

# Summary of genome-wide association studies

All genotypes

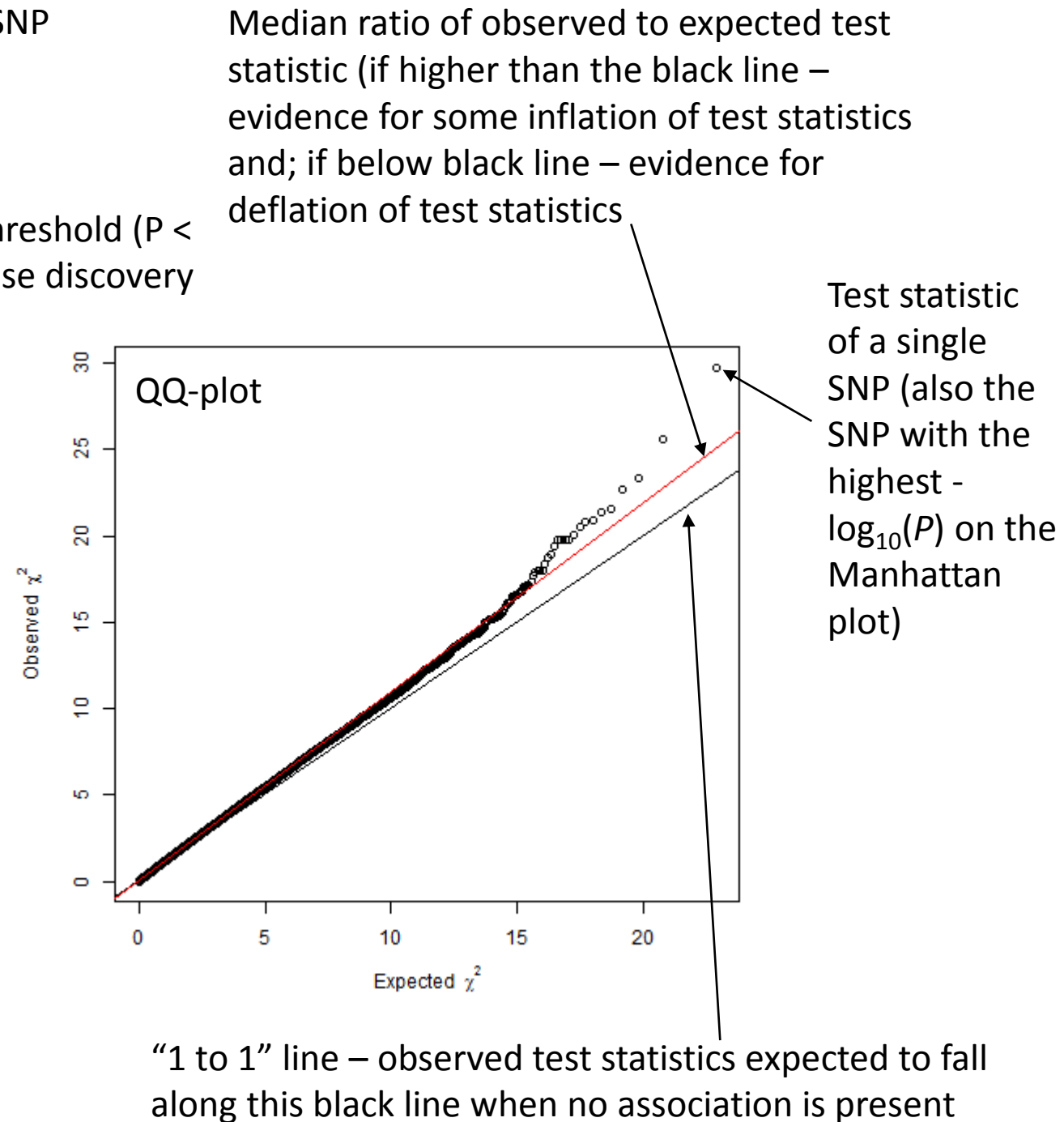
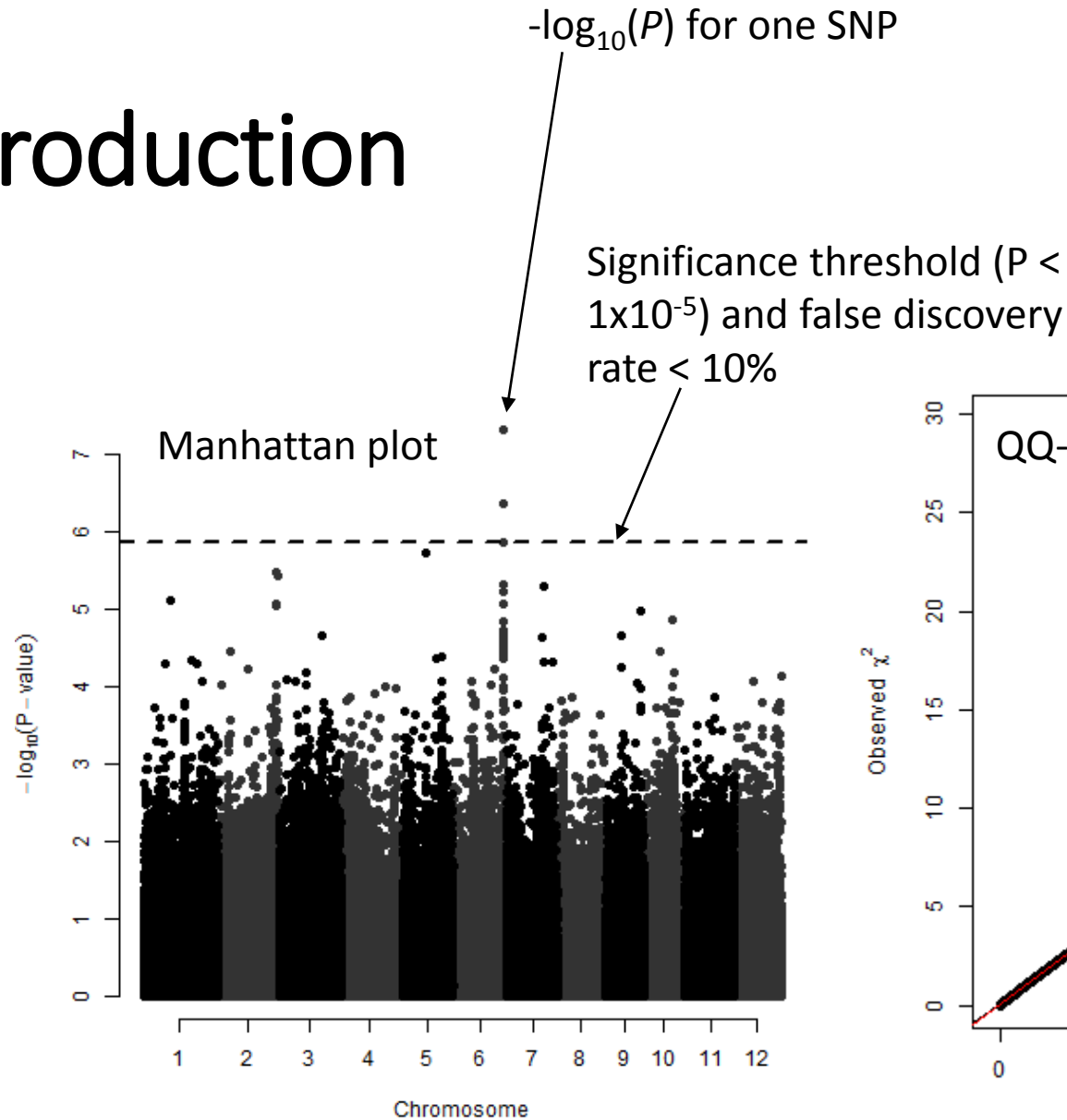
Sub-species: Indica and Japonica

Sub-populations: aus, indica, temperate japonica, and tropical japonica

# Introduction

- For each trait studies in Chapter 4 of the thesis, the results of GWAS are summarised for all genotypes as well as sub-population (Indica and Japonica) and sub-species (aus, indica, temperate japonica, and tropical japonica)
- Each association has a Manhattan plot and a quantile-quantile (QQ) plot which are explained on the next slide, using the shoot sodium concentration in the low potassium treatment as an example
- The low and high treatments were 0.1 and 1 mM K<sup>+</sup> respectively

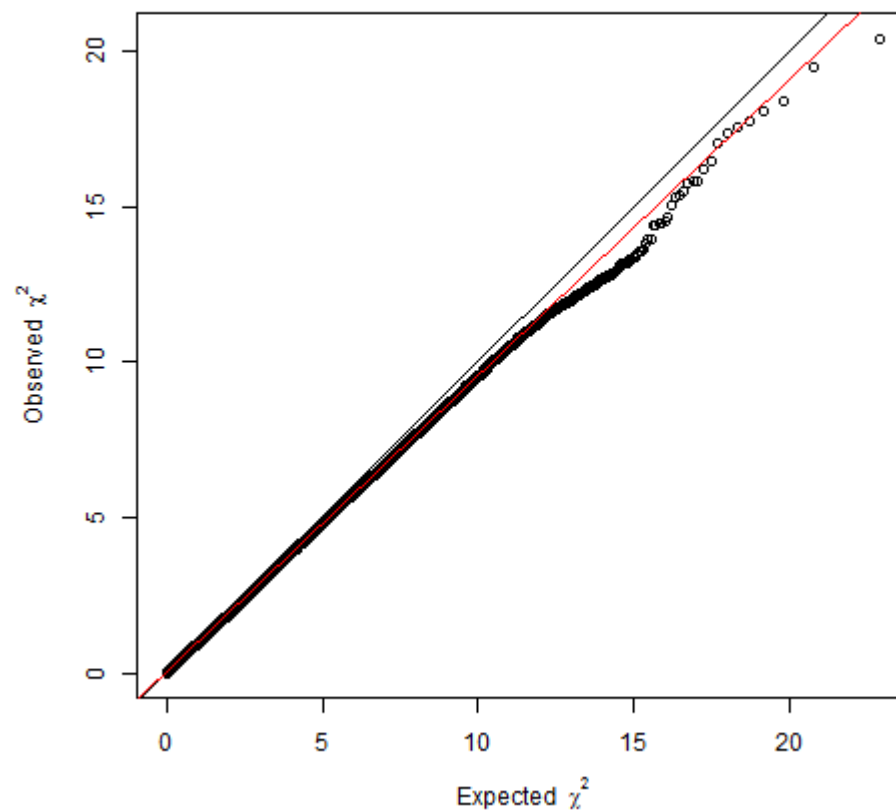
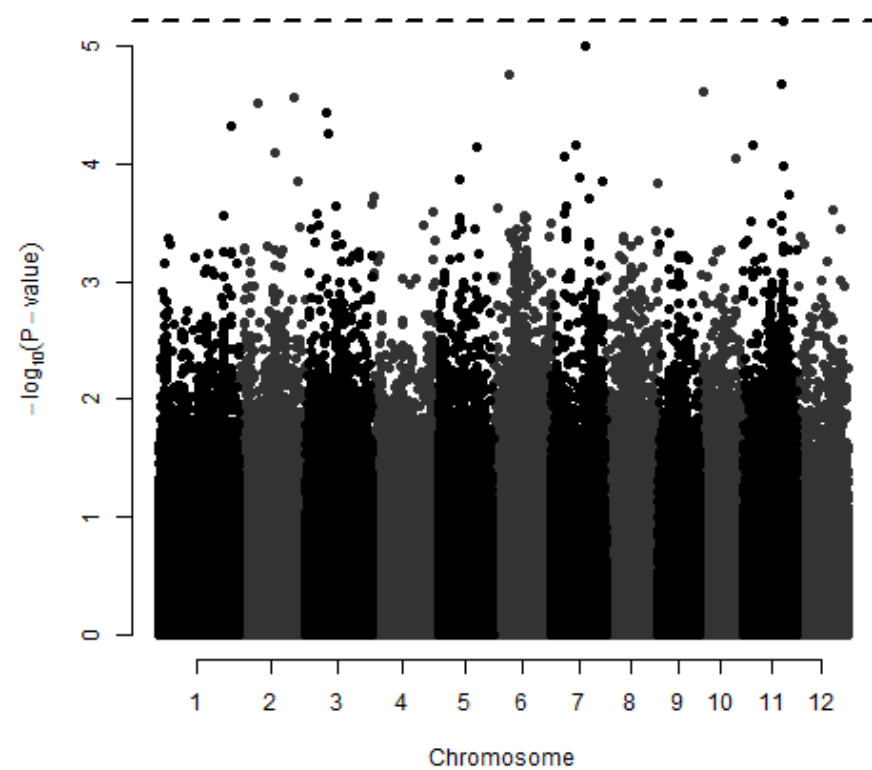
# Introduction



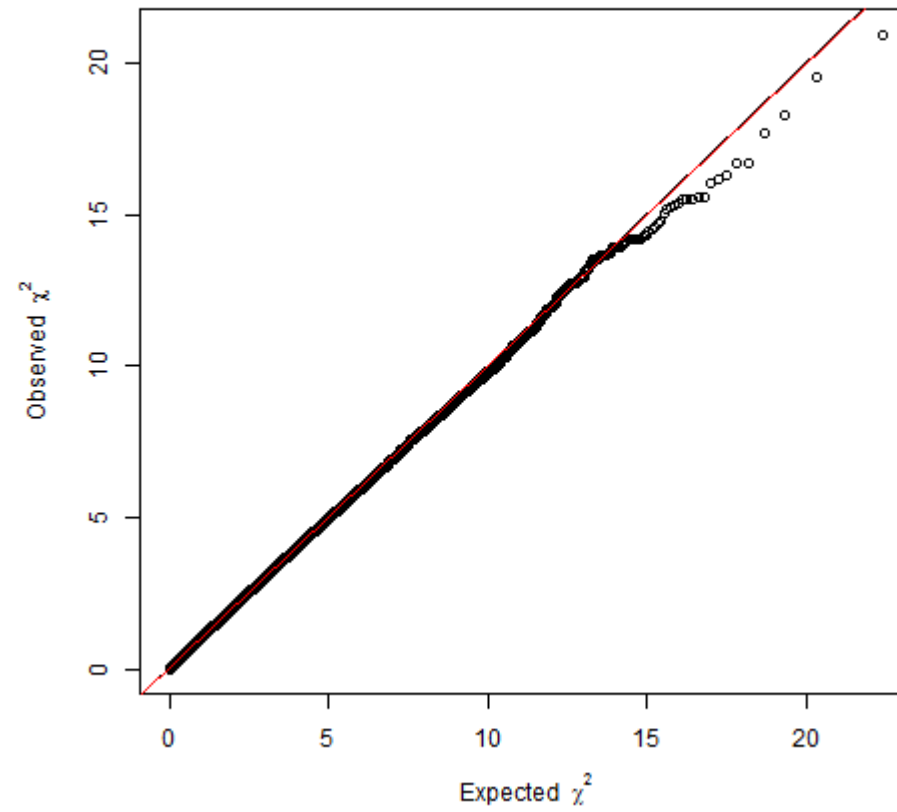
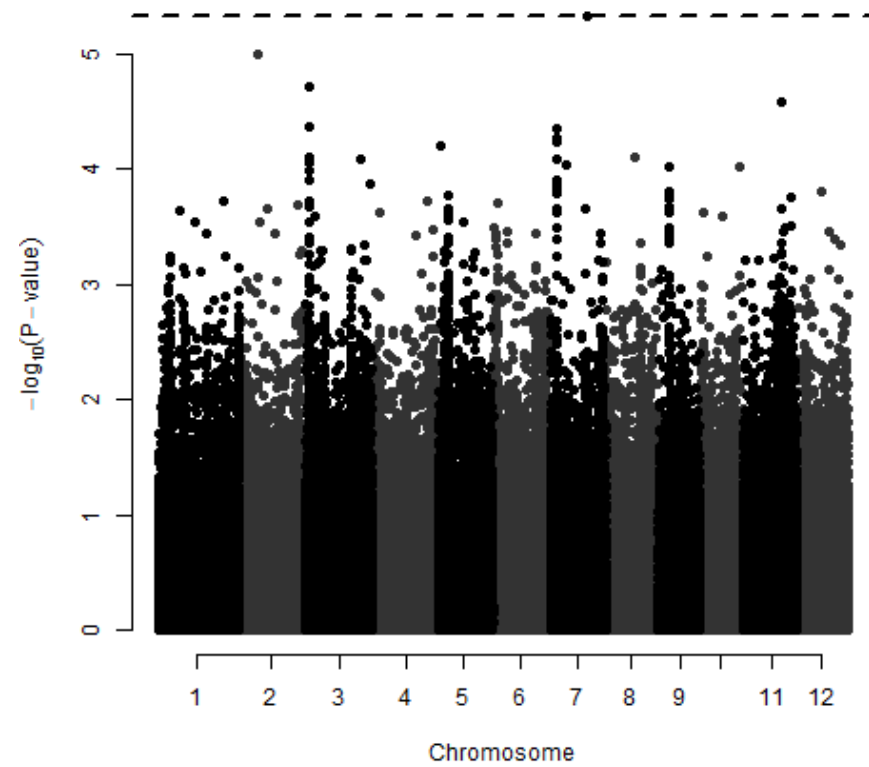
$$FWDW_{HT}$$

Fresh weight dry weight in the high treatment

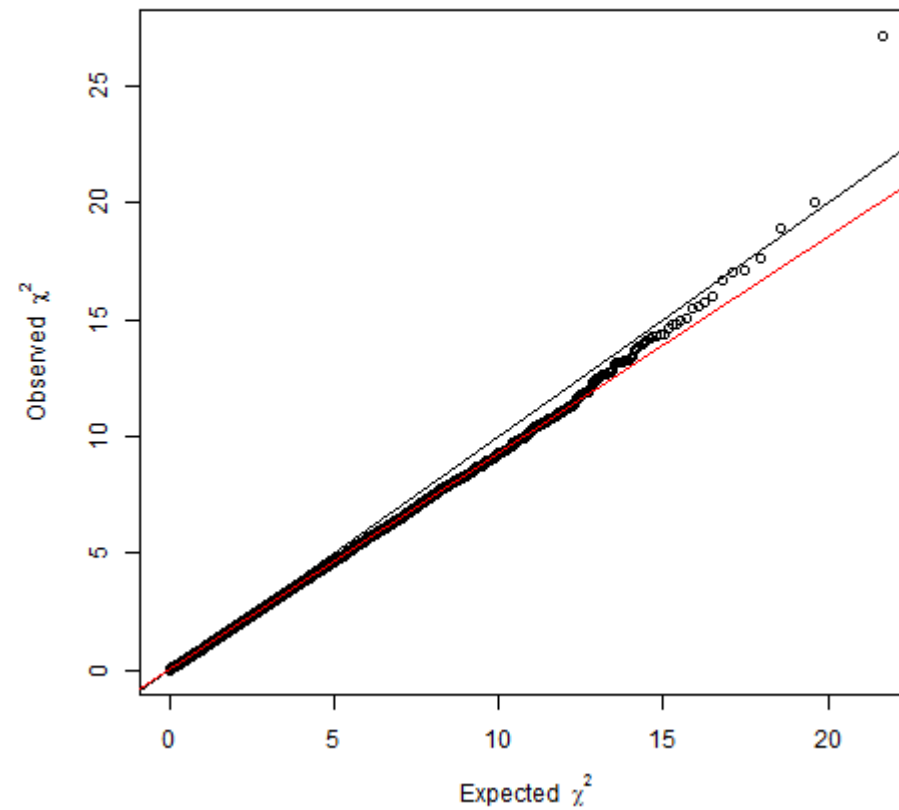
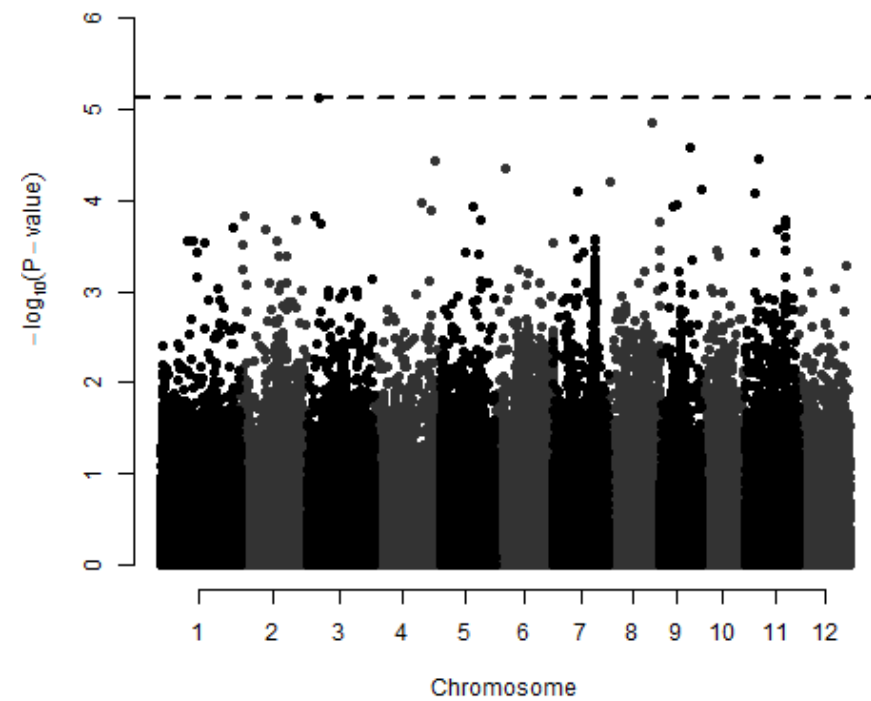
# All genotypes - $\text{FWDW}_{\text{HT}}$



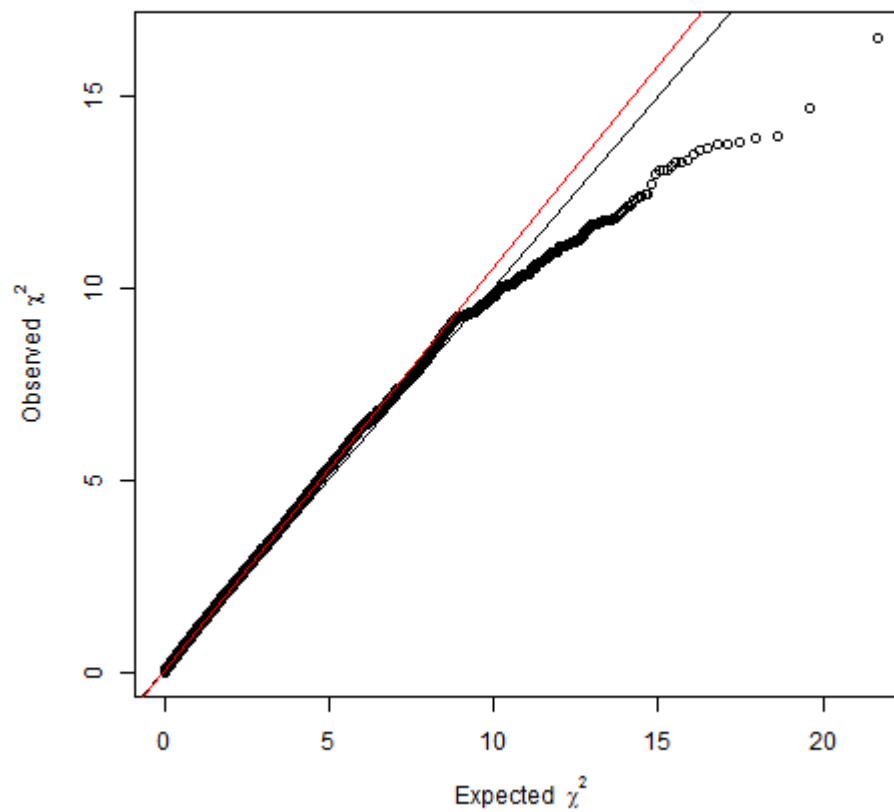
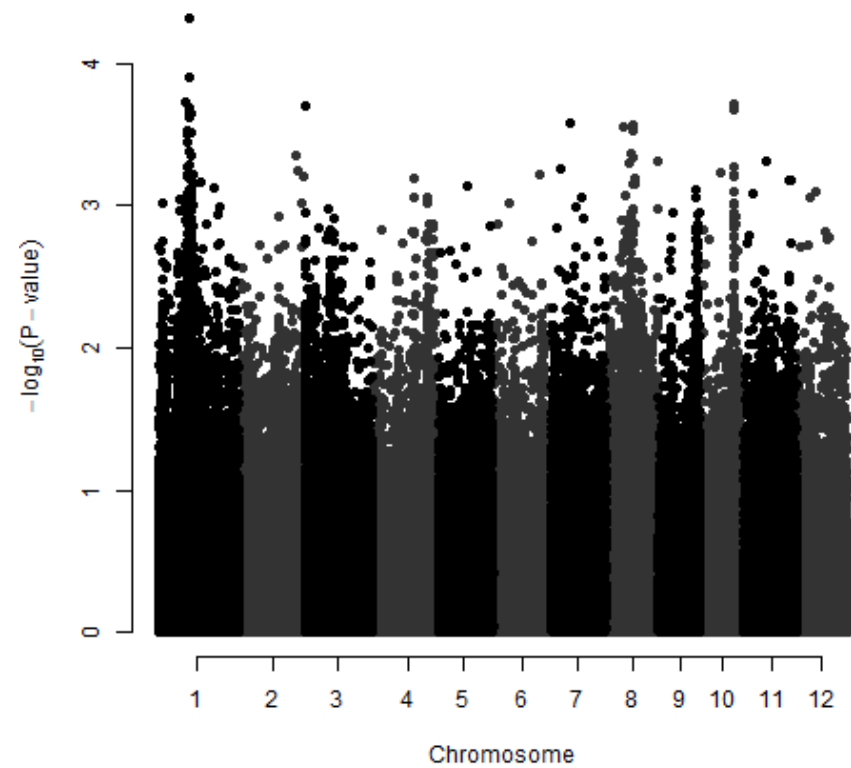
# Indica- FWDW<sub>HT</sub>



# Japonica - FWDW<sub>HT</sub>

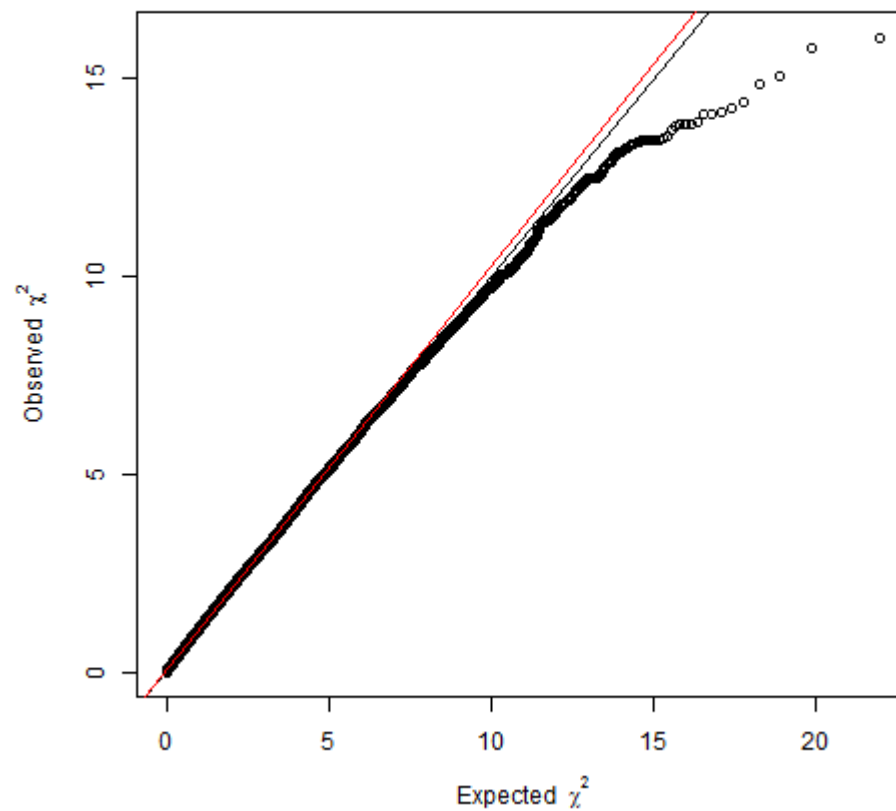
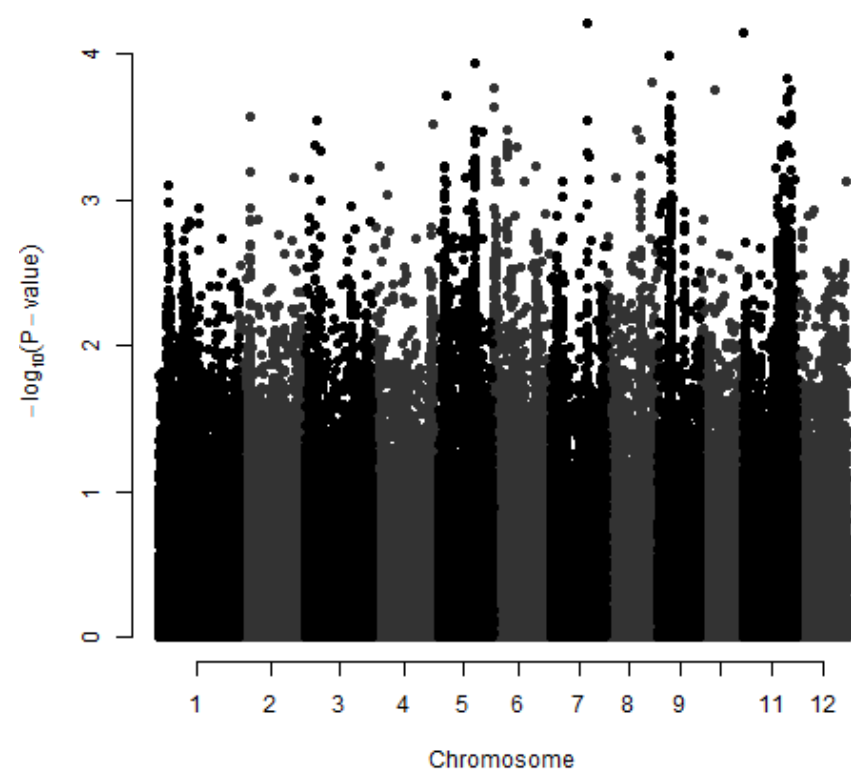


aus - FWDW<sub>HT</sub>

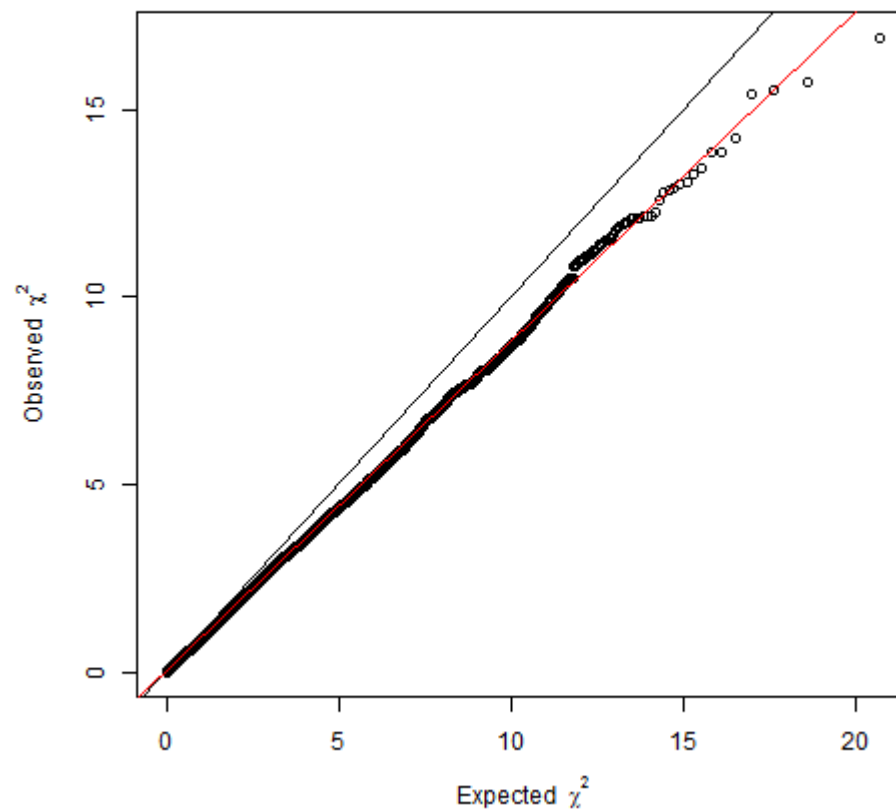
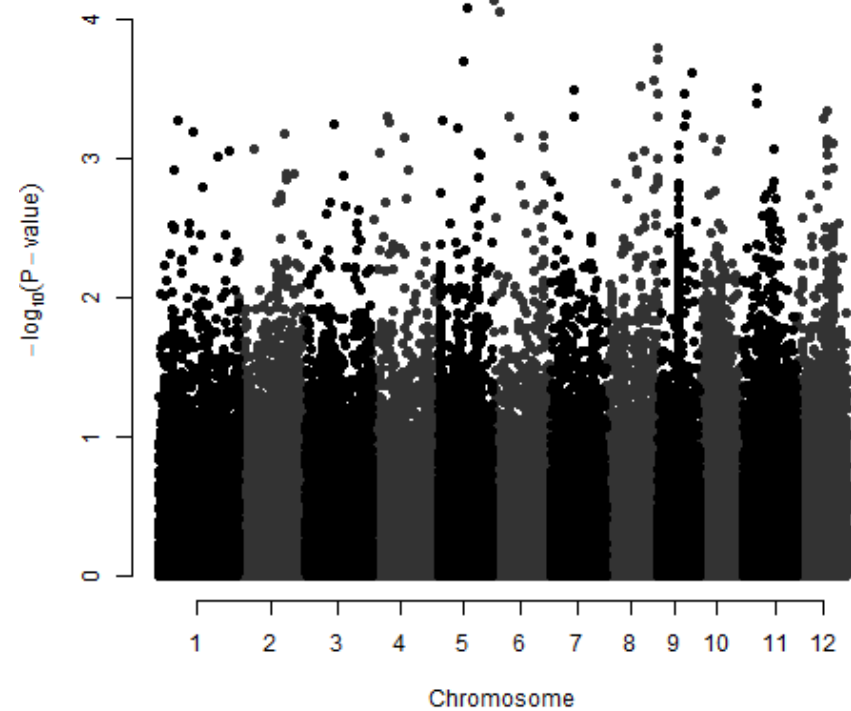




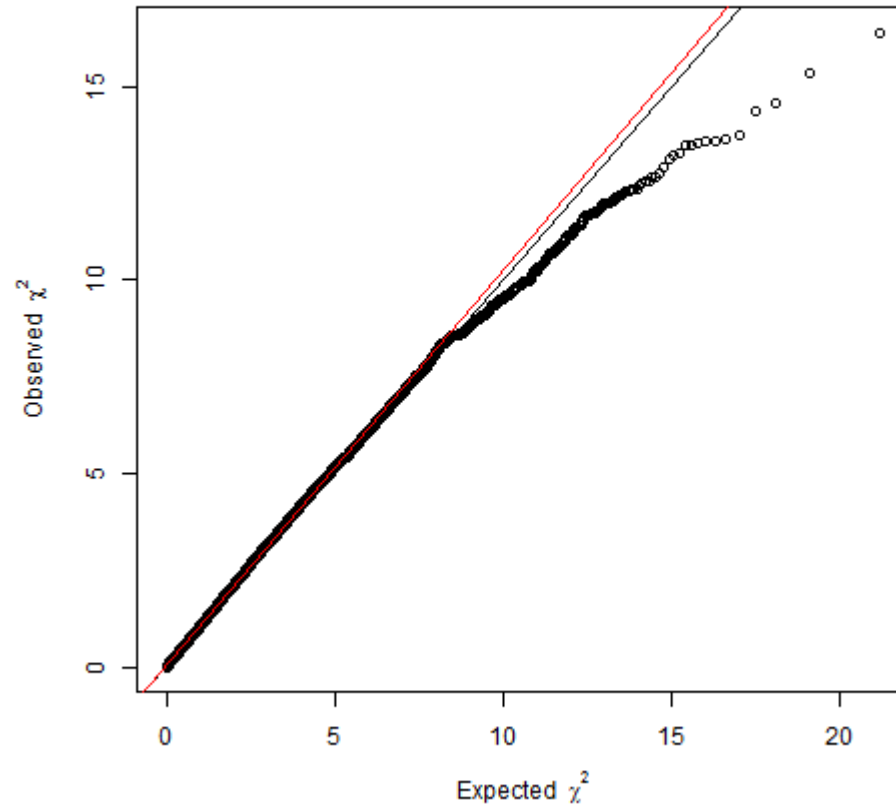
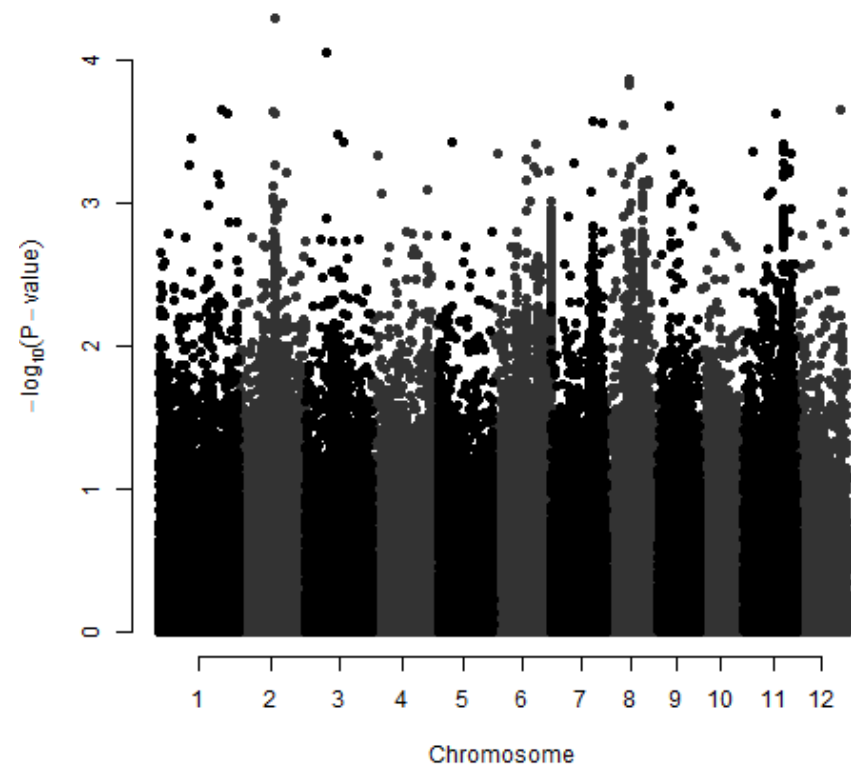
indica - FWDW<sub>HT</sub>



# temperate japonica - FWDW<sub>HT</sub>



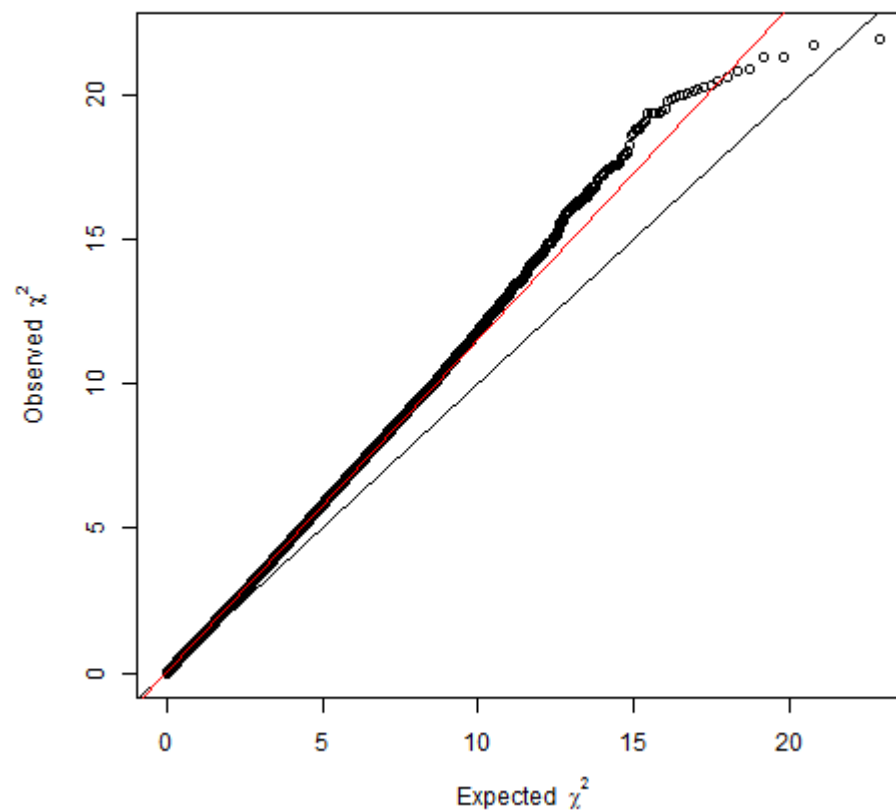
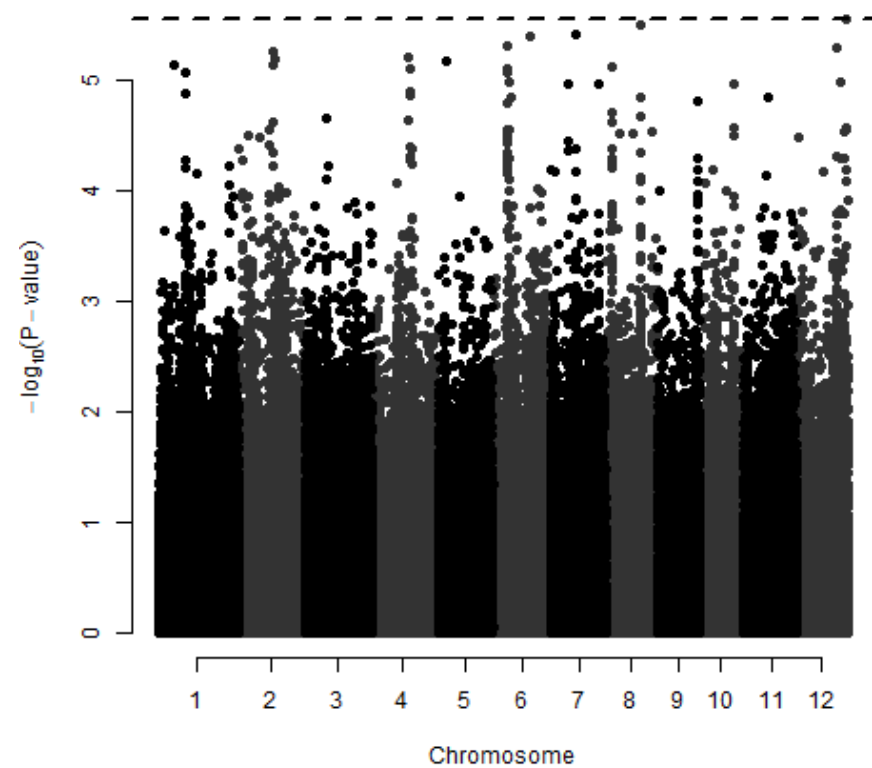
# tropical japonica - $\text{FWDW}_{\text{HT}}$



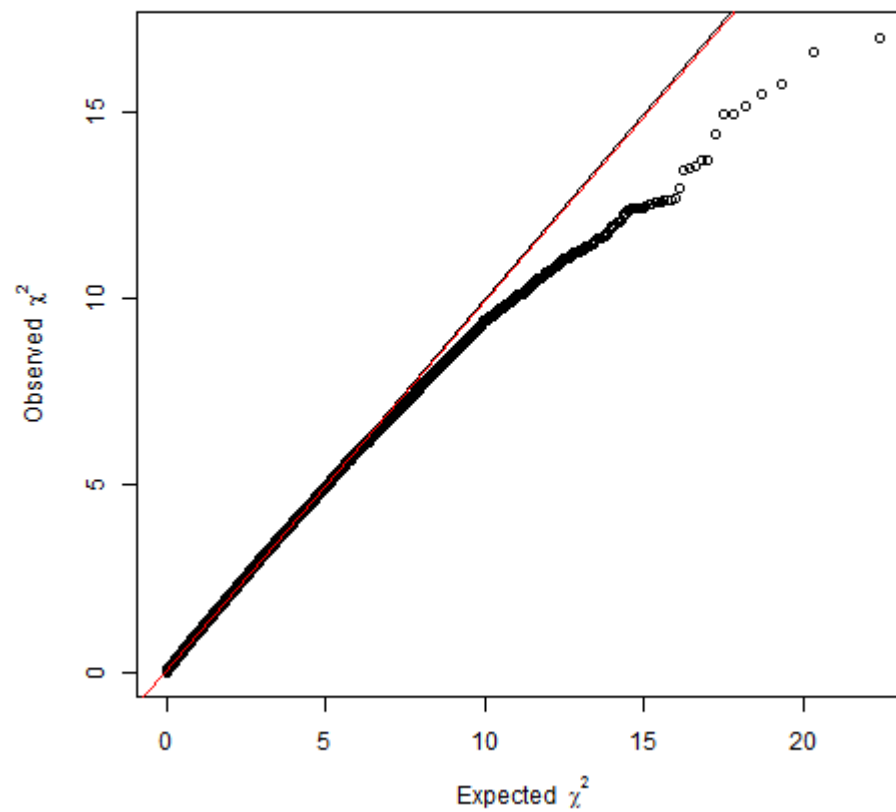
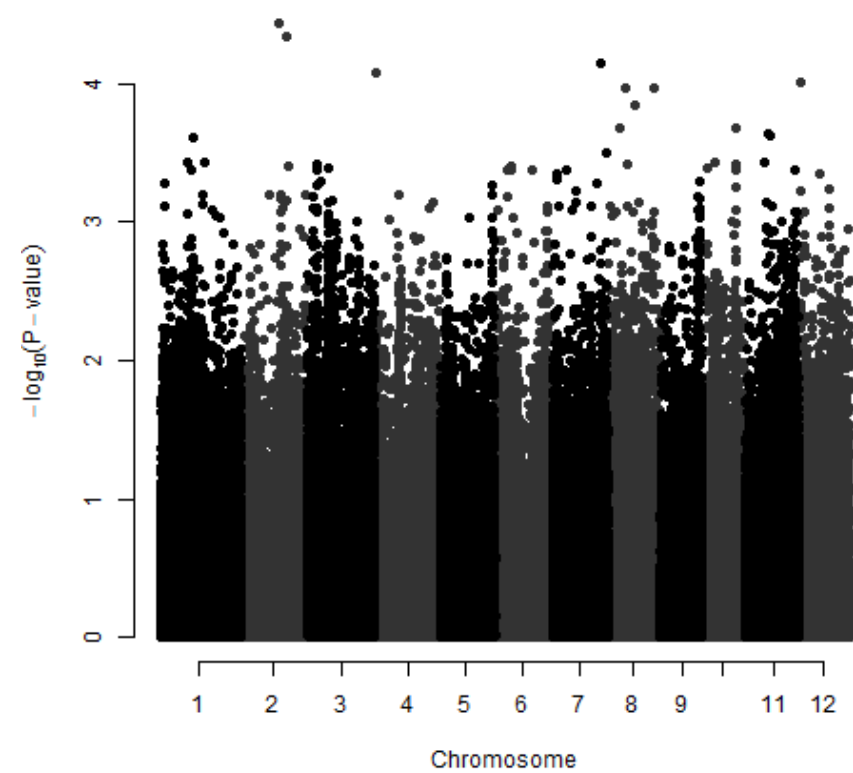
$$FWDW_{LT}$$

Fresh weight dry weight in the low treatment

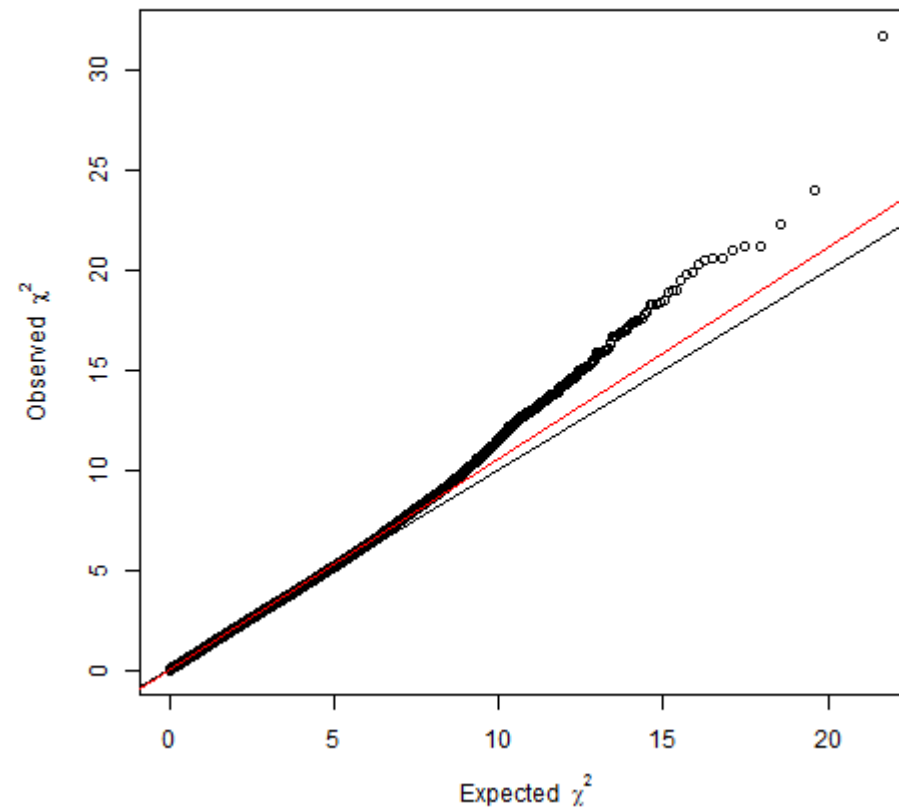
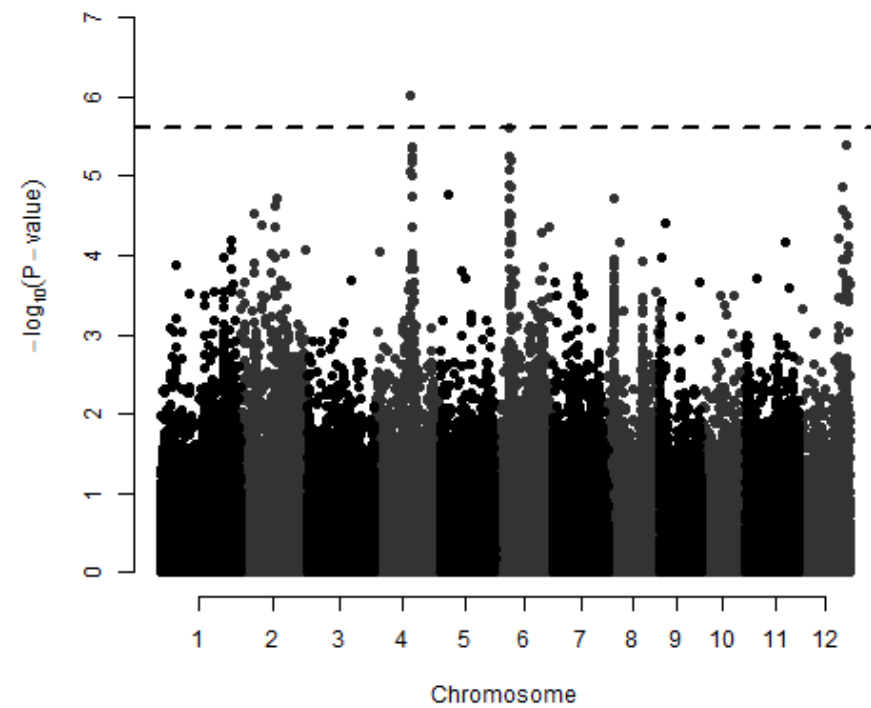
# All genotypes - FWDW<sub>LT</sub>



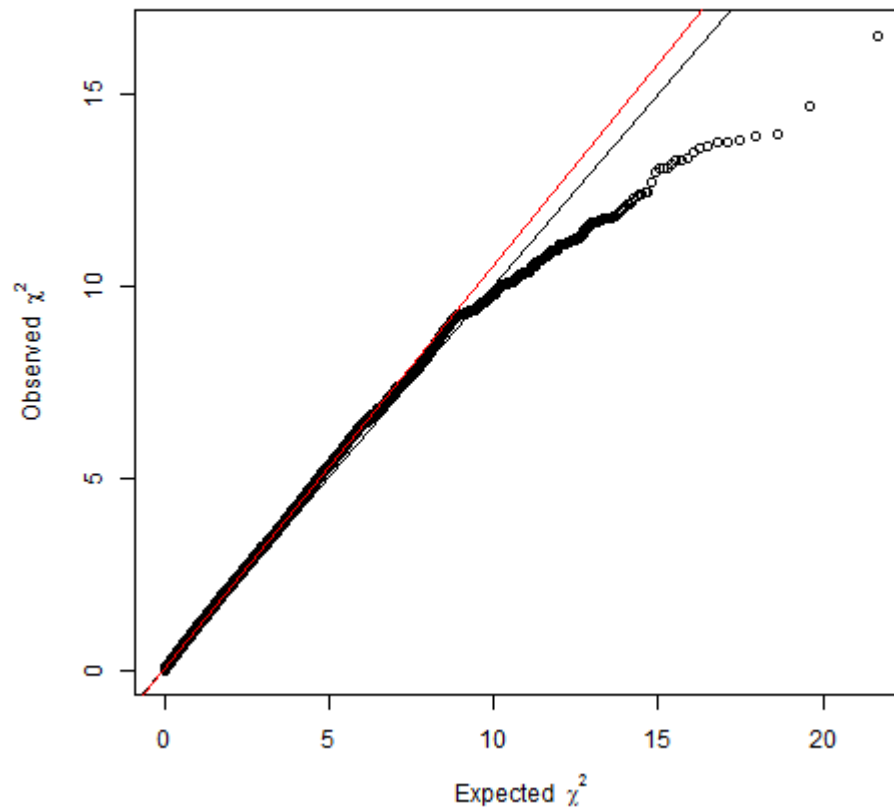
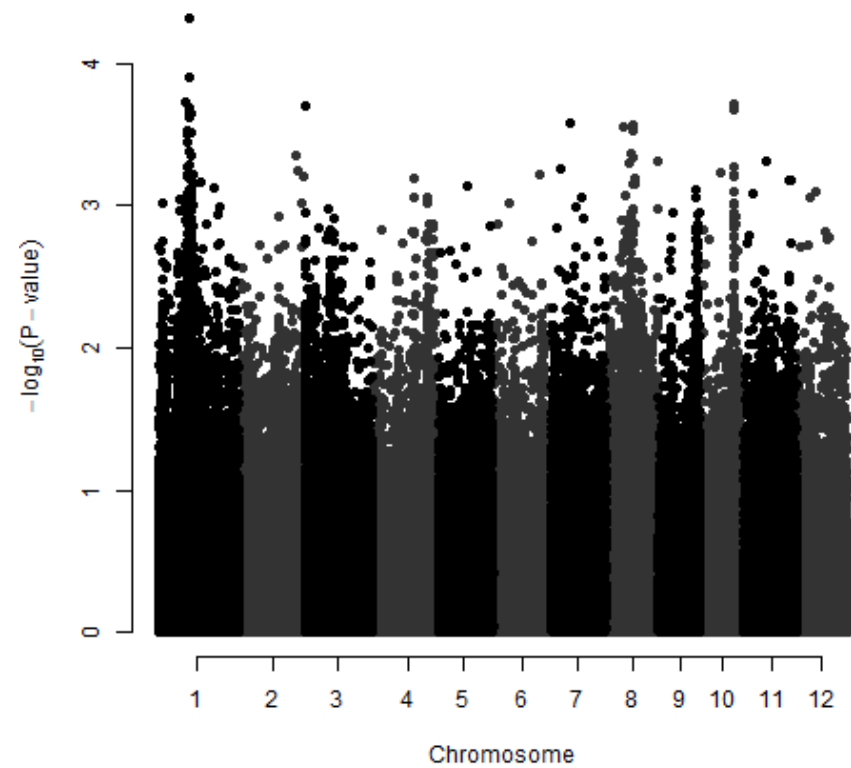
# Indica - FWDW<sub>LT</sub>



# Japonica - FWDW<sub>LT</sub>

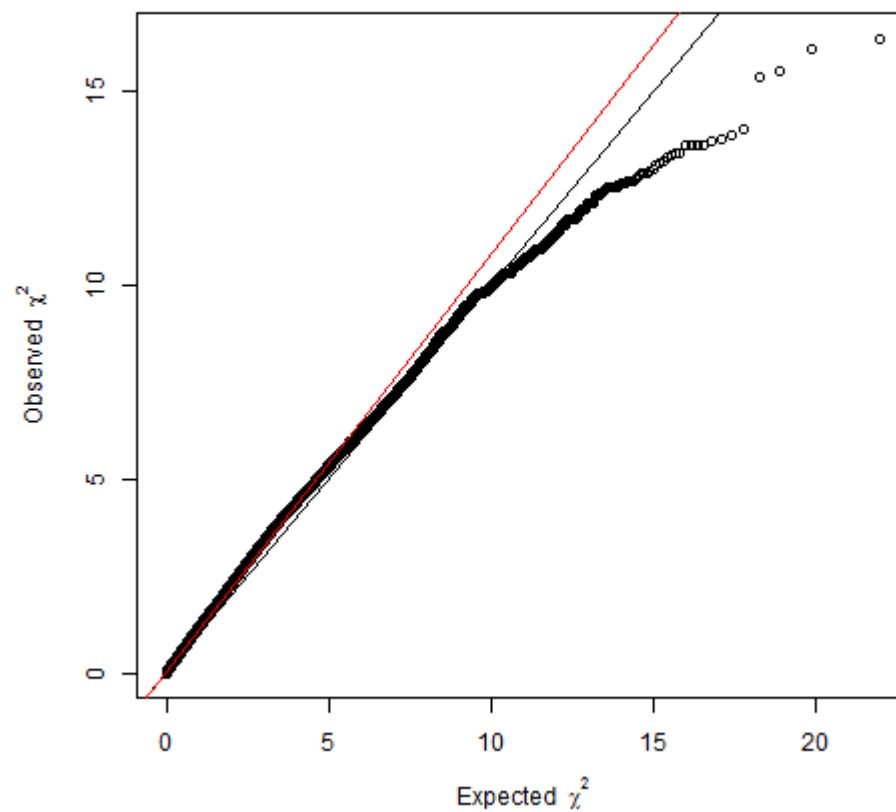
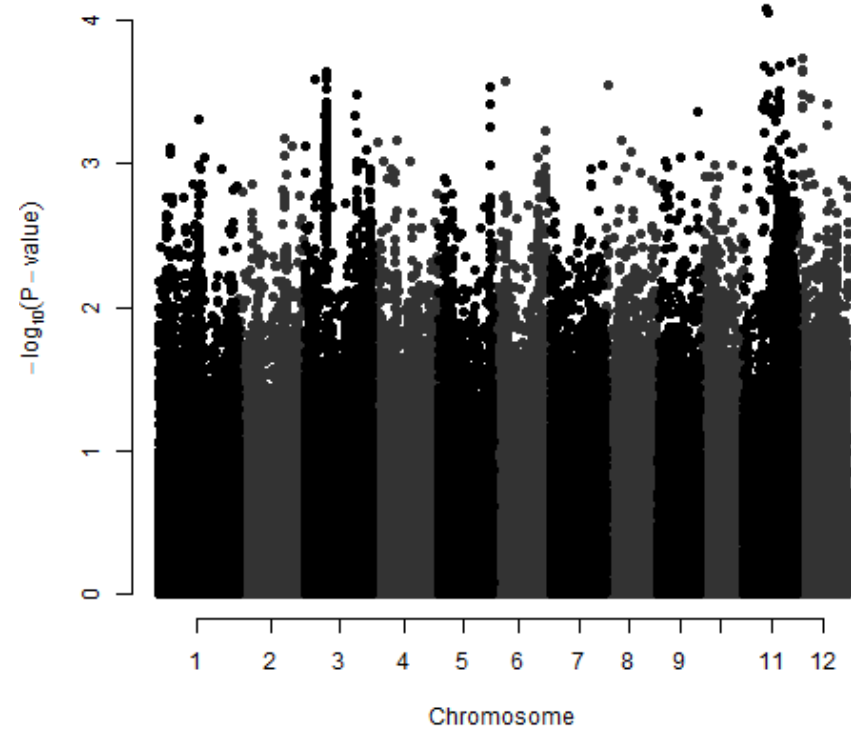


aus - FWDW<sub>LT</sub>

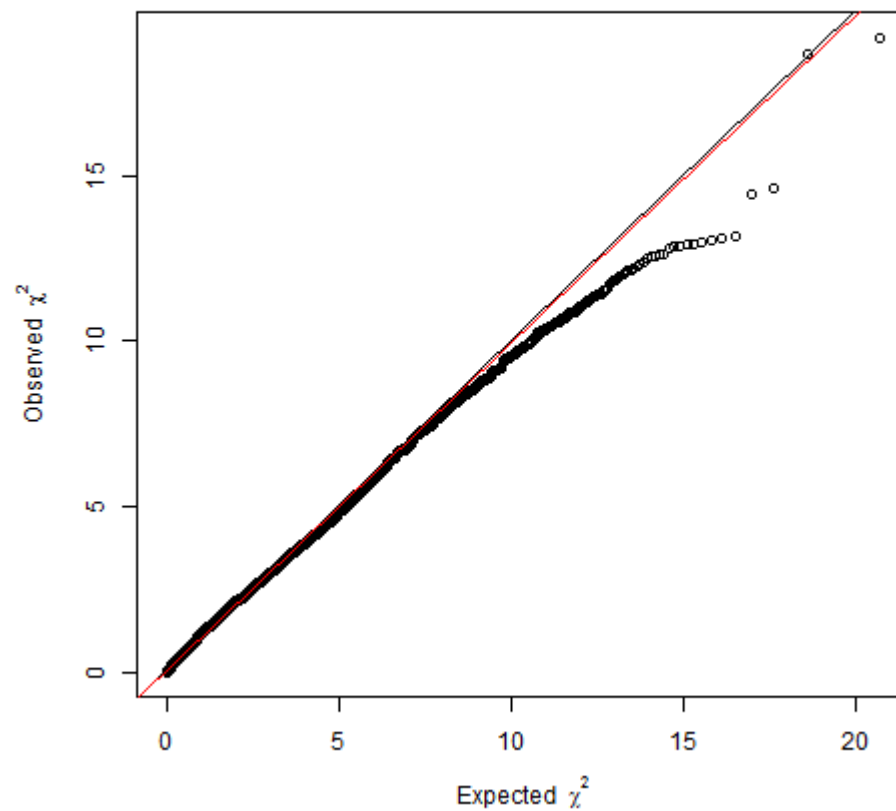
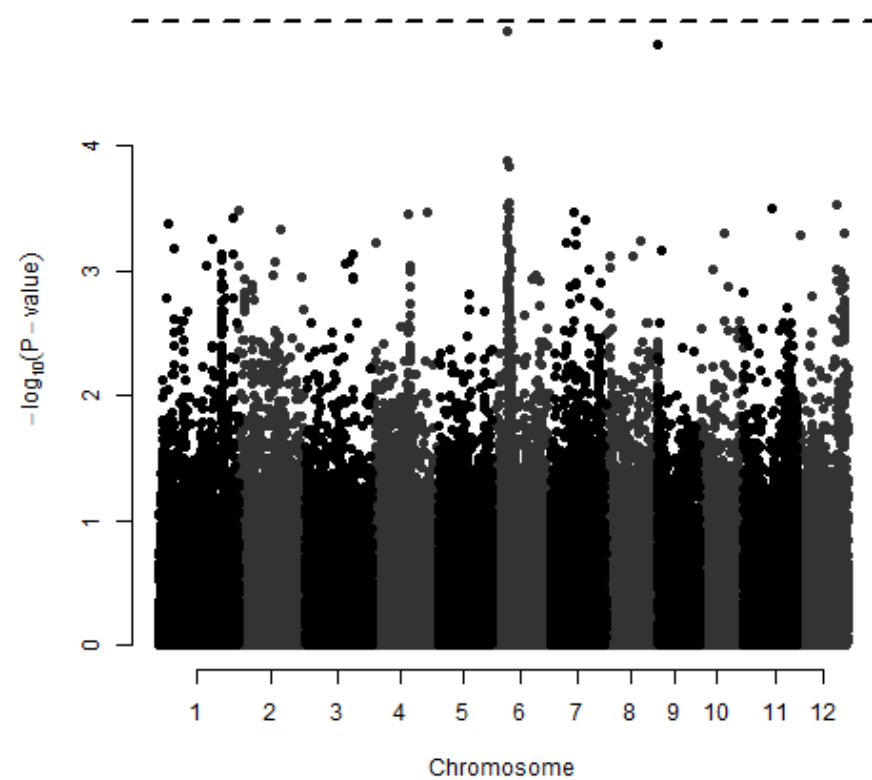




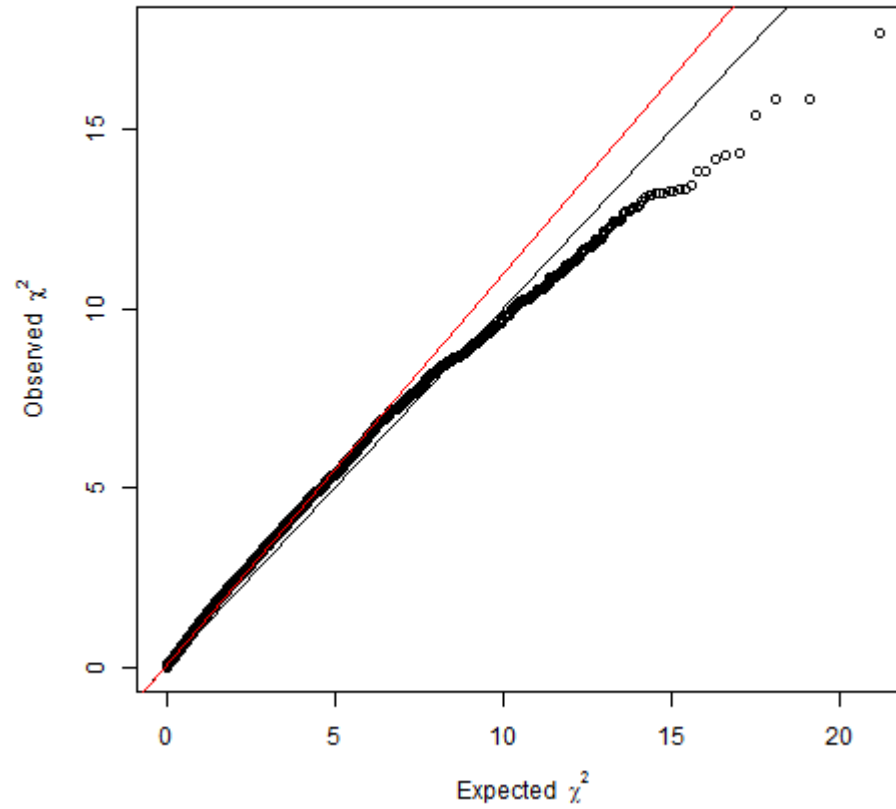
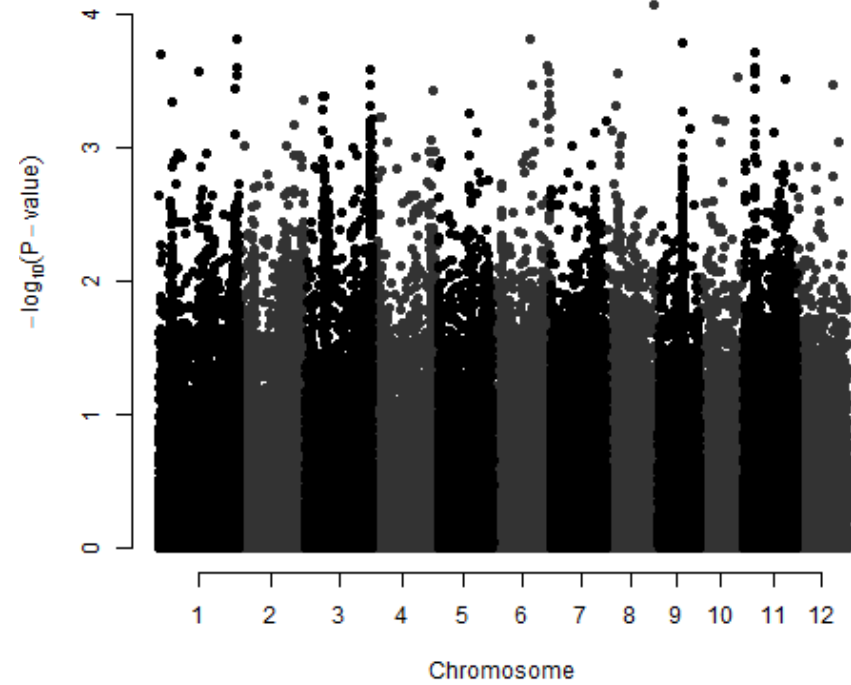
indica - FWDW<sub>LT</sub>



# temperate japonica - FWDW<sub>LT</sub>



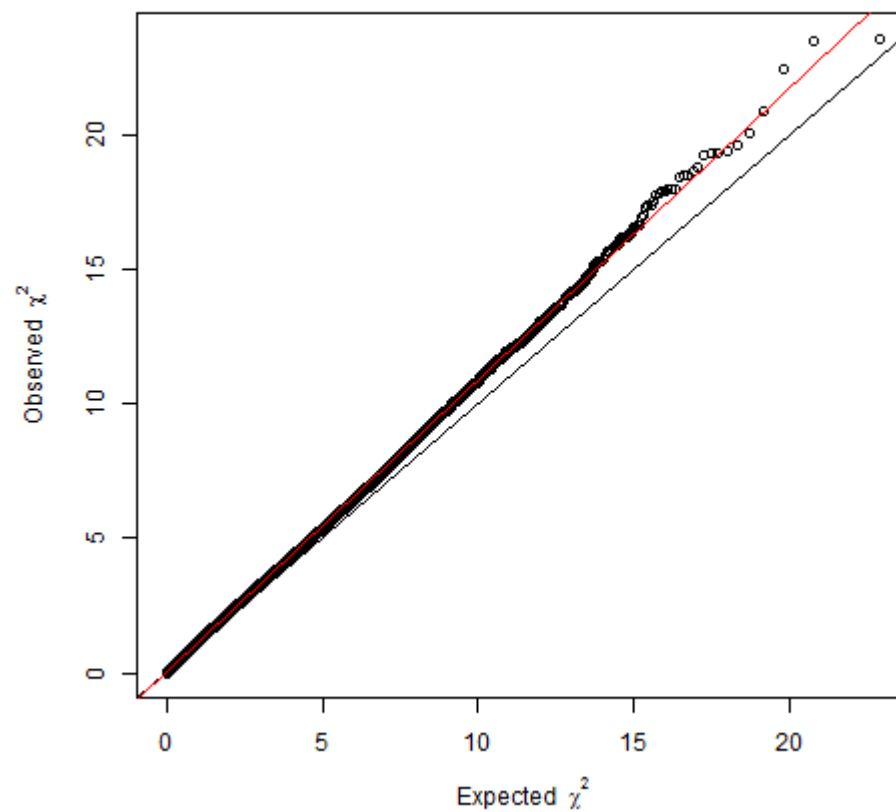
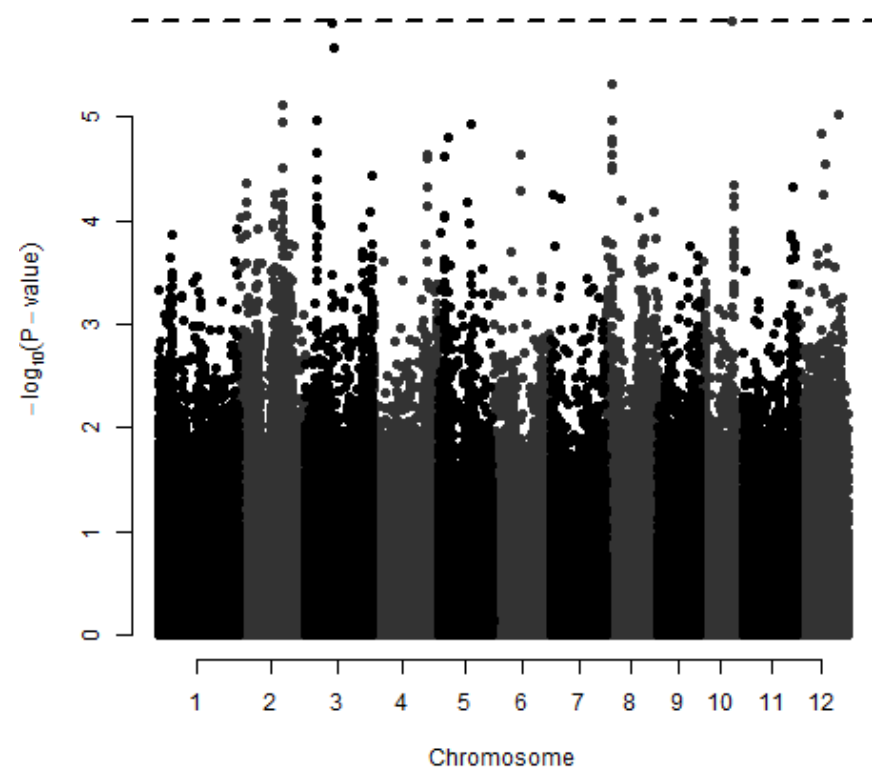
# tropical japonica - FWDW<sub>LT</sub>



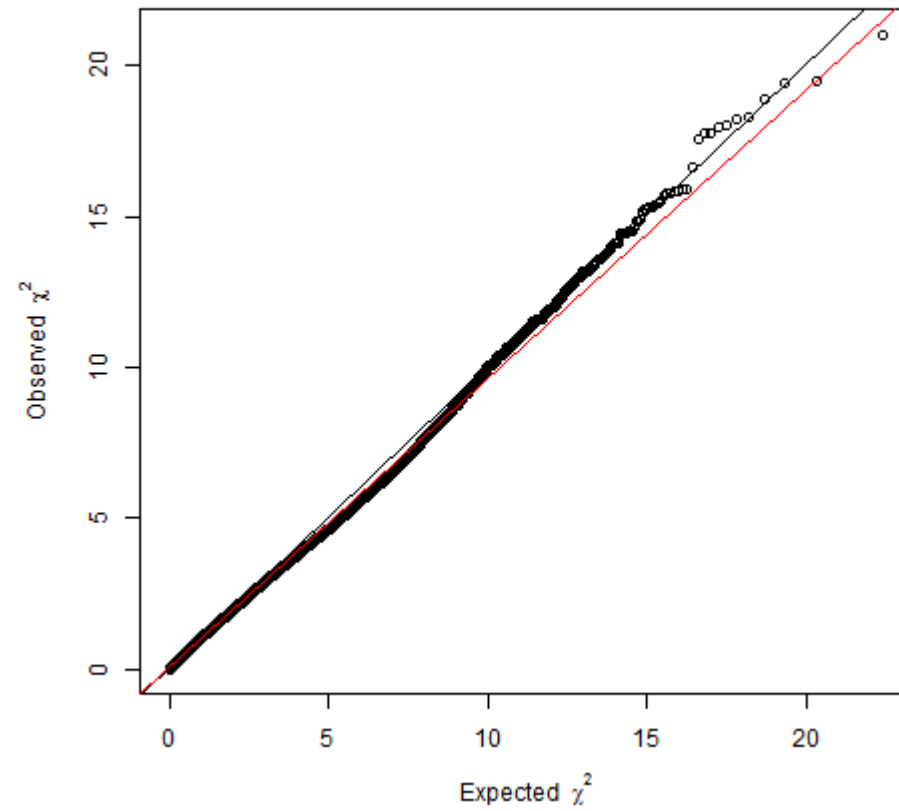
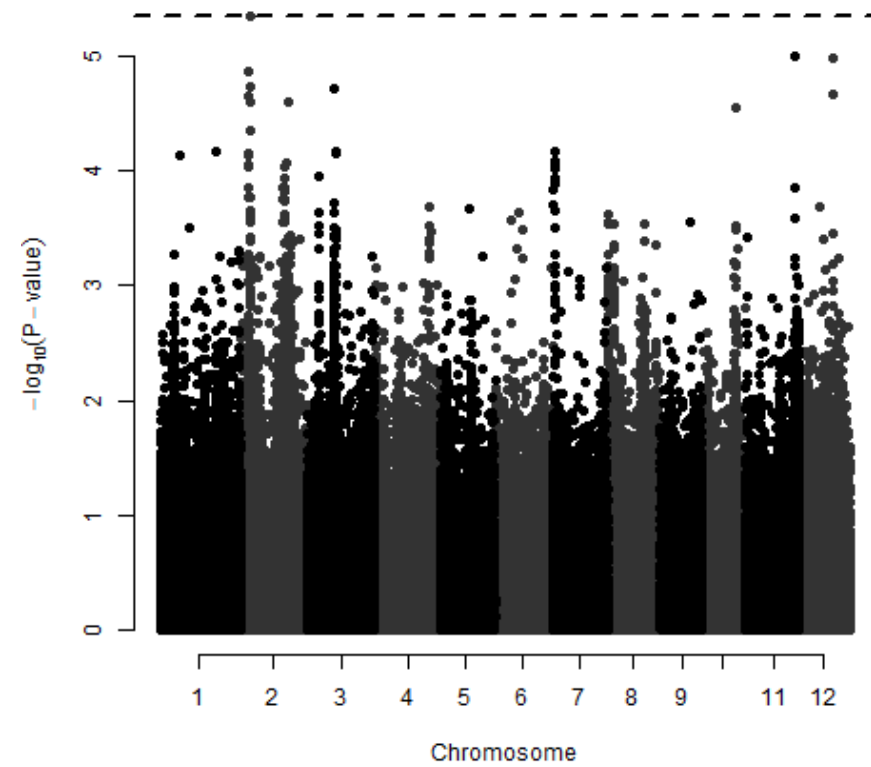
$$\text{KDI}_{\text{HT}}$$

Potassium distribution index in the high treatment

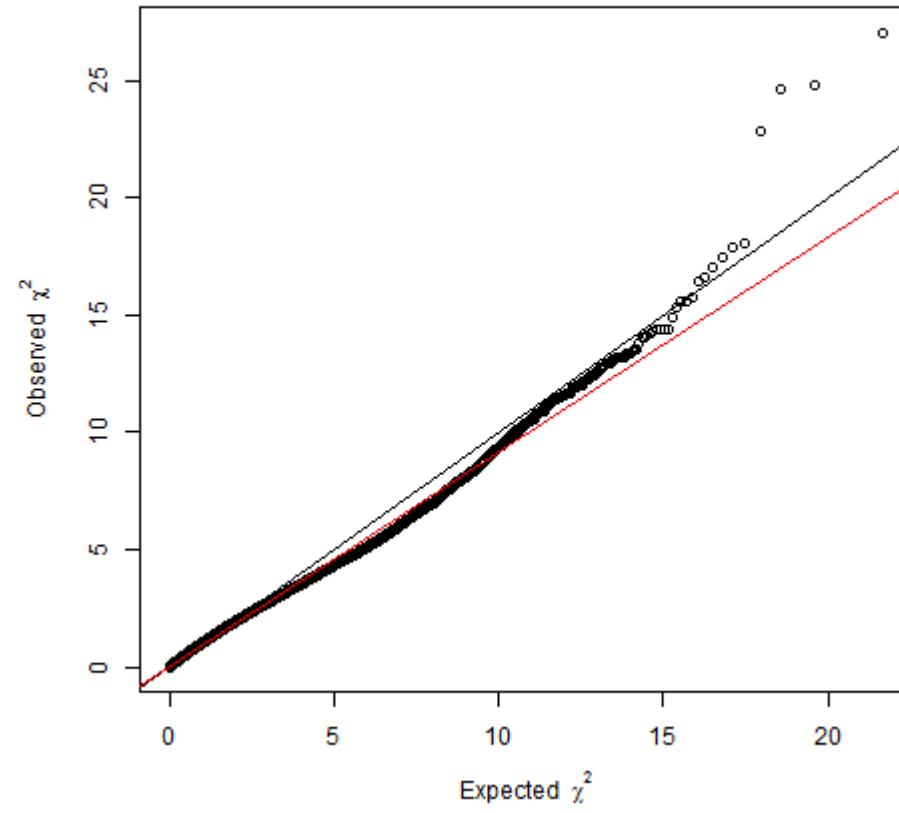
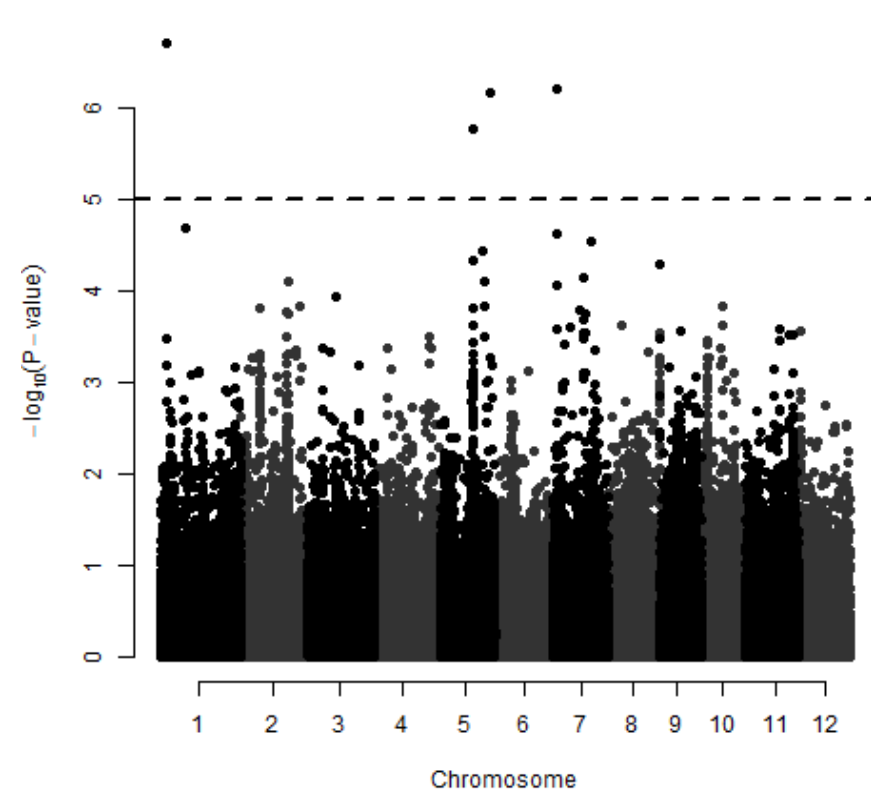
# All genotypes - $KDI_{HT}$



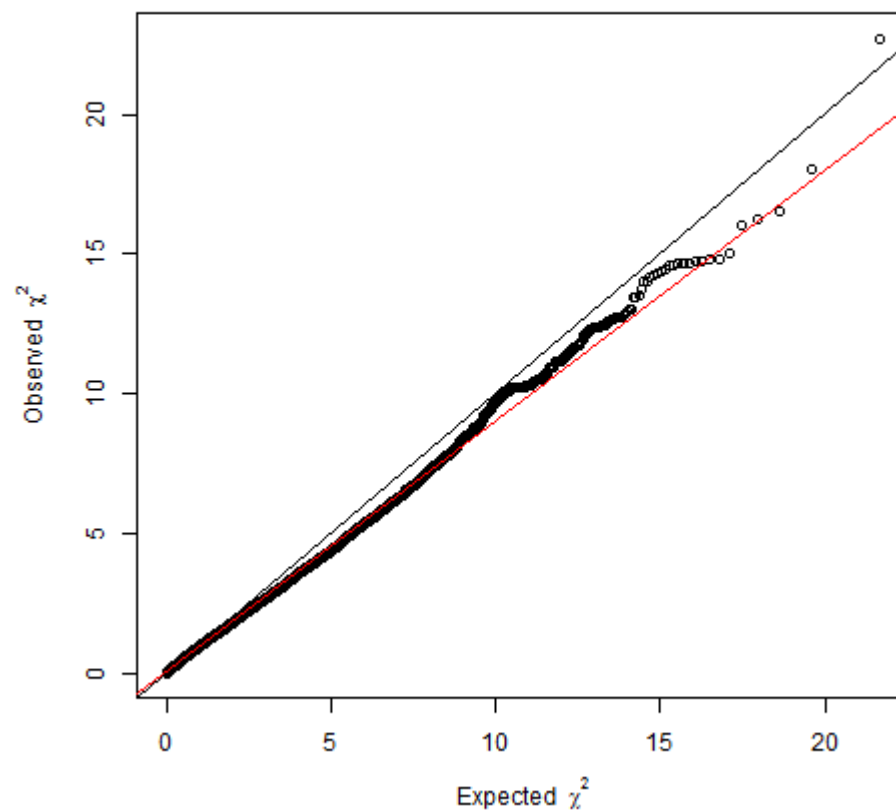
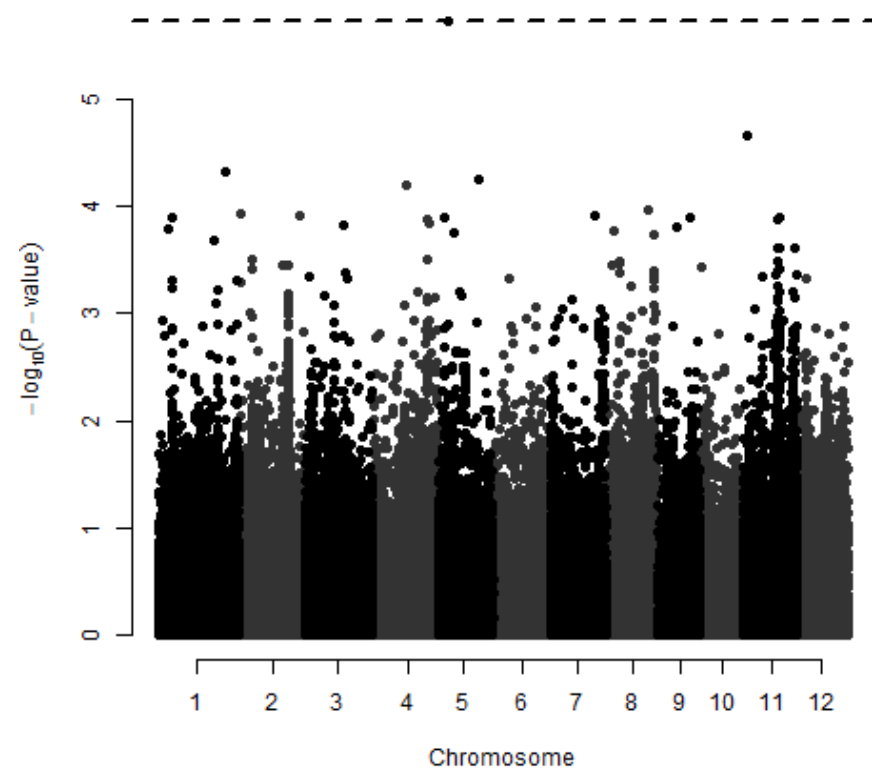
# Indica - $KDI_{HT}$



# Japonica - $KDI_{HT}$

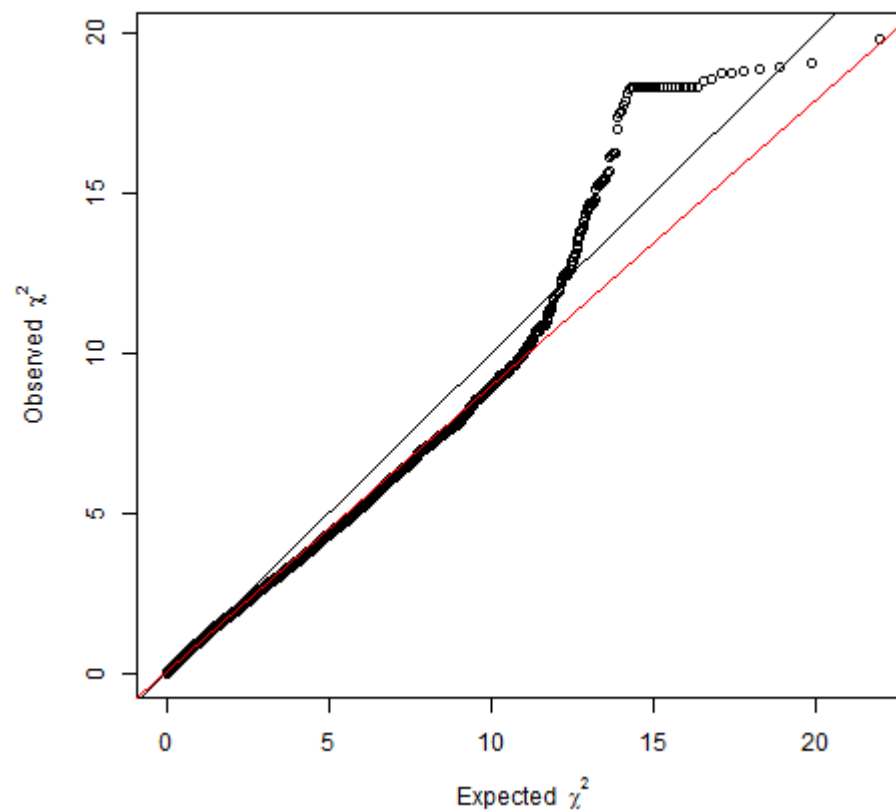
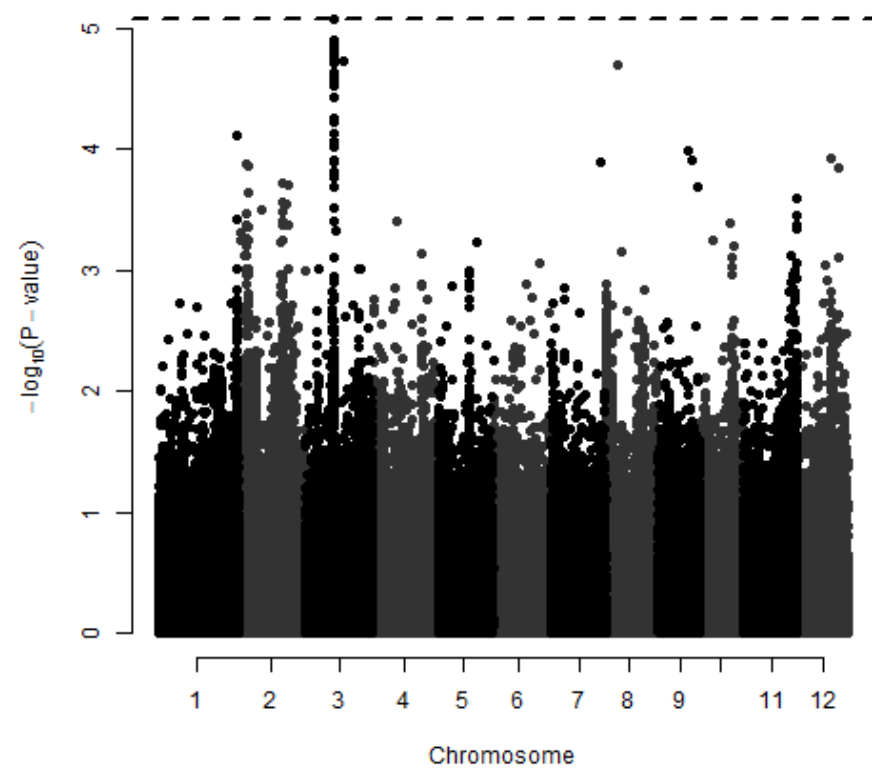


aus -  $\text{KDI}_{\text{HT}}$

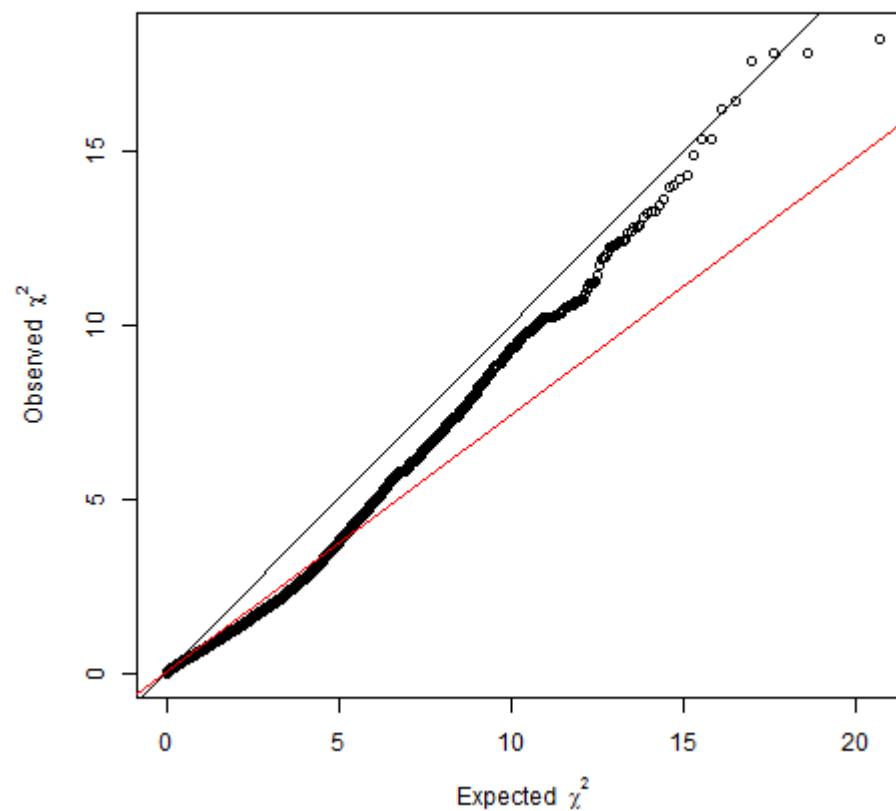
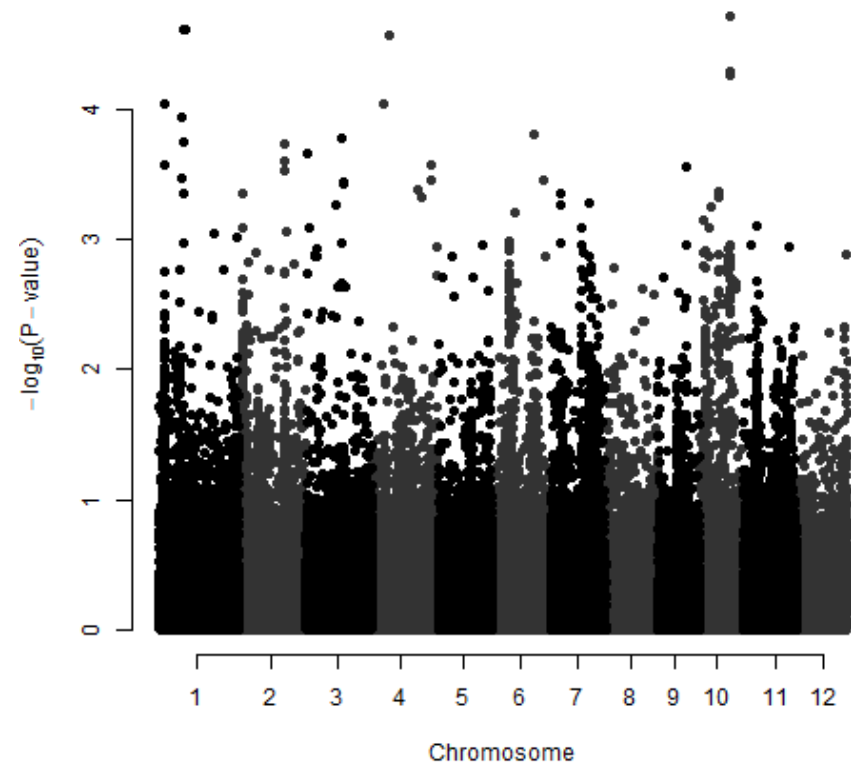




