Drought tolerance (Cerrado)

Wheat, Sugar cane, Soybean, Pseudocereals, Cofee and Forage grass

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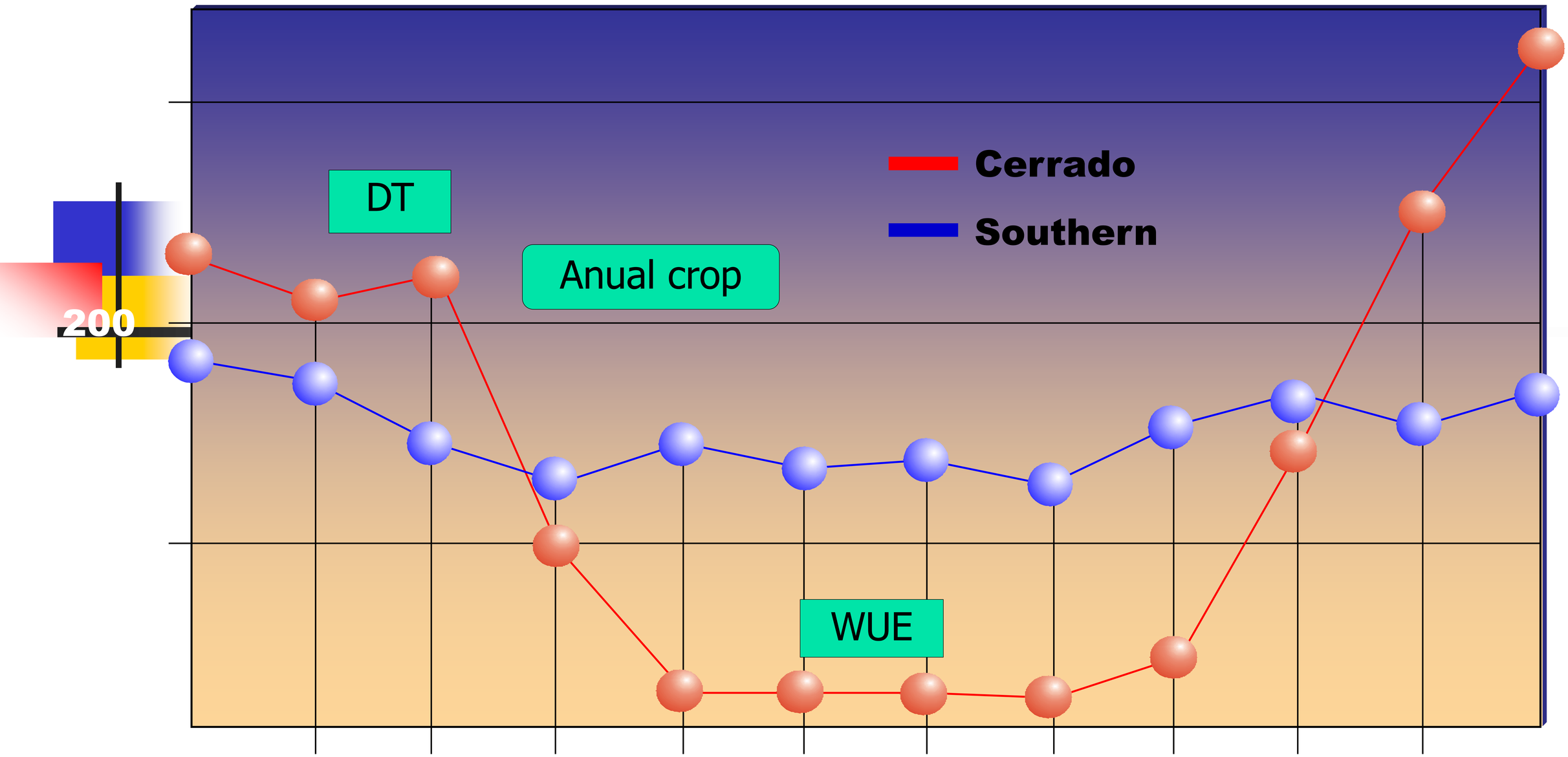
Embrapa
Cerrados

Rainfall distribution in the Cerrado: two well defined seasons



Why do we need drought tolerance and WUE?

PHENOTYPING SITE FOR DROUGHT TOLERANCE

2005/2013

Pipe/canal

Embrapa

Cerrados

(water retention/infiltration)

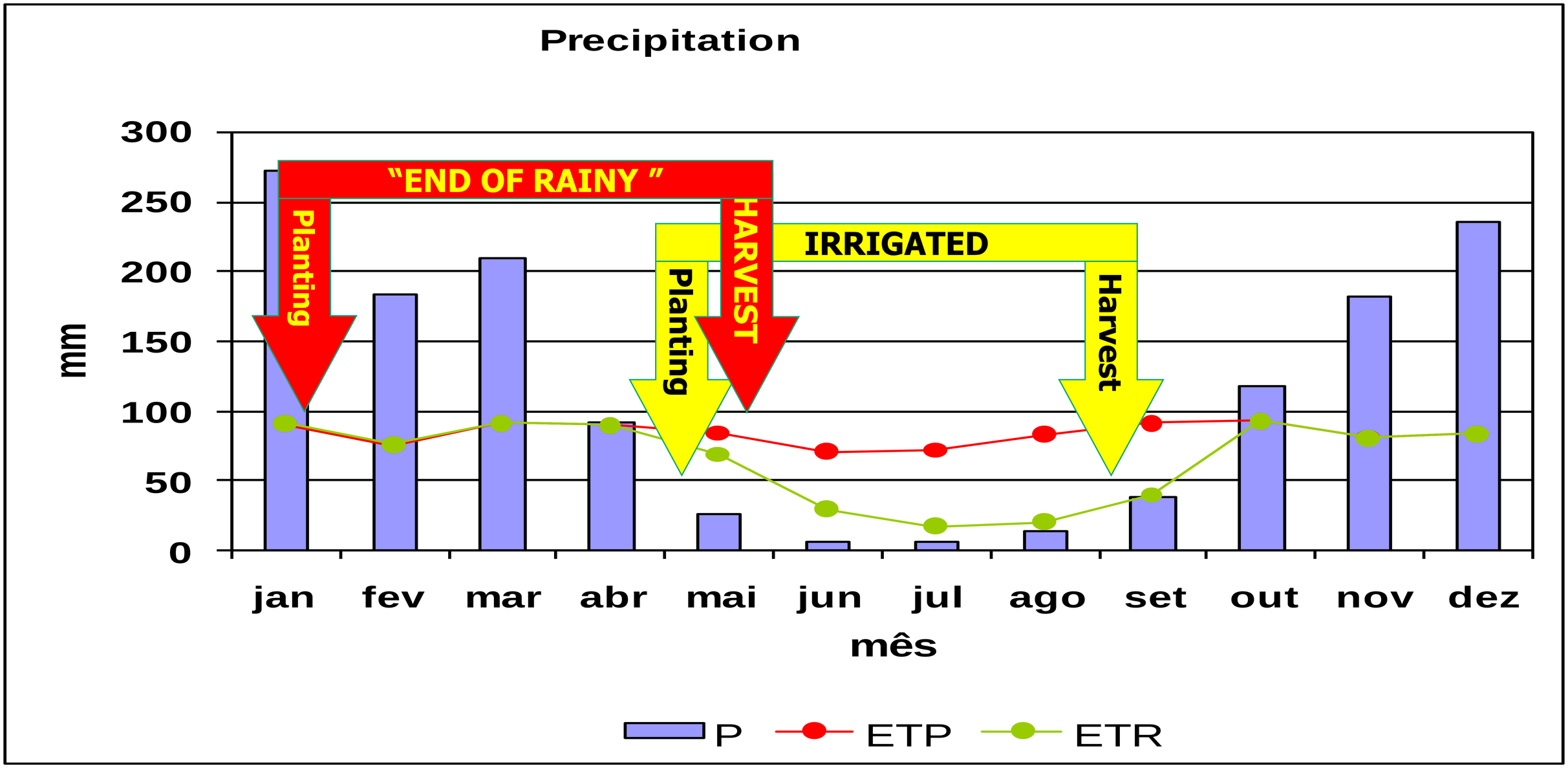
Phisic hydric characterization:

Strategies:

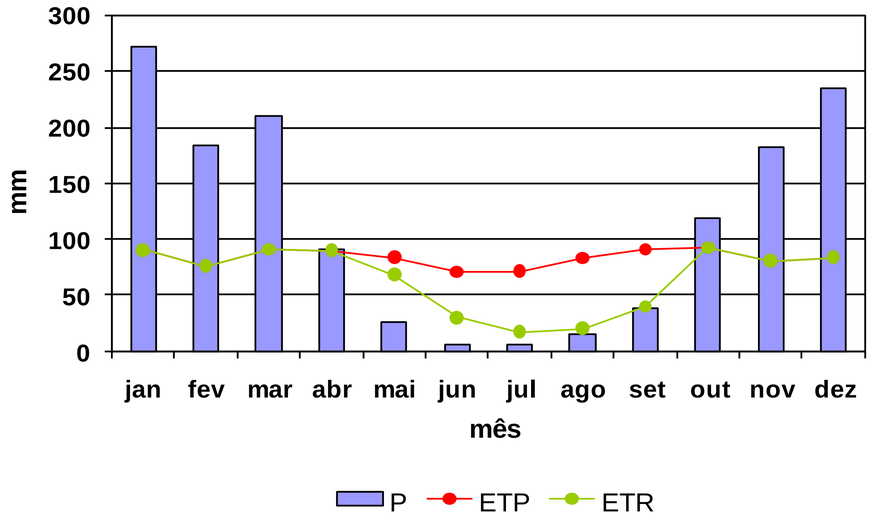
- Environmental site control (experimental mistakes)
- Improvement of phenotyping protocol (reliability)
- Identify drought mechanisms
- Plant breeding
- Gene prospection
- Modelling (2005 a 2013)
- Plant management reducing drought (when genetic strategy is not enough)

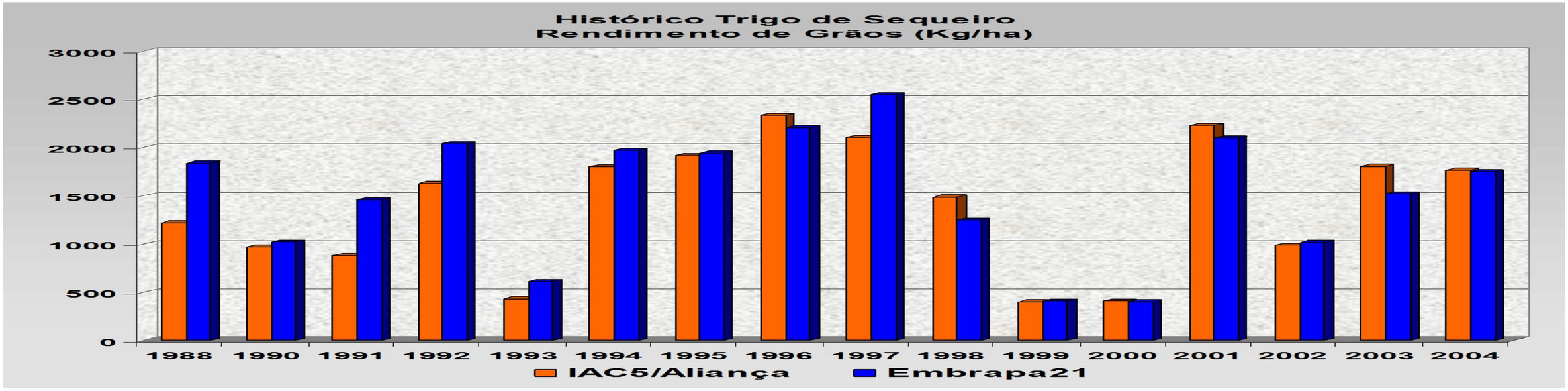
Wheat

Target period: “End of rainy season”
Selection: winter



Problems: Drought, heat, root insects, and blast





Drought Stress: Soluctions

Genetics

Plant Management

Drought tolerance genotype selection:

- Less:
- Leaf area
- Stomatic conductance
- Estomatal aperture
- Transpiration rate
- Higher:
- Hydric Potential
- Tissue quality

However:

- Less:
- Leaf area
- Photosinthesis

- Less:
- Stomatic conductance
- CO_2
- Photosinthesis

- Less transpiration
- Higher Leaf Temperature
- Higher cost to keep healthy leaves

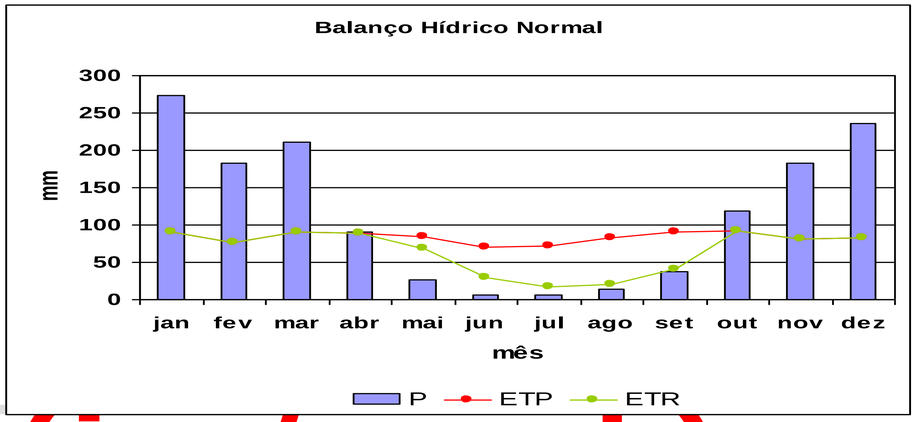
In conclusion:

- **“Avoid loss of water may be opposite to biomass acumulation”**

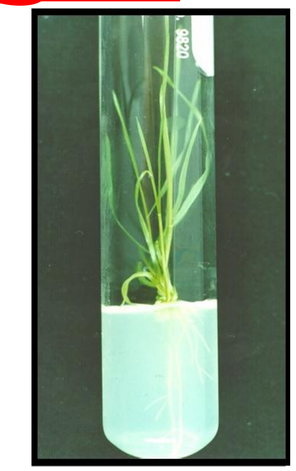
- Soluctions:
- Osmotic regulations: Inert solutes: Proline, Sorbitol, Manitol
- Antioxidant
- Escape: Deep Root, wax, plant management (no till), increase store water capacitu in the soil.

Generation
Cultivating Plant Diversity for the Resource-Poor

Phenotyping strategy:

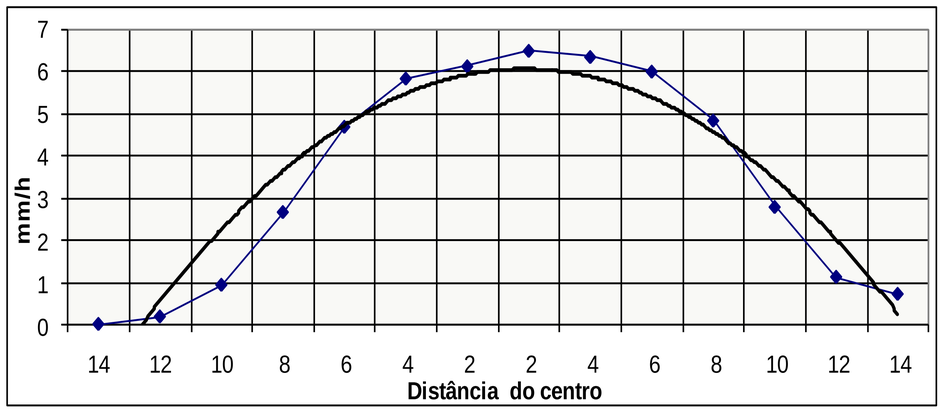


- **Preliminary selection (jan/march) heat/drought**

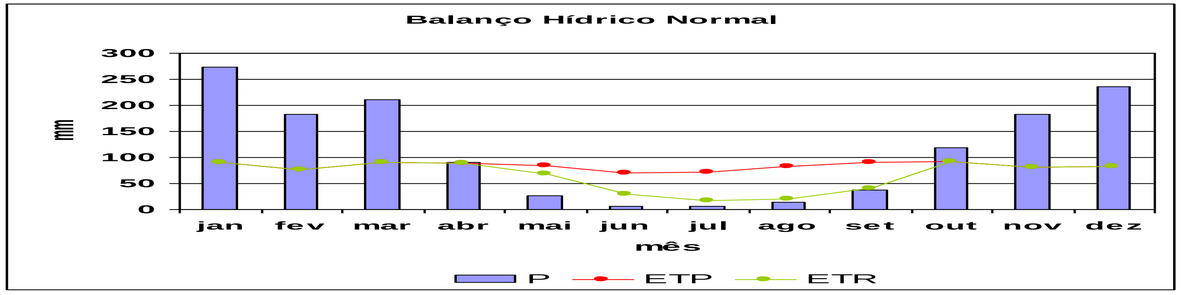


Correlation with field

- Intermediate selection
- Advanced selection

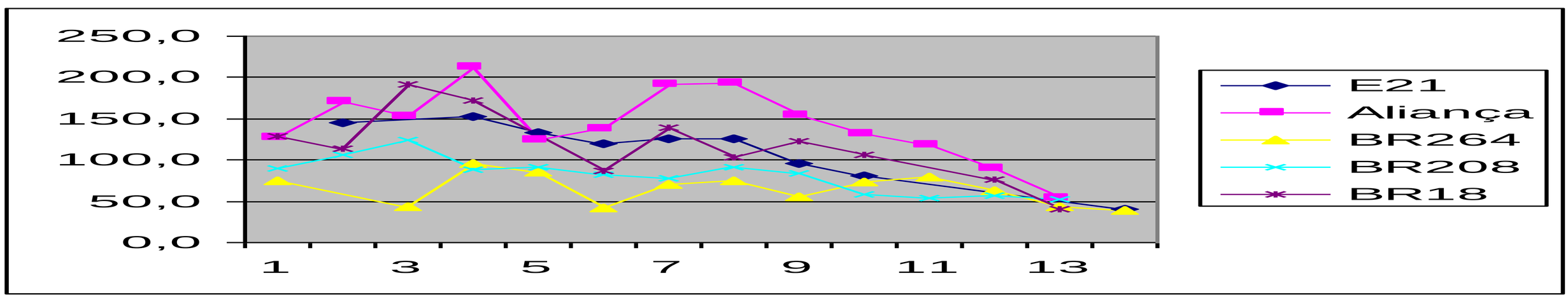


Correlation with field



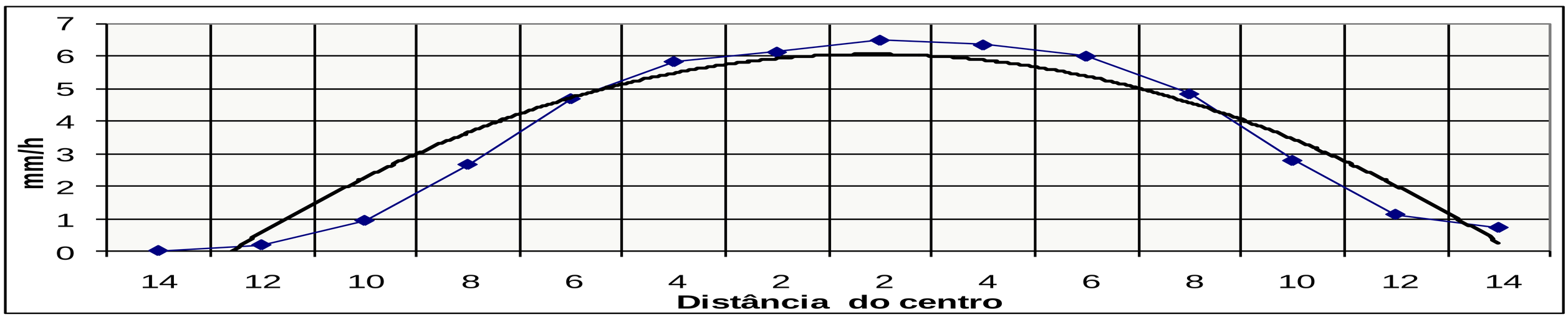
Preliminary selection: 150 genotypes

Genotypes	E1	E2	E3	Média
Excluded	1400,4	939,22	941,45	1093,7
Means	1843,9	1406,2	1328,1	1526,1
BR18	1545,7	2020	1958,4	1841,4
BRS208	1343,8	1858,7	2454,5	1885,6
BH1146	2584,2	1648,8	1571,6	1934,9
PF50003	2011,8	2381,2	1413	1935,4
PF500017	1471,3	3020,7	1409,9	1967,3
PF23056A	1843,1	2846,9	1998,3	2229,4
PF500014	2086,3	3325,5	1338,7	2250,2
PF500015	3937,7	2354,4	647,63	2313,2
PF50004	2272	2288,8	2386,6	2315,8
PF500018	3672	1518,8	1883,1	2357,9
E21	2772	2491,3	2147,2	2470,1
Aliança	2470,4	2194,6	3024,1	2563
Aliança	2058,2	2500	3273,2	2610,5
Aliança	2710,4	2942,7	2366,6	2673,2



