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Top : **Lavanya** *et al.*, P. 67
Bottom : **Waman** *et al.*, P. 74

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JOURNAL OF HORTICULTURAL SCIENCES

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Short Communications

In this issue…

The farmers involved in the production of horticultural produce have defied the challenges due to second wave of the ***COVID pandemic****. Especially, the information that India's horticulture production is expected to increase by 2.93 per cent to a record level of 329.86 million tonnes (MT) in 2020-21, according to the second advance estimate of horticulture production released by the Ministry of Agriculture is very much motivating. Though many hurdles are faced by the farmers due to the prevailing* ***Covid Pandemic*** *with respect to timely marketing, storage and other issues, the horticultural production has maintained the steady growth. Wish that in other countries also the horticulture production enhances to provide the nutritional security. Journal of Horticultural Sciences takes pride in sharing the recent research developments in different disciplines of Horticulture.*

Many native vegetable crops have nutraceutical values. One of them is Moringa or commonly called as drumstick. ***Jattan et al.*** *have reviewed the traditional values, requirement for crop cultivation, crop improvement, value addition, nutraceutical and pharmaceutical values with respect to this crop.*

Many under-utilized fruit crops are brought to cultivation again with scientific interventions. One such crop is mountain sweet corn (Flacourtia montana). The fruits have high potential for processing into jam, jelly, wine, etc. and this plant has good medicinal value. ***Tripathi et al.*** *evaluated and characterized the mountain sweet corn accessions from Western Ghats and identified a suitable line with higher yield, regular bearing nature and less thorniness.* ***Ravishankar et al.*** *isolated and characterized the microsatellite markers from the under-utilized tree species Garcinia indica. In their study, 3725 microsatellites were identified and primers were designed for 1374 microsatellites. The SSR developed will be useful in studying genetic diversity, mapping and fingerprinting of Garcinia indica and related species.*

Among the leafy vegetables, Amaranthus ranks first in production. ***Agadi et al.*** *estimated the nature and extent of genetic variability among twenty Amaranthus genotypes. They found that Arka Arunima, Chikmagalur local, IC-551486, IC-551494 and IC-551466 recorded high foliage yield per plot and could be utilized in further breeding programme.****Challam et al.*** *studied the morpho-physiological parameters associated with resistance to iron deficiency induced chlorosis in potato and their effect on yield attributed. They found that genotype CP-3443) was found tolerant to Fe deficiency induced chlorosis.* ***Ayub et al.*** *evaluated responses of different okra (Abelmoschus esculentus) cultivars to water deficit conditions in Pakistan. They concluded that drought caused significant variation on physical and biochemical attributes of okra whereas the cultivar 'Sabz Pari' showed resistance towards the water stress.*

Gamma ray is an effective mutagen which creates useful variability in crops where the natural variation is very meagre and creation of variability by conventional methods is cumbersome. ***Lavanya et al.*** *studied the induced variability in cluster bean due to gamma irradiation and found that the traits like*

plant height, pod length, pod width, pulp to seed ratio showed sufficient variability. ***Sankaran et al. also*** *employed the gamma irradiation to generate variability in pummelo. They found that 60 Gy gamma dose can effectively be used for raising the mutant populations to identify a desirable mutation in pummelo*

Soil microbiome plays important role in crop production. There is need to pay attention on the nutrition management practices. They should encourage the soil microbe population that will indirectly help the plant health. ***Al-Mosour and Kalaivanan*** *have demonstrated that integrated nutrient management can maximize soil microbial community dynamics which is considered as driving force behind regulating soil processes that support sustainable sweet basil cultivation.*

While attempting to evaluate the spectral manipulations on cultivation of cut foliage crops, ***Nair et al.*** *found that coloured shade nets did not influence vase life of the cut foliage in Philodendron and observed that cultivation of Philodendron 'Xanadu' under white shade resulted in maximum cut foliage yield and quality.*

Mango ginger is an underutilized rhizomatous species that has been valued in the tropical Asian countries as a source of vegetable, spice, salad, medicine and essential oil. Huge quantity of seed rhizomes is required to promote this crop in larger area. ***Waman et al.*** *developed an in vitro protocol for the multiplication of mango ginger.*

Jamun seed is a rich source of polyphenolic compounds with antioxidant potential and alpha - glucosidase inhibitory activity. ***Arivalagan et al.*** *have optimized the methodology for the extraction of such polyphenols from jamun seeds. This will be of much in nutraceutical industry. Similarly,* ***González et al.*** *studied the post-harvest quality and quantification of betalains, phenolic compounds and antioxidant activity in fruits of three cultivars of prickly pear in Mexico. They observed that there was high correlation between antioxidant activity and phenolic compounds. The methodologies developed by them will be useful tool for the quantification of bioactive compounds fruit tissues.*

Post-harvest disease management is an important aspect in delivering the harvested produce safely to the end-user. ***Bhandari et al.*** *have recorded that application of essential oils with wax improved shelf life of sweet oranges in Nepal and this treatment enhanced juice retention, firmness, titratable acidity, vitamin C and disease reduction.*

S. Sriram
Editor in Chief

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Original Research Paper

Characterization and evaluation of mountain sweet thorn (*Flacourtia montana* J. Grah) collections

