

**Table S2 Theoretical frequencies of the twelve identifiable genotypes in the double cross population for**

**Scenario 10.**  $A_1, B_1, C_1$  and  $D_1$  are the four alleles at locus 1.  $A_2$  and  $B_2$  are the two alleles at locus 2.

Recombination frequencies in the female and male parents are denoted as  $r_F$  and  $r_M$ , respectively. The combined recombination frequency is denoted as  $r$ . The last column gives the symbol of observed sample size of each genotype.

Genotype	Locus 1	Locus 2	Frequency	Combined recombination frequency	Sample size
1	$A_1C_1$	$A_2A_2$	$\frac{1}{4}(1-r_F)r_M$	$\frac{1}{4}r(1-r)$	$n_1$
2	$A_1C_1$	$A_2B_2$	$\frac{1}{4}(1-r_F)(1-r_M) + \frac{1}{4}r_Fr_M$	$\frac{1}{4}(1-2r+2r^2)$	$n_2$
3	$A_1C_1$	$B_2B_2$	$\frac{1}{4}r_F(1-r_M)$	$\frac{1}{4}r(1-r)$	$n_3$
4	$A_1D_1$	$A_2A_2$	$\frac{1}{4}(1-r_F)(1-r_M)$	$\frac{1}{4}(1-r)^2$	$n_4$
5	$A_1D_1$	$A_2B_2$	$\frac{1}{4}(1-r_F)r_M + \frac{1}{4}r_F(1-r_M)$	$\frac{1}{2}r(1-r)$	$n_5$
6	$A_1D_1$	$B_2B_2$	$\frac{1}{4}r_Fr_M$	$\frac{1}{4}r^2$	$n_6$
7	$B_1C_1$	$A_2A_2$	$\frac{1}{4}r_Fr_M$	$\frac{1}{4}r^2$	$n_7$
8	$B_1C_1$	$A_2B_2$	$\frac{1}{4}(1-r_F)r_M + \frac{1}{4}r_F(1-r_M)$	$\frac{1}{2}r(1-r)$	$n_8$
9	$B_1C_1$	$B_2B_2$	$\frac{1}{4}(1-r_F)(1-r_M)$	$\frac{1}{4}(1-r)^2$	$n_9$
10	$B_1D_1$	$A_2A_2$	$\frac{1}{4}r_F(1-r_M)$	$\frac{1}{4}r(1-r)$	$n_{10}$
11	$B_1D_1$	$A_2B_2$	$\frac{1}{4}(1-r_F)(1-r_M) + \frac{1}{4}r_Fr_M$	$\frac{1}{4}(1-2r+2r^2)$	$n_{11}$
12	$B_1D_1$	$B_2B_2$	$\frac{1}{4}(1-r_F)r_M$	$\frac{1}{4}r(1-r)$	$n_{12}$