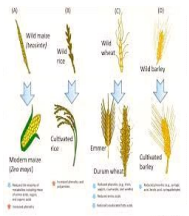
ISSN–0974–0759 | ●●● Article ●●● |Visit us : *www.researchjournal.co.in*|



Crop Ideotype: A science driven approach to develop model plant

Ashutosh Srivastava, Sharwan Kumar Shukla **and** Ashutosh Singh
Rani Lakshmi Bai Central Agricultural University, Jhansi (U.P.) India
(Email : aksri_du@yahoo.com)

Introduction: Crop ideotype refers to model plants or an ideal plant type which performs or behaves in a predictable manner within a specific environment. Specifically an ideotype is a biological model that combines morphological and physiological characteristics, is expected to give higher yield of grains, oil, fibres and millets etc. when developed as a cultivar. The ideotype approach was first proposed by Donald in 1968 while working on wheat crop. Initially Donald used only morphological traits to explain a wheat ideotype, subsequently in order to widen the concept of crop ideotype, physiological and biochemical variables were also added.

Main features of crop ideotype areas follows:

Individual trait: In ideotype breeding, emphasis is given on individual morphological and physiological trait which enhances the yield. The value of individual character is specified before initiating the breeding work.

Yield enhancing traits: Correlations analysis is used to identify various yield and yield attributing traits that should be included in the ideotype. The modelplantonly includes characters that exhibit positive relationship with yield.

Exploits physiological variation: Genetic variances exist in photosynthetic efficiency, photorespiration, nutrient uptake and other physiological characteristics. Ideotype breeding, in addition to different agronomic features, uses genetically controlled physiological variation to increase crop yield.

Slow progress: Ideotype breeding is a time taking method for development of a cultivar. The incorporation of various desirable characters from different sources into a single genotype is a lengthy process. Moreover, undesirable linkage also affects the progress adversely.

Selection: In ideotype breeding selection of genotype is focused on individual plant characters which enhance the yield crops.

Designing of model: In ideotype breeding, the phenotyping of new variety in terms of morphological and physiological traits can be carried out beforehand.

Interdisciplinary approach: Ideotype breeding is multidisciplinary involving genetics, breeding, physiology, pathology, entomology etc., disciplines.

A continuous process: In order to meet the changing needs new ideotypes are developed constantly by understanding individual traits and diversifying the genetic variations of traits.

Comparison between traditional and ideotype breeding:

In traditional breeding:

– The main objective is defined before initiating the breeding work.

– Selection of genotype is focused on yield and some otheryield attributing characters.

– It usually includes various morphological and economiccharacters.

– Value of each character is not fixed priorly

– It is a simple and rapid method of cultivar development

– The phenotypic of a new variety is not specified in advance.

Ideotype breeding:

– The conceptual theoretical model is prepared before initiation of breeding work.

– Selection of genotype is focused on individual plant characters.

– It includes various morphological, physiological and biochemical plant characters

– Value of each trait is defined beforehand.

– It is a difficult and tedious method of cultivar development.

– The phenotype of the new variety to be developed is known ahead of time.

Characteristic features of crop ideotypes : The crop ideotype is made up of several morphological and physiological traits that results in higher yield than currently available agricultural cultivars. The ideotypes differ in morphological and physiological characteristics from crop to crop, and sometimes even within a crop, depending on the necessity of irrigated or rainfed farming for the ideotype. The ideal plant types or model plants have been studied in crops like wheat, rice, maize, barley, cotton,

and beans.

The important features of ideotype of some important crops are as follows:

Wheat : The term ideotype was coined in 1968 by Donald while working on wheat crop. The ideotype of wheat proposed by Donald has following main features:

– A short strong stem : It imparts lodging resistance and reduces the losses due to lodging.

Erect leaves : Such leaves provide better arrangement for proper light distribution resulting in high photosynthesis or CO_2 fixation.

– Few small leaves : Leaves are the important sites of photosynthesis, respiration and transpiration. Reduction in leaf area will decreaserate of transpiration and in results minimum water loss.

– Larger ear : It will produce more number of grains per spike

– An erect ear : It will get light from all sides resulting in proper grain development.

– Presence of awns : Awns contribute towards photosynthesis.

– A single culm.

Rice : Jennings in 1964 introduced the concept of in ideotype in rice with the following features:

– Semi dwarf stature, high tillering capacity, short, erect, thick and highly angled leaves, more panicles per m^2 and high (55% or greater) harvest index.

Maize: In 1975, Mock and Pearce proposed ideal plant type of maizewith following characteristics:

– Stiff-vertically-oriented leaves above the ear, maximum photosynthetic efficiency, efficient translocation of photysynthate into grain, plant having short interval between pollen shed and silk emergence, small tassel size, photoperiod insensitivity, cold tolerance and long grain - filling period

Barley : The work on ideotype breeding was reviewed by Rasmusson (1987) and suggested ideal plant type of six rowed barley with following traits:

– Short stature, long awns, High harvest index and High biomass.

