

Study of pollen production and pollen: Ovule ratio in some common members of *Malvaceae* in Nagpur city

Archana Sawane^{1*}, Priya Taywade², Tejaswini Raut³

¹⁻³ Department of Botany, S.M. Mohota College of Science, R. T. M. Nagpur University, Nagpur, Maharashtra, India

Abstract

The family *Malvaceae* is one of the largest flowering plant families with 4465 species recorded worldwide belonging to 245 genera. 35 species are reported from Nagpur district. Plants have ornamental, economical and medicinal value. Though morphological pollen studies in these plants are published, very meagre quantitative data is available about pollen production and pollen:ovule ratio, which provides insight into breeding system of the plants. This project was, therefore, undertaken to evaluate the same in some common members of *Malvaceae* found in Nagpur city. 14 species belonging to 8 genera of *Malvaceae* were evaluated. With limitations of less sample size and smaller geographical area, this preliminary study has presented quantitative data on pollen production and pollen:ovule ratio. In our future studies, pollen production and P:O ratios would be studied in different regions of wider geographical area in different seasons and with larger sample size so that relationship of all these factors on breeding system can be better understood.

Keywords: *Malvaceae*, pollen production, Pollen: Ovule ratio

Introduction

The family *Malvaceae* commonly known as 'Mallow family', is one of the largest flowering plant families. Plants belonging to *Malvaceae* family are used as food to produce beverages, for fibre, for their ornamental value and also for their medicinal value. Some of the economically important species have been introduced and cultivated in different parts of the World. 4465 accepted species names belonging to 245 genera are reported in this family worldwide in *The Plant List*, 2013 ^[1]. Around 93 species belonging to 22 genera of the family are reported from India ^[2]. 35 species are reported from Nagpur district by Ugemuge, N.R. in Flora of Nagpur district ^[3].

Palynological studies can provide more accurate basis for the identification of plant species. The study of pollen biology has direct relevance in agriculture, horticulture, forestry, plant breeding, forensic sciences and biotechnology. For a taxonomist, the data about fertility of pollens is an important means to differentiate the potential hybrid and parental plant ^[4].

A plant during its entire flowering period produces large amount of pollen grains most of which are not involved in fertilization. This large amount of pollen released may float in air or water and finally get deposited in earth's surface. The knowledge of quantitative production gives some idea about the frequency of presence of particular plant pollen grains in the atmosphere ^[5].

The pollen-ovule ratio (P/O) provides the best insight into the breeding system of a species ^[6]. Pollen-ovule ratios reflect the pollination efficiency, i.e., the likelihood of a pollen grain reaching the stigma ^[7, 8]. There is a substantial decrease in P/O ration from xenogamy to facultative xenogamy to autogamy. P/O ratios are also affected by the sexual system, the pollen vectors, pollination mechanisms, and ecological factors.

Though morphological pollen studies in these plants are

published, very meagre data is available about number of pollen production per flower and pollen:ovule ratio. Keeping in mind the immense importance of pollen study, this project was undertaken to evaluate the pollen production and pollen:ovule ratio in some common members of *Malvaceae*.

Materials and Methods

Pollen production in 14 species belonging to 8 genera was evaluated in this project (Table 1). These plants are used as vegetables, medicinal plants and are of economic importance. The study was conducted from September 2018 to March 2019.

Pollen production

The plants selected for this study were collected from road side and open spaces in residential areas of Nagpur city. Mature and undehisced anthers from the flower buds were collected in the morning hours and pollen productivity (number of pollens per anther) was determined as per the method of Nair and Rastogi ^[9].

Pollen ovule ratio

To calculate pollen ovule (p/o) ratios, the number of grains per anther was averaged for three anthers from a flower. The mean number of grains per anther was then multiplied by the total number of anthers in the flower examined, and this was divided by the number of ovules in that flower. For each species, ten such flowers belonging to different individual plants were studied and finally average of number of anthers per flower, pollen production per flower and Pollen/ovule ratios along with standard deviation was calculated. Pollen/ovule ratios were log transformed to generate similar data as done by Cruden ^[7] in their extensive breeding system data and data published by Erbar and Langlotz ^[10].

