Kansas State University | Department of Entomology

A Fluorescent Approach to Understanding Nutrient and Dye Translocation in Crops

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Background

Tracking

- Understanding molecule movement in plants is key for improving plant physiology and agriculture.
- Traditional transport tracking uses radioisotopes or destructive sampling, limiting spatial and temporal resolution.

Knowledge gap in detection

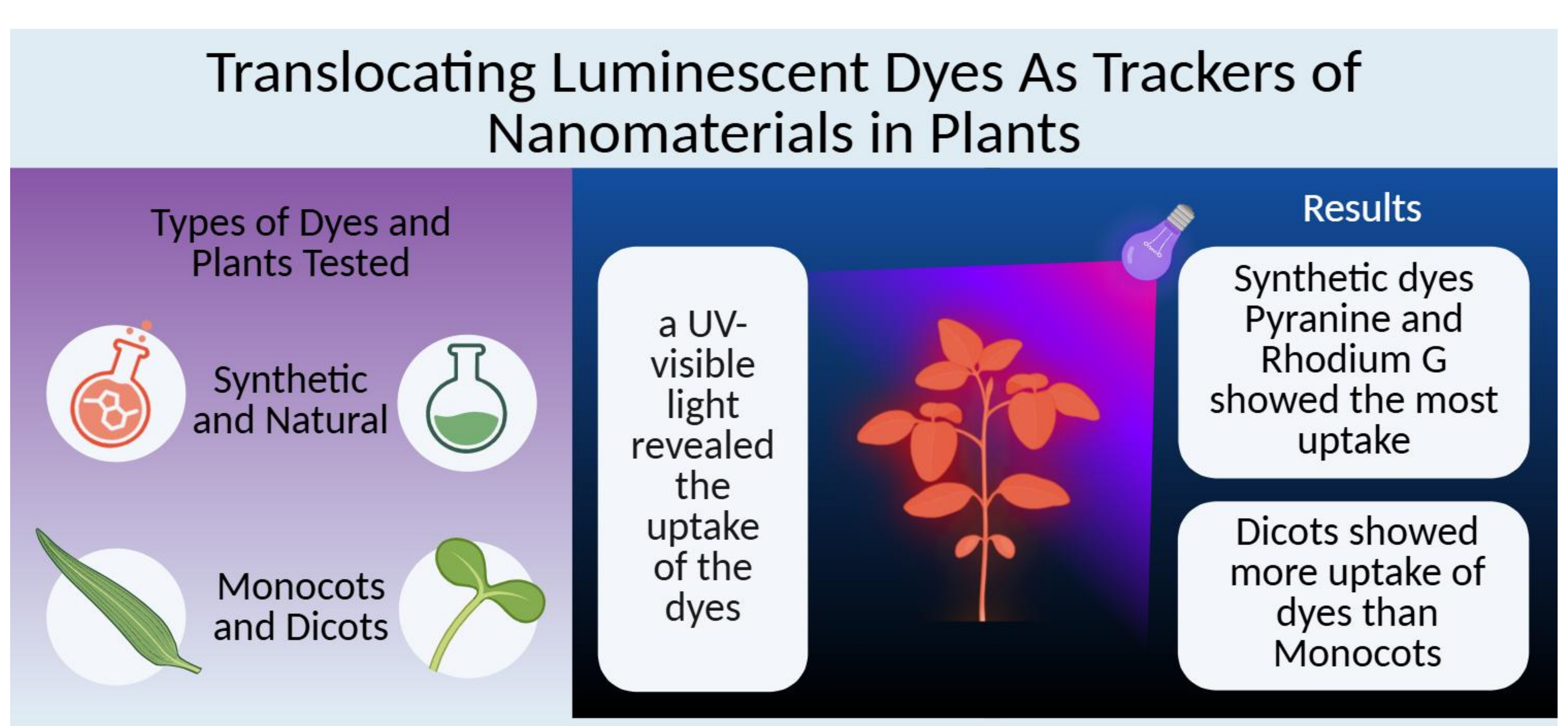
- Current methods for tracking transport processes—like radiolabeling, dye infiltration, or destructive sampling—are limited by resolution, invasiveness, and scalability.
- These limits hinder real-time visualization and quantification of translocation pathways.

Non-destructive solution

- This study presents luminescent seeds as a new way to study dye movement in germinating plants.
- We added fluorescent and luminescent dyes during seed soaking, creating plants that allow continuous, noninvasive imaging of molecular transport.
- Early results show dyes move from seeds to roots, shoots, and cotyledons in patterns matching xylem and phloem transport.

Impact and Application

- Luminescent seeds enable dynamic, high-resolution tracking of transport without destructive sampling, overcoming key limitations of current methods.
- This approach bridges a methodological gap in plant physiology, opening new ways to study nutrient allocation, stress responses, and agrochemical movement.
- Presenting luminescent seeds as a versatile tool, this work encourages new imaging strategies to reveal hidden plant transport pathways, with implications for research and sustainable agriculture.

