



Exploring the effect of nitrogen fertilization on plant traits that affect insect recognition cues and larval growth

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The amount of nitrogen in plant leaves affects survival and growth of larval insects that feed on them¹. Thus, adults may use traits that correlate with N content to assess plant quality for oviposition².

Using plants fertilized with different amounts of N, we will explore consequences of adult choice on **1 Larval growth** and examine plant traits adult insect may use to choose where to lay their eggs such as **2 Leaf age/area** and **3 UV reflectance/color**.

How does plant nitrogen content influence plant traits that affect larval growth and adult recognition cues for insects?

From the patterns we observed in these data, we design experiments that evaluate if the traits/cues matter to adult insects.

We study cabbage white butterflies (*Pieris rapae*) and their cabbage host plants fertilized with varying quantities of Osmocote 14-14-14 (N, P, K) fertilizer.

Answering questions about how insects find host plants contributes to research on animal search behavior³ and has applications for managing insect pests in agricultural settings⁴.

METHODS

Larval Growth

1

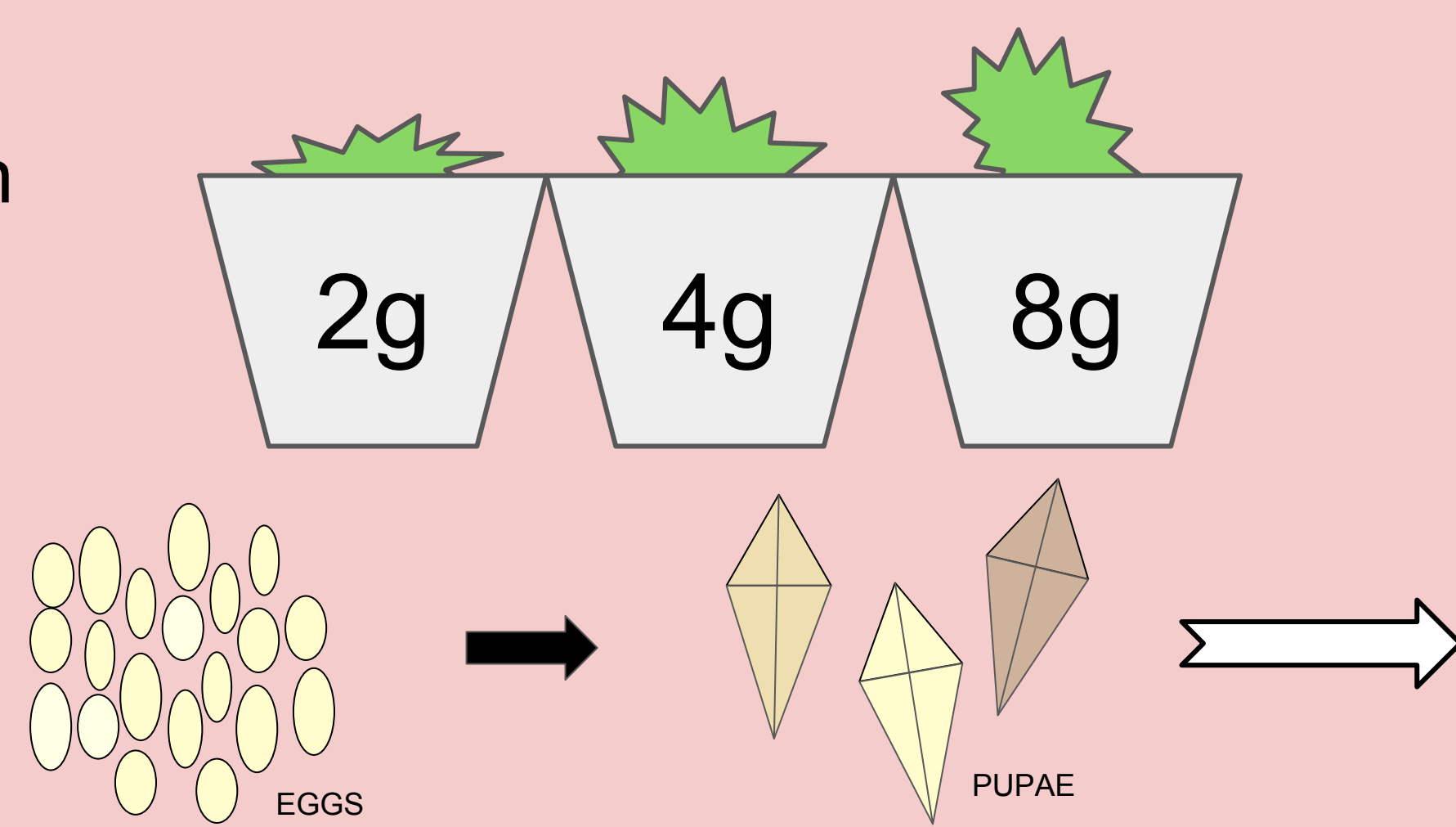


Figure 1. Methodology for calculating larval growth rate on various cabbages fertilized with different amounts of nitrogen.

