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IDENTIFICATION OF DONOR LINES FOR IMPROVING FRUIT YIELD OF K 35 x K 12 EGGPLANT HYBRID

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The aim of this study was to identify an eggplant donor line which possess the largest frequency of favourable alleles that control fruit yield. Such donor line should be used to improve the elite eggplant hybride K35 x K12. The fruit yield of the elite hybrid, its parents and their hybrids with three potential donor lines (K36/1, K11 and K22/2) was examined in a diallel set by means of field trials. The trials were set in a randomised block design in three replications. After the fruit yield had been measured, the modified method of evaluation of relative loci value according to DUDLEY (1987) was applied. All inbred lines expressed positive values of the $\mu G'$ parameter. The K11 inbred had the largest $\mu G'$ value (2.38*) and, also, the lowest frequency of unfavourable alleles on the loci class D (1.33). It was established that the K11 inbred line was more related to the K35 parental inbred line (7.81). Consequently, on the basis of the $\mu D'$ values, improvement should be obtained by backcrossing the elite hybrid K35 x K11 to the donor inbred K11.

Key words: eggplant, donor of favourable alleles, elite hybrid, improvement, backcrossing

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INTRODUCTION

Eggplant (*Solanum melongena* L.) is a vegetable crop whose varieties are produced in a different manner, including development of inbred lines (PATIL and SHINDE,1989). The appropriate choice of inbreds to be crossed is a key moment in gaining high yielding hybrids. Therefore, the evaluation of different inbreds in eggplant breeding programs is frequently achieved by diallel analysis and estimation of GCA values (CHADKA *et al*., 1990; AHMED *et al.*, 1998).

The identification of inbreds as donors of favourable alleles for improving elite single crosses after DUDLEY (1987) was developed in maize breeding programs (MIŠEVIĆ, 1989; MIŠEVIĆ, 1990). It is useful to establish whether it is possible to apply the method in other heterotic crops, such as eggplant. Determining whether any of inbred lines studied actually posesses favourable alleles for fruit yield, which are not present in the elite single cross hybrid, would enlarge current knowledge regarding eggplant germplasm in Serbia and its usefulness.

MATERIALS AND METHODS

The hybridization of a diallel set of five divergent eggplant inbred lines was conducted in 1996 in Centre for Vegetable Crops in Smederevska Palanka. The inbreds investigated were: K11, derived by selfing of Yugoslav variety Junior, K22/2, derived from foreign variety Black Beauty, also by selfing, K36/1, derived from hybrid variety Solara F_1, K12 and K35, derived by selfing varieties Violeta di New York and Long Purple, respectivelly. The F_1 progeny of these inbred lines was investigated in field trials in randomised block design, during 1997 and 1998, in three replications. Combining abilities after GRIFFING (1956) were determined with respect to fruit yield. The modified method of DUDLEY (1987) was applied in order to establish which of the three potential inbred donors (K11, K36/1, and K22/2) may actually improve the hybrid K35 x K12. The following parameters were calculated: $\mu G'$ (relative number of loci on class G, where the donor has the favourable and the parents of the improving hybrid have the unfavourable alleles), $\mu D'$ and $\mu F'$ (where the parents of the improving hybrid have favourable alleles, while the potential donor has unfavourable alleles for fruit yield) and the relative relatedness of parents K35 and K12 with the potential inbred donors. The relative number of loci in B, C, D, E, F, G classes was determined on the basis of frequency of recessive alleles on $C + E = j$ and $E + F = k$ classes, respectivelly, according to the relation:

$$(P_1 \times D) - (P_2 \times D) = [(P_1 \times P_2) - P_2]\, q_j - [(P_1 \times P_2) - P_1] q_k;$$

P_1 signifies the average performance of the first parent;

P_2 signifies the average performance of the second parent;

D signifies the average performance of the donor line.

q_j and q_k signify the relative frequency of the recessive alleles on the $C + D$ and $E + F$ classes, respectivelly.

The above formula is the basis of calculating the relative number of loci in each class. Classes of interest are B, C, D, E, F and G, because they express the

important differences between inbred donor and the parents of the improving hybrid. Depending on the frequency of the recessive alleles in the *j* and *k* classes, there are four ways with four set of formulae to determine the relative number of loci on each class of interest.

- If $q_k = 0$, $q_k = 1$, the following relations are valid:

$(P_1 \times D) - (P_2 \times D) > 0$;
$(P_1 \times D) - (P_2 \times D) < (P_1 \times P_2) - P_2$;
$(P_1 \times D) - (P_2 \times D) + (P_1 \times P_2) < 0$;
$(P_1 \times D) - (P_2 \times D) + (P_1 \times P_2) - P_1 < (P_1 \times P_2) - P_2$.