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ABSTRACT

Mountain sweet thorn (*Flacourtia montana* J. Grah) is an indigenous underutilized fruit of Western Ghats and other regions of peninsular India. It is a close relative of Governor's plum. It is bushy shrub or small tree with spiny trunks and branches which may grow up to 2.5 m height. The fruits are bright dark red 1-2 cm in diameter, sweet edible and have potential for processing into jams and jellies. The presence of thorn is one of the major hurdles forcommercialization of this crop. Thus, seeds of the thorny plants of the Mountain sweet thorn were collected from different locations and seedlings were planted to identify suitable line .The plant height ranged from 425 cm (accession 0208) to 710 cm (accession 0202). The plant girth ranged from 34.5 cm to 82 cm. The growth data revealed that all the accessions are vigourous, fast growing and various levels of thorniness. All the accessions were found to be spreading type. Significant variability was recorded for leaf characteristics among the accessions studied. Three major clusters were observed in cluster analysis for morphological and fruiting characterisconsisting of 1, 8 and 9 accessions, respectively. The number of fruits ranged from 0 to 4008. Highest yield (9.46 kg/plant) was obtained in accession - 0106 followed by accession- 0201 (7.83 kg). The average fruit weight ranged from 1.51 g to 3.94 g. Highest fruit weight (3.94g) was also recorded in 0106 followed by 2.84 (0102).The total soluble solids ranged from 10 ^{0} Brix to 15.1 ^{0} Brix. Over all, accession 0201 was found better than others with respect to yield, regular bearing and less thorniness.

Key Words: Mountain sweet thorn, segregation, thornless and yield

INTRODUCTION

There are several underutilized and wild fruits are native to Western Ghats of India (Arora, 1998; Tripathi *et al*, 2015) of which mountain sweet thorn (*Flacourtia montana* J. Grah) one of the important indigenous underutilized fruits of tropical region. It belongs to the family flacourtiaceae. It is a close relative of governor's plum. The plants of several species of *Flacourtia* genus are found growing in wild in Western Ghats and other regions of peninsular India (Barwick, 2004). It is bushy shrub or small tree with spiny trunks and branches which may grow up to 2.5 meter height. Fruiting begins in the month of January to March. It bears dark red coloured fruits which are pleasantly acrid, eaten raw and used also for jelly preparation. The fruits have high potential for processing into jam, jelly, wine, *etc*. (Mundaragi *et al*., 2019). Ripe fruits are often dried and stored. Ripe fruits are delicious to taste and rich in sugars, calcium, magnesium, potassium, sodium, phenolics, flavonoids and ascorbic acid (Mundaragi and Thangadurai, 2015). It has also been reported that the fruits leaves and bark of this species have various pharmacological activities like antibacterial, antidiabetic, anti-inflammatory and hepatoprotective *etc*. (Joshy *et al*., 2016). The presence of thorn is one of the major hurdles in commercialization of this crop. Thus, some accessions of Mountain sweet thorn which are less thorn were selected and evaluated for various characteristics during 2016-19.

MATERIAL AND METHODS

The *Flacourtia montana* J. Grah accessions were collected from Kerala during 2008-09 through extensive surveys from Palode. The seedlings

were directly planted in the field at a distance of 5x5m at ICAR-IIHR, Bangalore which is located at 13.133999 ° N latitude and 77.47880 ° E at 855m above sea level. It has sub humid tropical climate with annual rainfall of 86cm. The soil is red. The plants started fruiting in third year and yieldgot stabilized after five harvesting seasons. Eighteen accessions were evaluated for two years for vegetative growth, flowering, fruiting and fruit characteristics. Twenty-five mature fruits were harvested randomly from each accession to record the physico-chemical parameters. The fruits were washed with distilled water and the surface water was removed using blotting paper. The cleaned air-dried samples were used. The fruit weight, fruit length, fruit diameter was recorded using electric balance and digital vernier caliper. The fruit shape and fruit colours were recorded as per the standard fruit shape (Gupta, 1972 and Berg, 2007) and colour charts (RHS colour chart,1966). The fruits were cut and pulp colour was recorded. The total soluble solids (TSS) were determined with Erma hand refractometer (0-32^{o}Brix) and titratable acidity (%) was estimated using procedures described by Ranganna (1986).

Data analysis

The data was analysed using R software(R-4.0.3). The distance matrix required for hierarchical clustering was computed using the 'dist' function which is based on Euclidean distances between the accessions. The hierarchical clustering of the accessions was done using 'hclust' function based on complete linkage method. Principal Component Analysis (PCA) was done using the 'pca' function. (Team, 2019).

RESULTS AND DISCUSSION

Morphological characterization

Growth characteristics

Morphological characterization of 18 accessions of mountain sweet thorn was done as per the standard descriptors. The plant height ranged from 425 cm to 710 cm with highest in accession0202. The plant girth ranged from 34.5 cm to 82 cm. The plant spread (E-W) ranged from315 cm to 625 cm where as N-S ranged from 315 cm to 625 cm. The growth data revealed that all the accessions were vigourous, fast growing and spreading type. The foliage was dense and leaves were dark green. The new leaf colour was coppery red in all accessions (Table 1). Leaf length ranged from 8.53 cm to 15.9 cm.The leaf width ranged from 4.23 cm to 6.89 cm. The petiole length ranged from 0.33 to 0.59 cm in different accessions. The leaf blade was pinned and all the accessions have petiolate leaves. The leaf margin was serrated while leaf apex was acute or acuminate type. The leafbase was elliptical in most of the collections but it was ovate in accessions- 0103,0106,0202,0306. The leaf base was acuminate or rounded (Table 2). These all accessions are fast growing but different levels of thorniness. Some collections werehighly thorny while some have moderate thorny.The number of thorns per 1m stem trunk were highest (63) in accession-0105 followed by 47 thorns in accessions-207 and 0208. The accessions-0103,0104, 0201 were found thornless. All the accessions started flowering in December and continued for almost one month. There was only 1-2 weeks difference in the flowering period of different accessions. The flowering time varied in both years which may be due to weather conditions (Table 3).