Cotton: Ideotype for irrigated cultivation have following features:

– Short stature (90-120 cm), compact and sympodial plant habit making pyramidal shape, short duration (150-165 days), responsive to high fertilizer dose, more inter-plant competitive ability, more resistance to insect pests and diseases and High physiological efficiency.

Ideotype for rainfed conditions shows following traits (Singh and Narayanan 1993):

– Earliness (150-165 days)
– Fewer small and thick leaves
– Compact and short stature, indeterminate habit
– Sparse hairiness,
– Medium to big boll size
– Synchronous bolling
– High response to nutrients
– Resistance to insects and diseases

Procedure of ideotype breeding:

Ideotype breeding consists of following four important steps:

Development of conceptual model : To build a conceptual theoretical model plant, the values of various morphological and physiological features like plant height, maturity duration, leaf size, leaf number, leaf angle, photosynthetic rate, and other parameters are specified. Following that, efforts are undertaken to realise this model.

Selection of base material : Following the development of conceptual model of ideotype, selection of base material is an important step. Genotypes that will be used to create a model plant type should have a broad genetic foundation and wider adaptability. Plant stature, maturity time, leaf size and angle and resistance genotypes are chosen from the global gene pool of the considered crop species. With the help of physiologists, soil scientists, pathologists and entomologists, genotypes resistant or tolerant to drought, soil salinity, alkalinity, diseases, and insects are selected from the gene pool.

Incorporation of desirable traits : The next crucial step is to combine morphological and physiological features from various genotypes into a single genotype. Various breeding procedures like, single cross, three way cross, multiple cross, backcross, composite crossing, intermating, mutation breeding, and heterosis breeding ~~etc.~~, are used for the development of ideal plant types in majority of field crops.

Selection of ideal plant type : Plants with suitable morphological and physiological traits are selected and intermated in segregating populations to achieve the desired plant type. Visual observations to determine morphological traits and sophisticated equipments to record physiological information are used. Phenotyping or screening for tolerance to abiotic stresses like salinity, hight temperature, drought and biotic stresses like pathogen and insect is done under controlled conditions.

Factors affecting ideotypes: There are various factors which affect development of ideal plant type. These are briefly discussed below:

Crop species: Ideotype differs from crop to crop. The

ideotype of monocots considerably differs from those of dicots. In monocots, tillering is additional vital whereas in dicots branching is one among the vital options of ideotype.

Cultivation : In terms of crop farming, the ideotypes differ as well. Irrigated crops have different characteristics than rainfed ones. For instance, drought resilience and fewer / smaller leaves, are required for a rainfed crop to prevent water loss through transpiration. Furthermore, indeterminate forms of dicots are required for rainfed environments to produce a second flush of flowers if the initial flush is impacted by drought.

Socio -economic condition of farmers : Crop ideotype is also influenced by the socio-economic status of farmers. Dwarf sorghum, for example, is perfect for mechanical harvesting in the United States, but it is not good for African farmers who use the stalks for fuel or hut construction.

Economic use : The ideotype varies depending on the crop's economic value. For example, dwarf varieties are advantageous in sorghum and pearl millet when the crop is cultivated for grain, whereas tall height is preferred when the crop is grown for fodder. Furthermore, for grain production, less leafy genotypes are preferred, while for fodder production, more leafy genotypes are preferred. In the case of a fodder crop, the bigger leaves are also advantageous.

Received : *01.01.2022* ***Revised :*** *15.01.2022* ***Accepted :*** *05.02.2022*

RNI : UPENG/2006/16373 ISSN : 0973-1547

Accredited By NAAS : NAAS Rating : 4.15

INTERNATIONAL JOURNAL OF PLANT SCIENCES

An International Research Journal

Visit : www.hindagrihorticulturalsociety.co.in

SUBSCRIPTION FEE

HIND AGRICULTURAL RESEARCH ANDTRAINING INSTITUTE 418/4, SOUTH CIVIL LINES (NUMAISH CAMP), MUZAFFARNAGAR-251001 (U.P.)

JOURNAL	Annual Subscription Fee		Life Subscription Fee	
	Individual	Institution	Individual	Institution
International Journal of Plant Sciences	1500/-	2000/-	10000/-	20000/-
International Journal of Agricultural Sciences	1500/-	2000/-	10000/-	20000/-
Rashtriya Krishi (English Magazine)	500/-	1000/-	5000/-	10000/-
राष्ट्रीय कृषि (हिन्दी पत्रिका)	500/-	1000/-	5000/-	10000/-

Draft should be made in the name of the **Hind Agricultural Research and Training Institute** from any NATIONALIZED BANK PAYABLE AT MUZAFFARNAGAR -251001 (U.P.), INDIA.