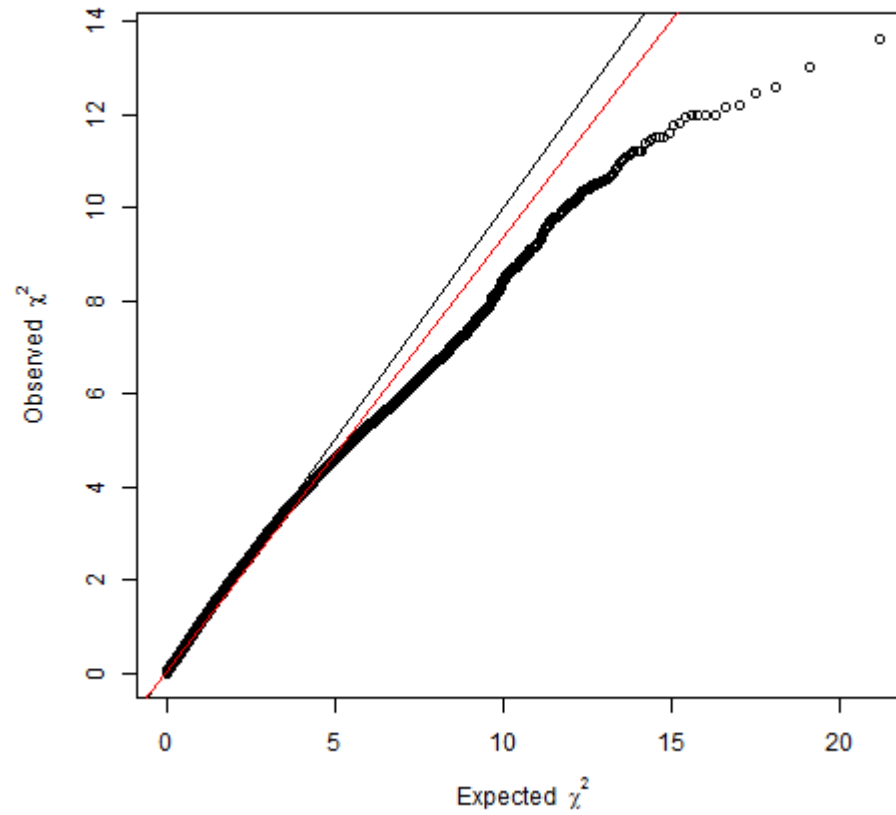
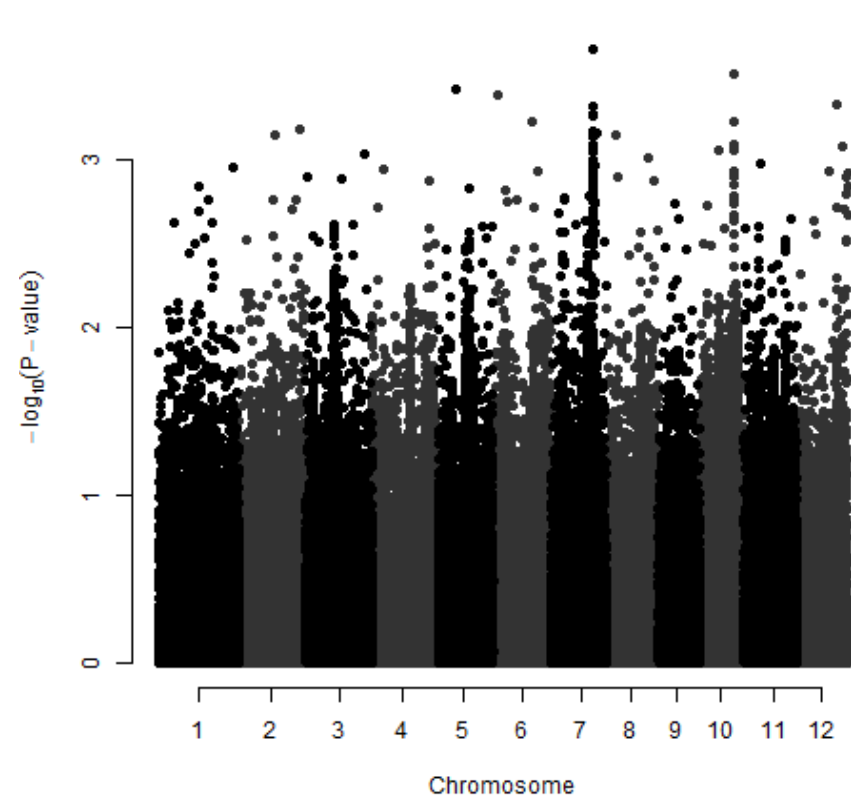
indica -  $KDI_{HT}$



# temperate japonica - $KDI_{HT}$



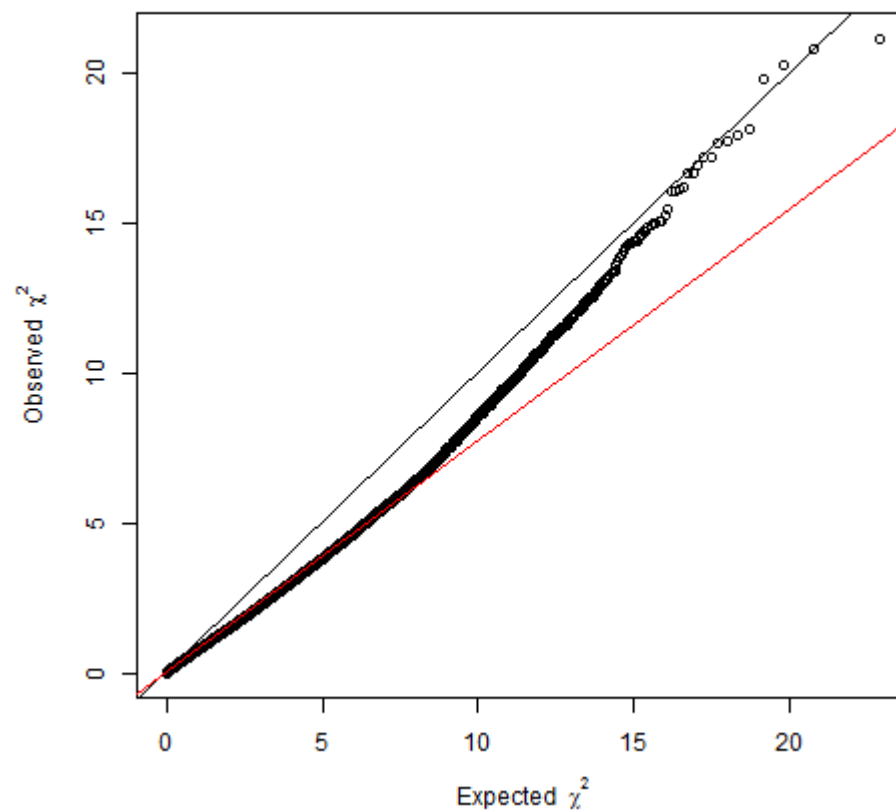
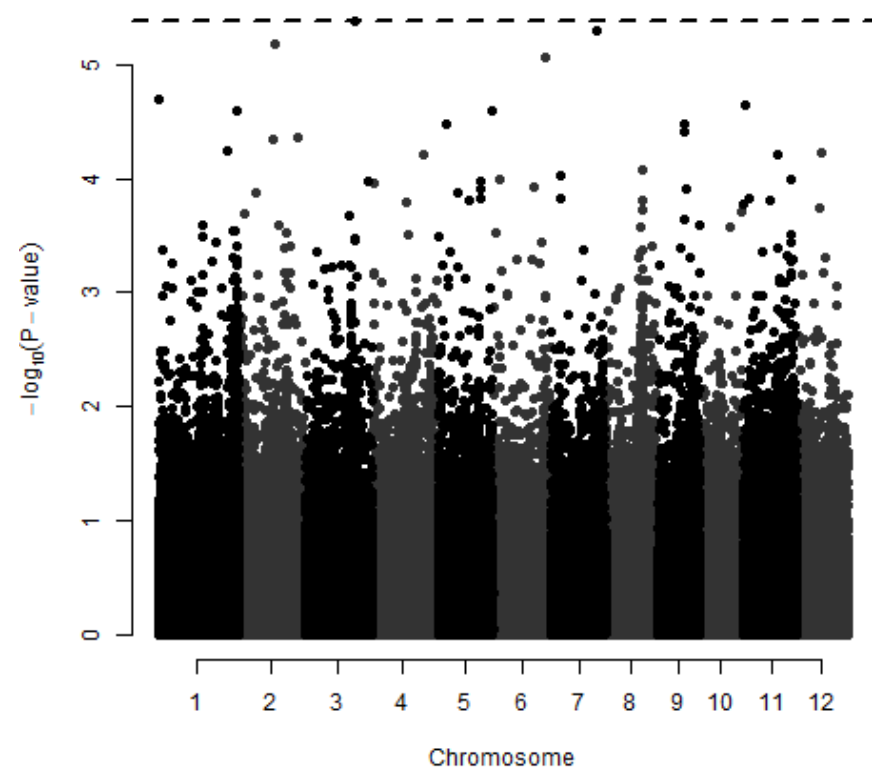
# tropical japonica - $KDI_{HT}$



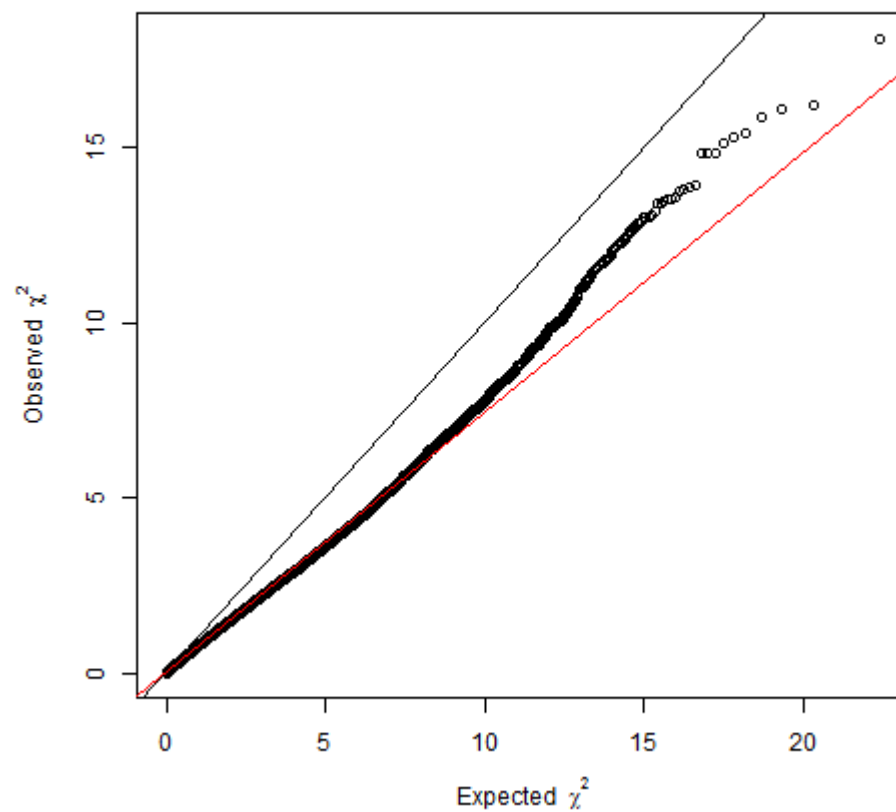
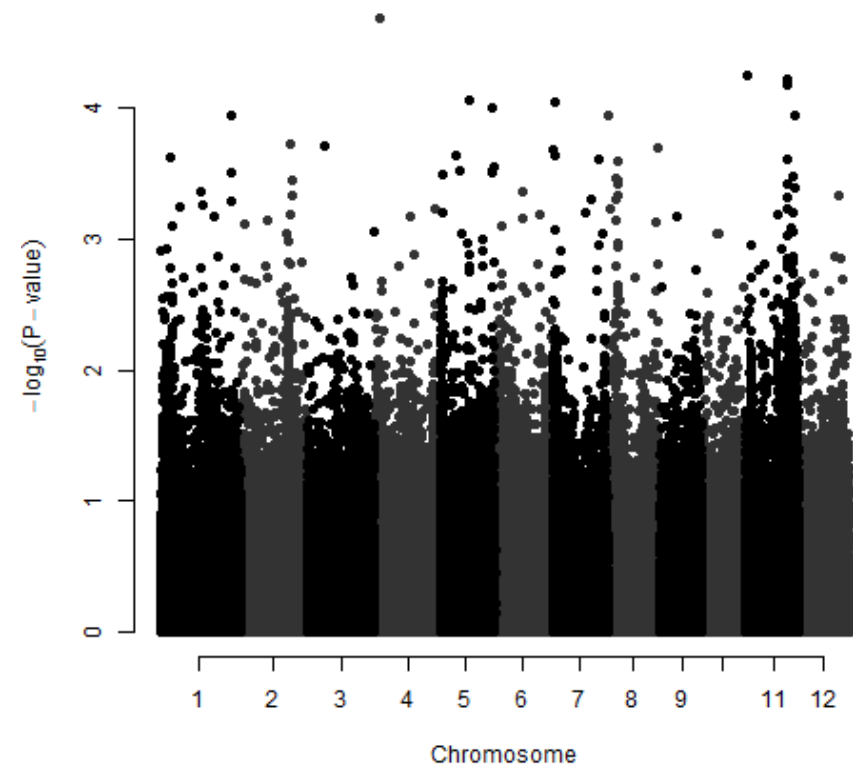
$$\text{KDI}_{\text{LT}}$$

Potassium distribution index in the low treatment

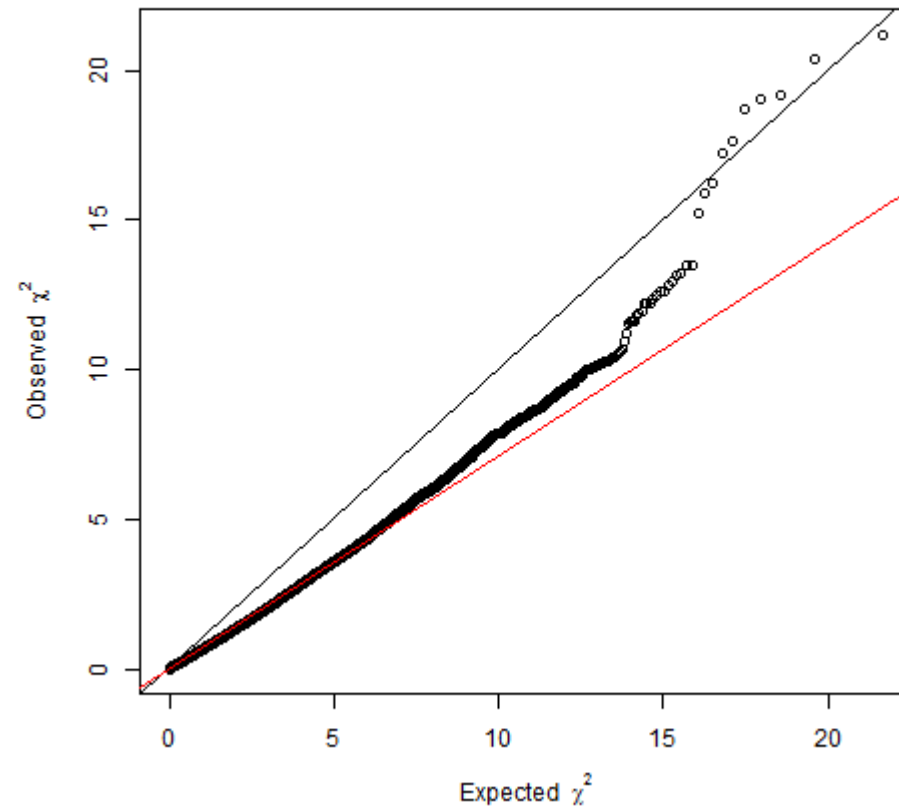
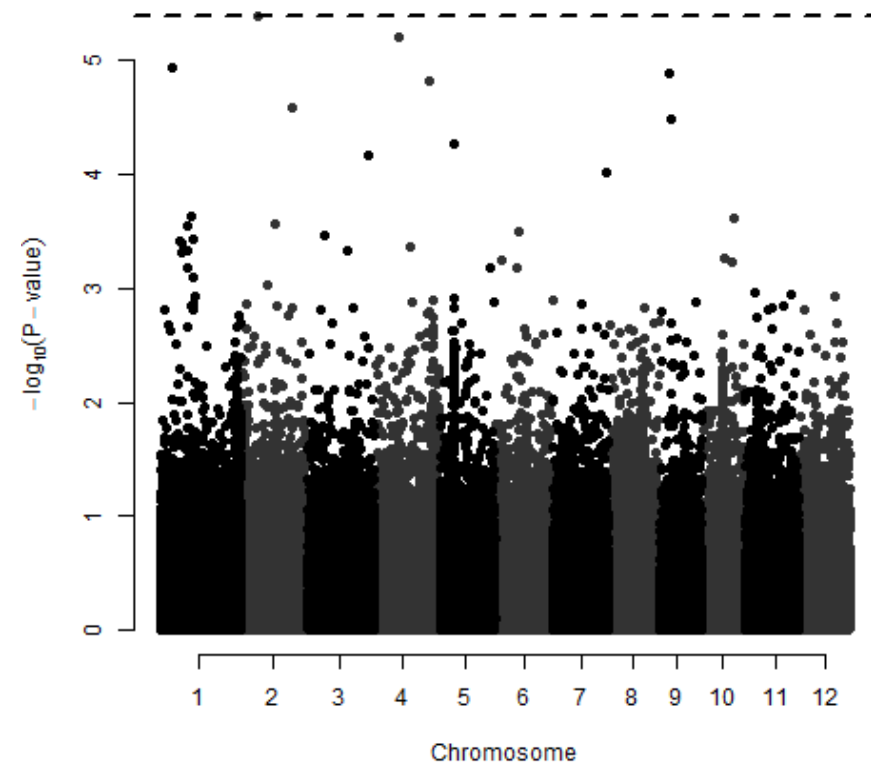
# All genotypes - $KDI_{LT}$



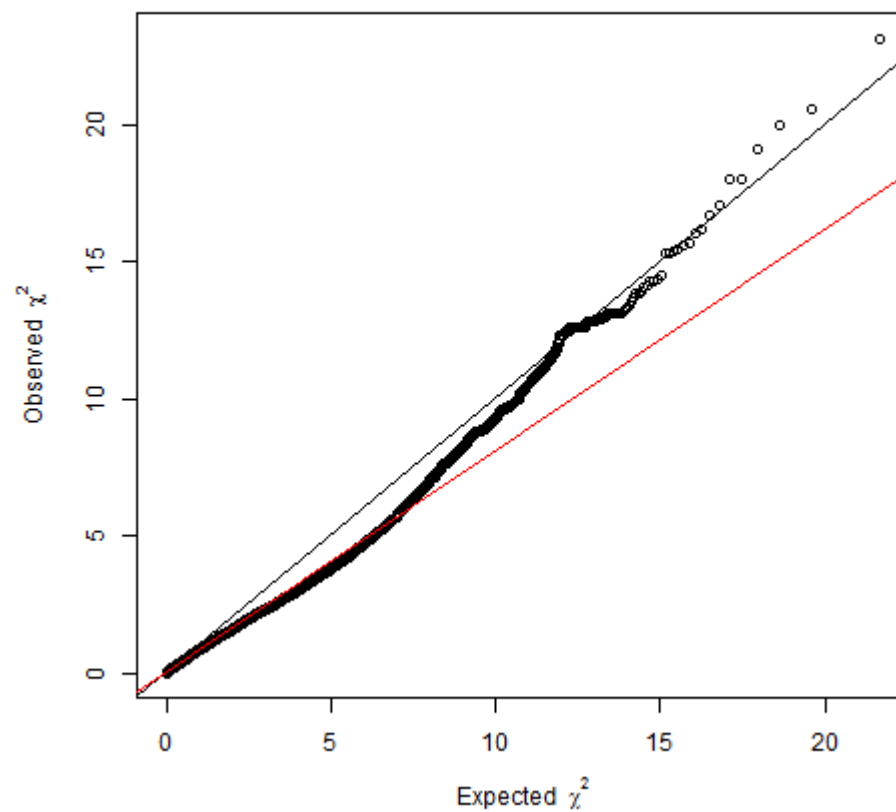
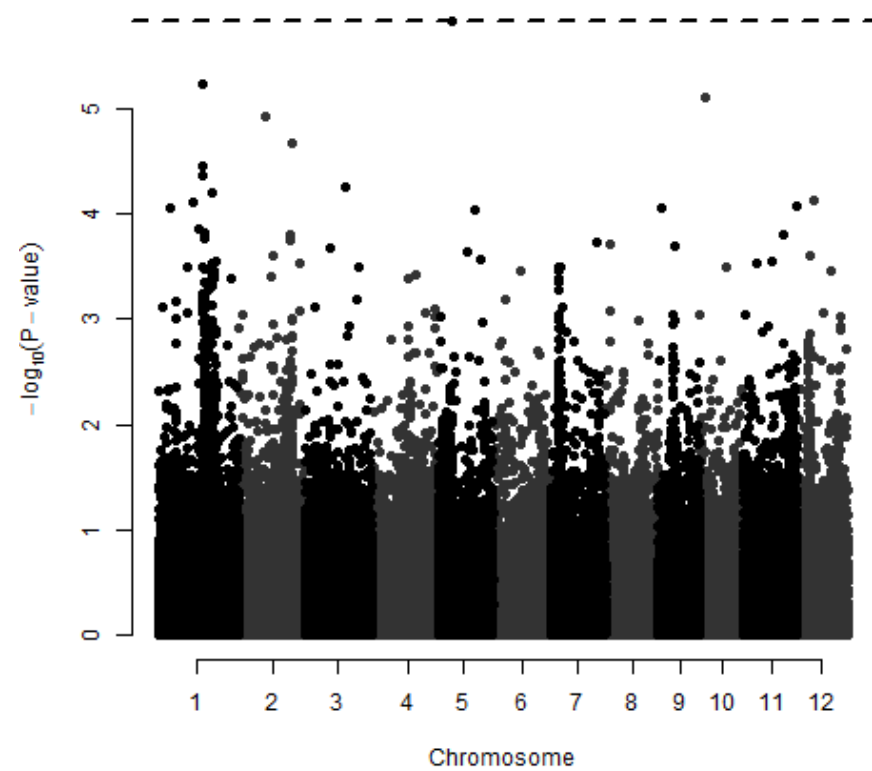
# Indica - $KDI_{LT}$



# Japonica - KDI<sub>LT</sub>

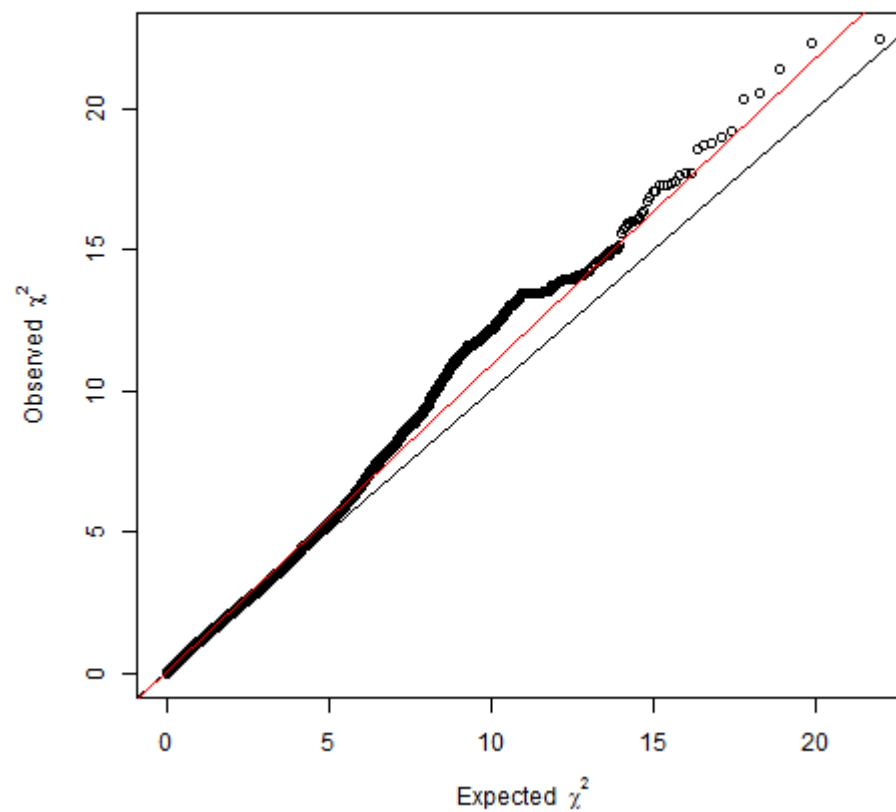
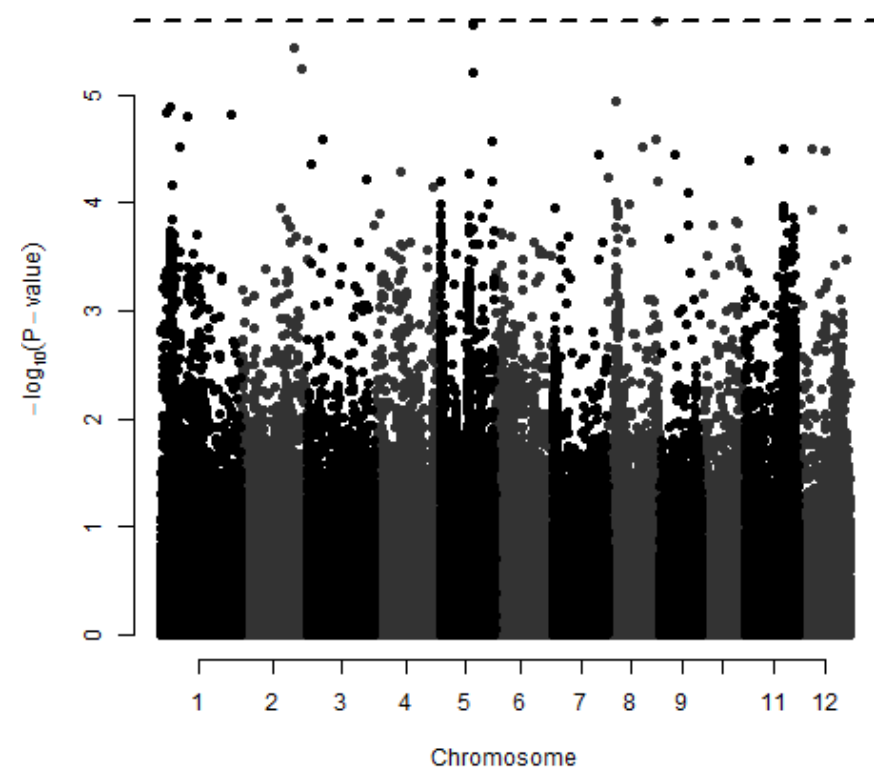


aus -  $\text{KDI}_{\text{LT}}$

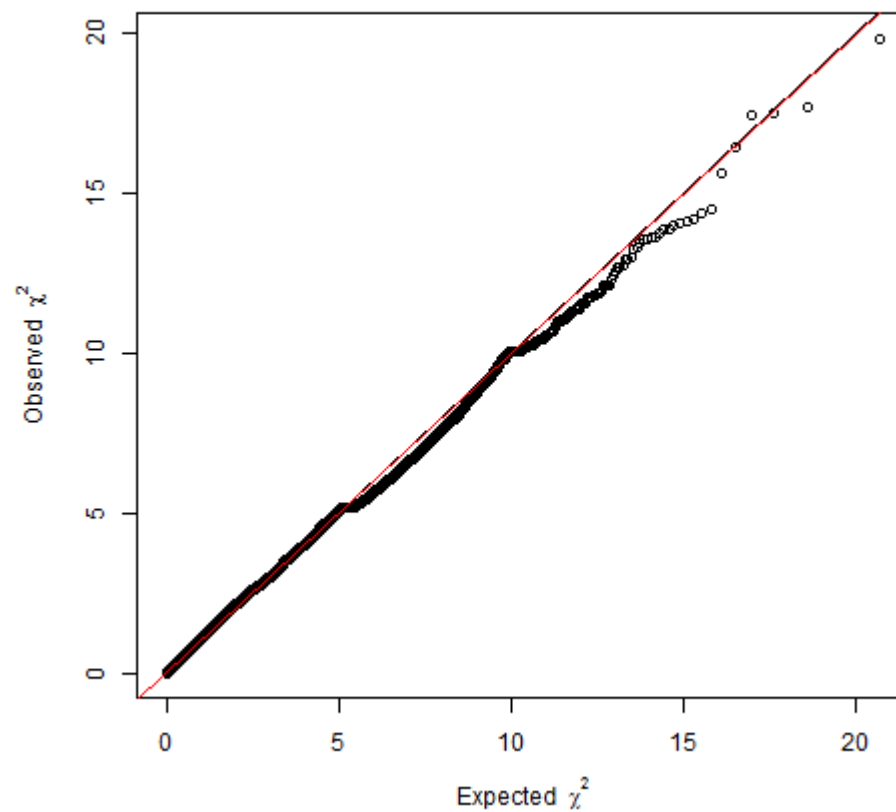
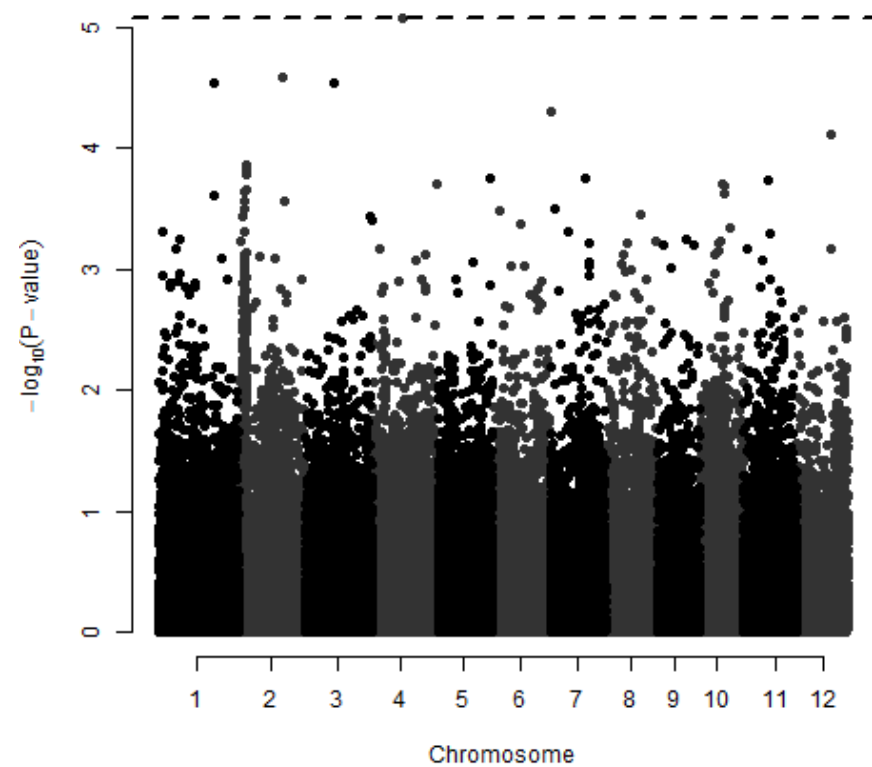




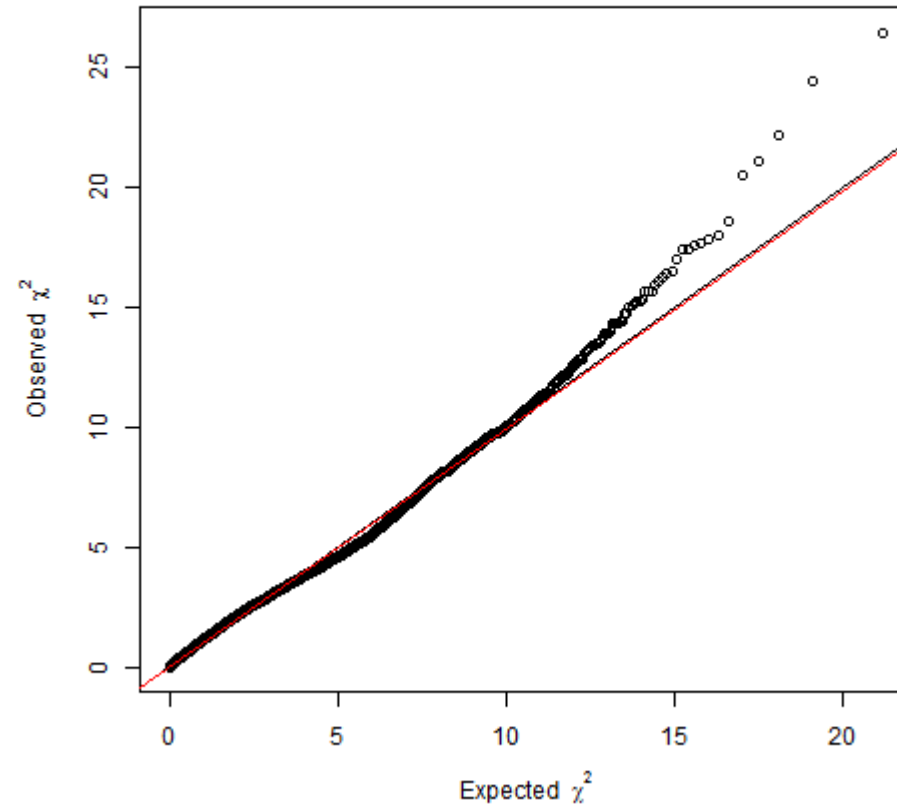
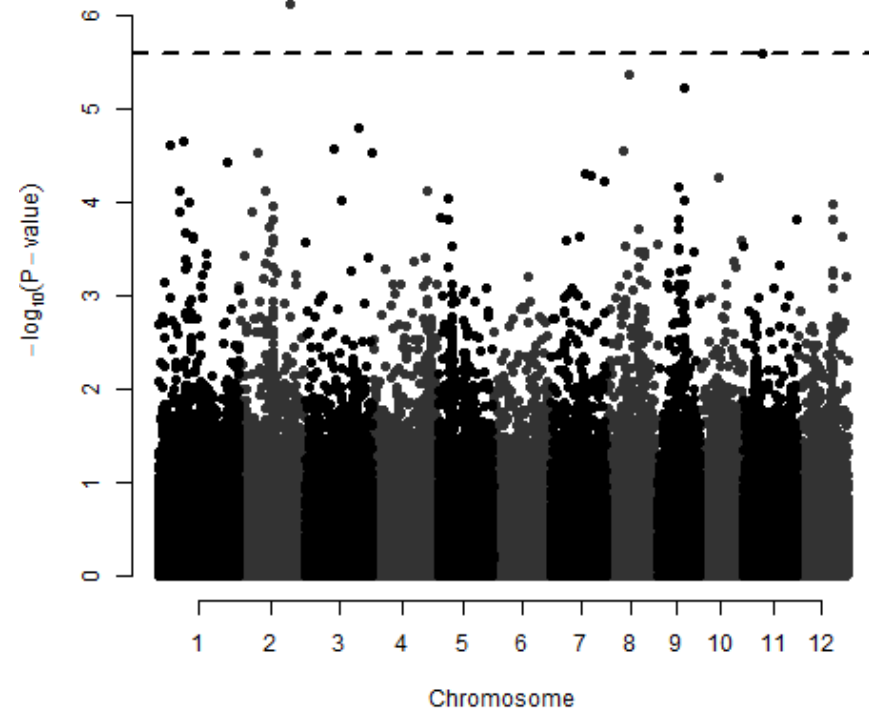
indica - KDI<sub>LT</sub>



# temperate japonica - $KDI_{LT}$



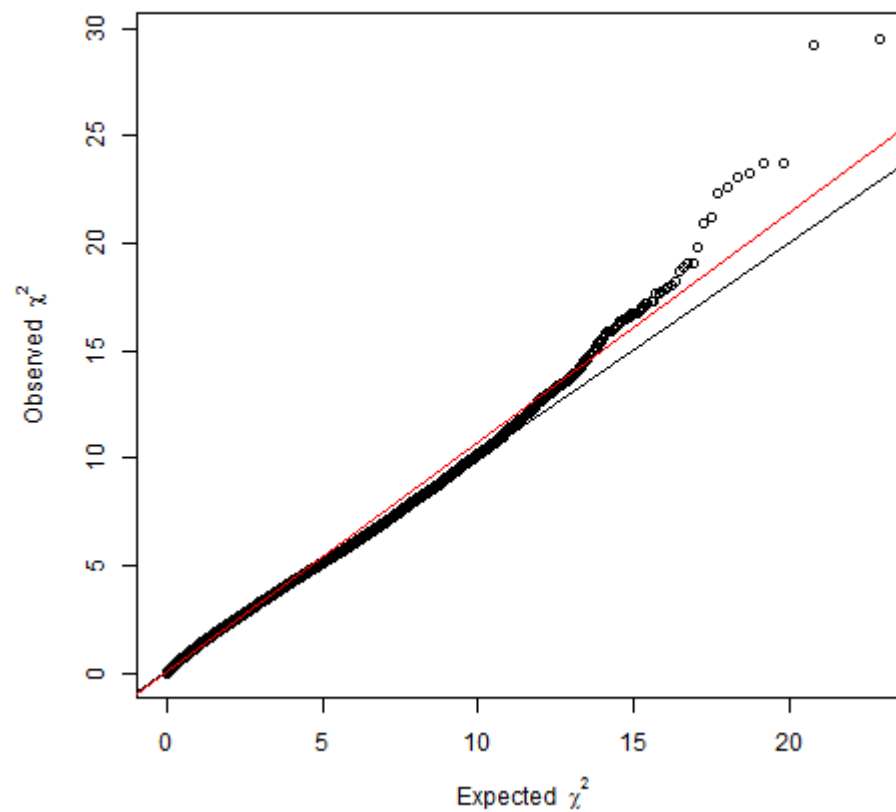
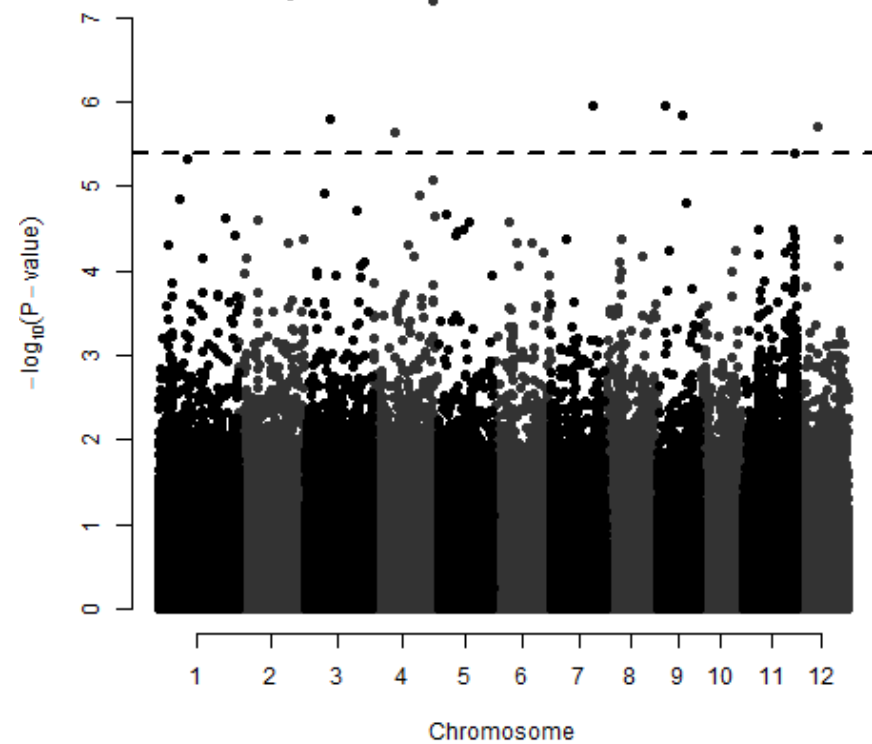
# tropical japonica - $KDI_{LT}$



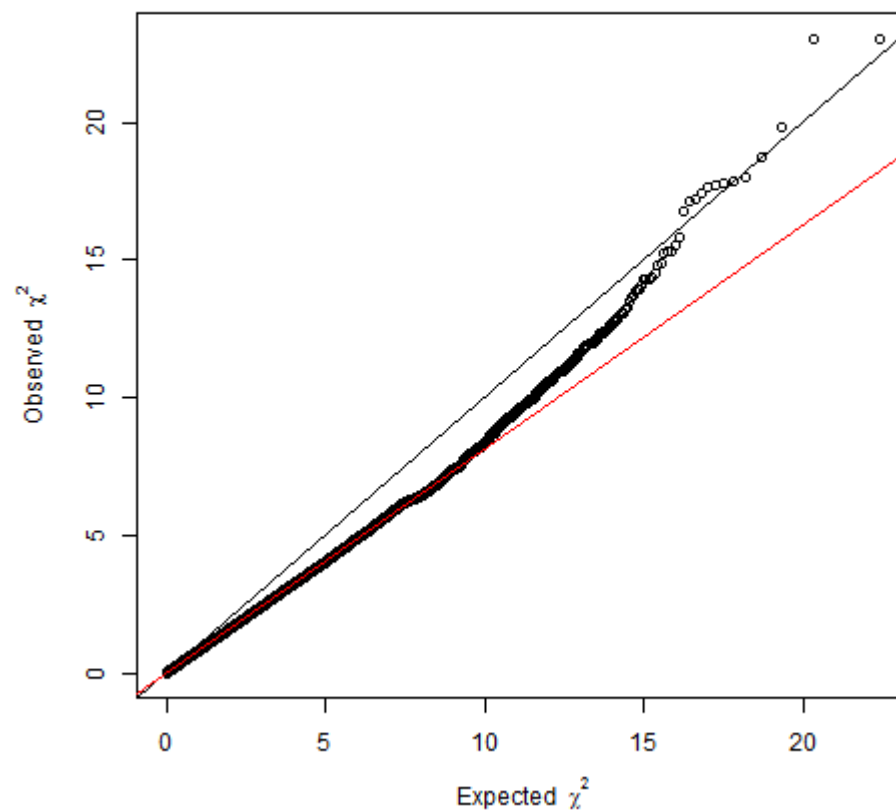
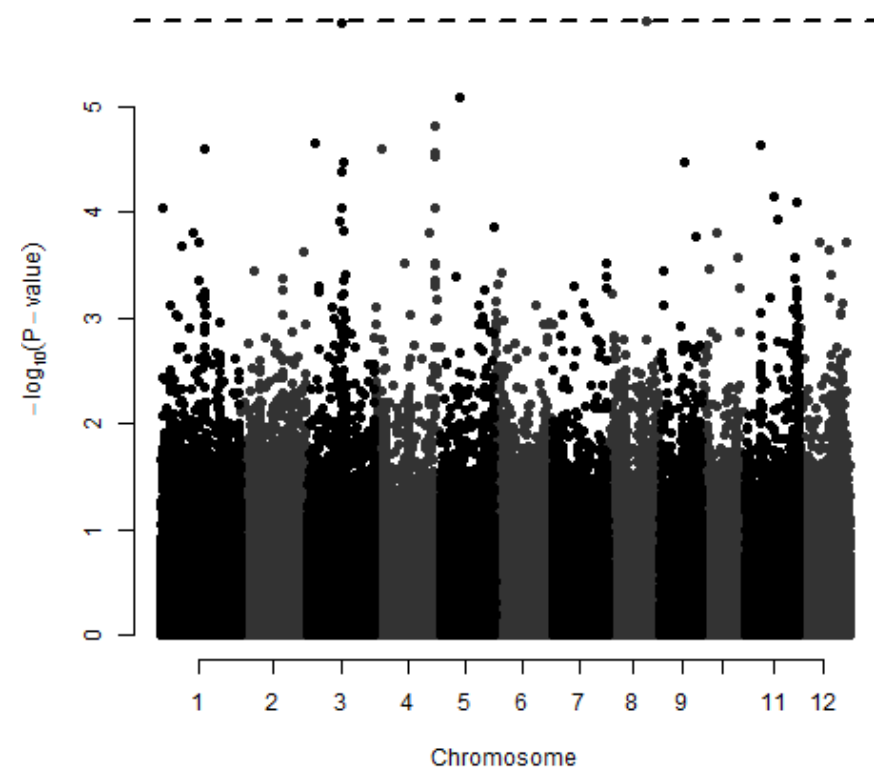
$$KR_{HT}$$

Root potassium concentration in the high treatment

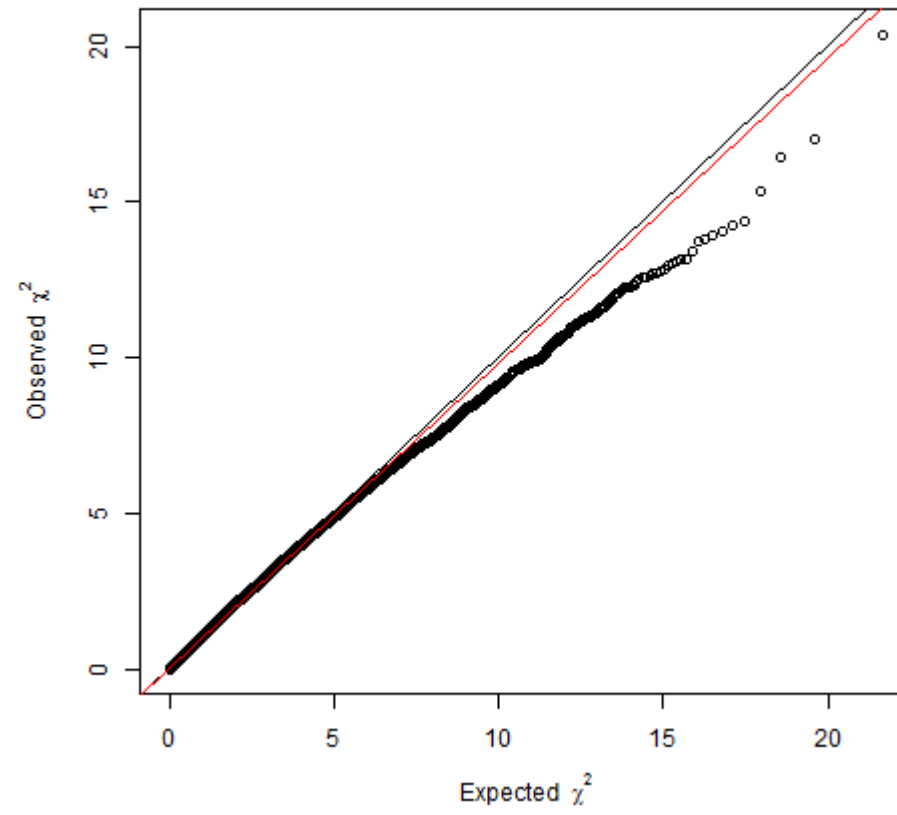
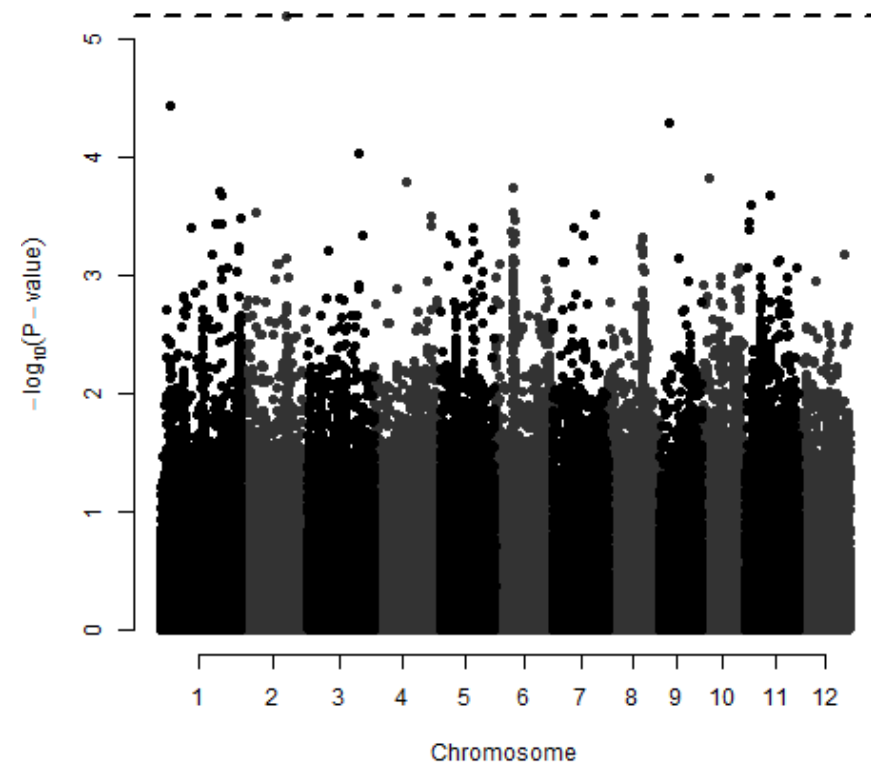
# All genotypes - $KR_{HT}$



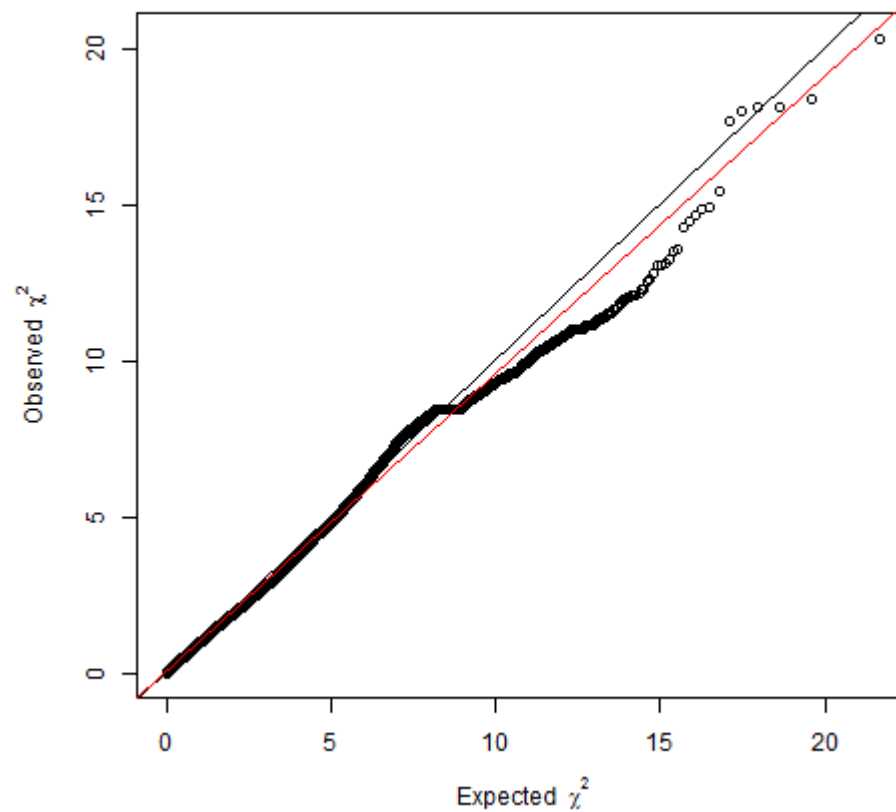
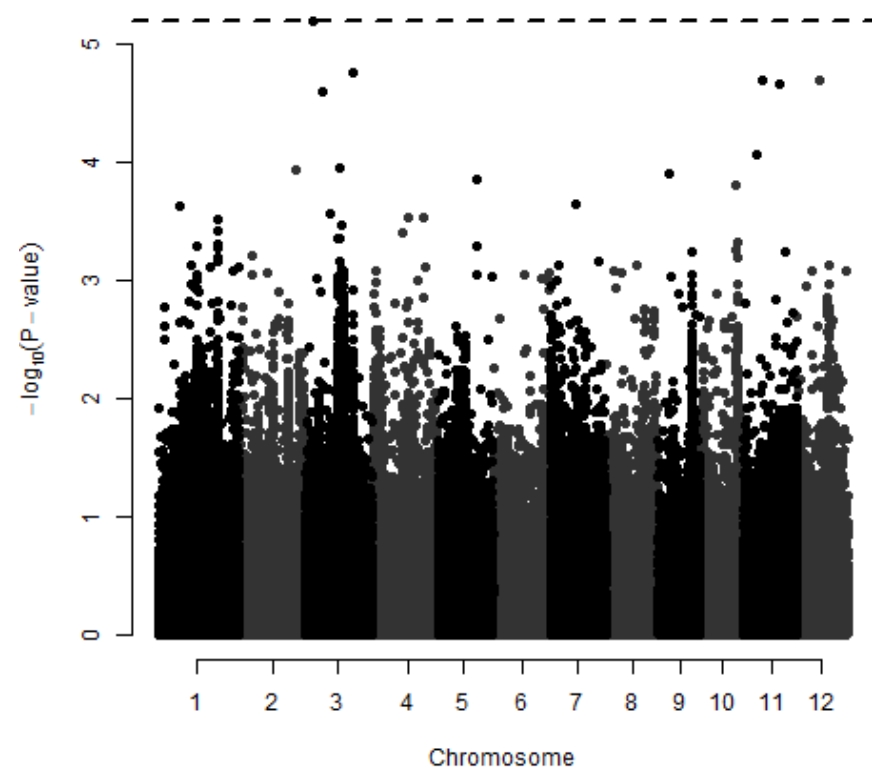
# Indica - $KR_{HT}$



# Japonica - $KR_{HT}$

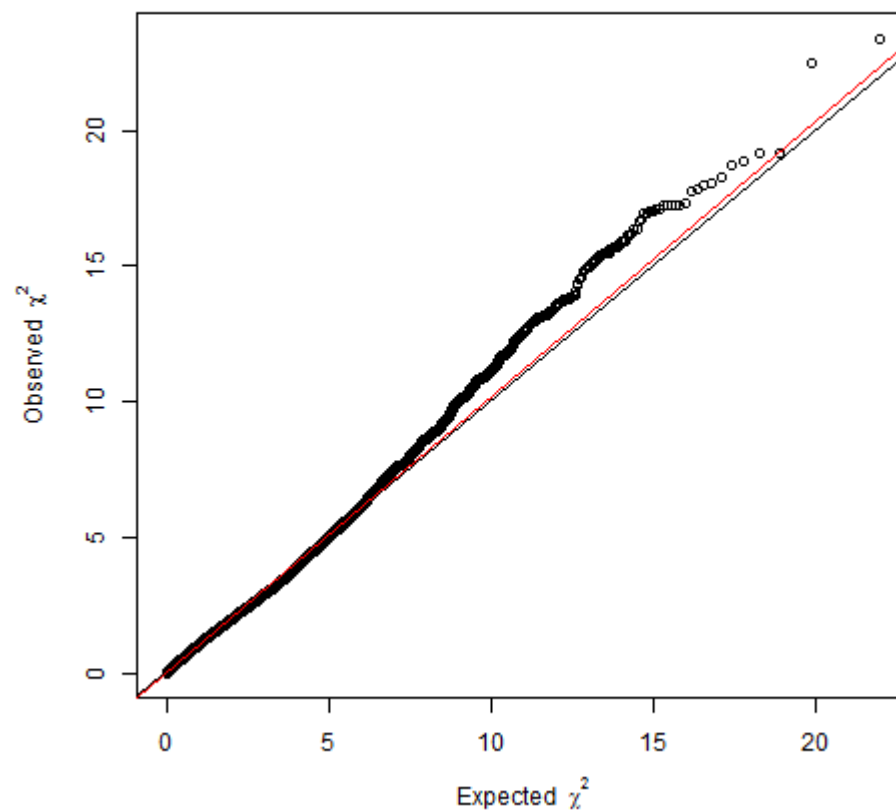
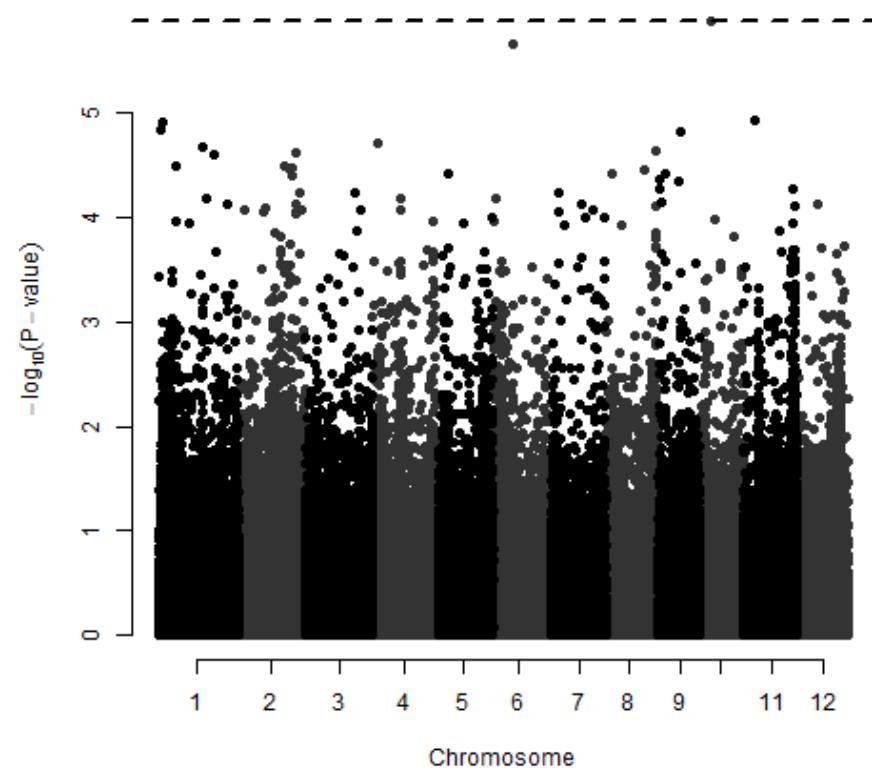


aus -  $KR_{HT}$

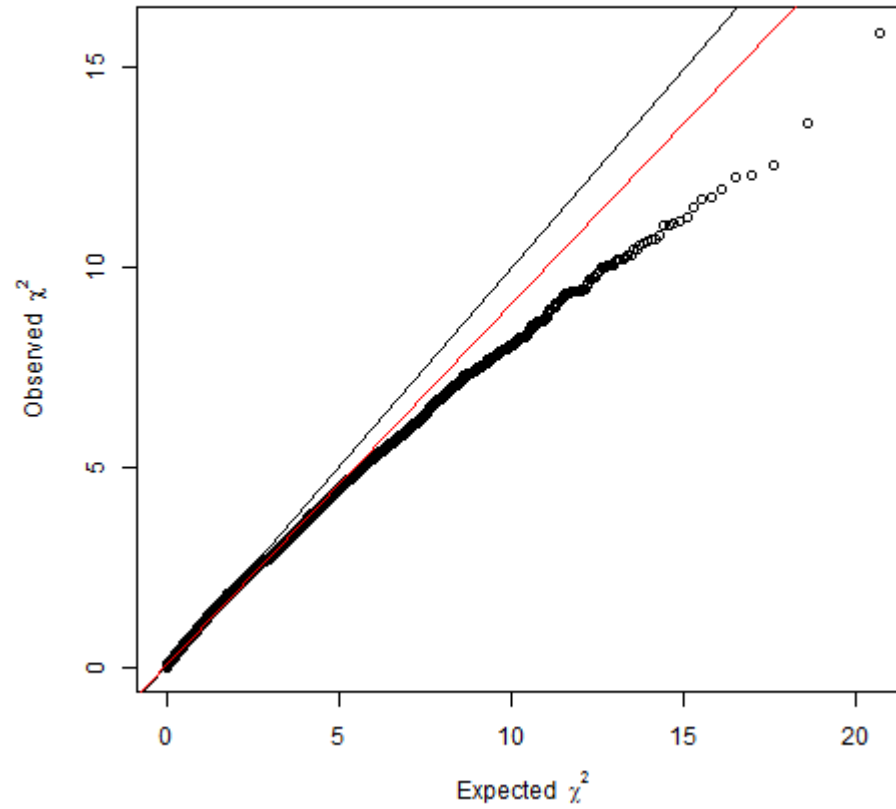
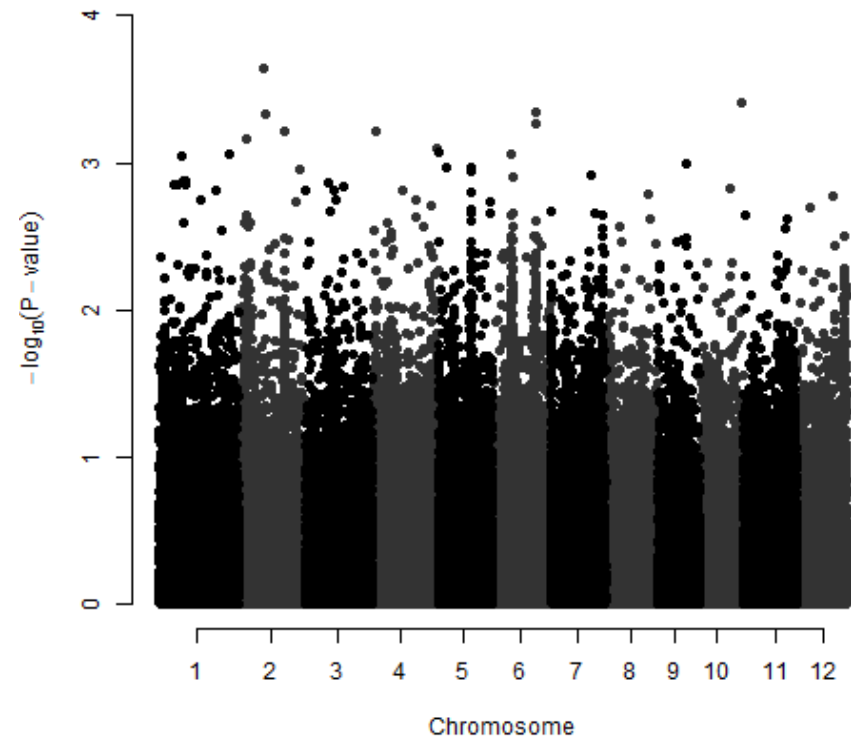




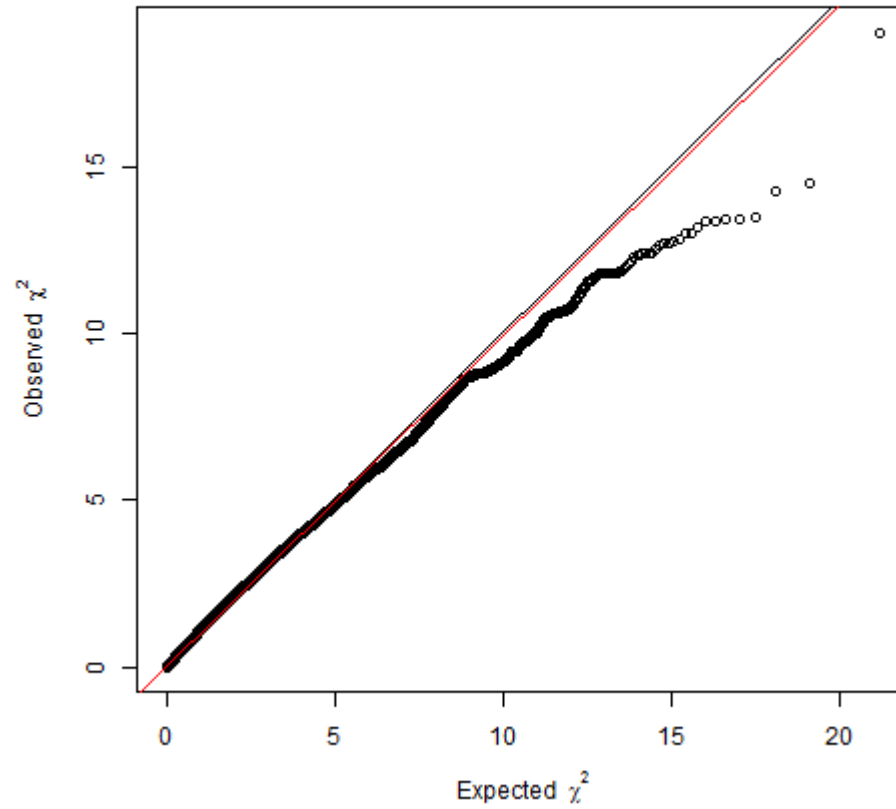
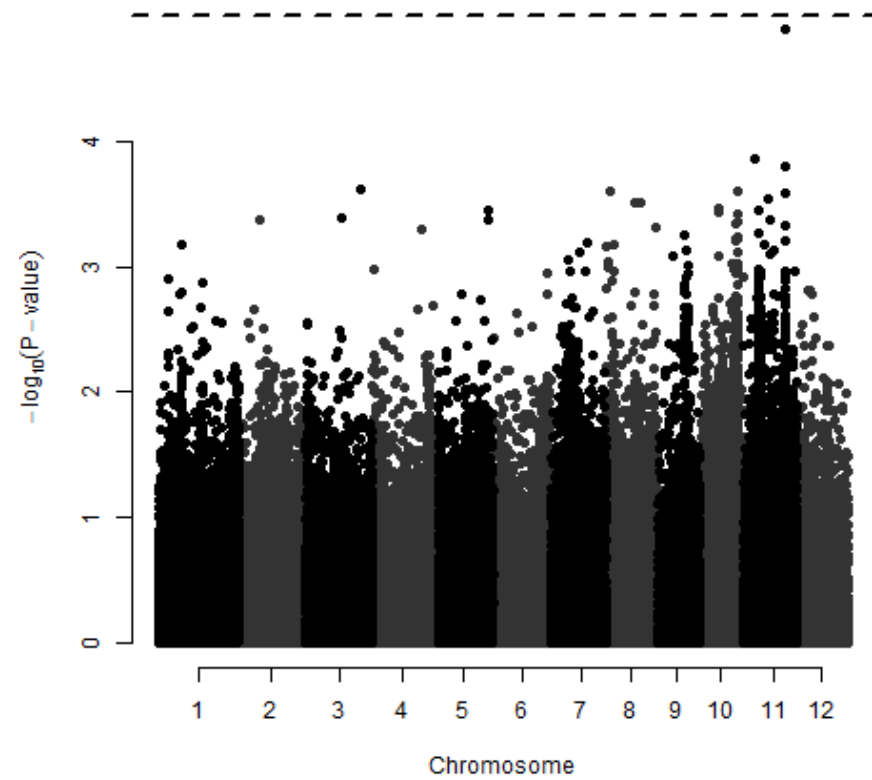
indica -KR<sub>HT</sub>



temperate japonica -  $KR_{HT}$



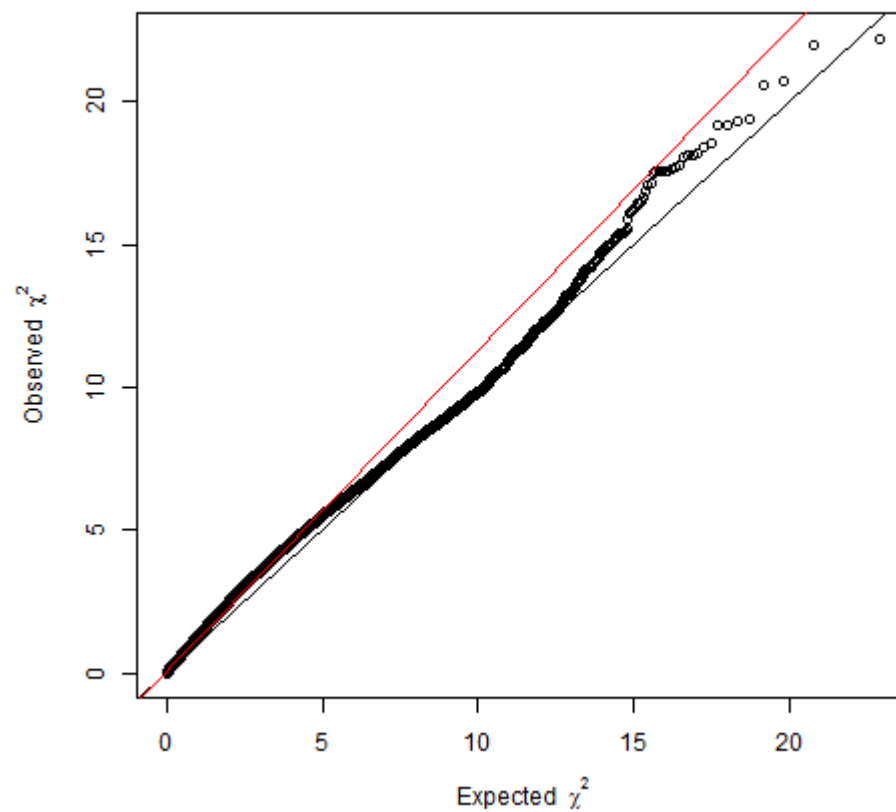
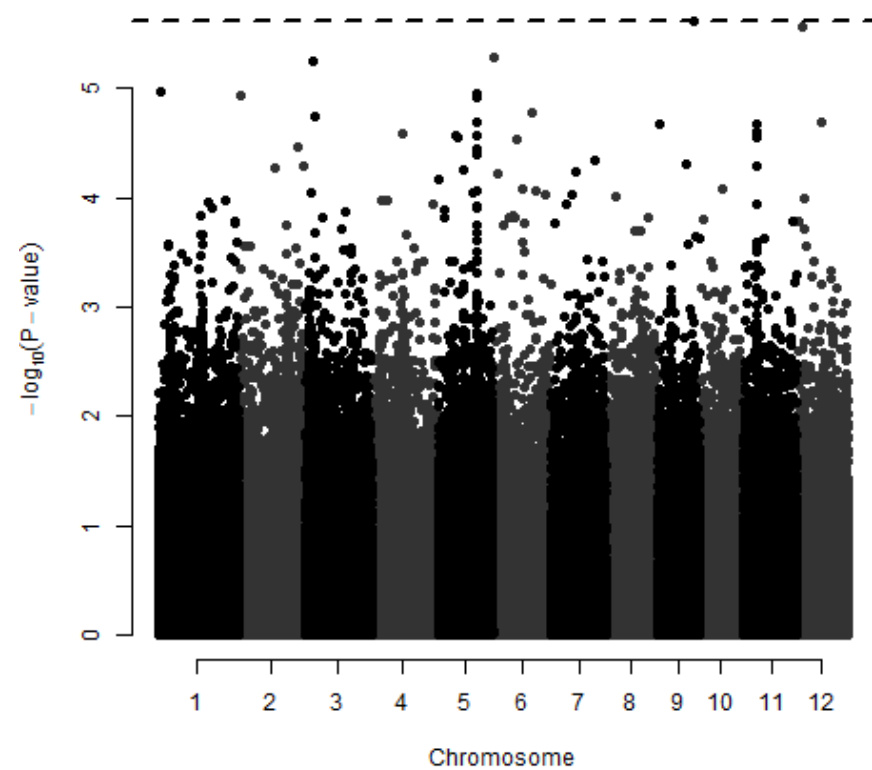
# tropical japonica - $KR_{HT}$



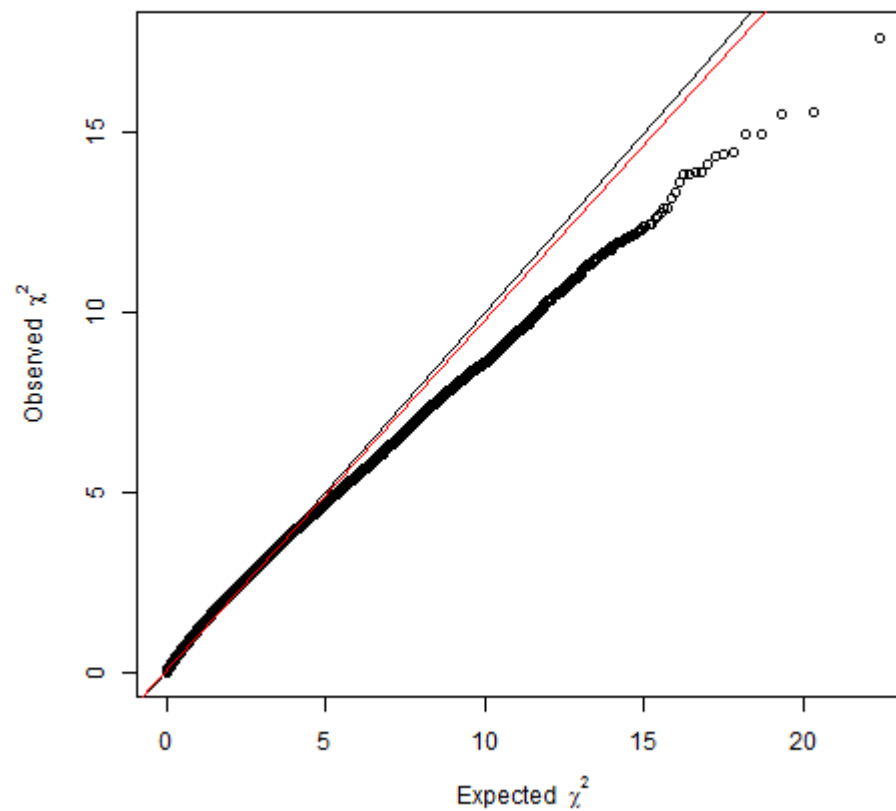
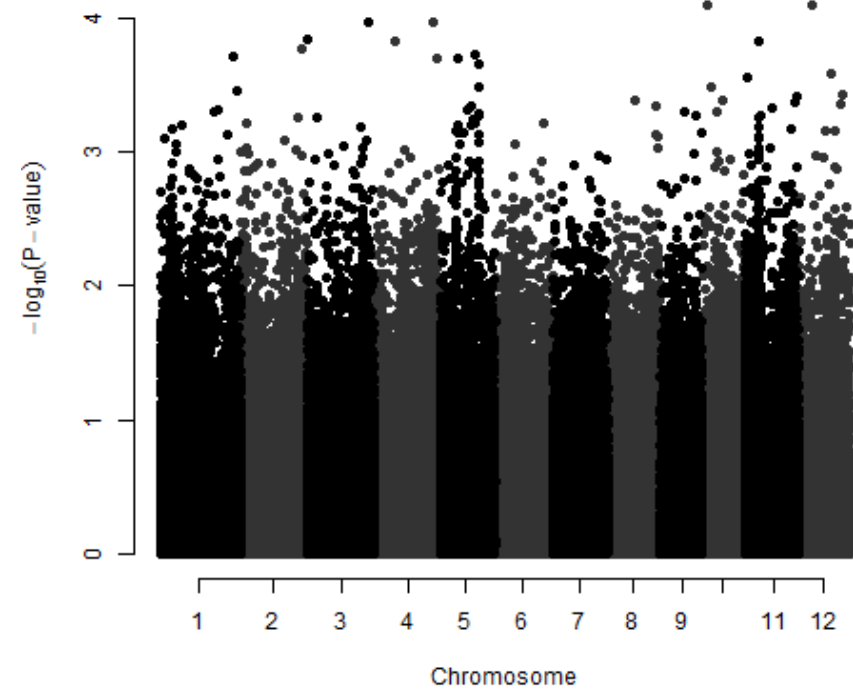
$$KR_{LT}$$

Root potassium concentration in the low treatment

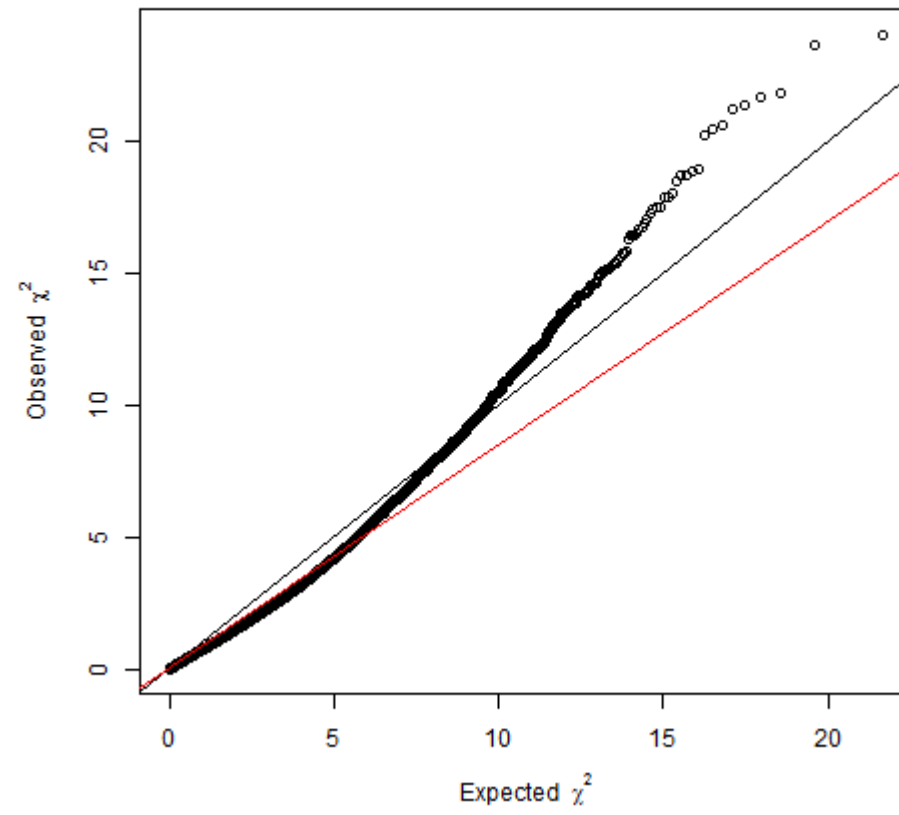
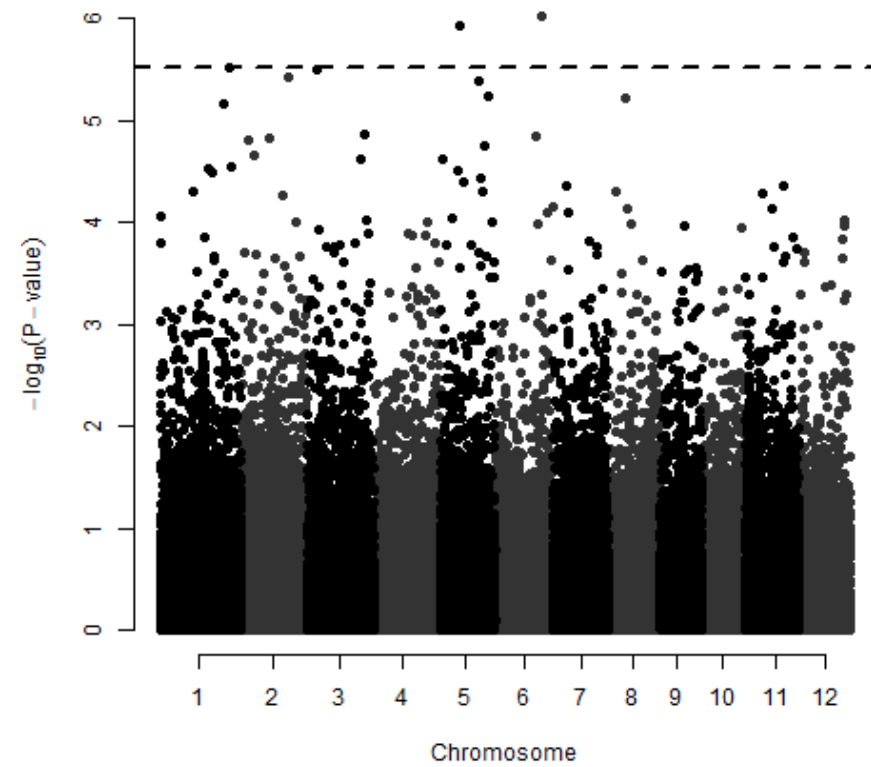
# All genotypes - $KR_{LT}$



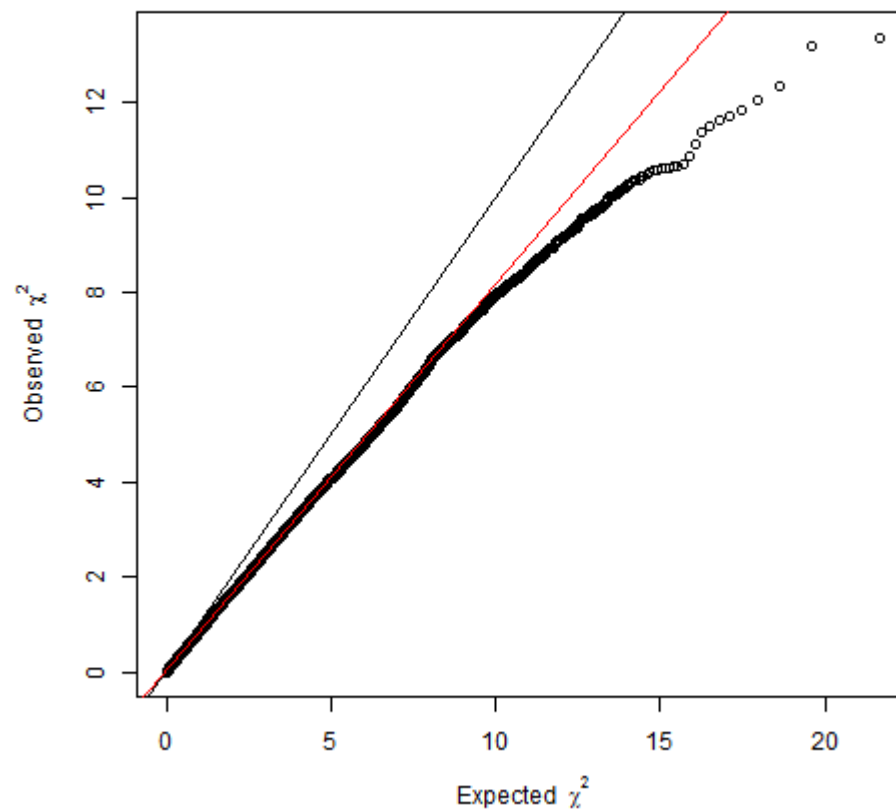
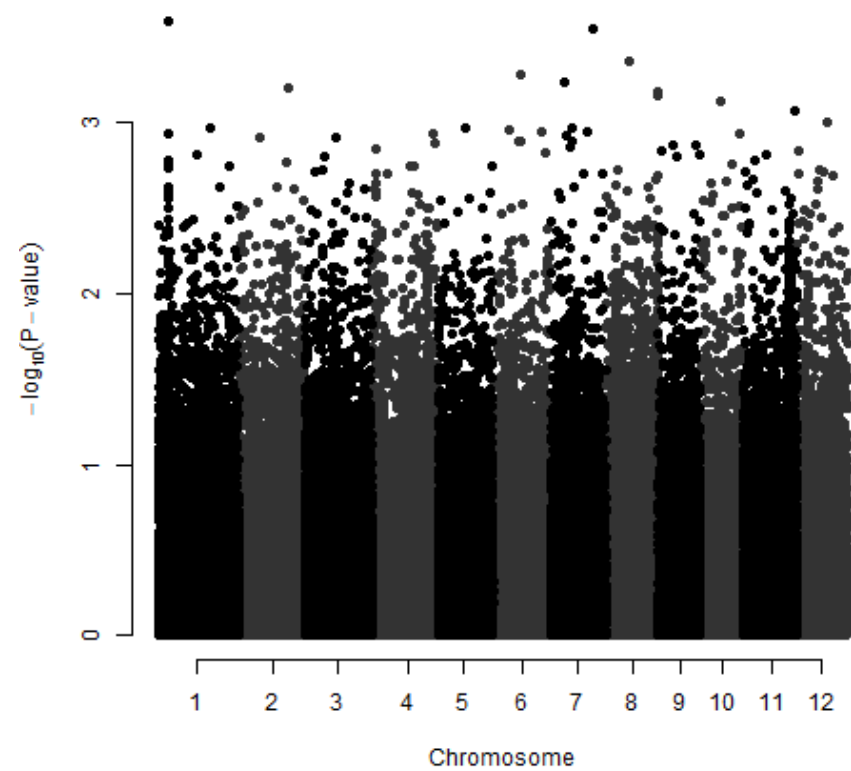
# Indica - KR<sub>LT</sub>



# Japonica - KR<sub>LT</sub>

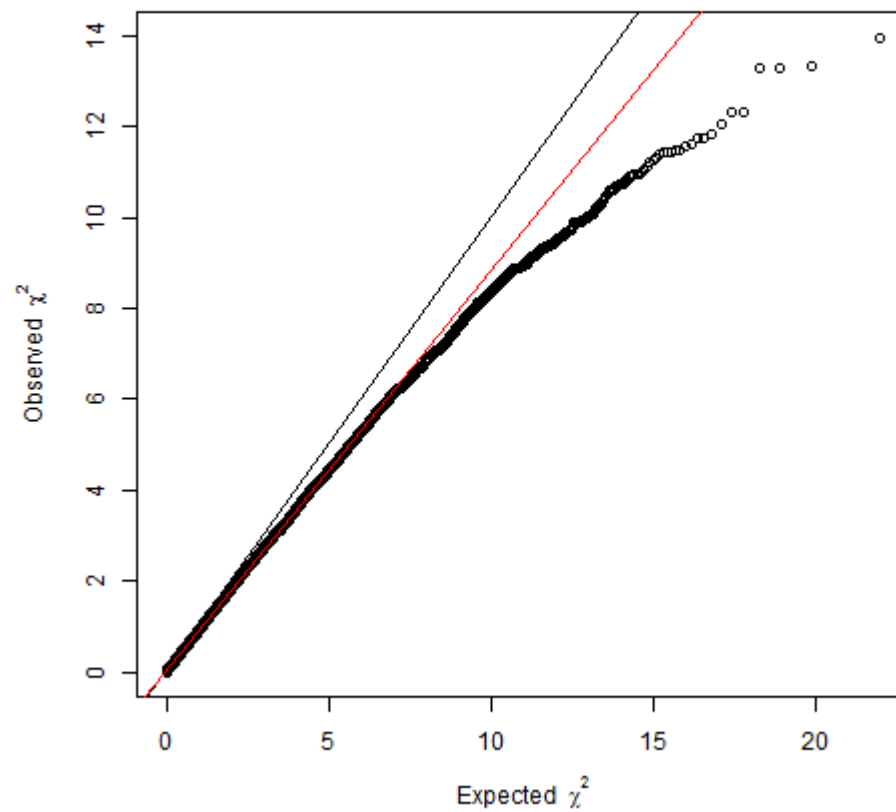
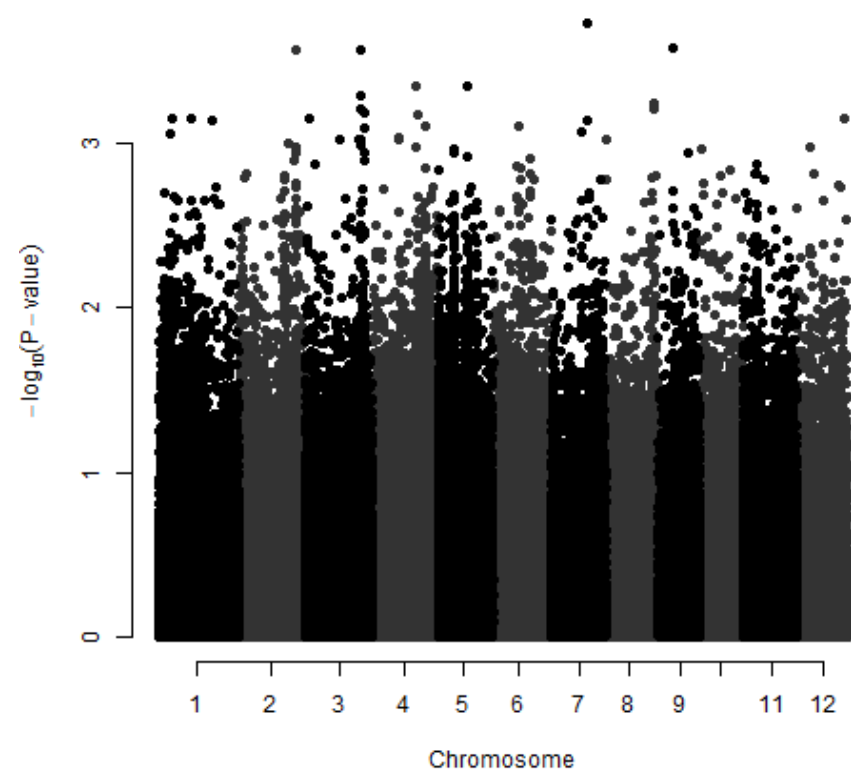


aus -  $KR_{LT}$

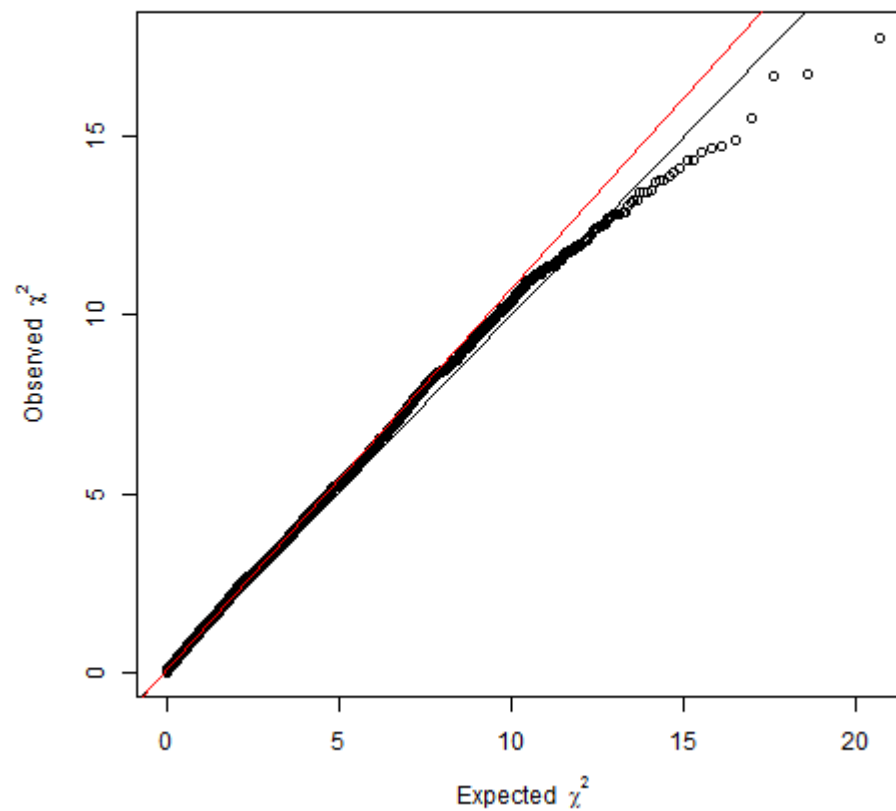
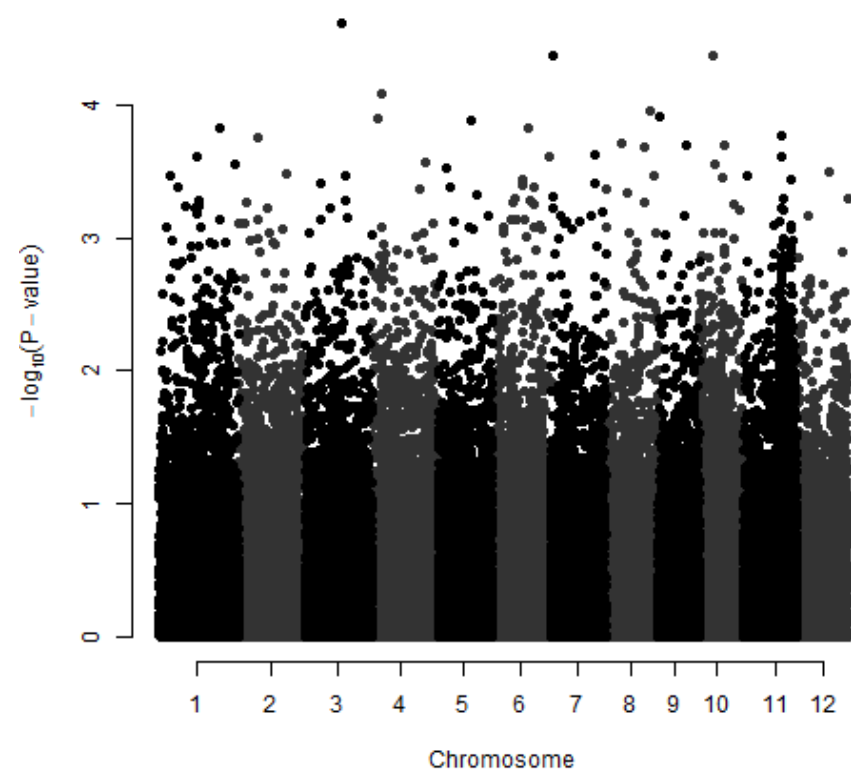




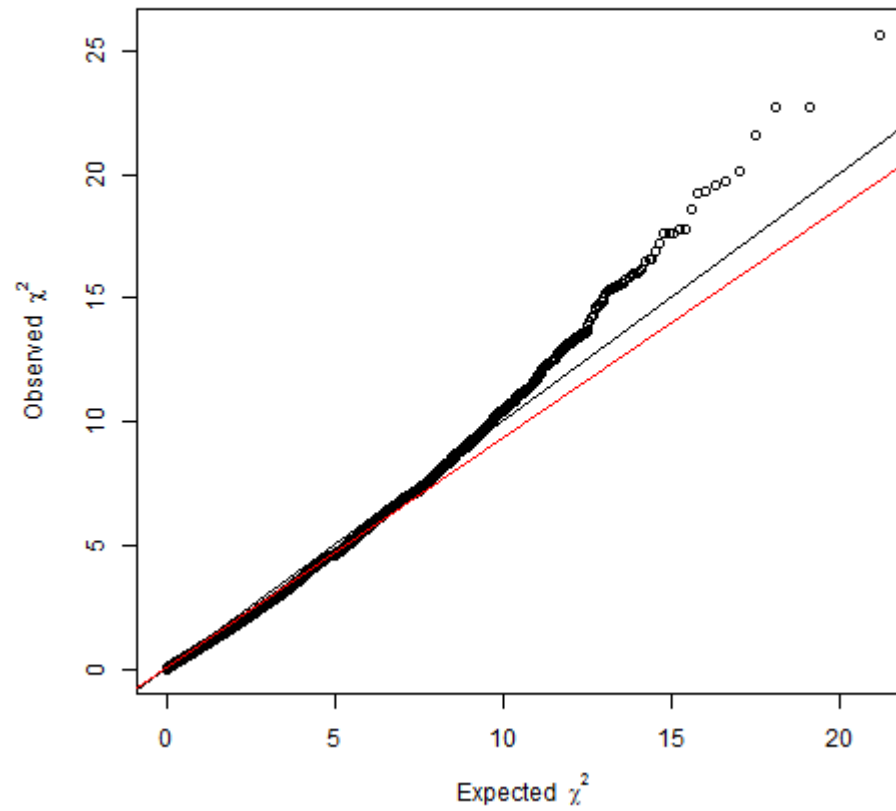
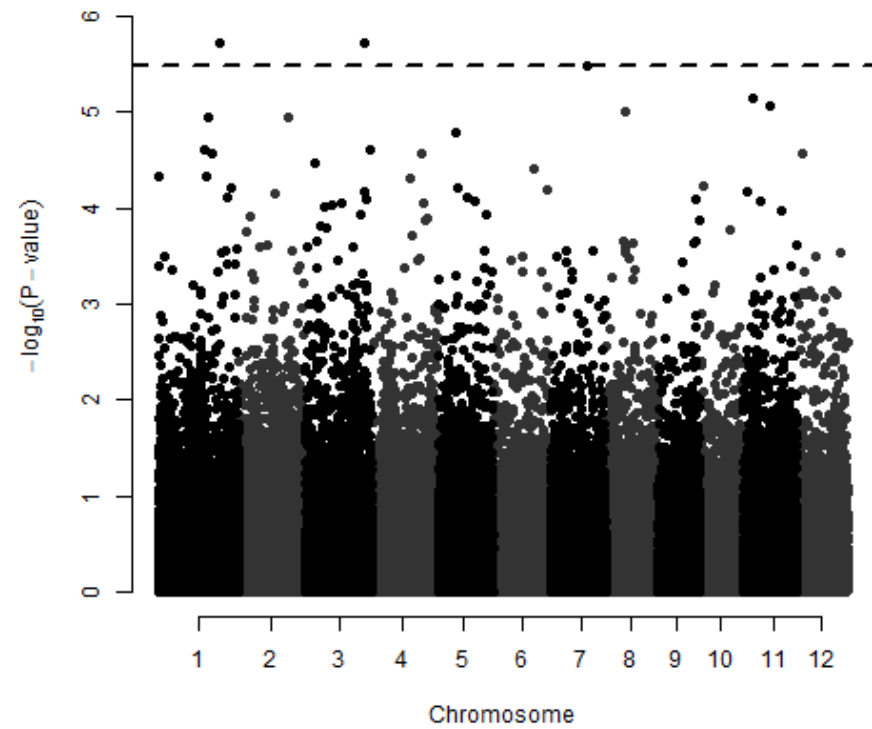
indica - KR<sub>LT</sub>



