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

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**Abstract**

The need for crop varieties with a combination of desirable traits for greater adaptation and increased production is driven by the changing climate. The process of breeding to produce crop varieties with a specific range of characteristics in one type is referred to as "ideotype breeding," and the resulting plant is known as a "ideotype." Contrary to conventional breeding, conceptually breeding does not proceed in this manner. Instead, a conceptual model of the plant is established first, and then efforts are being made 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 may perform 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 term have following synonyms:-**

Model plant type

Ideal model plant type

Ideal plant type

1. **Types of Ideotypes**
2. **Isolation ideotype:**

When a cultivar is developed, it is the biological model that is predicted to provide a larger amount or quality of grain, oil, or other useful product. 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 its less aggressive neighbours in the case of cereals. Such an ideotype will include annual habit, tallness, leafy canopy, tillering or branching, seed size, speed of germination, and root features in the case of annual seed crops.

1. **Crop ideotype:**

Due to the fact that individual plants in this ideotype are weak competitors, this ideotype operates best at 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 variability and extreme climate events 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. **CHARACTERISTICS OF A CROP IDEOTYPE**
2. It should be a weak competitor. That is able to accept all the photosynthate either from its own green surface or from other parts of the plant.
3. An ideotype will be the most efficient in utilizing its environmental resources.
4. The ideotype, must include morphological and physiological characteristics that result in a high harvest index.
5. A crop ideotype must be grown, as far as possible, in a weed-free situation in view of it being a weak competitor.

**STEPS IN IDEOTYPE DEVELOPMENT**

* The basic ideotype should he first developed for the optimum, non-limiting environment [2].
* Quality considerations would determine the limits to size, shape, etc. of the economic parts.
* Current agronomic practices would determine the limits to plant stature, branching and other features.
* It should now be assessed as to what changes in particular traits would improve yield potential in the target environment.
* The choice of characters to be included in an ideotype will also depend on certain other considerations.
* It does not encourage systematic thinking and accumulation of information on how yield is achieved in a crop.
* It does not deliberately generate genetic diversity that may or may not be useful in the future.
* Progress is relatively rapid. but may reach a plateau after a period It constitutes the main activity.

1. **IDEOTYPES OF SELECTED CROPS**

**Barley**

Rasmusson (1987) reviewed the work on Ideotype breeding and also suggested ideal plant type of six rowed barley [4]**.**

(1) Short, strong stem,

(2) Few, small, erect leaves,

(3) High harvest index,

(4) an erect car,

(5) Presence of awns,

(6) a single culm.

**Wheat**

**Donald in 1968 working on wheat, he proposed Ideotype with following main features.

1) A short strong stem. It imparts lodging resistance and reduces the losses due to lodging.

2) Erect leaves. Such leaves provide better arrangement for proper light distribution resulting in high photosynthesis or CO2 fixation.

3) Few small leaves. Leaves are the important sites of photosynthesis, respiration, and transpiration. Few and small reduce water loss due to transpiration.

4) Larger ear. It will produce more grains per ear. **Figure 1. Wheat breeding Ideotype design**

5) A presence of Awns. Awns contribute towards photosynthesis.

6) Presence of awns.

7) A single culm.

Thus, Donald included only morphological traits in the Ideotype. However, all the traits ere based on physiological consideration. Finally (1968) doubted the utility of single clum in wheat Ideotype. Considered tillering as important features of wheat flag type a wheat plant with moderately short but broad flag leaf, long flag leaf sheath, short ear extrusion with long ear, and moderately high tillering capacity should give yield per plant. Asana proposed wheat Ideotype for rainfed cultivation. Recent workers included both morphological and physiological characters in wheat Ideotype.

**Maize**

Ideal plant type of maize [3].

In Maize ,higher yields were obtained from the plants consisting of

1) Low tillers,

2) Large cobs, and

3)Angled leaves for good light interception. Planting of such type at closer spacings resulted in higher yields.

