CHAPTER - 1

In the food economies of many tropical countries, family Cucurbitaceae holds an important place and is valued as world's second largest vegetable yielding family after Solanaceae. One of the largest angiosperm families, it comprises of an estimated 120 genera and 960 species distributed worldwide, of which 94 species are reported to occur in India. Members of the family commonly termed as cucurbits exhibit tremendous genetic diversity and are adapted to wide range of habitats ranging from tropical and subtropical to arid deserts and temperate regions. Family is interesting from several perspectives, important among them being:

a) It is one of few angiosperm families where every type of sex expression is reported. It includes a range from hermaphrodite to dioecy. Many genera are known to include more than one sex expression distributed among different species. Monoecy is the predominat sex expression in the family (Yampolsky and Yampolsky, 1922; Yamasaki et al.,2001).

b) Since sex expression is variable, therefore most of the species rely on vectors for successsful pollination. Entomophily is widely spread in this family.

c) Considerable range in the monoploid (X) chromosome number is reported in different taxa, the range starts from 7 (*Cucumis sativus*) and extends to 11 (species of *Citrullis, Momordica, Lagenaria, Sechium and Trichosanthes*), 12 (*Benincasa hispida, Coccinia grandis, Cucumis sp*. other than *Cucumis sativus* and *Praecitrullus fistulosus*, 13 (*Luffa sp.*) and 20 (*Cucurbita sp.*).

All these features point toward the cucurbit taxa to be genetically diverse and most probably outcrossers. Lack of inbreeding depression is however an interesting feature in this family. There are no definite report about the number of cucurbit species growing in wild or in cultivation in Jammu district. Some information about the number and distribution of cucurbits growing in Jammu and its neighbouring districts was gathered from the description in Flora of Jammu (Sharma and Kachroo, 1981) and from the specimens deposited in Janaki ammal Herbarium of IIIM, Jammu and in herbarium of department of Botany, University of Jammu.

Objectives

1. To survey, identify, and enlist wild and cultivated cucurbits growing in and around Jammu and its neighbouring districts.
2. To work out the details of sex expression, pollination mechanism and breeding system operative in some selected cucurbits.

Various field surveys in different regions of Jammu and its neighbouring districts (Samba and Kathua) were conducted to identify and enlist wild and cultivated members of Cucurbitaceae family. A total of 23 taxa were listed(Table 1).

Table 1: List of cucurbits growing in wild and under cultivation in different areas of Jammu district, J&K state, India.

	Name of the Plant	Common Name	Status
1.	*Benincasa fistulosa* (Stocks) H. Schaef. & S.S. Renner	Tinda	Cultivated
2.	*Benincasa hispida* (Thunb.) Cogn.	White Gourd	Cultivated
3.	*Citrullus colocynthis* (L.) Schrad.	Bitter cucumber	-
4.	*Citrullus lanatus* (Thunb.) Matsun & Nakai	Watermelon	Cultivated
5.	***Coccinia grandis* (L.) Voigt**	**Kandoori**	**Wild/ Cultivated**
6.	*Cucumis melo* L.	Muskmelon	Cultivated
7.	*Cucumis sativus* L.	Cucumber	Cutivated
8.	*Cucurbita moschata* (Dushesne ex Lam.) Duschesne	Small pumpkin	Cultivated
9.	*Cucurbita pe*po L.	Field pumpkin	Cultivated
10.	***Luffa acutangula* (L.) Roxb.**	**Jangli tori**	**Wild**
11.	***Luffa cylindrica* (L.) M. Roem.**	**Sponge Gourd**	**Cultivated**
12.	Lagenaria siceraria (Molina) standl.	Bottle gourd	Cultivated
13.	*Momordica charantia* L.	Ban Karela	Wild