# temperate japonica - $KR_{LT}$



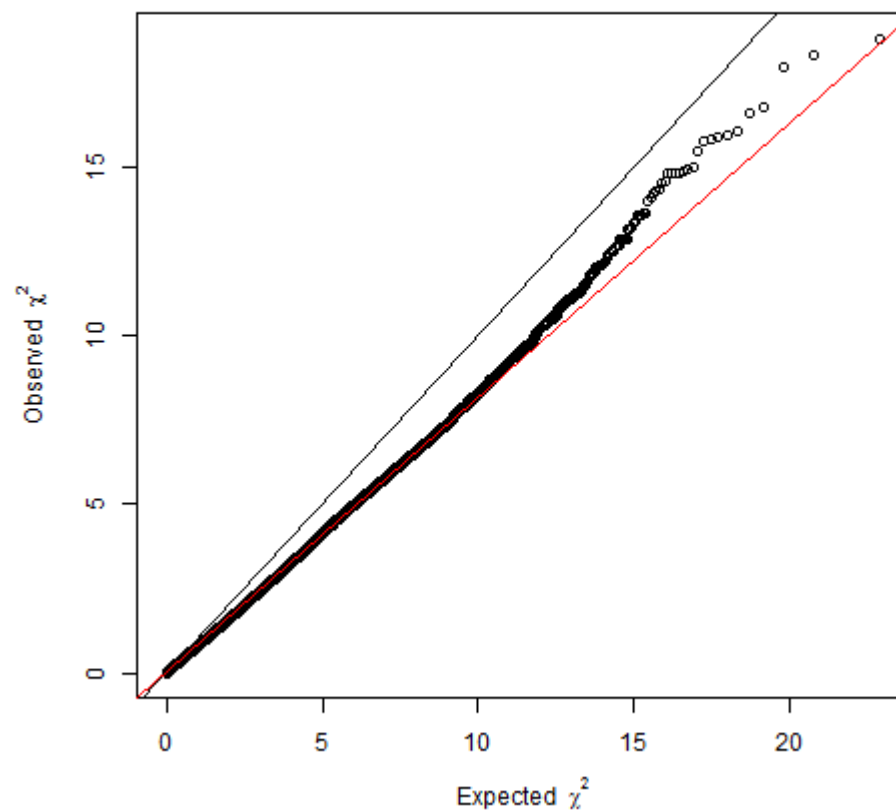
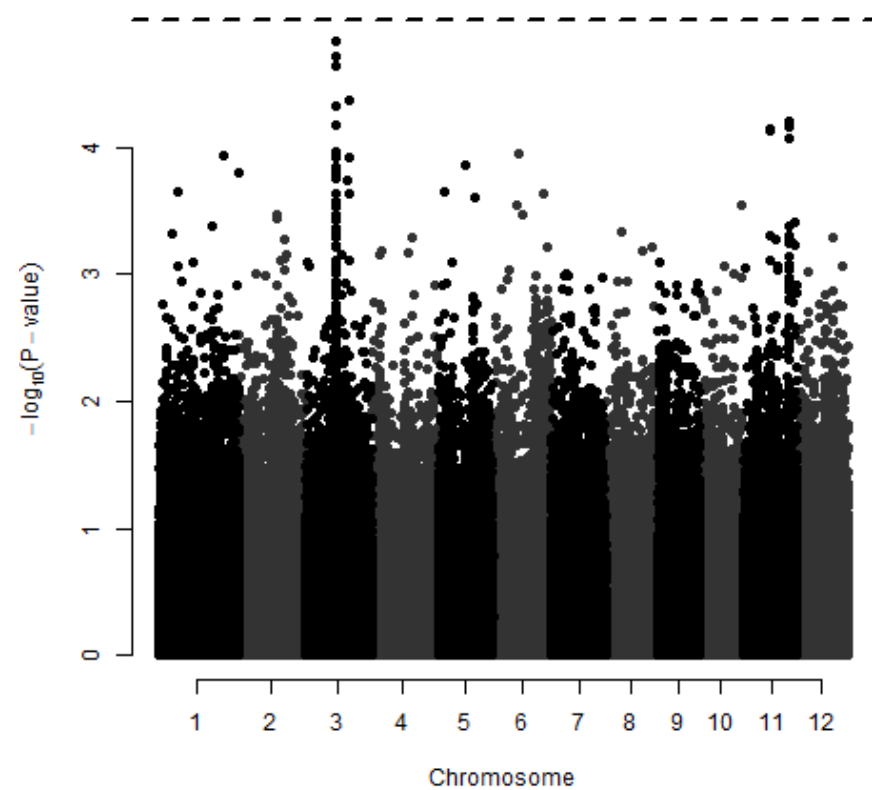
# tropical japonica - $KR_{LT}$



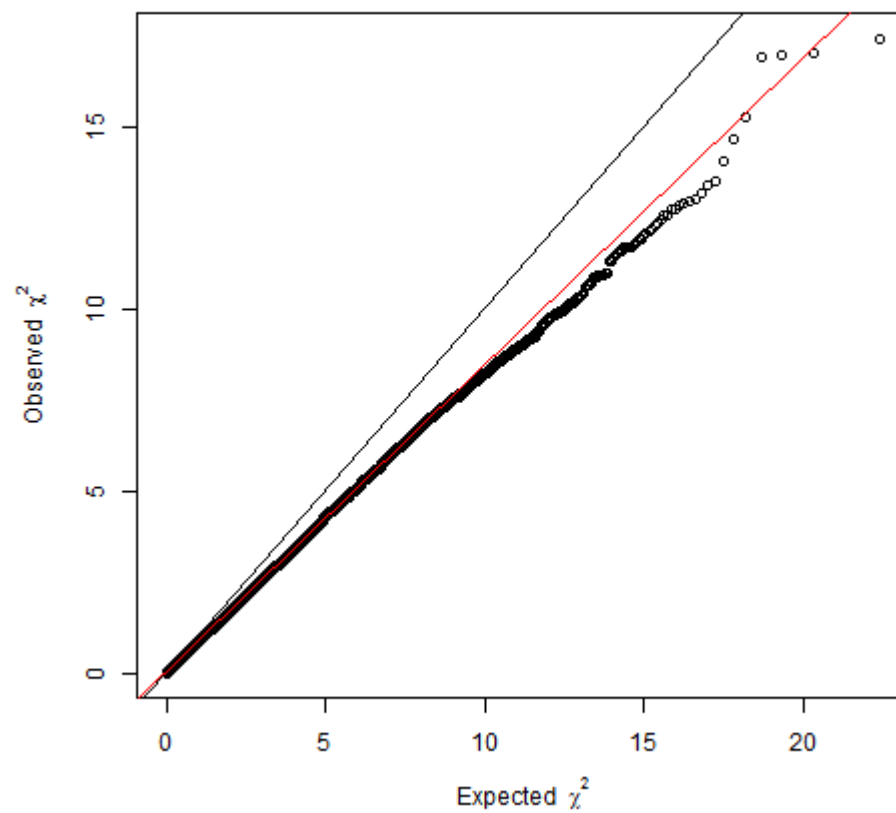
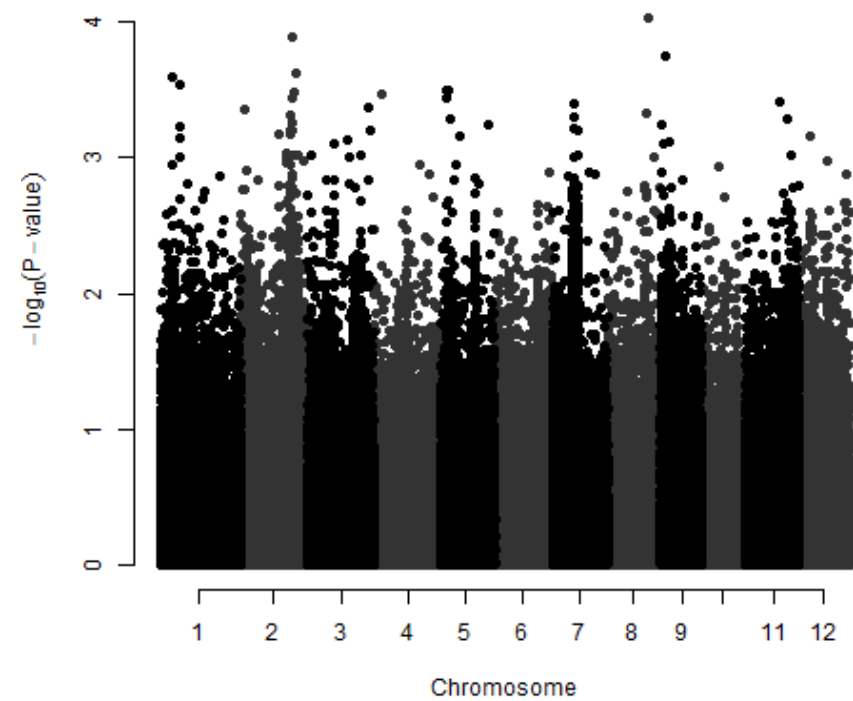
$KS_{HT}$ 

Shoot potassium concentration in the high treatment

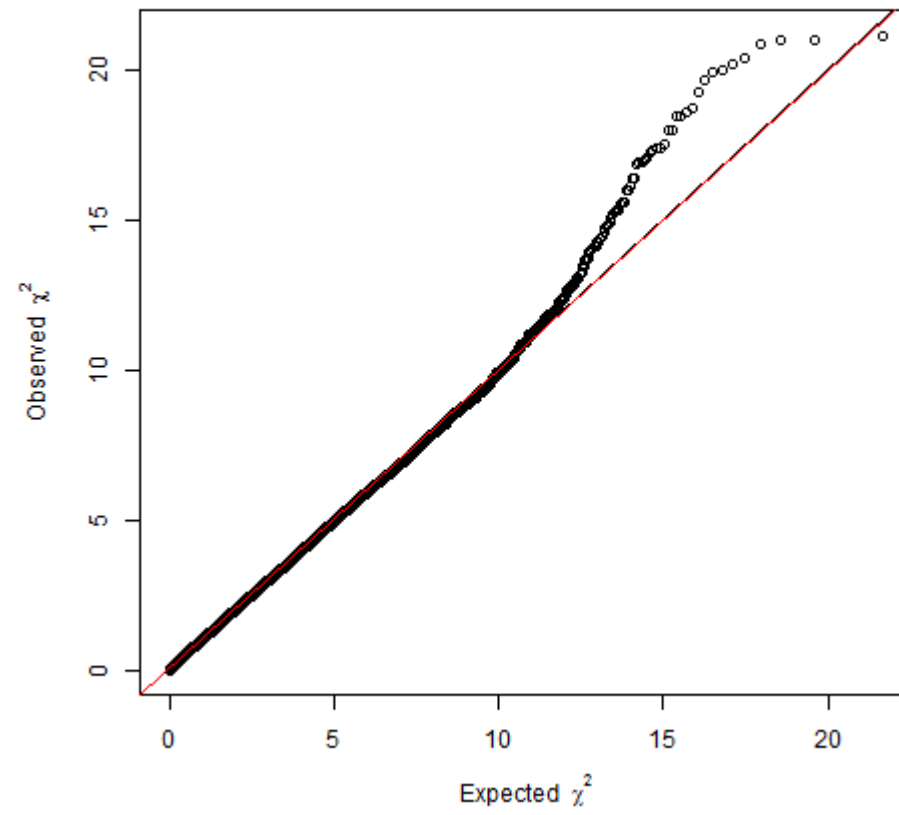
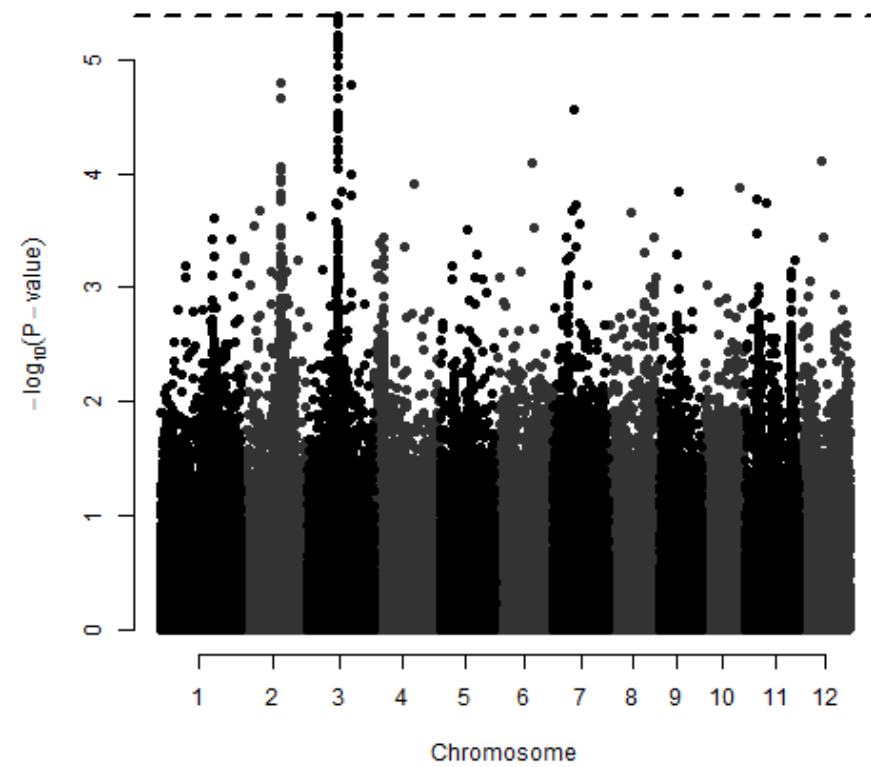
# All genotypes - $KS_{HT}$



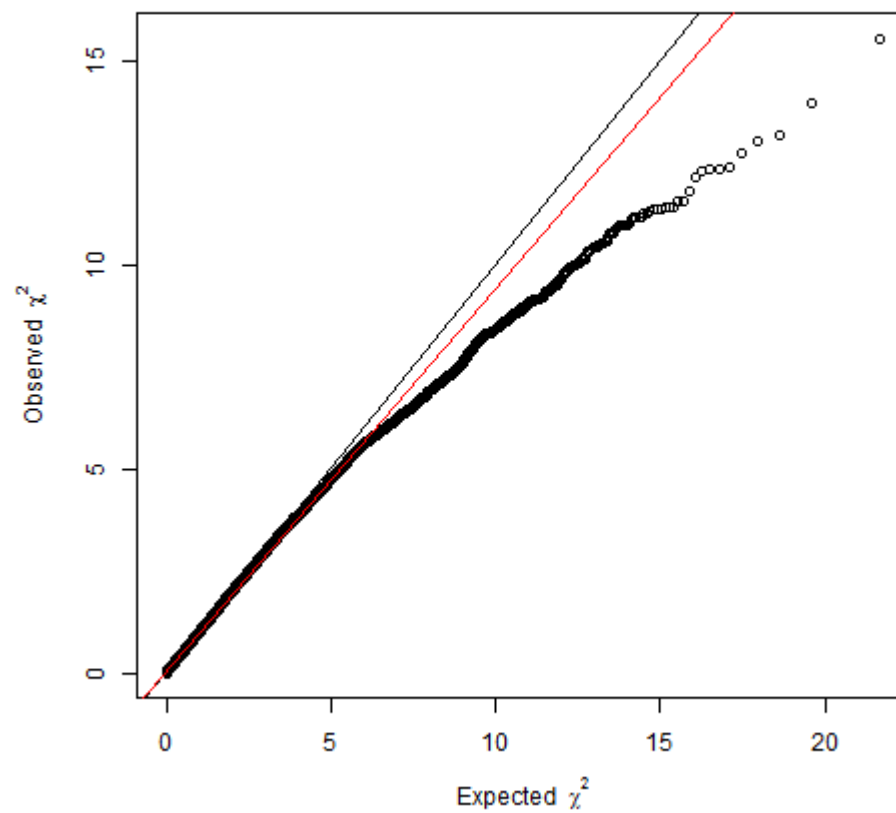
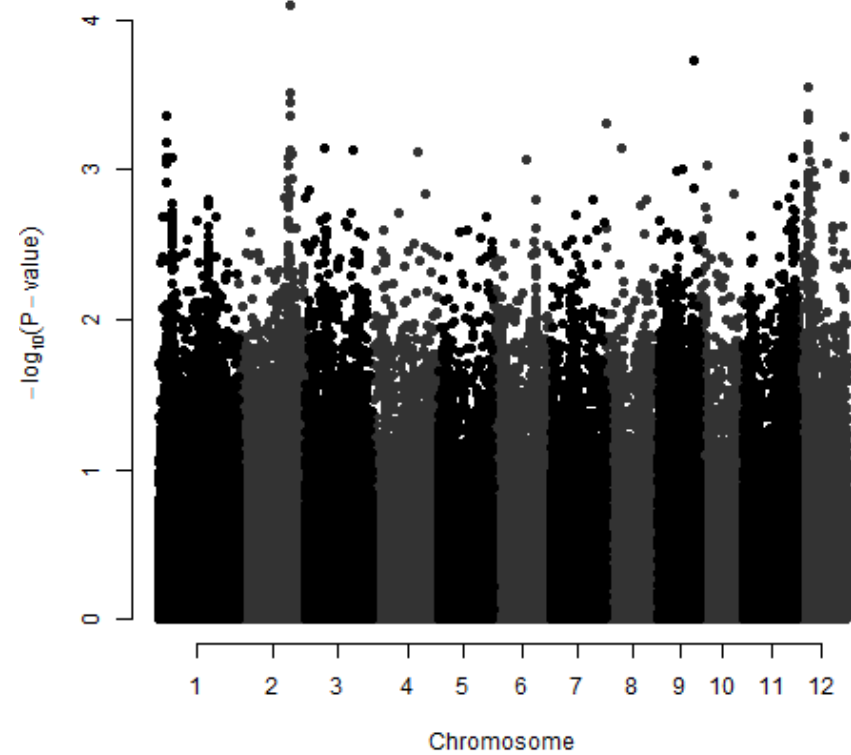
# Indica - $KS_{HT}$



# Japonica - $KS_{HT}$

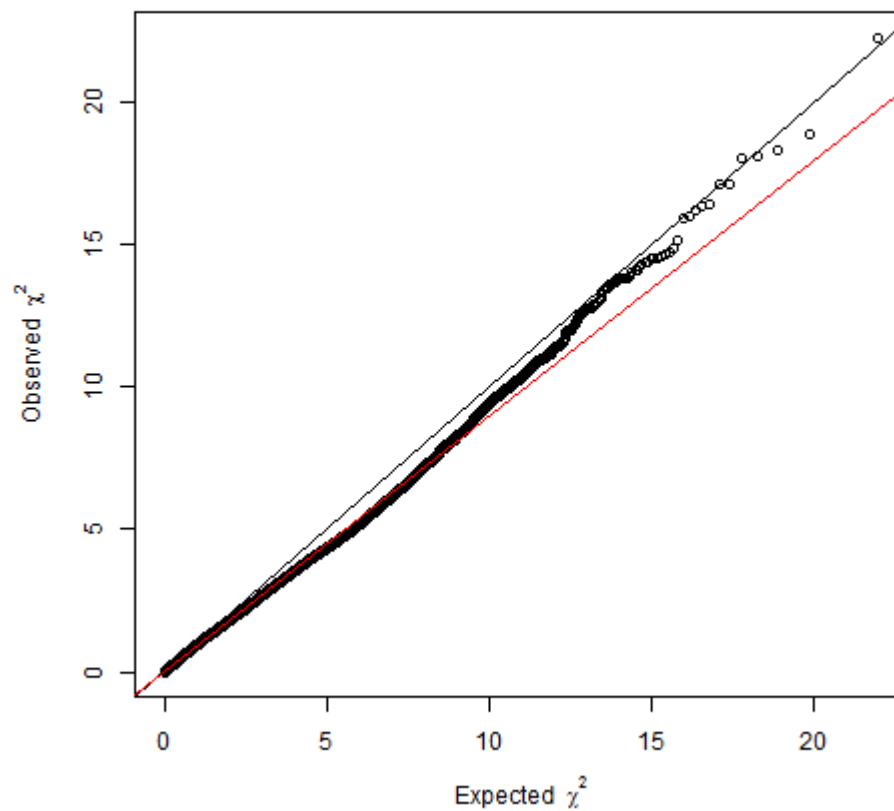
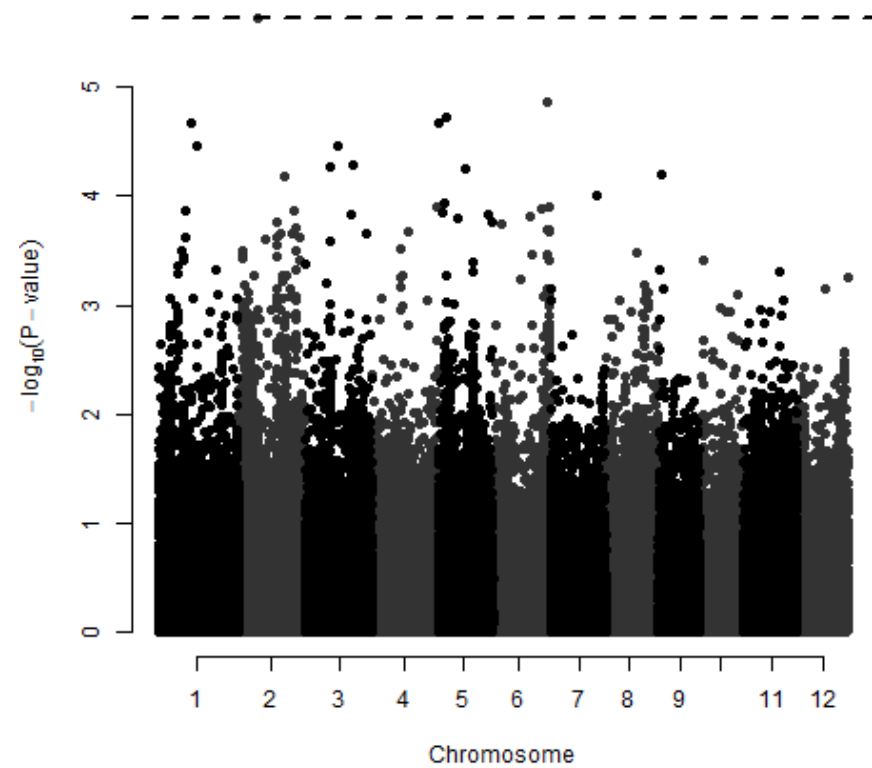


aus -  $KS_{HT}$

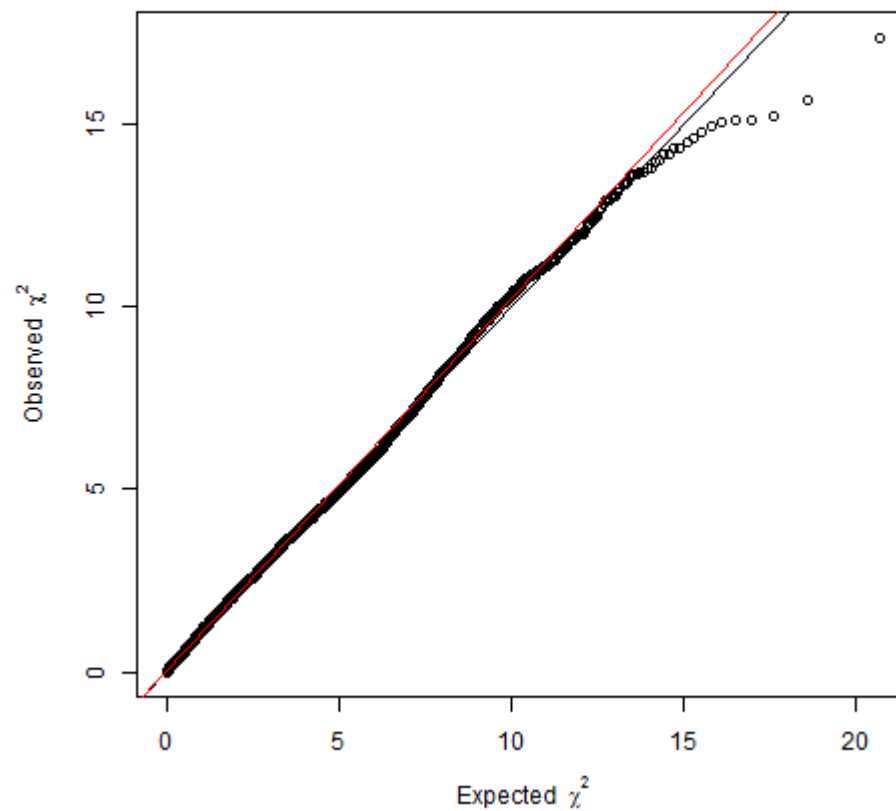
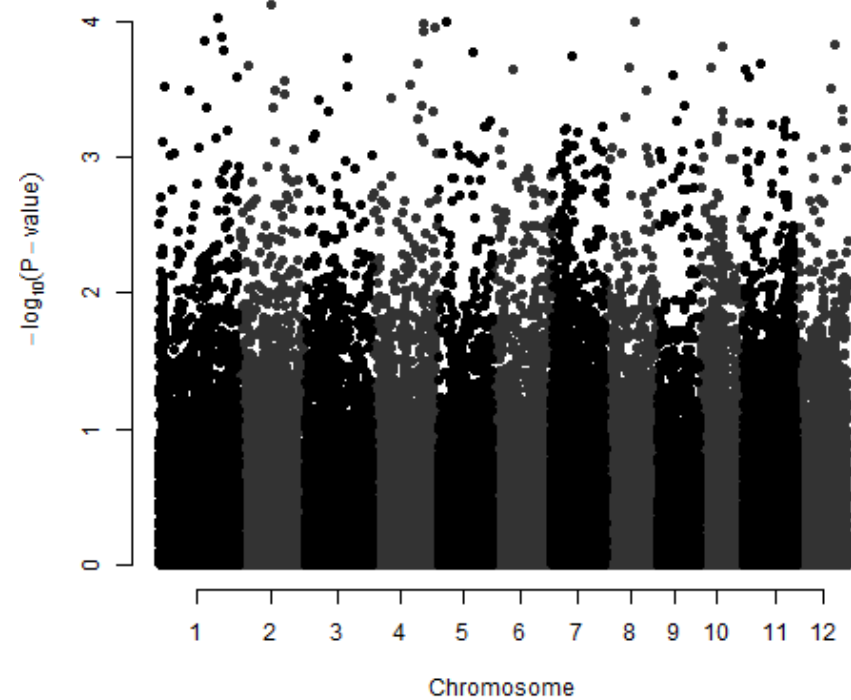




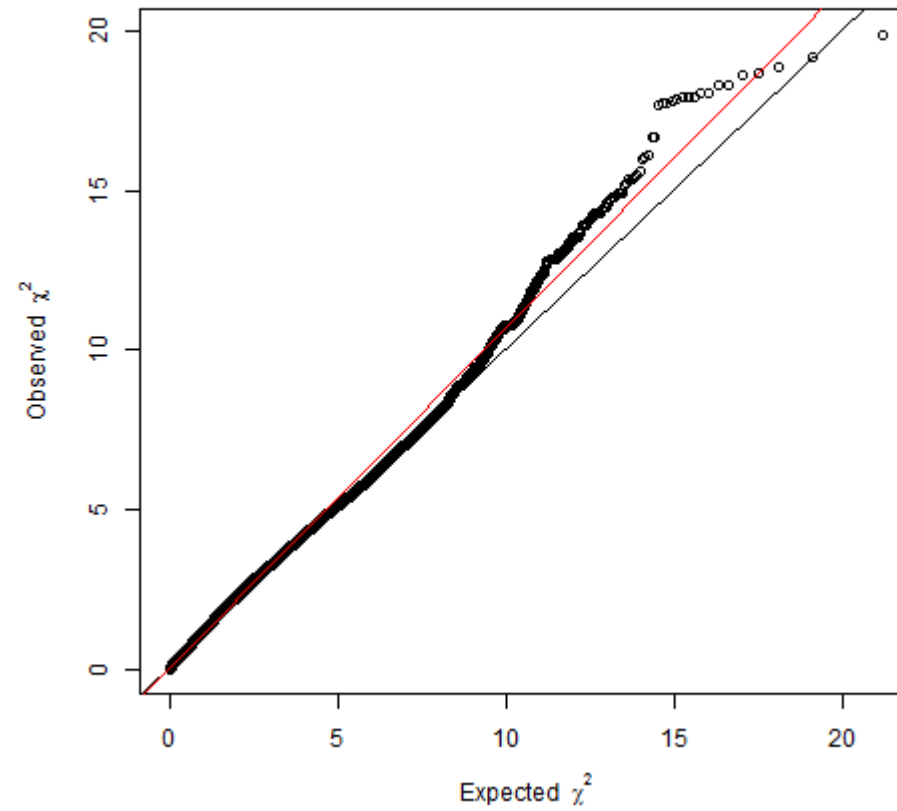
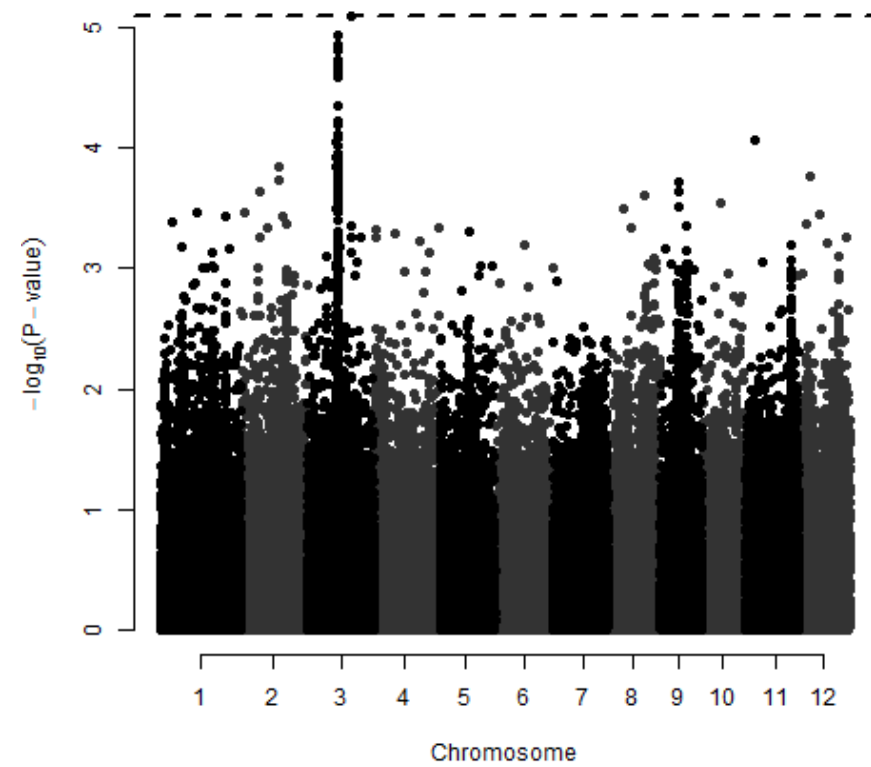
indica -  $KS_{HT}$



# temperate japonica - $KS_{HT}$



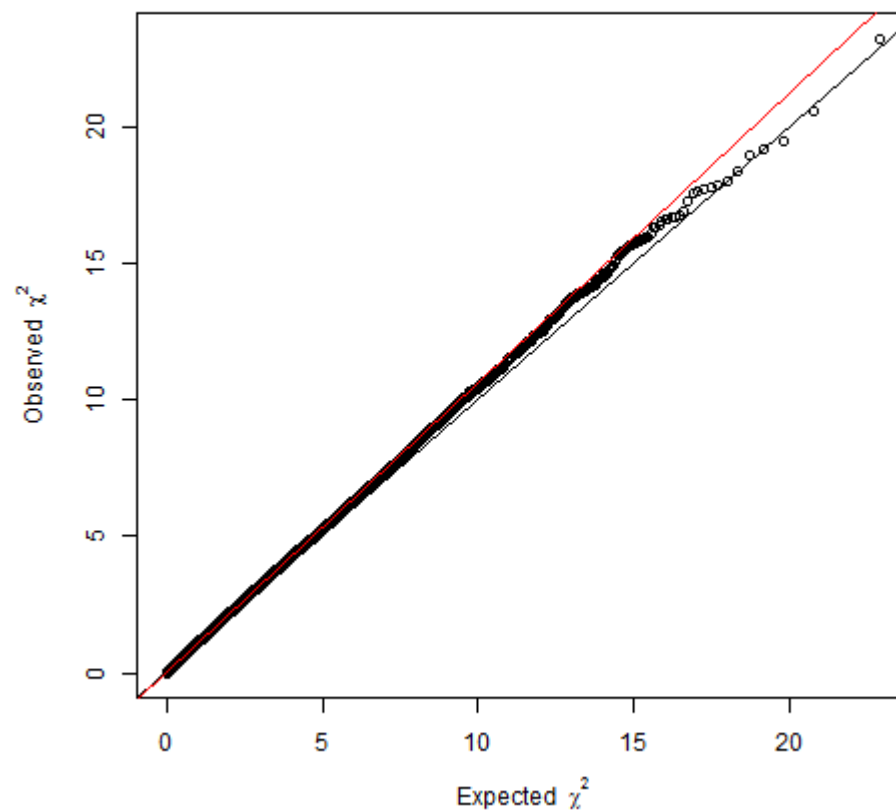
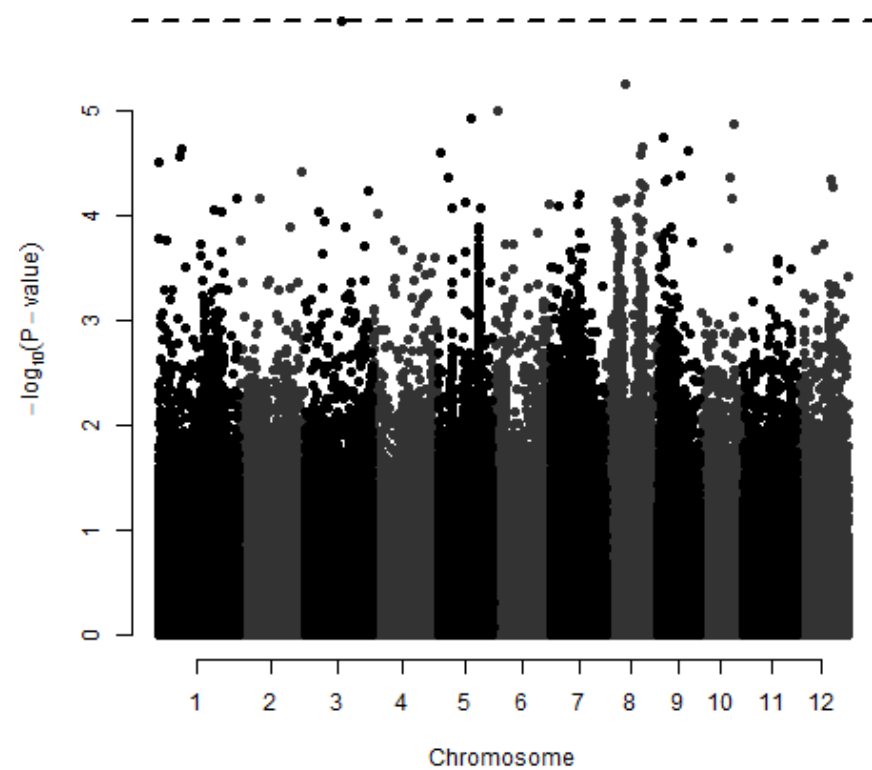
# tropical japonica - $KS_{HT}$



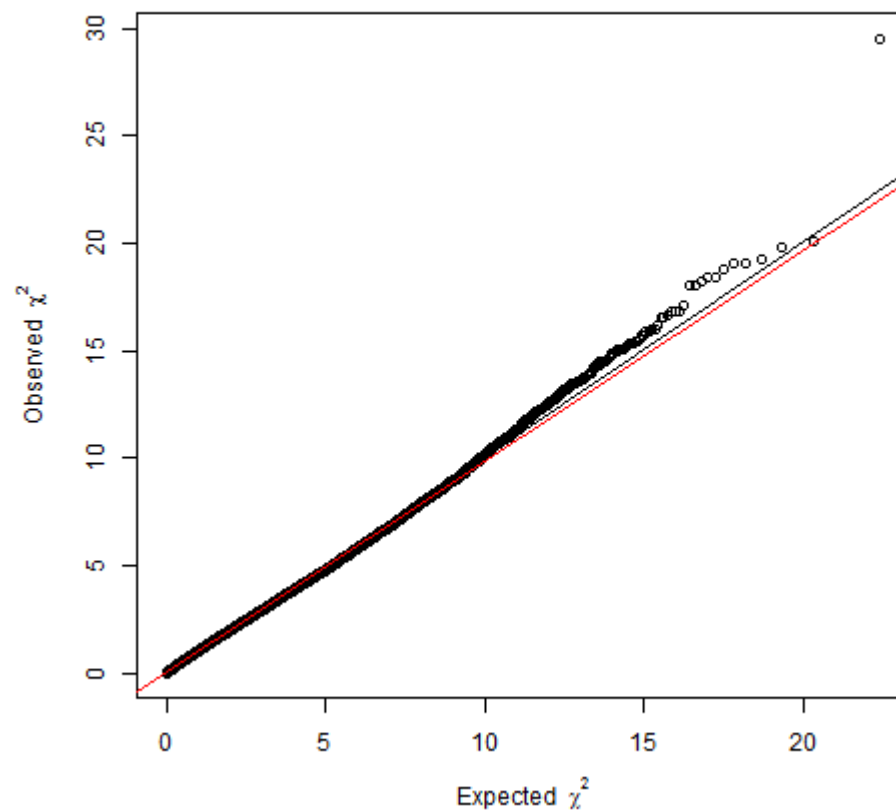
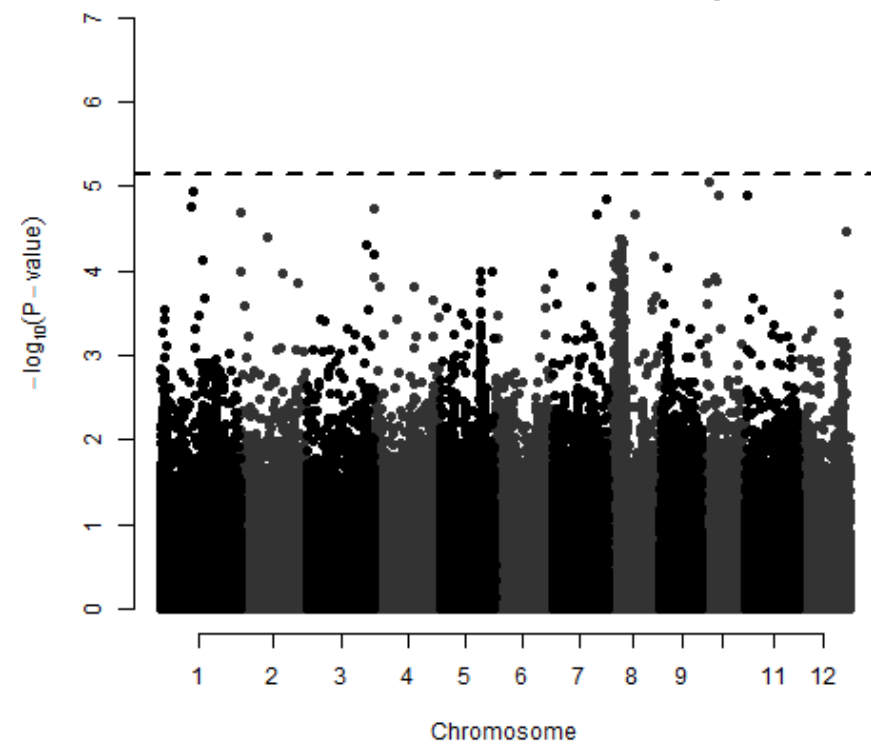
$KS_{LT}$ 

Shoot potassium concentration in the low treatment

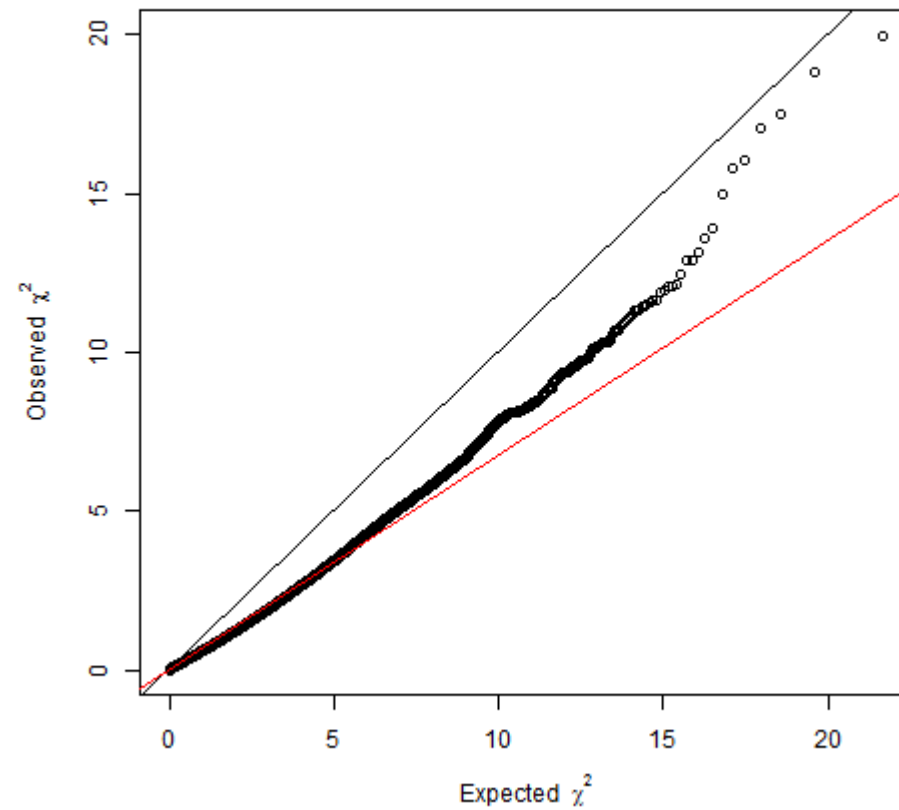
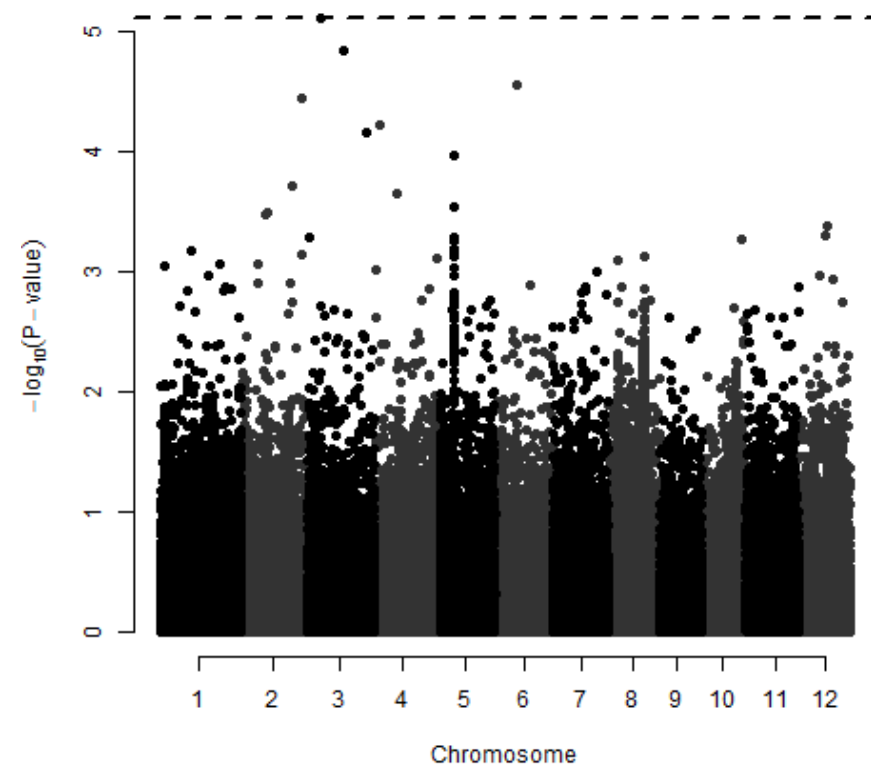
# All genotypes - $KS_{LT}$



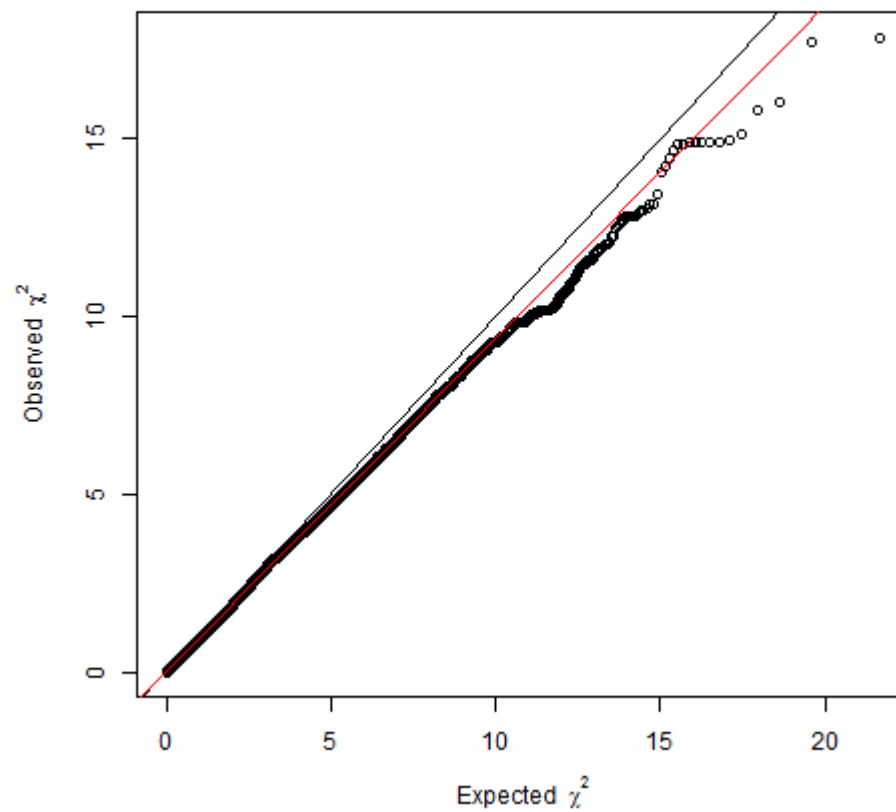
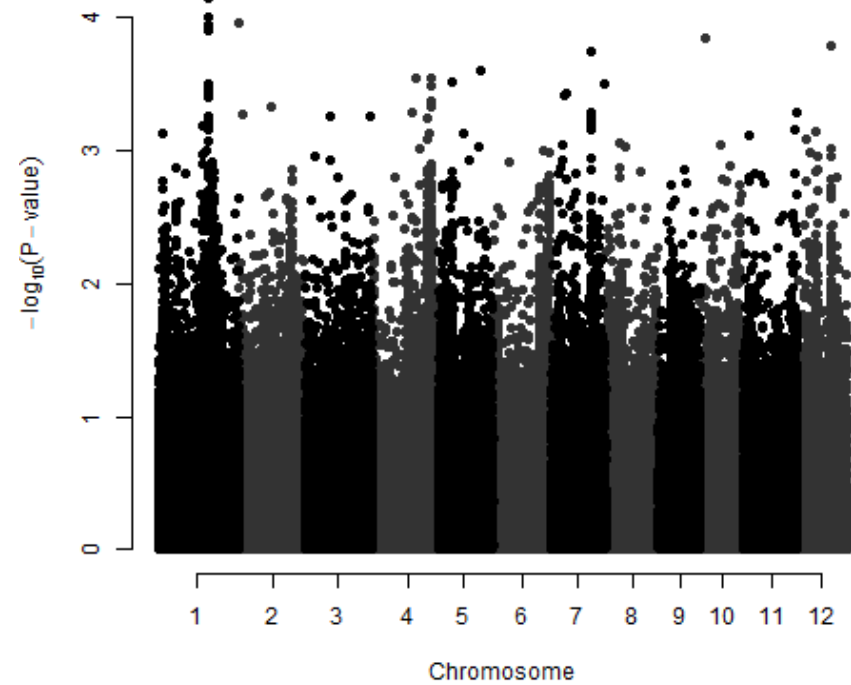
# Indica - $KS_{LT}$



# Japonica - $KS_{LT}$

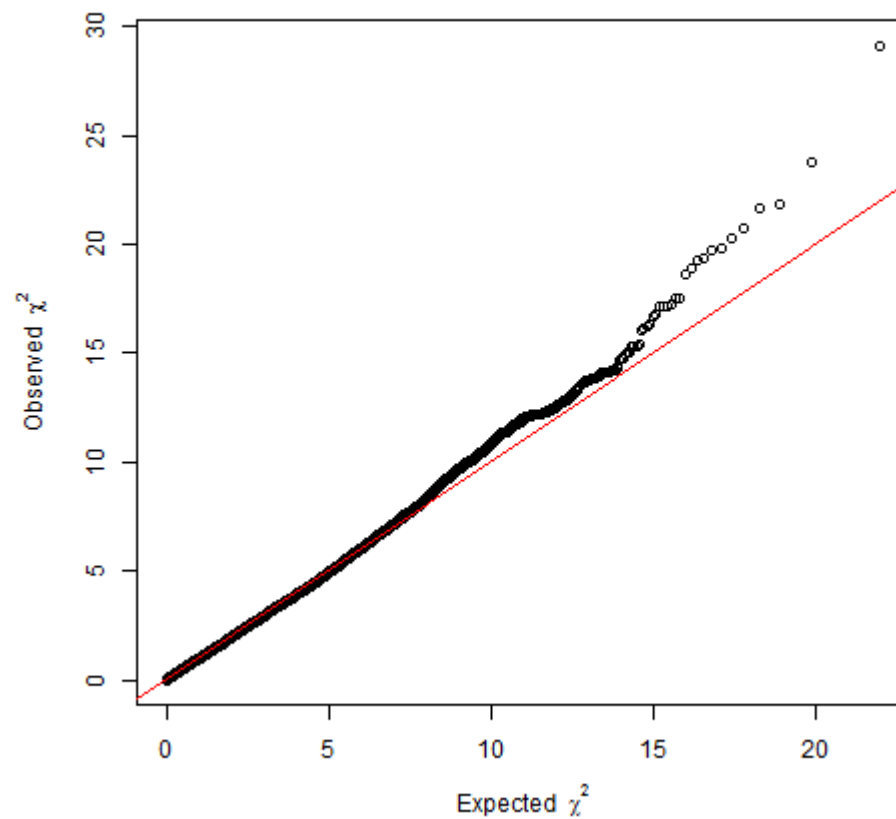
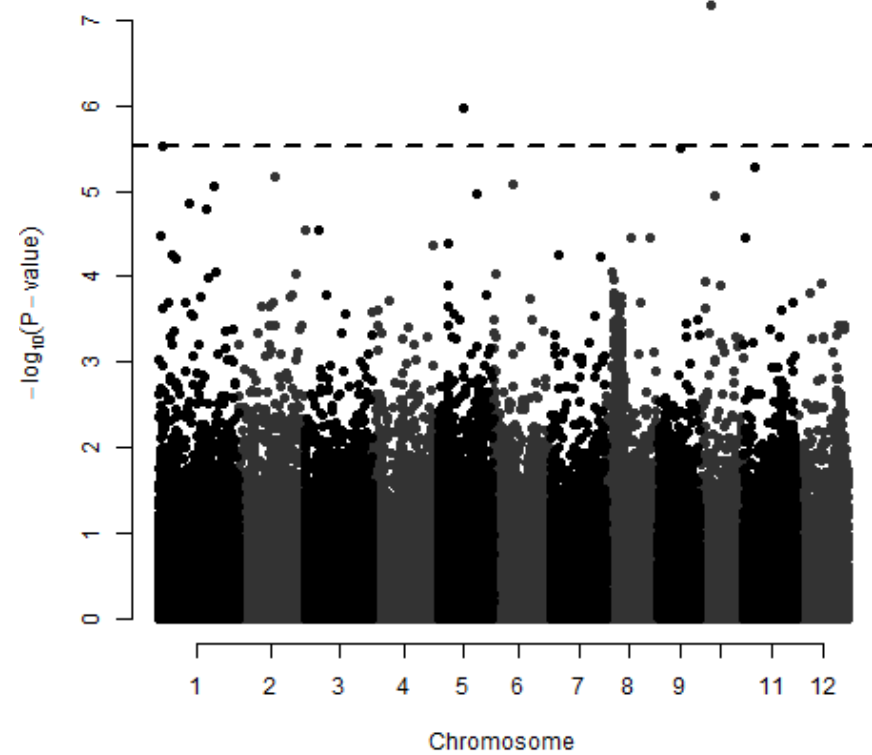


aus -  $KS_{LT}$

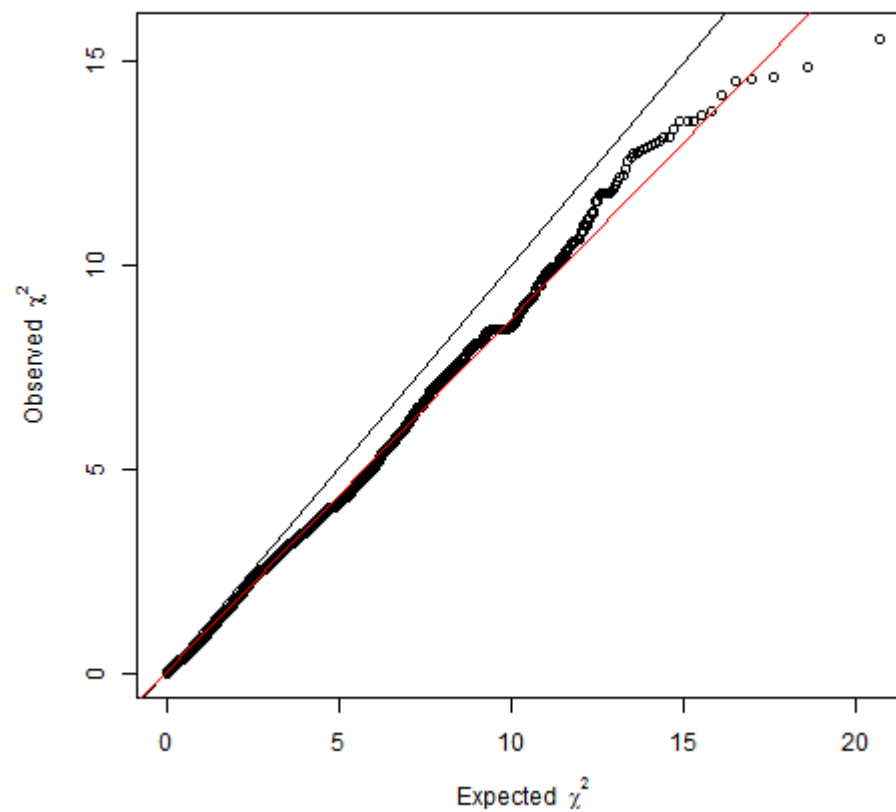
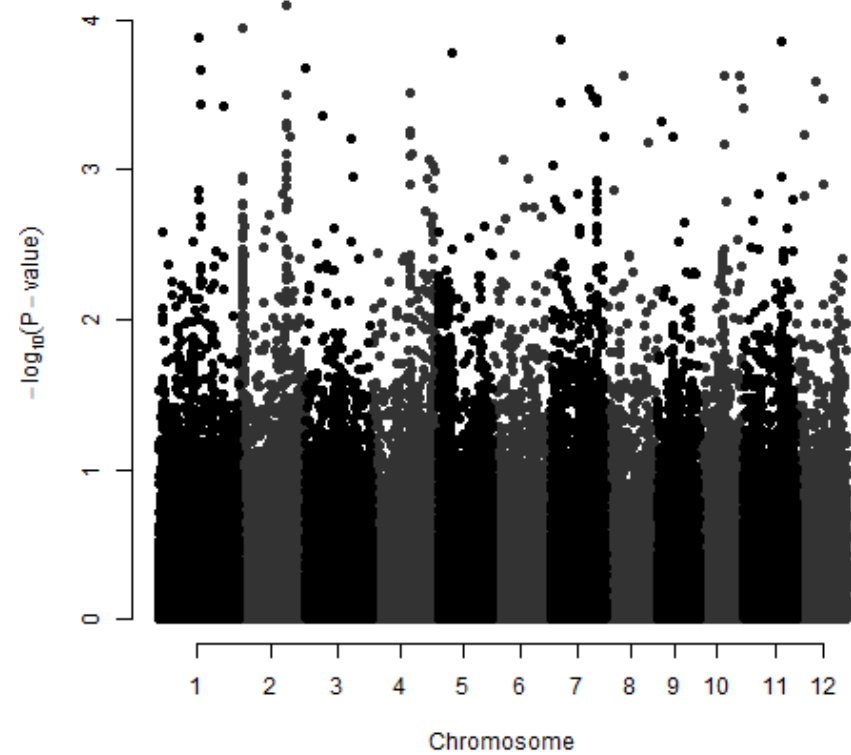




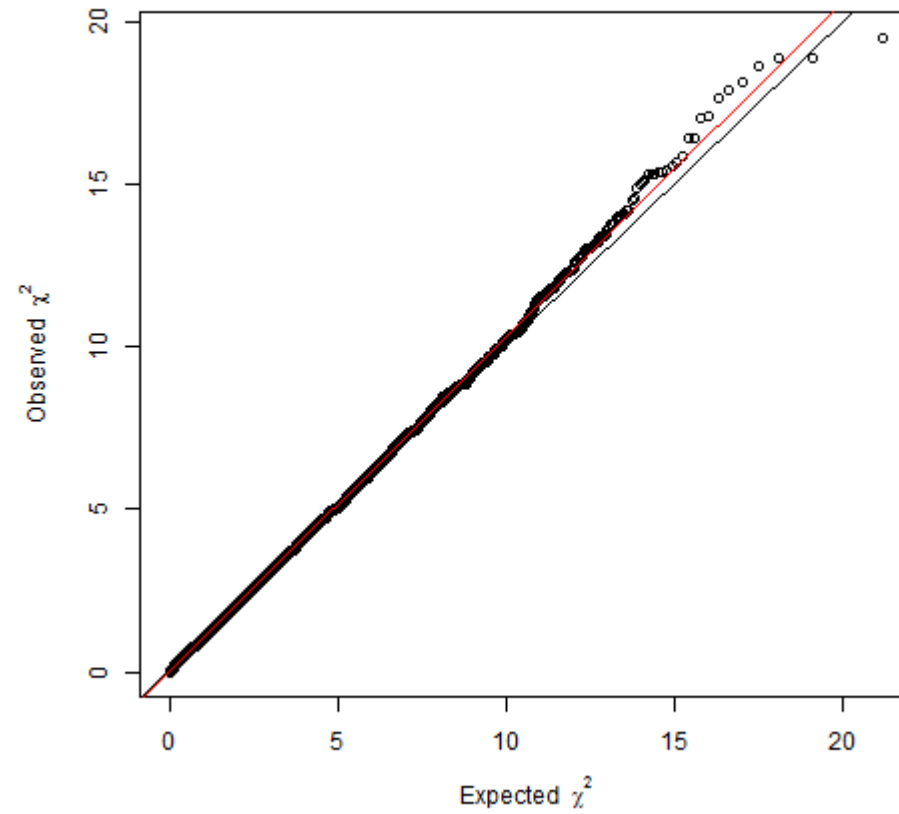
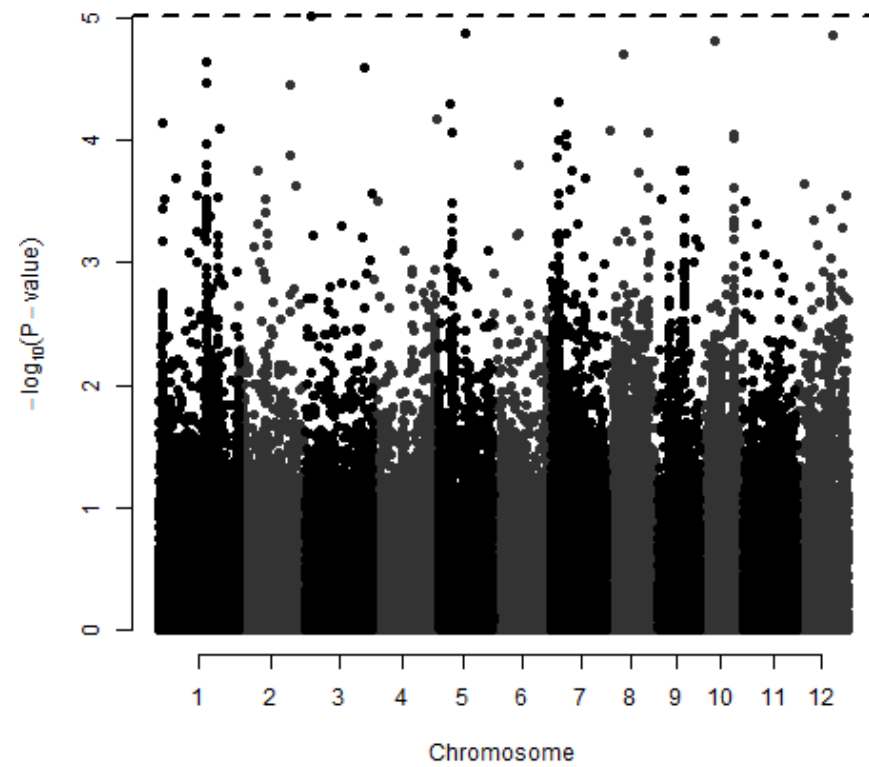
indica -  $KS_{LT}$



# temperate japonica - $KS_{LT}$



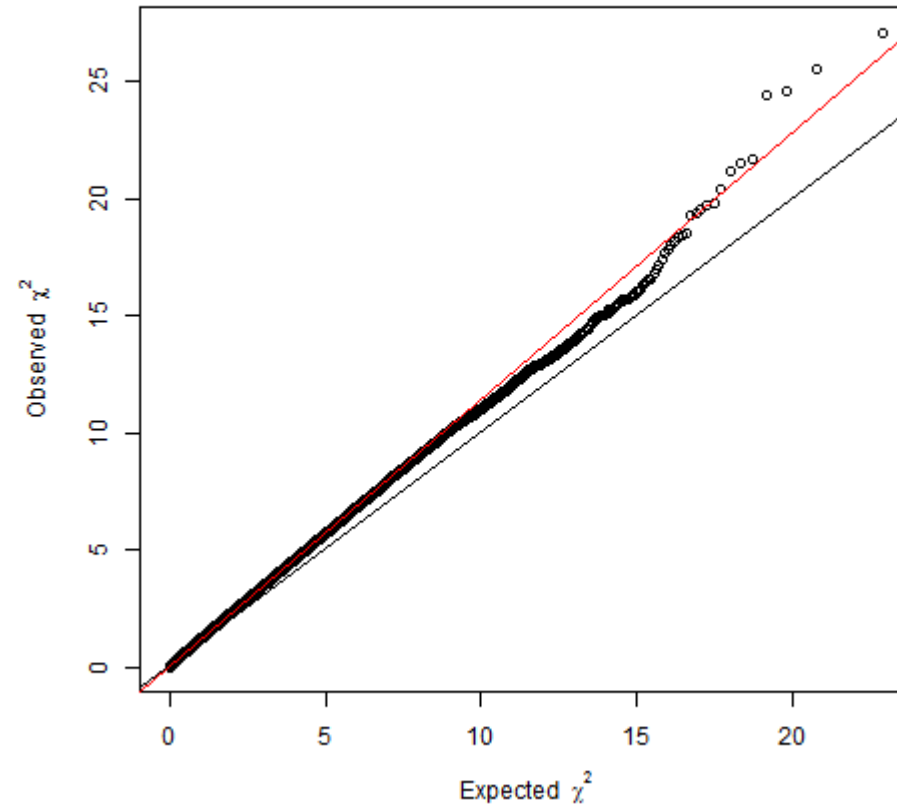
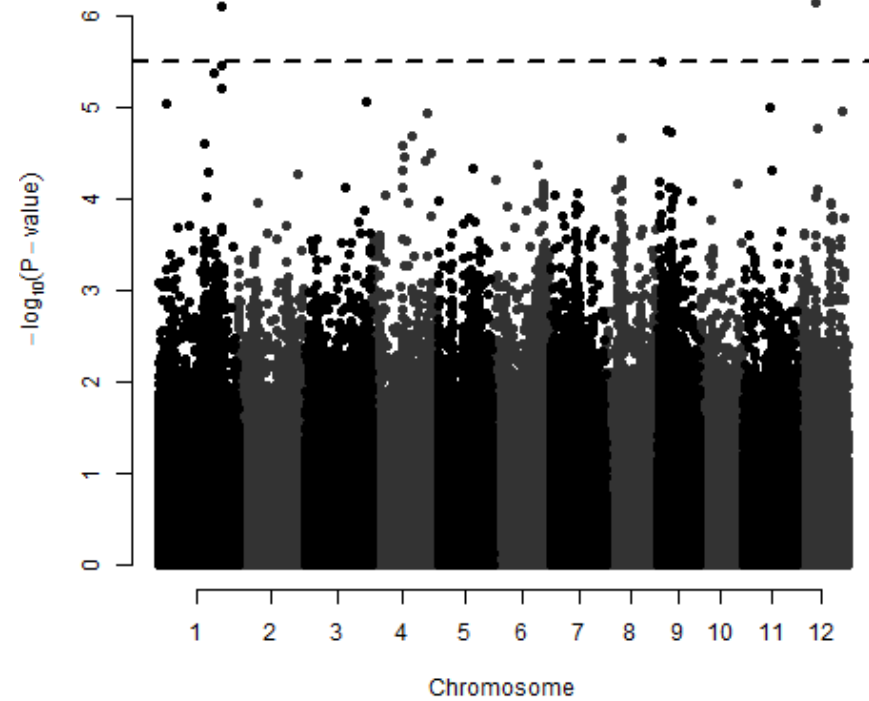
# tropical japonica - $KS_{LT}$



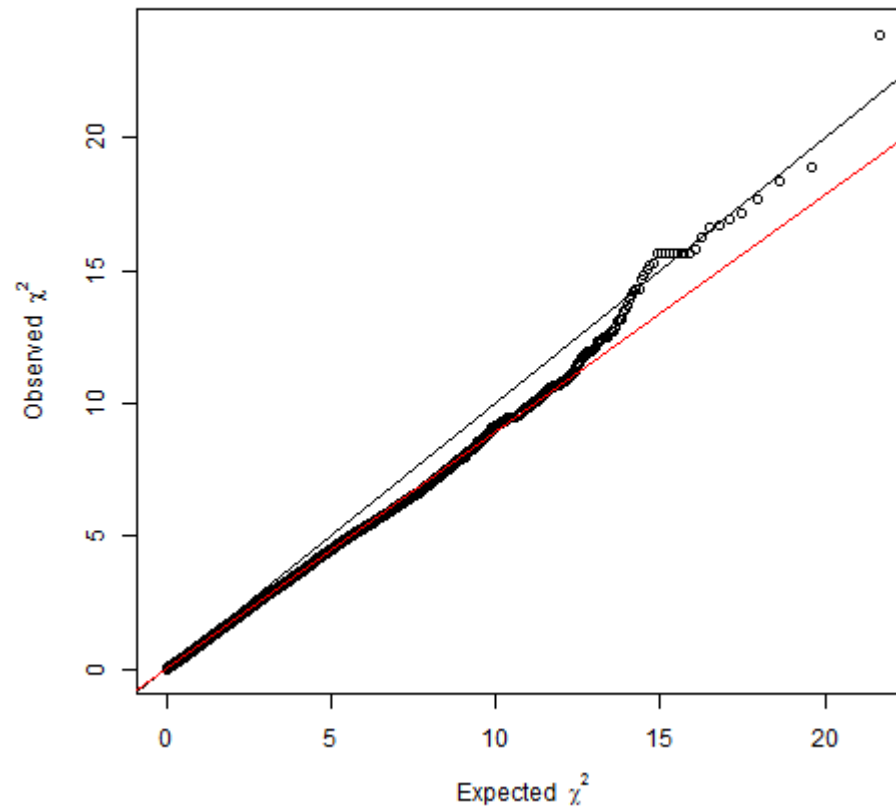
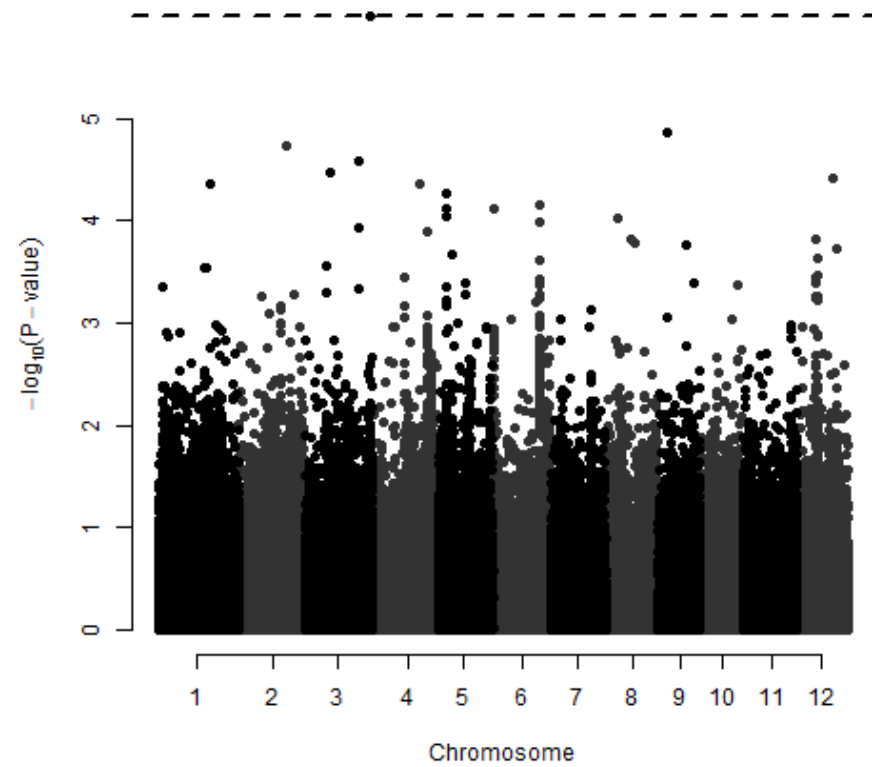
KU<sub>t</sub>R

Potassium utilisation ratio

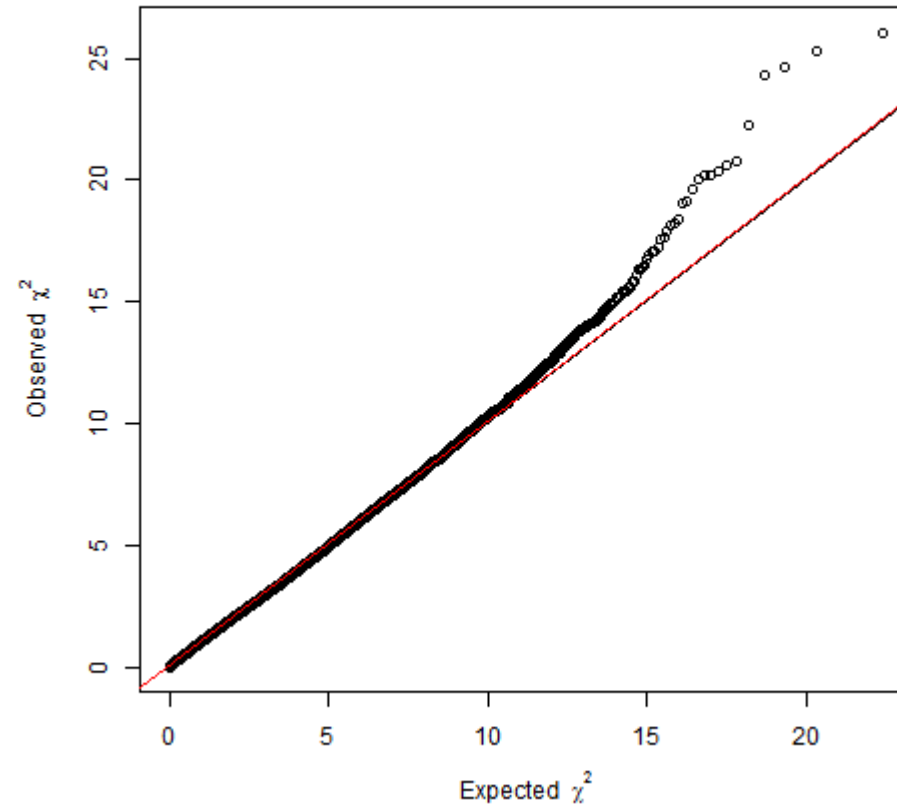
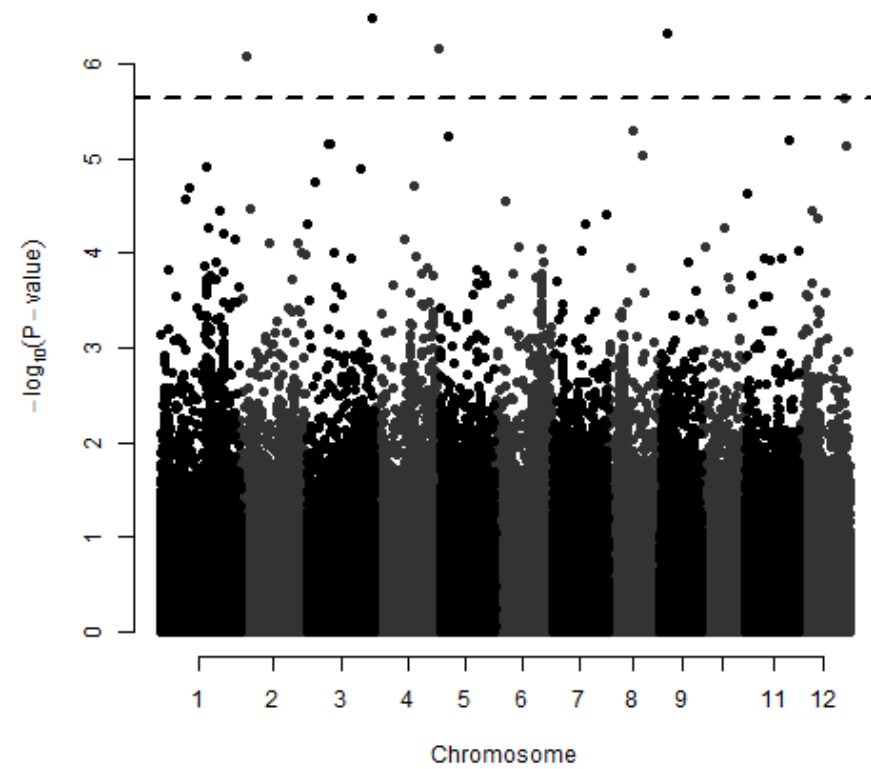
# All genotypes - KUtR



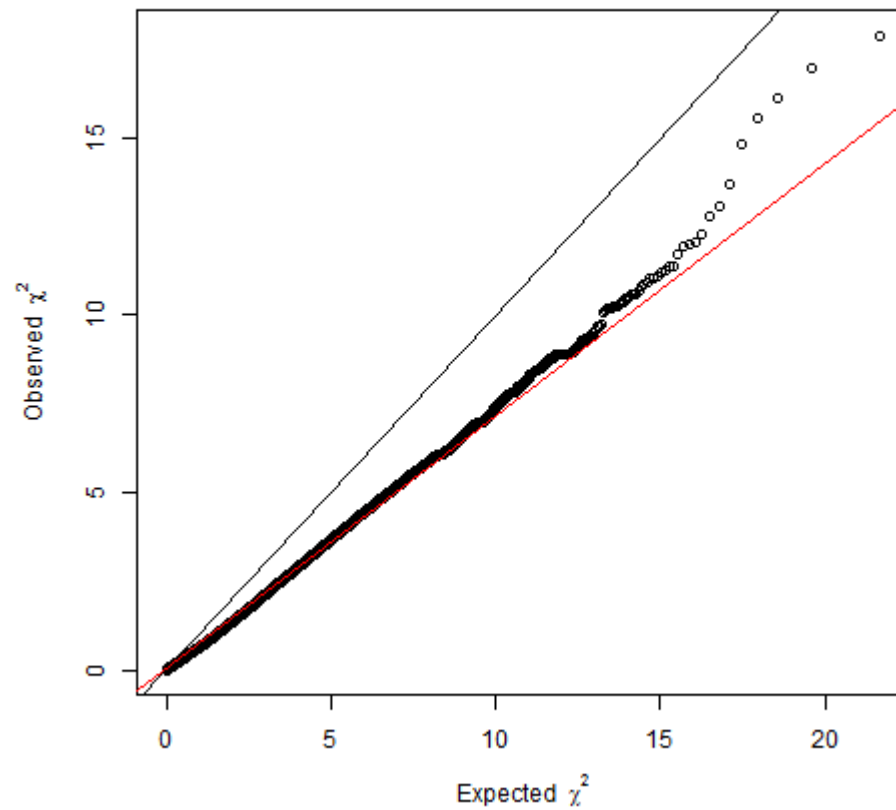
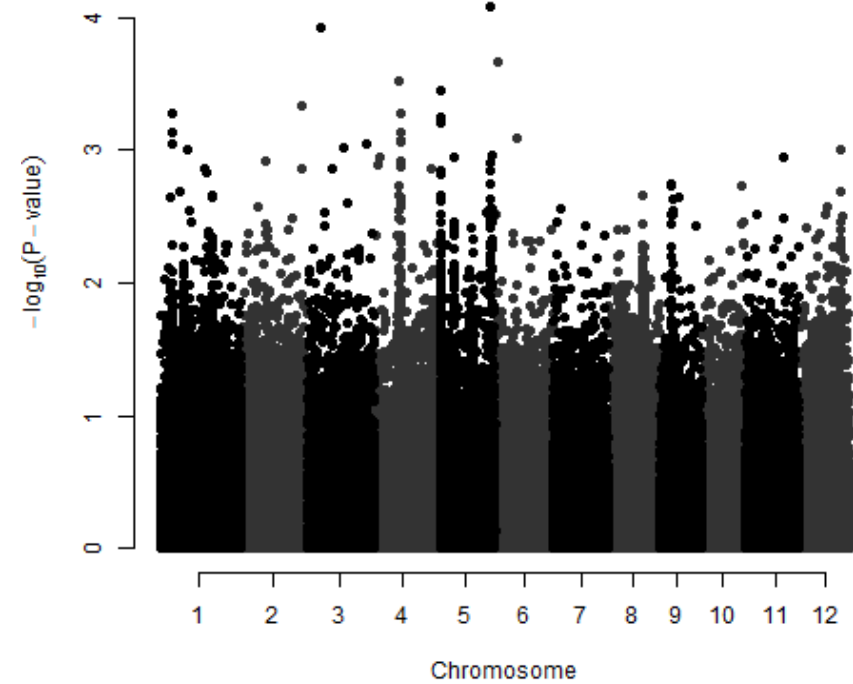
# aus - KUtR



# Indica - KUtR

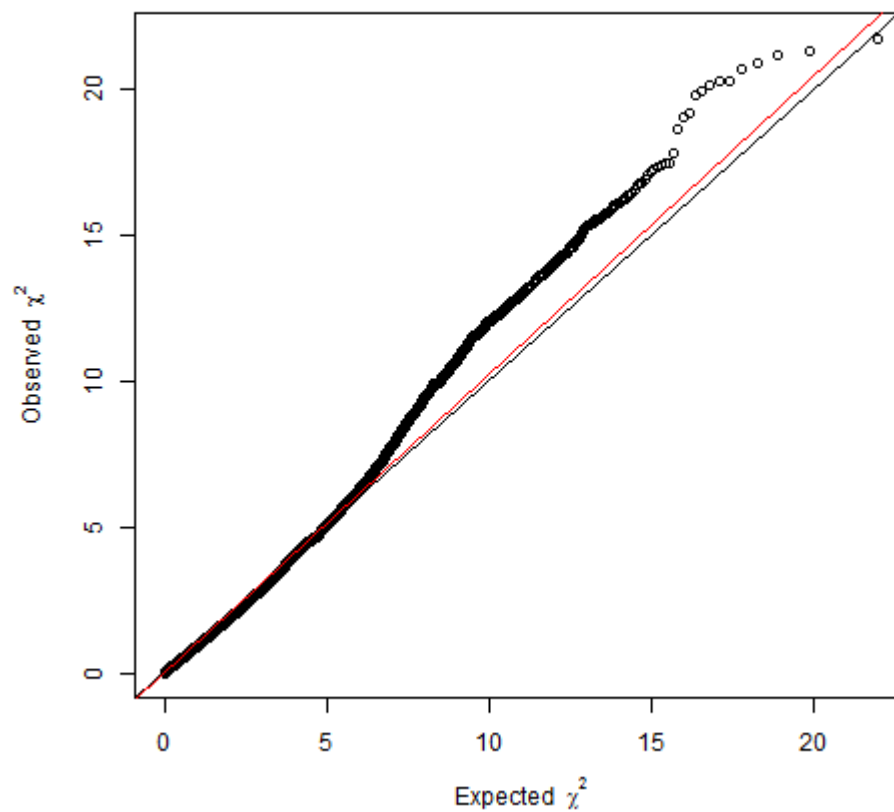
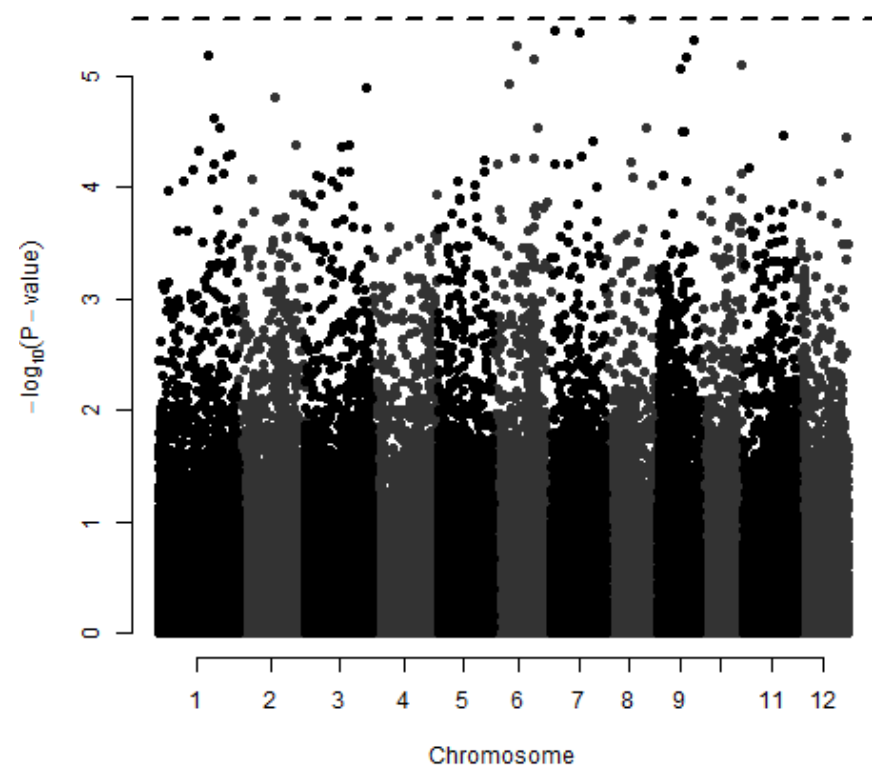


# Japonica - KUtR

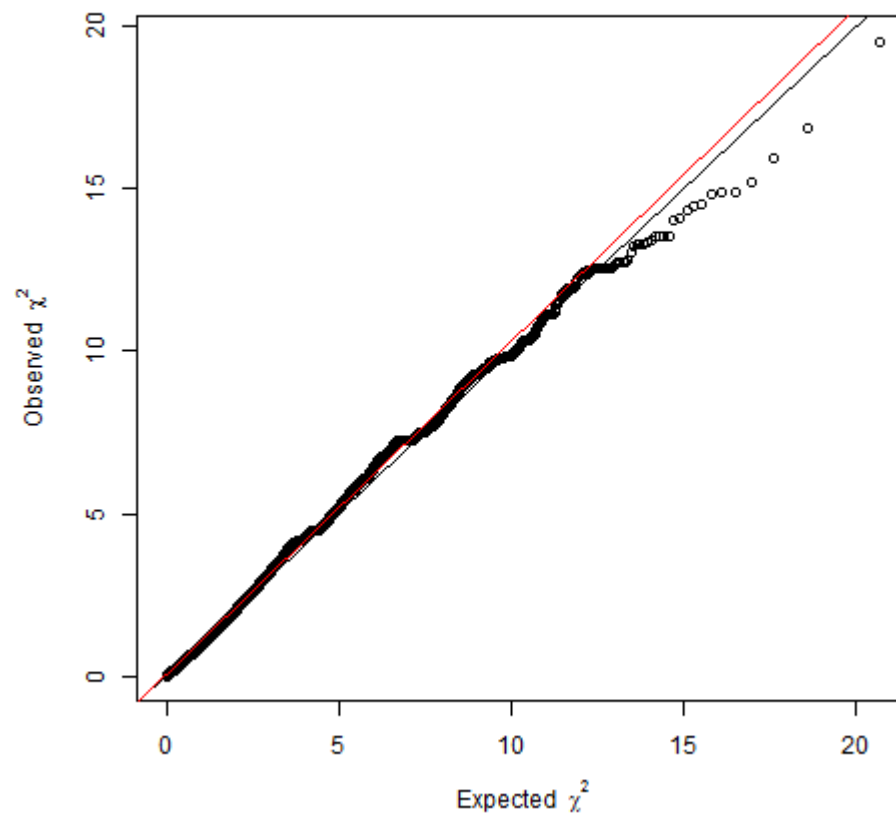
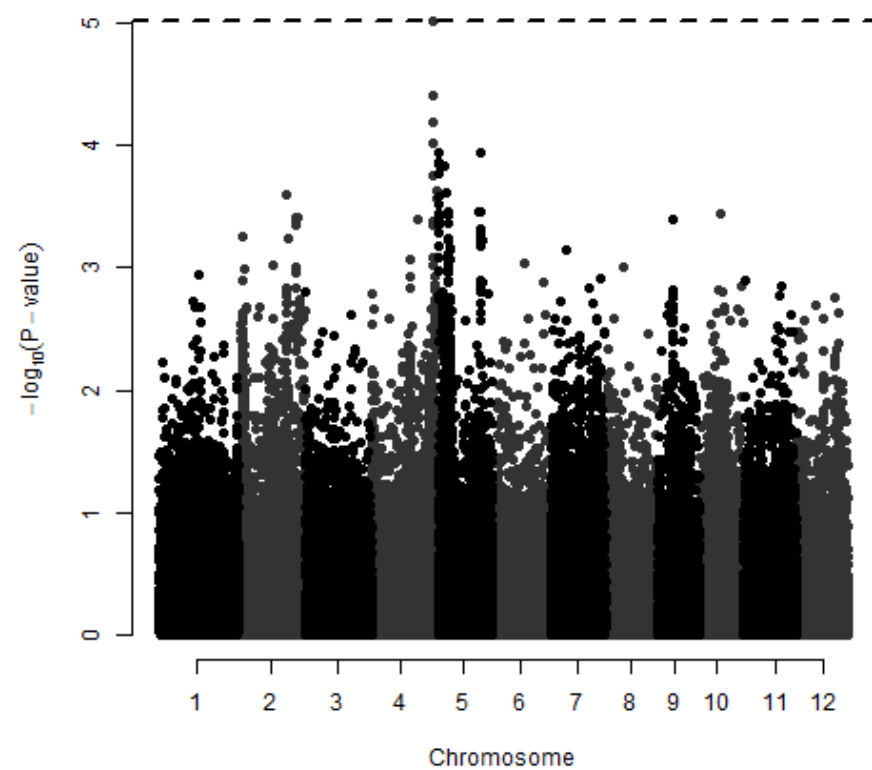




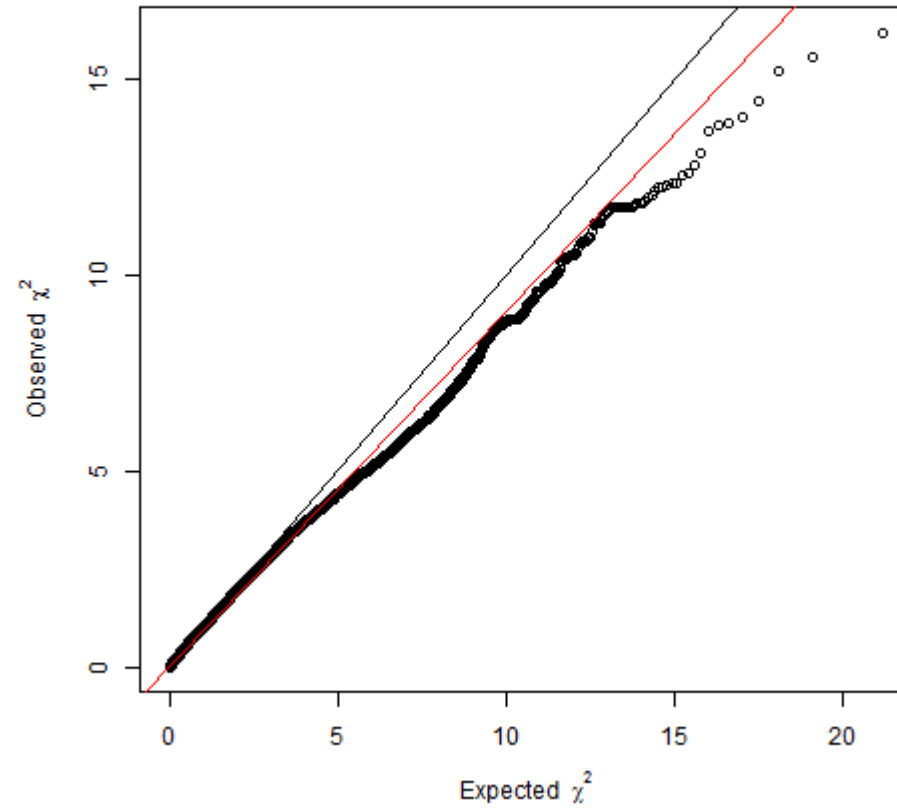
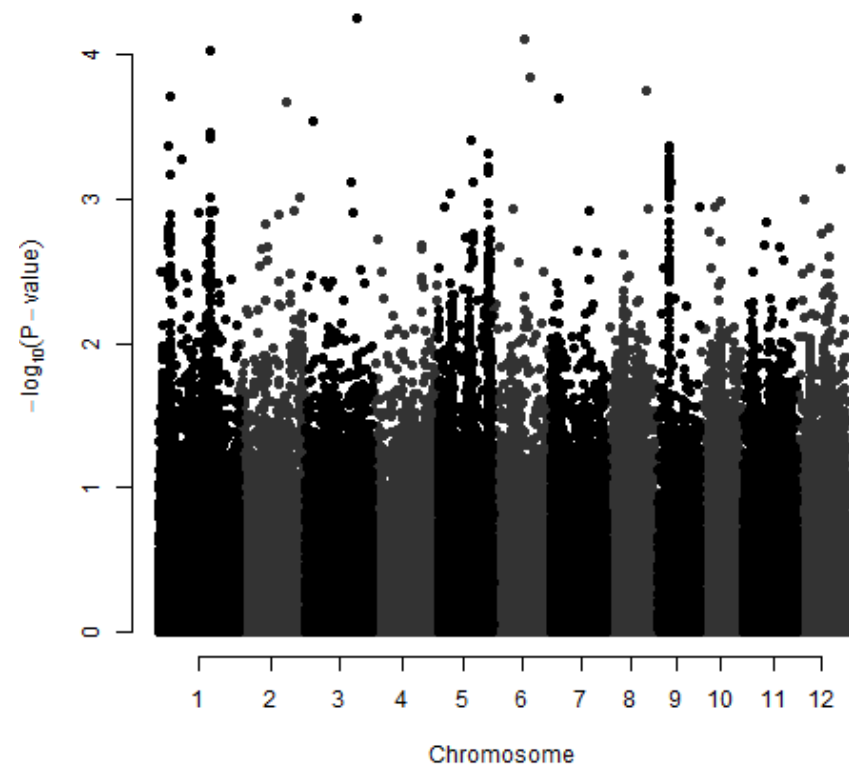
# indica - KUtR



# temperate japonica - KUtR



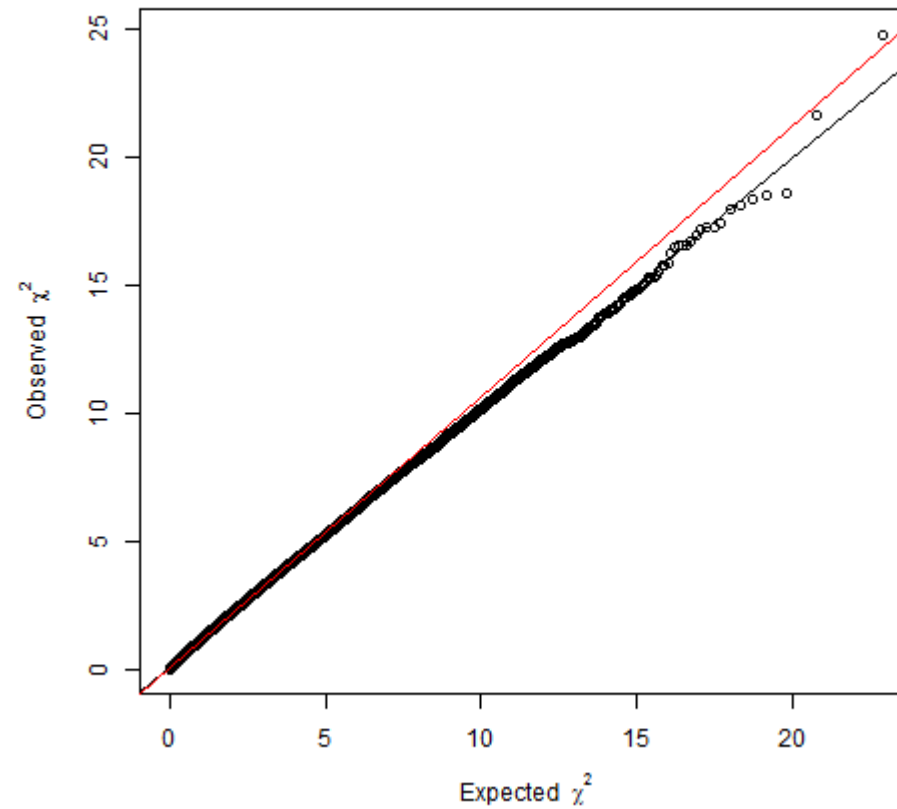
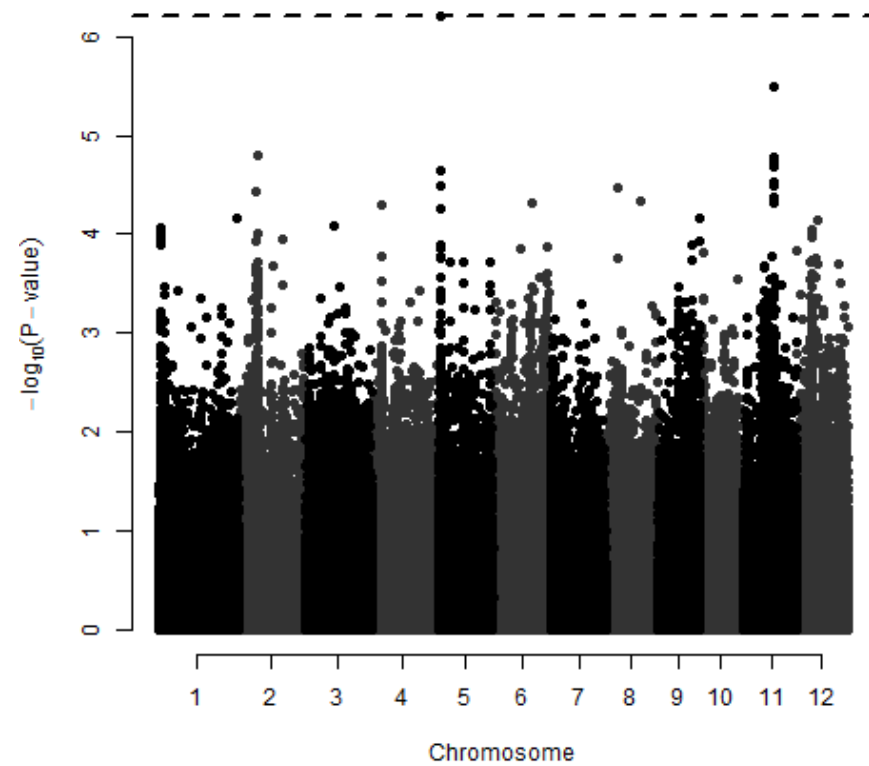
# tropical japonica - KUtR



