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AGRONOMIC TRAITS OF SPONGE GOURD (*LUFFA CYLINDRICA*) INBRED LINES UNDER PLASTIC HOUSE CONDITIONS IN THUA THIEN HUE, VIETNAM

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Abstract: In order to establish pure lines of sponge gourds containing aroma features, we selected the desirable inbred lines by using a self-pollinating method. The present study was performed to estimate the morphological traits and fruit quality of six sponge gourd inbred lines which generated at the 4th generation of an aroma Luffa accession B29 under plastic house conditions. The experiment was conducted in a randomized complete block design with three replications from May to November 2016. Five plants per replication were examined. The results indicated that all inbred lines could grow well under the cultivated conditions. The inbred lines had the same stem and leaf traits; while the fruit shape, skin colour and fruit veins colour were different among the lines. The aromatic trait retained in all the inbred lines either before or after cooking. A high yield was found in lines BC1 and BC2 with 10.1 ton/ha and 10.7 ton/ha, respectively. These inbred lines should be examined under open field conditions to confirm the presence of aromatic trait and yield potential before the completion of the procedures for the recognition of new Luffa varieties.

Keywords: : Sponge gourd, inbred line, agronomic traits, aroma, plastic house

1 Introduction

Sponge gourd (*Luffa cylindrical* (L.), smooth loofah or dish cloth gourd) belongs to *Luffa* genus, a Cucurbitaceae family. *Luffa* species have 13 pairs of chromosomes ($2n = 26$) (Dutt and Roy, 1990) and cross-pollinated habit (Bal et al., 2004). Sponge gourds originate from America (Mazali and Alves, 2005) and are assessed as a potential crop for small farms in America (Davis, 1993). Even so, there are main commercial production countries including China, Korea, India, Japan and Central America (Bal et al., 2004). As one of the warm season crops in Viet Nam, the sponge gourd is a wide adaptable plant. Sponge gourds are popularly cultivated for harvesting both of mature-green fruit and dry fruit because of its high nutrient value (Bor, 2006; Partap, 2012) and tough fibrous vascular system (Klemm, 2001; Mazali and Alves, 2005; Hassan, 2006). The green-mature fruits are vegetable used to cook soup or saute, while the mature fruits after separating from the skin, flesh and seeds can be used for bathing, cleaning and filtering. The sponge gourd is also regarded as an important medicinal plant that needs to be conserved (Sutharshana, 2013). An introduction of sponge gourds in Nepal was presented through five types of

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descriptors (passport, management, environment, site characterization and evaluation) (Bal et al., 2004).

Sponge gourds as another species in *Luffa* genus have unisexual flowers. Staminate flowers of *Luffa* develop in an inflorescence, while distillate flowers develop separately or in association with a staminate inflorescence (Takahashi, 1980). This botanical characteristic allows the appearance of random pollination. The cross-pollination of sponge gourds is highly and naturally performed via bees, insects and wind. This type of pollination, however, probably causes degradation and adulteration in open sponge gourd farms. Local farmers consistently cultivate sponge gourds using a traditional method which utilizes random seeds from the previous crops. Due to these reasons, valuable traits are difficult to maintain for the following crops. Furthermore, customers are interested in sponge gourd fruits containing high sweetness, aroma and stickiness. Thus, the protection and maintaining these valuable traits of local sponge gourd varieties is essential.

In the previous studies, we selected good sponge gourd lines having a high yield and fruit quality. In order to recover desirable characteristic, we developed sponge gourd inbred lines containing aroma features using a self-pollinating method. The aim of this study was to estimate the morphological traits and fruit quality of sponge gourd inbred lines under plastic house conditions. These results will enable to evolve the pure lines of aroma sponge gourds.