The estimation of the relative loci value is determined by the formulae:

$\mu B' = [2(P_2 \times D) - (P_1 \times P_2) + P_1 - 2D] / 4$;
$\mu C' = [- 2(P_1 \times D) + 2(P_2 \times D) + (P_1 \times P_2) + P_1 - 2P_2] / 4$;
$\mu D' = [2(P_1 \times D) - 2(P_2 \times D) + (P_1 \times P_2) - P_1] / 4$;
$\mu E' = [(P_1 \times P_2) - P_1] / 4$;
$\mu F' = [(P_1 \times P_2) - P_2] / 4$;
$\mu G' = [2(P_1 \times D) - (P_1 \times P_2) + P_1] / 4$.

- If $q_j = 0$, $q_j = 1$, the relations are:

$(P_1 \times D) - (P_2 \times D) < 0$;
$(P_1 \times D) - (P_2 \times D) < (P_1 \times P_2) - P_1$;
$(P_1 \times D) - (P_2 \times D) + (P_1 \times P_2) - P_1 > 0$;
$(P_1 \times D) - (P_2 \times D) + (P_1 \times P_2) - P_1 < (P_1 \times P_2) - P_2$.

The relative loci value in each class is calculated as follows:

$\mu B' = [2(P_1 \times D) - (P_1 \times P_2) - (P_1 \times P_2) + P_2 - 2D] / 4$;
$\mu C' = [(P_1 \times P_2) - P_2] / 4$;
$\mu D' = [(P_1 \times P_2) - P_2] / 4$;
$\mu E' = [2(P_1 \times D) - 2(P_2 \times D) + (P_1 \times P_2) - 2P_1 + P_2] / 4$;
$\mu F' = [- 2(P_1 \times D) + 2(P_2 \times D) + (P_1 \times P_2) - P_2] / 4$;
$\mu G' = [2(P_2 \times D) - (P_1 \times P_2) + P_2] / 4$.

- If $q_k = 0$, $q_j = 1$, the necessary conditions are:

$(P_1 \times D) - (P_2 \times D) > 0$;
$(P_1 \times D) - (P_2 \times D) < (P_1 \times P_2) - P_1$;
$[(P_1 \times D) - (P_2 \times D)] - [(P_1 \times P_2) - P_2] < 0$;
$[(P_1 \times D) - (P_2 \times D)] - [(P_1 \times P_2) - P_2] < (P_1 \times P_2) - P_1$.

The relative loci value are determined according to the set of formulae:

$\mu B' = [(P_1 \times D) + (P_2 \times D) - (P_1 \times P_2) + P_2 - 2D] / 4$;
$\mu C' = [- (P_1 \times D) + (P_2 \times D) + (P_1 \times P_2) - P_2] / 4$;
$\mu D' = [(P_1 \times D) - (P_2 \times D) + (P_1 \times P_2) - P_2] / 4$;
$\mu E' = [(P_1 \times D) - (P_2 \times D) + (P_1 \times P_2) - 2P_1 + P_2] / 4$;
$\mu F' = [- (P_1 \times D) + (P_2 \times D) + (P_1 \times P_2) - P_2] / 4$;
$\mu G' = [(P_1 \times D) + (P_2 \times D) - (P_1 \times P_2) - P_2] / 4$.

- If $q_k = 1$, $q_j = 0$, it means that:

$(P_1 \times D) - (P_2 \times D) < 0$;
$(P_1 \times D) - (P_2 \times D) < (P_1 \times P_2) - P_1$;
$(P_1 \times D) - (P_2 \times D) + (P_1 \times P_2) - P_1 > 0$;

$(P_1 \times D) - (P_2 \times D) + (P_1 \times P_2) - P_1 < (P_1 \times P_2) - P_2$.

The relative loci values are then calculated by the formulae:

$\mu B' = [(P_1 \times D) + (P_2 \times D) - (P_1 \times P_2) + P_1 - 2D] / 4$;

$\mu C' = [- (P_1 \times D) + (P_2 \times D) + (P_1 \times P_2) + P_1 - 2P_2] / 4$;

$\mu D' = [(P_1 \times D) - (P_2 \times D) + (P_1 \times P_2) - P_1] / 4$;

$\mu E' = [(P_1 \times D) - (P_2 \times D) + (P_1 \times P_2) - P_1] / 4$;

$\mu F' = [- (P_1 \times D) + (P_2 \times D) + (P_1 \times P_2) - P_1] / 4$;

$\mu G' = [(P_1 \times D) + (P_2 \times D) - (P_1 \times P_2) - P_1] / 4$.

The relative relatedness between the parents and the donor line is determined by the formula:

$(P_1 \times D) - (P_2 \times D) + (P_1 - P_2) / 2$.

