EFFECT OF PATCH SIZE AND FLORAL COLOR ON POLLINATION SUCCESS OF *IMPATIENS WALLERANA*

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Abstract. Impatiens wallerana flowers are found in both large and small patches and vary in petal color. We tested for differences in pollination success as a function of spatial distribution and petal color. Neither pollinator visits per flower nor the number of seeds per pod differed with patch size, even though seeds per pod were highly variable (range = 14-67). However, the estimated proportion of flowers that turn into pods was 3.9 times higher for solitary plants than plants in large patches. There was no obvious variation in pollination success among color morphs. Solitary plants appear to have higher reproductive success than clumped flowers, implying that variation in pollination success tends to equalize patch sizes in I. wallerana.

Key words: color, dispersion, Impatiens wallerana, *pollination success*

INTRODUCTION

Reproductive success in most flowering plants is contingent upon attracting pollinators. We explored factors that may affect pollination success in *Impatiens wallerana*, an insect pollinated plant that occurs as an exotic in Costa Rica. This plant grows in patches of variable size in both sunny and shady areas. We hypothesized that large clumps of flowers attract more pollinators per flower than solitary flowers because optimally foraging pollinators will seek to minimize travel time. We predicted (1) a higher rate of pollination success in clumped flowers, and (2) more pollinator visits per flower to clumped flowers than to solitary flowers.

I. wallerana flowers exist in several colors ranging from white to a deep pink color. We hypothesized that the low frequency white and light pink color morphs have a rare mate advantage because pollinators may be more attracted to relatively unusual flowers. If so, this could lead to frequency-dependent selection that would tend to maintain color variation within the population. Alternatively, pollinators may develop a search image for the more common color morph, in which case flowers with rare colors would be at a disadvantage and would tend to be selected out of the population.

METHODS

Pollinator visitation rates were measured for large patches and solitary flowers by observing a haphazardly-chosen square meter area and recording the number of potential pollinators contacting the anthers and/or stigmas, as well as the number of other visitors per flower in the area in a fifteen minute interval. Large patches were defined as having a density > 30 flowers/m2 and covering ≥ 15 m2. Solitary plants had less than three flowers and were > 4 m from the nearest conspecific flower. We compared visitation rates in solitary vs. clumped flowers with Chi squares.

Seed pods were collected from plants of the high frequency dark pink color morph in large patches (n=7) and from solitary plants (n=8). Seed pods were also collected from plants with low frequency petal colors and high frequency petal colors in multi-colored patches (n=7). The pod to flower ratio was estimated by counting flowers and pods within one square meter of a patch, and a sample of pods was chosen haphazardly from within each plant. We dissected six pods and counted the ovules to see if the potential number of seeds was constant for each pod. We counted actual numbers of seeds per pod for solitary vs. clumped and low vs. high frequency color morphs. ANOVAs were used to compare variation within and between solitary plants and large patches as well as bi-colored plots.

RESULTS

The number of insect visitors per flower was similar in large patches vs solitary plants (21 visitors / 437 flowers vs. 2 visitors / 12 flowers; $X^2 = 2.64$, df = 1, P > 0.05). Large patches had many fewer pods per flower than solitary plants (total pods / flower = 174 / 429 vs. 27 / 17; $X^2 = 51.4$, df = 1, P < 0.05), suggesting that flowers were more likely to turn into pods in solitary plants than large patches. *I. wallerana* plants exhibited substantial variation in the potential number of seeds per pod (mean ± SE = 42.0 ± 18.7, range = 14-65, n = 71 pods). However, the mean number of seeds per pod in clumped versus solitary patches was almost identical (mean + SE = 42.1 ± 2.5 vs. 41.5 ± 15.9, n = 7 and 8, respectively; Table 1).

Within patches of *I. wallerana* containing different colored flower morphs, pods from high frequency flower morphs (pink) contained nearly identical numbers of seeds per pod as the low frequency I. wallerana morphs (mean ± SE = 40.7 ± 3.9 vs. 41.4 ± 1.9; Table 2). Further, low frequency flower morphs had similar numbers of pods per flower (pods/flower = 61 / 84 vs 168 / 263; X^2=0.75, df=1, P > 0.05) as high frequency flower morphs.

DISCUSSION

Depending upon pollinator behavior, *I. wallerana* reproductive success could be higher, lower, or the same in large patches versus solitary plants. Our pollinator observations suggested that large patches have more total visitors, but similar numbers of visitors per flower. However, the total number of visitations that we observed was low, so this conclusion remains tentative. We found a higher ratio of pods per flower in solitary plants than in large patches, which suggests that the probability of pollination is greater in solitary plants. However, seeds per pod did not vary with patch size, perhaps indicating that when flowers were pollinated, there was no difference between large patches and solitary plants in how many pollen grains were transferred to the stigma. Because seed dispersal in *I. wallerana* is quite local (probably < 1 m except under unusual conditions), relatively high reproductive success in solitary plants will lead to a rapid transition from solitary plants to large patches. Thus patterns in reproductive success will tend to equalize patch sizes of *I. wallerana*. This could be tested by a long-term study following solitary plants over multiple generations.

Table 1. Nested ANOVA comparing number of seeds/pod between clumped and solitary *I. wallerana* in San Luis Biological Preserve, Costa Rica.

Source	df	MS	F
Patch Size	1	0	0.00
Subplots	13	613	2.07*
Error	56	297	

*P < .05

Table 2. Factorial ANOVA comparing number of seeds/pod between high frequency and low frequency *I. wallerana* color morphs in San Luis Biological Preserve, Costa Rica.

Source	df	MS	F
Plot	6	292	0.81
Color	1	7	0.02
Plot x Color	6	336	0.70
Error	76	416	

We found no patterns in reproductive success related to flower color. If frequency-dependent selection is not occurring, the low frequency morph should be eliminated from the population through genetic drift. We suggest that low frequency morphs continue to exist because of balancing selection or frequency-dependent selection on different spatial or temporal scales. This could be tested by comparing pollinator preference for different color morphs in different geographic locations (e.g. San Luis vs Monteverde).

Our research has provided preliminary insights into the pollination biology and reproductive success of *I. wallerana*. Important questions remain about the breeding system of *I. wallerana* (e.g. capacity for selfing), the efficacy of various visitors in delivering pollen, and the inheritance of flower color.