THE VALIDATION AND USE OF MARKER-ASSISTED SELECTION IN NS WHEAT BREEDING PROGRAM

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ITMI – COST, CLERMONT FERRAND, 31 August-4 September 2009.

From 1953 up to date 372 varieties of small grains have been developed at IFVC – Novi Sad:

winter wheat	230
spring wheat	31
winter barley	46
spring barley	41
winter durum	2
spring durum	2
winter oat	4
spring oat	4
winter triticale	11
winter ray	1

42 of which are registered abroad:

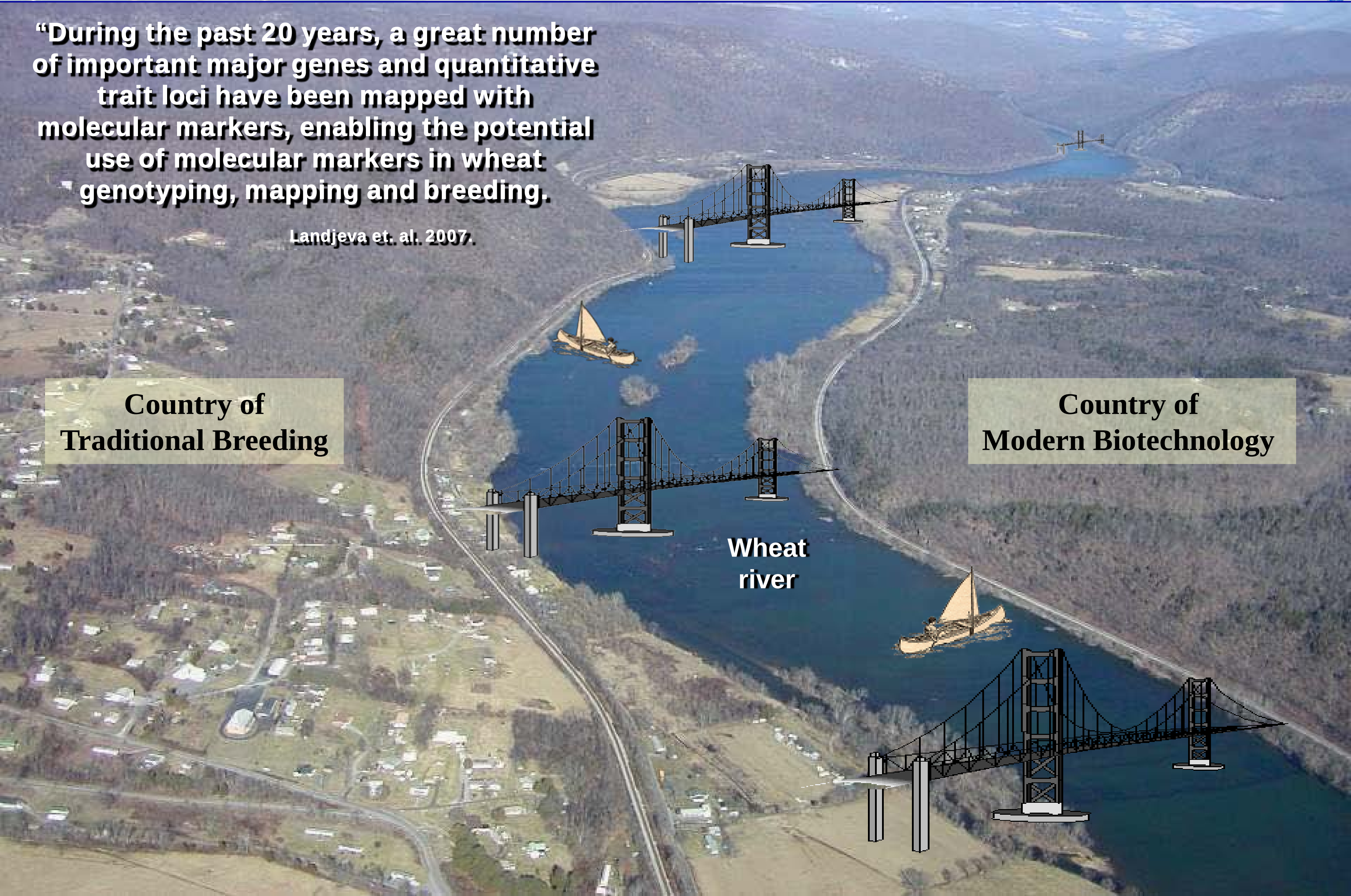
Hungary
Slovakia
Spain
Russia
Ukraine
Romania
Greece
Canada
Croatia
(EU) ...

Conventional breeding !

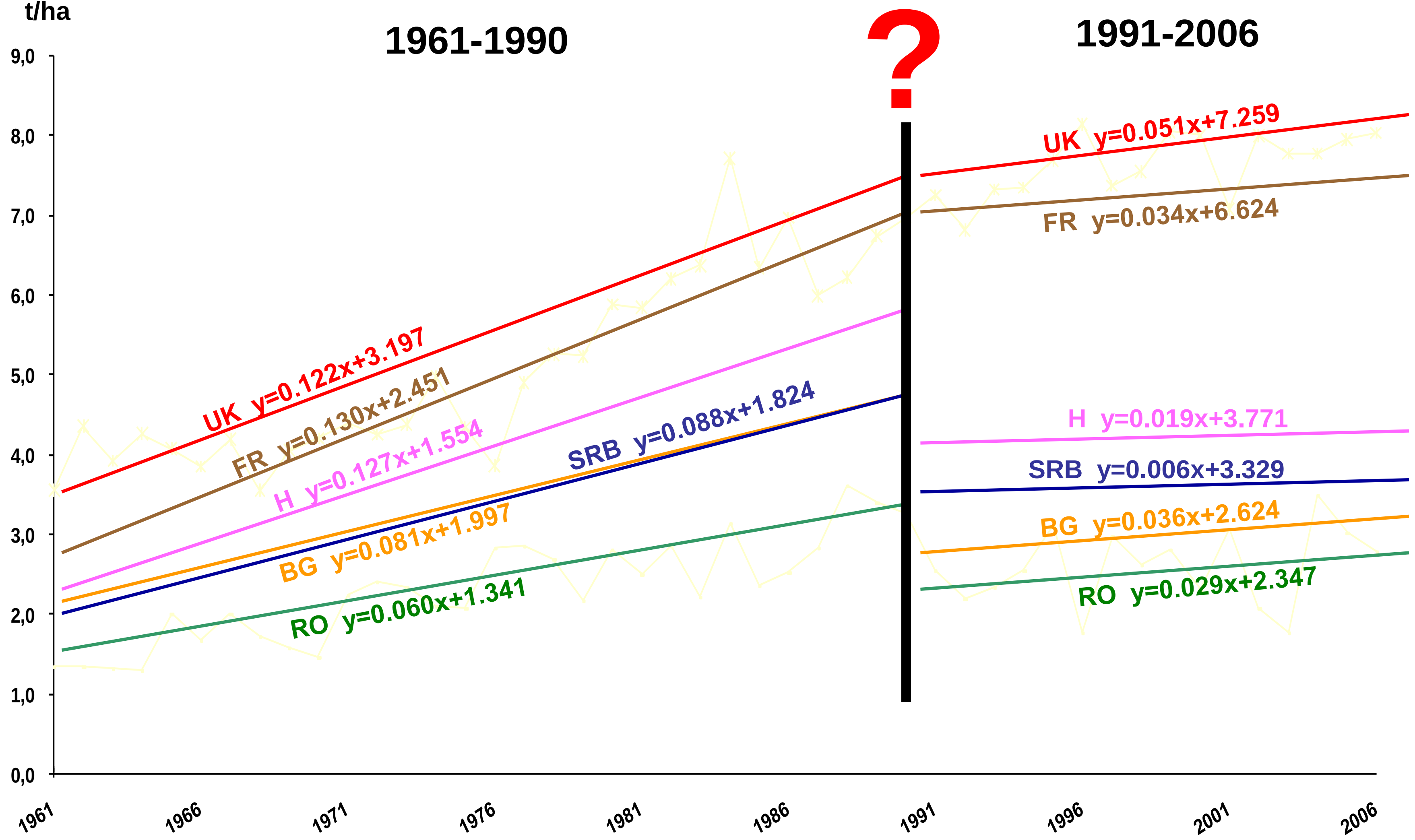
Two countries story

"During the past 20 years, a great number of important major genes and quantitative trait loci have been mapped with molecular markers, enabling the potential use of molecular markers in wheat genotyping, mapping and breeding.

Landjeva et. al. 2007.



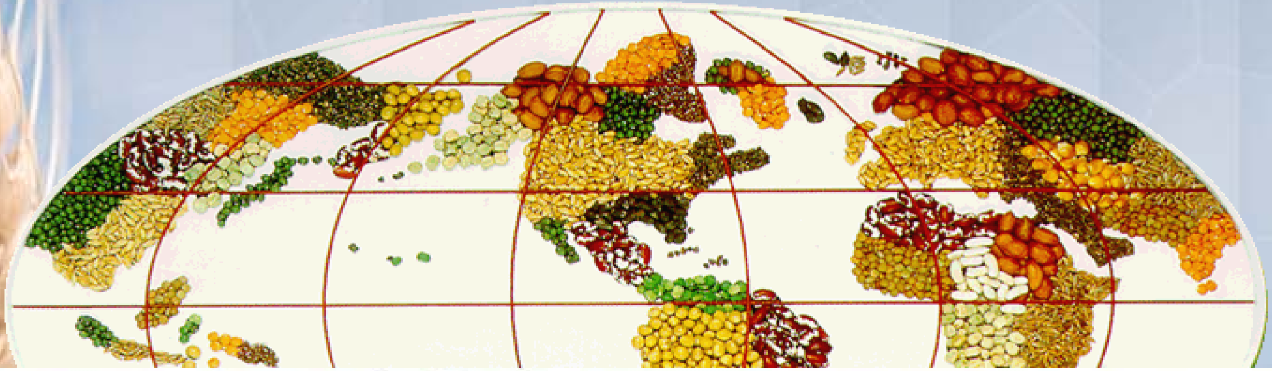
Wheat yields in UK, FR, HU, RO, BG and RS in 1961-2006 period



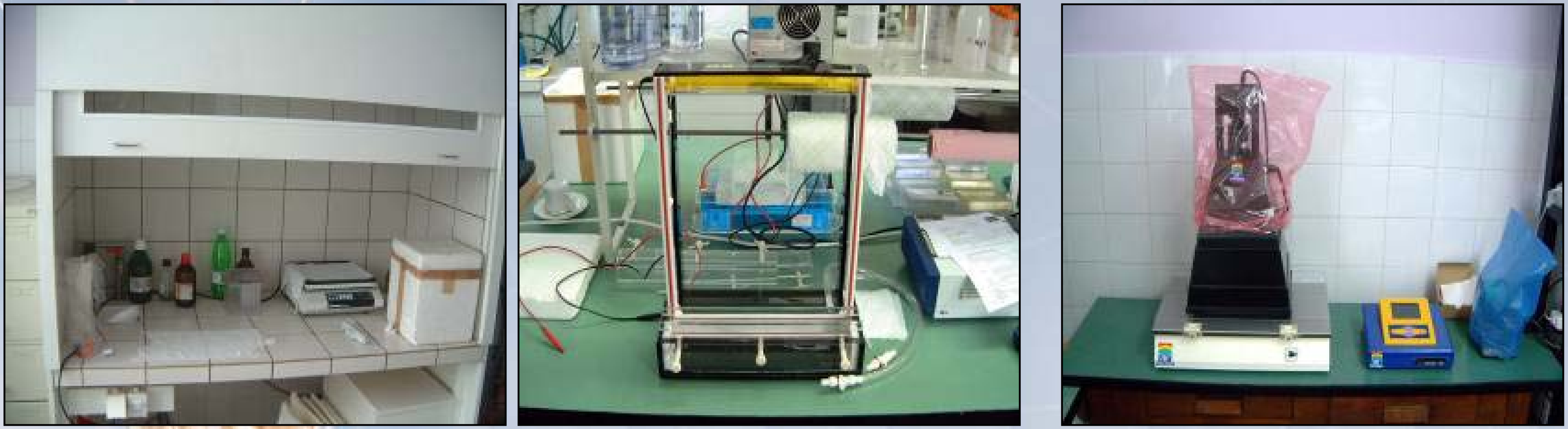
Climate change, lack of variability, "Yield plato" reached, "False" breeding objectives, Lower inputs...??

