

Genetic System of *Cucumis sativus* var. *hardwickii* (Royle) Alef. – (wild cucumber) in Jammu, J&K, India

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Short Report

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Abstract

A small population of *Cucumis sativus* var. *hardwickii* (wild cucumber) has been localized for the first time from Billawar, Kathua (District) in UT of J&K. This variety as expected is monoecious in sex expression, but shows unique pattern of development of male and female flowers on the vine throughout its blooming period. Keeping provision for both both self and cross pollination, it is found to be self compatible, insect pollinated taxa with high reproductive output and a stable diploid complement ($2n = 14$). Small proportion of cells (9.92%) shows tetraploidy ($2n = 28$). The species exhibits high and healthy fruit set on open pollination as well as on manual self and cross pollination.

Introduction

Genus *Cucumis* is distributed in tropical region with 52 species (Mabberley, 2008). This genus is of horticultural value as it has many cultivated species. Total six species of *Cucumis* are present in India (Chakravarty, 1982), of which *Cucumis sativus* L. is cultivated on large scale for its edible fruit. Its wild botanical variety i.e.- *C.sativus* var. *hardwickii* is rare and is reported to possess unique morpho-agronomic characters as well as resistance against pest, root knot nematodes (Walters *et al.*, 1997), cucumber green mottle mosaic virus (Hore and Sharma, 1996) and downy mildew diseases (Staub and Palmer, 1987). In India, it has been reported from the foot hills of Himalayas (Charakravarthy, 1982: Deakin,1971)) and in higher elevation of different states such as Chattishgarh, Himachal Pradesh, Uttar Pradesh, Rajasthan, Madhya Pradesh, Maharastra and Odisha (Dikshit, 2014). Present communication elaborates the genetic system of this variety based on observations on a small population sprawling at Billawar, Kathua in the UT of J&K. India.

Material And Methods

Present investigation was carried on wild variety of cucumber i.e. *Cucumis sativus* var. *hardwickii*. The variety has been collected by us from Billawar, District – Kathua of UT of J&K (Fig. 1a). The region of occurrence is characterized by high hills dominated by mostly Pinus trees at an altitude of $32^{\circ}28'26''$ N and $75^{\circ}24'5''$. Total 11 plants were observed at this site during our first field visits to Billawar and its adjoining areas in 2018. All vines were tagged for studying various features such as vine length, number of branches/vine, number of leaves/branch and number of flowers per inflorescence. Flowers were collected randomly from the vines to study various morphological features. Vines were regularly monitored throughout the season to determine their sex expression and timing of appearance of male and female flowers and their unique pattern of development on the vine.

For determining the reproductive efficiency, few mature and unopened female flowers were tagged and left as such for allowing pollination as it occurs in nature. These were monitored after some days to check fruit set on open pollination. Apomixis was checked by bagging few mature but unopened female flowers, that were left undisturbed to check %fruit set. To check the %age fruit set on hand self and cross pollination, some female flowers were hand pollinated with pollen from male flowers of same vine and

from different vine. These female flowers were bagged and observed after some days to check fruit set on manual self –pollination and cross- pollination.

%age fruit set on open and hand Self and Cross pollination was calculated as under :-

$$\frac{\text{Total number of fruits formed}}{\text{Total number of female flowers}} \times 100$$

For evaluating the meiosis, young male floral buds of these were fixed in mixture of 3 parts of ethyl alcohol and 1 part of acetic acid for studying Pmc meiosis. After 24 h of fixation, the floral buds were washed in water and preserved in 70% ethyl alcohol. Finally, the anthers were squashed in 1% propiocarmine to study pmc meiosis.

Results

Plants of this wild variety start their life cycle with the germination of seeds in August after excessive rains during July. Temperature and humidity at this time of year varies from 23°C (Minimum) to 38°C (Maximum) and 48–100% (Max.-Min.) respectively. Plants remain in vegetative phase for 15–20 days, thereafter they enter into flowering.