RESULTS

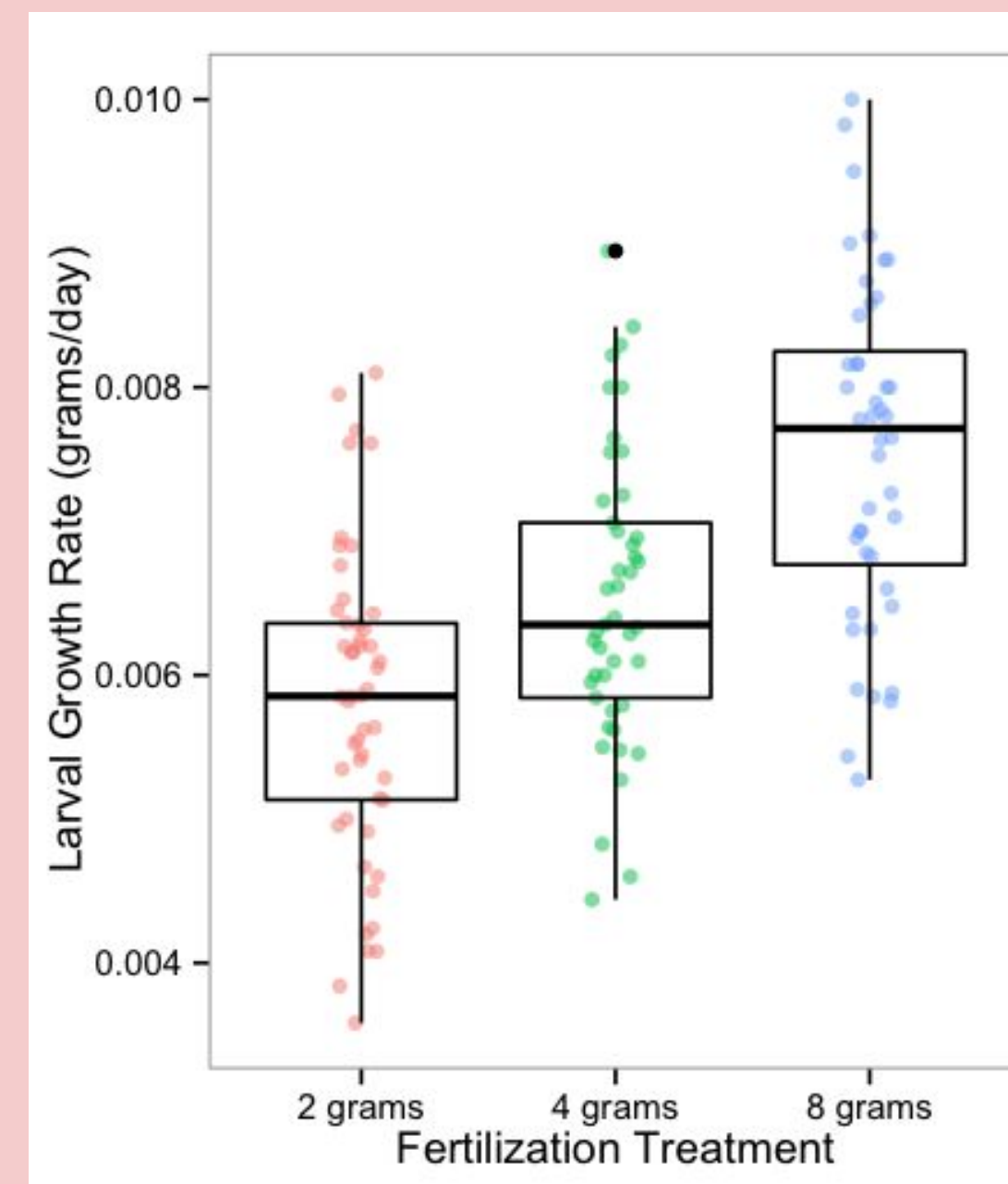


Figure 2. Effect of nitrogen fertilization on larval growth rate. Larval growth rate is measured as pupal mass divided by days to pupation. N ~ 50 larvae per treatment.

Larval growth rate is positively correlated with N fertilization.

However, we don't know if these are the results of N alone, other nutrients (P, K), or other indirect effects of N (defensive chemicals).

To determine if N affects other aspects of plant chemistry besides N content, we can compare growth of larvae fed on an artificial diet.

If the relationship between growth rate and fertilization differs between cabbage-fed and artificially-fed larvae, other chemicals in the plant may be affecting growth in addition to upregulated with N.

