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STUDIES ON FLORAL BIOLOGY AND POLLINATION BEHAVIOUR OF DURIAN (*Durio zibethinus* J. MUR.)

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ABSTRACT

Durian (*Durio zibethinus* J. Mur) is the most popular seasonal fruit in the ASEAN countries and is widely grown in Sri lanka. It is considered to be an exceedingly delicious, nutritious and most expensive fruit. The fruit set of durian is very low, even though it produces many flowers. Inadequate pollination is mainly responsible for it. The pollination under natural condition is carried out by bats and nocturnal insects. However, under natural conditions, the opportunity for pollination is limited. Therefore, experiments were carried out at Horticultural Crop Research and Development Institute, Gannoruwa, with the objectives of studying the floral biology and nature of pollination and to investigate the success of artificial pollination at different times. The floral biology was studied using twenty five flowers in five cultivars. Self pollination was carried out using the same cultivars to find out the extent of self compatibility. Artificial cross pollination was carried out using one male parent and three female parents. The pollination was done during 11.00 hrs to 19.00 hrs at two hour intervals. The average number of flowers per cluster was 25 and minimum and maximum were 5 and 66, respectively. The flower characteristics such as shape of flower buds, length of pedicels, colour of petals and stigma, number of stamens etc., varied with the cultivars and are useful for identification purposes. It was revealed that the stigma began to be receptive at around 11.00 hrs. Time of full blooming started from 16.00 hrs and anthers shed their pollen at 18.00 hrs. However, there was little variation between the cultivars and also with light intensity. The percentage of fruit set under self pollination of the five cultivars was 0-10% indicating that most of the cultivars are self incompatible. Hand pollination resulted in higher percentage of fruit setting (60%) than in natural pollination (17%). The highest percentage of fruit setting occurred at 19.00 hrs in all cultivars (75%). The results indicated that hand pollination could also be done using stored pollen during 13.00 hrs to 17.00 hrs. However, fruit setting was recorded only three weeks after pollination.

KEYWORDS: Floral characteristic, Receptivity, Self and Cross pollination.

INTRODUCTION

Durian (*Durio Zibethinus* J. Mur.) is a tropical fruit belonging to family Bombacaceae. It is the most famous and popular seasonal fruit in the ASEAN countries. Borneo is recognized as the center of diversity, but it is now grown widely in Thailand, Malaysia, Indonesia, Philippines and Sri Lanka. The main fruiting season of durian extends from June to August. However, occasionally, owing to climatic variations, a second crop could be obtained during February to March (Medagoda, 1999). In Sri Lanka, a high genetic variation in durian has been reported (Medagoda, 1996). Two

varieties of durian known as "Abathanna" and "Kasun" were recommended and released for cultivation in 1999 (Medagoda, 1999; Heenkenda, 1999).

Durian flowers are bisexual and have a high degree of self incompatibility. It is also reported that pollination is problematic in durian cultivars in the Philippines (Valmayor *et al.,* 1965). Hence, flowers must be cross-pollinated from other trees in order to set fruits (Malo and Martin, 1979). The fruit set of durian is very low, even though it produces many flowers. The stigma from the pistil comes out first and becomes receptive long before the anthers dehisce the pollen (Subhadrabandhu & Ketsa, 2001). Bats and nocturnal insects carry out pollination under natural conditions. However, under natural conditions, the opportunity for pollination is limited. It has been reported that hand pollination is successful and improves both fruit shape and size (Somasri, 1987). Little is known on pollination process of durian cultivars in Sri Lanka. Therefore, experiments were carried out at Horticultural Crop Research and Development Institute (HORDI), Gannoruwa, with the objectives of studying the floral biology and nature of pollination and to investigate the success of artificial pollination at different periods.

