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Floral biology studies in wild melon [*Cucumis melo* L. ssp. *agrestis* (Naudin) Pangalo var. *agrestis* Naudin]

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ABSTRACT

Studies on floral morphology, phenology and biology of wild melon revealed that the ratio of staminate and pistillate flowers was 3.40:1. The longevity of the male flowers were between 5 and 6 days, whereas, female flowers between 6 and 7 days. Anthesis was observed from 4.00 am to 10.00 am, while, the anther dehiscence started from 5.00 am which was continued to 7.00 am. The peak anthesis was observed from 8.00 am to 9.00 am and anther dehiscence from 6.00 am to 6.30 am. Freshly opened flowers showed pollen viability up to 98.35%, decreased upon closure and crashed to 17.48% in 3 days. Pollen germination was occurred after 15 minutes of incubation and continued up to 24 h of incubation. The stigma receptivity lasts from one to two days of anthesis. Major pollinator of wild melons observed was honey bee, mostly visited between 9:00 am to 6:00 pm.

Keywords: Anthesis, floral biology, phenology, pollen viability, wild melon

INTRODUCTION

India is considered to be secondary centre of origin for melons. The genus *Cucumis* contains cultivated cucumber (*Cucumis sativus* L.) and melon (*Cucumis melo* L.) and other wild species *viz.*, *C. prophetarum*, *C. callosus*, *C. hystrix*, *C. setosus* and *C. sativus* var. *hardwickii* (Chakravarty, 1982). Pitrat (2017) has classified wild melon traits (subsp. Agrestis) into two groups *viz.*, agresitis and *badi kachri*, the former is known as *Mekke kayi* (wild melon) in northern Karnataka and the later as semi domesticated. Botanically, it is an annual trailing vine plant with monoecious flower and has five sepals gamosepalous, petals are polypetalous, yellow colour, stamens are connective appendiculate, contain three anthers which are fused, ovary is fusiform with dense hairs, lobed and wet (Pandey et al., 2021). The wild species of melons possess various morphological and agronomic characters as well as resistance to pests and diseases. Therefore, emphasis has been laid on the utilization of these wild species of melons for the improvement of cucumber and muskmelon (Deakin *et al*., 1971).

Wild melon belongs to Cucurbitaceae family, with chromosome number 2n=24. It is an annual, trailing vine plant with monoecious flowers. The flowering period is from July to November. In Northern Karnataka, it is being cultivated as intercrop with sorghum on marginal lands with least crop husbandry. Due to its pleasant flavour, vivid hues (green, yellow, saffron, red, *etc*.) and nutritional profile, this underexploited cucurbit has gained a status of high value and taken pride of place in rural traditional cuisine (Kouonon et al., 2009). It is essential to conserve rare and threatened plant species like wild melons and the successful conservation programme relays on information of reproductive biology. The domain of reproductive biology includes floral biology, pollination dynamics, fertilization and embryogeny, seed development and germination (Marbaniang et al., 2018). Knowledge on floral biology is important for breeders for crop improvement and to frame hybridization work (Dhall et al., 2011).

Considering the scope of varietal improvement and conservation of endangered plants, an experiment was carried out to study the floral biology such as time of

anthesis, time of anther dehiscence, duration of stigma receptivity, pollen viability, longevity of flower and floral morphology to determine the effective hybridization time in wild melon.

MATERIALS AND METHODS

The experiment was conducted in the fields of the Department of Vegetable Science, College of Horticulture, Bagalkot during 2022. The experiment site was located at 16.18º N latitude and 75.07º E longitude with an altitude of 533 meters above mean sea level, in the northern dry zone of Karnataka. The promising wild melon genotypes HUB-9 suited for summer were studied using completely randomised design with 4 replications and 20 plants per replication. All the agronomical practices were adopted as per the recommendations of package of practice followed for pumpkin (Anon., 2019).

Observations on floral phenology, flower morphology and floral biology were recorded as per standard descriptors for melon (Srivastava et al., 2001; IPGRI, 2003). Other observations recorded were time of anthesis, anthesis (%), anther dehiscence (%), longevity of flowers, pollen viability (%), *in vitro* pollen germination (%) and stigma receptivity. Floral phenology of the wild melon was studied on five randomly selected plants (overall 30 male and female flowers) and female: male flower ratio and flowering season. The flowers from middle rows were selected at the time of anthesis (8 to 9 am). The floral morphology, flower structure, pollen grain shape were studied by dissecting flowers and images were captured using the Stereozoom Microscope (LMI, England, model SZM167).

