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International Journal of Current Research
Vol. 8, Issue, 10, pp.39629-39632, October, 2016

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

REVIEW ARTICLE

GENETIC BREEDING BACKGROUND AND SUSTAINABILITY IN ENVIRONMENTS OF PRODUCTION: AN REVIEW

*,[1]Maicon Nardino, [2]Ivan Ricardo Carvalho, [3]Diego Nicolau Follmann, [2]Alan Junior de Pelegrin, [2]Mauricio Ferrari, [4]Tiago Olivoto, [5]Vinicius Jardel Szareski, [5]Gabriel BaraldiVolpi, [1]Giordano Gelain Conte, [2]Tiago Corazza da Rosa, [1]Willian Silva Barros and [7]Velci Queiróz de Souza

[1]Department of Mathematics and Statistics, Federal University of Pelotas, Capão do Leão, Rio Grande do Sul, Brazil
[2]Plant Genomics and Breeding Center, Federal University of Pelotas, Capão do Leão, Rio Grande do Sul, Brazil
[3]Department of Agronomic and Environmental Sciences, Federal University of Santa Maria, Rio Grande do Sul, Brazil
[4]Department of Agronomic and Environmental Sciences, Federal University of Santa Maria Frederico Westphalen, Rio Grande do Sul, Brazil
[5]Department of Crop Science, Federal University of Pelotas, Capão do Leão, Rio Grande do Sul, Brazil
[6]Technician in agriculture, Federal University of Santa Maria
[7]Federal University of Pampa, Dom Pedrito, Rio Grande do Sul, Brazil

ARTICLE INFO

Article History:
Received 20th July, 2016
Received in revised form
15th August, 2016
Accepted 18th September, 2016
Published online 30th October, 2016

Key words:
Plant breeding, GxE interaction,
Inbred lines.

ABSTRACT

The plant breeding has been constantly working with the search for increasing agricultural productivity of many crops, targeting a system with higher productivity per area, due to the increasing world population, as well as foods with a higher content of nutrients. In this scenario, the corn crop stands out due to its direct contributions manufatured or processed foods as well as being the base of the feed chain. The advance in grain yield was very significant, this fact is due to the efficiency of the breeders and also the new tools being developed and serve to support the art and science of plant breeding. This literature review was developed in order to report the importance of improving the types of corn hybrids, driving methods, genotype x environment interaction, advantages and disadvantages of growing hybrids and future prospects of plant breeding.Is literature review was conducted from March to July 2016 in the Department of Mathematics and Statistics, Federal University of Pelotas.

Citation: Maicon Nardino, Ivan Ricardo Carvalho, Diego Nicolau Follmann, ***et al.*** **2016.** "Genetic breeding background and sustainability in environments of production", *International Journal of Current Research*, 8, (10), 39629-39632.

INTRODUCTION

Plant breeding is formed by a set of art and science, being the process that seeks for genetic alteration of plants aiming to supply the growing demand for food worldwide, meeting the needs of people and livestock. The food demand in the future will be much higher than currently due to the constant population growth. The projection is there will be over 9.4 billion people worldwide by 2050. The risk of hunger in the world is not recent, about 200 years ago an Englishman named Thomas Robert Malthus made daring predictions, postulated in 1798 that human populations would be limited by hunger. Malthus believed that population grew geometrically, while food proportion, arithmetically. The catastrophic Malthusian prediction, in fact, did not occur, despite the population increase has been confirmed in the expected way. The prediction was not accurate only because of the increased food production, which was underestimated at the time. The production increase occurred due to new agricultural frontiers advance, including new techniques and inputs. The agricultural mechanization, inputs utilization and new varieties developed by genetic breeding resulted in yield gains that Malthus had not expected. Currently, many countries have large food production, but several regions are subjugated to hunger and human malnutrition, events that occur by precarious food distribution. The purpose of this bibliographic review was to address the plant breeding history focused on corn crop, highlight the main used breeding methods and report the key future prospects.

Corresponding author: Maicon Nardino,
Department of Mathematics and Statistics, Federal University of Pelotas, Capão do Leão,Rio Grande do Sul, Brazil.