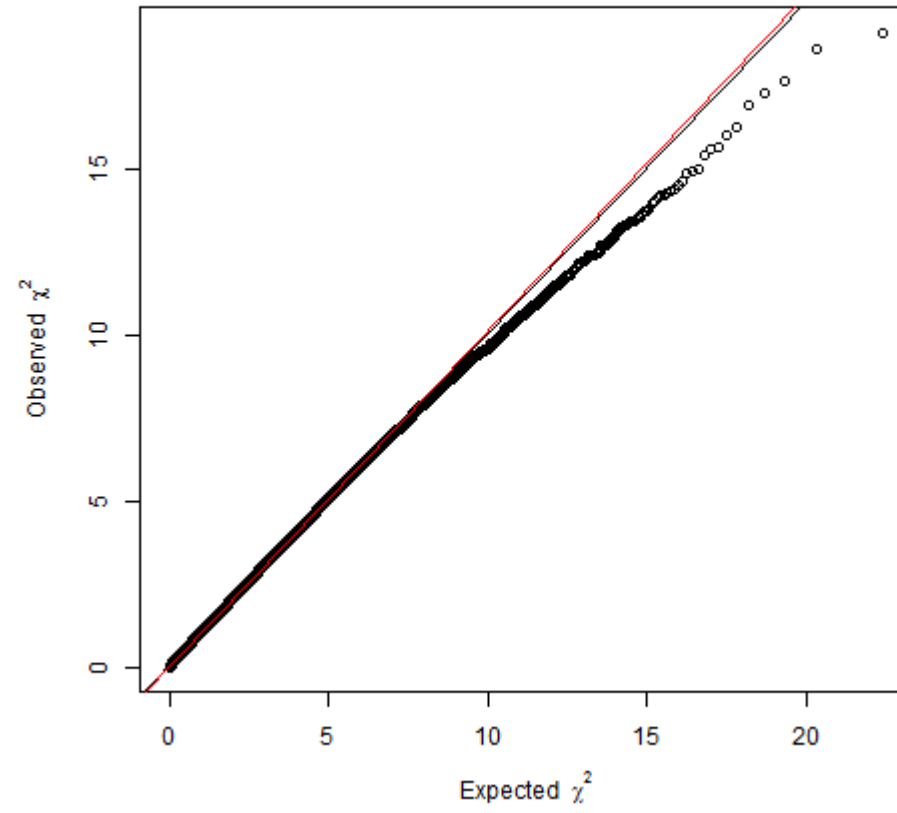
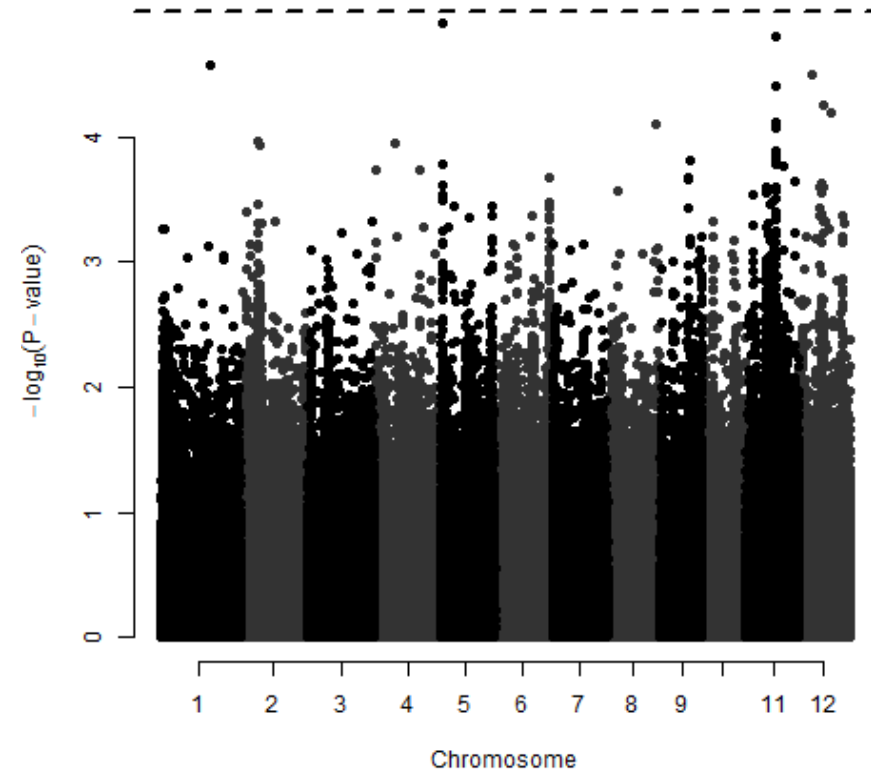
$\text{NaR}_{\text{HT}}$

Root sodium concentration high treatment

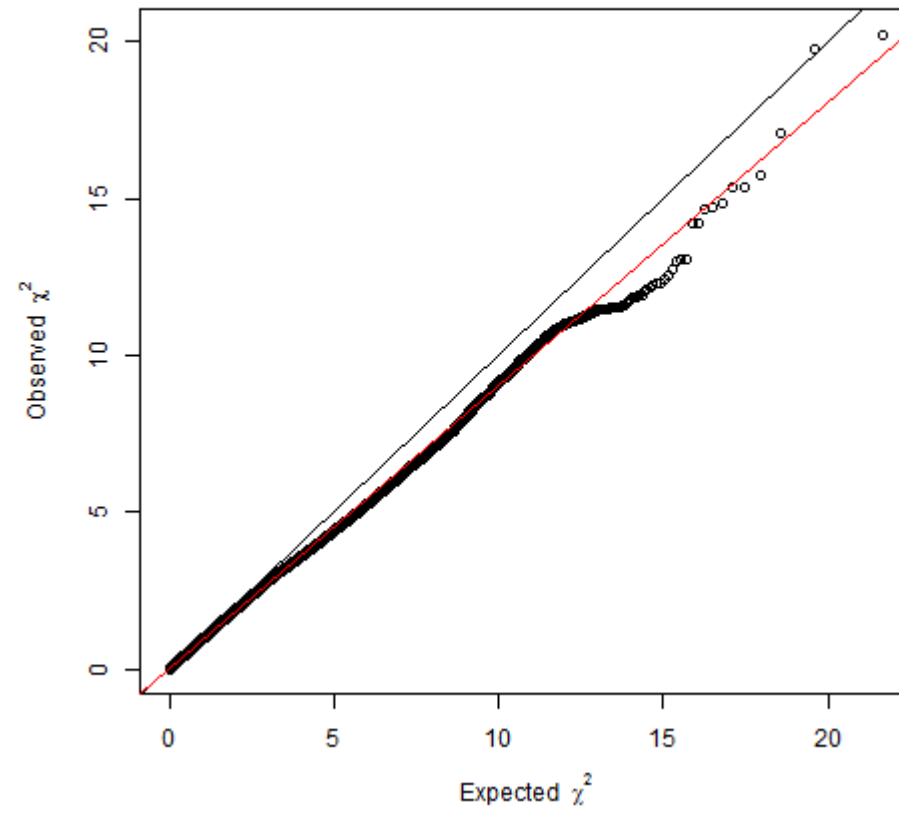
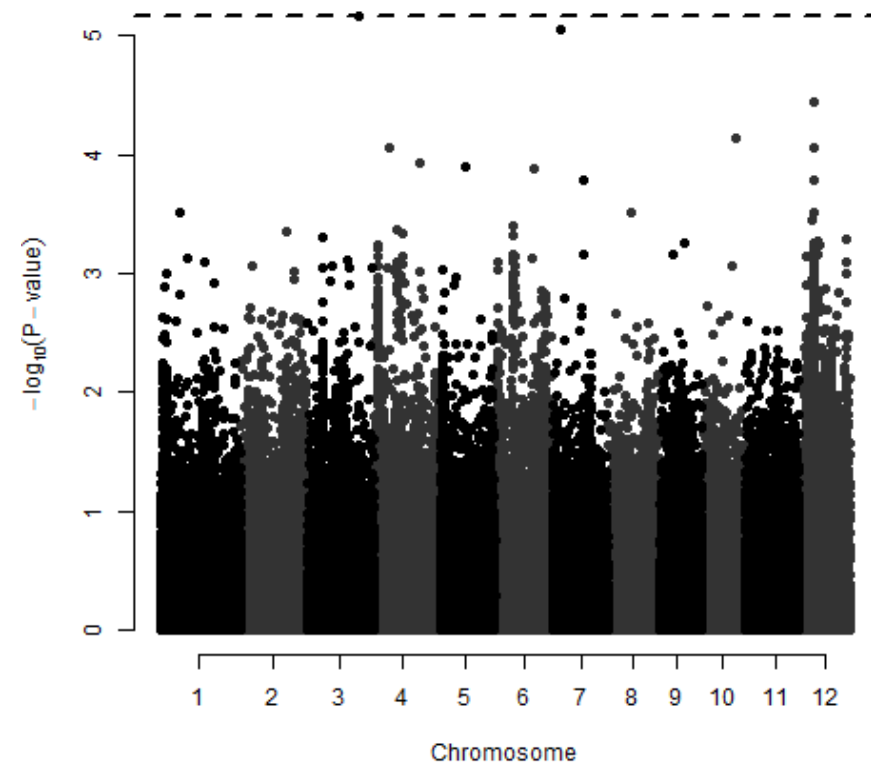
# All genotypes - $\text{NaR}_{\text{HT}}$



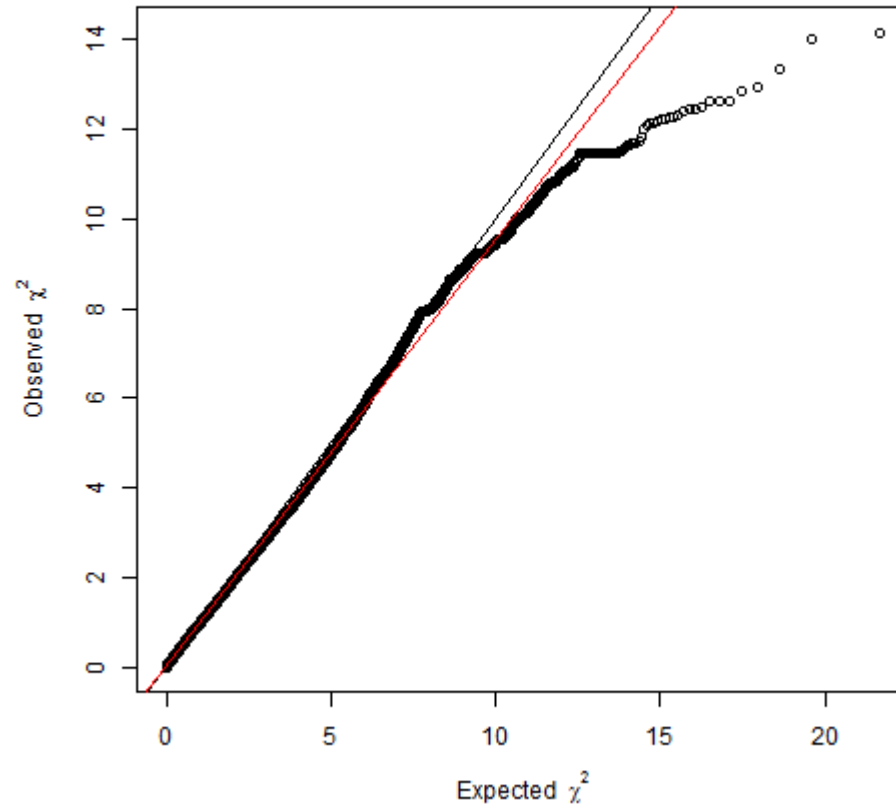
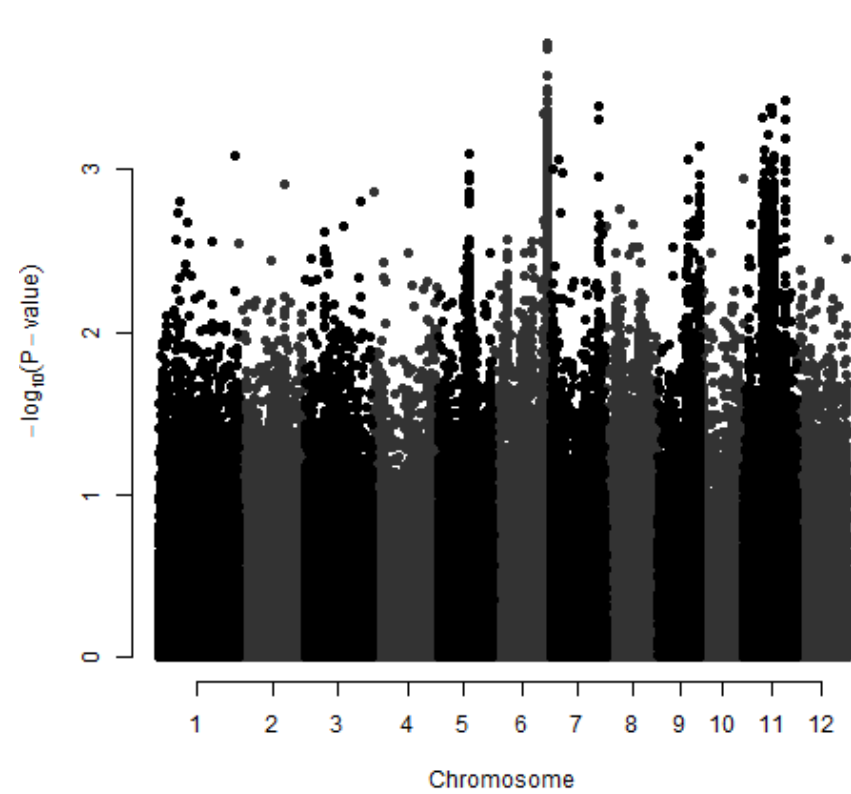
# Indica - NaR<sub>HT</sub>



# Japonica - NaR<sub>HT</sub>

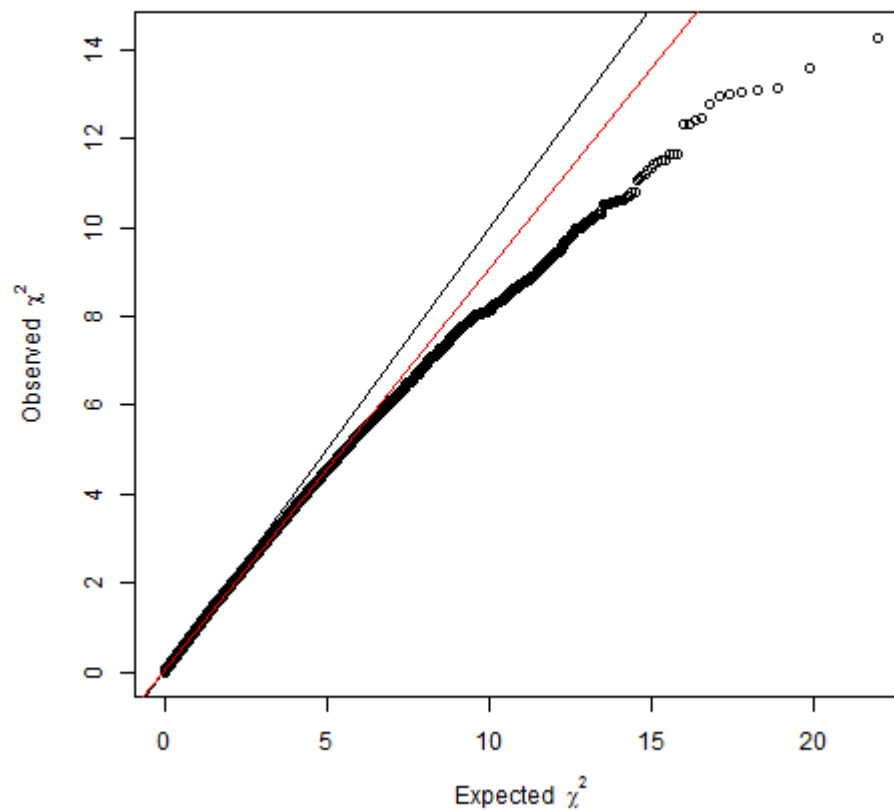
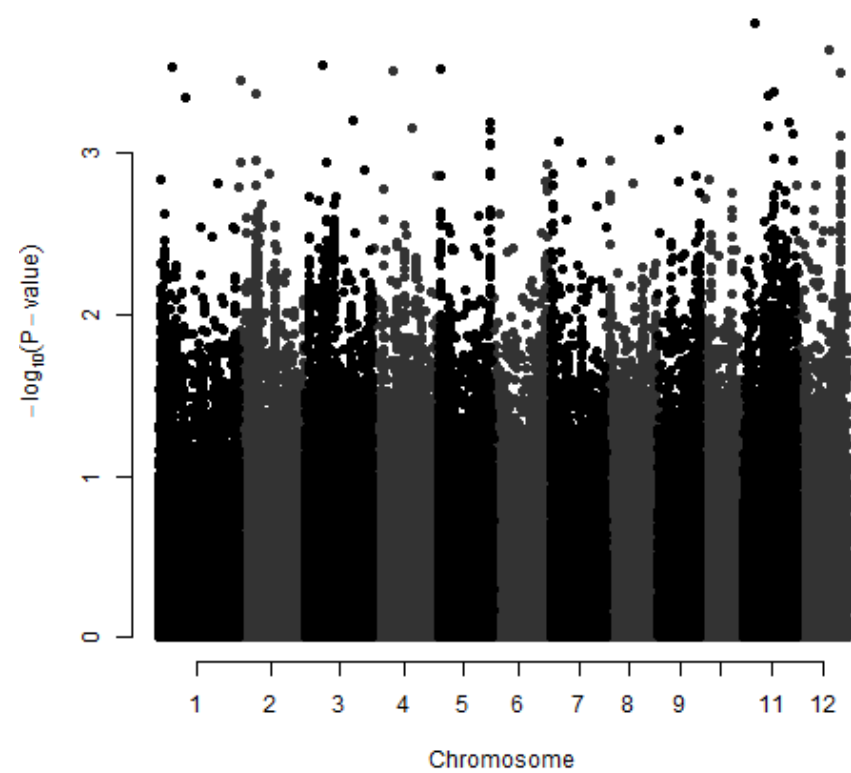


aus -  $\text{NaR}_{\text{HT}}$

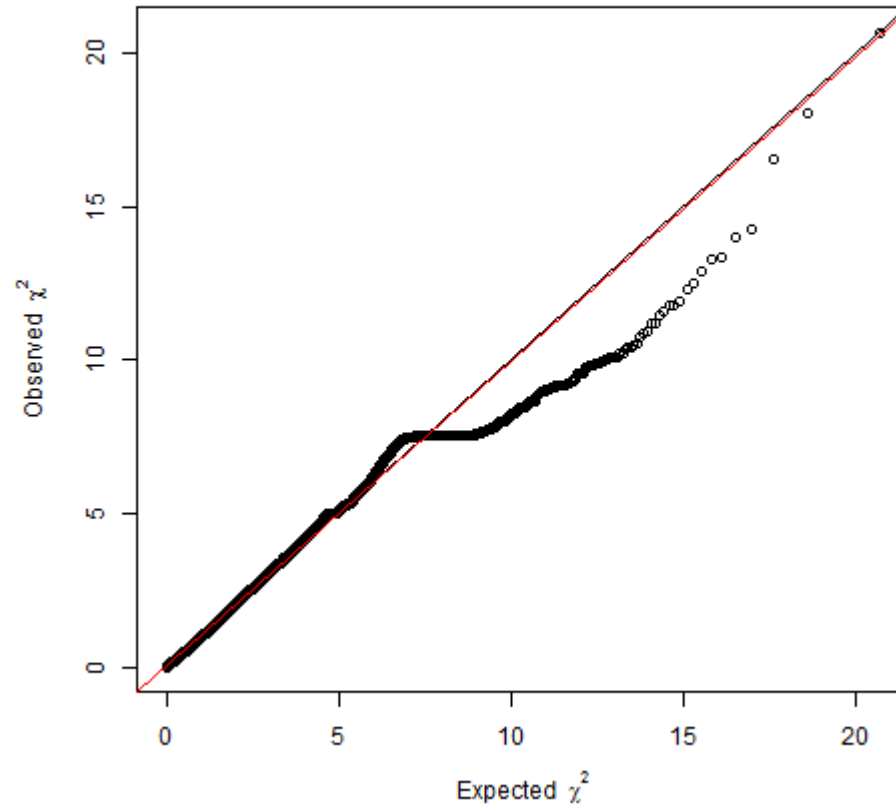
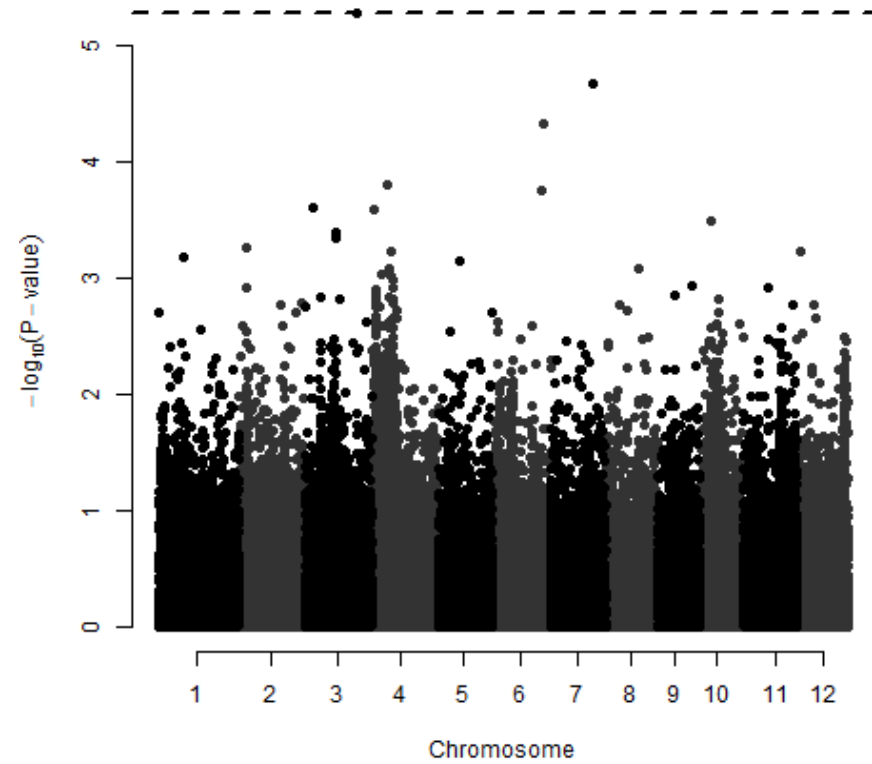




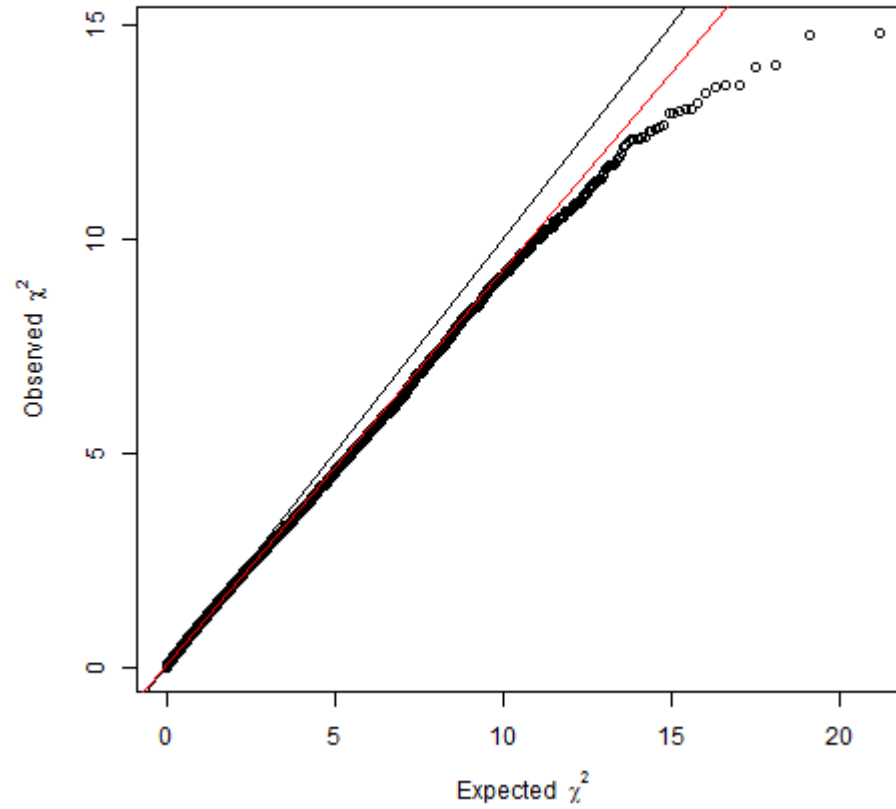
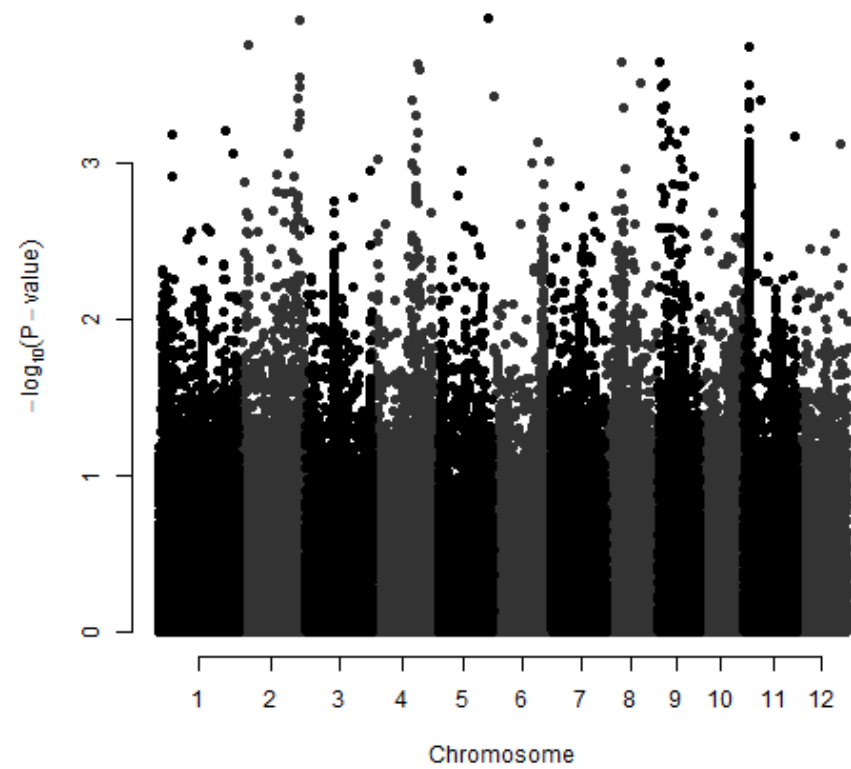
indica -  $\text{NaR}_{\text{HT}}$



# temperate japonica - $\text{NaR}_{\text{HT}}$



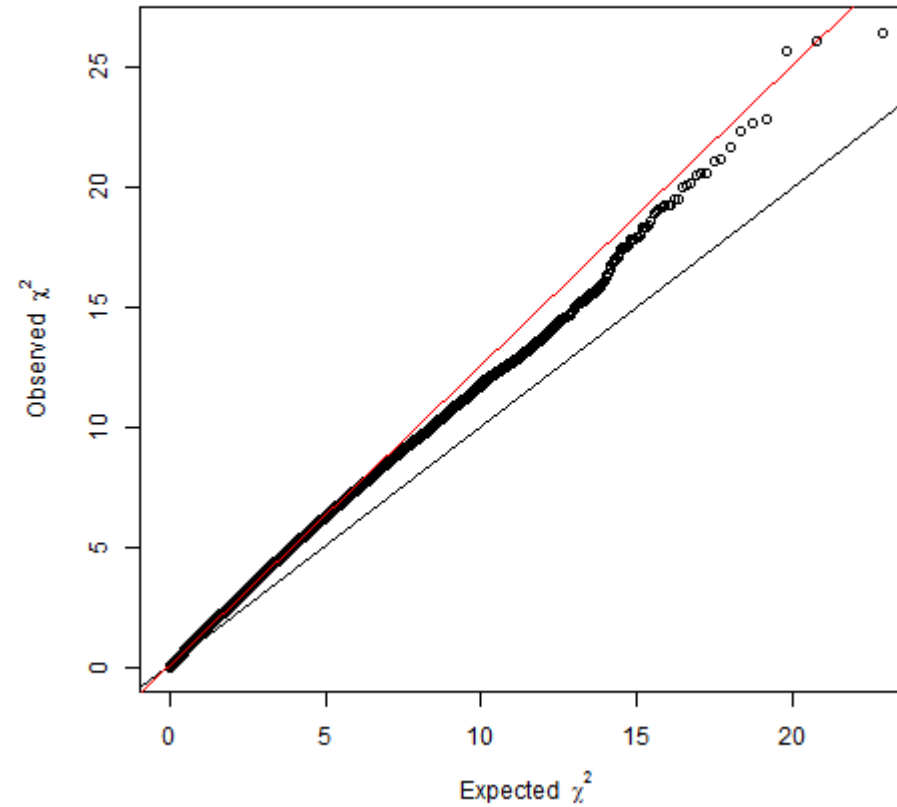
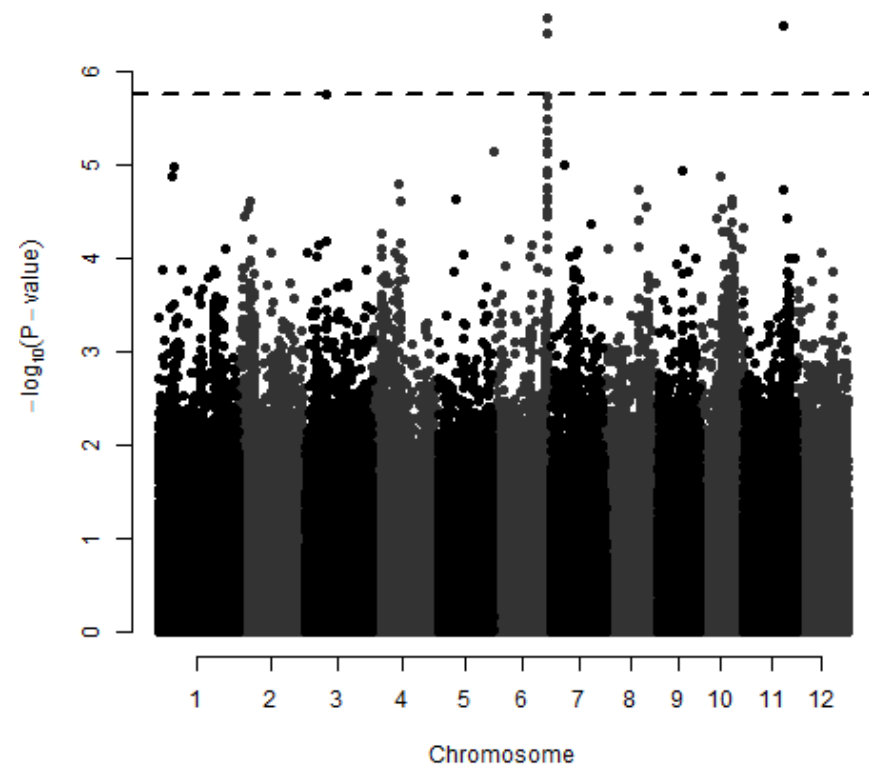
# tropical japonica - $\text{NaR}_{\text{HT}}$



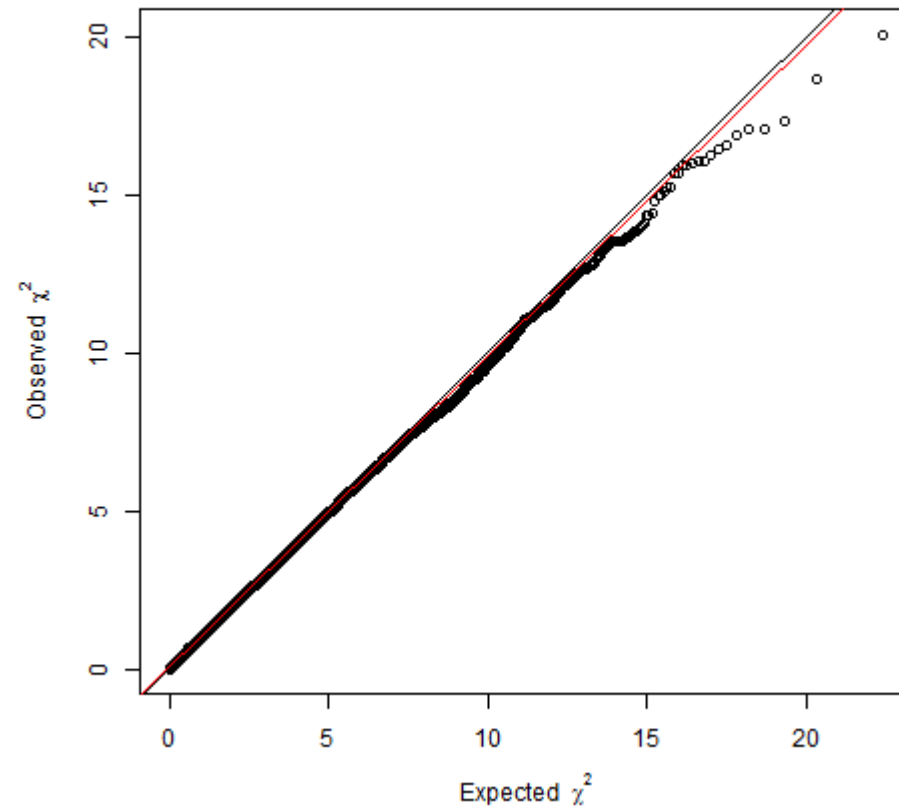
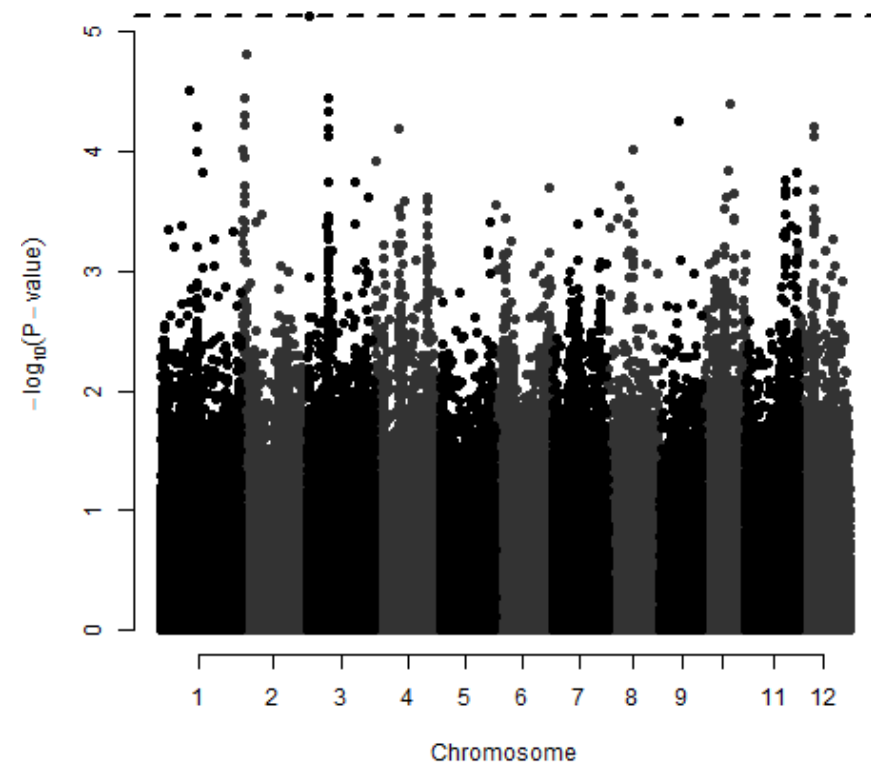
$$\text{NaR}_{\text{LT}}$$

Root sodium concentration in the low treatment

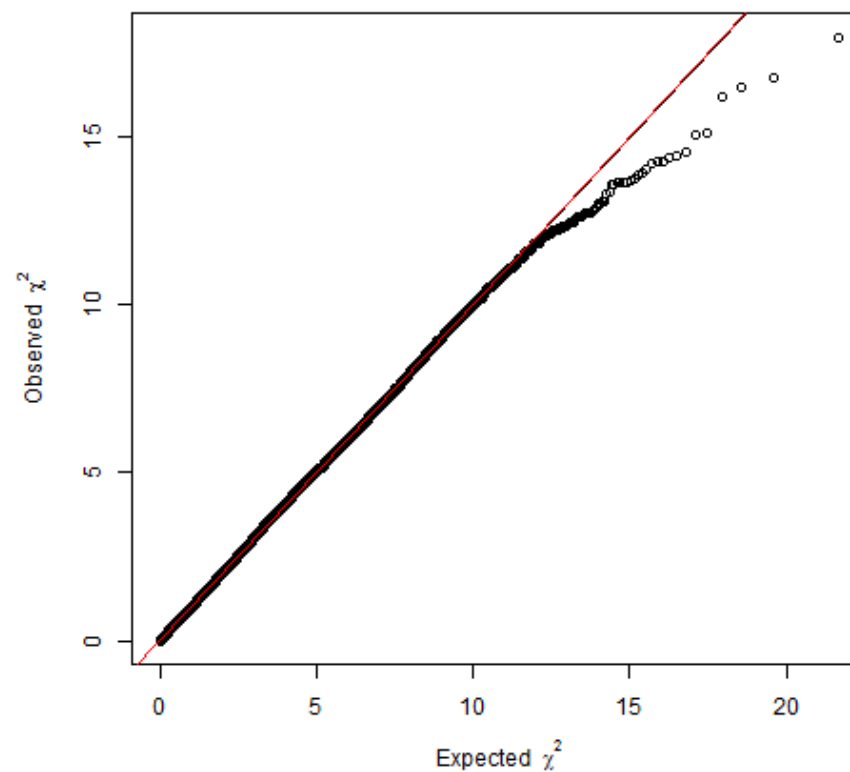
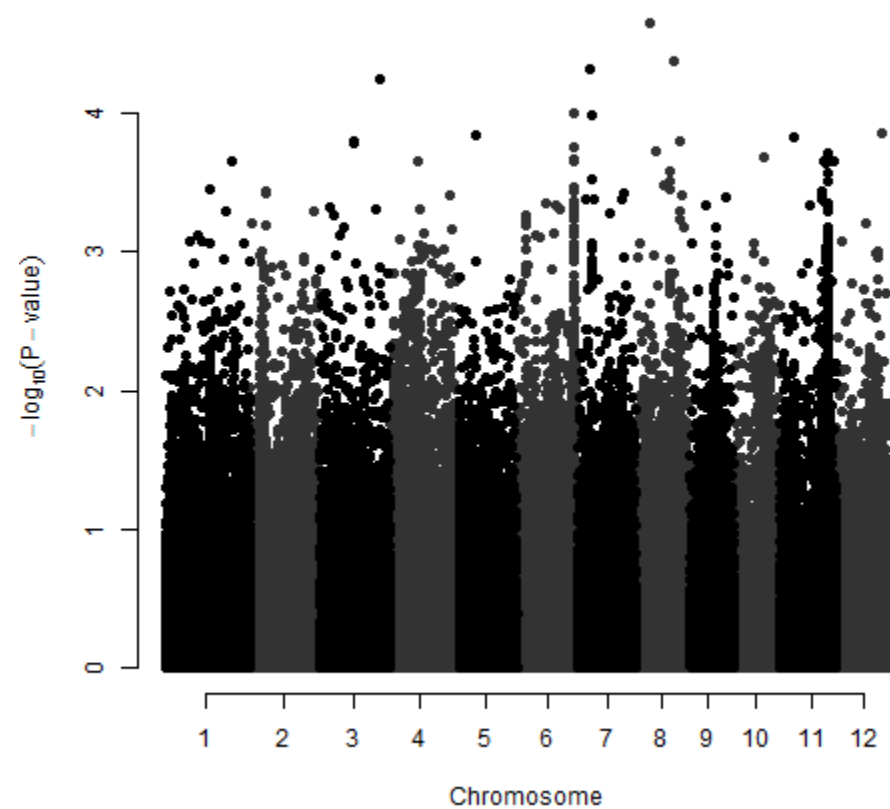
# All genotypes - NaR<sub>LT</sub>



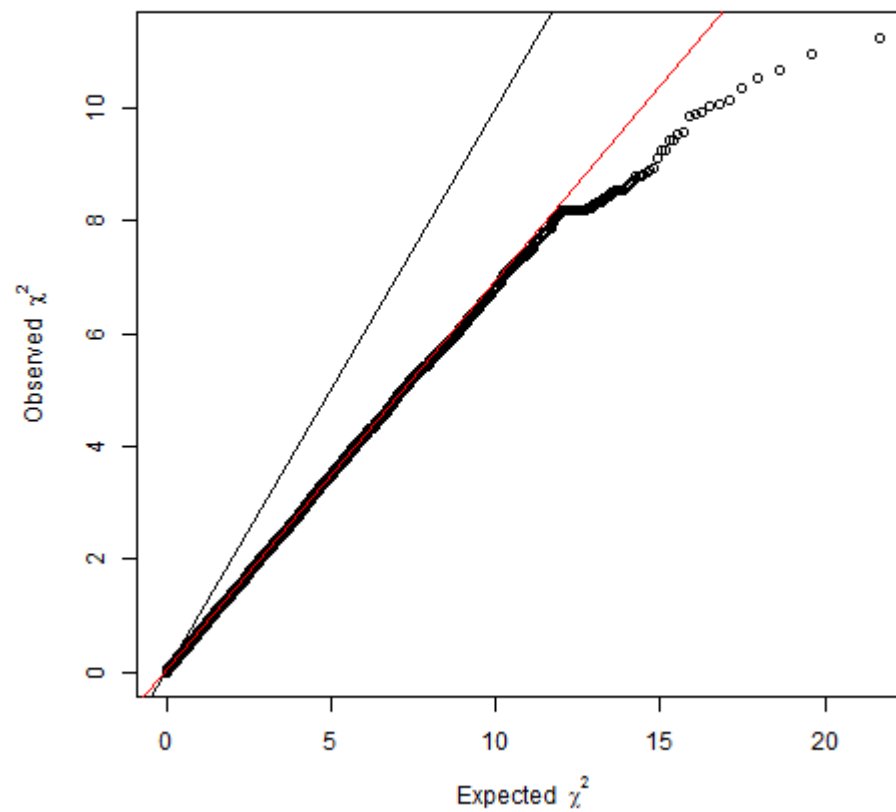
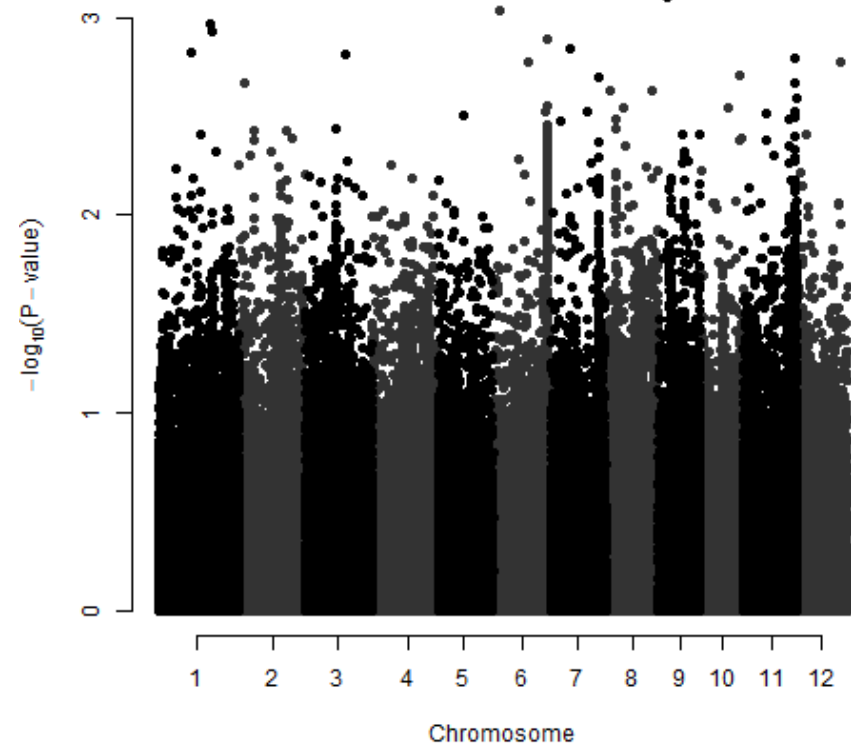
# Indica - NaR<sub>LT</sub>



# Japonica - NaR<sub>LT</sub>

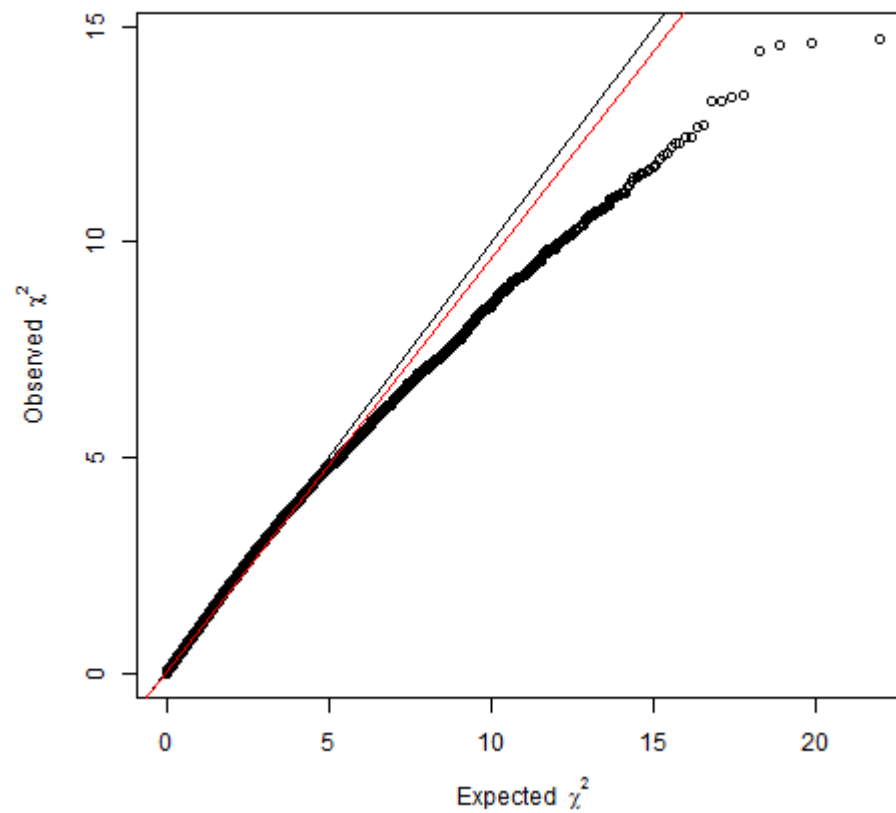
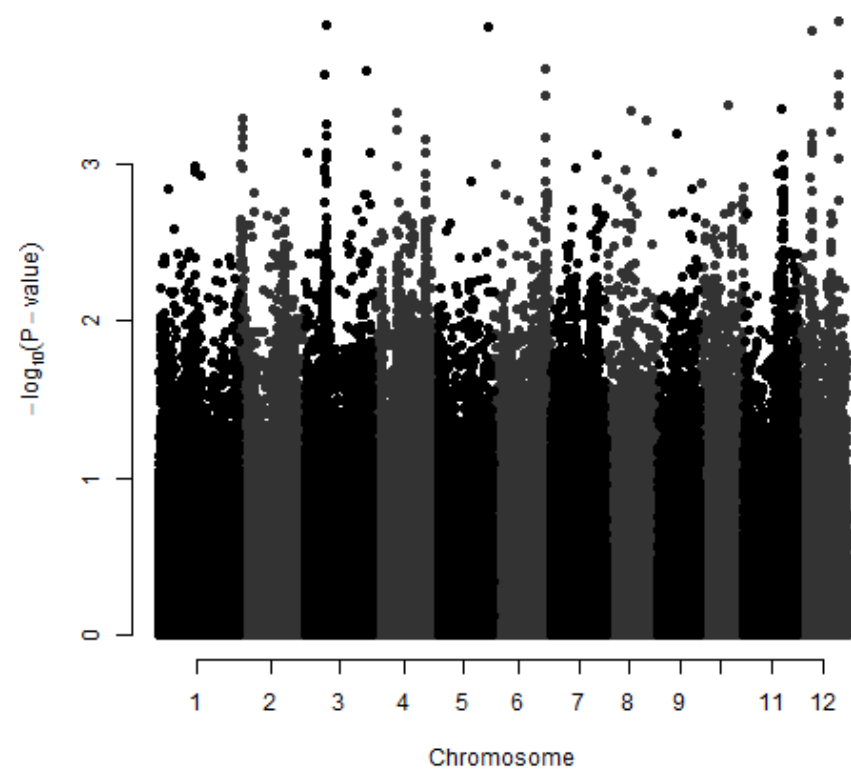


aus -  $\text{NaR}_{\text{LT}}$

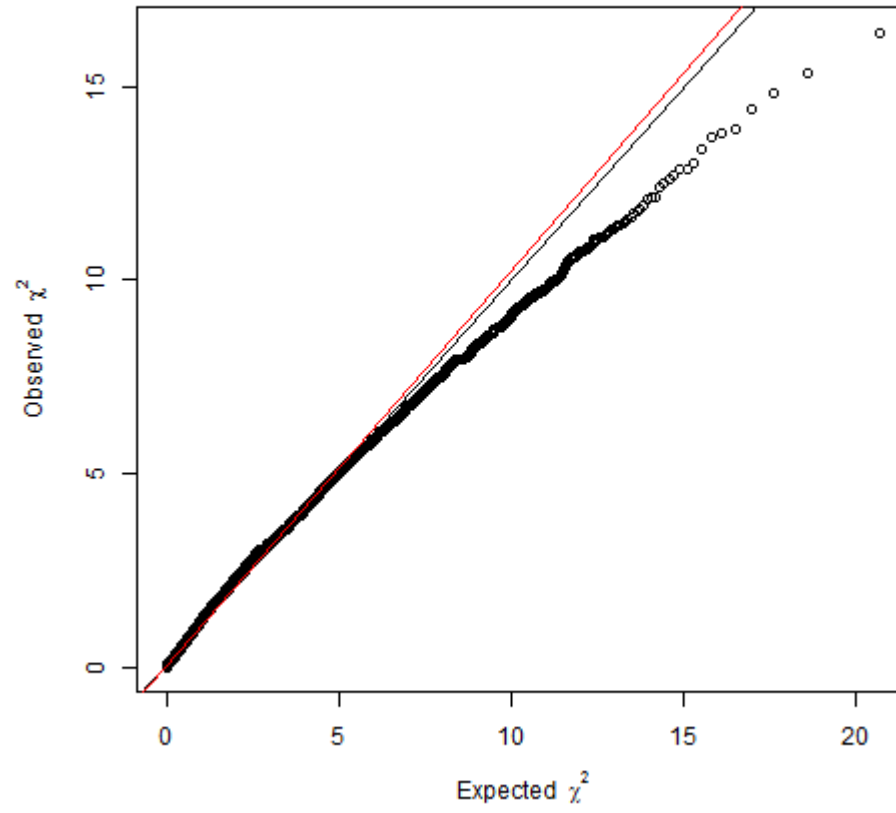
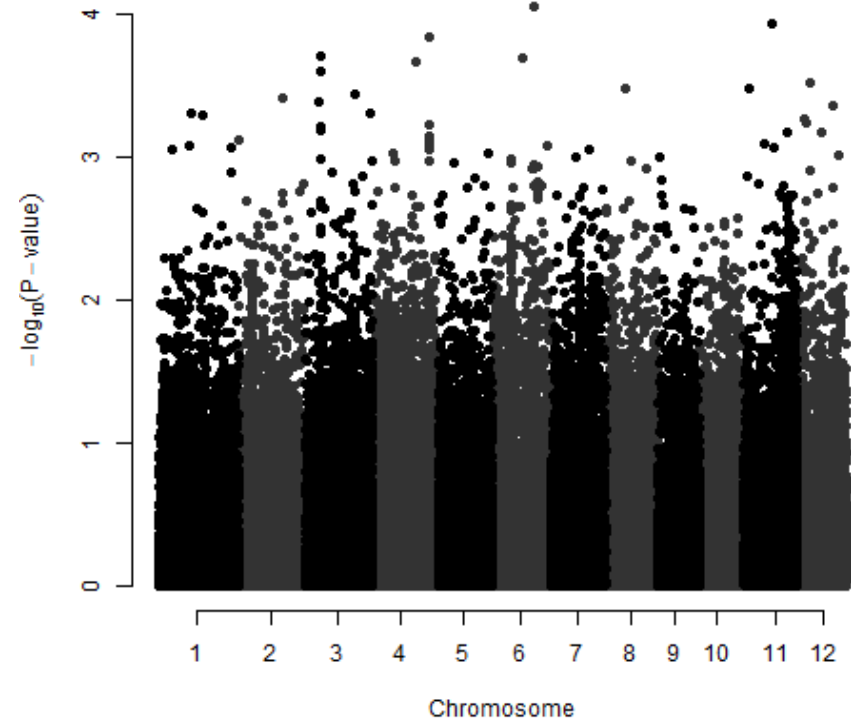




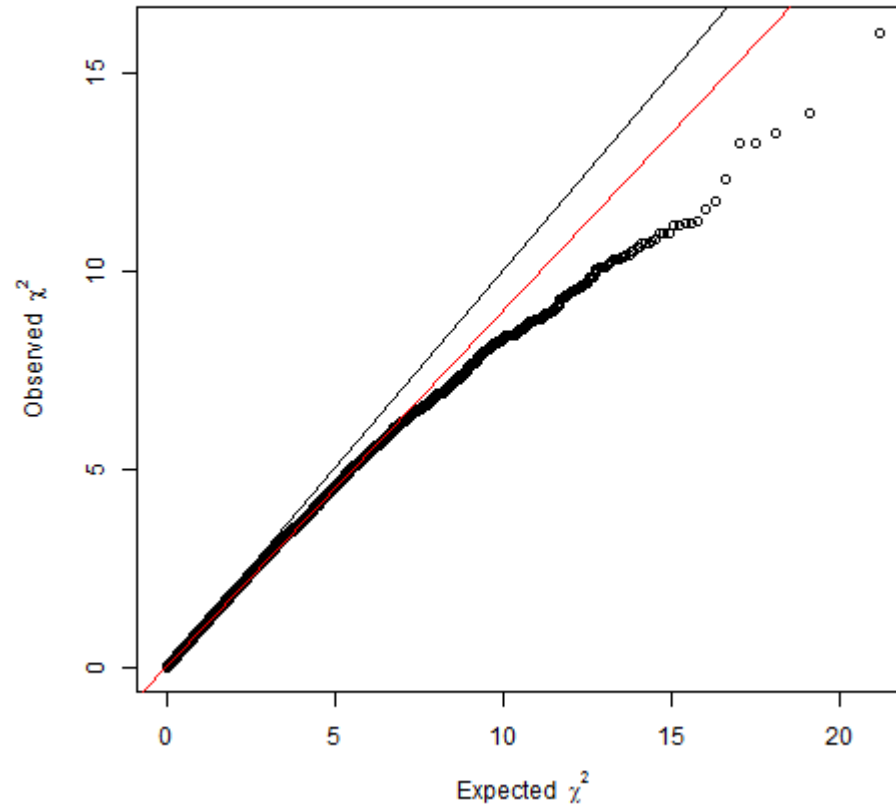
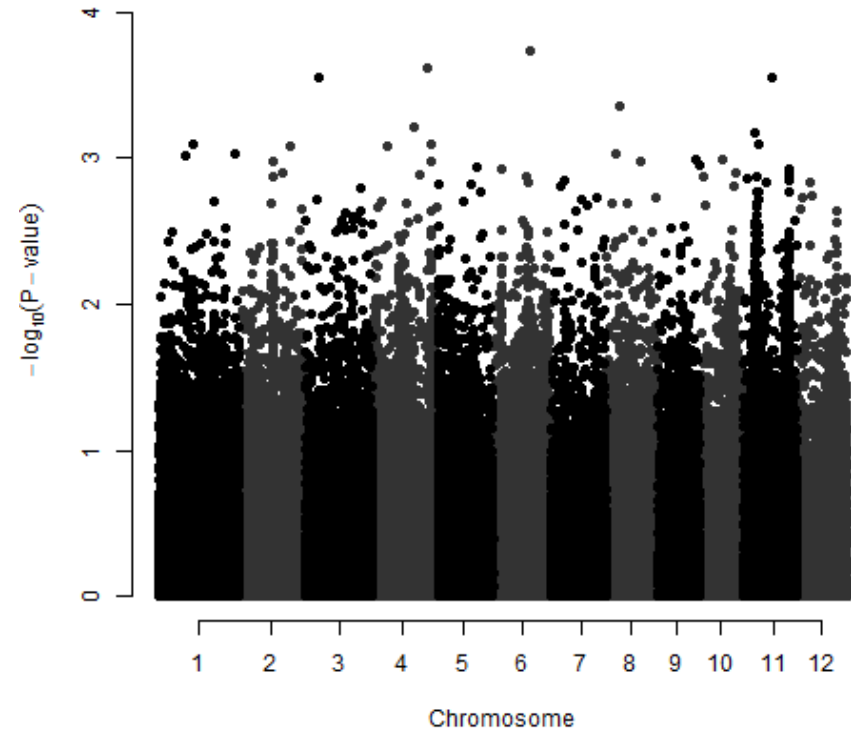
indica - NaR<sub>LT</sub>



# temperate japonica - $\text{NaR}_{\text{LT}}$



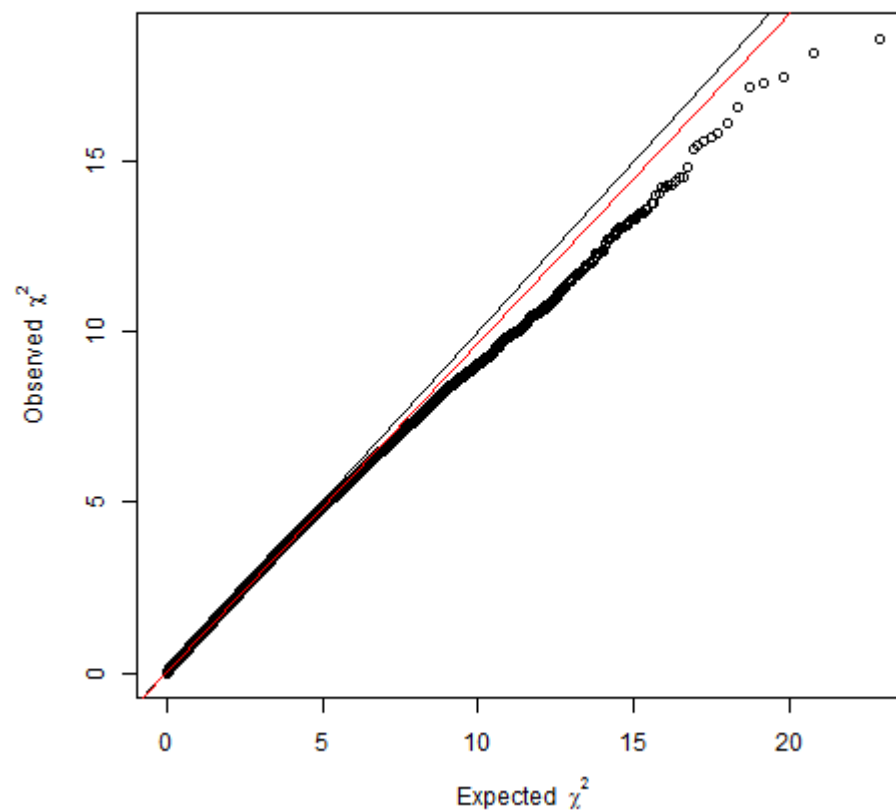
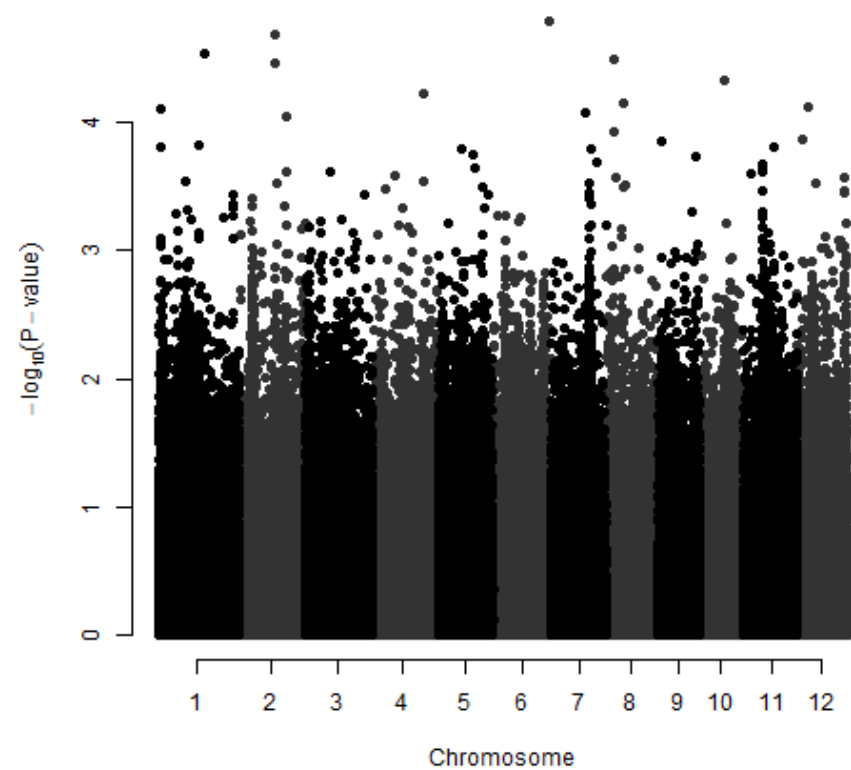
# tropical japonica - $\text{NaR}_{\text{LT}}$



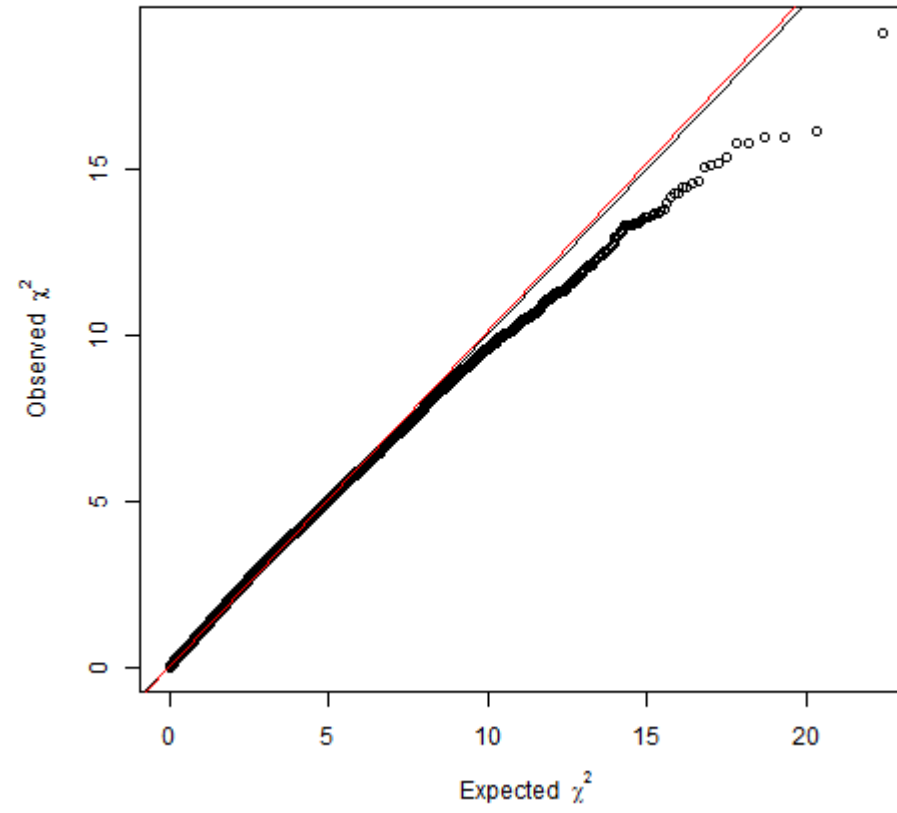
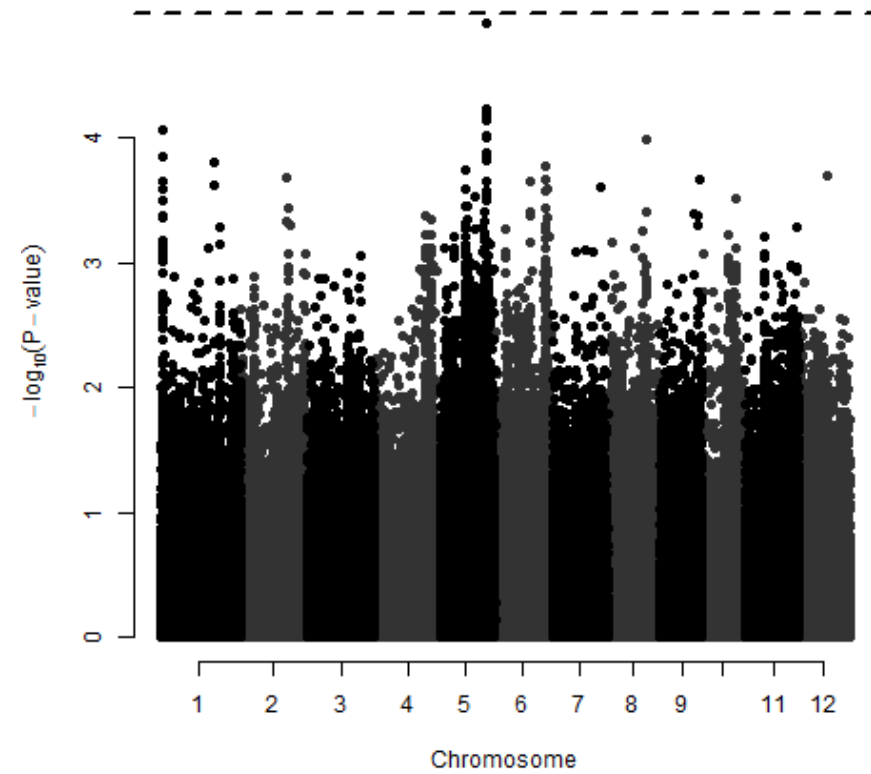
$$\text{NaS}_{\text{HT}}$$

Shoot sodium concentration in the high treatment

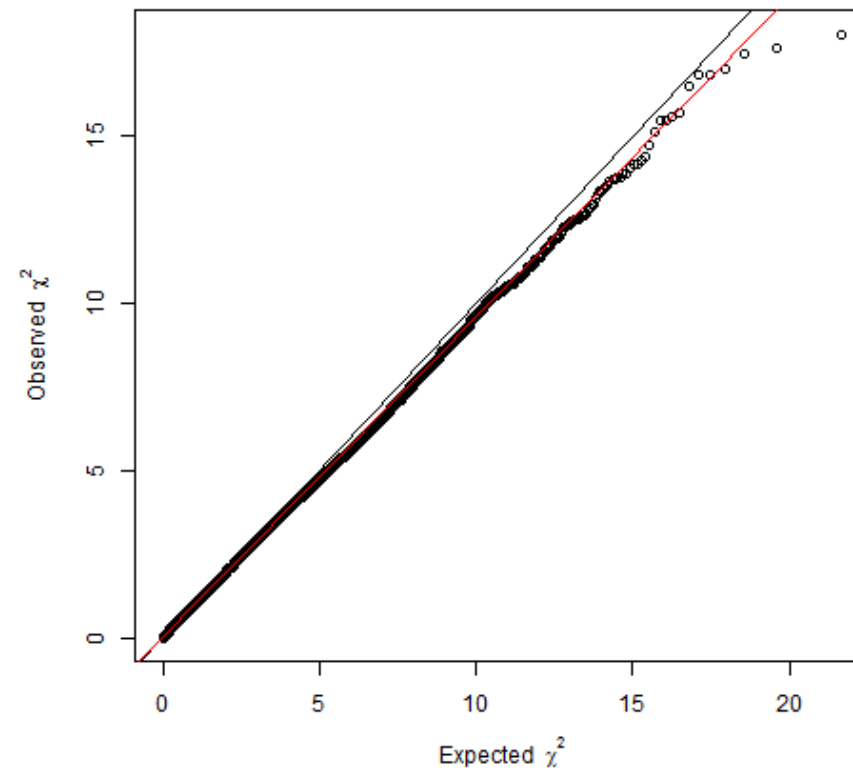
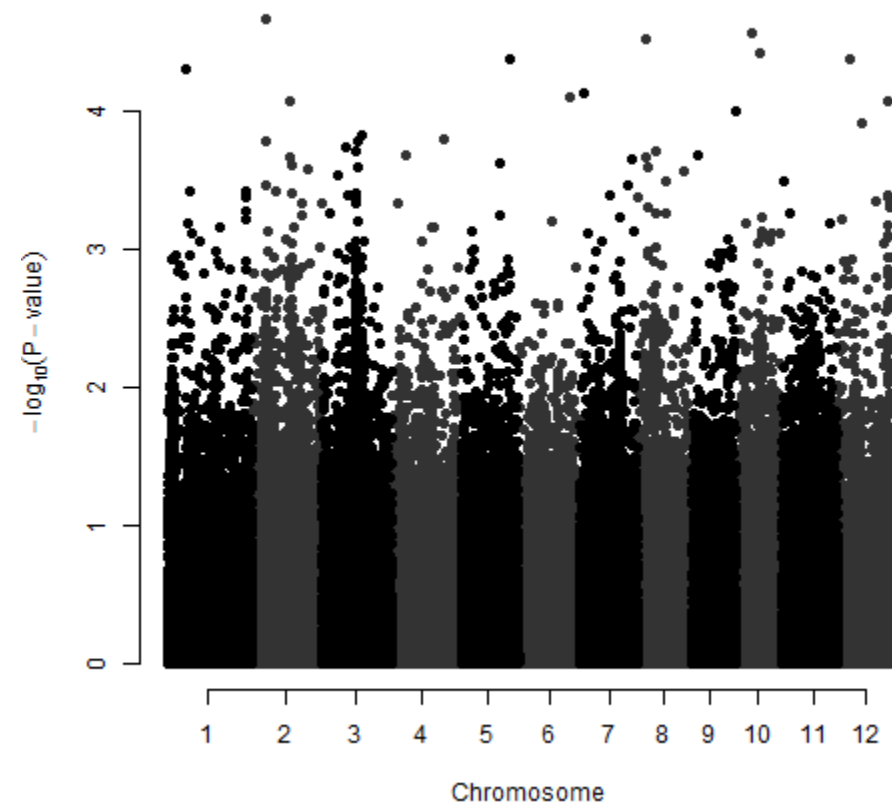
# All genotypes - NaS<sub>HT</sub>



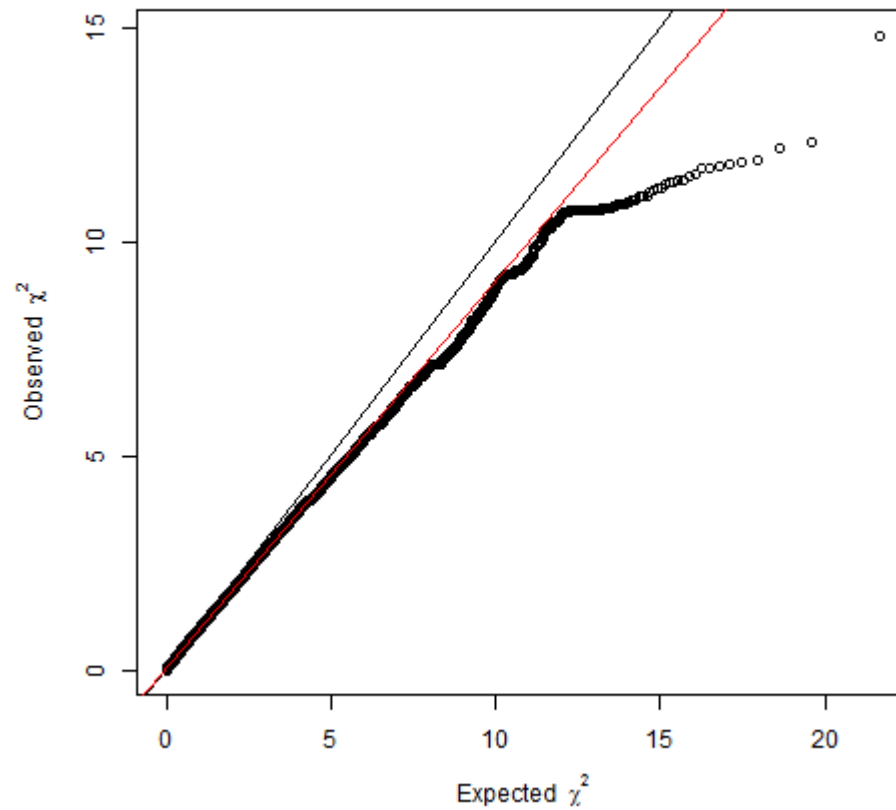
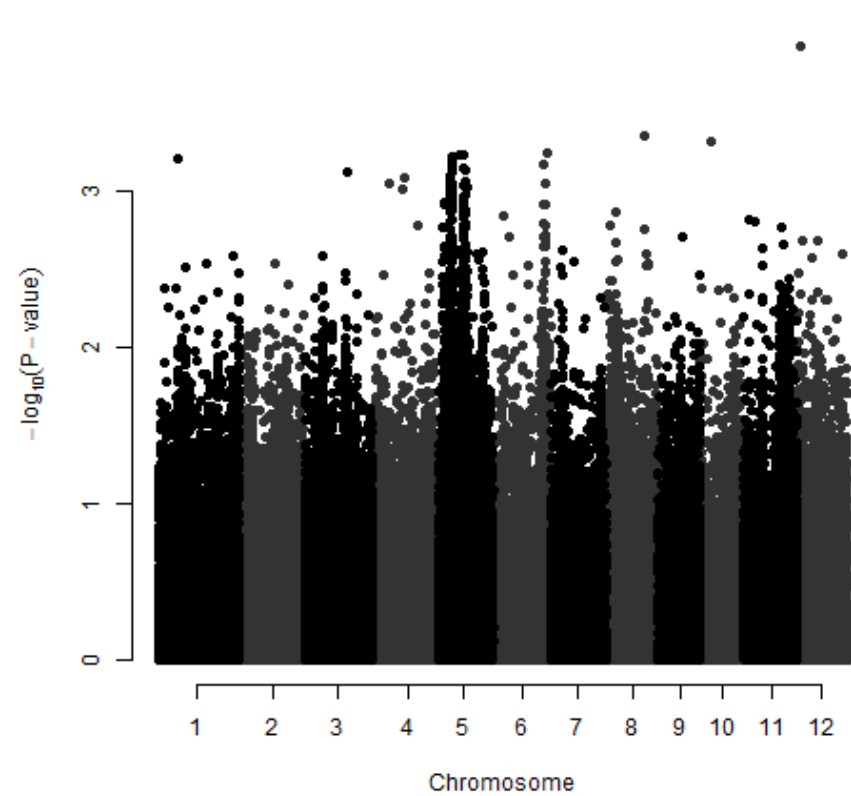
# Indica - NaS<sub>HT</sub>



# Japonica - NaS<sub>HT</sub>

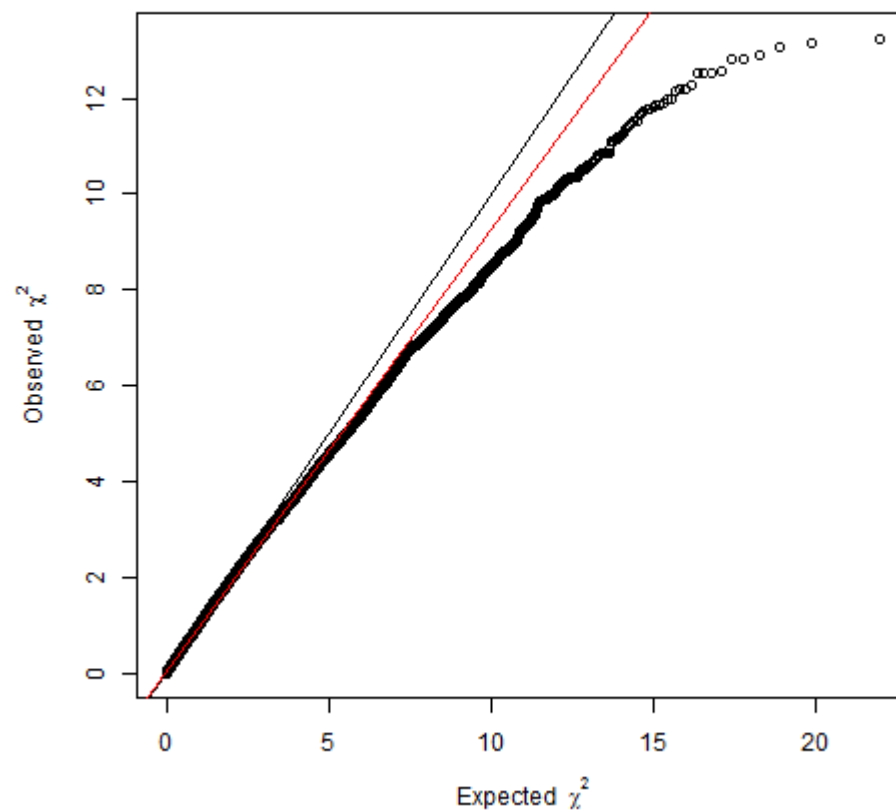
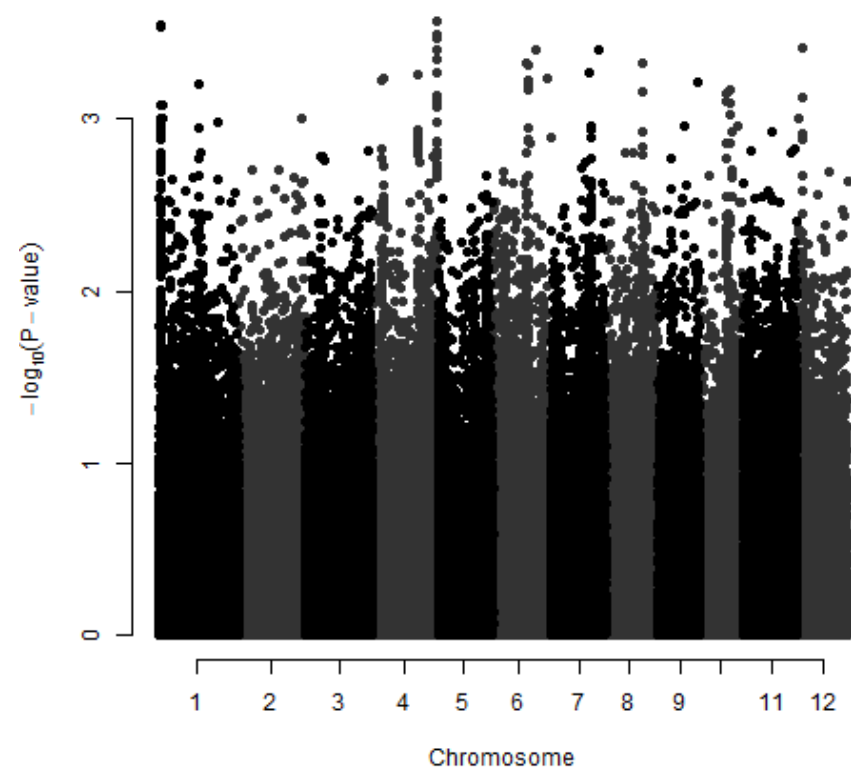


aus - NaS<sub>HT</sub>

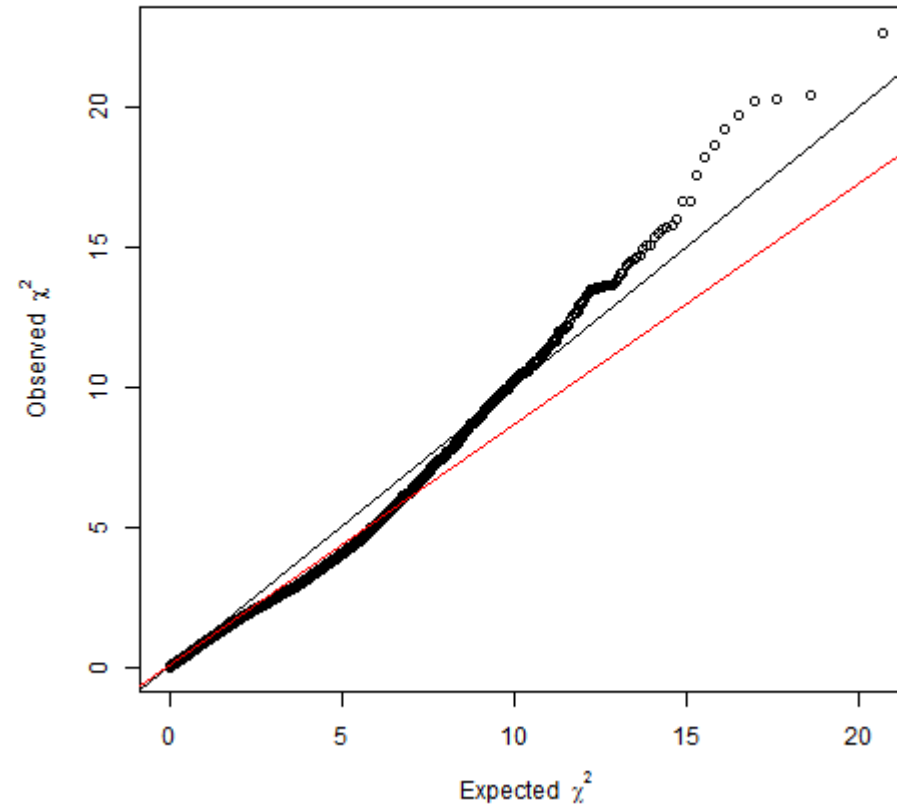
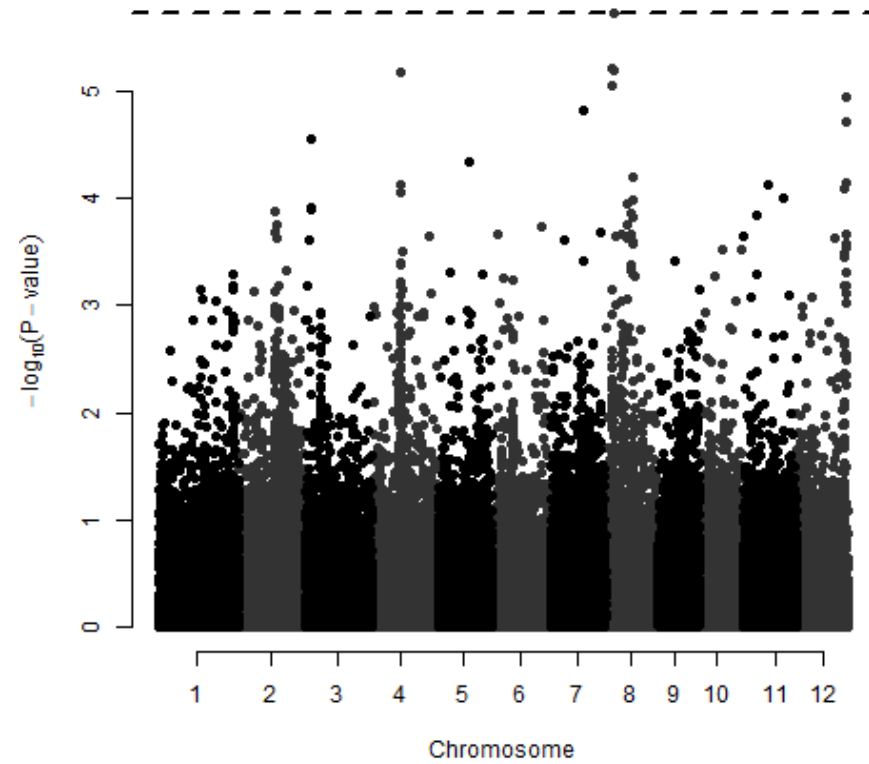




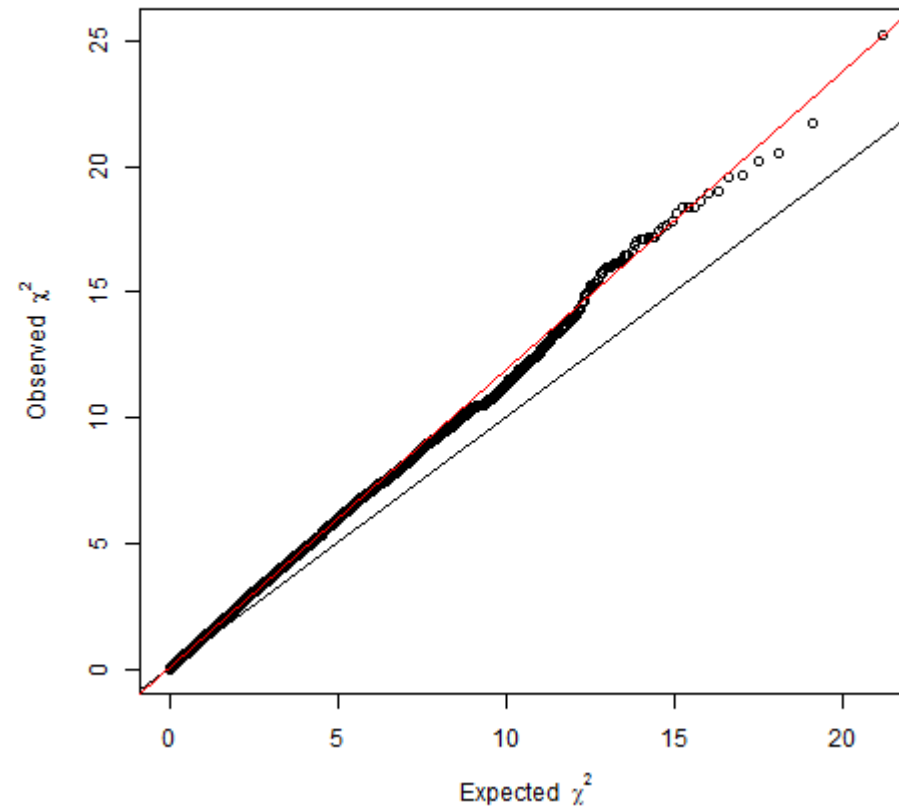
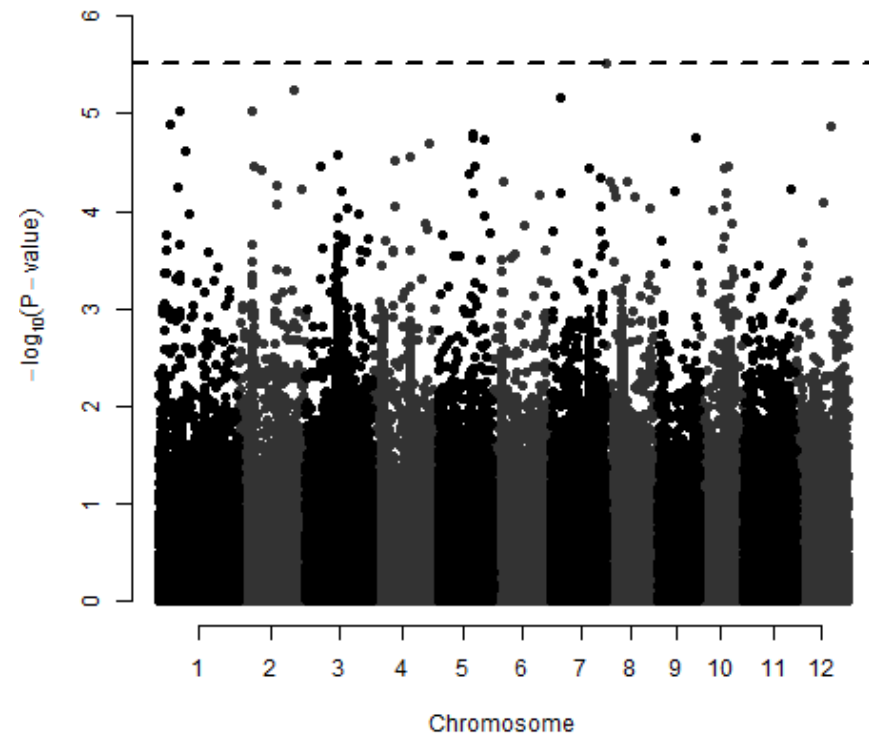
indica - NaS<sub>HT</sub>



# temperate japonica - NaS<sub>HT</sub>



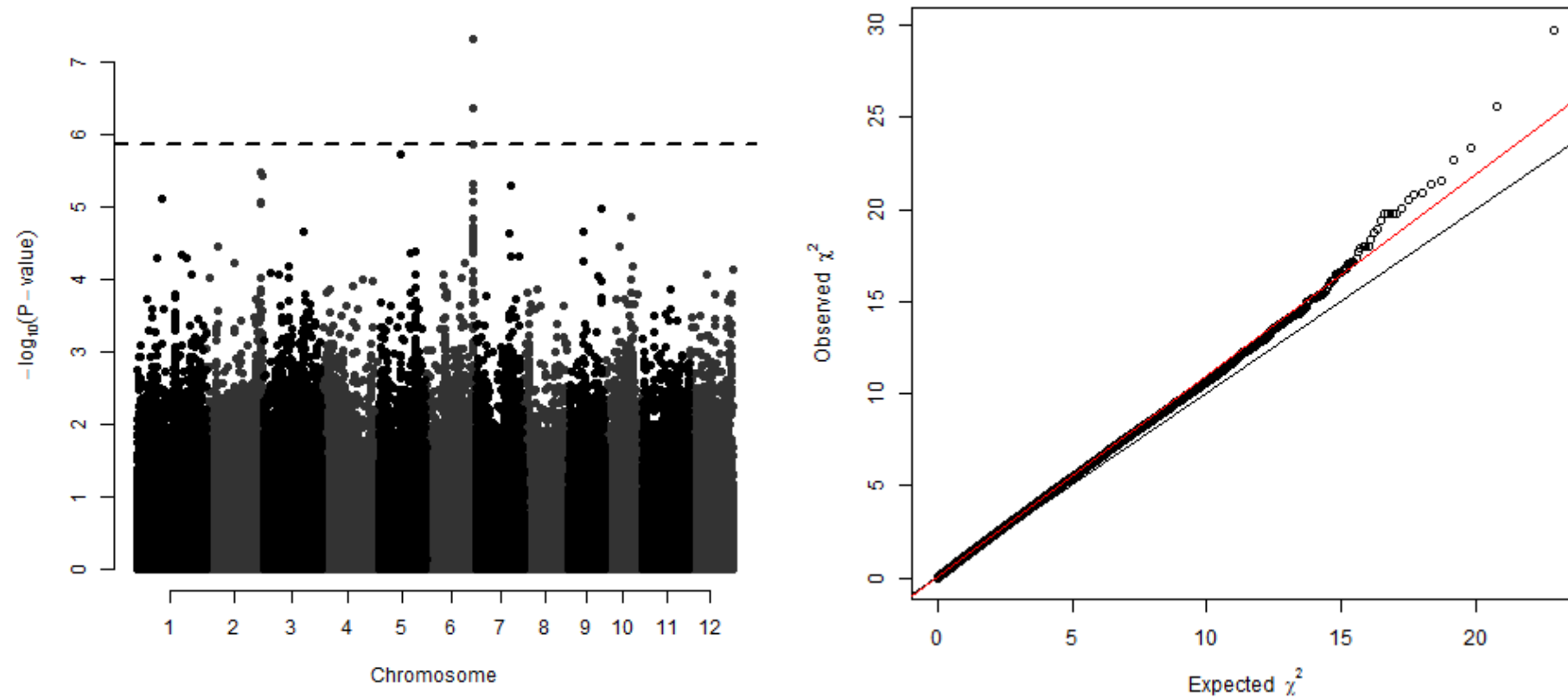
# tropical japonica - NaS<sub>HT</sub>



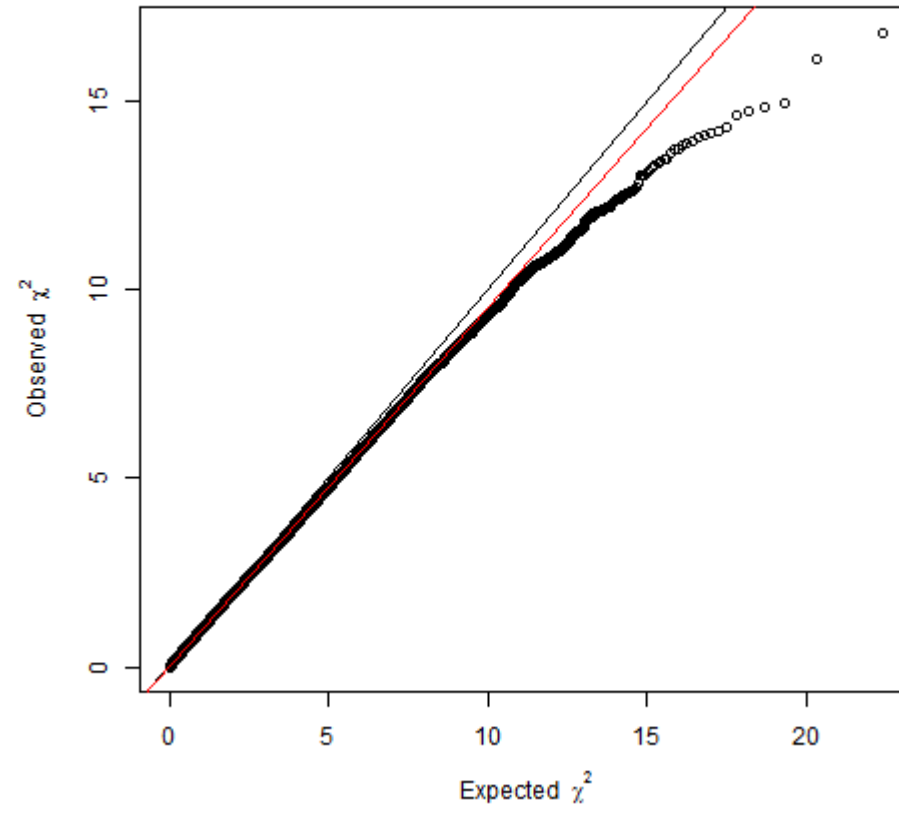
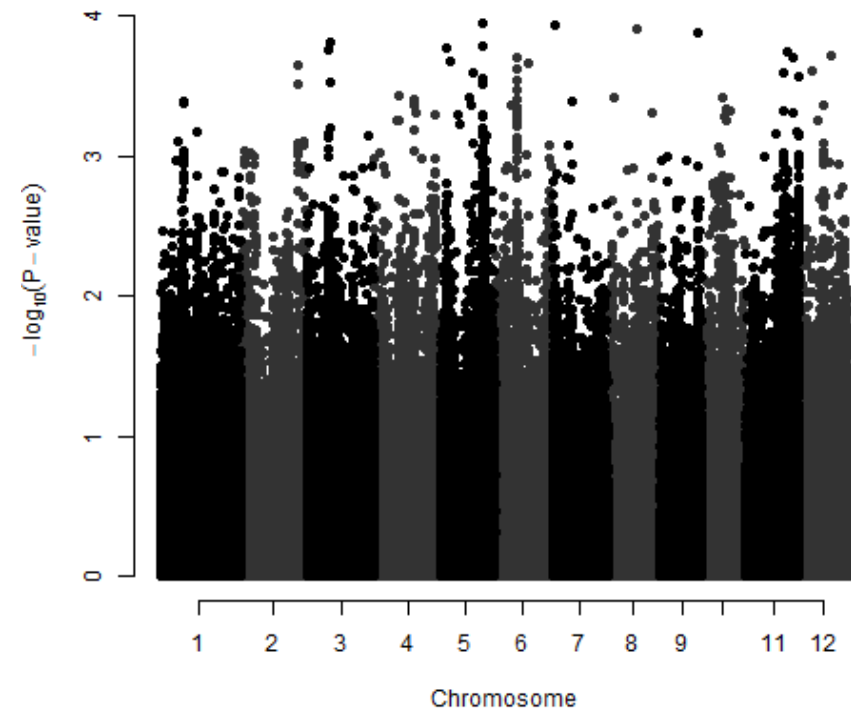
$$\text{NaS}_{\text{LT}}$$

