Induction Gene-based DH Breeding for Multicrops

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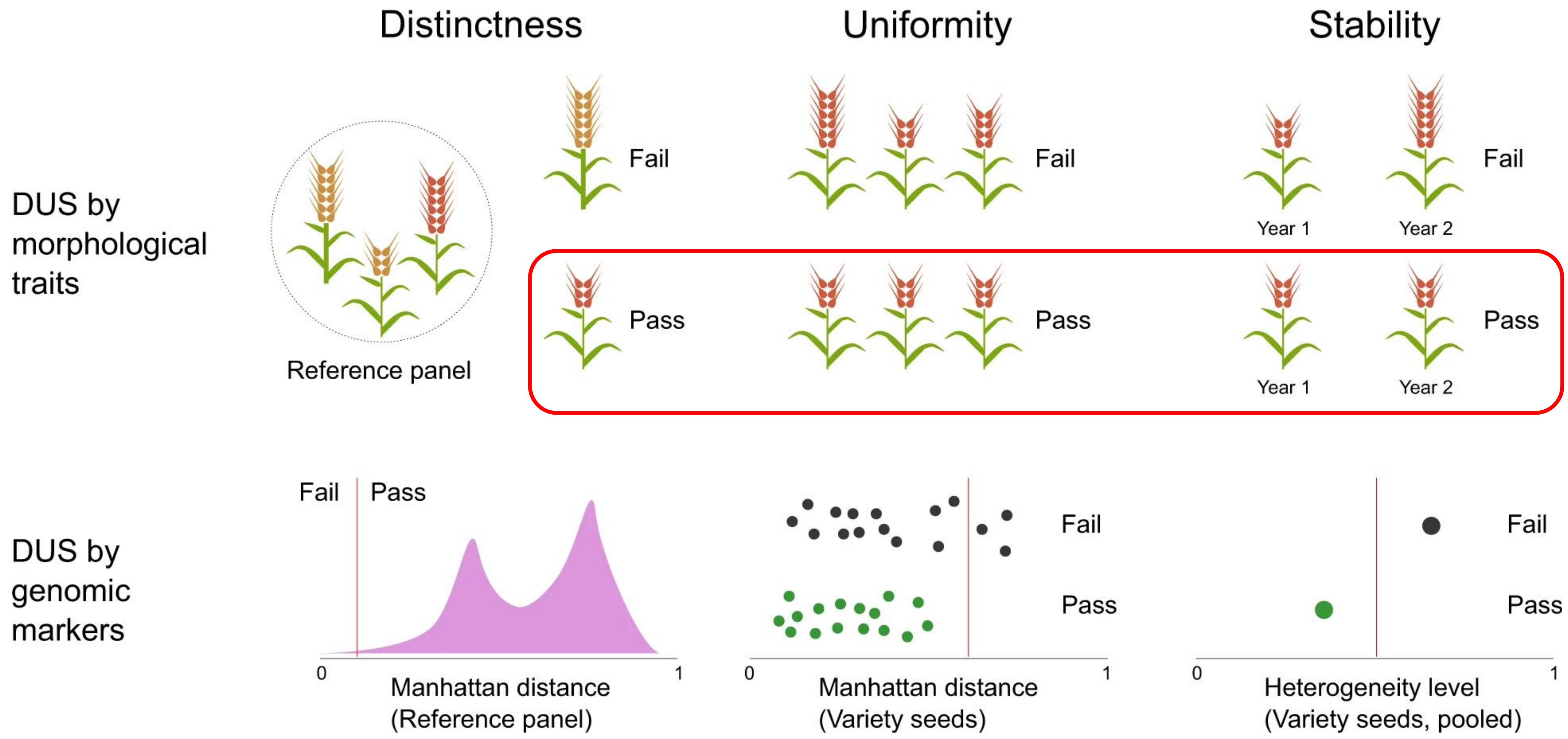
Outlines

- Introduction
- DH breeding in maize
- Induction gene-based DH breeding in multicrops
- Summary

PartI　　Introduction



For protection of variety's right in main crops, genetic homozygous lines are essential for DUS test.

Yang *et al*. 2021

Hybrid crops

Ye478
Female Parent

Yedan13
Hybrid

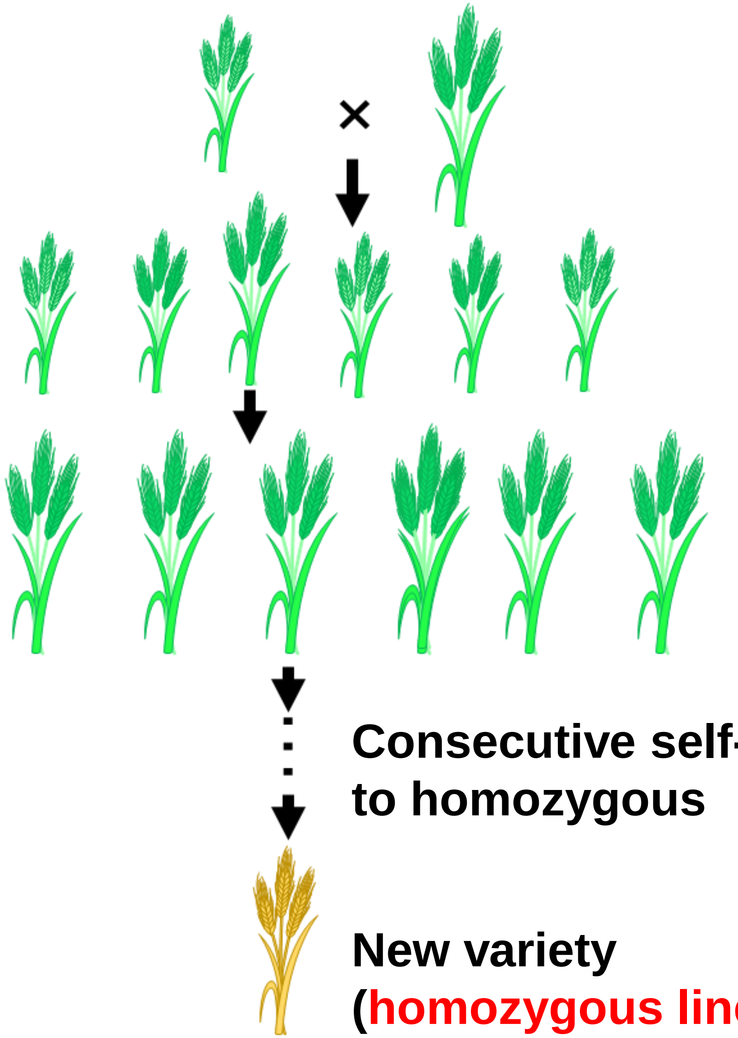
Dan340
Male Parent

Breeding of hybrid vatiety in maize needs male and female homozygous parent inbred lines

