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Studies on flower morphology of Pummelos (*Citrus grandis* L.) of Assam

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Abstract
Flower morphology of pummelo accessions of Assam was studied at the Assam Agricultural University during 2015-16. The study revealed that all the selected pummelo plants produced white colour hermaphrodite flowers consisting of both stamens and pistil. Arrangement of flowers were observed to be both solitary and in clusters with leafy and leafless inflorescence. The study revealed that there was difference in the time of flowering among the accessions. Fourteen numbers of accessions started flowering by 3rd week of February. While six accessions showed delay in flowering by one week i.e. 4th week February. Four number of accessions from Cachar district flowered late by 1st week of March. Variation in number of petals per flower was found to be statistically significant among pummelo accessions. Pummelo plants with 4 petals per flower and 5 petals per flower were recorded. Some of the accessions consisted of flowers with both 4 and 5 petals on same plant. However, no significant differences were recorded in flower buds per inflorescence, pedicle length, petal length, petal width and stamens per flower among the pummelo accessions.

Keywords: Pummelo, flower morphology, longistylous, brevistylou, pentamerous

Introduction
Pummelo or shaddock (*Citrus grandis* L.) has been regarded as one of the ancestral species amongst *citrus* (Shaaban, 2006) [1]. The fruit is mostly consumed as a fresh fruit in the region and also used as offering during various religious festivals. It is grown in the homestead garden as backyard crop in entire northeastern region and India as a whole. Pummelos reproduces sexually and is largely self incompatible and unlike other citrus species, it does not produce nucellar seedlings. It is one of the major monoembryonic species of citrus which grows easily in poor and inferior soil and are considered as an excellent tree for waste land development in arid and semi-arid region. Hybridization can usually occur between pummelos and other species of the genus and tends to exhibit a very wide range of variability in comparison with a number of other major economic species of Citrus (Paudyal and Haq, 2008) [2]. Being a cross pollinated crop, there is a tremendous amount of variability within the species with which the breeder can work and provides a wider selection of characters (Soost and Roose, 1996) [3]. So far, there are no well defined varieties of pummelo to be regarded as commercial type in the entire northeastern region. The pre-requisites of effective hybridization programme includes knowledge on floral morphology, biology, anthesis, dehiscence, pollen viability, stigma receptivity etc. (Ahmad, 1996) [4]. Keeping these in view the study was carried out in order to determine the variation in floral morphology among the Pummelos ecotypes of Assam.

Materials and method

The experiment was conducted in six districts representing different agro-climatic zones of Assam. Four healthy pummelo trees between 10 to 20 years of age were selected in each district comprising of twenty four (24) numbers of trees in six districts and were given a number for future identification. Two to three branches with flowers were tagged during flowering (Feb.-March). Data on morphological parameters of flowers were recorded based on Citrus descriptor.

Fisher's method of analysis of variance (ANOVA) was employed for statistical analysis of the quantitative data. Significance of variance among data was calculated out by calculating the value of 'F' at 5 per cent probability level (Panse and Sukhatme, 1985) [5]. The polymorphic qualitative characters i.e. flower type, arrangement of flowers, inflorescence position, inflorescence type, anther length, anther colour, flower colour were scored and expressed in frequency percentage.

Results and discussion

The observations on flower qualitative characters (Fig.1and Fig.2) showed that there was no variation in flower type, arrangement of flowers and flower colour among different pummelo accessions. All the selected pummelo plants produced white colour hermaphrodite flowers consisting of both stamens and pistil. Arrangement of flowers were recorded to be both solitary and in clusters with leafy and leafless inflorescence. Similar findings were reported by Orwa *et al.* (2009) [6] and Hoque (2015) [7]. Inflorescence type, position and anther colour showed no variation among pummelo accessions. In all accessions, raceme type of inflorescence was recorded on axillary and terminal position. Anther colour of all the pummelo accessions was yellow. Similar observations on flower characters were recorded by Hoque (2015) [7] in three pummelo accessions of Bangladesh and Phadung *et al.* (2011) [8] in pummelo cultivar 'Khao Nam Phueng' in Thailand.

Variability in terms of length of anther relative to stigma (Table 1 and Fig. 4) was recorded among different pummelo accessions. Among twenty four pummelo accessions, eighteen accessions (75.0%) had flowers with anther length shorter then stigma. Three accessions (12.5%) had longistylous and brevistylous flowers having both shorter and longer anther length than stigma. Medium (equal) length of anther and stigma was recorded in three accessions (12.5%). The present study is in conformity with the report of Hoque (2015) [7] who recorded flowers with shorter anther length relative to stigma in two pummelo accessions i.e. CG-1, CG-18 and flowers with both equal and longer anther length than stigma in CG-151.