Shoot sodium concentration in the low treatment

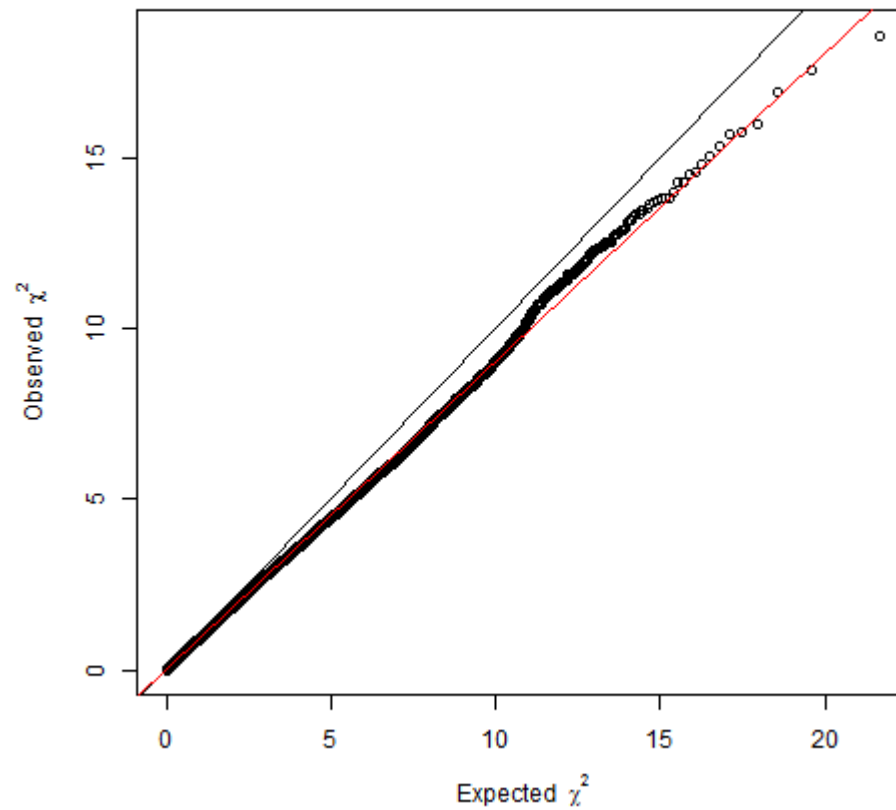
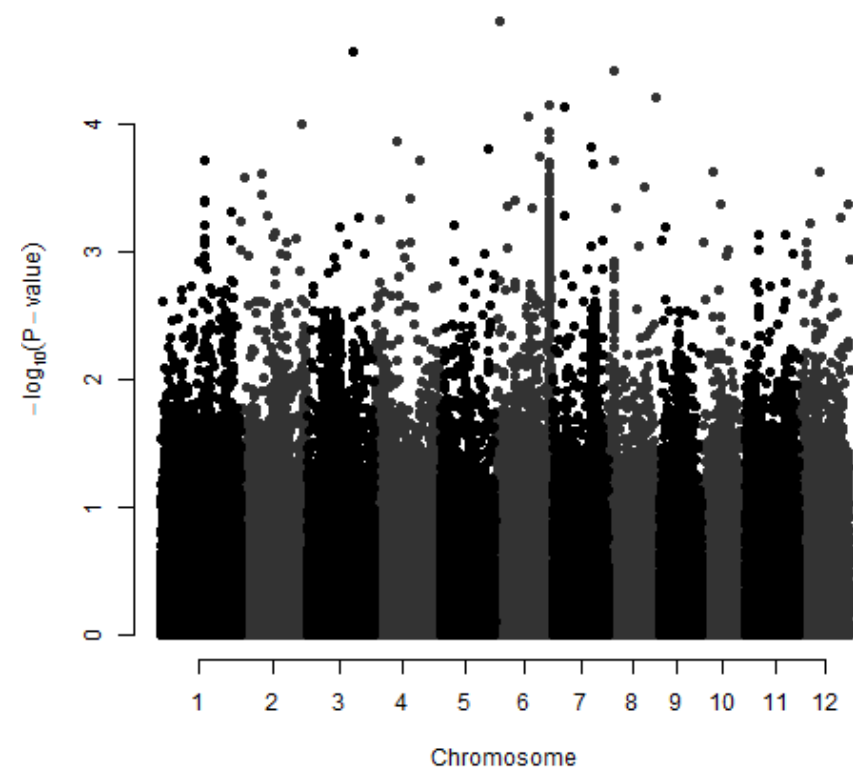
# All genotypes - NaS<sub>LT</sub>



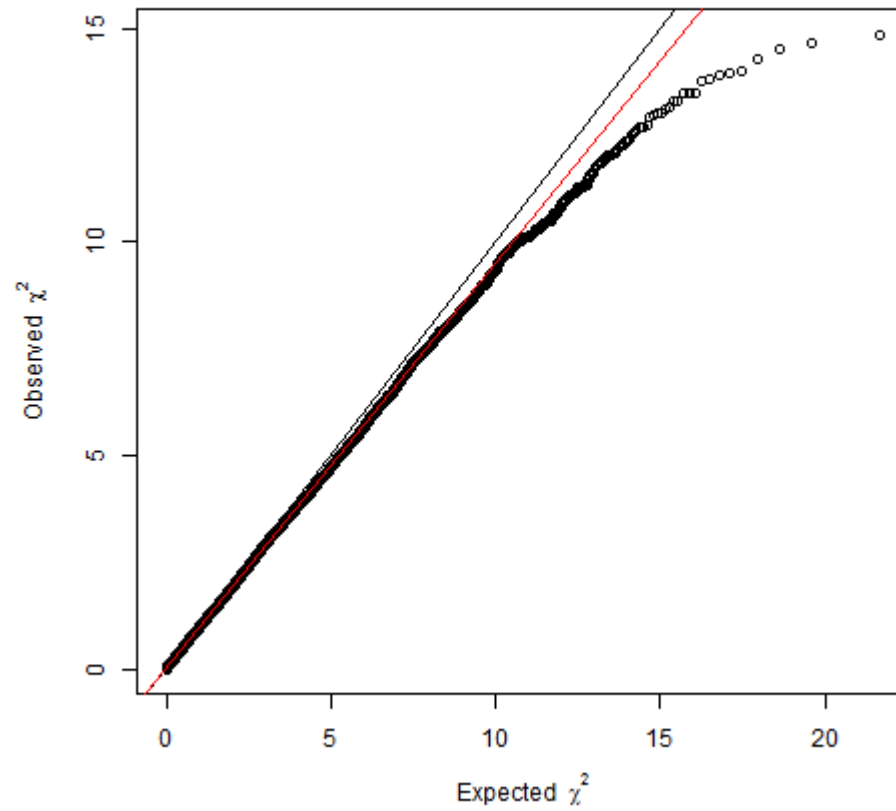
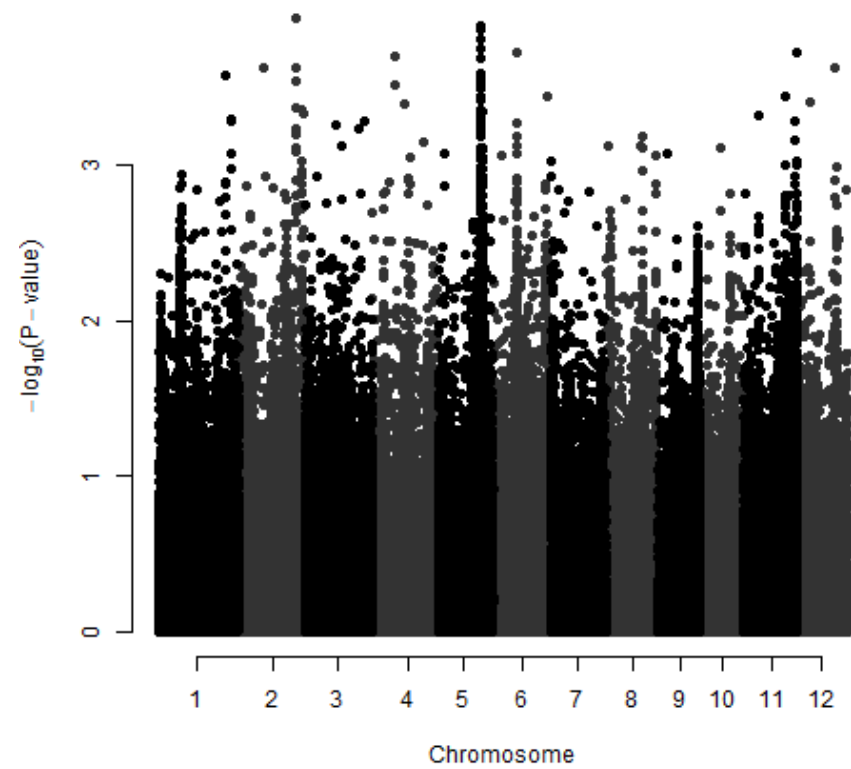
# Indica - NaS<sub>LT</sub>



# Japonica - NaS<sub>LT</sub>

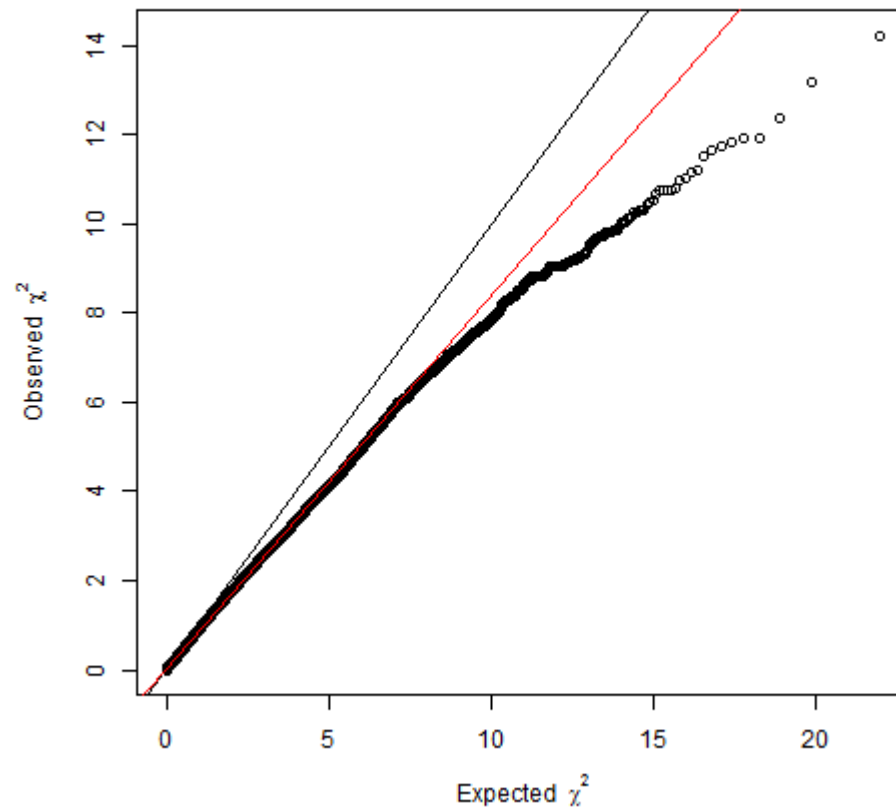
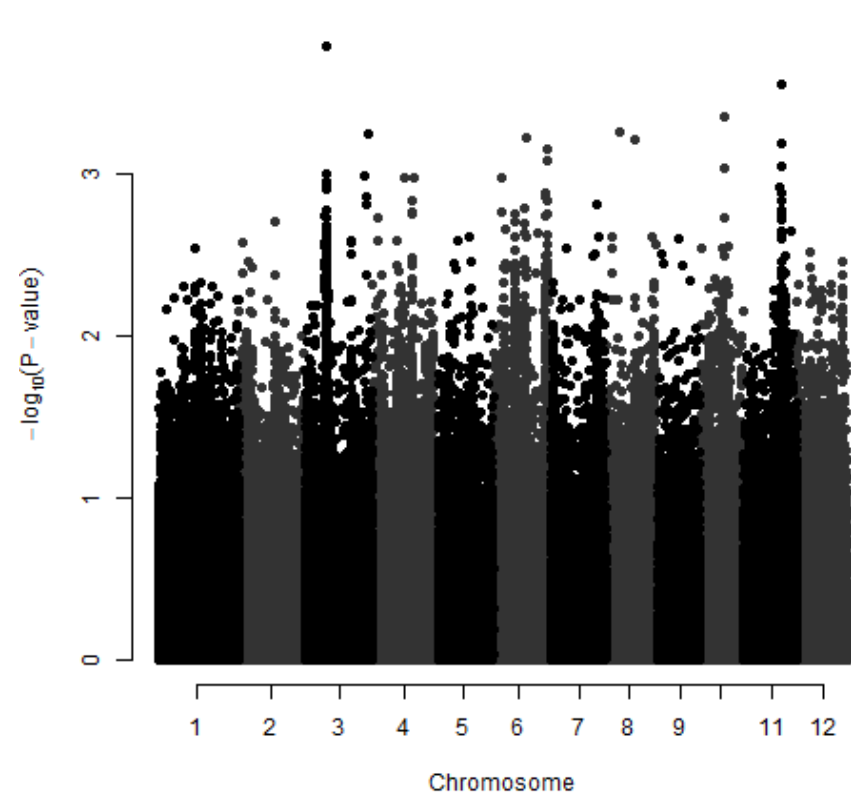


aus - NaS<sub>LT</sub>

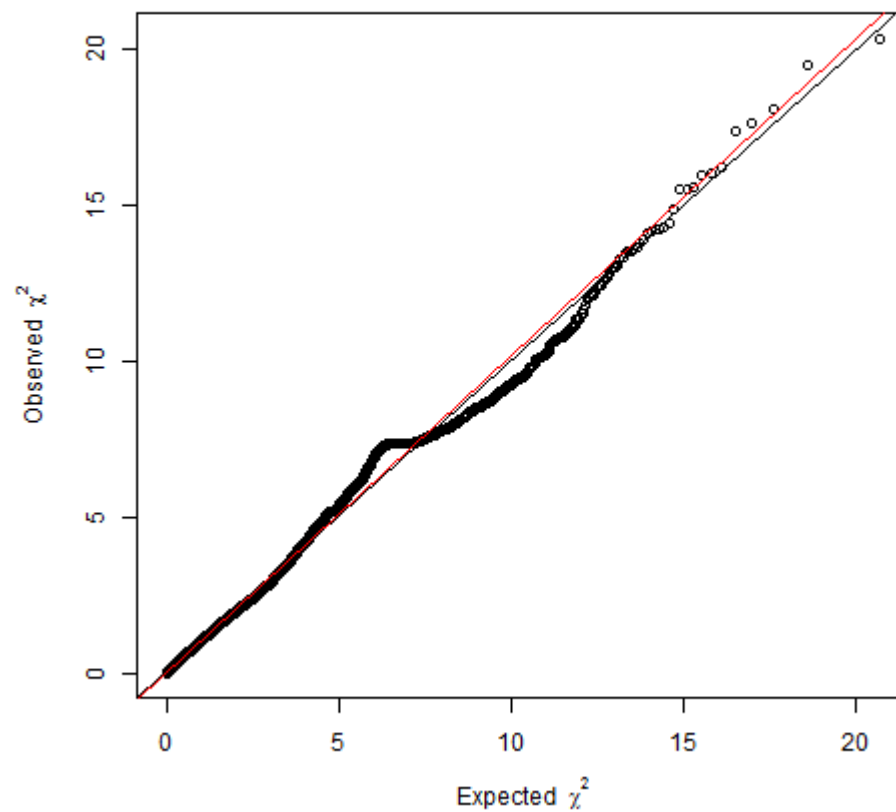
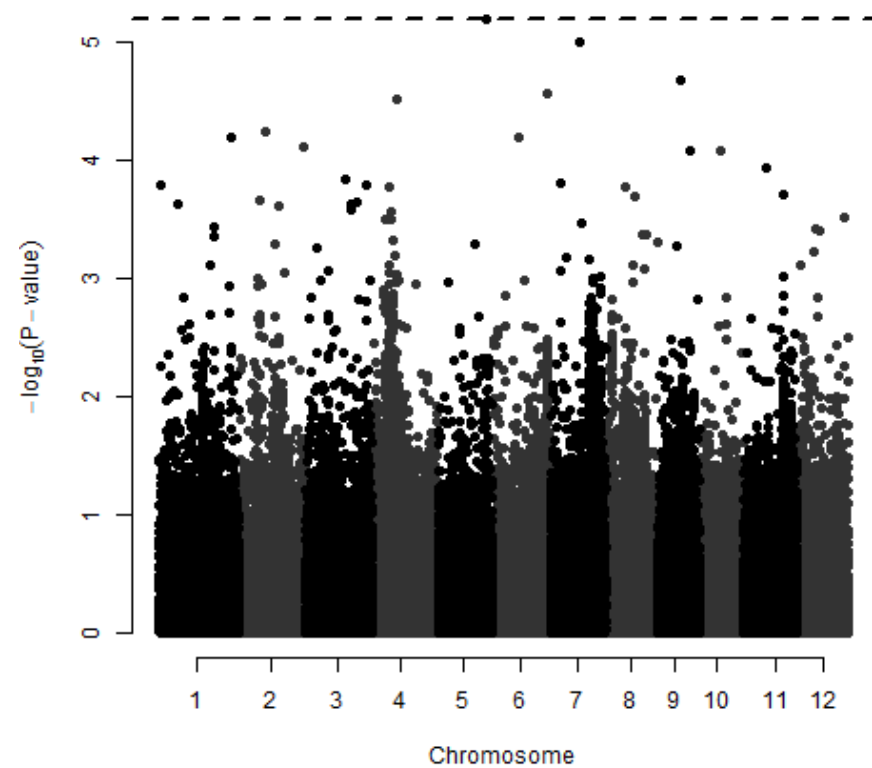




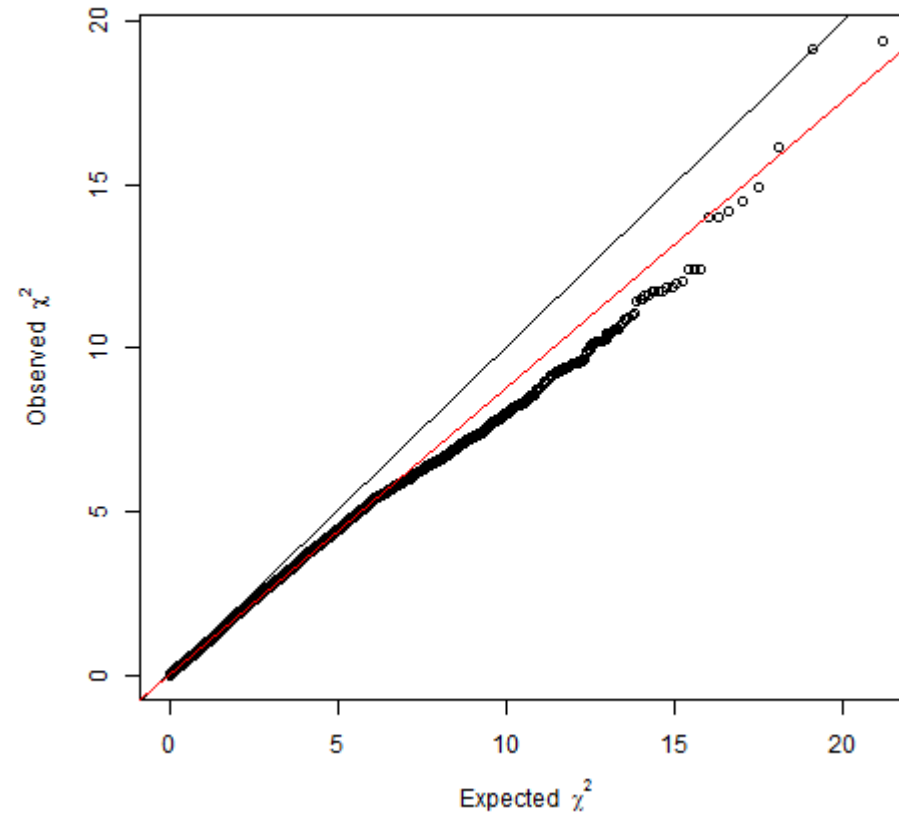
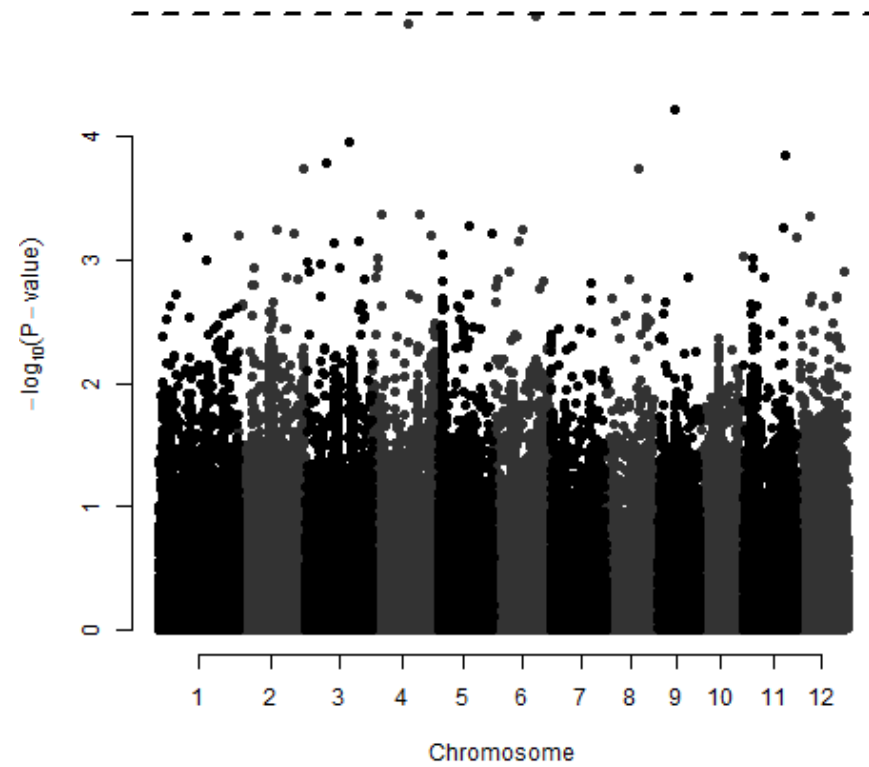
indica - NaS<sub>LT</sub>



# temperate japonica - NaS<sub>LT</sub>



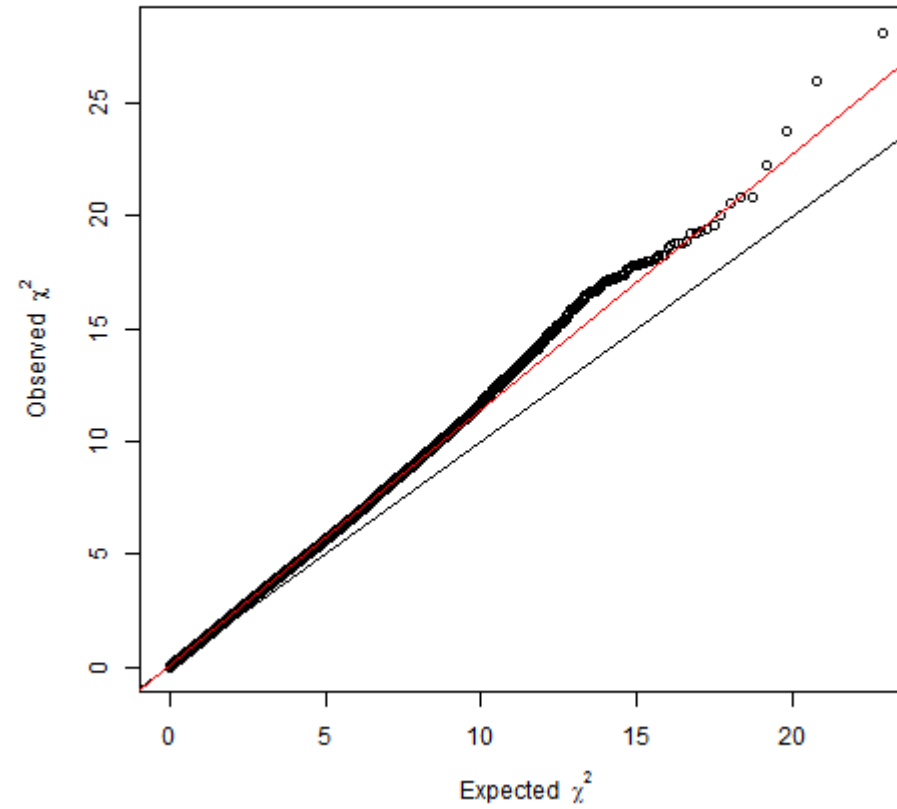
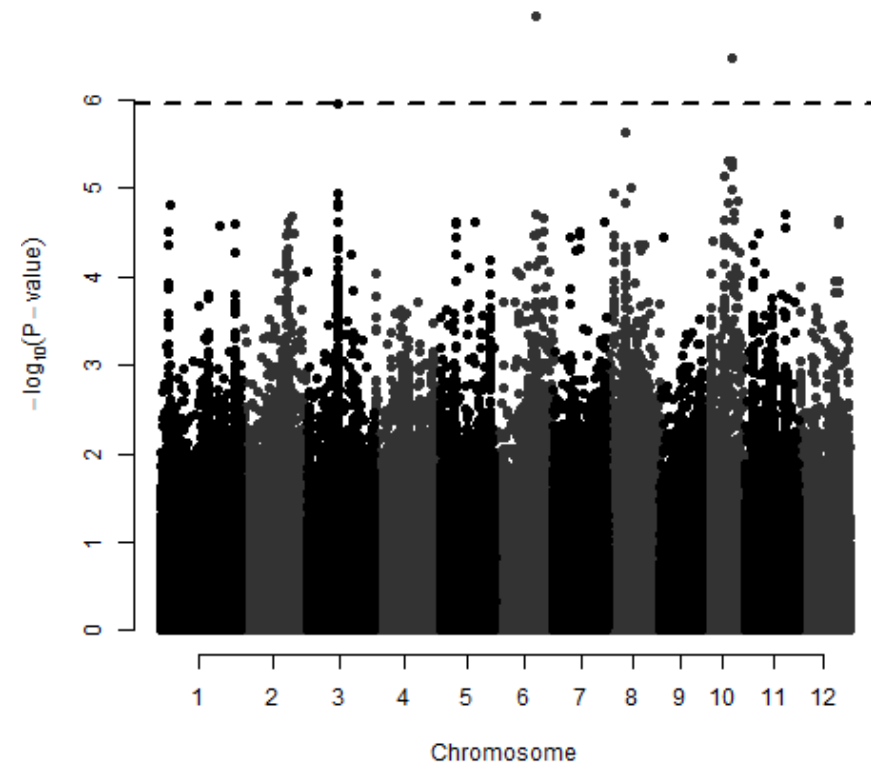
# tropical japonica - NaS<sub>LT</sub>



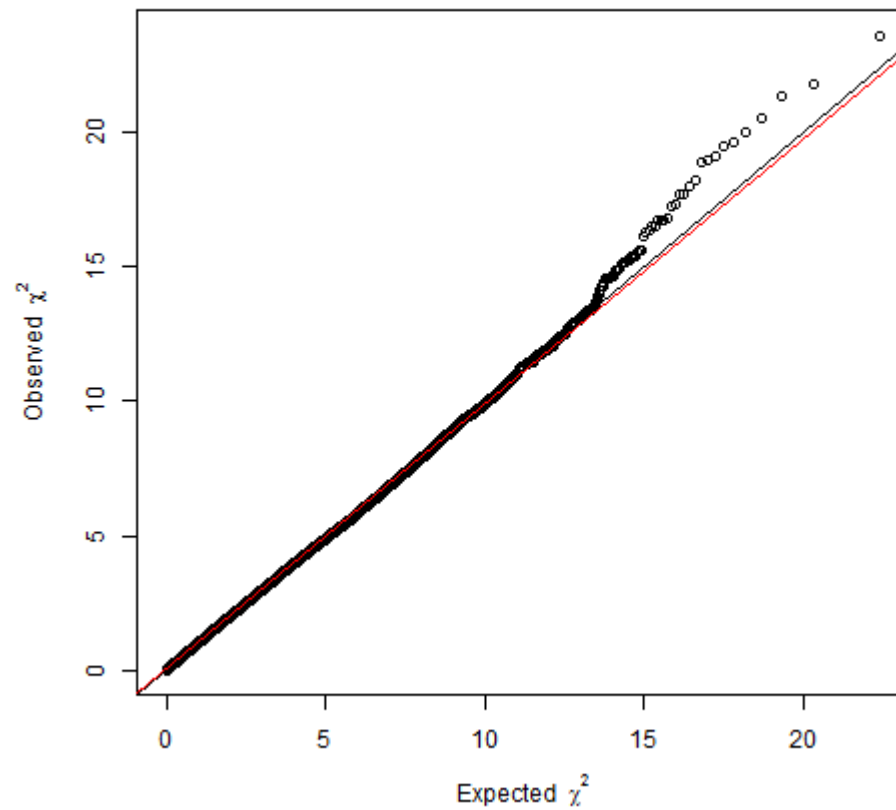
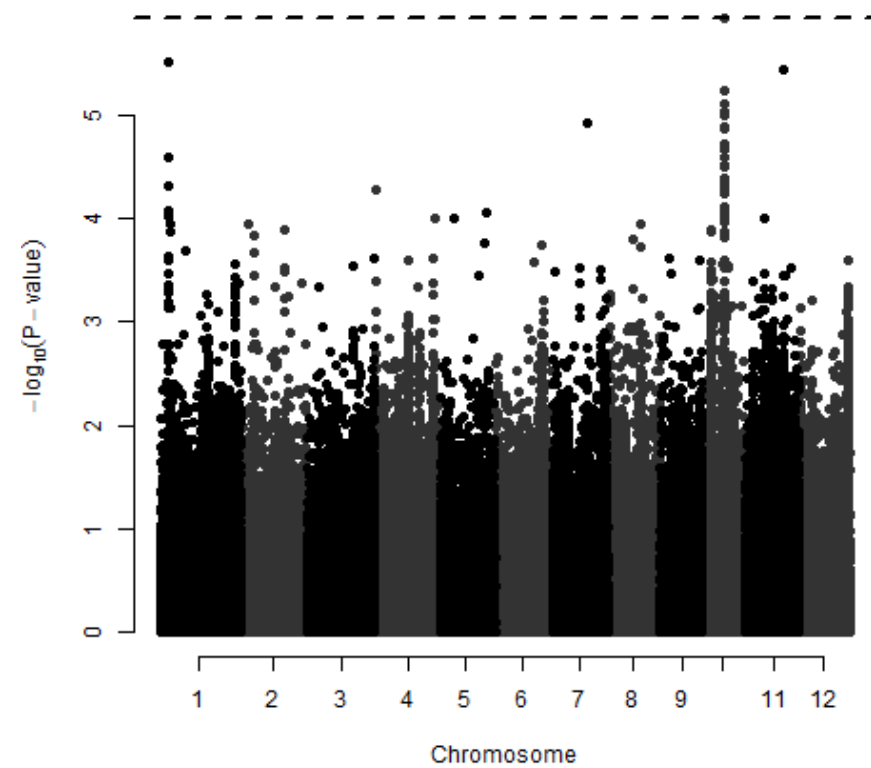
P

Plant mass in the low treatment

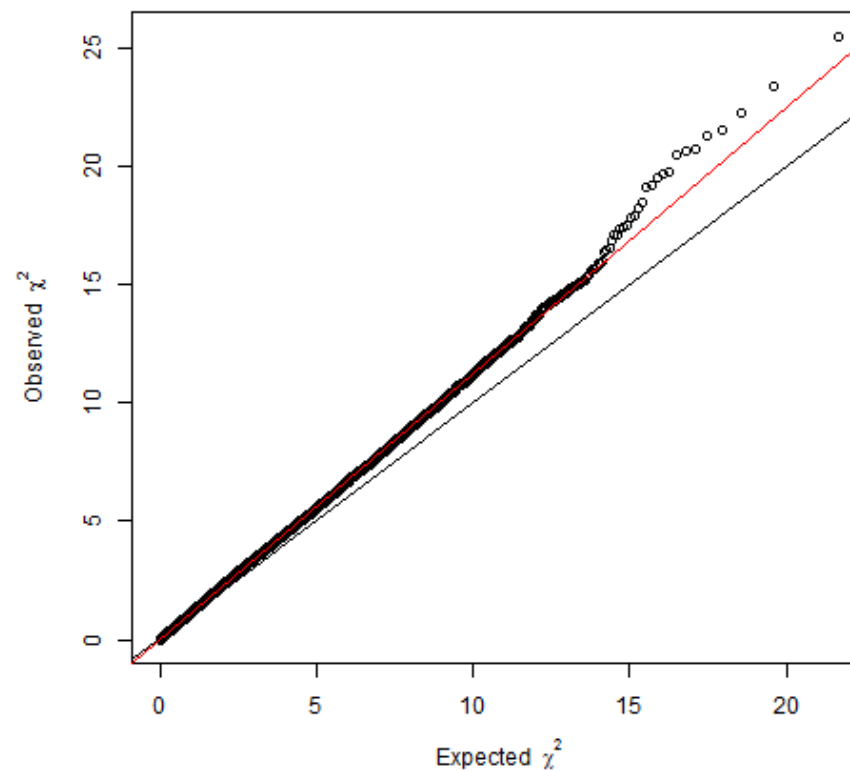
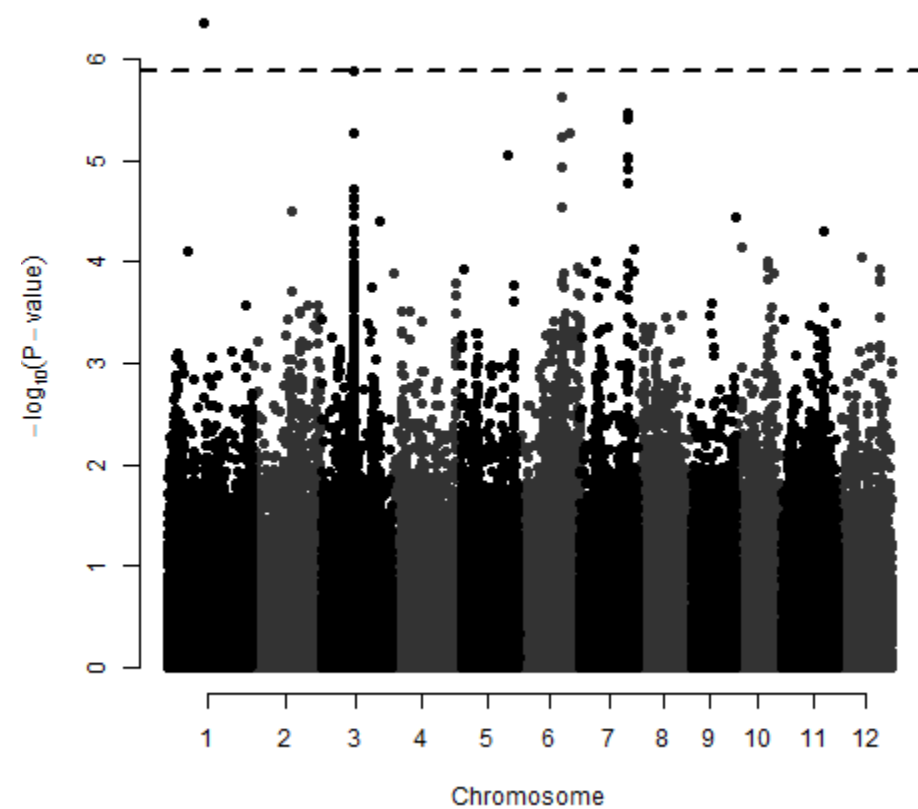
# All genotypes - P



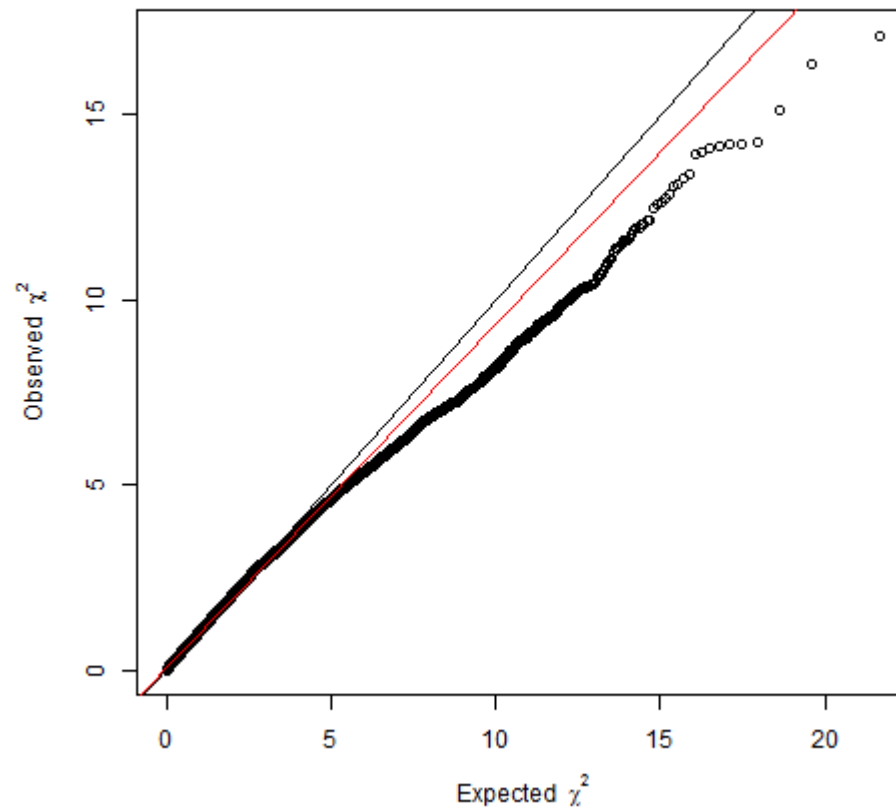
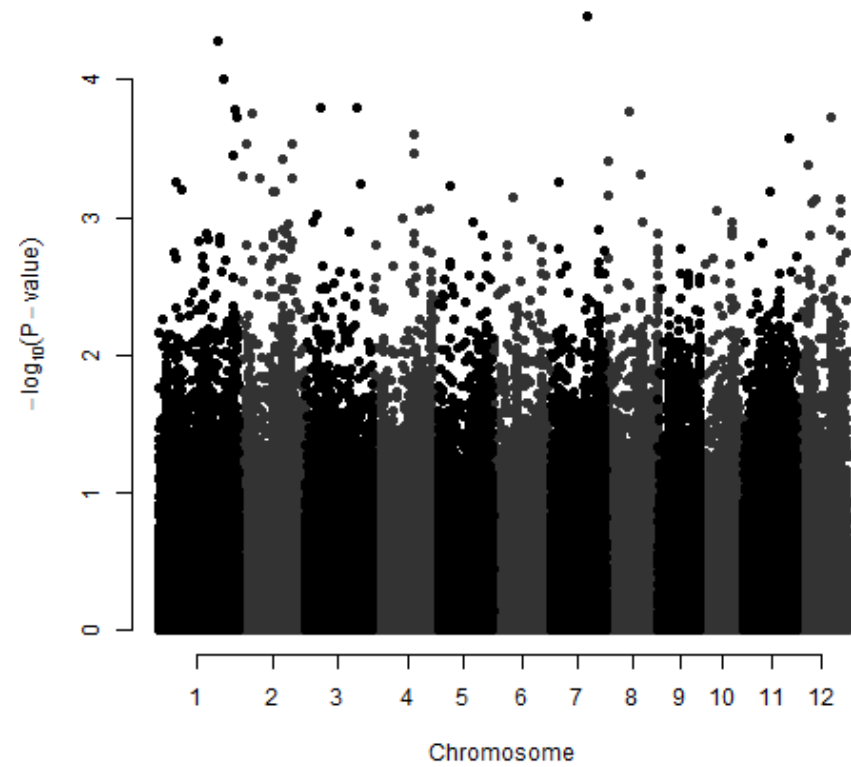
# Indica - P



# Japonica - P

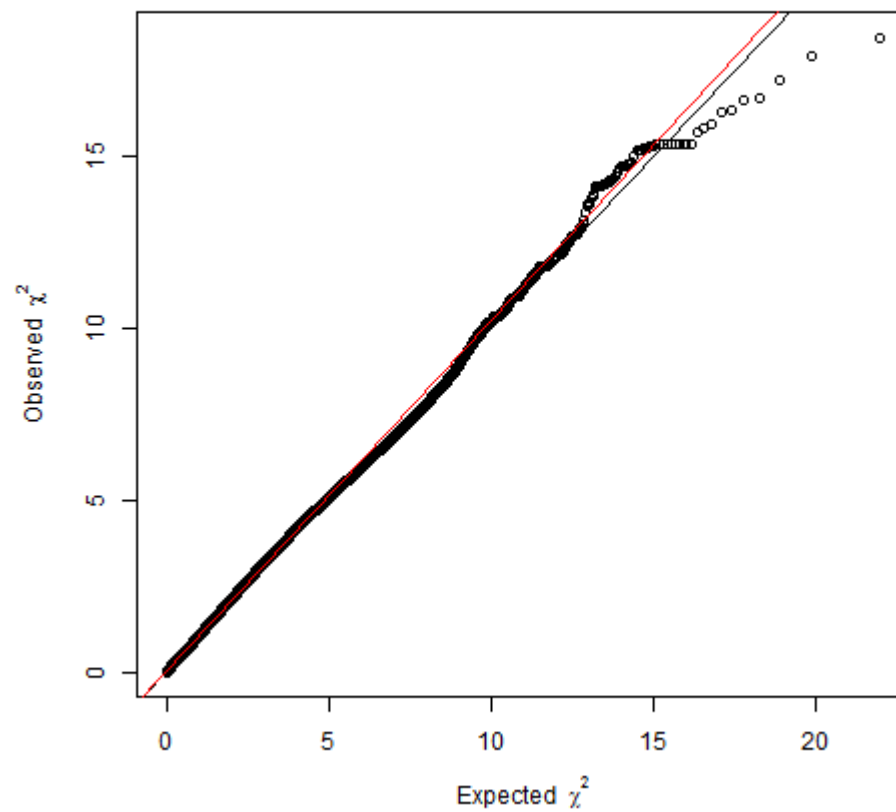
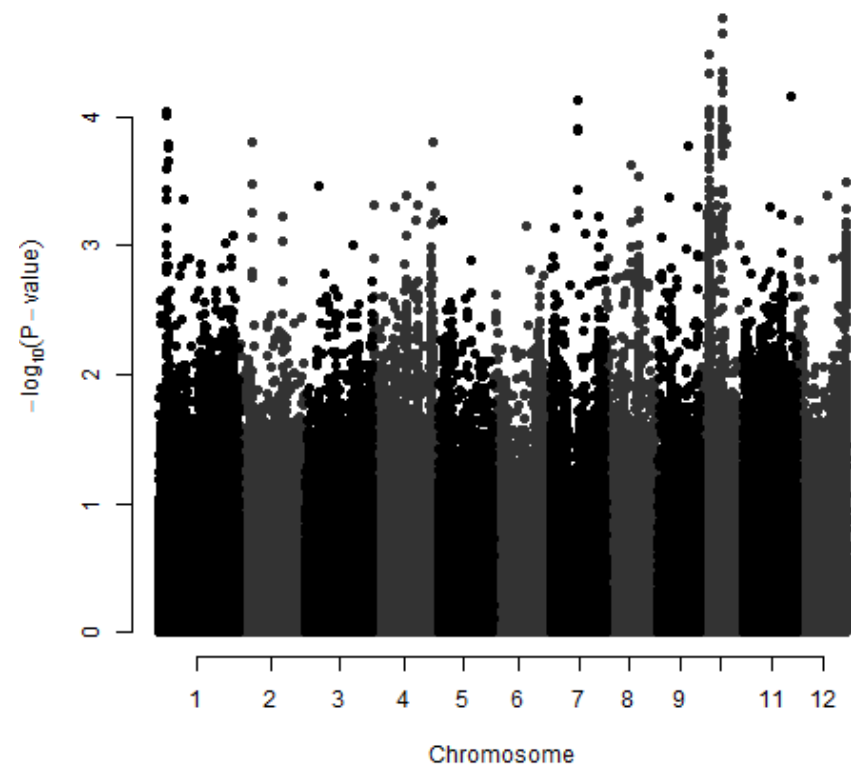


aus - P

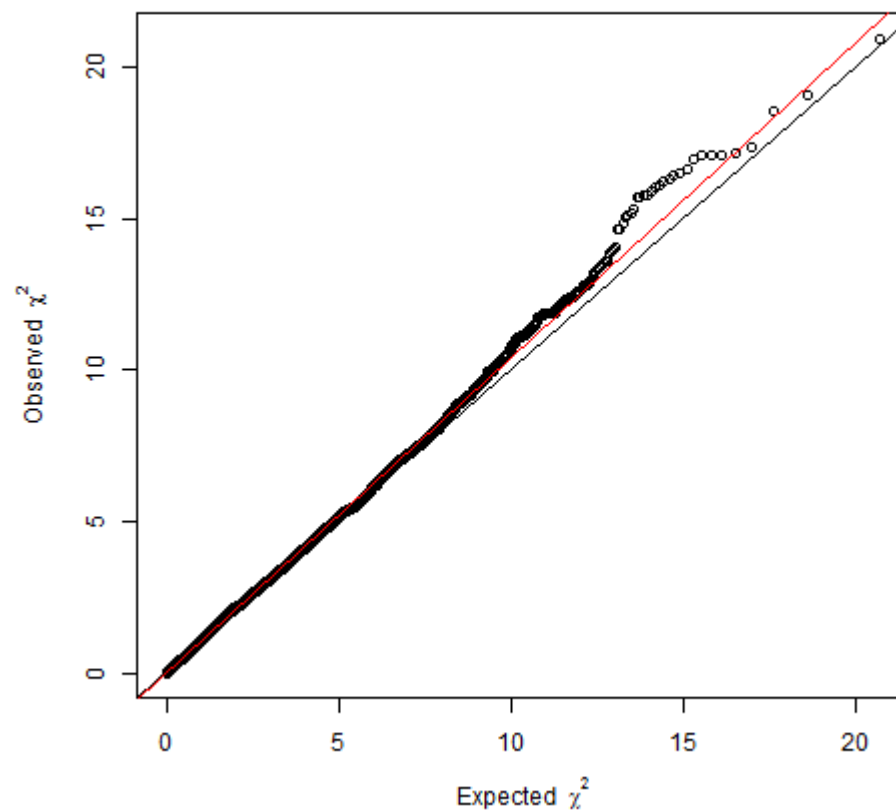
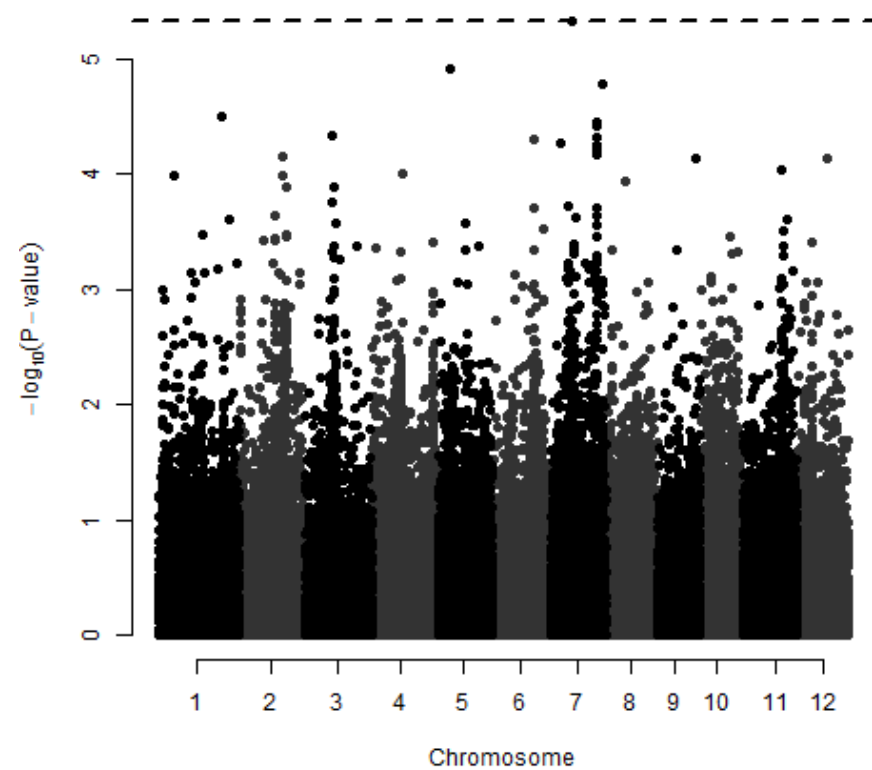




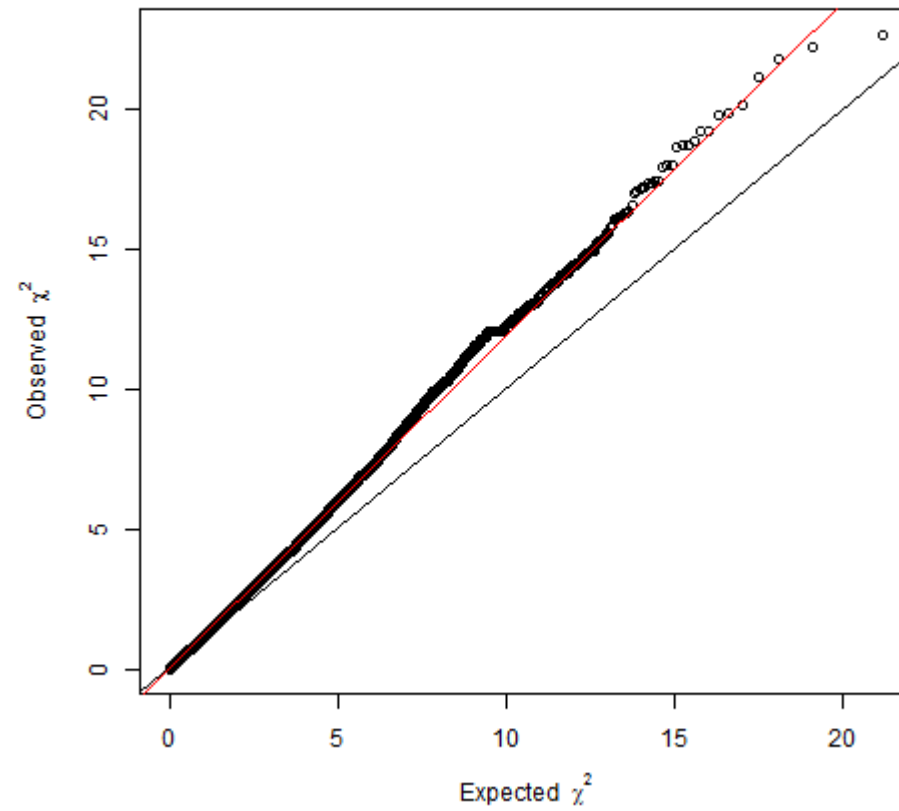
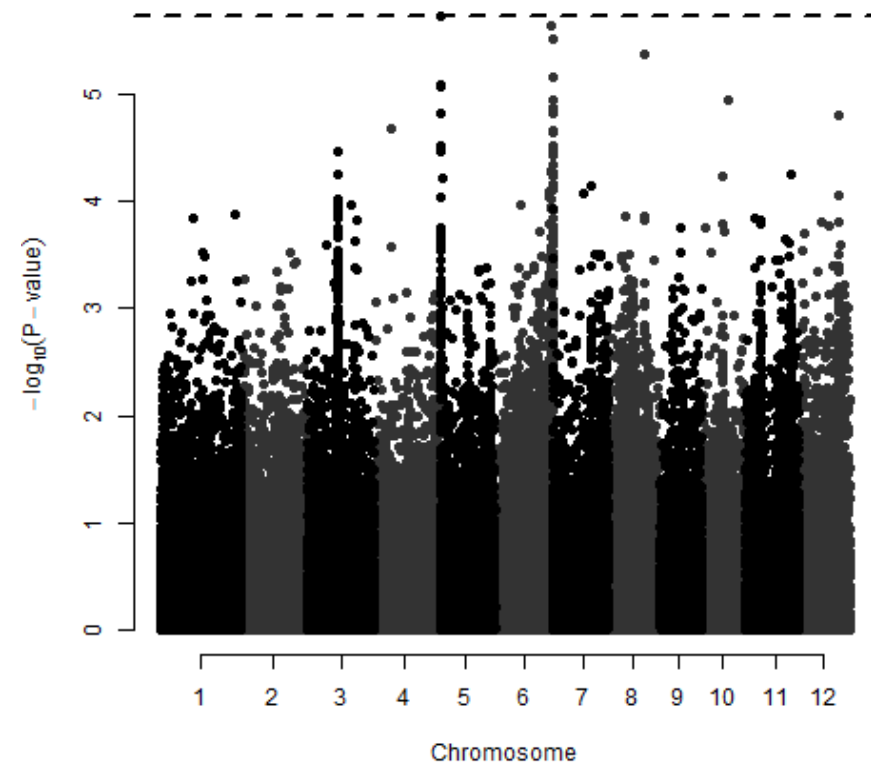
indica - P



# temperate japonica - P



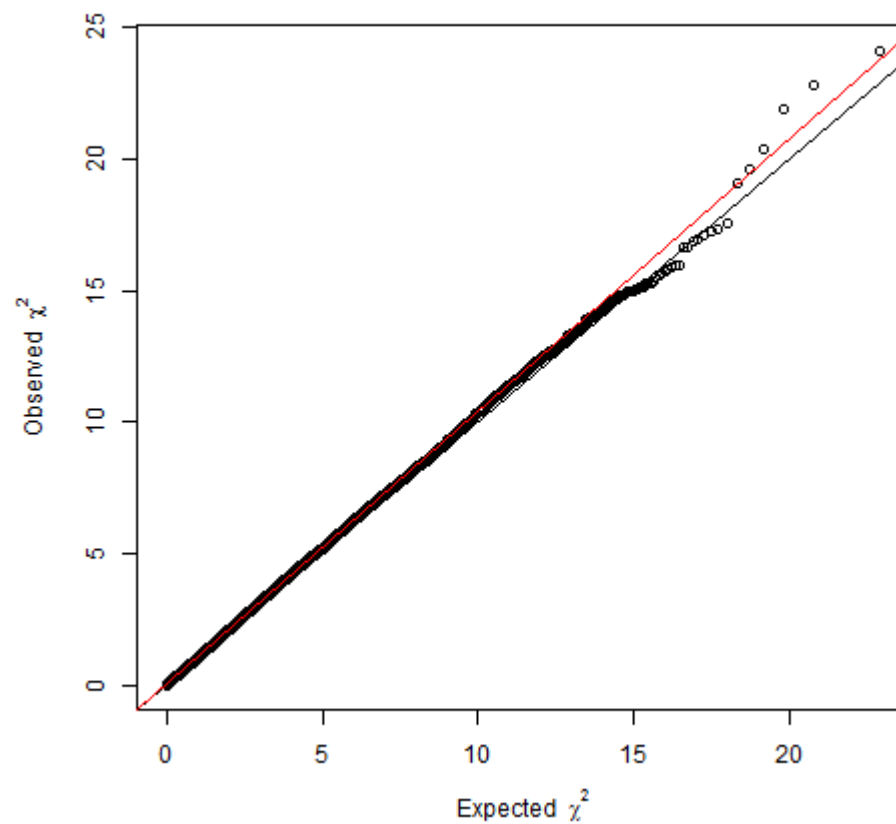
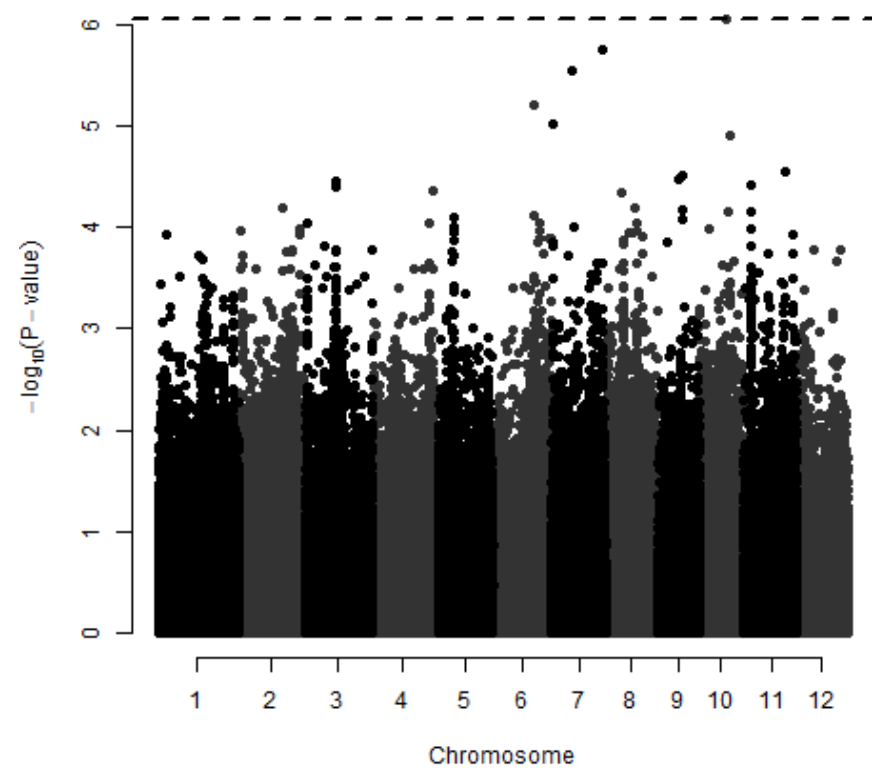
# tropical japonica - P



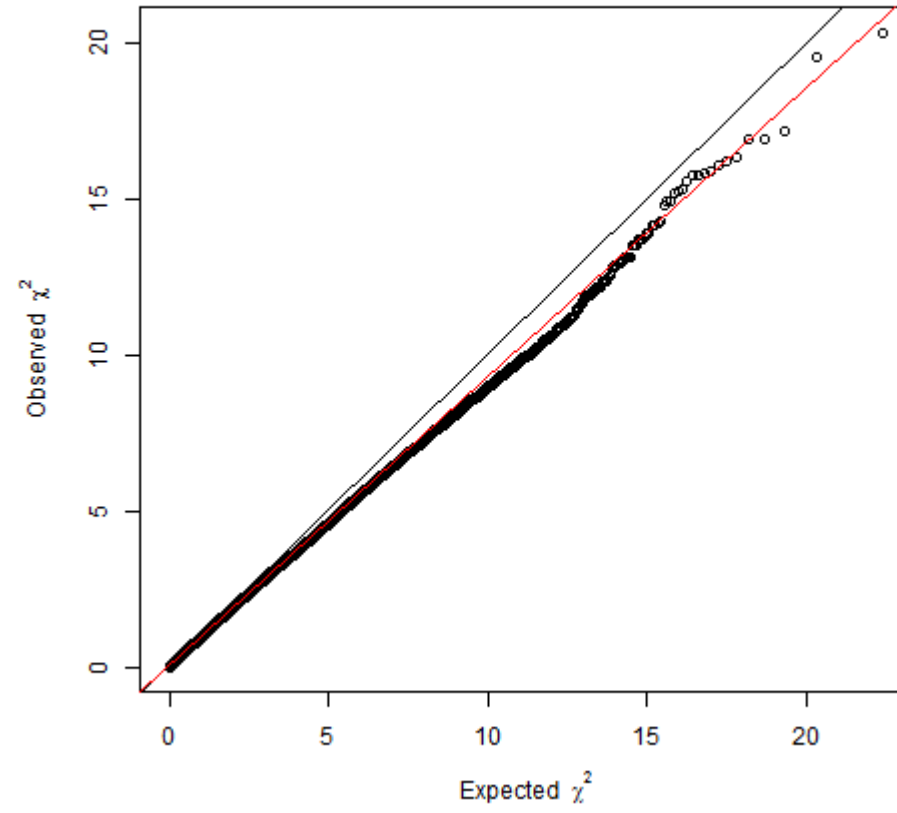
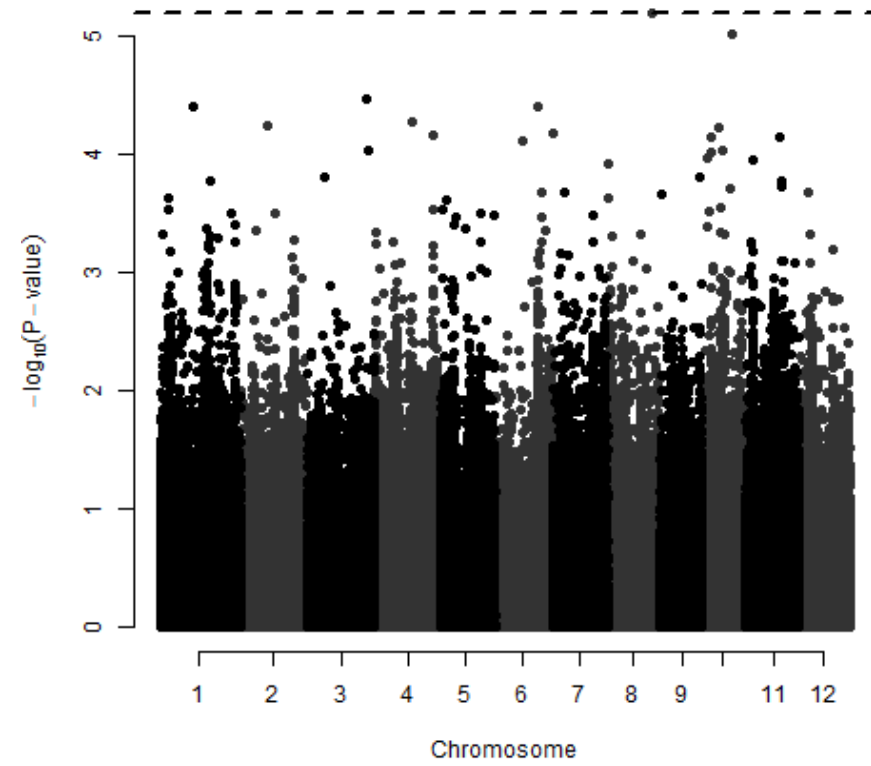
QP

Plant potassium content in the low treatment

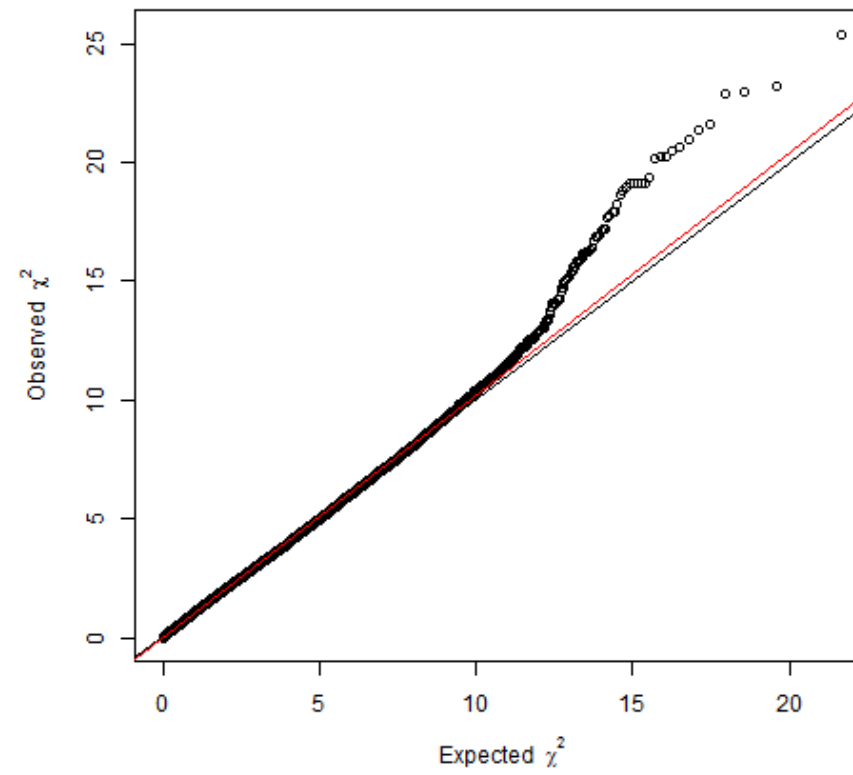
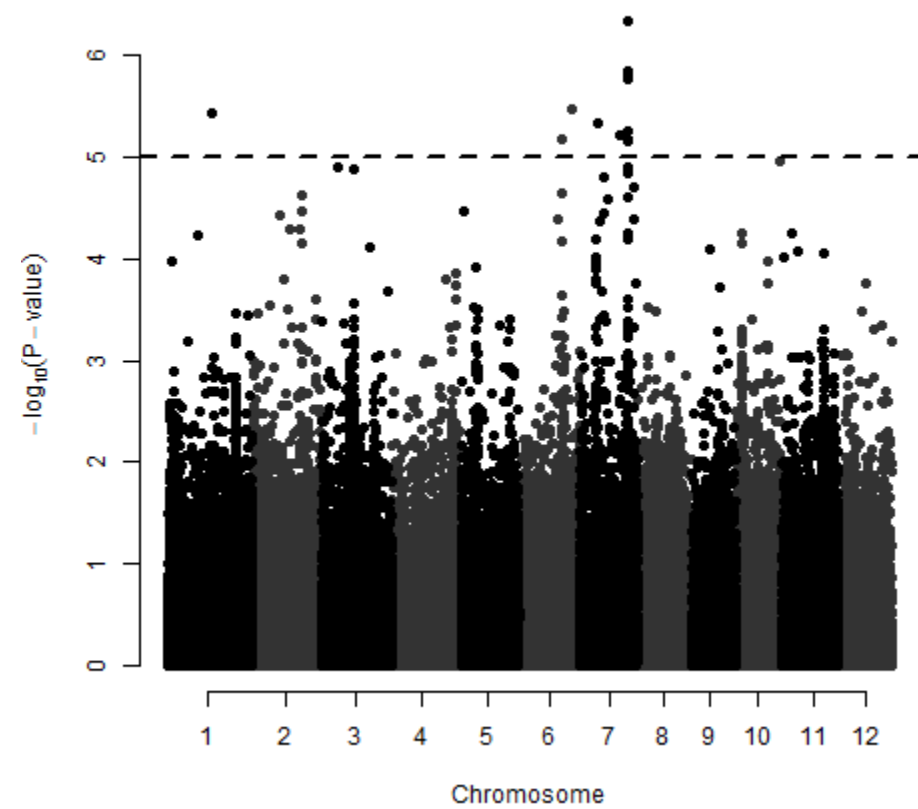
# All genotypes - QP



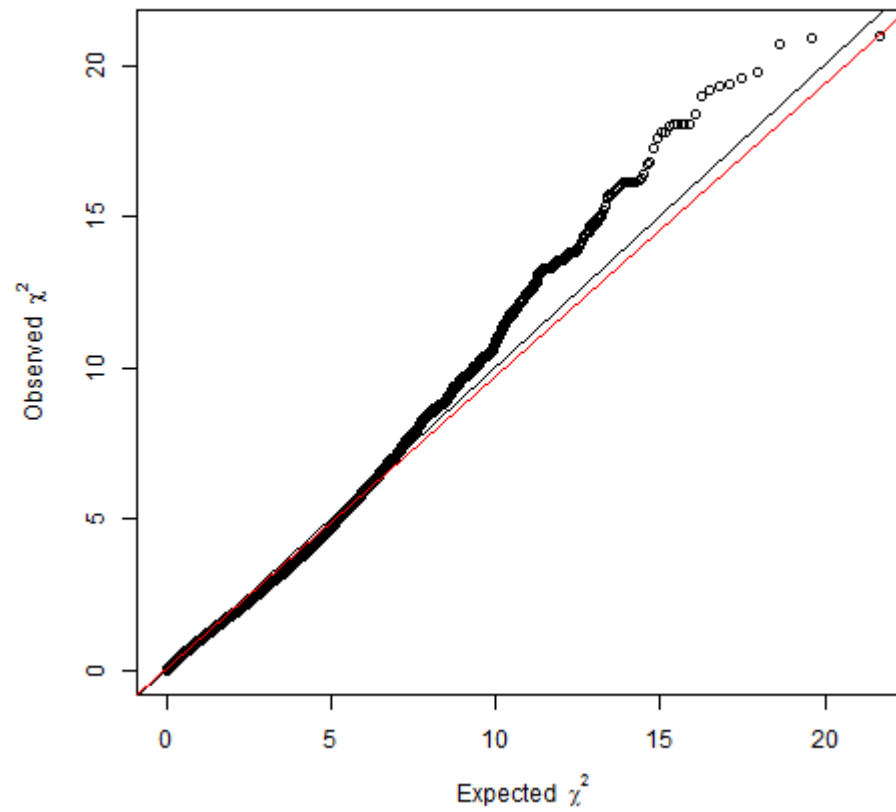
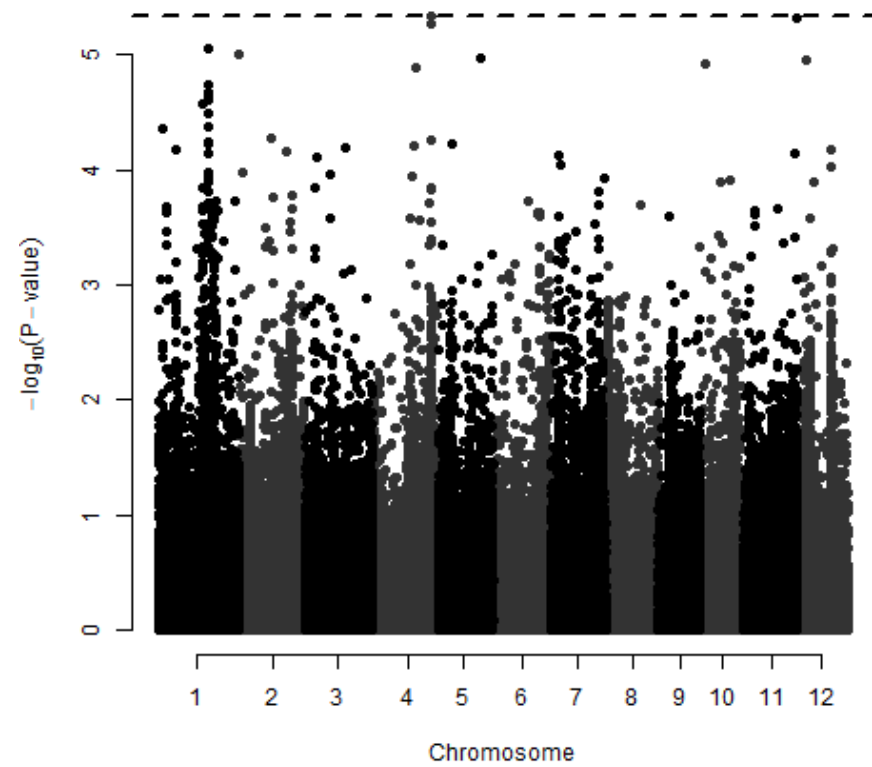
# Indica - QP



# Japonica - QP

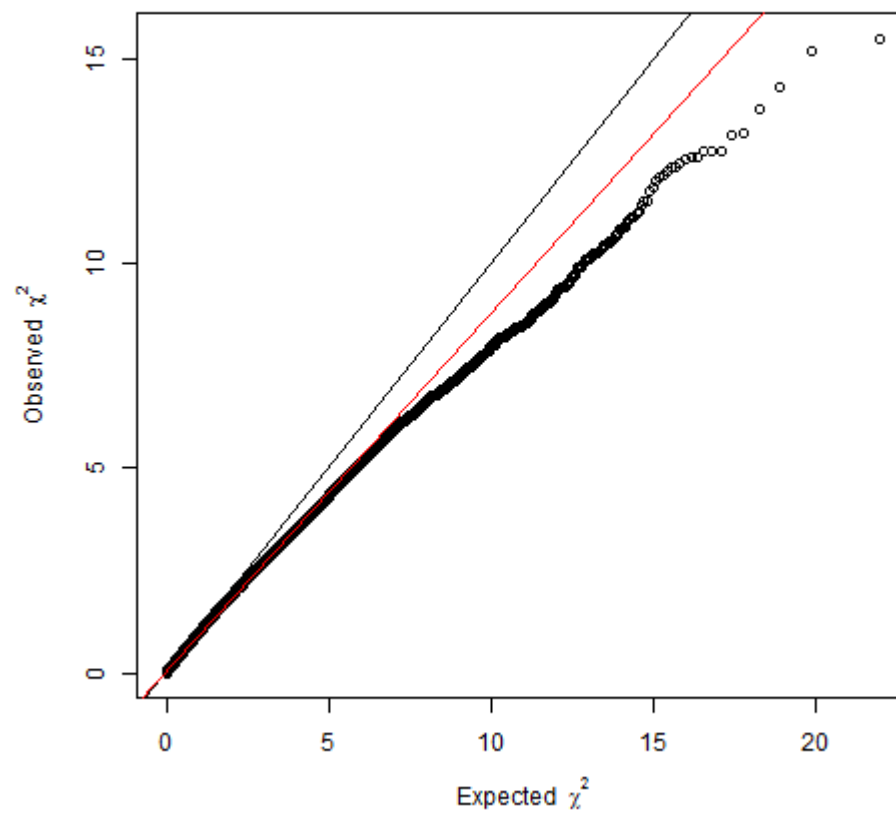
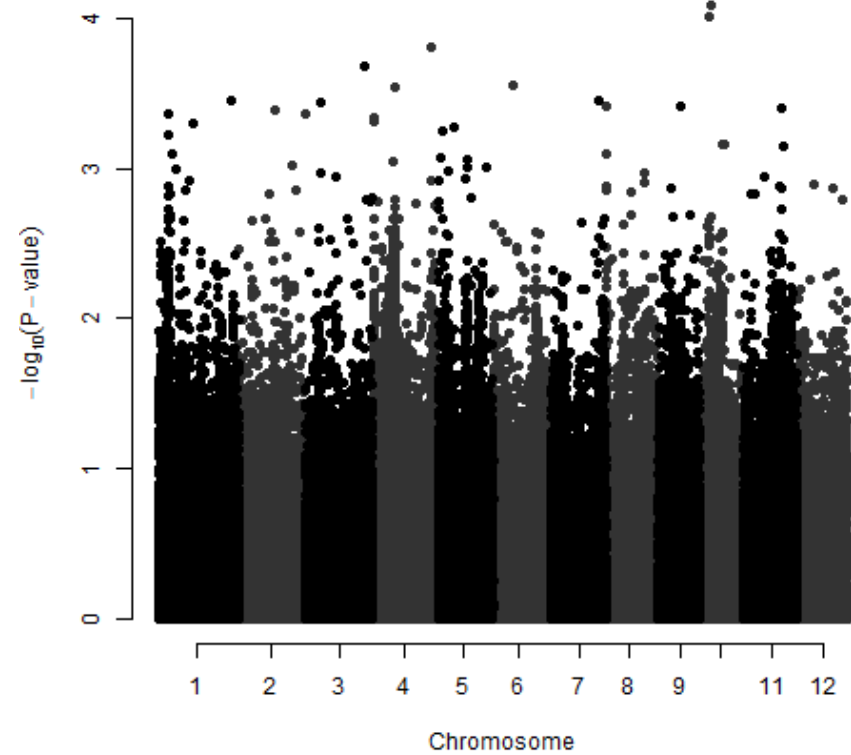


aus - QP

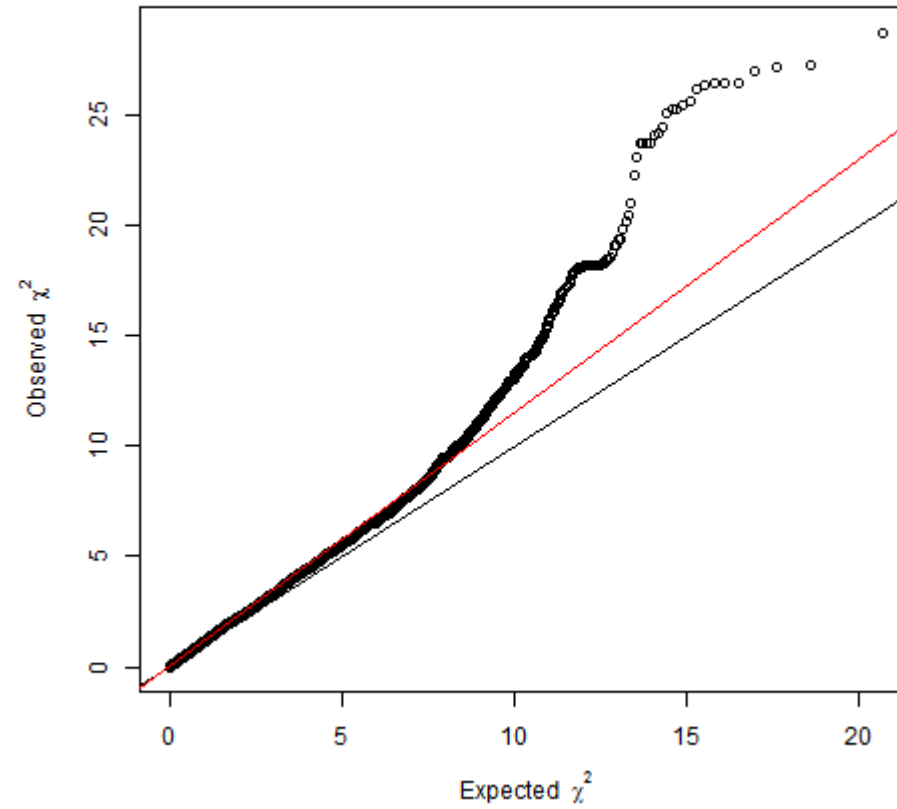
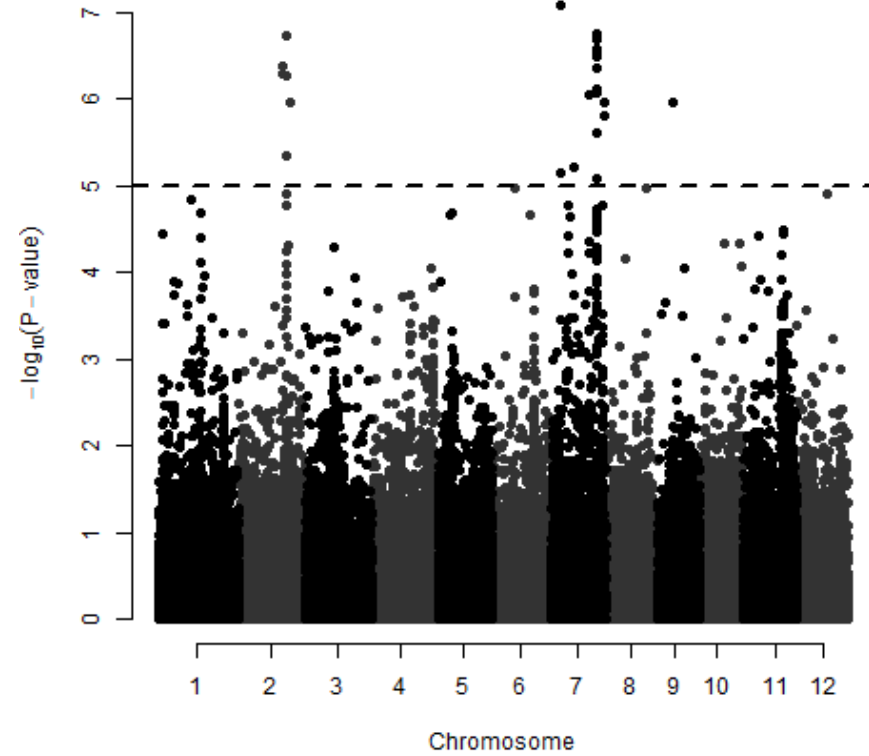




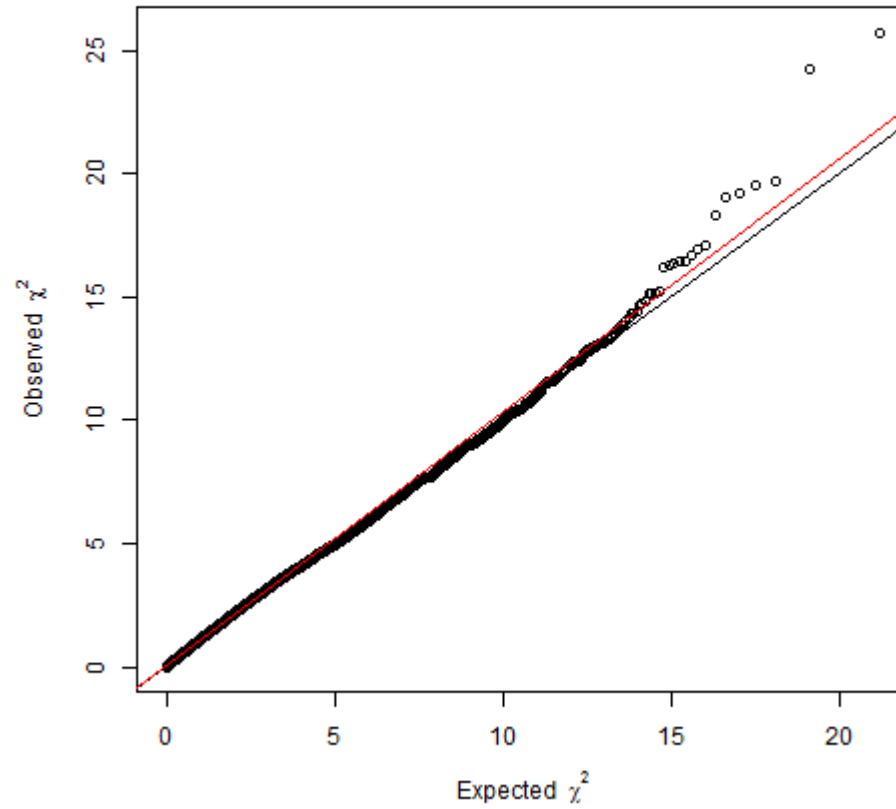
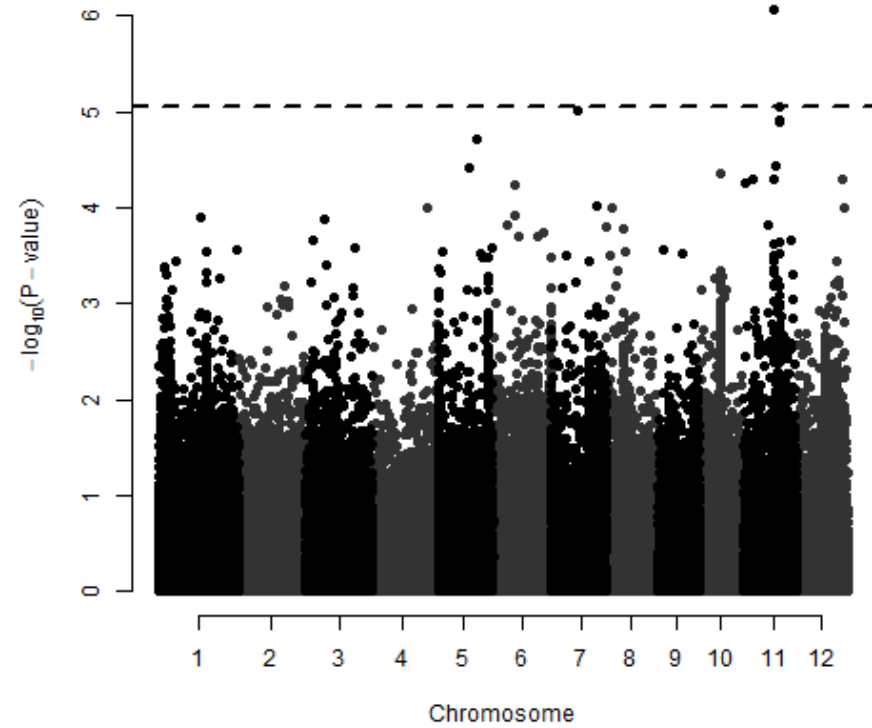
indica -QP



# temperate japonica - QP



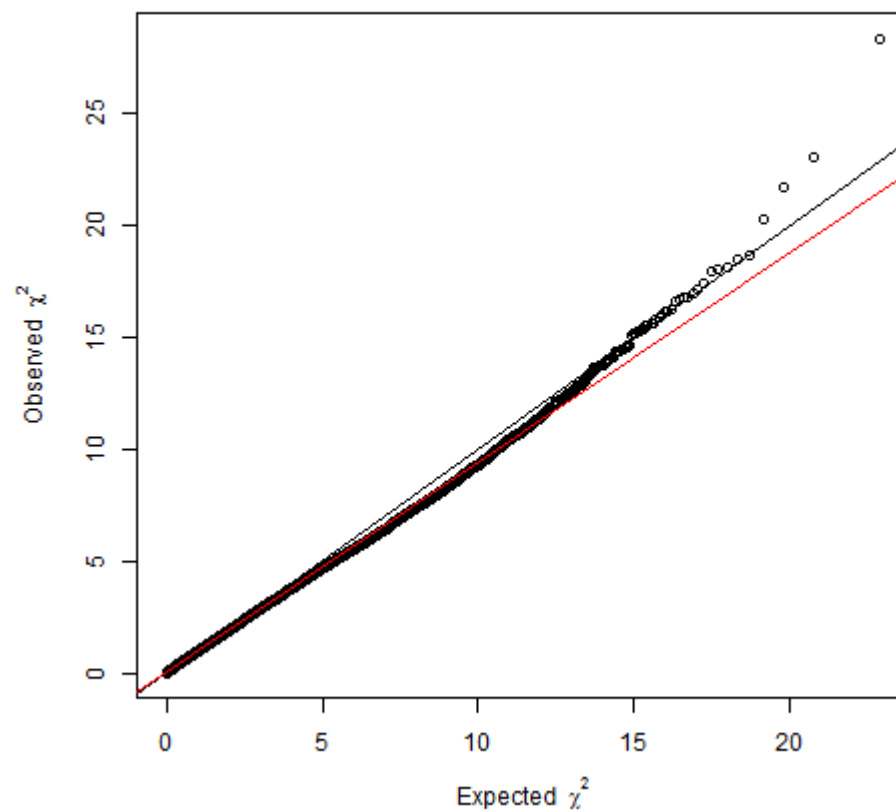
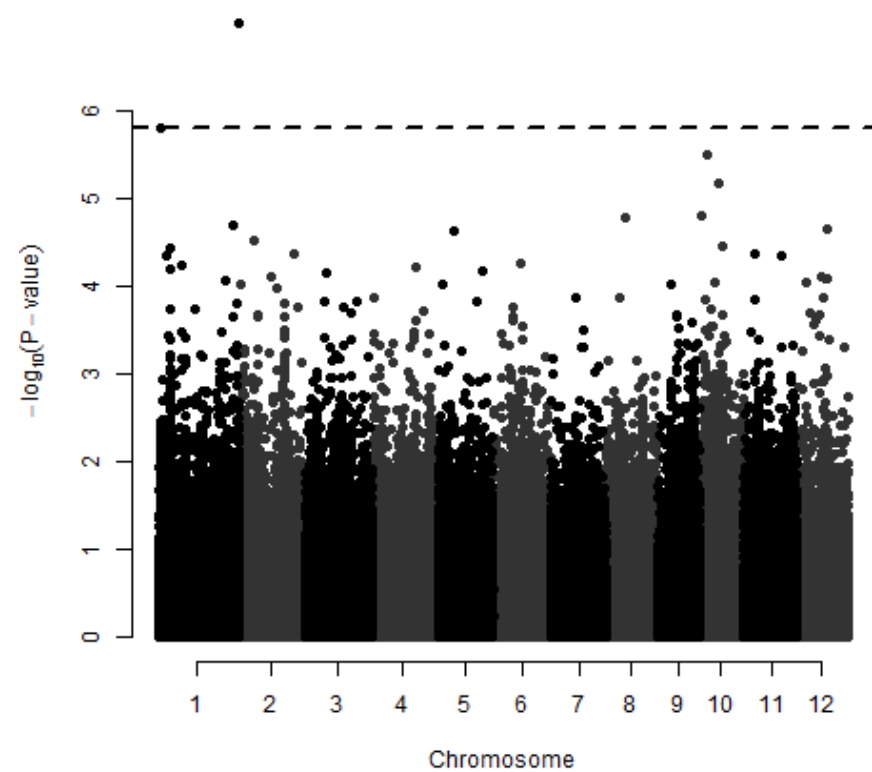
# tropical japonica - QP



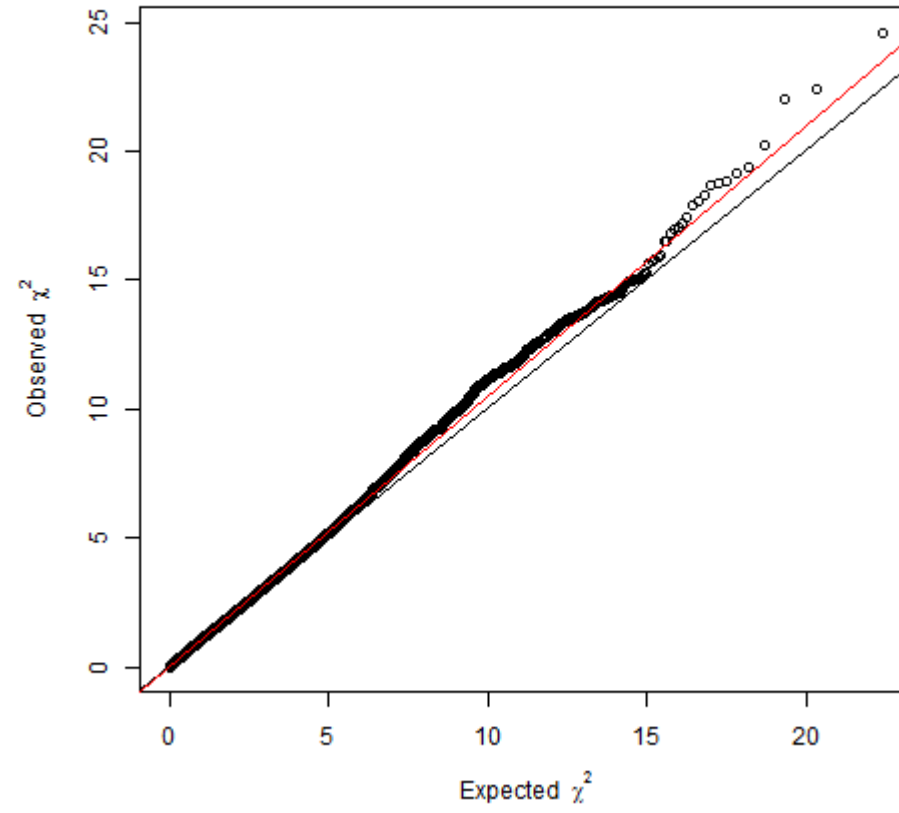
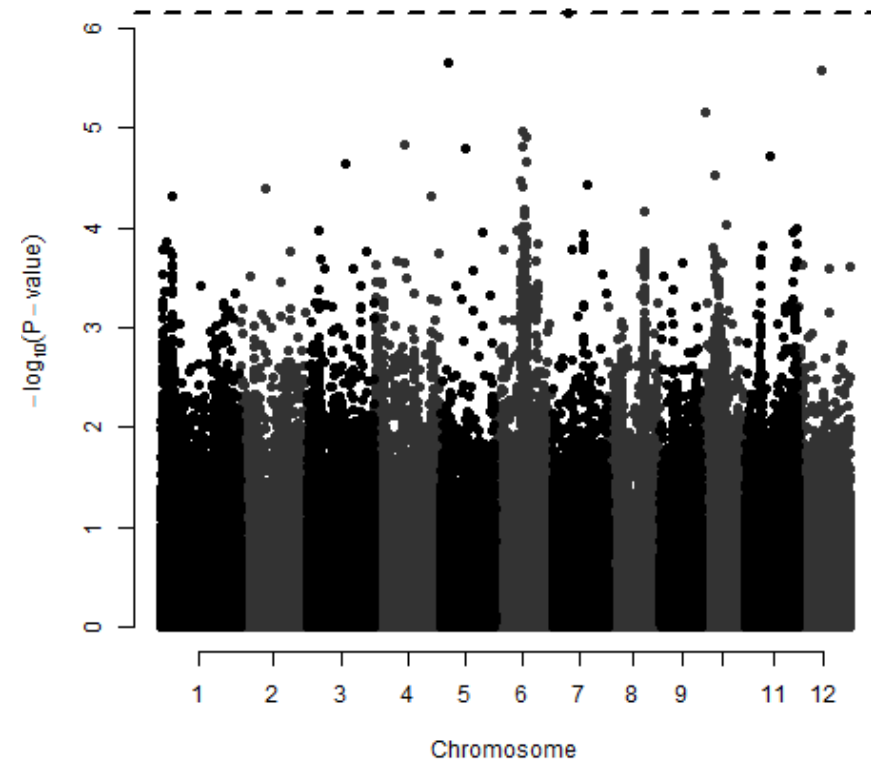
# RCR

Relative root potassium concentration

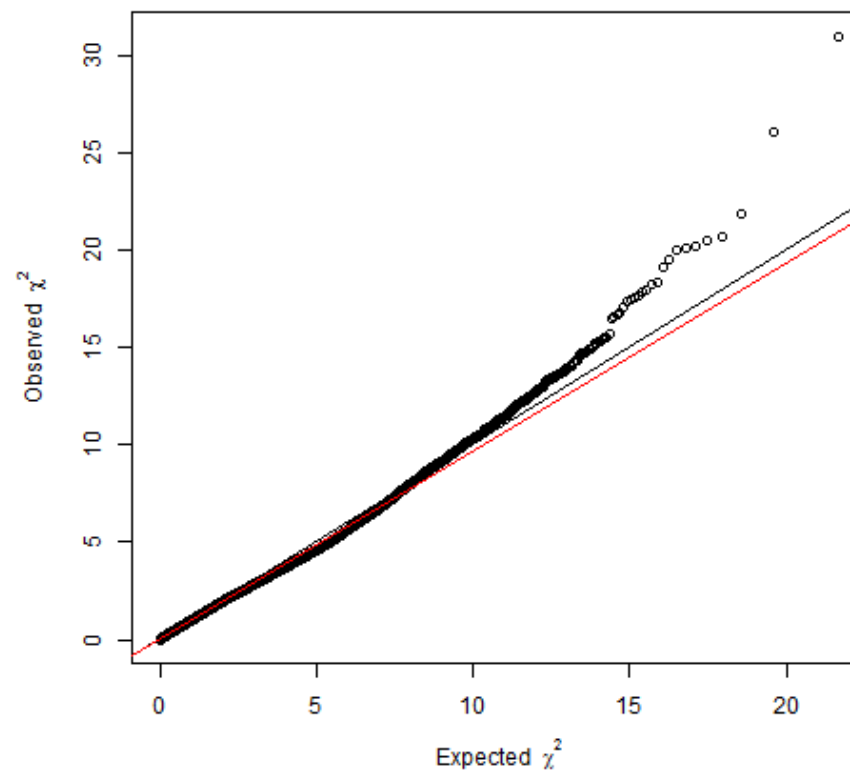
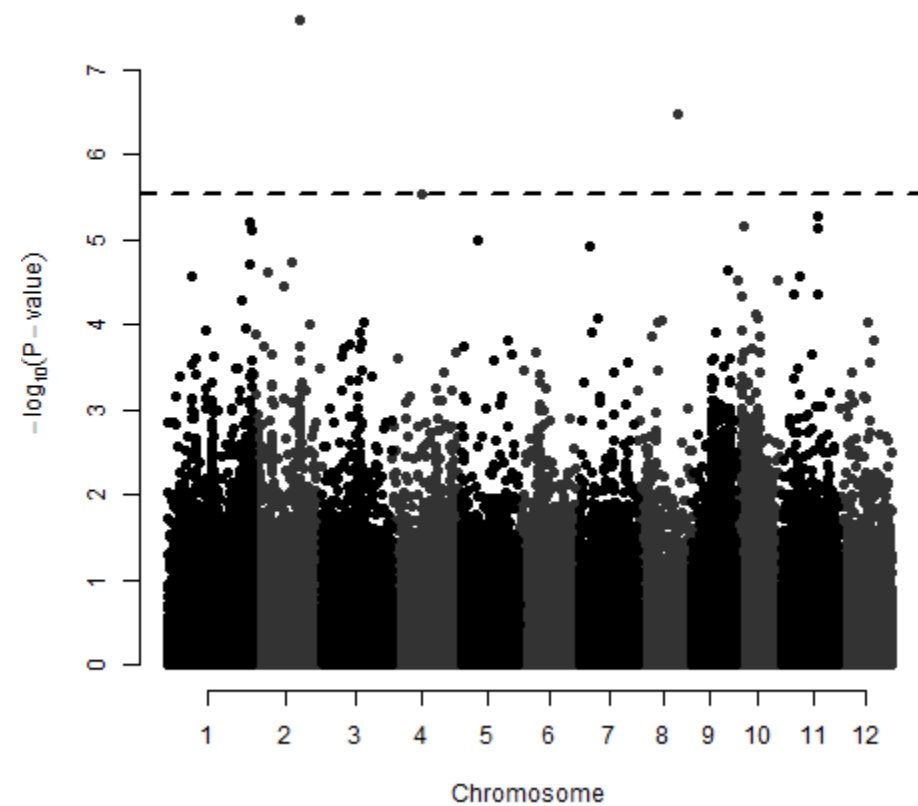
# All genotypes - RCR