Positive value of the given parameter indicates that the donor line is more closely related to the P_1 parental inbred, whereas negative value of this parameter means that the donor line is more closely related to the P_2 parental inbred. The final step in the improvement of commercial F_1 hybrid eggplant cultivars should be forming the initial population which will undergo breeding process. The initial population can be derived on the basis of the $\mu G`: \mu D`$ratio, in one of the three following manners:

- selfing the (P_1 x D) F_1 progeny, if there is no significant difference between $\mu G`$ and

$\mu D`$ values, i. e. $\mu G` = \mu D`$;

- backcrossing the F_1 (P_1 x D) hybrid progeny to the P_1 parental inbred, if $\mu G` > \mu D`$;

- backcrossing the (P_1 x D) hybrid to the donor line D, if $\mu G` < \mu D`$.

RESULTS

The best general combiner was the K11 inbred which had significant positive GCA value, followed by the K12 inbred. The other three inbreds had negative GCA values. The K36/1 inbred and the K22/2 had significant negative GCA value (Table 1).

Table 1. The GCA values for five eggplant inbred lines

Parental inbreds	GCA values	Rank	SE	LSD Values 0.05	0.01
K35	-0.438	3	0.368	0.754	1.018
K36/1	-5.649**	5			
K11	4.010**	1			
K22/2	-1.121**	4			
K12	3.198**	2			

**significant at P = 0.01

The K11 and K22/2 inbreds were more closely related to the K35 parental inbred and the K36/1 inbred was more closely related to the K12 parental component (Table 2). The K11 and the K 22/2 inbreds had the same $\mu G'$ value, but the

K11 inbred had lower number of the unfavorable alleles comparing to the K 22/2 inbred (Table 2.).

Table 2. The relative number of favorable and unfavorable alleles and the relative relatidness of parental inbreds (K35 x K12) to the potential donors

Donors	μG'	Relatedness ($+P_1$;- P_2)	μD' (μF')	Crossing of (D x P_x)
K11	2.38	+7.81	1.33	D
K22/2	2.38	+5.61	3.44	P_1
K36/1	2.29	-5.63	2.16	P_2

*>2SE

DISCUSSION

Investigated inbred lines showed significant differences in their general combining abilities which is in accordance with their different genetic basis and the results of IQBAL *et al.* (1995). The *μG'* value in the K11 and K22/2 inbreds respectivelly, was equal or higher than in the K36/1 inbred. Therefore, the K11 and K22/2 should be considered as potential donors of favorable alleles for fruit yield. The choice should be based on both the value of unfavorable alleles and the GCA value. The K11 inbred which was the best general combiner had also lower relative number of unfavorable alleles than the K22/2 inbred. Therefore, the K11 inbred was chosen to be the donor of favorable alleles in order to improve the elite eggplant hybrid K35 x K12 regarding the fruit yield. The mode of improvement should be determined on the basis of relative relatedness of parental hybrid components with the donor. Namely, the donor line always improves more closely related parent of the elite hybrid (DUDLEY, 1988). In this case, the best donor line (K11) should improve the K35 parent of the K35 x K12 elite hybrid, because it is more closely related to this parental component of the elite hybrid. The initial population for further improvement should be derived by backcrossing K35 x K11 hybrid of the diallel set, where the donor inbred (K11) should be the recurrent parent on the basis of *μG'* and *μD'* ratio. Improvement of fruit yield in the K35 x K12 elite hybrid would, most probably, be achieved in this manner.

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IDENTIFIKACIJA DONORA DONORA POŽELJNIH ALELA ZA PRINOS PLODA HIBRIDA K 35 x K 12 PLAVOG PARADAJZA

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I z v o d

Cilj ovog rada je bio da se izdvoje one inbred linije plavog paradajza koje poseduju najveću frekvenciju poželjnih alela za prinos ploda. Ovakve linije bi mogle da se iskoriste za unapređenje elitnog hibrida plavog paradajza K35 x K12. Prinos ploda ovog elitnog hibrida, njegovih roditeljskih linija i tri potencijalna donora poželjnih alela je bio utvrđen dialelnim ukrštanjem. Poljski ogledi su bili postavljeni po slučajnom blok sistemu u tri ponavljanja. Radi identifikacije donora poželjnih alela, primenjen je modifikovan matematički model po DUDLEY-u (1987). Sve inbred linije su ispoljile pozitivne vrednosti parametra μG'. Linija K11 je imala najveću vrednost μG' (2.38*) i, takođe, najnižu frekvenciju nepoželjnih alela na klasi lokusa D (μD'= 1.33) a bila je i najbolji opšti kombinator (4.01**). Ova linija je bila srodnija roditeljskoj komponenti elitnog hibrida K35 (7.81). Na osnovu vrednosti parametra μD', poboljšanje prinosa ploda hibrida K35 x K12 bi trebalo postići unapređenjem roditeljske komponente K35. Pri tome, početnu populaciju za selekciju poboljšane linije K35, po našim rezultatima, treba zasnovati povratnim ukrštanjem elitnog hibrida K35 x K11 sa linijom K11 kao rekurentnim roditeljem i donorom poželjnih alela.

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