Advances in Crop Science and Technology
ISSN: 2329-8863
Open Access

Philosophy of Plant Breeding: Ideotype Breeding

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Abstract

The philosophy of conventional plant breeding approach is to select for yield which bases selection on yield without giving consideration to how and why yield is achieved. The ideotype concept has been developed and modifed for a number of diferent crops. It is concluded that ideotypes are a useful tool for visualizing and conceptualizing how to combine specifc rare combinations of visible and invisible traits, aimed at the maximization of Harvest Index, even when the traits are only weakly related.

Most breeding programs uses grain yield as the main selection criterium to improve the agronomic performance of crop varieties. An alternative approach to improve productivity is the ideotype breeding. According to this philosophy, breeders should defne an ideal plant type for a specifc environment and then breed for this ideotype. Breeding through crop ideotypes is positive in terms of integrating principies of physiology, ecology and plant breeding, encoraging the generation of hypothesis about how yield is achieved and providing a holistic view about production systems.

Keywords: Ideotype breeding; Plant breeding; Criterium

Introduction

In a more general sense, DONALD described an Ideotype as a biological model that is anticipated to function or behave predictably in a speci c setting. Breeding with speci c breeding goals for each attribute is known as "Ideotype breeding," which aims to increase genetic yield potential through individual trait modi cation.

Donald was the rst to propose the idea of ideotype breeding (1968). According to Chahal and Gosal (2002), an ideotype is a hypothetical plant frame or architecture that is represented by characters that may e ectively utilize the resources at hand in order to maximize economic yield. In this instance, selection is solely determined by yield components (Smith, 1987; Singh, 2002).

e genetic expression of various qualities and the degree and pattern of their interaction with grain yield typically uctuate with

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Received: 02-Jan-2024, Manuscript No: acst-24-125607, **Editor Assigned:** 05-Jan-2024, pre QC No: acst-24-125607 (PQ), **Reviewed:** 19-Jan-2024, QC No: acst-24-125607, **Revised:** 23-Jan-2024, Manuscript No: acst-24-125607 (R), **Published:** 30-Jan-2024, DOI: 10.4172/2329-8863.1000661

Citation: Teressa T (2024) Philosophy of Plant Breeding: Ideotype Breeding. Adv Crop Sci Tech 12: 661.

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article is to review the Ideotype of plant breeding.

Ideotype of plant breeding

Ideotype breeding aimed at modifying the plant architecture is a time tested strategy to achieve increases in yield potential. A tried-and-true method for increasing yield potential is ideotype breeding, which modi es the plant architecture. Selection for short-statured grains, like sorghum, rice, and wheat, doubled the potential yield. e harvest index (HI) and total dry matter or biomass in uence yield potential. For example, the total biomass of tall and traditional rice was around 12 tons per hectare, and the HI was approximately 0.3. ey may thus produce up to 4 tons per hectare at most. According to the (Shalimar Campus, Srinagar (J&K) 2015), applying nitrogenous fertilizers could not improve their biomass.

e plants grew excessively tall, lodged improperly, and produced less rather than more. Improving the harvest index and nitrogen responsiveness by raising the lodging resistance is required to raise the production potential of crops. is was achieved by introducing a recessive gene for small stature, which decreased the height of the plant [4].

A new sort of plant was conceived in order to further boost the crop's potential production. Particularly when grown under direct sowing conditions, modern semi-dwarf plants generate a lot of ine ective tillers and an excessive amount of leaf area, which diminish canopy photosynthesis and sink size and induce mutual shade. e method of Ideotype breeding will be used to solve this.

e goal of plant breeding is to enhance a plant's qualities to make it more agronomically and commercially acceptable. e particular goals may di er signi cantly based on the crop being studied.

- **Higher yield:** Enhancing the yield of commercially viable product is the ultimate goal of plant breeding. Depending on the crop species, it could be the yield of grains, fodder, ber, tubers, cane, or oil. Either hybrids or high yielding types can be evolved to increase yield.