DISCUSSION

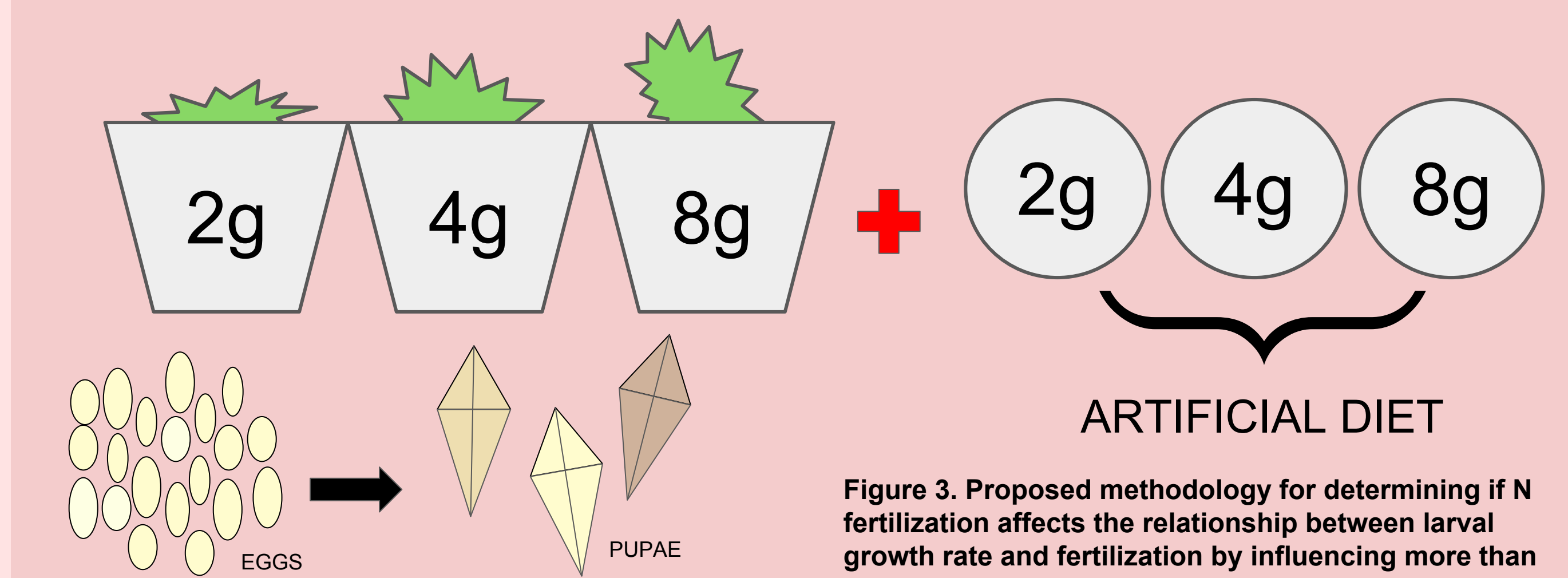


Figure 3. Proposed methodology for determining if N fertilization affects the relationship between larval growth rate and fertilization by influencing more than just N content in plants.

Leaf Area

2

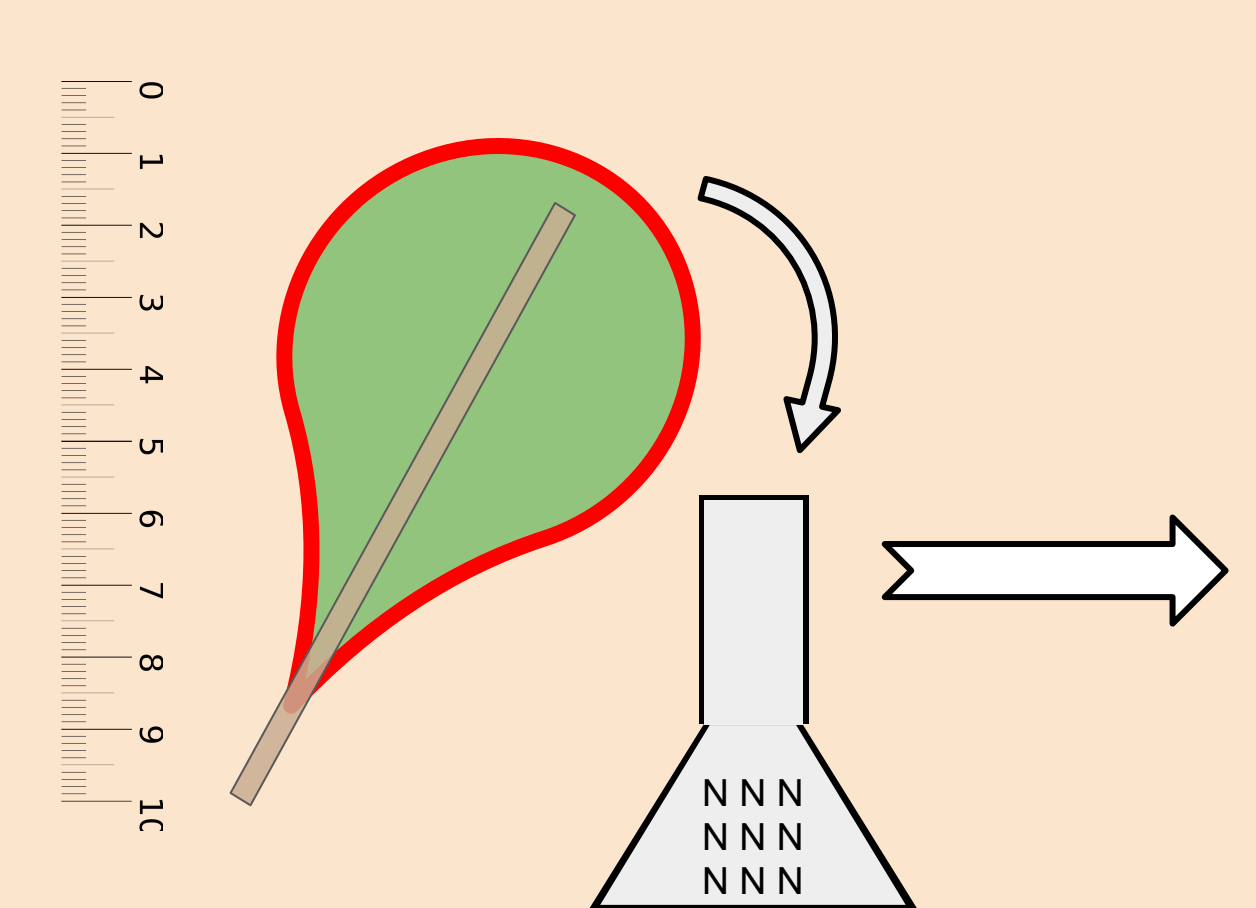


Figure 4. Methodology for calculating leaf area and N content. Measurements were taken on leaves from 3 cabbage plants per fertilization treatment.