Vines of *C.sativus* var. *hardwickii* are monoecious, tendril bearing with cordate leaves (three to five angled) averaging 2–3 m in length (Fig. 1b). Male flowers are borne in cluster of 2–9, while the female flowers are borne solitary. Approximately 23 leaves are present on single branch and each leaf averages 14.78cm ± 0.79 × 17.57cm ± 0.95.

Male flowers are pentamerous with five sepals and petals, yellow in colour averaging 1.93cm ± 0.04 in length and characterized by three epipetalous stamens bearing nectary disc at their base (Fig. 1c). Out of three stamens, two are wider averaging 0.25cm in width and third is narrow (0.16 cm) (Figs. 1d & e). Female flower are also yellow in colour, 2.19cm ± 0.56 in length with highly papilloneous stigma and small swollen ovary averaging 1.50cm ± 0.04in length (Fig. 1f &g)). Ovary is covered with numerous trichomes which provide protection to the fruit against herbivory during maturity. At the base of short style, cup shaped nectary disc is present that produces maximum nectar during early hours of the day.

Both male and female flowers exhibit unique arrangement on the vine (Fig. 1m). Male flowers are first to appear and open on lower nodes (either 1st or 2nd) of the vine in the first week of September (Day = 15-20th after seed germination). Thereafter, about 10–12 ♂ flowers appear on the upper nodes such as on second, third, fourth node and so on the main branch of the vine. These flowers open and shed their pollen unnecessarily before the first ♀ flower differentiates/opens. The time gap between the initiation of staminate and pistillate phase is around 10–12 days. 1st female flower appears and opens on 3/4th node and both male and female flowers co-occur on these nodes. Second female flower appears on either 13th or 14th node, after a time gap of 3–4 days of opening of 1st female flower. Thereafter ♀ flowers

differentiate both on middle and upper node while the sequence of male flowers is continuous on nodes toward the upper end. Peak flowering period of both ♂ & ♀ flowers was recorded during the mid of September. Staminate phase was observed during the first two weeks of September for 10–15 days when flowering initiation occur on the vine, followed by co- occurrence of both staminate and pistillate phase for longer period i.e. around 30–40 days. At the end of flowering period in last week of October, only staminate phase was observed with no female flowers and thereafter plants starts drying. This finding was found to be contrast with Shifriss (1961) where staminate phase is followed by co – occurrence of both male and female flowers and finally pistillate phase (Table 1).

Ratio of male to female flowers through out the season reiterated the above observation. Just after the completion of vegetative growth, vine undergoes flowering with maximum production of male flowers and no female flowers and their ratio was found to be 16:0 (♂:♀ flowers) and the same was observed for 10–12 days. In the mid of life cycle of vine, ratio was found to be around 24:4 (♂:♀ flowers) at this time, when maximum fruit production occurred (Table 1). The ratio again changes toward the end of flowering period when number of female flowers starts decreasing. It was recorded as 20:2 in mid October and in the final phase, it was recorded as 14:0 (Last week of October).

Table 1
Relationship between Male and Female Flowers on a vine throughout the season.

Plant Age (After Seed Germination)	Phases of the Plant	Number of Flowers		Ratio of ♂ to ♀ flowers
		♂	♀	(♂flower:♀ flower)
Day = 15-18th	Initiation of staminate phase	1	-	1:0
Day = 18-30th days (duration)	Staminate Phase	16	-	16:0
Day = 31st to 35th	Initiation of pistillate phase	20	1	20:1
Day = 35th -69th	Co- occurrence of both staminate and pistillate phase	24	4	6:1
Day = 69th	Staminate Phase overtakes	14	0	14:0

High reproductive output was observed in wild form of cucumber in term of %age fruit set. On open pollination, fruit set averages 85% and all the fruits were healthy and uniform in size averaging 38.76gm in weight. Fruit is whitish green in colour when young and small in size averaging 4.2cm ± 0.08 × 4.3cm ± 0.02 (Fig. 1i). Few female flowers were hand pollinated from the male flowers of same and different vines and then bagged. Their % fruit set was found to 75% & 80%, and their weight averages 37.76 and 35.52 respectively. On bagging female flowers (about to open), no fruit set was observed. This ruled out the role of apomixis in this species.

