MASTER PROJECT, based on a cooperation of Profs. Beissinger and Link

# Assessment of heritability in elite German maize: single-plant *versus* plot-based data, homogeneous *versus* heterogeneous stands
# Here: WL-excerpt of few slides

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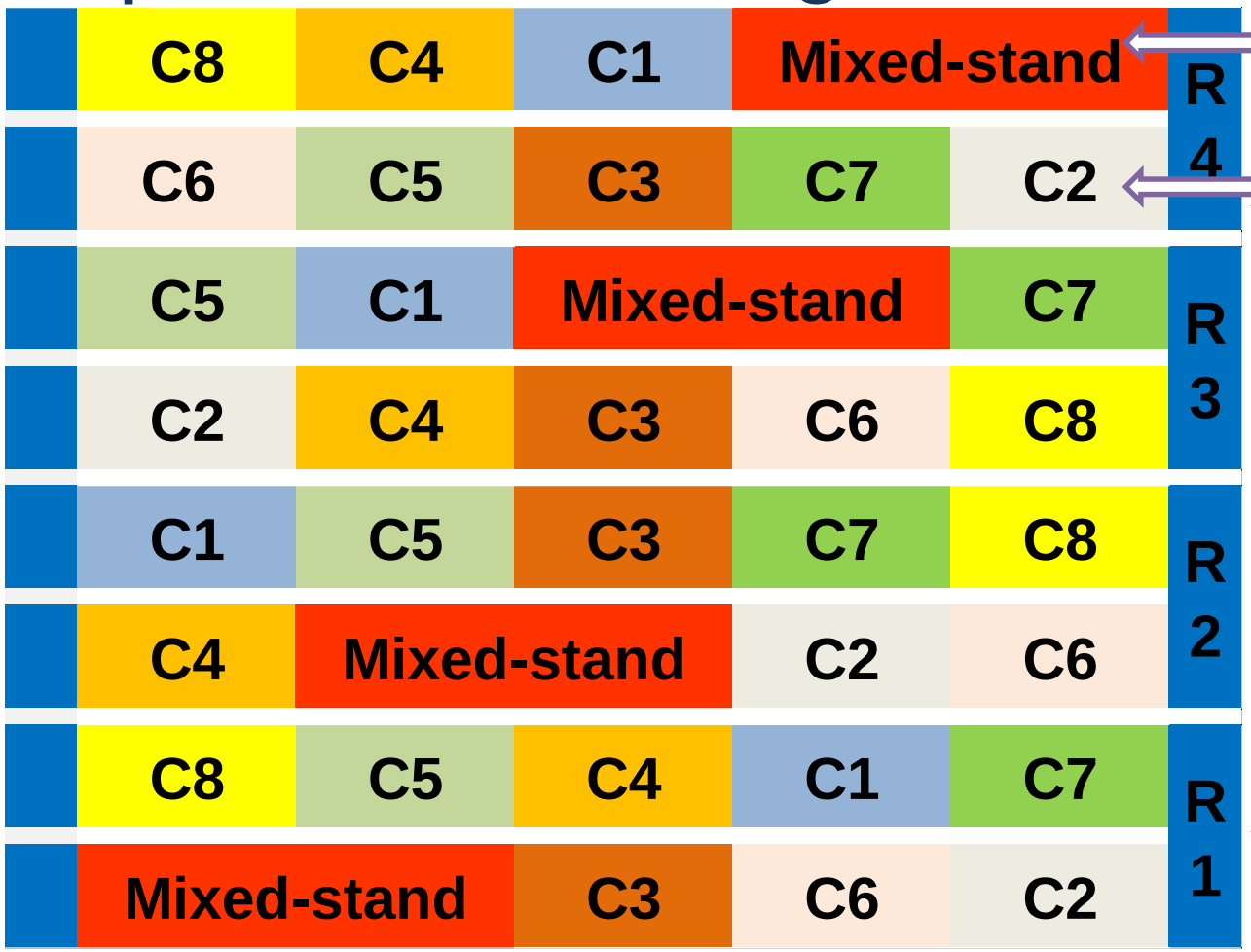
11.01.2022

# Experimental Design




**Crop stand: plot type**

**One “mixed-stand” plot – 12 rows**

**Eight “pure-stand” plots – 6 rows**

**(2 border rows)**

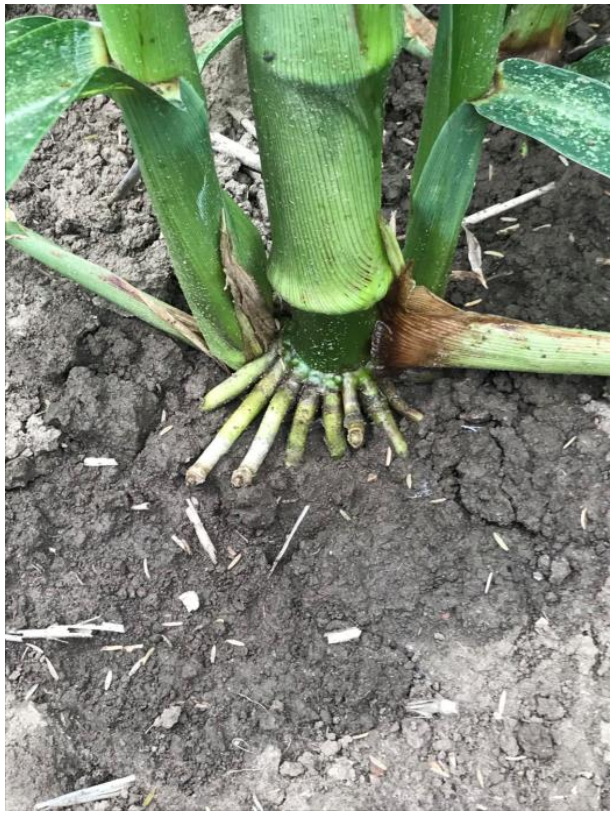
**Four replicates**

# Method and Materials

In the mixed stands, the genotype identity of each plant was visually detected based on “Registermerkmale”

