05.Helali	73	57	72	56	71	55	60	45
06.Lu-lu	73	55	73	56	70	57	59	46
07.Mabrum	73	57	73	55	70	55	58	45
08.Medjool	74	25	72	25	69	26	59	16
09.Sukkari	74	59	71	51	68	50	60	41
10.Zahidi	73	57	71	54	69	53	57	45

Appendix 3

Number of plants and suckers (off-shoot) produced in different durations from the population of date cultivars.

Cultivars	Duration of sucker production (Started from 3-years age)							
	1 st planting (36 months)		2 nd planting (30 months)		3 rd planting (24 months)		4 th planting (18 months)	
	Plants	Suckers	Plants	Suckers	Plants	Suckers	Plants	Suckers
01.Azwah	56	99	51	60	50	45	41	23
02.Ambar	57	85	54	54	53	42	45	20
03.Barhee	57	88	55	53	53	41	46	26
04.Deglet Noor	35	53	37	35	35	28	25	15
05.Helali	57	102	56	66	55	46	45	30
06.Lu-lu	55	80	56	48	57	40	46	26
07.Mabrum	57	67	55	55	55	43	45	25
08.Medjool	25	40	25	21	26	22	16	10
09.Sukkari	59	91	51	51	50	40	41	23
10.Zahidi	57	103	54	57	53	44	45	25

Appendix 4

Total number of plants and number of flowering plants at different age groups of different date cultivars, March 2019, Mujibnagar, Meherpur, Bangladesh.

Genotype	1 st planting (72 months)		2 nd planting (66 months)		3 rd planting (60 months)		4 th planting (54 months)	
	Total plants	Flowering plants	Total plants	Flowering plants	Total plants	Flowering plants	Total plants	Flowering plants
01.Azwah	56	26	51	17	50	13	41	6
02.Ambar	57	25	54	19	53	14	45	8
03.Barhee	57	24	55	21	53	14	46	8
04.Deglet Noor	35	14	37	12	35	7	25	4
05.Helali	57	36	56	30	55	24	45	15
06.Lu-lu	55	25	56	19	57	15	46	9
07.Mabrum	57	26	55	20	55	14	45	8
08.Medjool	25	10	25	9	26	5	16	3
09.Sukkari	59	27	51	18	50	13	41	6
10.Zahidi	57	38	54	34	53	25	45	16

Appendix 5

Number of male and female plants in the segregated population of different date cultivars, March 2019, Mujibnagar, Meherpur, Bangladesh.

Genotype	1 st planting (72 months)		2 nd planting (66 months)		3 rd planting (60 months)		4 th planting (54 months)	
	Male	Female	Male	Female	Male	Female	Male	Female
01.Azwah	23	3	15	2	12	1	4	2
02.Ambar	22	3	17	2	12	2	7	1
03.Barhee	22	2	18	3	12	2	7	1
04.Deglet Noor	12	2	11	1	6	1	3	1
05.Helali	32	4	28	2	21	3	14	1
06.Lu-lu	22	3	18	1	14	1	9	0
07.Mabrum	22	4	18	2	13	1	7	1
08.Medjool	9	1	8	1	5	0	3	0
09.Sukkari	24	3	16	2	12	1	6	0
10.Zahidi	34	4	31	3	23	2	15	1

Conclusion

The current study has opened an avenue of date palm research in Bangladesh. Sexual as well as vegetative propagation would be successful here. The current stock of segregated population from different famous cultivars would be used as a germplasm centre. Evaluation of each and every individual plant is now a crying need here. Further effort on screening might develop some superior genotypes and cultivars for Bangladesh.

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