**Figure 2. Maize breeding Ideotype design**

**Rice**

****The rice an ideal or model plant type consists of

1) Semi dwarf stature,

2) High tillering capacity,

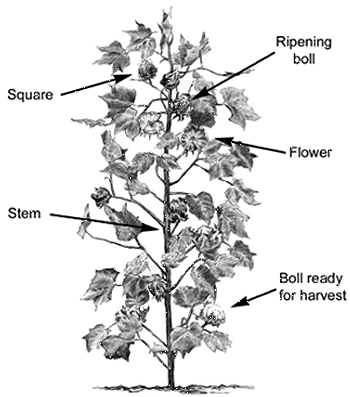
3) Short, erect, thick and highly angled leaves [4].

Jennings also included morphological traits in his model. Now emphasis is also given to physiological traits in the development of rice Ideotype.

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

**Irrigated Cotton**

In cotton, genotypes with zero branch, short stature, compact plant, small leaves and fewer sympodia were considered to enhance yield levels. Singh and Narayanan, 1993 proposed and ideal plant type of upland cotton growing belt. Ideotype includes: -

1. Short stature (90-120 cm),
2. ****Compact and sympodial plant habit making pyramidal shape,
3. Determinate the fruiting habit with unimodal distribution of bolling,
4. Short duration (150-165 days),
5. Responsive to high fertilizer dose,
6. High degree of inter plant competitive ability,
7. High degree of resistance to insect pests and diseases, and
8. High physiological efficiency.

The main features of proposed Ideotype include, earliness (150-165 days), fewer small and thick leaves, compact and short stature, interminate habit, spares hairness, medium to big boll size, synchronous bolling, high response to nutrients, and resistance to insect and diseases [5].

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

**Rainfed cotton**

1. Few smaller and thick leaves with sparse hairiness.
2. Medium to big boll size (3.5 to 4 g).
3. Responsive to nutrients.
4. High degree of resistance to insects and diseases.
5. Synchronous boiling habit.
6. Short stature (75-80 cm) and compact plant habit.
7. **Factors That Slow Breeding Progress**

* Symmetry in Size of Plant Parts: For example, leaf area. Culm diameter and kernels per spike are positively correlated in barley.
* Compensation among Plant Parts. For example. an increase in head number per plant in barley did not result in increased yields due to the simultaneous reductions in seed number/ear and seed weight
* Pleiotropy: For example, gen*e* produces large awn like glumes *(multiple awns)* in barley. Lines with multiple awns showed higher net photosynthesis, but much lower yields than the normal near-isogenic lines;
* Inferior Genetic Background: For example, the trait erect-leaf angle was transferred from barley line CI6146, which yielded only 59% of the check.

1. **Merits of Ideotype Breeding**

* In the past. yield has been enhanced by selecting for individual traits associated with yield. For example, reduced plant height in wheat and reduced plant height coupled with erect leaf in rice are well known cases.
* Grain yield is the direct or indirect product of individual plant traits. Substantial diversity is, therefore, generated for such traits that are considered to contribute to yield. This is likely to generate such gene combinations that would favourably change productivity.
* The primary gene pool of a crop may be divided into improved and unimproved gene pools. The improved or elite gene pool consists of lines developed by several cycles of breeding that are commonly used as parents in breeding programmes. The unimproved gene pool i s occasionally used for the transfer of specific traits.
* it is important that the goals for specific traits are established with a view to maximize their effects on yield. a conscious selection for the traits constituting the crop ideotype has to be exercised during the segregating generations.

1. **LIMITATIONS OF IDEOTYPE BREEDING**

* It has not been possible to identify individual traits that enhance yield universally or in a relatively limited genetic and environmental situations.
* costly and time taking, while their usefulness is not well established.
* An ideotype breeder may place a higher priority on obtaining genetic diversity for single traits than would be beneficial in the long run.
* Progress in individual trait breeding would largely depend on the amount of information available on how yield is achieved. This would require team effort to generate information of complex interactions involving genes, traits and the environment.
* Ideotype breeding should be considered as a method to augment conventional breeding; it can not be regarded either as a coequal or as a substitute of the latter. A breeder may make about 25% effort in trait-oriented or ideotype breeding.

1. **FUTURE THRUST**

* Through Ideotype breeding the development of high yielding varieties and hybrids and the alteration of plant characteristics, India has become self-sufficient in the 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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