- **Improved quality:** Another major goal in plant breeding is produce quality. e characteristics of quality di er amongst crops. For instance, the size, color, milling, and backing quality of wheat grains. Rice cooking quality, barley malting quality, fruit size, color, and quality, vegetable nutrition and preservation quality, pulse protein content, oilseed oil content, cotton ber length, strength, and neness [5].

- **Abiotic resistance:** Abiotic elements that a ect crop plants include drought, salinity in the soil, high temperatures, wind, cold, and frost. To prepare for these conditions, breeders must create kinds of crops that are resistant to these stresses.

- **Biotic resistance:** Crop plants are attacked by various diseases and insects, resulting in considerable yield losses. Genetic resistance is the cheapest and the best method of minimizing such losses. Resistant varieties are developed through the use of resistant donor parents available in the gene pool.

- **Change in maturity duration/earliness:** Earliness is the most desirable character which has several advantages. It requires less crop management period, less insecticidal sprays, permits new crop rotations and o en extends the crop area.

- **Elimination of toxic substances:** It is essential to develop varieties free from toxic compounds in some crops to make them safe for human consumption. For example, removal of neurotoxin in Khesari (Lathyruys sativus) which leads to paralysis of lower limbs, erucic acid from Brassica which is harmful for human health and gossypol from the seed of cotton is necessary to make them t for human consumption. Removal of such toxic substances would increase the nutritional value of these crops.

- **Photo insensitivity:** e creation of temperature-and light-insensitive cultivars aids in extending crop plant cultivation boundaries. Wheat and rice may now be grown in new places thanks to photo-and thermosensitive cultivars. Punjab now grows rice, whereas West Bengal's main rabi crop is wheat (Figure 1).

e conceptual dimensions of ideotypes

Since they represent the optimal gene combination (or QTL) to produce and achieve the desired phenotypes, ideals, which were initially established by and for plant breeders, contain a certain genetic component. But this genetic perspective was soon superseded by an agronomic one as Ideotype began to be seen as the plant component of a cropping system. Since stereotypes can only be de ned in reference to a production aim, they also have a particular socio-economic component. is is particularly true in terms of its acceptability; it is hard to envision the ideal plant kind in the event that farmers reject it [6].

Lastly, Ideotype are essentially digital depictions of plants that were conceived before they were real. Consequently, they are conceptual models that are based on sets of decision rules that enable one to select which qualities to assemble and how best to combine them; they may e mat.00ifyds iower li0mbs, included in the Ideotype are found. The characters in the model are limited to those that show a positive correlation with yield.

Exploits physiological variation

There are genetic differences for a number of physiological traits, including photosynthetic efficiency, nutrition uptake, photorespiration, etc. In addition to different agronomic variables, genotype-controlled physiological variation is used in genotype breeding to increase crop yields.

Slow progress

Ideotype breeding is a sluggish approach of developing cultivars because it takes a long time to incorporate diverse desired traits from different sources into a single genotype. Furthermore, unfavorable linkages might occasionally have a negative impact on progress.

Designing of model

The phenotypes of a new variety to be generated in ideal breed breeding are predetermined in terms of physical and physiological features. Numerous interrelated biochemical, morphological, and physiological processes that occur at various temporal and spatial scales at the crop level are what lead to crop growth and development (Martre et al., 2015).

With the introduction of the super hybrid rice variety "Lianyoupeijuu," the idea of plant type or Ideotype breeding was first applied to rice as the first instance of model-aided ideotype design and, ultimately, the first successful implementation of ideotype breeding. It is not unexpected that irrigated rice was the first crop to use the ideotype design as ideotyping is simpler and easier in this situation than in rain-fed agriculture conditions (Semenov et al., 2014) [7].

