

Spring Barley Research Program Achievements (2018-19) & Plan (2019-20)





Ramesh Verma & Barley Team

reas

Spring Barley Research Focus

- Hulled & Naked Barley
- Feed, forage & dual purpose
- Food and Malting
- Resistance to abiotic stresses
  - Drought
  - Cold /Heat
  - Salinity
- Resistance to biotic stresses
  - Rusts (Stripe and leaf)
  - Foliar blights (NB, SB, Scald)
  - Powdery Mildew
  - Aphid / BYDV



Product lines addressed

SN	Product line and region	Traits	Stations	Variety to be replaced
PL1.	Feed and forage barley for Asia and Africa	Higher grain and biomass	**Marchouch,** Jemma Shaim, Terbol, **Kfardan,** Amlaha	Local checks
PL2	Barley for marginal, low input conditions of Asia and Africa	Drought with heat & cold, salinity	**Marchouch**, Jemma Shaim, Kfardan, Amlaha	NARS recent releases
PL3	Barley for malting uses in East Africa and South Asia	Malt and brewing traits	**Marchouch**	NARS recent releases
PL4	Food barley with better nutritional quality	Beta glucan, Fe and Zn	**Marchouch**, Jemma Shaim, Terbol, Kfardan, Amlaha	NARS recent releases
PL5	Barley genotypes with diverse disease and pest resistance	Rusts(Yr, Lr), Foliar blights (NB, SB, Scald), Powdery Mildew	**Marchouch**, JS, Allal Tazi, Holetta, Bekoji, Varanasi, Durgapura	Provide options for NARS with effective/diverse resistance

Salient Achievements 2018-19

Eight new high yielding barley cultivars released in different countries from the ICARDA spring barley elite germplasm

Name	Country	Parentage	Traits
Behdan	Iran	Soufara-02/3/RM1508/Por//WI2269/4/Hml-02- ArabiAbiad//ER/Apm	Two row spring barley, adapted to warm and semi- warm regions of Iran. Main characteristics include improved yield, large seeds, resistant to Powdery Mildew and Scald, high protein content and earliness.
Mahtab	Iran	Bereke-54 (CB-84-10)	A six-row facultative barley variety with high yielding and adapted to cold area of Iran under irrigated conditions, MR to powdery mildew, yellow rust and net blotch
Norooz	Iran	GOB/Aleli//Canela/3/Arupo*2/Jet/4/ Arupo /K8755//Mora	Norooz, a new two-row spring barley variety with high yield, moderate resistance to stripe rust, powdery mildew and adapted to dry and warm areas of South Iran
Moata	Ethiopia	LEGACY/4/TOCTE//GOB/HUMAI 10/3/ATAH92 /ALELI/5/ARUPO/K8755//MOR	Six-row malting barley with yield range of 2.5 to 5.1 t/ha; disease resistant; pest tolerant; protein = 10.2%, extract= 81.8%, friability= 73.3%.
Adoshe	Ethiopia	QUINA/MJA//SCARRLET	Six row, food barley with yield range of 2.5-4.2 t/ha; disease resistant, pest tolerant
DARA	Turkey	Sutter*2/Numar/4/Raca 'S'/3/AC253 //CT05761 (ICB94-0768-0AP-0AP-12AP-0AP) IBYT-MRA (2004-05)-11	6 row Spring barley, early, tolerant to lodging. 6-8 t/ha high hectoliter weight and protein. Released by GAP ARI for Southeastern Anatolia of Turkey high rainfall and irrigated conditions
Karaca	Turkey	Alanda-01/Rhn-03 (ICB03-1568-0AP-1AP-0AP)	Two rowed spring barley; high yielding (5.1–6.3 t/ha): TKW (g): 42–48; protein (%):14–16; HL (kg): 72–74; height: short and lodging tolerant
VLB 130	India	MSEL//BUCK.M.8.88/E.ACACIA) (IBON-HI-107 2008-09)	Six-row dual purpose hulled barley for Uttarakhand under rainfed timely sown
PL891	India	IBON 343/ 12th HBSN 176	Six-row hulless barley for NWPZ under IRTS

Spring Barley Breeding Program

Breeding stations



Evaluation Sites

Morocco

Yield	Marchouch
Quality	Rabat
Drought	Jemma Shaim
Diseases	Allal Tazi, Sidi Al Ayidi Marchouch, Jemma Shaim

Lebanon

Terbol
- Yield potential

Kfardan
- Drought/cold

India

South Asia Platform, Amlaha,

Drought & heat	Amlaha,
Short winter	
Salinity	Kanpur,
Blights	Varanasi,
Rusts	Durgapura, Shimla (SRT)

Ethiopia

Scald, Net blotch	Holetta, Bekoji

Tunisia

BYDV

Spring barley yield Trials 2018-19

2903

SN	Name	Entries	Plots	MAR	JMA	TER	KFA	AML
1	HIBYT-2R-19	180	408	Y	-	Y	-	Y
2	HIBYT-6R-19	180	408	Y	-	Y	-	Y
3	LIBYT-2R-19	187 +3C	440	Y	Y	-	Y	Y
4	LIBYT-6R-19	153+3C	360	Y	Y	-	Y	Y
5	NBYT-19	85 +3C	200	Y	Y	-	Y	Y
6	EMBT	64 + 4C	170	Y	-	-	-	-
7	MBT	117+4 C	306	Y	-	-	-	-
8	HIPYT-2R-19	375	425	Y	-	-	-	-
9	HIPYT-6R-19	525	595	Y	-	-	-	-
10	LIPYT-2R-19	234 +3C	260	Y	-	-	-	-
11	LIPYT-6R-19	335	400	Y	-	-	-	-
12	NPYT-18	96 + 4C	120	Y	-	-	-	-
13	Dual Purpose Trial	37	80	Y				
14	DIIVA Trial	28	56	Y	Y	SAA, TESS, ANNA		
15	BDM	18	144	Y	Y	DOUY, SAA		
16	IBYT-HI-19	25	50	Y		Y		Y
17	6th GSBYT-19	25	50	Y		Y	Y	Y
18	IBON-HI-19	99	112	Y		Y		Y
19	6th GSBON-19	140	161	Y		Y	Y	Y