For all breeders, the most promising and challenging task is the possible use of molecular markers to enhance the selection of superior genotypes for traits that are:

1. **difficult or impossible to select phenotypically**
2. **subject to high environmental error**
3. **expensive to asses.**



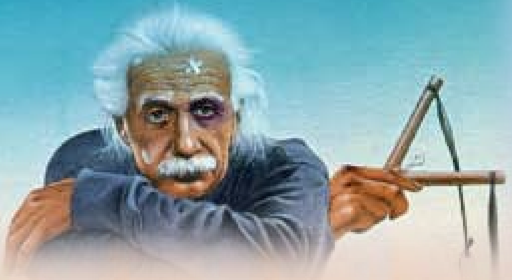
The Molecular Lab was established in year 2001 at IFVC



REDUCING COSTS AND INCREASING BREEDING EFFICIENCY !

Single cross strategy (parents AxB)

Target trait (gene)



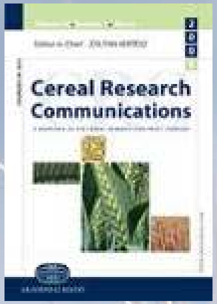
Scientist (with sling)

Association study (set of genotypes)

Target trait (gene)

Scientist (with gun)

ITMI mapping population (Opata x Synthetic)

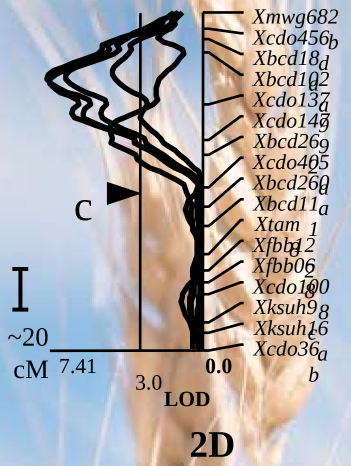


“Locating stable across environment QTL involved in the determination of agronomic characters in wheat”

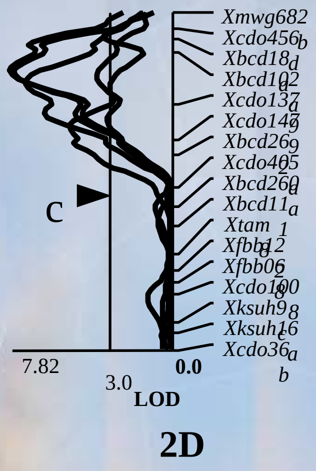
Borislav Kobiljski, Srbislav Denčić, Ankica Kondić-Špika,Ulrike Lohwasser and Andreas Börner

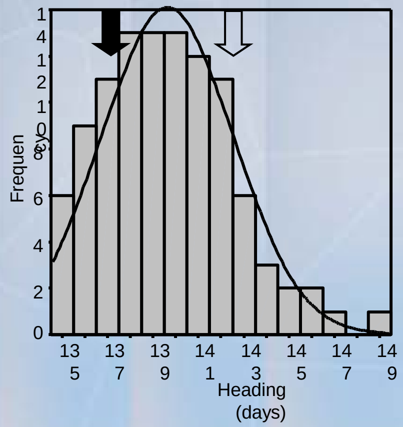
Cereal Research Communication (in press, sept.2009)

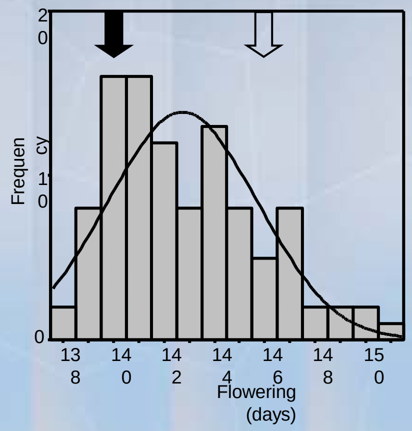
Heading



Flowering

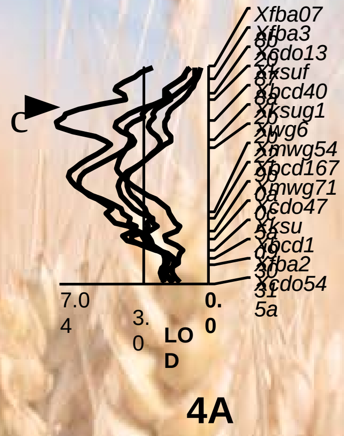


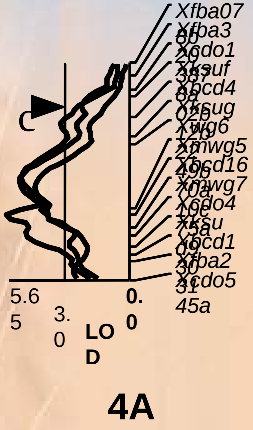


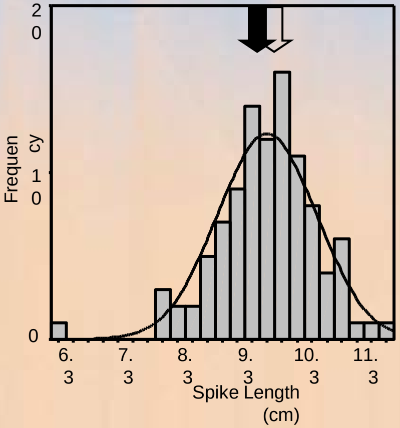


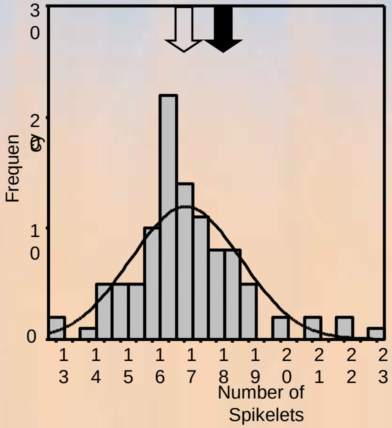
Spike Length

Number of Spikelets







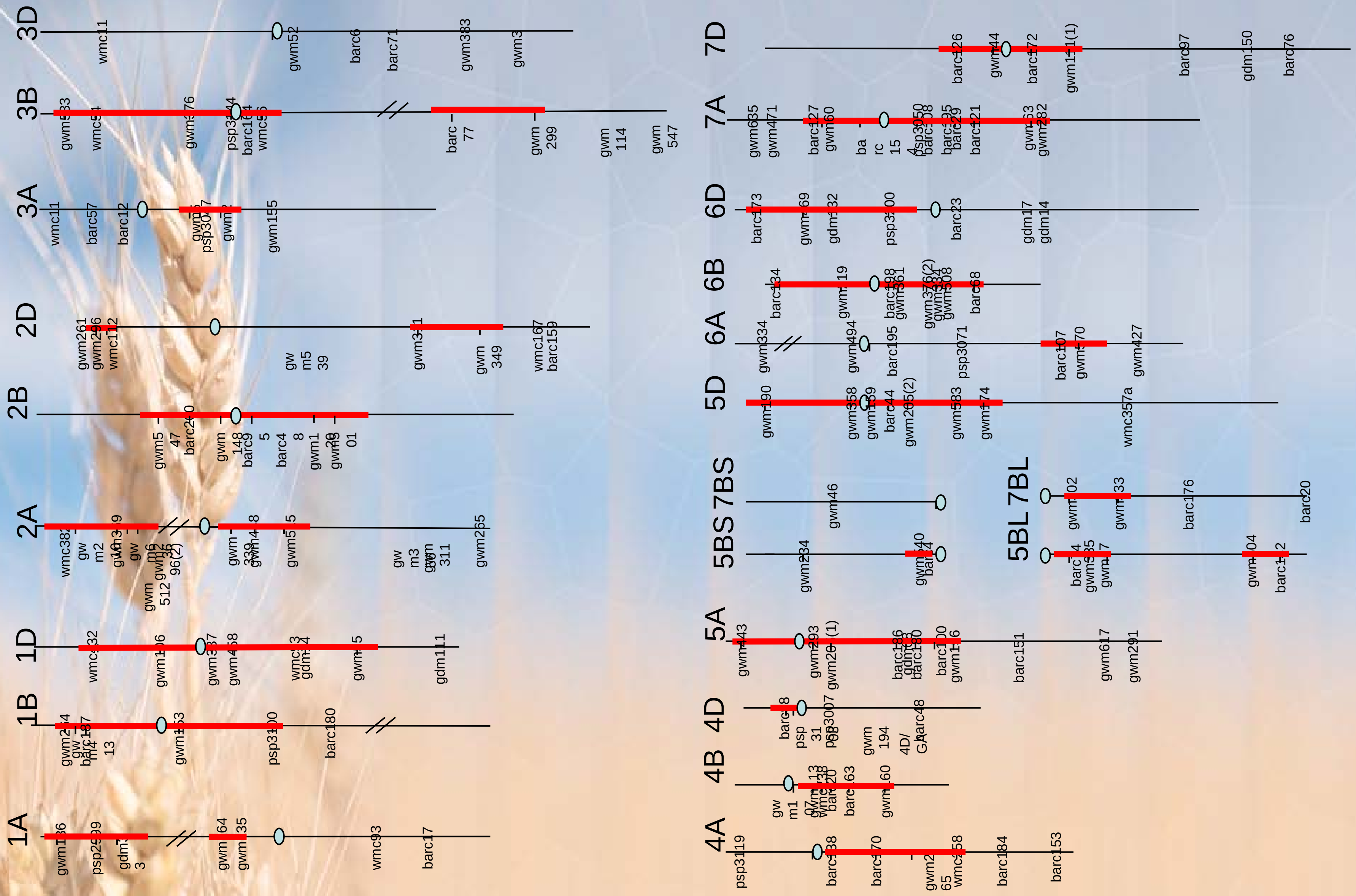


Savanahh / Renesansa DH population (single cross)

NS seme

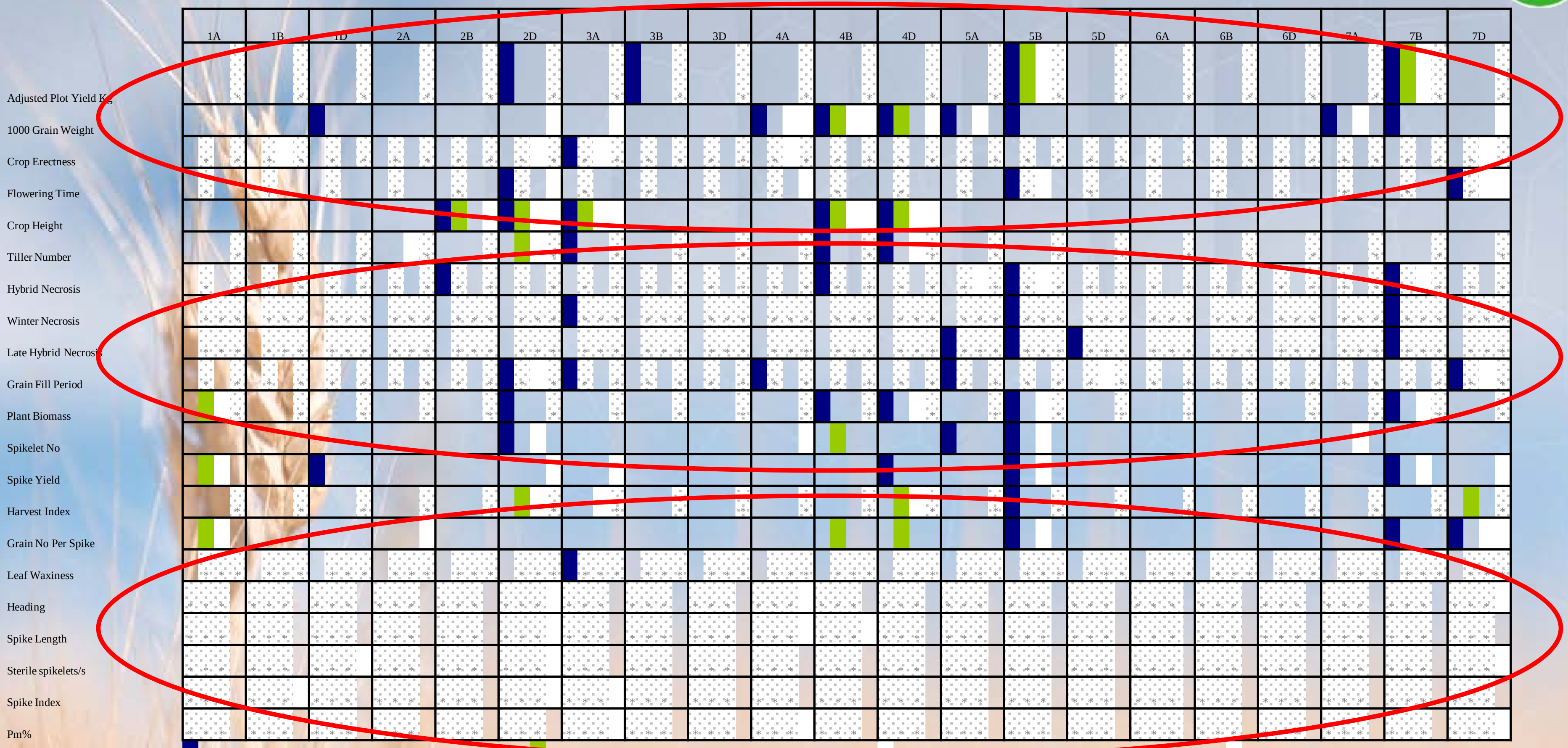
Savannah x Renesansa map

JOHN INNES CENTRE



Detected significant QTL’s in Savannah x Renesansa mapping population

QTL found using marker regression (>0.05) for Savannah x Renesansa comparing sites and years



■ Savannah x Renesansa (Church Farm 2002) 🟩 Savannah x Renesansa (Sandringham 2002) □ Savannah x Renesansa (Church Farm 2003) □ Savannah x Renesansa (Yugoslavia 2003)

▨ = Not Assessed

Where there are only two markers in a linkage group marker regression can not be carried out, in these cases

significant (& interesting) QTL found using single marker analysis have been included.

