
Rothamsted variety trials

http://www.wgin.org.uk/

defra
Department for Environment Food and Rural Affairs

JOHN INNES CENTRE

ROTHAMSTED RESEARCH

Nitrogen Use Efficiency
Rothamsted Variety Trials

Peter Barraclough

WGIN stakeholders meeting, Rothamsted, November 2005

Who cares about N use efficiency?

FARMERS - With N at £480/t and grain at £60/t

GOVERNMENT - Half of England designated a NVZ
Possible future limit on N use or tax on N? (cf Denmark)

MILLERS - High protein grain

ORGANIC GROWERS - No synthetic fertilisers allowed

PUBLIC – Global warming, biodiversity, eutrophication
£30M pa bill for cleaning-up drinking water in the UK

FERTILISER INDUSTRY – see above

PLANT BREEDERS – see above

RESEARCH FUNDERS – see above

WGIN-04 on Black Horse

WGIN-04
Varieties

32 Varieties x 4 N x 3 Reps

1. **AR**che	**EI**nstein	**M**aris **W**idgeon (t)	**RiB**and
2. **AV**alon	Enorm **(V1)**	**ME**rcia	**SC**orpion
3. **BA**tis	**Fl**anders (t)	Monopol **(V4)**	Sokrates **(V3)**
4. **BE**aver	**HE**reward	**OP**us	**S**oi**S**sons
5. **C**aden**Z**a	Hurley **(ELS)**	**PA**ragon	**S**o**L**stice
6. **C**a**P**horn	**IS**engrain	**PBI**S	**SP**ark
7. **C**appelle-**D** (t)	**LY**nx	Petrus **(V2)**	**XI**19
8. Chablis **(RE)**	**MA**lacca	**R**ia**L**to	Zyta **(AP)**