PMCs meiosis was also studied in *C. sativus* var. *hardwickii* to know the chromosome count by fixing the young floral male bud randomly from the different vines. Pollen mother cells at Metaphase –I revealed the presence of 7 bivalents showing diploid chromosome number for the the variety as $2n = 14$ (Fig. 1J). Total 75 pmcs were scanned for meiosis. Of these, 52 pmcs (69.33%) had seven perfect bivalents at Metaphase – I (Fig. 1J) and remaining 14 pmcs (18.66%) showed equal segregation of chromosomes 7:7 at each poles at Anaphase I (Fig. 1I). Few pmcs (9.33%) showed 14 bivalents at Metaphase I (Fig. 1k) indicating the presence of polyploidy in this species. The presence of 14IIs in few cells and seven perfect bivalents in maximum pmcs indicates cytologically stable nature of the variety.

Discussion

Cucumis sativus var. *hardwickii* (wild cucumber) is self compatible, insect- pollinated taxon with stable genome ($2n = 14$) and high reproductive output (85%) as compared to cultivated cucumber (73.3%) (Choudhary and Damke, 2015; Dikshit, 2014). Flowering in this wild variety initiates with the appearance of male flower after 10–12 days of seed germination followed by co- occurrence of both male and female flower. The male flowers predominated during the flowering phase. During the early phase of flowering period, the ratio of male and female flower (16:0) is less, maximum during peak blooming period (24:4) and again decreases (14:0) toward the end of flowering period. Once the vine starts setting fruits, the number of pistillate flower goes on decreasing and only staminate flowers continue to differentiate upto to the end of lifespan of the vine. Our observations are in accordance with the findings of Delaplane and Mayer (2000) in cultivated cucumber. These ratio of male to female flowers and time of emergence of male and female after the seed germination varies from species to species and might be influenced by environmental condition and depend on plant growth and vigour.

Cytologically, wild variety of cultivated cucumber is stable in nature with diploid chromosome number of $2n = 14$ at Metaphase -I and equal segregation of chromosomes (7:7) at Anaphase I. This stable chromosome number was also reported by Singh and Roy (1974) and Rajkumari *et al.*, (2013). But the existence of tetraploid cells in this wild variety of cucumber is not on record.

In relation to reproductive efficiency, wild variety of cultivated cucumber has high %age fruit set These findings was also reported by Choudhary and Damke in 2015. Reason might be large number of lateral branches(7–8) in wild cucumber as compared to cultivate cucumber (3–5).

Cultivated varieties of cucumber match with their wilder counterpart in being self compatible and in having diploid chromosome number of $2n = 14$. However the cultivated forms show abnormalities in Pmc meiosis in terms of quadrivalent and hexavalent formation and in having hypoploid and hyperploid cells. These also have comparatively low %age fruit set (73.35) (Previous observation unpublished).

Conclusion

This wild cucumber exhibits more lateral branches, more number of female flowers as a results high reproductive output (85%) as compared to the cultivated cucumber (73.3%).In view of these characters, genetic base of this plant can be used in cultivated cucumber by various hybridization techniques for crop better improvement.