**Amadeo (M2)**

**SY Telias (M2)**



**Dentrico (M2)**

**Claudinio(M2)**

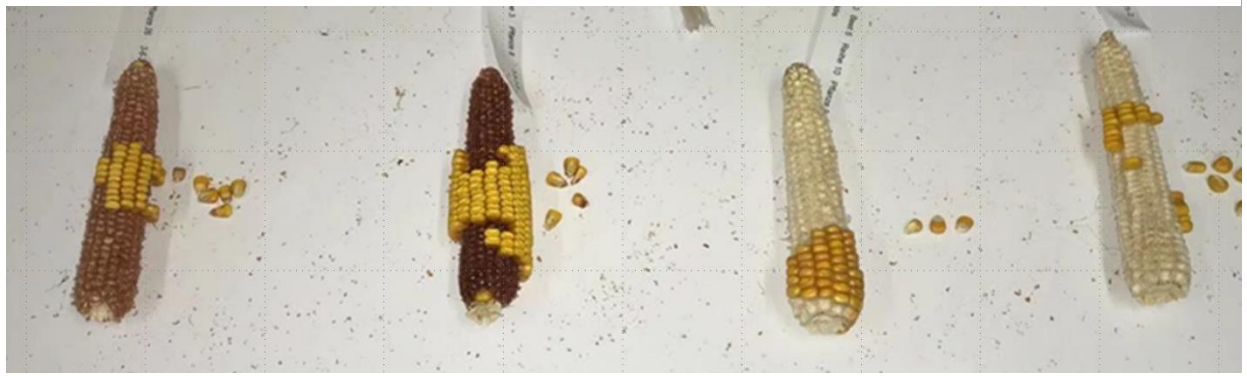
# Method and Materials

Color of silk

Color of anther

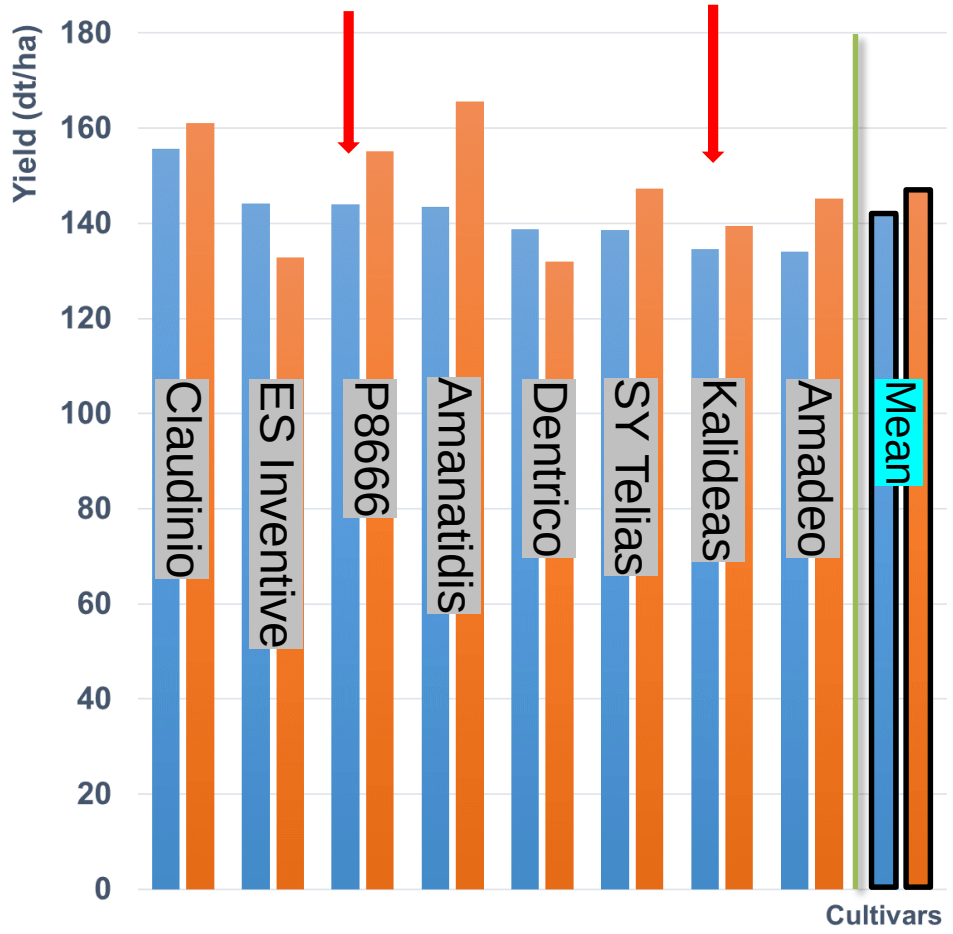
Bending angle of side tassels

Color of female glume after drying



# Results

## Yield data description: mean value of each cultivar (dt/ha)

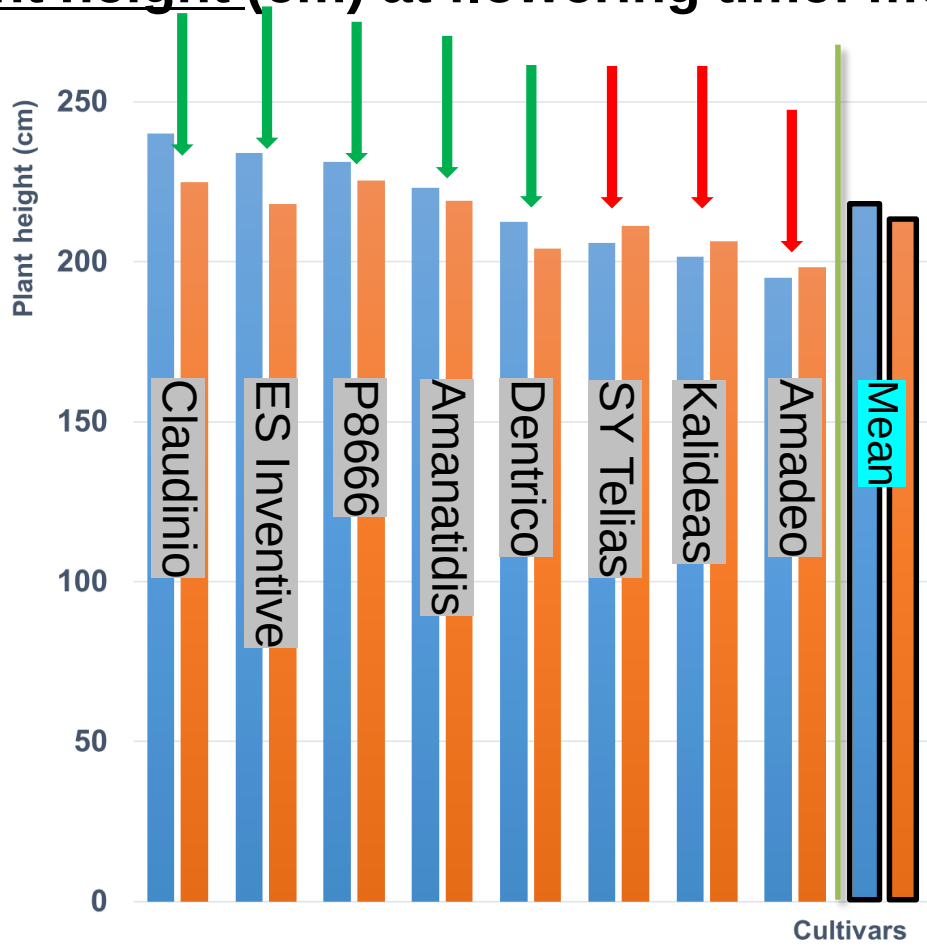



Pure-stand LSD = 8.40 (P = 0.05)

Mixed-stand LSD = 7.37 (P = 0.05)

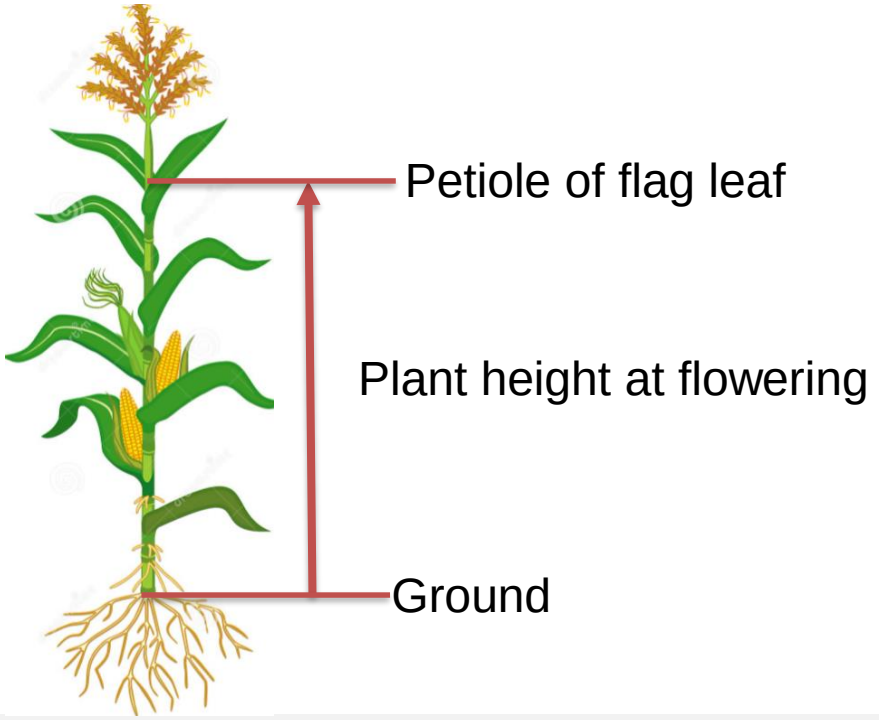
# Results

**Plant height (cm) at flowering time: mean value of each cultivar**




Pure-stand LSD = 7.50 (P = 0.05)

Mixed-stand LSD = 6.14 (P = 0.05)



# Results

## ANOVA table and variance component for yield data

$\sigma^2_{G(sum)} = \sigma^2_G + \sigma^2_{GL} + \sigma^2_{GY} + \sigma^2_{GLY}$

| Plot type | Source | DF | SS | MS | Var.cp | F-value | Heritability (Repeatability) |
|---|---|---|---|---|---|---|---|
| Pure-stand | G | 7 | 154878 | 22125.47 | 36.63 | 4.07*** | 0.75 |
| | R | 3 | 93277 | 31092.46 | 28.15 | 5.72*** | |
| | G×R | 21 | 117736 | 5431.30 | 40.44 | 6.60*** | |
| | P: RG | 3637 | 2994189 | 823.26 | 823.26 | | |
| | Total | 3647 | | | | | |
| Mixed-stand | G | 7 | 183498 | 26214.10 | 147.09 | 17.02*** | 0.94 |
| | R | 3 | 65138 | 21712.58 | 60.13 | 14.10*** | |
| | G×R | 21 | 33383 | 1540.00 | 15.88 | 1.76** | |
| | P: RG | 1333 | 1165060 | 874.01 | 874.01 | | |
| | Total | 1343 | | | | | |

$h^2 = \sigma^2_G / \sigma^2_P$

Repeatability of my experiment

# Results

Plant Breeding **127**, 541—547 (2008)


Number of locations = 29
Number of years = 16
Number of replicates = 4

## Genotypic and environmental variability of yield for cultivars from 30 different crops in German official variety trials

F. LAIDIG, T. DROBEK and U. MEYER

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*With 1 figure and 5 tables*

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*Communicated by W. E. Weber*

(Laidig, Drobek, and Meyer 2008)