14.	*Momordica dioica* roxb. Ex. Wild.	Kakora	Wild
15.	*Momordica denudata* (Thwaites) C.B. Clarke	-	Wild
16.	*Solena amplexicaulis* (Lam.) gandhi	Bankakri	Wild
17.	*Solena umbellata* (Willd.) W.J. de Wilde & Duyfjes	-	-
18.	*Solena heterophylla* Lour.	Creeping cucumber	Wild
19.	*Trichosanthes cordata* Roxb.	-	Wild
20.	**Trichosanthes cucumerina L.**	**Snake gourd**	**Wild**
21.	*Trichosanthes dioica* Roxb.	Pointed gourd	Wild
22.	*Trichosanthes tricuspidata* Lour.	Indrayan	Wild
23.	*Thladiantha cordifila* (Blume) Cogn.	Himalayan golden creeper	Wild

Of these, four were analysed in detail for their genetic systems. The same are highlighted in the Table 1.

CHAPTER – 2

MATERIAL AND METHODS

2.1 MATERIALS

The present study is based on four cucurbits namely *Coccinia grandis* (L.) Voigt., *Luffa cylindrica* (L.)M. Roem, *Luffa acutangula* (L.) Roxb. and *Trichosanthes cucumerina* L. Of these four species, *C. grandis* and *L.cylindrica* occur in cultivation in the area of study (J&K state, India), while others grow wild. Vines of *L.acutangula* and *T.cucumerina* were tagged in wild in different areas of Jammu province inculding Birpur, Purmandal, Samba and Vijaypur for further details. All the observations *on L.cylindrica* and *C.grandis* were made on the plants cultivated at experimental plots (3m ×2m) in the Botanical garden, University of Jammu, Jammu. The soil in these plots were thoroughly ploughed and supplemented with organic manure. Plants were raised from the seeds collected from local cultivars. The seeds were sown during the month of June, which is the normal planting season of these vegetable crops (Average temperature : min – 25.2ºC, max – 34.6ºC).

2.2 METHODS

1. Plant and Floral Morphology

Data on plant and floral morphology were collected in the wild and also in the experimentals plots of Botanical garden, University of Jammu, Jammu. This included various aspects like plant height, arrangement of leaves on the vine, leaf size, number of flowers per inflorescence, inflorescence type etc. Structure of flowers, number of floral parts and their morphology were recorded in the field itself. All these measurements were recorded using a centimeter scale.

2. Flower phenology

Anthesis, anther dehiscence and stigma receptivity were observed at regular interval of time in the field. The time taken by individual flower, inflorescence and whole plant to bloom was recorded. Flowers were collected at different timings to check the anther dehiscence. Stigma receptivity was checked from stigma fixed at different timings of the day in a mixture of 3 parts of absolute alcohol and 1 part of acetic acid for 6 – 8 hours. After that these stigmas were washed

in distilled water and stained in stain prepared by mixing 4ml of 1% aqueous acid fuschin, 2ml of 1% light green , 40 ml of lactic acid and 46 ml of distilled water. Finally mounted them in lactophenol and observed under the compound microscope. The stigmas with germinating pollen grains attached to their surface were considered receptive.

3. Pollen output, Ovule output and Pollen Ovule ratio:

Pollen output per flower was determined by counting the number of pollen grains in mature undehisced single anther (using 1% acetocarmine stain) and then multiplying the figure thus obtained by number of stamens present per flower. Similarly the ovules were counted by first carefully removing the outer green covering of the ovary and then teasing out the small transparent ovules from the inner white pulp with the help of fine and sharp needle.

4. Pollen size and Pollen viability

Dimensions of pollen grains were taken with the help of ocular and stage micrometers. Pollen stainability was determined by squashing fresh about top dehisce anthers in 1% acetocarmine. All healthy pollen grains with regular wall and deeply stained nucleus and cytoplasm were taken as viable. Viability was authenticated by enzyme assay, using TTC (2,3,5 – Triphenyl Tetrazolium chloride). For the same, fresh about to dehisce anthers were squashed on the slide in a drop of 0.5% of TTC. The preperation was then transferred to self designed humidity chamber in dark for 3 to 4 hours and then observed under compound microscope microscope. Pollen grains that turned red to pink in colour were considered as viable.