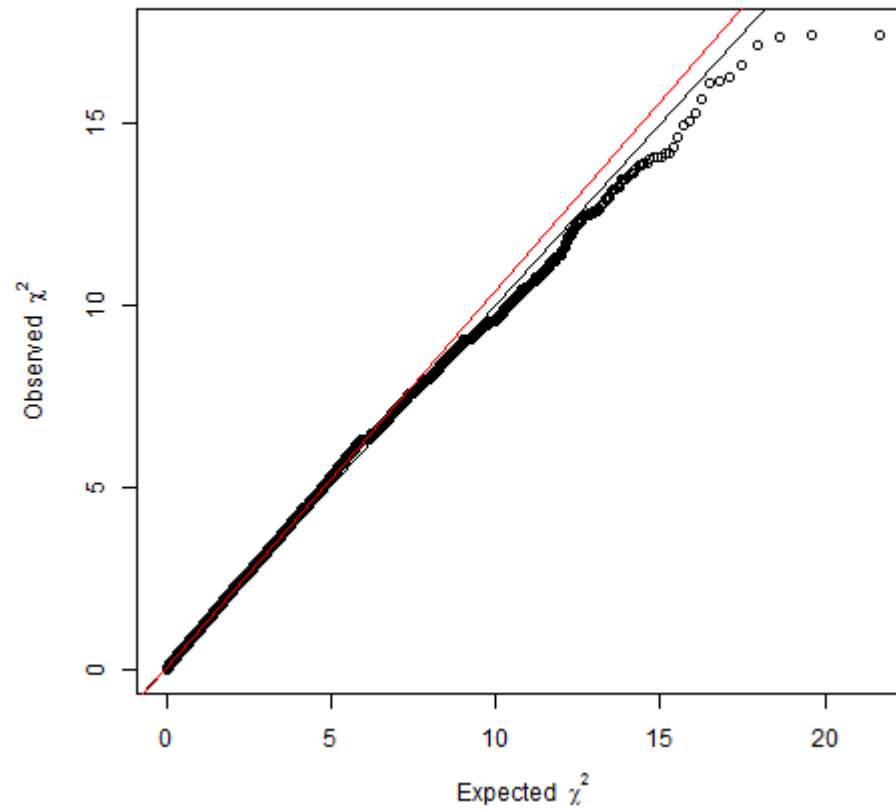
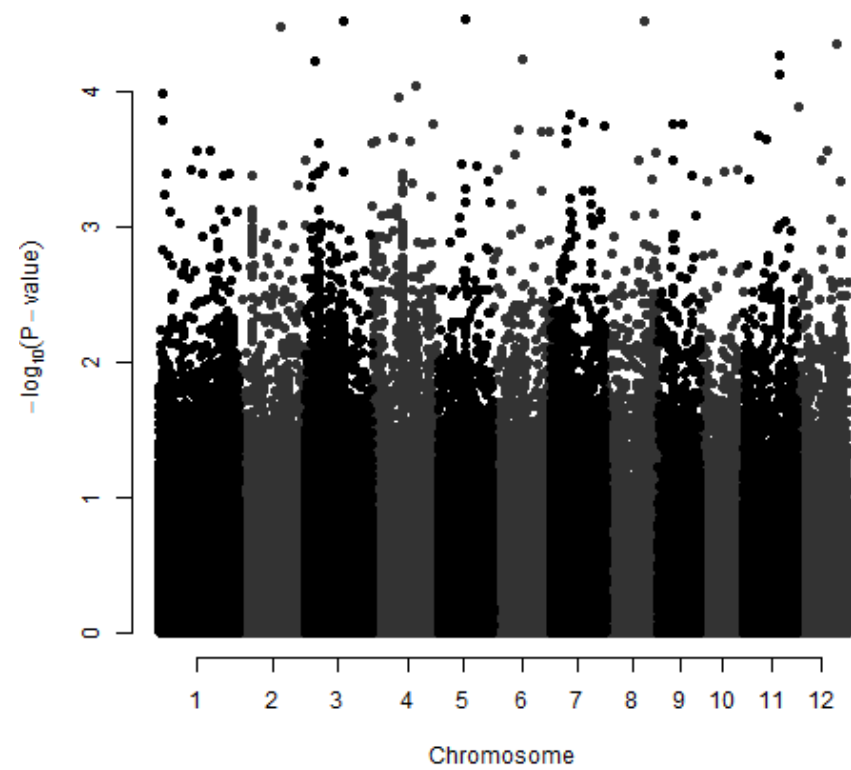
# Indica - RCR



# Japonica - RCR

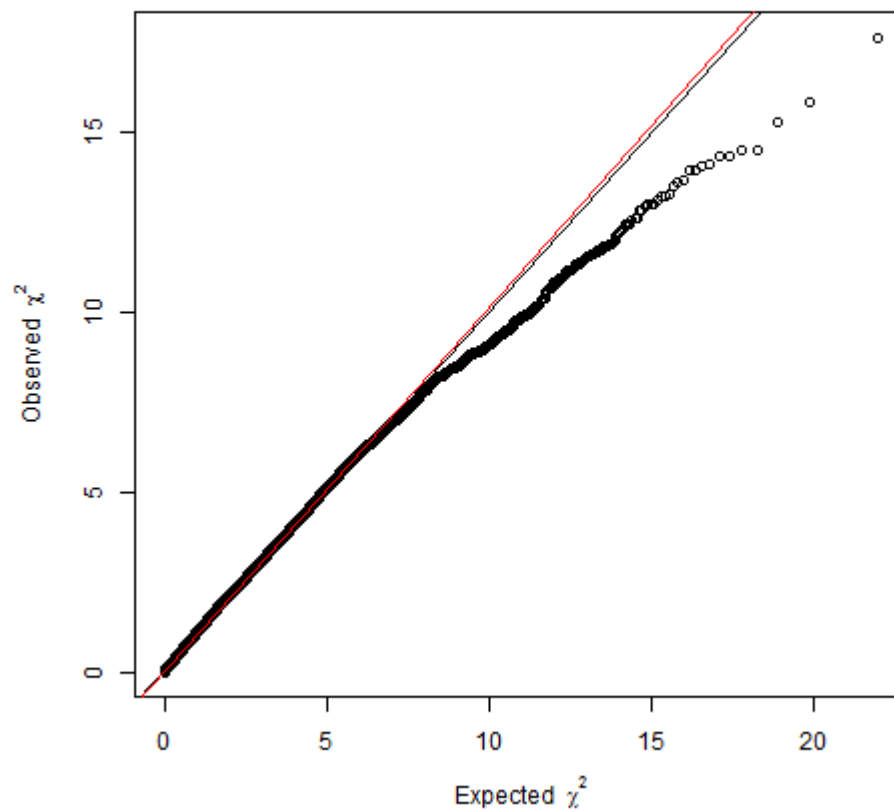
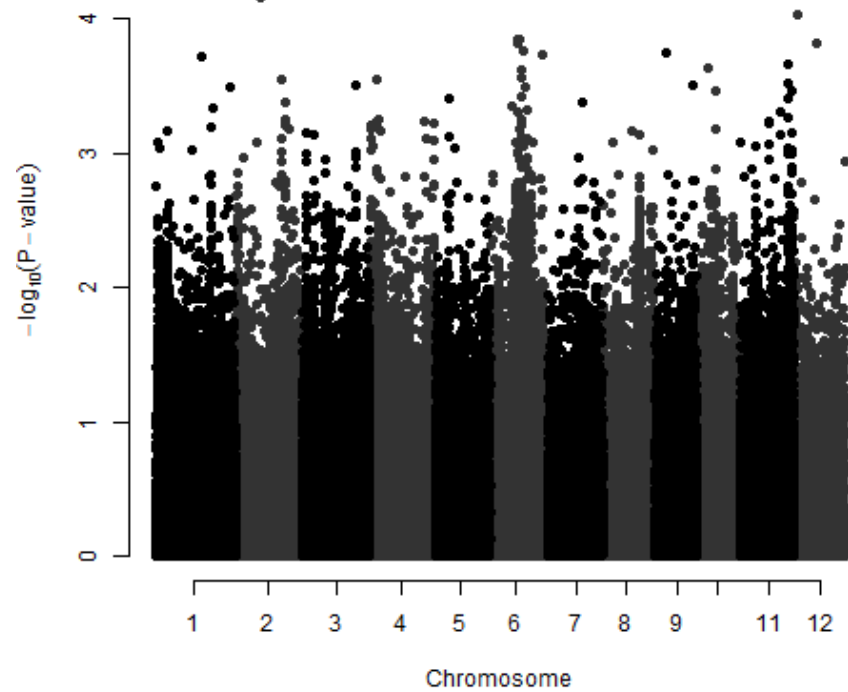


# aus - RCR

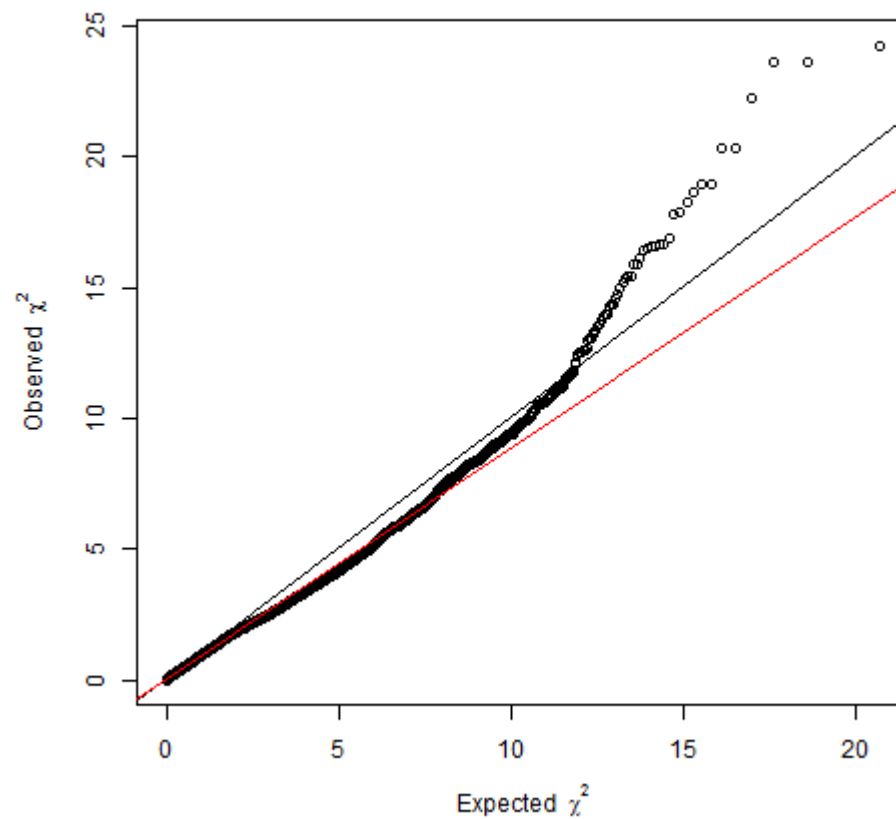
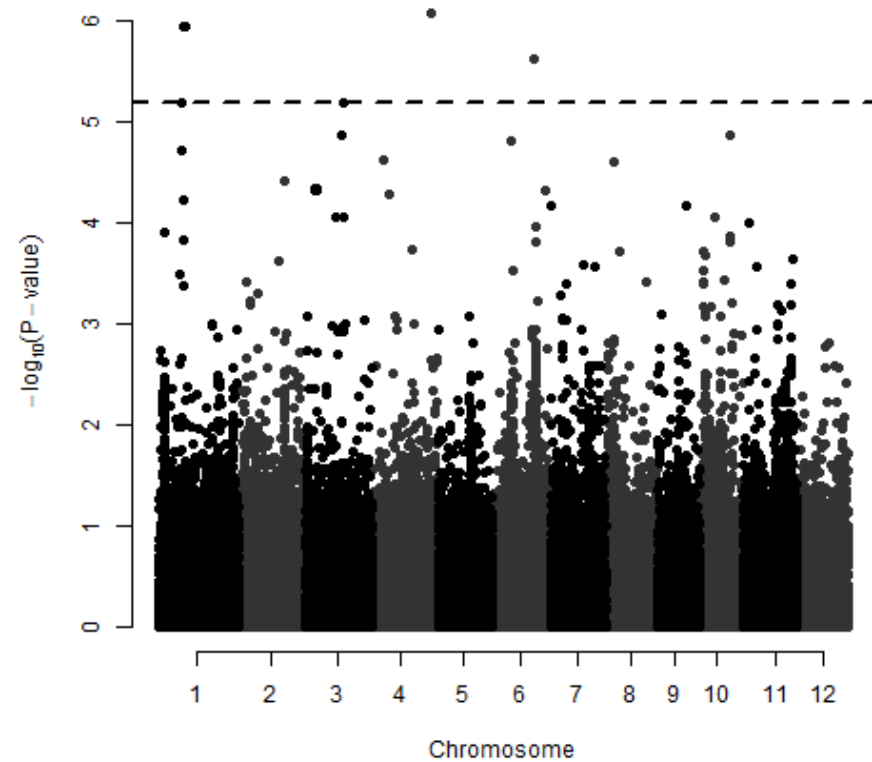




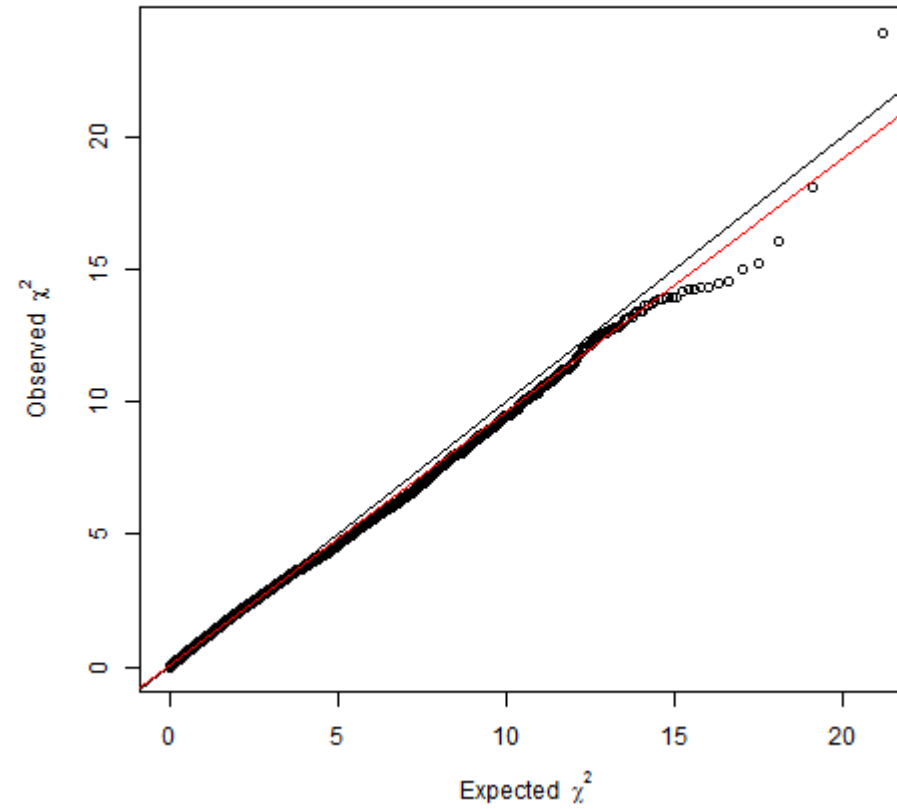
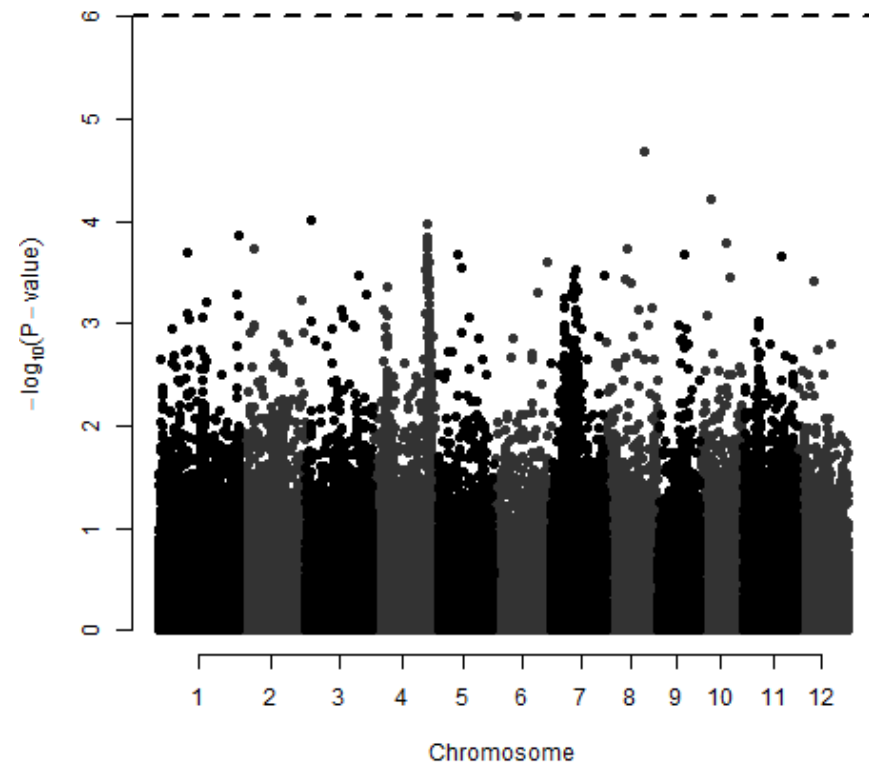
# indica - RCR



# temperate japonica - RCR



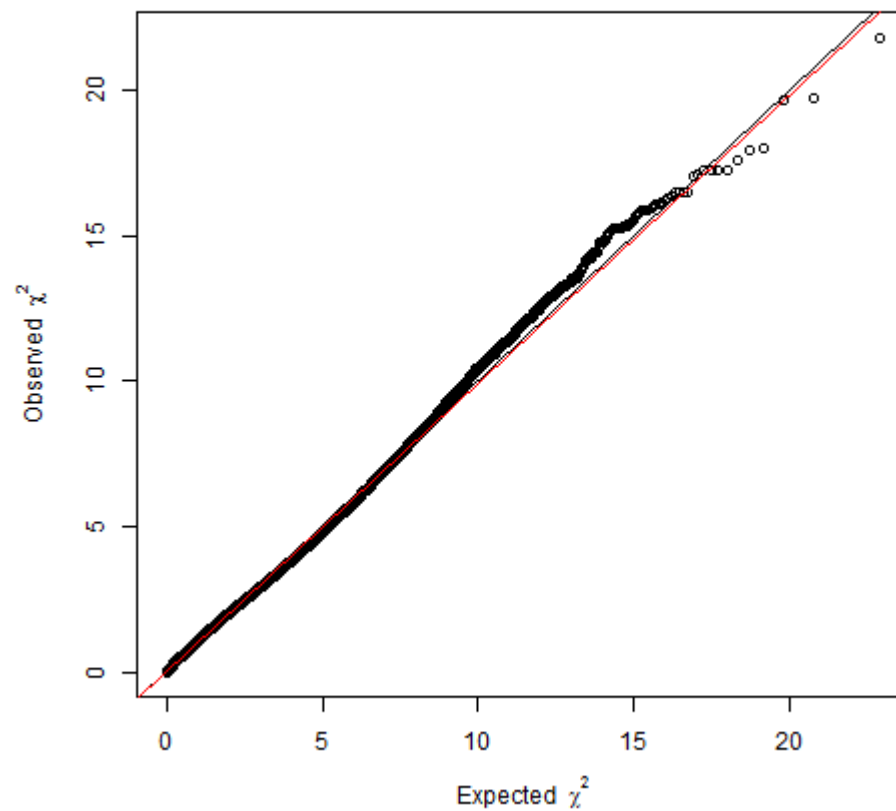
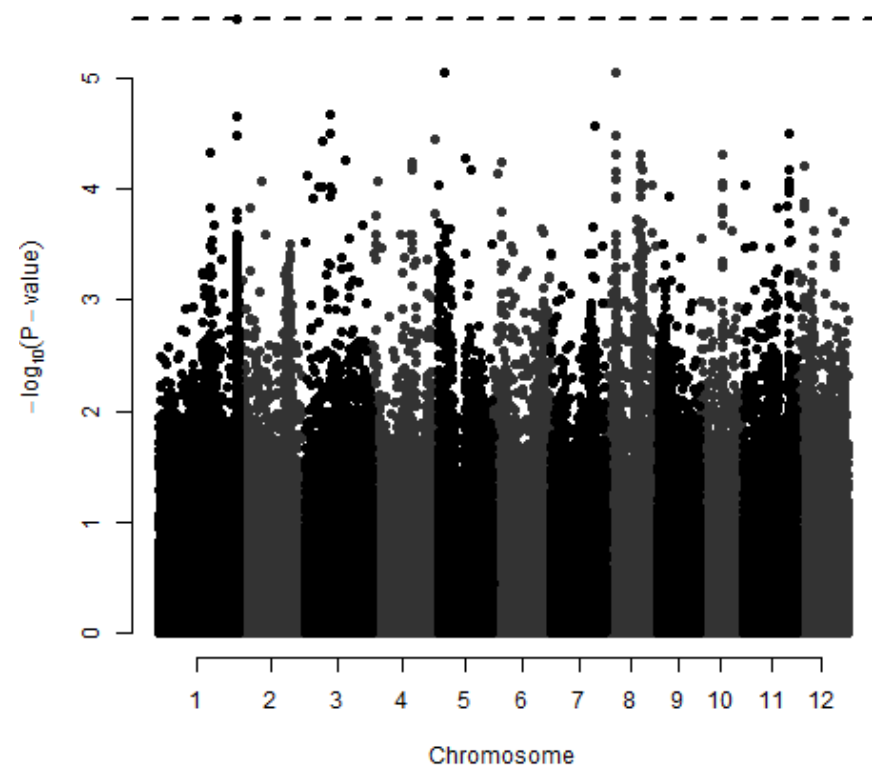
# tropical japonica - RCR



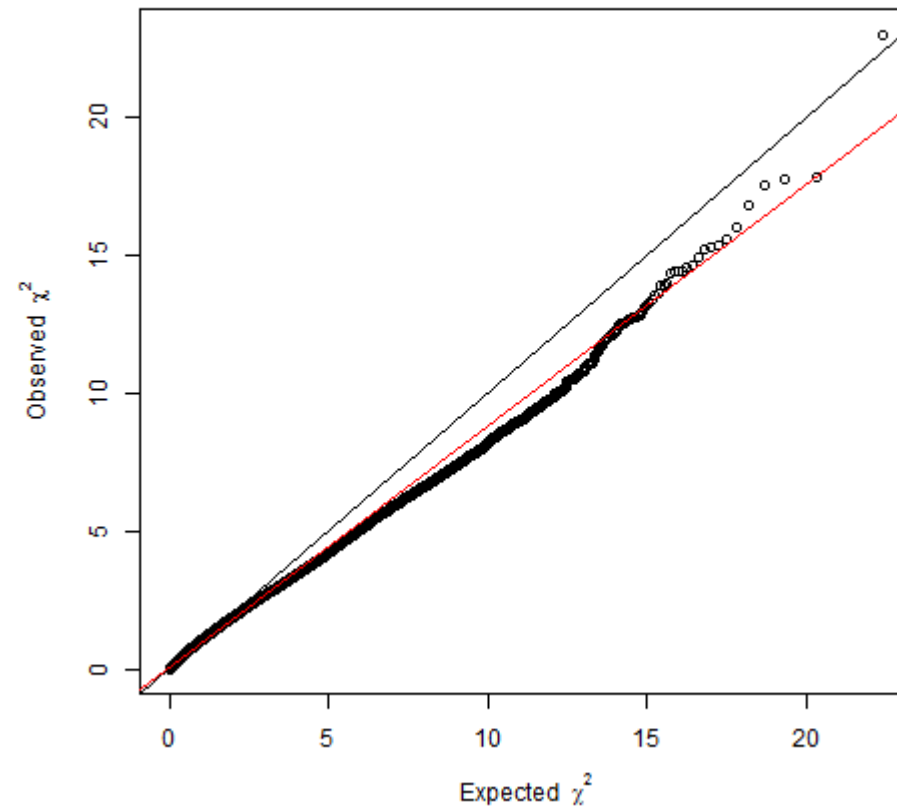
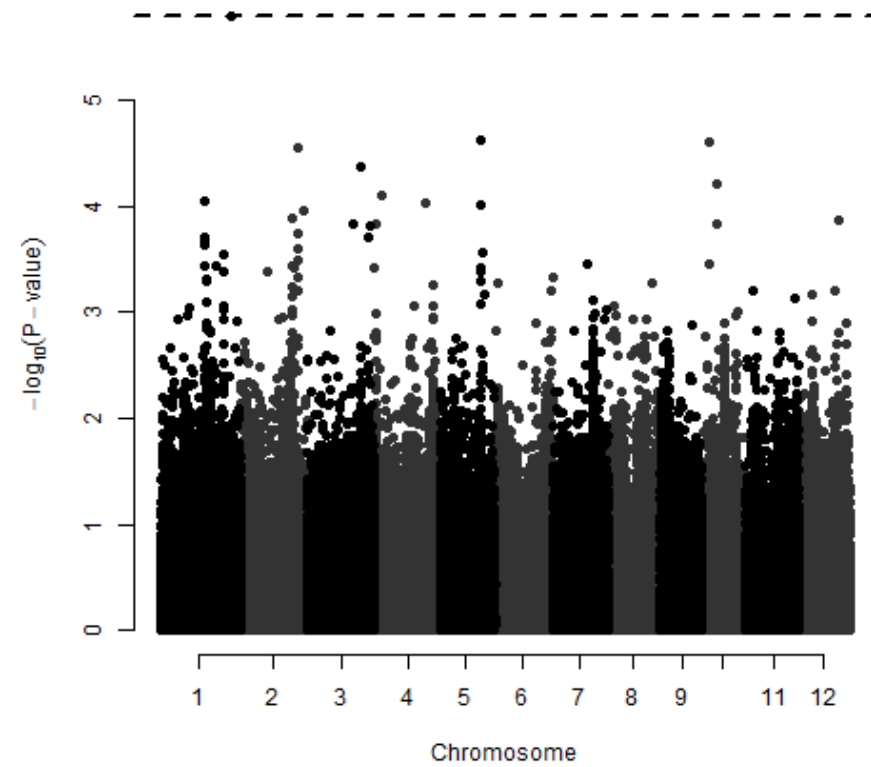
# RCS

Relative shoot potassium concentration

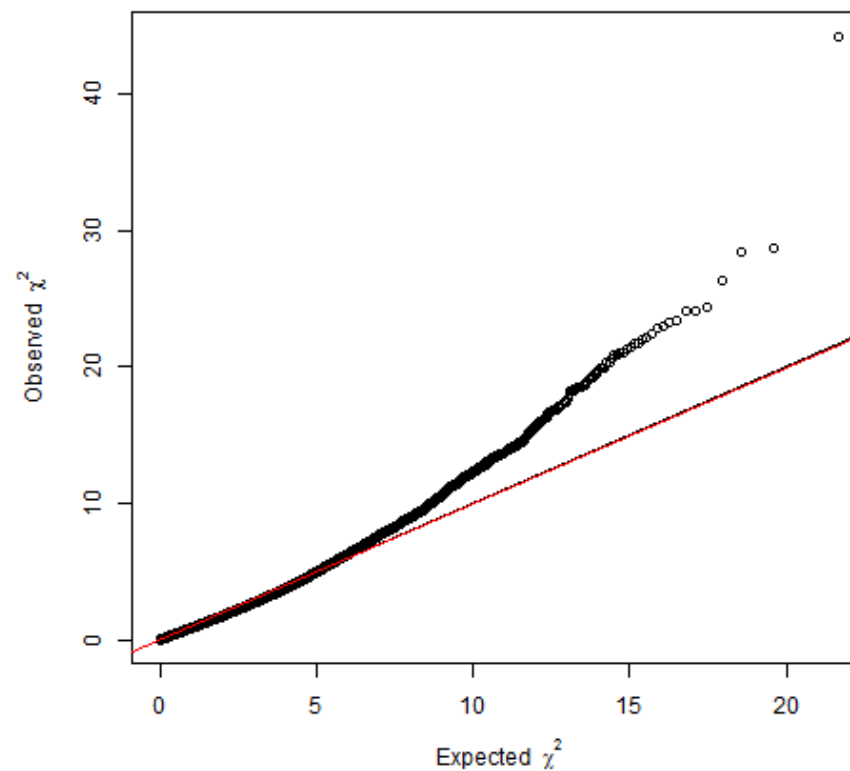
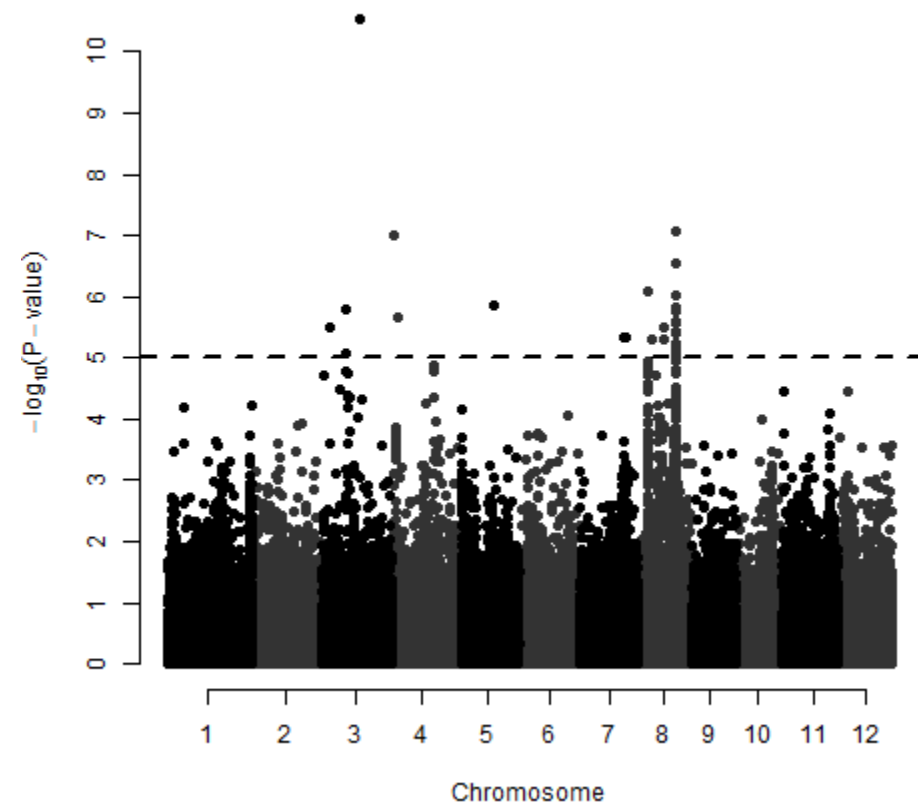
# All genotypes - RCS



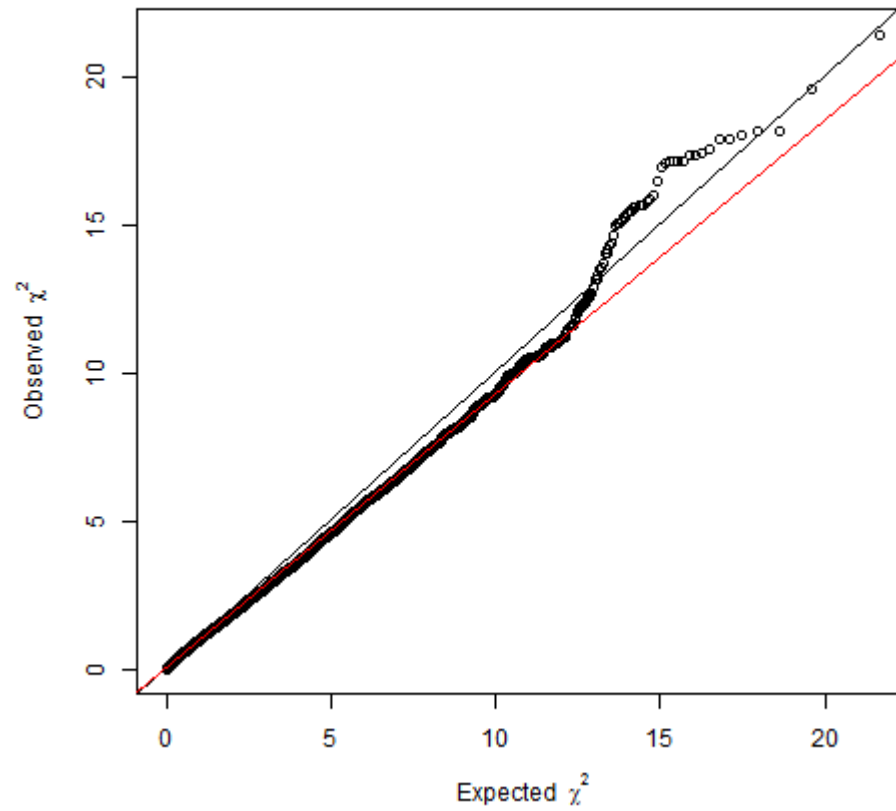
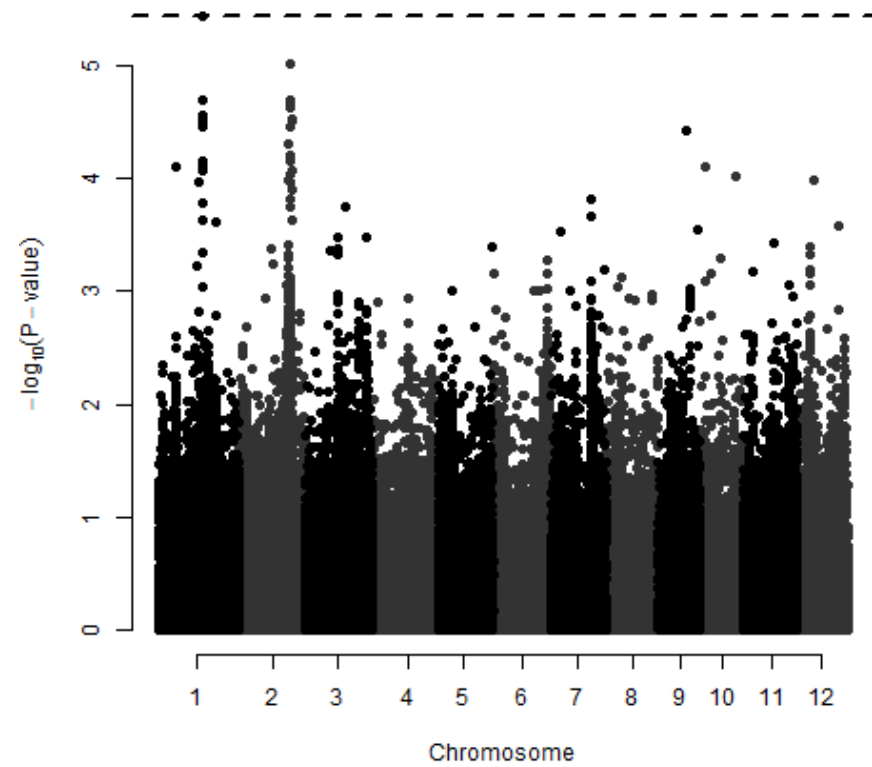
# Indica - RCS



# Japonica - RCS

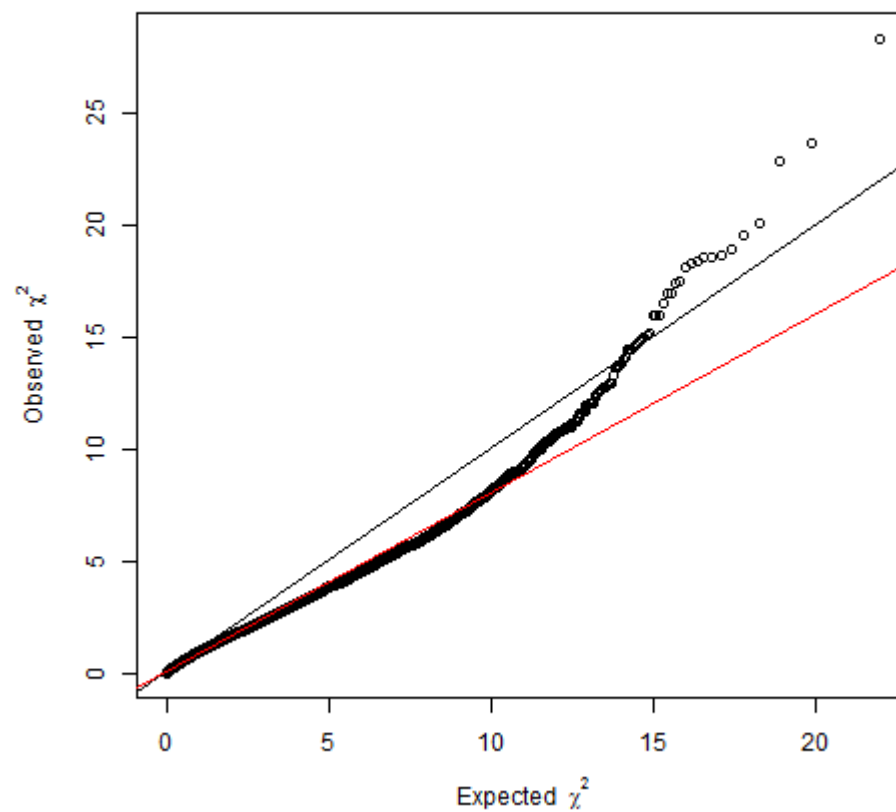
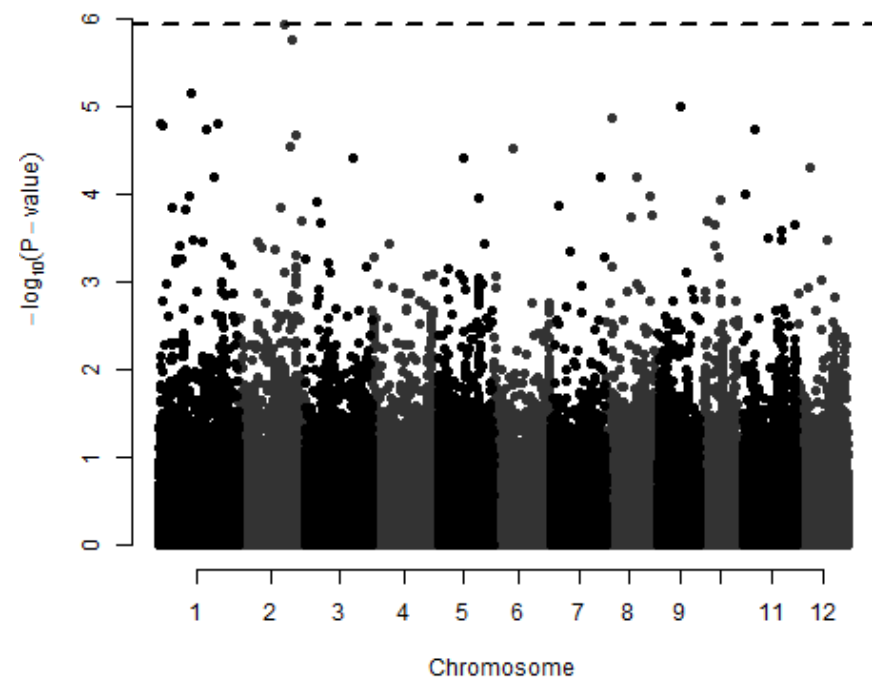


# aus - RCS

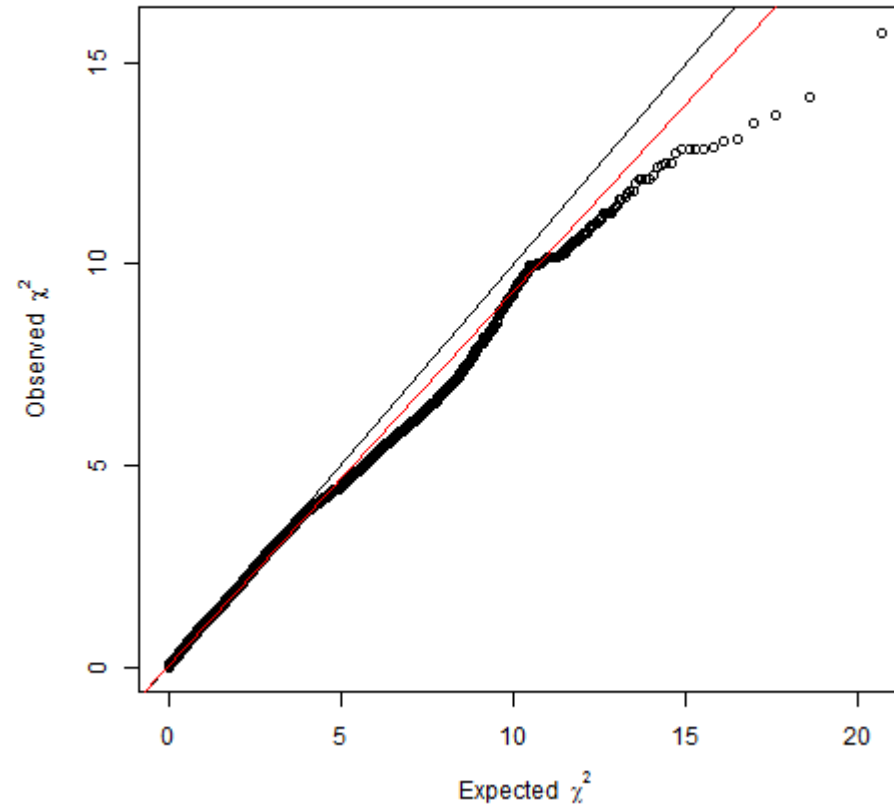
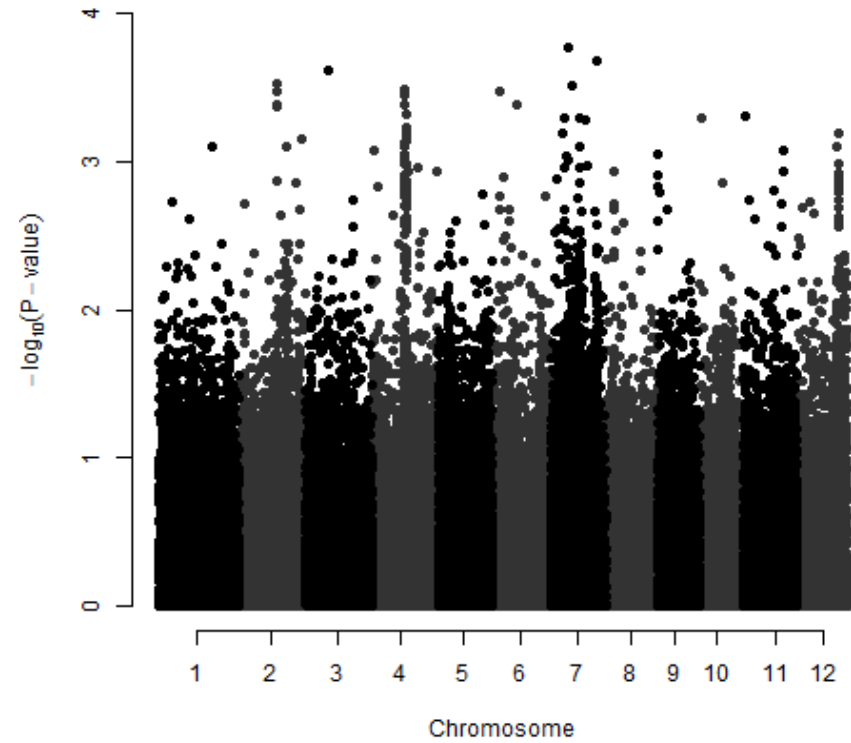




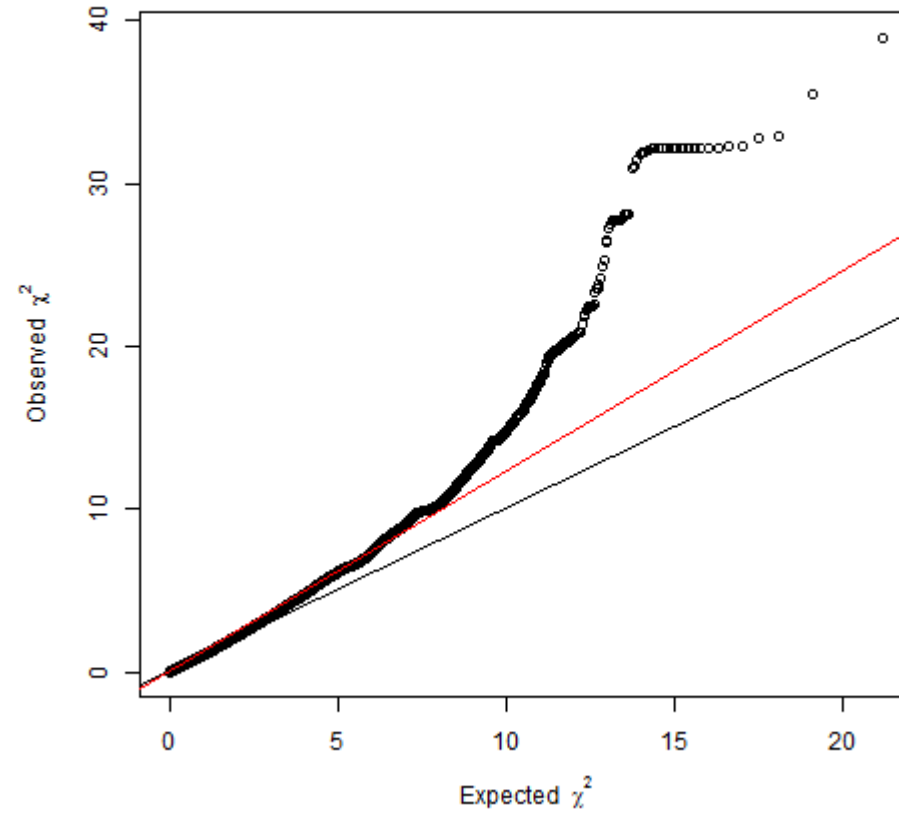
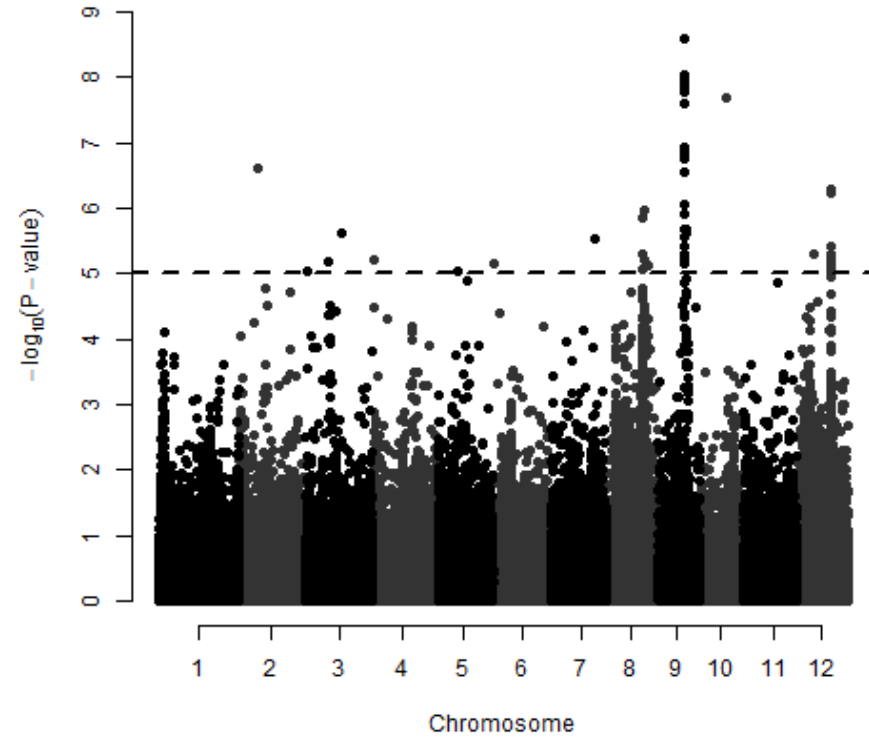
# indica - RCS



# temperate japonica - RCS



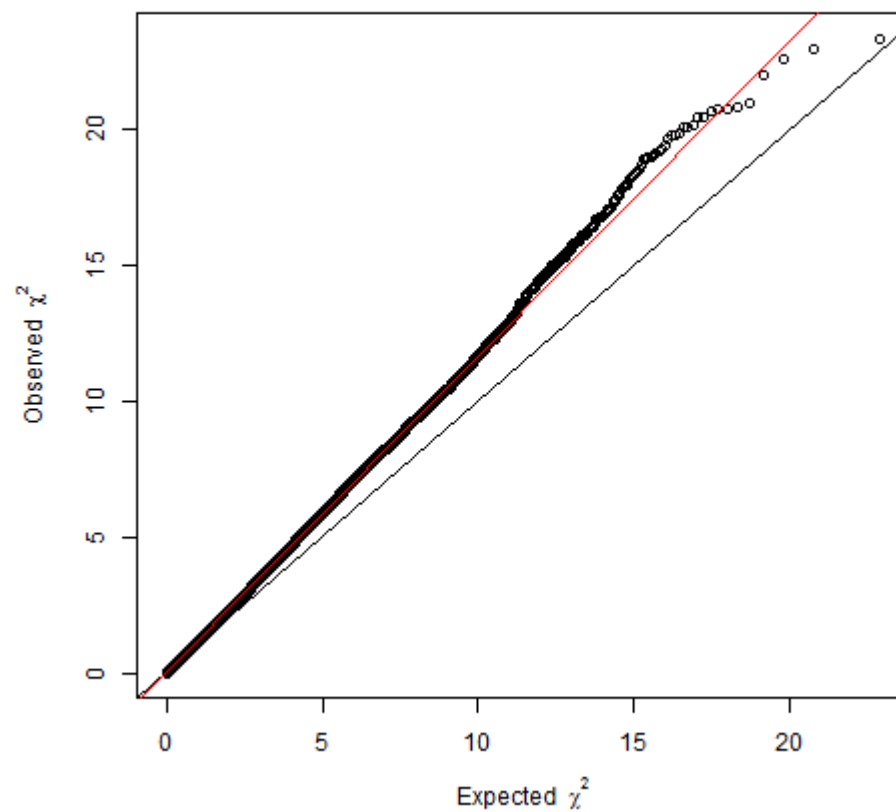
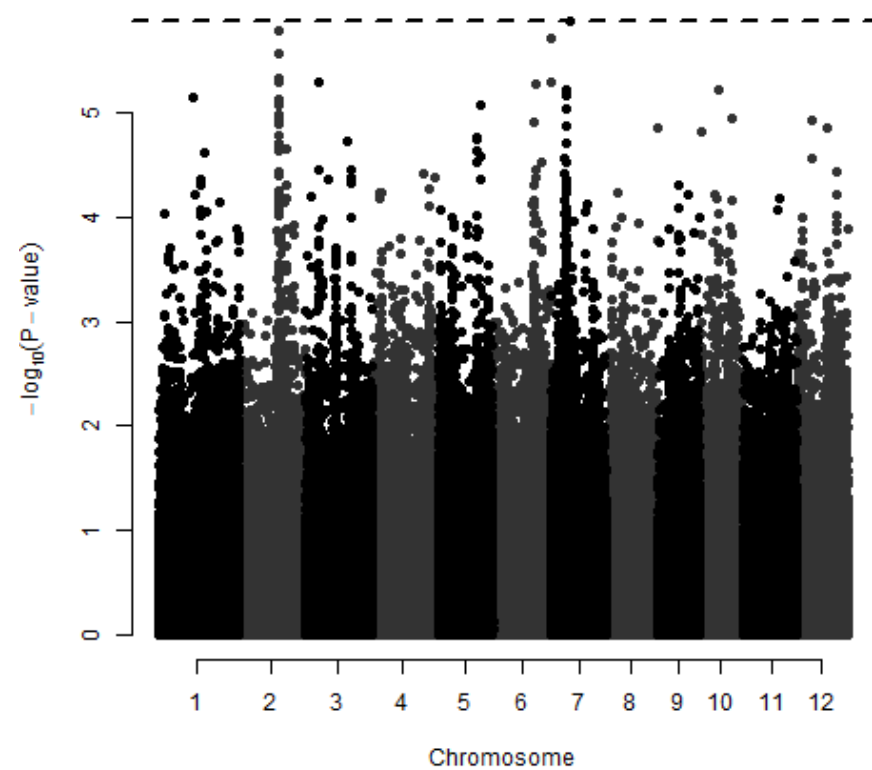
# tropical japonica - RCS



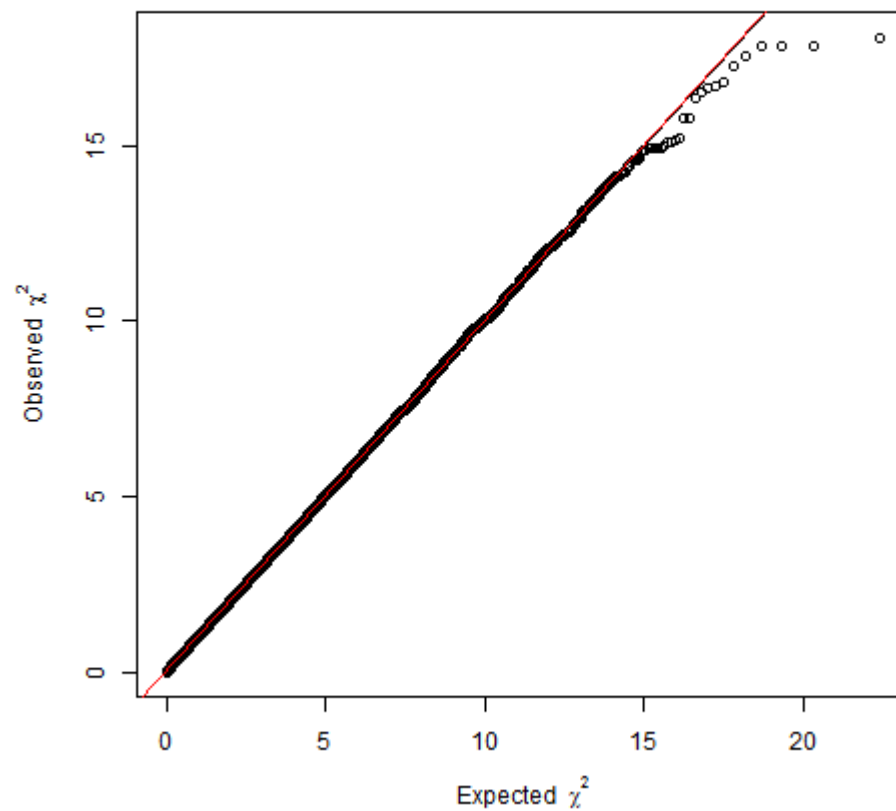
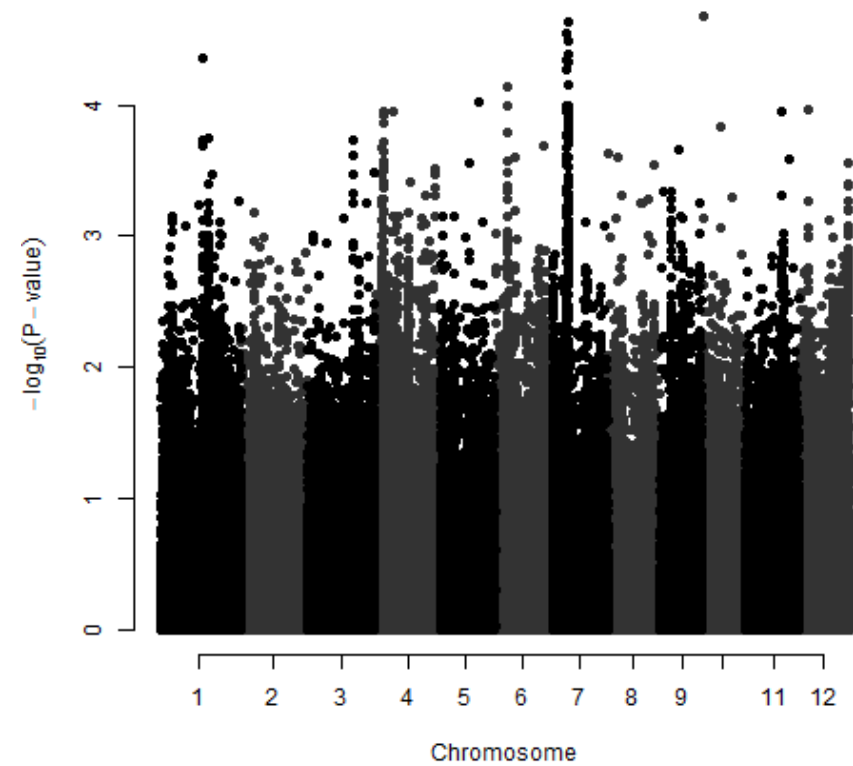
$$\text{RGR}_{\text{HT}}$$

Relative growth rate in the high treatment

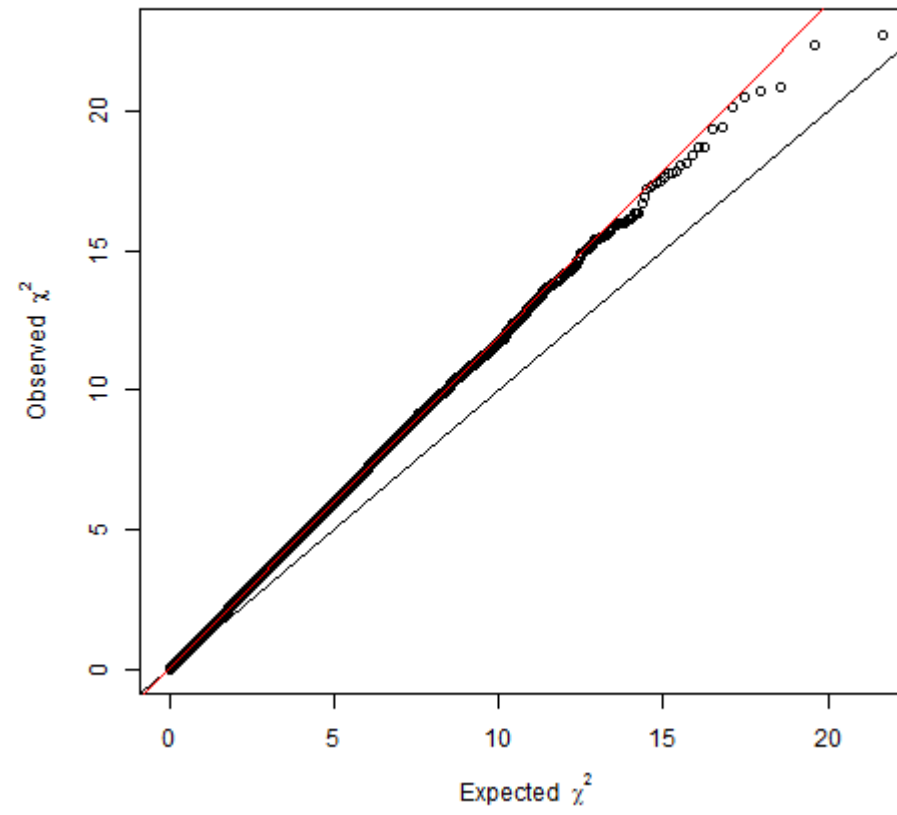
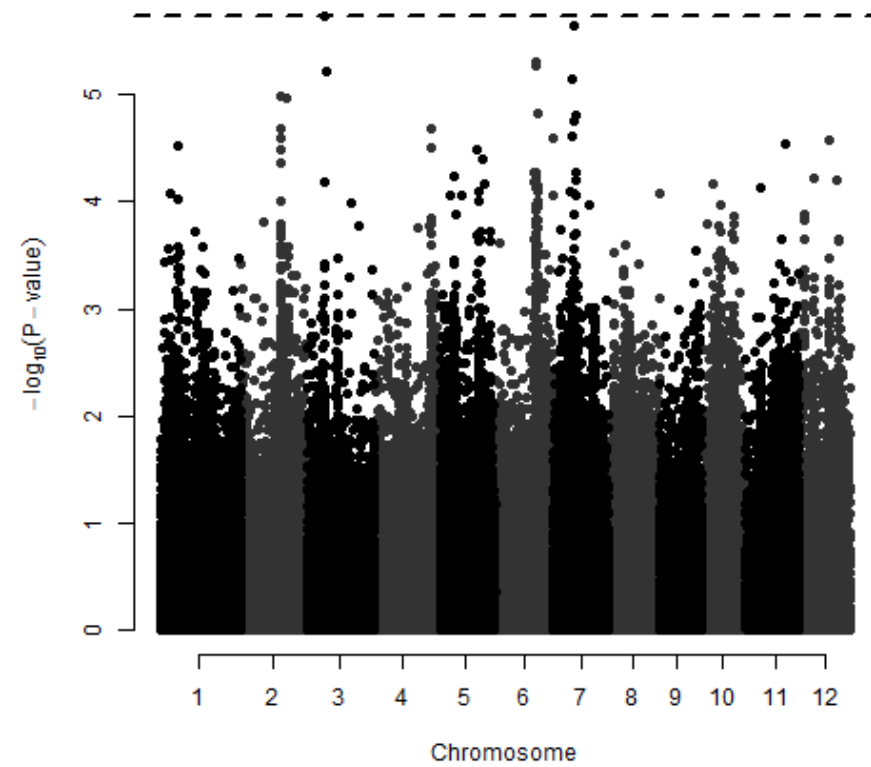
# All genotypes - $RGR_{HT}$



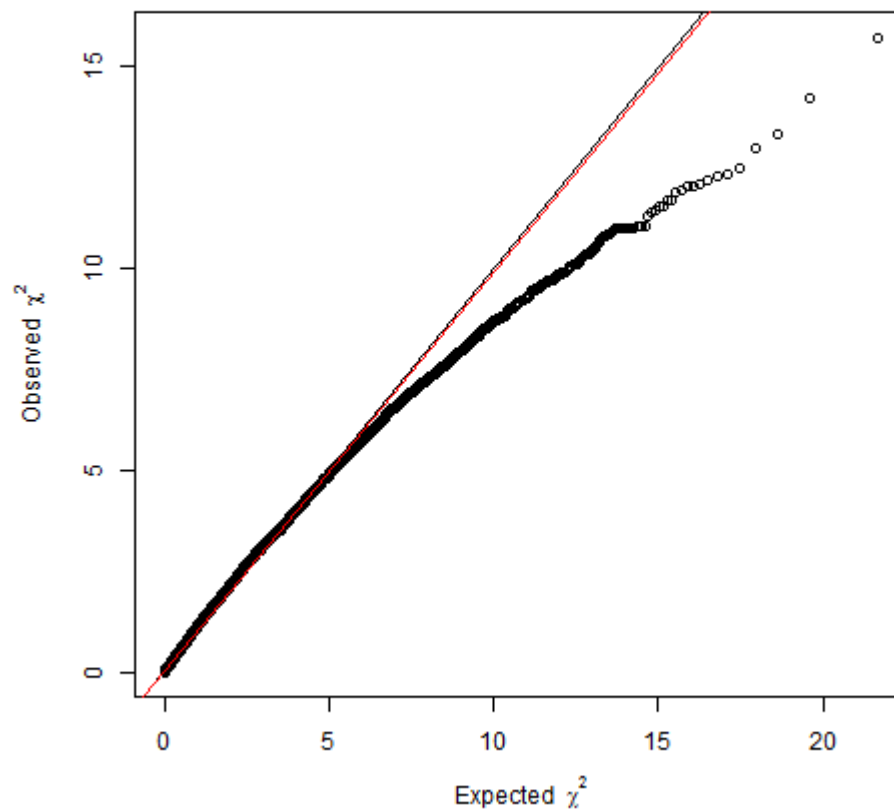
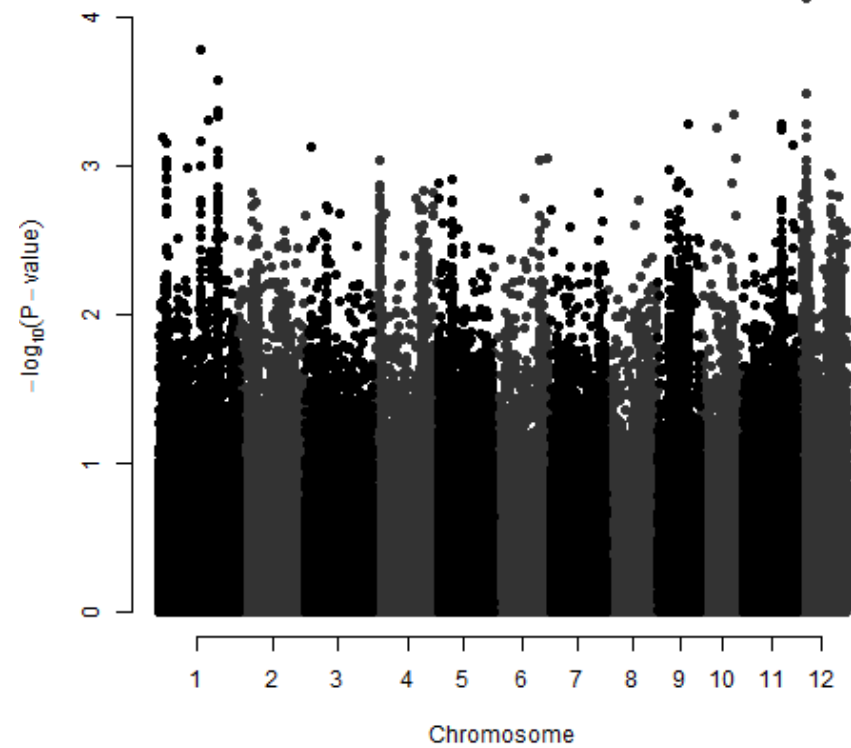
# Indica - $RGR_{HT}$



# Japonica - $RGR_{HT}$

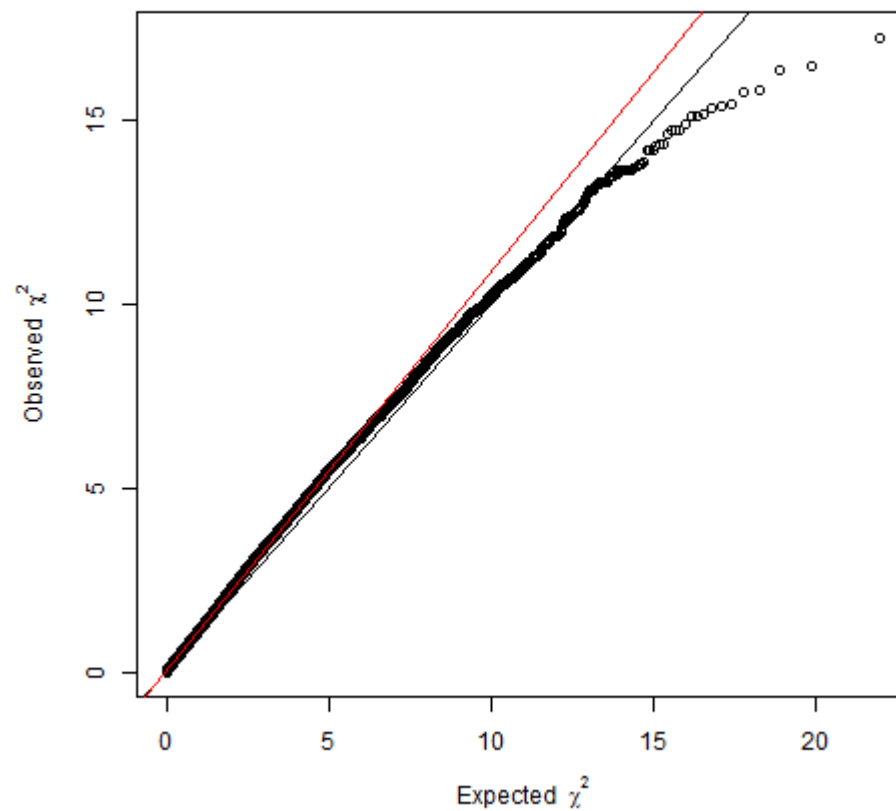
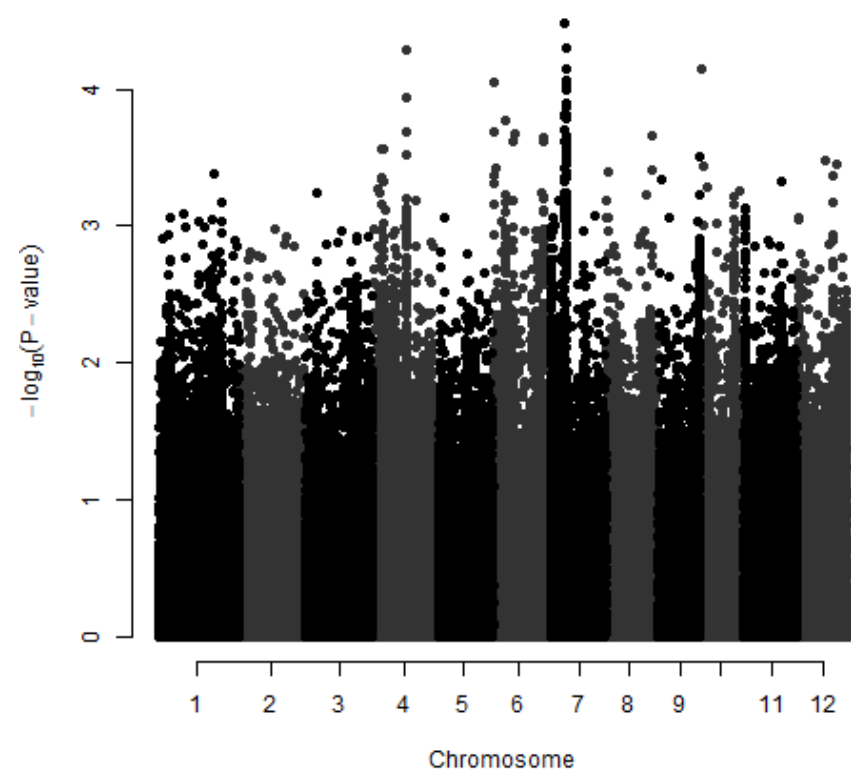


aus -  $\text{RGR}_{\text{HT}}$

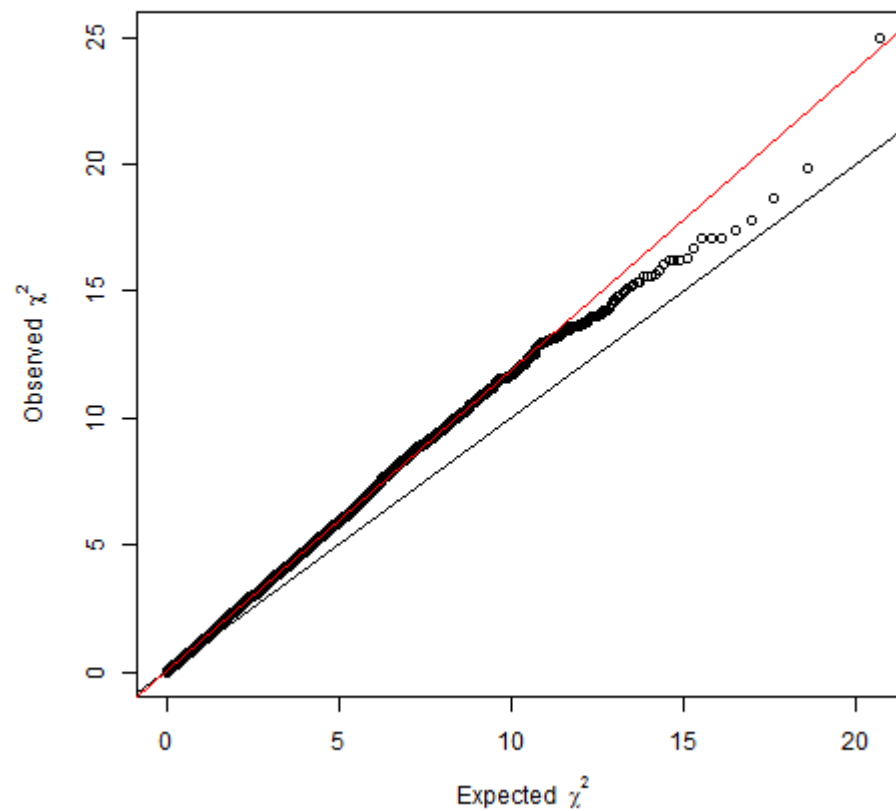
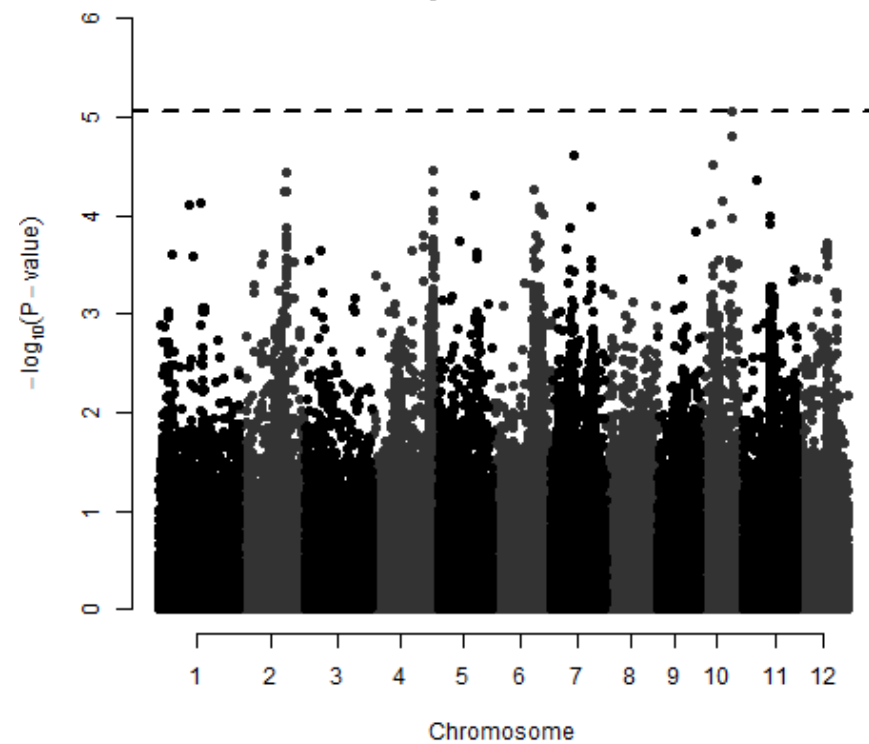




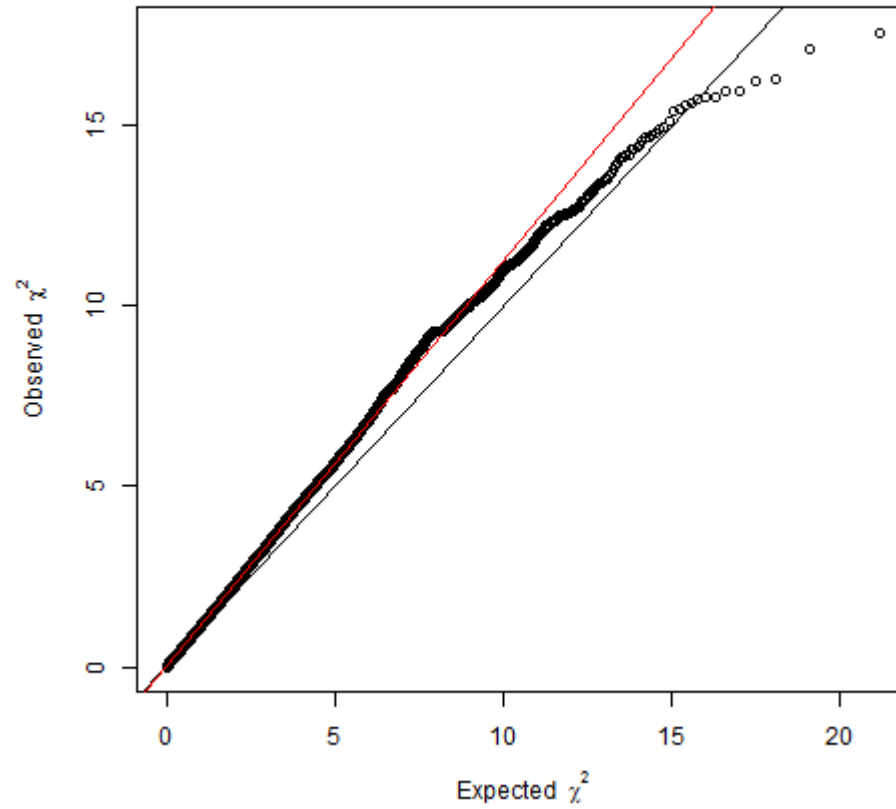
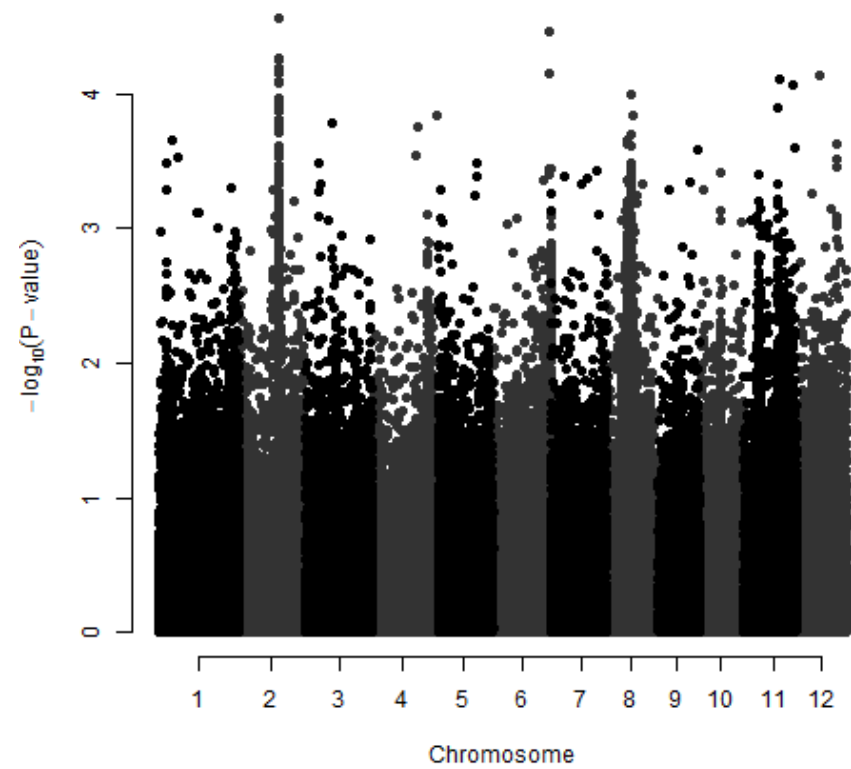
indica -  $\text{RGR}_{\text{HT}}$



# temperate japonica - $\text{RGR}_{\text{HT}}$



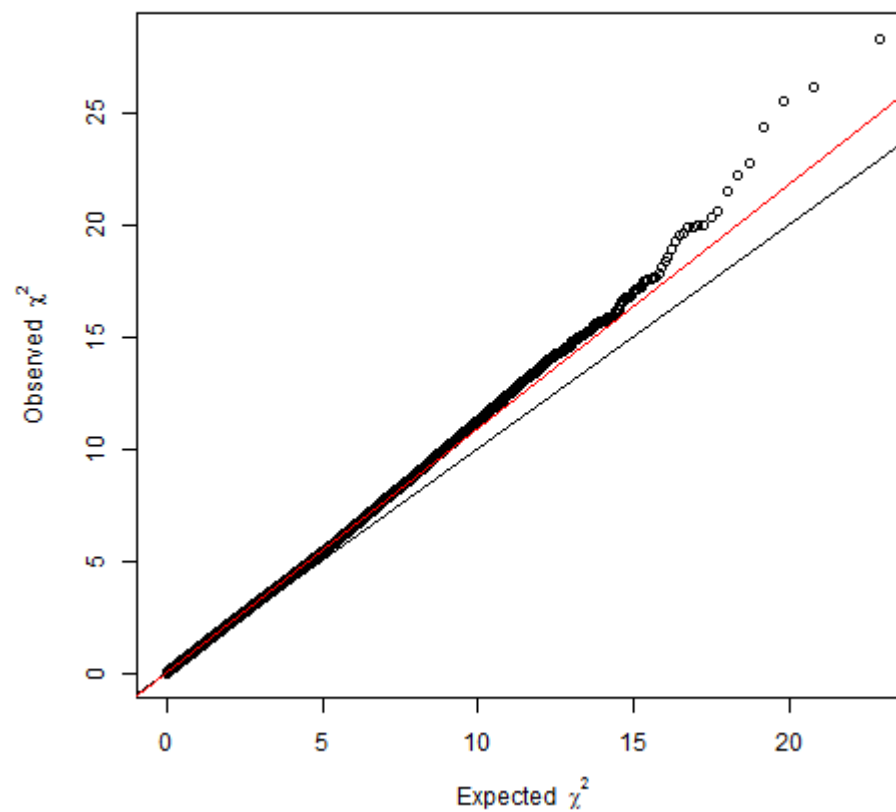
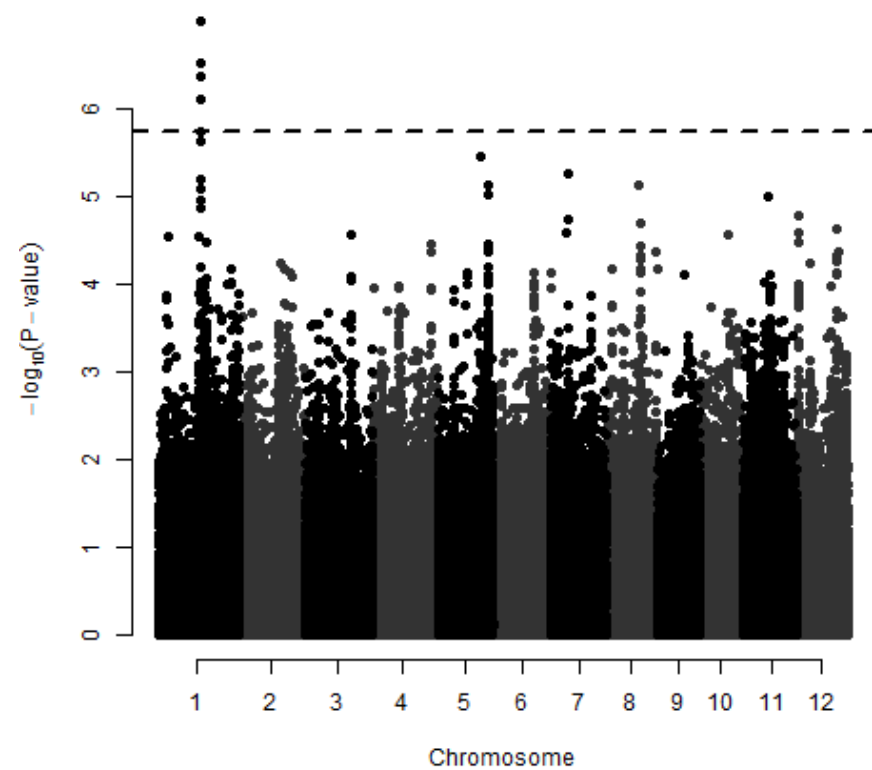
# tropical japonica - $\text{RGR}_{\text{HT}}$



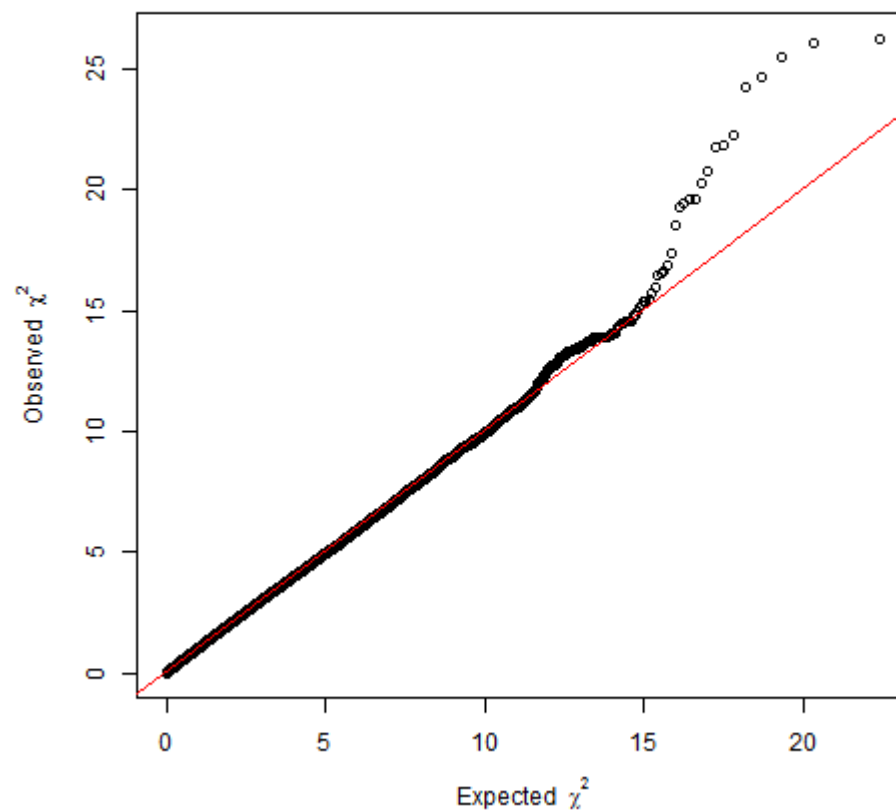
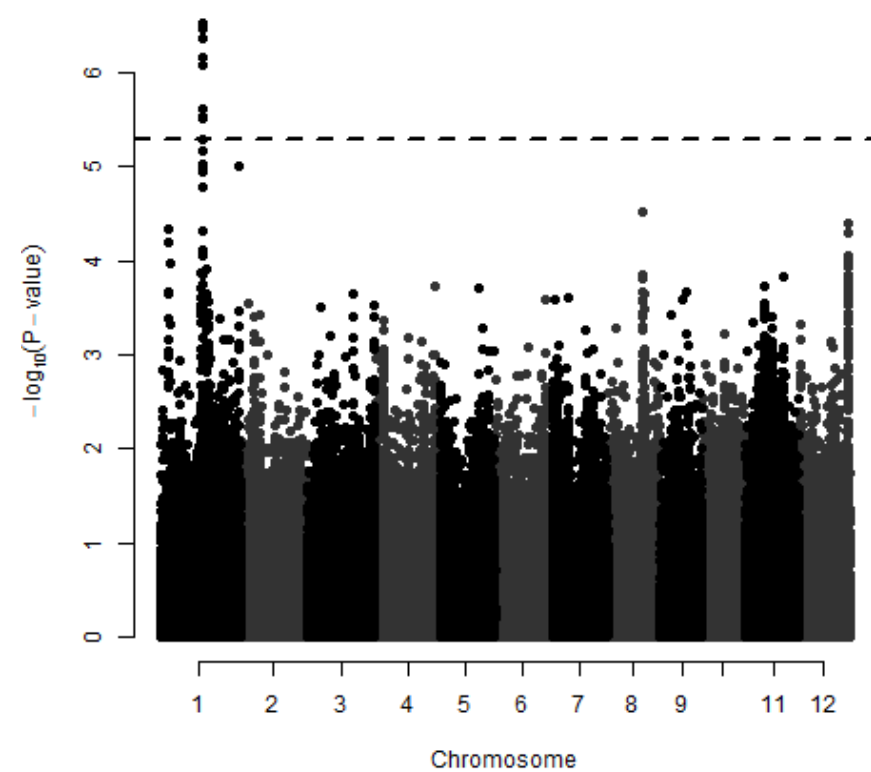
$$\text{RGR}_{\text{LT}}$$

Relative growth rate in the low treatment

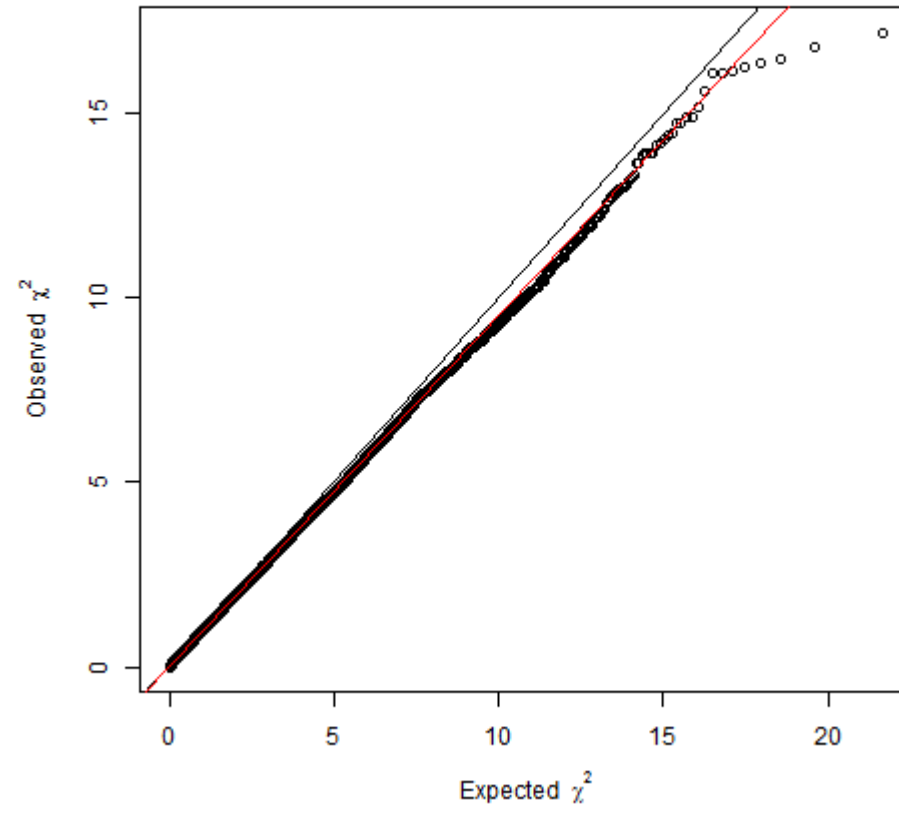
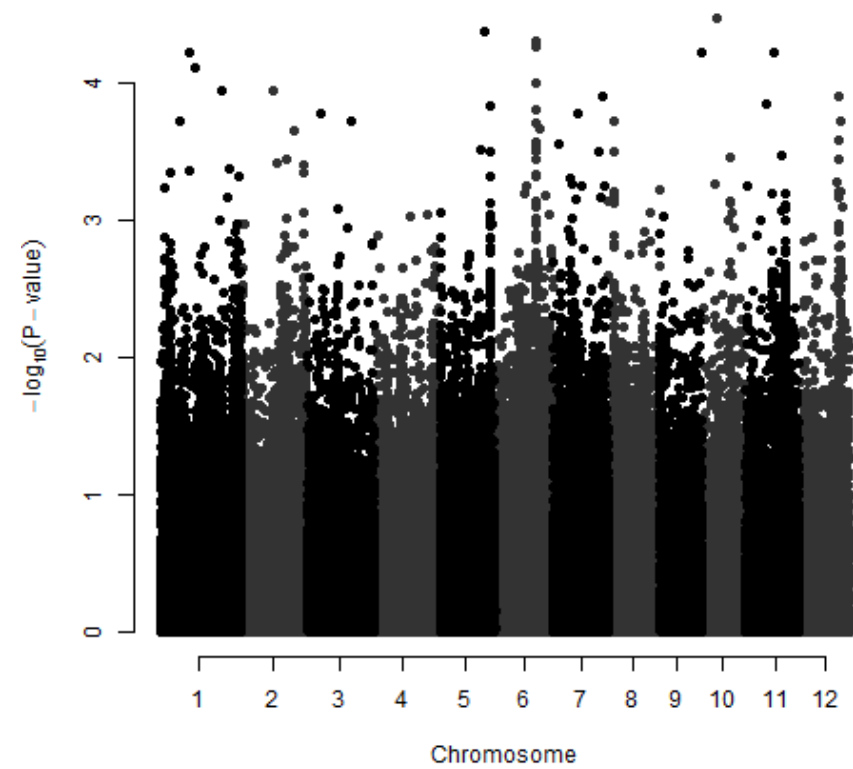
# All genotypes - $RGR_{LT}$



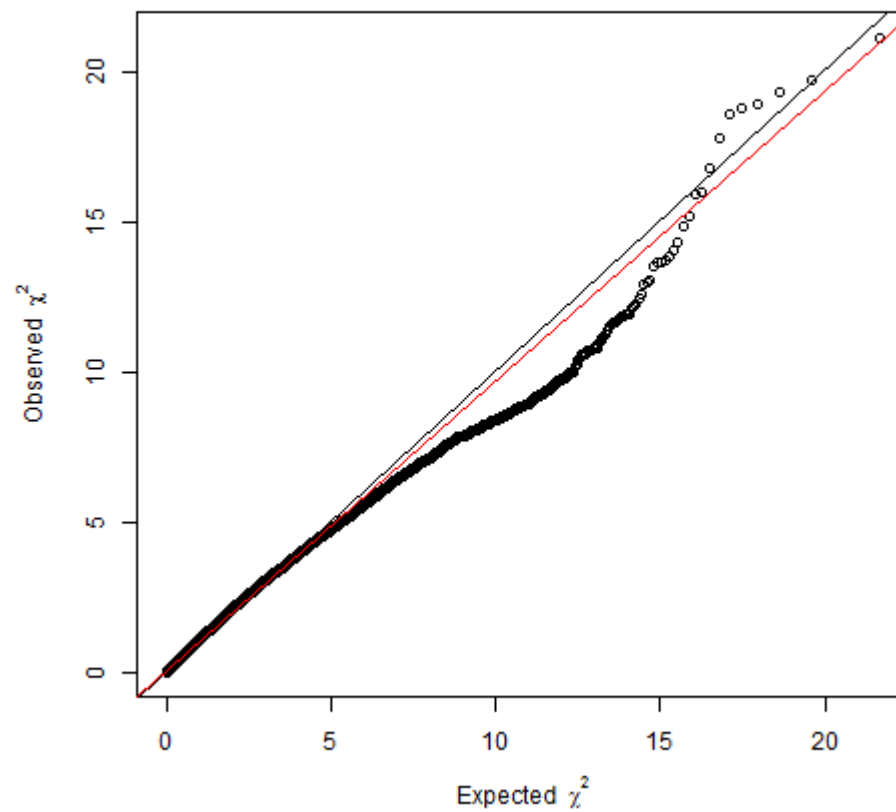
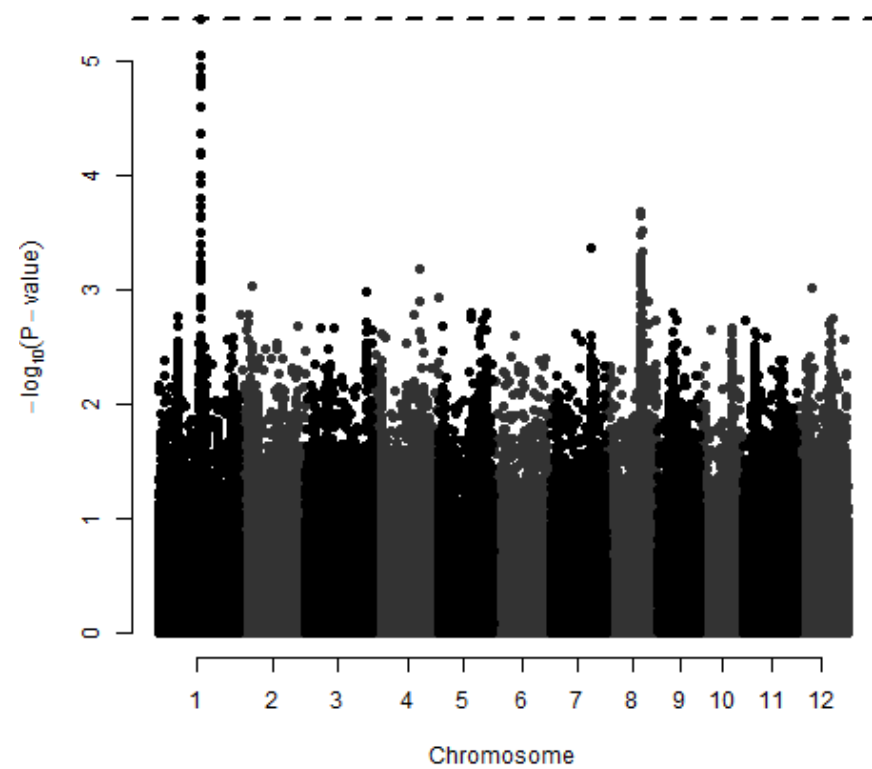
# Indica - RGR<sub>LT</sub>



