Genetic Divergence in Mahua (*Bassia latifolia*) under Semi-Arid Ecosystem of Gujarat

Sanjay Singh, AK Singh, VV Apparao, BG Bagle and DG Dhandar
Central Horticultural Experiment Station, Vejalpur (Godhra), Panchmahals 389 340 (Gujarat)

Survey was carried out in the district Panchmahals and adjoining areas to identify the elite genotypes among its population. The study revealed that there was a wide variation among the genotypes. Peak period of flowering was earliest (1st week of March) in MH 25, while it was delayed in MH 26, MH 29, MH 31 and MH 32 (1st week of April). MH 32 recorded maximum number of flowers and fruits per fascicle. Early ripening i.e. 4th week of May was recorded in MH 21, MH 22 MH 27, MH 31 MH 32, and MH 33, while it was noted late (3rd week of June) in MH 23, MH 28, MH 34 and MH 35. Dry flower yield ranged from 27-48 kg /plant being highest in MH 32. Fruit yield was found to be highest in MH 32 (98.00 kg /plant). The flower Juice was found to be highest (67.00 %) in MH 32. Total soluble solids, total sugar, reducing sugar and vitamin C content of flowers were the highest in MH 32. Weight of mahua fruit was found to be maximum in MH 34. The seed per cent was found to be maximum in MH 35 (42.91). The total soluble solids, total sugar and vitamin C contents of the fruits were maximum in MH 32.The kernel per cent varied from 74.13-82.68 with highest in MH 24. The highest protein and mineral contents were recorded in MH 34. Fruit yield was found to be positively and significantly associated with flowers and fruits per fascicle, flower weight and flower yield per plant.With respect to all traits studied in these genotypes, MH 32, MH 34, MH 35, MH 26, MH 27, MH 23 and MH 33 were found to be promising and would be exploited as potential parents to develop high yielding stable genotypes.

Key words: Mahua, Flowering, Fascicle, Genetic diversity, Kernel, Minerals, Protein

Mahua (*Bassia latifolia* Roxb.) is an economically multipurpose tree of the family Sapotaceae. The tree is well known to the rural folk since ages in India. It is very hardy and thrives well on rocky, gravelly, saline and sodic soils, even in pockets of soil between crevices of barren rock (Singh, 1998). Its flowers, fruits and seed oil are consumed in various ways. The corolla commonly called mahua flower is a rich source of sugar containing appreciable amount of vitamins and minerals and may be used for preparation of distilled liquors and potable spirits (Singh *et al.*, 1999). The fruit pulp may be utilized as source of sugar for alcoholic fermentation. The oil obtained from kernel is used for edible purpose and permitted for preparation of vegetable oil. Mahua oil is used in manufacture of soap, lubricating grease, fatty alcohols and candles. Cake obtained after extraction of oil is used as manure and has insecticidal properties. In tribal belt of Gujarat, Mahua trees are found growing naturally as stray plantation on wasteland. It is highly heterozygous, cross-pollinated fruit crop and as such seedlings exhibit a wide range of variations, which aids in the selection of the superior desirable genotypes. Due to cross pollination and predomination of seed propagation over a long period of time, it gives immense opportunity to locate elite trees having positive horticultural traits. Wide variations were observed in sweetness, acidity, size, shape and bearing habits in mahua under Uttar Pradesh and Gujarat conditions (Singh *et al.*, 1999; Anonymous, 2002; Singh and Singh, 2005). Considerable genetic diversity under various agro-climatic conditions in different under-utilized fruits like tamarind, jamun has also been reported (Keskar *et al.* 1989a, Keskar *et al.*, 1989 b; Karale *et al.*, 1999; Devi *et al.*, 2002,; Rai and Mishra, 2005 and Singh and Singh, 2005). Present investigation was carried out to find out variability in flowering, fruiting and fruit quality attributes of different genotypes so that the valuable germplasm could be protected from being eroded and at the same time their utilization is also maximized under crop improvement programme.