5. Pollination studies:

Vines of all the species studied were regularly observed in the field during peak blooming periods for the presence of different types of insect visitors visiting them. Various parameters including time of insect visitation, duration of their visit to flower,, their frequency of visit and their foraging behaviour were recorded at regular time intervals in the field, in order to classify them as pollinators, robbers, and herbivores. Regular and frequent insect visitors were captured and dissected under the compound microscope for pollen load on their body parts. These insect visitors were then identified upto order and family level.

6. Breeding experiments

The nature of breeding system operative in the species was essessed by estimating the fruit and seed set on open pollination and by various bagging experiments.

7. Fruit and Seed set

Fruit and seed set on open pollination, manual selfing and manual cross pollination was estimated by applying the following formulae:

Percentage fruit set on open pollination $= \frac{Number\ of\ fruits\ formed}{Number\ of\ female\ flowers} \times 100$

Percentage fruit set on manual cross pollination =

$$\frac{Number\ of\ fruits\ formed}{number\ of\ female\ flowers\ manually\ pollinated} \times 100$$

CHAPTER – 3 OBSERVATIONS

3.1 *Coccinia grandis* (L.) Voigt

3.1a PLANT MORPHOLOGY

Coccinia grandis is a perennial herbaceous vine with smooth and pentagonal stem. Leaves are smooth, alternate, five lobed and show great variation in their shape. Each leaf bears tendril in its axil. Species passes a brief vegetative period of about 2- 3 months and then starts bearing flowers. Species is dioecious with separate male and female vine. The intensity of male flowers is high as compared to female flowers and during monsoon (June – July), the intensity of flowering is less as compared to other months.

3.1b MALE VINE

Male vine has long blooming period of 7 months (June – December) with peak flowering time during August – September. Male flowers are pentamerous, bracteate, pedicellate and white in colour having single prominent green coloured ridge on outerside (Fig1a & b). Sepals are five in number having brown colouration at tips. Each male flower has three stamens which are connected to a single filament column. The anthers form globose head produces pollen from S shaped thecae. A cup shaped nectary is present at the base of stamens.

3.1c FEMALE VINE

Female flower are pedunculate, pentamerous, bracteate and white in colour with three fused styles terminating into trilobed stigma having dense papillae. Each lobe of stigma again bifurcates (Fig2b). Ovary is longitudinal, tricarpellary, syncarpous, inferior with parietal placentation. A cup shaped nectary is also present at the base of flower.

3.1d PLANT PHENOLOGY

Coccinia grandis is diurnal. Anthesis starts around 6 a.m. in both the sexes and each flower opens for one day only. When they close, they never open again. Flower closure in both the

sexes initiates around 4:00 p.m. and gets completed by 6:00 p.m. So, each flower opens for about 9 – 10 hrs.

Anther dehiscence is extrose and marked by the formation of longitudinal slits. It initiates app. half an hour before the opening of flower and gets completed by 1100 – 1200hrs (Table2). Stigma is dry and densely papillate. It attains peak receptivity by 1200 – 1300 hrs, on the day of flower blooms. At this time, stigma turns brown in colour.

Table 2 : Events of floral phenology in *Coccinia grandis*

S.No.	Characters	Male flower	Female flower
1.	Floral anthesis	6:00 a.m. – 8:00 a.m.	6:00 a.m – 8:00 a.m
2.	Anther dehiscence	Initiates half an hr before anthesis	-
3.	Peak stigma receptivity	-	12:00 – 1:00 p.m.
4.	Flower closure	4:00 p.m. – 6:00 p.m.	4:00 p.m. – 6:00 p.m.
5.	Duration of flower opening	10 – 12 hrs	10 -12 hrs
6.	Day of flowers closure	On the same day of flower opening	On the same day of flower opening

3.1 e POLLINATION

Few insects were observed visiting *Coccinia grandis*. These include black ants (*Lasius* sp.) and two species of *Apis* (Fig3 a,b and c). Black ants spend longer time on flowers of both male and female vine acting mainly as robbers, with no role in pollination. *Apis* sp. (Honey Bee) are the main pollinators of this species. Each bee spends approximately 2 – 3 sec. on each flower and their frequency of visitation is higher than the other insects.