Underlined = parent of public DH mapping population

Blue = public molecular data available

Green = Broadbalk @ RRes

Purple = spring variety

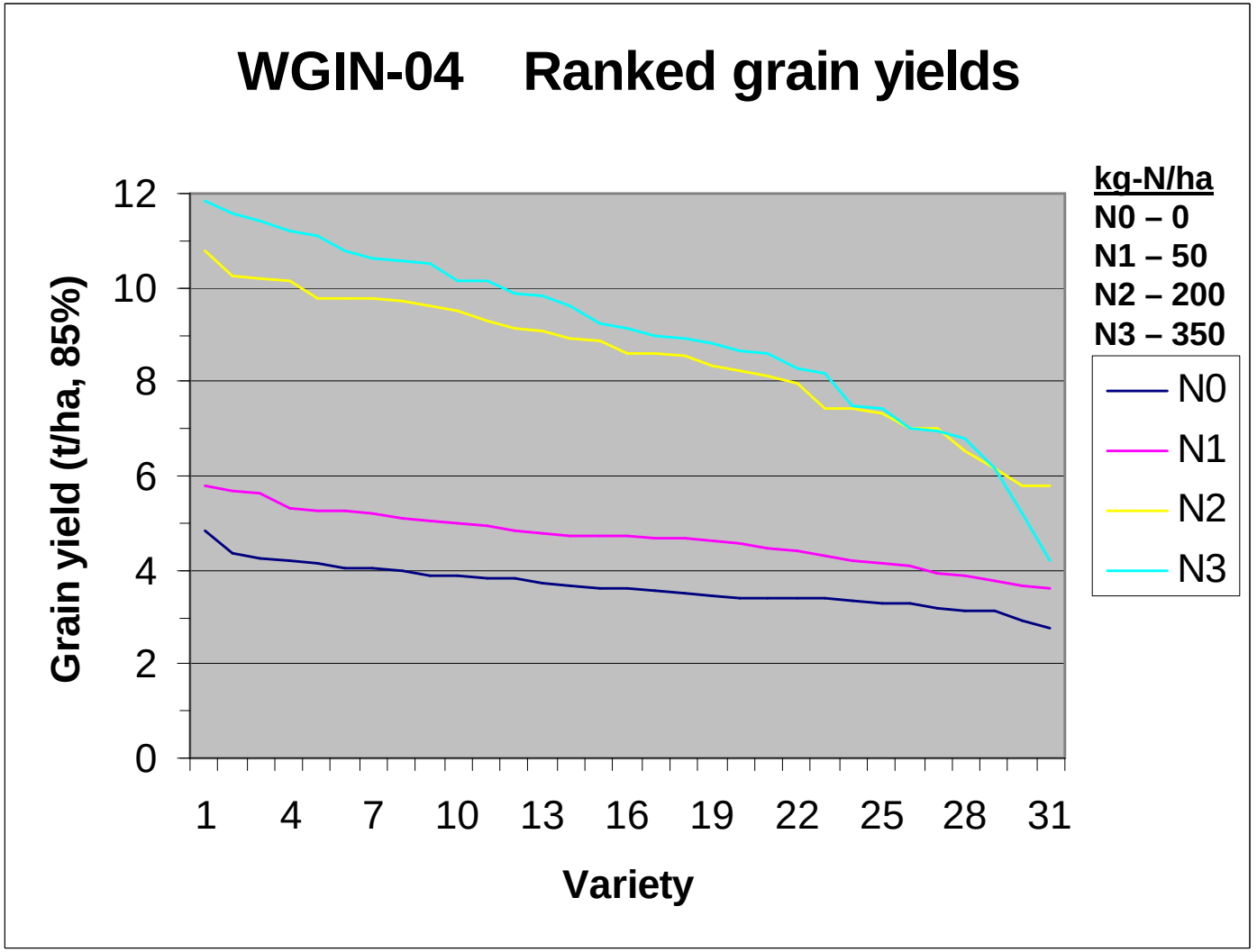
(t) = Tall variety

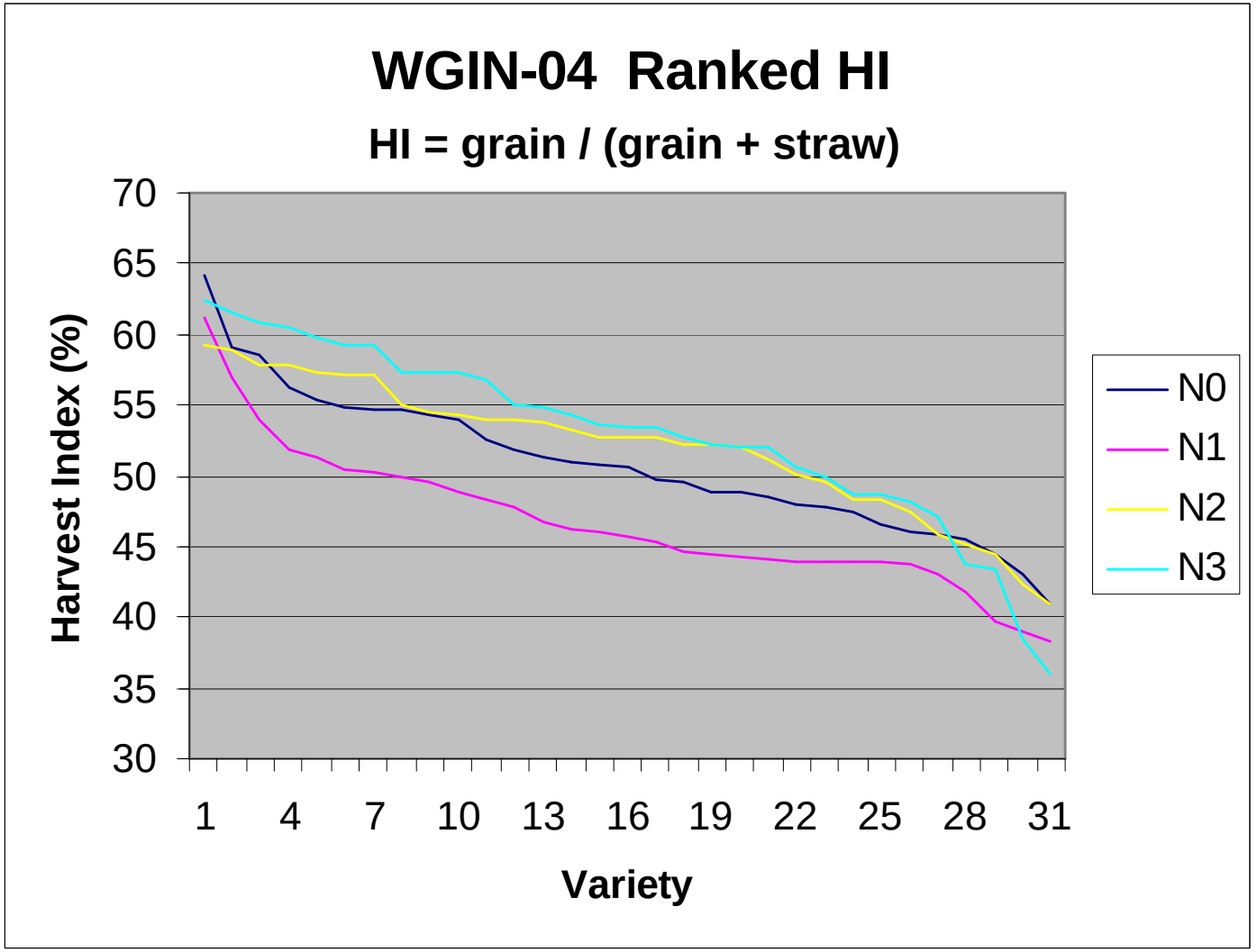
WGIN-04 Basics

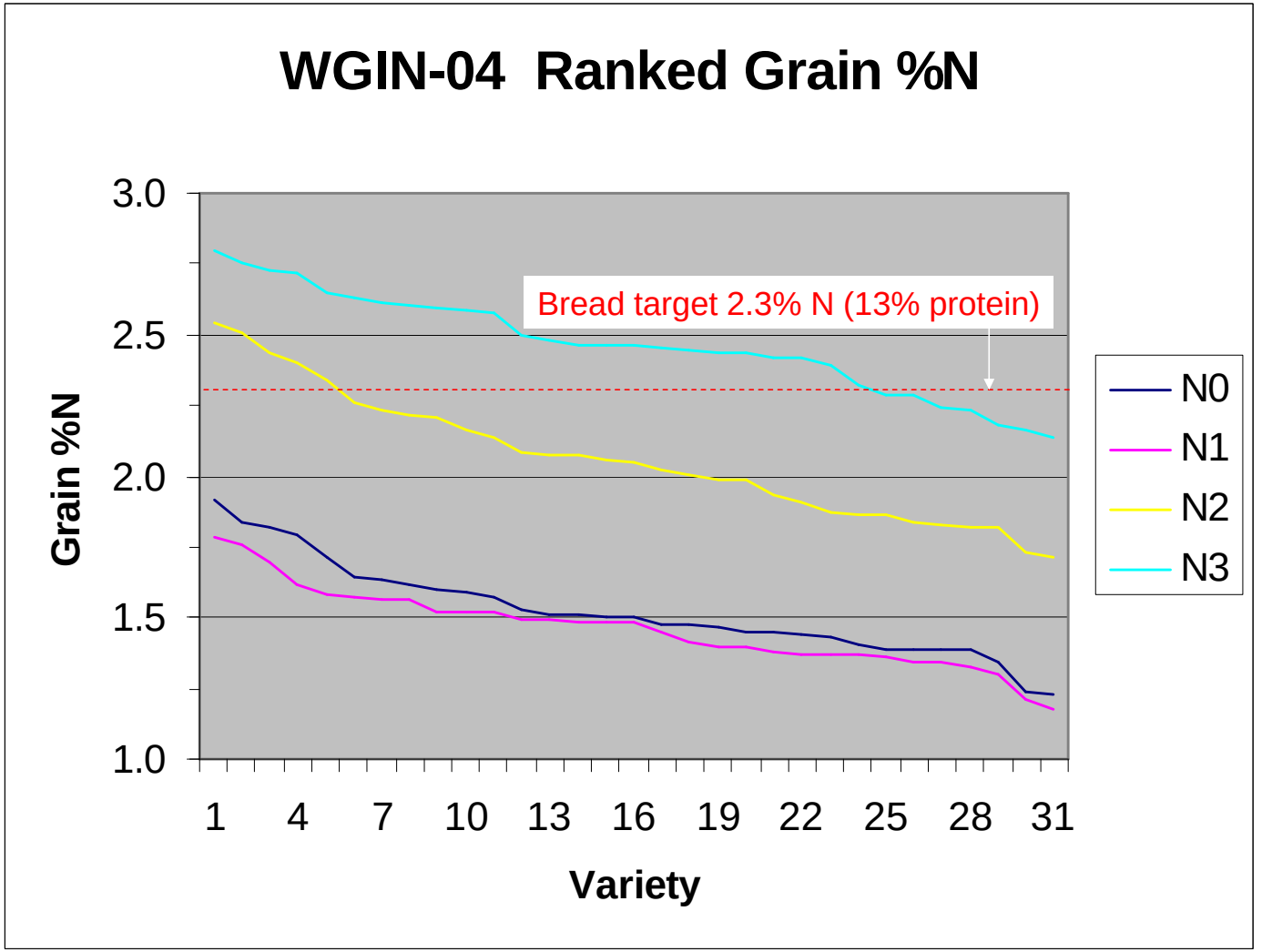
Basic measurements…

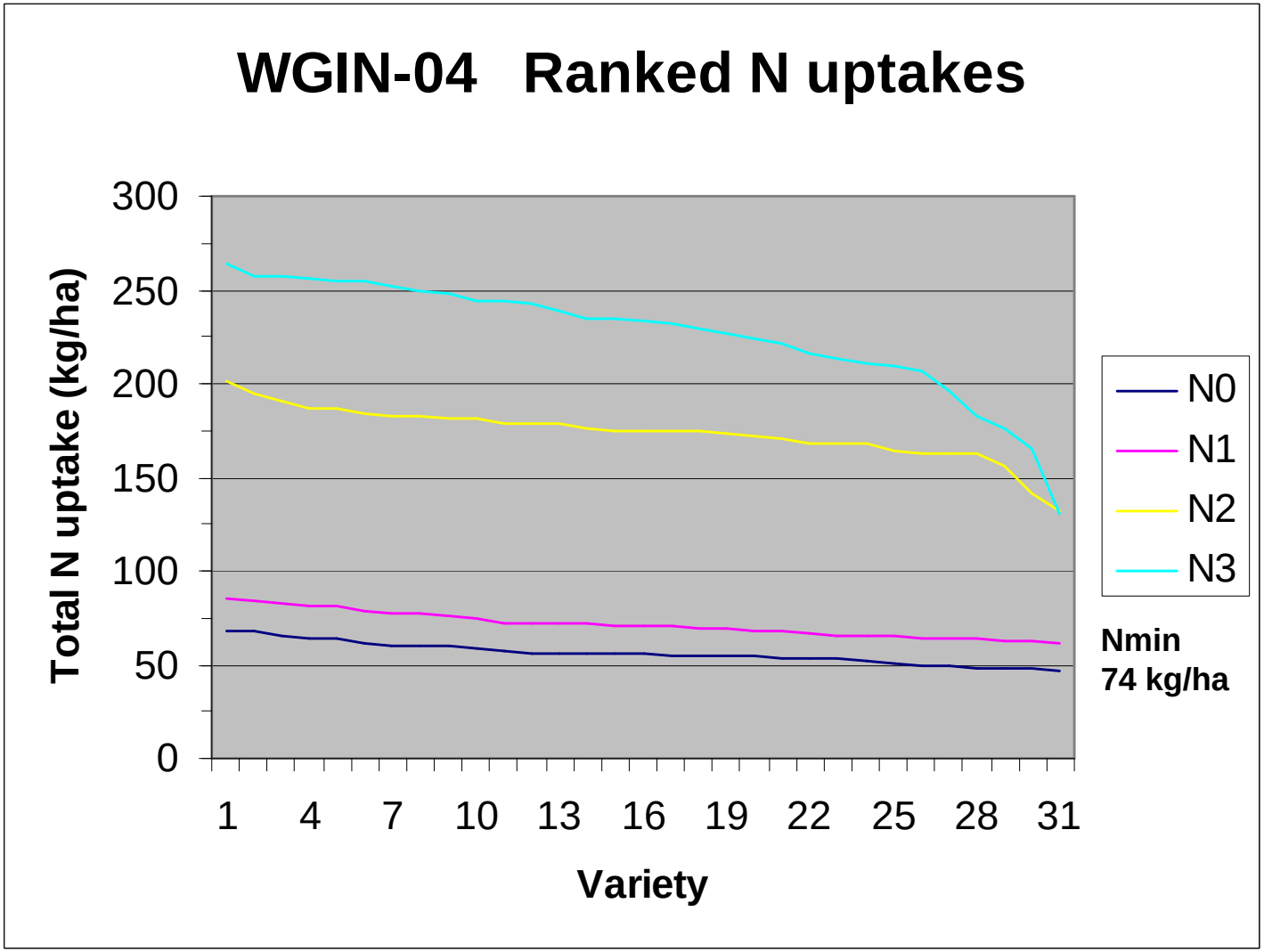
Grain Yield
Straw Yield
%N in Grain
%N in Straw