* - Denotes where no assessment was made

POTENTIAL USES OF MICROSATELLITES IN MARKER – ASSISTED SELECTION (MAS) FOR IMPROVED GRAIN YIELD IN WHEAT

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Genetic (Core) Collection - 603 genotypes – 38 countries

Pheno data base
(54 traits, 3-8 years)

26 TRAITS (SRB+UK)

603 GENOTYPES

The “worst” 48

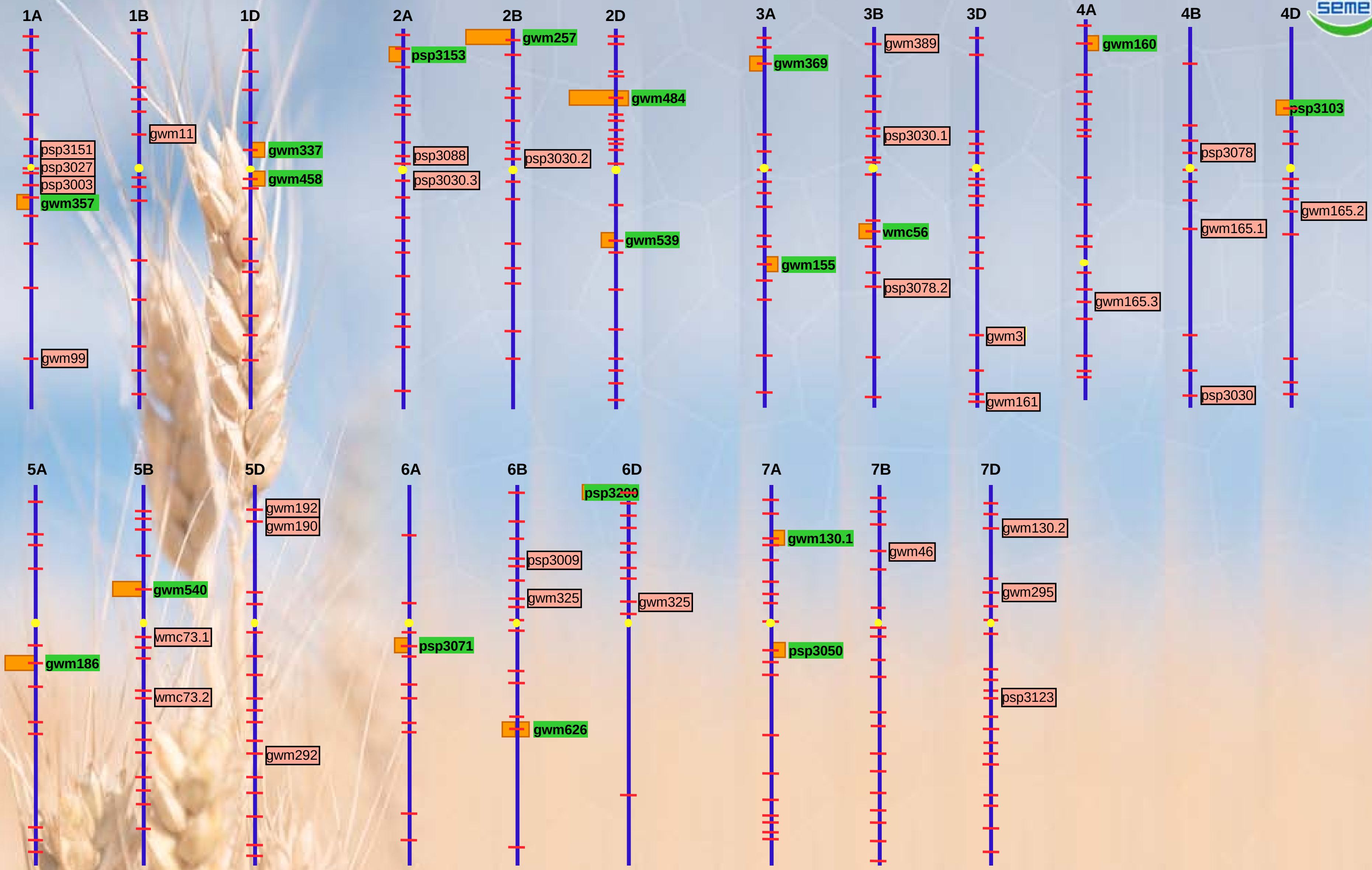
The “best” 48

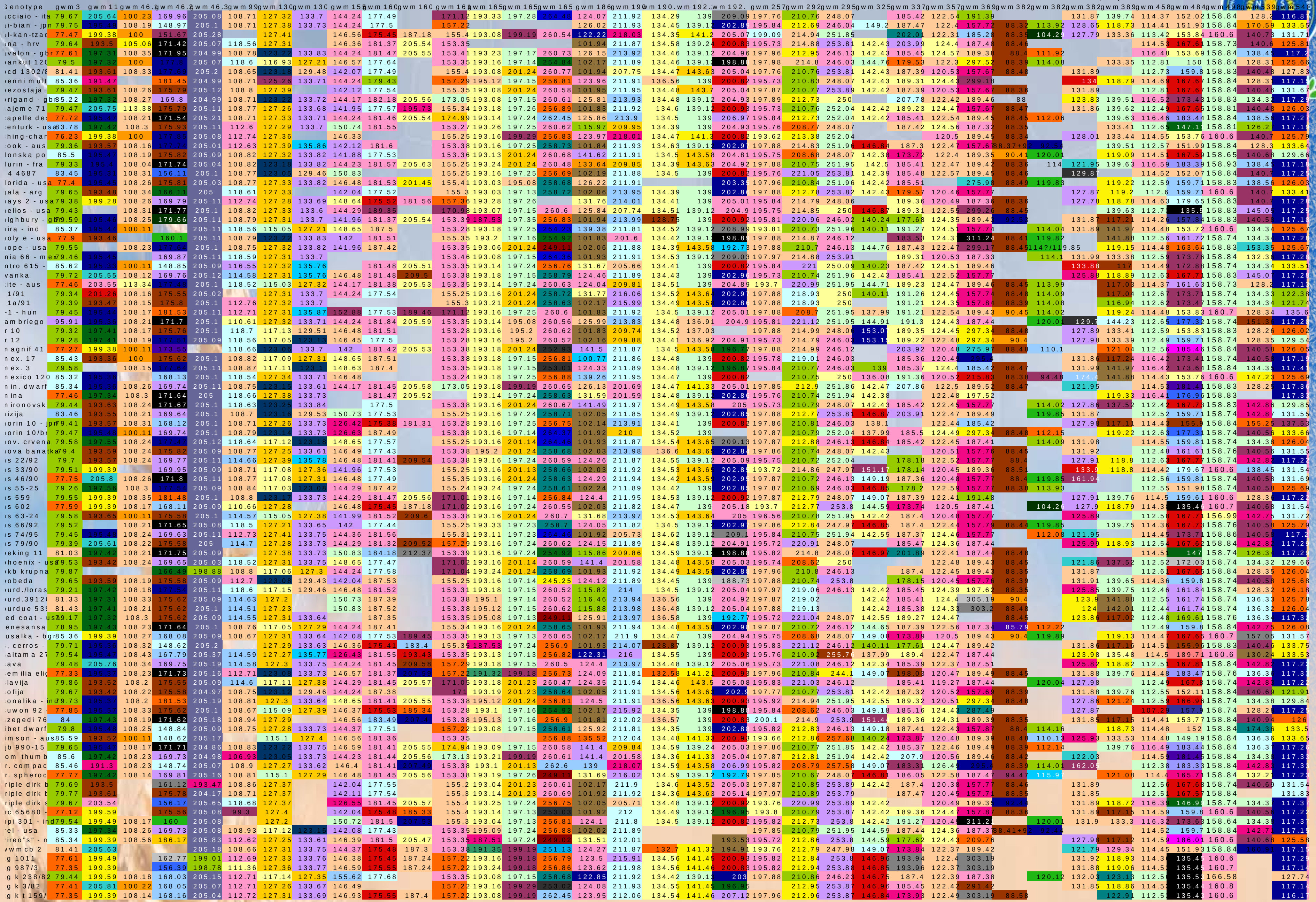
96 genotypes representing overall phenotypic variation

96 wheat “delegates” for molecular screening

Acciaio
Ai-bian
Al KanTzao
Ana
Avalon
Bankuty 1205
BCD 1302/83
Benni multifloret
Bezostaya 1
Brigand
Cajeme 71
Capelle Desprez
Centurk
Ching-Chang 6
Cook
Don.polupatuljasta
Durin
F 4 4687
Florida
Gala
HAYS 2
Helios
Highbury
Hira
Holly E
Hope
Inia 66
INTRO 615
Ivanka
Kite
L 1/91
L 1A/91
L - 1
Lambriego Inia
Lr 10
Lr 12
Magnif 41
Mex.17 bb
Mex.3
Mexico120
Minister Dwarf
Mina
Mironovska 808
Nizija
Norin 10/Brev.14
Norin 10
Nov. Crvena
Nova Banatka
NS 22/92
NS 33/90
NS 46/90
NS 55-25
NS 559
NS 602
NS 63-24
NS 66/92
NS 74/95
NS 79/90
Peking 11
Phoenix
PKB Krupna
Pobeda
Purd./Loras
Purdue 39120
Purdue 5392
Red Coat
Renesansa
Rusalka
Siete Cerros
Saitama 27
Sava
Semillia Eligulata
Slavija
Sofija
Sonalika
Suwwon 92
Szegedi 768
Tibet Dwarf
Timson
TJB 990-15
Tom Thumb
Tr. compactum
Tr sphaerococcum
Triple Dirk B
Triple DirkB (cont.)
Triple Dirk S
UC 65680
UPI 301
Vel
Vireo “S”
WWMCB 2
ZG 1011
ZG 987/3
ZG K 238/82
ZG K 3/82
ZG K T 159/82

