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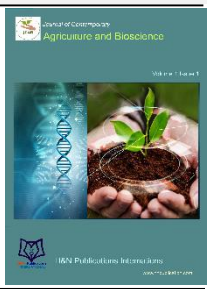

Research Article

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Morphological Study of Pummello Germplasm in Chattogram Region of Bangladesh

SM Kamrul Hasan Chowdhury[a], Md. Golam Azam[b] and ASM Harunor Rashid[c]

[a]Plant Pathology Division, Bangladesh Agricultural Research Institute, Khulshi, Chattogram-4225, Bangladesh.
[b]Plant Breeding Division, Bangladesh Agricultural Research Institute, Khulshi, Chattogram-4225, Bangladesh.
[c]Horticulture Division, Bangladesh Agricultural Research Institute, Khulshi, Chattogram-4225,Bangladesh.

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***Corresponding author:**
kahachowdhury@gmail.com

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A b s t r a c t

An experiment was conducted at Agricultural Research Station, Khulshi, Chattogram during 2019-2020 for the evaluation of twenty two pummello genotypes. Among these twenty two germplasm, ten genotypes namely CG Pah002, CG Pah003, CG Pah005, CG Pah006, CG Pah008, CG Pah013, CG Pah015, CG Pah020, CG Pah021 and CG Pah022 produced fruits.The heaviest fruit (1826g) was recorded from CG Pah 013 followed by CG Pah005 that weighted 1790g. The lightest fruit (730g) was observed in CG Pah020 followed by CG Pah021 that weighted 740g. The largest fruit size (15.2 cm x 17.9 cm) was obtained from CG Pah013 and the smallest fruit size (10.67cm x 12.57cm) was recorded from CG Pah021. The heaviest segment (73.20g) was recorded from CG Pah006 and the lightest segment (33.92g) was recorded from CG Pah020. Maximum edible portion (68.0%) was calculated from CG Pah015 and minimum edible portion (46.84%) was calculated from CG Pah003. The highest total soluble solid (10.73) was counted from CG Pah020 and the lowest total soluble solid (7.04) was counted from CG Pah002. CG Pah015 produced maximum amount of fruit (24.15 kg) and CG Pah002 produced minimum amount of fruit (1.13 kg). All the genotypes were bitter in taste except CG Pah006. Based on qualitative and quantitative characters CG Pah003, CG Pah005 and CG Pah006 were found promising.

Keywords: *Pummelo, qualitative characters, Quantitative characters, Climatic condition*

Introduction

Citrus fruits are widely acknowledged as a critical component of the human diet due to their low salt and cholesterol content, as well as their high vitamin C, folic acid, potassium, flavonoids, coumarins, pectins, and dietary fiber content (Dugo and Di Giacomo, 2002; Roy *et al.,* 2014). Pummelo is a tropical citrus fruit that belongs to the Rutaceae family. Due to its excellent nutritional content and antioxidant properties, pummelo is gaining popularity. Pummelo plants are primarily grown in private gardens, and no commercial plantations have been established to far. It was a significant progenitor of numerous citrus fruits, including lemons, oranges, and grapefruits (Youseif *et al.,* 2014). Pummelo is grown in Bangladesh, Cambodia, Chile, India, Indonesia, Japan, Laos, Malaysia, the Philippines, Thailand, and Vietnam (Orwa et al., 2009). It is also grown in China (Vinning and Moody, 1997; Taiping and Shaolin, 2000), Sri Lanka, and Nepal. Though it is the largest citrus fruit, despite its health and nutritional merits, it has not achieved commercial success. Researchers examined the morphological characteristics of various crops, including mustard (Azam *et al.,* 2018; Azam *et al.,* 2020), and guava (Azam et al., 2020), under the agro-ecological condition of Chattogram region. The purpose of this study was to analyze the pummello germplasm under the Chattogram region's climatic conditions for releasing it as a variety in order to commercialize the pummelo throughout the country.