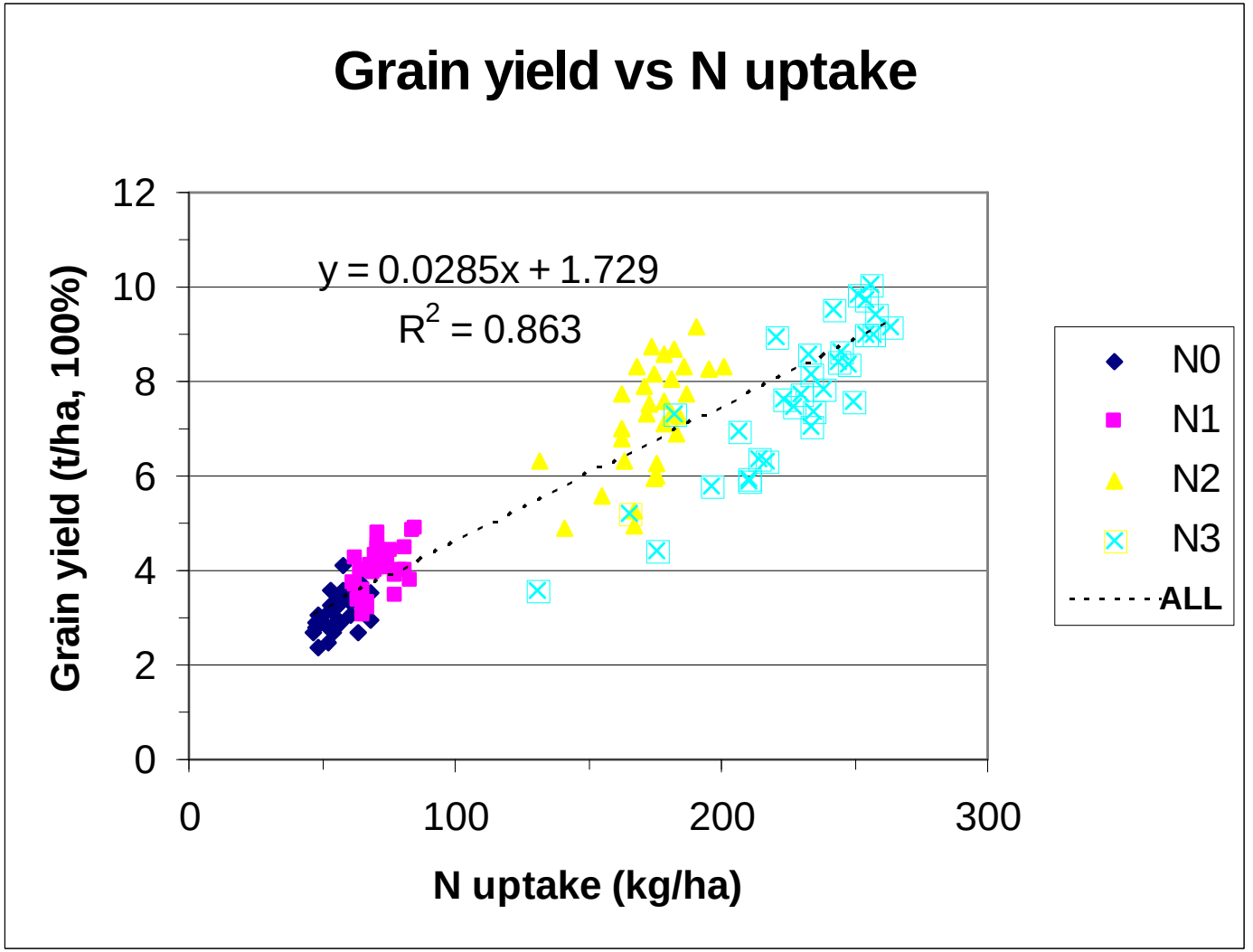
Soil Nmin

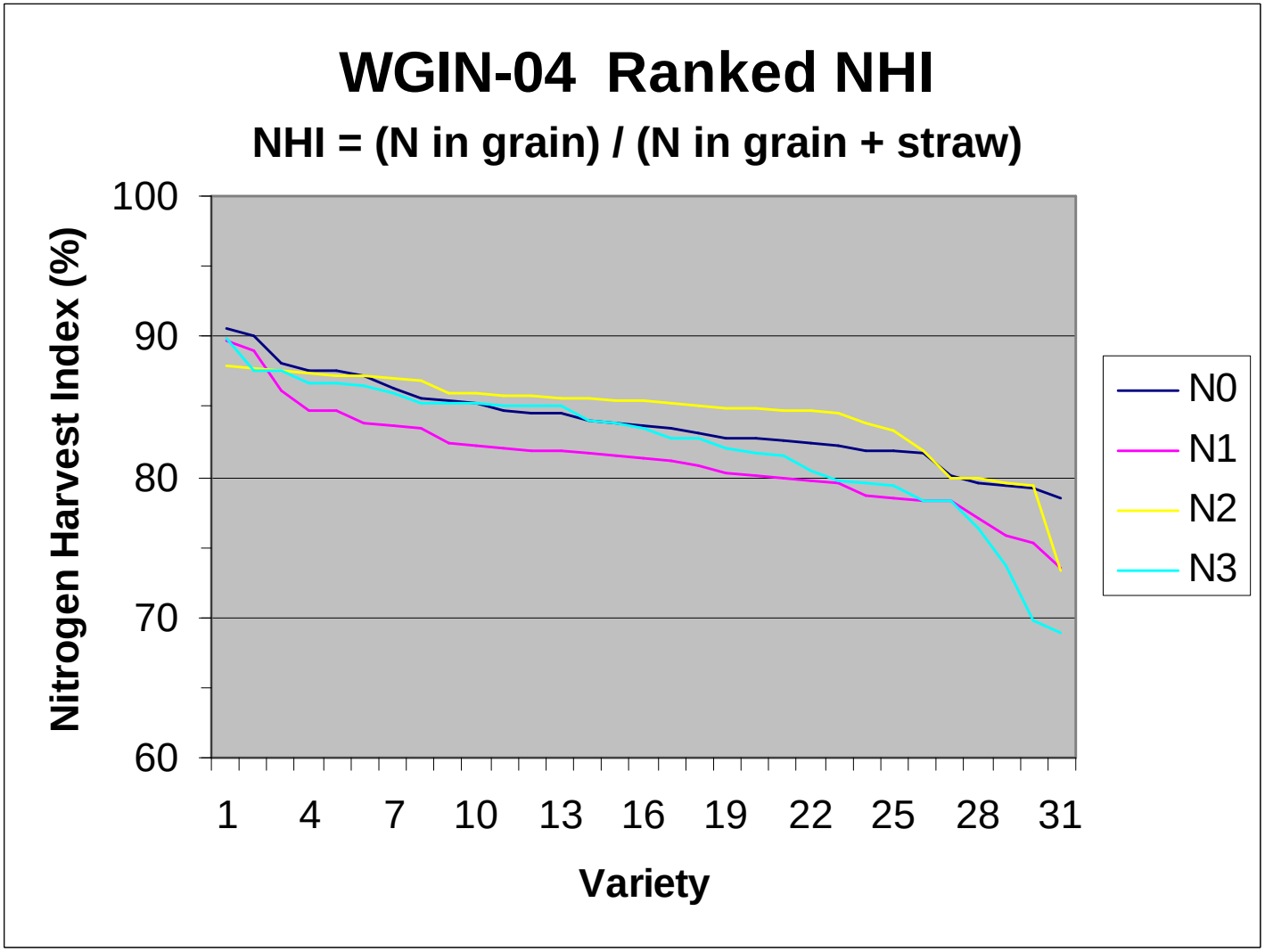

WGIN-04 Ranked grain yields
Grain yield (t/ha, 85%)
12
10
8
6
4
2
0
1
4
7
10
13
16
19
22
25
28
31
Variety
kg-N/ha
N0 – 0
N1 – 50
N2 – 200
N3 – 350
N0
N1
N2
N3


WGIN-04 Ranked HI
HI = grain / (grain + straw)
Harvest Index (%)
70
65
60
55
50
45
40
35
30
1
4
7
10
13
16
19
22
25
28
31
Variety
N0
N1
N2
N3


WGIN-04 Ranked Grain %N
Grain %N
3.0
2.5
2.0
1.5
1.0
Bread target 2.3% N (13% protein)
1
4
7
10
13
16
19
22
25
28
31
Variety
N0
N1
N2
N3


WGIN-04 Ranked N uptakes
Total N uptake (kg/ha)
300
250
200
150
100
50
0
1
4
7
10
13
16
19
22
25
28
31
Variety
N0
N1
N2
N3
Nmin
74 kg/ha


Grain yield vs N uptake
y = 0.0285x + 1.729
R2 = 0.863
Grain yield (t/ha, 100%)
N uptake (kg/ha)
0
2
4
6
8
10
12
0
100
200
300
N0
N1
N2
N3
ALL