Interdisciplinary approach

In the past, crop modelers have worked with agronomists, breeders, and geneticists on a variety of cereal crops to develop various methods for (i) more accurately forecasting a cultivar's performance in a given e cacy, at least in some pathosystems (Tivoli et al. 2012). is helps to impede the spread of epidemics. Additionally, it may alter an organ's susceptibility to an infection, favor mechanisms that help an organ escape an infection, or improve tolerance (Ney et al. 2012). Although there is a signi cant genetic component to architecture (Bendokas et al. 2012), aspects of the agricultural production system can also be used to control it (Simon et al. 2012). is allows for the design and construction of plants or canopies that reduce the ability for one or more pests to spread, at least theoretically.

Features of crop ideotype: A crop ideotype is a plant model, which is expected to perform or yield a greater quantity or quality of grain, oil or other useful product when developed as a cultivar, model plant type, ideal model plant type (Ronaldo Vigo,2014).

A number of morphological and physiological characteristics make up the crop ideotype, which contributes to a yield that is higher than that of currently popular crop varieties. Crop Ideotype's physical and physiological characteristics are necessary for rainfed or irrigated farming. e ideal plant, regardless of whether irrigation or rain-fed cultivation calls for the Ideotype. Model plants or ideal plant types have been discussed for a number of crops, including cotton, beans, maize, barley, wheat, and rice.

Wheat

Donald rst used the term "Ideotype" in 1968 while working on wheat with a short, robust stem. It lessens hotel-related losses and imparts resistance to lodging. Erect leaves: these leaves are better arranged to distribute light properly, which increases photosynthesis or CO_2 xation. A few little leaves are the key components of respiration, transpiration, and photosynthesis. Tiny and sparse decrease transpiration related water loss. It will yield more grains per ear if its ear is larger. Awns contribute towards photosynthesis.

Tillering is regarded as one of the key characteristics of the wheat ag type. A wheat plant with a long ag leaf sheath, a short ear extrusion with a long ear, a relatively high tillering capacity, and a moderately short but broad ag leaf should yield a yield per plant (Hsu and Watson, 1917). Wheat Ideotype was expanded by recent workers to include both physiological and morphological characteristics.

Rice

Jennings developed the concept of plant Ideotype in rice breeding in 1964. Donald used the term "Ideotype" in 1968. He proposed that

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combine certain characters. e development of stereotype breeding is impeded by the existence of such linkage.

Ideotype breeding, which improves yield and one or two additional qualities, is a sluggish way of cultivar creation because it takes longer to combine multiple morphological and physiological features from di erent sources. Conventional or traditional breeding methods cannot be replaced by stereotype breeding. It is an addition to the earlier https //agriinfo.in/merits-and-demerits-of-ideotype-breeding-2096/.

Ideotype is a moving object which changes with change in knowledge, new requirements, national policy, etc [9]. us new Ideotype have to evolved to meet the changing and increasing demands of economic products http://agriinfo.in/default.aspx.

Summary and Conclusion

e majority of plant breeding is focused on yield selection or defect eradication. Crop Ideotype plants having model traits known to a ect photosynthesis, growth, and grain in cereal production are bred, o ering a useful supplementary strategy. ere are a few examples of this type of model character being used successfully again.

Numerous harvests have led to the development and modi cation of the Ideotype idea. e conclusion is that, even in cases when the qualities are only tangentially related, Ideotype can be a helpful tool for conceiving and visualizing how to combine particular, uncommon combinations of visible and unseen features in order to maximize Harvest Index. A crop Ideotype will use the fewest resources possible for each unit of dry matter generated.

Further, in cereals, each unit of dry matter will include such a number of orets as to ensure that the ear has su cient capacity to accept all photosynthates either from its own green surfaces or from other parts of the plant. A wheat Ideotype is described. It has a short, strong stem; few, small, erect leaves; a large ear this speci cally means many orets per unit of dry matter of the tops; an erect ear; awns; and a single culm. Ideotype breeding exploits various morphological and physiological traits are speci ed and each character or trait contributes towards enhanced yield but it has its own draw back Incorporation of di erent sources into a single genotype is a di cult task.

It is concluded that ideotypes are a useful tool for visualizing and conceptualizing how to combine speci c rare combinations of visible and invisible traits, aimed at the maximization of Harvest Index, even when the traits are only weakly related.

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