Non-hybrid crops

Rice

Wheat

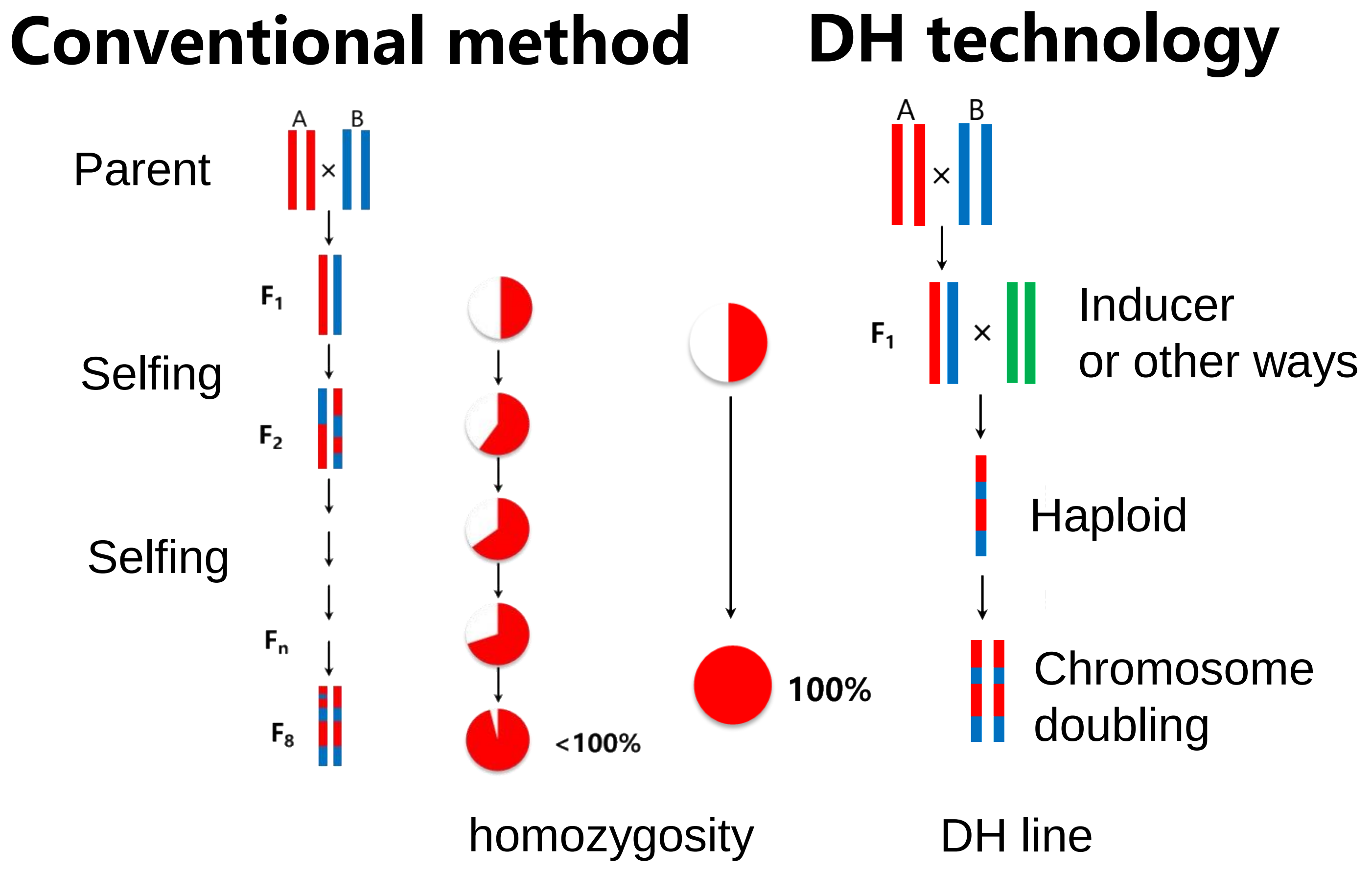


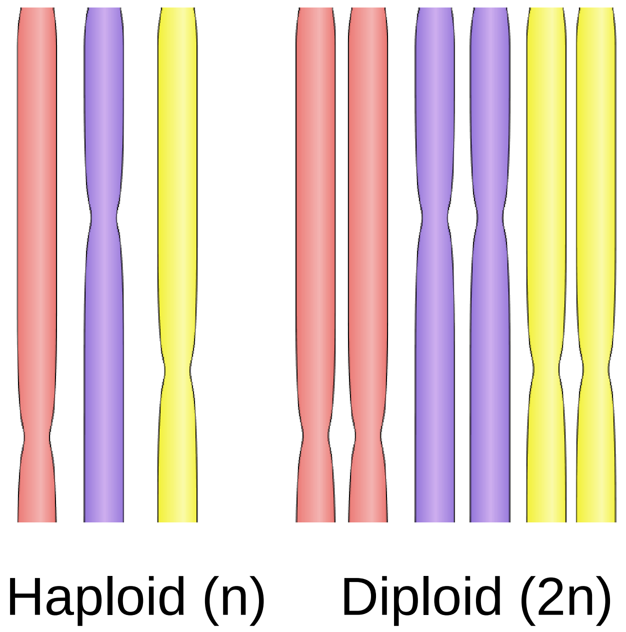
Consecutive self-pollination till to homozygous

New variety (homozygous line)

For non-hybrid crops, it needs to be self-pollinated generations to obtain homozygous lines for conventional variety

