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# Role of Sink and Source in Crop Improvement

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In the context of plant physiology, the terms "source" and "sink" refer to specific tissues or organs within a plant that play crucial roles in the movement and allocation of carbohydrates (mainly sugars produced through photosynthesis). Understanding the dynamics between sources and sinks is essential for grasping the factors influencing plant yield. The concepts of source and sink in plants were first proposed by Mason and Maskell (1928). In general, Source is a material producer and exporter, and sink is a material importer and consumer (Foyer and Paul, 2001).

## Source

A source is any part of the plant where carbohydrates are produced or stored. The primary source organ is the leaves, where photosynthesis occurs. During photosynthesis, plants convert light energy into chemical energy, producing sugars (mainly sucrose) as a result.

The source tissues supply the plant with the necessary carbohydrates for growth, maintenance, and energy. These carbohydrates can be transported to other parts of the plant or stored for later use.

## Sink

A sink is any part of the plant that consumes or stores carbohydrates. Sink tissues include growing leaves, flowers, fruits, roots, and developing seeds. These organs are active in using or storing the sugars produced by the source tissues.

Sinks are essential for plant development and reproduction. They require a continuous supply of carbohydrates for processes such as cell division, expansion, and the formation of reproductive structures.

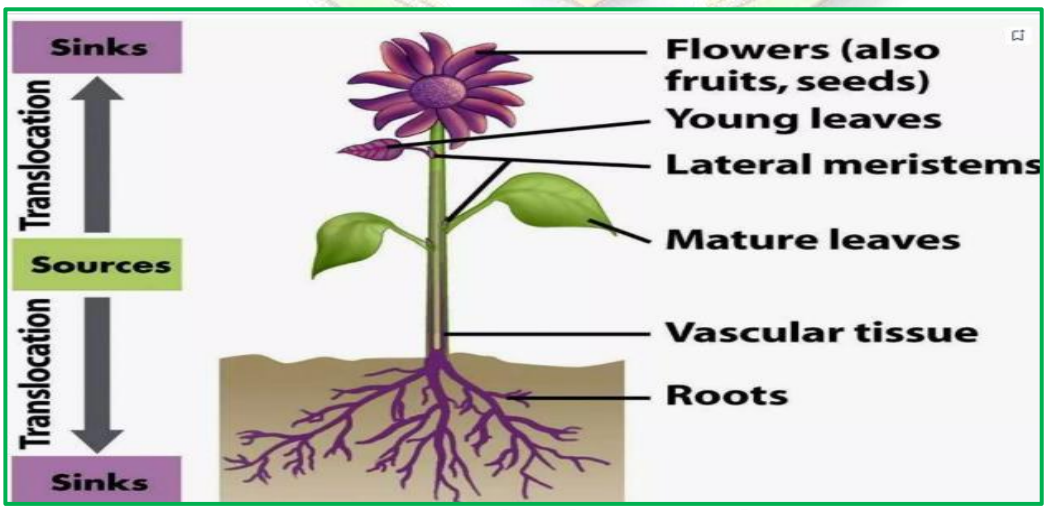


**Figure 1: Sink and Source in plants**

## Phloem translocation

Phloem is a conducting tissue in plant that transport food to all parts of plant. The movement of food from source to sink is called as a phloem translocation.

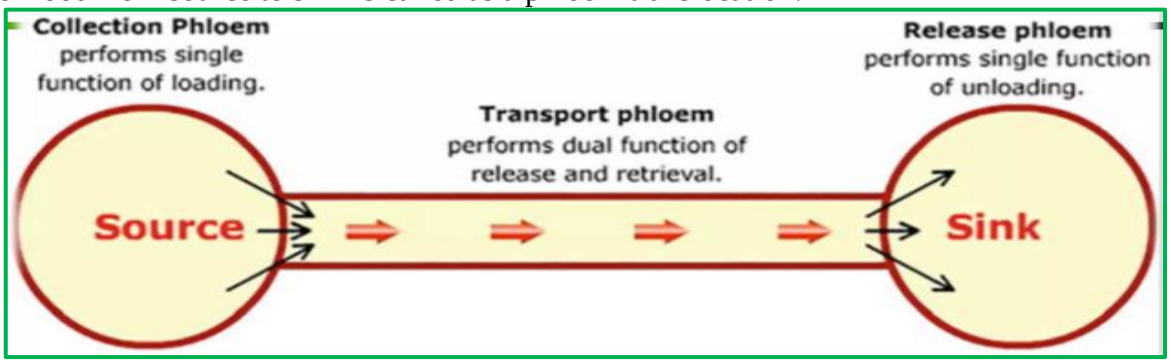


**Figure 2: Phloem loading and unloading**

## Relationship and impact of sink and source on plant yield

The balance between source and sink organs is critical for achieving optimal plant yield. Several factors influence this relationship:

- Photoassimilate Production (Source Strength): Photosynthetic Rate: The rate at which the source tissues (usually leaves) perform photosynthesis directly affects the amount of assimilates produced. Factors such as light intensity, carbon dioxide concentration, and temperature influence photosynthesis.
- Assimilate Loading in Source Tissues: Phloem Loading: The loading of assimilates into the phloem at the source is a critical step. There are two main types of loading: apoplastic loading (movement through cell walls) and symplastic loading (movement through plasmodesmata). The efficiency of loading mechanisms affects the overall transport of assimilates.
- Phloem Unloading at Sink Tissues: Sink Activity: Sink tissues, such as growing roots, fruits, and developing seeds, exert a pull on assimilates. Sink strength, determined by the demand for carbohydrates in these tissues, influences the rate of unloading at the sink. Active cells in sinks rapidly take up the assimilates.
- Phloem Transport System: Phloem Structure and Function: The structure and function of the phloem itself impact the transport of assimilates. The pressure flow hypothesis explains how assimilates move through the phloem under the influence of pressure differentials generated by source-sink interactions.
- Developmental stages: Roots and shoot are major sink during vegetative stages, while developing fruit become a major sink during a vegetative stage. At a time of senescence, mature leaves served as a sink
- Translocation Pressure: Turgor Pressure: The movement of assimilates in the phloem relies on pressure differentials. Turgor pressure, maintained by water movement into the phloem, is essential for pushing assimilates along the phloem tubes.
- Environmental Factors:
  Temperature: Phloem transport is temperature-sensitive. Optimal temperatures enhance enzymatic activity, affecting loading and unloading processes.
  Water Availability: Water status influences turgor pressure, which is crucial for maintaining the flow of assimilates in the phloem.
  Nutrient Availability: Adequate nutrients, especially minerals, are essential for the synthesis of compounds involved in phloem transport.

- Hormonal Regulation: Hormones, such as auxins, cytokinins, and gibberellins, can influence the efficiency of phloem transport. For example, auxins are involved in sink development and can affect phloem unloading.
- Disease and Stress Conditions: Pathogens and Stress: Disease, pathogen attacks, or other stress conditions can disrupt phloem function and compromise the transport of assimilates. Understanding these factors and their interplay is crucial for optimizing the transportation of assimilates in plants, ultimately influencing growth, development, and overall plant yield.

**Major source and sink organs for C and inorganic and organic N (**Chang and Zhu, 2017)

| Substrates | Major source organs | Major sink organs | Intermediate organs |
|---|---|---|---|
| C | Mature leaves, green fruits/seeds coat, green branches | Root, tubers, elongating stem, developing fruits/seeds | Temporary reserve pool (e.g. stem phloem parenchyma cells), immature leaves |
| Inorganic Nitrogen | Root | Leaves, tubers, fruits/seeds (coat) | |
| Organic Nitrogen | Mature leaves, green fruits/seeds coat, green branches | Root, tubers, elongating stem, developing fruits/seeds | Root, temporary reserve pool, immature leaves |

There are some organs which can act as a source or sink depending on the plant status and organ development stage. Mature leaves and other green tissues are a source of carbon (C), while root and growing tubers/fruits/seeds are a sink of C (Table 1). Similarly, root is the only source of inorganic nitrogen (N), and mature leaves are often the major source for organic N, whereas the growing tubers/fruits/seeds are a sink for both inorganic and organic N (Table 1). Stem and/or leaf sheath phloem parenchyma cells often act as a reserve pool for temporary storage of C and N—before tuber/seed/fruit setting, they act as a sink, and during tuber/seed/fruit setting they often play the role of a source.

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