

14.1 SOURCE AND SINK CONCEPT

Determination of factors that influence yield is a large and intensively studied area of crop physiology. Yield is the manifestation of all physiological processes occurring in plants. There are different types of yield among the domesticated crops. They are as follows.

| Crop | Types of yield / Storage organ |
|-------------|---|
| Cereals | Seed / grains mainly for CH ₂ OS |
| Pulses | Proteins |
| Oilseeds | Seed mainly for lipids / oils / waxes |
| Sugarcane | Cane for sugar |
| Fibers | Bolls for lint especially in cotton |
| Tubers | Tubers for CH ₂ Os |
| Fodders | Fresh or dry weight of stalk |

Since yield is the resultant of dry matter partitioned between the different parts of plant, possibilities of changing the distribution of assimilates in crops by physiological manipulation is one of the most promising ways of increasing agricultural productivity. To achieve this, knowledge of source – sink concept is important to understand the direction of transport of assimilates.

The movement of assimilates from source to sink is currently believed to occur as follows

- 1) The photosynthetic source cell produces the sugars, which can move symplastically or apoplastically to the sieve tubes.
- 2) Phloem loading increases the sugar concentration of sieve tubes above that of the apoplast.
- 3) At the sink, carbohydrates are being absorbed and either actively partitioned into cell constituents (eg. Starch) or changed to other carbohydrates. Phloem unloading lowers the concentration of sugars in sieve tubes.
- 4) The buildup of sugars at the source and the removal of sugar at the sink establish a hydrostatic pressure gradient, which moves water and sugar from sources to sinks.

Thus, higher production of assimilates (source strength), their rapid translocation and utilization in growth and development (sink strength) are some key factors of concern to increase crop yield.

14.2 DRY MATTER PARTITIONING IS DECIDED BY SOURCE STRENGTH AND SINK STRENGTH:**14.2.1 SOURCE STRENGTH:**

Source strength is a function of source size and source activity.

Source strength = Source size X source activity

The total amount of photosynthates produced in a crop is decided by the optimum crop canopy size (actively photosynthesizing leaf area or source size) and the rate of assimilation per leaf area (photosynthetic efficiency or source activity) of crops. The estimates of efficiency of utilization of photo synthetically active radiation (PAR) some crops is given below.

| Crop | Utilization of PAR (%) |
|-------------------------------------|-------------------------------|
| Maize (<i>Zea mays</i>) | 6.2 |
| Sugarcane (<i>Saccharum spp</i>) | 7.7 |
| Rice (<i>Oryza sativa</i>) | 6.2 |
| Sugar beet (<i>Beta vulgaris</i>) | 8.8 |
| Soybean (<i>Glycine max</i>) | 7.7 |

14.2.2 SINK STRENGTH:

Sink strength is a function of sink size and sink activity.

Sink Strength= sink size X sink activity

Sink size or sink capacity is the maximum space available for accumulation of photosynthetic products. In grain crops it is expressed as number and size of grains.

Sink activity is the inherent capacity of the sink to create a translocation gradient for photosynthates assimilated at source.

According to the mass flow hypothesis, any increase in photosynthesis increases hydrostatic pressure and translocation rate. However, this is true only if sinks have the ability to utilize more assimilates. If they are unable to utilize the increased production there would be a steady build up of sugars in the system causing a **feedback inhibition** resulting in reduced photosynthesis. Presumably, photosynthetic rate would be altered to the rate at which sinks could accept assimilates.

Thus, for leaf photosynthesis to be at maximum potential rates, sinks must be able to rapidly utilize the assimilates produced by the source. Under these conditions partitioning would be controlled by sink strength that is sink availability and the rate at which available sinks can utilize assimilate (sink demand).

Role Of Hormones In Alteration Of Source-Sink Relationship: The effect of hormones on enzymatic activity and the elasticity of sink cells can have a dramatic effect on partitioning. Indoleacetic (IAA), cytokinins, ethylene and gibberillic acid, when applied to cut stem surfaces causes assimilates to accumulate in the region of application. In bean seedlings, the main control over the distribution of sucrose between root and shoot sinks can be attributed to auxin and cytokinin concentrations in various sinks. Hormonal influences on initiation, development and abortion of flowers and seeds have a significant effect on the source – sink relationships in crops.

14.3 HARVEST INDEX

Two useful terms used to describe partitioning of dry matter by the plant are **Biological yield & economic yield**. The term biological yield was proposed by **Nichiporovich** (1960) to represent the total dry matter accumulation of a plant's system. Economic yield and agricultural yield have been used to refer to the volume or weight of those plant organs that constitute the product of economic or agricultural value. The proportion of biological yield represented by economic yield has been called the harvest index or the migration coefficient. These terms characterize the movement of dry matter to the harvested part of the plant. The harvest index, the most widely used term, is defined as follows.

$$\text{Harvest index} = \frac{\text{Economic yield}}{\text{Biological yield}} \times 100$$

(It must be remembered that the biological yield total, often does not include root weight because of the difficulty in obtaining those values)

Crop yield can be increased either by increasing the total dry matter produced in the field or by increasing the proportion of economic yield (the harvest index) or both. There is potential for increasing yields by both methods.

The economic fraction of biological yield usually referred to harvest index varies among the species.

| Crop | Harvest Index (%) |
|-----------|-------------------|
| Cereals | 50 – 60 |
| Pulses | 30 – 45 |
| Oilseeds | 45 – 50 |
| Sugarcane | 35 |

Yield of a crop is a function of biomass X Harvest index. Grain yield in cereals is a product of dry matter accumulation and partitioning.

Thus, grain yield can be understood as product of a number of subtractions called yield components which can be expressed as follows.

$$Y = Nr Ng Wg$$

Where, Y = grain yield

N = number of reproductive units (e.g heads, ears, panicles per unit of ground areas)

Ng= the number of grains per reproductive units and

Wg- the average weight per grain

Thus, the economic yield (Harvest index) depends upon the total dry matter produced and the amount of which is partitioned towards reproductive units in the post anthesis period. Yield components are affected by management, genotype and environment.