How to develop homozygous lines in breeding



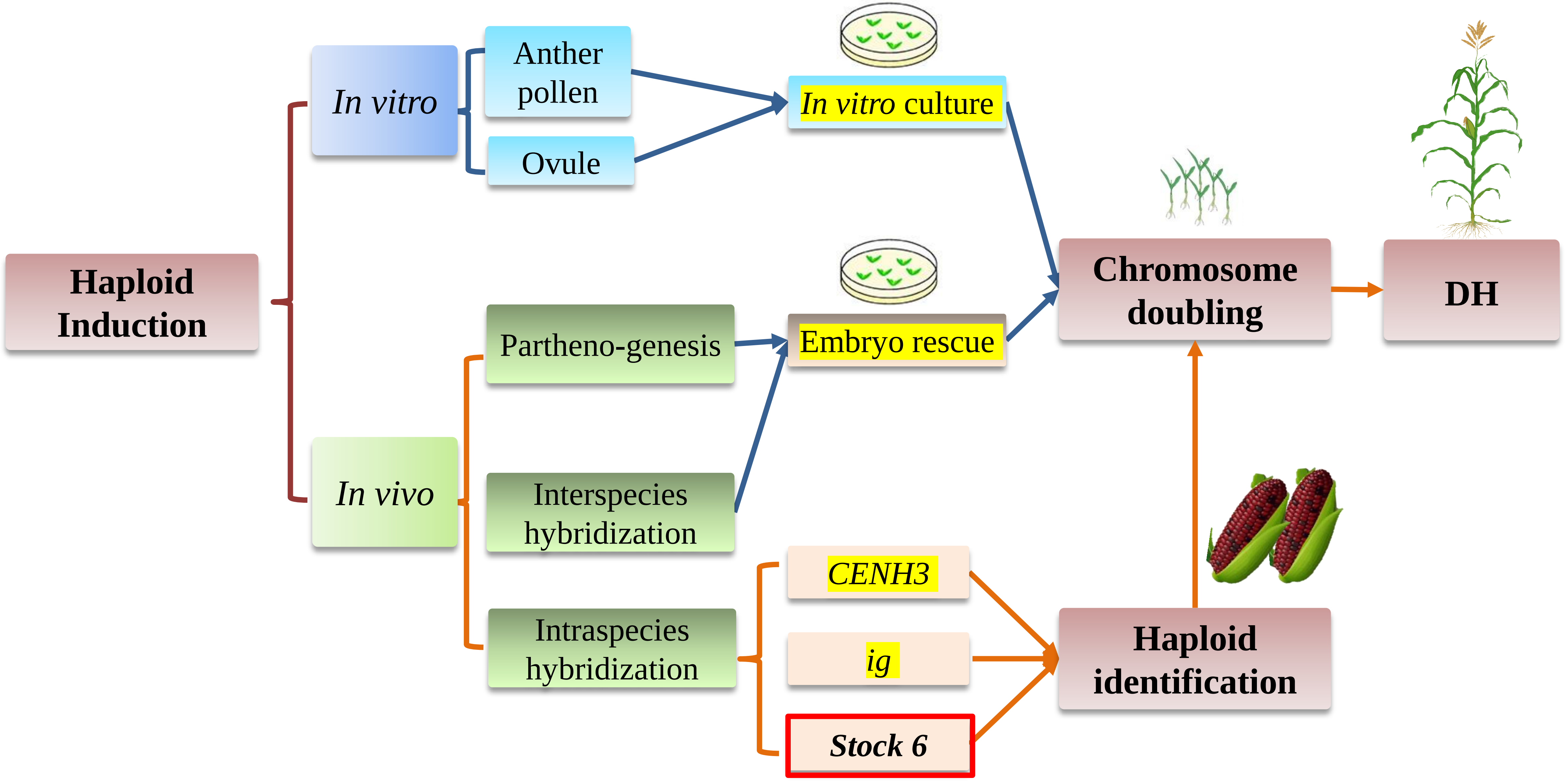


1.Tradition way needs continious selfing about 8 or more generations

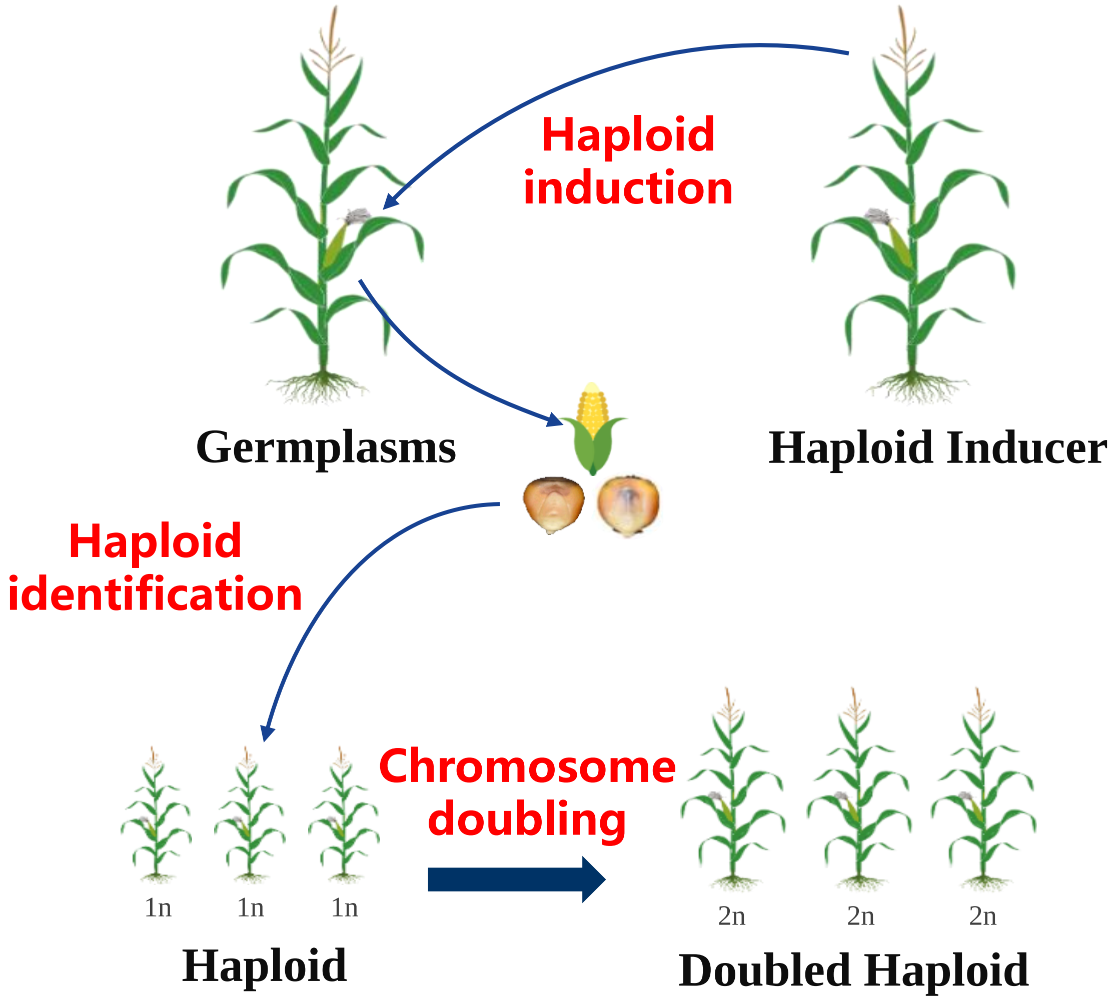
2. DH way can achieve the homzygous lines in only 2 generations via haploid and chromosome doubling.

-----Accelerating breeding cycle

The haploid generation pathways in plants



Part II DH technology system in maize (*in vivo*)



Advantages

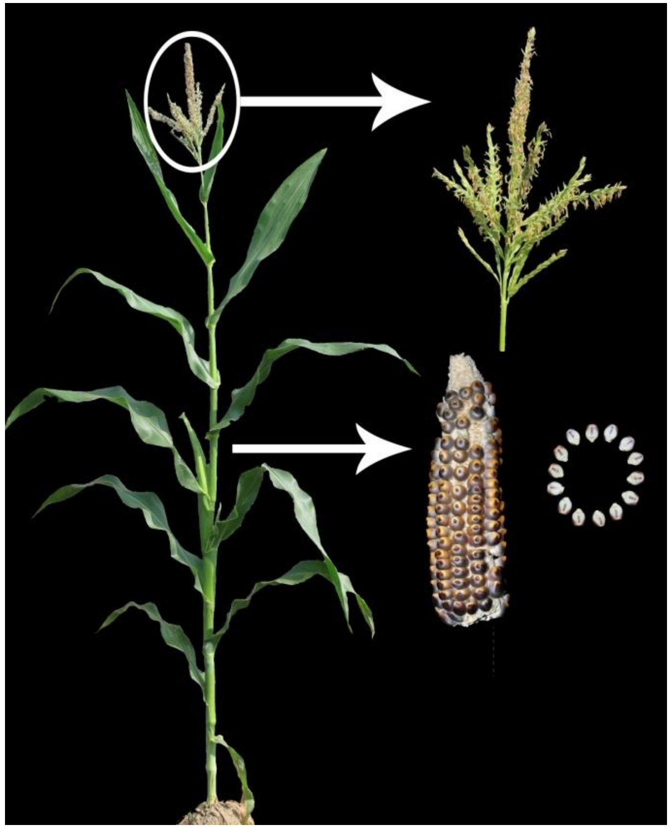
- Maternal origin
- genotype-independent
- Easy operation
- High efficiency
- High homozygosity
- Accurate phenotypic evaluation