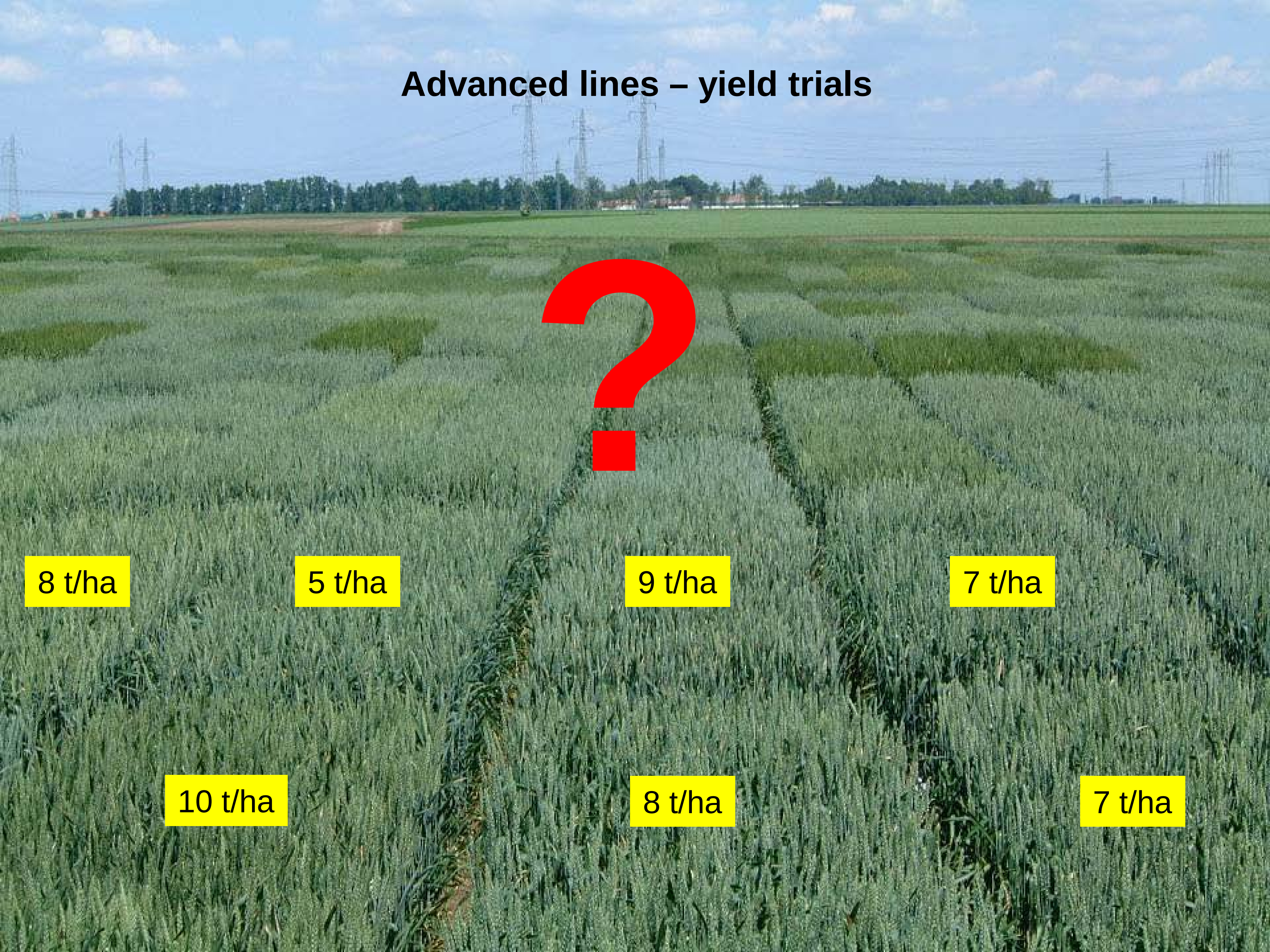
SSRs used for evaluation of the 96 “delegates”





