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E: ISSN NO.: 2349-980X **Shrinkhla Ek Shodhparak Vaicharik Patrika**

Flowering Phenology and Comparison of Seed Yield in different Pollination Treatment in *Gossipium hirsutum* L.

A. S. Dahat
Assistant Professor,
Dept. of Botany,
Art, Commerce & Science College,
Arvi Dist.Wardha.(M.S.) India

Abstract

The present investigations are being carried out during the three consecutive years at Arvi Dist.Wardha. The plant species were visited daily or on alternate day, for collection of blooming phonological data. During the present investigation it is observed that in Gossypium hirsutum L. flowering stars from second week of September and peak period was observed during third week of September and termination phase was observed during third week of January. The pollen production was found to be15175.65 ± 1158.89, The pollen viability percentage was recorded 97.54% to 92.90 %. Estimated pollen: ovule ratio was found to be 607.02 to 618.97. The important flower pollinators in *G.hirsutum* were *Trigona* , *A. florea*, small black bee (unidentified), *A. dorsata*, large size black bee (unidentified), Butterfly, casual visitors were thrips ants and spider. The effect of different treatments on the yield in terms of weight of cotton with seed per capsule was measured 28.745 to 30.433 gm in self- pollination, 67.697 to 66.871 gm in open-pollination and 71.874 to 69. 538gm in insect pollination.

Keywords: *Gossipium hirsutum* L., Pollinators, *Apis Dorsata,* Yield.

Introduction

Pollination is an important and essential stage in the sexual reproduction of flowering plants. It involves the transfer of pollen from anther to the receptive stigma of the flower. As such pollination is an essential prerequisite to seed and fruit set. Plants in general are classified on the basis of their floral biology as adapted to self and cross-pollination, either by wind or by animals, a majority of these being insects (Deodikar and Suryanarayana, 1977).

Cross-pollination needs a biological vector for the transfer of pollen from anthers of one flower to the stigma of another flower, to accomplish the process of pollination. Only the potential biological vector can fulfill this job (Free, 1993). Bees are considered to be the most important pollinators because they are the only insects whose immature stages are reared exclusively on pollen and nectar (Crane, 1990). The foraging mode of the insect visitors determines them as pollinators or non-pollinators. Insect visitors are characterized as pollinator, if it transfers pollen intentionally in a foraging attempt or unintentionally (Sihag, 1988). Several factors like abundance, foraging behavior, number of loose pollen grains carried on the body, foraging rate and activity duration of the insect pollinator determine its pollinating efficiency (Priti and Sihag, 1997). During the present investigation detail study of these parameters of insect pollinators was carried out. Indian economy is more depend on agricultural and horticultural practice and this serves as a most important livelihood source. Several agricultural and horticultural crops are being cultivated in various parts in India derived benefit or depended on pollinating insect for maximum fruit and seed yields.

Objectives of the Study

The foremost objective of the study was to know the role of insect in general and bees in particular as a pollinator rendering their services for pollination of the crop plants cultivated in Arvi Dist. Wardha and thus to enhance the yield. Another objective in the focus was to record the vegetation providing sustenance to the pollination in the absence of crop plants and enabling them to live until the flowering of crop plants. Moreover other objectives were to study the following aspects of the pollination of the crop plants.

1. Flowering phenology of the crop plants.

2. Duration of flowering
3. Time of anthesis
4. Anther dehiscence
5. Pollen production
6. Timing of nectar secretion
7. Insect / pollinator census
8. Period of pollinator activity
9. Behaviour of the pollinator
10. Floral rewards
11. Pollen load carried out by pollinator
12. Fruit sets under 'SP', 'BP' and 'OP'
13. Percentage of fruit/seed set and
14. Natural vegetation providing forage to flower visitors.

Materials and Methods

The present investigations are being carried out during the three consecutive years at Arvi (North latitude 20 0 18⏐ to 700 30⏐ and East longitude 290 22⏐ to 190 15⏐). Situated in wardha district of Maharashtra State. The observations were taken from different cultivated fields around Arvi. Three different study sites were selected for study.

Blooming Phenology **t**he plant species were visited daily or on alternate day, for collection of blooming phonological observations. The opening of flower and anthesis were observed with help of hand lens (10 x). Simple method of Nair and Rastogi (1963) was adopted to know the pollen production per anther/ flower. Pollen viability rates were observed with tetrazolium (TTC) test method (Loken, 1942) to determine the pollen viability *in vitro*. Pollen:ovule ratio calculated by dividing the number of pollen grains produced per flower by the number of ovules in the flower the pollen: ovule ratio of plants under investigation was obtained by (Cruden, 1977).

Stigma was observed through hand lens of 10 X magnification. Pollen load carried out by insect was estimated as per method proposed by (Dafni, 1992). The flower visitors were observed for their visit timings at the different study sites during the flowering period of plant. Yield comparison of three different pollination treatments, viz., "SP" (self-pollinated), "BP" (insect pollination) and "OP" (open pollination) were done as per the method followed by Panda *et al*. (1988) and Rao and Suryanarayana (1979).

