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## Floral Biology of Different Exotic and Indigenous Ash Gourd Genotypes (*Benincasa hispida*)

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**Abstract:** Seven exotic and three local ash gourd genotypes were studied to evaluate their floral biology. It was observed that the first male flowers of exotic materials except Bisexual opened within 33-34 days and female flowers within 35-36 days from seed sowing and their node number were 5-9 and 5-13, respectively. For first female flower opening lowest plant heights were observed 93.11 cm (High female), 99.9 cm (Chiqua-9) and 106 cm (Chiqua-90-10). However, in case of the local materials 56.8-58.9 days for first male flower opening, 58.6-63.3 days for first female flower opening were required. In local materials plant heights at first female flower opening were 306.1-324.1 cm. The Bisexual produced first hermaphrodite flower at the height of 200.4 cm. Anthesis of male flowers required 4 days and female flowers required 5 days from visible appearance of flower buds for all types. Maximum number of fruits (7.8) per plant as well as the highest percentage of fruit set (74.30%) was found in the genotype Chiqua-90-10. The lowest percentage of fruit set (13%) was observed in the Bisexual which produced the highest number of hermaphrodite flowers (11.5). In all genotype the anthesis of staminate flowers started within the range of 4:33 to 4:45 am and required 20 to 30 min for full blooming. The anthesis of female flowers started from 4:20 to 4:30 am and required 20-25 min for full blooming. Anther dehiscence of all genotypes took place within 1:45 to 2:40 am i.e., 2 h before anthesis. The stigma became receptive 6 h before anthesis and remained so till 16 h after anthesis in all monoecious ash gourds. All the genotypes were cross compatible for each another and in all directions. Pollen grains remain viable up to 20 h after anthesis.

**Key words:** Ash gourd, *Benincasa hispida*, floral biology, cross compatibility

### INTRODUCTION

Ash gourd is a good source of carbohydrate, fat, protein and mineral salts. Many human nutritional deficiencies and disease commonly encountered in the developing countries are preventable by an intelligent and fuller utilization of vegetables. *Benincasa hispida*, commonly known as ash gourd, fallow gourd, Chinese preserving melon, white gourd or wax gourd, belongs to the family Cucurbitaceae and is cultivated mainly for its edible fruits which also have high medicinal value (Thomas and Sreejesh, 2004). It is indigenous to Asian subtropics. It is widely cultivated in India, China, Malaysia, Indonesia, Taiwan and Bangladesh. Among the non traditional crops Bangladesh has been earning a handsome amount of foreign currency by exporting ash gourd to UK, Pakistan and Middle East (Alamgir, 1981). There are two ecotypes of ash gourd, one is orange shaped planted in winter and the other is oblong shaped grown in summer season. It becomes available even in the rainy season when other vegetables are scarce in Bangladesh (BARI, 2006).

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The plant is a trailing or a climbing herb with stout stems and hairy leaves (Thomas and Sreejesh, 2004) and commonly known as cross-pollinated crop (Rashid, 1999). In Bangladesh only monoecious plants are in cultivation; hermaphrodite and andromonoecious types are rare. Plants of the indigenous ash gourd genotypes bear very poor number of female flowers and fruits per plant. Consequently, the yield of these genotypes is poor. Moreover, they are mostly long vine types and thus need trellis for vegetative growth. In case of these local types one hectare of land can include only 1500 plants and their productivity ranged from 6.93 to 30 t ha<sup>-1</sup> (Hamid *et al.*, 1989; Rashid, 1999; BARI, 2006). On the other hand, there are many exotic genotypes, which are semi dwarf type and have short life cycle but high yield potential. For these semi dwarf types one hectare of land can include 6000 of plants. Some of these exotic genotypes bear deep green long fruits, which are attractive. Flower buds of these genotypes appear 20-25 days earlier than the local genotypes. The exotic genotypes do not need trellis because of their medium climbing habit. A two meter long bamboo stick is sufficient for their climbing. However, the exotic types are more susceptible to different virus diseases than the local genotypes (Mukit, 1995). This variability among the indigenous and exotic genotypes are important genetic attributes, which can be combined through hybridization to develop short vine type varieties with high yield, virus resistance and capability to produce high number of female flowers in Bangladeshi climate.