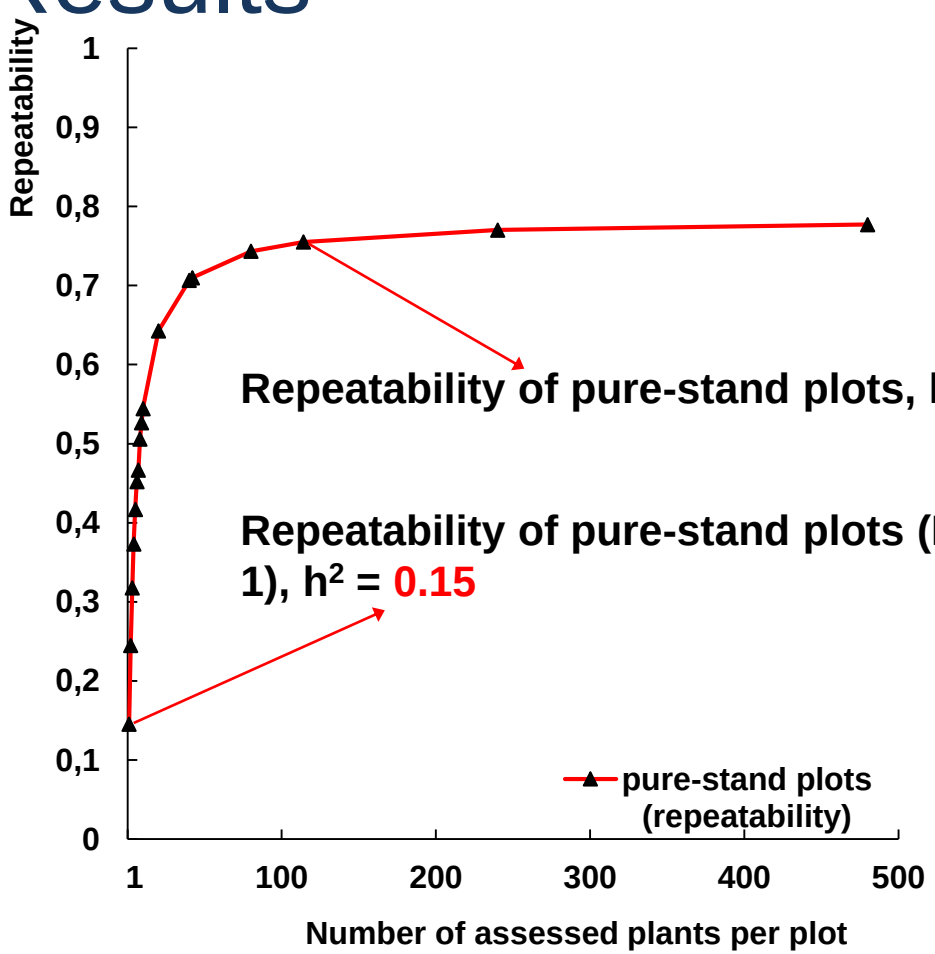
Table 3: Genotype, environmental and genotype by environmental components of variance for yield of crops from official German variety trials in the period 1991–2006

| | | Estimated components of variance (dt/ha) $^2$ | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Crop | Mean | *L* | *Y* | LY | *G* | GL | GY | GLY |
| Maize | | | | | | | | |
| Grain maize early | 109.0 ± 2.4 | 133.6 ± 26.9 | 22.3 ± 8.8 | 75.9 ± 23.5 | 19.6 ± 2.5 | 6.1 ± 2.0 | 5.1 ± 1.0 | 11.7 ± 1.8 |
| Grain maize medium | 110.7 ± 2.1 | 129.3 ± 33.6 | 33.0 ± 11.4 | 97.0 ± 20.9 | 19.7 ± 2.1 | 7.2 ± 1.4 | 4.2 ± 0.6 | 10.2 ± 1.7 |
| Grain maize late | 113.6 ± 2.5 | 158.8 ± 42.5 | 45.8 ± 29.8 | 82.7 ± 22.2 | 27.9 ± 4.3 | 10.7 ± 2.2 | 5.8 ± 1.4 | 10.8 ± 1.8 |
| Forage maize early | 181.5 ± 3.1 | 264.2 ± 81.1 | 94.6 ± 53.3 | 278.4 ± 113.7 | 38.7 ± 4.0 | 15.6 ± 4.6 | 8.6 ± 1.9 | 17.8 ± 3.9 |
| Forage maize medium | 190.9 ± 2.2 | 311.7 ± 52.4 | 70.0 ± 40.3 | 220.6 ± 54.8 | 41.5 ± 4.1 | 9.5 ± 3.4 | 8.0 ± 1.9 | 19.4 ± 3.6 |
| Forage maize late | 192.7 ± 2.9 | 300.5 ± 85.5 | 73.9 ± 26.1 | 280.8 ± 60.3 | 43.7 ± 6.6 | 12.7 ± 4.9 | 11.3 ± 3.2 | 25.4 ± 4.3 |

# Estimated repeatability (pure-stand plots and mixed-stand plots) of yield under the circumstance of different number of assessed plants per plot (number of replicates = 4)