Materials and Methods

Pummello genotypes were collected from different parts of Bangladesh and planted to the fruit orchard of Agricultural Research Station, Pahartali, Khulshi, Chattogram during 2016-2017. The experimental areas lie between 22.18^0 N latitudes and 91.89^0 E longitudes at an average elevation of 20 m above the sea level. The experimental unit belongs to Agro-ecological Zone 23 known as Chittagong Coastal Plains. The physiographic unit of these areas is low hills and valleys. The soils are predominantly moderately fine textured and the pH of soil is about 6.5. The organic matter ranges from 0.7 %-1.47 % in top soil and 0.38 % – 0.76 % in sub soil (Azam *et al.*, 2020). Twenty two pummello germplasm namely CG Pah 001CG Pah 002, CG Pah 003, CG Pah 004, CG Pah 005, CG Pah 006, CG Pah 007, CG Pah 008, CG Pah 009, CG Pah 010, CG Pah 011, CG Pah 012, CG Pah 013, CG Pah 014, CG Pah 015, CG Pah 016, CG Pah 017, CG Pah 018, CG Pah 019, CG Pah 020, CG Pah 021 and CG

Table 1. Qualitative characters of tested genotypes

Sl. no	Line	Fruit shape	Fruit base shape	Fruit apex shape	skin color	skin surface	Adherence to epicarp to mesocarp	Nature of oil glands	Mesocarp color	Adherence of segment to each other	pulp color	Juice taste	Bitterness	Seed color
1	CG Pah 002	Oblate	Concave	Depressed	Yellow	Pitted	Moderate	Conspicious	Pink	Moderate	Pink	Good	Moderate	Creamy
2	CG Pah 003	Spheroid	Truncate	Truncate	Yellow	Smooth	Moderate	Conspicious	White	Slight	Whitish pink	Excellent	Very slight	Creamy
3	CG Pah 005	Oblate	Truncate	Truncate	Yellow	Rugose	Moderate	Conspicious	White	Slight	Whitish pink	Excellent	Very slight	Creamy
4	CG Pah 006	Oblate	Truncate	Truncate	Yellow	Rugose	Moderate	Conspicious	Pink	Slight	Red	Excellent	None	Creamy
5	CG Pah 008	Spheroid	Convex	Truncate	Yellow	Smooth	Strong	Conspicious	Pink	Strong	Red	Good	Moderate	Creamy
6	CG Pah 013	Ovate	Truncate	Depressed	Yellow	Smooth	Moderate	Very Conspicious	Pink	Moderate	Whitish pink	Good	Moderate	Creamy
7	CG Pah 015	Spheroid	Convex	Truncate	Yellow	Rugose	Strong	Conspicious	Pink	Strong	Red	Fair	Moderate	Creamy
8	CG Pah 020	Spheroid	Concave	Truncate	Yellow	Smooth	Moderate	Conspicious	White	Moderate	White	Good	Moderate	Creamy
9	CG Pah 021	Ovate	Truncate	Truncate	Yellow	Smooth	Moderate	Conspicious	Red	Strong	Pink	Poor	Moderate	Creamy
10	CG Pah 022	Pyriform	Convex	Truncate	Yellow	Pitted	Moderate	Conspicious	Pink	Moderate	Pink	Good	Moderate	Creamy

Pah 022 were evaluated under this experiment. Manures and fertilizers were applied @ 15 kg cowdung, 500 g urea, 350 g TSP and 400 g MoP per plant per annum in three equal installments. Intercultural operations were done as and when necessary. Different qualitative and quantitative characters were recorded according to minimal descriptors of agri-horticultural crops (Mahajan *et al.,* 2002).