Observations on time of flowering showed that there was difference in the time of flowering among the accessions. Fourteen numbers of accessions started flowering by 3rd week of February. While, six accessions showed delay in flowering by one week and flower opening started by 4th week February. Four number of accessions i.e. all from Cachar district flowered late by 1st week of March. Two accessions *viz.*, AP03T3 and AP04T1 recorded flowering twice a year (September) and (February) with main flowering in the month of February. The fruits of both the accessions could be harvested early from June onwards. In general, the flowering period was recorded to be from 3rd week of February to 2nd week of April. Similar findings were reported by Hoque (2015) [7] and Bhattacharyya and Dutta (1956) [2]. The variation in flowering time among accessions might be due to genetic, physiological status of the plant and environmental factors.

Data pertaining to flower buds per inflorescence revealed that there was no significant difference in flower buds per inflorescence among accessions. The mean number of flower buds per inflorescence was recorded to be 5.40. The study is in agreement with the report of Orwa *et al.* (2009) [6] who recorded 2 to 10 flowers per cluster in a pummelo plant. Variation in number of petals per flower (Fig.) was found to be statistically significant among pummelo accessions. Pummelo plants with 4 petals per flower and 5 petals per flower and combination of 4 and 5 petals per flower were observed during the study. The highest number of petals per flower was recorded to be 5.0 in accession number AP01T1 followed by AP01T2, AP02T2, AP04T1, and AP06T1 (4.6), respectively. The lowest petal number of 4.0 was recorded in seventeen accessions. The mean number of petals per flower was recorded to be 4.15. The study is in conformity with Hoque (2015) [7] who reported that, pummelo flowers are tetramerous (4 petals) and pentamerous (5 petals) and the variation in number of petals per flower among the accessions might be attributed to genetic differences.

The perusal of data presented in the Table 1 revealed that, there was no significant variation in pedicel length among pummelo accessions. However, the highest pedicle length of 1.62 cm was recorded in accession number AP05T1 and the lowest was recorded in AP03T2 (0.98 cm). The mean pedicel length of pummelo flower was recorded to be 1.41 cm. No significant variation in petal length was recorded among the accessions. However, the highest petal length was recorded in accession number AP06T4 (2.56 cm) and the lowest was recorded in accession number AP02T1 (2.28 cm). The average petal length was recorded to be 2.42 cm. The result of the study is in accordance with the report of Hoque (2015) [7] who recorded non-significant variation in petal length among three pummelo accessions of Bangladesh.

Petal width showed no significant variation among accessions. However, the highest petal width was recorded to be 1.16 cm and the lowest 0.72 cm with a mean value of 0.94 cm. Stamens per flower also showed no significant variation among pummelo accessions collected from different locations of Assam. The highest stamens per flower was recorded in accession number AP04T1 (37.00) and the lowest was recorded in AP06T1 (31.20) with a mean of 33.11. The present finding is in conformity with the report of Hoque (2015) [7] who recorded a mean stamen number of 30.90 per flower and found no significant variation among three pummelo genotypes of Bangladesh.