Materials and Methods

The mahua trees are found scattered throughout Gujarat from cultivable land to waste lands. An extensive survey was made in Panchamahal district and adjoining areas during the year 2004 and 2005 to identify elite types of germplasm among its population. Fifteen promising genotypes from different locations and age group were selected, which had fairly wide spectrum of variability of various characters and they were considered as experimental materials. The observations were recorded on tree characters, flowering, fruiting and fruit quality attributes for two consecutive years and pooled data were presented (Tables 1-4). Twenty healthy fascicles from each tree were randomly selected to record number of flowers and fruits per fascicle. The ripe fruits differing in shape, size and appearance were collected to study the variability in physico-chemical attributes. The trees were free from pests and diseases. Healthy fruits were harvested and experiment was laid out in completely randomized design with three replications. Flower and fruit yield per tree was recorded on different dates and at the last total yield was calculated. Total soluble solids and titratable acidity were determined by standard methods. Protein, minerals, Vitamin C and sugars were analyzed by the method advocated by AOAC, 1980. Oil content in kernel was determined by the method described by Rangana, 1986.

Results and Discussion

Perusal of the data, collected from the studies on the genetic diversity of mahua in Gujarat revealed that the different trees varied widely in flowering, fruiting and fruit quality attributes. The tree age ranged from 35.00 to 48.00 years in different genotypes (Table 1). Peak period of flowering was earliest (1st week of March) in MH 25, while it was delayed in MH 26, MH 29, MH 31 and MH 32 (1st week of April). There was marked variation in average number of flowers per fascicle in most of the genotypes and MH 32 recorded maximum number of flowers per fascicle (33.50) and fruits (12.50) per fascicle followed by MH 27, MH 26, MH 35 and MH 24 while, it was found least in MH 31. Wide range of variability in different mahua genotypes was recorded under Uttar Pradesh conditions and recorded 66.00,54.60, 64.30 and 78.50 flowers per fascicle were observed in collection number 2,4, and 8 respectively. The leaf area (cm^2) varied from 90.00-122.00 cm^2 and MH 30 being at the top followed by MH 26, MH 31, MH 25 and MH 35. Early ripening (4th week of May) was recorded in MH 21, MH 22 MH 27, MH 31, MH 32 and MH 33, while it was noted late (3rd week of June) in MH 23, MH 28, MH 34 and MH 35. Dry flower yield ranged from 27-48 kg/plant and it was found to be highest in MH 32 followed by MH 27, MH 26, MH 24, MH 35 and MH 25. Wide range of variability was observed in fruit yield per plant. It was found to be highest in MH 32 (98.00 kg /plant) followed by MH 27, MH 26, MH 35 and MH 24, while lowest fruit yield was recorded in MH 31(68.00 kg/ plant). Singh (1998) also recorded the variability in fruit yield attributes on 5-7 year old grafted plants of mahua under Uttar Pradesh conditions. Variation in soil and climatic conditions might have caused wide range of variability in different genotypes. Karale *et al.*, 1999; Keskar *et al.*, 1989a; Devi *et al.*, 2002; Kundu *et al.*, 2001; Mitra, 1998; Pareek and Awasthi, 2002; Maiti and Mitra, 2002 and Sakhyan *et al.*, 2004 observed variability in under-utilized fruits like tamarind, jamun, jackfruit and sea buckthorn under various agro-climatic conditions.

Variability recorded in physical and biochemical characters in mahua flowers has been presented in Table 2. Weight of fresh mahua flowers ranged from 2.00 gm-2.32 gm with highest in MH 23 followed by MH 22, MH 32, MH 24 and MH 27. The flower juice was

