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Use Of Cytoplasmic Male Sterility In The Selection Of Sorghum Cultures.

Alexander Borisovich Volodin[1]*, Inna Anatolievna Donets[2], Anna Sergeyevna Golub[2], Nina Stefanovna Chukhlebova[2], and Andrey Sergeevich Kapustin[3].

[1]North Caucasus Federal Agricultural Research Center, 356241, Mikhailovsk, Nikonov st. 49, Russia.
[2]Stavropol State Agrarian University, Zootekhnicheskiy lane 12, Stavropol 355017, Russia.
[3]North Caucasus Federal University, Pushkina str. 1, Stavropol 355000, Russia.

ABSTRACT

This article presents long-term studies on sorghum breeding for heterosis based on cytoplasmic male sterility (CMS). The results of the study of parental forms of sorghum grain for combining ability are given. The combination ability (TCA and SCA) of parental forms for heterotic selection was determined. Donors of consistently high yields, short stature, early maturity and grain quality were identified. Hybrid combinations were obtained for variety testing and transfer to state variety testing.
Keywords: selection, heterosis, combining ability, cytoplasmic male sterility, hybrid combinations.

***Corresponding author**

INTRODUCTION

The intensification of agricultural production, the widespread use of progressive methods [1, 2, 4], allow not only to increase the yield of products, but also to fully improve its quality [5, 7, 8].

In the southern and south-eastern regions of the country, where droughts are periodically observed, the sorghum culture becomes important in strengthening the food supply. With the proper selection of varieties and hybrids and the technology of cultivation, it gives high and stable grain yields [9, 10], as well as green mass for silage, hay and green fodder.

However, sorghum is an uncommon culture in our country. This is primarily due to the unsatisfactory state of seed production, poor development of integrated technology for the cultivation, harvesting, storage and use of grain and green mass. The main objective of the successful implementation of this crop in agricultural production is the creation of high-yielding, early ripening and high-quality varieties and hybrids, adapted to specific soil and climatic conditions.

The use of cytoplasmic male sterility (CMS) in sorghum has opened a new stage in the selection of this culture, which consists in breeding high-yielding heterotic hybrids on a sterile basis.

In this regard, an important means of increasing the productivity of crop production is the practical use of the heterosis effect (i.e., an increase in the power and productivity of hybrids compared to parental forms).

In many cultures, such as sorghum, onions, carrots, sugar beets, etc., mass castration of flowers is practically difficult to implement, so the production of hybrid seeds is possible only when using sterile forms.

Sorghum CMS is manifested in the form of underdeveloped anthers with a small amount of sterile pollen, and sometimes without pollen. The development and functioning of gynecium in plants with CMS is normal, with the exception of the non-viability of the pollen of maternal forms.

Sorghum has bisexual flowers, and is capable of fertilizing both from self-pollination and cross-fertilization. The problem of obtaining hybrid seeds from cross-pollination in sorghum seed production is very important. The main method of obtaining heterotic sorghum hybrids is the use of forms with male sterility, in which self-pollination is excluded and cross-pollination is provided [3].

The use of CMS in breeding and seed production of sorghum is associated with the creation of sources of sterility, the study of the reaction of varietal samples to sterility, the elimination of sterile analogues and the selection of reducing fertility pollen. The magnitude of heterosis depends on the specific combinations of crosses, which resulted in hybrids.

They significantly exceed the parental forms in such economically valuable features as plant height, bushiness, panicle and leaf size, stem thickness, grain yield, green mass and absolute seed weight [6].

At the same time, early ripeness in hybrid combinations can be intermediate or lag behind in its development. The dominance of a short growing season of one of the parental forms indicates the presence of a heterosis of precocity. At the same time, significant cases of lengthening of the growing season were found, even when crossed with early-ripening samples. Consequently, it is not possible to determine in advance the heterotic effect without additional assessments of the material under study on the basis of characteristics not controlled by the phenotype.

The main purpose of the combining ability to select the best parental forms, taking into account the patterns of heritability of selection-significant traits and properties and the ability to fix sterility and restore pollen fertility in the hybrid.

MATERIAL AND METHODS

Our studies of combining ability were carried out with eight sterile lines with three testers in various combinations for qualitative and quantitative characteristics. At the same time, the parental forms showed a high coefficient of heritability of the general combining ability (TCA) than the specific (SCA) and low susceptibility of paratypical variability, depending on the complex of external genotypic features of the parental forms.

RESULTS AND DISCUSSION

Analysis of the productivity options of hybrids of the first generation testifies to very large differences in the values of TCA varieties of pollinators and TCA sterile lines.

Separate sterile lines are consistently inherited by TCA and are donors. These include: A 3622 for increasing crop yields, plant height, Zersta 38A, A3615, A3622 for early ripening, for a complex of signs and properties (yield, grain quality, short stature and early ripeness) Knyazhna, Zersta 38A, A3615, A803, Zersta 90s.

The sterile line of Knyazhna was characterized by a high overall combination capacity for grain productivity, regardless of the influence of the paratypic factor over the years of testing. The lines with high specific combining ability (SCA) - Zersta 38A, A3622, A320 showed a heterosis effect on grain productivity.

A significant level of TCA variation in sterile lines was predetermined by a high degree of interaction of their genotypes, not only with the genotypes of the paternal forms, but also with paratypical factors.

Lines with high and medium TCA estimates in most cases provide high heterotic hybrids. A large variation of TCA in top-cross crosses occurs due to the unequal influence of the paratypical factor on the genotypes of the sterile lines and sorghum pollinator varieties, which depends on the genetic complexity of the crossed parental forms.

In top-cross-breeding using CMS, phenotypic variability is the result of the interaction of genotypic and paratypical variability caused by hereditary characteristics and environmental conditions.

The decomposition of genotypic variability (h^2) into constituent elements and the determination of the degree of heritability are due to the genotypes of the maternal ($h^2 p_1$) and paternal (h^2 p_2) forms, as well as their interaction (h^2 p_1 p_2) (Table 1.)

Table 1: Coefficients of heritability of productivity in grain sorghum hybrids

Maternal or paternal form	H^2	h^2	h^2_{p1}	h^2_{p2}	$h^2_{p1\,p2}$
♀	0.8780	0.5165	0.3693	0.1475	0.3614
♂	0.8160	0.5188	0.1304	0.3883	0.2972

The source material, analyzed by the productivity of hybrids of the first generation of grain sorghum, showed that the heritability coefficient of the productivity of hybrids of grain sorghum, due to the genotypes of the studied forms, is relatively stable and has high indicators regardless of the influence of the paratypical factor.

The results of our research on the genetic characteristics of the source material made it possible to isolate a number of heterotic hybrids.

A heterotic hybrid of sorghum grain Ekva 1, with a heterosis effect of 16.3% in relation to the maternal form and 3 1.1% in relation to the paternal form was singled out for the complex of economically valuable traits. The heterotic hybrid sorghum grain Equa 1 is included in 1 state register of breeding achievements and is recommended for use in production. The effect of heterosis on the collection of digestible protein and metabolizable energy from 1 hectare of sowing of the Ekva 1 hybrid was 87.5% and 77.7%, respectively.

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CONCLUSION

Breeding programs for creating heterotic hybrids require complete information about the source material. The selection of parental pairs is carried out not only for phenotypic characters, but also for genetic features. The determination of the genetic nature of each with a high degree of severity may be carried out in assessing the effects of general and specific combination ability (TCA and SCA).

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