Linear system: Reel/bar
Stress: speed or water gradient

Linear system: Good environmental control

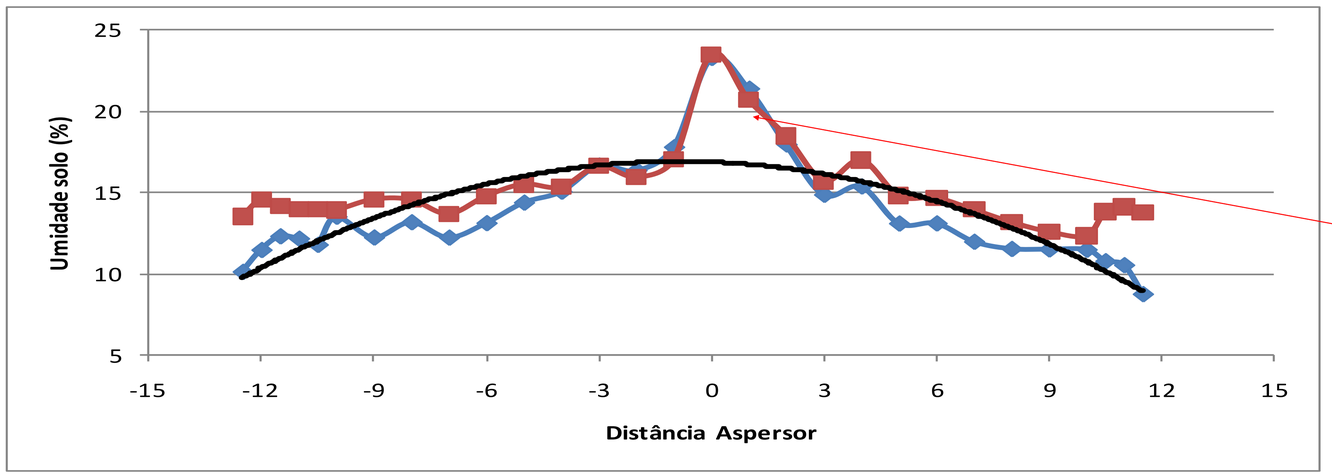


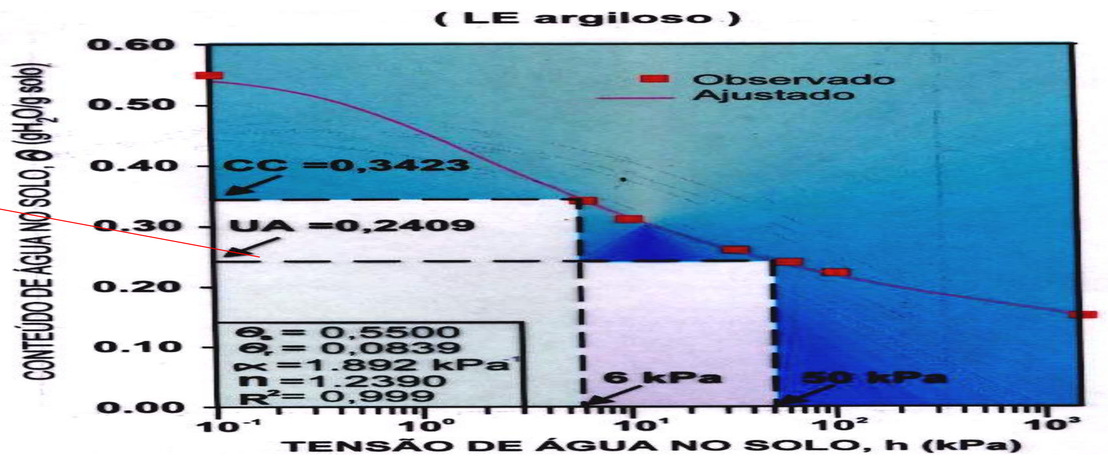
Drought isolated

Line source:

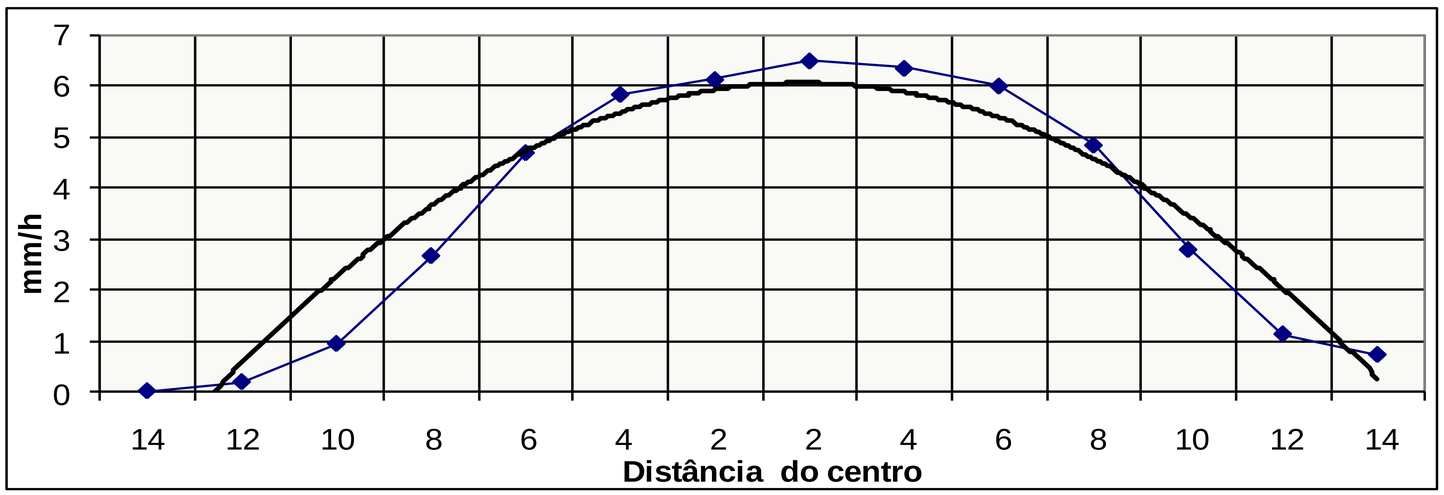

N
Mapa
Fotos
Image © 2012 GeoEye
© 2012 MapLink/Tele Atlas
© 2012 Cnes/Spot Image
Google earth
Termos de Uso