WGIN-04 Ranked NHI
NHI = (N in grain) / (N in grain + straw)
Nitrogen Harvest Index (%)
100
90
80
70
60
1
4
7
10
13
16
19
22
25
28
31
Variety
N0
N1
N2
N3

WGIN-04 Derived

Derived parameters and correlations

NUE, NupE, NutE

Some examples…

WGIN-04
Parameters

LIST OF RANKED PARAMETERS

1. Grain Yield (t/ha @ 100%DM)
2. Adj-Straw Yield (t/ha @ 100%DM)
3. Total DM Yield (t/ha @ 100%DM)
4. Harvest Index (HI)
5. Grain %N
6. Straw %N
7. Grain N Uptake (kg/ha)
8. Adj-Straw N Uptake (kg/ha)
9. Total N Uptake (kg/ha)
10. Nitrogen Harvest Index (NHI)
11. N Uptake Efficiency (NupE) (kgN/kgN)
12. N Utilisation Efficiency (NutE) for Grain (kgDM/kgN)
13. N Use Efficiency (NUE) for Grain (kgDM/kgN)
14. N Utilisation Efficiency (NutE) for Total DM (kgDM/kgN)
15. N Use Efficiency (NUE) for Total DM (kgDM/kgN)

WGIN-04
Definitions

'Nitrogen Use Efficiency'

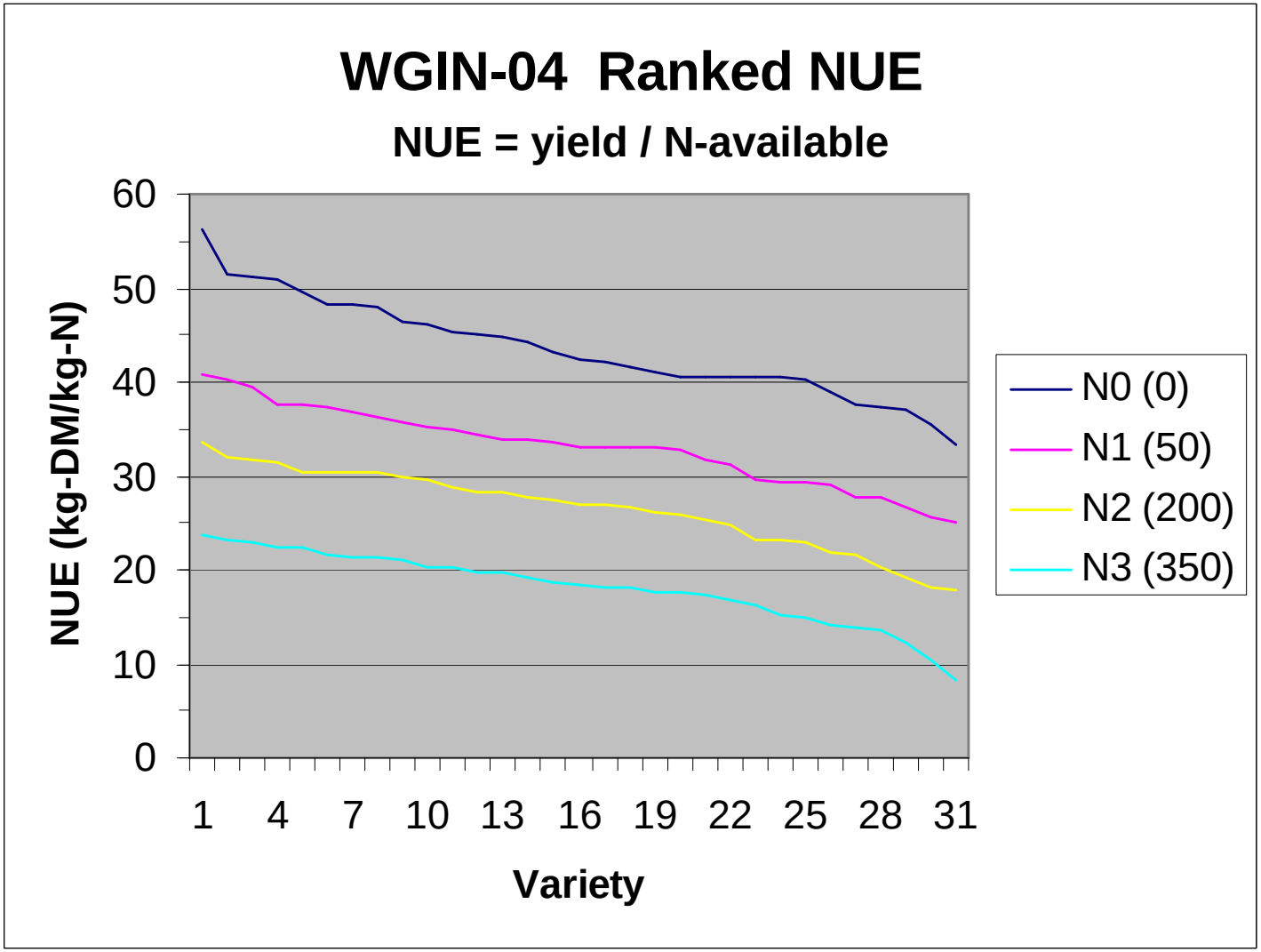
Fertiliser Use Efficiency (FUE)
% of applied fertiliser recovered by crop

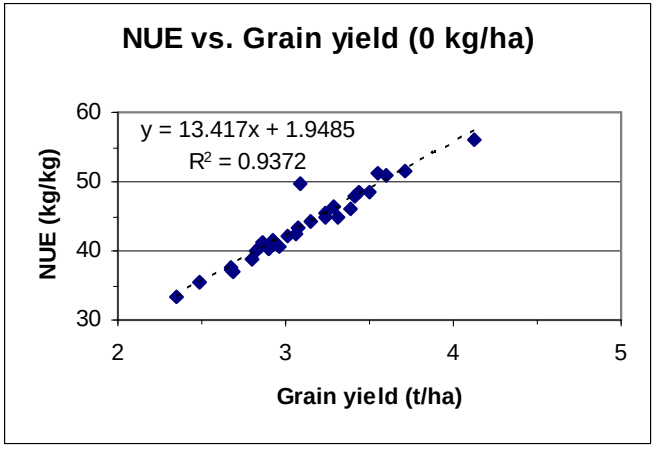
Nitrogen Uptake Efficiency (NupE)
N-uptake/N-available (Nup/Nav)

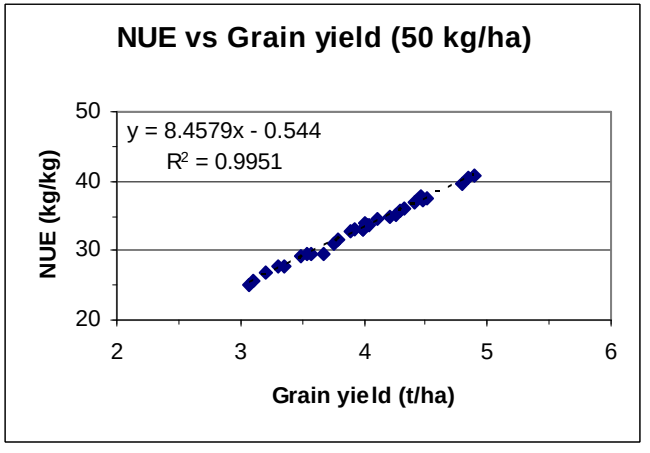
Nitrogen Utilisation Efficiency (NutE)
Grain yield/N-uptake (Y/Nup)

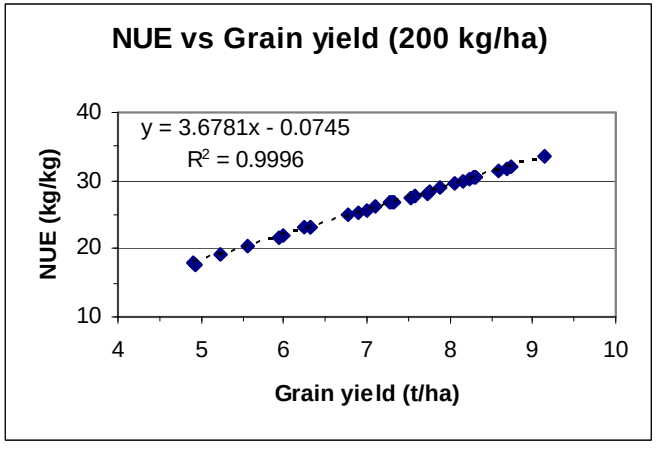
Nitrogen Use Efficiency (NUE)
Uptake efficiency x Utilisation efficiency