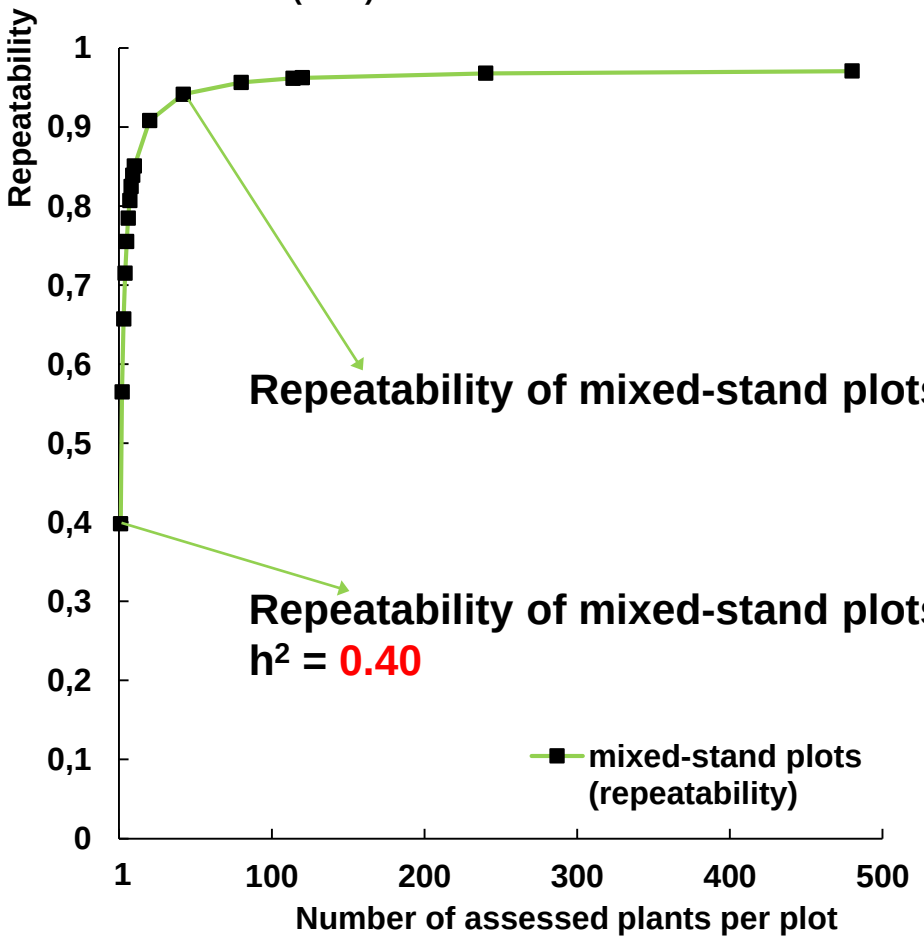
## Results

$h^2$(in the sense of repeatability) = $\sigma^2_{G(SUM)} / \sigma^2_P$




Repeatability of pure-stand plots, $h^2$ = 0.75

Repeatability of pure-stand plots (R = 4 P = 1), $h^2$ = 0.15



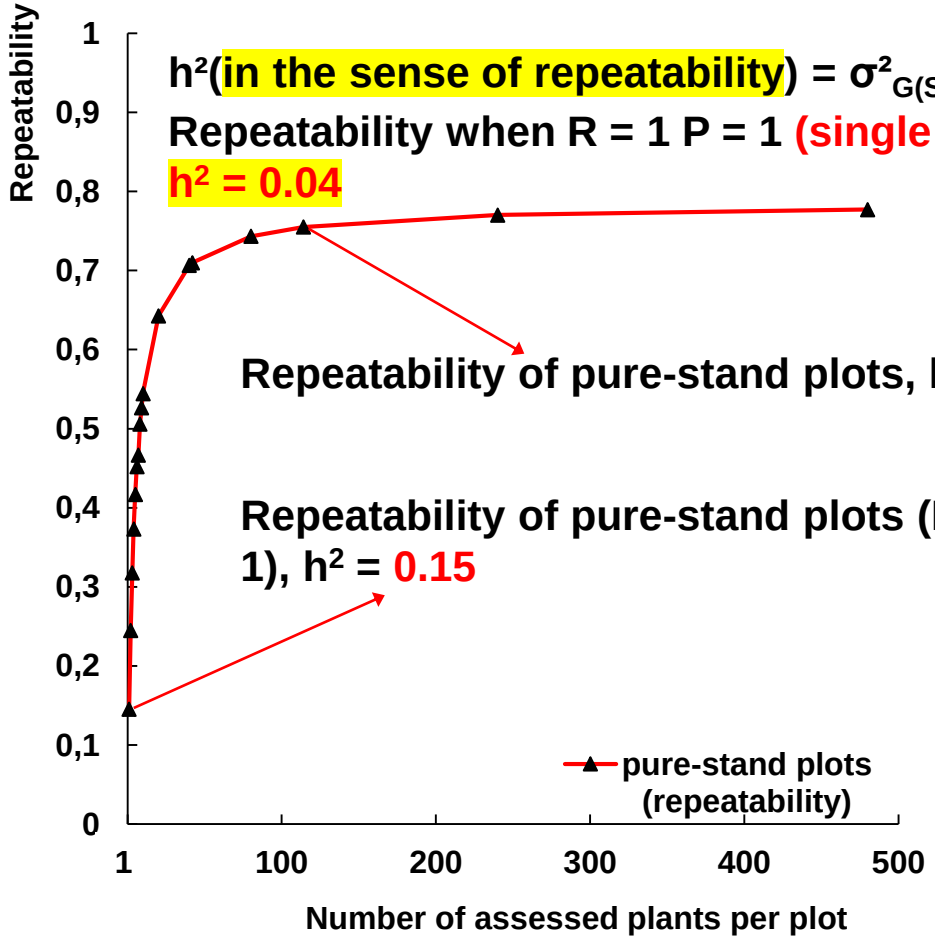

Repeatability of mixed-stand plots, $h^2$ = 0.94

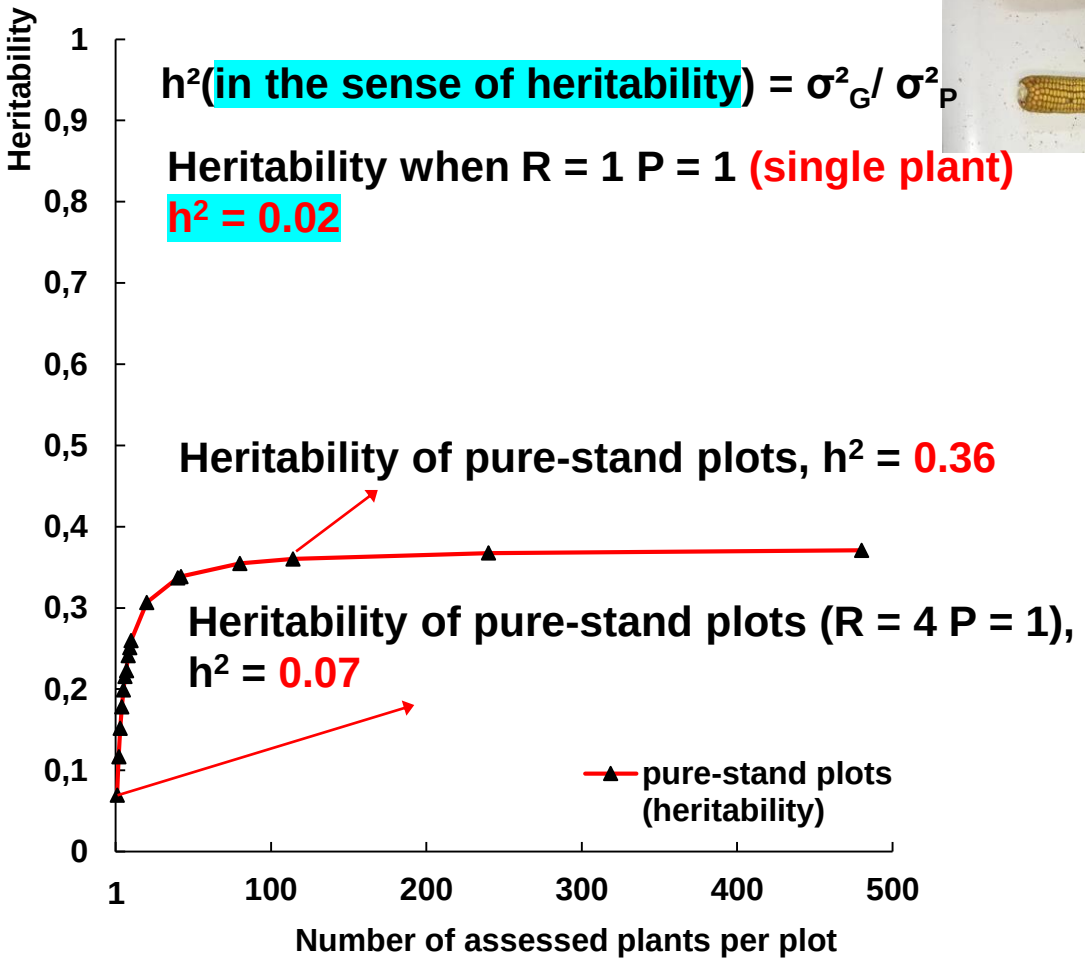
Repeatability of mixed-stand plots (R = 4 P = 1), $h^2$ = 0.40