MATERIALS AND METHODS

Floral biology

Five selected durian cultivars (GA, KN 8, KN 22, KN 61 and KN 62) were used for the studies on floral biology. Ten flower clusters per tree were labeled and the number of flowers per cluster was counted. The average number of flowers and the maximum and minimum number of flowers per cluster were then recorded. Observations were made on time of full blooming, time from flower initiation to blooming, time of stigma exertion and the characteristic of the flowers in each cultivar. The anther dehiscence time was observed every 1/2 hour starting from 14.00 hrs by touching the anthers with the fingers and recording the time that pollen adhere to the fingers. As it was difficult to observe the colour changes of the stigma at receptive time, the stigma receptivity was found by applying pollen at hourly intervals, starting from 10.00 hrs to 22.00 hrs. The flowers were emasculated and pollen applied thoroughly and carefully to the stigmas. The flowers were kept closed for five days using oilpaper bags to avoid contamination. The pollen stored in a refrigerator on the previous day was used to pollinate flowers at 10.00 hrs to 17.00 hrs. But the pollen collected on the same day was used to pollinate the flowers from 18.00 hrs to 22.00 hrs. The success of pollination was recorded after 3 weeks of pollination and at this stage it showed an enlargement of the ovary. The flowers that were not pollinated dropped after 4-5 days. Subhadrabandhu & Ketsa (2001) stated that if pollination is successful, the

colour of the young fruit changes from light brown to light green and within a week the ovary starts to enlarge.

Pollination studies

A study was carried out to find the nature of pollination. Twenty five well developed flower buds from each cultivar were covered using oil paper bags and pollen applied from the same tree to find the success of pollination due to selfing. The success was recorded after 3 weeks of pollination.

The preliminary studies on hand pollination (artificial pollination) was done at two different sessions. One session was from 11.00 hrs to 17.00 hrs at two hour intervals (11.00 hrs, 13.00 hrs, 15.00 hrs and 17.00 hrs) and the other from 19.00 hrs. The pollen collected on the previous day was used to pollinate flowers during 11.00 hrs to 17.00 hrs, as there was no pollen during that period. But pollen produced on the same day was used to pollinate at 19.00 hrs. One tree (KN 62) was used as a pollen source or male parent and three trees (GA, KN 8, KN 61) were used as female parents. Twenty five flowers were used from each tree to pollinate at different times. The pollen was applied on fully opened flowers by rubbing the pollen on the stigma. Pollinated flowers were bagged using oilpaper bags to avoid contamination. Pollination at a particular time could not be done on the same day in all three cultivars due to variation of stages of flower development. The success of fruit set at different times of pollination was recorded three weeks after pollination.

RESULTS AND DISCUSSION

Floral biology

In Durian, the inflorescences are borne on lateral branches of the tree. According to Nakasone and Paull (1998) a durian tree can produce 20,000–40,000 flowers in a season. Time taken from flower initiation to full bloom was 40-50 days. Durian flowers develop in clusters mainly from branches of the tree. The number of flowers per cluster varied from 5-66 with an average of about 25 in locally selected cultivars (Table 1). Somsri (1987) reported the number of flowers per cluster as 50. However, the data shows that the number of flowers per cluster is very high and can vary with the cultivar. Two different shapes of flower buds were observed as buds with rounded apex (cvs. GA, KN 8, KN 22, KN 62) and with pointed apex (cv. KN 61) (Table 1). The cultivar KN 22 has longer pedicels than the other cultivars (Table 1). The colours of the flower petals varied from greenish white to creamy white. Flowers are bisexual. The epicalyx is entirely closed initially and later splits into two to four segments. Flowers possess five sepals, except in some cases which had four or six sepals (Table 1).

Table 1. Floral characters of five selected cultivars.

Cultivar	*Av. No. of fls/cluster (min & max)*	*Av. Lth. of pedicel (cm)*	*Shape of flower buds*	*No. of sepals*	*No. of petals*	*Colour of sepals*	*Colour of petals*	*No. of stamen bundles*	*No. of stamens*	*Av. Length. of flower (cm)*	*Av.length of petals (cm)*	*Length. of stamens (cm)**	*Length. of style (cm)*	*Colour of stigma*
GA	23 (5 - 50)	5.0	Rounded	4 - 5	5	Light orange	Creamy white	5	35 - 50	4.7	4.5	- 3.1 - 4.1	4.5	Orange
KN 8	28 (7 - 66)	4.5	Rounded	5 - 6	5 - 6	Light orange	Creamy white	5 - 6	60 - 80	5.0	4.5	3.0 - 4.0	4.5	Orange
KN 61	25 (6 - 55)	6.0	Pointed	4 - 5	5 - 6	Light orange with green tip	Greenish white	5 - 6	40 - 55	5.0	5.0	3.5 - 4.5	6.0	Orange
KN 22	19 (5 - 35)	7.0	Rounded	5 - 6	5 - 6	Light orange with green tip	Greenish white	5 - 6	40 - 55	4.5	4.0	3.0 - 3.5	3.8	Light yellow
KN 62	30 (7 - 60)	4.5	Rounded	5 – 6	5 - 6	Light orange with green tip	Greenish white	5 – 6	40 – 55	5.0	4.5	3.1 – 4.1	4.5	Orange

