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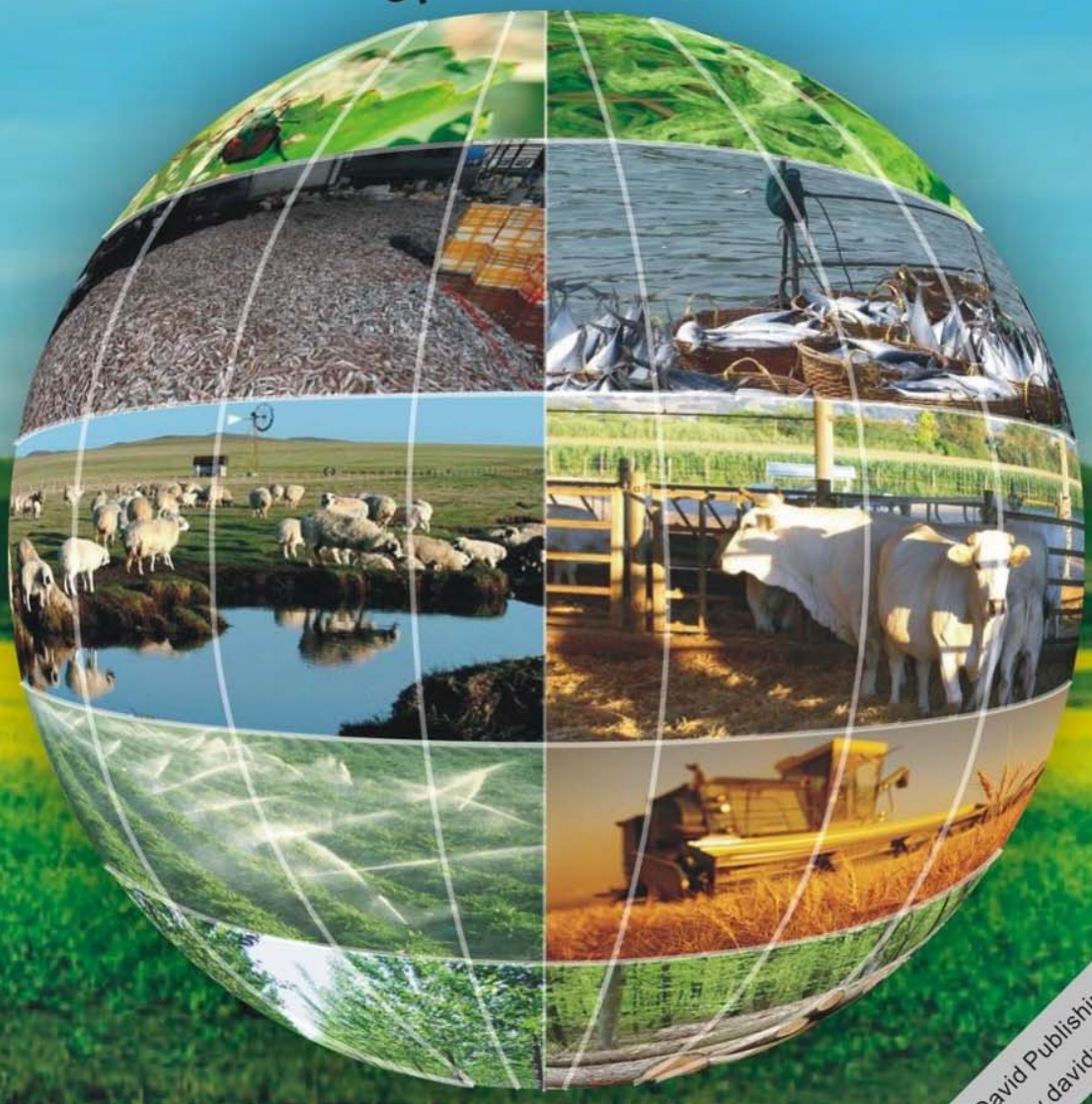

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Evaluation of Promissing Sponge Gourd (*Luffa cylindrical*) Accessions in Summer-Autumn Season 2014 in Thua Thien Hue

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Abstract: Sponge gourd varieties having aroma after cooking have been degenerated because of cross pollination. Collection and evaluation of sponge gourd germplasm are needed for conservation and breeding of high quality varieties. The objective of the study was to identify varieties having high yield, good quality and aroma under local conditions. Ten promising sponge gourd accessions, including A2, A6, A7, A13, A16, A17, B29, B30, HN and QN were evaluated for growth, morphological traits, fruit quality and yield. The experiment was carried out in Hue University of Agricultural and Forestry from June to October in 2014. The results showed that all promising accessions grew well. Different morphological traits were observed among promising lines. Yield of accessions A7, A13 and A17 were higher than the others. Only fruits of accession B29 had aroma after cooking. These lines can be used in sponge gourd breeding programs.

