

DESIGN OF A LOW DENSITY SNP CHIP FOR GENOMIC SELECTION IN LAYER CHICKENS

Herry Florian^{1,2}, Hérault Frédéric², Varenne Amandine¹, Burlot Thierry¹, Le Roy Pascale² & Allais Sophie²

¹NOVOGEN, 22800 Le Foeil, ²PEGASE, INRA, Agrocampus Ouest, 35590 Saint-Gilles

INTRODUCTION

Since 2013, a commercial high-density SNP chip of 600 000 SNP for chicken is available and enables the implementation of genomic selection in layers production. However, genotyping costs still remain high for a routine use on a large number of selection candidates. Combining genotyping on low-density SNP chip, at a lower cost, and genotype imputation should be considered on a large number of selection candidates. Thus, the definition of SNP panel is the milestone of this approach.

The main objective of this study is to choose the best strategy for low density genotyping of laying hen lines in order to optimize selection scheme.

MATERIALS AND METHODS

Study populations: Study of two different lines of *Rhode Island (RI)* and *Leghorn (L)* from Novogen, genotyped on HD SNP chip (Table 1). After quality control, respectively 300 351 and 245 667 SNP are retained and distributed for *Rhode Island* and *Leghorn* lines on the genome.

Line	Rhode Island	Leghorn
Number	1027	1474
Sires	1027 ♂	561 ♂
Dams	0 ♀	913 ♀
Generation 0 (G0)	447	711
Generation 1 (G1)	580	763

Table 1 : Study populations

Imputation strategies : Use of Fimpute (Sargolzaei et al., 2014) to impute G0 from G1. From low density SNP chips designed, study of the effect of:

- SNP density,
- LD threshold used to designed low density SNP chips,
- the type of chromosome (macro-chromosomes (1 to 5), intermediate chromosomes (6 to 10), micro-chromosomes (11 to 33) and sexual chromosome Z,
- MAF (Minor Allelic Frequency) of SNP,
- the methodology used to designed low-density SNP chips.

Low density SNP chips:

Simulation of low-density SNP chip according to two intra-chromosomes methodologies (Table 2):

- « Equidistant » methodology: Selection of SNP at regular intervals.
- « Linkage Disequilibrium » methodology: Selection of SNP according to the LD between SNP.

Methodology	SNP Chip	Number of SNP	
		Rhode Island	Leghorn
Equidistant	50Kequi	49636	50307
	40Kequi	40160	39838
	30Kequi	29970	30075
	20Kequi	19910	19948
	15Kequi	14963	14955
	10Kequi	10001	9966
	7.5Kequi	7527	7496
	5Kequi	4991	4996
	4Kequi	4023	4000
	3Kequi	2992	3003
Linkage Disequilibrium	2Kequi	2013	2004
	DL0.8	21717	18052
	DL0.7	16615	13696
	DL0.6	13214	10736
	DL0.5	10711	8626
	DL0.4	8521	6944
	DL0.3	6875	5578
	DL0.2	5371	4330

Table 2 : Summary of SNP chips studied

RESULTS AND DISCUSSION

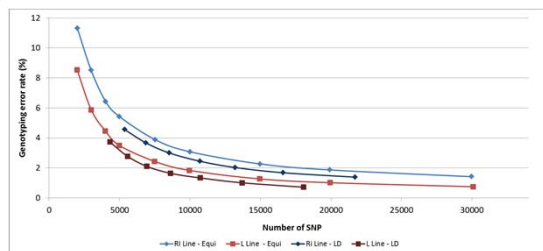


Figure 2 : Evolution of genotyping error rate as a function of the number of SNP on low density SNP chip

Choice of the methodology:

- « Equidistant » methodology: Number of SNP proportional to the size of chromosome (Figure 4).
- « LD » methodology: Consideration of the particular structure of chicken species' LD and of the lower persistence of LD on micro-chromosomes than on macro-chromosomes.
 - Necessity of a greater number of SNP on micro-chromosome to cover the whole chromosome (Figure 4).
- « LD » methodology seems to be the most appropriated to get good imputations.

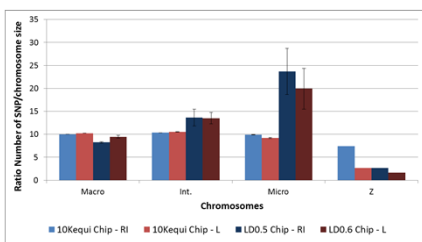


Figure 4 : Evolution of the ratio Number of SNP/Chromosome size as a function of the type of chromosome.

Influence of Minor Allelic Frequencies (MAF):

- Variability of genotyping error rate higher with equidistant methodology than with LD methodology (Figure 5).
- Lower genotyping error rates obtained with LD methodology, except for SNP with high MAF.
- Decrease of genotyping error rates for SNP high MAF with equidistant methodology.
- Valid for both lines.

Influence of SNP density:

- Decrease of genotyping error rate with an increase in the number of SNP (Figure 2).
- Valid for both methodologies.

Influence of LD threshold:

- Decrease of genotyping error rate with an increase in LD threshold (Figure 3).
- By increasing LD threshold, the number of SNP on low density SNP chip increases. The increase of LD threshold also makes it possible to choose a SNP still more representative of its group.

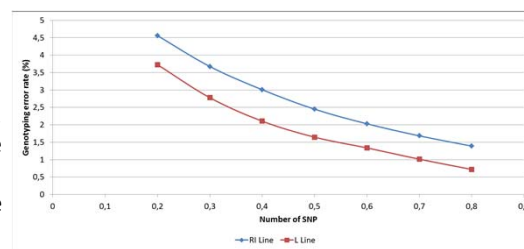


Figure 3 : Evolution of genotyping error rate as a function of LD threshold

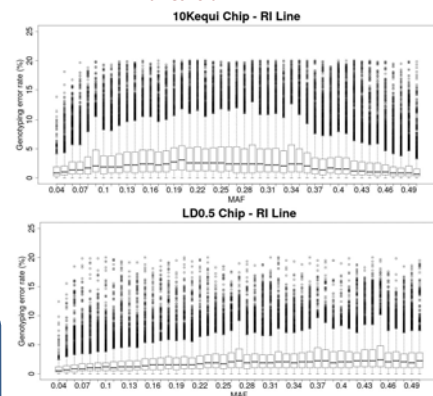


Figure 5 : Evolution of genotyping error rate according to the MAF for Rhode Island Line.

- Consideration of the particular structure of chicken species' LD with LD methodology.
- Better results of imputation obtained with low density SNP chip based on LD.
- According to the MAF, lower genotyping error rates obtained with LD methodology, excepted for SNP with high MAF.