Chapter 9

Growth and development of crops, ideotypes

Growth is defined as an irreversible change in the size of a cell, organ or whole organism.

Commonly, growth is the increase in the amount of living material (protoplasm) which leads to an increase in cell size and ultimately cell division. Growth occurs only in living cells by metabolic process involved in the synthesis of proteins, nucleic acids, lipids and CHO at the expense of metabolic energy provided by photosynthesis and respiration.

Development is a term that includes all changes that an organism goes through during its life cycle from germination of the seed to senescence.

Development stages:

They undergo following growth stages during their life cycle

1. Germination and emergence

Seed germination is defined as the sum of events that begin with hydration of the seed and culminate in emergence of the embryonic axis (usually the radicle) from the seed coat.

Germination is the development of seedling from the seed embryo which is able to produce a normal plant under favourable condition.

Emergence represents the point in time when a **seedling** is weaned from dependence upon nonrenewable **seed** reserves originally produced by its parent, and when photosynthetic autotrophism begins.

The key **difference between germination** and **emergence** is that seed **germination** is the development of the seeds into new plants while **emergence** is the appearance of a seedling through the soil.

2. Seedling growth

Seedling growth covers the period in the life cycle of green plants from emergence of the radicle through the seed coat until the appearance of enough green leaves to make the plant independent of stored energy. The major activity of **seedling growth** is the establishment of root and shoot tissue for autotrophism.

3. Maximum vegetative growth stage

During this stage crops grow at a faster rate. Plant start producing branches or tillers and the crop covers the ground, as much as possible to intercept more radiation. The loss of plant population that occurs during early stages can overcome in this stage by producing more number of tillers or branches. The number of ears per unit area is also decided during this stage. This stage is variously called as tillering stage, active tillering stage, branching stage *etc.* depending on the crop.

4. Primordial differentiation

This stage is called as panicle initiation in cereals and millets, squaring in cotton, flower bud initiation in sunflower *etc.* With starting of this stage plants enter reproductive phase. The number of fruits or grains are decided during this stage. This stage is more sensitive to moisture and solar radiation in cereals.

5. Flowering stage

This stage is also called as 50 per cent flowering, anthesis, blooming *etc.* The crop is said to be at 50 per cent flowering when 50 per cent of plants put forth flower. Opening of flowers and shedding of pollen is called anthesis. Blooming also indicates opening of flowers. This stage is very sensitive to moisture stress. Fruit set is development of flower into fruits and this is a very important stage.

6. Fruit growth

During this stage, photosynthates are accumulated in thr fruits. Fruit growth is also called as growth in cereals, pod growth in groundnut and pulses, boll growth in cotton *etc.*

7. Physiological maturity

When fruit growth is complete and photosynthates are no longer translocated to fruits, is is known as physiological maturity. An abscission layer forms between fruit and peduncle. Crops, if necessary, can be harvested in this stage.

8. Harvest maturity

At physiological maturity, the moisture percentage of grains is 20-30 per cent. In addition, all the grains might not be at physiological maturity. Therefore, it is a general practice, to allow the crop for 10 or more days after physiological maturity to loose the moisture pecentage and also to provide time for the development of late formed grains.

Biological yield

The total dry matter produced per plant or per unit area. It includes all parts - the leaf, stem, grain, and root dry matter produced by the plant.

Economic yield

The volume or weight per unit area of only those plant parts that have marketable value.

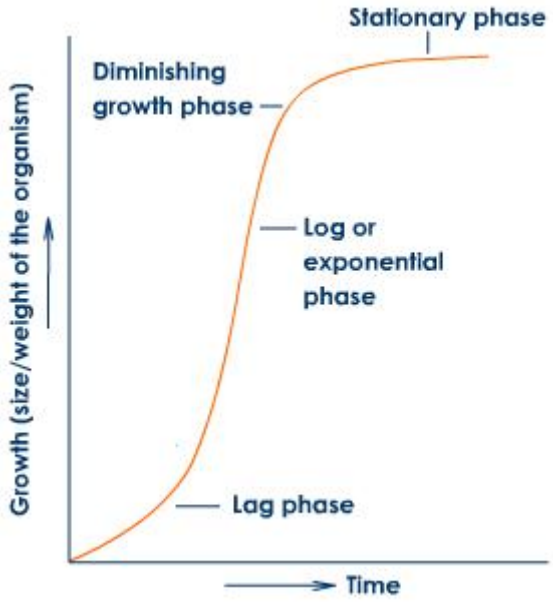
Harvest index

Harvest index is defined as the Kg of grain yield divided by the total Kg of above ground biomass (stover plus grain).

Sigmoid growth curve:

Growth curve – It is an 'S' shaped curve obtained when we plot growth against time. It is also called 'sigmoid 'curve. This curve mainly shows four phases of growth

1. **Lag phase:** Initial slow growth
2. **Log phase:** The rapid period of growth (/grand period of growth/exponential phase) where maximum growth is seen in a short period and
3. **The diminishing phase** where growth will be slow and
4. **Stationary / steady phase** where finally growth stops.



Plant ideotypes

The term ideotype was introduced by Donald (1968). Acc. to him ideotype is a biological model, which is expected to perform or behave in a predictable manner within a defined environment. This term has synonyms viz., Model plant type, Ideal plant type.

In case of cereals, a crop ideotype is erect, sparsely-tillered plant, with small erect leaves. Main traits of the ideotype should be: Satisfactory levels of production (both quantitative and qualitative) a deep root system, being able to establish symbiotic relationships with soil micro-organisms. Moreover it should compete with weeds.

Factors affecting ideotypes :

- Crop species: in monocots, tillering is more important but in dicots branching is important.
- Cultivation: the features of irrigated crops differ from that of rainfed crop.
- Socio-economic condition of farmers: e.g.; dwarf crop is ideal for mechanical harvesting,
- Economic use.

Ideotypes for dryland areas

- **Crop duration:** short duration is essential for dryland areas as it matures early.
- **Plant architecture:** Short stature, moderate tillering, sturdy stems and dark green leaves. Elastic plant (capacity to adjust its volume with variation in soil moisture) is better than non-elastic plant.
- **Intra-plant competition**: should be less and has the capacity to remobilize photosynthates to the economic part at the end season drought.
- **Drought tolerance:** should have deep root system with maximum branching at deeper zones, drought tolerant mechanisms (Leaf drooping, shedding leaf / branches, chemical balance in stomata etc)
- **Pest and diseases resistance**
- **Input / Nutrient responsive**

Wheat ideotype :

- A short strong stem
- Erect leaves
- Few small leaves
- Larger and an erect ear
- Presence of awns

Rice ideotype :

- Erect, short and thick leaves
- Semi- dwarf stature
- High tillering capacity
- More panicles
- High harvest index

Maize ideotype :

- Small tassel size
- Low tillers
- Large cobs
- Angled leaves for good light interception