Results and Discussion

The present research work was started with the aim to know the role of insects in general and bees in particular in pollination of the crop plants cultivated in Vidarbha and thus to enhance the yield of crops. It was proposed to study the population of pollinators, their activity, behavior and their role in crop pollination.

To fulfill the above said objectives observations on different aspects of pollination and the flower visitors were undertaken for three consecutive years. Asia represents a wide variety of climatic zones and accordingly several kinds of crops are grown; many of these are cross-pollinated and required external agents for pollination for increased fruit/seed production (Sihag, 1995).

Pollination is an essential prerequisite for seed and fruit development in temperate and tropical crops involving the transfer pollen from the male organs or anthers to the female organs of receptive stigmas (Kevan *et al.,* 1990). It is important to study the process of pollination and pollinators in crop plant because more than 80 % of all flowering plants species relay on different animals for pollination (Torchio, 1990 and Nabhan and Buchmann, 1997).

G.hirsutum is a shrub, widely cultivated in states of Madhya Pradesh, Bihar, Andhra Pradesh, Maharashtra, Uttar Pradesh and Karnataka. It is commonly known as "Cotton". Leaves hairy 3-5 lobes triangular, acute, stipulate cordate, acuminate. Involucaral bract large, deeply laceriate corolla uniformly yellowish white. It is the second important oil crop of India. Seeds are of greater importance and every part of the plant is useful. The kernels yield one of the most important fatty oils, cotton seeds oil and an oil cake and meal which are used for fertilizer stock, feed, and flour and as a dyestuff.

Flowering phenology is a critical life-history trait that strongly influences reproductive success (Rathcke and Lacey, 1985). Many species show gradual changes in flowering time over geographical and environmental gradients (Hodgkinson and Quinn, 1978 and Blionis *et al*., 2001). During the present study observations were carried out during the months of October to January. The flower initiation observed from second week of September and peak period was observed during third week of September and termination phase was observed during third week of January. The various parameters influencing flowering are photoperiod, light intensity, temperature, moisture supply including ambient humidity and soil moisture, nutrient supply and various agricultural practices involved (Sihag, 1982).

During present study the timing of anthesis takes place during 06.30 hrs and open fully at 09.00 hrs. The time of anther dehiscence was during 08.30 to 09.00 hrs.

In the present investigation it was observed that anthesis starts during morning hours. The process of anthesis was delayed by an hour during rainy days. The present findings on anther dehiscence are in agreement with the Free (1970) and Deodikar *et al.* (1976). However, Opler *et al.* (1976) demonstrate that the rainfall is an important factor in the release, timing and synchronization of anthesis.. The environmental factors such as temperature, relative humidity (RH) and rainfall influences the time of anthesis.

During present investigation the pollen production was found to be 15175.65 ± 1158.89, to 13963.95 ± 2257.93. Present finding indicates that the pollen production and flower size are positively correlates with each other. Cross-pollinated plants usually produce greater number of pollen grains than self-pollinated ones, thus increasing the probability of success of fertilization. The ample pollen grains were observed in flower of *G.hirsutum.* There may be little

correlation between pollen production and removal of paternity. In addition, post pollination processes such as pollen tube competition, incompatibility and selective abortion can alter the paternity of resultant seeds (Mulcahy, 1979 and Marshall, 1990).

The pollen viability percentage was recorded 97.54% to 92.90 %. It was further noted that pollen viability also plays an important role in fruit and seed set. In present observation maximum fruit set was noted during open pollination which is an indication of pollen viability.

The pollen:ovule ratio was determined by counting the number of pollen grains produced per flower and divided by the number of ovules per flower. There is a strong correlation between pollen: ovule and breeding system (Cruden, 1977). During present investigation estimated pollen: ovule ratio was found to be 607.02 to 618.97. According to Cruden (1977) the pollen:ovule ratio ranges between 2.7 to 6.7 in cleistogamous flowers, 18.1 to 39.0 in obligate autogamous flowers, 31.9 to 396.9 in facultative autogamous flowers, 244.7 to 2558.6 in facultative xenogamous flowers and 2108 to 19523 in xenogamous flowers.During the present investigation the data of pollen:ovule ratio corroborates with the result reported by Cruden (1977).

During present investigation in *G.hirsutum* stigma becomes receptive during 08.15 hrs. to 9.00 hrs. which appeared glossy and yellowish red in colour on the loss of receptivity it becomes blackish red during 17.00 hrs. to 18.00 hrs. next day of flower opening. The duration of stigma receptivity varies from a few hours to few days and the age of flower, the time in the day and the presence or absence of stigmatic exudates may influence stigma receptivity (Dafni, 1992). The period of receptivity is influenced by environmental factor such as temperature and humidity. During the cloudy and rainy days normally receptive period of stigma is extent up to the third day of flower opening. The present findings are in agreement with Dafni (1992) and Gori (1983).