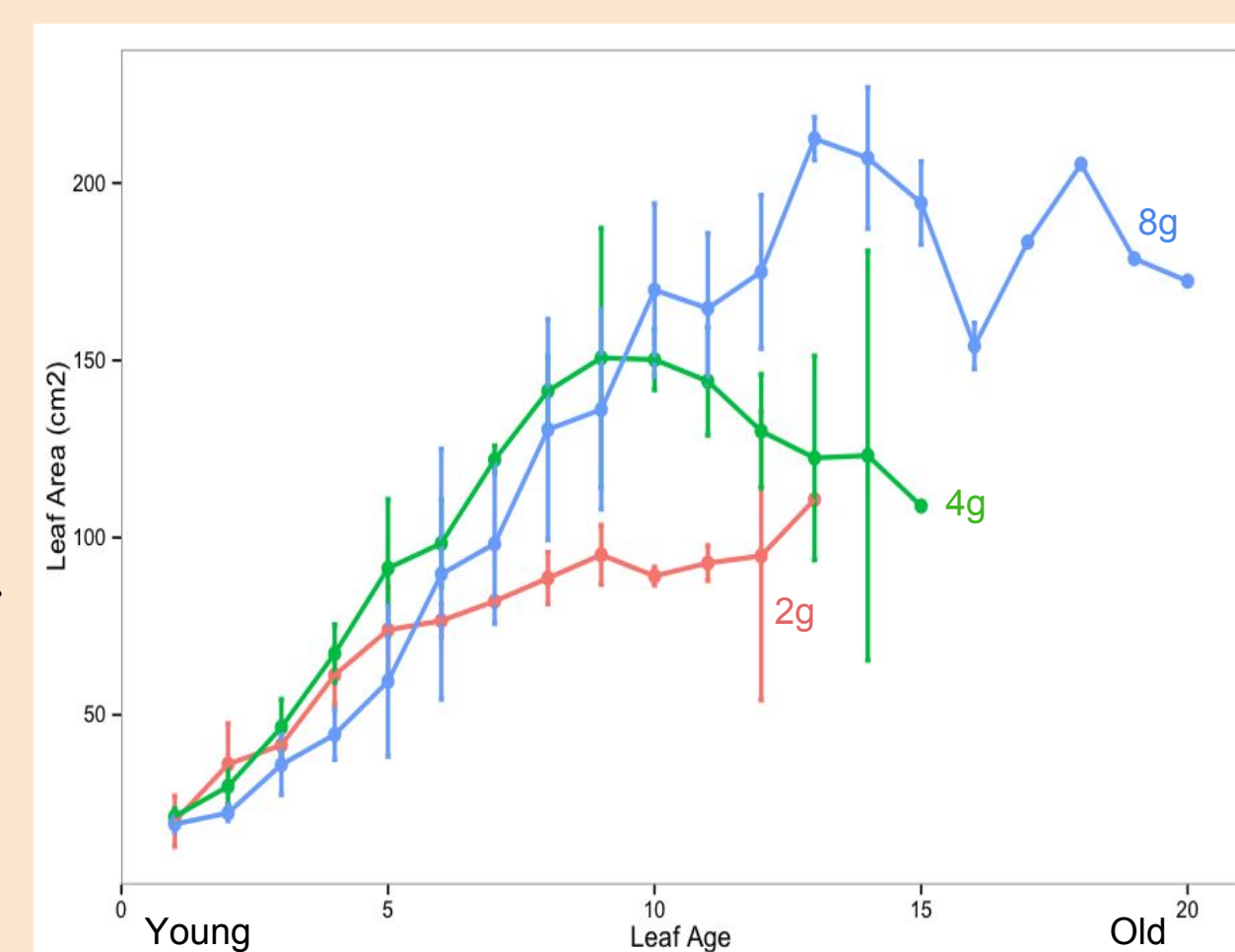


Figure 5. Area of leaves of different ages on cabbages fertilized with different levels of N. Each point represents the mean leaf area for its respective leaf age. Error bars represent +/- 1.96 SE from the mean.