Genotype	gwm 3	gwm 11	gwm 46.1	gwm 46.2	gwm 46.3	gwm 99	gwm 130	gwm 130	gwm 155	gwm 160	gwm 160	gwm 161	gwm 165	gwm 165	gwm 165	gwm 186	gwm 190	wm 190.	wm 192.	wm 192.	gwm 257	gwm 292	gwm 295	gwm 325	gwm 337	gwm 357	gwm 369	gwm 382	gwm 382	gwm 382	gwm 389	gwm 458	gwm 484	gwm 498	gwm 539	gwm 540
cciaio - ita	79.67	205.64	100.23	169.96	205.08	108.71	127.32	133.7	144.24	177.49		171.12	193.33	197.28	264.48	124.07	211.92	134.29	139	209.09	197.76	210.76	248.07		185.42	122.54	191.39			131.87	139.74	114.37	152.02	158.84	128.2	116.87
i-bian - jpn	79.75	195.49	108.19	148.97	205.1	108.71	127.38	133.73	144.24	177.5		157.22				126.02	211.93	134.45	139.12	202.89	195.84	212.69	246.04	149.2	187.47	122.4	157.72	88.32	113.92	128.65	118.73	114.41	151.93	158.84	170.59	133.55
l-kan-tzac	77.47	199.38	100	151.67	205.28		127.41		146.56	175.45	187.18	155.4	193.08	199.19	260.54	122.22	218.03	134.35	141.2	205.07	199.09	214.94	251.85		202.01	122.31	185.28	88.35	104.29	127.79	133.36	113.42	153.84	160.6	140.73	131.71
na - hrv	79.64	193.5	105.06	171.42	205.07	118.56	127.31		146.36	181.37	205.54	153.35				101.94	211.87	134.58	139.24	200.83	195.73	214.88	253.81	142.43	203.99	124.4	187.48	88.46				114.53	167.61	158.73	140.6	125.81
valon - gbr	77.61	197.31	108.35	171.95	204.99	108.78	123.22	133.83	144.24	181.47	205.55	153.41	193.23	197.17	260.73	126.15	213.92	134.46	139.12	204.96	197.96	212.95	246.13	142.43	185.45	124.57	189.38	88.4	111.92			116.48	153.69	158.84	138.45	117.2
ankut 120	79.5	197.32	100	177.8	205.07	118.6	116.93	127.21	146.57	177.64		153.35	193.16	197.14	254.84	102.17	211.89	134.46	139.12	198.88	197.98	214.8	246.03	144.76	179.53	122.3	297.52	88.39	114.08		133.35	112.81	150	158.84	128.31	125.66
cd 1302/8	81.41	193.61	108.33	177.69	205.2	108.65	123.18	129.48	142.07	177.49		155.4	193.08	201.24	260.77	101.94	207.75	134.47	143.63	205.04	197.76	210.76	253.81	142.43	187.39	120.53	157.67	88.48		131.89		112.73	159.8	158.83	140.48	127.83
enni mult	85.36	191.47		181.45	204.99	108.71	125.26	133.71	144.24	179.43		157.29	195.12	197.15	256.81	123.96	211.91	136.56	139	200.82	195.73	210.83	248.07	142.43	189.31	124.43	299.18			134	118.79	114.69	167.67	158.84	128.31	117.15
ezostaja	79.47	193.61	108.26	175.79	205.12	108.8	127.39		142.12	177.54		155.35	193.08	201.24	260.58	101.95	211.95	134.48	143.7	205.04	197.87	210.77	253.89	142.42	187.39	120.53	157.67	88.36		131.89		112.81	167.67	158.84	140.46	131.67
rigand - gbr	85.22	197.32	108.27	169.8	204.99	108.71	123.22	133.72	144.17	182.18	205.56	173.05	193.08	197.15	260.61	125.81	213.93	134.48	139.12	204.93	197.89	212.73	250		207.78	122.42	189.46	88		123.83	139.51	116.52	173.43	158.83	134.32	117.29
ajeme 71	79.47	205.75	113.38	175.79	205.11	108.77	127.26	133.68	141.95	177.57	195.73	155.34	193.18	197.26	256.89	101.83	211.92	134.6	139.12	200.93	195.73	210.76	252.04	142.42	189.23	124.47	157.67	88.47		131.86	139.62	112.49	167.65	158.81	140.48	126.03
apelle des	77.72	195.47	108.21	171.54	205.21	108.71	127.33	133.71	144.24	181.46	205.54	174.99	193.14	197.24	262.45	125.86	213.9	134.5	139	206.97	195.84	212.73	252.04	142.42	185.41	122.54	189.45	88.45	112.06		139.63	116.46	183.44	158.84	138.56	117.27
enturk - usa	83.78	197.42	108.3	175.93	205.11	112.6	127.29	133.7	150.74	181.55		153.27	193.26	197.25	260.62	115.97	209.95	134.39	139	204.93	195.76	208.77	248.07		187.42	124.56	187.32	88.35			133.41	112.65	147.1	158.81	126.27	117.19
hing-chan	76.23	199.38	100	177.85	205.08	112.74	127.36		146.33			155.25	193.16	199.29	256.83	123.97	218.01	134.47	141.3	200.82	193.62	213.38	252.04			120.5	189.45	88.34		128.01	133.44	114.55	153.76	160.6	140.7	125.79
ook - aus	79.36	193.57	108.16	177.74	205.01	112.63	127.39	135.86	142.12	181.6		153.38	193.16	197.25	258.73	101.84	211.93	134.63	139.12	202.97	197.88	214.83	251.96	146.84	187.3	122.47	157.67	88.37+92	92.54		139.51	112.57	151.99	158.84	128.3	133.64
lonska po	85.5	195.47	108.19	175.82	205.09	108.82	127.32	133.82	141.88	177.53		153.36	193.13	201.24	260.68	141.62	211.91	134.5	143.58	204.81	195.75	208.68	248.07	142.38	173.72	122.4	189.35	90.41	120.01		119.09	114.51	167.59	158.65	140.68	129.66
lurin - fra	79.33	195.4	108.04	171.74	205.04	108.82	123.18	133.82	144.23	181.57	205.63	155.25	193.24	201.24	260.48	133.64	209.85	134.39	143.63	204.92	197.88	210.75	251.95	142.5	185.41	122.47	189.42	88.36	114	121.95	139.63	116.59	183.39	158.93	138.45	117.18
4 4687	83.45	195.31	108.31	156.11	205.1	108.77	123.05	129.46	150.83			155.25	193.16	197.25	256.69	102.19	211.88	134.5	139	200.82	195.76	221.05	253.81	142.39	185.48	122.57	189.45	88.46		129.87		114.52	152.07	158.84	140.7	117.25
lorida - usa	77.4	195.45	108.26	175.81	205.03	108.77	127.33	133.82	146.48	181.53	201.45	155.41	193.03	195.08	258.68	126.22	211.91			203.35	197.96	210.84	251.96	142.42	185.51		275.98	88.49	119.83		119.22	112.59	159.71	158.83	138.56	126.03
ala - arg	79.65	193.48	108.34	166.11	205	118.61	127.33		142.04	177.52		155.3	193.03	197.13	258.72	102.06	213.95	134.39	139	202.86	197.88	212.78	253.82	142.43	179.57	120.46	157.77			127.87	119.2	112.6	159.71	160.6	140.7	133.41
ays 2 - usa	79.38	199.28	108.26	169.79	205.11	112.74	127.28	133.69	148.64	175.52	181.56	157.36	193.28	197.26		131.76	214.01	134.41	139	205.01	195.84	214.79	248.06		189.36	120.49	187.36	88.36		127.78	118.78	114.63	179.65	158.83	140.7	117.28
elios - usa	79.43		108.31	171.77	205.1	108.82	127.33	133.6	144.29	189.35		170.98	193.07	197.15	260.6	125.84	207.74	134.51	139.12	204.9	195.75	214.85	250	146.87	189.31	122.55	299.26	88.45			139.63	112.7	135.5	158.83	145.05	117.25
ighbury - gbr	79.59	195.46	108.25	179.66	205.11	108.79	127.31	133.7	141.96	181.37	205.54	153.39	187.53	197.35	256.83	101.94	213.99	128.75	139	200.92	195.81	220.96	246.02	140.24	177.68	124.35	189.43	92.53		131.87	117.21	114.26	157.84	158.83	140.58	117.18
ira - ind	85.37	195.44	100.11		205.11	118.56	115.05	127.21	148.65	187.5		153.28	193.18	197.25	264.23	139.38	211.81	134.52	139.12	208.99	193.81	210.73	251.96	140.11	191.27	124.51	157.74		114.04	131.89	141.97	114.48	153.72	160.6	134.34	125.67
oly e - usa	77.9	193.46		160.1	205.11	108.79	123.22	133.83	142	181.51		155.35	193.2	197.16	254.92	101.83	201.6	134.42	139.12	198.89	197.88	214.87	246.12		183.53	124.37	311.24	88.41	119.82		141.88	112.56	161.72	158.74	134.34	117.28
ope - usa	79.55		108.23	177.64	205.1	108.75	127.32	133.82	141.96	187.42		153.35	193.06	201.24	249.11	102.06	211.88	134.39	143.58	192.73	197.88	210.7	246.13	144.76	187.43	122.47	299.17	88.45	114?/119.85		119.15	114.48	163.64	158.83	153.35	125.67
nia 66 - mex	79.46	195.45		169.87	205.11	118.59	127.31	133.7				153.46	193.08	197.15	264.36	101.93	211.91	134.53	139.12	209.03	197.97	214.88	253.91		189.31	120.53	187.33		114.1	131.99	133.38	112.59	173.76	158.84	132.36	117.28
ntro 615 -	85.62	195.33	100.11	148.85	205.09	116.55	127.32	135.76		181.48	205.51	153.35	193.14	197.24	256.76	131.67	205.66	134.41	139	200.82	195.84	221	250.09	140.23	187.42	124.51	189.46			133.88	117	114.49	172.88	158.74	134.34	133.51
vanka	79.72	205.55	108.12	169.76	205.12	114.58	127.31	135.76	146.48	181.48	209.5	153.38	193.18	197.15	258.79	124.46	211.89	134.43	139	202.96	195.73	210.74	251.96	142.43	185.41	122.52	157.77			125.88	118.89	112.63	167.71	158.83	145.07	117.28
ite - aus	77.46	203.55	113.34	177.48	205.1	118.52	115.03	127.32	144.17	181.38	205.53	153.35	193.14	197.24	260.63	124.04	209.81	134.51	139	204.89	193.7	220.99	251.95	144.71	189.23	124.47	189.46	88.45	113.99		117.03	114.37	161.63	158.73	128.2	117.13
1/91	79.34	201.26	108.16	175.55	205.02		127.31	133.7	144.24	177.54		155.25	193.16	201.24	258.72	131.77	216.06	134.52	143.64	202.97	197.88	218.93	250	140.11	191.26	124.45	157.74	88.48	114.09		117.04	112.67	173.71	158.74	134.33	122.38
1a/91	79.39	193.47	108.15	175.8	205.1	112.76	127.32	133.7				155.3	193.21	201.24	258.63	102.17	215.99	134.49	143.58	202.86	197.88	218.93	250		191.21	124.35	157.84	88.39	114.08		116.94	112.62	173.47	158.74	134.34	121.74
-1 - hun	79.45	195.44	108.17	181.53	205.11	112.71	127.31	135.87	152.88	177.53	189.46	171.12	193.16	197.25	260.6	101.83	211.92	134.5	139.12	205.01	197.88	208.7	251.95	137.99	191.21	122.54	189.43	90.45	114.02		119.24	114.48	153.83	160.7	128.34	135.6
am briego	95.91	195.36	108.21	171.7	205.1	110.61	127.32	133.71	144.24	181.84	205.59	153.35	193.14	195.08	260.56	125.99	213.83	134.48	136.91	204.9	195.81	221.12	251.95	144.91	191.3	124.43	187.44		120.01	129.7	144.23	112.65	177.32	158.74	151.36	117.28
r 10	79.32	197.41	108.17	175.76	205.1	118.7	117.13	129.51	146.48	181.51		153.28	193.16	195.2	260.62	101.83	209.74	134.52	137.03		197.88	214.99	248.06	153.07	189.35	124.45	297.34	88.48		127.89	133.41	112.59	153.83	158.83	128.26	126.02
r 12	79.28	197.41	108.19	177.51	205.09	118.56	117.05	123.13	146.45	177.5		153.28	193.16	195.2	260.52	102.16	209.88	134.41	136.92	204.91	195.73	214.79	246.03	153.15	189.22	122.48	297.34	90.4		127.98	133.39	112.49	159.71	158.74	128.35	129.54
agnif 41	77.27	199.38	100.11	173.55		118.66	123.06	133.7	142	181.42	205.53	153.38	193.18	201.24	252.93	141.5	211.87	134.5	143.58	196.77	197.88	214.99	246.12		203.92	120.48	275.97	88.48	110.1		121.04	112.56	185.46	158.84	140.58	126.05
ex. 17	85.43	193.36	100	175.62	205.1	108.82	117.09	127.31	148.65	187.51		153.38	193.18	197.15	256.81	100.77	211.86	134.48	139	200.82	195.78	219.01	246.03		185.36	120.49	295.4			131.86	117.24	116.42	173.41	158.74	140.58	117.19
ex. 3	79.58		108.15	177.64	205.11	108.87	117.11	123.1	148.63	187.4		153.35	193.18	197.15	253.01	124.33	211.89	134.48	139.12	196.87	195.84	210.77	246.03	139	185.37	124.4	185.42	88.47		131.99	141.97	116.42	173.64	158.84	134.35	117.41
exico 120	85.32	195.36		168.13	205.1	118.54	127.34	133.71	146.48			153.24	193.18	197.25	256.88	139.26	211.95	134.47	139	200.82		210.75	250	136.08	191.36	120.52	215.83	88.38	94.48	174.4	141.88	114.43	153.76	160.6	147.23	125.69
in. dwarf	85.34	195.36	108.26	169.74	205.11	108.75	123.15	133.61	144.17	181.45	205.58	173.05	193.18	199.19	260.65	126.13	201.69	134.47	141.33	205.01	197.85	212.9	251.86	142.47	207.86	122.5	189.52	88.47		121.95		114.53	181.41	158.83	128.25	117.36
ina	77.46	197.34	108.3	171.64	205	118.66	127.38	133.73		181.47	205.52		193.14	197.24	258.63	131.59	201.59	134.48	139.12	202.86	195.76	210.74	251.94	142.38		122.48	197.52				119.33	116.41	176.96	158.83		117.33
ironovsk	79.44	193.63	108.24	171.67	205.1	118.63	123.25	133.84		177.5		153.38	193.16	201.24	260.67	141.49	211.97	134.49	143.58	205	195.73	210.79	248.07	142.43	185.42	122.45	157.77		114.02	127.86	137.52	112.42	167.73	158.83	142.86	129.85
izija	83.46	193.55	108.21	169.64	205.1	108.7	123.16	129.53	150.73	177.53		155.25	193.16	197.24	258.71	102.05	211.85	134.49	139.12	202.85	197.88	212.77	253.81	146.87	203.91	122.47	189.49		119.85	131.87		112.52	159.71	158.74	142.87	131.55
orin 10 - jpn	79.41	193.57	108.31	168.12	205.1	108.71	127.26	133.73	126.42	175.38	181.31	153.28	193.16	197.25	256.75	102.14	213.91	134.41	139	200.82	197.86	210.81	246.03	138.1		122.44	185.42			127.98	117.11	114.43	155.9	158.84	155.25	137.53
orin 10/br	79.47	195.48	100.11	169.74	205.1	108.79	123.14	133.73	126.63	187.49		153.38	193.16	197.14	264.37	101.92	210	134.52	139		197.87	210.79	252.04	137.99	185.5	124.49	297.34	88.48	112.15		119.22	112.63	177.31	158.74	140.56	133.66
ov. crvena	79.58	197.55	108.24	177.47	205.12	118.64	117.12	123.18	148.65	177.57		155.25	193.16	201.14	264.46	101.93	211.87	134.54	143.65	209.13	197.87	212.88	246.13	146.84	185.42	122.45	187.41		114.09	131.98		114.55	159.81	158.74	134.38	126.04