3.1f REPRODUCTIVE OUTPUT

Fruit of *Coccinia grandis* is green in colour when immature and becomes red on maturity. Fruit set on open pollination is 100%. Few female flowers were bagged to check the presence of apomixis and the fruit set was found to be 59% indicating facultative apomixis in *Coccinia grandis*. Thus , species possess both sexual and asexual mode of reproduction.

3.2 *Luffa acutangula* (L.) Roxb.

3.2a PLANT MORPHOLOGY

Luffa acutangula is an annual climbing stout herbaceous vine with hairy and pentagonal stem (Fig2a). Leaves are orbicular in shape and each leaf bears tendril in its axis. The species is monoecious, first flowers to differentiate on the vine are male only, thus the lower nodes bear only staminate flowers. As the vine grows and attains a height of 2m, both staminate and pistillate flowers appear simultaneously on the middle nodes of the vine. Female flowers are borne solitary in the axil of leaf, while male flowers are borne on pedunculate racemes.

3.2b MALE FLOWER

Male flowers are pale yellow coloured, small , bracteate, pedicellate, actinomorphic and pentamerous with 5 stamens forming three groups/bundle as 2 +2 +1(Fig 2b). Anthers are basifixed and dehisce by longitudinal slits. A cup shaped nectary is located at the base of stamens.

3.2c FEMALE FLOWER

Female flowers are solitary and pale yellow coloured, borne on long pedicels and large in size as compared to male flower (Fig 2c). Each female flower is bracteate, pedicellate, actinomorphic and pentamerous with three fused styles terminating into trilobed stigma. Ovary is longitudinally ribbed, tricarpellary, syncarpous and inferior with parietal placentaion. Nectary is absent in the female flowers.

3.2d FLOWER PHENOLOGY

As the vine develops, male flowers are first to appear and open on the vine on lower staminate nodes. On the middle nodes, flowers of both the sexes coexist. At these nodes, female flowers are first to open. At the apices of vine, only female flowers are present. Opening of female flower at the middle nodes overlaps with the opening of male flowers at the lower staminate lobes and that of female flowers at upper pistillate nodes overlaps with the male flower at both lower and middle nodes. This species is nocturnal and both male and female flowers remain

open throughout the night. Opening of flowers is initiated between 1730 to 1800 hrs. and their closing occurs around 0500 hrs and is complete by 0830 hrs with female flowers closing half an hour later than the male flowers.

3.2e POLLEN OUTPUT, OVULE OUTPUT AND POLLEN OVULE RATIO

Total pollen output/ anther averages 1,515.49 ± 46.9, thus the total pollen production per flower having five anthers arranged in three bundles comes to be 7,577.45 ± 191.96.Total ovule number per flower averages 319.7 ± 8.89.The pollen ovule ratio comes to be 24.29 ± 0.99. Pollen are spherical to oval in shape and pollen viability by 1% acetocarmine and TTC (2,3,5 Triphenyl tetrazolium chloride) averages 68.16% and 70.88% respectively (Fig 5a,b and c).

3.2f ANTHER DEHISCENCE

Anther dehiscence gets initiated half an hour before the flower opens and gets completed by 2300 to 2400 hrs. Around the same time, stigma attains peak receptivity. Maximum pollen germination is noted on its surface, at this time (Fig 5d and e). An average number of 59.2 ± 7.89 pollen grains were seen germinating on the surface of receptive stigma in open pollinated vines. Maximum (3,561.7±190.21) number of germinating pollen grains were recorded on manually selfed stigma followed by the ones that are manually cross pollinated (3378.8±177.24)..

3.2g POLLINATION SYSTEM

Some insects were observed on the vine of this species (Fig 6a,b,c and d). These were collected and screened for pollen load and pollen were observed on their body parts i.e legs and proboscis.