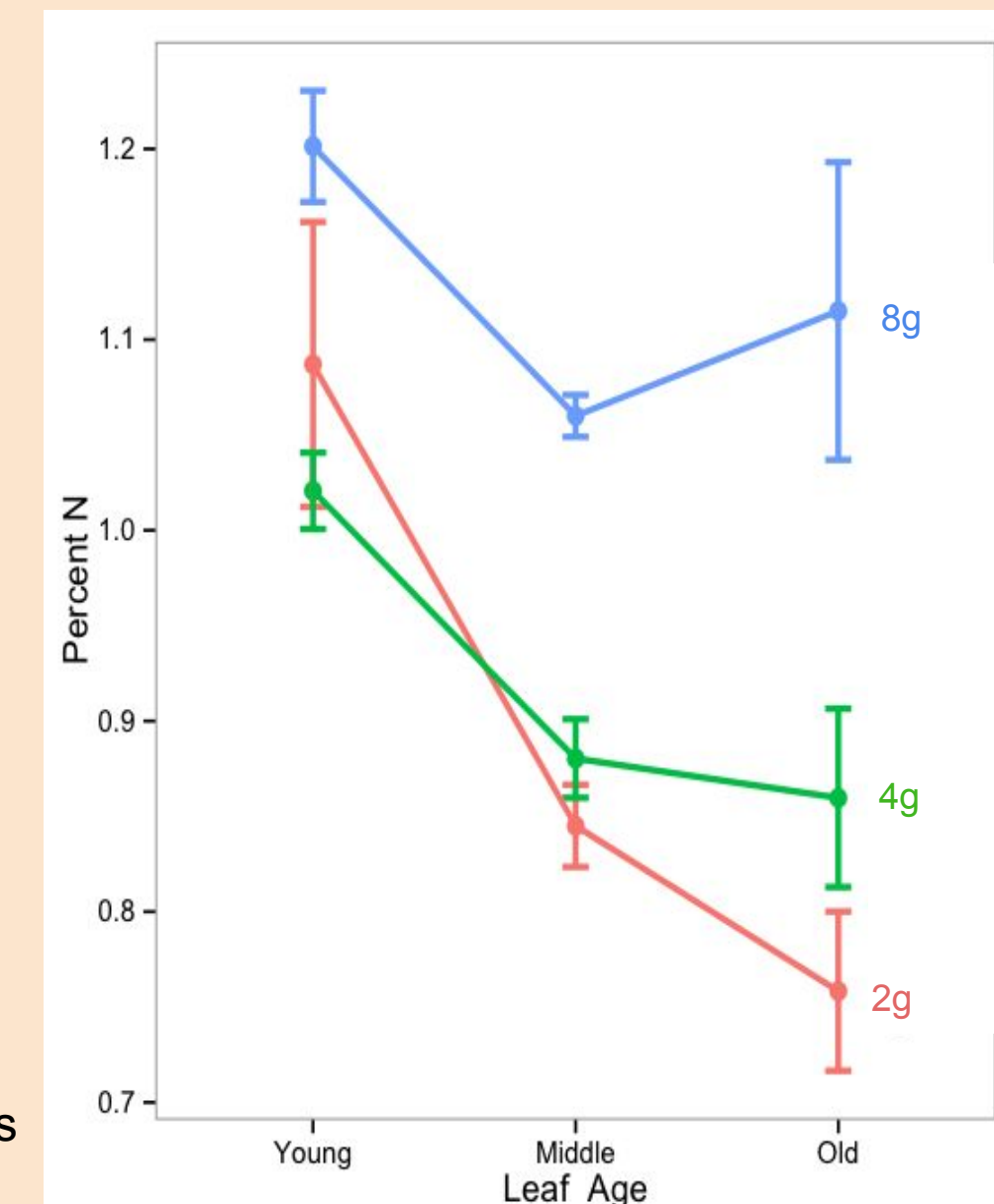


Figure 6. % Nitrogen by dry weight of leaf for leaves of different ages at different levels of nitrogen fertilization. Each point represents the mean % N for leaves of three age groups. Error bars represent +/- 1.96 SE from the mean.

8g cabbages have more leaves and larger leaves than 4g and 2g cabbages. N content varies with leaf age in 2g and 4g plants, but is relatively constant across all ages in 8g plants.

Competition for young leaves may play a larger role for larvae reared on 2g and 4g cabbage.

However, we don't know if butterflies have a preference for oviposition location within a cabbage.

To determine if adult butterflies recognize leaf age as a cue for leaf quality (N content), we can record oviposition patterns for various fertilized cabbages.

If it is important, we would expect adults to lay eggs on all ages of 8g leaves, but primarily young leaves on 2g, and 4g

Limitation: N may be confounded with other nutrients, placement, or chemical cues.

