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Reproductive strategies and invasion – case studies of two common weeds of Jammu region

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ABSTRACT

Weeds have evolved beautiful reproductive strategies to establish themselves in their areas of invasion. While many combine vegetative and sexual reproduction in various proportions, ones relying on sexual reproduction only have the ability to secure a good seed bank. Limited studies available on the pollination biology of weed species relying heavily on sexual reproduction indicate a shift in their breeding system from outbreeding to selfing particularly in invasion species. Present study is based on two weed species that form recurrent natural populations on barren lands and fields in the area of study i.e. Jammu district of Jammu and Kashmir, India. These include Fumaria indica and Hyptis suaveolens. Based on floral morphology these species apparently look outcrossers, however, details of floral phenology and life cycle confirm them to be inbreeders. Autogamy/selfing in these weed species seems to have evolved over a period of time to ensure reproductive assurance. Inspite of them being strictly autogamous and high fruit setter, seed set/fruit is low. This low seed set is because of the high incidence of ovule abortion indicating prevalence of inbreeding depression. This shift in breeding system towards selfing ensures reproductive assurance in these species which ultimately makes them better colonizers albeit at the cost of low seed set because of inbreeding depression.

Keywords: Autogamy, inbreeding depression. ovule abortion, reproductive assurance.

I INTRODUCTION

Term "weeds" denotes several explanations but is generally applied to the plants that grow at places, where they are not desired (Buchholtz, 1967). Such plants are opportunistic, highly competitive, and thrive well in every type of habitat including the disturbed ones like agricultural fields, wastelands and lawns. Although prolific seed production has been recognized as an important adaptation of many weeds, studies on their reproductive biology, which is the base of seed production, have remain neglected (Sutherland, 2004). Information on the aspect is of utmost important in order to understand the life history patterns and the effective management of these plant species. In this context

the studies on pollination and reproductive biology of weeds assumes importance. Present work on *Fumaria indica* (Hauskn.) Pugsley and *Hyptis suaveolens* is an attempt in this direction.

II MATERIAL AND METHODS

Present study is based on populations of *Fumaria indica* (Hauskn.) Pugsley of family Fumariaceae. These populations were tagged at distinct sites all within the area of Jammu.

2.1Morphology

In order to study the vegetative and floral morphology, the plants and flowers were tagged in the field itself. Data was collected on various morphometric aspects of plant and floral structure with emphasis on the reproductive apparatus including length of the pistil, length of stamens, length of anthers, length of flower, length of outer and inner petal pair and length of sepals was studied in laboratory. All these measurements were carried out using a scale and/or stage micrometer.

2.2Anthesis and anther dehiscence

Observations on anthesis and anther dehiscence were made in the field at regular intervals of time. Inflorescences and flowers were regularly monitored throughout the day and over the blooming period to record the time of peak flowering and for the time taken by the individual inflorescence or flower to bloom. Flowers of different sizes were collected before and after anthesis to check anther dehiscence.

2.3Stigma receptivity

It was checked from stigmas of different ages fixed in a mixture of three parts of absolute alcohol and one part of acetic acid for 6 -8 hours .These stigmas were washed in distilled water, stained in a mixture consisting of lactic acid, distilled water, glycerin and phenol in ratio of 1:1:1:1. These were then mounted in Lactophenol. The stigmas with germinating pollen grains attached to their surface or showing copious exudations were considered receptive.

2.4Ovule abortion

Pistils were dissected out from the flowers, fixed in carnoy's fixative for 24 hours and transferred to 70% alcohol. After 24 hours, the carpels were thoroughly washed in distilled water and cleared in 4N NaOH in an oven maintained at 60°C. These pistils were washed and stained with mixture as specified for stigma receptivity and mounted in a drop of lactophenol on a clean glass slide. The prepared slides were observed for the position and

number of ovule aborting within a carpel under compound microscope. Ovules reduced in size were treated as aborted.

2.5Fruit and seed set

In order to estimate the reproductive potential, the inflorescences were initially monitored for number of flowers per inflorescence and then for number of fruits per inflorescence. Solitary flowers were monitored individually for fruit set .Fruits were later collected and studied for number of seeds. In order to determine, the percentage fruit and seed set, formula used were

i. $$\frac{\text{Average fruit count/inflorescence}}{\text{Average flower count/inflorescence}} \text{x } 100$$

ii. $$\frac{\text{Average number of seeds/fruits}}{\text{Average number of ovules/flower}} \text{x Percentage fruit set}$$

III RESULTS AND DISCUSSIONS

Fumaria indica (Hauskn.) Pugsley (Fumariaceae) and *Hyptis suaveolens* (Lamiaceae) the material of present study forms annual weeds in the subtropical climates of Jammu. *Fumaria indica* have a brief life cycle of 4 -5 months, this species is devoid of vegetative means of propagation and reproduces only sexually. *H. suoveolans* is perennial weed and reproduces sexually also. Flowers of *Fumaria indica* are pale pink, and remain aggregated into small sized racemes. Reproductive organs remain completely enclosed inside the closed involucres of petals. The flowers can thus be termed cleistogamous (Araf and Hamal, 2009). The period of anther dehiscence and stigma receptivity overlaps to a great extent. Cleistogamy, placement of anthers and stigma close to each other, assisted by the curvature of style at top, final closure of these inside the closed petals and an overlap between anther dehiscence and stigma receptivity make conditions conducive for autogamy in this species. Another feature favoring autogamy in the species is the prevalence of *in situ* pollen germination in a proportion of flowers scanned at all the sites. Frequency of *in situ* pollen germination was seen to vary from 30 – 38 % and had a correlation with the environmental conditions. Phenomenon of *in situ* pollen germination which was first reported in cleistogamous flowers of *Viola* is an important attribute of species practicing autogamy. It has previously also been shown to be highly correlated with temperature and relative humidity (Connors and Mathews, 1977; Lord, 1979). Flowers of *Hyptis* are sessile, small, zygomorphic, bisexual, tubular in appearance and bilabiate. The upper lip has two lobes and lower lip is divided into three lobes. The central carinal lobe of this lower lip encloses sex organs. Petals are pinkish blue in colour and show the presence of dark purple nectar guides on the upper lip. A fleshy nectar disc is

present at the base of ovary. Four didynamous, epipetalous and basifixed stamens are present which are held under carinal lobe. Ovary is bicarpellary, syncarpous and tetralocular with one ovule in each locule. Flower opening in this species is initiated by opening up of upper lip, with the lower lip along its carinal lobe remaining closed. This carinal lobe opens only if disturbed. In the absence of disturbance, this lobe enclosing the dehisced anther and ultimately self pollination occurs. Though the species are autogamous seed set per flower is low. In nature it is less than or close to 50 % at different sites in all these species. The decrease in seed set in these species is because they aborts a proportion of their ovules. Ovule number per ovary varies from 1 – 4 in the young buds of *Fumaria indica and Hyptis suaveolens*. As the pollen tubes invade the ovary, only one ovule is fertilized, and thus only one seed is formed in both the species. A comparable situation has been reported in *Trifolium dubium* by Sharma and Koul (1996). In this species with cleistogamous flowers, the two ovuled pistil invariably aborts its pedunclar ovule inspite of the availability of sufficient pollen most of which germinates *in situ* (Sharma & Koul, 1996; Dhar *et al*., 2006).This low seed set is an indicator of inbreeding depression. This shift in breeding system towards selfing ensures reproductive assurance in these species which ultimately makes them better colonizers albeit at the cost of low seed set because of inbreeding depression.

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