**CONCEPT OF IDEOTYPE AND IT’S ROLE IN PLANT BREEDING**

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**Abstract**

The need for crop varieties that incorporate several desirable attributes of greater adjustment and increased production is driven by the changing climate. The process of breeding to produce crop varieties with a specific range of characteristics in such kind is described as "ideotype breeding," and the resulting plant is known as "ideotype." Contrary to conventional breeding, conceptually breeding does not proceed in this manner. Instead, a model provides a framework of the plant is established attempts are made first, then being to generate such plants. The goals and needs of an ideotype breeding are taken into consideration when developing an ideotype. To ensure a higher production of plant population in the field, varieties created with individual weak competitors are typically preferred. This is because weak competitors might present well individually, but population performance is not promising. Establishing a conceptual plant type, selecting the source(s) for the traits, combining the desired qualities from different sources into one type, and selecting plants with the best possible combination of features are all steps in the systematic process of ideal-type breeding. For an ideotype, characteristics with positive correlations between them and with yield are typically selected. The ideotype attributes change in response to changing conditions and needs. Ideotype breeding is a powerful technique for overcoming yield constraints, identifying solutions to a wide range of issues, including biotic and abiotic stresses, as creating cultivars for particular locations.

**Keywords:** Biotic and abiotic stresses, crop varieties, ideotype breeding, weak competitors

1. **INTRODUCTION**

The definition of "ideotype" as first used by Donald in 1968. According to him, a "ideotype" is a biological model that is predicted to perform or behave appropriately in a certain environment. If created cultivar just like opposed to already-existing cultivars in the field, it consists of diverse phenotypic, phenological, and physiological traits that contribute to yield, bigger amount of grains, fiber, oil, or other product. Because of the changing global climate, crops will need to change if they want to survive. Breeders must therefore create varieties with characteristics that could aid the plant in better adjusting to the changing climate. "Ideotype breeding" refers to the process of breeding plants to create varieties with the best possible mix of features to ensure adaptation to various climatic conditions and higher yields. Donald originally coined the term "ideotype" in 1967 while working on wheat [2]. To create a wheat ideotype, he only included morphological characteristics; later, physiological and biochemical parameters were added to expand the idea of crop ideotype. Another way to think about it is as a plant producing the most dry matter per unit of input. Every effort is being made to increase crop quality, production, and tolerance to biotic and abiotic stressors as well as adaptability, stability, and uniformity. Breeding for ideotypes is the process of creating crop varieties with all of these characteristics, and a plant that possesses all of these characteristics is referred to as an ideotype. Ideoptyping is a moving target that alters depending on the climate, kind of agriculture, national legislation, and market demand, among other factors.

A breeder needs to understand the concept of an ideotype since it gives them an idea of the plant which will perform the best in a particular environment. It paints a picture of the key characteristics that crop plants ought to have. One quantitative variable that arises from the interaction of various morphological and physiological traits is yield. The ideotype in this situation directs a breeder to stack such characteristics in a single plant type. Donald introduced a brand-new ideotype that he called the communal ideotype. This idea contends that crop productivity and plant productivity are two distinct concepts. A plant's performance does not ensure a crop's high yield.

**The terminology can be used to mean the following:-**

 Model plant type

 Ideal model plant type

Ideal plant type

1. **Various types of Ideotypes**
2. **Isolation ideotype:**

When a cultivar is developed, the biological model suggests that a greater quantity or higher quality of oil, grain, or even other valuable product will be produced. When the plants are space-planted, this particular plant variety works at its best. For instance, loose unrestricted tillering in cereals.

1. **Competition ideotype:**

 In populations with a wide genetic diversity, this ideotype functions well. This ideotype is a tall, green, free-tillering plant that can shadow it is much fewer active companions in the case of cereals. In the case of annual seed crops, such an ideotype would comprise annual behavior, tallness, leafy canopy, tillering or branching, seed size, speed of germination, and root characteristics.