Results and Discussion

Growth, yield and yield contributing characters of twenty two pummelo germplasm were presented in table 1, 2 & 3. Among these twenty two germplasm, ten genotypes namely CG Pah 002, CG Pah 003, CG Pah 005, CG Pah 006, CG Pah 008, CG Pah 013, CG Pah 015, CG Pah 020, CG Pah 021 and CG Pah 022 produced fruits during reporting period. The qualitative and quantitative data of the fruit were described in table 1 & 2. Fruits of CG Pah 013 and CG Pah 021 are ovate shape. CG Pah 003, CG Pah 008, CG Pah 015 and CG Pah 020 produced spheroid shaped fruit. Only one genotype, CG Pah 022 produced pyriform fruit. Base shape of fruit was concave in CG Pah 002; truncate in CG Pah 003, CG Pah 005, CG Pah 006, CG Pah 013 and CG Pah 021; and convex in CG Pah 008, CG Pah 015 and CG Pah 022. The shape of fruit apex was truncate in CG Pah 003, CG Pah 005, CG Pah 006, CG Pah 008, CG Pah 015, CG Pah 020, CG Pah 021 and CG Pah 022; and depressed in CG Pah 002 and CG Pah 013. Fruits of these genotypes were yellow. In this study, fruits of pummelo genotypes varied in fruit shape, fruit base, fruit skin color, pulp color as compared with the findings of scientists (Mitra *et al.*, 2011 and Samarasinghe *et al.*, 2005).

Fruit surface of tested genotypes varies in pitted, smooth and rugose. Pitted skin surface was observed in CG Pah 002 and CG Pah 022. Smooth skin surface was observed in CG Pah 003, CG Pah 008, CG Pah 013, CG Pah 020 and CG Pah 021. Rugose skin surface was observed in CG Pah 005, CG Pah 006 and CG Pah 015. Epicarp of CG Pah 002, CG Pah 003, CG Pah 005, CG Pah 006, CG Pah 013, CG Pah 020, CG Pah 021 and CG Pah 022 was moderately adhered to mesocarp of respective genotypes. Epicarp of CG Pah 008 and CG Pah 015 was strongly adhered to mesocarp of both genotypes. Conspicuous oil glands were found in all tested genotypes except CG Pah 013 which oil glands were very conspicuous. CG Pah 002, CG Pah 006, CG Pah 008, CG Pah 013, CG Pah 015 and CG Pah 022 belong to pink colored mesocarp. CG Pah 03, CG Pah 005 and CG Pah 020 belong to white colored mesocarp. CG Pah 021 belongs to red colored mesocarp. Hoque and Hossain (2012) stated that all the genotypes tested by them were smooth skin surface which was varied in this findings.

Pulp of CG Pah 002, CG Pah 021 and CG Pah 022 was pink. Pulp of CG Pah 003, CG Pah 005 and CG Pah 013 was whitish pink Pulp of CG Pah 006, CG Pah 008 and CG Pah 015 was red. Seeds of all tested genotypes were creamy color. CG Pah 015 found fair taste. CG Pah 021 found poor taste. CG Pah 002, CG Pah 008, CG Pah 013, CG Pah 020 and CG Pah 022 found good taste. CG Pah 003, CG Pah 005 and CG Pah 006 found excellent taste. The present result is identical with many other studies [Shanmugavelu (1987), Singh (1995), Chen and Rao (1999) Ullah *et. al*., (2001),)] CG Pah015 gave maximum number of fruits that was 23 followed by CG Pah 021. CG Pah 002, CG Pah 003, CG Pah 005, CG Pah 006, CG Pah 008, CG Pah 013, CG Pah 020, CG Pah 021 and CG Pah 022 gave 1,6,1,3,5,1,5,14,3 of fruit(s) respectively. The heaviest fruit (1826g) was recorded from CG Pah013 followed by CG Pah005 that weighted 1790g. The lightest fruit (730g) was observed in CG Pah020 followed by CG Pah021 that weighted 740g. Fruits of CG Pah 002, CG Pah 003, CG Pah 006, CG Pah 008, CG Pah 015 and CG Pah 022 produced 1132g, 1330g, 1500g, 820g, 1050g and 810g respectively. The variation of fruit weight among different germplasm was roughly similar as stated by Ara *et*

al. (2008). On the other hand, some workers found wide range of variations on fruit weight Mitra *et al.* (2011).