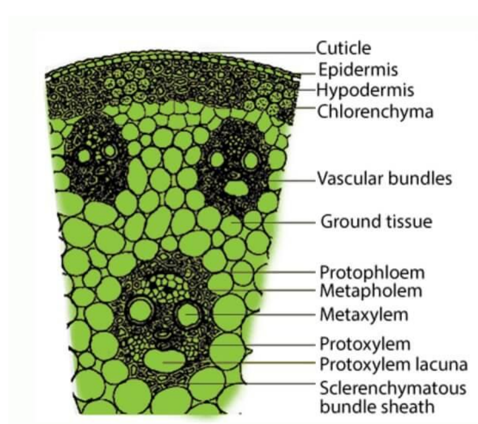


Treatment of Plants

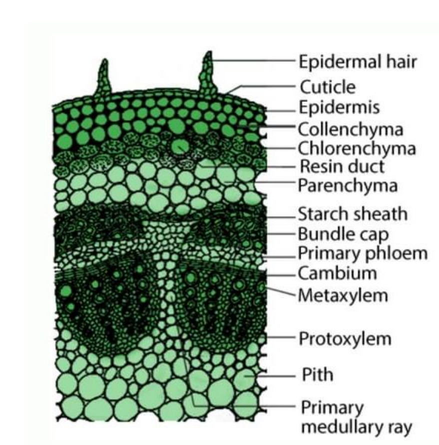
Dry Treatment	Wet Treatment
For each trial, 10 seeds of each plant were coated and tumbled for 12 hours in approximately 1 gram of each respective dye. This was repeated 5 times.	For each trial, 10 seeds of each plant were soaked for 12 hours in solutions of 200 milliliters of water mixed with approximately 1 gram of each dye. This was repeated 5 times.