Key progress1: High induction rate haploid inducers

Regular inducer

Induction rate~>10%

High-oil inducer



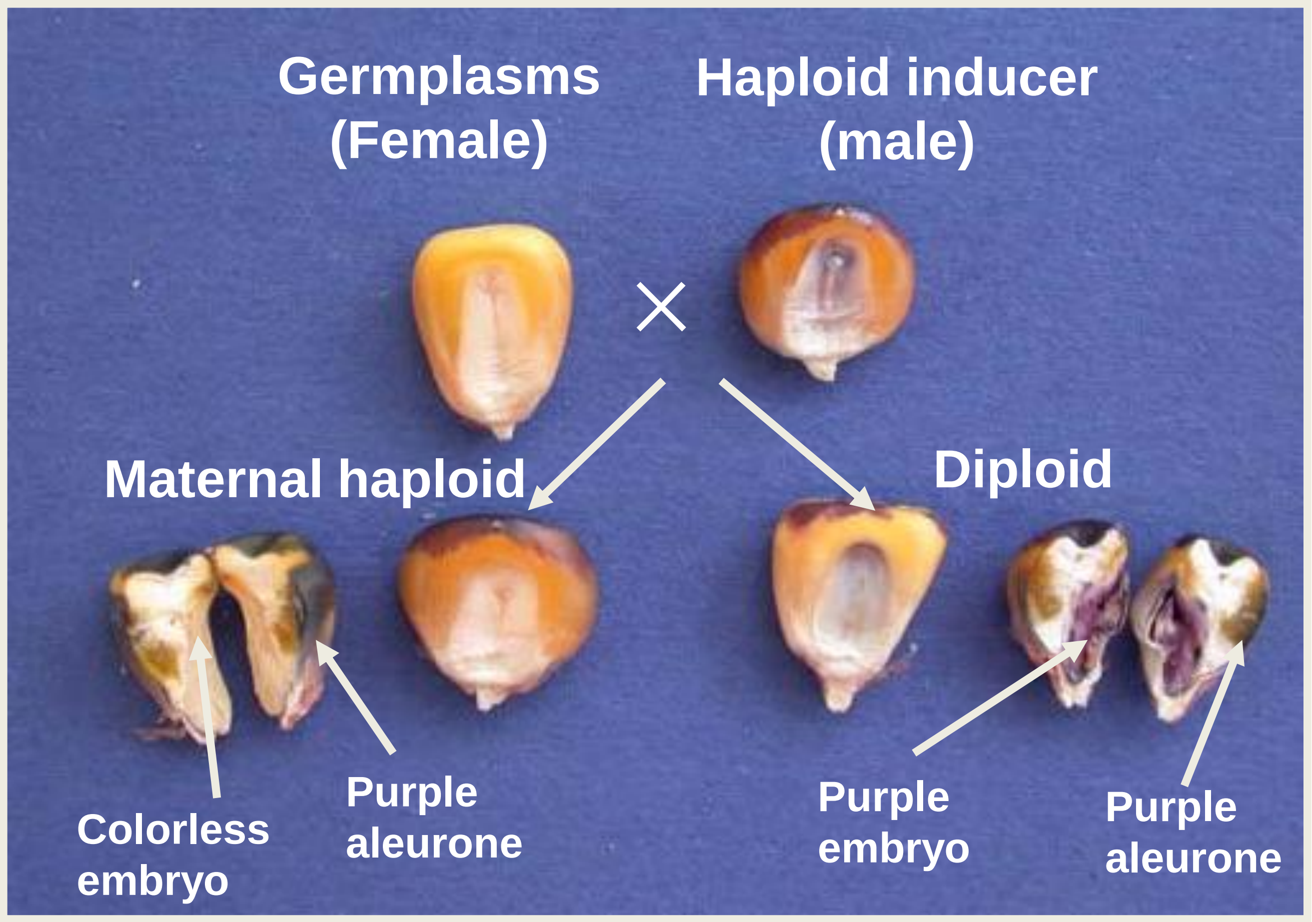
Induction rate~8-10%

kernel oil content~8-10%

Inducers as male parent can trigger maternal haploid in large scale in different breeding germplasms

Key progress2: High efficency identification systems

Haploid Diploid



R-nj color system, Sarkar and Coe, 1966

Kernel oil marker and automatic screening system

Common kernel and High-oil kernel

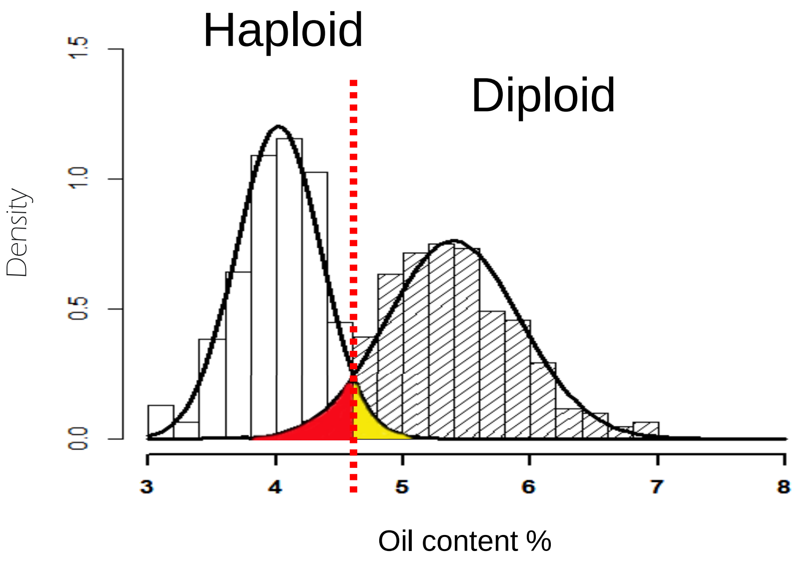
KOC~4%

KOC~8%

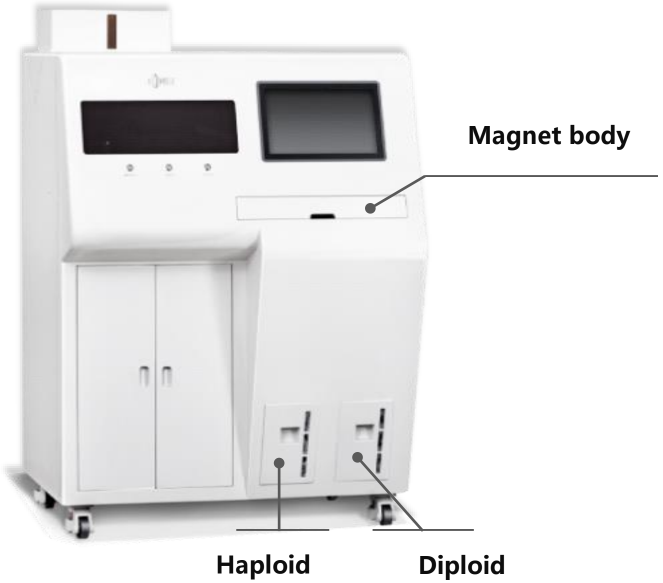
Haploid
(KOC~3-4%)

Diploid
(KOC~5-6%)

High-oil inducer (KOC >8%)