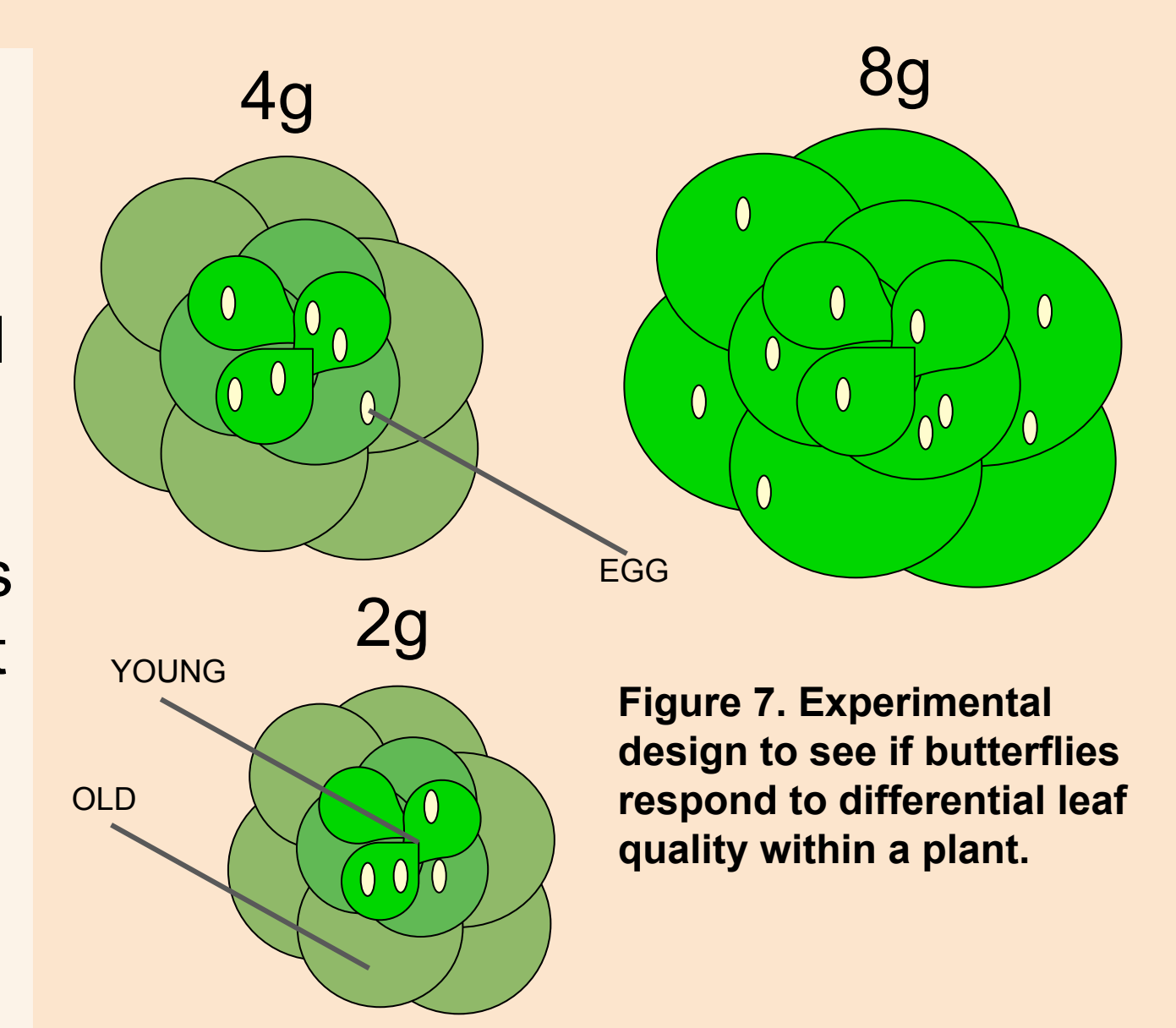


Figure 7. Experimental design to see if butterflies respond to differential leaf quality within a plant.