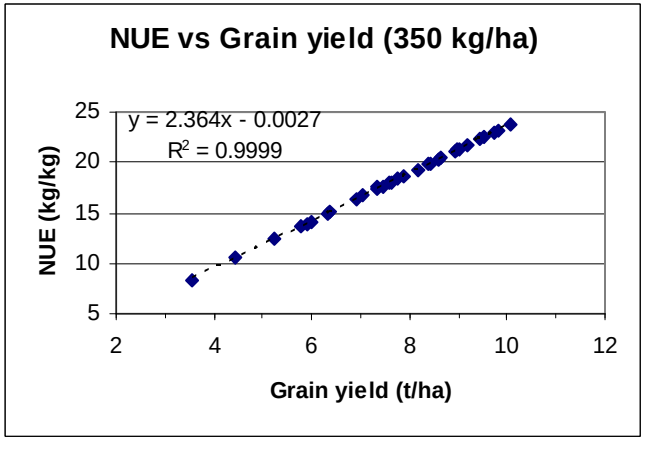
NUE = Nup/Nav x Y/Nup = Y/Nav


WGIN-04 Ranked NUE
NUE = yield / N-available
NUE (kg-DM/kg-N)
60
50
40
30
20
10
0
1
4
7
10
13
16
19
22
25
28
31
Variety
N0 (0)
N1 (50)
N2 (200)
N3 (350)

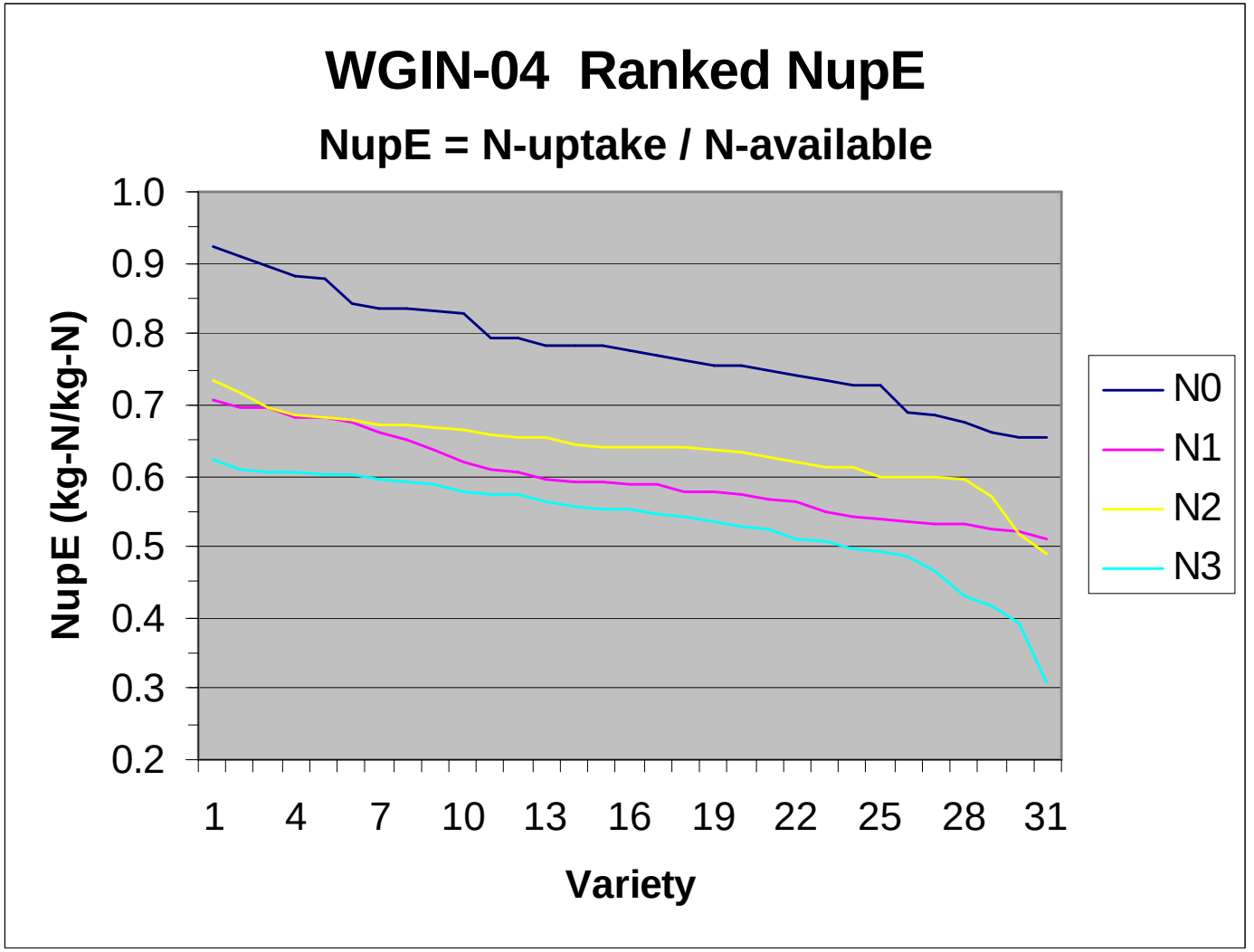








NUE = yield / N-available

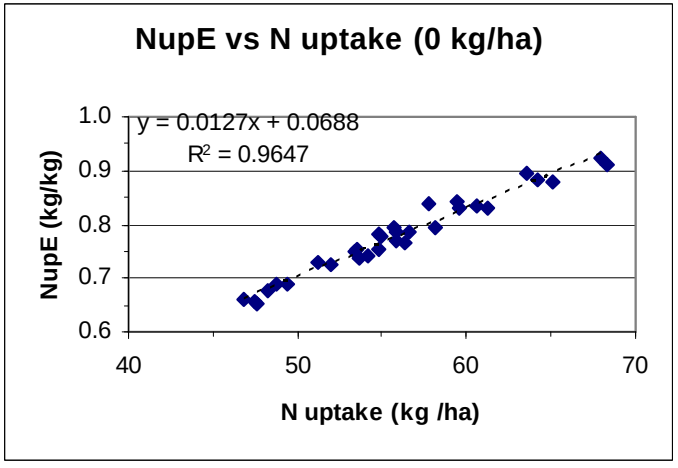

WGIN-04 Ranked NupE
NupE = N-uptake / N-available
NupE (kg-N/kg-N)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
1
4
7
10
13
16
19
22
25
28
31
Variety
N0
N1
N2
N3

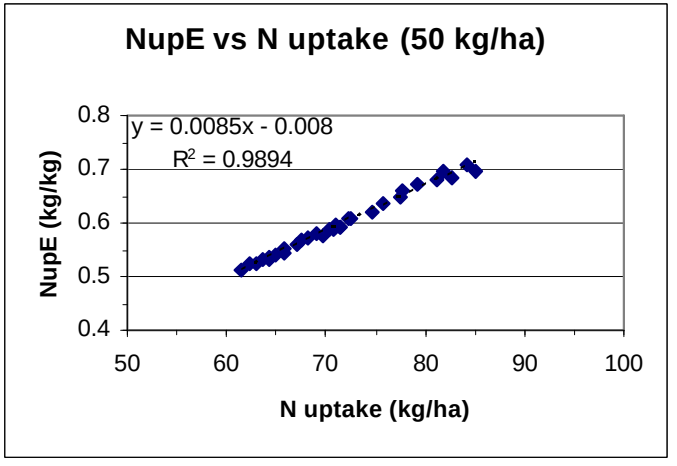
WGIN-04
N rates

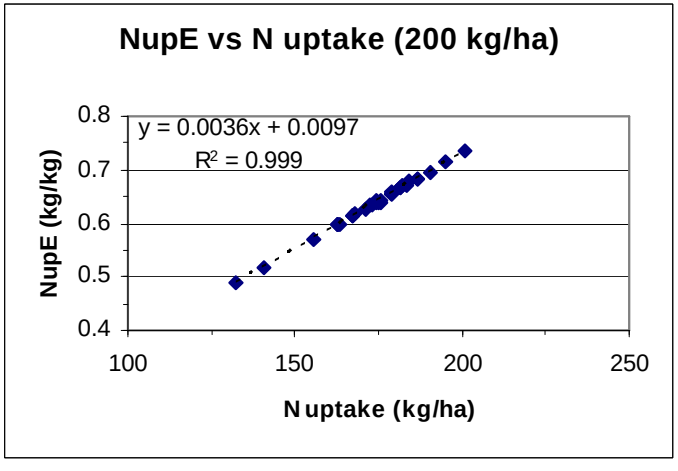
4 x Fertiliser-N rates*

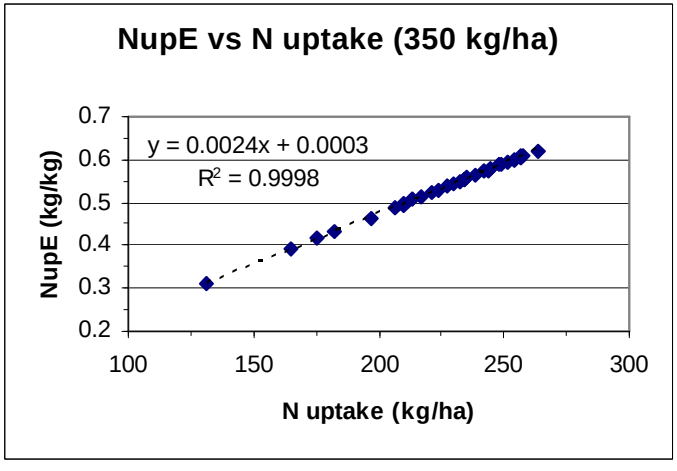
		Split N application		
Code	**kg N/ha**	**Mar**	**Apr**	**May**
N0	**0**			
N1	**100****	**50**	**50**	
N2	**200**	**50**	**100**	**50**
N3	**350*****	**50**	**250**	**50**
		GS 24	**GS 31/32**	**GS 37**