Anthesis time, anthesis (%) and anther dehiscence (%) were recorded on ten flower buds in each replication. Anthesis time was recorded at different times of the day (early morning, morning, afternoon, evening and late in the evening) and anther dehiscence (%) was observed before and after flower opening using magnifying lens. Longevity of male and female flowers was recorded by observing 20 flowers of male and female flowers from bud stage up to either fruit set or drop off. The pollinators of wild melon were observed by visual counts and species were identified.

In vitro pollen germination was observed on germinating media containing 10% sucrose solution + 10 ppm boric acid (Brewbaker & Kwack, 1963). Stigma receptivity was studied by using the starving method, starting one day before anthesis, on the day of anthesis and one, two and three days after anthesis. For each genotype, sixty flower buds in total were studied. The selected flower buds were hand-pollinated with fresh pollen collected from male flowers at different intervals and expressed in percentage. By keeping an eye on the ovary as it grows in the pollinated flowers, fruit set was confirmed and the percentage was calculated.

RESULTS AND DISCUSSION

Floral phenology

The flowering in wild melon started 30 days after sowing, male flowers emerged first and female flowers appeared 8 days after male flowers. The total blooming period of male flowers was 40 to 45 days and female flowers, about 30 to 35 days, similar to the observations of Tschoeke et al. (2015). The extended blooming period in wild melon may be attributed to local weather conditions and genetic variations of the crop. The number of male and female flowers per vine was 109 and 33, respectively. Mean daily production of male flowers was consistently higher than female flowers. The production of a greater number of male flowers over female flowers would have favoured effective pollination and ensured sufficient amount of pollen deposits on female flowers, thus helping in effective pollination (Deyto & Cervancia, 2009). The male: female sex ratio per vine throughout the blooming period observed was 3.40: 1 as against earlier reported 6:1 ratio of male: hermaphrodite flowers in melons (Tschoeke et al., 2015). The variation in number of days taken to first flower bud appearance among cultivars was due to environmental conditions (Delaplane & Mayer, 2000).

Flower morphology

Wild melon (*Cucumis melo* ssp. *agrestis*) exhibited monoecious vine character (Fig. 1a) by producing unisexual flowers of globular shape at bud stage and showed actinomorphic symmetry. The average length and diameter of male flowers was 4.08 cm and 3.88 cm, respectively, born solitary or sometimes in a cluster of 2- 3 on thin pedicel having length of 1.55 cm. The staminate flowers contained 5 sepals which are fused, 1.10 cm long, with dense hairs and 5 petals which were free, yellow in colour with length of 1.78 cm and inserted into the calyx-tube. Stamens were

observed to be connective appendiculate, capitate and had 4 filaments and 3 anthers (Fig. 1b), where filaments were free in nature and anthers were fused together (Fig. 1c). The average length and diameter of female flower was 4.45 cm and 3.45 cm, respectively, always borne solitarily on leaf axile with a short pedicel of 0.75 cm. The pistillate flowers contained 5 fused sepals (that were fused, hairy, deeply lobed, 0.89 cm long) and 5 petals which were polypetalous, yellow in colour having length of 1.58 cm and inserted into the calyx-tube. The ovary length was 1.83 cm and diameter 5.59 mm. The ovary was inferior, fusiform (spindle shaped) without hairs and showed free central placentation. The style was short with lobed stigma and showed wet surface (Fig. 1d). Similar results were reported by Pandey et al. (2021).

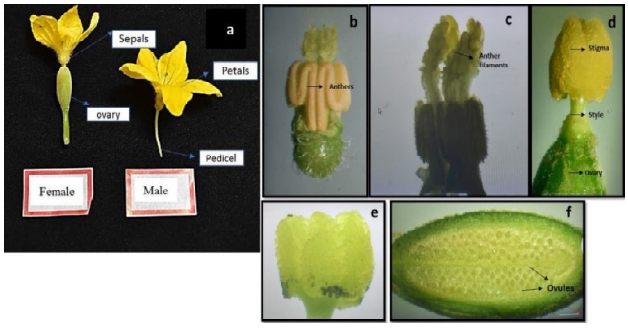

Fig. 1 : Flower characters of wild melon, (a) female and male flowers, (b) anthers of staminate flower, (c) anther filaments, (d) style, stigma and ovary, (e) lobed stigma with wet surface, (f) L.S of ovary

The flowers of wild melon were borne on the leaf axils. Exposed flowers were easy to access by pollinators and the flat structure was convenient for landing and the yellow colour could attract the pollinators (Goulson, 1999). The flowers remained open only for a day and the pollination had enhanced fruit set (Deyto & Cervancia, 2009). The morphology of flower was designed in such a way that both the plant and the pollinator mutually benefited.