As a crop, ash gourd has a number of problems like low yield, poor number of female flowers, thin rind of the fruits, disease and insect susceptibility and late fruiting are common. No hybridization program has yet been taken to overcome these problems. Being a cross-pollinated crop, it seems easy to transfer suitable traits by crossing appropriate genotypes of ash gourd. Unfortunately, there is no detail report on the floral biology, which is a prerequisite for a successful hybridization program.

Considering the above problems and scopes the present investigation was carried out with the following objectives:

- To study the floral biology such as time of anthesis, time of anther dehiscence, duration of stigma receptivity, pollen viability, cross compatibility and pollen tube growth behavior with a view to find out the most suitable time for emasculation and pollination and appropriate process for hybridization.
- To evaluate different desired plant characteristics of indigenous and exotic genotypes with a view to develop high yielding variety or varieties.

## MATERIALS AND METHODS

The study was carried out at the experimental field as well as in the laboratory of the Bangobandhu Sheikh Mujibur Rahman Agricultural University, Salna, Gazipur, Bangladesh during summer 2006. The location of the site is at 24°0' North latitude and 90°25' East longitude.

Ten genotypes of *Benincasa hispida* were selected to study the different aspects of floral biology. There were seven exotic materials and three indigenous materials. The seeds of genotypes were collected from the department of Genetics and Plant Breeding Bangobandhu Sheikh Mujibur Rahman Agricultural University, Salna, Gazipur.

The land was prepared properly with fertilizer and manures as per recommended by Rashid (1999). Healthy seedlings of 20 days old were transplanted in the pits of experimental field on 16th May. A spacing of one meter between rows and plants on each bed was maintained. The soil around the base of each seedling was pulverized after the seedling was established.

The growing plants were individually supported by 2 m-long bamboo sticks to prevent lodging. All bamboo sticks were tightened strongly by rope with long wire. Cultural operation, such as weeding and irrigation were done and insecticides were applied as and when necessary for proper growth and development of the plants.

## RESULTS AND DISCUSSION

### **Days Taken to and Node Number of First Male and Female Flower Opening**

The onset of flowering is an important character to determine earliness or lateness of a genotype. The time required for exotic ash gourd genotypes excluding Bisexual type to anthesis of first male flower was 33 to 35 days, whereas the local genotype required 58.6 to 58.9 days. The bisexual genotype, an exotic genotype, needed 48.2 days (Table 1). Anthesis of the first female flower of exotic and local materials required 35.1 to 36.6 days and 58.6 to 63.3 days, respectively. From the study, it was observed that the anthesis of the first male and female flowers of exotic materials was earlier than the local materials. Hamid *et al.* (1989) reported that the local materials of ash gourd gave first male flower within 41 to 59 days, whereas the female flower opened 51 to 70 days. These informations are important for the synchronization of male and female flowers of different genotypes for crossing.

The node number at which the first male flower opened differed from one genotype to other. The first male flower of exotic materials opened between 5.5 to 9.0th node (Table 1). But in case of local materials, the first male flower had opened within 29 to 31.9th node. Female flowers appeared at lower nodes in exotic materials. Most of the monoecious exotic genotypes of ash gourd produced the first female flower at 5.8 to 11.9th node. On the contrary, the first female flower in the local genotypes appeared at 33.1 to 34.1th node. The first hermaphrodite flowering of bisexual genotypes was observed at 13.1th node.

In both the exotic and local genotypes, the male flowers appeared earlier at lower node as compared to the female flowering node. Seshadri (1986) and Rashid (1999) reported that the male flowers appeared at the lower node than the female flowers. Hamid *et al.* (1989) observed in their study that the first male flower appeared with the node order of 10 to 13 in some local genotypes and 22 to 28 in other genotypes of their study.