Fig 1: Terminal flowering in cluster

Fig 2: Axillary flowering - solitary and clusters

Fig 3: Pummelo flowers with different petal number

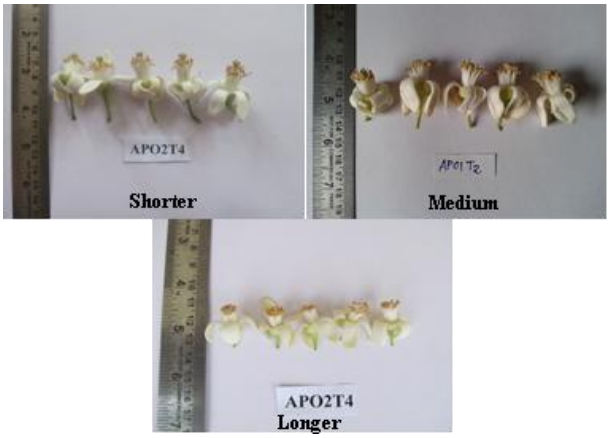

Fig 4: Length of another relative to stigma

Table 1: Flower characters of pummelo accessions of Assam

Plant No.	Accession No.	Flowering time	Anther length relative to stigma	Flower buds/ inflorescence	Pedicel length (cm)	Petal / flower	Petal length (cm)	Petal width (cm)	Stamen / flower
1	AP01T1	3rd week of February	Shorter	5.80	1.48	5.00	2.42	1.00	35.00
2	AP01T2	3rd week of February	Shorter	5.40	1.60	4.60	2.36	0.72	32.80
3	AP01T3	3rd week of February	Shorter	5.60	1.46	4.20	2.44	0.90	33.80
4	AP01T4	4th week of February	Shorter	5.40	1.50	4.00	2.40	0.94	34.00
5	AP02T1	3rd week of February	Medium	4.60	1.38	4.00	2.28	1.04	32.00
6	AP02T2	4th week of February	Medium	4.40	1.44	4.40	2.50	0.76	32.40
7	AP02T3	3rd week of February	Shorter	6.00	1.36	4.00	2.36	1.16	32.00
8	AP02T4	3rd week of February	Shorter and longer	5.20	1.38	4.20	2.38	0.90	32.80
9	AP03T1	3rd week of February	Shorter	4.20	1.40	4.00	2.42	0.98	34.00
10	AP03T2	3rd week of February	Shorter	4.80	0.98	4.00	2.50	0.86	31.60
11	AP03T3	February, September	Shorter	5.00	1.50	4.00	2.46	0.98	32.00
12	AP03T4	3rd week of February	Shorter	5.00	1.42	4.00	2.38	1.12	33.40
13	AP04T1	3rd week of February	Shorter	5.40	1.58	4.60	2.40	0.94	37.00
14	AP04T2	3rd week of February	Shorter	7.00	1.40	4.00	2.39	1.04	35.60
15	AP04T3	3rd week of February	Shorter	7.40	1.56	4.00	2.30	0.86	31.80
16	AP04T4	4th week of February	Medium	4.80	1.40	4.00	2.46	1.02	31.60
17	AP05T1	3rd week of February	Shorter and longer	5.20	1.62	4.00	2.42	0.98	35.00
18	AP05T2	4th week of February	Shorter	5.80	1.42	4.00	2.50	0.92	32.20
19	AP05T3	3rd week of February	Shorter	4.00	1.54	4.00	2.52	1.04	34.80
20	AP05T4	3rd week of February	Shorter and longer	5.40	1.48	4.00	2.34	0.90	33.20
21	AP06T1	3rd week of February	Shorter	6.80	1.34	4.60	2.48	0.72	31.20
22	AP06T2	3rd week of February	Shorter	5.80	1.54	4.00	2.44	0.82	31.60
23	AP06T3	February, September	Shorter	4.60	1.03	4.00	2.54	1.00	32.20
24	AP06T4	3rd week of February	Shorter	6.20	1.18	4.00	2.56	0.96	32.80
Mean				5.40	1.41	4.15	2.42	0.94	33.11
SEd (±)				1.60	0.18	0.16	0.11	0.12	2.74
CD(0.05)				NS	NS	0.32	NS	NS	NS

Conclusion

The study on flower characters revealed that flowers of all pummelo accessions were white in colour with yellowish anther colour borne singly or in clusters of leafy and leafless inflorescence. Sex form in all flowers was recorded to be hermaphrodite and three accessions recorded heterostylous flower. Two accessions i.e. AP04T1 and AP03T3 recorded flowering twice a year (Sept-Oct and Feb- March) and could be harvested early from June onwards. Pummelo flowers may tetramerous (4 petals) and pentamerous (5 petals) however no significant differences were recorded in flower buds per inflorescence, pedicle length, petal length, petal width and stamens per flower among the pummelo accessions.

References

1. Shaaban EA, Abd-EL-Aal SKH, Zaied NS, Rizkalla AA. Assessment of genetic variability on some orange accessions using RAPD-DNA markers. Res. J Agri. Biol. Sci. 2006; 2:564-570.
2. Paudyal KP, Haq N. Variation of pomelo [*Citrus grandis* (L.) Osbeck] in Nepal and participatory selection of strains for further improvement. Agro forest Syst. 2008; 72:195-204.
3. Soost RK, Roose MK. Citrus. In: Fruit Breeding, Tree and Tropical Fruits (Janick, J. and Moore, J. N., eds.), Pub. John Wiley & Sons, Inc. New York, 1996; 1:257-324.
4. Ahmad MR. Study on floral biology of guava. An Unpublished MS Thesis. Department of Horticulture. Institute of Postgraduate Studies in Agriculture, Salna, Gazipur, 1996.
5. Panse VS, Sukhatme PV. Statistical methods for agricultural workers, 4th Edn. ICAR, New Delhi, 1985.
6. Orwa C, Mutua A, Kindt R, Jamnadas R, Anthony S. Agroforestry Database: A tree reference and selection guide, 2009, 4. http://www.worldagroforestry.org/sites/treedbs/treedatabases.asp.
7. Hoque MA. Floral biology of indigenous pummelo genotypes. Bangladesh J. Agril. Res. 2015; 40:177-188.
8. Phadung T, Krisanapook K, Phavaphutanon L. Paclobutrazol, water Stress and nitrogen induced flowering in 'Khao Nam Phueng' pummelo. Kasetsart J (Nat. Sci.). 2011; 45:189-200.
9. Bhattacharya SC, Dutta S. Classification of citrus fruits of Assam. Sci. Monograph. Government of India Press, Delhi. 1956; 20:110.