Water control
Soil X Plant

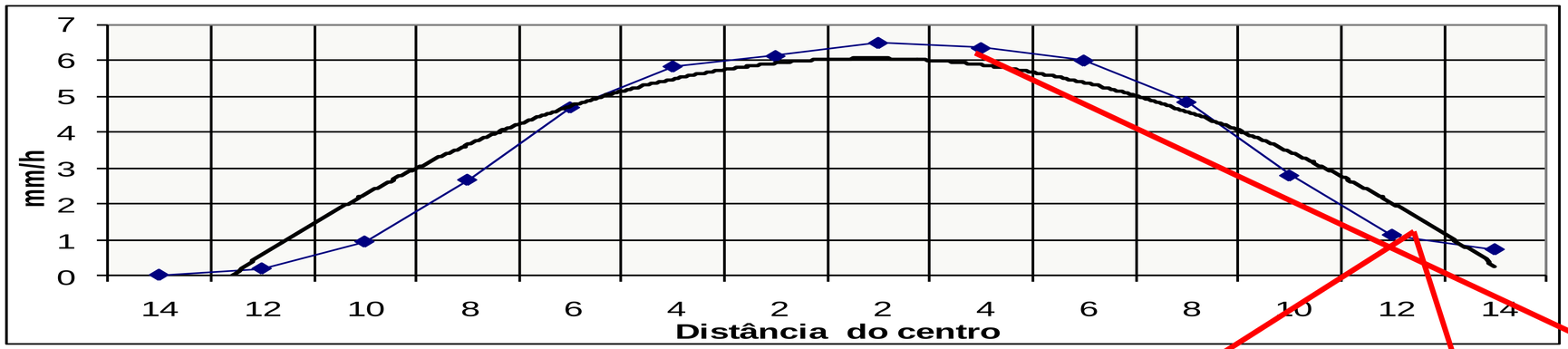


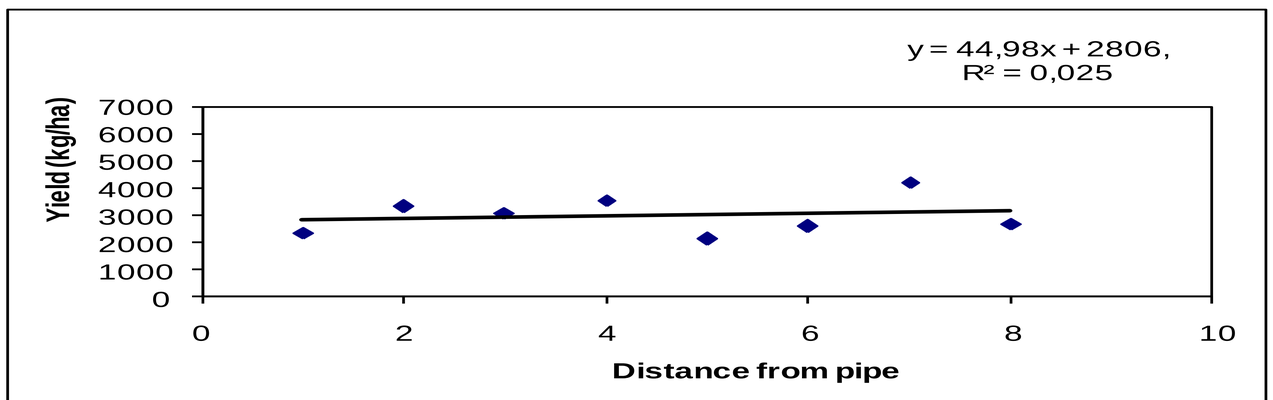


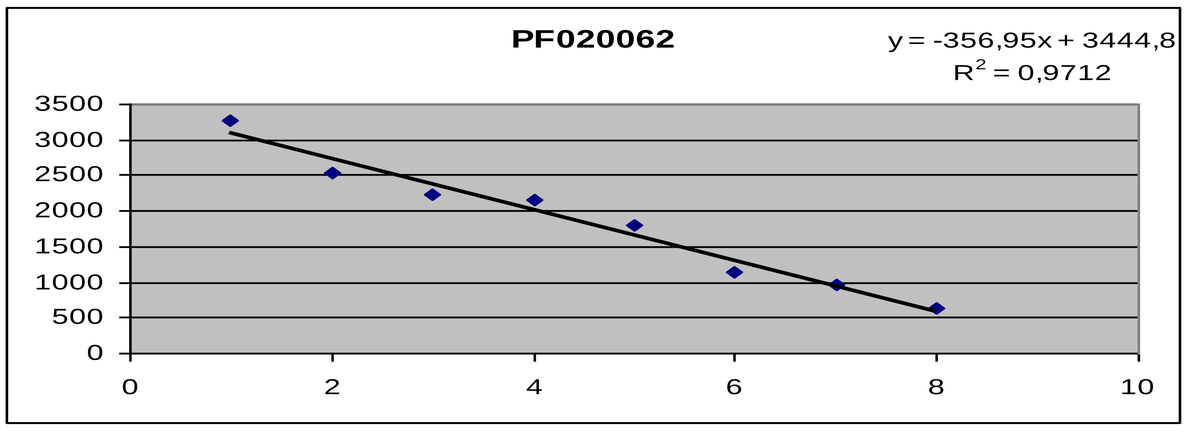
Infiltration



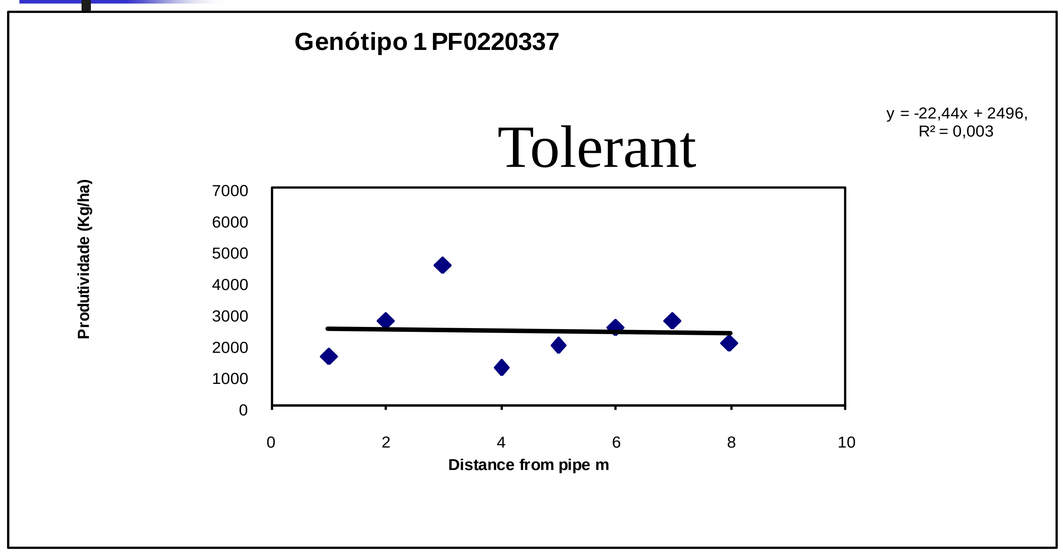
Tolerant x Sensitive



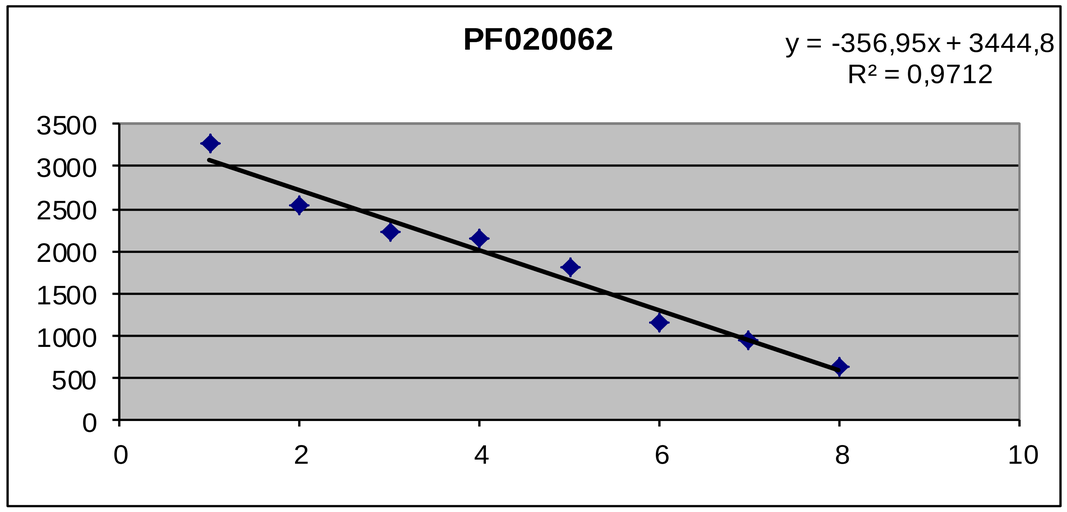


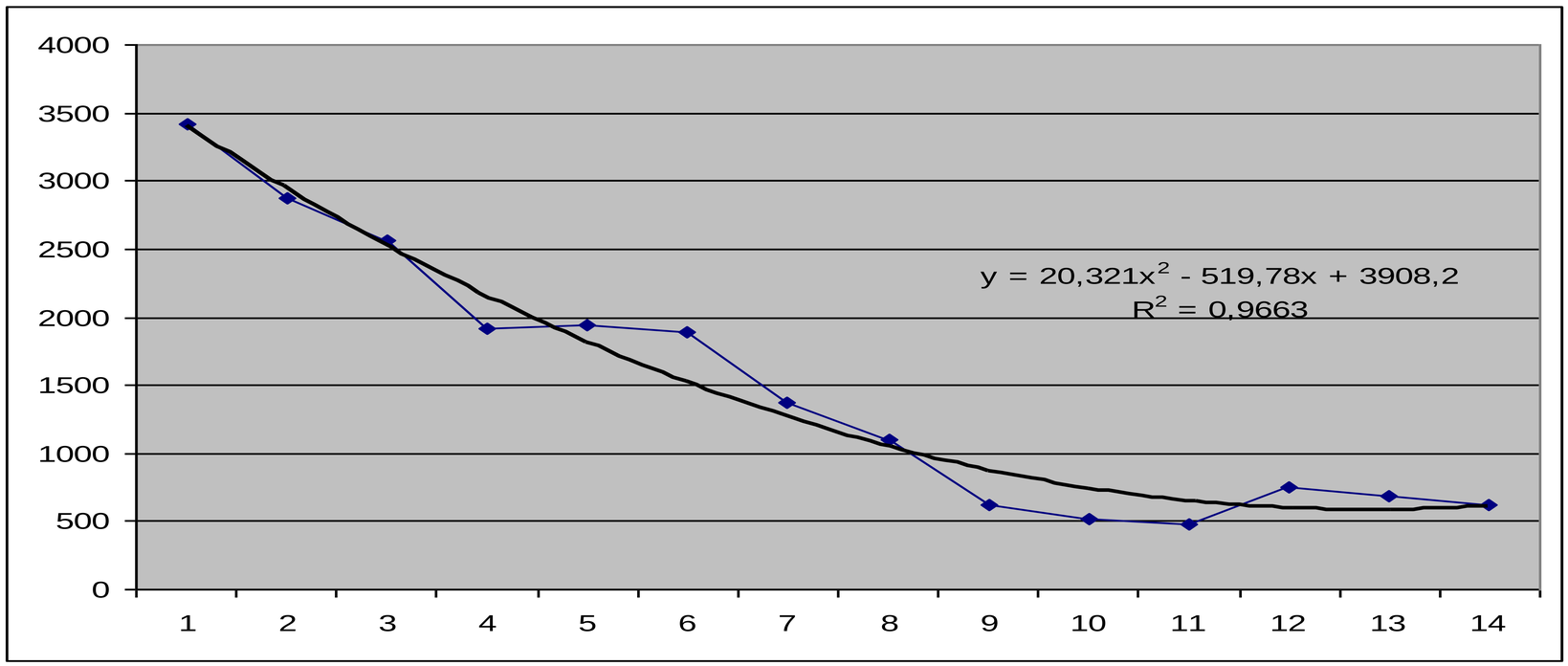


B value



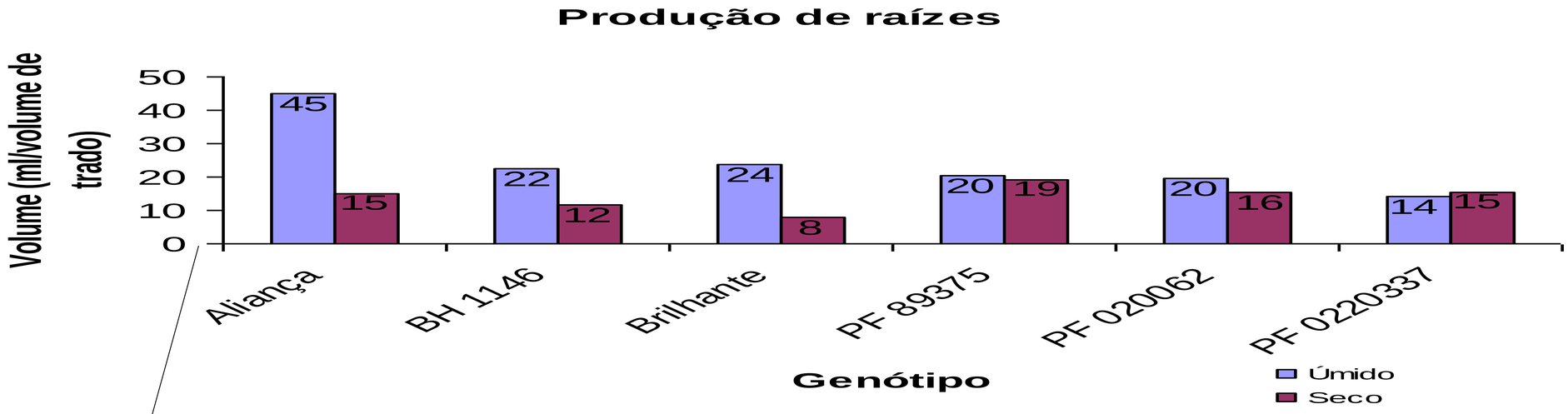
Sensitive





Very sensitive

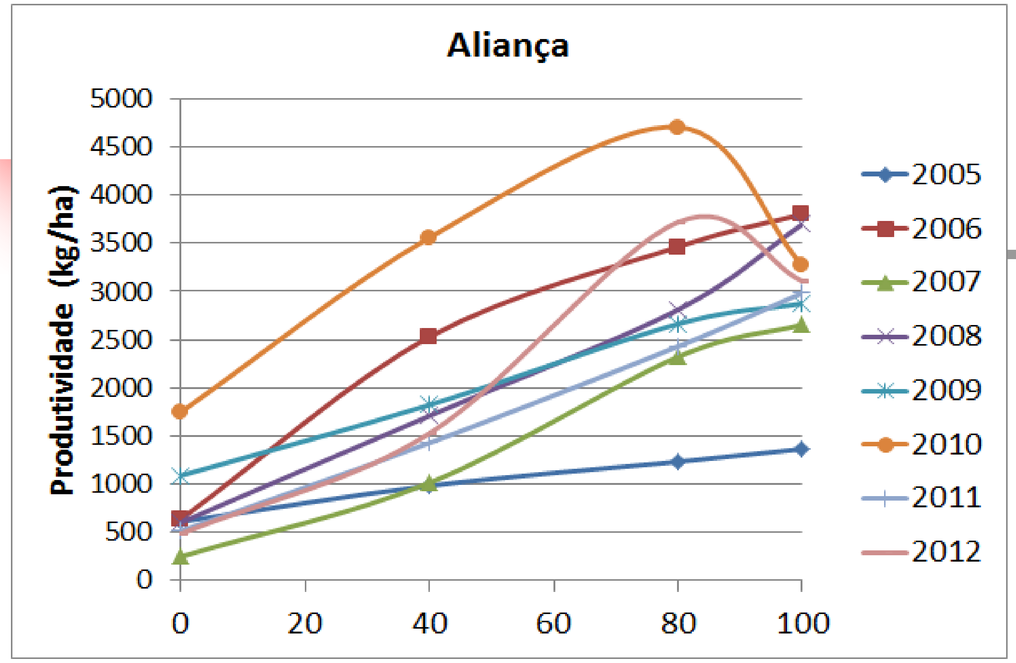
B value

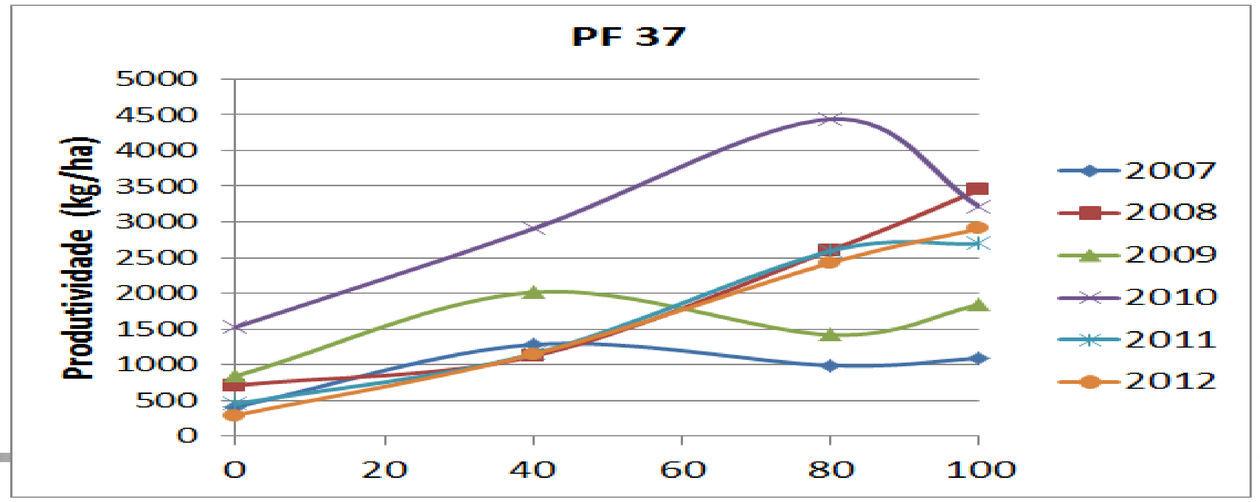


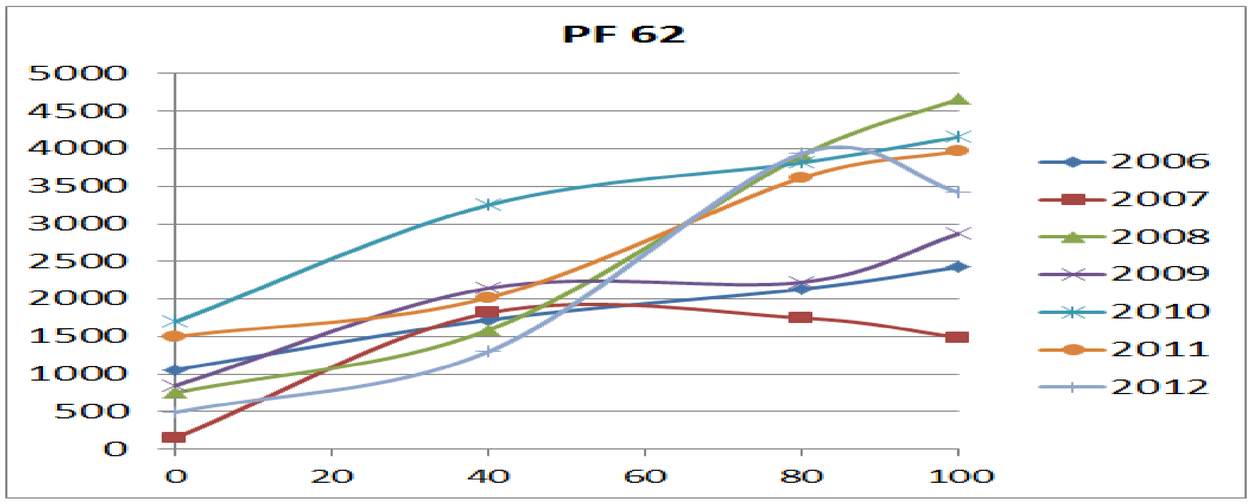
Genótipo	2007	R2
Aliança	27,6	0,8
BRS234	52	0,8
Brilhante	60	0,8
PF89375	141	0,8
PF0220337	154	0,83
BRS264	-140	0,77
PF020062	-169	0,84
BH1146	-199	0,95
BR18	-285	0,91

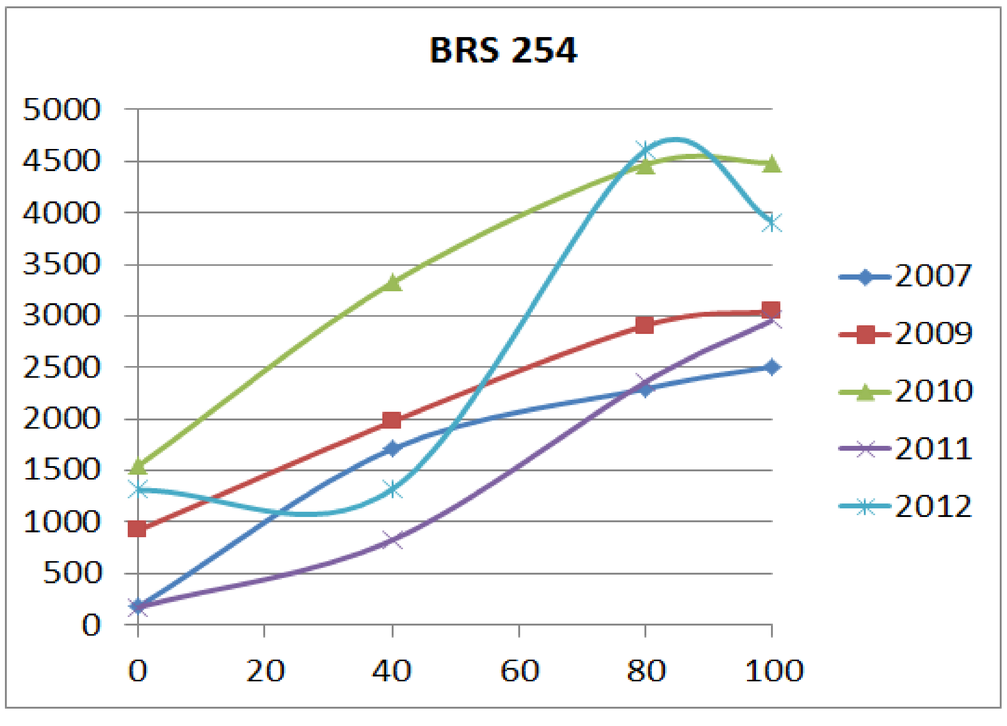
Wax as a mechanism:
Temperature
wax reflect light
Survival x yield

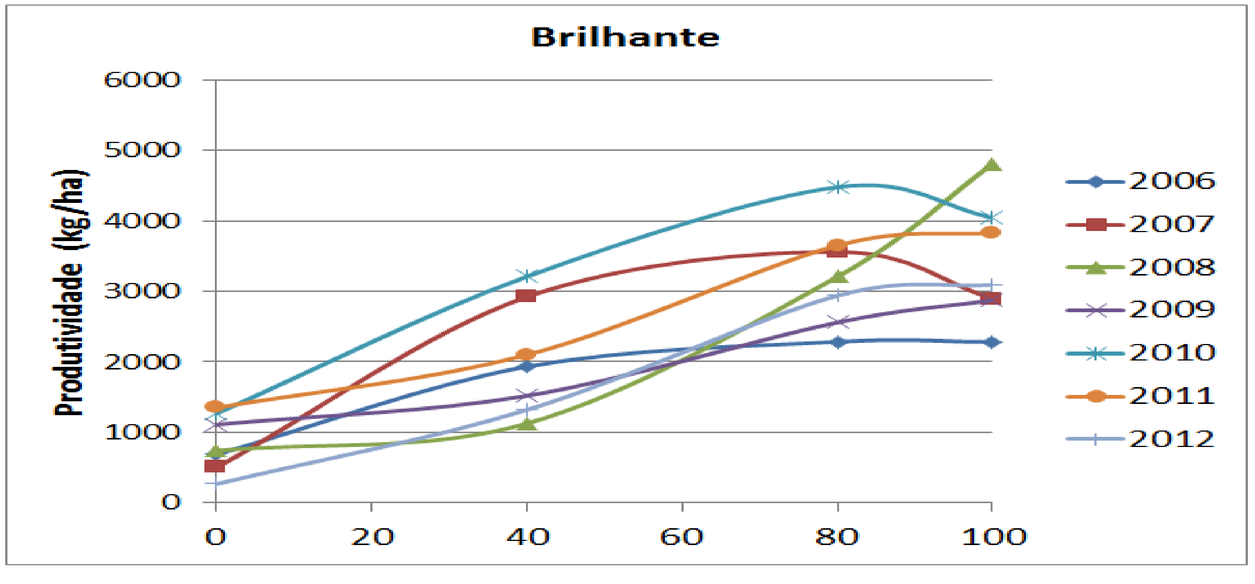
2005 a 2012


Aliança
Produtividade (kg/ha)
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
0
20
40
60
80
100
2005
2006
2007
2008
2009
2010
2011
2012

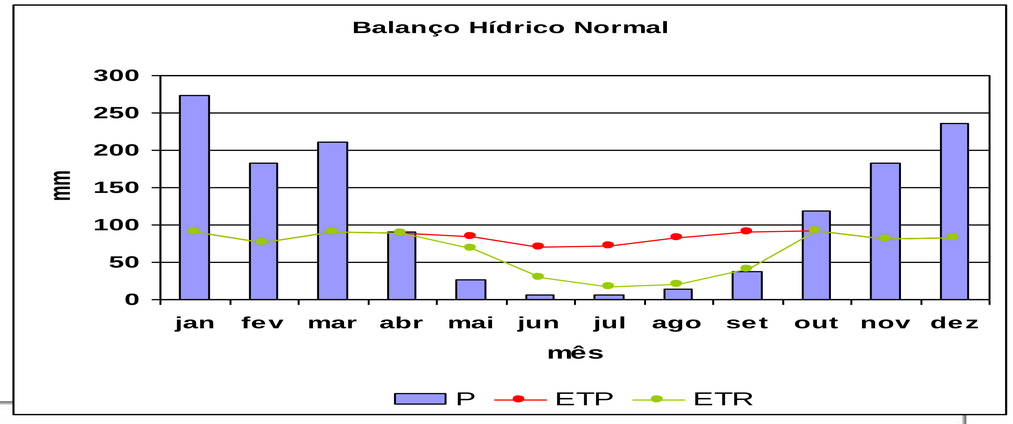

PF 37
Produtividade (kg/ha)
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
0
20
40
60
80
100
2007
2008
2009
2010
2011
2012

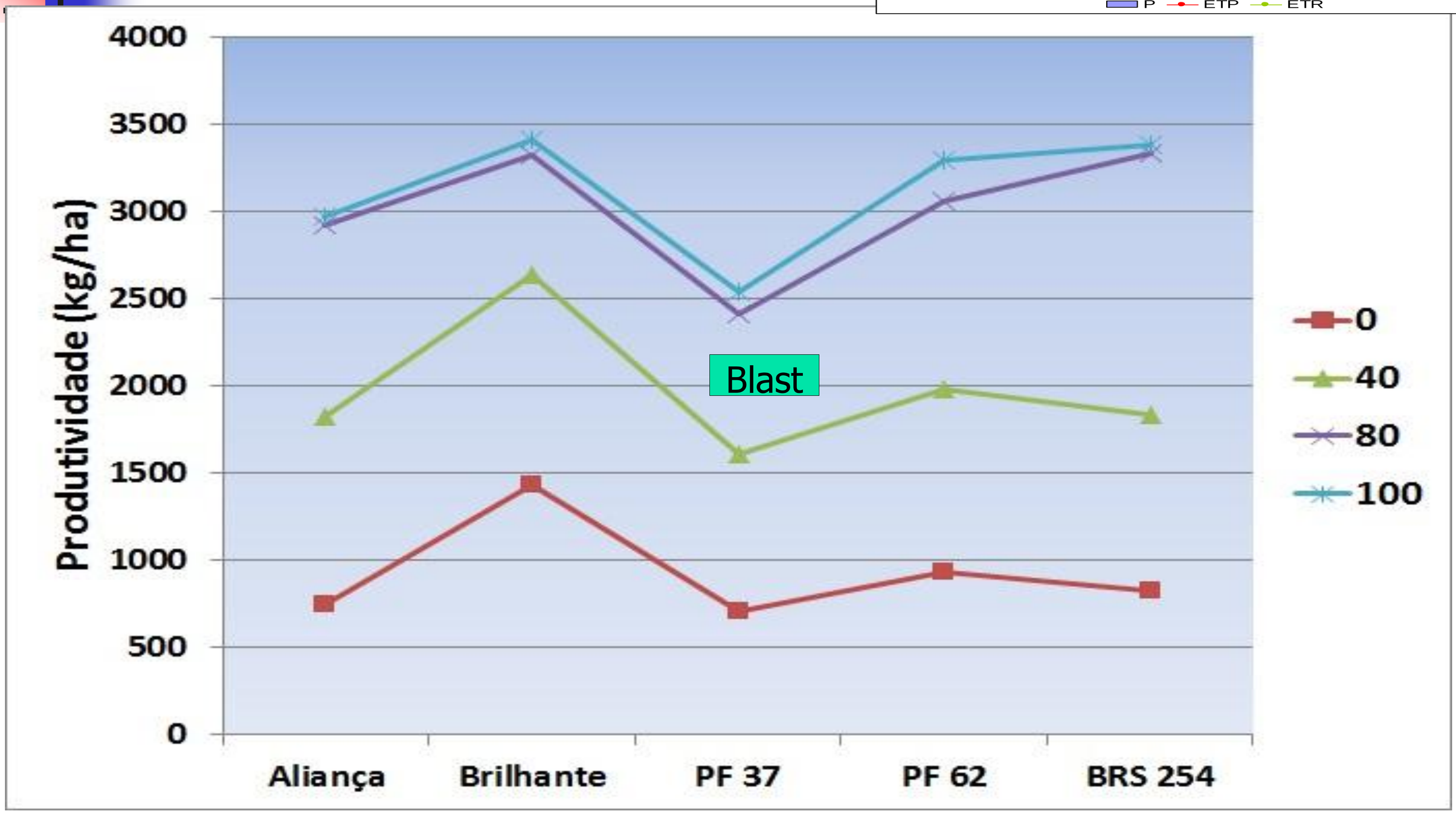

PF 62
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
0
20
40
60
80
100
2006
2007
2008
2009
2010
2011
2012


BRS 254
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
0
20
40
60
80
100
2007
2009
2010
2011
2012


Brilhante
Produtividade (kg/ha)
6000
5000
4000
3000
2000
1000
0
0
20
40
60
80
100
2006
2007
2008
2009
2010
2011
2012

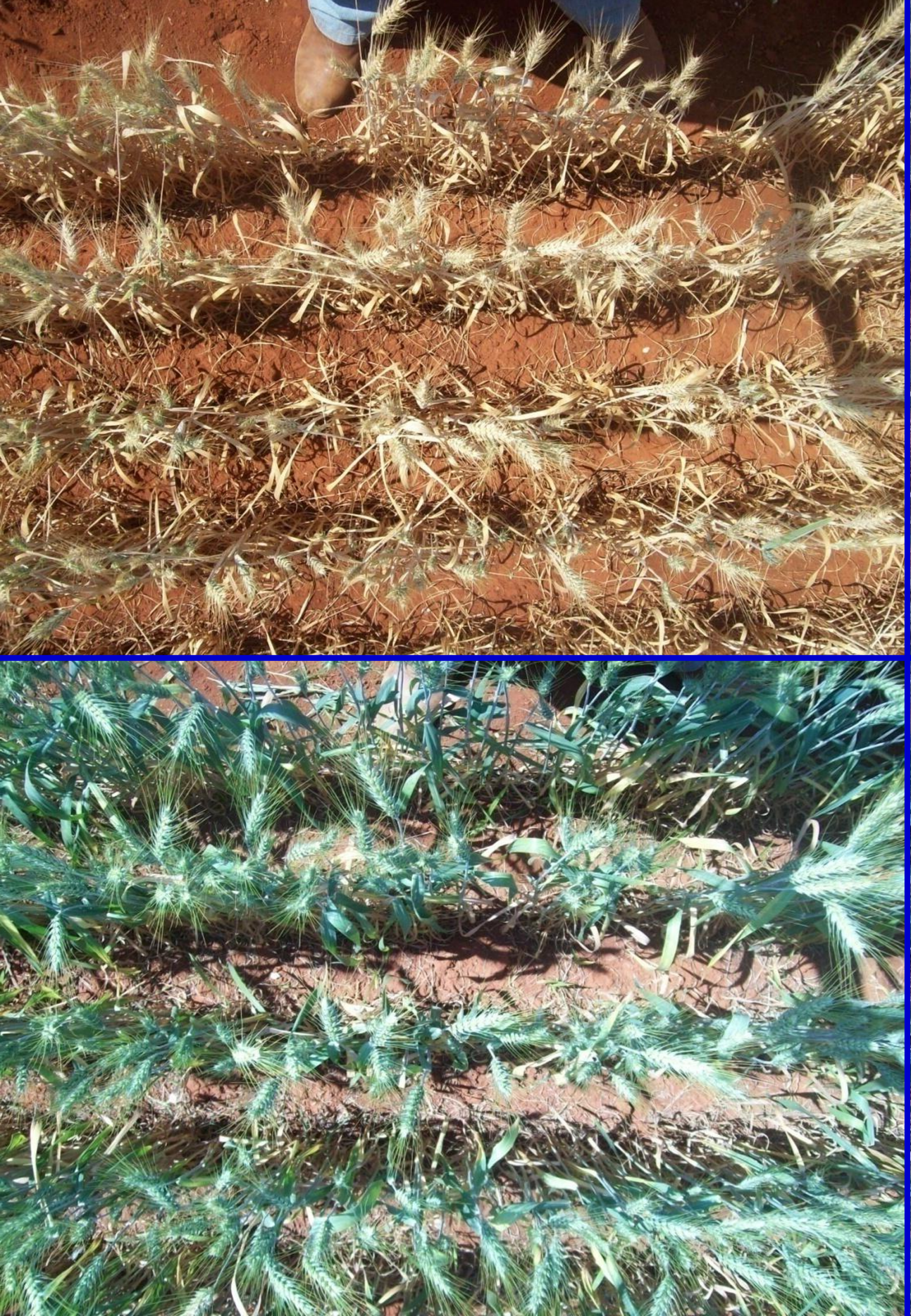
2005 – 2012: stress after tillering stage