* Shortest - longest

The sepals are usually united below the middle and drop off as a unit. The cultivar KN 8 has many stamens and it may be an important character for pollination studies. The number of sepals also varies with the cultivars and these may be important for the identification of the cultivars. Even though the durian flowers are hermaphrodite, when the flowers open, the stigma and the stamen do not mature at the same time and thus naturally avoids self pollination. Time of full blooming started from 16.00 hrs and anthers started to shed pollen after 18.00 hrs confirming the results of Subhadrabandhu & Ketsa (2001). But according to the observations in this study, these times varied slightly with the cultivar and also with light intensity. It was observed that in cloudy weather conditions, anthers shed their pollen as early as 17.00 hrs. Even the time of stigma emergence varies from tree to tree. In some cultivars, the stigma does not emerge completely before flower opening whereas in others it is visible. It was observed that all the mature parts of the flower fall on the same day, leaving the female parts on the tree. These too drop after 4-5 days if not successfully pollinated.

Table 2 show that the stigma began to be receptive around 11.00 hrs. At this stage, in some trees, the stigma was still inside the flower. The results showed that the pollen collected on the previous day and stored in refrigerator could be used to pollinate flowers from 11.00 hrs to 17.00 hrs. However, the viability of pollen has to be studied further. The pollen collected on the same day could be used to pollinate successfully during 19.00 hrs–20.00 hrs and the success declines thereafter. However, there are some practical difficulties for pollination after 19.00 hrs due to inadequacy of light. The percentage success was 40% at 18.00 hrs. Pollen dehiscence begins during the same period of time and thus the inadequacy of pollen may be the reason for the low success.

Table 2. Percentage fruit set at different times (3 weeks after pollination).

Time of pollination (hrs.)	*% Success*
10.00	05
11.00	48
12.00	60
13.00	71
14.00	75
15.00	65
16.00	67
17.00	70
*18.00	40
*19.00	94
*20.00	78
*21.00	50
*22.00	25

Note: Adjusted local times were used * Pollinated with pollen collected on the same day.

Pollination studies

Table 3 shows all the cultivars are either self incompatible or have a very low percentage of self compatibility. Therefore, cross pollination is essential to increase fruit setting. Thus, in large scale plantations, varieties should be planted alternatively in order to facilitate pollination.

Table 3. Percentage fruit set 3 weeks after self pollination.

Crosses	*% fruit set*
T1 x T1	00
T2 x T2	10
T3 x T3	00
T4 x T4	00
T5 x T5	00

T–Indicates tree number

Figure 1 shows the percentage fruit set in hand pollinated and natural pollinated flowers in three different cultivars. A higher percentage (60%) of fruit set was achieved by hand pollination compared to natural pollination.