General gain of plant breeding

Plant breeding is related to the search of multiple characters agronomically and economically important, in order to identify and select superior genotypes to obtain a plant ideotype. However, in the course of this search, some difficulties are found, which will be, in part, complemented on this work. The increasing genetic advance of cultivars makes plant breeding to become the main agriculture pillar, providing fruits, vegetables, cereals and oilseeds for human population. It works increasing oil production, developing more productive species, and increasing ethanol and biodiesel production. For livestock, it improves the quality of forage species, producing more meat, milk and dairy products. Through plant breeding, the production systems may become more sustainable. With the introduction of genetic material resistant and tolerant to biotic and abiotic factors, which dispense insecticides, herbicides and fungicides utilization, great precursors of production cost increases. Even for abiotic factors that are often beyond the producer control, cultivars are developed to tolerate fluctuations of temperature and precipitation. Plant breeding works to create new products of different values, bringing information from research laboratories to farmers, consumers, and other members of the production systems, through the commercialization of improved seeds and seedlings. Generally, plant breeding is involved by a large context that aims to increase quality and quantity of specific products, such as oils, proteins, minerals; resistant and tolerant cultivars to soil and climatic conditions; longest post-harvest products conservation; creating food security for the population and increasing income opportunities to farmers.

Knowledge fields contextualized with plant breeding

The plant breeder must have great ability of selecting plants in a population, depending on the apparent characteristics and objectives outlined on his mind, of which characteristics an ideal plant must present to be selected or remain being part of the program. In the past, plant breeding followed criteria without scientific methodologies, it was executed in form of an art. With scientific advances and a more consistent formation of the breeders, the selection process has become more rigorous and effective, more science than art. The interrelation of breeding, especially on current times with other fields, brought major scientific advances, especially at the genetic level.

Among the fields most related to plant breeding, are:

Genetics: Knowledge about the principles of gene and chromosomal expressions, parentage degree expression and choice of the best breeding method for obtaining a new cultivar.
Biochemistry: Study of proteins and enzymes actions, and the relationship with other molecules, resulting in the selection of individuals with better quality, especially nutritional.
Physiology: Knowledge about plants growth and development processes, relations with hormone production in specific conditions, assisting in genotyping response identification to specific environmental conditions.
Botany: The understanding of botany allows the comprehension of plants reproductive systems, identifying superior individuals to leave descendants for future generations.
Statistics and Experimentation: their knowledge enables the assessment and identification of genetically superior groups within a set of genetic materials, as well as parentage analysis, adaptation to different environmental conditions, combining abilities, based on the identifying probability that certain individuals are superior to others.
Entomology: knowledge about insect relationships and anatomy, as well as how insect pests attack the plant, and identification of the response to the form of attack. Phytopathology; understanding the form of fungal infection and its etiology, in order to identify the possible plant resistance.

The related knowledge fields constitute the tools that a breeder must be ported to run his activities. It has been mentioned some lines that breeders should have knowledge, however, depending on the purpose, other sciences become crucial as soils, plant nutrition, cytogenetic, climatology, agronomy in general, as well as farmers and market demands for cultivars development. Plant breeding is composed by a large context of other sciences, being a process that must remain continuous, because natural circumstances and needs are changing over time. The lines quite discussed currently in numerous events, mainly sustainability, should be progressing and involving breeding programs, in a way that market preferences are always met, as well as people who engage in different production systems.

Mishaps caused by genotype x environment interaction

Over time of crop breeding, agriculture has moved towards greater environmental conditions control. The environment consists of all factors which positively or negatively affect plants growth and development, being all components except the genetic of the material. Nowadays, Brazil presents a very wide range of cultivars and varieties available in the seed market. This large number of genotypes is required due to responses mishaps in different environmental conditions. Some materials perform better in higher humidity, lower occurrence of weeds, while others are more responsive to greater solar radiation, low humidity, being more tolerant to biotic stress factors. However, due to these and countless other factors, genotypes show variation, especially in productivity by environmental conditions. A cultivar may present high technology and genetic potential, however, if the environmental conditions are not favorable for expressing its potential, it will not express significant amounts of response for the submitted conditions. Thus, genetic and environment should be moving in parallel to reach full genotype response magnitude. The G x E interaction is an extremely important phenomenon that challenges breeders and agronomists, especially in competitive test of cultivars and recommendation. When genotypes are evaluated in different years and location, usually significant results for G x E interaction are found, mainly because abiotic conditions are contrasting, changing the response of the same materials under these conditions. According to Bradshaw (1965), the magnitude of genotypes response to environmental conditions are due to phenotypic plasticity, depending on the material aggregated genetic, there may occur no significant responses to contrasting environments. These cultivars may go through a phenotypic adjustment process, which is inversely proportional to the magnitude of heterozygosity. When a cultivar is composed by a large number of genotypes, especially when it already shows adaptation to the environment, it presents phenotypic plasticity for environmental conditions adjustment, due to the buffering effect.