Cluster analysis

Clustering of the 18 accessions was done based on the morphological data. As the dataset consisted of mixed data types viz. numeric and attribute, the distance between the accessions was computed using Gower's distance measure. Hierarchical clustering of the accessions based on the complete agglomeration method was done for the above distance matrix and a dendogram was generated (Fig 1). Three major clusters were observed consisting of 1, 8 and 9 accessions, respectively. The first cluster consisted of the one accession i.e. O102. Cluster 2 consisted of 7 female plants and one male plant (O206) while cluster 3 consisted of 6 male plants and two female plants. The minimum distance was found between the accessions O201 and O205 (cluster III) while the maximum distance was observed between O102 (cluster I) and O103 (cluster III) (Fig 1).

Principal Component Analysis

The principal component analysis was done based on the numeric characters of morphological and leaf data. 68.7% of the total variance was explained by the first two components (39% by 1st component and 29.7% by 2nd component) (Fig 2 & Table 4).

Table 1 : Morphological characterization of *Flacourtia montana* accessions

Accession No.	Plant height (cm)	Plant girth (cm)	Plant spread (E-W) cm	Plants spread (N-S) cm	Habit	Growth pattern	New Leaf colour	Foliage density	Leaf Colour
O102	705	82	577.5	487.5	Small Tree	Spreading	Coppery red	Dense	Light Green
O103	615	49.5	502.5	450	Small Tree	Spreading	Coppery red	Dense	Light Green
O104	655	53	490	492.5	Small Tree	Spreading	Coppery red	Dense	Light Green
O105	633.5	71.5	442.5	570	Small Tree	Spreading	Coppery red	Dense	Light Green
O106	660	59.5	625	602.5	Small Tree	Spreading	Coppery red	Dense	Light Green
O201	592.5	45	535	495	Small Tree	Spreading	Coppery red	Dense	Light Green
O202	710	53.5	447.5	471	Small Tree	Spreading	Coppery red	Dense	Light Green
O203	560	62	470	485	Small Tree	Spreading	Coppery red	Dense	Light Green
O204	585	53.5	510	560	Small Tree	Spreading	Coppery red	Dense	Light Green
O205	600	54	450	480	Small Tree	Spreading	Coppery red	Dense	Light Green
O206	580	77.5	497.5	492.5	Small Tree	Spreading	Coppery red	Dense	Light Green
O208	425	34.5	315	320	Small Tree	Spreading	Coppery red	Dense	Light Green
O302	595	42	550	535	Small Tree	Spreading	Coppery red	Dense	Light Green
O303	655	47	385	505	Small Tree	Spreading	Coppery red	Dense	Light Green
O304	655	53.5	432.5	500	Small Tree	Spreading	Coppery red	Dense	Light Green
O305	622.5	56	440	482.5	Small Tree	Spreading	Coppery red	Dense	Light Green
O306	590	40	387.5	525	Small Tree	Spreading	Coppery red	Dense	Light Green
O307	655	71.5	557.5	505	Small Tree	Spreading	Coppery red	Dense	Light Green
Average	616.31	55.86	478.61	497.69	-	-	-	-	-
Min	425	34.5	315	320	-	-	-	-	-
Max	710	82	625	602.5	-	-	-	-	-
SD	63.67	12.96	76.07	58.30	-	-	-	-	-