$$\sigma^2_P = \sigma^2_{G(sum)} + (1/4)\sigma^2_{(RG)(LY)} + (1/4\underline{P})\,\sigma^2_{PR(GLY)}$$ (R=4; L = Y = 1)

# Estimated repeatability and heritability in pure-stand plots of yield under the circumstance of different number of assessed plants per plot (number of replicates = 4)

## Results

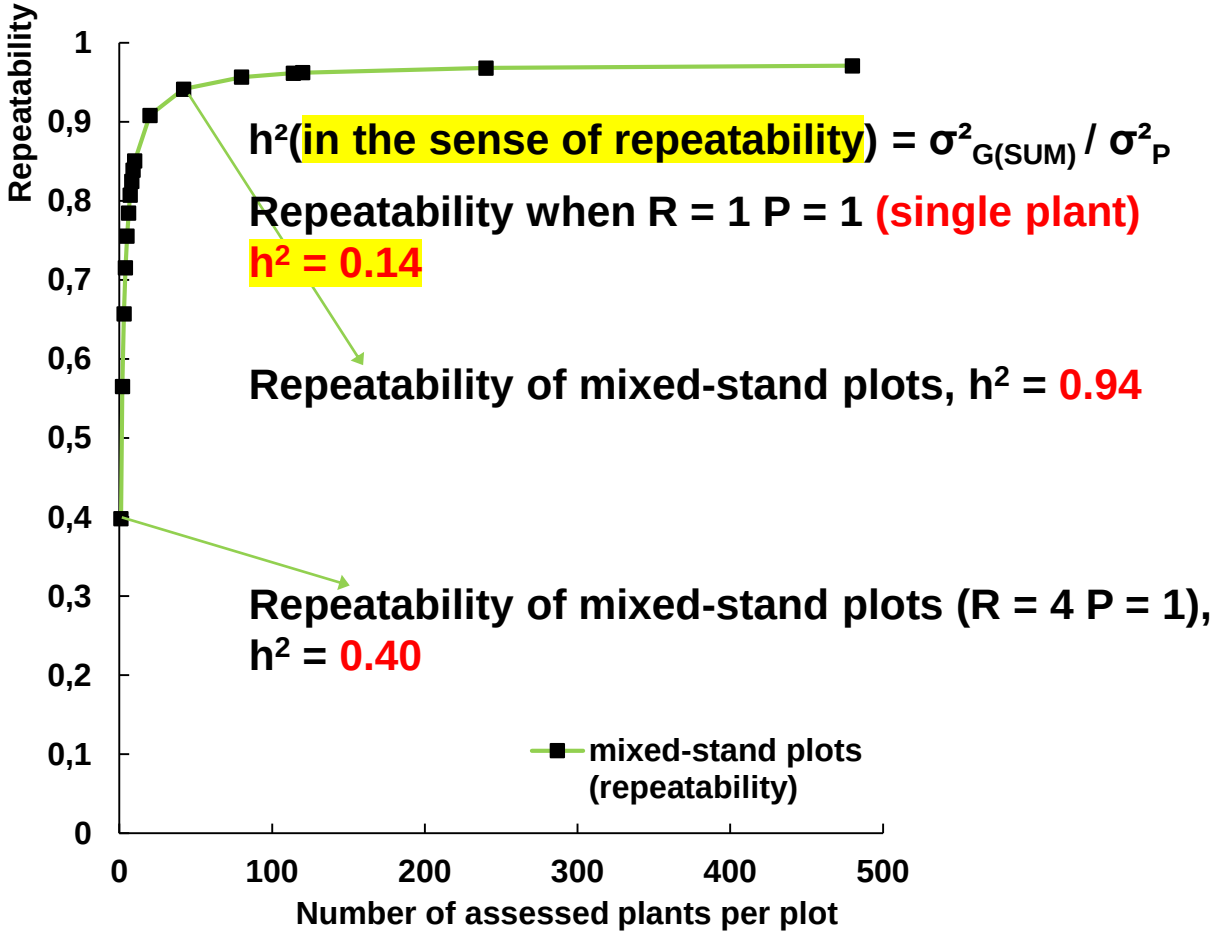



$$\sigma^2_P = \sigma^2_G + \sigma^2_{GL} + \sigma^2_{GY} + \sigma^2_{GLY} + (1/4)\sigma^2_{(RG)(LY)} + (1/4P)\,\sigma^2_{PR(GLY)}$$ (R=4; L = Y = 1)

# Estimated repeatability and heritability in mixed-stand plots of yield under the circumstance of different number of assessed plants per plot (number of replicates = 4)