### **Plant Height and Number of Leaves at First Male and Female/Hermaphrodite Flower Opening**

It was observed that the plant height of exotic monoecious materials at first male flower opening ranged from 89 to 126 cm, whereas the height of the local genotypes from 301 to 314 cm. In case of first female flower opening the height of the exotic monoecious genotypes ranged from 93 to 128 cm. In this study, the height of the local genotypes of ash gourd ranged from 306 to 324 cm. In case of Bisexual genotype, it was observed that the mean height was 200 cm at first flower opening.

Most of the exotic monoecious materials produced 17-27 leaves at the first male flower anthesis. Indigenous materials flowered later than the exotic materials. All the indigenous materials had 66 to 70 leaves at first male flowering. The same difference between the exotic and local materials was also found in the first female flower opening. The average number of leaves was found to be 17 to 28 in exotic monoecious materials at first female flower anthesis. But the local materials produced 68 to 73 leaves at this stage. The Bisexual had 59 leaves at first flowering. It was observed that first male and female flower opening at the lower node and at lower plant height are the important criteria for earliness of these cultivars as well as semi dwarfness of these cultivars. For semi dwarfness of the cultivars several times more plants could be accommodated in the same land than local vine types. Due to this criterion semi dwarf types give several times more yield than local vine types.

### **Number of Days Taken to Anthesis from the Visible Appearance of Male and Female/Hermaphrodite Flower Buds**

Anthesis required 3 to 5 days from the visible appearance of male flower buds for all the genotypes. A similar trend was also observed in case of female flowers. This information is important for making successful cross among the genotypes.