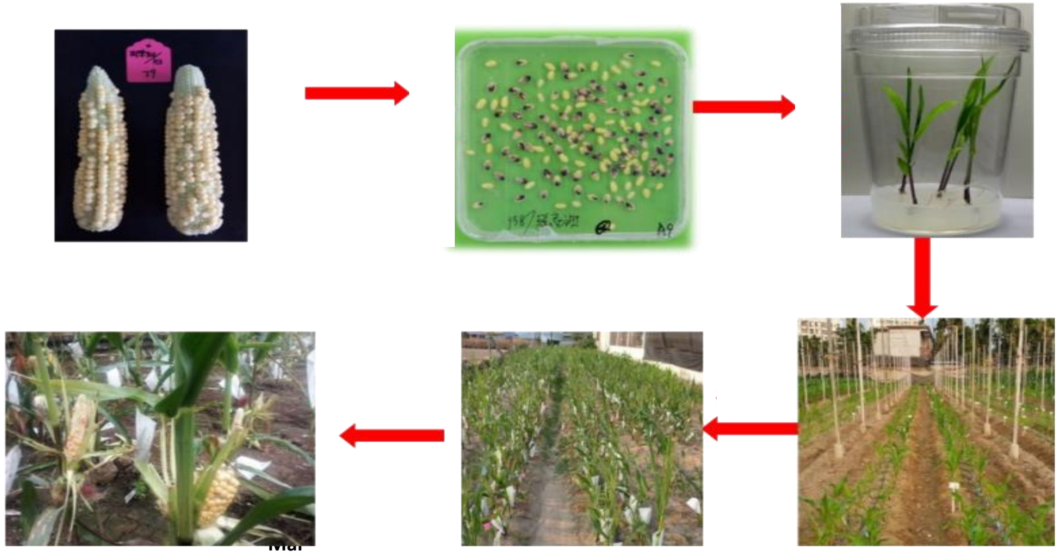
The automatic haploid screening system

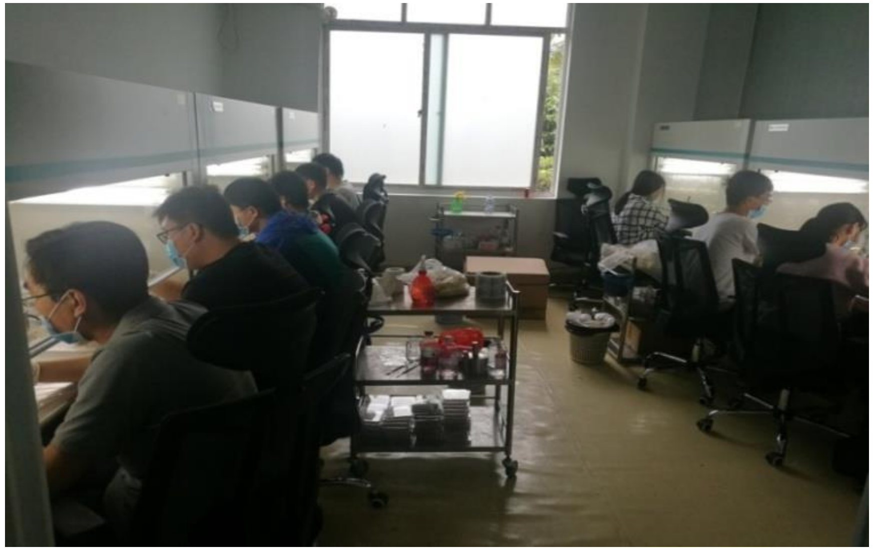


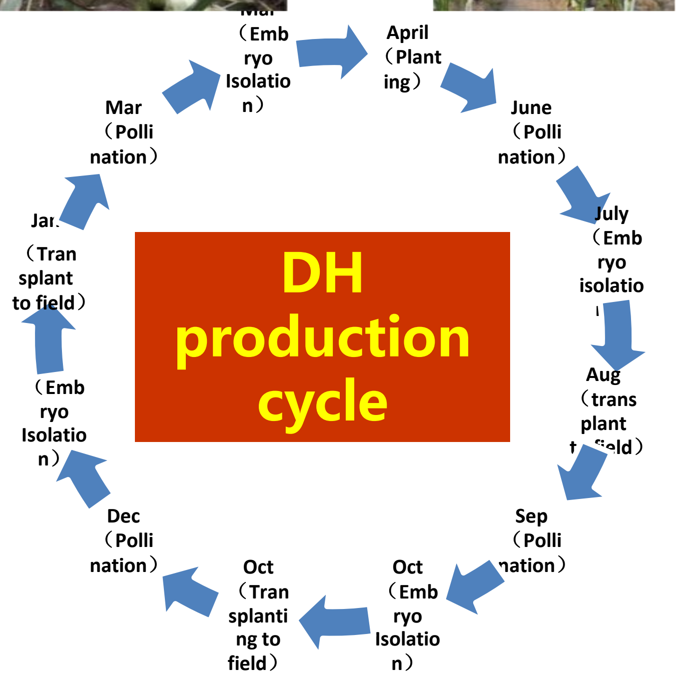
accuracy >90%

With high oil haploid inducers, haploids can be screened by automatic system based on the oil content in the crossed seeds.

Key progress 3:   Large-scale DH line production







DH technology in commercial maize breeding

1. Seed companies using DH technology

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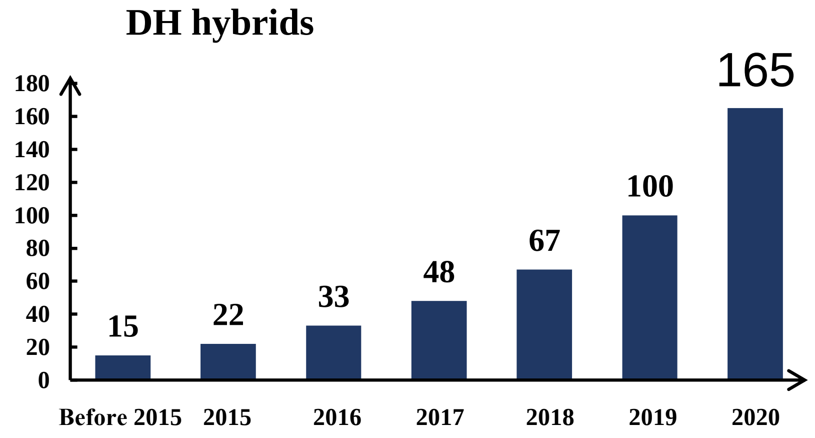
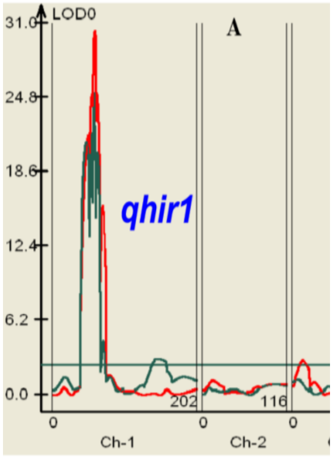
2. DH service

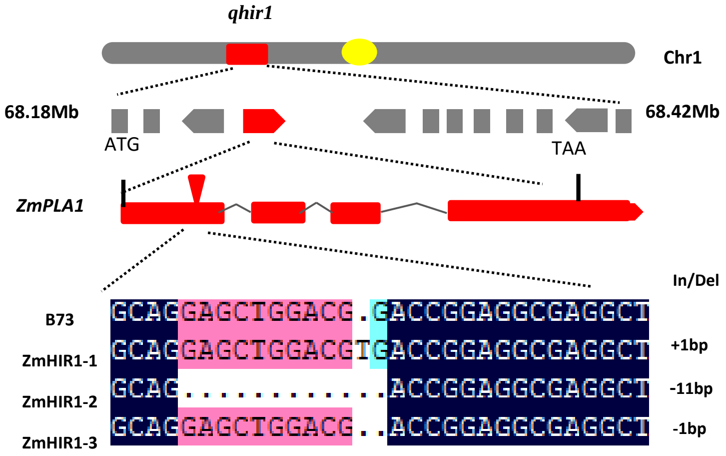
…… ……



DH technology has been successfully used in large scale and hybrids from DH lines have replaced the traditional ones rapidly in maize breeding over the past decades.