3.2h REPRODUCTIVE OUTPUT

Fruit of *L.acutangula* is ringed pepo having ridges and furrows on its surface (Fig 7a). It is dark green in colour when immature. Fruit set is very low averaging 21.07% on open pollination, it shows a drastic increase on manual crossing i.e. 76.8% and on manual selfing i.e. 62.2% (Table3).

3.2i FRUIT AND SEED

Fruits obtained on open pollination are small in size than that obtained through manual selfing and manual crossing (Table 4). Dehiscence of fruit takes place by separation of basal plate when the fruit matures and dries up. Seeds are elliptical in shape and have a black coloured seed coat (Fig 7b).

Table 3 : Fruit set on open pollination, manual selfing and manual crossing

S.No.	Character	Average
1.	Fruit Set (On open pollination)	21.07%
2.	Fruit Set (On manual selfing)	62.2%
3.	Fruit set (On manual crossing)	76.8%

Table 4: Data on fruit size

S.No.	**Character (Fruit Size) (cm)**	**Average**
1.	**On Open pollination**	
	Length	14.5±0.65* (9.5-22)**
	Breadth	14.4±0.53 (8-18.2)
2.	**On manual selfing**	
	Length	17.15±0.39 (14-22.1)
	Breadth	17.34±0.28 (15-21.5)
3.	**On manual crossing**	
	Length	17.9±0.34 (14.5-21.9)
	Breadth	17.31±0.29 (13.3-19.9)

*Mean±Standard error **Range

3.3 *Luffa cylindrica* (L.)M.Roem.

3.3a PLANT MORPHOLOGY

Luffa cylindrica is an annual climbing herbaceous vine with hairy and pentagonal stem (Fig 8a). Leaves are orbicular in shape and bear pentafid tendril in their axils. Species passes a brief vegetative period of about 3 months and then starts bearing flowers in the month of August in the area of cultivation (Temp. Min.- 24.2ºC, max.- 32.6 ºC). Species is monoecoius with lower nodes bearing only staminate flowers followed by subsequent nodes bearing both male and female flowers. Male flowers are borne on pedunclate racemes (Fig 8b and c), with each pedunculate raceme on lower nodes bearing 15 -39 male flowers that serve as pollen donor to the female flowers of middle nodes as well as upper nodes throughout the flowering season of the vine. Female flowers occur solitary in the axil of leaves. The time gap between appearance of the first staminate flower at the lower node and the first female flower on the middle node is 13 – 15 days. A cup shaped nectary is located at the base of stamens.

Female flowers are single, solitary, bright yellow in colour borne on long pedicel (Fig11a). Sepals are small, ranging between 1.4 -1.8 cm in length, whereas petals are large ranging between 4.6 – 5.5 cm in length. Each female flower is bracteate, pedicellate, incomplete, actinomorphic, pentamerous with three fused styles terminating into trilobed stigma. Ovary is long, tricarpellary, syncarpous and inferior with parietal placentation. Female flower shows the presence of rudimentary staminodes and cup shaped nectary of 0.16cm+0.01 size at the base of style.

3.3b FLORAL PHENOLOGY

L.cylindrica is diurnal and flower opening is initiated between 0530 to 0600 hrs. During the early development of the vine, only male flowers develop and open at lower nodes. As the vine grows and attains a height of 3m, opening of male flowers at lower staminate nodes shows an overlap with the opening of female flowers at the middle nodes. In the later developmental phase of the vine, opening of male flowers at the lower and middle nodes overlaps with the opening of female flowers at upper nodes. On the middle nodes where male and female flowers coexist, opening of male flowers is delayed, these open only when fruit formation has initiated in the

female flowers at these nodes. Flower opening in both the sexes decreases with the decrease in temperature (min. – 17.4ºC, max. – 29.9 ºC).

On a day, male flowers are first to open by 530 hrs followed by the opening of female flowers after a time gap of 15 mins (0545 hrs). Both male and female flowers remain open for 11 hrs 30 mins and 12 hrs and 15 mins respectively.

