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Influence of Pre-Dispersal Seed Predation on the Reproductive Yield of *Brassica rapa*

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Influence of Pre-Dispersal Seed Predation on the Reproductive Yield of *Brassica rapa*

by Janet Crawford

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The Assignment: Conduct original research and write a technical paper about the research.

ABSTRACT

This study used *Brassica rapa*, a rapidly growing radish, to examine which component of reproductive yield; flower count, fruit count, seed number per plant, seed number per fruit or seed mass; is least variable and therefore of greatest importance for a plant to maintain. The effect of pre-dispersal seed predation on the least variable yield component was also examined by removing up to four developing fruit pods from each plant in a treatment group. Only flower count per plant varied significantly between experimental treatments. It was unknown how the impact of this difference, which was not experimentally altered, affected the remaining components of radish reproductive yield. Coefficient of variation was lowest for mass per seed, which indicates it is of greater importance for *B. rapa* to maintain for species fitness.

INTRODUCTION

Understanding the components of reproductive yield; flower count, fruit count, seed number per plant, seed number per fruit, and seed mass; is essential for profitable crop management. One major concern for crop management is decreased yield due to arthropod herbivores. It has been estimated that 13% of U.S. crops are destroyed yearly by insects and that about $1.2 billion per year is spent on pesticides in an attempt to minimize the losses (Pimentel et al. 2000). However in some cases plant species can overcompensate for dramatic losses due to pest damage. Cotton plants can sustain up to 100% early removal of foliage and removal of early fruits without affecting crop yield (Wilson et al. 2003).

Previous studies have shown that flower count significantly varies with plant biomass, plant height and with plant competition (Miller 1997). Stowe (1998) found that as damage treatment to the leaves of *Brassica rapa* increased, the total flower count correspondingly decreased. Actually, only a small percent of flowers normally become mature fruits (Burd 1998). For example, usually less than 15% of *Lindera benzoin* flowers develop into fruits (Niesenbaum 1996). There have been many hypothesis proposed to explain the excess flowers: a large number of flowers attract more pollinators, they allow for greater fruit production in years of increased resources, they provide ovaries that can be matured to replace those lost, they allow the plant to selectively mature superior fruits, and the excess act as staminate flowers providing pollen (Burd 1998).

Mature fruits are more likely to be produced from the earlier flowers, even when additional pollen is manually applied to later flowers; however, if early flowers are removed the later flowers will then mature fruits (Medrano et al. 2000). Plants tend to abort fruits with less pollen tubes per style (Niesenbaum 1996) and those with less seeds (Burd 1998). Environmental factors like additional shading also increase fruit abortion rates (Neisenbaum 1996).

Seed number per plant varies with plant spacing, water, plant biomass, light availability, atmospheric C concentration, and foliage predation (Bolanos-Aguilar et al. 2002, Egli 2002). Seed number per fruit can also be significantly reduced by simulated predation (Bolanos-Aguilar et al.

2002, Stowe 1998).

Most studies seem to find no significant variation in seed weight (Bolanos-Aguilar et al. 2002, Miller 1995, Stowe 1998, Niesenbaum 1996). Although *Cosmos bipinnatus* seeds were found to vary significantly with plant mass (Linville 1995); and *Arum italicum* seeds were found to vary with fruit position (Mendez 1997).

The objective of this study was twofold. First, to determine which component of reproductive yield; flower count, fruit count, seed number per plant, seed number per fruit, or seed mass; is least variable, and therefore, most important for a plant to maintain. Second, to ascertain how pre-dispersal seed predation influences the reproductive yield component that is found to be least variable.

METHODS

B. rapa, is an Eurasian annual weed found worldwide (Pilson 1996), and is also used in canola oil making it an important crop (Rajcan et al. 1997*)*. A rapidly growing variety of this radish species was chosen for study because it is an indeterminate annual, and was expected to complete its growth cycle in about six weeks. As annual species live for only one growing season, they must dedicate most of their energy to producing viable seeds to ensure their survival for the following year (Smith 1996). This quality combined with the indeterminate nature of their continual growing and flowering until senescing, makes the rapid radish a good specimen for studying the effects of pre-dispersal seed predation. The radish seeds were obtained from Carolina Biological Supply Company (Burlington, NC).