The important flower visitors in G.hirsutm were Trigona, A. florea, small black bee (unidentified), A. dorsata, large size black bee (unidentified), Butterfly, casual visitors were thrips ants and spider also visited the flower. The activity of visitors was more from 09.30 hrs. to 13.30 hrs. The flower visitor activity was less during the afternoon time, however, from 15.30 hrs. Onwards towards the evening hours activity was again more.

Bees visit the flower to collect pollen and nectar is found to be most valuable process in the pollination. Their frequent visit from one flower to other flower may perhaps help transfer of pollen (Deodikar and Suryanarayana, 1977). During the present investigation several insect foragers were found to be visiting on *G.hirsutum.*

A number of insect species were visited the flowers. The activity of pollinators starts after the opening of the flowers. Insect visits the flower to collect pollen and nectar. The bees land on flower to collect the pollen and deposited it in pollen basket and remain stay on flower for few second to one and half minutes and they visit 2 to 6 flowers per bout. During their flower to flower visit the pollen grains were deposited on the stigma of other flower which fascilated the cross pollination. The butterflies were found to be regular visitors. They visit flower during 10.10 to 17.00 hrs, visits 1 to 4 flowers per bout and stay for 2-19 seconds. The other occasional visitors such as large ants and thrips. The small and large ants visit the flower during 08.30 to 17.00 hrs and stay on flower for long period. The thrips reside the flower also for long period.

Each flower provides a variable but generally small reward that is often hidden; flowers are patchily distributed in time and space and are erratically depleted of rewards by other foragers. Insects that specialize in visiting flowers have evolved an array of foraging strategies that act to improve their efficiency, which in turn determine the reproductive success of the plants that they visit (Goulson, 1999).

The estimation of pollen load carried by the pollinators is one of the traditional methods of measuring constancy (Dafni, 1992). Priti and Sihag (1997) reported the number of loose pollen grains that adhered to the body of the insect visitors. *A. florea* carried out the pollen load 6578.90 ± 755.31, *A. dorsata* carried the pollen load 9891.10 ± 901.13, *A. mellifera* carried the pollen load 9002.15 ± 849.09 and also reported that maximum numbers of pollen grains were carried by *A. dorsata* among all the insect visitors.

During the present investigation maximum pollen load carried out by A. florea and Trigona spp. It was found to be 18443 and 4218 pollen respectively. The pollen grain on the body of large size bee and small size bee was found to be 24720 and 11781 pollen respectively. Thrips carried negligible number of pollen grains number of pollen grains respectively. During the present investigation bees are found to be dominant amongst all foragers. Bees forage on the flower to collect the pollen and nectar. The maximum pollen load was found to be carried out by *Xylocopa* spp. and *A. dorsata* as compared to other foragers.

During the present investigations breeding experiments showed that fruit set in open or natural and insect pollination is always higher, which is an indication of successful pollination. Pollen:ovule ratio is also served as an index of breeding system. The proportion in which pollen gains and ovules differentiate in an individual reflects the efficiency of pollen transfer among its flowers (Cruden, 1977). It is reported that pollen:ovule ratio more or less reflects the breeding system in all crop plant species. The present observations corroborate with the observations made by Cruden (1977). Crop plants which are predominantly self-pollinated have low pollen:ovule ratios, however, the plants which are cross pollinated have high pollen:ovule ratio.

Deodikar and Suryanarayana (1977) roughly estimated the data on yield parameters. The effect of different bee species on yield shows that there is a gradual increase in number of seeds and seed weight per pod in order of *A. florea, A. cerana and A. dorsata* visited flowers. Sinha and Chakrabarti (1995) reported the effect of two pollination modes on seed yield and

weight. In the present investigation the effect of different treatments on the yield in terms of weight of mature fruit was measured 28.745 to 30.433 gm in self- pollination, 67.697 to 66.871 gm in open-pollination and 71.874 to 69. 538. It was found higher seed yield in insect-pollination and open-pollination over self-pollination (Table No.1).

Table No. 1: Effect of different pollination treatment on the yield (in grams).

Year	Self pollination	Open pollination	Insect pollination
Frist year	28.745	67.697	71.874
Second year	30.433	66.871	69.538
Third year	39.648	58.486	66.871

Fig. No.1. *A. florea* visiting the flower of *G. hirsutum*

Fig. No.2. *A. dorsata* foraging on the flower of *G. hirsutum*

Fig. No.3. Halictidae fly visiting the flower of *G. hirsutum*

Fig. No.4. Red color bee foraging on the flower of *G. hirsutum*

Fig. No.5. Grass hopper visiting the flower of *G. hirsutum*

Fig. No.6. Red beetle foraging on the flower of *G. hirsutum*

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