Table 2 : Leaf characteristics of *Flacourtia montana* accessions

Accession No.	Leaf length (cm)	Leaf width (cm)	Petiole length (cm)	Leave type	Leaf Blade	Venation	Leaf Margin	Leaf Apex	Leaf Shape	Leaf Base
O102	8.53	4.23	0.33	Petiolate	Pinned	Pinnate	Serrate	Acuminate	Elliptical	Acuminate
O103	14.8	5.43	0.38	Petiolate	Pinned	Arcuate	Serrate	Acute	Ovate	Rounded
O104	13.04	5.4	0.34	Petiolate	Pinned	Arcuate	Serrate	Acute	Elliptical	Acuminate
O105	14.8	5.27	0.33	Petiolate	Pinned	Arcuate	Serrate	Acuminate	Elliptical	Acuminate
O106	13.85	6.09	0.39	Petiolate	Pinned	Arcuate	Serrate	Acuminate	Ovate	Rounded
O201	11.98	5.57	0.33	Petiolate	Pinned	Arcuate	Serrate	Acuminate	Elliptical	Acuminate
O202	10.65	4.79	0.37	Petiolate	Pinned	Arcuate	Serrate	Acuminate	Ovate	Rounded
O203	13.5	6.12	0.44	Petiolate	Pinned	Pinnate	Serrate	Acute	Elliptical	Acuminate
O204	12.63	5.56	0.41	Petiolate	Pinned	Arcuate	Serrate	Acuminate	Elliptical	Acuminate
O205	12.17	5.46	0.33	Petiolate	Pinned	Arcuate	Serrate	Acuminate	Elliptical	Acuminate
O206	13.7	6.89	0.48	Petiolate	Pinned	Arcuate	Serrate	Acute	Elliptical	Rounded
O208	11.52	5.23	0.45	Petiolate	Pinned	Arcuate	Serrate	Acute	Elliptical	Rounded
O302	13.93	5.68	0.44	Petiolate	Pinned	Arcuate	Serrate	Acuminate	Elliptical	Acuminate
O303	14.6	6.18	0.55	Petiolate	Pinned	Pinnate	Serrate	Acute	Elliptical	Rounded
O304	12.24	6.23	0.53	Petiolate	Pinned	Arcuate	Serrate	Acute	Ovate	Acuminate
O305	12.09	5.20	0.59	Petiolate	Pinned	Arcuate	Serrate	Acute	Elliptical	Acuminate
O306	15.9	6.48	0.575	Petiolate	Pinned	Arcuate	Serrate	Acuminate	Elliptical	Acuminate
O307	13.58	5.76	0.475	Petiolate	Pinned	Arcuate	Serrate	Acute	Elliptical	Acuminate
Average	12.97	5.64	0.43	-	-	-	-	-	-	-
Min	8.53	4.23	0.33	-	-	-	-	-	-	-
Max	15.90	6.89	0.59	-	-	-	-	-	-	-
SD	1.73	0.63	0.09	-	-	-	-	-	-	-

Table 3: Flowering characteristics of *Flacourtia montana* accessions

Accession No.	Date of start of flowering		Date of end of flowering		Date of start of fruit maturity		Date of full fruit maturity	
	2017-18	2018-19	2017-18	2018-19	2017-18	2018-19	2017-18	2018-19
O102	Dec 21,2017	Dec 14,2018	Jan 20, 2018	Jan 21, 2019	Feb 14, 2018	Feb 14, 2019	March 26,2018	March 26,2019
O103	Dec 21,2017	Dec 14,2018	Jan 24, 2018	Jan 22, 2019	-	-	-	-
O104	Dec 18,2017	Dec 10,2018	Jan 24, 2018	Jan 21, 2019	Feb 14, 2018	Feb 14, 2019	March 26,2018	March 26,2019
O105	Dec 21,2017	Dec 14,2018	Jan 24, 2018	Jan 22, 2019	-	-		-
O106	Dec 15,2017	Dec 15,2018	Jan 18, 2018	Jan 21, 2019	Feb 14, 2018	Feb 14, 2019	March 26,2018	March 26,2019
O201	Dec 21,2017	Dec 14,2018	Jan 20, 2018	Jan 21, 2019	Feb 14, 2018	Feb 14, 2019	March 26,2018	March 26,2019
O202	Dec 21,2017	Dec 14,2018	Jan 24, 2018	Jan 22, 2019	-	-	-	-
O203	Dec 21,2017	Dec 15,2018	Jan 24, 2018	Jan 21, 2019	Feb 14, 2018	-	March 26,2018	-
O204	Dec 18,2017	Dec 142018	Jan 20, 2018	Jan 21, 2019	Feb 14, 2018	-	March 26,2018	-
O205	Dec 18,2017	Dec 142018	Jan 20, 2018	Jan 21, 2019	-	-	-	-
O206	Dec 18,2017	Dec 142018	Jan 20, 2018	Jan 21, 2019	-	-	-	-
O208	Dec 18,2017	Dec 24,2018	Jan 24, 2018	Jan 21, 2019	-	Feb 14, 2019	-	March 26,2019
O302	Dec 18,2017	Dec 14,2018	Jan 24, 2018	Jan 22, 2019	-	-	-	-
O303	Dec 15,2017	Dec 24,2018	Jan 20, 2018	Jan 21, 2019	Feb 14, 2018	Feb 14, 2019	March 26,2018	March 26,2019
O304	Dec 21,2017	Dec 24,2018	Jan 20, 2018	Jan 22, 2019	Feb 14, 2018	-	March 26,2018	-
O305	Dec 18,2017	Dec 24,2018	Jan 20, 2018	Jan 22, 2019	Feb 14, 2018	-	March 26,2018	-
O306	Dec 18,2017	Dec 24,2018	Jan 20, 2018	Jan 22, 2019	-	-	-	-
O307	Dec 21,2017	Dec 24,2018	Jan 20, 2018	Jan 22, 2019	Feb 4, 2018	-	March 26,2018	-