Seventy small plastic pots, each with a hole in the bottom for watering as needed, were filled with about 80 ml of soil. One *B. rapa* seed was placed into each pot and the rapid radish seeds were sown in an environmental chamber set at a photoperiod of 15/9 hours light/dark and equipped with fluorescent lights. After 20 d the growing 38 plants were numbered and random hand cross pollination was initiated. Counts of flowers and pods were taken per plant every 2-4 d. Thirty-four days after planting, during the early stages of fruit development, the remaining 26 plants were randomly divided into a control group and an experimental group that simulated pre-dispersal seed predation. Four inflated pods were randomly cut from each of the experimental plants to simulate pre-dispersal seed predation. If less than four inflated pods were present on a plant, all pods were removed.

After 82 d, four mature pods were randomly selected from each senescing plant for seed counts and individual measurements of seed mass. If a plant had less than four mature pods, all were sampled. Seeds having a mass less than 6 mg appeared dead and were not included in the data. Flower counts were made based on the sum of flower number visible at the time of counting, evidence of prior flower formation where no pods formed, pods inflated, and the pods removed.

Student t-tests were used to test for statistical differences between control and seed predation treatments. Flower counts per plant were log transformed prior to analysis as to insure homogeneity of variance. Coefficient of variation was computed as a weighted measure of how the components of radish reproductive yield varied.

RESULTS

There were no significant differences in the number of pods initiated per plant, pods ripened per plant, seeds matured per plant, or the mass per seed between the control and simulated predation treatments (Table 1). Only flower count per plant varied significantly between experimental treatments. It was unknown how the impact of this difference, which was not experimentally altered, affected the remaining components of radish reproductive yield. Coefficient of variation was lowest for mass per seed (Table 2).

DISCUSSION

The significant flower number variation found in this study between experimental pre-dispersal seed treatment and control group supports previous studies that found flower count varied with plant and environment conditions (Miller 1997, Stowe 1998). It appeared that after seed predation, the treated *B. rapa* plants concentrated their energy resources into maintaining more pods and the seeds within to maturity, thereby ensuring their species survival, rather than producing as many excess flowers.

The mass per seed had the smallest coefficient of variance, as did most of the previous studies (Bolanos-Aguilar et al., Miller 1995, Stowe 1998, Niesenbaum 1996). This is an indication that seed mass is the most important yield component for *B. rapa* to maintain. Unlike perennial plants which can live for many years, the survival of annual species relies on plants producing viable seeds for the next year's plant population, as the seed producing plant dies (Smith1996). In contrast to perennial plants which can rely on starting its growth from some of the previous years energy that was stored in its roots; each season annual plants begin their life from a seed. Therefore each viable seed must contain sufficient energy to sustain a new plant until it can begin photosynthesis (Smith 1996).

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Table 1. Summary (mean $\pm$ standard error; n) of the components of plant reproductive yield between the control and pod removal treatment. Statistical comparisons are shown between experimental treatments on the far right. *denotes significance (P –$\leq$ 0.05). flower counts per plant were log10 transformed prior to statistical analysis.

Component of reproductive yield	Control plants	Pod removal treatment	t	P
Flower count per plant	45.5 $\pm$ 7.00(13)	25.8 $\pm$ 3.68(10)	2.45	*0.02
Pods initiated per plant	7.0 $\pm$ 0.9(13)	10.0 $\pm$ 1.8(10)	1.57	0.13
Pods ripened per plant	5.2 $\pm$ 1.1(13)	4.6 $\pm$ 1.4(10)	0.35	0.73
Seeds matured per plant	10.0 $\pm$ 4.1(13)	5.4 $\pm$ 1.6(10)	0.93	0.36
Mass (mg) per seed	10.2 $\pm$ 0.7(11)	11.3 $\pm$ 1.9(9)	0.57	0.58

Table 2. Coefficient of variation according to component of reproductive yield and experimental treatment.

Component of reproductive yield	Coefficient of variation	
	Control plants	Pod removal treatment
Flower count per plant	14.0	5.3
Pods initiated per plant	1.52	3.38
Pods ripened per plant	3.22	4.46
Seeds matured per plant	1.15	5.01
Mass per seed	0.53	2.91