Results and Discussion

Average number of anthers, average number of pollens per anther and average number of ovules/seeds per fruit were counted in all the studied plants. The results obtained are

presented in Table 2. Pollen: ovule ratios and log transformed Pollen: Ovule ratios for all 14 species studied are presented in Table 3.

Table 1: Showing Botanical names, vernacular and common names and habit of the studied plants

Sr. No.	Botanical Name	Vernacular name	Common Name	Habit
1	<i>Abelmoschus esculentus</i> L.	Bhendi	Lady finger	Herb
2	<i>Abelmoschus manihot</i> L.	Ranbhendi	Sweet hibiscus	Herb
3	<i>Abutilon indicum</i> L.	Petari Atibala	Indian mallow	Herb
4	<i>Abutilon hirtum</i> (Lam)	Barkanghi	Buttonweed	Herb
5	<i>Gossypium hirsutum</i> L.	Kapus	Mexican cotton	Shrub
6	<i>Hibiscus cannabinus</i> L.	Ambadi, San	Deccan hemp	Shrub
7	<i>Hibiscus rosasinensis</i> L.	Jaswand	China rose	Shrub
8	<i>Hibiscus sabdariffa</i> L.	Lal ambadi	Roselle	Herb
9	<i>Malachra capitata</i> L.	Vilayati bhendi	Brazil jute	Herb
10	<i>Malva sylvestris</i> L.	Kubaaajee	High mallow	Herb
11	<i>Sida acuta</i> (Burm. f.)	Chikna	Common wireweed	Shrub
12	<i>Sida cordata</i> (Burm.f.)	Bhumi petari / Bhuichikana	Country mallow	Herb
13	<i>Sida cordifolia</i> L.	Bala	Heart leaf sida	Shrub
14	<i>Urena lobata</i> L.	Vanbhendi	Caesarweed	Shrub

Table 2: Showing Average number of anthers, average number of pollens per anther and average number of seeds/ovules per fruit in the studied plants.

Sr. No.	Botanical Name	Average Number of anthers \pm Std Dev	Average number of pollens per anther \pm Std Dev	Average number of ovules/seeds per fruit \pm Std Dev	Average number of Pollens per flower \pm Std Dev
1	<i>Abelmoschus esculentus</i> L.	52.00 \pm 3.16	80.00 \pm 8.60	37.80 \pm 5.85	4170.4 \pm 595.2
2	<i>Abelmoschus obate</i> L.	55.20 \pm 8.07	82.40 \pm 6.23	25.20 \pm 3.27	4547.2 \pm 760.1
3	<i>Abutilon indicum</i> L.	52.00 \pm 3.16	43.20 \pm 3.03	39.00 \pm 4.24	2252.0 \pm 273.2
4	<i>Abutilon hirtum</i> (Lam)	47.60 \pm 3.85	62.00 \pm 7.75	81.40 \pm 11.78	2948.0 \pm 415.8
5	<i>Gossypium hirsutum</i> L.	69.20 \pm 5.76	61.20 \pm 8.90	23.60 \pm 5.18	4255.2 \pm 880.6
6	<i>Hibiscus cannabinus</i> L.	32.00 \pm 2.00	62.40 \pm 7.40	22.40 \pm 2.07	1990.4 \pm 195.1
7	<i>Hibiscus rosasinensis</i> L.	64.80 \pm 10.64	90.20 \pm 4.02	52.00 \pm 4.90	5836.8 \pm 919.0
8	<i>Hibiscus sabdariffa</i> L.	32.00 \pm 3.16	50.40 \pm 3.85	25.00 \pm 3.39	1615.2 \pm 223.1
9	<i>Malachra obate</i> e L.	21.80 \pm 2.05	30.60 \pm 4.77	19.60 \pm 4.04	669.6 \pm 137.7
10	<i>Malva sylvestris</i> L.	33.60 \pm 3.85	57.60 \pm 3.85	10.80 \pm 1.10	1946.4 \pm 339.5
11	<i>Sida acuta</i> (Burm. F.)	50.80 \pm 11.97	46.40 \pm 5.18	6.20 \pm 0.45	2402.4 \pm 777.7
12	<i>Sida cordata</i> (Burm.f.)	14.60 \pm 1.52	70.20 \pm 4.15	5.00 \pm 0.00	1022.6 \pm 93.4
13	<i>Sida cordifolia</i> L.	36.80 \pm 4.82	44.40 \pm 3.85	10.40 \pm 1.67	1639.2 \pm 305.8
14	<i>Urena obate</i> L.	30.80 \pm 2.28	47.60 \pm 3.85	37.20 \pm 4.60	1468.8 \pm 188.4

Table 3: Pollen: Ovule ratio in the studied plants of Malvaceae.