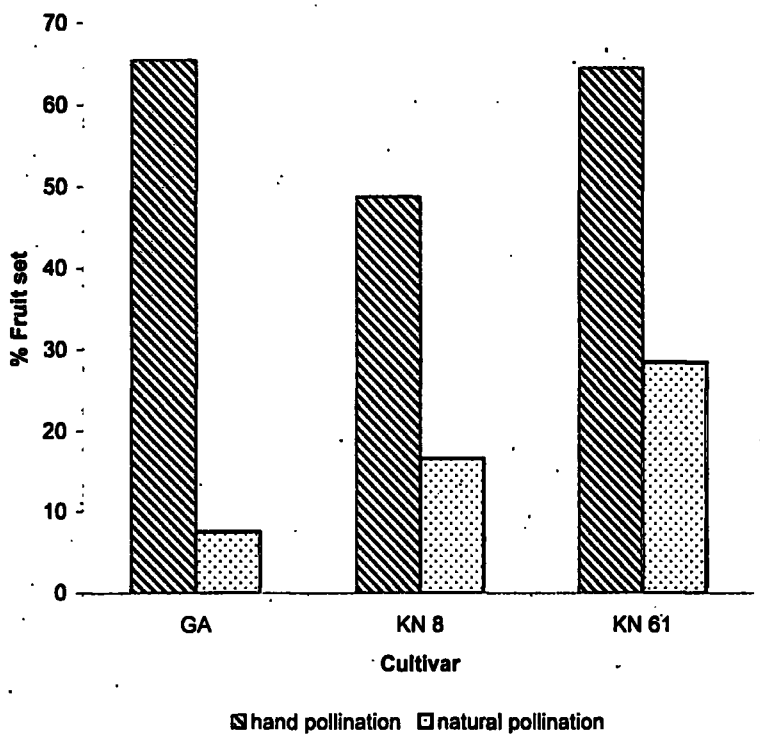

Figure 1. Percentage fruit set by hand and natural pollination (3 weeks after pollination).

Figure 2 shows the relationship between time of pollination and the success of fruit set. The highest percentage of fruit set occurred at 19.00 hrs in all three cultivars. The results indicated that hand pollination could also be done during the 13.00 to 17.00 hr period. However, cultivar KN 8 showed low percentage of fruit set at 17.00 hrs. This may be due to the adverse environmental conditions, especially the high rainfall that occurred during the time of pollination. According to Nakasone and Paull (1998) rain dew can dilute the stigmatic exudates leading to low pollen germination. However, fruit set was recorded only at three weeks after pollination. Therefore, fruit development in later stages should be studied further.

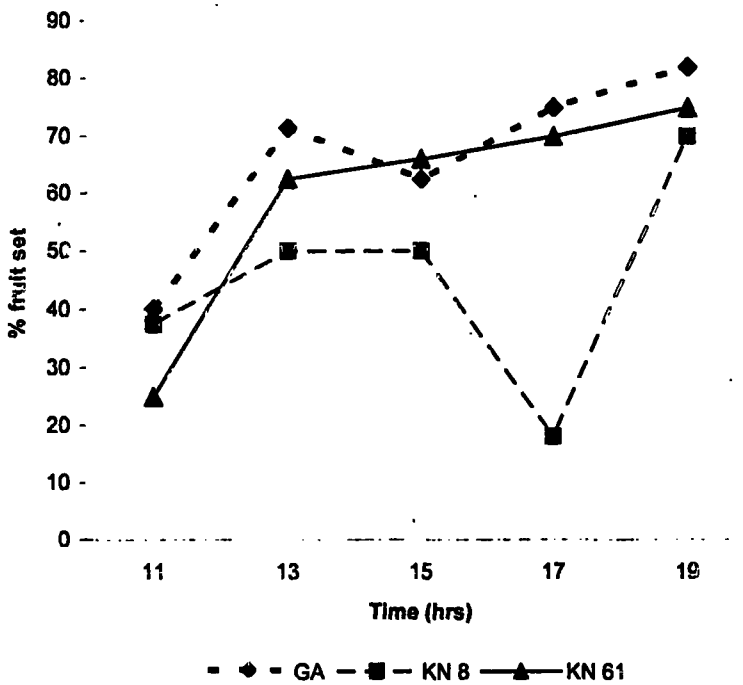

Figure 2. Effect of time on fruit set by artificial pollination.

CONCLUSIONS

The characteristics such as the shape of flower buds, length of pedicels, colour of petals and stigma, number of stamens etc. vary in different cultivars and therefore these could be used to identify the cultivars. The average number of flowers per cluster was recorded as 25 and minimum and maximum were 5 and 66 respectively. The stigma receptivity begins around 11.00 hrs. Time of full blooming started at 16.00 hrs and anthers started to shed their pollen at 18.00 hrs. These varied significantly with cultivars and light intensity. The pollen collected on the same day could be used for

pollination after 18.00 hrs. The pollen collected on the previous day and stored in refrigerator could be used to pollinate flowers from 11.00 hrs to 17.00 hrs, as pollen is not available during that time. The percentage fruit set of five cultivars under self pollination varied from 0-10%. The percentage of fruit set by hand pollination was higher than in natural pollination. The highest percentage (75%) of fruit set occurred at 19.00 hrs in all cultivars. Hand pollination was also successful during the period 13.00 hrs to 17.00 hrs. However, fruit set was recorded only at three weeks after pollination. Therefore, fruit development in later stages should be studied further.

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