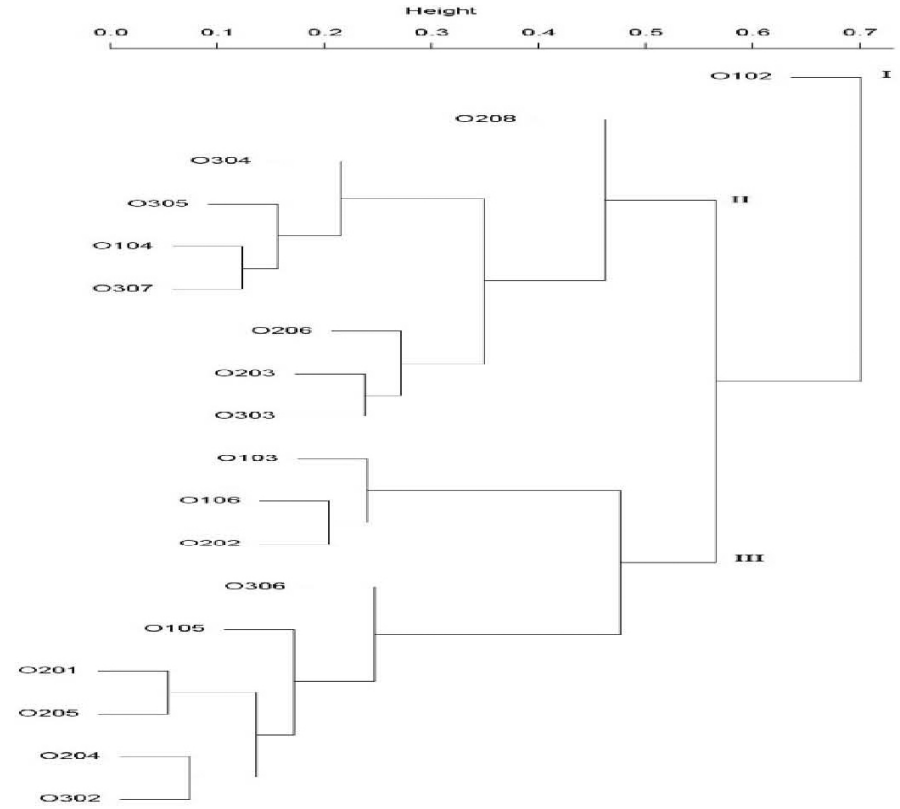

Fig. 1: Clustering of *Flacourtia* accessions Collections for morphological and leaf characters

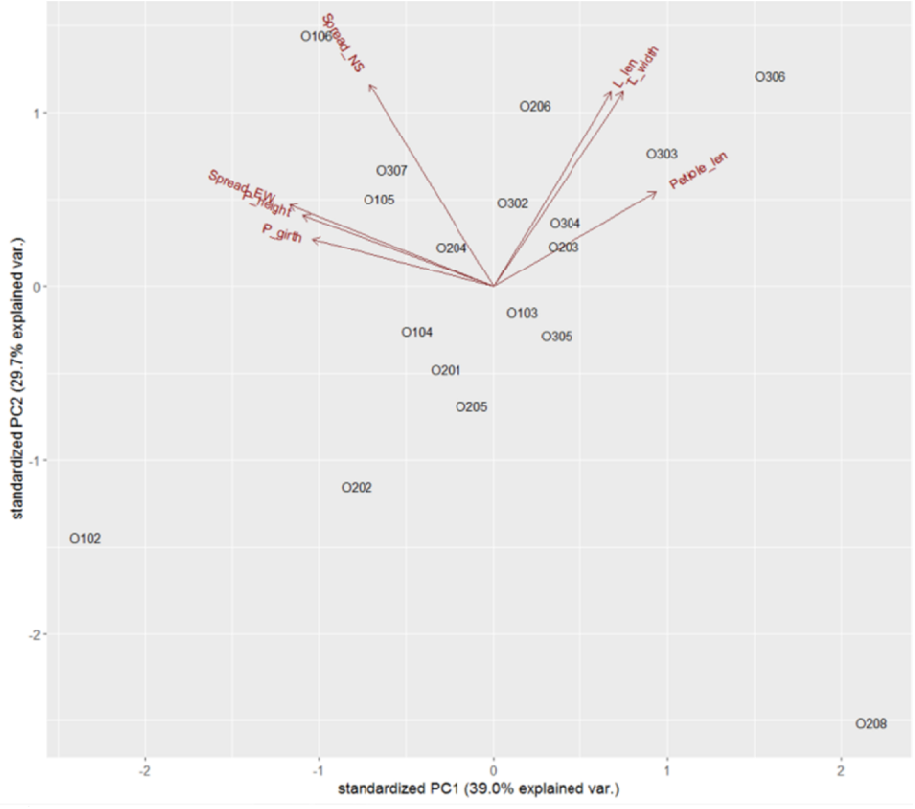

Fig. 2: Principal component analysis for morphological and leaf characters

Table 4: Fruit traits of *Flacourtia montana* collections

Accession No.	Pulp weight (g)	No.of Seed/ fruit	Seed wt. (g)/ Fruit	TSS (^{O}Brix)	Acidity (%)
O102	2.14	9.0	0.67	15.0	0.22
O104	2.62	11.0	0.66	15.0	0.51
O106	3.26	9.0	0.68	10.5	0.53
O201	1.50	10.0	0.74	15.0	0.25
O203	1.25	10.0	0.66	15.1	0.53
O204	1.32	10.0	0.67	15.0	0.47
O208	1.01	9.0	0.64	10.5	0.34
O303	2.13	10.0	0.70	15.1	0.43
O304	2.20	8.0	0.61	15.0	0.43
O305	0.85	8.0	0.63	15.1	0.39
O307	0.97	9.0	0.65	15.2	0.41
Average	1.75	9.36	0.67	14.23	0.41
Min	0.85	8.00	0.61	10.50	0.22
Max	3.26	11.00	0.74	15.20	0.53
SD	0.84	1.00	0.04	1.93	0.13