Table 1: Different important characteristics of different ash gourd genotypes

Characteristics	Ash gourd genotypes									
	Chiqa 90-2	Chiqa 90-5	Chiqa 90-10	Chiqa 9	Mk-1	High female	Bisexual	Local (long)	Local (round)	Local
<b>Days to fist flower opening</b>										
Male	33.0 ±0.5	34.4 ±0.6	33.6 ±0.5	33.8 ±0.4	33.9 ±0.3	34.9 ±0.4	-	58.8 ±0.9	56.8 ±0.6	58.9 ±0.5
Female/ hermaphrodite	35.8 ±0.5	36.6 ±0.6	36.0 ±0.4	35.1 ±0.7	36.5 ±0.7	35.7 ±0.3	48.2 ±0.9	59.2 ±0.8	58.6 ±0.7	63.3 ±0.6
<b>First flowering node</b>										
Male	5.8 ±0.3	9.4 ±0.4	7.2 ±0.1	5.5 ±0.3	7.0 ±0.5	9.0 ±0.2	-	29.0 ±0.8	29.4 ±1.1	31.9 ±0.7
Female/ hermaphrodite	5.8 ±0.3	11.9 ±0.8	8.6 ±0.9	7.9 ±0.6	9.2 ±0.7	7.8 ±0.2	13.1 ±0.4	33.1 ±0.9	33.4 ±0.1	34.1 ±1.3
<b>Plant height at first flower opening (cm)</b>										
Male	92.80 ±6.79	126.40 ±6.53	107.60 ±4.09	92.50 ±4.53	119.4 ±5.41	89.00 ±1.09	-	314.2 ±5.05	301.2 ±5.26	305.9 ±5.21
Female/ hermaphrodite	113.20 ±6.76	127.30 ±6.10	106.70 ±3.88	99.90 ±2.62	128.0 ±4.31	93.11 ±0.90	200.40 ±2.53	324.10 ±3.15	319.40 ±4.76	306.10 ±4.00
<b>No. of leaves at first flower opening</b>										
Male	17.0 ±1.0	27.0 ±1.6	21.0 ±0.7	17.0 ±0.7	20.0 ±0.8	17.0 ±0.2	-	70.0 ±1.0	66.0 ±0.7	67 ±0.8
Female/ hermaphrodite	20.0 ±1.1	28.0 ±1.8	18.0 ±0.8	17.0 ±0.6	22.0 ±1.0	17.0 ±0.3	59.0 ±1.4	73.0 ±0.8	71.0 ±1.0	68.0 ±0.7
<b>Days taken to anthesis from the visible appearance</b>										
Male flower buds	4.0 ±0.1	4.0 ±0.1	4.0 ±0.1	4.0 ±0.1	4.0 ±0.1	4.0 ±0.2	-	4.0 ±0.2	4.0 ±0.1	4.0 ±0.1
Female/ hermaphrodite flower buds	5.0 ±0.1	5.0 ±0.2	5.0 ±0.2	5.0 ±0.1	5.0 ±0.2	5.0 ±0.2	5.0 ±0.1	5.0 ±0.2	5.0 ±0.2	5.0 ±0.2
<b>No. of female flowers/plants</b>										
Range	7-11	7-12	8-13	6-11	8-12	8-13	8-16	8-10	6-10	6-10
Mean	9.30 ±0.47	9.50 ±0.62	10.50 ±0.57	9.30 ±0.47	10.60 ±0.49	10.80 ±0.70	11.50 ±0.83	8.50 ±0.83	8.00 ±0.58	7.00 ±0.47
<b>No. of fruit set/plant</b>										
Range	4-6	3-6	5-8	4-7	5-8	5-8	1-3	5-7	5-7	3-5
Mean	5.20 ±0.28	4.90 ±0.22	7.80 ±0.24	5.40 ±0.29	7.50 ±0.32	7.40 ±0.38	1.50 ±0.25	5.30 ±0.25	5.80 ±0.24	3.40 ±0.15
Percentage of fruit setting	55.9	51.6	74.3	58.1	70.8	68.5	13.1	62.4	72.5	48.6
<b>Anthesis time of male flowers</b>										
Starting time of anthesis (am)	4:41	4:38	4:45	4:37	4:38	4:33	-	4:35	4:37	4:34
Full blooming time (am)	5:05	5:10	5:00	4:55	5:05	5:03	-	4:52	5:00	4:50
<b>Anthesis time of female flowers</b>										
Starting time of anthesis (am)	4:25	4:25	4:25	4:20	4:30	4:25	4:48	4:25	4:25	4:25
Full blooming time (am)	4:50	4:50	4:55	4:50	5:00	4:55	5:15	4:45	4:45	4:45
<b>Time of anther dehiscence</b>										
Range (am)	2:15- 2:30	1:45- 2:25	2:15- 2:30	2:15- 2:35	2:15- 2:35	2:00- 2:15	2:25- 2:35	2:30- 2:40	2:15- 2:35	2:30- 2:35
Mean (am)	2.21 ±0.05	2.04 ±0.11	2.25 ±0.05	2.23 ±0.06	2.26 ±0.06	2.07 ±0.04	2.30 ±0.03	2.32 ±0.03	2.26 ±0.06	2.32 ±0.19

±: Standard error

### Number of Female Flower per Plant and Fruit Set

The total number of female flowers per plant varied from 6 to 16 in different genotypes. The highest number of hermaphrodite flowers was 11.5 (range 8 to 16) in the genotype Bisexual. The first (10.8) and the second highest number (10.6) of female flowers bloomed in High female and Mk-1

genotypes, respectively. The indigenous materials produced lower number of female flowers per plant than the exotic materials. In the local genotypes the range of female flowers per plant was 6 to 10 only.

In general, the number of fruit set in a plant is directly related with female flower production. Although the genotype Bisexual produced the highest number of hermaphrodite flower per plant, but it produced lowest number of fruits. The highest number of fruits set per plant (average 6.8) was observed in the genotype Chiqua-90-10 which also showed the highest percentage (74.3%) of fruit setting. The second and third highest fruit set as well as their percentage was observed in the genotypes Mk-1 and high female. The percentage of fruit setting in the exotic monoecious materials was higher than the local ones, In case of three local materials; the highest fruit setting was 50.6%. It was obvious that the number of fruit setting depended on the number of female flowers and the influence of the environmental factors. It was observed that pollination was hampered by heavy shower. It was also observed that the percentage of fruit setting was poor from natural pollination. The Bisexual genotype produced lowest number of fruits even though its pollen grains were viable. It is assumed that it could not suit well in Bangladesh climatic conditions and therefore, produced the lowest yield. Through hybridization program these desired characteristics can be accommodated in one genotype.