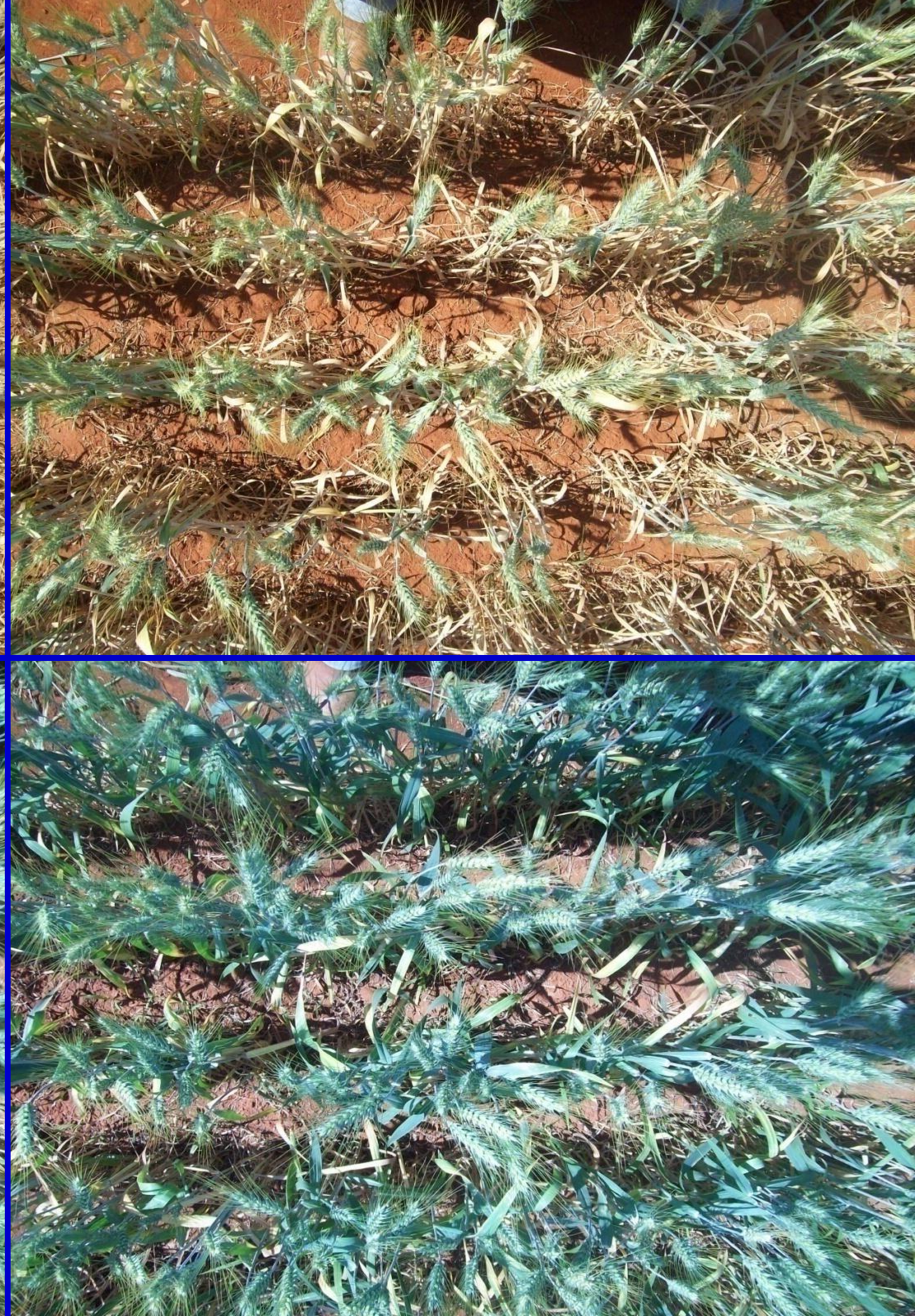




Hydric Potential -MPa (Grain Filling)

Stress	Aliança	BH1146	PF020062	PF0200337
without	-0,23	-0,57	-0,55	-0,37
with	-0,95	-2,12	-2,52	-2,26





Gene prospection:

(diferential expression)

Soluctions:

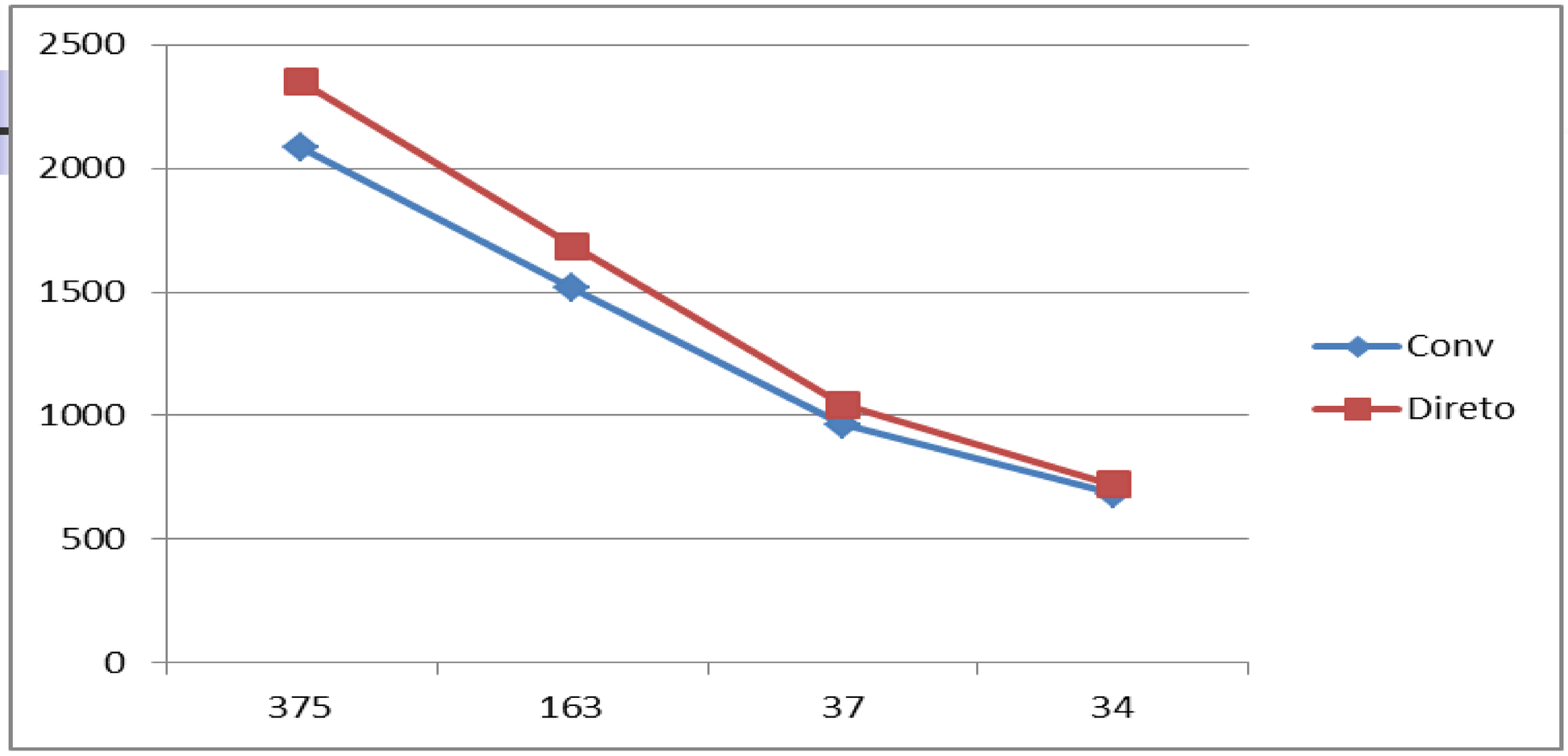
Plant selection

Plant Management

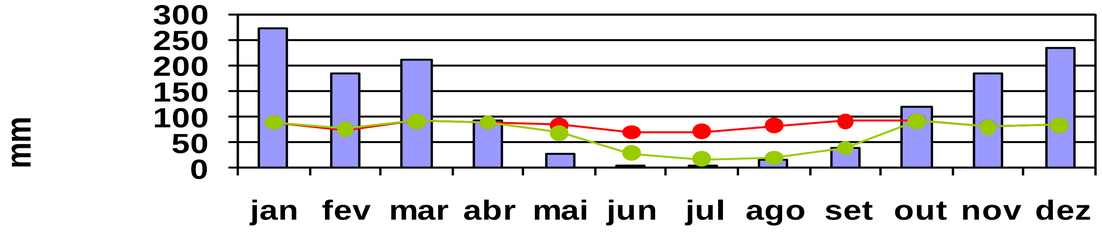
No till

Plant reducer

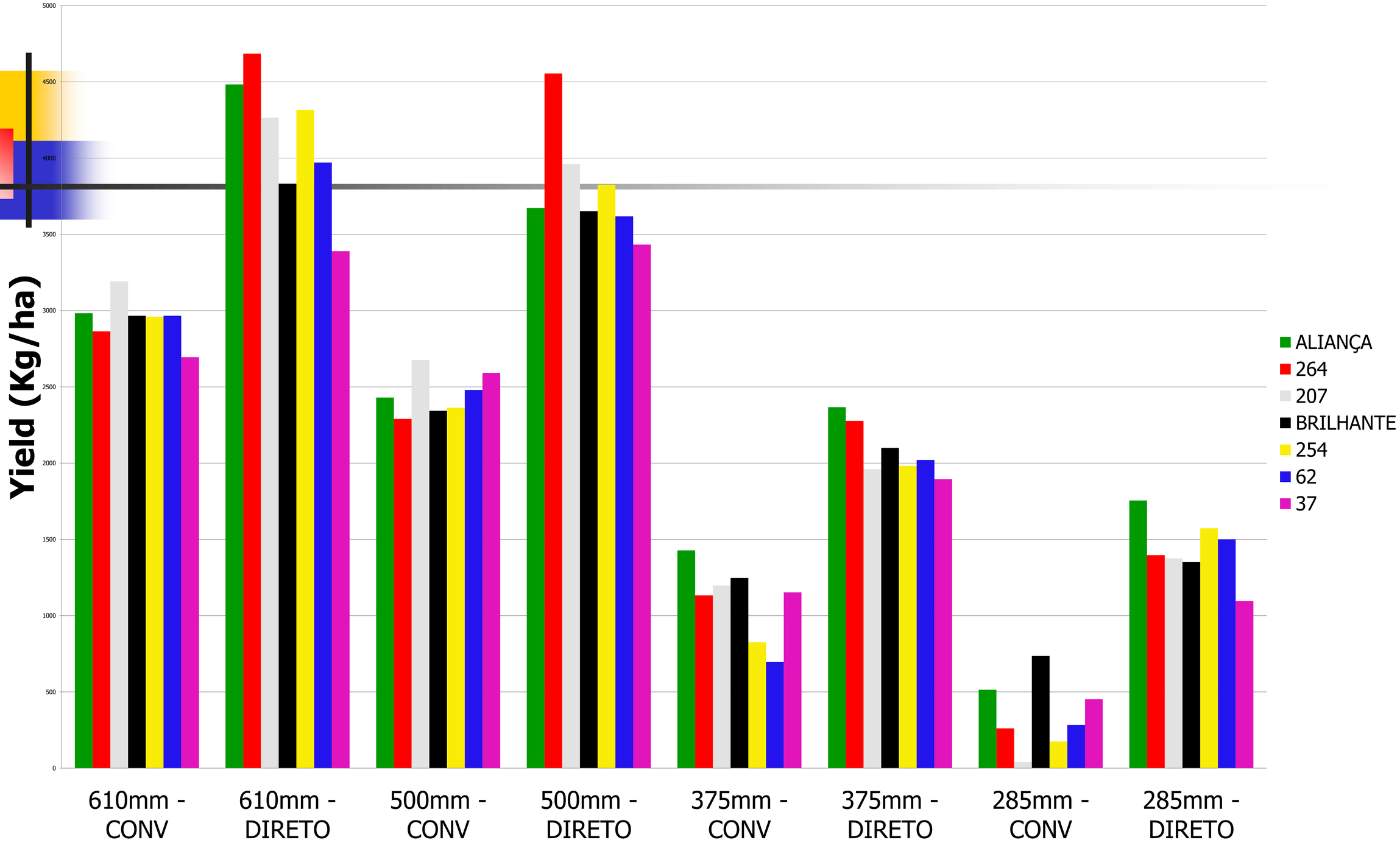
Plant manegement:
Conventional x First year No till: 2011



No visual diferences

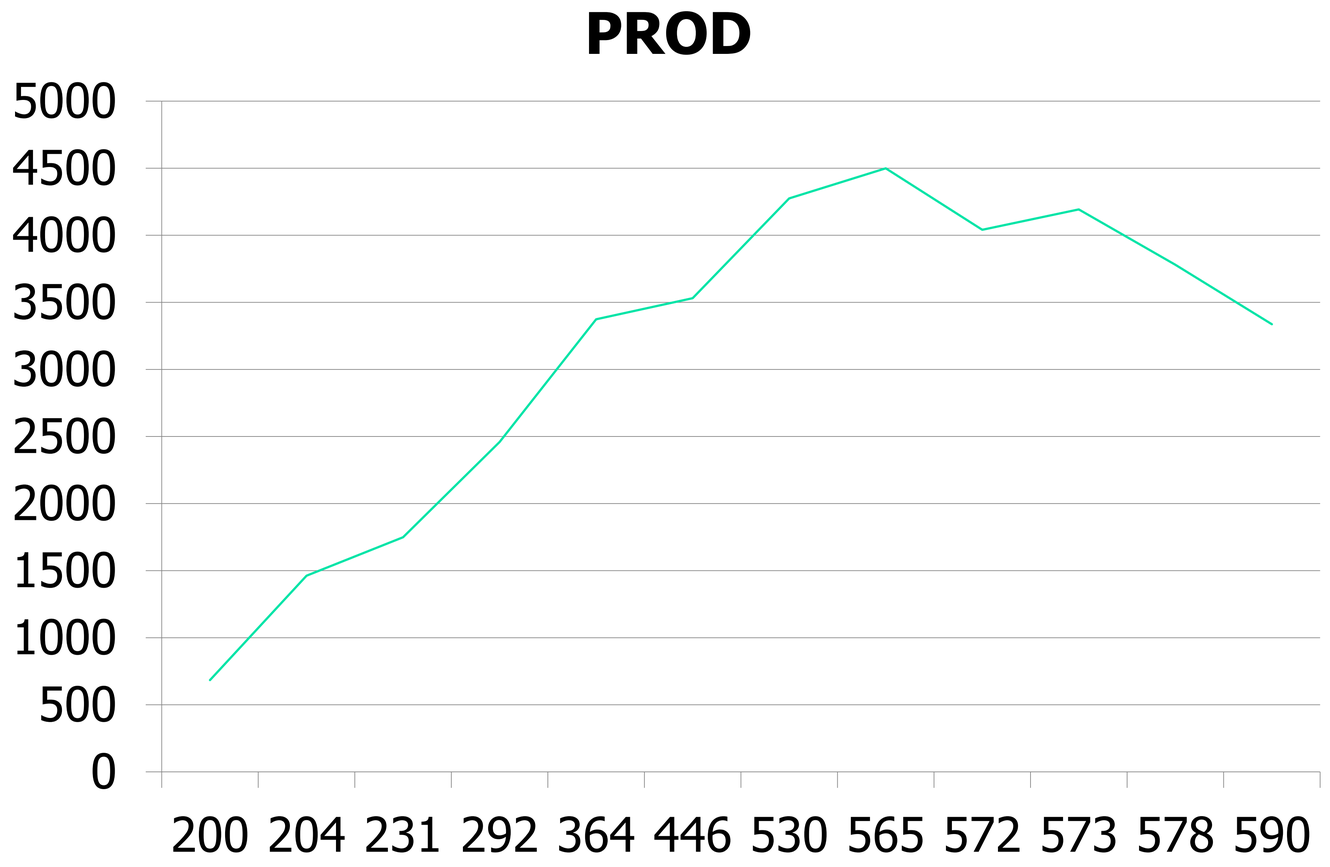


4 years No till :

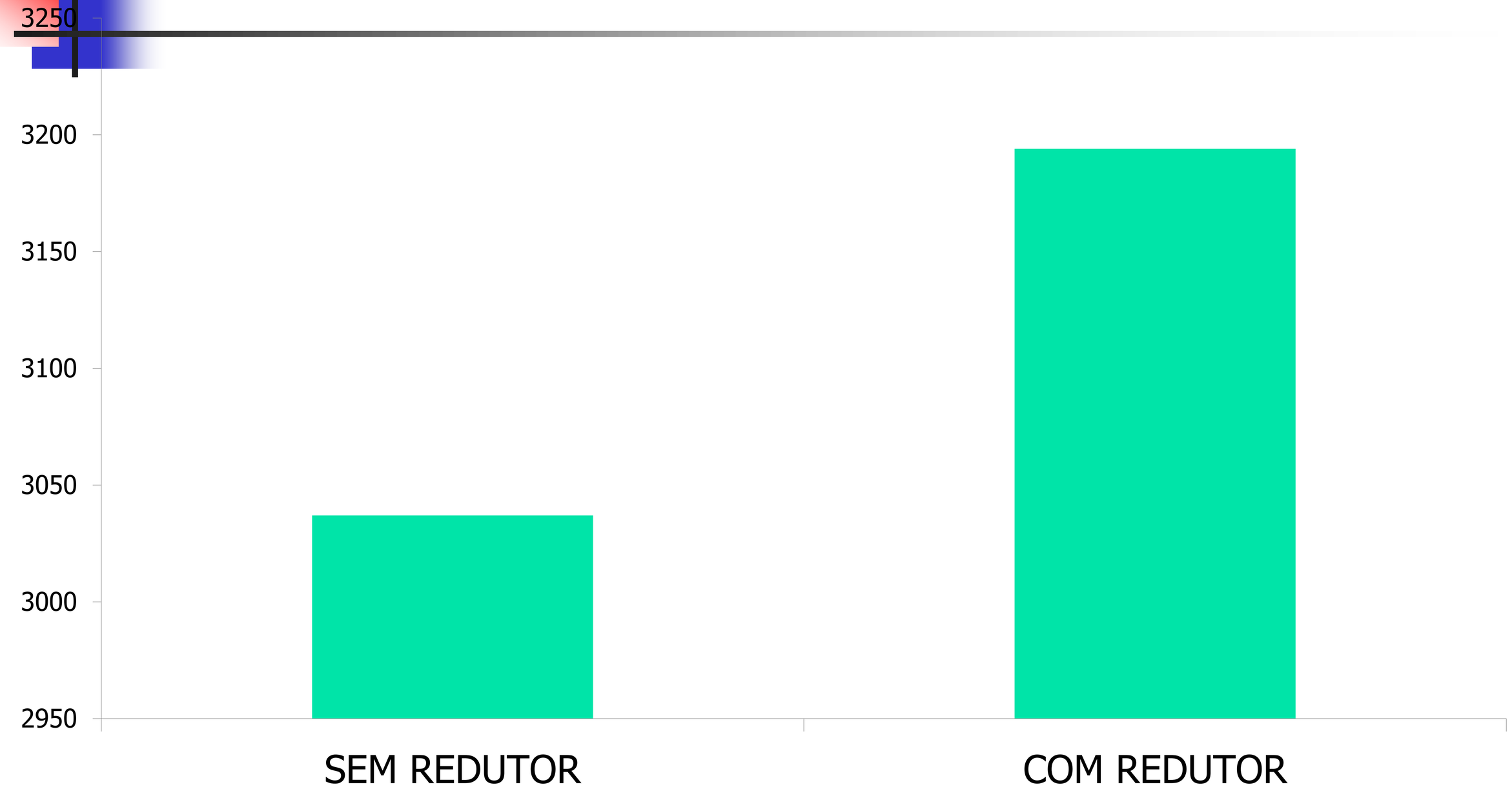

Yield (Kg/ha)
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
610mm - CONV
610mm - DIRETO
500mm - CONV
500mm - DIRETO
375mm - CONV
375mm - DIRETO
285mm - CONV
285mm - DIRETO
ALIANÇA
264
207
BRILHANTE
254
62
37