ova banatka	79.4	193.59	108.24	175.82	205.09	108.77	127.25	133.61	146.49	177.43		153.38	195.2	201.24	258.68	102.03	213.98	136.6	143.65	202.84	197.86	210.74	248.07	142.43		120.51	157.76	88.45		131.92		112.48	161.61	158.76	140.56	131.55
s 22/92	79.7	193.57	108.24	169.77	205.11	114.66	127.39	135.78	146.48	181.41	209.54	153.38	193.16	197.24	260.59	124.26	211.87	134.55	139.12	205.09	195.75	210.72	252.04		178.18	122.52	157.77	88.4		127.91	118.8	112.63	167.77	158.74	142.82	117.22
s 33/90	79.51	199.39		169.95	205.09	108.71	117.08	127.36	141.96	177.53		155.25	193.16	201.13	258.66	102.03	211.92	134.53	143.65	202.85	193.72	214.86	247.97	151.17	178.14	120.45	189.36	88.51		133.9	118.8	114.42	179.67	160.6	138.45	131.54
s 46/90	77.75	205.8	108.26	171.8	205.11	108.77	117.08	127.31	146.48	177.49		155.35	193.16	201.24	258.63	124.29	211.94	134.42	143.59	202.95	197.87	210.72	246.13	149.19	187.36	120.48	157.77	88.4	119.85	161.94		112.56	159.81	158.74	140.58	131.69
s 55-25	79.26	197.56	108.3	177.54	205.09	108.84	117.03	123.08	144.29	187.42		155.24	193.24	197.24	258.61	102.24	211.89	134.42	139	202.85	197.87	210.69	246.03	146.85	178.2	122.59	157.77	88.38	113.93			112.55	151.98	158.74	140.58	125.69
s 559	79.55	199.39	108.35	181.48	205.1	108.8	123.17	133.73	144.29	181.47	205.56	171.01	193.16	197.14	256.84	124.4	211.95	134.53	139.12	200.92	197.87	212.79	248.07	149.07	187.39	122.41	191.48			127.91	139.76	114.5	159.61	160.6	128.36	117.22
s 602	77.59	199.39	108.17	168.11	205.09	110.66	127.28		146.48	175.45	187.18	171.02	193.16	197.24	260.55	102.03	211.82	134.47	139	205.18	193.7	212.77	253.8	144.59	173.74	120.5	187.41		104.26	127.9	118.79	114.38	135.46	160.7	140.68	131.54
s 63-24	79.58	193.65	100.11	175.58	205.1	114.57	115.05	127.38	141.99	181.52	209.6	153.38	193.16	201.24	260.7	131.68	213.97	134.53	143.64	205	196.56	210.78	251.95	142.42	187.4	120.48	157.77			125.89		112.58	167.71	156.99	142.75	131.72
s 66/92	79.52		108.21	171.65	205.08	118.5	127.21	133.65	142	177.44		155.25	193.33	197.23	258.7	124.05	211.82	134.5	139.12	202.97	197.86	212.84	247.97	146.85	187.4	122.44	157.79	88.44	119.85		139.75	114.36	167.73	158.76	140.58	125.79
s 74/95	79.45	195.48	108.24	169.63	205.11	112.73	127.41	133.75	144.36	181.56		155.31	193.11	197.23	264.46	101.92	205.73	134.62	139.12	209.1	195.84	210.75	251.94	142.55	187.37	124.46	157.77		112.08	121.95		114.45	173.71	158.86	140.58	117.2
s 79/90	79.39	205.61	108.22	175.58	205	114.7	127.28	133.73	144.29	181.32	209.52	157.29	193.16	197.24	260.62	124.15	211.89	134.48	139.12	204.91	195.72	220.91	248.07		185.47	124.36	187.44			125.99	118.93	112.54	167.62	158.84	142.82	117.29
eking 11	81.03	197.42	108.21	171.75	205.09		127.38	133.73	150.83	184.18	212.37	153.39	193.16	197.24	254.92	115.86	209.86	134.59	139.12	198.88	195.82	214.8	248.07	146.97	201.89	122.41	187.44	88.48				114.51	147	158.74	126.34	117.29
hoenix - usa	79.53	193.42	108.24	169.65	205.03	118.52	127.31	133.75	148.65	177.47		171.02	193.16	201.14	260.59	141.4	201.58	134.48	143.58	205.03	195.74	208.62	250			122.48	189.43	88.45		121.86	137.52	112.52	172.03	158.74	134.32	129.66
kb krupna	79.87			166.49	198.88	108.8	117.06	127.3	144.24	177.58		171.04	193.24	201.24	258.69	101.93	211.92	134.49	143.58	202.88	197.96	210.8	246.13		187.4	122.45	189.43	88.35		131.87		112.61	167.65	158.84	128.35	126.04
obeda	79.65	193.59	108.19	175.58	205.09	112.7	123.08	129.43	142.04	187.53		155.25	193.16	197.14	245.25	124.12	211.89	134.45	139	188.73	197.88	210.74	253.8		178.15	120.45	157.76	88.39		131.91	139.65	114.36	159.8	158.74	140.58	125.68
urd./loras	79.21	197.42	108.18	177.54	205.11	118.6	117.15	129.46	146.48	181.52		153.31	193.18	197.15	260.52	115.82	214	134.5	139.12	205.04	197.97	219.06	246.13	142.42	185.45	124.39	197.62	88.35		125.85	139.75	112.46	161.84	158.74	128.32	126.18
urd.39120	81.33	197.31	108.33	175.62	205.09	114.63	127.2		150.73	187.39		153.38	195.1	197.14	260.52	116.46	213.94	136.56	139	204.92	197.87	219.02		142.42	185.41	124.4	305.19	90.4		123.9	141.88	112.55	161.74	158.74	136.33	125.78
urdue 539	81.43	197.41	108.21	175.62	205.1	114.51	127.23		150.83	187.52		153.38	195.12	197.15	260.62	115.88	213.98	136.48	139.12	205.04	197.88	219.13		142.42	185.38	124.33	303.2	88.48		124	142.01	112.44	161.74	158.74	136.32	126.04
ed coat - usa	79.17	197.32	108.3	175.62	205.09	114.55	127.31	133.64		187.35		153.35	195.08	197.13	249.11	125.91	213.97	136.58	139	192.77	195.72	221.04	248.07	142.55	189.27	124.47		88.45		123.86	117.02	112.48	169.61	158.76	136.34	117.32
enesansa	78.95	197.43	108.23	171.64	205.1	108.76	117.05	127.29	144.24	187.41		155.34	193.16	201.24	258.65	101.93	211.94	134.48	143.58	202.98	197.87	210.72	246.12	144.65	187.39	122.56	187.34	85.79	112.22			112.49	159.8	158.84	142.75	126.08
usalka - bgr	85.36	199.39	108.27	168.08	205.09	108.67	127.31	133.64	142.08	177.53	189.45	153.35	193.13	197.13	260.65	102.17	211.9	134.47	139	204.94	195.75	208.68	248.07	149.08	173.89	120.5	189.43	90.4	119.89		119.13	114.47	167.65	160.7	157.05	131.57
, cerros -	79.71	195.36	108.32	148.62	205.2		127.29	133.63	146.36	175.41	183.4	155.35	187.53	197.24	256.9	101.93	214.07	128.87	139.12	200.93	195.83	221.12	246.12	140.11	177.61	124.47	189.42			131.86	117.16	114.51	155.96	158.83	140.46	133.75
aitama 27	79.54	195.47	108.43	167.79	205.37	114.59	127.27	135.77	126.43	181.55	193.43	153.35	193.13	197.13	256.82	122.31	216	134.55	139	200.93	195.76	210.92	255.76	137.99	189.4	122.47	187.44			123.98	135.48	114.5	189.71	160.6	130.24	133.53
ava	79.48	205.76	108.34	169.75	205.19	114.58	127.3	133.75	144.24	181.45	209.58	157.29	193.18	197.15	260.5	124.4	213.97	134.48	139.12	205.06	195.73	221.08	246.12	142.34	185.39	122.37	187.51			125.82	118.82	112.51	167.81	158.84	142.82	117.22
emilia elig	77.33	195.37	108.23	171.73	205.16	112.71	123.08	133.73	146.57	181.37	207.59	157.22	191.32	199.18	256.73	124.09	211.81	132.58	141.21	200.93	197.96	210.84	244.1	149.07	198.03	120.47	189.49	88.45		131.88	139.76	114.48	183.47	158.76	136.36	117.33
lavija	79.86	193.52	108.2	175.55	205.09	114.6	117.11	127.38	144.29	181.45	205.57	171.05	193.18	201.23	260.47	124.35	211.94	134.46	143.5	205.08	195.83	221.03	246.12		185.41	119.27	187.44		120.04	127.98		112.49	167.8	158.74	142.83	117.22
ofija	79.67	193.42	108.22	175.58	204.97	108.75	123.12	129.46	144.24	187.38		171	193.19	201.23	258.64	102.05	211.91	134.56	143.63	202.9	197.77	210.77	253.81	142.42	187.32	120.52	157.69	88.39		131.88	139.76	112.55	152.11	158.84	140.69	121.91
onalika - ind	79.73	195.37	108.2	181.53	205.19	108.81	127.3	133.64	148.65	181.41	205.55	153.38	195.12	201.24	256.81	124.5	211.91	136.56	143.63	200.93	195.92	214.94	251.95	142.55	189.32	120.51	297.34	88.48		127.86	121.24	112.59	166.96	158.74	134.38	129.84
uwon 92 -	77.85	195.57	108.33	175.62	205.1	108.67	115.09	127.39	146.37	175.53	185.34	153.28	193.1	197.16	254.92	102.17	215.92	134.35	139	198.88	195.84	208.62	246.03	149.18	185.16	124.43	287.49			127.87		107.29	157.9	158.74	128.28	117.25
zegedi 76	84	197.43	108.19	171.62	205.18	108.94	127.29		146.56	183.49	207.4	153.38	195.13	197.16	256.9	101.81	212.02	136.57	139	200.83	200.1	214.9	253.9	151.44	189.36	124.31	189.39	88.35		131.85	117.15	114.41	153.77	158.84	140.94	126
ibet dwarf	79.8	195.48	108.25	148.84	205.09	108.75	127.28	133.73	144.37	177.51		157.22	193.08	197.15	258.61	125.92	211.81	134.35	139	202.88	195.82	212.83	246.13	149.18	187.41	122.43	157.87	88.4	114.16		118.73	114.48	152	158.84	174.36	133.5
imson - aus	85.59	193.52	100.11	148.62	205.17		115.1	127.4	146.56	181.36		153.35			256.88	135.52	212.04	134.48	141.33	200.93	193.66	212.86	257.68	140.24	173.87	120.48	189.39	88.48	110.13	125.93	133.53	114.48	149.19	158.84	136.36	133.65
jb 990-15	79.65	195.47	108.17	171.71	204.86	108.83	123.22	133.75	146.59	181.41	205.55	174.94	193.09	197.15	260.58	141.4	209.84	134.59	139.24	205.03	197.86	210.77	251.85	142.42	185.37	122.46	189.49	88.39	112.14		139.76	116.49	183.44	158.84	136.37	117.26
om thumb	85.6	197.42	108.23	169.73	204.98	106.93	123.05	133.73	144.23	181.44	205.56	173.13	193.21	199.19	260.61	141.4	201.58	134.36	141.33	205.04	197.87	212.81	251.94	142.42	207.9	120.56	189.46	88.42		122.03		114.59	181.45	158.84	134.38	117.33
r. compac	85.46	191.3	108.23	148.74	205.07	108.9	127.27	133.62	146.4	181.41	207.49	153.38	193.1	201.13	262.6	139	218.07	134.59	143.58	206.99	195.82	208.79	257.58	149.07	183.31	126.49	295.4	88.39	114.01	162.05		112.38	183.33	158.84	142.83	117.33
r. spheroc	77.77	197.42	108.14	169.81	205.16	108.81	115.1	127.29	146.48	181.45	205.56	153.38	193.19	197.26	249.11	131.69	216.02	134.59	139.12	192.79	197.85	210.67	248.07	146.81	186.05	122.58	187.47	94.47	115.97		121.08	114.4	165.71	158.84	132.21	117.23
riple dirk b	79.69	193.5		161.12	193.47	108.86	127.37		142.04	177.55		155.2	193.04	201.23	260.61	102.17	211.9	134.6	143.52	205.03	197.87	210.85	253.89	142.42	187.4	120.38	157.77	88.46		131.89		112.56	167.68	158.74	140.69	131.54
riple dirk b	79.77	193.61		175.78	204.17	108.71	127.37		142.11	177.54		155.3	193.14	201.23	260.69	101.92	211.92	134.36	143.63	205.14	197.97	210.89	253.79		187.47	120.45	157.71	88.35		131.85		112.51	167.57	158.84		131.83
riple dirk s	79.67	203.54		156.17	205.65	118.68	127.37		126.55	181.45	205.57	155.4	193.25	197.24	256.75	102.05	205.71	134.48	139.12	200.92	193.76	220.99	253.89	142.42		120.49	189.35	92.44		131.89	118.72	116.39	146.99	158.74	134.37	117.37
c 65680 -	77.12	199.59		175.56	205.08	99.3	127.4		142.04	175.48	185.33	155.4	193.14	197.13	253.03	101.92	212	134.49	139.12	196.95	193.8	210.79	253.87	142.42	189.36	124.47	157.87	88.36		131.89	117.15	114.59	159.8	160.6	140.56	117.22
pi 301 - ind	79.54	199.49	108.17	160	205.08		127.2		150.72	181.5	207.53	155.3	193.04	197.13	256.81	124.1	211.8	134.5	139.12	200.82	195.82	212.73	253.8	142.42	191.27	120.49	311.21		120.01	131.9	133.3	116.32	173.63	158.64	134.38	117.37
el - usa	85.33	197.34	108.26	169.73	205.08	108.93	117.12	123.15	142.08	177.43		153.35	195.09	197.24	256.88	102.02	211.89				197.85	210.79	251.95	144.59	187.44	124.36	187.37	88.41+92	92.44			114.52	159.7	158.84	142.71	117.15
ireo"s" - m	85.34	199.39	108.56	186.17	205.83	112.62	127.25	133.61	146.39	181.5	205.47	153.35	187.51	197.24	249.02	131.51	212.01			193.53	195.72	212.86	253.8	144.59	177.62	124.43	209.76			127.98	117.12	114.59	186.01	160.6	140.68	125.58
wm cb 2	81.41	205.63			205.18	108.66	127.31	133.75	144.37	175.48	187.3	153.38	191.35	199.19	251.13	124.27	211.87	132.7	141.32	194.91	193.76	212.79	247.98	149.07	173.84	122.37	189.42			121.79	129.34	114.45	151.93	158.84	160.91	117.15
g 1011	77.61	199.49		162.77	199.01	112.69	127.33	133.76	146.38	175.45	187.24	157.22	193.16	199.18	256.79	123.5	215.91	134.56	141.45	200.93	195.82	212.84	253.8	146.96	193.94	122.4	303.19			131.92	118.93	114.3	135.45	160.6		117.29
g 987/3	77.35	199.39		156.39	198.78	111.36	127.36	133.77	146.59	175.55	187.24	157.22	193.24	199.18	256.86	123.62	211.98	134.56	141.46	200.83	195.82	212.94	253.88	146.85	193.96	122.37	303.19			131.88	119.06	114.5	135.45	160.7		117.14
g k 238/82	79.44	199.59	108.18	168.03	205.15	112.71	117.14	127.35	155.62	177.68		153.35	193.08	197.15	258.68	122.85	211.92	134.42	139.13	203	197.88	210.86	246.23	146.75	187.4	122.39	187.38		120.12	132.03	123.13	112.5	135.53	166.58		127.74
g k 3/82	77.41	205.81	100.22	168.05	205.07	112.71	127.26	133.67	146.49			157.22	193.16	199.29	253.02	124.08	211.93	134.55	141.45	196.95		212.95	253.87	146.96	185.45	122.42	291.42			131.85	118.86	114.5	135.44	160.8		117.14
g k t 159/	77.35	199.39	108.14	168.16	205.04	112.72	127.31	133.69	146.93	175.55	187.4	157.22	193.08	199.19	262.45	123.95	212.06	134.54	141.46	207.12	197.96	212.96	253.87	146.84	173.93	122.49	303.19	88.58			122.91	112.5	135.43	160.6		116.17