#### **Time of Anthesis**

Anthesis time of different ash gourd genotypes did not differ very much from one genotype to another. The anthesis of the pistillate flowers took place earlier than the staminate flowers. The earliest anthesis of male flowers was observed on the genotype High Female (4.33 am). Within 4.45 am anthesis of male flowers of all ash gourd genotypes started and required 20 to 30 min for full blooming (Table 1).

The anthesis of female flowers started from 4.20 to 4.30 am and completed their full blooming within the range of 4.50 to 5:15 am. Among all the genotypes of ash gourd, earliest starting of anthesis of the female flowers was observed in Chiqua-9 at 4:00 am within a period of 10 min, anthesis of female flowers of all other genotypes took place.

Randhawa *et al.* (1982) studied some features of the floral biology of ash gourd and reported that the anthesis of both male and female flower took place at 4:30 to 7:30 am. Seshadri (1986) as well as BARI (2006) also reported that the anthesis of ash gourd took place in early morning.

#### **Time of Anther Dehiscence**

Anther dehiscence of different ash gourd genotypes took place at 1:45 to 2:40 am. (Table 1). The first dehiscence occurred in the genotype Chiqua-90-5. The mean time of this material to dehiscence its anthers was at 2:04 am. The genotype High female also showed early dehiscence in comparison to other genotypes. In case of the Bisexual genotype, anther dehiscence took place at 2:30 am.

The results of this study differed a little from the observation of Randhawa *et al.* (1982) who reported that the anther dehiscence took place at 3:00 to 5:00 am.

The average temperature for growth and other physiological activities which influence the dehiscence would be around 30 to 35°C. The required day temperature is above 25°C with bright sunshine. For normal growth, all cucurbits required optimum average monthly temperature from 25 to 30°C (Seshadri, 1986), but for ash gourd, Rashid (1999) reported that the temperature should be within 25 to 35°C. The time of anther dehiscence may vary from place to place due to variation of sunshine and temperature.

#### **Duration of Stigma Receptivity and Pollen Viability**

To ensure the duration of stigma receptivity and pollen viability, fruit setting was taken as an index. Pollination with fresh pollen just after anthesis produced 100% fruit set (Table 2). Pollination

Table 2: Effect of age of pistil, pollen and time of pollination on fruit set in different ash gourd genotypes

Postillate flowers	Stage of pistillate flower	Pollen source	Age of pollen	Time of pollination	% of fruit set
Chiqua 90-2	8 h before anthesis	Self/cross	18 h	9 pm	0
Chiqua 90-5	..	..	..	..	0
Chiqua 90-10	..	..	..	..	0
Chiqua 9	..	..	..	..	0
Mk-1	..	..	..	..	0
High female	..	..	..	..	0
Bisexual	..	..	..	..	0
Local (long)	..	..	..	..	0
Local (round)	..	..	..	..	0
Local	..	..	..	..	0
Chiqua 90-2	6 h before anthesis	Self/cross	20 h	11 pm	60
Chiqua 90-5	..	..	..	..	40
Chiqua 90-10	..	..	..	..	60
Chiqua 9	..	..	..	..	20
Mk-1	..	..	..	..	40
High female	..	..	..	..	40
Bisexual	..	..	..	..	20
Local (long)	..	..	..	..	40
Local (round)	..	..	..	..	40
Local	..	..	..	..	20
Chiqua 90-2	At anthesis	Self/other monoecious	fresh	6 am	100
Chiqua 90-5	..	..	..	..	100
Chiqua 90-10	..	..	..	..	100
Chiqua 9	..	..	..	..	100
Mk-1	..	..	..	..	100
High female	..	..	..	..	100
Bisexual	..	..	..	..	80
Local (long)	..	..	..	..	100
Local (round)	..	..	..	..	100
Local	..	..	..	..	100
Chiqua 90-2	8 h after anthesis	Monoecious (self/cross)	10 h	1 pm	100
Chiqua 90-5	..	..	..	..	100
Chiqua 90-10	..	..	..	..	100
Chiqua 9	..	..	..	..	100
Mk-1	..	..	..	..	100
High female	..	..	..	..	100
Bisexual	..	..	..	..	40
Local (long)	..	..	..	..	100
Local (round)	..	..	..	..	100
Local	..	..	..	..	100
Chiqua 90-2	12 h after anthesis	Monoecious (self/cross)	14 h	5 pm	60
Chiqua 90-5	..	..	..	..	60
Chiqua 90-10	..	..	..	..	80
Chiqua 9	..	..	..	..	60
Mk-1	..	..	..	..	80
High female	..	..	..	..	80
Bisexual	..	..	..	..	0
Local (long)	..	..	..	..	80
Local (round)	..	..	..	..	40
Local	..	..	..	..	60
Chiqua 90-2	16 h after anthesis	Any monoecious (self/cross)	18 h	9 pm	20
Chiqua 90-5	..	..	..	..	20
Chiqua 90-10	..	..	..	..	40
Chiqua 9	..	..	..	..	20
Mk-1	..	..	..	..	40
High female	..	..	..	..	20
Bisexual	..	..	..	..	0
Local (long)	..	..	..	..	20
Local (round)	..	..	..	..	40
Local	..	..	..	..	20