LS 2010: Plant reducer (Moddus)

Kg/ha

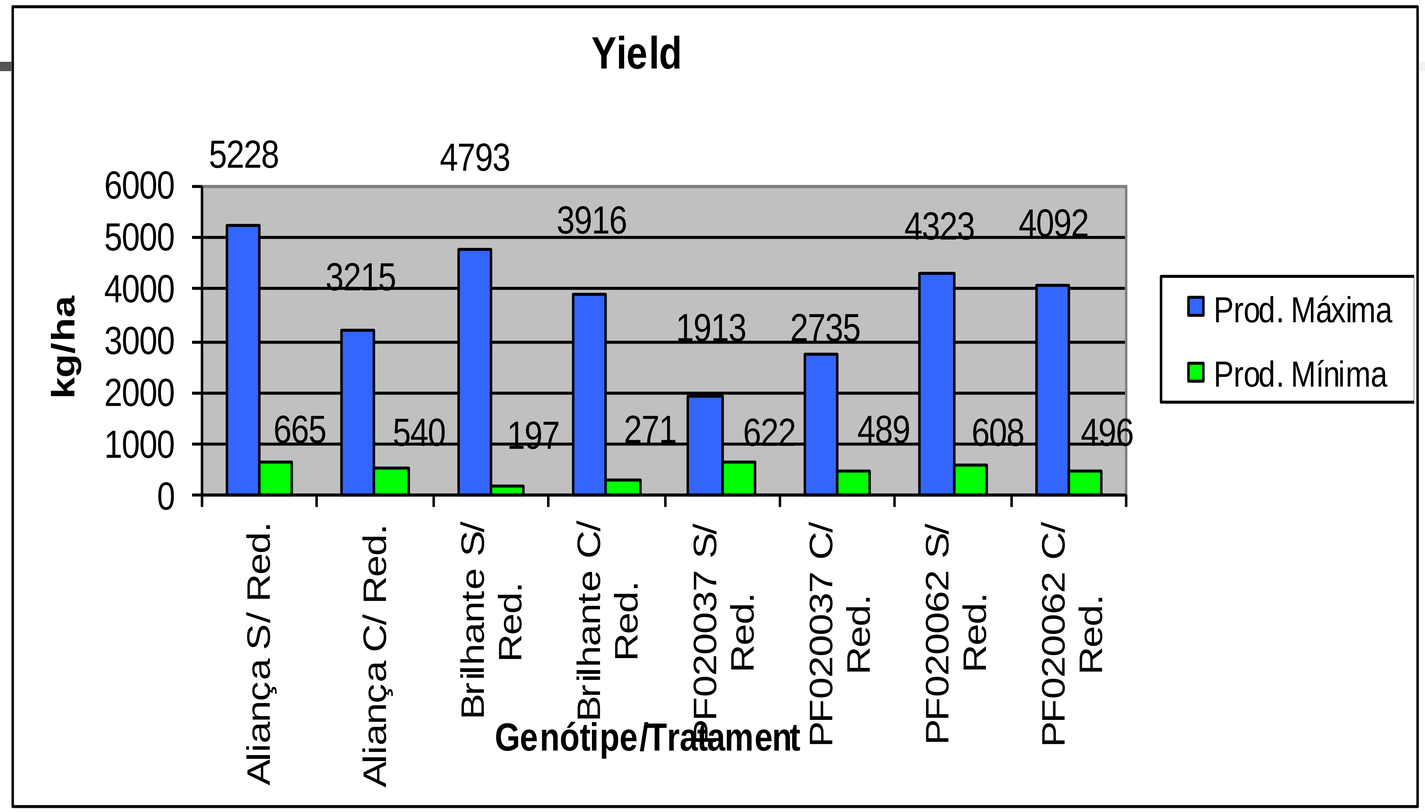


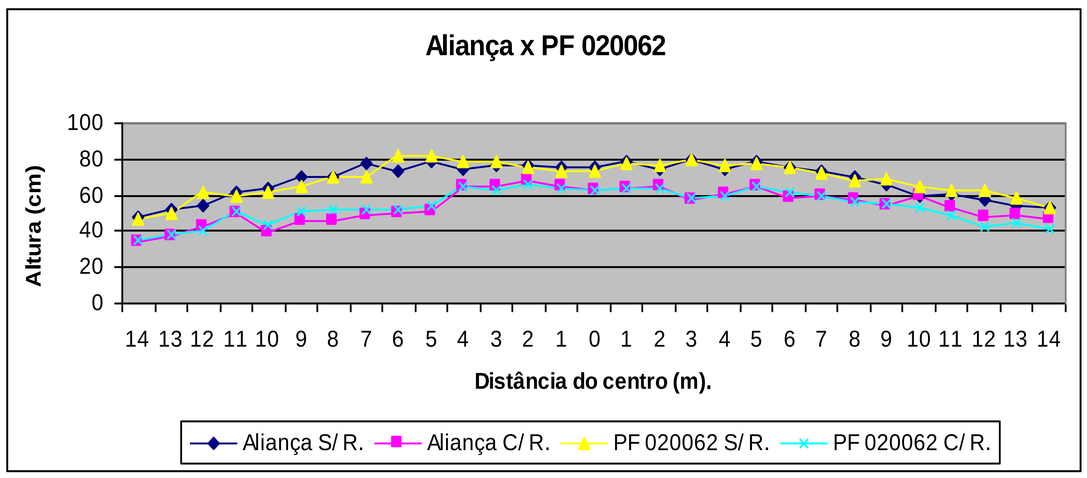
LS 2010

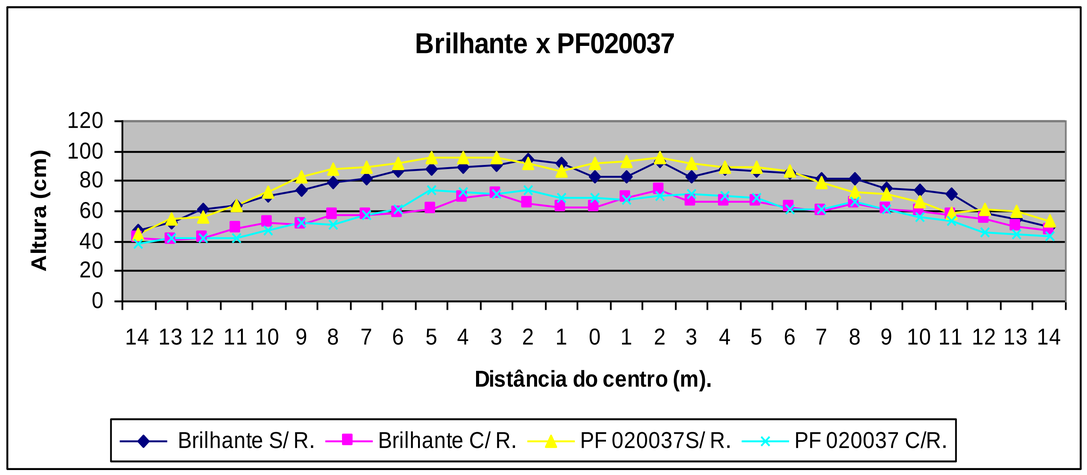


Plant reducer saves water? Root?

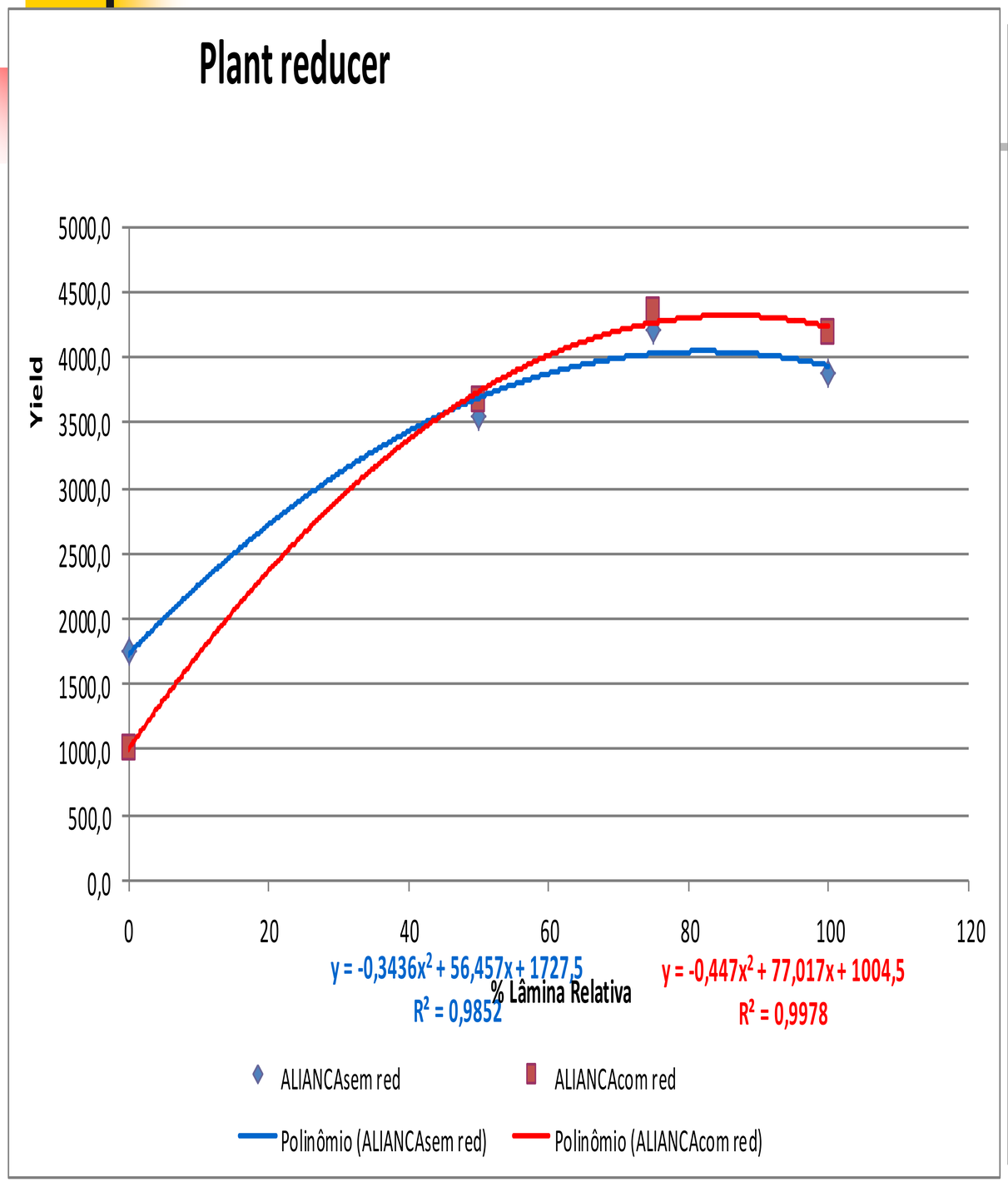
Plant reducer (2009) 1000ml .ha

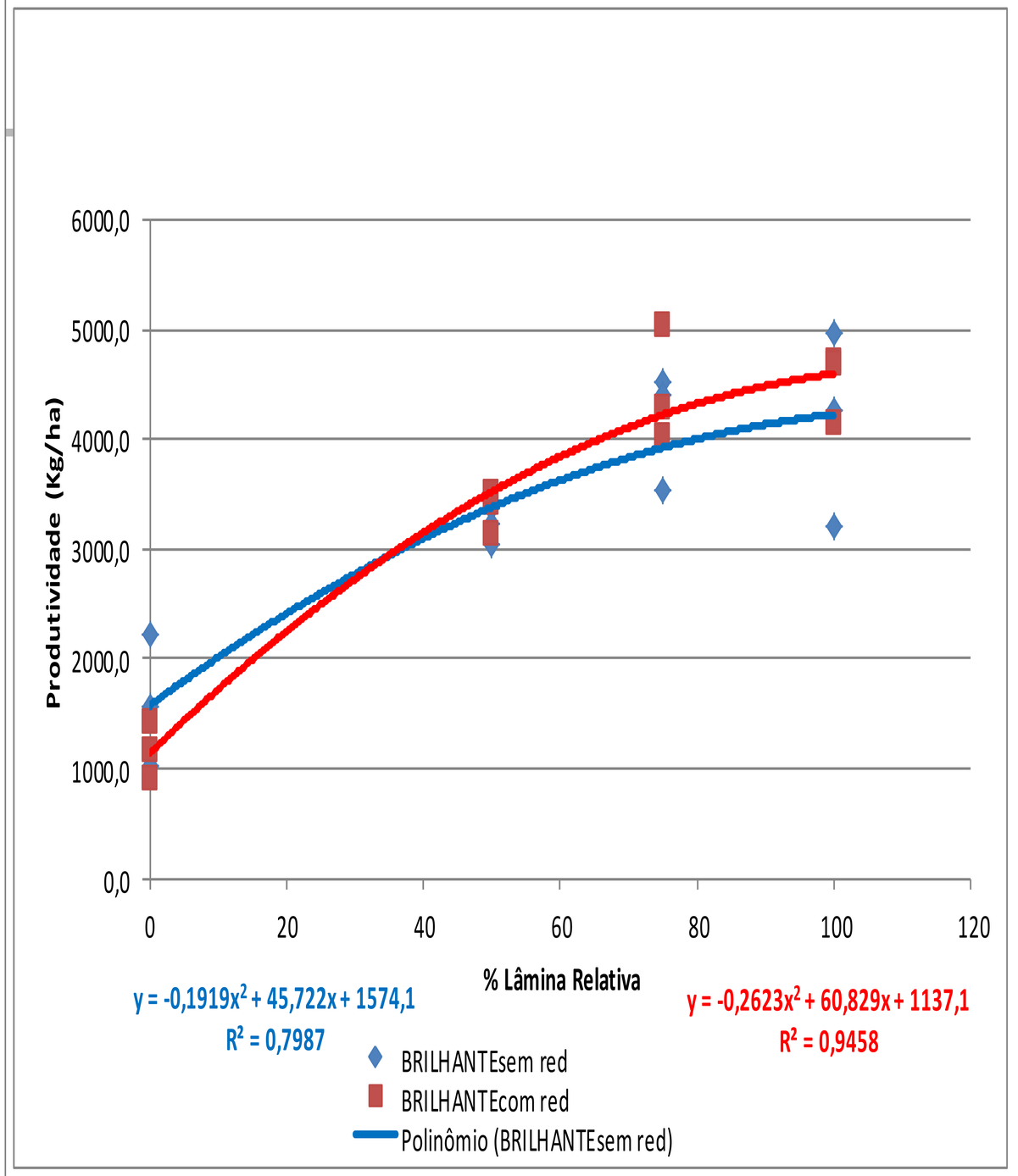






Trinexapac ethyl:Moddus: 500ml/ha



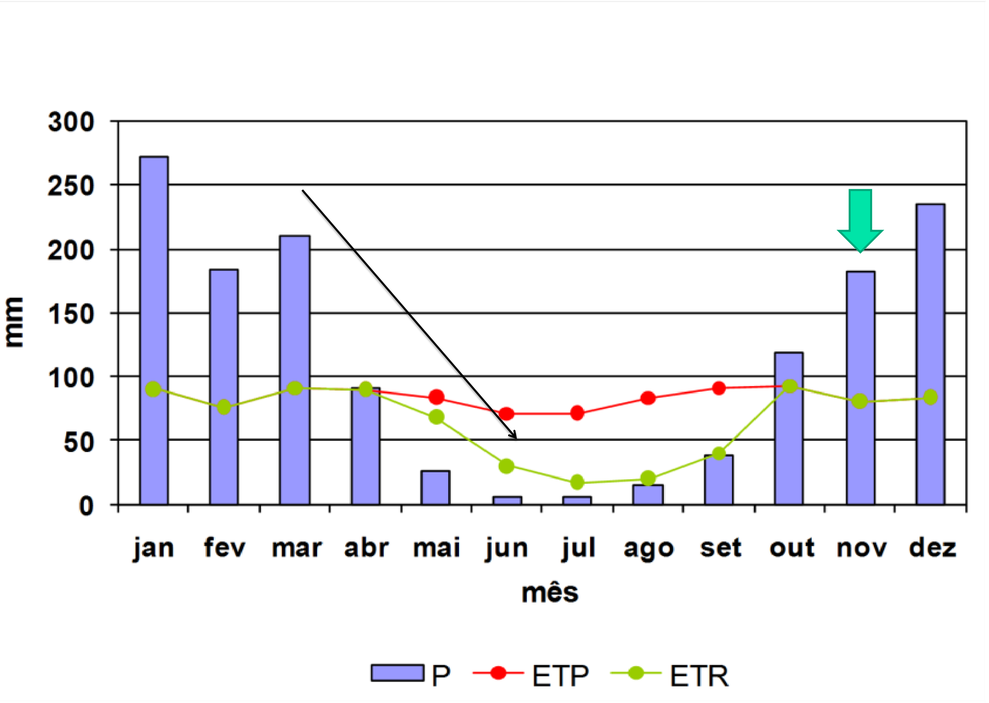


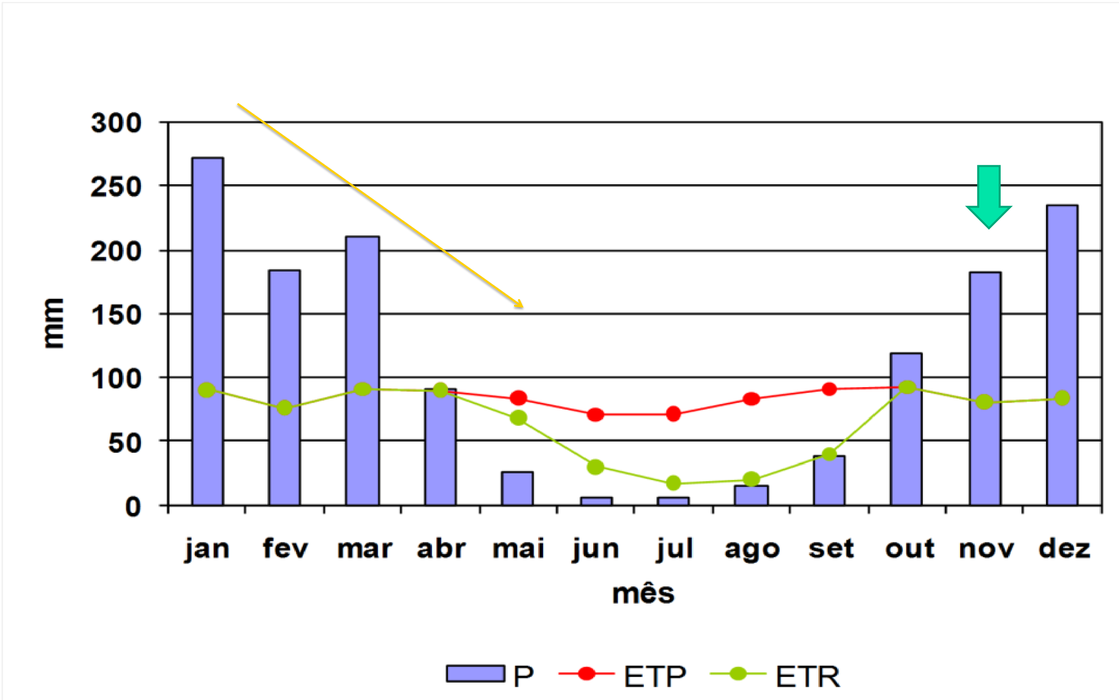
Escape from drought
Sorghum-wheat intercroped with soybean

Why?