Advanced lines – yield trials



?

8 t/ha

5 t/ha

9 t/ha

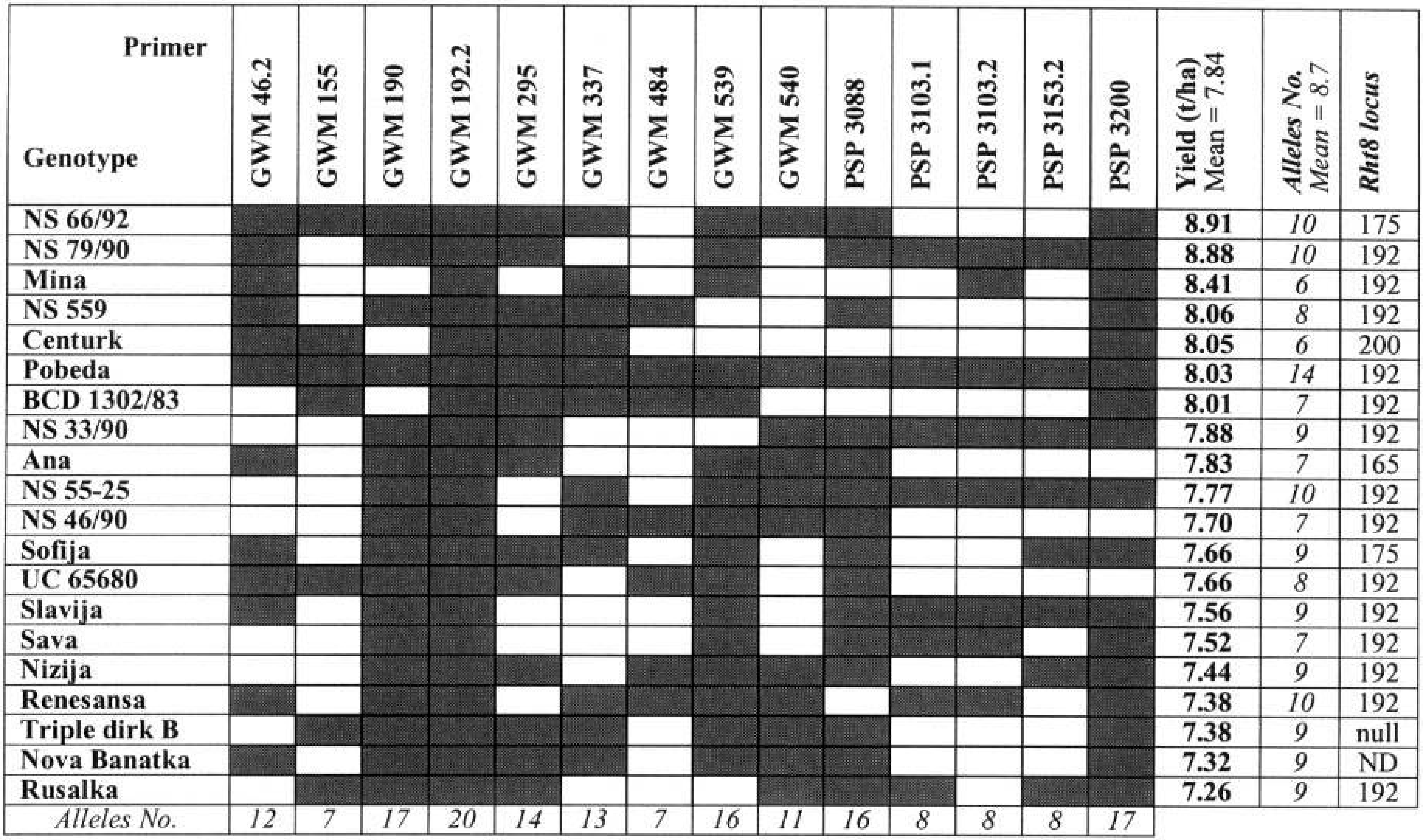
7 t/ha

10 t/ha

8 t/ha

7 t/ha

Distribution of presumed “high-yielding” alleles in the 20 LYG and 20 HYG



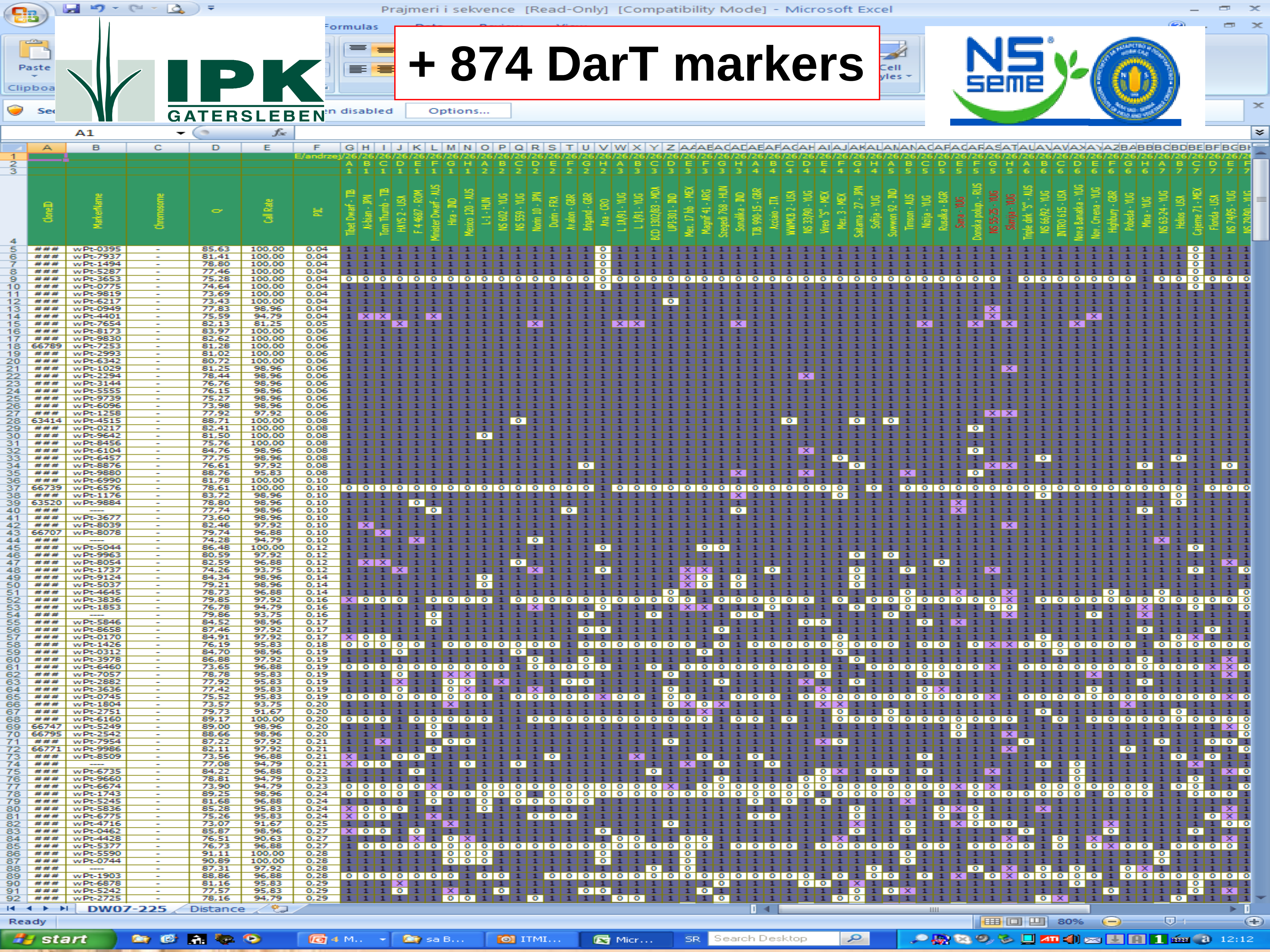
Primer / Genotype	GWM 46.2	GWM 155	GWM 190	GWM 192.2	GWM 295	GWM 337	GWM 484	GWM 539	GWM 540	PSP 3088	PSP 3103.1	PSP 3103.2	PSP 3153.2	PSP 3200	Yield (t/ha) Mean = 7.84	*Alleles No. Mean = 8.7*	***Rht8 locus***
NS 66/92	■	■	■	■	■	■		■	■	■				■	**8.91**	*10*	175
NS 79/90	■		■	■	■			■		■	■	■	■	■	**8.88**	*10*	192
Mina	■			■		■		■				■		■	**8.41**	*6*	192
NS 559	■		■	■	■	■	■			■				■	**8.06**	*8*	192
Centurk	■	■		■	■	■								■	**8.05**	*6*	200
Pobeda	■	■	■	■	■	■	■	■	■	■	■	■	■	■	**8.03**	*14*	192
BCD 1302/83		■		■	■	■	■	■						■	**8.01**	*7*	192
NS 33/90			■	■	■				■	■	■	■	■	■	**7.88**	*9*	192
Ana	■		■	■	■			■	■	■					**7.83**	*7*	165
NS 55-25			■	■		■		■	■	■	■	■	■	■	**7.77**	*10*	192
NS 46/90			■	■		■	■	■	■	■					**7.70**	*7*	192
Sofija	■		■	■	■	■		■		■			■	■	**7.66**	*9*	175
UC 65680	■	■	■	■	■		■	■		■					**7.66**	*8*	192
Slavija	■		■	■				■		■	■	■	■	■	**7.56**	*9*	192
Sava			■	■				■		■	■	■		■	**7.52**	*7*	192
Nizija			■	■	■		■	■	■	■			■	■	**7.44**	*9*	192
Renesansa	■		■	■		■	■	■	■		■	■		■	**7.38**	*10*	192
Triple dirk B		■	■	■	■	■		■	■	■				■	**7.38**	*9*	null
Nova Banatka	■		■	■	■	■		■	■	■				■	**7.32**	*9*	ND
Rusalka		■	■	■	■				■	■	■		■	■	**7.26**	*9*	192
Alleles No.	*12*	*7*	*17*	*20*	*14*	*13*	*7*	*16*	*11*	*16*	*8*	*8*	*8*	*17*			

Developments in Plant Breeding, Wheat Production in Stressed Environments. Buck, H.T.; Nisi, J.E.; Salomón, N. (Eds.), Vol. 12.

