

## Ideotype Breeding

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### Abstract

Crop ideotype refers to model plants or ideal plant type for a specific environment. In broad sense an ideotype is a biological model which is expected to perform or behave in a predictable manner within a defined environment. More specifically, crop ideotype is a plant model which is expected to yield greater quantity of grains, fiber, oil or other useful product when developed as a cultivar. The term ideotype was first proposed by Donald in 1968 working on wheat.

**Keywords:** Ideotype, genetic manipulation, linkage and base materials

### The main points about Ideotype are given below:

- Crop Ideotype refers to model plants or ideal plant type for a specific environment.
- Donald included only morphological characters to define an Ideotype of wheat, subsequently, physiological and biochemical traits were also included for broadening the concept of crop Ideotype.
- Ideal plants or model plants are expected to give higher yield than old cultivars in a defined environment.
- Ideotype is a moving goal which changes according to climatic situation, type of cultivation, national policy, market requirement etc. In other words, Ideotype have to be redesigned depending upon above factors. Thus, development of crop Ideotype is a continuous process.
- Ideal plant type or model plant type also varies from specie to specie. Moreover, this is a difficult and slow method of cultivar development because various morphological, physiological and biochemical characters have to be combined a single genotype from different sources.

## Ideotype Breeding

Ideotype breeding can be defined as a method of crop improvement which is used to enhance genetic yield potential through genetic manipulation of individual plant character.

## Features of Ideotype Breeding

- **Emphasis on Individual Trait:** In Ideotype breeding, emphasis is given on individual morphological and physiological trait which enhances the yield. The value of each character is specified before initiating the breeding work.
- **Includes Yield Enhancing Traits:** Various plant characters to be included in the Ideotype are identified through correlation analysis. Only those characters which exhibit positive association with yield are included in the model.
- **Exploits Physiological Variation:** Genetic difference exists for various physiological characters such as photosynthetic efficiency, photo-respiration, nutrient uptake, etc. Ideotype breeding makes use of genetically controlled physiological variation in increasing crop yields, besides various agronomic traits.
- **Slow Progress:** Ideotype breeding is a slow method of cultivar development, because incorporation of various desirable characters from different sources into a single genotype takes long time. Moreover, sometimes undesirable linkage affects the progress adversely.
- **Selection:** In Ideotype breeding selection is focused on individual plant character which enhances the yields.
- **Designing of Model:** In Ideotype breeding, the phenotypes of new variety to be developed is specified in terms of morphological and physiological traits in advance.
- **Interdisciplinary Approach:** Ideotype breeding is in true sense an interdisciplinary approach. It involves scientist from the disciplines of genetics, breeding, physiology, pathology, entomology etc.
- **A Continuous Process:** Ideotype breeding is a continuous process, because new Ideotype have to be developed to meet changing and increasing demands. Thus, development of Ideotype is a moving target.

Ideotype breeding differs from traditional breeding in the sense that values for individual traits are specified in case of Ideotype breeding, whereas such values are not fixed and then efforts are made to achieve such model. In traditional breeding, such models are not developed before initiation of breeding programmes. There are several differences between traditional breeding and Ideotype breeding

### **Steps in Ideotype Breeding:**

Ideotype breeding consists of four important steps, viz:

- 1) Development of conceptual theoretical model
- 2) Selection of base material
- 3) Incorporation of desirable characters into single genotype
- 4) Selection of ideal or model plant type

These steps are briefly discussed below:

### **Development of Conceptual Model:**

Ideotype consists of various morphological and physiological traits. The values of various morphological and physiological traits are specified to develop a conceptual theoretical model. For Example, value for plant height, maturity duration, leaf size. Leaf number, angle of leaf, photosynthetic rate etc. are specified. Then efforts are made to achieve this model.

### **Selection of Base Material:**

Selection of base material is an important step after development of conceptual model of Ideotype. Genotype to be used in devising a model plant type should have broad genetic base and wider adaptability (Blixt and Vose. 1984) so that the new plant type can be successfully grown over a wide range of environmental condition with stable yield. Genotypes for plant stature, maturity duration, leaf size, and angles are selected from the global gene pool of the concerned crop species. Genotypes resistant or tolerant to drought, soil salinity, alkalinity, disease and insects are selected from the gene pool with the cooperation of physiologist, soil scientist, pathologist and entomologist.