## Results

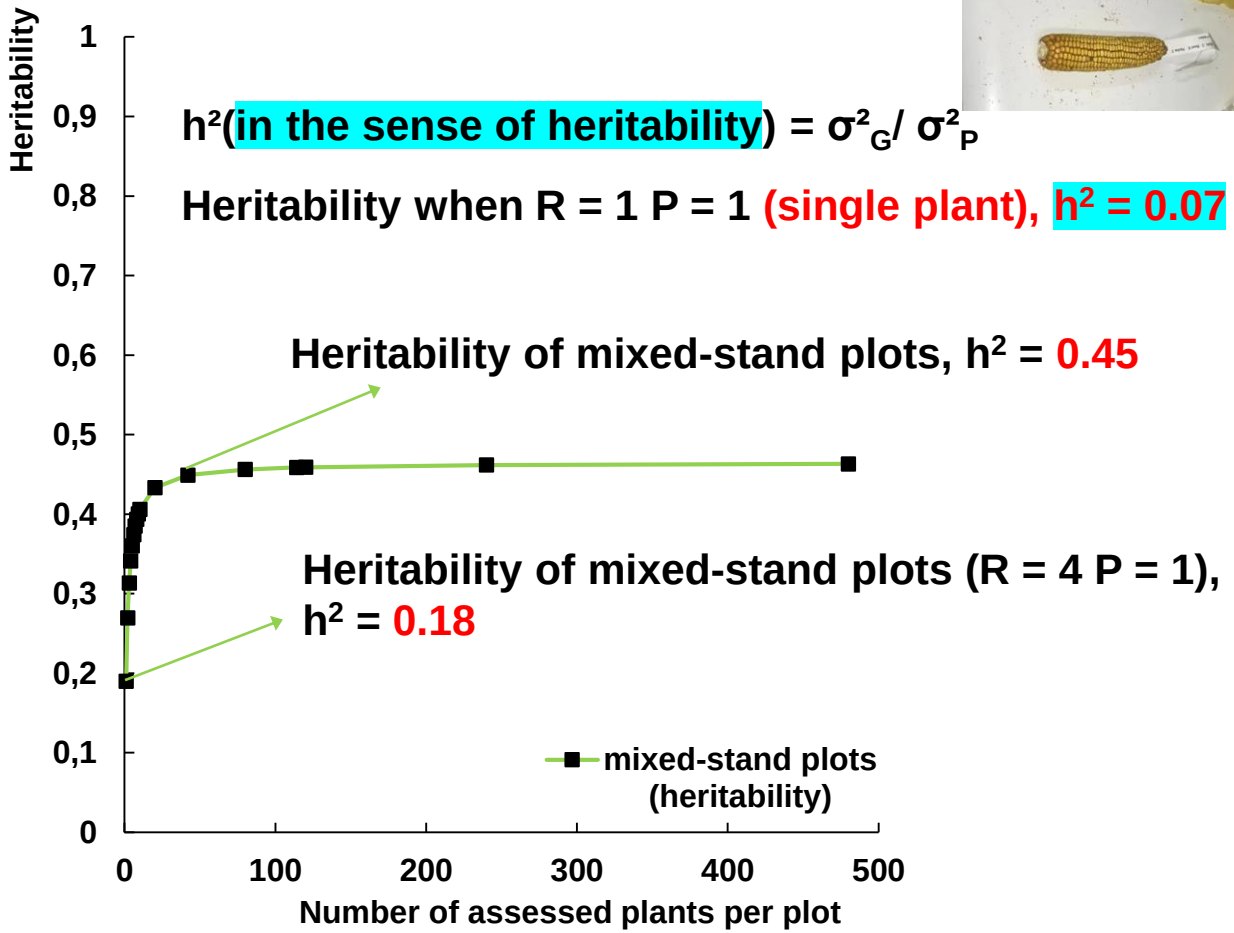



$h^2$(in the sense of repeatability) = $\sigma^2_{G(SUM)} / \sigma^2_P$

Repeatability when R = 1 P = 1 (single plant) $h^2 = 0.14$

Repeatability of mixed-stand plots, $h^2 = 0.94$

Repeatability of mixed-stand plots (R = 4 P = 1), $h^2 = 0.40$




$h^2$(in the sense of heritability) = $\sigma^2_G / \sigma^2_P$

Heritability when R = 1 P = 1 (single plant), $h^2 = 0.07$

Heritability of mixed-stand plots, $h^2 = 0.45$

Heritability of mixed-stand plots (R = 4 P = 1), $h^2 = 0.18$

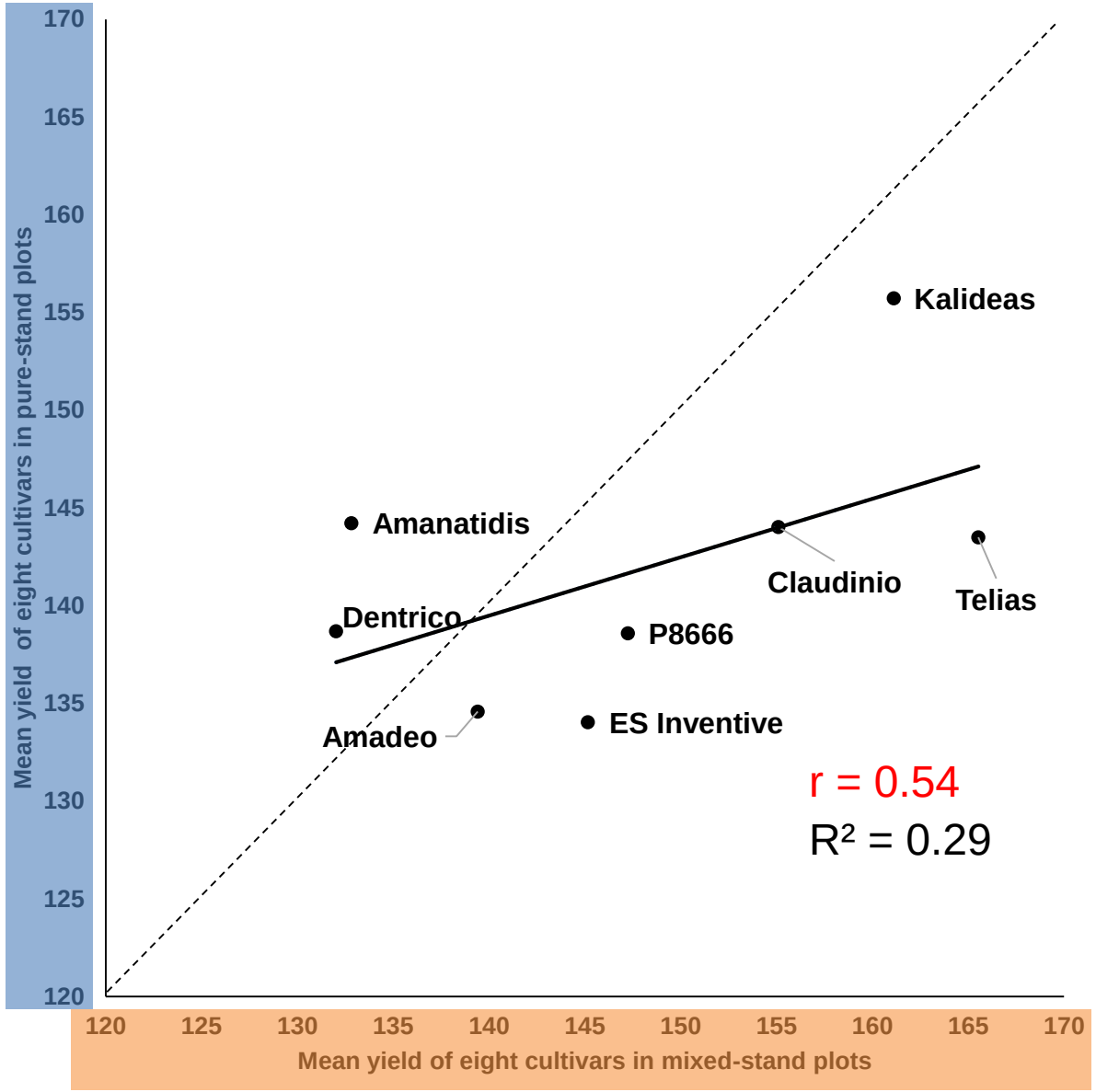
(R=4; L = Y = 1)