Table 2. Quantitative characters of tested genotypes

Sl. no	Line	Number of fruits	Fruit weight (g)	Fruit length (cm)	Fruit Breadth (cm)	Rind thickness (mm)	Skin weight (g)	Number of segment	Indv. Segment weight (g)
1	CG Pah 002	01	1132	15.50	15.30	26.33	508	12	51.00
2	CG Pah 003	06	1330	14.00	16.00	20.07	624	16	70.00
3	CG Pah 005	01	1790	15.20	17.55	25.40	696	14	63.29
4	CG Pah 006	03	1500	15.35	17.10	18.40	567	15	73.20
5	CG Pah 008	05	820	13.55	13.35	16.80	316	14	36.86
6	CG Pah 013	01	1826	15.20	17.90	22.40	740	15	72.50
7	CG Pah 015	23	1050	13.07	13.03	11.80	275	14	61.70
8	CG Pah 020	05	730	13.10	13.43	19.80	323	12	33.92
9	CG Pah 021	14	740	10.67	12.57	14.40	295	15	44.80
10	CG Pah 022	03	810	13.20	12.70	10.60	232	13	36.67

Table 2. Continued

Sl. no	Line	Segment length (cm)	Segment Breadth (cm)	20 Seed weight (g)	Seed length (mm)	Seed Breadth (mm)	Edible portion (%)	TSS	Yield/ plant (kg)
1	CG Pah 002	9.28	4.36	8.40	17.40	11.60	53.36	7.04	1.13
2	CG Pah 003	10.30	4.75	7.40	17.46	9.00	46.84	10.23	7.98
3	CG Pah 005	10.06	4.42	2.00	15.83	11.67	60.56	9.57	1.79
4	CG Pah 006	9.28	5.20	9.40	17.00	9.40	57.60	9.28	4.50
5	CG Pah 008	7.52	4.00	3.80	14.00	8.40	59.88	8.56	4.10
6	CG Pah 013	10.10	5.07	6.80	15.40	9.40	56.96	8.63	1.83
7	CG Pah 015	9.64	5.20	9.40	18.50	10.90	68.00	6.86	24.15
8	CG Pah 020	7.53	3.83	8.40	16.20	9.20	51.37	10.73	3.65
9	CG Pah 021	9.06	4.82	7.80	17.30	9.10	56.62	7.18	10.36
10	CG Pah 022	7.76	4.38	5.00	16.60	7.90	66.91	8.42	2.43