Reflectance

3

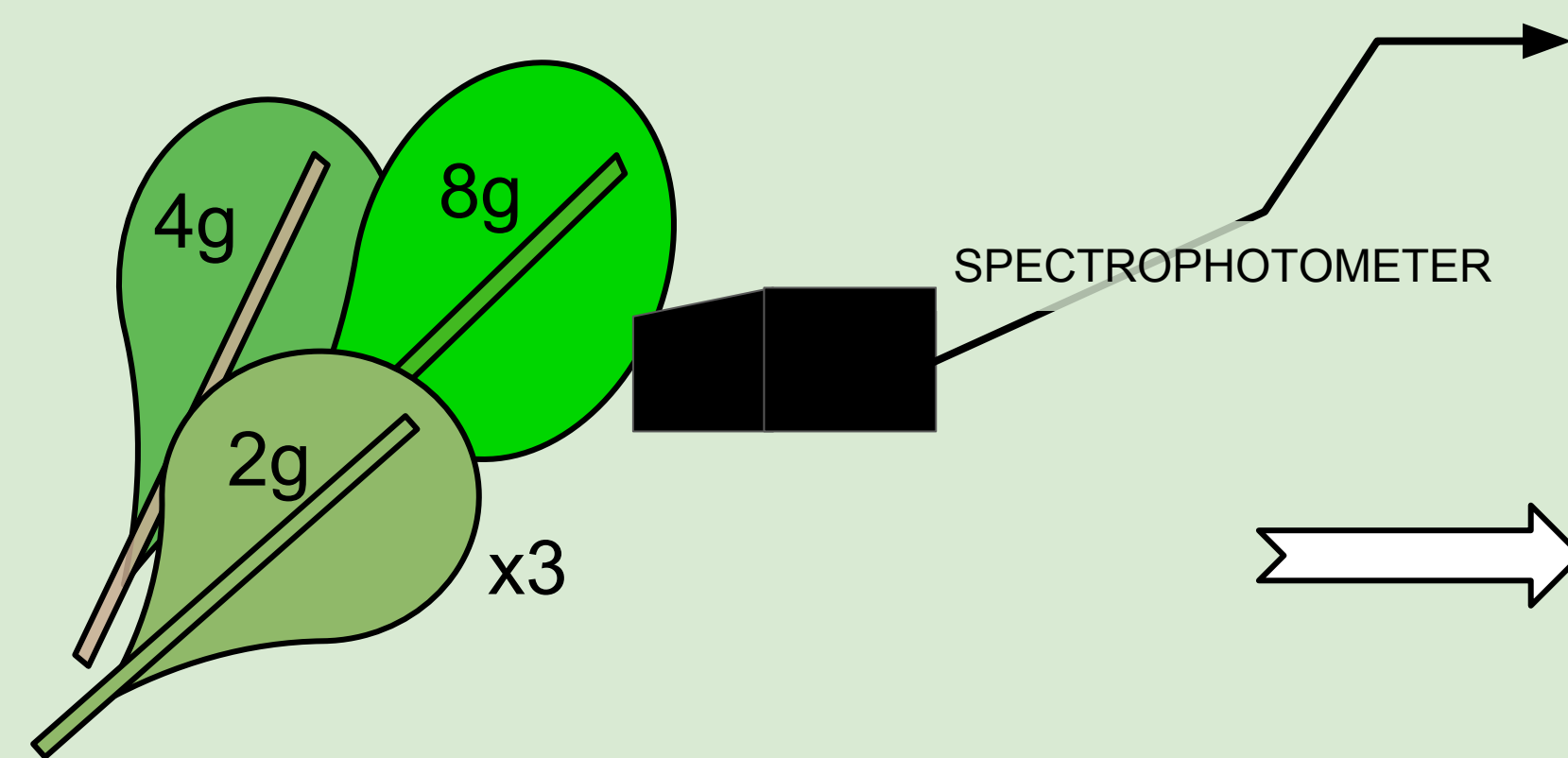


Figure 8. Methodology for calculating % reflectance at different wavelengths for each N fertilization treatment. Measurements were taken from three cabbage plants per fertilization treatment.

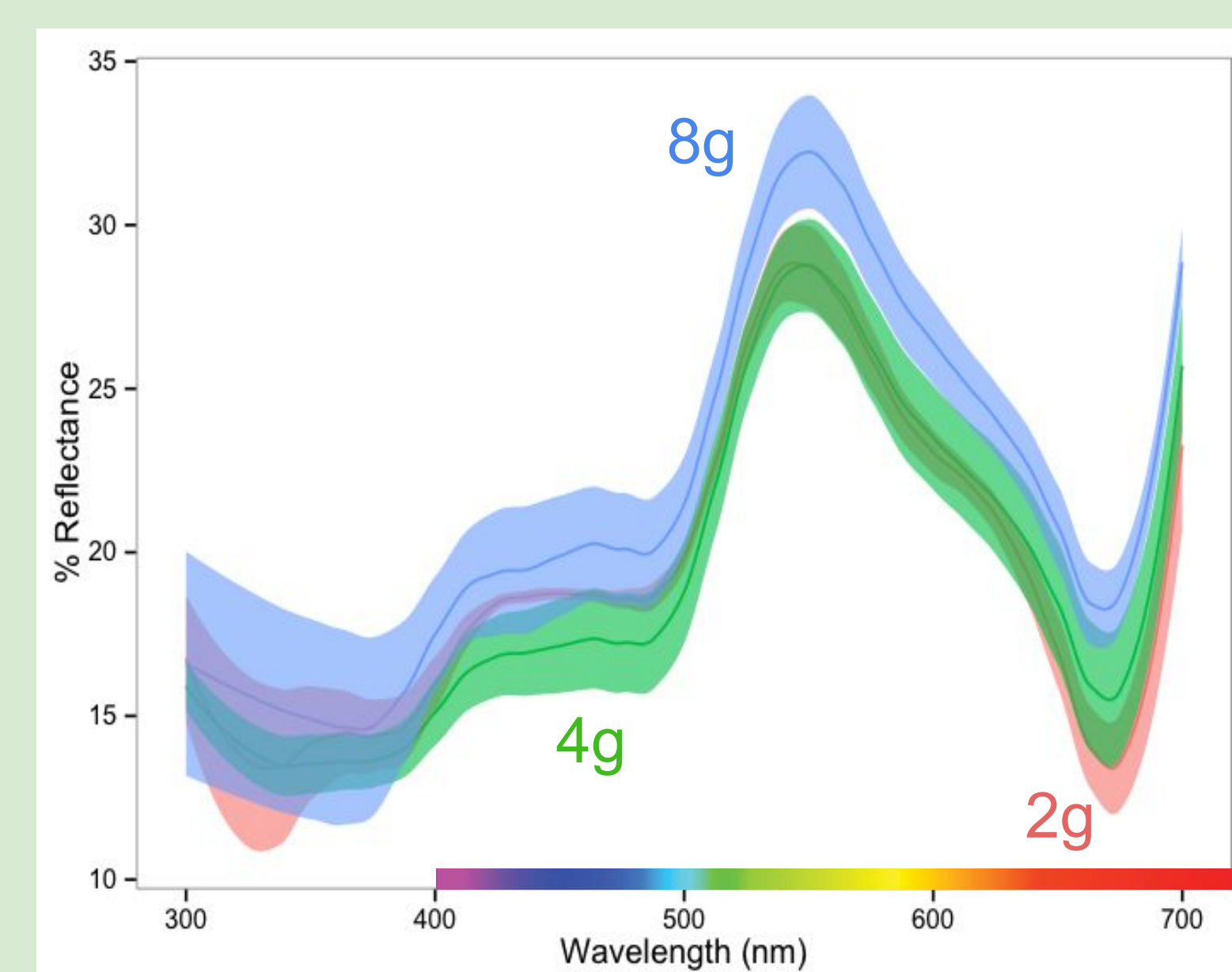


Figure 9. % Reflectance at differing wavelengths for three N fertilization treatments of cabbage plants. Line is mean % reflectance for each treatment at each wavelength. Ribbon is a 95% confidence interval (+/- 1.96 SE from the mean).