2 Materials and methodology

Materials

Six inbred lines namely BC1, BC2, MN1, MN2, MN3, and MN4 were evaluated. These inbred lines were obtained from self-pollination at the 4th generation of accession B29 that has aroma features (Truong et al., 2014, Phan et al., 2015) at the Agronomy Faculty, University of Agriculture and Forestry, Hue University.

Methods

This study was conducted in a plastic house at University of Agriculture and Forestry, Hue University from May to November in 2016. The experiment was performed in a randomized complete block design with three replications. Each replication had five plants. The spacing was 45 cm between plants and 55 cm between rows.

The basal fertilizer mixture included 100 kg manure, 8 kg organic fertilizer, and 5 kg Trichoderma. The liquid of 1 % NPK was watered once a month. A plastic film mulch was used to cover the bed. The net was set for the standing of sponge gourds.

The evaluated traits consisted of stem shape; leaf shape, leaf colour, leaf margin, depth of lobing, leaf pubescence; fruit shape, fruit colour, stem-end fruit shape, blossom-end fruit shape, fruit rib shape, fruit veins colour, peduncle transactional shape and peduncle separation from fruit. The characteristics were observed in five plants per each replication. The fruit size was determined using the fruit length and fruit diameter. The fruit length is the distance between the stem end and the blossom end of the fruit, and the fruit diameter is the widest part of the fruit. The mean values of these characteristics were estimated with five random fruits in each replication. After the sponge gourd was boiled in water, the aroma feature was assessed by five people smelling, while flesh colour was evaluated through the appearance of the grey colour. The average brix degree was recorded on five fruits in each replication. The data were analyzed by Excel and the trial Statistix 10 softwares.

3 Results and discussion

Morphological traits

All evaluated sponge gourd inbred lines expressed similarly morphological traits such as an angular stem shape, an orbicular leaf shape, a shallow depth of lobing, dented leaf margin, low leaf pubescence in dorsal face and medium leaf pubescence in ventral face (data not shown).

There were differences in the fruit traits between accessions (Table 1). The elliptical fruit shape was found in the BC2, MN1, MN2, MN3, and MN4 accessions; while the elongate slim fruit was found in the BC1 accession. The skin colour was light green in BC1, BC2, and MN1; MN2, MN3 and MN4 had green fruit skin. The stem-end fruit shape, fruit rib shape and peduncle transactional shape were found to have a round shape in all accessions. The fruits of the inbred lines had a round shape. The fruit veins colour was green (BC1, BC2 and MN1) and dark green (MN2, and MN3). The peduncle separation from fruit was difficult in BC1 and easy in the others.

Table 1. Observation on the morphological traits of sponge gourd fruits

Accession	Fruit shape	Skin colour	Stem-end fruit shape	Blossom-end fruit shape	Fruit rib shape	Fruit veins colour	Peduncle transactional shape	Peduncle separation from fruit
BC1	elongate slim	light green	round	round	round	green	round	difficult
BC2	elliptical	light green	round	round	round	green	round	easy
MN1	elliptical	light green	round	round	round	green	round	easy
MN2	elliptical	green	round	round	round	dark green	round	easy
MN3	elliptical	green	round	round	round	dark green	round	easy

Accession	Fruit shape	Skin colour	Stem-end fruit shape	Blossom-end fruit shape	Fruit rib shape	Fruit veins colour	Peduncle transactional shape	Peduncle separation from fruit
MN4	elliptical	green	round	round	round	green	round	easy

Fruit quality

Table 2 shows the fruit traits of the inbred lines. The longest fruit was found in BC2 (27.1 cm) and the shortest fruit was found in MN3 (22.8 cm). The smallest fruit diameter was observed in BC1 and MN2 (4.7 cm), while the biggest fruit diameter was observed in MN3 (4.9 cm). The length of fruit peduncle was significantly different among accessions. It ranged from 13.2 cm (MN1) to 16.9 cm (BC1).