Table 5: Events of floral phenology in *L. cylindrica*

S.No.	Characters	Male (Average)	Female (Average)
1.	Flower anthesis	0530 -0600 hrs	0545 -6000 hrs
2.	Anther dehiscence	0500 – 1200 hrs	-
3.	Peak stigma receptivity	-	1100 hrs
4.	Flower closure	1400 – 1700 hrs	1400 – 1800 hrs
5.	Duration of flower opening	11 hrs 30 mins	12 hrs 15mins
6.	Day of flower closure	On the same day of opening	On the same day of opening

3.3c POLLEN OUTPUT, OVULE OUTPUT AND POLLEN OVULE RATIO

Total pollen output per anther is quite high in *L.cylindrica* averaging 11,433.9±318.50. Ovule count per female flower in the species averages 581.2±15.64 and the pollen ovule ratio in *L.cylindrica* averages 106.852.93.

3.3d POLLEN SIZE AND POLLEN VIABILITY

Pollen *of L. cylindrica* are spherical to oval in shape (Fig 9a,b,c and d) with the size of the individual pollen grain averaging 198.37um ± 2.30. Pollen viability as estimated by 1% acetocarmine stainability test averages 41.55% ± 2.23, by TTC it averages 34.53% ± 1.40.

3.3e ANTHER DEHISCENCE AND STIGMA RECEPTIVITY

Anthers are extrose and dehisce by longitudinal slits. Stigma is dry and papillate. It attains peak receptivity by 1100 hrs, on the day of flower blooms. At this time, it turns brown in colour and reveals high pollen load. Maximum number of germinating pollen grains were however observed on manually cross pollinated stigmas i.e. 14.535±328.95 followed by the manually selfed ones i.e. 11496.8±577.95 (Fig 9d and e).

To check the role of wind in pollination, slides meared with egg albumen and glycerine were hung at the distance of 1m on wooden stands during the full blooming phase of plant. No pollen load of this species was detected in these slides. Several insects were observed visiting both male and female flowers throughout the blooming period. These were two species of honey bee (*Apis* sp.), bumblee bee (*Xylocopa* sp.) and butterfly (Fig 10 a, b,c and d). These were screened for pollen load and pollen was observed on the legs and ventral surface of the main body.

3.3f REPRODUCTIVE OUTPUT

Fruit type in *L. cylindrica* is a pepo, smooth and cylindrical in shape. Fruit set is maximum on manual selfing (87.5%) followed in order by fruit set on manual crossing (77.5%) and on open pollination (74.52%) (Table 6). Dehiscence of the fruit takes place by basal plate which separates when fruit matures to discharge seeds.

Table 6 : Fruit set on open pollination, manual selfing and manual crossing in *L. cylindrica*

S.No.	Character	Average
1.	Fruit set on open pollination (%age) (n= 30)	74.52 ± 1.42 (62.5 – 88.8)
2.	Fruit set on manual selfing (%age) (n=30)	87.5 ± 0.84 (57.4 – 88.8)
3.	Fruit set on manual crossing (%age) (n=30)	77.5 ± 1.60 (55.5 – 88.8)

3.3g FRUIT AND SEED

Young fruits are edible and are used as vegetable, whereas mature fruits yield sponge of commercial importance. Seeds are elliptical in shape and have white coloured seed coat (Fig 11b). Seed size in manually selfed fruits is 1.24cm ± 0.008(l) × 0.85cm ± 0.008 (b), that of seeds obtained on open pollination is 1.2cm±0.005(l) × 0.75±0.01(b) and on manual crossing is 1.16cm ± 0.008(l) × 0.67cm ± 0.01(b). Seed weight per sample (20 seeds) was found to be highest (2.16g+0.008) in fruits obtained on manual selfing and lowest in fruits obtained on manual crossing(1.53g±0.006).

3.4 *Trichosanthes cucumerina* L.

3.4a PLANT MORPHOLOGY

Trichosanthes cucumerina is a herbaceous annual climbing vine with slender glabrous to slightly hairy stem (Fig 12a). Leaf lamina is suborbicular to broadly ovate, averaging 12 cm±0.01 (l) × 15 cm ± 0.02 (b) in size. Each leaf bears trifid tendrils in its axil.