Anthesis time, anthesis (%) and anther dehiscence (%)

The flower opening began at 4.00 am and it continued till 10.00 am and remained open till evening. Flowers opening was observed in both male and female at 04:00 to 05:00 am, at 06:00 am apex of petals separated, at 07:00 am flower half opened, by 08:00 to 09:00 am flowers were completely opened (Fig. 2), similar to the observations of Tschoeke et al. (2015). The variation of 1- 2 h for anthesis may be due to the local weather conditions. Since, on cloudy days, anthesis was slower than the sunny days (Kiill et al., 2016). Anthesis was totally ceased after 10.00 am. Peak period of anthesis was observed between 8.00 am to 9.00 am (72.00%) as maximum number of flowers opened during this period (Table 1) because of favourable temperature and relative humidity.

Fig. 2 : Anthesis in wild melons: male flower (a, b, c, d) and female flower (e, f, g, h)

Dehiscence of anthers in wild melon started at 5.00 am and continued till 7.00 am with a peak period from 6.00 to 6.30 am (68.50%) (Table 1). Deyto & Cervancia (2009) also reported similar findings. The temperature range of 30º to 35ºC is most favorable for anther dehiscence, which may vary from species to species and location to location with environmental conditions.

Table 1 : Flower opened, duration and anther dehiscence in wild melon

Duration	Flowers opened (Nos.)	Duration	Anther dehiscence (%)
6.00- 7.00 am	10.80	5.00- 5.30 am	8.30
7.00- 8.00 am	11.80	5.30- 6.00 am	15.30
8.00- 9.00 am	72.00	6.00- 6.30 am	68.50
9.00-10.00 am	5.50	6.30- 7.00 am	8.00

Pollen viability (%) and *in vitro* pollen germination (%)

The maximum pollen viability (98.35%) was recorded at the time of anthesis, while, it decreases at advance stage. Pollen viability after 48 h of anthesis was 51.65% and minimum was observed at 72 h after anthesis (17.48%) (Fig. 3 & 4). Revanasidda & Belavadi (2019) observed pollen viability of one day in muskmelon, whereas, in wild melon it was up to 3 days. The decrease in pollen viability after anthesis may be due to dehydration of pollen, drying and wilting of male flowers in *Cucurbita* (Agbagwa et al., 2007). In wild melon, both flowers are open from 9 am and close at 6 pm, at this time, flowers are accessible to pollinators resulting maximum viability as plants with insects have longer pollen viability than those with wind pollination (Bassani et al., 1994).

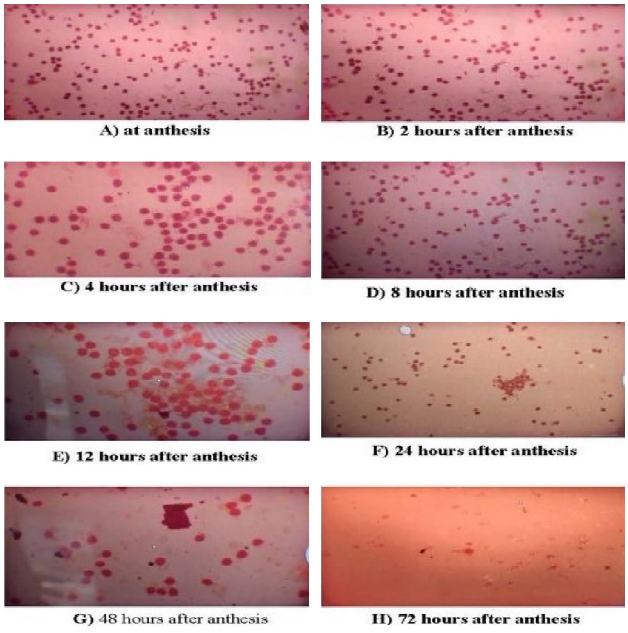

Fig. 3 : Viability of pollen at different time intervals

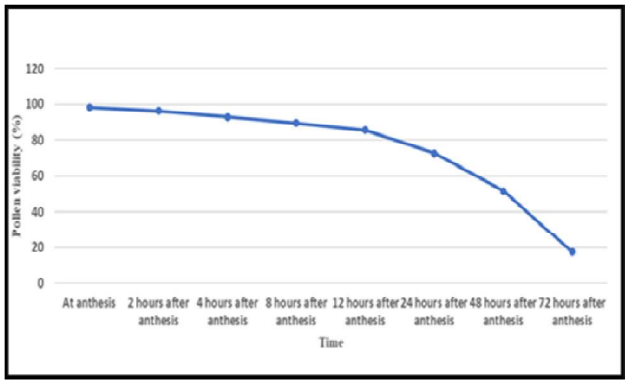

Fig. 4 : Pollen viability (%)

Pollen germination was observed to start after 15 minutes of incubation and continued up to 24 h. The minimum (52.08 %) pollen germination was recorded at 15 minutes of incubation, it was increased to 96.93% at 24 h (Table 2). Higher pollen germination could be due to availability of nutrients for a longer period to pollinators (Zaman, 2006).