Table 1. Variability in tree age, flowering, fruiting and fruit yield attributes

Genotypes	Age (Year)	Flowering time	Flowers/ fascicle	Fruits/ fascicle	Bearing habit	Leaf area (cm^2)	Harvesting time	Dry-flower yield (kg/ plant)	Fruit yield (kg/ plant)
MH 21	35.00	2nd week March	22.50	6.50	Regular	90.20	4th week May	35.00	73.00
MH 22	40.00	4th week March	24.50	6.80	Regular	105.00	4th week May	37.00	78.00
MH 23	45.00	3rd week March	26.50	7.20	Regular	106.00	3rd week June	39.00	80.00
MH 24	46.00	3rd week March	28.00	7.50	Regular	111.20	2nd week June	41.50	80.50
MH 25	42.00	1st week March	27.20	7.00	Regular	115.00	1st week June	40.50	78.50
MH 26	38.00	1st week April	30.00	8.00	Regular	120.00	2nd week June	42.00	86.00
MH 27	36.00	2nd week March	31.50	8.50	Regular	111.80	4th week May	43.00	87.00
MH 28	36.00	3rd week March	25.50	7.00	Regular	105.80	3rd week June	38.50	77.00
MH 29	40.00	1st week April	22.00	5.00	Regular	103.00	2nd week June	28.00	72.00
MH 30	38.00	2nd week March	20.20	4.80	Regular	122.00	1st week June	27.50	70.00
MH 31	42.00	1st week April	18.00	4.20	Regular	115.20	4th week May	27.00	68.00
MH 32	39.00	1st week April	33.50	12.50	Regular	112.45	4th week May	48.00	98.00
MH 33	42.00	3rd week March	22.80	5.50	Regular	113.80	4th week May	28.50	70.00
MH 34	44.00	2nd week March	24.00	6.00	Regular	108.00	3rd week June	30.20	75.00
MH 35	48.00	2nd week March	28.50	8.60	Regular	114.50	3rd week June	41.00	85.00
CD (*P=0.05*)	–	–	**4.41**	**0.70**	–	**5.16**	–	–	–

found to be highest (67.00%) in MH 32 followed by MH 31, MH 30 and MH 29, while pomace per cent was noted to be highest in MH 26 (38.10). Total soluble solids, total sugar, reducing sugar and vitamin C content of flowers was the highest in MH 32 ie 26.20 %, 23.78%, 20.13% and 62.60 mg/ 100g respectively, it was closely followed by MH 26, MH 33, MH 22 and MH 34. Titratable acidity of fresh mahua flowers ranged from 0.09-0.27% being highest in MH-28.Weight of mahua fruit was found to be maximum in MH 34 followed by MH 25, MH 35, MH 24 and MH 33, while least fruit weight was recorded in MH 21 and MH 29. The fruits of MH 22 recorded maximum husk per cent (62.71) and that of MH 35 the lowest (57.08). The seed per cent was found to be maximum in MH 35 (42.91) followed by MH 24, MH 25, MH 26 and MH 34. The total soluble solids, total sugar and vitamin C contents of the fruits were maximum in MH 32 i.e., 13.80%, 11.75%, 8.73%, 60.00 mg/100g respectively followed by MH 25, MH 27, MH 26 and MH 28. Singh *et al.* (1999) and Anonymous (2002) have also recorded the variation in fruit quality attributes in different mahua genotypes. They also emphasized that early maturing genotypes had more juice content than late ones. It might be due to low temperature prevailing during early flowering period.

The kernel percent varied from 74.13-82.68 with highest in MH 24, it was closely followed by MH 35, MH 34, MH 25, and MH 26, while least kernel content was recorded in MH 23. Similarly shell per cent varied from 17.57-25.50 being at the top in MH 23. The chemical composition of kernel also showed variation in terms of protein and minerals (Table 3). The highest protein and mineral contents were recorded in MH 32 *i.e.*, 23.34 and 4.48 % respectively, it was closely followed by MH 32, MH 28, MH 29, MH 23 and MH 33. The oil content of the kernel ranged from 40.29-46.68% and it was noted highest in MH 32 (46.68 %) followed MH 23, MH 34, MH 28 and MH 35. Mahua can play an important role in vegetable oil production, as it is one of the highest yielding trees per unit area. Singh *et al.* (1999) observed similar results in different mahua genotypes. Genetic diversity in kernel characters among different genotypes of pecan nut and Persian walnut was also recorded under cold arid conditions (Thompson and Baker, 1993; Sharma and Sharma, 2001 and Kaushal and Sharma, 2002). Correlation studies provide reliable information on nature and extent of relationship for bringing out improvement in yield and other traits. There was significant positive association of flowers and fruit per fascicle, flower weight and flower yield with fruit yield per plant. These traits may be observed for their positive behaviour while selecting superior genotypes. Machewade *et al.* (2003) surveyed the chironji (*Buchanania lanzan*) growing area of Maharastra and studied correlation and path analysis and concluded that there was highest significant positive association of number of panicles and total number of fruit per tree with weight of fruit. Singh and Mishra (2004) reported that fruit weight showed significant positive correlation with flower length and breadth, petal length and breadth, filament and anther length, stigma and ovary diameter and bud length at flower opening.With respect to all traits studied in these genotypes, MH 32, MH 34, MH