Key words: Sponge gourd, *Luffa cylindrical*, Thua Thien Hue, aroma.

1. Introduction

Sponge gourd (*Luffa cylindrical*) is member of Cucurbitaceae family, *Luffa* genus. It is used as a vegetable either prepared like squash or eaten raw like cucumber [1]. In many developing country, old fruit is produced for wide applications in bathing and washing by fibrous vascular system, such as utensil cleaning sponges, bath sponge and adsorbent for heavy metal in waste water. Sponge gourd is a cross-pollinated crop and has 26 chromosomes ($2n$ = 26) [2]. Sponge gourd was first grown commercially in Japan in the early 1890s [3]. Sponge gourd is known as important medicine plant, especially in China. Fruits are used in the traditional Chinese medicine as an anthelmintic, stomachic and antipyretic phytomedicinal drug. Saponins from the leaves and fruits possess effect on anoxia and fatigue and immunological activity [4]. Additionally, the Luffin, a ribosome-inactivating protein isolated from *Luffa* seed, has been shown to be effective against growth of parasites, protozoa, insects, fungi and HIV [5]. *Luffa* seed has been shown to be effective against growth of parasites, protozoa, insects, fungi and HIV [6]. Nowadays, there are many researches who have mentioned application capacity of *Luffa* fibrous system and chemical compounds extracted from fruit, seed and leaf. Thus, sponge gourd is known not only in vegetable but also in industrial and science researching materials.

Sponge gourd is a tropical and sub-tropical plant which requires warm temperature. It is widely and easily cultivated in Vietnam. However, nowadays, Sponge gourd's growing area is limited in Vietnam; in addition, famers keep the seed of local varieties to continue next sowing season. In this case, crossing pollinating cause degraded and adulterated, thus

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leading to decreased quality of local variety, such as high yield, aroma and sticky. It's necessary to select and conserve good sponge gourd lines having high yield, good quality, and disease resistance to increase production efficiency. In the previous study, the sponge gourd germplasm consisting of 49 accessions was evaluated in Ha Noi [7]; however, selected promising accessions are needed to confirm their growth ability and fruit quality under local conditions. Therefore, the purpose of this study was to evaluate the potential of promising *Luffa cylindrical* accessions on yield and fruit quality under local conditions and to select good lines for breeding programs and introducing to crop system in Thua Thien Hue.

2. Materials and Methods

2.1 Materials

A total of 10 accessions, including eight accessions obtained from Plant Genetic Resource of Vietnam (A2, A6, A7, A13, A16, A17, B29 and B30) and two local aroma sponge gourd accessions HN (collected from Ha Noi) and QN (collected from Quy Nhon), were used in this study.

2.2 Methods

2.2.1 Experimental Design

The evaluation was conducted from June to October 2014 in a greenhouse at Hue University of Agricultural and Forestry, Thua Thien Hue. The experiment was laid out in a random complete block design (RCBD) with three replications, as following Harika et al. designed for bottle gourd in 2012 [8] and Choudhary et al. designed for ridge gourd (*Luffa acutangula*) in India in 2014 [9]. Each accession in each replication was represented by six plants in a plot size of 6 m^2. The spacing was 100 cm between plants and 100 cm between rows. Sponge gourd was cultivated based on national technical regulations of QCVN 2013 DUS of Angel Loofah (*Luffa acutangula*) [10]. Seedlings with 2-3 fully expanded true leaves were transplanted into experimental field in plastic house. The basal fertilizing consisted of 20 tons manure, 120 kg superphosphate and 30 kg potassium per ha. Watering fertilizers were applied every three weeks with 37.5 g N:P:K (16:16:16), 24 g urea and 4 g K for each plot. Plastic film mulch was used to cover the bed. Setting frame stand for plant was before appearing tendrils.