# Japonica - RGR<sub>LT</sub>

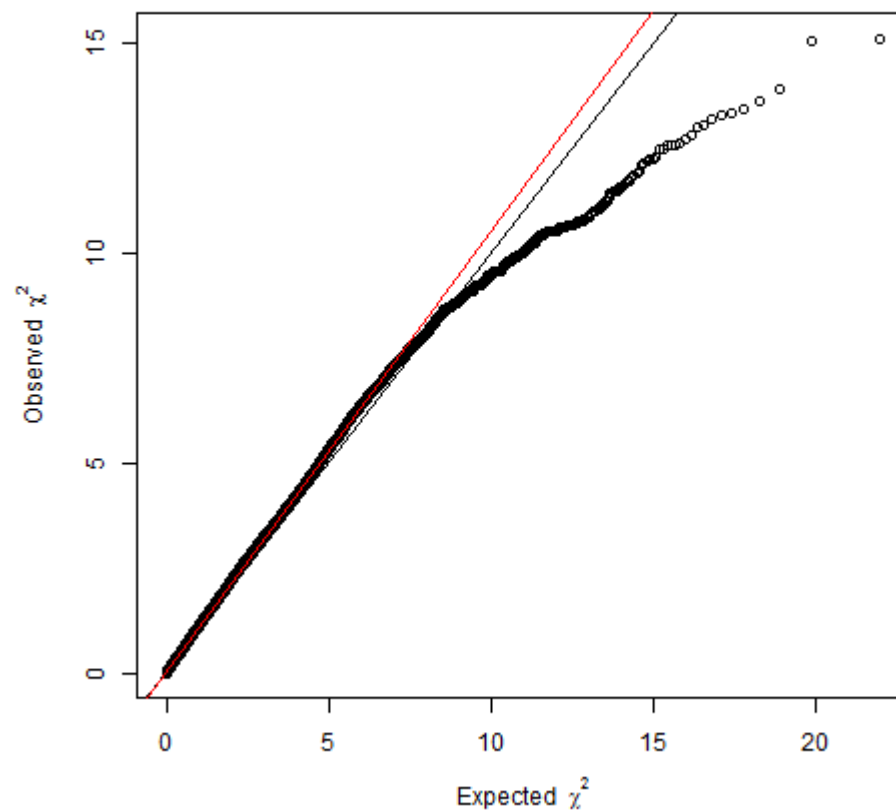
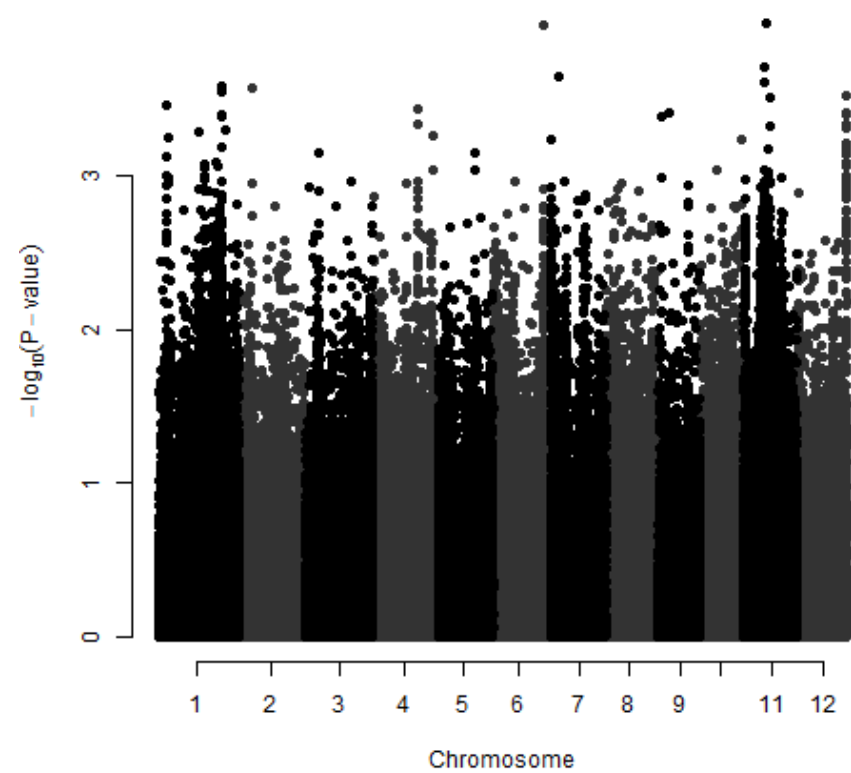


aus - RGR<sub>LT</sub>

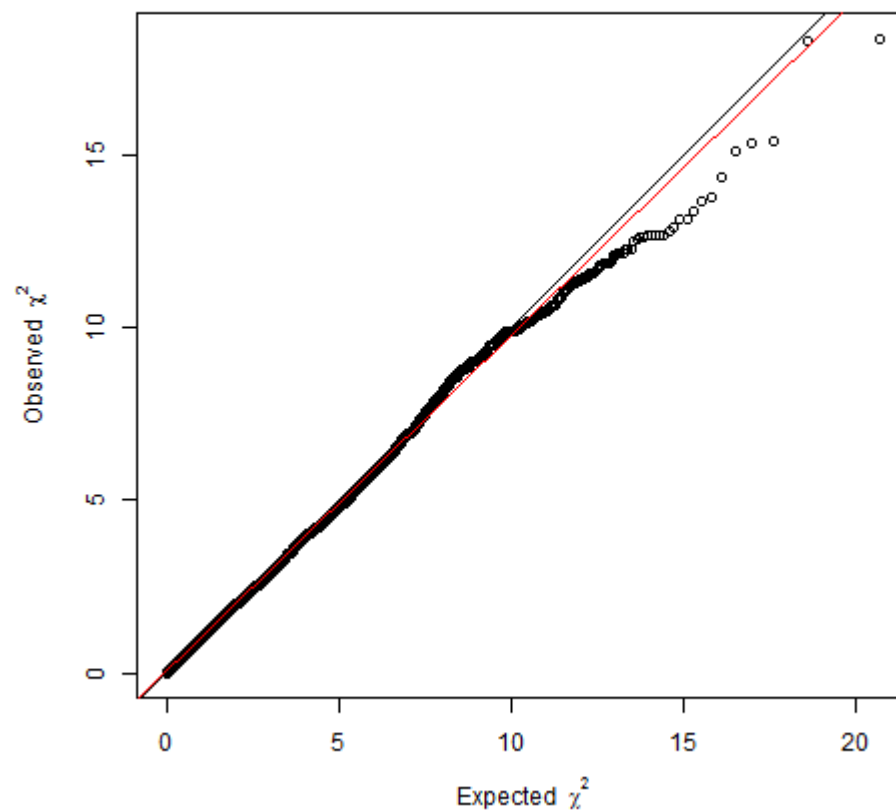
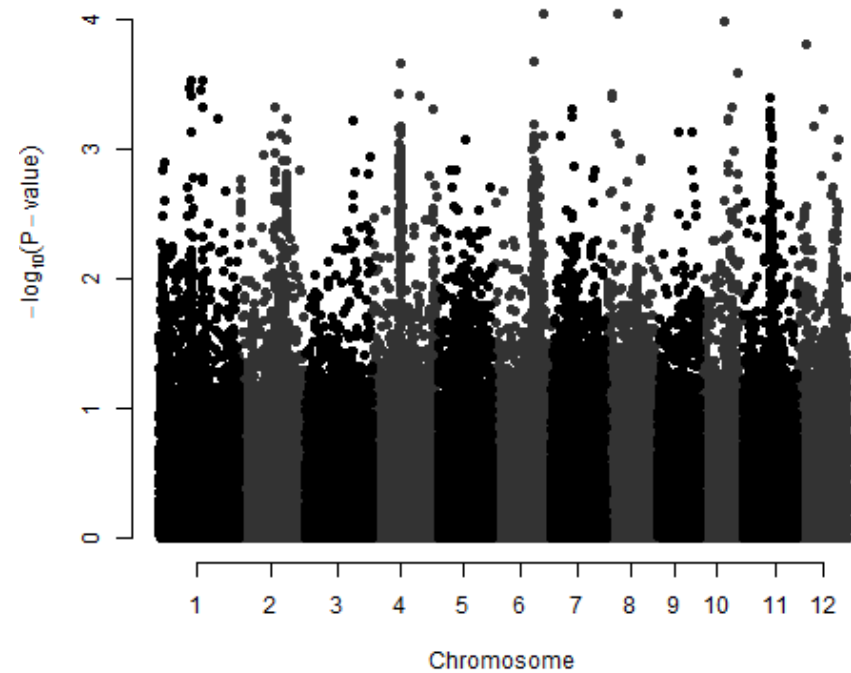




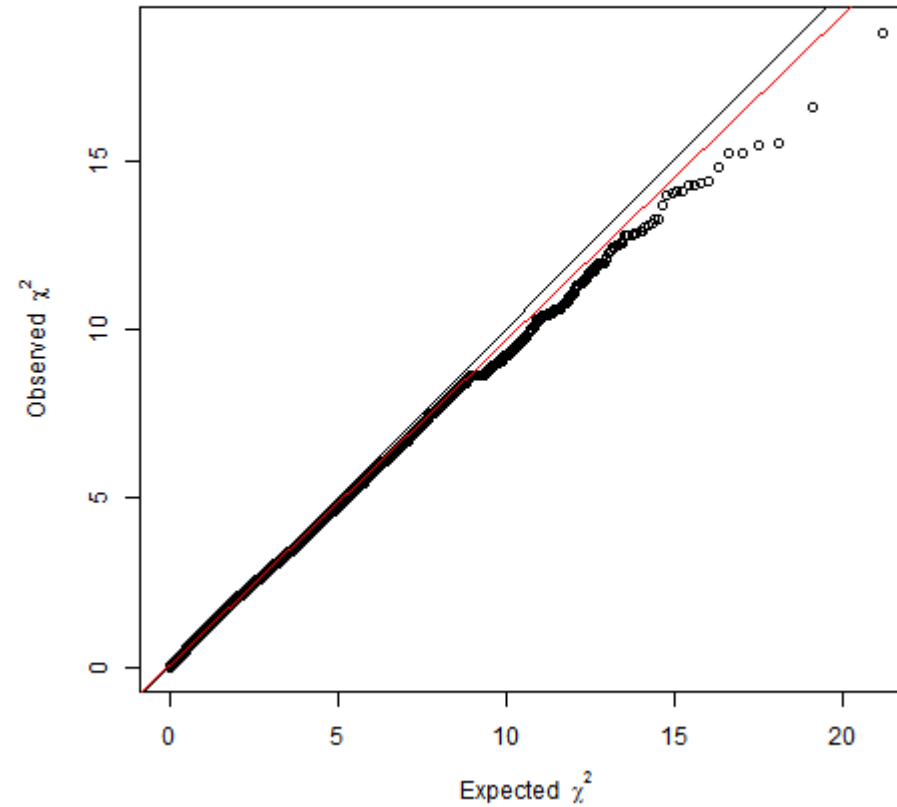
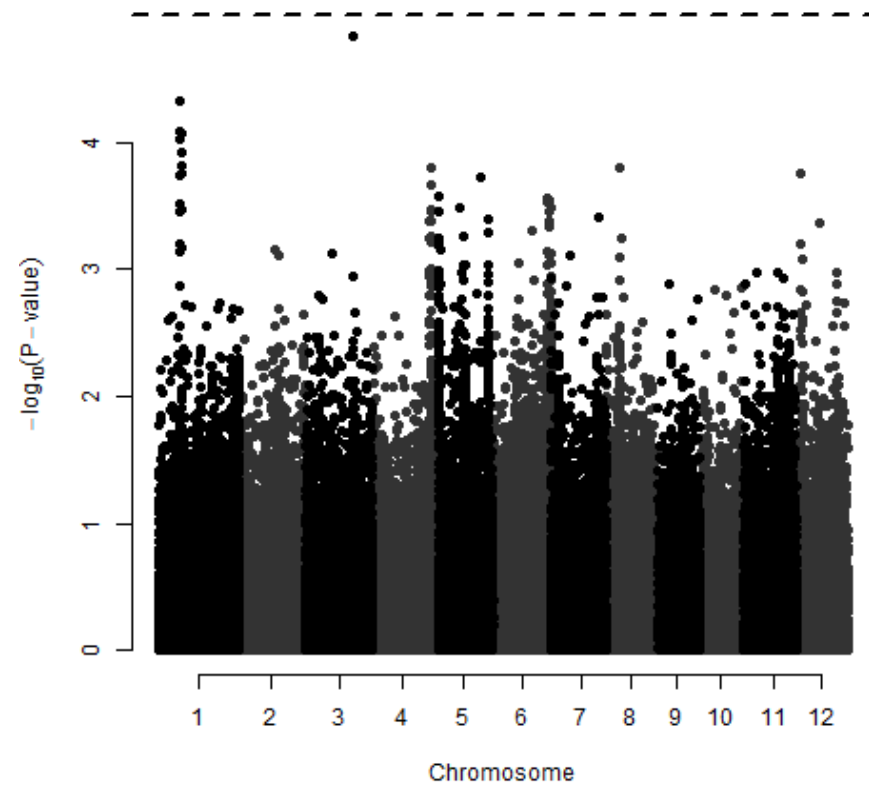
indica - RGR<sub>LT</sub>



# temperate japonica - $\text{RGR}_{\text{LT}}$



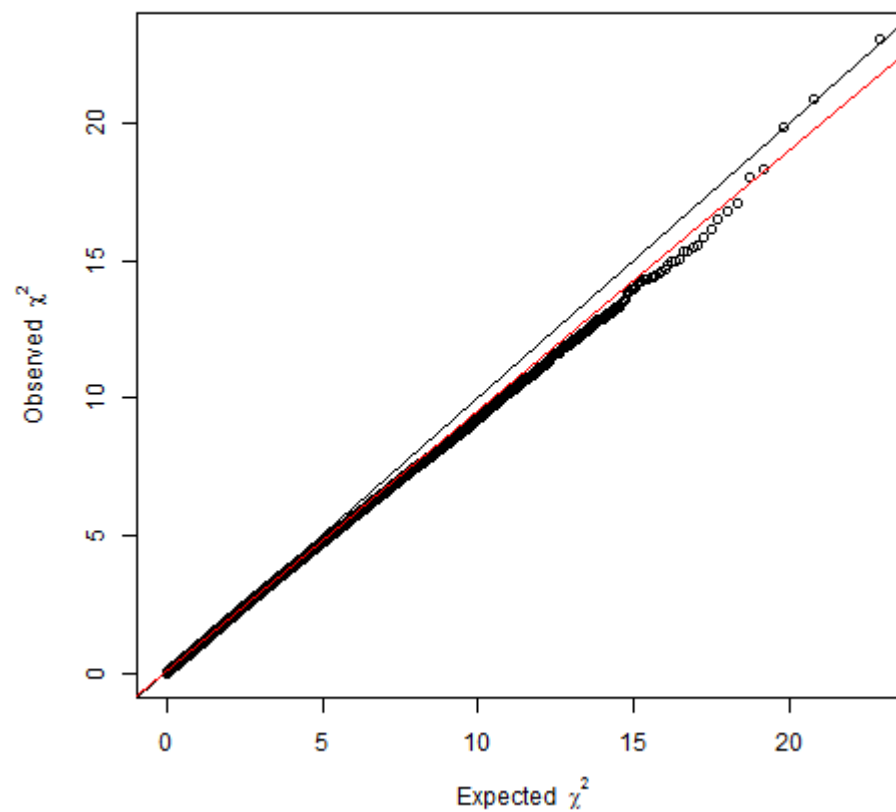
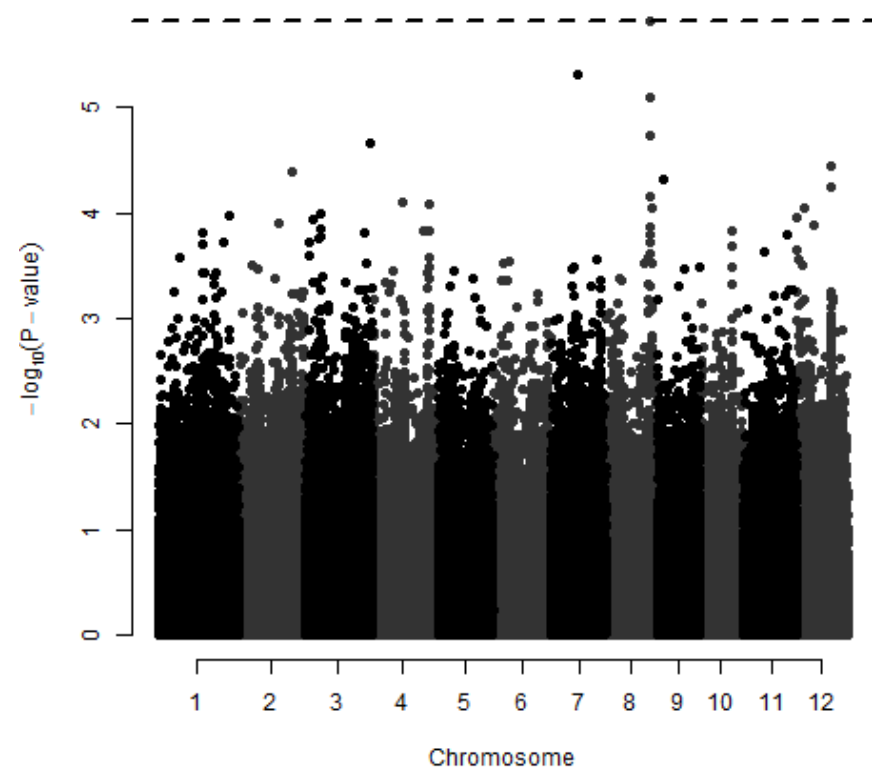
# tropical japonica - RGR<sub>LT</sub>



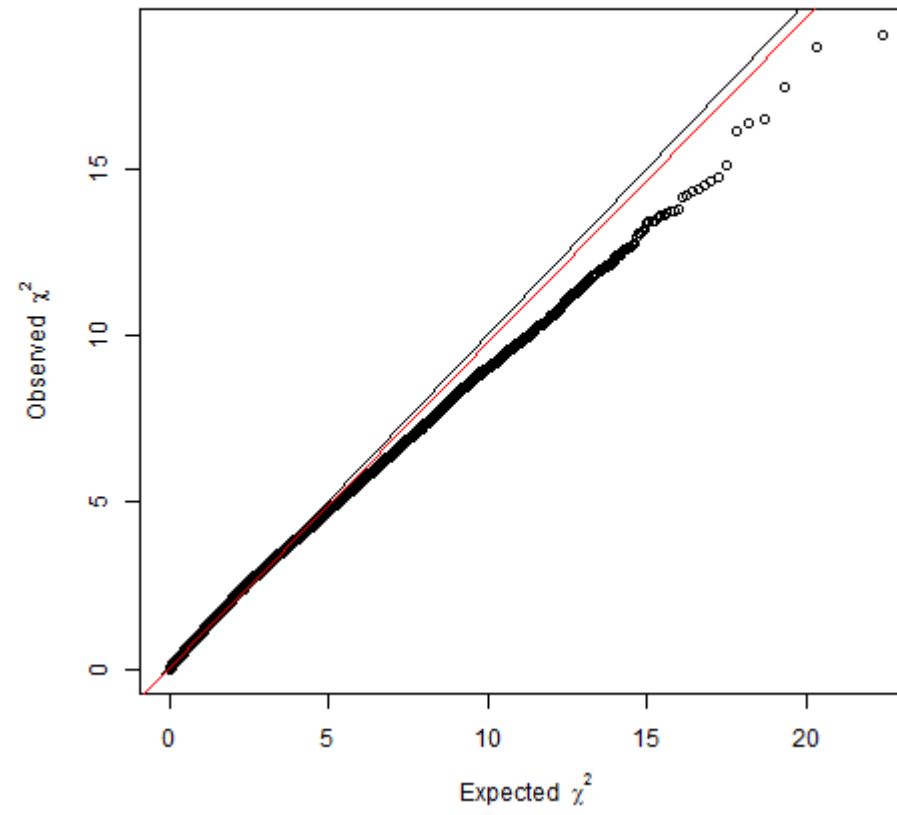
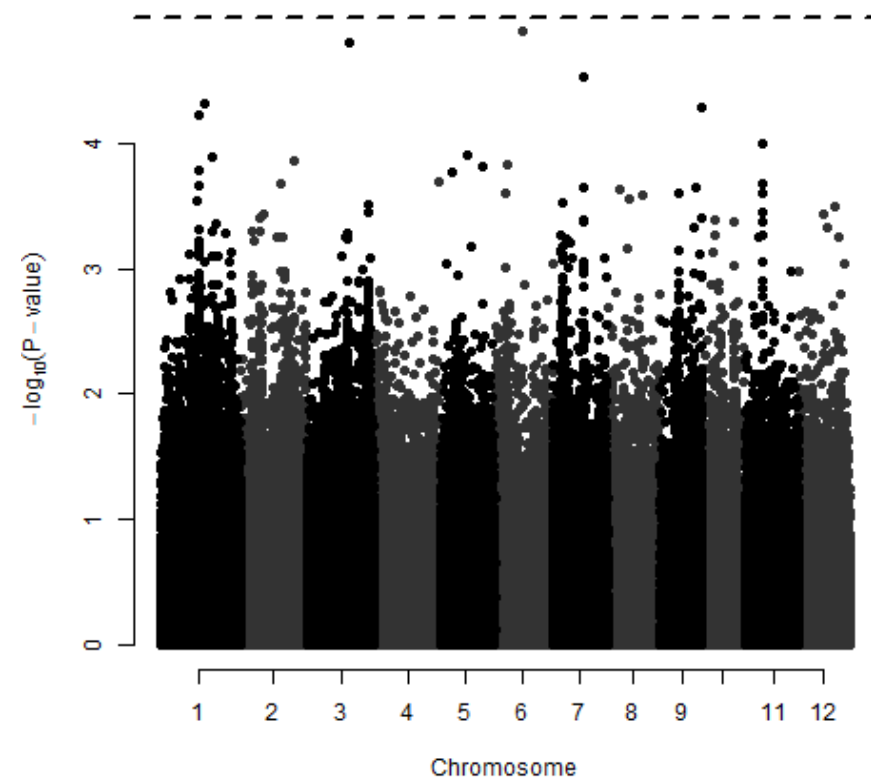
RP

Relative plant mass

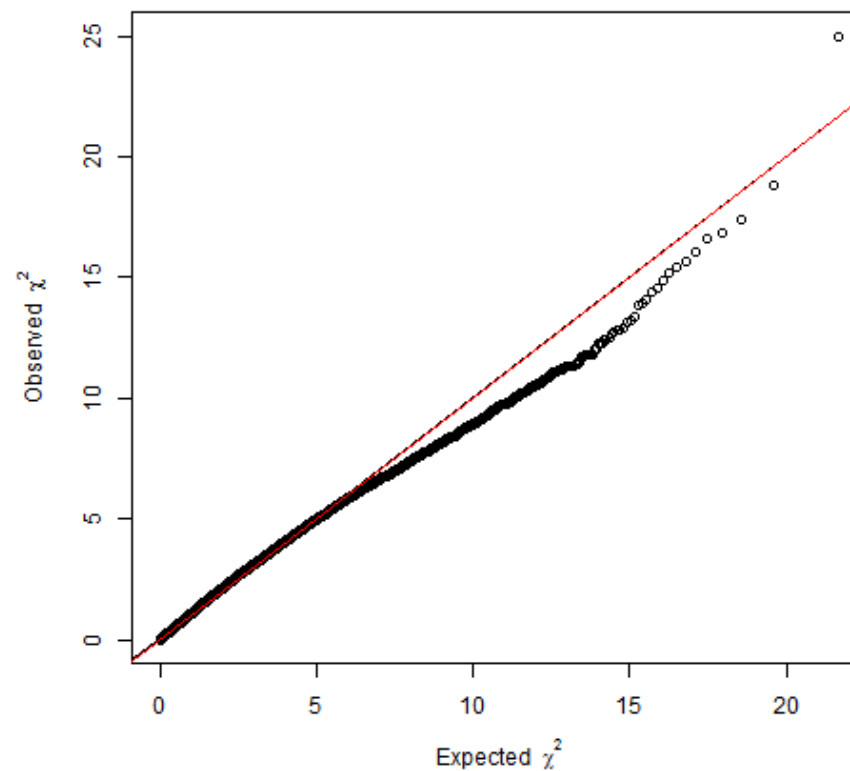
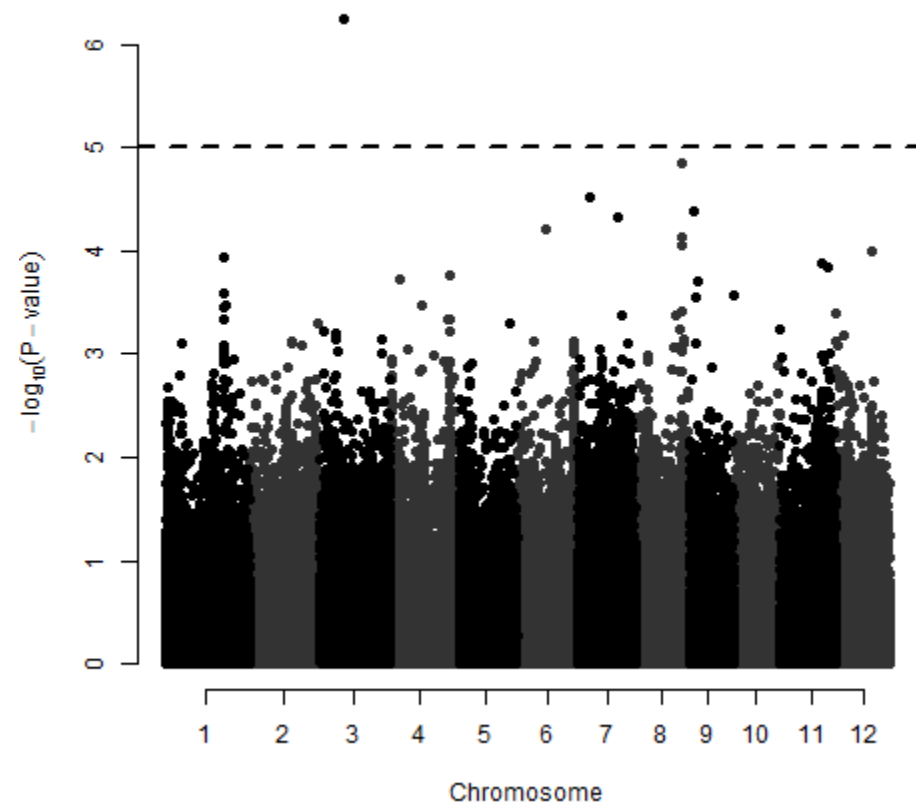
# All genotypes - RP



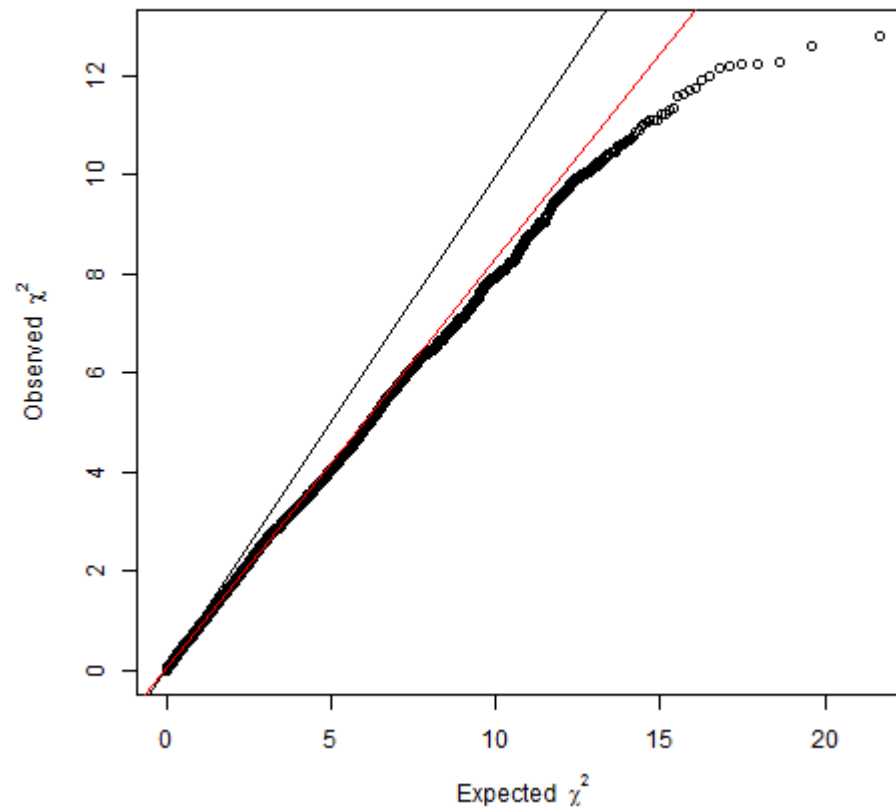
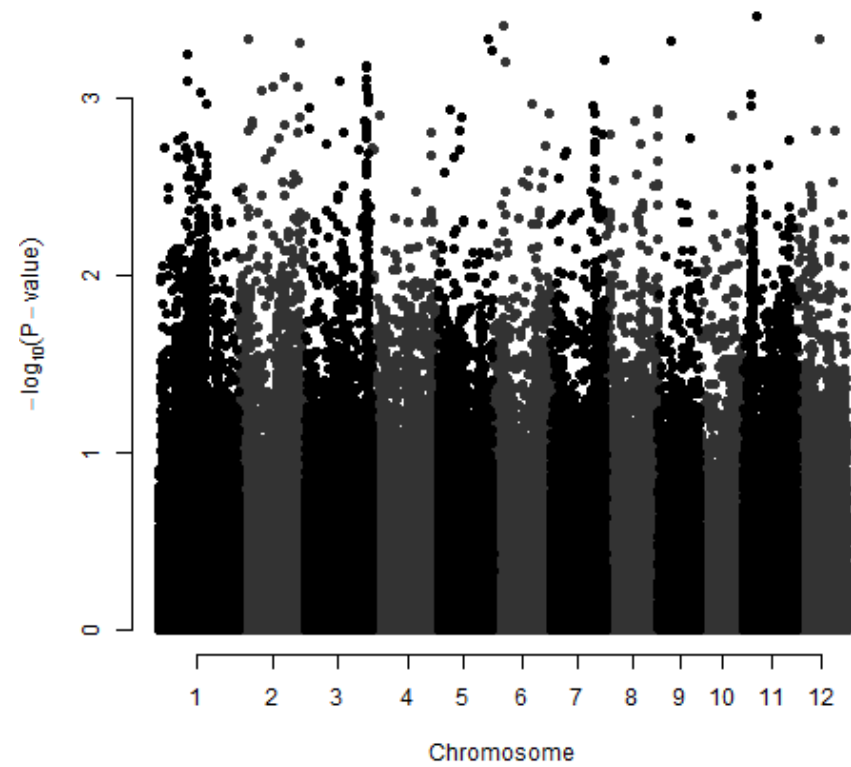
# Indica - RP



# Japonica - RP

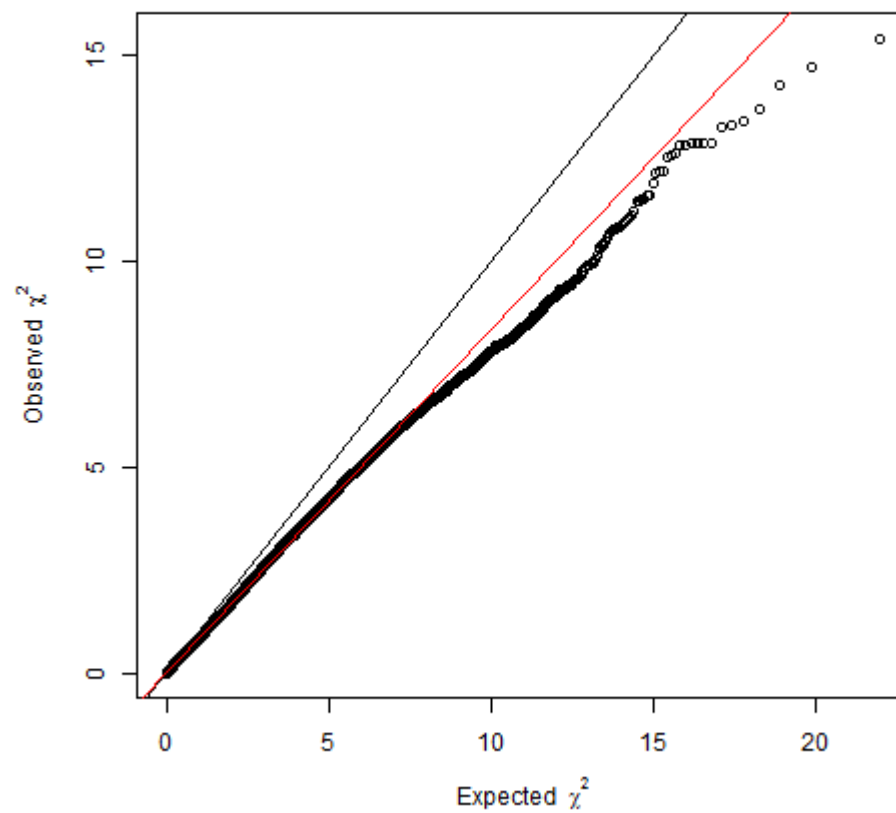
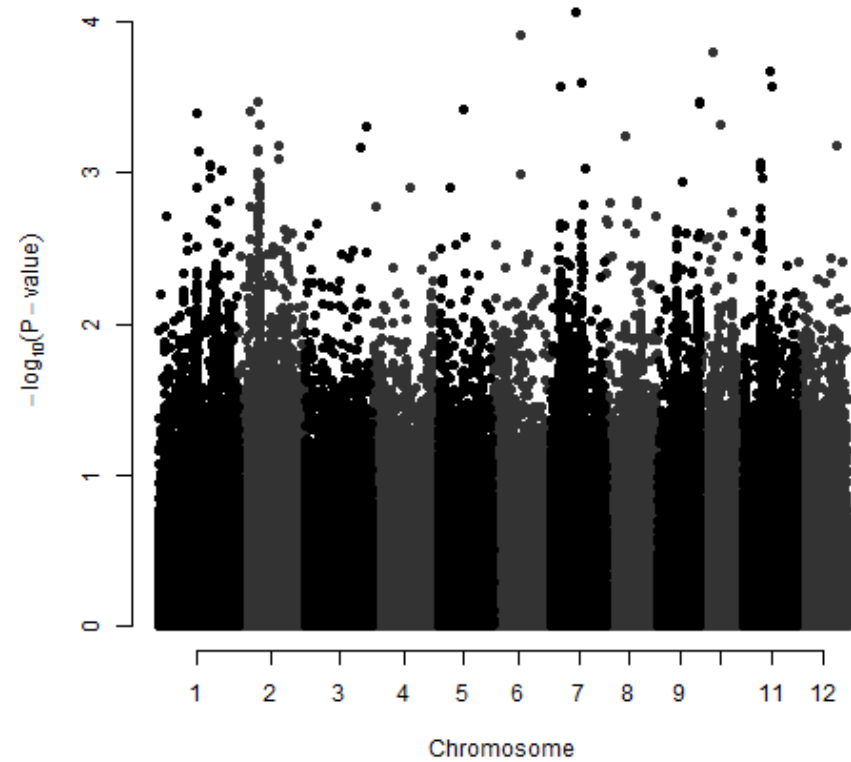


aus - RP

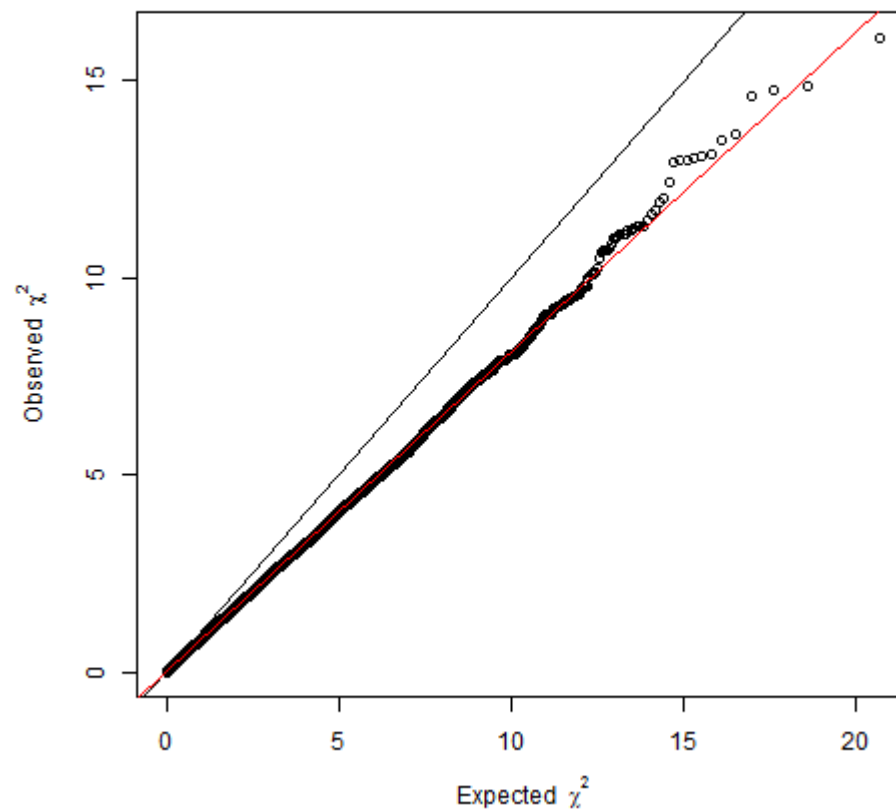
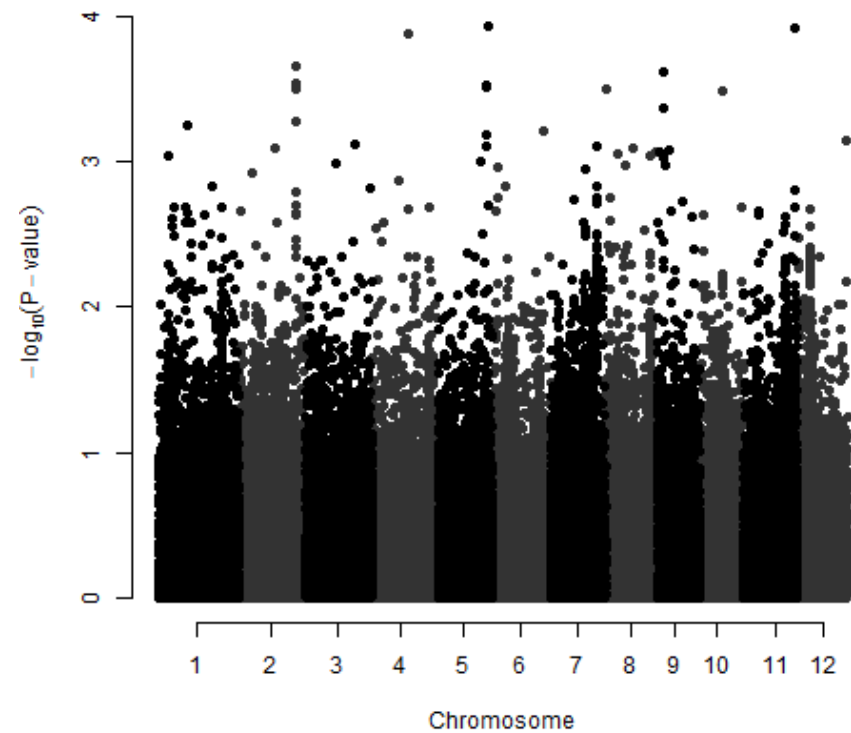




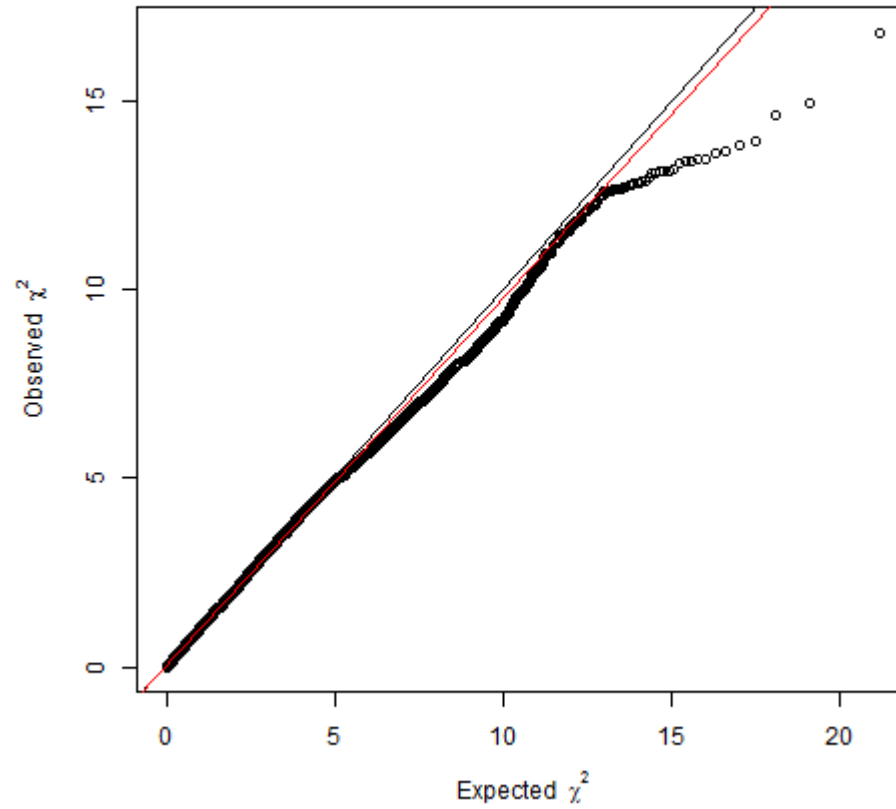
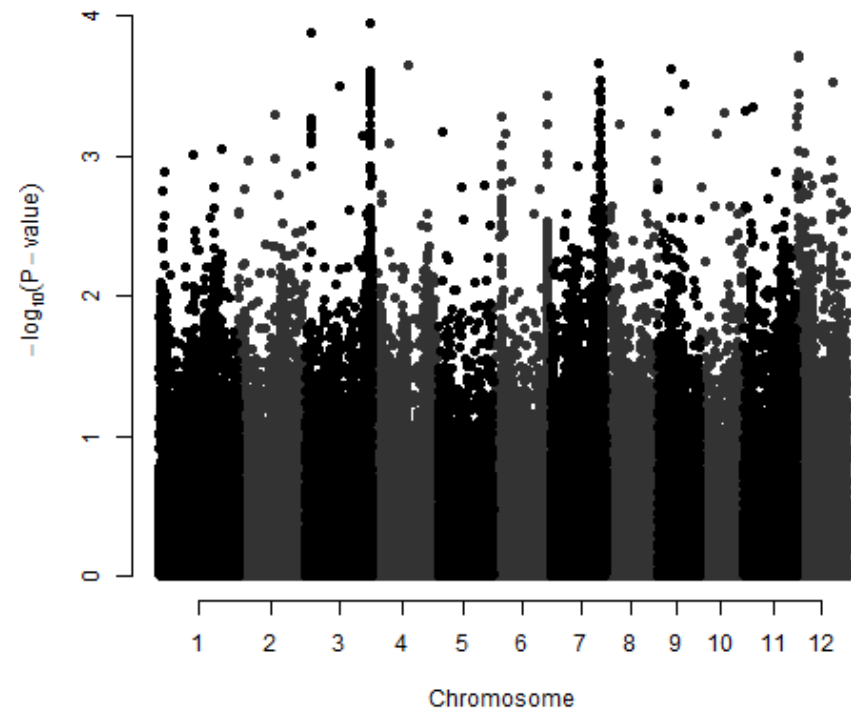
# indica - RP



# temperate japonica - RP



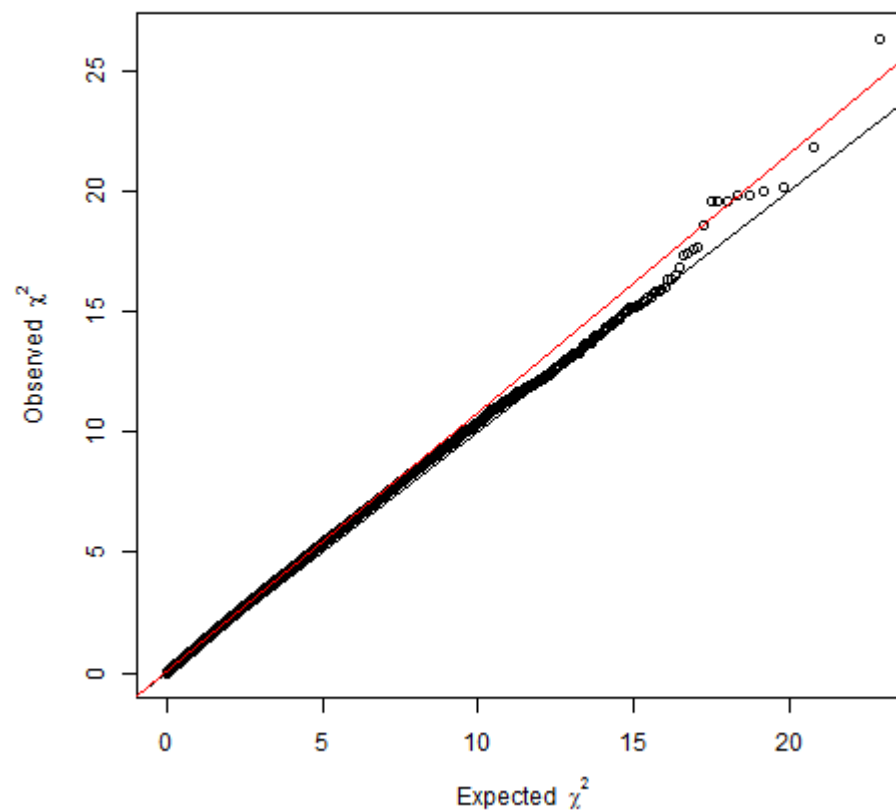
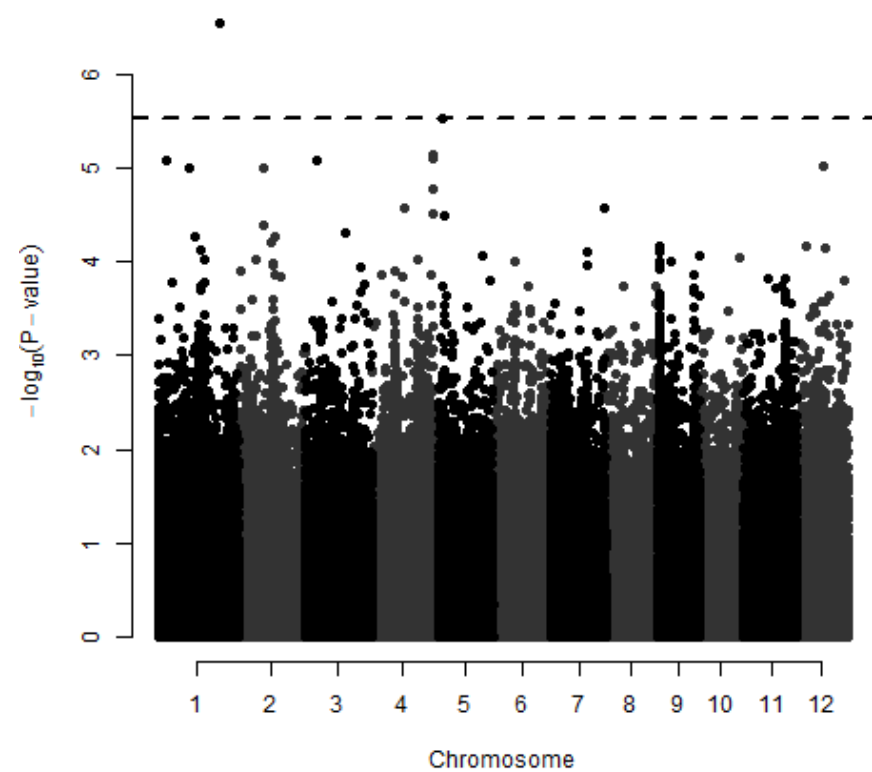
# tropical japonica - RP



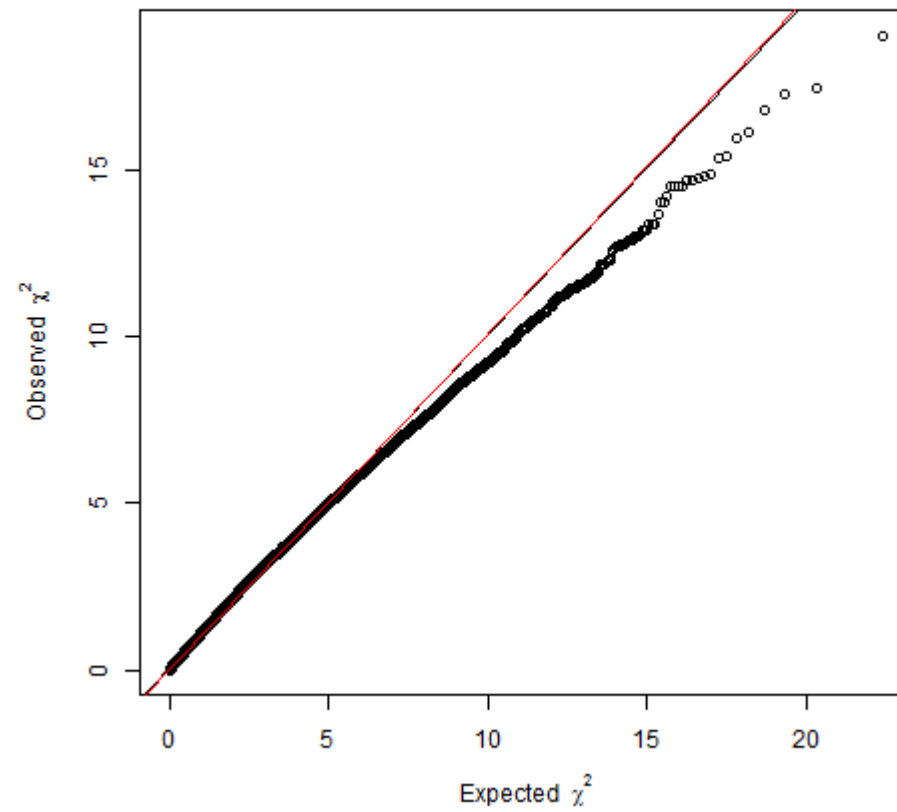
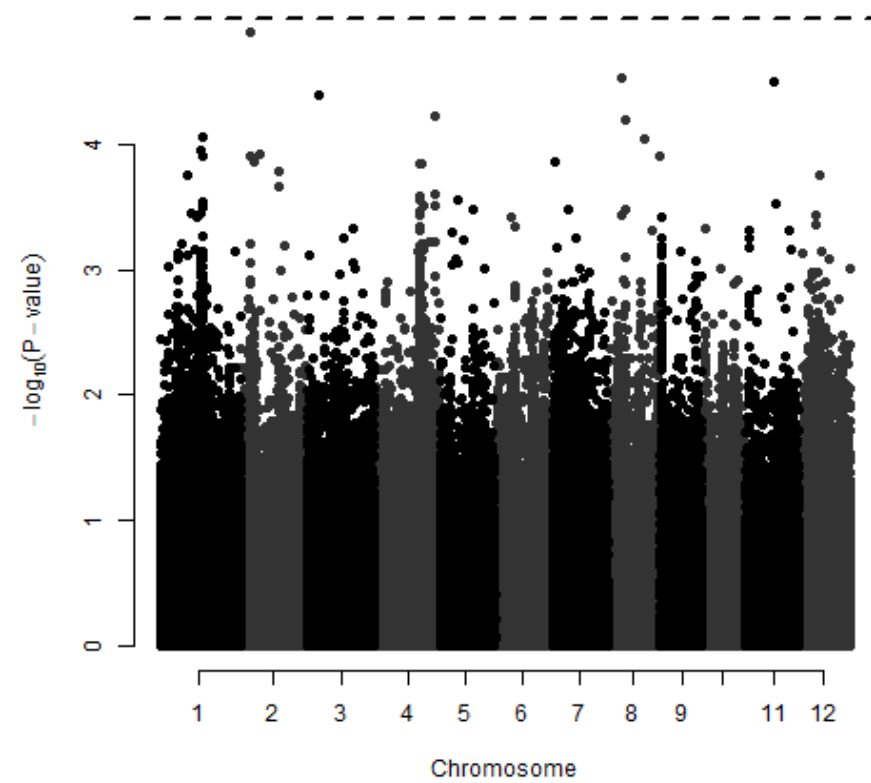
$$RSR_{HT}$$

Root to shoot ratio in the high treatment

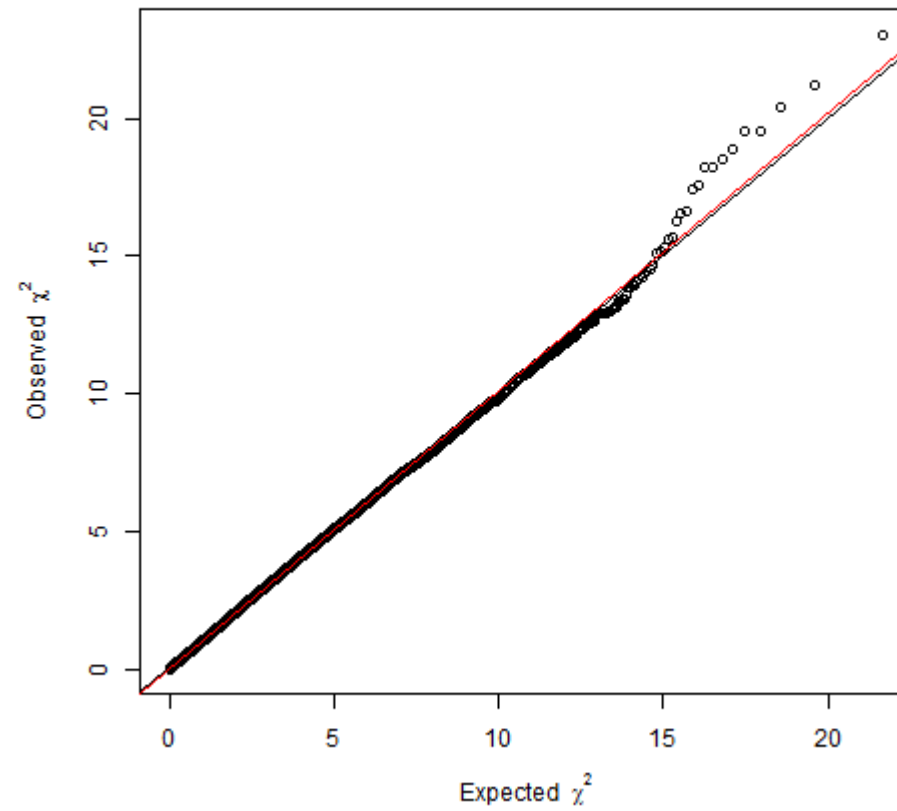
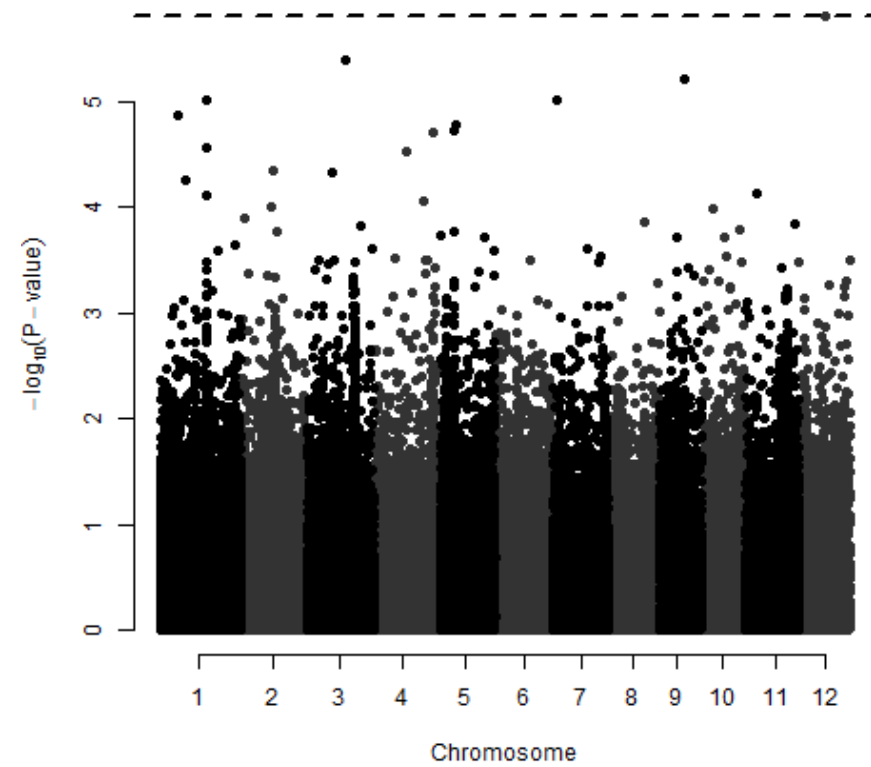
# All genotypes - $\text{RSR}_{\text{HT}}$



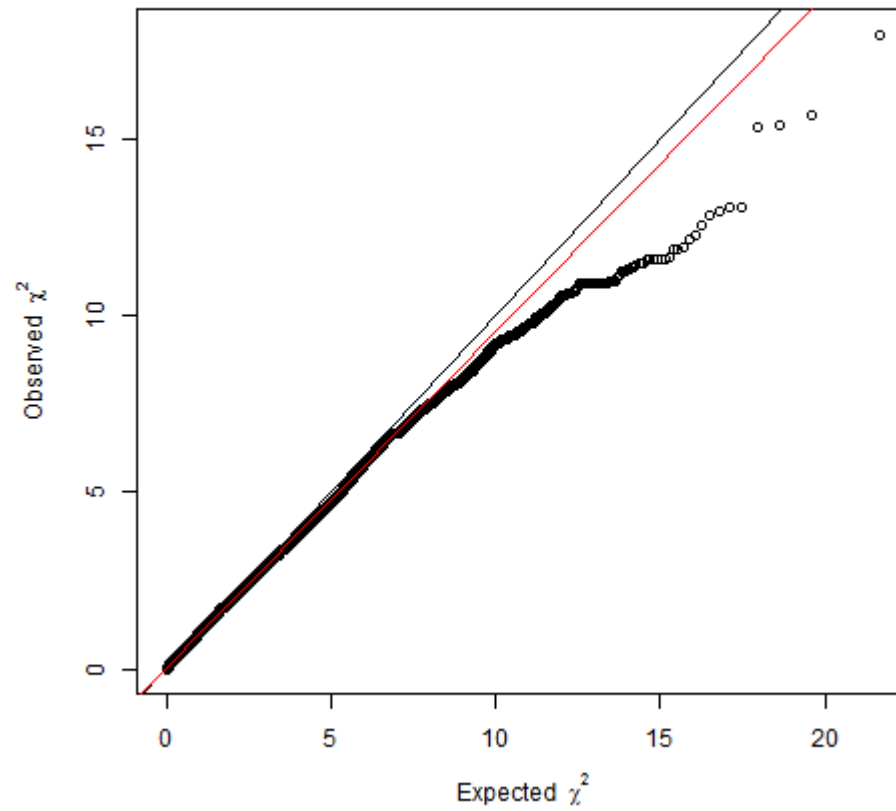
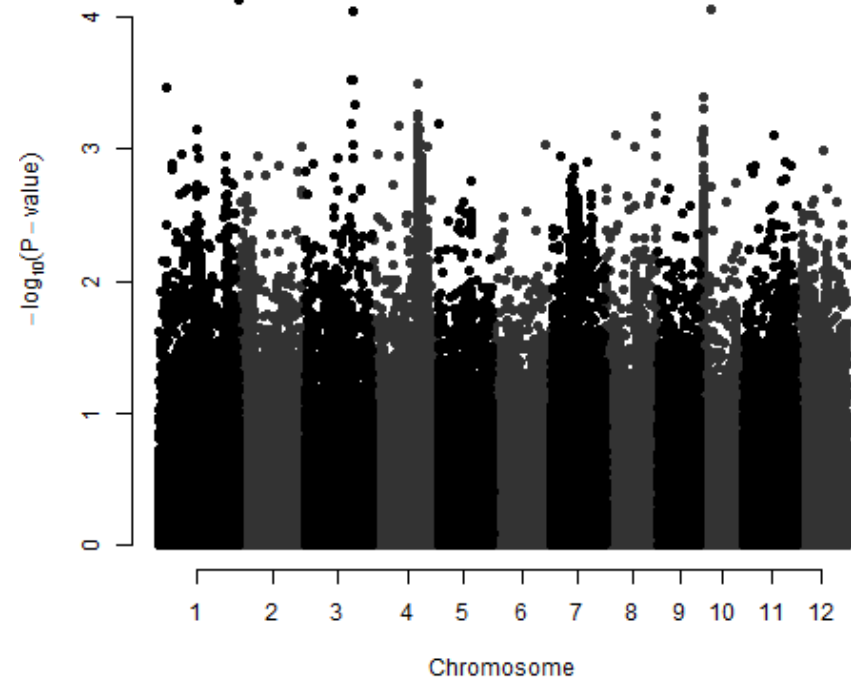
# Indica - $\text{RSR}_{\text{HT}}$



# Japonica - $\text{RSR}_{\text{HT}}$

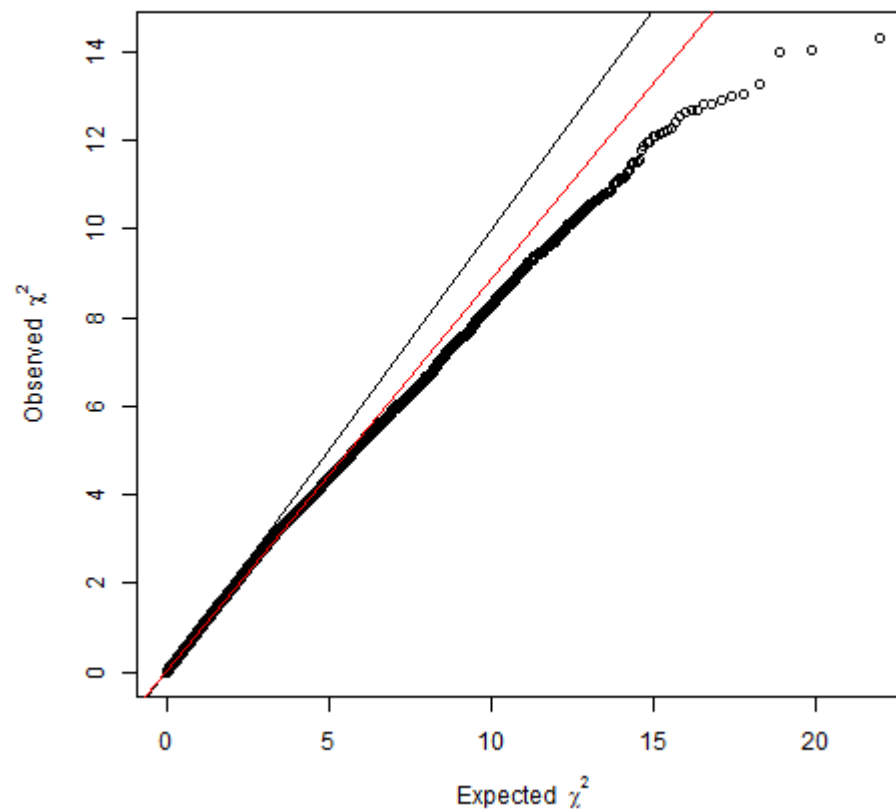
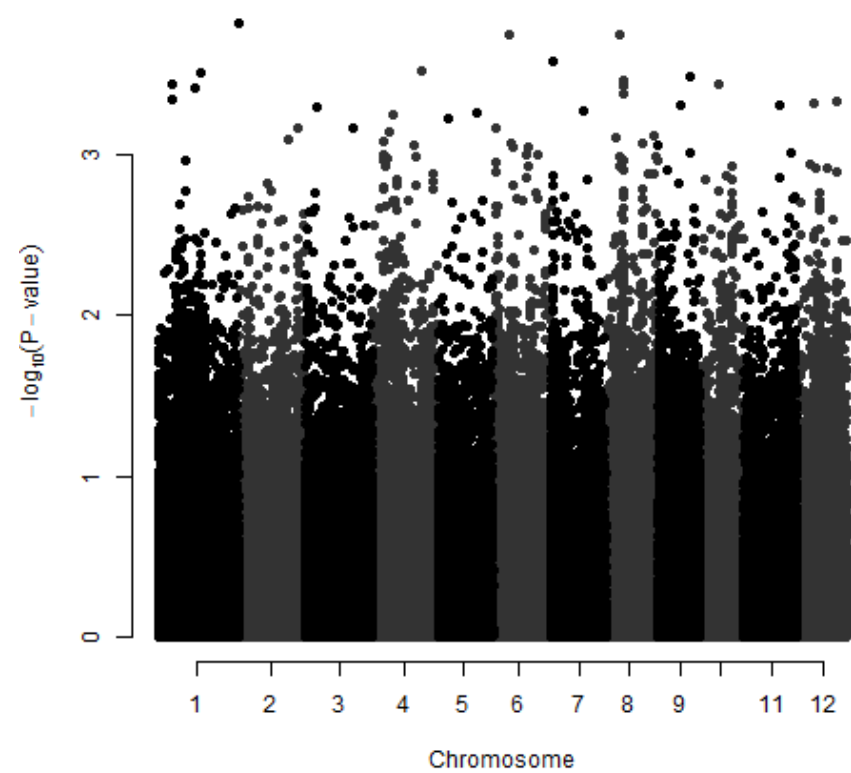


aus -  $\text{RSR}_{\text{HT}}$

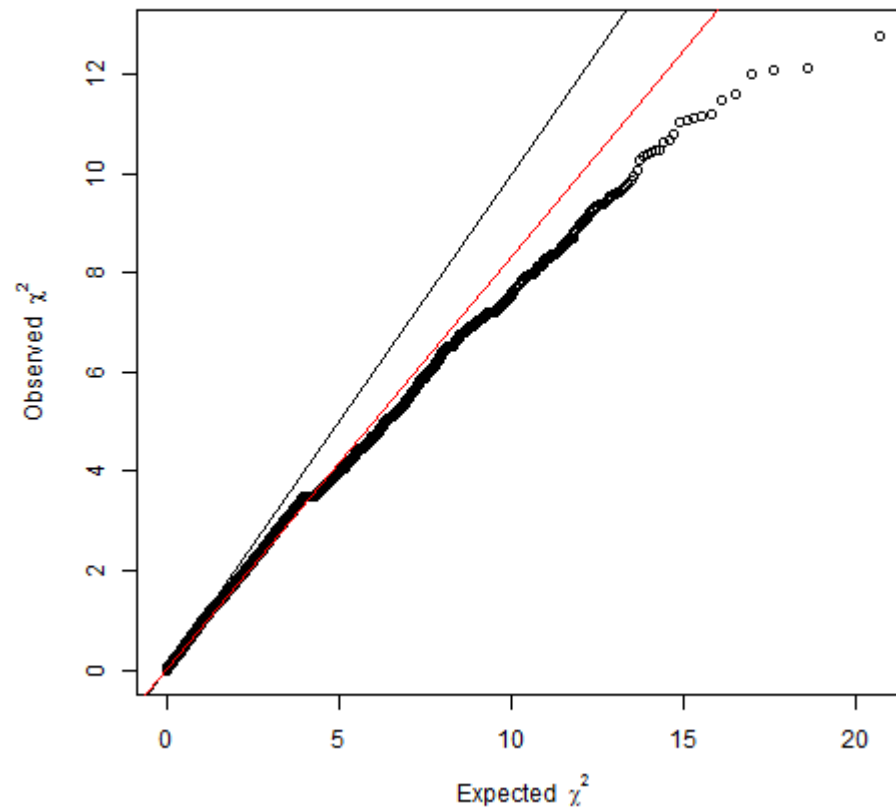
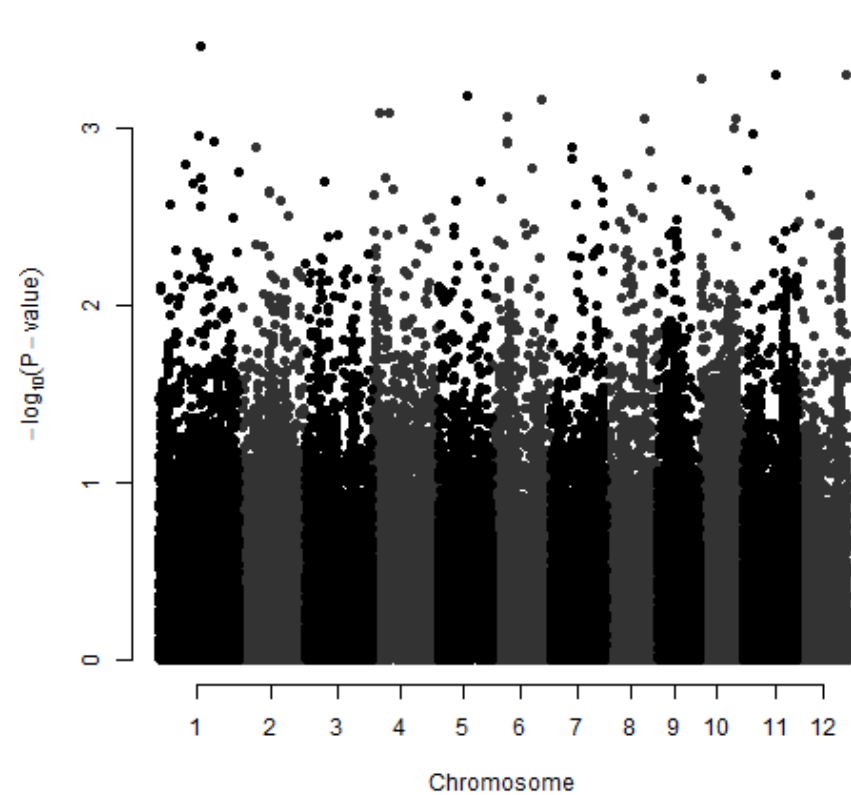




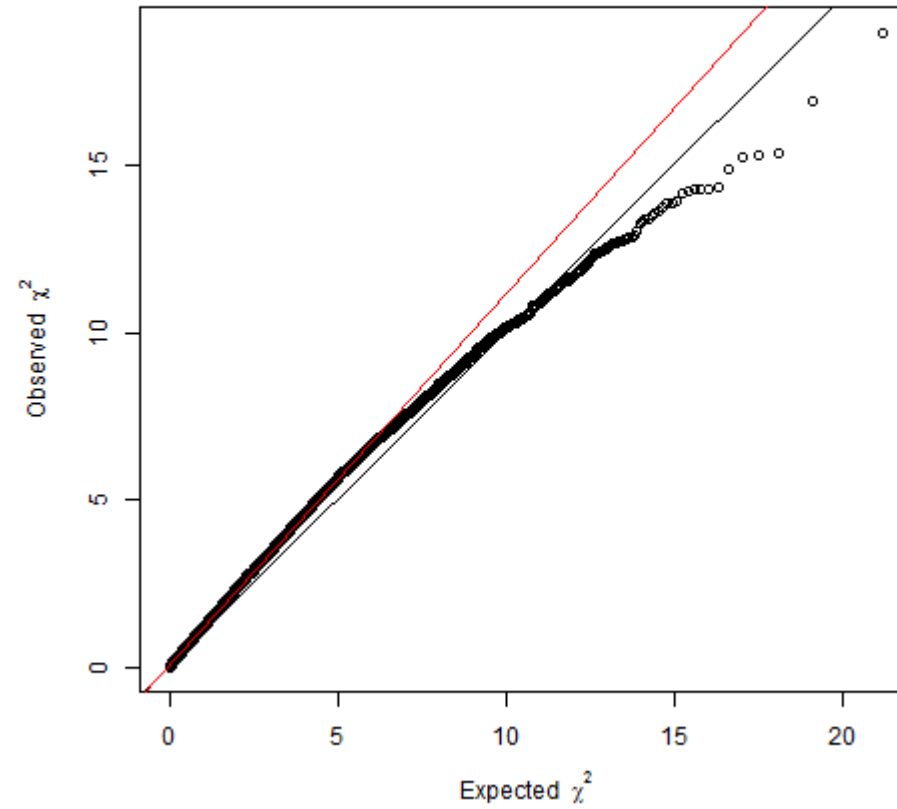
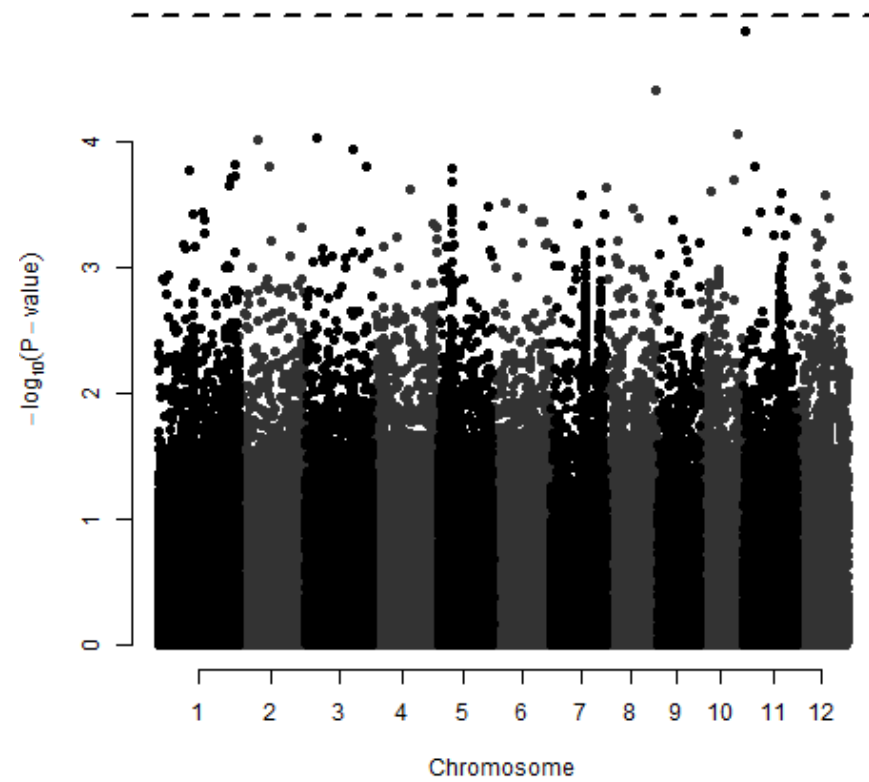
indica -  $\text{RSR}_{\text{HT}}$



# temperate japonica - $\text{RSR}_{\text{HT}}$



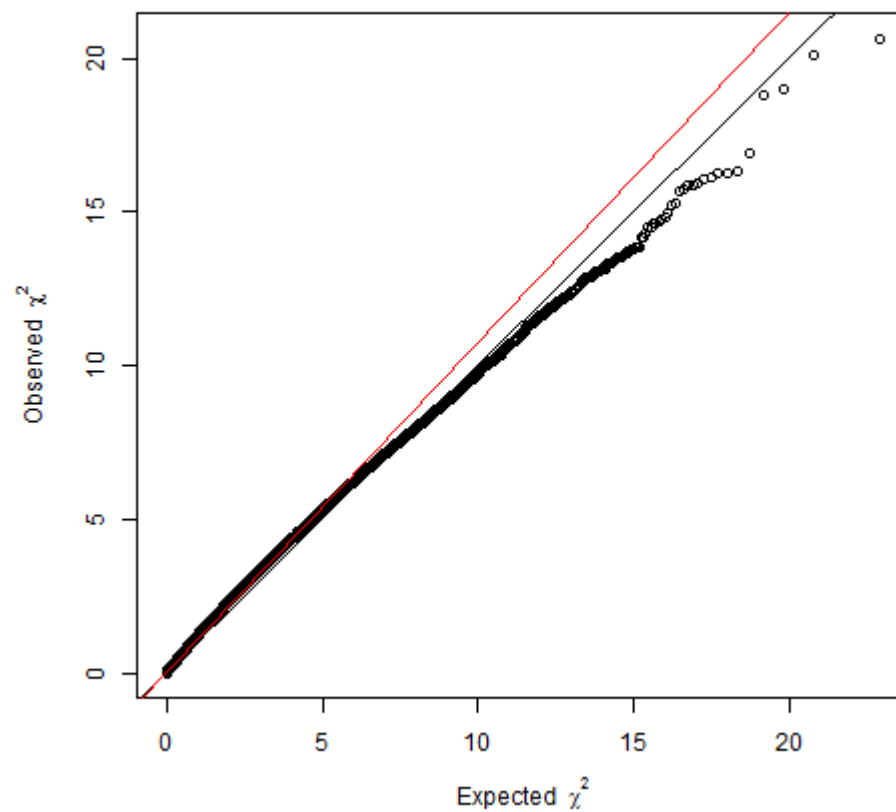
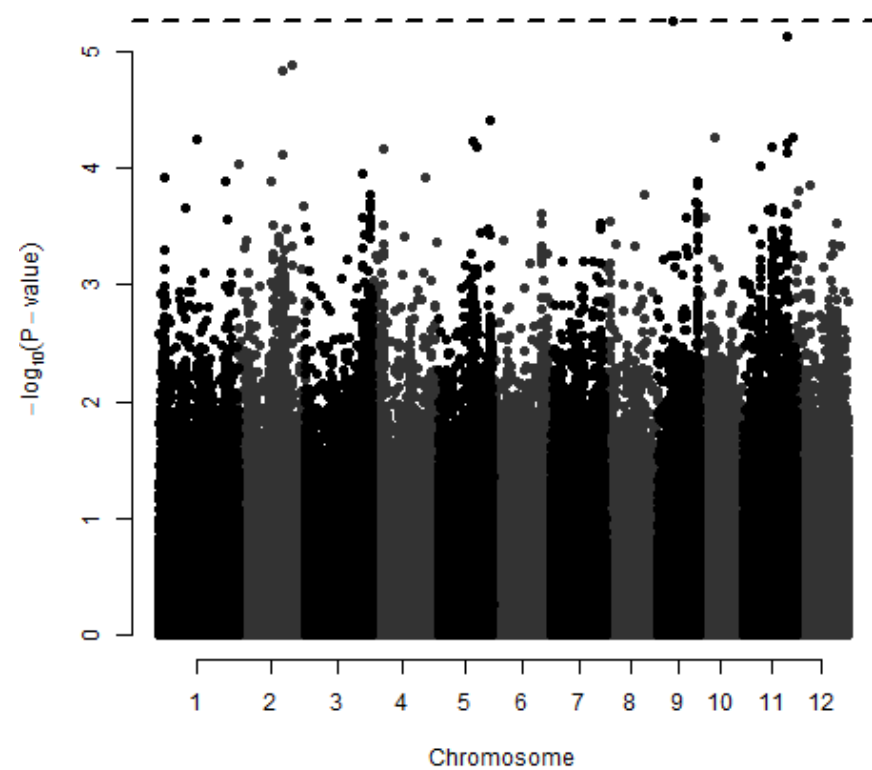
# tropical japonica - $\text{RSR}_{\text{HT}}$



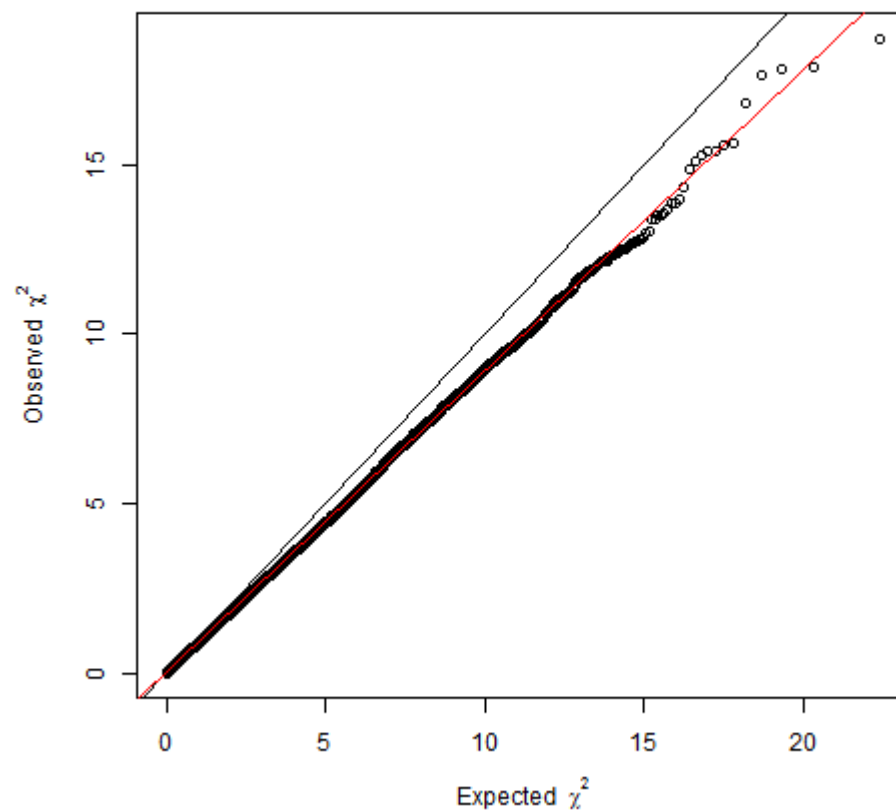
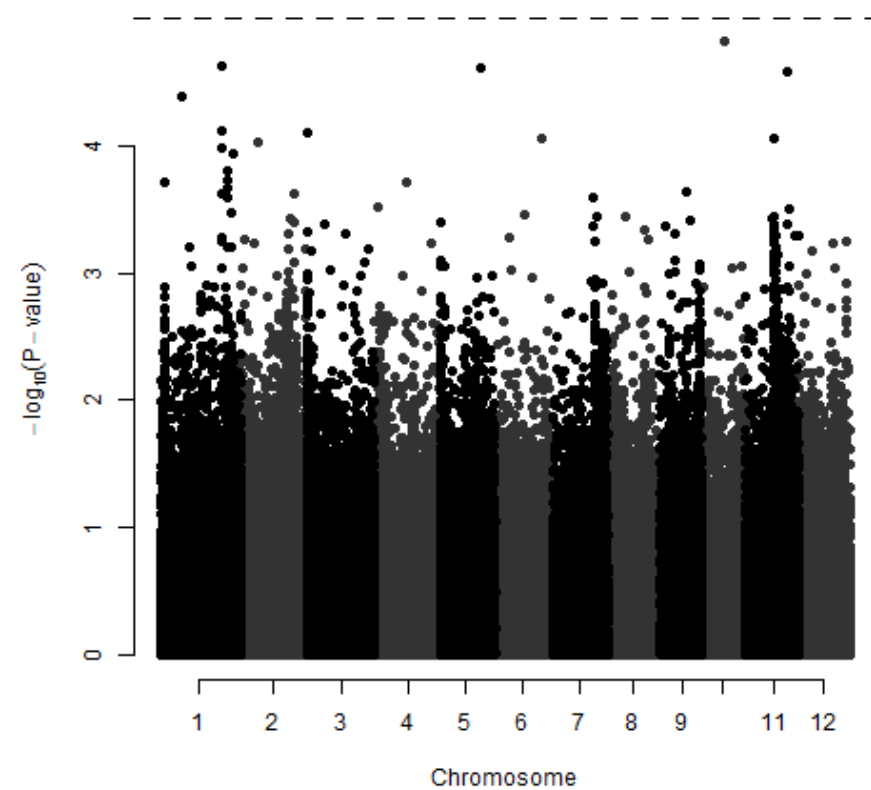
$$RSR_{LT}$$

Root to shoot ratio in the low treatment

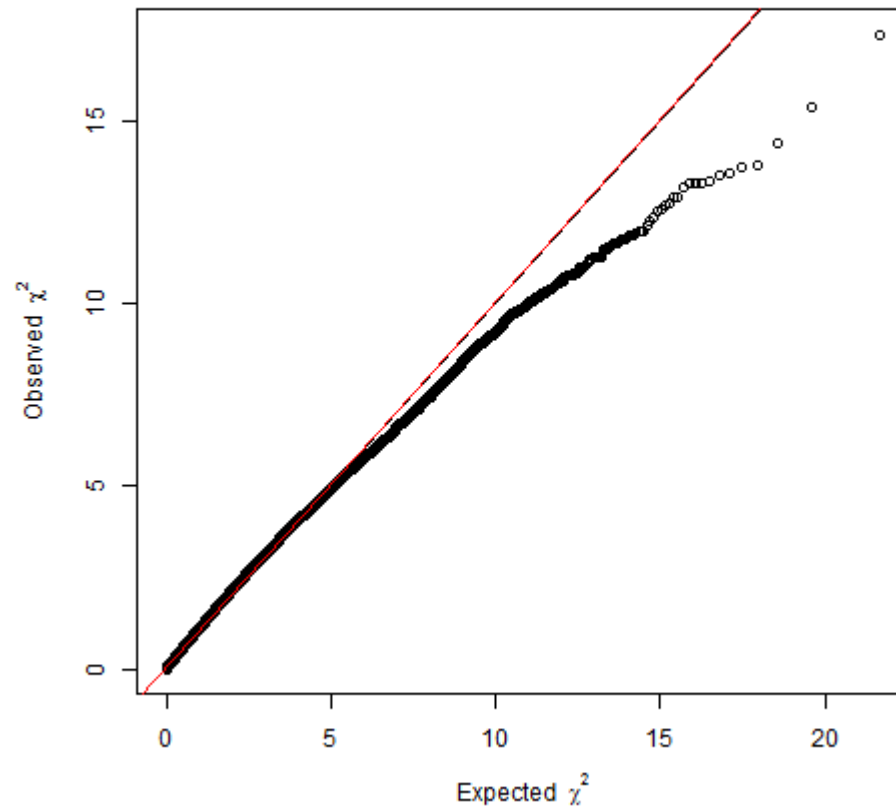
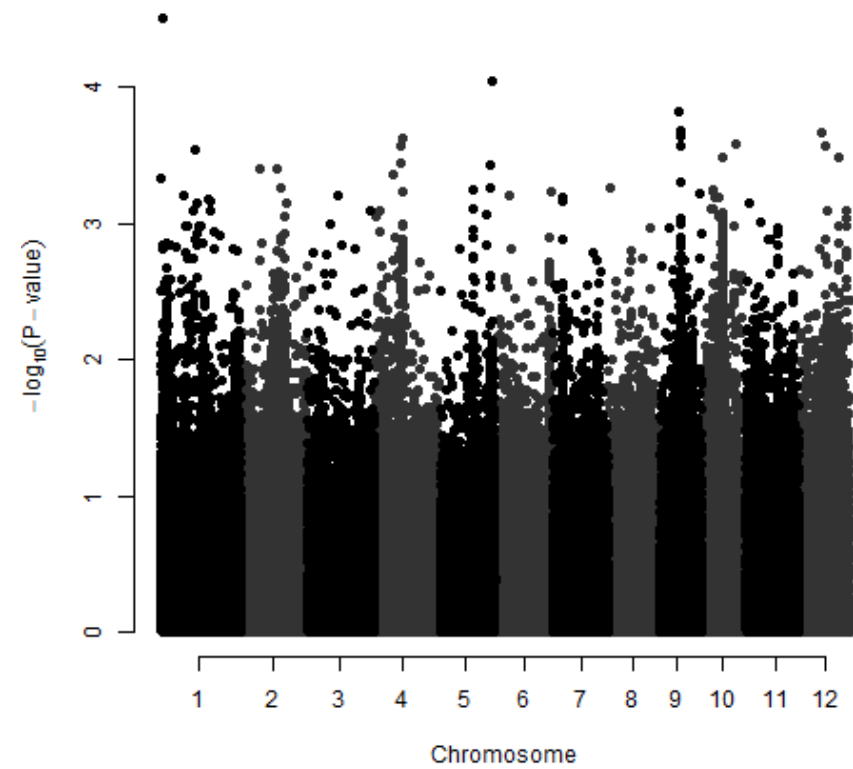
# All genotypes -RSR<sub>LT</sub>



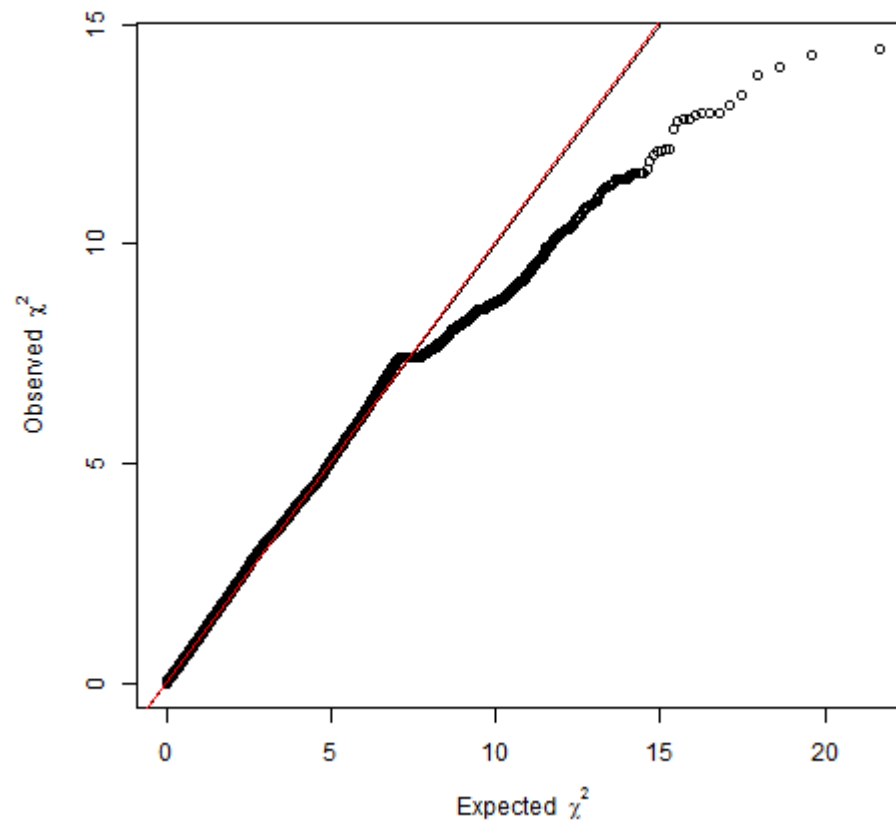
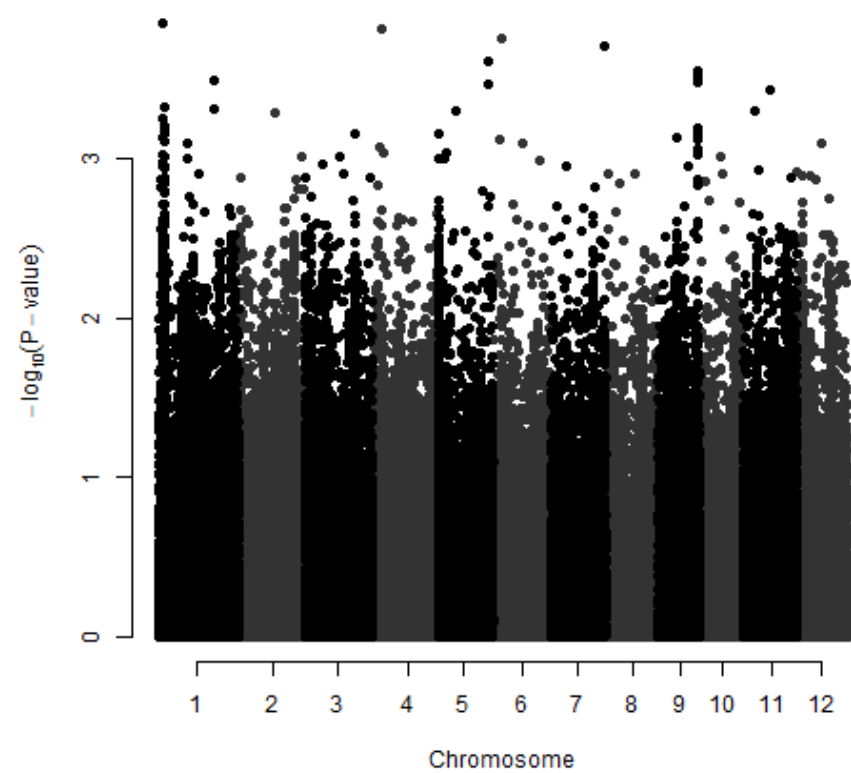
# Indica - $\text{RSR}_{\text{LT}}$



