

Why seeds produced by a plant are not the same?

Offspring of any organism, if they are not clones, differ from each other. Seeds produced by a mother plant are no exception, and they vary in size, color and shape. Usually, these differences are minor and represent a continuum of gradual changes, but some plant species produce several categories of distinctly different seeds. This phenomenon is called discrete heteromorphism. An example is a production by a single plant two kind of seeds: seeds having a special structure for wind dispersal called pappus and those without pappus. Production of two kinds of seeds has a functional importance: while some seeds stay at the place of origin, others are dispersed away from it.

Another kind of seed heteromorphism, when seed can not be categorized into several distinct classes of shape, color or size, called continuous heteromorphism, until recently was thought to be purely a result of developmental variation. Seeds within the fruit, inflorescence or dispersal unit can compete for available resources, and as a result be larger or smaller. This explains, for example, why seeds of flowers at basal positions, which are the first-formed and therefore better-developed are usually larger than seeds of flowers at distal positions.

The question that we asked was whether this variation is only a by-product of seed developmental process within a plant or has some functional importance for a plant and as such became a target for natural selection.

Wild wheat, a progenitor of cultivated wheat that grows in Near East and Turkey, produces spikes that at maturity disarticulate into arrow-shaped spikelets. Each spikelet comprises 2- or rarely 3-grains. Grains of different position within a spikelet slightly differ in size, but, as we have shown in a series of experiments, differ in germination pattern under both field and controlled conditions. The upper grain in a spikelet is larger than the bottom grain, and either germinates in the season following dispersal, or dies. In contrast, a substantial fraction of the bottom grains does not germinate in the first season, but remains dormant in the soil seed bank for one year.

The two grain difference in dormancy can not be explained by a competition for resources alone. When plants are grown in a greenhouse, resources are in good supply, and competition for them between the two grain types is unlikely or minor. Under these conditions the difference in size between upper and bottom grain is subtle but a difference in grain dormancy is retained.

Theoretically, production of both dormant and non-dormant seeds can help to deal with environmental unpredictability, when some seeds will stay dormant in the soil in a year when amount of rainfall is below a threshold for plant survival and reproduction allowing population persistence. In this case a higher proportion of dormant seeds can be more important and selected for under higher aridity. Another hypothesis relates production of both dormant and non-dormant seeds to competition among the offspring in species with low seed dispersal ability. This hypothesis predicts higher importance of production of two kind of seeds in more productive environment

because in this environment competition is more intense.

We found some increase in seed dormancy of the bottom grains with increase in aridity of their locations, but high seed dormancy was present in spikelets of all origins.

It seems that seed polymorphism can not be attributed to a single evolutionary cause, and is a life history trait with complicated evolutionary history and wide adaptive applicability. Seed polymorphism appears to originally evolve as an adaptation for reducing competition in productive (high precipitation) environments, and under increasing aridity became important for surviving periods of insufficient rainfall.

Sergei Volis

*Key Laboratory for Plant Diversity and Biogeography of East Asia, Kunming Institute of Botany,
Chinese Academy of Sciences, Kunming, China*

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Volis S

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