1. **Crop ideotype:**

 Due to the fact that individual plants in this ideotype are weak competitors, this ideotype operates most efficient for commercial crop densities. A crop ideotype for cereal is an upright plant with short, erect leaves that is sparsely tilled.

1. **Market ideotype:**

These archetypes are created in particular for market value and customer desire. It covers characteristics such as seed size, colour, and cooking and baking quality, among others.

1. **Climatic ideotype:**

Grain quality and yields are both impacted by climate change. A crop's mix of features (genes) that provides a satisfactory adaption to climatic diversity and severe weather situations in a particular environment and under a particular cropping system is referred to as an ideotype for climate change. It comprises characteristics necessary for climatic adaptation, such as resilience to heat and cold, length of maturity, and resistance to drought.

1. **Stress ideotype:**

Stress is any condition that has a negative impact and reduces crop yield. Both biotic and abiotic stressors are included. Resistance to both biotic and abiotic stimuli is demonstrated by stress ideotypes. It demonstrates resilience to biotic and abiotic stress.

1. **CROP IDEOTYPE'S PROPERTIES**
2. It ought to be a weak competitor. It has the capacity to take all of the photosynthate either through its own greenish surface or from other plant sections.
3. The easiest way to use the environment's resources is to be an ideotype.
4. The ideotype requires to have physiological and morphological traits that lead to a high harvest index.
5. Given that a crop ideotype is a weak competitor, it must be grown as weed-free as feasible.

**IDEOTYPE DEVELOPMENT STEPS**

* The fundamental ideotype should be created initially for the ideal, unrestrictive environment [2].
* Limits on the size, form, and other characteristics of the economic elements would be set by quality considerations.
* The restrictions on plant stature, branching, and other characteristics would be set by current agronomic methods.
* Whether adjustments to specific features would increase crop productivity in the specific environment should now be evaluated.
* The selection of characters for an ideotype would also depend on a few other factors.
* It does not promote methodical thinking or the gathering of knowledge about how agricultural production is obtained.
* Genetic variation that could or could not be beneficial in the future is not purposefully created.
* Progress is made fairly quickly. but after some time, it can approach a plateau. It is the primary activity.
1. **IDEOTYPES OF SELECTED CROPS**

**Barley**

In addition to reviewing the research on ideotype breeding, Rasmusson (1987) proposed the best plant type for six-rowed barley [4]**.**

 (1) Short, robust stem,

 (2) Few, tiny, upright leaves,

 (3) Enhanced harvest index,

 (4) an upright ear,

 (5) Presence of awns,

 (6) A solitary culm

**Wheat**

**While working on wheat in 1968, Donald proposed Ideotype, which had the properties listed below.

1) A strong, short stem. It increases lodging resistance and lowers lodging-related losses.

2) Upright leaves These leaves offer a better configuration for appropriate light distribution, leading to enhanced photosynthetic or CO2 fixation.

3) Few tiny leaves. The crucial locations for photosynthesis, respiration, and transpiration are leaves. Fewer and smaller animals reduce water loss via transpiration.

4) Bigger ear more grains will be produced each ear. **Figure 1. Wheat breeding Ideotype design**

5) Awns are present. Awns assist in photosynthesis.

6) A single culm.

**** As a result, Donald limited the Ideotype to physical features. All qualities were, however, based on physiological considerations. Finally, the usefulness of a single clump in wheat Ideotype was contested in 1968. A wheat plant should produce a certain amount of yield per plant if it has a somewhat short but broad flag leaf, a long flag leaf sheath, a short ear extrusion with a long ear, and a moderately high tillering ability. Asana suggested the wheat Ideotype for production using rainwater. In wheat Ideotype, recent researchers have integrated both morphological and physiological features.

 **Maize**

Ideal plant type of maize [3].

In maize, plants with 1) Low tillers,

**Figure 2. Maize breeding Ideotype design**

2) Large cobs, and

3) Angled leaves for effective light absorption produced higher yields. The yields were larger when plants of this kind were planted at closer intervals.

**Rice **

The characteristics of the perfect rice plant include: 1) Semi-dwarf stature, 2) Strong number of tillers capacity,

3) Leaves that are short, upright, thick, and sharply angled [4].