Table 2: Continued

Postillate flowers	Stage of pistillate flower	Pollen source	Age of pollen	Time of pollination	% of fruit set
Chiqua 90-2	18h after anthesis (self/cross)	Any monoecious	20h	11 pm	0
Chiqua 90-5	..	..	..	..	0
Chiqua 90-10	..	..	..	..	0
Chiqua 9	..	..	..	..	0(5)
Mk-1	..	..	..	..	0
High female	..	..	..	..	0
Bisexual	..	..	..	..	0
Local (long)	..	..	..	..	0
Local (round)	..	..	..	..	0
Local	..	..	..	..	0
Chiqua 90-2	26h after anthesis	Monoecious (self/cross)	Fresh	6 am	0
Chiqua 90-5	..	..	..	..	0
Chiqua 90-10	..	..	..	..	0
Chiqua 9	..	..	..	..	0
Mk-1	..	..	..	..	0
High female	..	..	..	..	0
Bisexual	..	..	..	..	0
Local (long)	..	..	..	..	0
Local (round)	..	..	..	..	0
Local	..	..	..	..	0

No. of observations = 5 (For each case)

before 6 h of anthesis resulted in 20-60% fruit set in different ash gourd genotypes of this study. But pollination before 8 h of anthesis failed to set fruit. Therefore, it was indicated that stigma became receptive about 6 h before anthesis.

Pollination of pistils after 8 h of anthesis with 10 h old pollen resulted in 60-100% fruit set excluding the Bisexual. A good number of fruit setting (20-40%) was found from pollination after 16 h of anthesis with 18 h old pollen. However, there was no fruit setting in Bisexual genotype.

Pollination after 18 h of anthesis with 20 h old pollen failed to set any fruit irrespective of genotypes, but the pollen grains appeared to be viable under microscope. Besides these, pollination after 26 h of anthesis with fresh pollen did not result in any fruit setting. From the study, it was observed that the stigma remained receptive 16 h after anthesis. Time of pollination had no conspicuous effect on fruit set in ash gourd.

A similar study was carried out by Randhawa *et al.* (1982). They reported that the stigma was receptive from 8 h before anthesis to 18 h after anthesis. BARI (2006) reported that pollination should be done before 11 am.

### **Cross Compatibility**

All the genotypes used in this study were crossed in all direction and all of these crosses were successful i.e., they are cross compatible.

The present study suggests that the sowing of indigenous genotypes should be 25-30 days earlier than exotic ash gourd genotypes for synchronization of flowering and initiating a successful crossing program. The stigma became receptive 6 h before anthesis and receptivity continued up to 16 h after anthesis. Therefore, crossing should be performed within this period and pollination can be done any time of the day. All the genotypes used in this study were cross compatible. Hybridization program can be done to develop a semi dwarf, early and high yielding variety or varieties.

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