Table 2. Fruit traits of inbred lines

No.	Accession	Fruit length (cm)	Fruit diameter (cm)	Fruit peduncle length (cm)
1	BC1	25.9 [a]	4.7 [a]	16.9 [a]
2	BC2	27.1 [a]	4.8 [a]	13.7 [ab]
3	MN1	26.4 [a]	4.8 [a]	13.2 [b]
4	MN2	25.2 [a]	4.7 [a]	15.7 [ab]
5	MN3	22.8 [a]	4.9 [a]	15.7 [ab]
6	MN4	25.2 [a]	4.8 [a]	16.1 [ab]

[ae] Means with different letters in each columns indicate significant difference at $\alpha = 0.05$

The fruit quality, particularly the aroma and the colour of fruit flesh are highly appreciated by customers. All inbred lines in this study produced aroma fruits before and after cooking, and the flesh colour did not change after cooking (Table 3). Degree brix was found lowest in BC2 (3.5) and highest in MN3 (4.1).

Table 3. Fruit quality of sponge gourd inbred lines

No.	Accession	Aroma		Flesh colour	Brix
		Raw	After cooking		
1	BC1	Yes	Yes	No change	3.5 [b]
2	BC2	Yes	Yes	No change	3.4 [b]
3	MN1	Yes	Yes	No change	3.6 [ab]
4	MN2	Yes	Yes	No change	3.9 [ab]
5	MN3	Yes	Yes	No change	4.1 [a]
6	MN4	Yes	Yes	No change	3.7 [ab]

[ae] Means with different letters in each columns indicate significant difference at $\alpha = 0.05$.

Yield components and yield

The yield components and yield of sponge gourd inbred lines are presented in Table 4. There was a significant difference in the number of fruits per plant among lines. The highest was found in BC2 with 4.4 fruits and lowest in MN2 with 2.2 fruits. Lines MN1, MN2, MN3 and MN4 had the number of fruits that was significantly lower than that of the others. Line BC1 had the highest fruit weight (264.2 g), followed by BC2 (239.5 g). The lowest fruit weight was found in MN2 with 190.2 g. The predicted yield was estimated by means of the number of fruits per plant and the fruit weight. The highest predicted yield was found in BC1 with 13.5 ton/ha, followed by BC2 with 13.2 ton/ha. These two lines produced a higher predicted yield than the others as they had a higher number of fruits. The lowest predicted yield was found in MN2 with 4.1 tons/ha. Lines BC2 and BC1 also indicated a high actual yield of 10.7 ton/ha and 10.1 ton/ha, respectively.

Table 4. Yield components and yield of sponge gourd inbred lines

No.	Accession	Number of fruits/plant (fruit)	Fruit weight (g)	Actual yield (ton/ha)	Predicted yield (ton/ha)
1	BC1	3.9 ^{b}	264.2 ^{a}	10.1 ^{a}	13.5 ^{a}
2	BC2	4.4 ^{a}	239.5 ^{a}	10.7 ^{a}	13.2 ^{a}
3	MN1	2.4 ^{c}	223.2 ^{a}	5.4 ^{b}	6.3^{b}
4	MN2	2.2 ^{c}	190.2 ^{a}	4.0 ^{b}	4.1 ^{b}
5	MN3	2.3 ^{c}	226.8 ^{a}	5.3 ^{b}	6.2 ^{b}
6	MN4	2.4 ^{c}	220.4 ^{a}	5.3 ^{b}	5.9 ^{b}

^{ae} Means with different letters in each columns indicate significant difference at $\alpha = 0.05$.

4 Conclusion

The results of this study indicated that all the studied sponge gourd inbred lines could grow well under plastic house conditions. They showed identical morphological traits of stems and leaves and did not change their aroma after cooking. Lines BC1 and BC2 had significantly higher yield than the others. In order to confirm the presence of aromatic trait and yield potential, these sponge gourd inbred lines should be examined in open fields under the local weather conditions and soil types to complete the procedures for the recognition of new Luffa varieties in the near future.

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