Characterisation for fruit traits and evaluation for yield

The fruit started maturing in the month of February and peak fruiting was in March. The number of fruits/tree ranged from 0 to 4008. There were no fruits in accessions 0103, 0105, 0202, 0205, 0206, 302 and 0306. It seems these were male plants. The accessions 0102, 0104, 0106, 0201, 0203, 0204, 0208, 0303, 0304, 0305 and 0307 produced fruits either in one year or both the year (Table 5). As it is well known that *Flacourtia* montana have unisexual flowers, Some trees produces only male flower while others produce only female flowers. (*http://www.flowersofindia.net)*. Among the remaining plants highest yield (9.46 kg) was obtained in accession- 0106. Higher yield was also obtained in accession- 0201 (7.83 kg).Average fruit yield ranged from 0 to 9.46 kg per plant. Most of the accessions are mid-season maturing and except accession 0307 which was early maturing. The fruits of all the accessions were spherical (Table 5). The productivity was low in most of the accessions. The low productivity may be associated with lack of pollination. The average fruit weight ranged from 1.51 g to 3.94 g. Highest fruit weight (3.94g) wasalso recorded in 0106 followed by 2.84 (0102).The fruit equatorial diameter ranged from 0.825cm to1.036 cm while fruit polar diameter ranged from 1.014cm to -1.062 cm. The fruit colour was dark red (Red 46b) .Fruit pulp was smooth and fibre content was low.There was no flavour.The average pulp weight ranged from 0.85 g to 3.26 g. Number of seeds/fruit ranged from 8 to 11. The highest numbers of seeds per fruit were found in accessions-0104 (11) while it was lowest in accessions-304,305(8). The total soluble solids ranged from 10 ^{0}Brix to 15.1 ^{0}Brix. Higher total soluble solids (>15 ^{0}Brix) were