Key progress 4: Cloning of induction genes

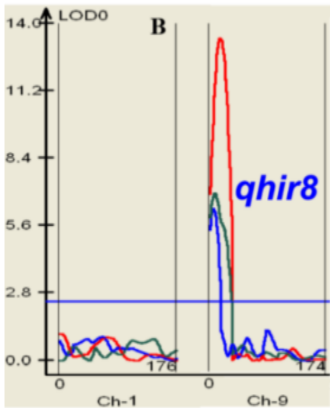


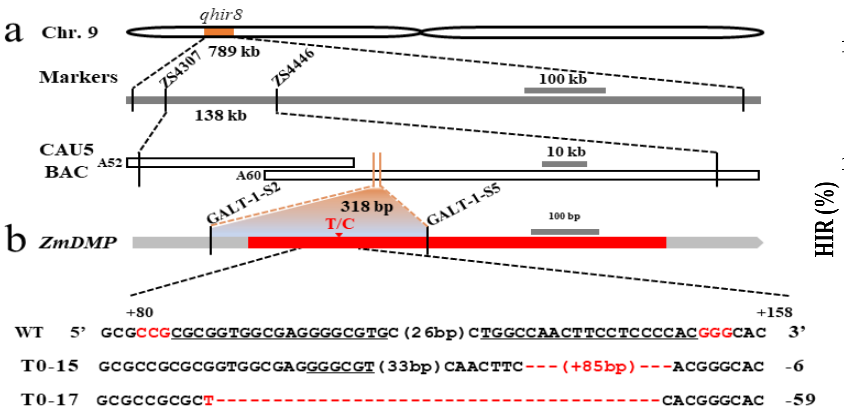


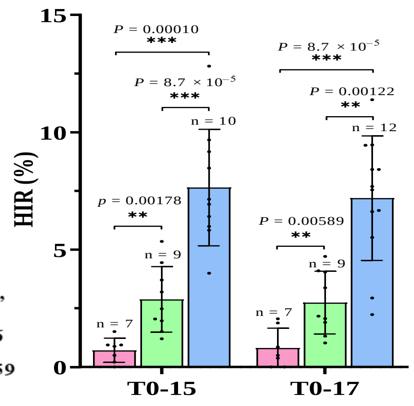
ZmPLA1

Contributes to about 90% of HIR

ZmDMP





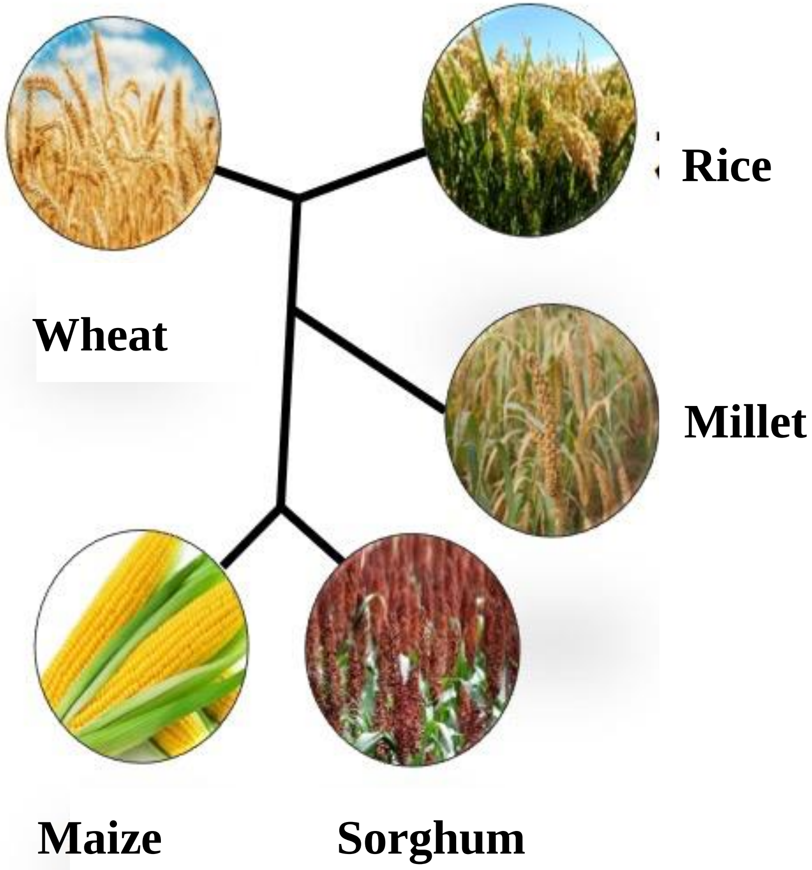


Liu *et al*.2017； Zhong *et al*. 2019

The finding above confirmed that the system is actually "Induction gene-based DH system"

Part III Induction gene-based DH technology in multicrops

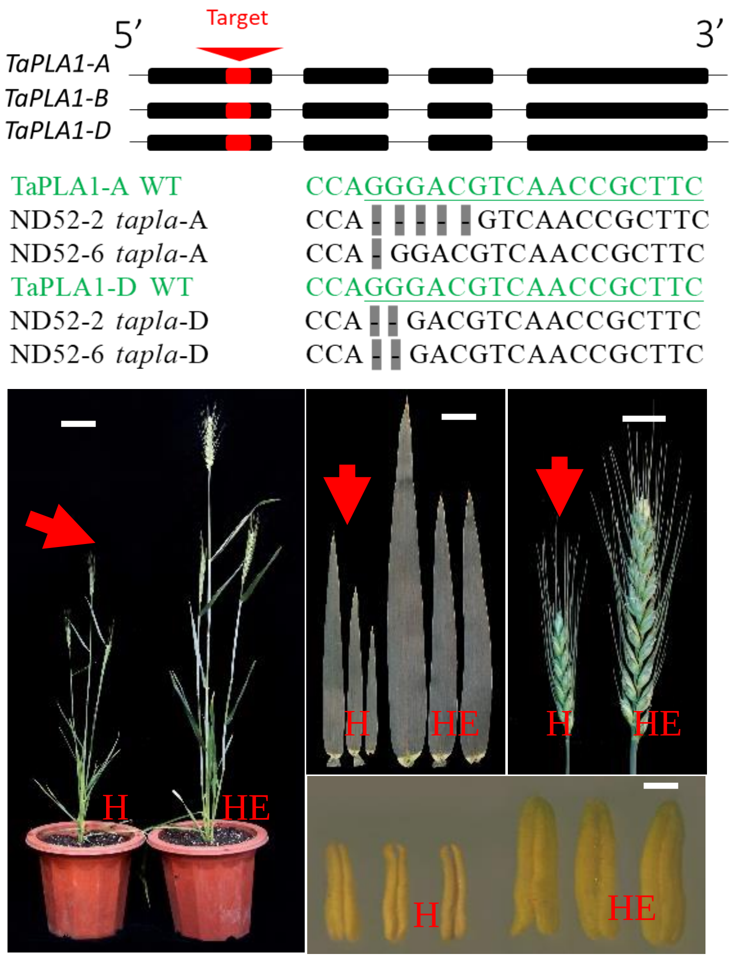
MTL/PLA1/NLD -based DH system in cereal crops



Crops		Amino acid sequence identity (%)
Sorghum		90.39
Millet	√	84.32
Indica rice	√	77.05
Wheat	√	76.78
Japonica	√	76.16

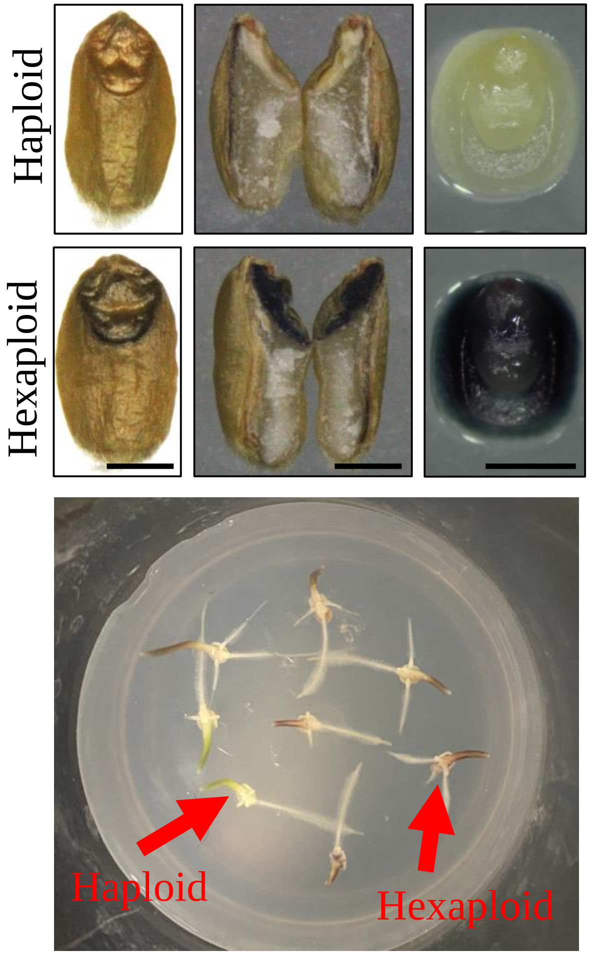
The induction gene has homologous gene in different monocot cereal crops like wheat etc.