Table 2. Variability in physico-chemical attributes of mahua flowers

Genotypes	Flower weight (g)	Juice (%)	Pomace (%)	Stamen (%)	TSS (%)	Acidity (%)	Total sugar (%)	Reducing sugar (%)	Vitamin-C (mg/100g)
MH 21	2.20	63.50	35.69	0.81	24.50	0.12	21.89	17.54	56.13
MH 22	2.30	62.10	37.20	0.70	26.00	0.13	23.13	19.34	52.14
MH 23	2.32	64.00	35.22	0.78	25.80	0.19	22.70	18.13	61.20
MH 24	2.28	63.50	35.60	0.90	24.10	0.17	21.13	17.34	56.23
MH 25	2.26	62.80	36.27	0.93	24.50	0.23	21.15	17.32	54.45
MH 26	2.29	61.00	38.10	0.90	26.10	0.21	23.47	19.56	53.14
MH 27	2.28	64.80	34.36	0.84	25.10	0.25	22.12	18.00	55.45
MH 28	2.16	63.70	35.47	0.83	23.80	0.27	20.70	17.13	57.45
MH 29	2.22	64.00	35.11	0.81	24.50	0.23	21.49	17.45	58.46
MH 30	2.00	65.00	33.97	0.83	24.89	0.21	21.79	17.89	53.93
MH 31	2.12	66.00	33.14	0.86	25.13	0.18	22.43	18.46	54.00
MH 32	2.30	67.00	32.09	0.91	26.20	0.11	23.78	20.13	62.60
MH 33	2.23	62.00	37.07	0.93	26.00	0.09	23.00	19.52	61.13
MH 34	2.14	63.00	36.08	0.92	25.80	0.10	22.87	18.91	60.59
MH 35	2.13	64.12	34.98	0.90	24.90	0.16	21.89	17.93	58.36
CD (*P=0.05*)	**0.09**	**1.34**	**1.93**	**NS**	**0.62**	**0.02**	**0.53**	**0.52**	**1.54**