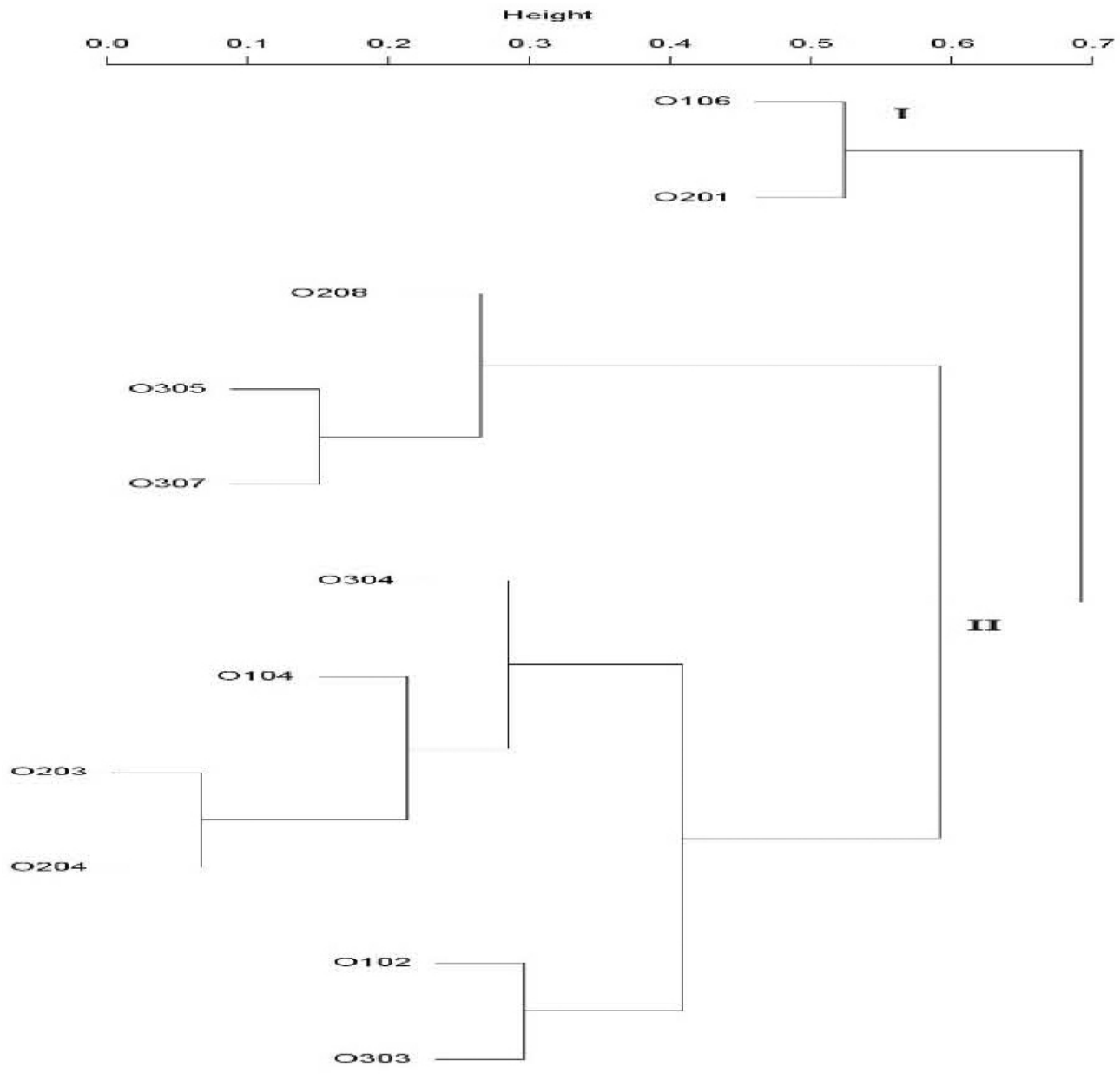

Fig. 3: Cluster analysis for fruit characters of *Flacouria montana* accassions

recorded in most of the accessions. The titrable acidity was ranged from 0.22 % to 0.53 %., it was height in accession- 0203 (Table 6).

Cluster analysis

Clustering of the 11 accessions was done based on the yield and yield contributing characteristics the dataset consisted of mixed data types viz. numeric and attribute, the distance between the accessions was computed using Gower's distance measure. Hierarchical clustering of the accessions based on the complete agglomeration method was done for the above distance matrix and a dendogram was generated (Fig 3). Minimum distance was observed between O305 and O204 while maximum distance was found between O104 and O102. Principal Component Analysis

The analysis of PCA for yield showed that 64.5% of the total variation was explained by the first two principal components (40% by PC1 and 24.5% by PC2) (Fig.4).

Table 5: Fruit yield and related traits in *Flacourtia montana* accessions

Accession No.	Branch thorniness	No. of thorns up to 1 m stem height	Type of plants	Immature fruit drop	Average No. of fruits/tree	Average Yield (kg /tree)	Maturity group	Fruit shape	Productivity status
O102	Less thorny	15.0	Female	High	1942	5.51	Mid	Spherical	Low
O103	Thornless	0.0	Male	-	0	0	-	-	Nil
O104	Thornless	0.0	Female	Low	441.5	1.43	Mid	Spherical	Low
O105	Highly thorny	63.0	Male	-	0	0	-	-	Nil
O106	Less thorny	3.0	Female	High	2400	9.46	Mid	Spherical	High
O201	Thornless	0.0	Female	High	4008.5	7.83	Mid	Spherical	High
O202	Less thorny	6.0	Male	-	0	0.00	-	-	Nil
O203	Moderate thorny	21.0	Female	Low	44.5	0.17	Mid	Spherical	Low
O204	Moderate thorny	31.0	Female	Low	14	0.02	Mid	Spherical	Low
O205	Moderate thorny	45.0	Male	-	0	0	-	-	Nil
O206	Moderate thorny	32.0	Male	-	0	0	-	-	Nil
O208	Moderate thorny	47.0	Female	Low	275	0.45	Mid	Spherical	
O302	Less thorny	18.0	Male	-	0	0	-	-	Nil
O303	Highly thorny	67.0	Female	High	1025	2.91	Mid	Spherical	Low
O304	Less thorny	6.0	Female	Low	175	0.98	Mid	Spherical	Low
O305	Moderate thorny	36.0	Female	Low	22.5	0.07	Mid	Spherical	Low
O306	Moderate thorny	33.0	Male	-	0	0.00	-	-	Nil
O307	Moderate thorny	47.0	Female	Low	69.5	0.23	Early	Spherical	Low
Average	-	26.11		-	578.19	1.61	-	-	-
Min	-	0.00		-	0.00	0.00	-	-	-
Max	-	67.00		-	4008.50	9.46	-	-	-
SD	-	21.79		-	1109.88	2.93	-	-	-

Table 6: Fruit traits of *Flacourtia montana* accessions

Accession No.	Fruit length (cm)	Fruit width (cm)	Fruit wt (g)	Fruit colour	Pulp colour	Pulp fibre content	Pulp taste	Pulp flavour
O102	1.019	1.048	2.84	Dark red	Dark red	Low	Sweet	No
O104	1.034	1.062	3.24	Dark red	Dark red	Low	Acid sweet	No
O106	1.036	1.055	3.94	Dark red	Dark red	Low	Acid sweet	No
O201	0.89	1.014	2.26	Dark red	Dark red	Low	medium sweet	No
O203	1.034	1.049	1.94	Dark red	Dark red	Low	Acid sweet	No
O204	0.942	1.055	2.0	Dark red	Dark red	Low	Acid sweet	No
O208	0.89	1.014	1.64	Dark red	Dark red	Low	Acid sweet	-
O303	1.037	1.054	2.84	Dark red	Dark red	Low	Acid sweet	No
O304	0.891	1.025	2.81	Dark red	Dark red	Low	Acid sweet	No
O305	0.936	1.025	1.51	Dark red	Dark red	Low	Acid sweet	No
O307	0.825	1.027	1.62	Dark red	Dark red	Low	Acid sweet	No
Average	0.96	1.04	2.42	-	-	-	-	-
Min	0.83	1.01	1.51	-	-	-	-	-
Max	1.04	1.06	3.94	-	-	-	-	-
SD	0.08	0.02	0.84	-	-	-	-	-

Correlation analysis between growth and yield characters

There was no significant correlation of growth characters with yield and plant height. The plant spread was positively corelated with yield and fruit weight. The petiole length was found positively correlated with thorniness (Table 7). The characterization and evaluation of mountain sweet thorn accessions revealed that most of them are thorny and about 45 percent are male.