Table 2 : *In vitro* pollen germination (%) in wild melon

Incubation period	Pollen germination (%)
15 minutes after incubation	52.08
30 minutes after incubation	67.23
45 minutes after incubation	76.38
1 hour after incubation	83.38
2 hours after incubation	88.18
4 hours after incubation	93.88
12 hours after incubation	95.25
24 hours after incubation	96.93

Stigma receptivity

The stigma became receptive one day prior to anthesis and remained receptive for two days after anthesis. The fruit set at one day before anthesis, on the day of anthesis, one day and two days after anthesis was noticed to be 14.75%, 80.75%, 23.00% and 16.95%, respectively (Table 3). Stigma became fully receptive on the day of anthesis (80.75) as surface of the stigma appeared to be stickier and more bulged due to which a greater number of pollen grains would have settled and germinated, leading to higher degree of fruit set. After 3 days of anthesis, stigma was found to be non-receptive due to advancement of time, the surface of the stigma dried and lead to less pollen accumulation (Naik et al., 2013).

Table 3 : Duration of stigma receptivity on artificial crossing (%) in wild melon

Time of pollination	Fruit set (%)
One day before anthesis	14.75
On the day of anthesis	80.75
One day after anthesis	23.00
Two days after anthesis	16.95

The longevity of the male and female flowers was 5 to 6 and 6 to 7 days, respectively. Staminate flower took 3 days from bud initiation to opening

(Fig. 5 & 6). Pistillate flowers took 4 days from bud stage to opening and for fruit set. Similar findings were also reported by Deyto & Cervancia (2009) and Ekeke et al. (2018).

Fig. 5 : Longevity of male flower, (a) 1st day- bud stage, (b) 2nd day-bud stage, (c) 3rd day-anthesis, flower remained open till evening, (d-e) 4th day-petals closed started to fade, (f-g) 5th day-flower closed fully, bent slightly and pointed upward, (h) 6th day-flower dried up completely

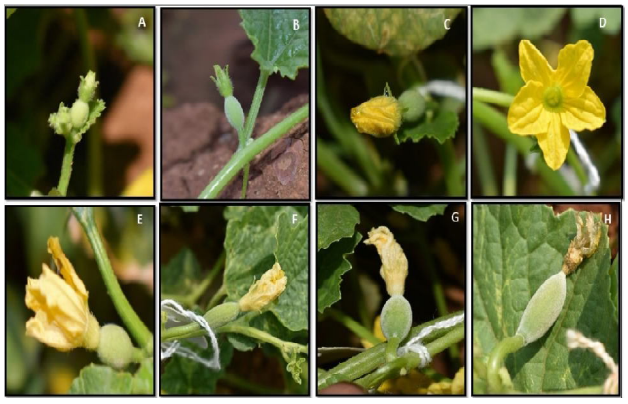

Fig. 6 : Longevity of female flower: (A) 1st day- bud stage, (B) 2nd day-bud elongation, (C) 3rd day-bud elongation, (D-E) 4th day-anthesis, flower remained open till evening, (F) 5th day-petals closed and started to fade, (G) 6th day-petals dry and hang down at tip, (H) 7th day-fruit set

Flower visitors and pollinators

Wild melon flowers were mainly visited by *Apis dorsata* and *Apis cerana*, between 09:00 am to 6:00 pm with two peak visiting from 9:00 am to 11:00 am and 3:00 pm to 5:00 pm. They spend 5-10 seconds on male flower in search of nectar or pollen. These pollen carrying bees pollinate nearby female flower stigma. The results are in accordance with the finding of Revanasidda & Belavadi (2019) in muskmelon and Ekeke et al. (2018) in cucumber.

CONCLUSION

In wild melon, peak anthesis was recorded between 08:00 to 09:00 am and anther dehiscence 06:00 to 06:30 am. Maximum pollen viability was recorded at the time of anthesis, while, stigma receptivity and pollen germination was recorded maximum on the day of anthesis. Hence, for hybridisation, manual pollination to be carried out on the day of anthesis which gives maximum fruit set and seed yield.

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