Table 3. Variability in physico- chemical attributes of mahua fruits and kernels

Genotypes	Mahua fruits										Mahua kernels						
	Fruit weight (g)	Husk weight (g)	Husk (%)	Seed weight (g)	Seed (%)	TSS (%)	Acidity (%)	Total sugar (%)	Reducing sugar	VitaminC (mg/100g)	Kernel weight (g)	Kernel (%)	Shell weight (g)	Shell (%)	Protein (%)	Minerals (%)	Oil (%)
MH 21	21.50	13.45	62.55	8.05	37.44	12.45	0.12	10.14	7.03	45.00	6.32	78.50	1.73	21.49	20.50	4.13	42.00
MH 22	22.50	14.11	62.71	8.39	37.28	11.45	0.19	9.19	6.14	52.34	6.39	76.16	2.00	23.83	21.39	4.11	43.50
MH 23	26.15	15.17	58.01	10.98	41.98	11.89	0.21	9.45	6.24	56.47	8.14	74.13	2.80	25.50	22.36	3.39	45.60
MH 24	28.30	16.17	57.14	12.13	42.86	12.90	0.19	10.30	7.14	50.49	10.03	82.68	2.10	17.31	20.87	4.19	42.68
MH 25	29.50	16.87	57.19	12.63	42.81	13.50	0.16	11.45	8.30	53.14	10.19	80.68	2.44	19.32	21.39	4.28	43.29
MH 26	24.50	14.11	57.59	10.39	42.40	13.11	0.18	11.13	8.12	45.13	8.34	80.26	2.05	19.73	20.45	4.35	42.28
MH 27	23.10	13.78	59.65	9.32	40.34	13.45	0.11	11.41	8.24	48.00	7.13	76.50	2.19	23.49	22.37	4.19	43.00
MH 28	22.50	13.34	59.28	9.16	40.71	13.10	0.12	11.10	8.10	47.14	7.03	76.74	2.13	23.25	22.89	3.18	45.24
MH 29	21.50	12.87	59.86	8.63	40.13	12.14	0.09	10.08	7.02	18.31	6.83	79.14	1.80	20.85	22.48	4.10	40.29
MH 30	23.80	13.88	58.31	9.95	41.80	12.40	0.09	10.11	7.08	49.45	7.78	78.19	2.17	21.80	21.50	3.15	41.50
MH 31	25.11	14.90	59.33	10.21	40.66	11.80	0.10	9.40	6.45	53.61	8.13	79.62	2.08	20.37	21.00	3.14	43.50
MH 32	24.00	14.14	58.91	9.86	41.08	13.80	0.09	11.75	8.73	60.00	7.73	78.39	2.13	21.60	23.34	4.48	46.68
MH 33	27.58	16.13	58.48	11.45	41.50	12.46	0.13	10.14	7.13	52.49	9.13	79.73	2.32	20.26	22.11	3.92	42.57
MH 34	29.70	17.19	57.87	12.51	42.12	11.50	0.15	9.53	6.56	53.11	10.10	80.73	2.41	19.26	23.10	3.83	45.00
MH 35	28.50	16.27	57.08	12.23	42.91	12.80	0.16	9.26	7.27	55.60	10.08	82.42	2.15	17.57	21.50	3.73	44.67
CD	2.14	1.32	1.74	1.37	1.12	0.51	NS	0.62	0.63	2.12	1.10	0.59	0.30	1.34	0.61	0.39	1.19
(P=0.05)																	

Table 4. Correlation studies in mahua genotypes

Characters	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	1															
2	**0.92	1														
3	0.16	0.06	1													
4	*0.62	0.52	-0.22	1												
5	0.03	0.26	0.06	-0.26	1											
6	-0.02	-0.25	-0.09	0.28	**-0.99	1										
7	0.21	0.27	0.24	0.32	-0.12	0.12	1									
8	0.07	-0.12	0.20	-0.06	-0.06	-0.06	*-0.56	1								
9	0.12	0.02	0.41	-0.03	-0.20	0.18	0.11	-0.28	1							
10	0.06	-0.01	0.30	-0.01	-0.23	0.22	0.15	-0.39	**0.98	1						
11	0.17	0.05	0.49	-0.05	-0.16	0.14	0.07	-0.17	**0.99	**0.94	1					
12	0.16	0.04	0.49	-0.08	-0.17	0.15	0.02	-0.19	**0.97	**0.93	**0.99	1				
13	0.23	0.29	-0.06	0.04	0.37	-0.37	0.17	-0.02	0.01	-0.01	0.03	-0.04	1			
14	*0.61	*0.55	-0.13	0.07	-0.26	0.26	0.25	-0.25	0.03	0.05	0.00	0.06	-0.08	1		
15	**0.93	**0.90	0.47	*0.62	0.07	-0.06	0.07	0.13	0.06	0.01	0.09	0.08	0.06	*0.53	1	
16	**0.96	**0.97	0.16	*0.55	0.22	-0.21	0.30	0.00	0.03	-0.02	0.08	0.07	0.25	*0.56	**0.92	1

1: Flowers per fascicle, 2: Fruits per fascicle, 3: Leaf area (cm^2),), 4: Flower weight (g), 5: Flower juice (%), 6: Flower pomace (%), 7: Flower TSS (%), 8: Flower acidity (%), 9: Fruit weight (g), 10: Husk weight (g), 11: Seed weight (g), 12: Kernel weight (g), 13: Kernel Protein (%), 14: Kernel minerals (%)15: Dry-flower yield (kg/ plant), 16: Fruit yield (kg/ plant)

r: 0.514 and 0.641 at 5 and 1 per cent respectively

* Significant at 5 % level, ** Significant at 1 % level

35, MH 26, MH 27, MH 23, and MH 33 were found to be promising on the basis of desired horticultural characters. Vegetatively propagated promising genotypes have been planted in the field for their further evaluation.