In the green wavelength range, 8g cabbages have a greater % reflectance.

Adults may use color as cue for leaf quality.

However, butterflies could also pay attention to variables other than color (chemical cues, water content, leaf size).

To determine if butterflies use color as a cue for oviposition, we can:

1. **Train** butterflies to associate certain colors with high glucosinolate, then
2. **Test** them in an arena with all three colors (Figure 10)

If color alone is important, frequency of landing will correlate with color.

If not, butterflies may be unable to distinguish between different greens or they do not remember color cues.

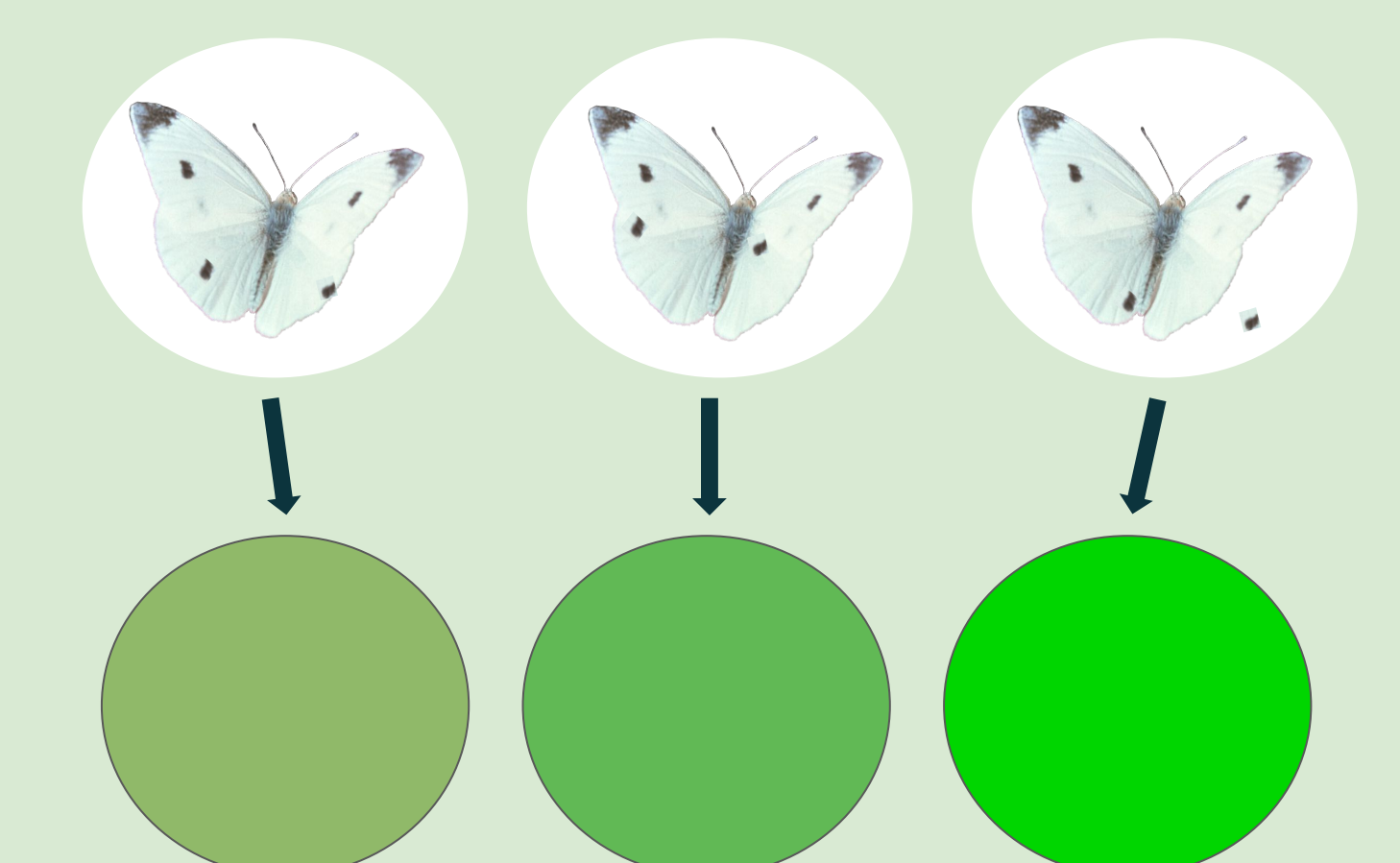


Figure 10. Methodology for assessing if color alone is a significant insect cue for oviposition.