IPK GATERSLEBEN

+ 874 DarT markers

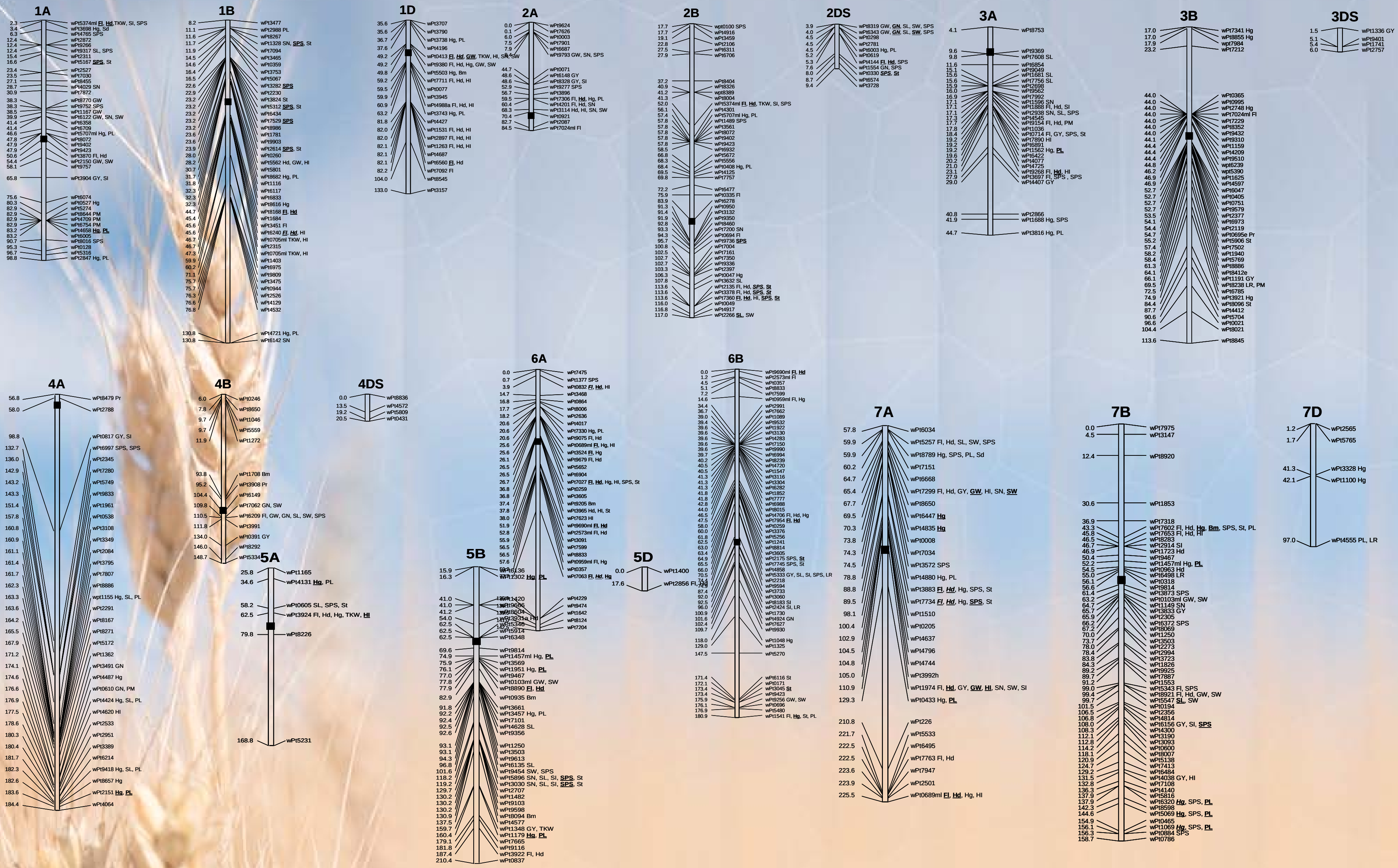
NS seme



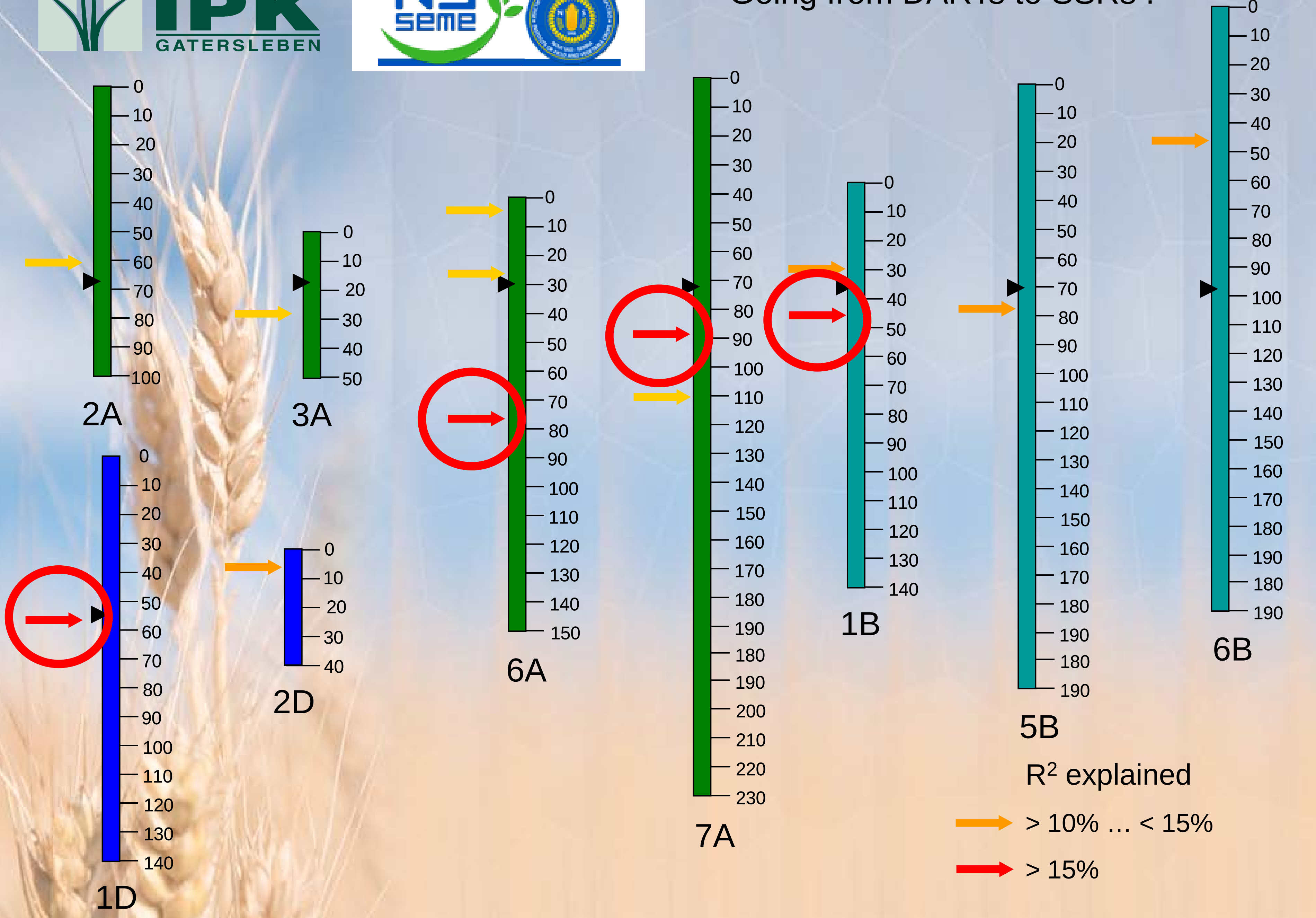
	CloneID	MarkerName	Chromosome	Q	Call Rate	PIC
5	###	wPt-0395	-	85,63	100,00	0,04
6	###	wPt-7937	-	81,41	100,00	0,04
7	###	wPt-1494	-	78,80	100,00	0,04
8	###	wPt-5287	-	77,46	100,00	0,04
9	###	wPt-3653	-	75,28	100,00	0,04
10	###	wPt-0775	-	74,64	100,00	0,04
11	###	wPt-9819	-	73,69	100,00	0,04
12	###	wPt-6217	-	73,43	100,00	0,04
13	###	wPt-0949	-	77,83	98,96	0,04
14	###	wPt-4401	-	75,59	94,79	0,04
15	###	wPt-7654	-	82,13	81,25	0,05
16	###	wPt-8173	-	83,97	100,00	0,06
17	###	wPt-9830	-	82,62	100,00	0,06
18	66789	wPt-7253	-	81,28	100,00	0,06
19	###	wPt-2993	-	81,02	100,00	0,06
20	###	wPt-6342	-	80,72	100,00	0,06
21	###	wPt-1029	-	81,25	98,96	0,06
22	###	wPt-2294	-	78,44	98,96	0,06
23	###	wPt-3144	-	76,76	98,96	0,06
24	###	wPt-5555	-	76,15	98,96	0,06
25	###	wPt-9739	-	75,27	98,96	0,06
26	###	wPt-6096	-	73,98	98,96	0,06
27	###	wPt-1258	-	77,92	97,92	0,06
28	63414	wPt-4515	-	88,71	100,00	0,08
29	###	wPt-0217	-	82,41	100,00	0,08
30	###	wPt-9642	-	81,50	100,00	0,08
31	###	wPt-8456	-	75,76	100,00	0,08
32	###	wPt-6104	-	84,76	98,96	0,08
33	###	wPt-6457	-	77,75	98,96	0,08
34	###	wPt-8876	-	76,61	97,92	0,08
35	###	wPt-9880	-	88,76	95,83	0,08
36	###	wPt-6990	-	81,78	100,00	0,10
37	66739	wPt-6576	-	78,61	100,00	0,10
38	###	wPt-1176	-	83,72	98,96	0,10
39	63520	wPt-9884	-	78,80	98,96	0,10
40	###	----	-	77,74	98,96	0,10
41	###	wPt-3677	-	73,60	98,96	0,10
42	###	wPt-8039	-	82,46	97,92	0,10
43	66707	wPt-8078	-	79,74	96,88	0,10
44	###	----	-	74,28	94,79	0,10
45	###	wPt-5044	-	86,48	100,00	0,12
46	###	wPt-9963	-	80,59	97,92	0,12
47	###	wPt-8054	-	82,59	96,88	0,12
48	###	wPt-1737	-	74,26	93,75	0,12
49	###	wPt-9124	-	84,34	98,96	0,14
50	###	wPt-5037	-	79,21	98,96	0,14
51	###	wPt-4645	-	78,73	96,88	0,14
52	###	wPt-3836	-	79,85	97,92	0,16
53	###	wPt-1853	-	76,78	94,79	0,16
54	###	----	-	79,86	93,75	0,16
55	###	wPt-5846	-	84,52	98,96	0,17
56	###	wPt-8658	-	87,46	97,92	0,17
57	###	wPt-0170	-	84,91	97,92	0,17
58	###	wPt-1426	-	76,19	95,83	0,18
59	###	wPt-0312	-	84,70	98,96	0,19
60	###	wPt-3978	-	86,88	97,92	0,19
61	###	wPt-6460	-	73,65	96,88	0,19
62	###	wPt-7057	-	78,78	95,83	0,19
63	###	wPt-2882	-	77,92	95,83	0,19
64	###	wPt-3636	-	77,42	95,83	0,19
65	###	wPt-0745	-	75,52	95,83	0,19
66	###	wPt-1804	-	73,57	93,75	0,20
67	###	wPt-2751	-	79,73	91,67	0,20
68	###	wPt-6160	-	89,17	100,00	0,20
69	66747	wPt-5249	-	89,00	98,96	0,20
70	66795	wPt-2542	-	88,66	98,96	0,20
71	###	wPt-7954	-	87,22	97,92	0,21
72	66771	wPt-9986	-	82,11	97,92	0,21
73	###	wPt-8509	-	73,56	96,88	0,21
74	###	----	-	77,08	94,79	0,21
75	###	wPt-6735	-	84,22	96,88	0,22
76	###	wPt-9660	-	78,81	94,79	0,23
77	###	wPt-6674	-	73,90	94,79	0,23
78	###	wPt-1743	-	89,25	98,96	0,24
79	###	wPt-5245	-	81,68	96,88	0,24
80	###	wPt-5836	-	85,28	95,83	0,24
81	###	wPt-6775	-	75,26	95,83	0,24
82	###	wPt-4716	-	73,07	91,67	0,25
83	###	wPt-0462	-	85,87	98,96	0,27
84	###	wPt-4428	-	76,51	90,63	0,27
85	###	wPt-5377	-	76,73	96,88	0,27
86	###	wPt-5590	-	91,11	100,00	0,28
87	###	wPt-0744	-	90,89	100,00	0,28
88	###	----	-	87,31	97,92	0,28
89	###	wPt-1903	-	88,86	96,88	0,28
90	###	wPt-6878	-	81,16	95,83	0,29
91	###	wPt-5242	-	77,57	95,83	0,29
92	###	wPt-2725	-	78,16	94,79	0,29

Tibet Dwarf - TIB, Ai-bian - JPN, Tom Thumb - TIB, HAYS 2 - USA, F 4 4687 - ROM, Minister Dwarf - AUS, Hira - IND, Mexico 120 - AUS, L-1 - HUN, NS 602 - YUG, NS 559 - YUG, Norin 10 - JPN, Durin - FRA, Avalon - GBR, Brigand - GBR, Ana - CRO, L 1A/91 - YUG, L 1/91 - YUG, BCD 1302/83 - MDA, UPI-301 - IND, Mex. 17 bb - MEX, Magnif 41 - ARG, Szegedi 768 - HUN, Sonalika - IND, TJB 990-15 - GBR, Acciaio - ITA, WWMCB 2 - USA, NS 33/90 - YUG, Vireo "S" - MEX, Mex. 3 - MEX, Saitama - 27 - JPN, Sofija - YUG, Suwwon 92 - IND, Timson - AUS, Nizija - YUG, Rusalka - BGR, Sava - YUG, Donska polup. - RUS, NS 55-25 - YUG, Slavija - YUG, Triple dirk "S" - AUS, NS 66/92 - YUG, INTRO 615 - USA, Nova Banatka - YUG, Nov. Crvena - YUG, Highbury - GBR, Pobeda - YUG, Mina - YUG, NS 63-24 - YUG, Helios - USA, Cajeme 71 - MEX, Florida - USA, NS 74/95 - YUG, NS 79/90 - YUG

Many NSBSIC (NS Breeding Site Important Candidate) QTLs have been determined



Going from DARTs to SSRs !



R^2 explained

🟧 → > 10% … < 15%

🟥 → > 15%

We are going further – chasing important QTLs for the rest of the genotypes from the Core Collection (app.500) for 20 traits (data - 8 years, 3 field plot reps., on 1,2 m^2, ..)

Validation of 20 candidate markers which we believe could be of value for the NS wheat breeding program

(yield and yield components, pathogen resistance, drought and heat stress tolerance, etc.).

1	**WMC89**	4A
2	**WMC31**	7D
3	**WMC48**	4A
4	**WMC420**	4A
5	**gwm295**	7D
6	**gwm337**	1D
7	**gwm539**	2D
8	**gwm428**	7D
9	**gwm174**	5D
10	**gwm11**	1B

11	**gwm194**	4D
12	**gwm601**	4A
13	**psp 3071**	6A
14	**psp3094**	7A
15	**psp3200**	6D
16	**psp3103**	4D
17	**gwm18**	1B
18	**gwm46**	7B
19	**gwm95**	2A
20	**gwm261**	2D

- **20 highest yielders from Core Collection 96 set**
- **20 lowest yielders from Core Collection 96 set**
- **20 lowest yielding advanced lines**
- **20 highest yielding advanced lines**
- **16 registered and most popular Serbian varieties**

PLAN OF ACTIONS - STARTING DATE 15. OCTOBER 2009.

1. Routine screening for major genes (Lr, Pm, FHB, Rht, Ppd..)

2. Validation and use of mm for desirable QTLs from biparental populations

3. Validation and use of mm for desirable QTLs from association study (CC)

4. Additional screening for desirable QTLs in 500 genotypes from CC (SSRs)

5. Along with these, new markers of potential value for the NS wheat breeding program will be continually included in the validation process in order to create the best and most up-to-date collection of markers which can be used for MAS.

MOLECULAR

Be
R ational
E ffective
E enthusiastic
D ecisive
I nventive
N atural
G enuine

2009

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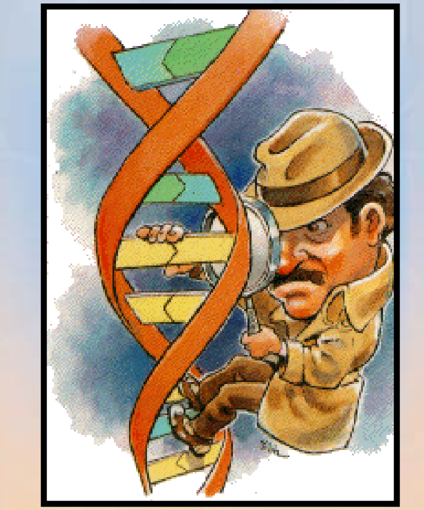

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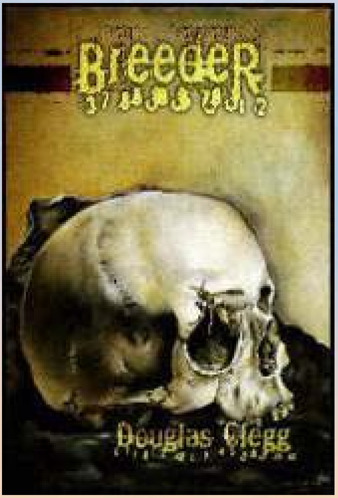

THANKS