Soja

Soybean with 100 Days cycle





Sunflower, quinoa, amaranth, intercroped with soybean

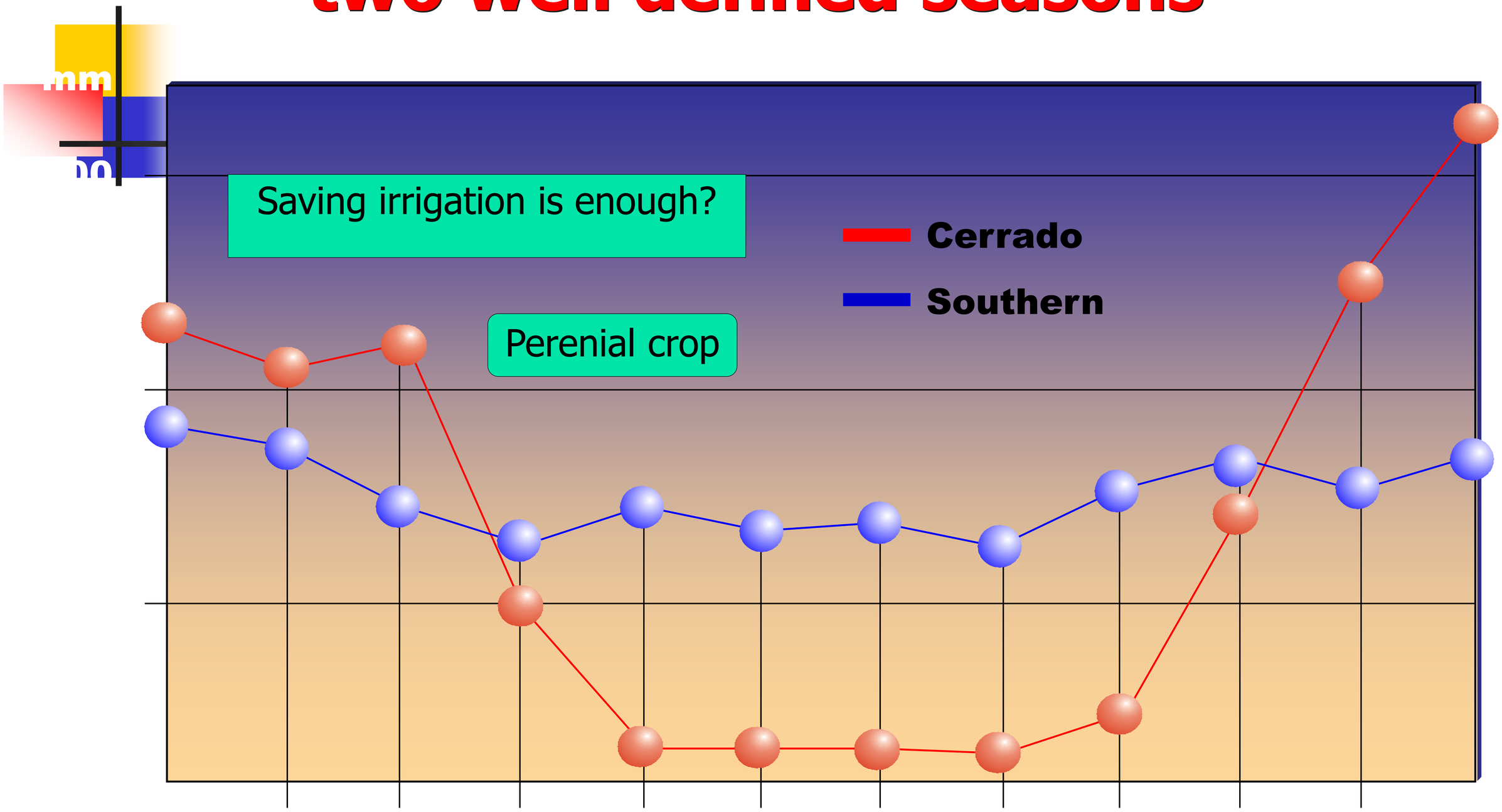
Intercrop soybean: Only wheat or sorghun survived: Drought Escape

Deep root during interruption of precipitation

Herbicide low level

Sugar cane:

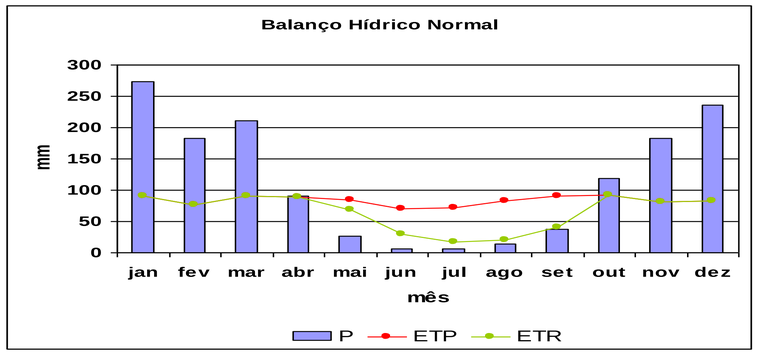
Rainfall distribution in the Cerrado: two well defined seasons



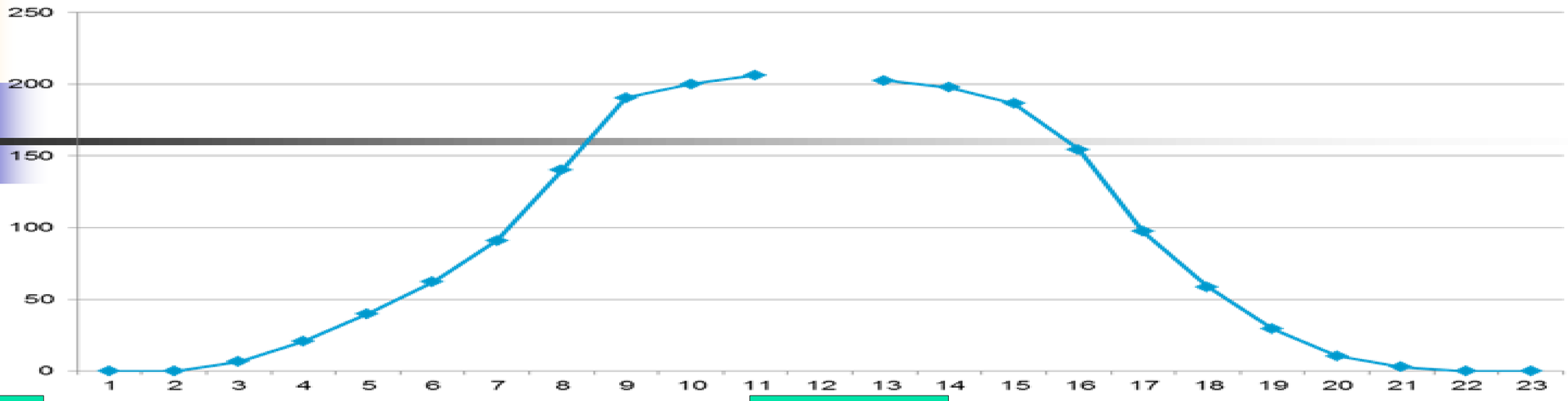
Why do we need drought tolerance and WUE?

Hydric Stress:

Embrapa



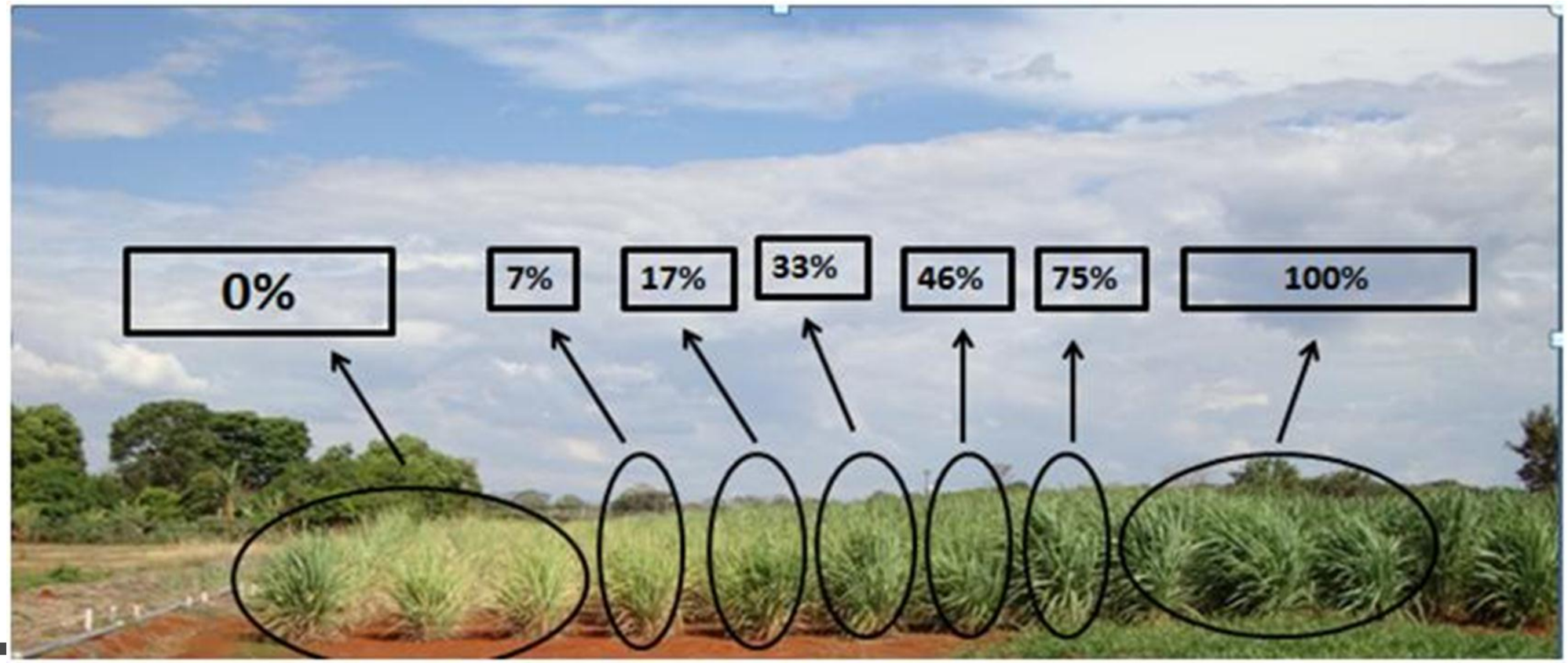
Estrategy: “Line source”:

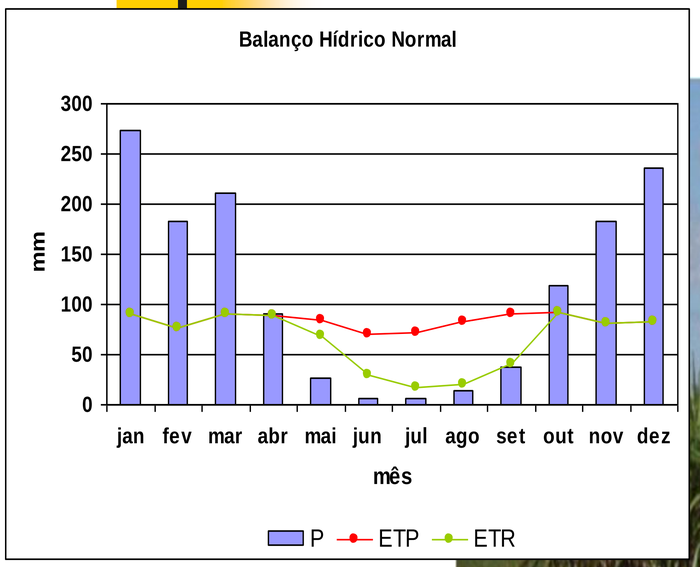


40mm

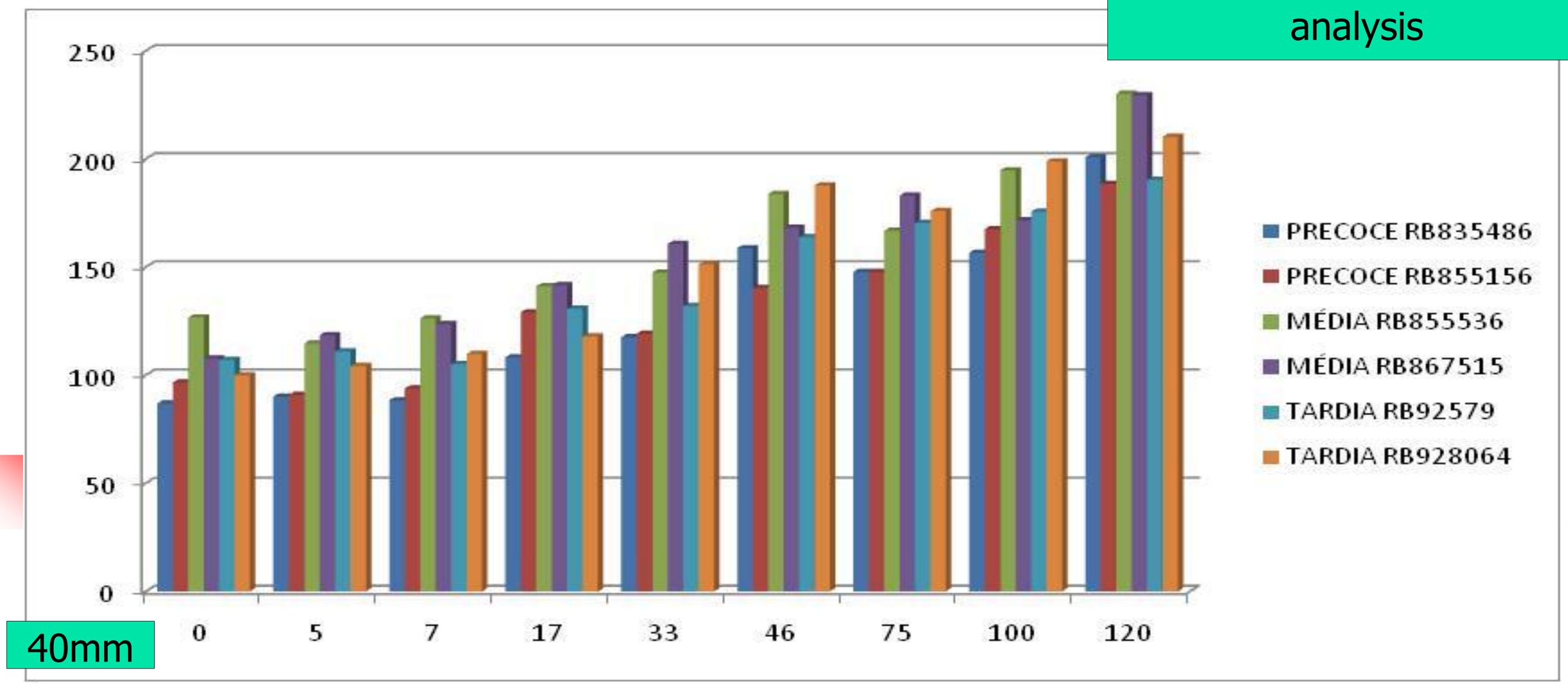
400 mm

Sensitive x Tolerant (responsive to irrigation)


0%
7%
17%
33%
46%
75%
100%


Balanço Hídrico Normal
300
250
200
150
100
50
0
mm
jan
fev
mar
abr
mai
jun
jul
ago
set
out
nov
dez
mês
P
ETP
ETR

Economic/environmental analysis



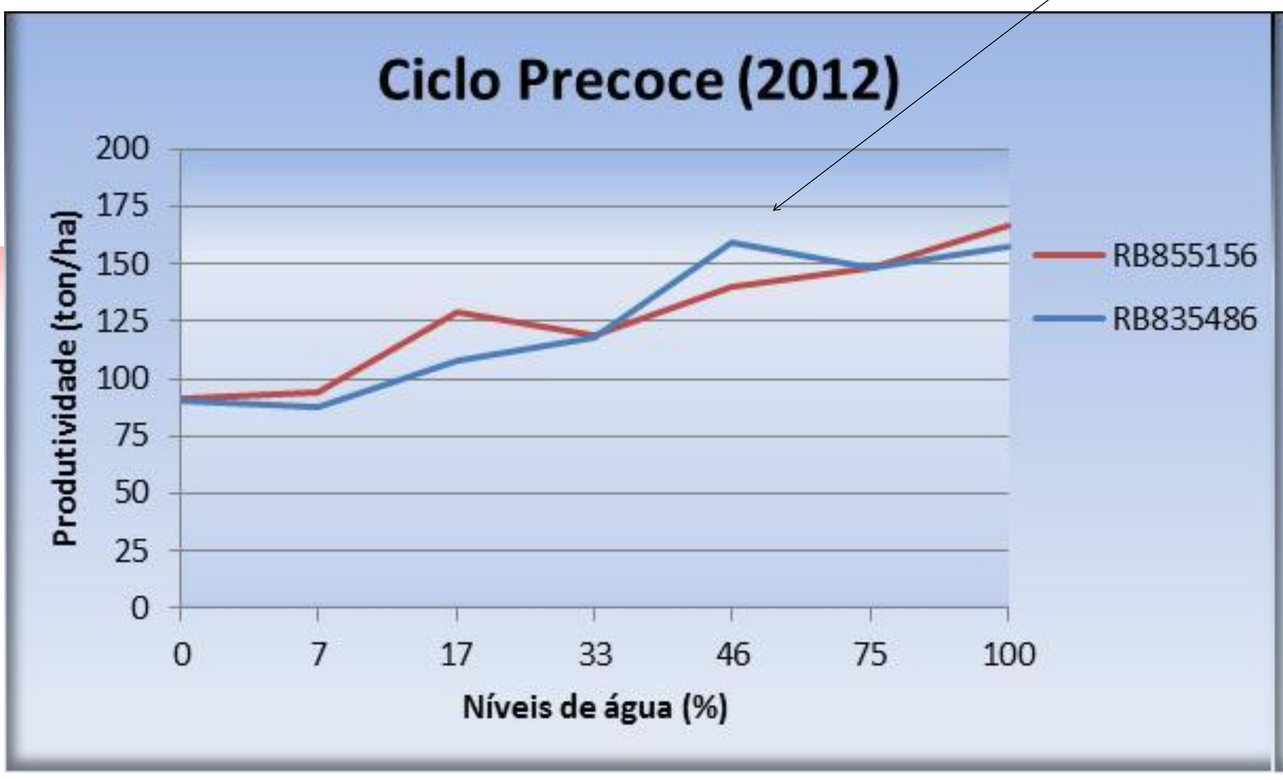
40mm

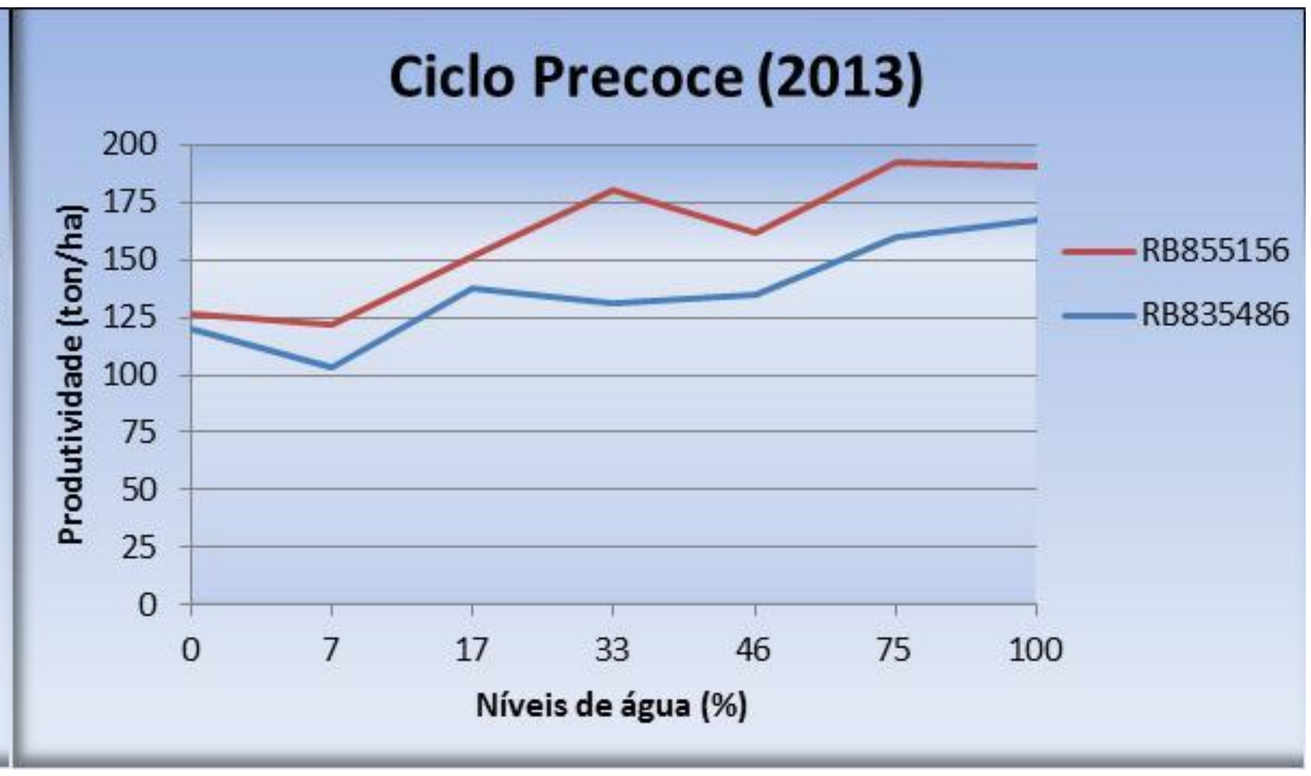
Genótipo	Irrigado		Sequeiro	Média
RB855536	230,15	Medium	126,74	178,44 A
RB867515	229,49		107,74	168,61 AB
RB928064	210,26	Long	100,00	155,13 AB
RB92579	190,26		107,00	148,63 B
RB835486	200,71	Short	86,85	143,78 B
RB855156	188,48		96,59	142,53 B
Média	208.22 a		104.15 b	

