International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Study on Monoecious and Dioecious Reproduction in Pea Plants (Pisum sativum L.)

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Abstract:
Pea (Pisum sativum L.) is a widely cultivated leguminous crop valued for its nutritional content and soil fertility benefits. Understanding its reproductive biology is crucial for breeding, yield improvement, and genetic diversity conservation. Pea plants exhibit both monoecious and dioecious reproductive systems. Monoecious plants bear both male (staminate) and female (carpellate) flowers on the same plant, which allows self-pollination and ensures fruit set. Dioecious plants, with male and female flowers on separate plants, promote cross-pollination and enhance genetic variation. This study investigates floral morphology, reproductive strategies, and pollination efficiency of monoecious and dioecious pea plants through field observation, controlled pollination, and quantitative analysis. The findings provide a scientific basis for selecting appropriate breeding strategies for Pisum sativum improvement.

Keywords: Pea, Pisum sativum, Monoecious, Dioecious, Pollination, Reproduction, Genetic diversity.

1. Introduction

Leguminous crops play a significant role in global agriculture due to their nutritional value and nitrogen-fixing ability, which enriches the soil. Among legumes, Pisum sativum L. (pea) is extensively cultivated for its seeds and pods. Understanding the reproductive biology of pea is essential for breeding programs aimed at improving yield, quality, and resistance to environmental stresses.

Pea plants display two major reproductive systems:
1. Monoecious Reproduction: In monoecious plants, both male and female flowers are borne on the same individual. This allows self-pollination, ensuring reproductive success even in the absence of pollinators. Monoecious reproduction promotes uniform progeny, which is advantageous for seed production.

2. Dioecious Reproduction: Dioecious plants bear male and female flowers on separate individuals. This system enforces cross-pollination, enhancing genetic diversity and adaptability. However, it relies on pollinators or wind for successful fertilization.

The reproductive system significantly affects flower morphology, fruit set, seed production, and genetic variability. While monoecious pea varieties are commonly used for uniform seed production, dioecious varieties are crucial for breeding programs that aim to introduce new traits.

This study aims to:

- Examine the floral morphology of monoecious and dioecious pea plants.
- Evaluate pollination efficiency and fruit set in different reproductive systems.
- Discuss implications for breeding and crop improvement.

2. Materials and Methods

2.1 Plant Material and Experimental Site

Seeds of local Pisum sativum cultivars were collected from Birbhum, West Bengal.
Field experiments were conducted in a randomized block design with uniform spacing (30 cm between plants, 50 cm between rows).

Standard agronomic practices were followed to maintain healthy plant growth.

2.2 Observation of Floral Morphology
Flowers were examined at bud, anthesis, and post-anthesis stages.
Floral organs, including sepals, petals, stamens, and carpels, were studied under a dissecting microscope.
Male and female flowers were counted per plant.

2.3 Pollination Experiments
Monoecious plants were subjected to self-pollination and manual cross-pollination.
Dioecious populations were isolated to prevent unintended pollination. Pollination was carried out manually, simulating insect-mediated transfer of pollen.

2.4 Data Collection and Analysis
Parameters recorded: flower number, fruit set percentage, pod length, number of seeds per pod, and seed viability.
Data were analyzed using descriptive statistics (mean, standard deviation) and comparative analysis.
Fruit set (%) = (Number of pods formed / Number of flowers pollinated) × 100

3. Results
3.1 Floral Morphology

Parameter	Monoecious Plants	Dioecious Plants
Flower type	Both male and female on same plant	Male and female on separate plants
Flower position	Leaf axils	Male: clusters; Female: solitary
Average flowers/plant	25–30	Male: 30–35, Female: 10–15
Flower size	Male smaller, female larger.	Male smaller, female larger

Monoecious plants produced flowers suitable for self-pollination, while dioecious plants required cross-pollination.

Male flowers of both types were generally smaller and less conspicuous, whereas female flowers were larger and solitary.

3.2 Pollination and Fruit Set
Monoecious plants: Self-pollination yielded 85–90% fruit set, while cross-pollination slightly reduced success due to partial incompatibility.

Dioecious plants: Cross-pollination was essential. Natural pollination resulted in 70–75% fruit set, while manual pollination increased success to 80–85%.

3.3 Seed Characteristics
Monoecious seeds were uniform in size and shape, with high germination rates (90–95%).
Dioecious seeds showed greater variability, reflecting enhanced genetic recombination (germination rate 85–90%).

3.4 Observations on Reproductive Efficiency
Monoecious reproduction ensures reproductive assurance even in the absence of pollinators.
Dioecious reproduction enhances genetic diversity, important for adaptation and breeding programs.

4. Discussion

The study highlights the advantages and limitations of each reproductive system:
Monoecious System:
Pros: High fruit set, uniform seeds, easy seed production.
Cons: Limited genetic diversity; vulnerable to diseases if progeny is uniform.

Dioecious System:
Pros: Promotes genetic variation; better adaptability to changing environments.
Cons: Requires pollinators; lower fruit set without effective cross-pollination.

Breeders can utilize monoecious varieties for commercial seed production and dioecious varieties for hybridization and trait improvement.

Pollinator presence is critical for dioecious plants; thus, agroecological management can improve fruit set.

5. Conclusion

Pea plants demonstrate distinct reproductive strategies:
Monoecious plants favor self-pollination, ensuring uniformity and reproductive assurance.
Dioecious plants require cross-pollination, promoting genetic diversity.

Understanding these mechanisms is crucial for breeding programs, yield improvement, and genetic conservation. Both systems have practical applications: monoecious varieties for seed uniformity and dioecious varieties for hybrid breeding and adaptability.

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