The largest fruit size (15.2 cm x 17.9 cm) was obtained from CG Pah013 followed by CG Pah005 and CG Pah006 that were 15.2 cm x 17.55 cm and 15.35 cm x 17.1 cm respectively. The smallest fruit size (10.67cm x 12.57cm) was found from CG Pah021 followed by CG Pah022 that was 13.20cm x 12.70cm.The thickest rind (26.33mm) was observed in CG Pah002 followed by CG Pah005 which was 25.4mm and the thinnest rind (10.6cm) was recorded in CG Pah022 followed by CG Pah015 which got 11.8mm. The weightiest rind (740g) was found in CG Pah013 followed CG Pah005 that was 696g. The lightest rind (232g) was noted in CG Pah022 followed by CG Pah015 that was 275g. A varied rind thickness was observed by Hoque and Hossain (2012). Maximum number of segments (16) was observed in CG Pah003 followed by CG Pah021 that was 15. The heaviest segment (73.20g) was recorded from CG Pah006 followed by CG Pah013 and CG Pah003 that were 72.5g and 70.0g respectively. The lightest segment (33.92g) was recorded from CG Pah020 followed by CG Pah022 that were 36.67g. The largest segment size (10.1cm x 5.07cm) was obtained from CG Pah013 followed by CG Pah015, CG Pah003 and CG Pah006 that were 9.64 cm x 5.2 cm, 10.3 cm x 4.75 cm and 9.28cm x 5.2cm respectively. The smallest segment size (7.53cm x 3.83cm) was found from CG Pah020 followed by CG Pah022 that was 7.76cm x 4.38cm. Variable number and size of segments in fruit among the genotypes was also testified by Ullah *et. al*., (2001), Azmatullah *et al.,* (2006) and Morton (2006).
Twenty seeds of each genotype were weighted. The weightiest seed (9.4g) was recorded from CG Pah006 and CG Pah015 followed by CG Pah002 and CG Pah020; both were 8.4g. The lightest seed (2.0g) was recorded from CG Pah005 followed by CG Pah008 that were 3.8g. The biggest seed size (17.4mm x 11.6mm) was found from CG Pah002 followed by CG Pah015 that was 18.5mm x 10.9mm respectively. The smallest seed size (14.0mm x 8.4mm) was found from CG Pah008 followed by CG Pah022 that was 16.6mm x 7.9mm. Maximum edible portion (68.0%) was calculated from CG Pah015 followed by CG Pah022 that was 66.91%. Minimum edible portion (46.84%) was calculated from CG Pah003 followed by CG Pah020 that were 51.37%. The highest total soluble solid (10.73) was counted from CG Pah020 followed by CG Pah003 that was 10.23%. The lowest total soluble solid (7.04) was counted from CG Pah002 followed by CG Pah021 that were 7.18%. CG Pah015 produced maximum amount of fruit (24.15 kg) followed by CG Pah021 and CG Pah002 produced minimum amount of fruit (1.13 kg) followed by CG Pah005. There was no bitterness of CG Pah006 which is mostly desirable for a variety Azmatullah *et al.,* (2006).

Table 3. Growth, yield and yield contributing characters of twenty two pummello germplasm.

Accession no.	Plant height (m)	Plant girth (cm)	Plant Spread (m)	
			E-W	N-S
CG Pah 001	0.68	2.5	0.54	0.57
CG Pah 002	1.57	3.7	1.25	1.42
CG Pah 003	1.70	3.6	1.25	1.50
CG Pah 004	1.25	4.6	0.97	1.27
CG Pah 005	0.90	2.0	0.50	0.47
CG Pah 006	1.43	1.2	1.32	1.15
CG Pah 007	0.98	3.7	0.50	0.40
CG Pah 008	1.45	1.7	0.97	0.37

CG Pah 009	2.15	4.0	0.95	1.45
CG Pah 010	2.10	3.4	0.85	1.20
CG Pah 011	0.90	3.0	0.80	0.90
CG Pah 012	1.70	3.4	1.50	1.37
CG Pah 013	0.60	1.7	0.40	0.42
CG Pah 014	0.70	0.8	0.40	0.42
CG Pah 015	1.15	2.5	0.62	0.55
CG Pah 016	0.90	2.0	0.60	0.53
CG Pah 017	2.75	5.8	1.40	0.70
CG Pah 018	2.10	6.3	2.00	1.90
CG Pah 019	1.92	4.3	1.50	1.45
CG Pah 020	1.05	2.8	0.65	0.75
CG Pah 021	1.62	4.5	1.04	1.15
CG Pah 022	2.86	6.0	1.70	2.10
Sd	0.64	1.52	0.45	0.52
Max	2.86	6.3	2	2.1
Min	0.6	0.8	0.4	0.37

Conclusion

Considering the quantitative and qualitative characters, especially the bitterness, CG Pah003, CG Pah005 and CG Pah006 might be considered as a promising line. Though it was first data collection, evaluation will be needed for the next consecutive years.

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