$$\sigma^2_P = \sigma^2_G + \sigma^2_{GL} + \sigma^2_{GY} + \sigma^2_{GLY} + (1/4)\sigma^2_{(RG)(LY)} + (1/4P)\,\sigma^2_{PR(GLY)}$$

$$\sigma^2_P = \sigma^2_G + \sigma^2_{GE}$$

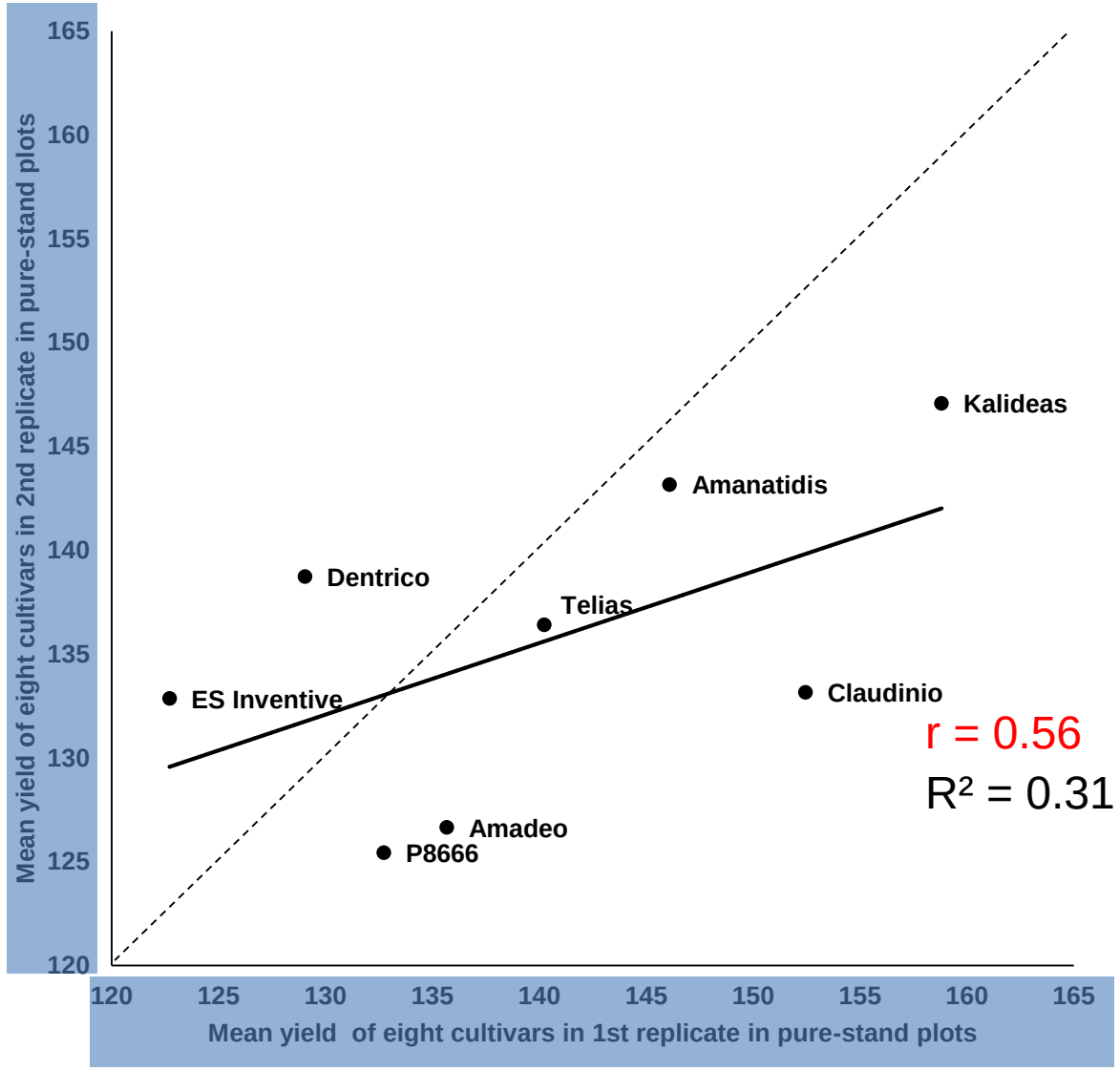
# Yield relationship in pure-stand plots and in mixed-stand plots (dt/ha)²

## Results



# Yield relationship in pure-stand plots between 1st and 2nd replicates

## Results




Mean of the correlations between single replicates in pure-stand plots: 0.45

Mean of the correlations between single replicates in mixed-stand plots: 0.84

Mean of the correlations between single replicates in pure-stand plots: and mixed-stand plots: 0.38