In Jennings' model, morphological features were also added. In the creation of the rice ideotype, physiological features are now also emphasised.

 **Figure 3. Rice highly angled leaves design**

**Irrigated Cotton**

 In cotton, it was thought that genotypes with no branches, short stature, compact plants, small leaves, and fewer sympodia would increase output levels. Upland cotton - producing belt suitable plant type was presented by Singh and Narayanan in 1993. Ideotype characteristics include the following:

1) Short stature (90-120 cm);

2) Compact and sympodial plant habit creating pyramidal form;

3) Determining the fruiting behavior by unimodal dispersion of bolling;

4) Short duration (150-165 days); and

5) Responsive to high fertiliser dose.

6) A high level of interplant competition,

7) A high level of disease and insect pest resistance, and

8) A high level of physiological efficiency.

Earlyness (150-165 days), less tiny and thick leaflets, compacted and short stature, interminate behavior, sparse hairness, medium to large boll size, synchronized bolling, strong sensitivity to nutrients, and tolerance to insects and diseases are the primary characteristics of the suggested ideotype [5].

 **Figure 4. Rice highly angled leaves design**

 **Rainfed cotton**

1) Fewer, thicker, sparsely haired leaves that are smaller in size.

2) Medium to large sized boll (3.5 to 4 g).

3. Sensitive to nutrition

4) High level of disease and pest resistance.

5) The synchronised boiling behaviour.

6) Compact plant habit and 75–80 cm in height.

1. **Elements Might Slow Breeding Progress**
* Symmetry in Plant Part Size: Consider the area of a leaf. The number of kernels per spike and culm diameter in barley are positively connected.
* Plant element compensation. An schematic representation. Due to the concurrent decreases in seed number/ear and seed weight, an increase in the number of heads per plant of barley did not lead to an increase in yields.
* Pleiotropy: For instance, a gene in barley produces several, huge awn-like glumes. Multiple-awn lines had increased net photosynthesis but significantly lower yields compared to the typical near-isogenic lines;
* For instance, the trait erect-leaf angle was derived from the inferior barley line CI6146, which only produced 59% of the check.
1. **Advantages of Breeding Ideotypes**
* In the previous. Selecting for specific features related to yield has improved yield. For instance, well-known examples include lower plant height in rice and reduction in plant height combined by erect leaf in wheat.
* The immediate or indirect result of specific plant features is grain yield. As a result, features that are thought to affect yield generate a significant amount of diversity. Any gene combinations that might improve productivity are expected to result from this.
* It is possible to distinguish between enhanced and undeveloped land gene pools in a crop's main gene pool. The lines created through multiple breeding cycles that are frequently employed as parents in genetic improvement make up the enhanced or elite gene pool. Certain qualities are periodically passed down through the unimproved gene pool.
* it is crucial that the objectives for particular qualities are set with the intention of maximising its impact on yield. During the segregating generations, deliberate selection must be made for the features that make up the crop ideotype.
1. **CONSTRAINTS OF IDEOTYPE BREEDING**
* It has not been able to pinpoint specific features that increase yield across the board or in a wide range of genetic and environmental contexts.
* Pricey and time-consuming, and it is not clear how useful they are.
* An ideotype breeder might priorities acquiring genetic variation for particular qualities more than would be advantageous in the long term.
* The amount of information accessible on how yield is achieved would have a significant impact on the progress made in individual trait breeding. To gather data on complicated relationships including genes, traits, and the environment, a collaborative effort would be needed.

Ideotype breeding must be viewed as a way to supplement traditional breeding; it cannot be viewed as a coequal or a replacement for the latter. Breeders who focus on traits or ideotypes may devote roughly 25% of their time to this process.

1. **FUTURE THRUST**
* Through Ideotype breeding the development of high yielding varieties and hybrids and the alteration of plant characteristics, India has become independent in terms of production of food grains. Exploiting physiological variance will be necessary to make the next breakthrough in yield and quality. It is necessary to create prototypes for both high and low input technological conditions.

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