Table 7: Correlation analysis between growth and yield characters

	No of thorns	No. of Fruits/tree	Yield	Fruit length	Fruit width	Fruit weight
Plant height	-0.27	0.20	0.33	0.30	0.46	0.55
Plant girth	-0.17	-0.01	0.11	0.17	0.33	0.13
Plant spread (E-W)	-0.54	0.48	0.59	0.15	0.34	0.43
Plants spread (N-S)	-0.34	0.24	0.41	0.33	0.57	0.53
Leaf length	0.27	-0.21	-0.12	0.10	0.26	0.11
Leaf width	0.07	-0.13	-0.06	0.00	0.09	0.17
Petiole length	0.63	-0.57	-0.53	-0.23	-0.26	-0.38

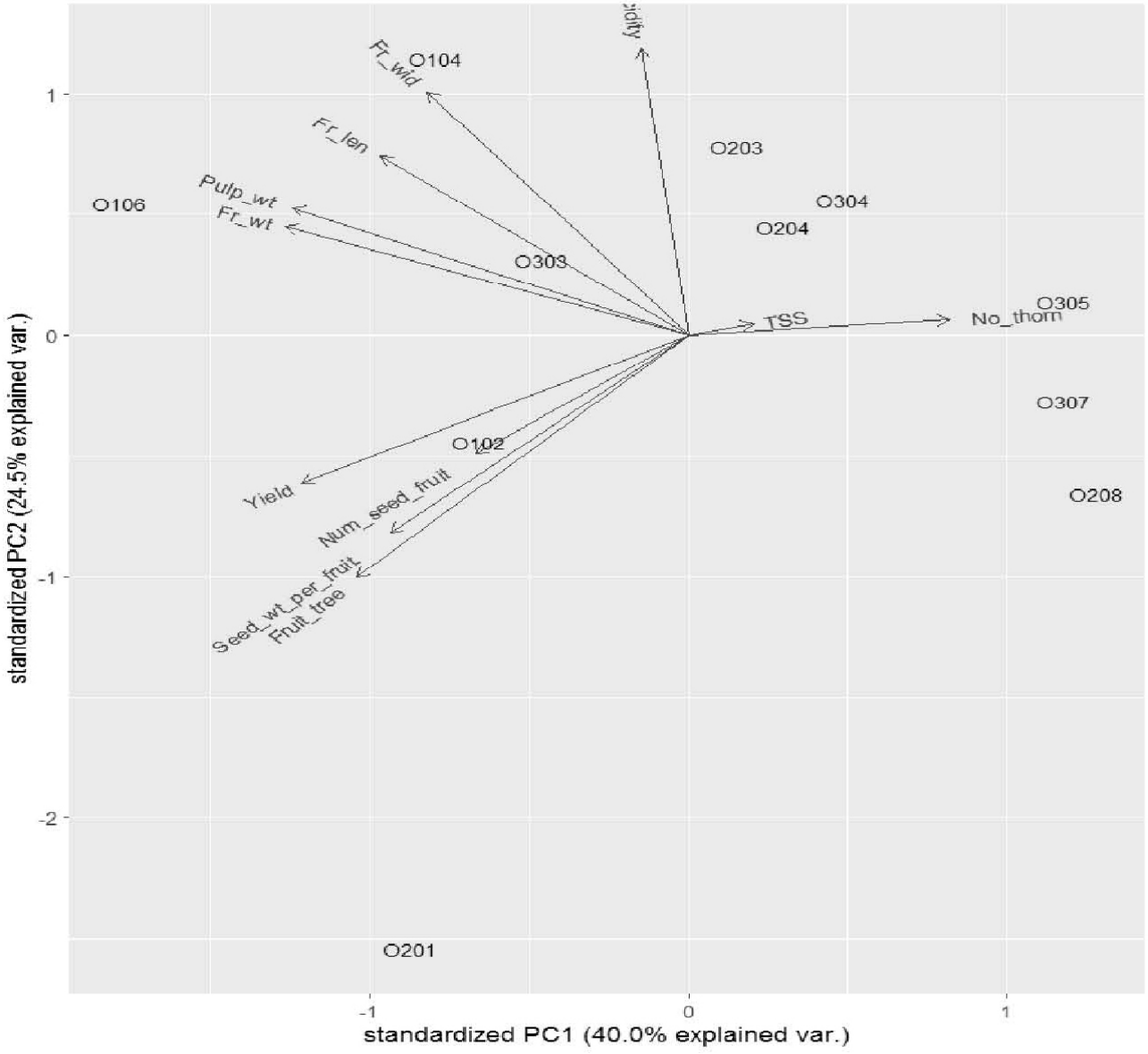

Fig. 4: Principal component analysis for fruit characters

All the accessions were dioecious as either they produce either only male flower or only female flowers. The fruits are bright and bearing habit is sparse to heavy. The fruits are dark red with weight ranging from 1 to 3 g. On the basis of the evaluation one collection (accession- 0201) was found thornless, heavy and regular bearer and average fruits weight (2.26 g).This high yielding, thornless accession is recommended for cultivation.

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