Declarations

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Figures

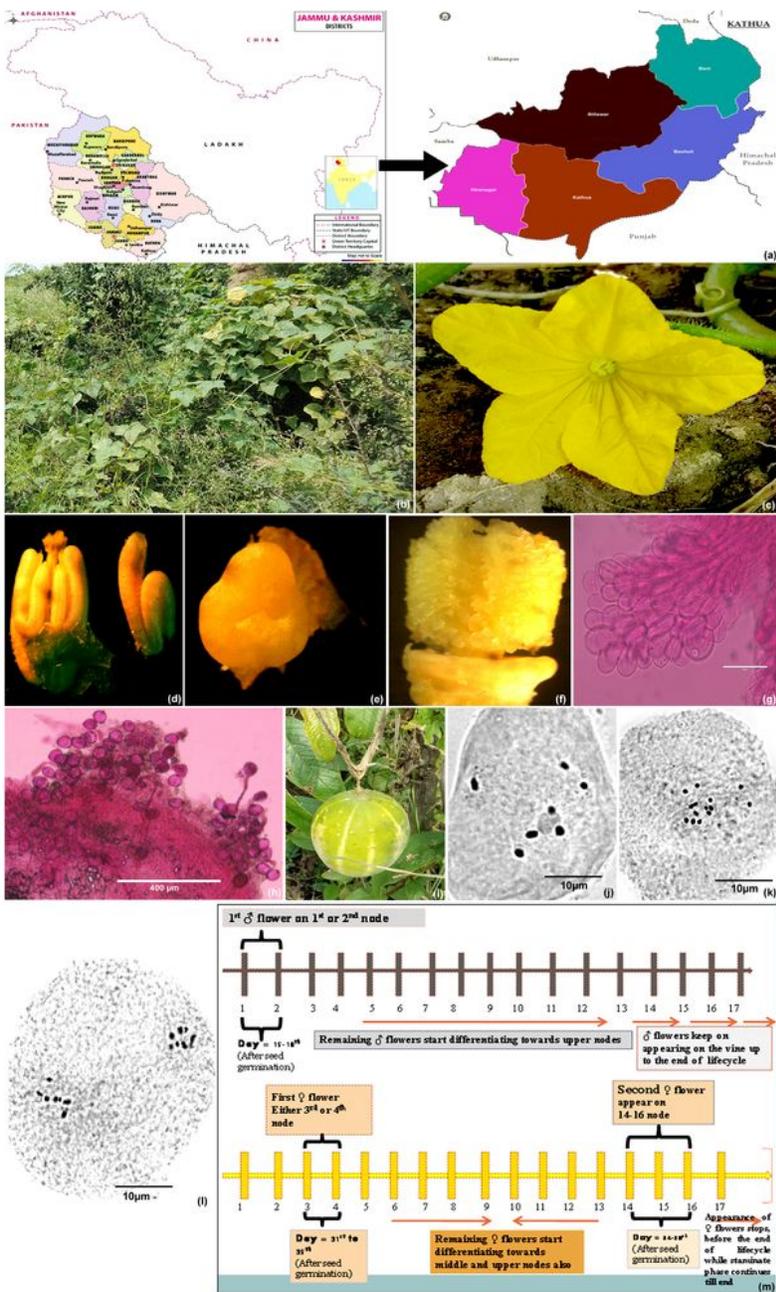


Figure 1

Fig 1a) Map of The J&K showing Billawar Tehsil of Kathua District. Fig 1b) Small population of *C. sativus* var. *hardwickii* Fig1c) An open male Flower Fig1d) Showing wider and narrow anther of *C. sativus* var. *hardwickii*. Fig1e) A trilocular nectary disc Fig 1f) A carpel with cup shaped nectar disc at its base.

Fig 1g) Pappiplate stigmatic surface (1Bar=400µm) Fig1h) Pollen germination on stigmatic surface (1 Bar= 400µm) Fig 1i) Fruit of *C. sativus* var. *hardwickii* Fig1j) A PMC at Metaphase – I showing seven perfect bivalents (1 Bar = 10µm) Fig 1k) A PMC at Metaphase – I showing $2n=28$ at Metaphase- I (1Bar = 10µm) Fig 1l) A PMC at Anaphase –I showing equal segregation of chromosomes (1Bar = 10µm) Fig 1m) showing unique pattern of development of male and female flowers on the vine Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or bbnhjr of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.