Vine of the species pass a brief vegetative phase of approximately 2 months and start bearing flowers in last week of July. Species is monoecious. Lower 14 – 15 nodes of the plant bear only male flowers. Vine branches thereafter and the subsequent nodes bear female flowers also along with the male flowers. Male flowers are borne in pedunculate racemes, each of which bears on an average 29.9±0.56 flowers. Each female flower is borne solitary in the axil of leaf. Time gap between the appearance of 1st male flower at the lower node and the 1st female flower at the middle node is 16 – 17 days.

3.4b FLOWER MORPHOLOGY

Male flowers of *T. cucumerina* are small, ebracteate, pedicellate, actinomorphic and pentamerous (Fig 12b). These are white in colour. Sepals are hairy and have an average length of

1.82cm ±0.02. Corolla is tubular at base and then expands at the top into deeply divided fimbriate petals, it has an average diameter of 1.75 cm± 0.03. Female flower is small, ebracteate, pedicellate, actinomorphic and pentamerous with 3 fused styles terminating into trilobed stigma at its apex(Fig 12c).

3.4c POLLEN SIZE AND VIABILITY

Pollen grains of *T. cucumerina* are spherical to oval in shape (Fig 13a,b,c and d). Species shows pollen dimorphism as two types of pollen grains are observed i.e. larger and smaller pollen grains having an average size of 98.7 um ±1.54 and 42. 35µm ± 1.54 respectively. %age of larger pollen is high in the beginning of flowering phase of the vine but as the vine progresses toward the senescence, the percentage of small sized pollen increases. Pollen viability in the species averages 77.91 % ± 0.94 and 72. 69% ± 1.51 by 1% acetocarmine.

3.4d ANTHER DEHISCENCE

Anthers in *T. cucumerina* are extrose and dehisce by longitudinal slits. Anther dehiscence begins 20-30 min after the flower opens and dehiscence is complete by morning hours. Stigma attains maximum receptivity between 0700 to 0730hrs of the morning (Fig 13e and f).

3.4e POLLINATION SYSTEM

Wind pollination is absent in this species as no pollen was ever observed on the slides, fixed around the blooming vines of *T. cucumerina*. Flowers of both the sexes are visited by insects. Both male as well as female flowers remain open for long period of 22 hrs, starting from the 2000 hrs of the night; species is thus visited by both nocturnal and diurnal insect visitors. During night, two different insect visitors belonging to order lepidoptera were observed on the flowers. These were hawkmoth and moth (Fig 14 a,b,c and d). They frequently visit the vine from 2030 to 2130 hrs, thereafter their visits decreases. Screening of these insects for pollen load revealed the presence of 60 -70 and 50 – 60 pollen grains on the body parts of hawkmoth and moth respectively. Pollen load was observed only on proboscis of these visitors. During the day time, butterflies visit both male and females flowers.

Table 7 : Fruit set on open pollination, manual selfing and manual crossing in *T. cucumerina*

S.No.	Character	Average
1.	Fruit set on open pollination (%age)	64.2 ± 2.01 (50 -90)
2.	Fruit set on manual selfing (%age)	83.85 ± 1.44 (72.72 – 100)
3.	Fruit set on manual crossing (%age)	83±1.09 (69.23 – 91.6)

3.4f REPRODUCTIVE OUTPUT

Fruits of *T. cucumerina* is a pepo, small in size and spindle shaped (Fig 15a). An immature fruit is green in colour with white streaks on its surface. On maturation, the fruit turns red. Fruit set in the species is high on manual selfing and manual crossing. In open pollinated vines, it is slightly lower and averages 64.25 % ± 2.01 (Table 7). Fruit size is minimum on manual selfing and almost comparable for the ones obtained after open pollination and manual crossing. Dehiscence of the fruit takes place by bursting and dispersal of seeds is aided by birds and ants due a sweet mucilagenous covering outside the seed coat.

Seed are ovate with broad head and pointed base (Fig 15b). Seed coat is light brown in colour with sculptured surface and wavy margins. Average seed size and seed weight varied only slightly in fruit obtained through different pollinations experiments.