Early cycle

First cut: 47%

Secound cut: 61%





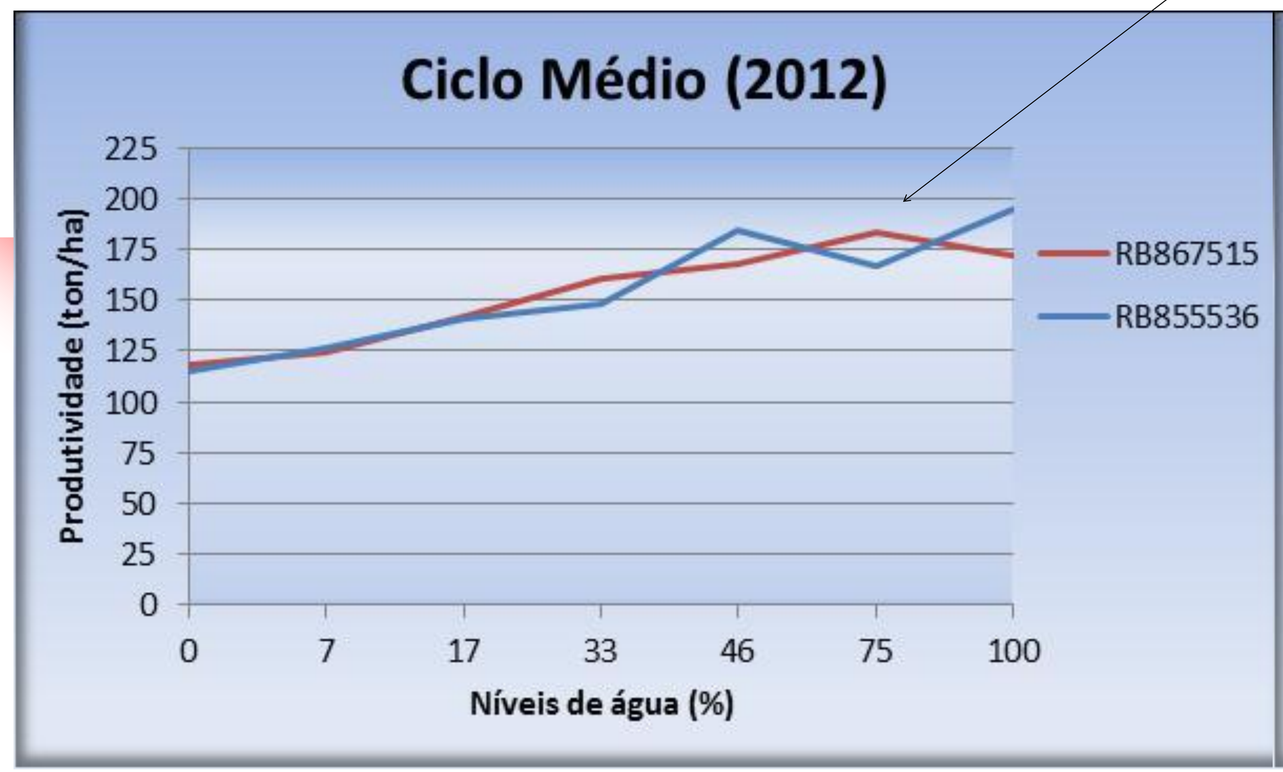
15 days

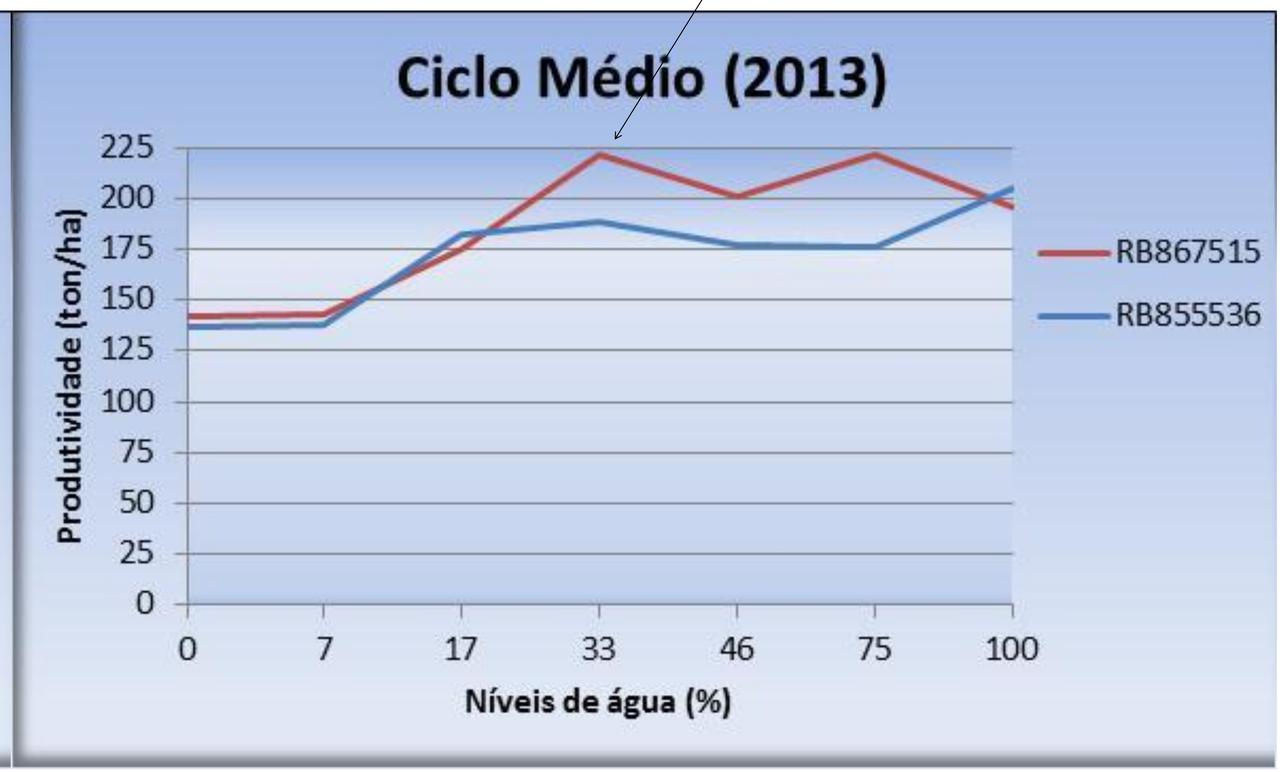
10 days

Medium cycle:

First cut:
51%

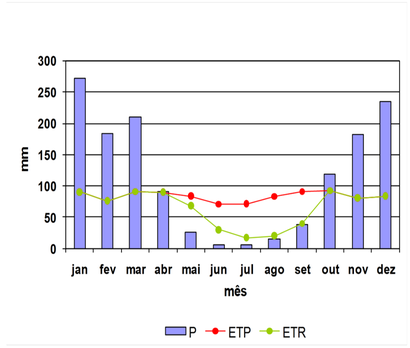
Secound cut:
62%





How many cuts?
Longevity

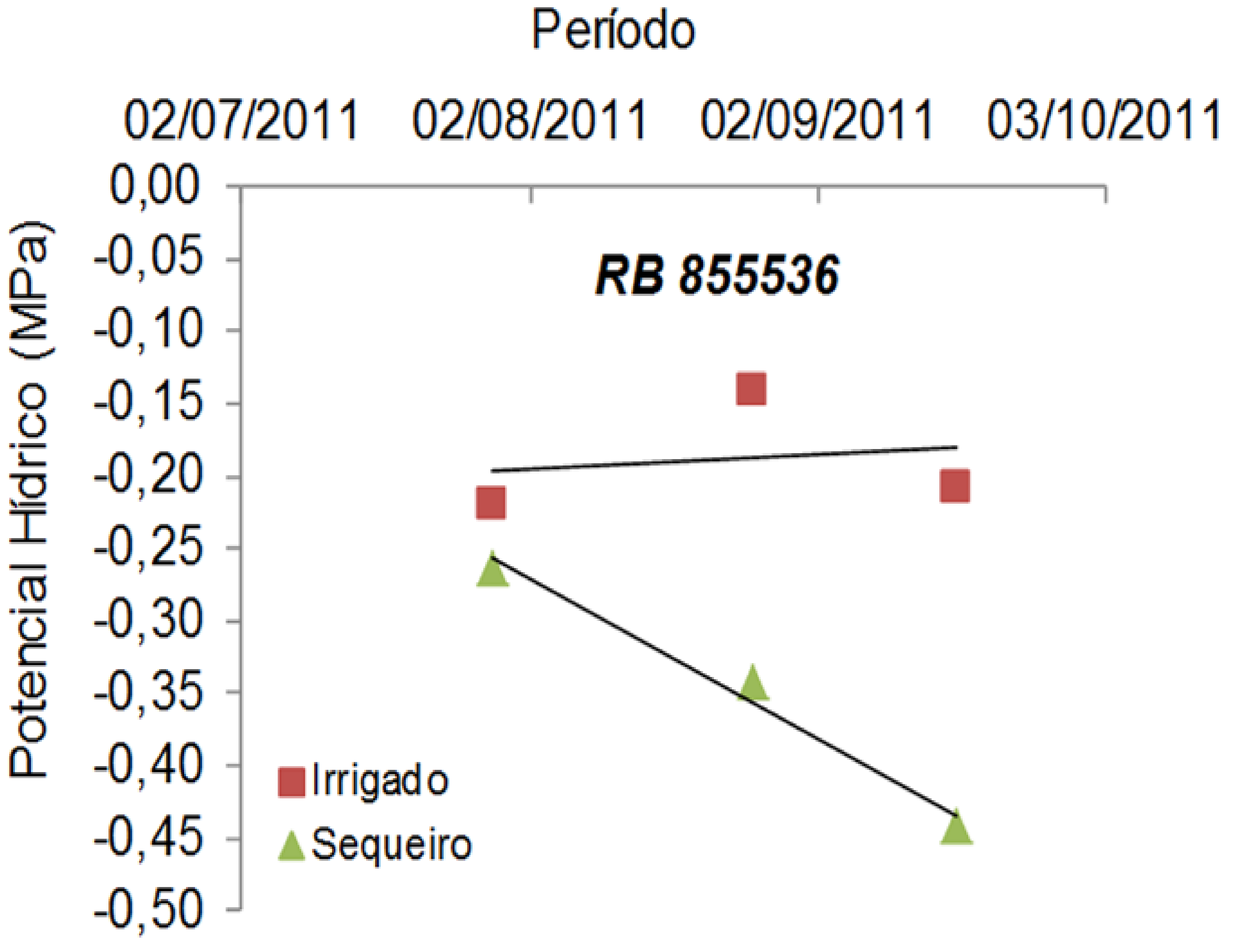
Long cycle:

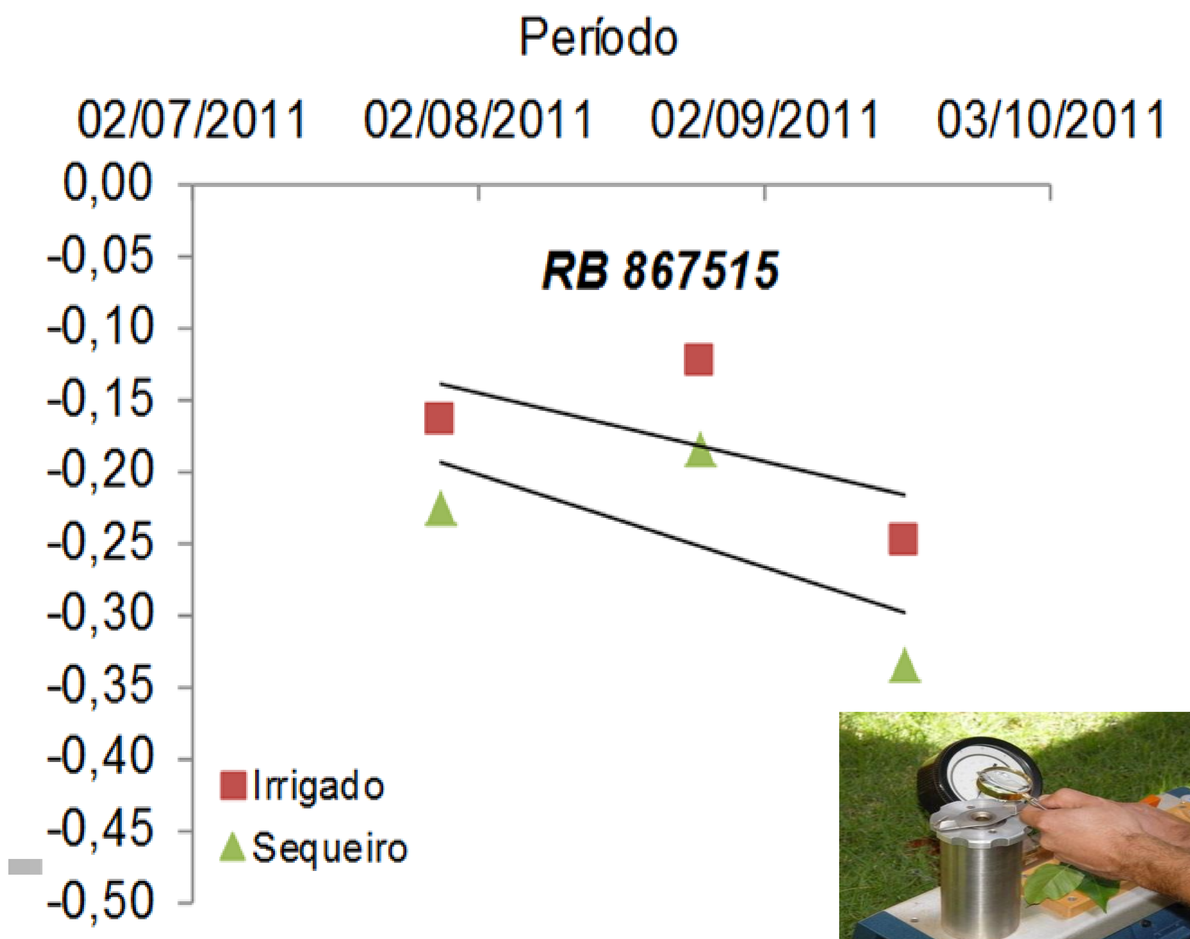


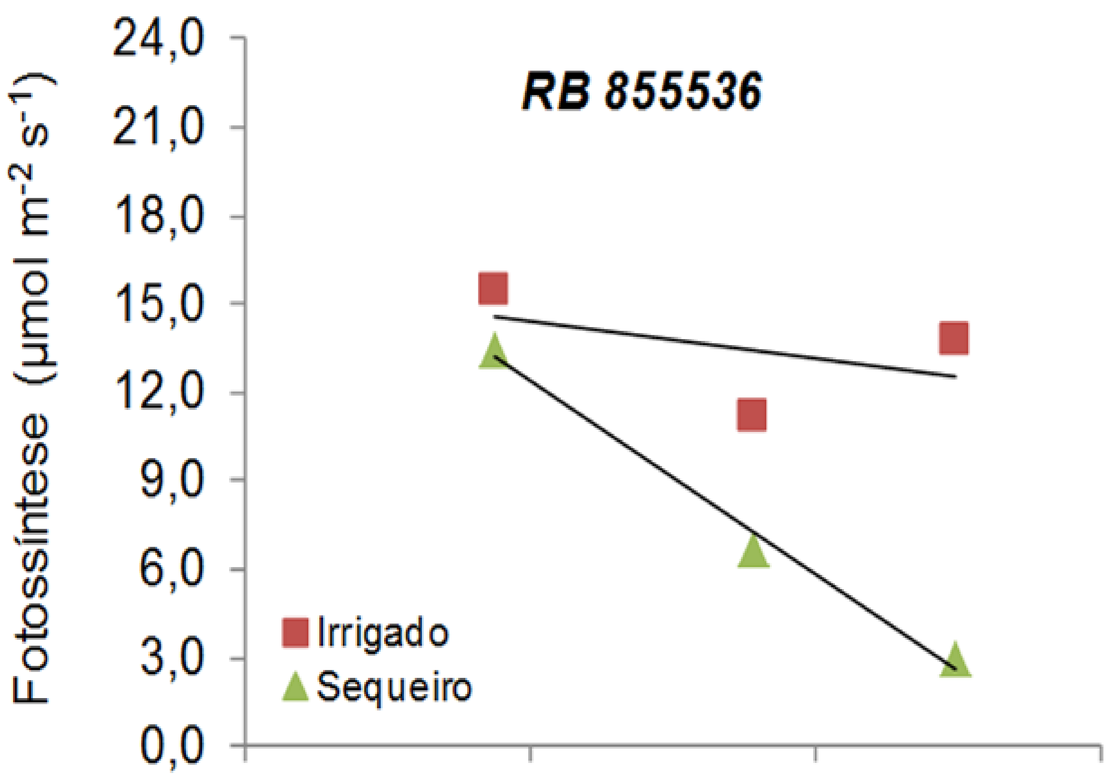
First cut:
52

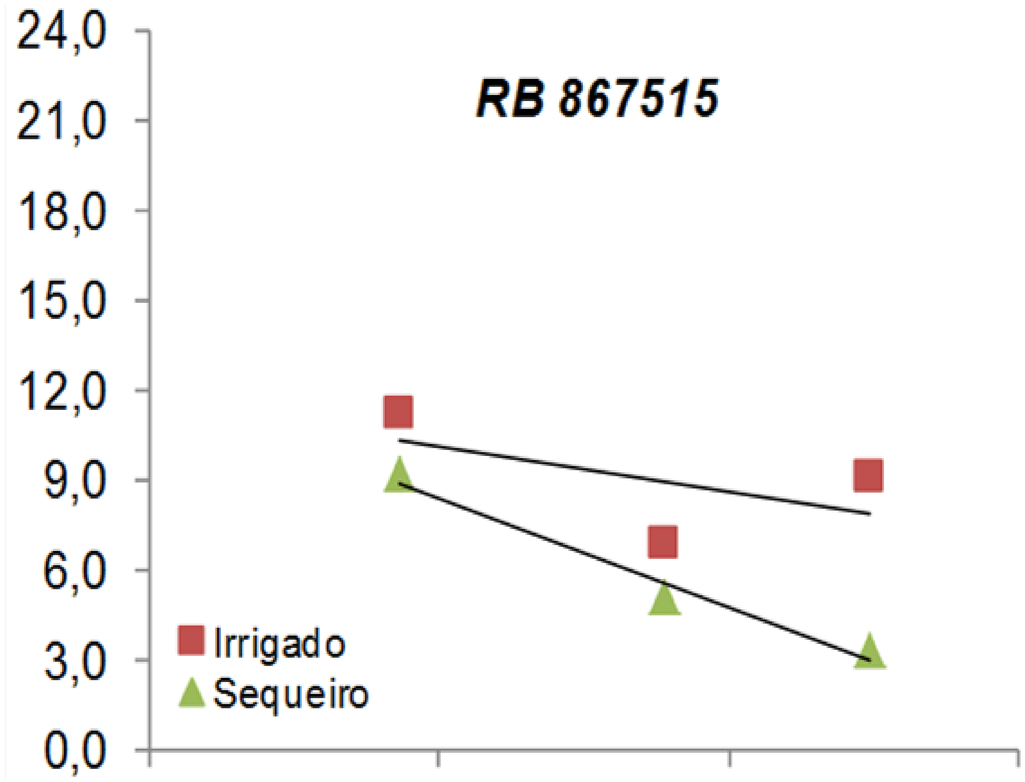
Secound cut:
62%

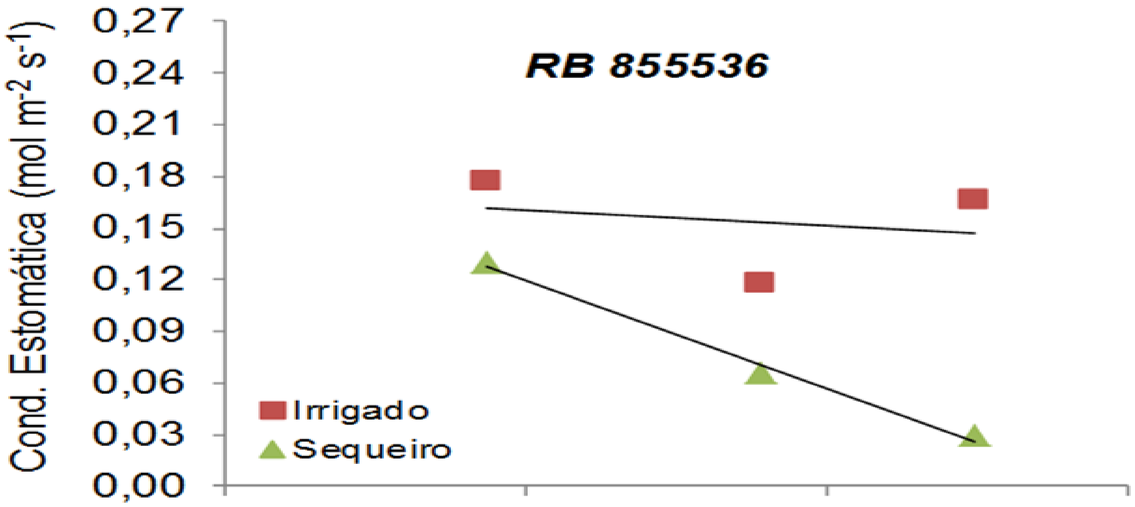
Bar shoul be taller

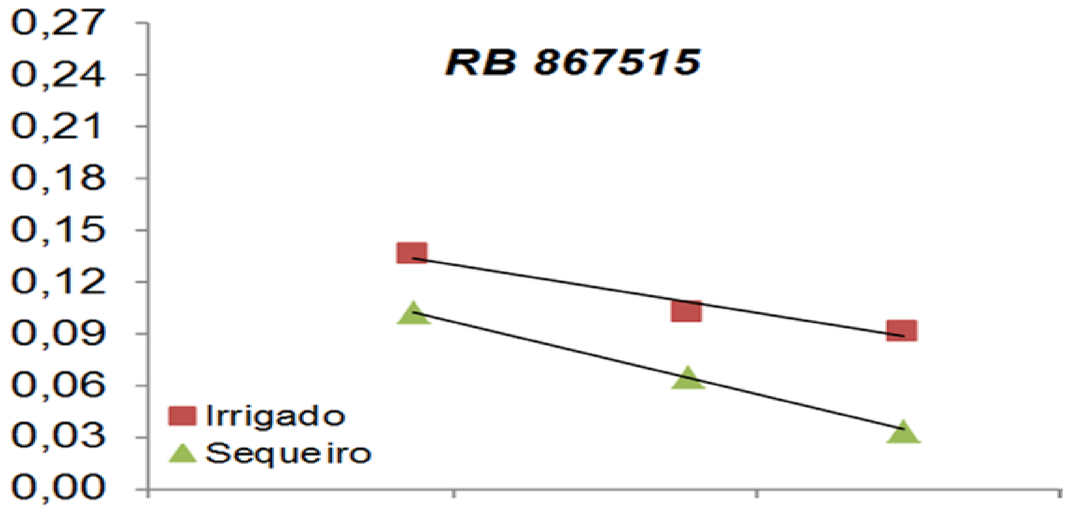

Período
02/07/2011
02/08/2011
02/09/2011
03/10/2011
Potencial Hídrico (MPa)
0,00
-0,05
-0,10
-0,15
-0,20
-0,25
-0,30
-0,35
-0,40
-0,45
-0,50
RB 855536
Irrigado
Sequeiro

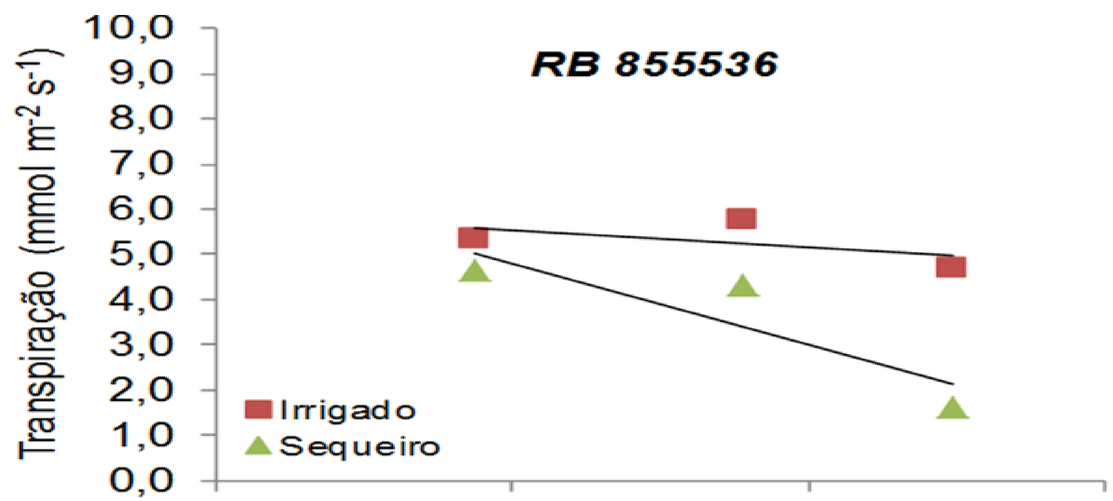

Período
02/07/2011
02/08/2011
02/09/2011
03/10/2011
0,00
-0,05
-0,10
-0,15
-0,20
-0,25
-0,30
-0,35
-0,40
-0,45
-0,50
RB 867515
Irrigado
Sequeiro

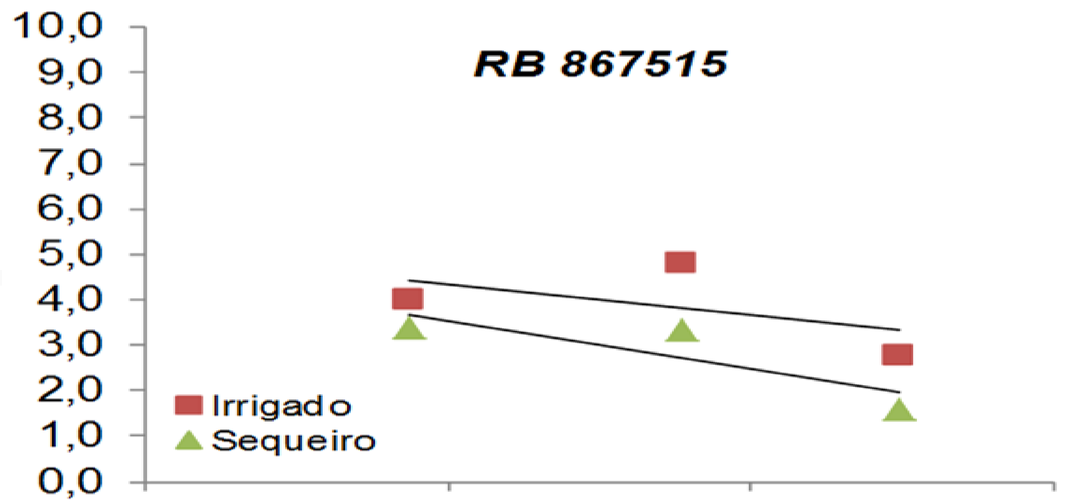

Fotossíntese (µmol m-2 s-1)
24,0
21,0
18,0
15,0
12,0
9,0
6,0
3,0
0,0
RB 855536
Irrigado
Sequeiro

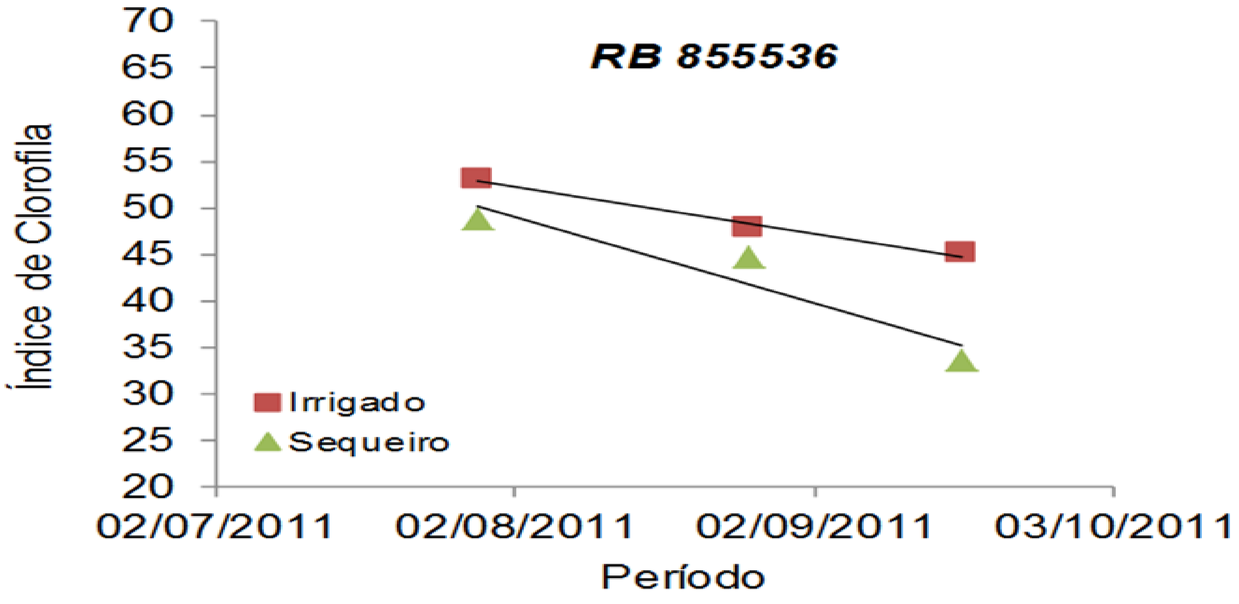

24,0
21,0
18,0
15,0
12,0
9,0
6,0
3,0
0,0
RB 867515
Irrigado
Sequeiro

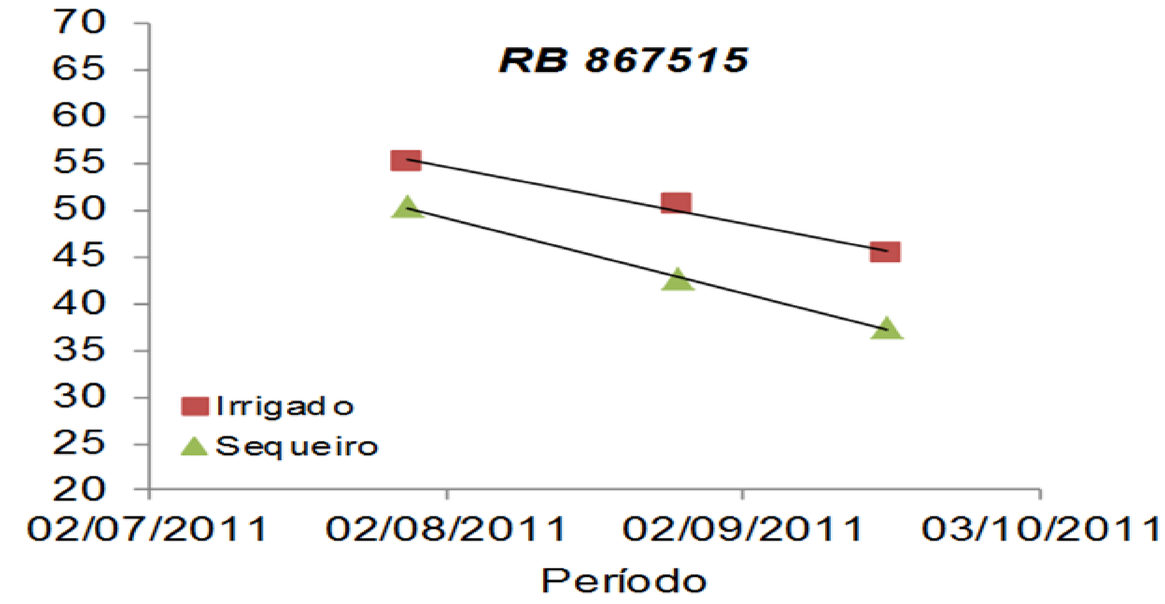

RB 855536
Cond. Estomática (mol m-2 s-1)
0,27
0,24
0,21
0,18
0,15
0,12
0,09
0,06
0,03
0,00
Irrigado
Sequeiro


RB 867515
0,27
0,24
0,21
0,18
0,15
0,12
0,09
0,06
0,03
0,00
Irrigado
Sequeiro


RB 855536
Transpiração (mmol m-2 s-1)
10,0
9,0
8,0
7,0
6,0
5,0
4,0
3,0
2,0
1,0
0,0
Irrigado
Sequeiro

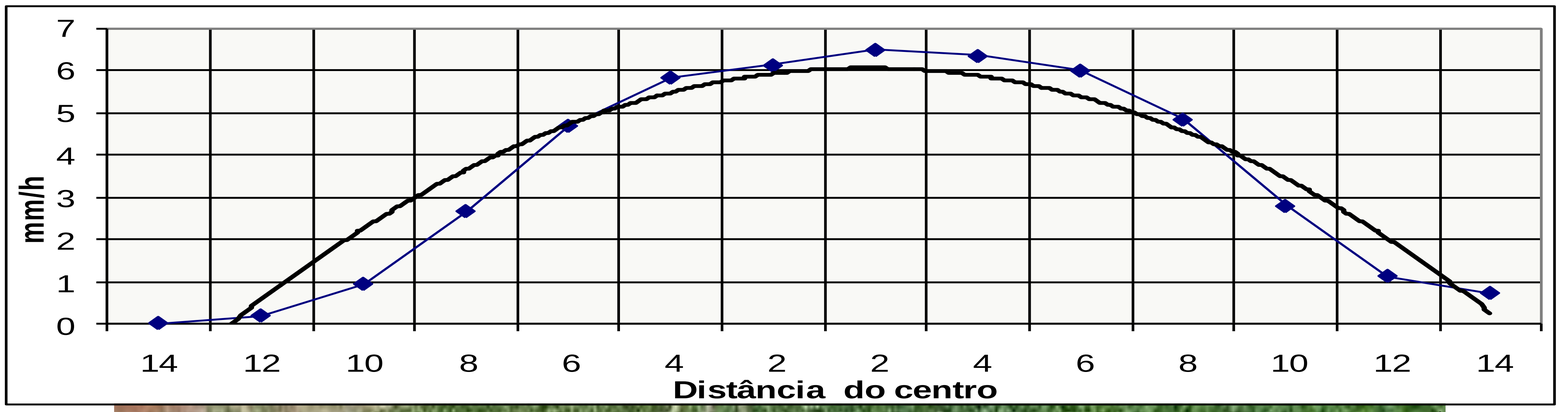

RB 867515
10,0
9,0
8,0
7,0
6,0
5,0
4,0
3,0
2,0
1,0
0,0
Irrigado
Sequeiro


RB 855536
Índice de Clorofila
70
65
60
55
50
45
40
35
30
25
20
Irrigado
Sequeiro
02/07/2011
02/08/2011
02/09/2011
03/10/2011
Período


RB 867515
70
65
60
55
50
45
40
35
30
25
20
Irrigado
Sequeiro
02/07/2011
02/08/2011
02/09/2011
03/10/2011
Período

Root: Scanning

Soybean:



Emprapa Cerrados

BRS 7580

Correntina - BA

Coffee

- Intensity and duration of hydric stress in *Coffea canephora*

Tradicional System

Embrapa Ministério da Agricultura, Pecuária e Abastecimento GOVERNO FEDERAL
CONSÓRCIO BRASILEIRO DE PESQUISA E DESENVOLVIMENTO DO CAFÉ

Embrapa Ministério da Agricultura, Pecuária e Abastecimento GOVERNO FEDERAL
CONSÓRCIO BRASILEIRO DE PESQUISA E DESENVOLVIMENTO DO CAFÉ

Maturation

Embrapa Ministério da Agricultura, Pecuária e Abastecimento GOVERNO FEDERAL
CONSÓRCIO BRASILEIRO DE PESQUISA E DESENVOLVIMENTO DO CAFÉ

Perspectives:

- Trusteable and Authomatised Selection
- Drought Mecanisms Identified
- Breeding – Improved cultivar (Wheat) Soybean? Sugar cane?
- Gene prospection (Syntheny – Promoter in rice or GMO) – GMO in sugar cane
- Plant Management (gypsum)
- Modeling (risk and environmental watershed)

Infrared

Team: Wheat, sugar cane, soybean, Cofee: 70 workers (46)

- **Agro metereology:** Alexsandra
- **Crosses:** Márcio Soesilva
- **Fenotyping:**, Júlio, Walter
- **Genetic:** Allan, Cristina, F. Faleiro, Gisele, Hugo, Jorge, Marco, Marília, Rodrigo
- **Irrigation**: Guerra, Omar, Sebastião, Vinicius
- **Mapping:** Luciano, Sandra M.
- **Modeling:** Balbino, Lineu, Macena
- **Phitopatology**: Alexei, Angelo
- **Plant management:** Adilson, André, F. Pedro, Karina, Kleberson, Sebastião Pedro, Vilela
- **Plant physiology**: Gustavo, Lucrécia, Mauro, Sidney, Solange
- **Roots**: João de Deus
- **Soil Fertility:** Thomaz
- **Students: BSc, MSc, PhD, Post doc**
- Adley (PhD), Afonso, Auri, Alexandre, Anderson, Caio, **Cristiane (Post-doc)**, Dina, Giovani, Gustavo, Jonhson, Kelen, Laryssa (MSc), Leonardo, Leticia (Post-doc), Luan, Maria Theresa, Neurivan, Rodrigo, Batista (PhD), Thiago, Umberto (MSc)
- **Technitians:** Amilton, Beto, Fabiano, Carlão
- **Field workers**: Cleber, Douglas, Geraldo, Jesuino, J. Reis, Juvêncio

Walter.quadros@embrapa.br

Thank you!