2.2.2 Data collection

The data was collected from five randomly selected plants per replication. The time of growth periods had been measured since 50% number of plants of each accession had reached of requirements. Node height, stump diameter, leaf width and leaf length were measured to describe the ability of growth. Observations on leave were recorded in mature leaf emerging from nodes of the 15th to 20th. Fruit traits were recorded during harvesting period. Aroma trait was assessed by sense evaluation from 10 people. Total of 23 traits were evaluated during experiment.

2.2.3 Statistical analysis

Average values which collected from each plot were analyzed using analysis of variance (one-way ANOVA) by Statistix 9.0 version. Differences between means values were compared using Duncan's test at $P < 0.05$ [11].

3. Results and Discussions

3.1 Period of Growth and Development

Time from sowing to appearing the first male flower ranged from 46 d (A13) to 65 d (HN) (Table 1). Time from sowing to appearing the first female flower ranged from 46 d (A13) to 72 d (HN). Time which the first female flower opened was later than the first male flower in almost accessions. Choudhary et al. [9] reported that days to first female flower had negative and significant correlation with marketable fruit yield per plant. Thus, selection of genotypes producing female flowers early would increase yield of ridge gourd (*Luffa acutangula*). Choudhary et al. [12], Hanumegowda et al. [13] and Prasanna et al. [14] also reported similar trend in ridge gourd. Kumar et al. [15]

Table 1 Period of growth and development of promising sponge gourd accessions.

Accession	Time from sowing to…				
	Appearing the 1st male flower	Appearing the 1st female flower	Harvesting		
			1st time	2nd time	3rd time
A2	51	61	98	131	176
A6	49	56	98	131	176
A7	51	51	98	131	176
A13	46	46	98	131	176
A16	51	60	98	131	176
A17	57	60	98	131	176
B29	62	57	98	131	176
B30	60	65	98	131	176
HN	65	72	98	131	176
QN	61	70	98	131	176

Table 2 Ability of growth and development of sponge gourd accessions.

Accession	Node height (cm)	Stump diameter (mm)	Leaf width (cm)	Leaf length (cm)
A2	16.80^{abc}	54.53^{a}	26.00^{a}	19.70^{a}
A6	14.57^{bc}	56.00^{a}	21.76^{c}	17.56^{bc}
A7	17.38^{abc}	55.13^{a}	23.73^{abc}	17.41^{bc}
A13	17.46^{ab}	54.27^{a}	23.36^{abc}	18.56^{ab}
A16	17.87^{ab}	53.87^{a}	22.87^{bc}	18.15^{ab}
A17	18.81^{a}	59.00^{a}	22.75^{bc}	16.88^{bc}
B29	16.71^{abc}	54.33^{a}	23.53^{abc}	18.79^{ab}
B30	14.03^{c}	54.27^{a}	21.03^{c}	15.44^{c}
DC	17.70^{ab}	61.67^{a}	25.35^{ab}	18.08^{ab}
QN	17.72^{ab}	59.47 ^{a}	23.64^{abc}	17.73^{ab}
LSD $_{0.05}$	3.35	10.34	2.94	2.13

$^{a, b, c}$ Means in different letter (s) are significantly different at $P = 95\%$.

indicated that days to anthesis of the first male flower were positively correlated with total yield per vine in sponge gourd [15]. In this study, B29, B30, HN and QN had the first male flower at about 60 d and A13 had the earliest of first female flower (46 d). All of accessions had the same harvesting times.

3.2 Ability of Growth and Development of Promising Sponge Gourd Accessions

Ability of growth and development was presented in node height, stump diameter, leaf width and leaf length. Choudhary et al. [12], Chowdhury and Sharma [16], Karuppaiah et al. [17], and Singh et al. [18] have observed a wide variation in growth and flowering traits of ridge gourd. The height of node ranged from 14.03 cm to 18.81 cm (Table 2). Node height of A17 was the highest and the lowest one was B30. The difference was found significantly between them. These results were similar to internodal length (from 12.85 cm to 17.17 cm). This result is in agreement with result of Choudhary et al. (2008) [12]. The big stump diameter shows good growth ability. Stump diameter was obtained from 53.87 cm (A16) to 61.67 cm (DC), but there was no significant difference among accessions. Leaf width and leaf length are not only variety's feature, but also characteristic to affect photosynthesis capacity of plant. Leaf width and leaf length of A2 were found to be biggest, whereas B30 accession had the lowest leaf width (21.03 cm) and the lowest leaf length (15.44 cm). Leaf width and leaf length were significantly different among accessions.

