



Open and Closed Breeding of Crops

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Abstract

Mutual suiting relationship between breeding way and widening germplasm was first analyzed. Source of utilization germplasm was the more the widener from only using variation in a variety to among family even bigger scope, especially transformation gene breeding could use superfine gene of living things in the world and create germplasm resources that could not obtain in conventional breeding. Secondly contradiction and its movement between ecological and yield ability character, among yield ability characters or ecological characters exist all; this verified that explaining all of phenomenon was “net system of character composition of yield performance”, “theoretical genetics and breeding science of crops” theory system setting up by author. Thirdly new concepts, closed breeding and open breeding were put forward on basis of relationship of unity of opposition among above characters (genes) and supplying way of necessary energy in character express. Theory of closed and open breeding was a generalization of most essential distinction for different breeding way, also theory basis of correct evaluation these. It made people abandon tradition concept that only had variation and also emergence of new variety, and also made people refute mythology on basis of theory that depending on closed breeding could obtain higher yield variety. Openness of sexual cross breeding etc. decided that it will forever be foothold in an invincible position, develop always and any breeding way will not all replace it.

Keywords

Open Breeding, Closed Breeding, Crop

Subject Areas: Plant Science

1. Introduction

As was known to all, ways of crop breeding were more and more. How did correctly analyze these most essential distinctions? This had decisive significance for rationally using different breeding way and enhancing breeding efficiency. But there was not report of this respect until present.

2. Relationship between Breeding Way and Widening Germplasm

Original pure line selection to transforming gene breeding of sure significance, with changes of breeding me-

thods [1], from only using variation in variety to inheritance gene between species, family, above family, genes of variety were more and more abundant, merits more and more. Most important function of transforming gene breeding were creating good variety (germplasm) resource that using conventional breeding could not obtained, then using conventional breeding transformed related gene into other commercial varieties (Table 1).

3. Several Illustrations of Mutual Actions among Different Genes Looking at from Outside Character Performance

3.1. Mutual Action between Adaptive Ability and Yield Ability Characters

1) A determinate pod-bearing habit soybean variety Zaofeng1 was planted over along period of time under not adaptive environment, enhancing its adaptive ability and reducing yield ability. Data in Table 2 showed that variation index of precipitation increased from 31.9% to 41.6% in growing period in last decade, but yield reduced from 97.3% to 84.1%, highest yield in decade reduced. This showed that adaptive ability for less precipitation increased and yield ability reduced, protruding performance of increasing adaptive ability was changed from typical determinate pod-bearing habit into semideterminate [2] (Figure 1).

2) Yield of variety bred using backcross breeding of resistance to disease was reduced compared with original susceptibility parent in year without disease, reason was that express of introduced gene of resistance to disease consumed energy of original variety and reduced express level of yield ability character (Table 3).

3) Yield of varieties transferring glyphosate gene reduced 5% - 19% compared with original tradition variety under condition of not applying glyphosate [3].

Table 1. Relationship between breeding way and widening germplasm.

Breeding ways	Applying scope				
	In a variety	Among varieties	Among species	Among genus	Among family
Pure line selection	√				
Physical and chemical induction of mutation, astronavigation breeding	√				
Crossing breeding, hybrid vigor utilization, current selection		√			
Haploid breeding		√			
Multiploid breeding					
With edge polyploid		√			
Different flange polyploid			√	√	
Aneuploidy breeding (chromosome engineering)			√	√	
Somatic hybridization			√	√	√
Modern biotechnology breeding					
DNA fragments import			√	√	√
Objective genes into			√	√	√

Table 2. Relationship between precipitation in growing period and yield change in two decade from 1954 to 1973.

Item	Years	Average in decade	Highest	Lowest	(Highest-average)/ average (%)	(Average-lowest)/ average (%)	Variation index (%)
Precipitation in growing period (mm)	1954-1963	536.8	582.4	410.0	8.5	23.4	31.9
	1964-1973	474.6	531.8	364.8	10.4	31.2	41.6
Yield (kg/hm ²)	1954-1963	2156.3	3217	1116	49.0	48.3	97.3
	1964-1973	2265.9	3056	1149	34.9	49.2	84.1



Figure 1. Changes of pod-bearing habit Zaofeng1, soybean variety planting in Gongzhuling in twenty years. Left: 1954, typical determinate; right: 1973, semideterminate.

Table 3. Introducing gene of resistance to disease raised adaptability and reduced yield ability.