MTL/PLA/NLD-based DH system in wheat



Wheat haploid induction

HIR ~ 10-20%



Haploid identification

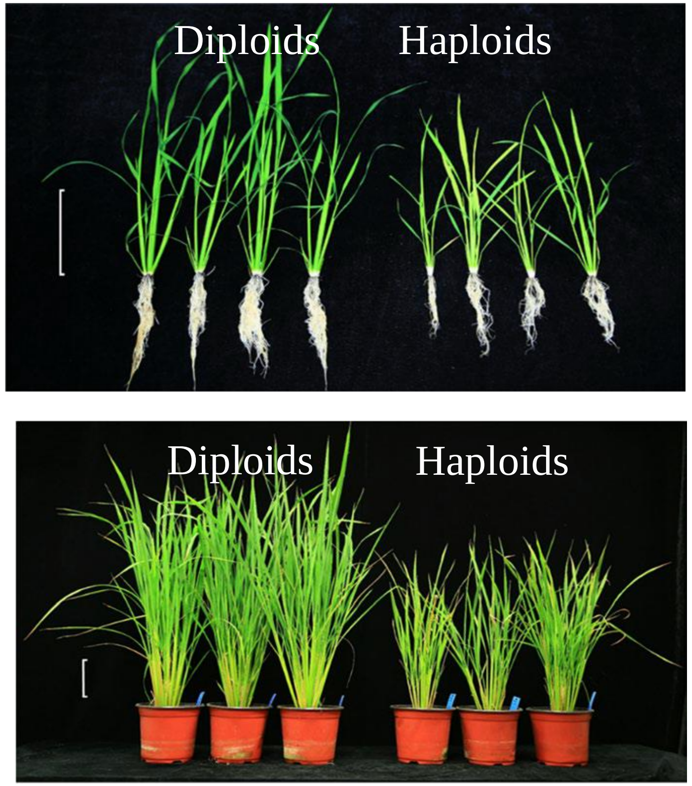
Accuracy ~ 97.7%

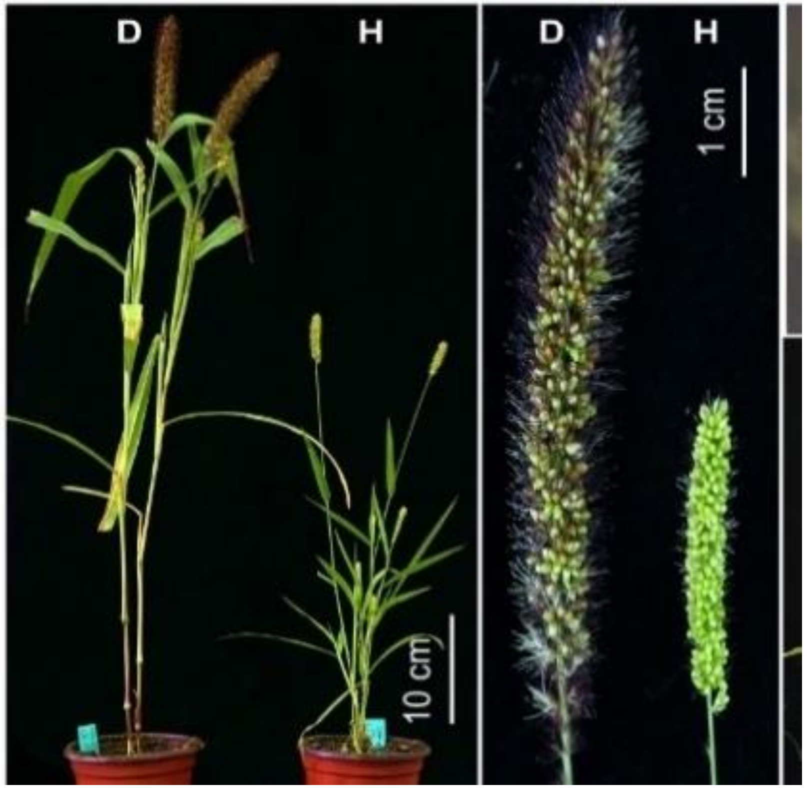
Chromosome doubling

Doubling rate > 90%

Liu *et al*., 2019
Qi *et al*., 2023

MTL/PLA1/NLD-based haploid induction in rice and millet





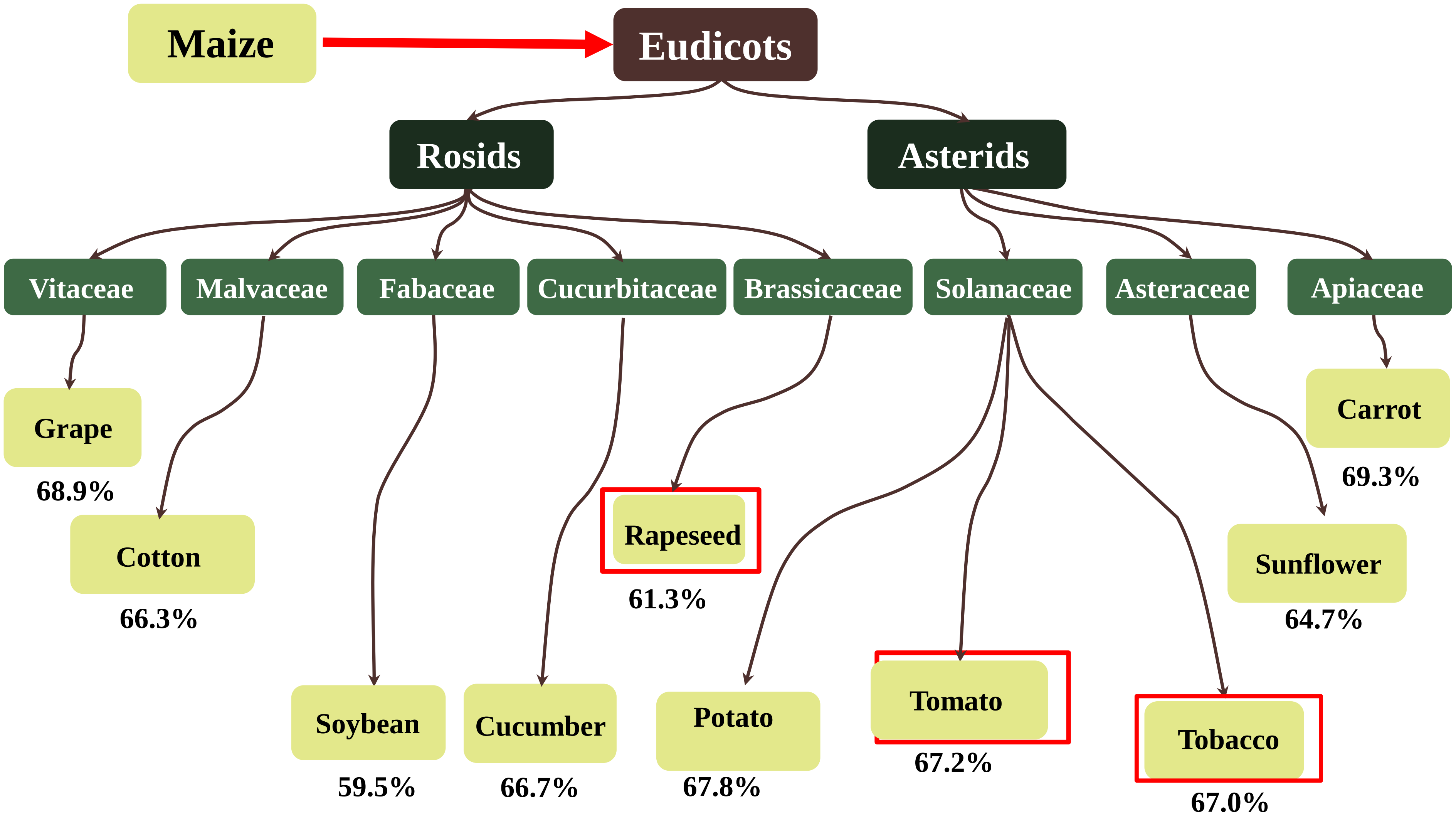
Rice
HIR ～ 2-6%

Foxtail millet
HIR ～ 2.8%

Yao *et al*., 2018

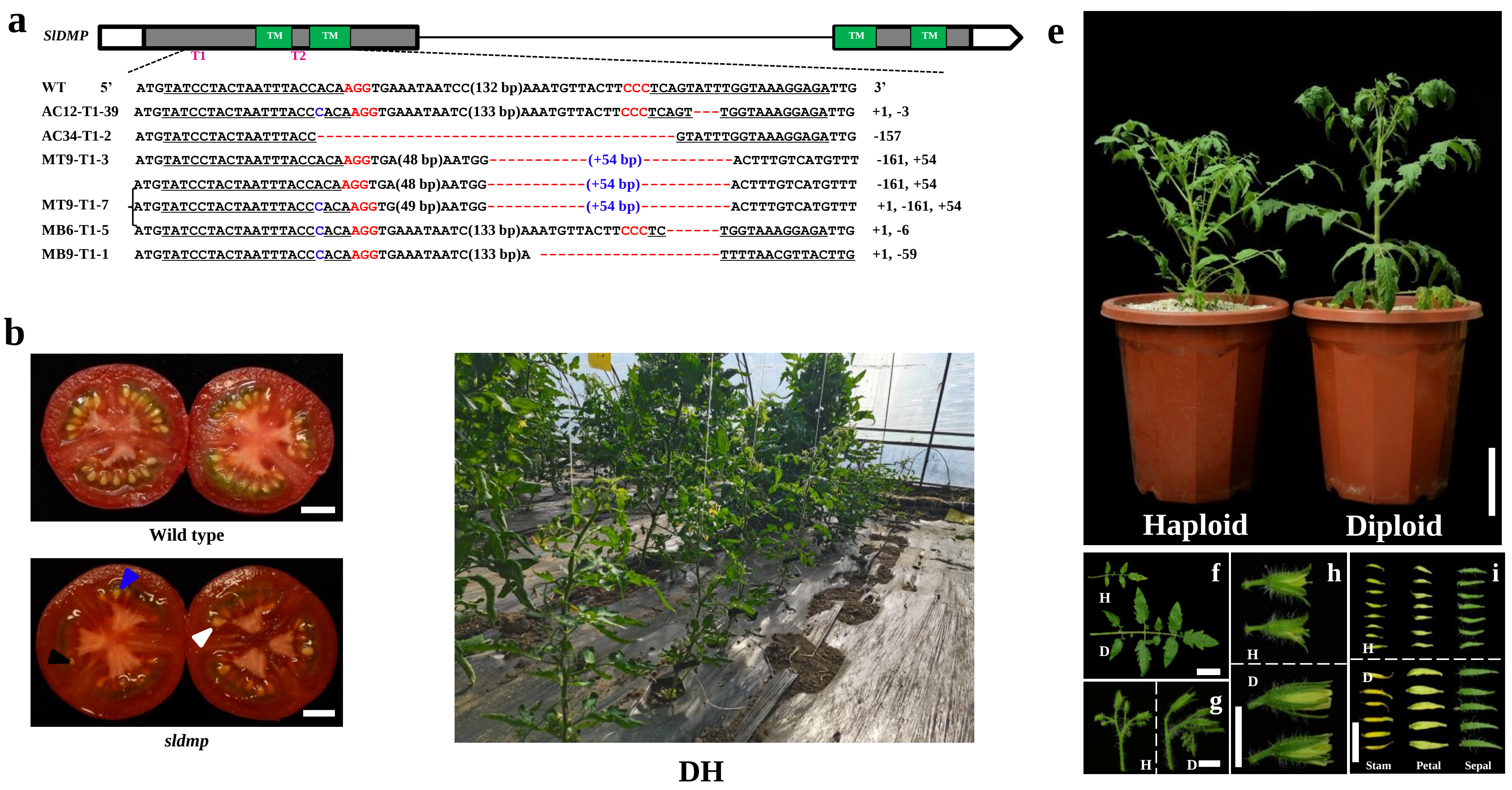
Cheng *et al*., 2021

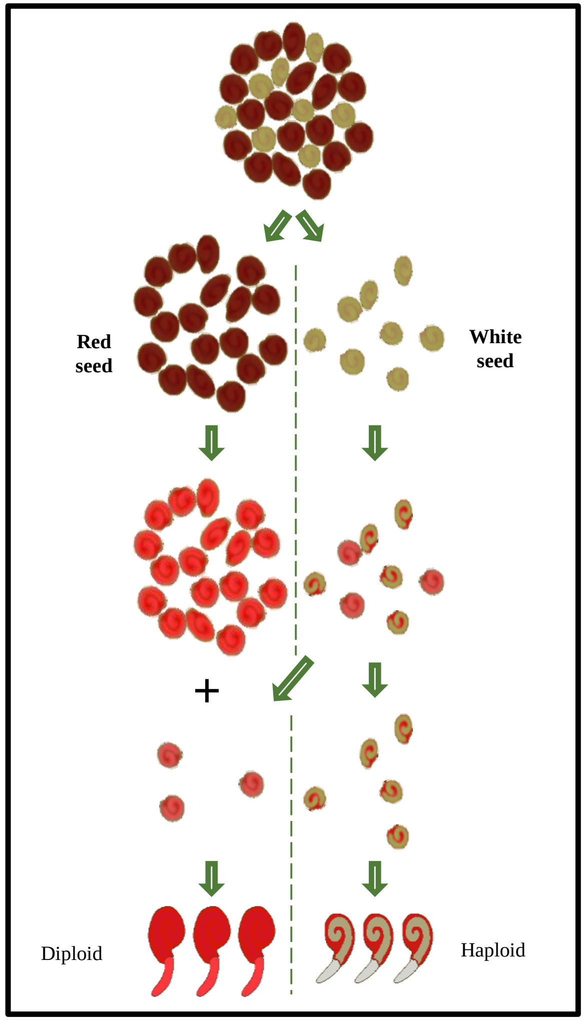
DMP-based DH system in dicot crops



Species with *DMP* gene amino acid sequence identity higher than 60%.

DMP-based DH system in tomato





Female parent	Male parent	Seed setting rate (%)	Total seeds	Haploids	HIR (%)
39 different genotypes	AC-*dmp*	24.70	29,397	509	1.94 ± 0.74

Zhong et al., 2021

DMP-based haploid induction in rapeseed and tobacco

Arabidopsis

HIR ~ 2.2%

Rapeseed

HIR ~ 2.6%

Tobacco

HIR ~ 1.1%

Zhong *et al*. 2020, 2022

Part IV Summary

1. The induction gene-based DH breeding system has obvious advantages and has been successfully used in maize.

2. The DH system has confirmed effective in multicrops and pave the way to accelerate practical breeding.

3. The high homozygosity of DH lines is beneficial for the protection of variety right.


Thank You