Main factors causing significant effects for genotype x environment interaction (g x e)

The main influencing factors are:

- Rainfall during the crop cycle;
- Photoperiod;
- Solar radiation, mainly for materials responsive to thermal accumulation;
- Sowing time - always willing to respect the agroclimatic zoning;
- Insect control - pest;
- Disease control;
- Weed control;
- Air and soil temperature;
- Agricultural practices of crop management;
- Soil fertility;

In the pursuit for sustainability of a program, or by the producer, these practices are essential to be observed, although some of them are difficult to control and unpredictable, such as precipitation, air and soil relative humidity, photoperiod and solar radiation. However, other practices can be controlled or planned, it is important that they occur according the experimental design or at farming level, allowing the cultivar to reach or get close to its maximum genetic yield potential, thereby returning on sales for seed market, and representing good expressiveness to farmer's earnings.

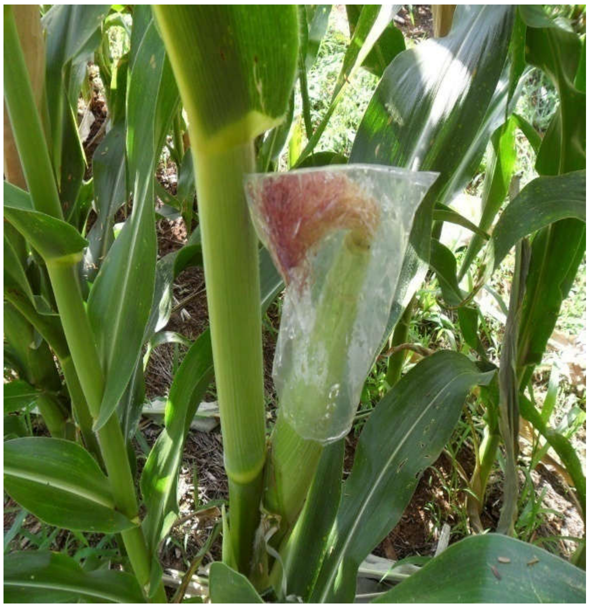
Main features of maize genetic breeding (*Zea mays* L.)

Currently, numerous species are being genetically improved in Brazil, the main ones are maize, soybeans, wheat, oats and cotton. Among the major commercial crops, maize, with the hybrids technology, is at advanced level on the market. Considering the importance for the market and the national scenario, the main factors involving maize hybrids development will be elucidated. The search for highly productive hybrid aims to take advantage of the heterosis effects. Heterosis is the genetic expression resultant of hybridization beneficial effects. Endogamy is another extremely important process on the search for vigor, although it removes plants vigor, consists of crossing individuals with parentage, leading to homozygosity of genetic materials.

Lineages breeding

The selfing are essentially important to obtain endogamic lines. The plants in a maize open population are heterogeneous, essentially single-cross hybrids, since they result from the union of two distinct gametes. Some techniques are effectively used for pollination control (figures 1 and 2). The methods consist of protecting male and female organs (tassel and ear).There are many methods for lineages achievement, some will be described below;

Standard method - Technique consisting of selfing, performing selection among and within progenies according to generations advance. Plants are selected based on favorable agronomic characteristics.



Field of lineages crossing, PatoBranco, RS, 2012.
Font: The author.

Single pit method - This method is similar to the standard, but differs in the plants establishment, where each offspring is represented by a single pit with three plants. The advantage is **reducing the area occupied by the progenies.**
Genealogical method - Two lineages of good combining ability are chosen, in order to isolate new second cycle lineages of the hybrid among the first lineages by endogamy.
Cryptic hybrid method -This is a recent method, consisting of an early combination test through crosses between individual plants. Some authors affirm that this method is efficient for lineages and hybrids development.
Zygotic selection – Also a recent method, used when a superior commercial lineage is available, and the goal is to obtain a new strain from a heterogeneous population, aiming a superior hybrid.

There are other methods applied to maize breeding, in general these are some of the most used, however the best method varies depending on the objective sought by the breeder.

Types of hybrids

On table 1, there is a classification according to the types of hybrids.

Table 1. Types of maize hybrids and their respective crossings (Viégas and Miranda Filho, 1978)

Hybrids	Obtainingthrough crossings
Top Cross	Lineages x Cultivars
Single-crosshybrid	Lineage A x Lineage B
Double-cross hybrid	(Lineage A x Lineage B) x (Lineage C x Lineage D)
Triple-crosshybrid	(Lineage A x B) x Lineage C
Modified single-crosshybrid	(Lineage A xLineage A') x B
Multiplehybrid	Lineage (AxB) x (CxD) x (ExF) x (GxH)
Intervarietalhybrid	Variety A x Variety B

Next, the commercial importance of each hybrid will be described.