# Japonica - $\text{RSR}_{\text{LT}}$

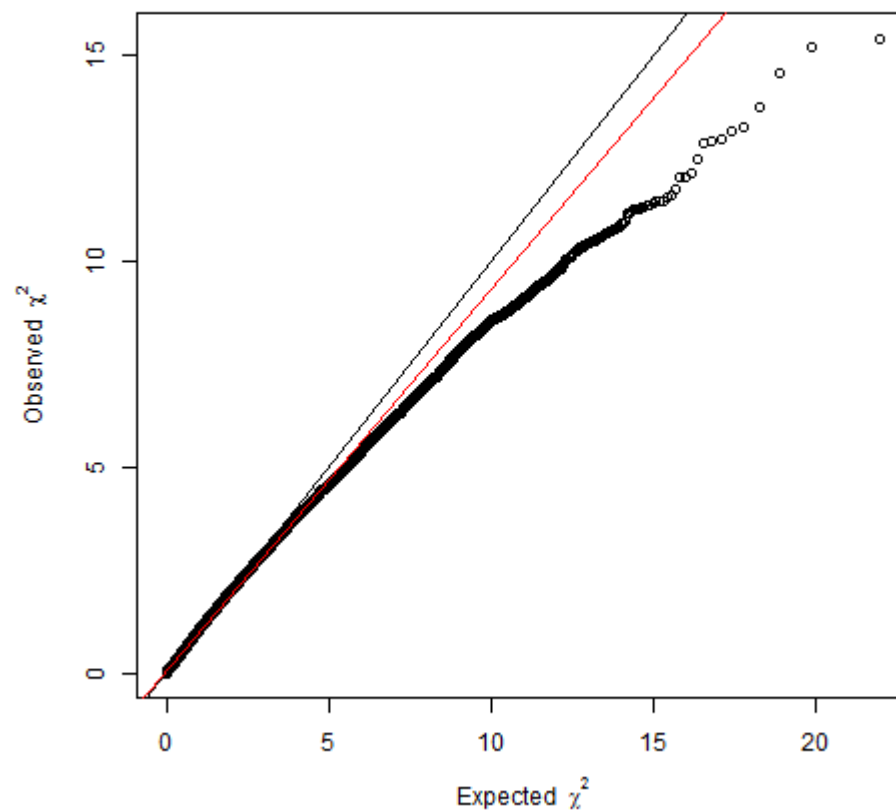
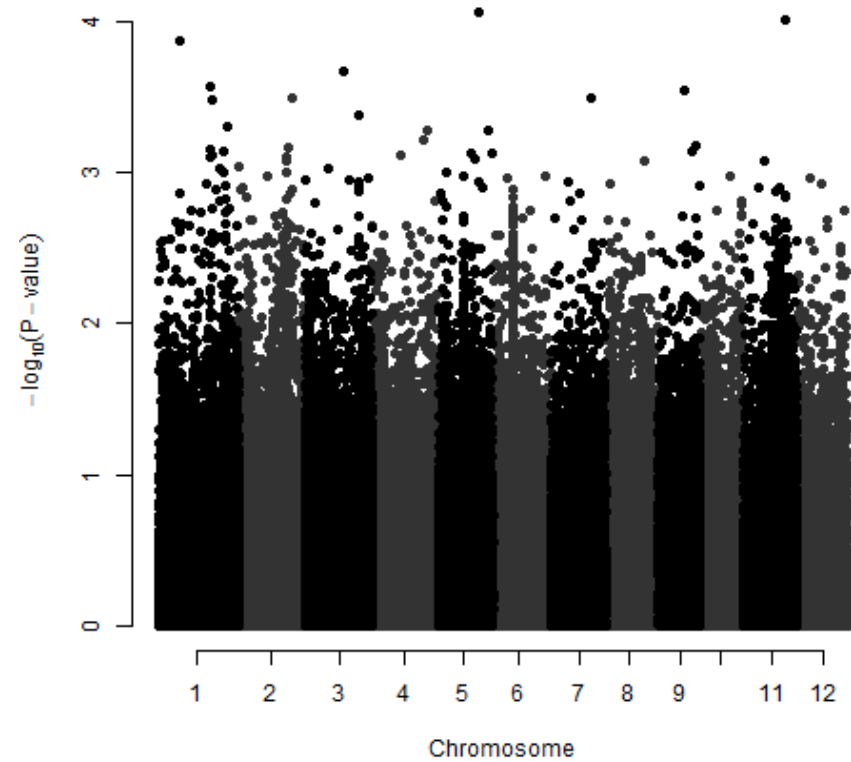


aus -  $\text{RSR}_{\text{LT}}$

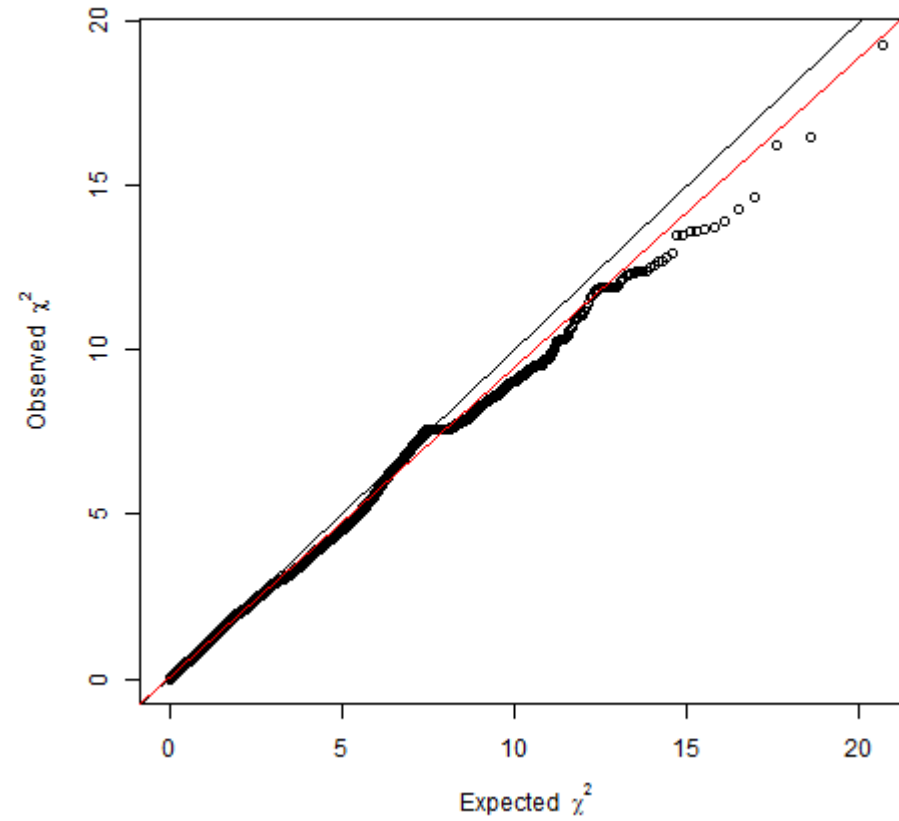
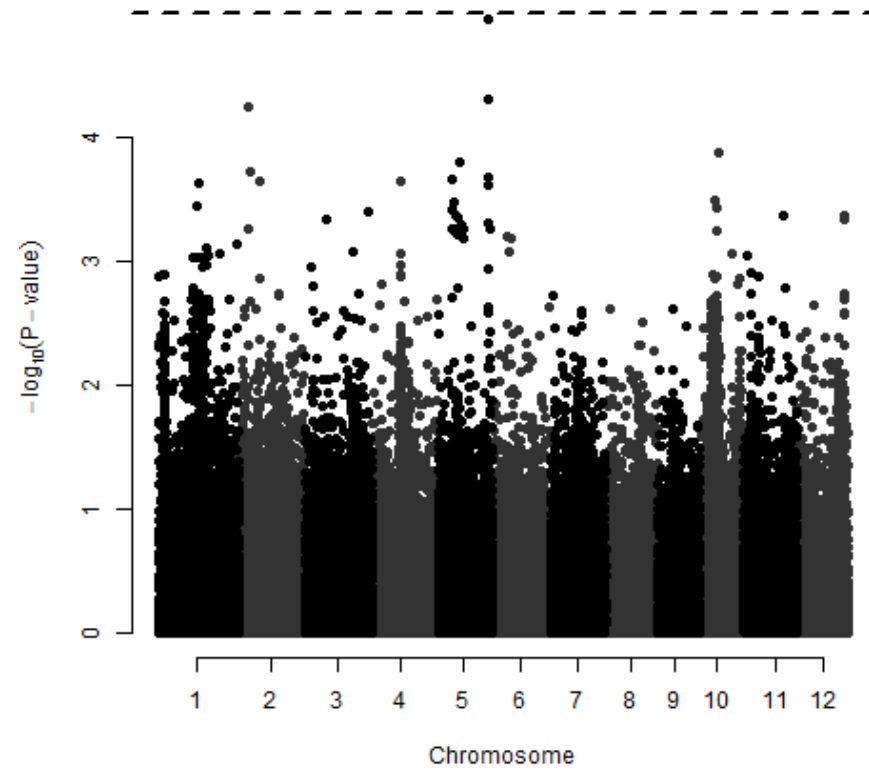




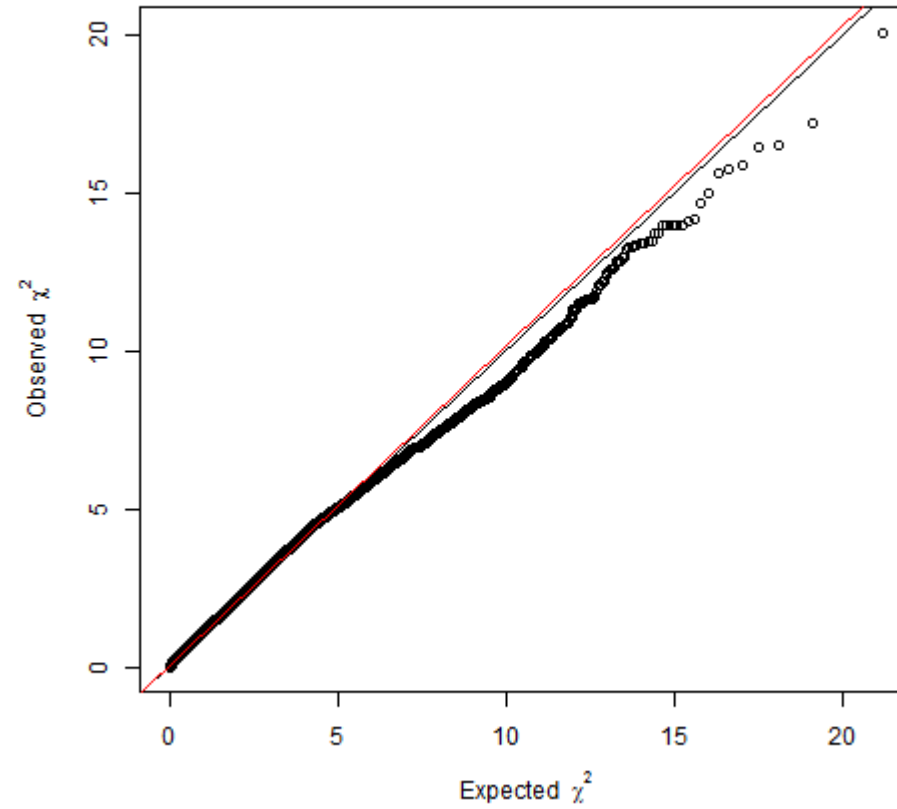
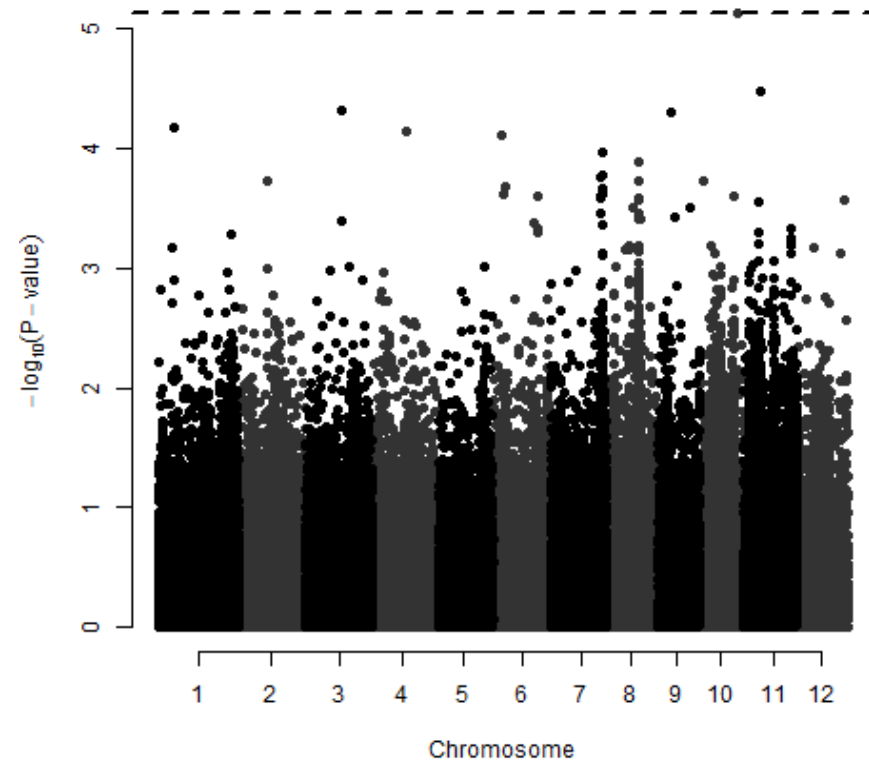
indica -  $\text{RSR}_{\text{LT}}$



# temperate japonica - $\text{RSR}_{\text{LT}}$



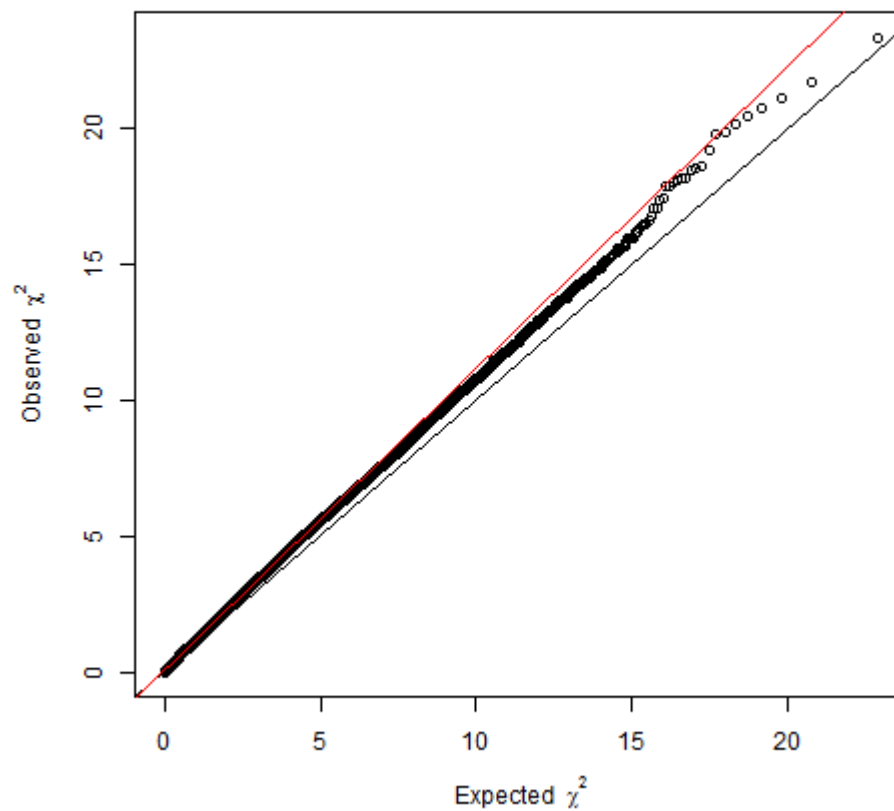
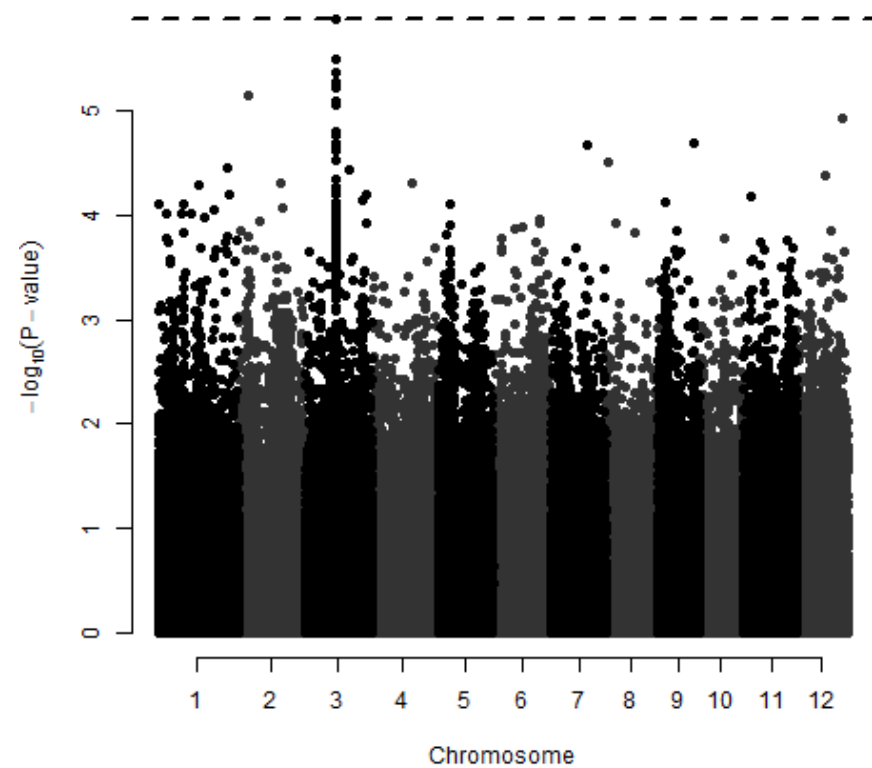
# tropical japonica - $\text{RSR}_{\text{LT}}$



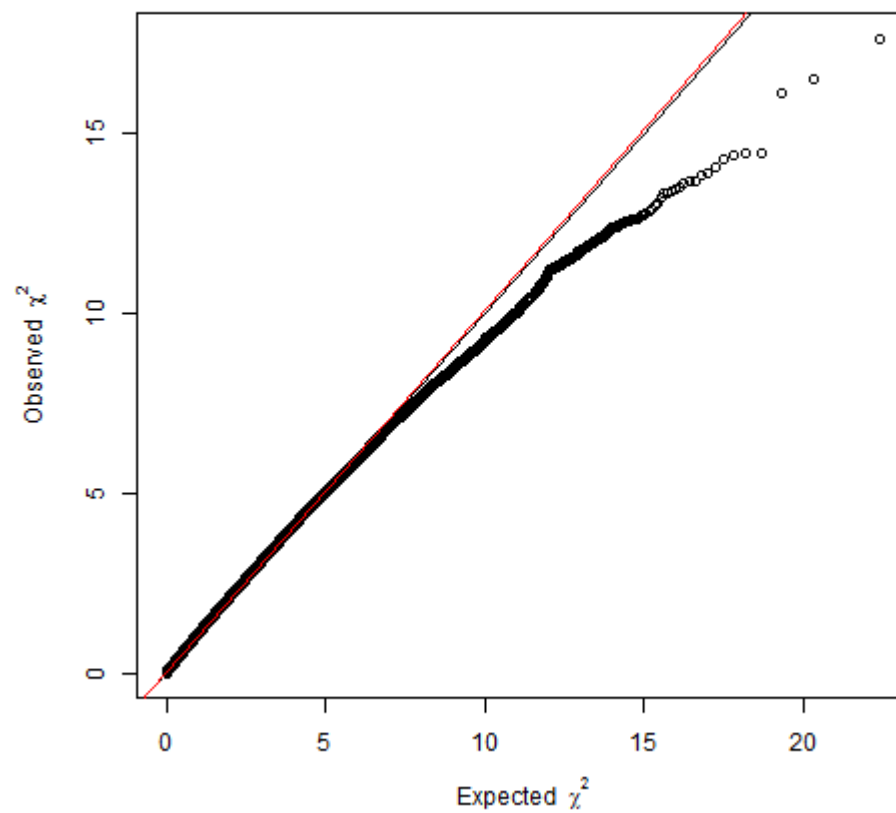
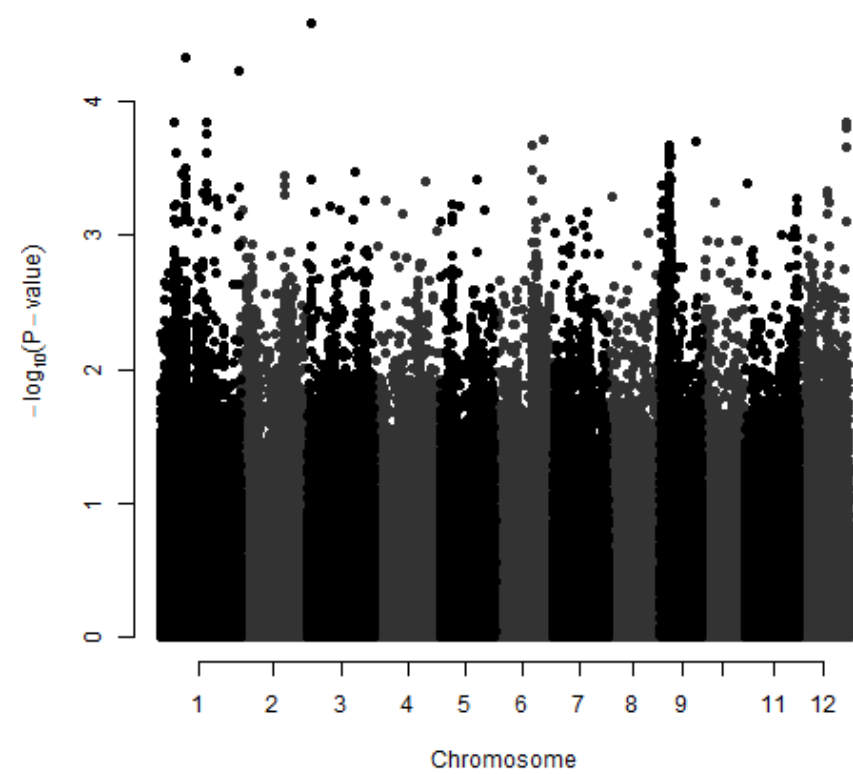
$$U_{HT}$$

Uptake of potassium per gram of root in the high treatment

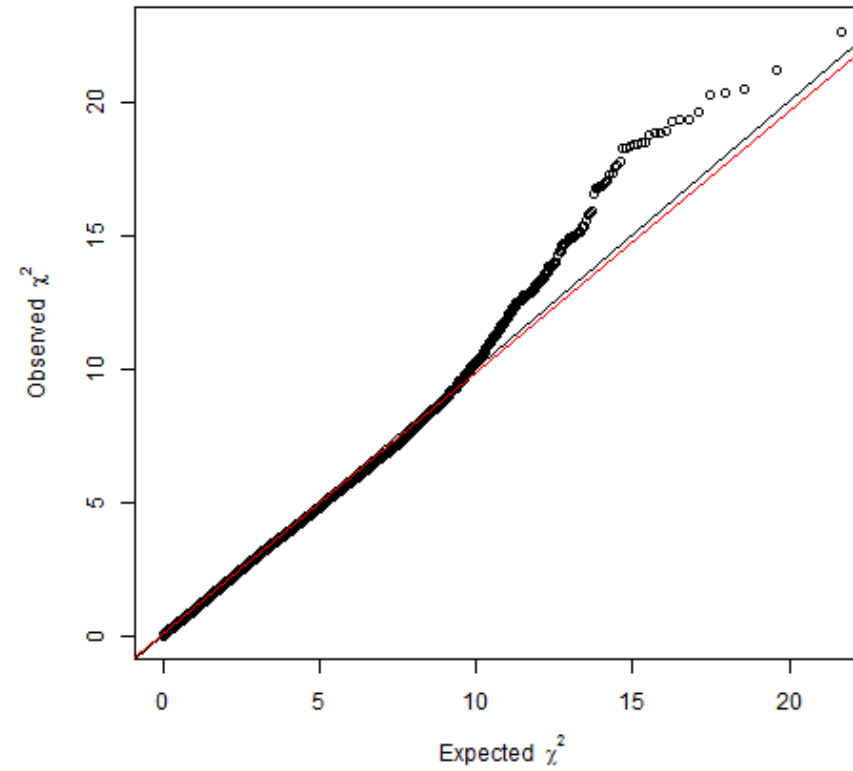
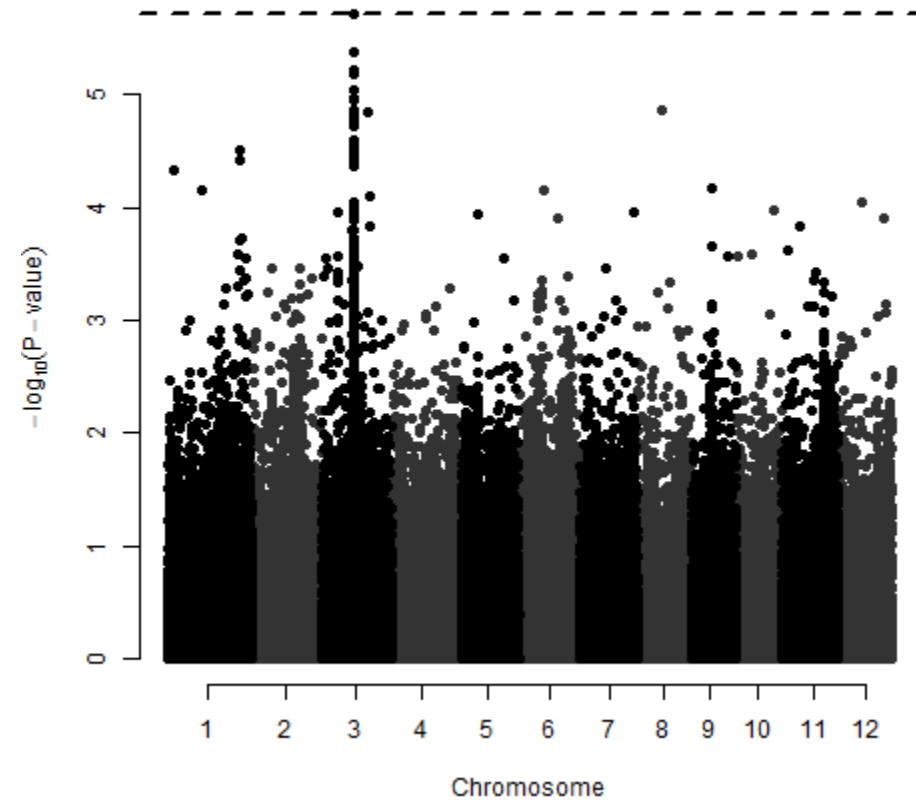
All genotypes -  $U_{HT}$



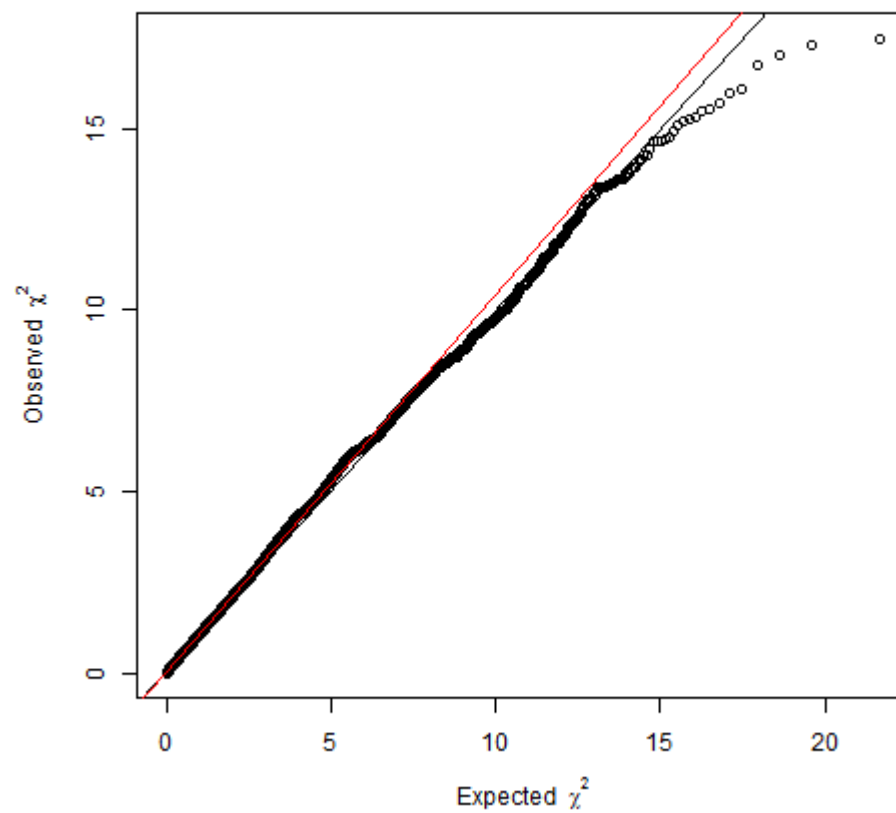
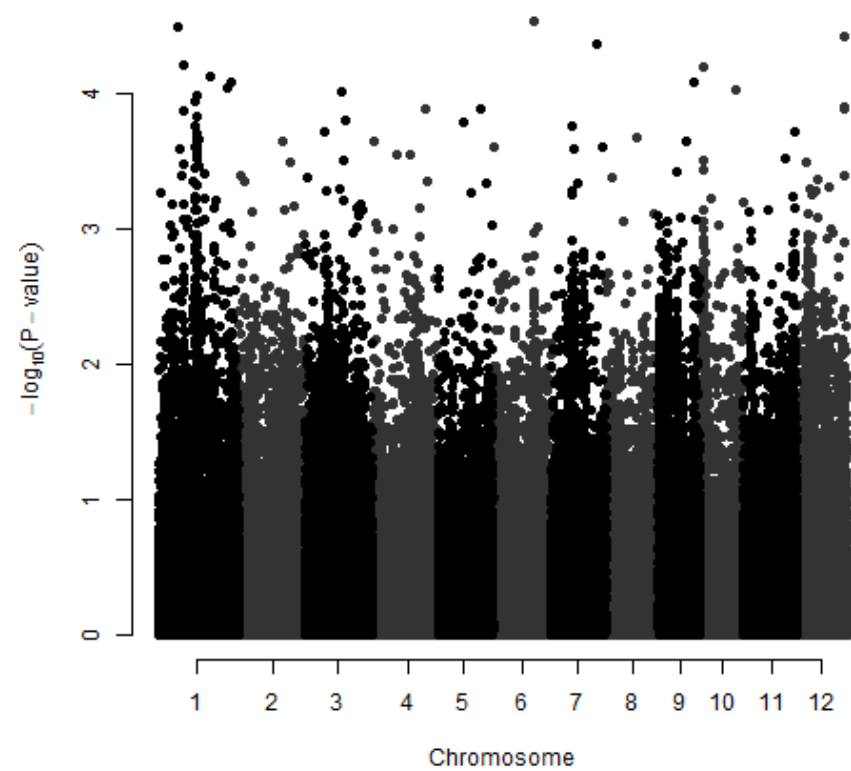
Indica -  $U_{HT}$



# Japonica - $U_{HT}$

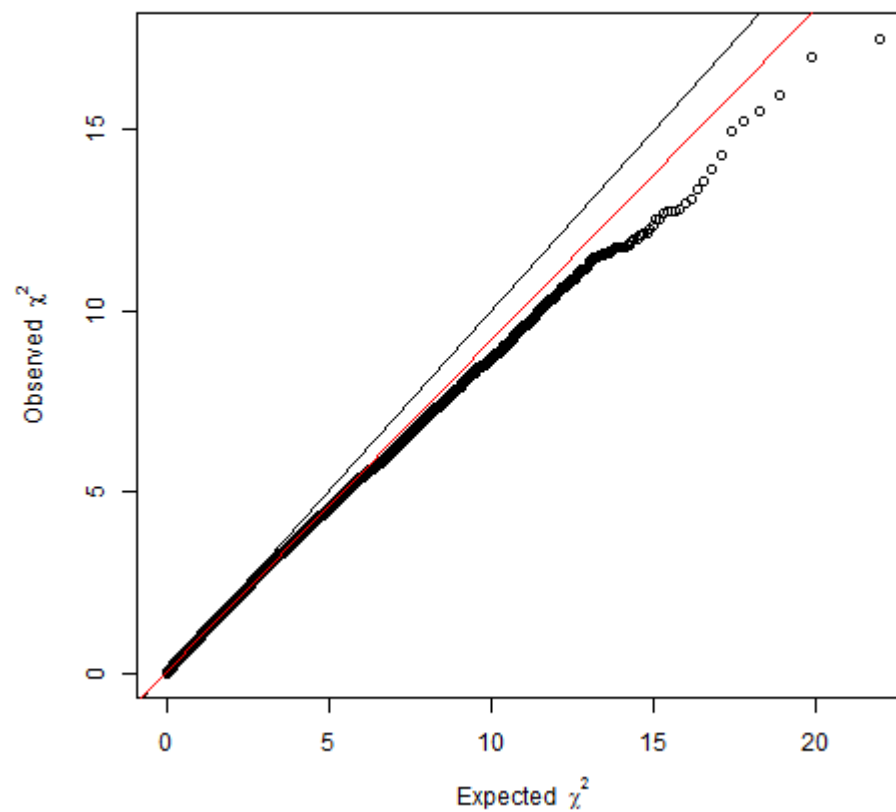
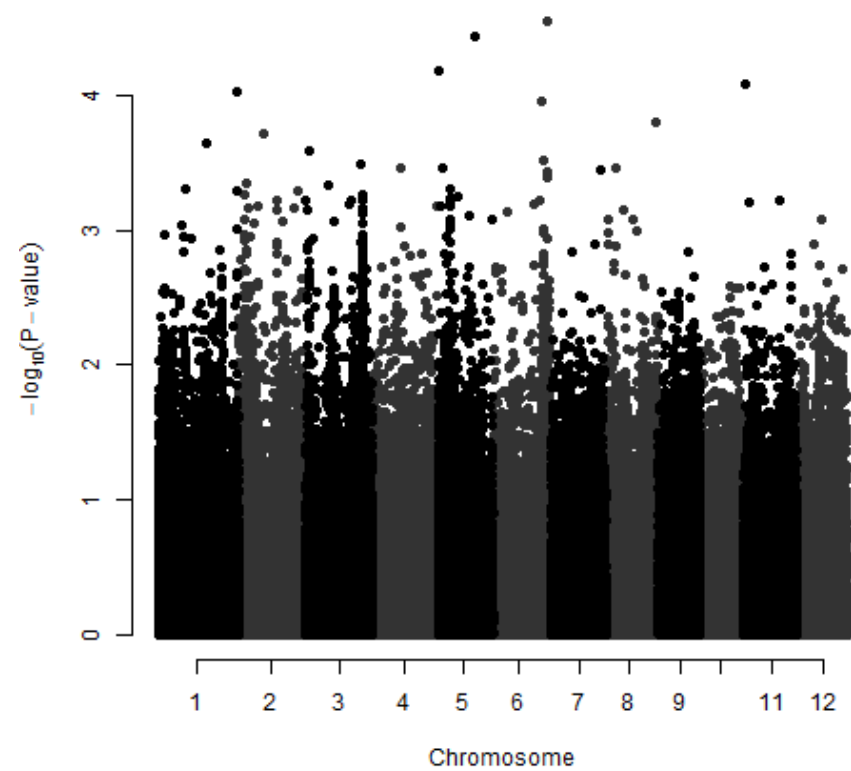


aus -  $U_{HT}$

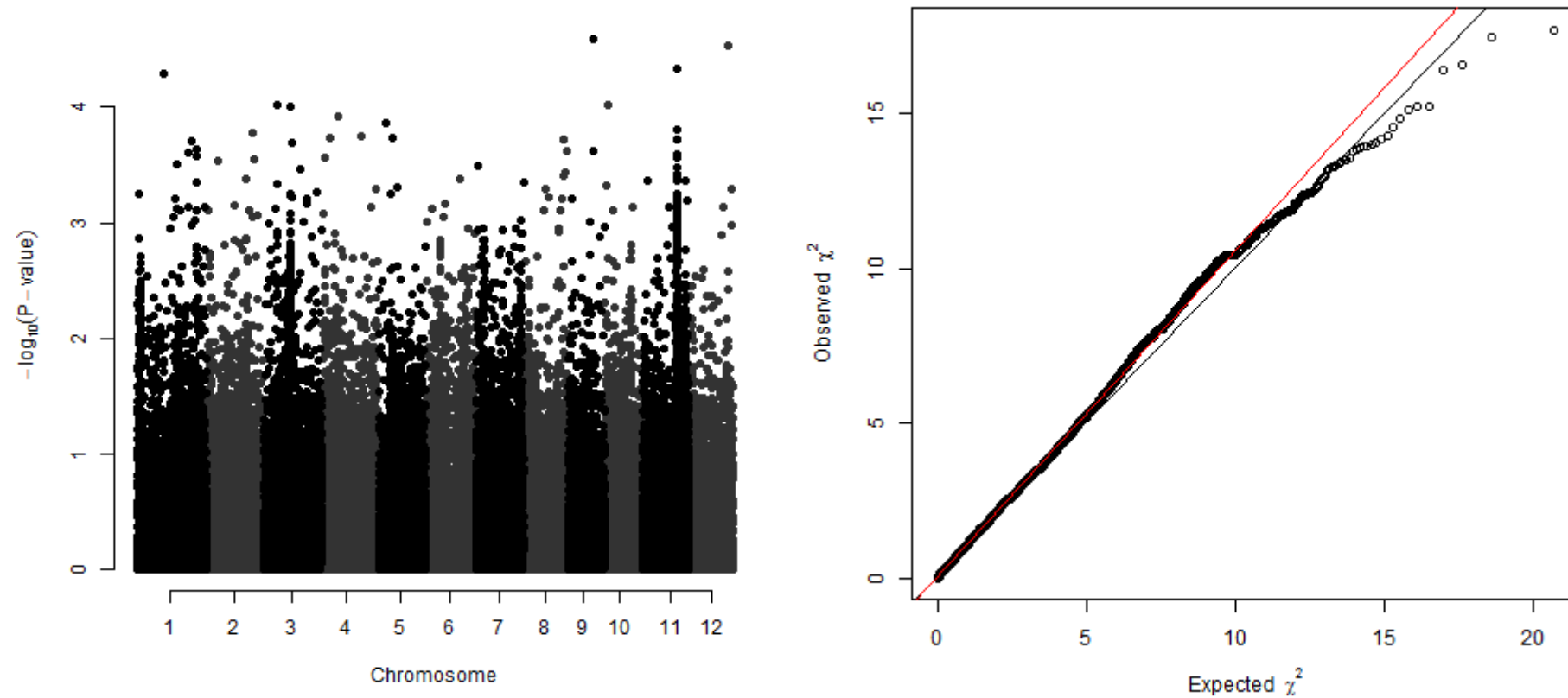




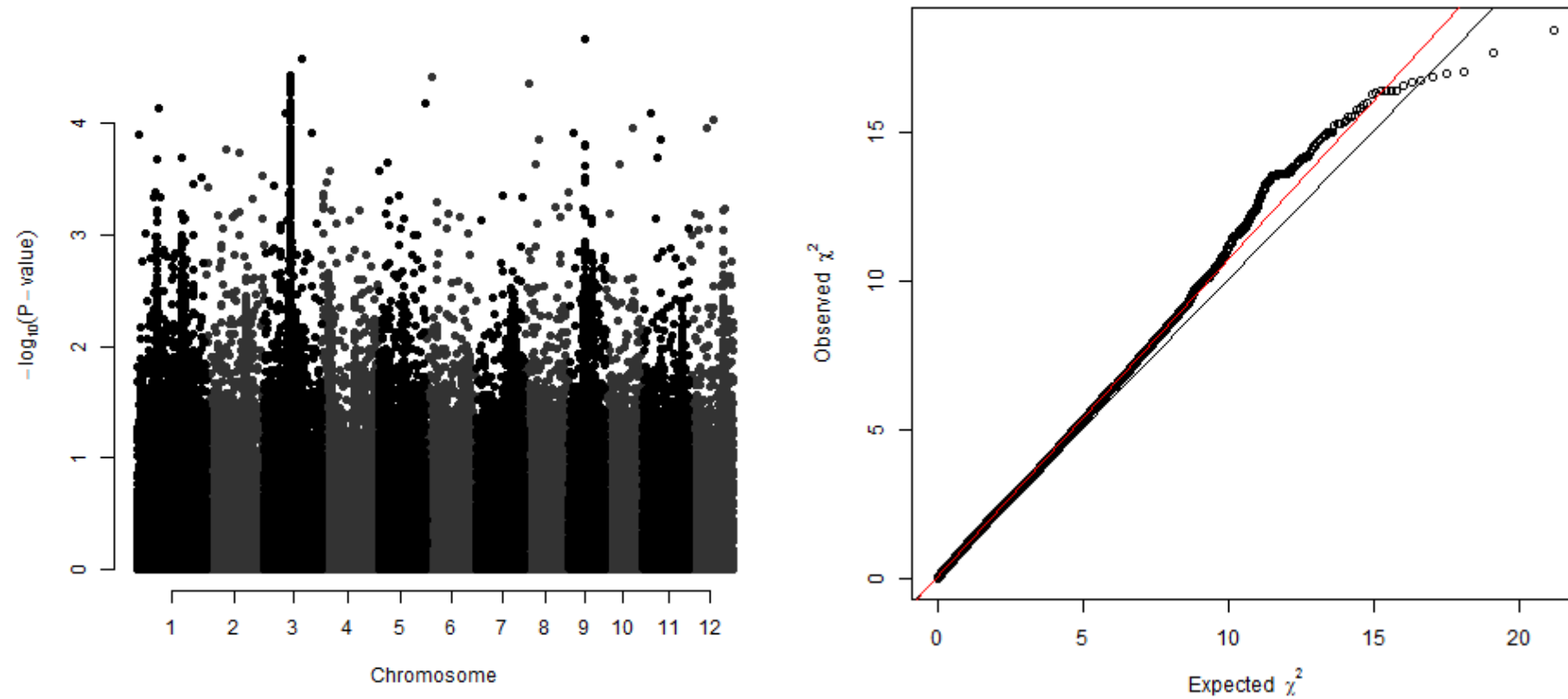
indica -  $U_{HT}$



temperate japonica -  $U_{HT}$



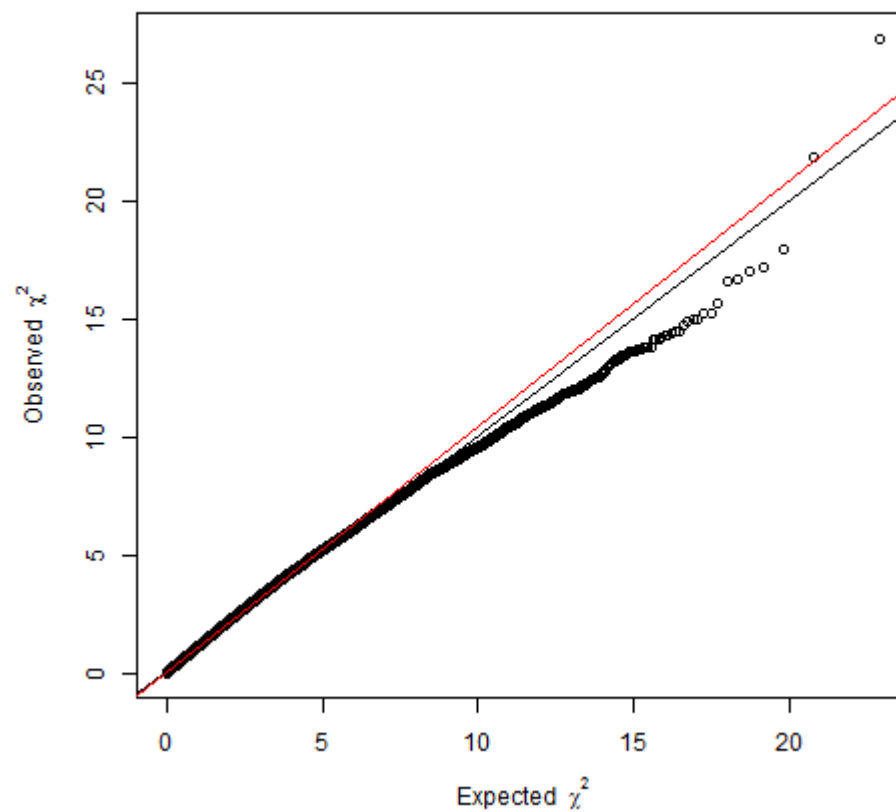
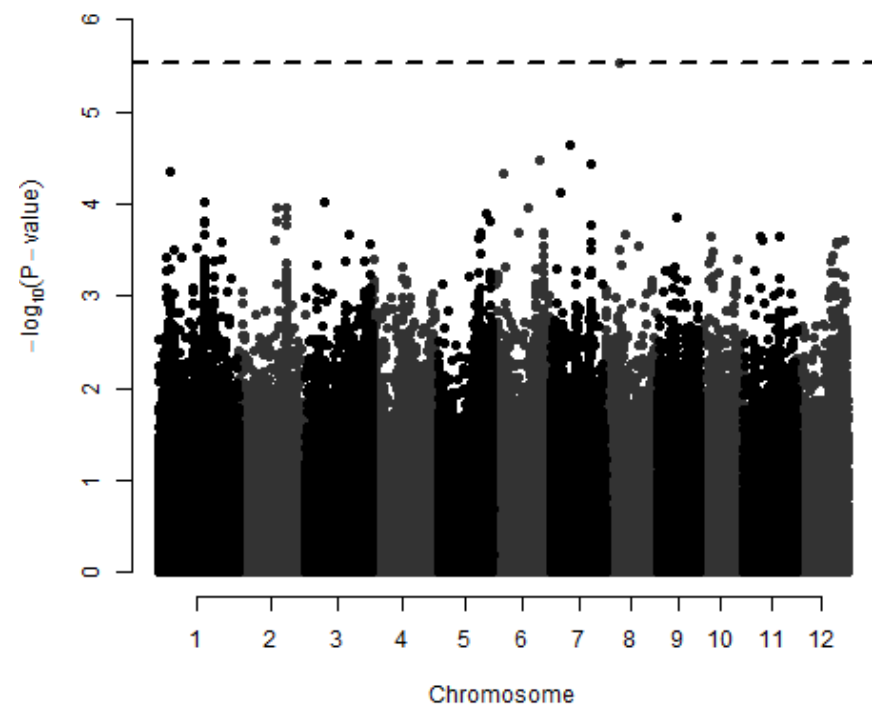
tropical japonica -  $U_{HT}$



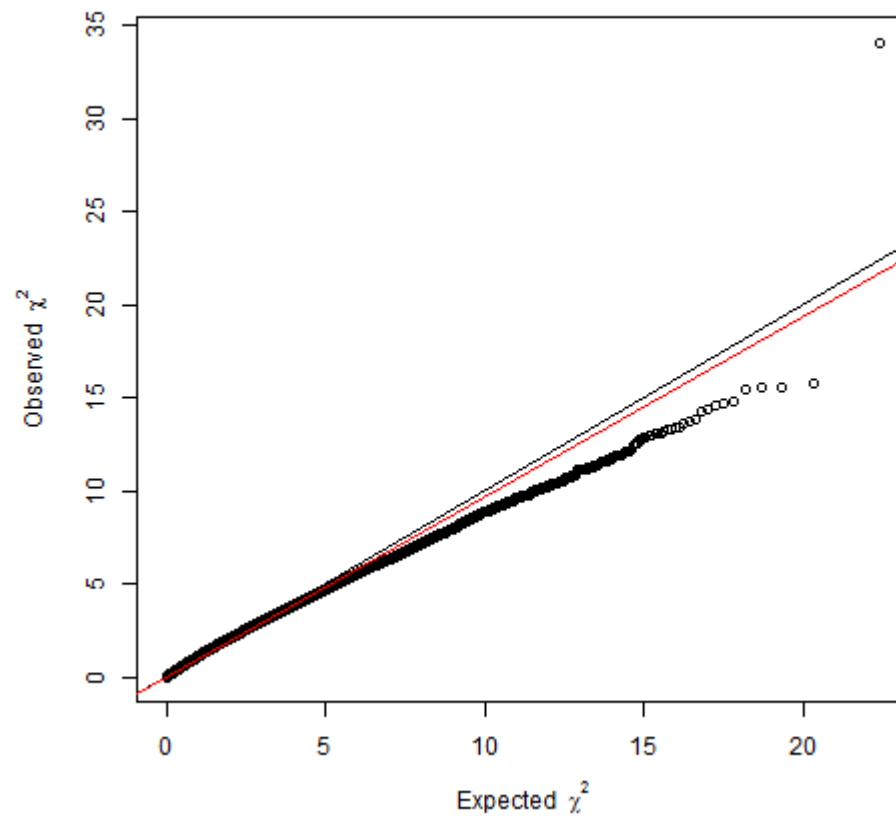
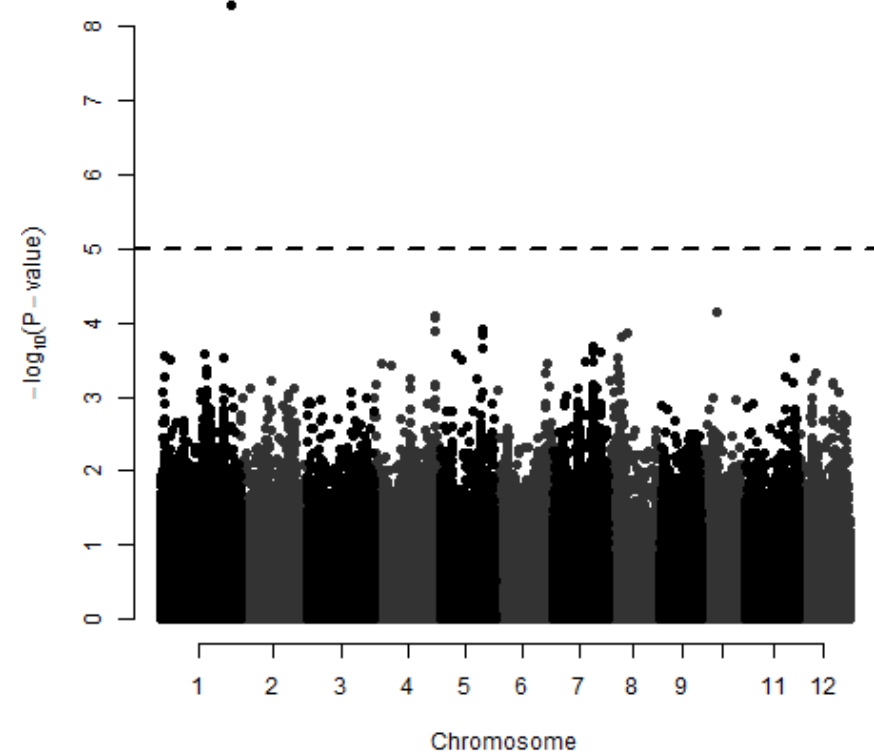
$$U_{LT}$$

Uptake of potassium per gram of root in the low treatment

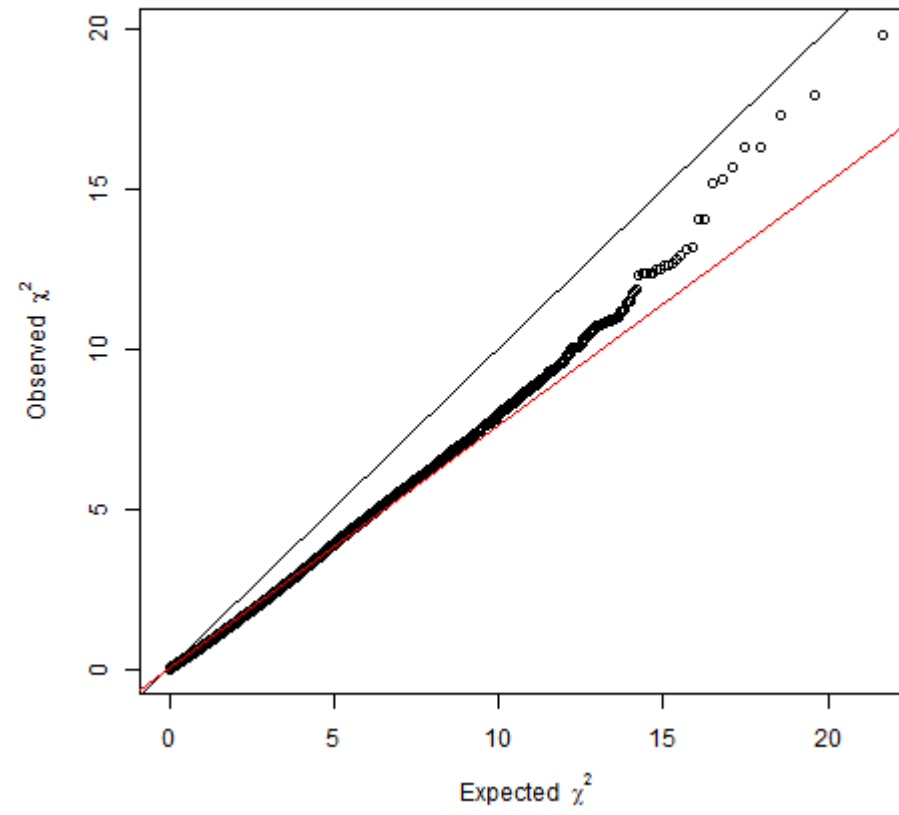
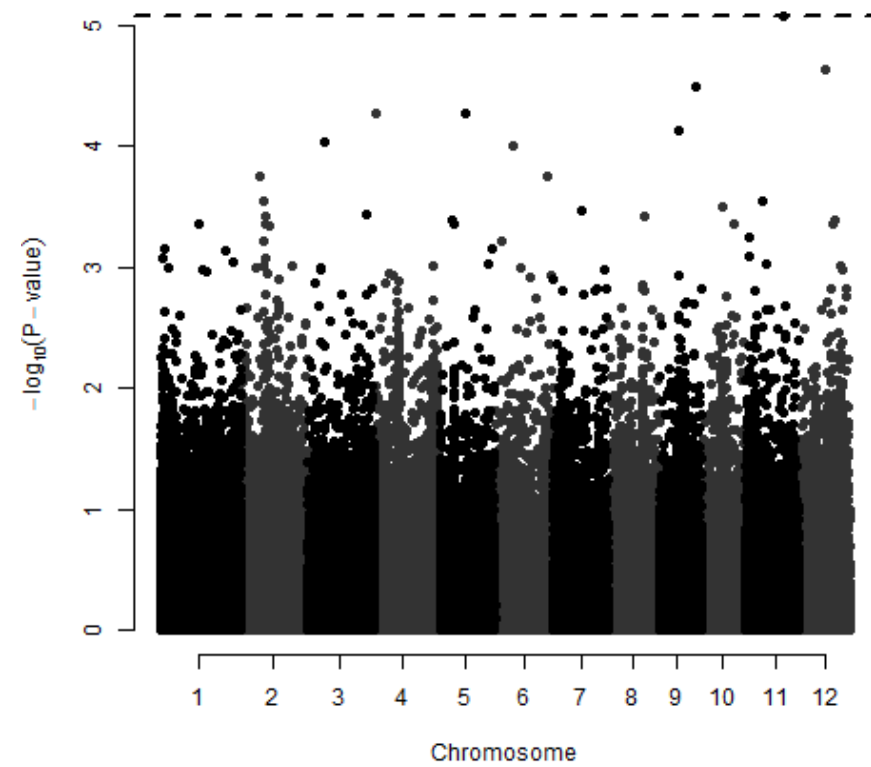
# All genotypes - $U_{LT}$



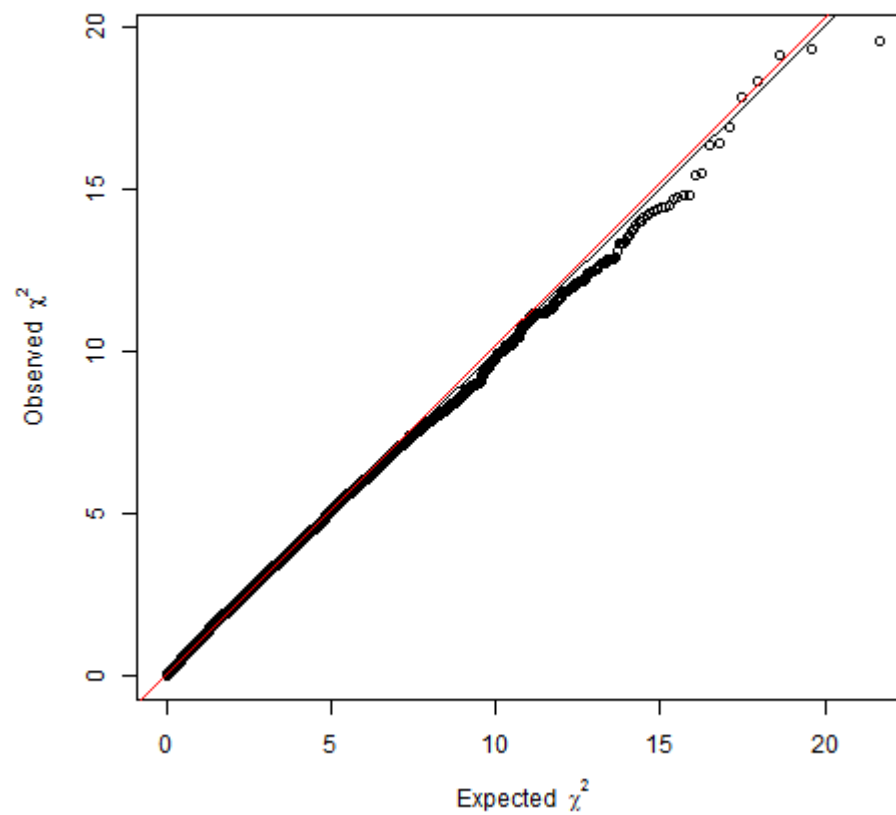
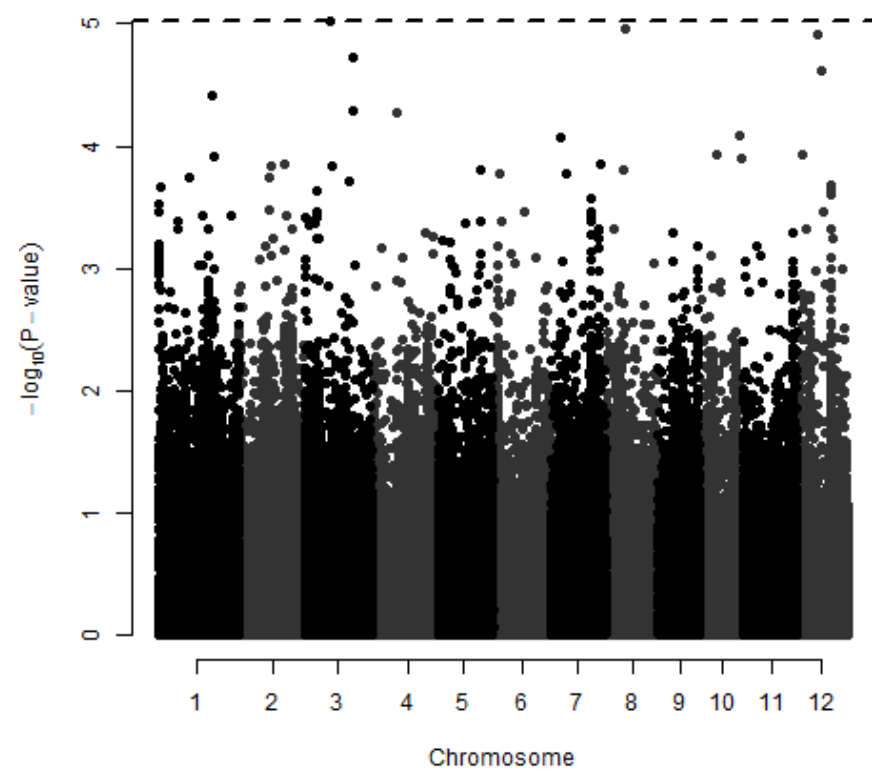
# Indica - $U_{LT}$



# Japonica - $U_{LT}$

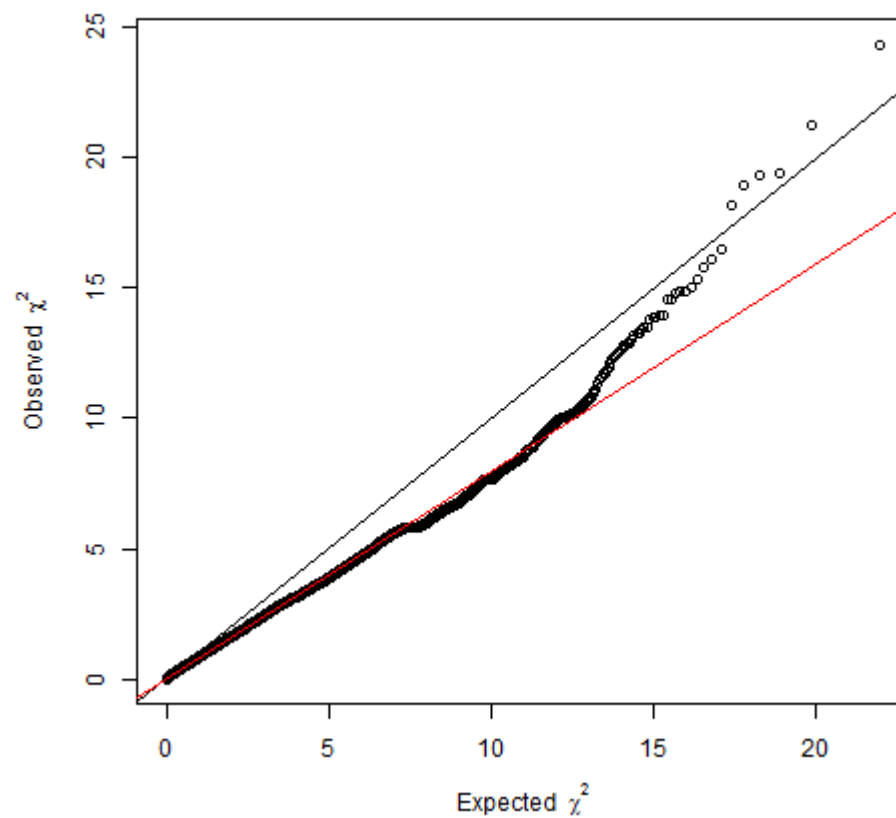
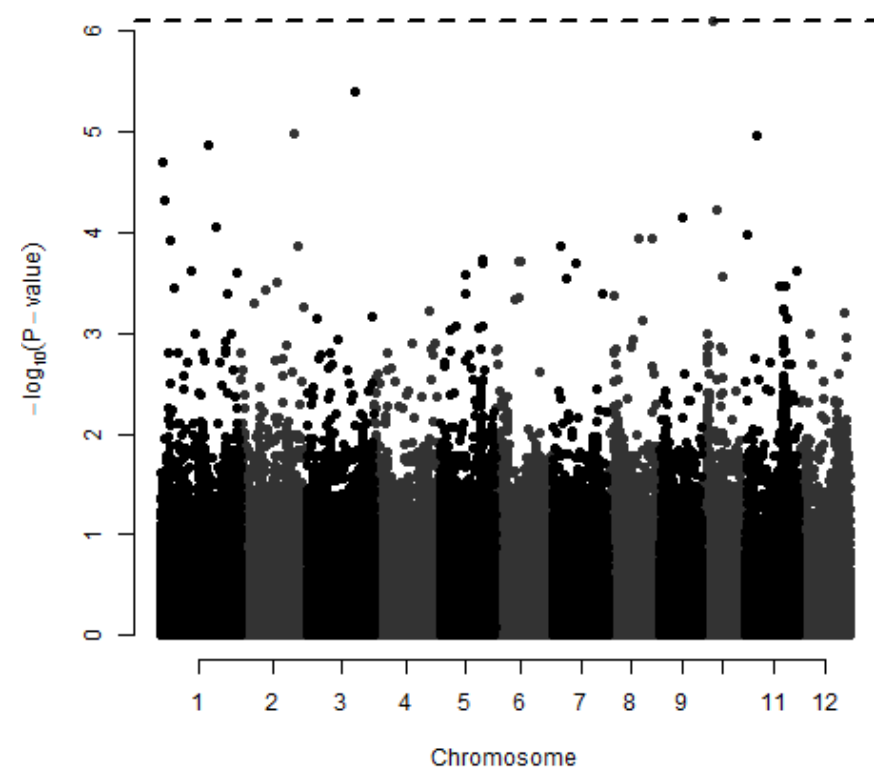


aus  $-U_{LT}$

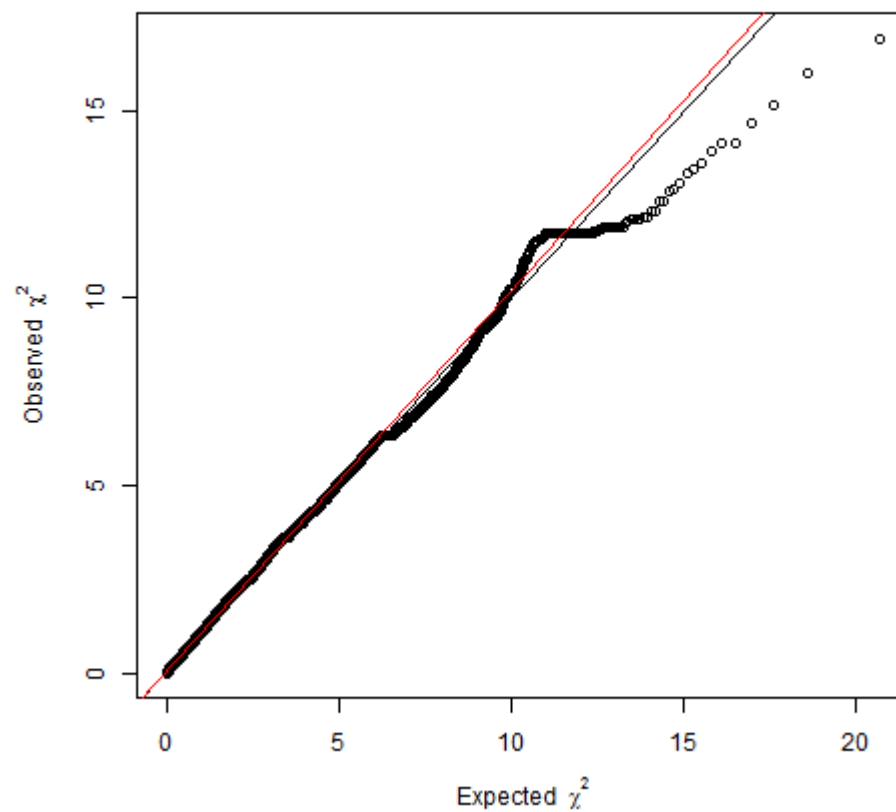
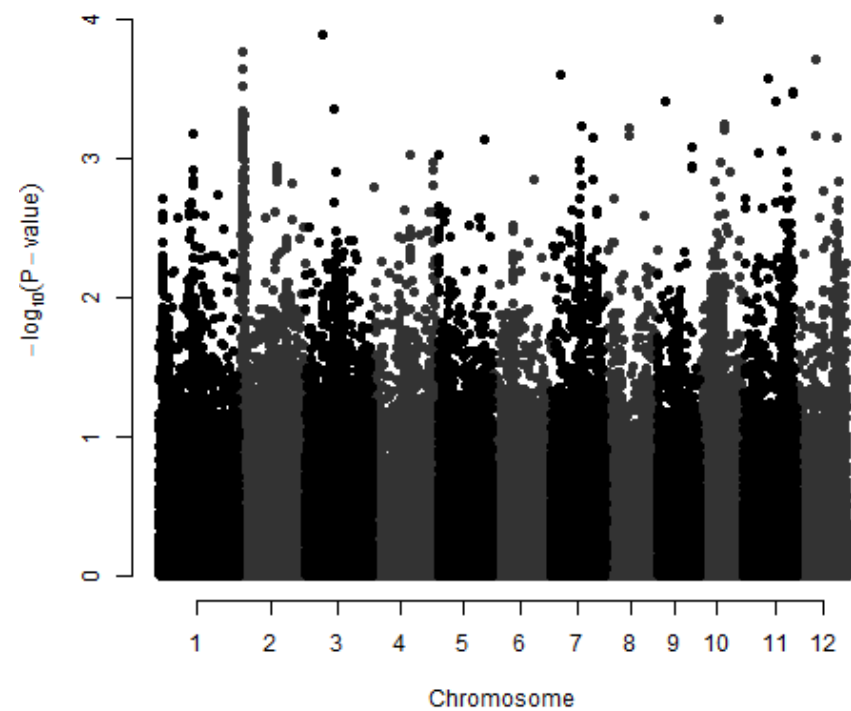




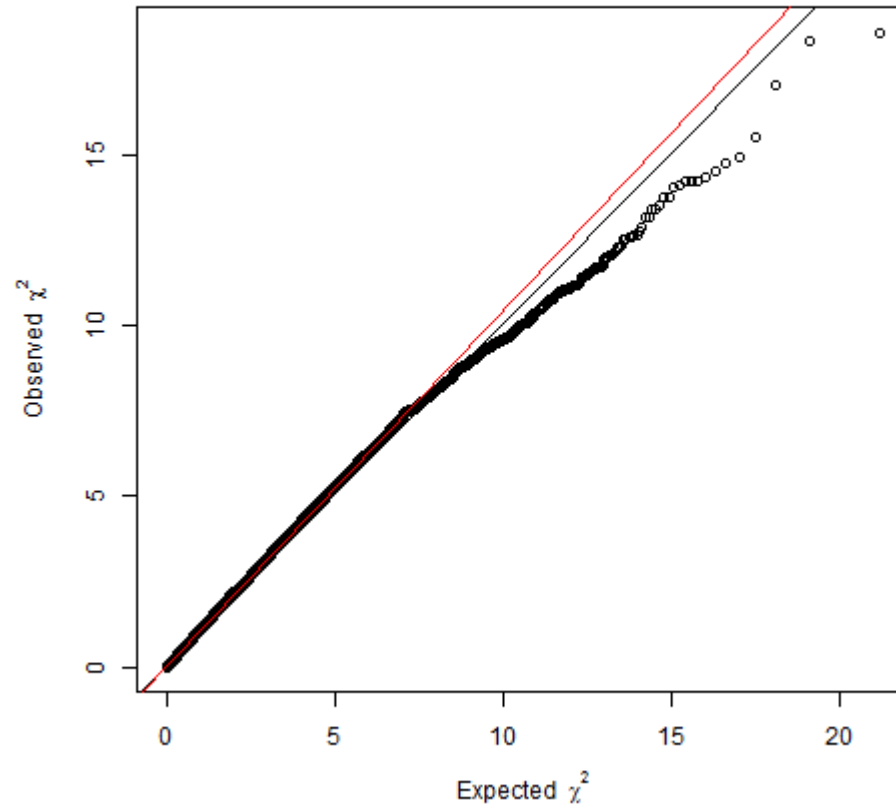
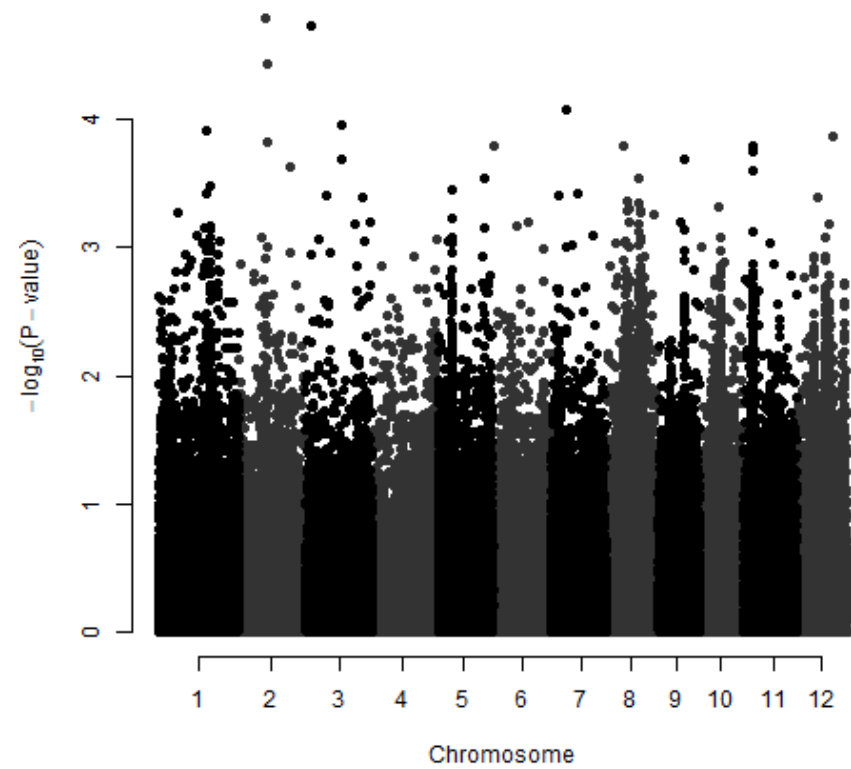
indica -  $U_{LT}$



temperate japonica -  $U_{LT}$



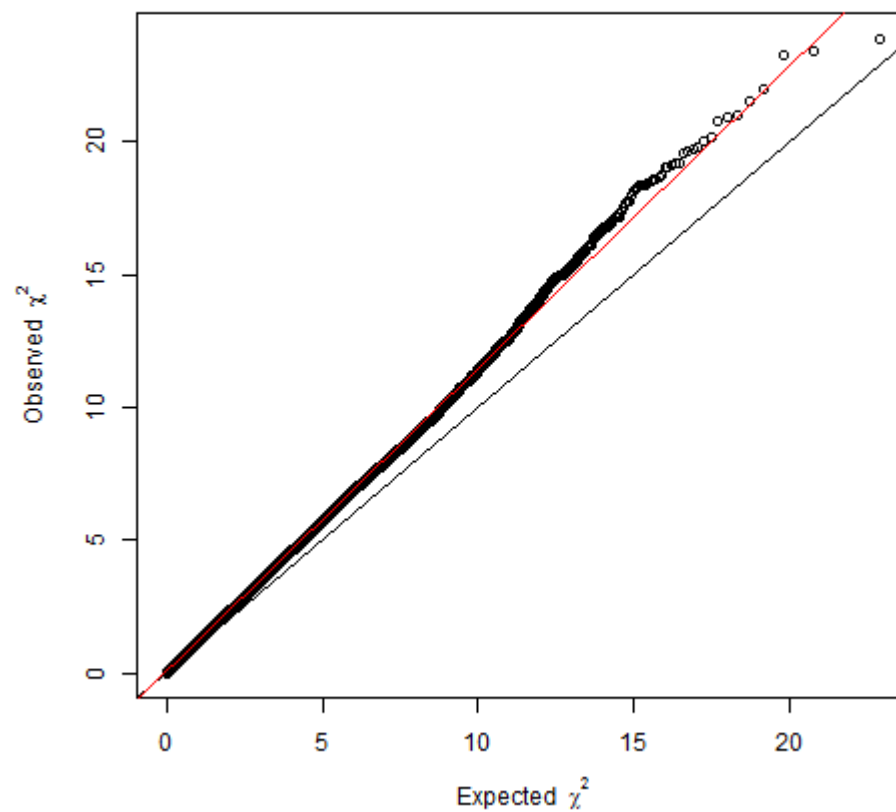
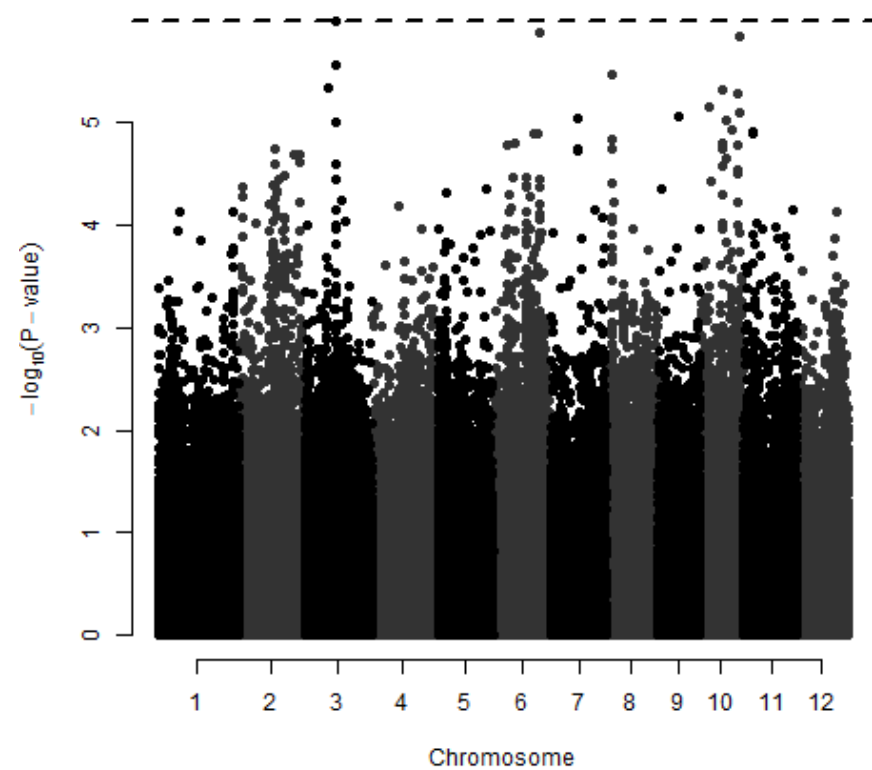
# tropical japonica - $U_{LT}$



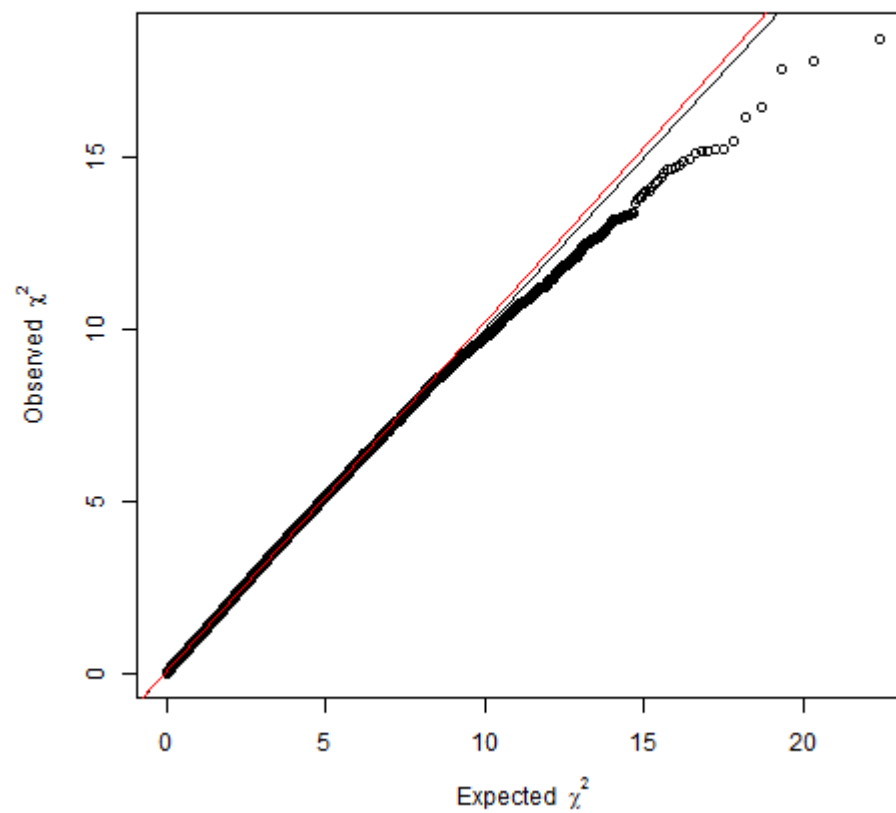
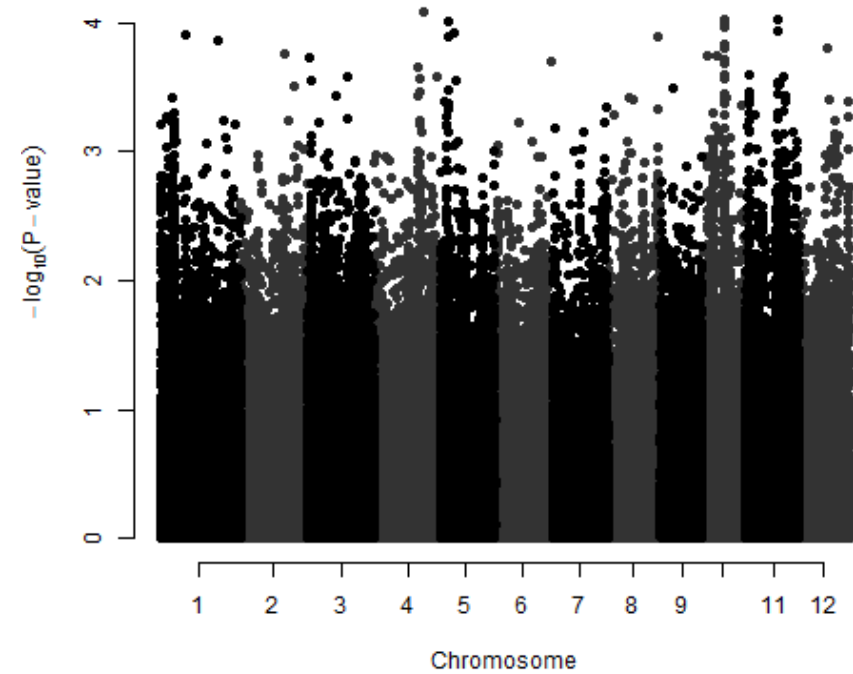
$$W_0$$

Initial plant mass

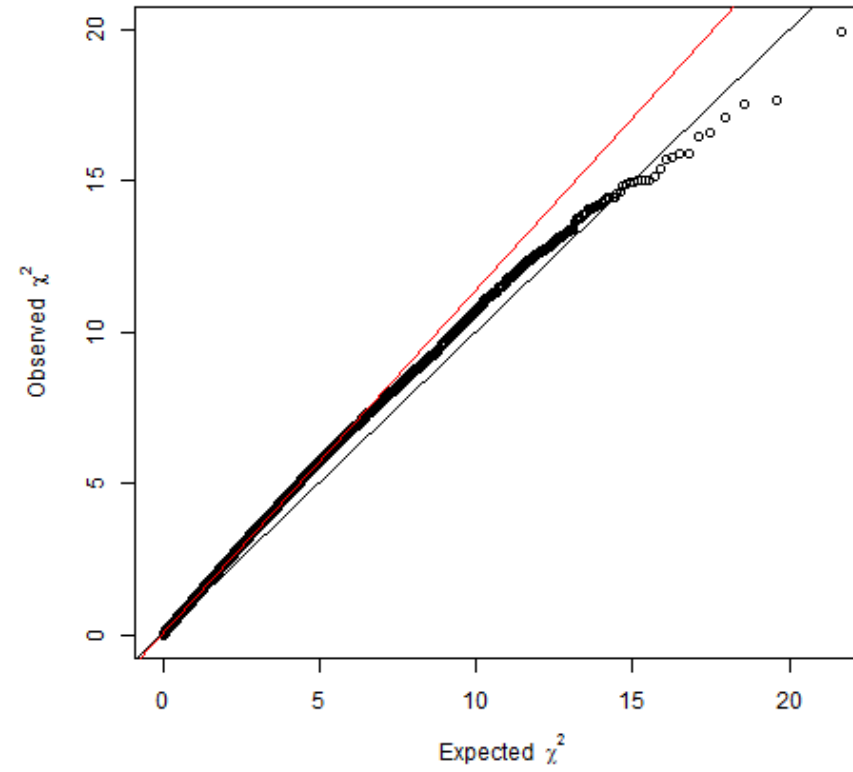
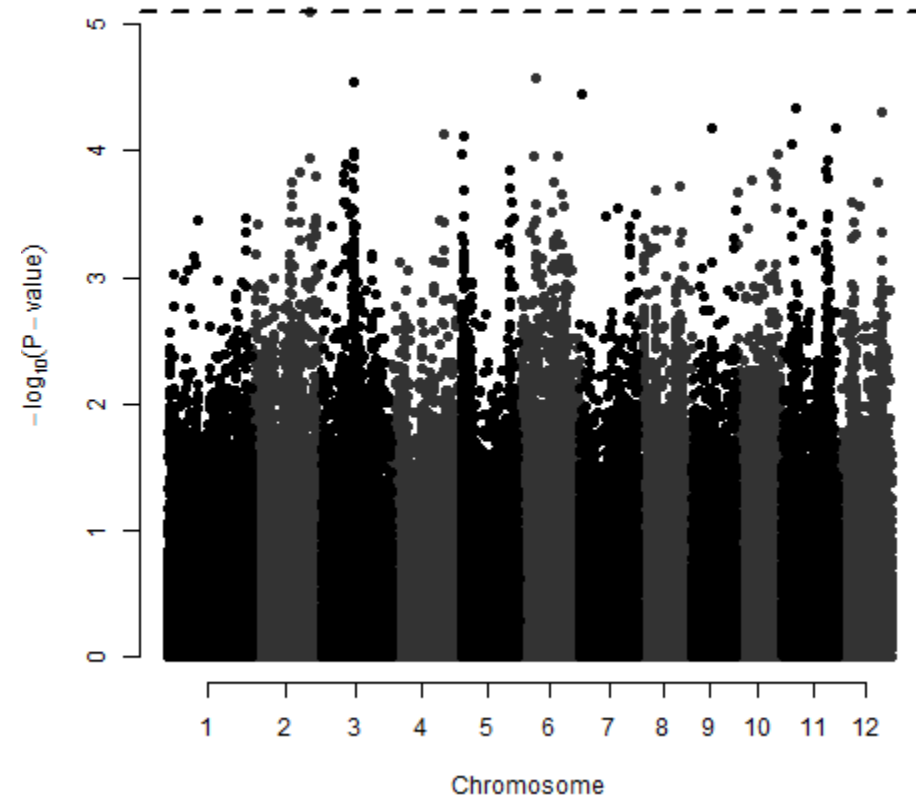
# All genotypes - $W_0$



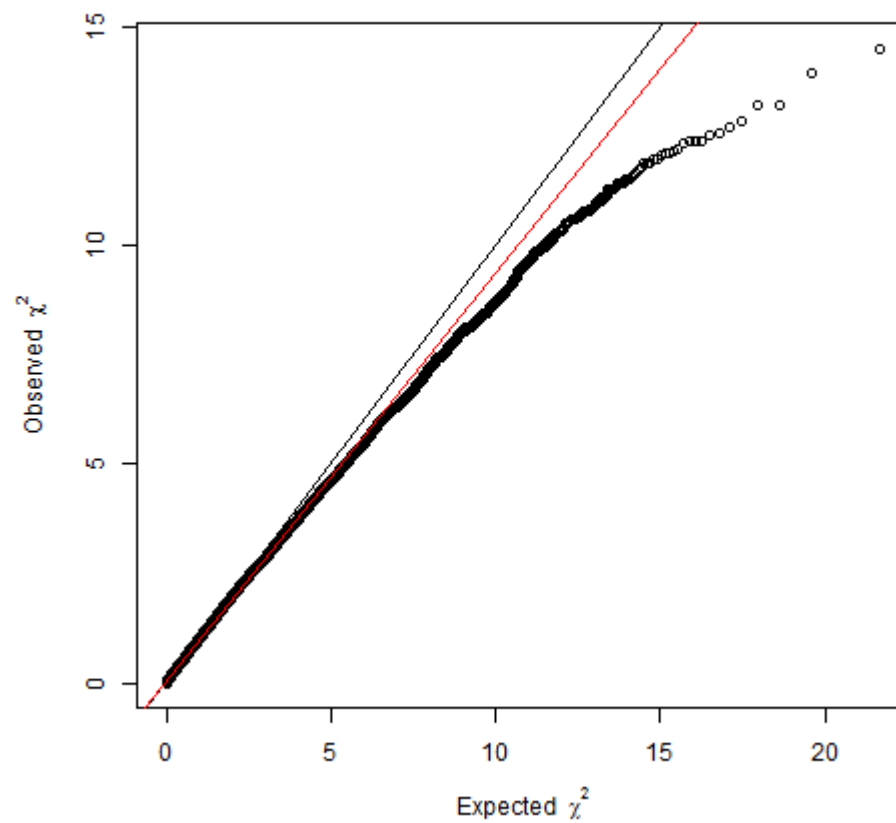
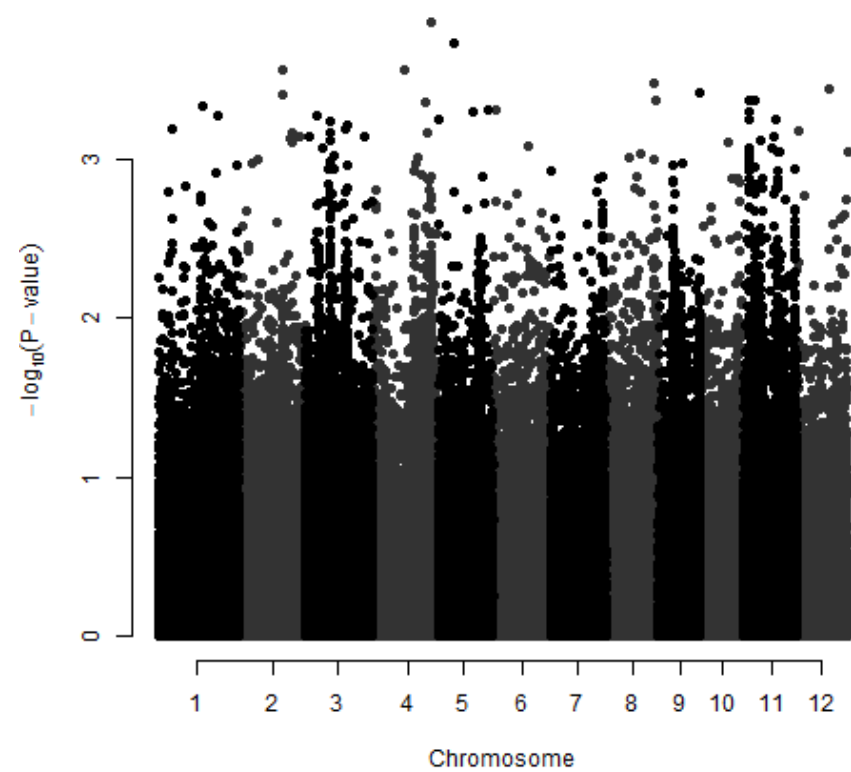
Indica -  $W_0$



# Japonica - $W_0$

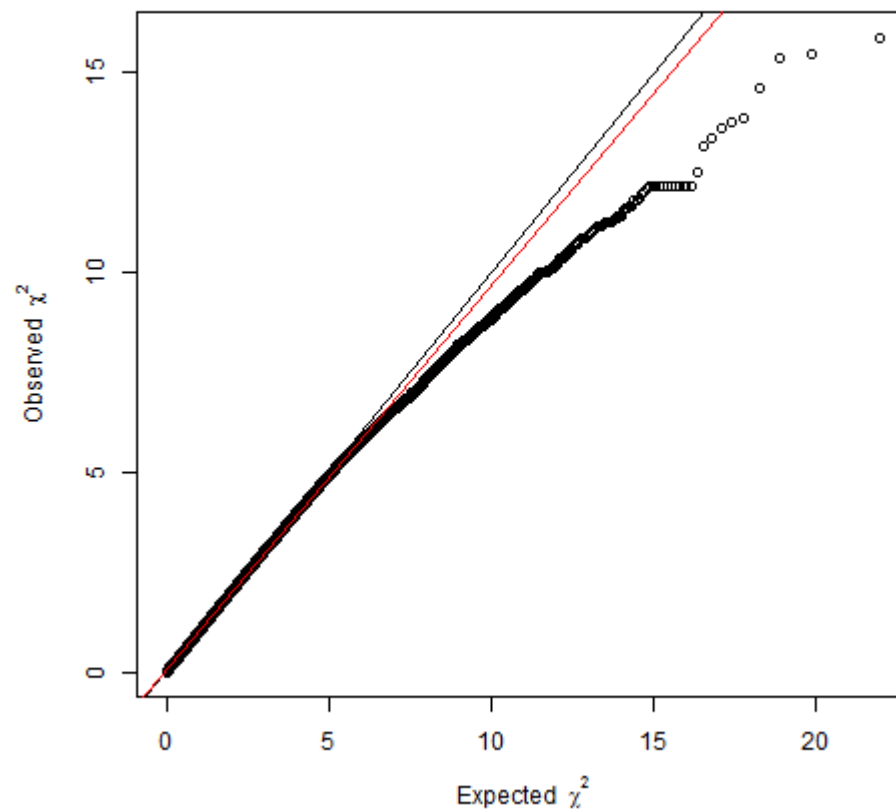
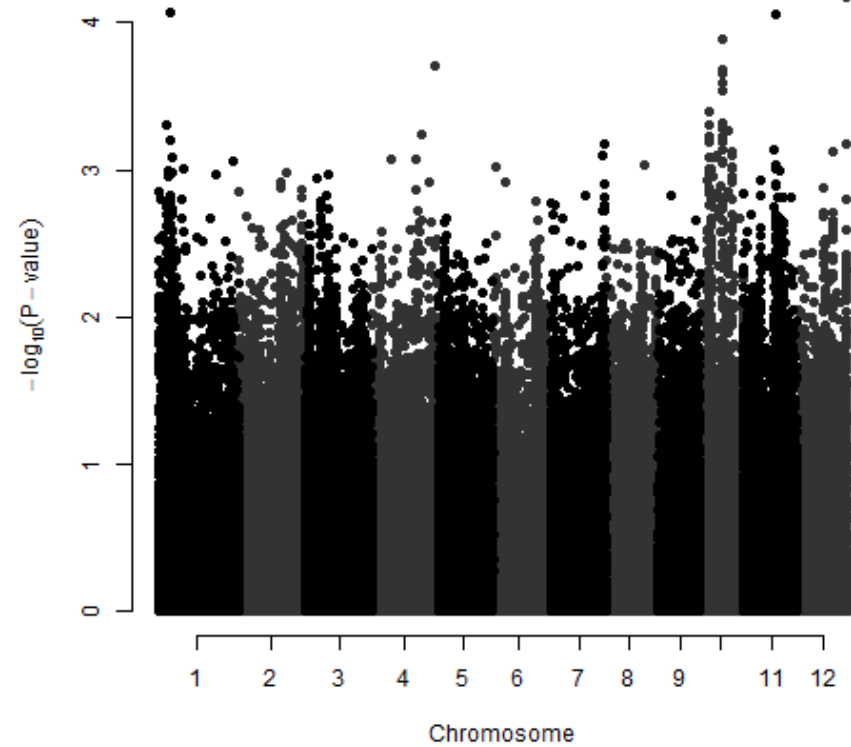


aus -  $W_0$

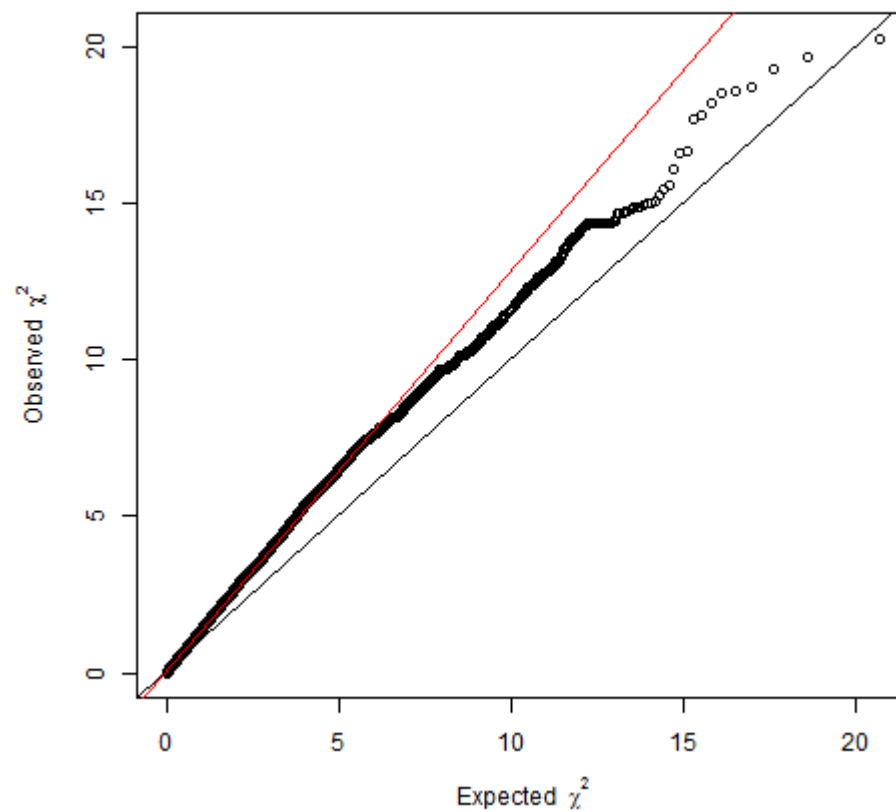
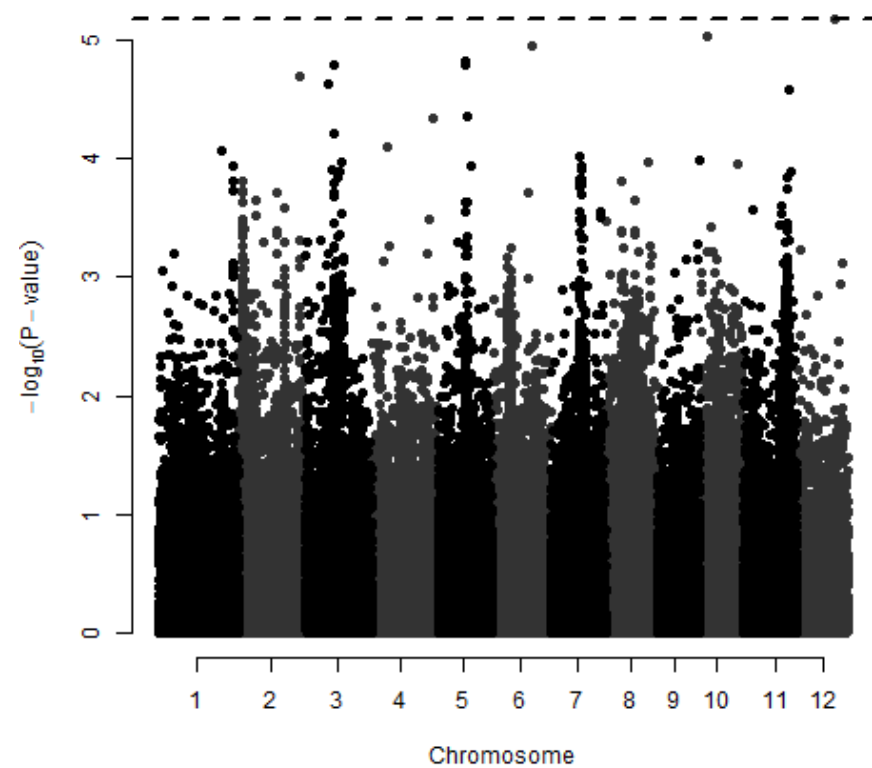




indica -  $W_0$



temperate japonica -  $W_0$



# tropical japonica - $W_0$