References

AOAC (1980) Official methods of Analysis, Association of official Agricultural chemists. Washington USA.

Anonymous (2002) Annual Report, Central Institute for Arid Horticlture, Bikaner, p 31.

Devi P S, Thangam M, Desai A R and Adsule PG (2002) Studies on variavility in physico-chemical characters of different jamun (*Syzygium cumini* Skeels) accessions from Goa. *Indian J Hort* **59**: 153-156.

Kaushal R and Sharma SD (2002) Genetic divergence in seedling trees of pecan (*Carya illioensis* (Wang) K Koch) for various metric nut and kernel characters in Himachal Pradesh. *Theoret Hort J* **15**: 11-17.

Karale A R, Wagh A P, Pawar BG and More TA. (1999) Association of fruit characters in tamarind. *J Maharastra Agril Univ* **24(3)**: 319-320.

Keskar BG, Karale AR, Dhawale BC and Chaudhary KG (1989a) Improvement of jamun by selection. *Maharashtra J Hort* **4**: 117-20.

Keskar BG, Karale AR, Dhawale BC and Chaudhary KG (1989 b) Improvement of tamarind by selection. *Maharashtra J Hort* **4**: 121-24.

Kundu S, Ghosh DK and Maity SC (2001) Evaluation of some local types of Jamun (*Syzygium cumini* Skeels) of West Bengal. *Environment and Ecology* **19**: 872-874.

Maiti CS and Mitra, SK (2002) Studies on genetic resources of jackfruit (*Artocarpus heterophylus* Lamk) in West Bengal. *The Hort J* **15**: 33-43.

Machewad PM, Shinde GS and Munde VM (2003) Correlation and path analysis studies in *charoli* (*Buchanania lanzan Spreng*). *The Hort J* **16**: 29-34.

Mitra SK (1998) Genetic diversity of jackfruit (*Artocarpus heterophylus* Lamk) *Indian Hort* **43**: 1.

Pareek OP and Awasthi OP (2002) Genetic resources of tamarind. *Indian J Plant Genet Resour* **15**: 197-202.

Rangana S (1986) Hand Book of Analysis and Quality Control for fruit and Vegetable Products, 2nd Edn. Tata Mc Graw Hill Publishing Co. Ltd. New York.

Rai Deepti and Mishra KK (2005) Studies on genetic divergence in Bael (*Aegle marmelos* Correa) *Indian J Hort* **62**: 152-154.

Sakhyan HP, Sehgal RN and Bhrot NP (2004) Morphological characters variation in different species of sea buckthorn in cold deserts of Himachal Pradesh. *Indian J Forestry* **27**: 129-32.

Sharma OC and Sharma SD (2001) Genetic divergence in seedling trees of Persian walnut (*Juglans regia* L.) for various metric nut and kernel characters in Himachal Pradesh. *Scientia Hort* **88**: 163-71.

Singh IS (1998) Mahua–An oil-bearing tree. Technical Bulletin, PP 3-11, ND University of Agriculture and Technology, Kumarganj, Faizabad, UP, India.

Singh IS, Srivastava AK and Singh B (1999) Improvement of some under-utilized fruits through selection *J Applied Hort* **1**: 34-37.

Singh VP and Mishra KK (2004) Estimation of variability parameters for floral traits and yield in Bael (*Aegle marmelos* Correa) *Progressive Hort* **36**: 253-258.

Singh Sanjay and Singh AK (2005) Genetic variability in jamun (*Syzygium cumini* Skeels) in Gujarat *Progressive Hort* **37**: 144-148.

Singh Sanjay and Singh AK (2005) Genetic diversity in *mahua* (*Bassia latifolia*) under semi arid ecosystem of Gujarat. *Indian J Agril Sci* **75**: 519-23.

Thompson TE and Baker JF (1993). Heritability and phenotypic correlation of six pecan nut characteristics. *J American Soc Hort Sci* **118**: 415-418.