* Soil N_{min} (90 cm in Feb) 74 kg/ha (57-96)
** 50 kg/ha applied in error
*** PGR important to prevent lodging

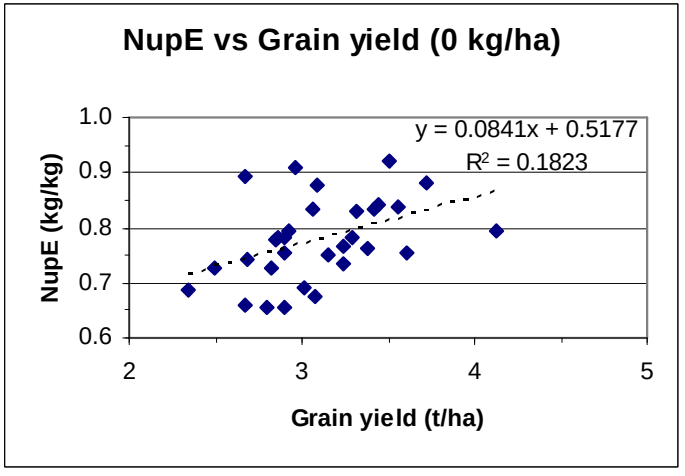


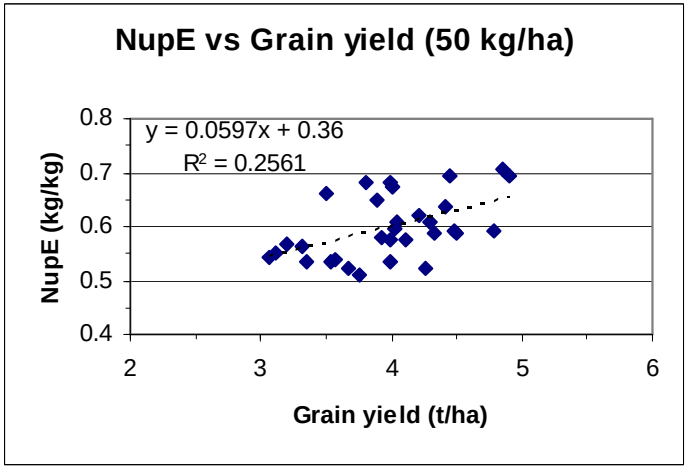


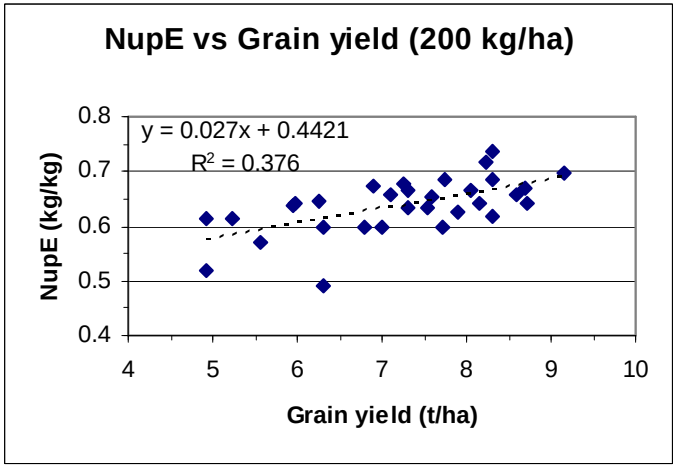


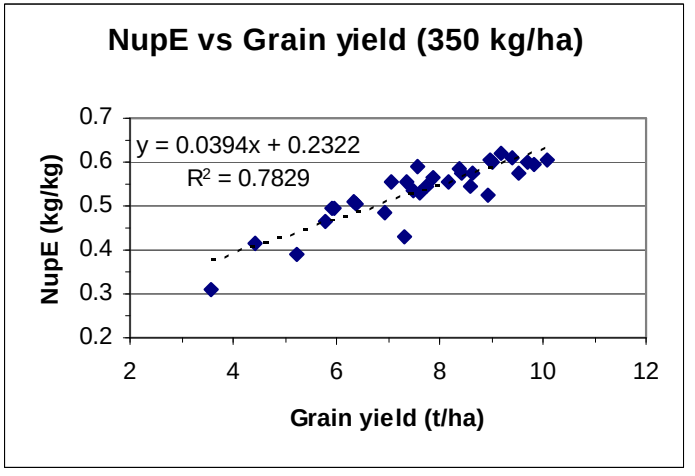


NupE = N-uptake / N-available

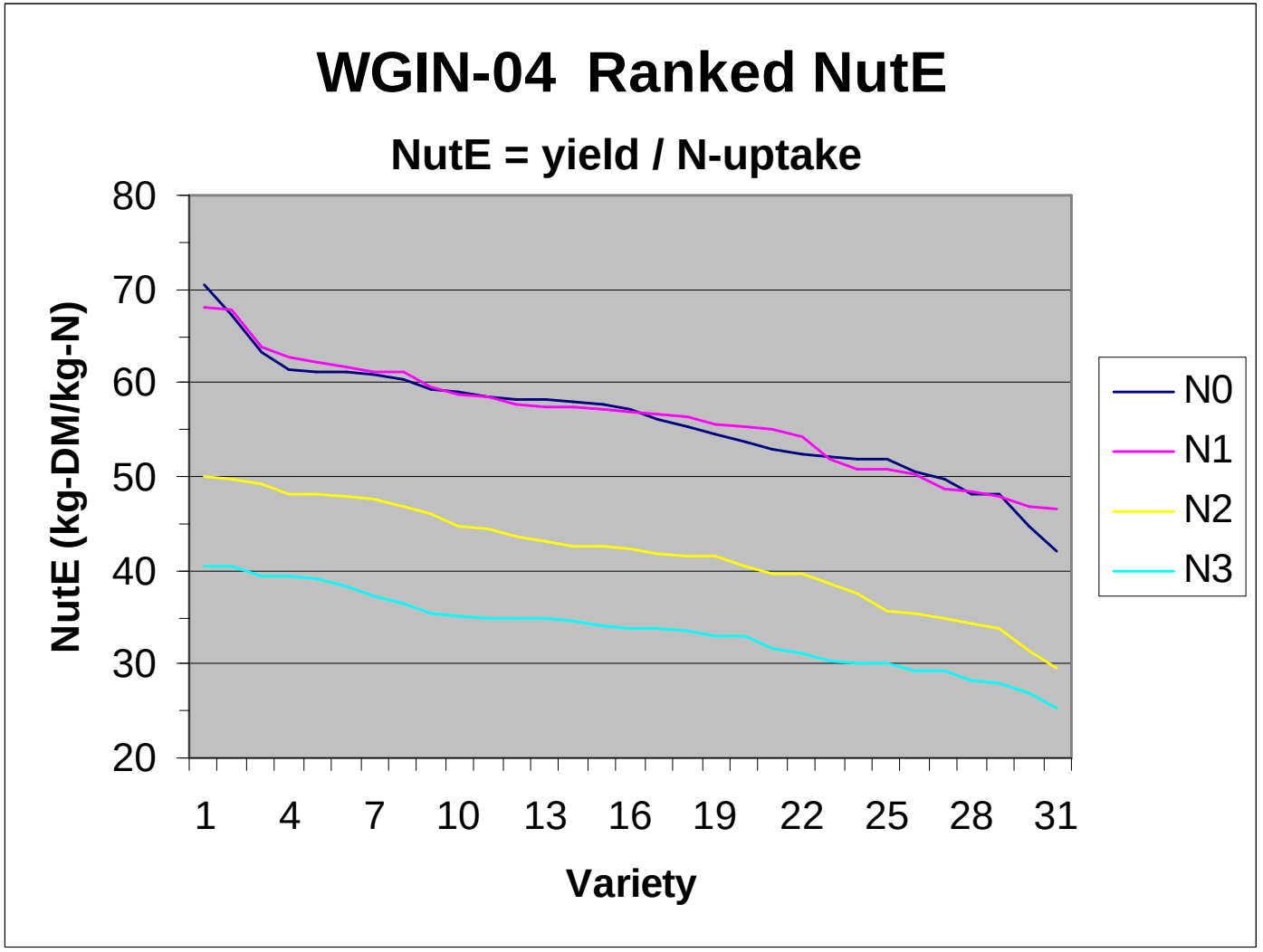


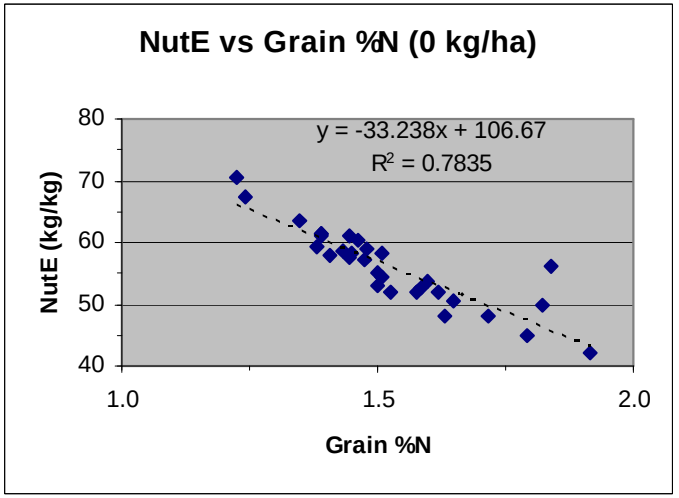


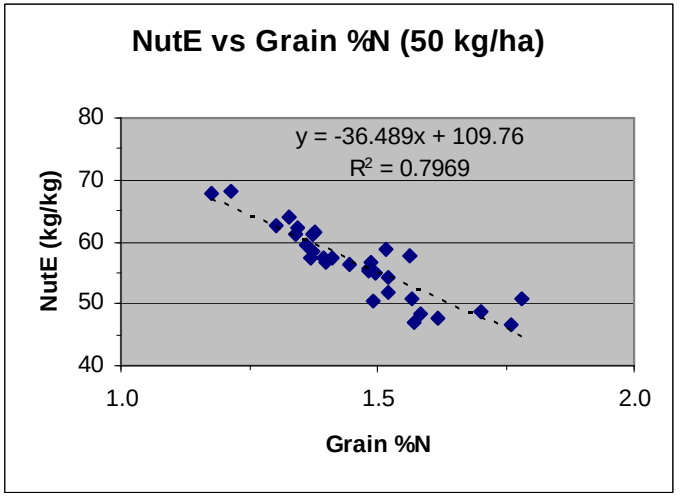


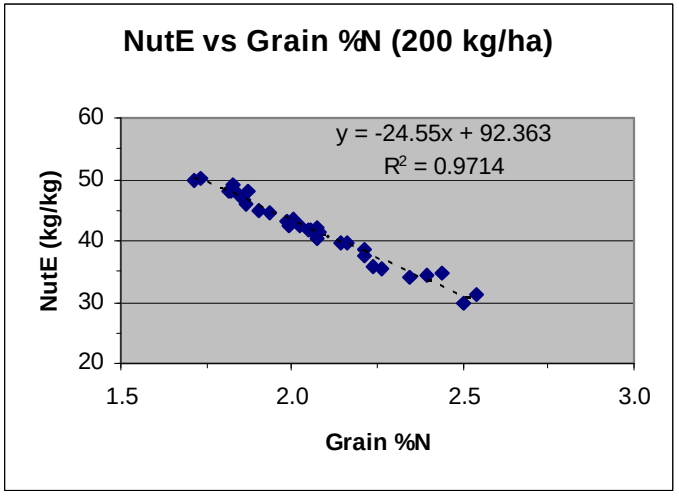


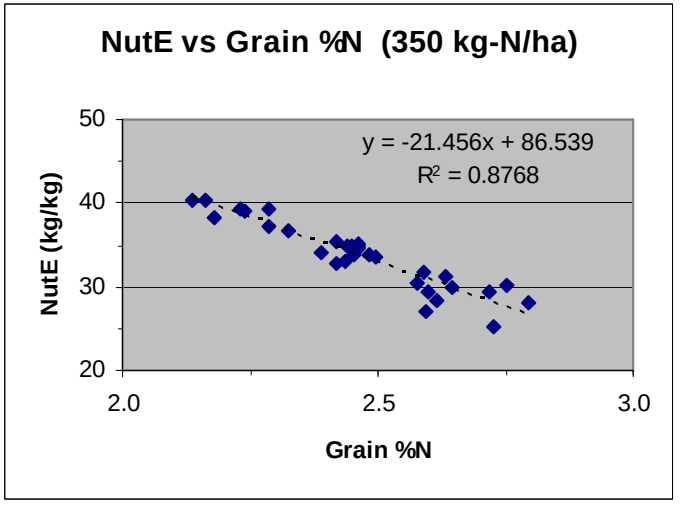
NupE = N-uptake / N-available


WGIN-04 Ranked NutE