CHAPTER- 4

SUMMARY

Four cucurbits namely *Luffa acutangula, Luffa cylindrica, Trichosanthes cucumerina* and *Coccinia grandis* occuring in wild and under cultivation in some parts of Jammu and its neighbouring districts (J&K state, India) have been investigated for the details of their reproductive biology. All these species pass brief vegetative phase of 2 – 3 months before they start bearing flowers. Out of four , three sp. i.e. *L. acutangula, L. cylindrical* and *T. cucumerina* exhibit monoecy. Male flowers are first to initiates on a vine and are borne on pedunculate racemes. Female flowers differentiate later and are borne solitary in the axil of leaf. Each species has definite pattern for the appearance of male and female flowers. Lower node on the vine bear male flowers only , while at the middle node, female flowers also appear, so that both male and female flowers co- exit at these nodes. At the uppermost nodes both male and female flowers co – exist in *L. cylindrica* and *T. cucumerina* , while only female flowers are present at these nodes in *L. acutangula*. Now last, *Coccinia grandis* is dioecious with separate male and female vines.

Male and female flowers in these species are actinomorphic, pentamerous and epigynous. In both *Luffa* sp., nectary is present in male flowers only whereas in *Coccinia grandis* nectary is present at the base of both male and female flowers. In *T. cucumerina*, male flowers have grandular structure at the base of the tubullar corolla that secrete nectar. Female flowers of all the four species are bracteates, pedicellate, and pentamerous with three fused styles terminating into trilobed, densely papillate stigma with inferior ovary.

Four species studied presently vary in the details of their floral phenology. *L cylindrica* is diurnal with the opening of male flowers initiating at 0530 hrs followed by the opening of female flowers after a time gap of 15 mins. Anther dehiscence starts with the opening of male flower and completes by 1200 hrs. Stigma attains receptivity as soon as the flower opens and shows peak receptivity around 1100 hrs. Flower closure in the species completes by 1800 hrs of the

same day with male flowers closing first . Flowers of both the sexes thus remain open for a time span averaging 11 hrs 30 mins and 12 hrs 15 mins respectively in male and female flowers.

L. acutangula is a nocturnal blooming species. Male flower of the vine open around 1730 hrs, while the female flowers open slightly late. Anther dehiscence in the species begins along with the male flower opening and completes by 2400 hrs, at a time when stigma also attains its peak receptivity. Flower closure in the species completes by 0830 hrs with female flowers closing later than the male flowers. Flower opening in the species thus extends for an average of 14 hrs and 40 mins.

Trichosanthes cucumerina is also a nocturnal blooming species with flower opening initiating during evening hours. Opening of male flowers initiates at 2000 hrs, while the female flowers open around 2035 hrs. Anther dehiscence begins with the male flower opening and proceeds for a long duration , completing by 0630 hrs of the next day. Stigma becomes receptive as soon as flower opens, but attains peak receptivity by 0700 hrs. Flower closure in the species completes by 1830 hrs of the next day with female flower closing later than the male flowers. Flowers of both the sexes thus have long blooming period of 22 hrs. Flowers of all the four species do not open again once they close themselvess.

Data on %age fruit and seed set in three species i.e *L. acutangula, L. cylindrica* and *T. cucumerina* reveals the lowest value on open pollination (74.52%, 21.07% and 64.2% respectively in *L. cylindrica, L. acutangula* and *T. cucumerina*). Manual pollinations augment the same to some extent. Degree of augmentation is highest on manual selfing in *L. cylindrica* followed by that on manual crossing. Percentage fruit set is less on manual selfing in *L. acutangula* indicating some level of inbreeding depression. *T. cucumerina* shows high and almost comparable values of fruit set on manual selfing (83.85%) and crossing (83%). In *Coccinia grandis*, %age fruit set is 100% on open pollination. On bagging of female flowers, the % age fruit set was found to be 59%. This indicates both sexual and asexual modes of reproduction are present in this species.