3.3 Morphological Traits of Promising Sponge Gourd Accessions

Morphological traits depend on genetics and are different among accessions. Morphological traits of the sponge gourd accessions were recorded and presented in the Table 3. Leaf, fruit and seed were different in color and shape. Leaf shape of five accessions, such as A2, A7, A16, A17, B29 and QN was reniform, whereas orbicular leaf shape was observed in other accessions. A7, A16 and QN had dark green leaves; the remained accessions had green color. High leaf pubescence (hair on ventral surface) will have high ability of pest resistance. A13, A17, B30 and QN had high leaf pubescence.

Fruit shape was divided in two kinds, ellipse and oblong. The ellipse was observed in A2, A6 and A17, and the remains were oblong. Fruit color consisted of light green (A2, A7, A13 and A17), green (A6, A16 and B29) and dark green (B30, HN and QN).

3.4 Fruit Quality Traits

Fruit quality is an important criterion for sponge gourd production. Joshi et al. (2004) [19] reported that fruit length and fruit weigh were considered as primary traits for increasing fruit number. Fruit size determined by fruit length and fruit diameter was significant difference among accessions (Table 4). Fruit length was recorded from 29.3 cm to 43.7 cm. B29 had the shortest fruit (29.3 cm) and QN had the longest fruit (43.7 cm). There was significant difference among accessions. Fruit diameter ranged from 4.55 cm to 5.87 cm. B29 had the smallest fruit (4.55 cm), whereas A13 had the biggest fruit (5.87 cm). Davis and DeCourley [20] have reported that average of sponge gourd fruit length varied from 48 cm to 79 cm and the diameter from 7 cm to 11 cm, respectively. The longest fruit peduncle belonged to A13 (17.27 cm) and the shorted fruit peduncle belonged to QN (18.55 cm). The length of fruit peduncle of accession was significantly different among accessions.

Davis [21] emphasized that important characteristic of *Luffa* depends on the purpose of the use of sponge gourd. As vegetable for daily meal, almost consumers will choose good fruits as weight, sweetness and aroma. Thus, total soluble solid (brix) and aroma were evaluated. Brix ranged from 2.17 (B30) to 3.32 (B29). Almost accessions had similar brix value. Only B29 kept aroma after cooked. Stickiness help food more tasty. All of accessions were sticky.

3.5 Yield Components and Yield

Ratio of fruit setting, number fruit per plant and fruit weight constituted of yield. Ratio of fruit setting ranged from 16% (QN) to 45.17% (B29). Ratio of fruit setting of all accessions was significantly different (Table 5). This fruiting rate was higher than those in previous study [7].

Table 3 Morphological traits of promising sponge gourd accessions

Accession	Leaf shape	Leaf color	Leaf pubescence	Fruit shape	Fruit color
A2	R	G	M	E	LG
A6	O	G	M	E	G
A7	R	DG	M	OB	LG
A13	O	G	H	OB	LG
A16	R	DG	M	OB	G
A17	R	G	H	E	LG
B29	R	G	M	OB	G
B30	O	G	H	OB	DG
HN	O	G	M	OB	DG
QN	R	DG	H	OB	DG

R = reniform, O = orbicular, G = green, DG = dark green, LG = light green, M = medium, H = high, E = elliptical, OB = oblong blocky.

Table 4 Fruit quality of promising sponge gourd accessions.

Accession	Fruit length (cm)	Fruit diameter (cm)	Length of fruit peduncle (cm)	Brix	Aroma	
					Raw	After cooked
A2	38.89^{abc}	5.17^{abcd}	15.05^{abc}	2.55^{bcd}	Yes	No
A6	38.37^{abc}	5.69^{ab}	10.58^{d}	2.53^{bcd}	No	No
A7	35.06^{cd}	5.20^{abcd}	14.89^{abc}	2.37^{bcd}	No	No
A13	39.56^{abc}	5.87^{a}	17.27^{ab}	2.68^{bcd}	Yes	No
A16	41.80^{ab}	4.97^{bcd}	16.97^{ab}	2.92^{ab}	No	No
A17	30.83^{de}	5.64^{abc}	13.68^{bcd}	2.79^{abc}	Yes	No
B29	29.30^{e}	4.55^{d}	12.63^{cd}	3.32^{a}	Yes	Yes
B30	38.08^{bc}	4.86^{cd}	11.17^{cd}	2.17^{d}	No	No
HN	39.25^{abc}	5.00^{bcd}	17.11^{ab}	2.31^{cd}	No	No
QN	43.70^{a}	4.96^{bcd}	18.55^{a}	2.52^{bcd}	Yes	No
LSD $_{0,05}$	5.45	0.82	4.02	0.57		

[a, b, c] Means in different letter (s) are significantly different at $P = 95\%$.