NutE = yield / N-uptake
NutE (kg-DM/kg-N)
80
70
60
50
40
30
20
1
4
7
10
13
16
19
22
25
28
31
Variety
N0
N1
N2
N3

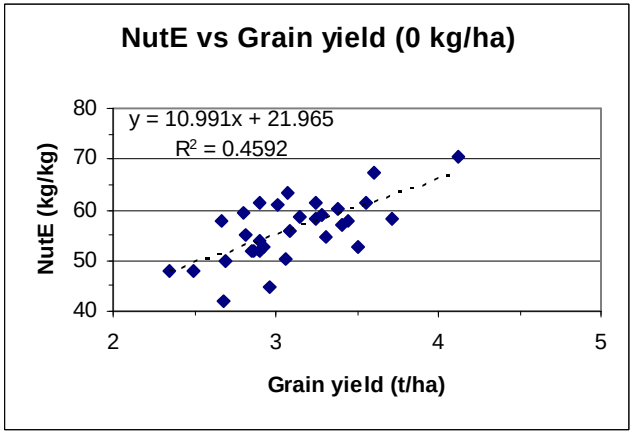


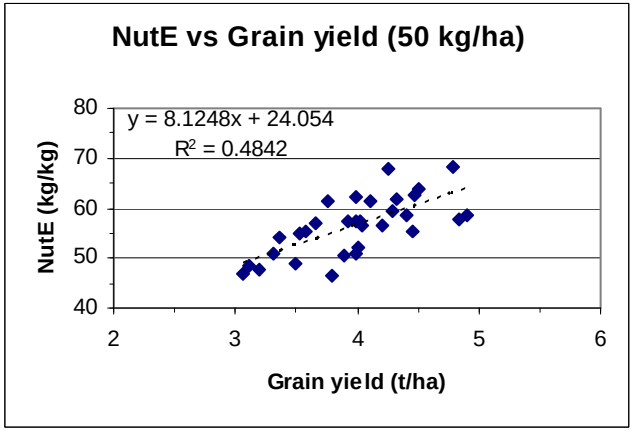


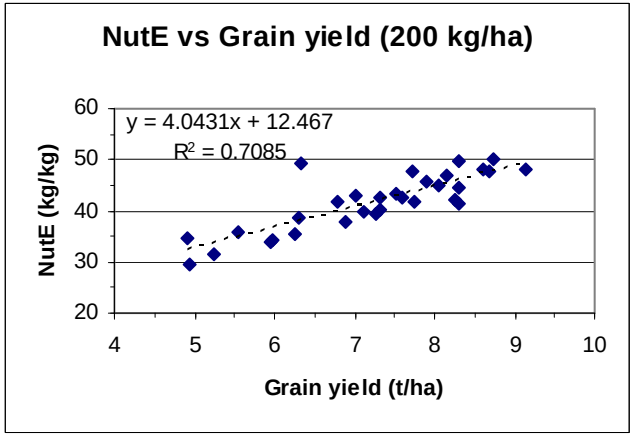


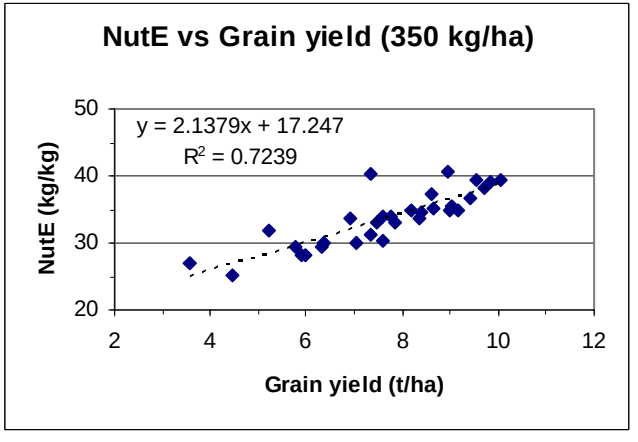


NutE = yield / N-uptake









NutE = yield / N-uptake

WGIN-05 Varieties

WGIN-05… is being analysed

20 Varieties x 2 N x 3 Reps

1.	AValon	HUrley	MOnopol	SHamrock
2.	BAtis	ISabraq	PAragon	SoiSsons
3.	CAdenza	LYnx	RIband	SoKrates
4.	CLaire	MAlacca	ROBigus	SoLstice
5.	HEreward	Maris Widgeon*	SAvannah	XI19

