Characterization of a large reciprocal translocation in banana (Musa acuminata) and its impact on chromosomal segregation using NGS

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Radiation of wild Musa/Domestication

- hybridization between species and subspecies made possible by human migration
- selection of diploid and triploid, seedless, parthenocapic hybrids by early farmers

Large structural variations suspected based on ...

Chromosomal pairing during meiosis of sub-species hybrids.

Multivalents

Dessauw, 1987; Dodds, 1993; Dodds et al., 1999; Noyer et al., 2003; Shepherd, 1999; Vilarinhos, 2004

1 to 4 translocations between groups

7 structurally homogeneous groups defined by Shepherd (1999)

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Chromosomal pairing during meiosis of sub-species hybrids.

Multivalents

Dessauw, 1987; Dodds, 1993; Dodds et al., 1999; Noyer et al., 2003; Shepherd, 1999; Vilarinhos, 2004

Impact of structural variations

* Structural heterozygosity within diploid hybrids

At least partially responsible of banana low fertility

Seedless fruits

complicates cross between hybrids of interest

Impact on chromosomal recombination and segregation

Prevent or reduce genetic mixing

Limit genetic determinism analysis of traits

Need to characterize these structural variations

The Musa reference sequence, new resource for structural variation search

* M. acuminata ssp. malaccensis
* 11 chromosomes
* 44 % of the assembly composed of repeat sequences

Development of an approach based on resequencing and discordant reads detection
Looking for structural variations by re-sequencing

(1) Mate pair sequencing of X
(2) Alignment on reference
(3) Discordant read detection
(4) X structure inference

Duplication in X
(chr1, chr2) Accession X

A new pipeline

Translocation region: chr01 900000 1400000 target: chr01 2950000

Structural heterozygosity suspected in PT-BA-00267

* Self progeny, 180 individuals, DArTseq

Structural heterozygosity identified in PT-BA-00267

A reciprocal translocation?

* PT-BA-00267 5kb mate pair illumina sequencing

Structural heterozygosity identified in PT-BA-00267

Consequence on chromosomal segregations

* A genetic map on PT-BA-00267 (diploid and fertile)
Structural heterozygosity identified in PT-BA-00267
Consequence on chromosomal segregations

- The rearranged structure preferentially transmitted to the progeny (70% vs 30%)
- Shepherd observed in such structural heterozygote:
  - 11 bivalent: 57%
  - 1 trivalent V-shape : 39%

78/57/192
57/192

Unbalanced
Unbalanced

Investigation of the chromosomes 1/4 translocation in other accessions

*14 banana accessions resequenced with illumina insert size 5-8kb
Homologous as the reference
Heterozygous
Homologous for alternative

Investigation of the chromosomes 1/4 translocation in other accessions

*10 banana accessions resequenced with illumina insert size 5-8kb
Homologous as the reference
Heterozygous
Homologous for alternative

Investigation of the chromosomes 1/4 translocation in Musa germplasm through PCR

* Multivariate analysis performed on GBS data

Investigation of the chromosomes 1/4 translocation in Musa germplasm through PCR

* Alternate structure also found at heterozygous state in the Mlali group (2n donor of Cavendish and Gros Michel)

* Alternate structure also found at heterozygous state in half of triploid AAA, AAB and ABB subgroups tested including Cavendish

Structural heterozygosity favored the emergence of triploid accessions via increased number of unreduced gamete?