Variety	Resistance to root rot disease	No disease year	Middle susceptible year	Serious susceptible year	Average	Alteration index %
Harosoy	S	38.2	34.7	13.3	28.7	86.7
Harosoy63	R	38.1	39.7	43.7	40.5	13.9
Howcoy	S	35.6	29.1	7.1	23.9	119.1
Howcoy63	R	35.1	37.9	41.9	38.3	17.8
Lindalin	S	37.3	31.0	10.5	26.3	102.0
Lindalin63	R	35.9	39.4	38.8	38.0	9.5
Clark	S	40.0	35.4	24.1	33.2	47.9
Clark63	R	40.0	41.7	44.4	42.2	9.6

Unit: bushel/acre.

3.2. Mutual Actions among Yield Ability

1) Yield of maize lines suiting to low nitrogen and including high nitrataase, to high nitrogen and low nitrataase under general condition reduced all (Eichelberger, 1989). Yield of millet transforming nitrogenase gene to be bred last years reduced compared with original variety, and suggested that this millet was planted in dry area or hungry soil.

2) Contradiction and its movement between seed yield and quality, among quality characters existed throughout in character performance of crossing generation. Breeding practice in several decade showed that accomplishment of high-yielding breeding was frequently at cost of declining quality [4].

3) Seed yield of bred lines of transforming gene breeding for all improving fatty acid components reduced all.

Explaining and illustrating above all of phenomenon were Net System of Character Composition of Yield Performance of Crops [4].

4. Closed and Open Breeding

4.1. Closed Breeding

All of above situations had a common point, in a same genotype background certain type of gene(s) or one gene changed to guide change of other type or one gene and reached new balance among genes. Definitely speaking, energy assimilating by receptor gene system not changed, when certain character happened change, especially was character in higher layer such as ecological adaptability character, energy of receptor was consumed in process of character or gene expression, normal expression of character in lower layer was done at cost to complement energy needing for adaptability reaction, and energy using seed yield formation was reduced, guiding to reducing yield. This was inevitable result of closed moving of the gene (or character) system. Breeding using this pattern was called closed breeding. List breeding belongs to closed breeding:

- Natural mutation of gene in a variety.
- Selection of isoline and near isogenic line.
- Backcross breeding for a resistance.
- Transforming gene breeding for ecological adaptability and quality character.
- Physical and chemical mutation breeding in general situation.
- Astronavigation breeding (space breeding) in general situation.
- DNA fragments import in general situation.

Closed function of above breeding ways decided its limitation, seed yield of transformation gene variety for many characters was reduced, this decided that transformation gene variety for these characters could not directly utilized in crop production in state that extremely attached importance to yield, unless function of these characters for increasing yield performance or pure value of product was more than that for reducing yield ability. But transformation gene material could become parent in cross breeding, and added new gene for cross breeding, especially gene that there was not excellent gene in germplasm resource of a crop.

4.2. Open Breeding

Sexual cross breeding, heterosis utilization breeding and recurrent selection breeding belong to open breeding, its special feature was whole character (gene) system all participated in recombination and could bring about chain improvement between initiative selection and passive selection. Improvement of character in higher layer could not be at cost of character express of lower layer, at last more energy was absorbed and assimilated from environment due to improvement of other relative characters improvement of resistance etc. ecological characters, increasing yield ability or improvement of quality could be assured.

Openness of sexual cross breeding etc. decided that it will forever be foothold in an invincible position, develop always and any breeding way will not all replace it.

In present sexual cross breeding initiative selection merely for less characters, even only for yield could be conducted, therefore according to theory system, Theoretical Genetics and Breeding Science of Crops, changing passive selection into initiative selection, function of these characters in increase yield could be fully brought into play, role of these characters could not be replaced by other. This was the key of modern breeding development. Future cross breeding was surely combination between single item breeding of more characters and multiply synthetic breeding, it will become certainly a big systemic engineering.

Theory of closed and open breeding was a generalization of most essential distinction for different breeding way, also principal basis of correct evaluation for them.

It made people abandon tradition concept that only had variation and also emergence of new variety, also made people refute mythology on basis of theory that depending on closed breeding could obtain higher yield variety.

5. Conclusion

Author discussed firstly Mutual suiting relationship between breeding way and widening germplasm, and pointed out main function of modern breeding way such transformation gene was widening germplasm, using

gene that existed in biosphere and had not in present crops. Secondly new concepts, closed breeding and open breeding were put forward on the basis of eternal contradiction and its movement among different characters and supplying way of necessary energy in character express. Theory of closed and open breeding was a generalization of most essential distinction for different breeding way, also theory basis of correctly evaluating them. Openness of sexual cross breeding etc. decided that it will forever be foothold in an invincible position, develop always and any breeding way will not all replace it.

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