Underlined = parent of public DH mapping population

Blue = public molecular data available

Purple = spring variety

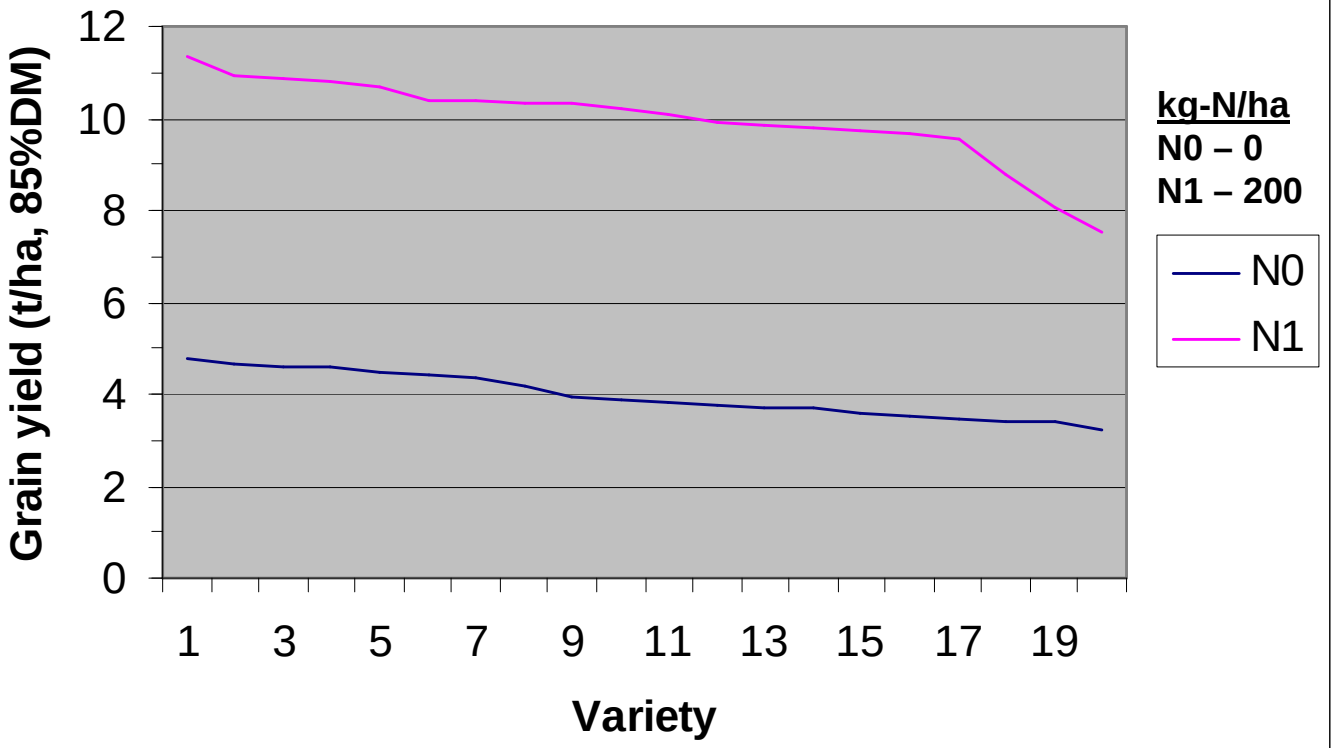
Green = Broadbalk @ RRes

***Tall variety**

ArchitectureWGIN-05

WGIN-05 Ranked Grain Yields

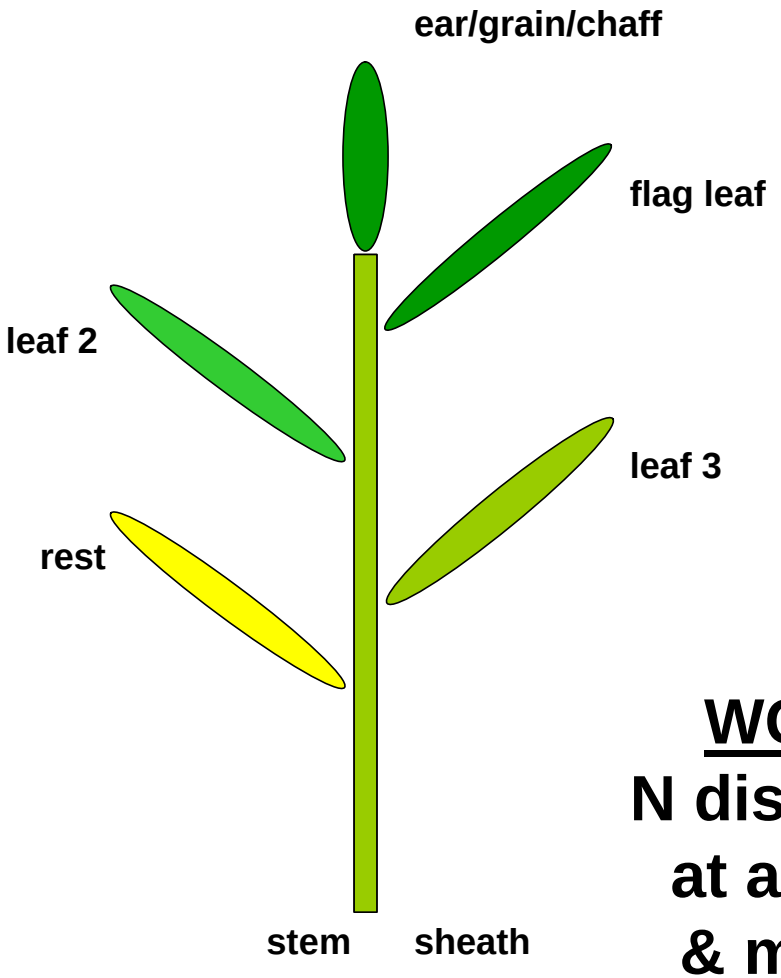
(20 varieties)



WGIN-05
Parameters

LIST OF RANKED PARAMETERS

1. Grain Yield (t/ha @ 100%DM)
2. Straw Yield (t/ha @ 100%DM)
3. Total DM Yield (t/ha @ 100%DM)
4. Harvest Index (HI)
5. Grain %N
6. Straw %N
7. Grain N Uptake (kg/ha)
8. Straw N Uptake (kg/ha)
9. Total N Uptake (kg/ha)
10. Nitrogen Harvest Index (NHI)
11. N Uptake Efficiency (NupE) (kgN/kgN)
12. N Utilisation Efficiency (NutE) for Grain (kgDM/kgN)
13. N Use Efficiency (NUE) for Grain (kgDM/kgN)
14. N Utilisation Efficiency (NutE) for Total DM (kgDM/kgN)
15. N Use Efficiency (NUE) for Total DM (kgDM/kgN)



WGIN-05

N distribution at anthesis & maturity

WGIN-06 Varieties

WGIN-06… is in the ground

24 Varieties x 3 N x 3 Reps

1.	Avalon	HEreward	MErcia	SAvannah
2.	BAtis	HURley	MONopol	SHamrock
3.	Beaver	ISTabraq	NApier	SoiSsons
4.	CadenZa	LYnx	PAragon	SoKrates
5.	CLaire	Malacca	RIband	SoLstice
6.	COrdiale	Maris Widgeon*	ROBigus	XI19

Underlined = parent of public DH mapping population

Blue = public molecular data available

Green = Broadbalk @ RRes

Purple = spring variety

***Tall variety**

WGIN-04
Grain available from the WGIN archive

WGIN-05
Grain available from the WGIN archive

WGIN-06
Questions, comments?
Want to use the expt?
Suggest measurements?
Help with measurements?

peter.barraclough@bbsrc.ac.uk
kim.hammond-kosack@bbsrc.ac.uk

And finally…
You can't get something for nothing!

Even wheat crops obey the 1st Law of Thermodynamics

10 ton/ha of grain at 2% N = 200 kg N/ha

If you don't put 200 kg in

(from all sources)

You can't take 200 kg out

Yield and/or Quality MUST fall

Thanks


Rothamsted variety trials