### **Incorporation of Desirable Traits:**

The next important step is combining of various morphological and physiological traits from different selected genotypes into single genotype. Knowledge of the association between various characters is essential before starting hybridization programme, because it helps in combining of various characters.

Linkage between procedures viz. single cross, three way cross, multiple cross, backcross, composite crossing. E.g. Mutation breeding, heterosis breeding, etc. are used for the development of ideal plant types in majority of field crops. Backcross technique is commonly used for transfer of Oligogenic traits from selected germplasm lines into the background of an adapted genotype.

### **Selection of Ideal Plant Type:**

Plant combining desirable morphological and physiological traits are selected in segregating population and inter-mated to achieve the desired plant type. Morphological features are judged through visual observation and physiological parameters are recorded with the help of sophisticated instruments. Screening for resistance to drought, soil salinity, alkalinity, disease and insects is done under controlled conditions. This task is completed with the help of scientist from the disciplines of physiology, soil science, pathology and entomology. Finally, genotypes combining traits specified in the conceptual model are selected, multiplied, tested over several locations, and released for commercial cultivation.

### **Merits and Demerits of Ideotype Breeding**

#### **Merits:**

- ✓ Ideotype breeding is an effective method of enhancing yield through manipulation of various morphological and physiological crop characters. Thus, it exploits both morphological and physiological variation.
- ✓ In this method of various morphological and physiological traits are specified and each character or trait contributes towards enhanced yield.
- ✓ Ideotype breeding involves experts from the discipline of plant breeding, physiology, biochemistry, entomology and plant pathology. Each specialist contributes in the development of model plants for traits related to his field.
- ✓ Ideotype breeding is an effective method of breaking yield barriers through the use of genetically controlled physiological variation for various characters contributing towards higher yield.
- ✓ Ideotype breeding provides solution to several problems at a time like disease, insect and lodging resistance, maturity duration, yield and quality by combining desirable genes for these traits from different sources into a single genotype.
- ✓ It is efficient method of developing cultivars for specific or environment.

## Demerits:

- ✓ Incorporation of several desirable morphological and physiological and disease resistance traits from different sources into a single genotype is a difficult task. Sometimes, combining of some characters is not possible due to tight linkage between desirable and undesirable characters. Presence of such linkage hinders the progress of Ideotype breeding.
- ✓ Ideotype breeding is a slow method of cultivar development, because combining together of various morphological and physiological features from different sources takes more time than traditional breeding where improvement is made in yield and one or two other characters.
- ✓ Ideotype breeding is not a substitute for traditional or conventional breeding. It is a supplement to the former.
- ✓ Ideotype is a moving object which changes with change in knowledge, new requirements, national policy, etc. Thus, new Ideotype have to evolve to meet the changing and increasing demands of economic products.

## Future Prospects of Ideotype Breeding

In India, the future research on crop Ideotype should be directed towards following aspects:

- India has achieved self-sufficient in the production of food grains through modification of plant characters and development of high yielding varieties/ hybrids. The further breakthrough in yield and quality has to be achieved through the exploitation of physiological variation. Ideotype both for high and low input technology condition have to be developed.
- To further the yield potential of food grain crops, Ideotype have to be evolved for straight varieties and hybrids. There is ample scope of developing hybrid Ideotype in crops like maize, sorghum, pearl millet and rice. China has developed hybrid rice for commercial which covers more than 18 million hectares (Barwale, 1993).
- Crop Ideotype have been developed in cereals and millets. There is ample scope for developing ideal plants or models plants in pulses, oilseeds, cotton and several other field crops. In these crops, again Ideotype have to be evolved both for irrigated as well as rain fed cultivation. In cotton, Ideotype have to be developed for regard to agro-climatic conditions.
- In addition to traditional breeding approaches, biotechnological approaches, especially tissue culture and protoplast technology, have to be utilized in future for designing new plant types.



Biotechnology may help in the development of insect resistant cultivars through the use of transgenic plants.

- Development of crop Ideotype is a continuous process, Ideotype is a moving goal which changes with advancement in knowledge, new requirements, change in economic policy, etc.
- Ideotype should be developed to adverse condition such as heat cold, salinity, and drought conditions.