1. Top Cross - Commercially, has no value. Most used in the breeding program for evaluation of lineages, potentially hybrid producer.
2. Single-cross hybrid - has the greatest potential for yield, presents uniformity of agronomic characteristics. However, presents high cost for seed production.
3. Double-cross hybrid- Until recently, it was a very used method, but lost some space on the market with the single-cross hybrid advent. Generally, it presents greater stability than single-cross hybrids.
4. Triple-cross hybrid - Results of a cross between a single-cross hybrid and a lineage, and presents good plant uniformity. However, requires two years of cultivation to be obtained.
5. Modified single-cross hybrid – The production cost of seeds is lower, and has taken space of double-cross hybrid since it presents a higher degree of heterosis and lower labor to be achieved.
6. Multiple hybrid – Commercially, it does not show much expression. By employing six to eight lineages, it has the advantage of better adaptation.
7. Intervarietal hybrid - Obtained through crossing different classes of hybrids. Currently, with hybrids obtained from selfed lineages, these materials lost ground, but were important in the first quarter of the twentieth century.

Advantages and disadvantages of hybrids cultivation

The hybrids production is not only related to benefits, there are some important factors to be evaluated.

Major Advantages of hybrid seed production

- Development of highly productive genetic materials;
- Plants with cycle and agronomic characteristics uniformity;
- Utilization of gene interactions for hybrid production;
- Materials responsive to environmental conditions;

Major disadvantages of hybrid seed production

- Production of these seeds is only viable in places of suitable processing and distribution structure.
- Isolated fields are required in order to avoid contamination.
- Some hybrids present high cost of seed production.
- Response to fluctuations occur, depending on the intrinsic environmental conditions.

As already mentioned in this chapter, hybrid production involves a number of factors, which are extremely important to be evaluated. Maize breeding is well advanced in terms of technology, although yields are well below the cultivars genetic potential. Among the determining factors are sowing date outside agro-climatic zoning, recommendation of nonspecific cultivars to the farmer technological condition, as well as the utilization of unsuitable material for specific environmental conditions. The plant breeder acts improving cultivars, making them increasingly more productive and responsive to soil and climatic conditions. However, within the context of sustainability, the entire system will only be efficient and flow normally when all practices are adequate and performed alongside, in order to both breeder and farmer achieve satisfactory returns. When the sustainability of a system is sought, importance should be given for all means, not only considering specific parts, because sustainability is composed, in production environments, for a very large context and may only be achieved through combined and reliably performances.

Plant breeding prospects and future

For many crops such as maize, classical breeding reached very high levels of productivity, and also improved other correlated and agronomically important characters. A new cultivar development is a slow process, which requires care and knowledge of the breeder about many related areas. However, programs being currently conducted, especially with study of lineages and hybrids, require less time. These factors are emerging because advances in genetics and plant breeding, but also aggregating other fields and combined studies of related areas, resulting in a significant evolution. Nowadays, with studies at DNA level, the set of these fields originated a new tool, the biotechnology. This tool has collaborated with plant breeding process, as well as other fields. Along the molecular markers technique, the study of agronomic traits at DNA level could be progressively evolved, monitoring the responses of plant adaptation to environmental conditions. It allowed to assess the gene expression according to environmental conditions, when it is expressed, where, and the magnitude of variation when plants are submitted to adverse conditions.

REFERENCES

Allard, R.W. 1971. Princípios do melhoramento genético de plantas. São Paulo: Edgard Blucher, 381p.

Borém, A.; Miranda, G.V. 2009. Melhoramento de plantas. 5 ed. Viçosa, MG. Ed: UFV, 529p.

Bradshaw, A.D. 1965. Evolutionary significance of phenotypic plasticity in plants. *Adv. Gent*., v.13, p. 115- 155.

Bueno, L.C.S.; Mendes, A.N.G.; Carvalho, S.P. 2006. Melhoramento Genético de Plantas: Princípios e Procedimentos. 2 ed. Lavras: UFLA, 319p.

Ramalho, M; Santos, J. B; Pinto, C. B. 1990. Genética na Agropecuária. 2° Edição. Editora Globo S. A., 359p.

Viegas, G. P.; Miranda filho, J. B. 1978. Milho híbrido. In: Paternian (ed.) Melhoramento e Produção do Milho no Brasil. Edição da Fundação Cargil, p. 257 – 309.

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