Dyes and Plant Types

Plants

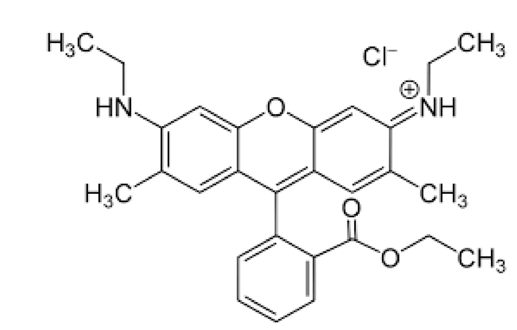


Monocots: Wheat, Sorghum

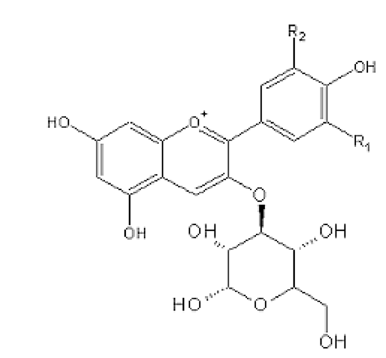


Dicots: Soybean, Sunflower

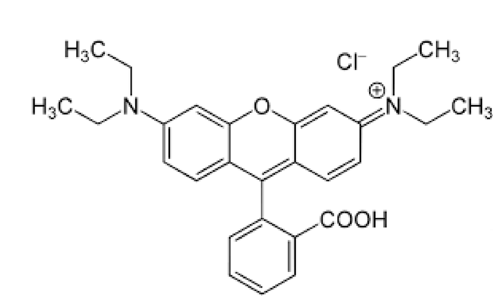
Dyes & Molecular Structure



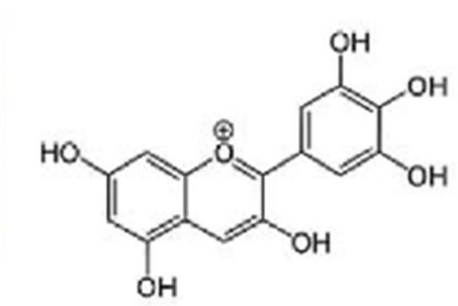
Rhodamine G



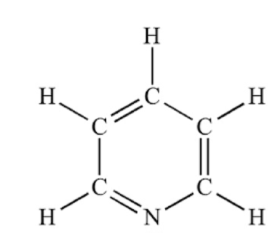
Red Cabbage



Rhodamine B

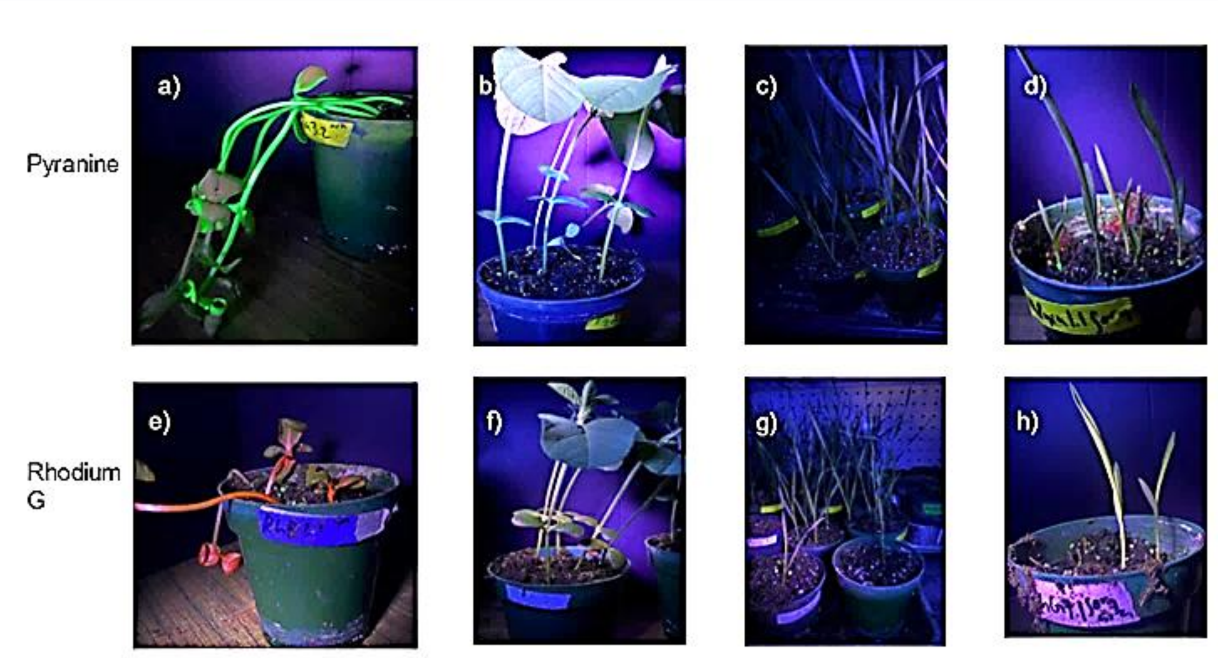


Butterfly Pea



Pyranine

Photos of Luminescence



Crops with seed treatments of either Rhodamine G and Pyranine photographed of under a UV-visible light a) & e) sunflowers b) & f) soybeans c) & g) wheat d) & h) sorghum

Germination

Dye	Dry Wheat	Wet Wheat	Dry Soybeans	Wet Soybeans	Dry Sorghum	Wet Sorghum	Dry Sunflowers	Wet Sunflowers
Rhodamine G	0.5 ± 0.3	4.2 ± 1.9	2.6 ± 0.7	7.2 ± 2.3	2.0 ± 0.9	3.0 ± 2.0	2.8 ± 1.5	5.8 ± 2.0
Rhodamine B	5.0 ± 1.9	4.5 ± 1.7	6.8 ± 1.2	4.4 ± 1.6	6.2 ± 1.4	4.6 ± 1.6	7.4 ± 1.2	7.2 ± 0.8
Pyranine	7.8 ± 1.5	7.6 ± 1.2	5.2 ± 2.0	5.0 ± 1.4	6.4 ± 1.6	6.6 ± 1.2	6.4 ± 1.8	8.4 ± 0.8
Red Cabbage	8.4 ± 0.9	7.6 ± 1.1	9.0 ± 0.3	8.2 ± 0.5	4.6 ± 1.7	6.6 ± 1.2	8.8 ± 0.7	8.4 ± 1.1
Butterfly Pea	10 ± 0.0	8.6 ± 0.9	2.6 ± 0.7	7.4 ± 1.1	2.0 ± 0.9	6.6 ± 1.2	2.8 ± 1.5	5.8 ± 1.1

Average Germination from 5 reps, of 10 plants for each treatment of dye and plant type

UV-visible Data of Dyed Seeds

	λ_{max}							
Dye	Wet Wheat	Dry Wheat	Wet Soybeans	Dry Soybeans	Wet Sorghum	Dry Sorghum	Wet Sunflowers	Dry Sunflowers
Rhodamine G	540	540	525	525	531	528	526	530
Rhodamine B	560	555	540	540	555	545	549	555
Pyranine	430	420	420	425	405	404	419	406
Red Cabbage	260	300	240	250	258	257	255	262
Butterfly Pea	275	260	240	240	253	286	239	256

Dye was extracted from the seeds by removing the seeds from the solutions and drying them on a dry surface for 24 hours. The seeds were then added to 100 mL of water. The seeds were allowed to soak in the water for 48 hours; during this time, the dye on the outside of the seed was absorbed into the water. The change in the water's color highlighted this. The UV-visible spectrum of the solution was recorded. Taking the UV-visible spectrum allowed us to quantify the amount of dye absorbed by the seed in each treatment.

Conclusions

- The seeds absorbed the 5 dyes as shown by the UV-visible
- The plants were able to translocate Rhodamine G and Pyranine from the seeds
- Other dyes were visible on the leaves of the plants through a spraying application, but seed treatments did not result in translocation of the dyes.

Acknowledgement

Kansas Water Institution
BioRender