Table 5 Yield components and yield of promising sponge gourd accessions.

Accession	Ratio of fruit setting (%)	Number of fruit/plant (fruit)	Fruit weigh (g)	Theory yield (ton/ha)	Yield (ton/ha)
A2	41.08^{ab}	3.33^{abc}	367.33^{abc}	60.05^{abcd}	46.61^{abc}
A6	37.50^{ab}	3.33^{abc}	416.00^{ab}	65.66^{abc}	51.73^{abc}
A7	39.42^{ab}	4.80^{a}	356.00^{bc}	82.83^{a}	83.25^{a}
A13	39.50^{ab}	3.47^{abc}	471.33^{a}	78.67^{ab}	62.56^{ab}
A16	43.42^{ab}	2.33^{cd}	372.00^{abc}	40.61^{abcd}	34.51^{bc}
A17	38.92^{ab}	4.60^{ab}	356.00^{bc}	79.55^{ab}	71.17^{ab}
B29	45.17^{a}	2.60^{bcd}	274.00^{c}	33.65^{cd}	29.95^{bc}
B30	29.17^{bc}	1.80^{cd}	439.33^{ab}	36.98^{bcd}	58.67^{ab}
HN	42.17^{ab}	1.90^{cd}	416.00^{ab}	39.39^{bcd}	34.51^{bc}
QN	16.00^{c}	0.87^{d}	440.11^{ab}	18.30^{d}	14.91^{c}
LSD $_{0,05}$	14.88	2.02	112.51	42.97	42.00

[a, b, c] Means in different letter (s) are significantly different at $P = 95\%$.

Number of fruit per plant ranged from 0.87 fruit to 4.8 fruits. QN had the lowest number of fruit per plant (0.87 fruit) and A7 had the highest number of fruits per plant (4.8 fruits), and the followings were A17 (4.6 fruits) and A13 (3.47 fruits). The accession A7 only had 2.6 fruits per plant reported in 2014 by Truong et al. [7]. While Davis and DeCourley [20] reported that number of fruits of gourds per plant were ranged from 3.5 to 20 fruits.

Fruit weight ranged from 274 g to 471.33 g. B29 had the smallest fruit weigh (274 g), whereas A13 had the biggest fruit (471.33 g). Some accessions had big fruit, such as QN (440.11 g) B30 (439.33 g), A6 and HN (416 g), but there was no significant difference. Kumar et al. [15] have reported that fruit number per vine ranged from 20.92 to 35.87 fruits and fruit weight ranged from 106.87 g to 216.20 g. While Choudhary [9] reported that fruit weight of ride gourd ranged from 74.04 g to 109.06 g. Thus, number of fruit, fruit length and average weight of fruit are important characters for increasing yield potential in *Luffa*.

Theory yield ranged from 18.3 ton/ha to 82.83 ton/ha. QN had the lowest theory yield (18.3 ton/ha), whereas A7 had the highest theory yield (82.83 ton/ha). This occurred in true yield too. A7 obtained the highest yield (83.25 ton/ha), following by A17 (71.17 ton/ha) and A13 (62.56 ton/ha). There was no significant difference among accessions. QN had the lowest yield (14.91 ton/ha), and next was B29 (29.95 ton/ha). These results were in agreement with results of Kumar et al. [15] that fruit number was positively correlated with total yield. Choudhary et al. [9] also

indicated that the marketable yield per plant had positive and highly significant correlation with fruit weight and number of marketable fruit per plant at phenotypic level [9].

4. Conclusions

All promising accessions can grow well under Thua Thien Hue conditions. Different varieties had different morphological traits and growth characteristics. Only fruit of accession B29 kept aroma after cooked, but fruits of all accessions were sticky after cooking. Accessions A7, A13 and A17 had higher yield than other accessions. Accessions B29, A7, A13 and A17 had high yield and good fruit quality (aroma, sticky), therefore should be used in breeding F1 Sponge gourd.

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