Sr. No.	Botanical Name	P:O Ratio \pm Standard Deviation	Log P:O Ratio
1	<i>Abelmoschus esculentus</i> L.	110.6914 \pm 8.42	2.044114
2	<i>Abelmoschus manihot</i> L.	180.1387 \pm 13.51	2.255607
3	<i>Abutilon indicum</i> L.	58.15111 \pm 8.65	1.764558
4	<i>Abutilon hirtum</i> (Lam)	36.92901 \pm 7.88	1.567368
5	<i>Gossypium hirsutum</i> L.	187.0768 \pm 52.78	2.27202
6	<i>Hibiscus cannabinus</i> L.	88.98753 \pm 6.33	1.949329
7	<i>Hibiscus rosasinensis</i> L.	112.7075 \pm 19.03	2.051953
8	<i>Hibiscus sabdariffa</i> L.	65.14815 \pm 9.64	1.813902
9	<i>Malachra capitata</i> L.	36.52058 \pm 15.08	1.562538
10	<i>Malva sylvestris</i> L.	182.8267 \pm 42.14	2.26204
11	<i>Sida acuta</i> (Burm. f.)	390.8 \pm 137.14	2.591955
12	<i>Sida cordata</i> (Burm.f.)	204.52 \pm 18.67	2.310736
13	<i>Sida cordifolia</i> L.	157.9533 \pm 16.69	2.198529
14	<i>Urena lobata</i> L.	39.5951 \pm 3.70	1.597641

P:O ratio was highest in *Sida acuta*, followed by *Sida cordata*, *Gossypium hirsutum*, *Malva sylvestris*, while low ratios were found in *Malachra capitata*, *Abutilon hirtum*, *Urena lobata*. When compared to Cruden's Breeding systems classified on the basis of P:O ratio, all the plants studied may be considered to be having facultative

autogamy breeding system. Cruden ^[7] suggested that the P/O ratio indicates whether a plant species is xenogamous or autogamous and whether it is obligately or only facultatively so: The P/O ratios decrease from xenogamous to autogamous species (P/O \approx 5: cleistogamy, \approx 30: obligate autogamy, \approx 170: facultative autogamy, \approx 800: facultative

xenogamy, ≈ 6000 : xenogamy). However, there are many variations and deviations for such classification as observed by Erbar and Langlotz^[10].

Many different factors have been mentioned to influence the variation in the P/O ratios: pollen grain size, stigma surface, duration of stigma receptivity, pollen-bearing area of the pollinator, type of pollen vectors, special pollen-transporting mechanisms^[8]. A further factor influencing the P/O ratio is the viability of pollen grains^[11]. Lower pollen ratio also indicates the more efficient transfer of pollen and P/O ratios are also influenced by the pollinators. With lack of suitable pollinators and habitat in the city, the P/O ratio may become lower. P/O ratios for the species studied in current investigation may be lower as the study was conducted only in city limits.

Number of anthers per flower, number of grains per anther and pollen: ovule ratio vary within species due to different factors. Variations may be seen in tetraploids annuals, diploid annuals, diploid perennials. Pollen size, number of anthers per flower, number of grains per anther as well as pollen: ovule ratio show increase from tetraploids annuals to diploid annuals to diploid perennials^[12]. Such a correlation with ploidy levels could not be established in the current study as these factors causing variability in P/O ratio were not studied.

Conclusion

Data about Pollen production and pollen:ovule ratios were generated for common members of family *Malvaceae*. Limitation of the current investigation is the limited geographical area in which plants were studied and lesser number of flowers studied. Even with these limitations, this preliminary study is justified keeping in view the fact that there is lack of pollen ovule ratio studies in this region in common members of *Malvaceae*. In view of the variations in P/O ratios due to above-mentioned reasons, further studies should be carried out in different regions of wider geographical area in different seasons and with larger sample size so that relationship of all these factors on breeding system can be better understood.

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