Spring breeding material evaluation 2018-19

Generation	High input (MAR)	Low input (KFA)	Total
Crossing block	516	516	516
F_2	1126	203	1329
F_3	842	301	1143
F_4	1020	776	1796
F_5	754	596	1350
F_6	72 (BYDV)	2390	2462
F_7	741	741	741
Total	4330	5523	9853

Breeding material (# families)

Trials with LARI 2018-19 (Lebanon)



LARI-ICARDA BARLEY VARIETY TESTING (LIBVT-19)				
Steps	Year of Testing	No. of Entries	Remarks	No. of Checks
1	2018 - 2019	8	Get Results	2 Rihane-03 (6R) Litani (2R)
2	2019 - 2020	4 + 6 new	4 as exceed checks	2 Rihane-03 (6R) Litani (2R)
3	2020 - 2021	2 + 2 + 6 new	2 to be Released in 3 year 2 Goes to 2nd Year testing	2 Rihane-03 (6R) Litani (2R)
4	2021 - 2022	1 + 3 + 6 new	1 Released Proposal	2 Newly released
Date of Sowing : 15 - 30 November				
Plot Size : 6 rows X 5 meters (Length) X 0.2 meter (within rows)				
Fertilizer : Basal (N = 40 , P = 30 , K = 30 Kg/ha)				
Number of Locations :		3 (1-Tel Amara, 2-Terbol, 3-Kfardan)		

Trials

Barley experiments at Amlaha, India





SN	Name	Entries	Total Plots
1	IBYT-HI-19	25	50
2	6th GSBYT-19	25	50
3	IBON-HI-19	99	112
4	5th GSBON-18	140	161
5	HIBYT-2R-18	180	408
6	HIBYT-6R-18	180	408
7	LIBYT18-2R	187	440
8	LIBYT18-6R	153	360
9	NBYT-18	85	200
	Total	1057	2092

Also coordinating the phenotyping of BYT entries & AM17 for diseases and salinity with ICAR centers

Barley experiments at Amlaha, India





AM 17 population evaluated for heat tolerance studies (Staggered sowing in two dates of 4 groups)
Left : Timely sown Right late sown (Photograph on 14 February 2019)

Crosses made during 2018-19 crop season

SN	Category	#crosses
1	Low input program crosses	268
2	HI Input program crosses	452
3	Huskless/ naked food barley crosses	165
4	Malting quality crosses	304
	Total crosses attempted	1189 (849 + 340)



Terbol is still the main facility for hybridization and off season but Morocco is catching up



Barley F1 generation at Annaceur, Morocco during July (left) , August (middle) and September (right), a significant progress

Spring barley increases at AREC in 2018-2019 for international trials of 2020-21



Type	# Entries
New entries for ICARDA International trials	33-IBYT 31 -GSBYT
New entries for ICARDA International nurseries	IBON=114 GSBON= 117
TOTAL	295

Dual Purpose barley genotypes (CRP Livestock)







- *40 barley genotypes evaluated for dual uses (forage and feed) in 5 M x 6 rows plots at Marchouch*
- *Cut for green forage @ 55 DAS in half plot and half remained uncut*
- *Green forage yield, straw and grain yield from cut and no cut recorded*

Genetic variation for green forage yield and regeneration capacity in barley



Cut treatment (left) at 55 days crop in dual purpose trial

Regeneration differences in genotypes at early (left) and late (right) stages





DIIVA barley trial (2018-19) GY (Kg/ha)

Entry.19	Cross.name	ANA	JMA	MAR	SAA	TSA	MGY
8	Moroc9-75//WI2291/WI2269/5/SLB15-05/4/H.spont.96-3/3/Roho //Alger/Ceres362-1-1	1242	1691	1301	954	1682	1374
4	Soufara-02/3/RM1508/Por//WI2269/4/Hml-02/ArabiAbiad//ER/ Apm/5/SLB15-05/4/H.spont.96-3/3/Roho//Alger/Ceres362-1-1	1153	1596	1226	1063	1763	1360
1	SLB15-05/4/H.spont.96-3/3/Roho//Alger/Ceres362-1-1/5/Roho /4/Zanbaka/3/ER/Apm//Lignee131	1176	1561	1190	1125	1655	1341
21	Clipper//WI2291*2/WI2269/5/SLB15-05/4/H.spont.96-3/3/Roho //Alger/Ceres362-1-1	1053	1517	1298	1004	1824	1339
5	Clipper//WI2291*2/WI2269/5/SLB15-05/4/H.spont.96-3/3/Roho //Alger/Ceres362-1-1	1131	1642	1222	946	1720	1332
10	ChiCm/An57//Albert/3/Alger/Ceres362-1-1/4/Arta/5/SLB15-05/4/ H.spont.96-3/3/Roho//Alger/Ceres362-1-1	1197	1574	1285	850	1623	1306
25	WI2291	1304	1519	1292	994	1603	1342
27	Furat-3	1154	1593	1203	870	1622	1308
26	Adrar	1201	1580	1101	953	1603	1288
28	Tamellalt	1061	1594	1241	737	1586	1284
	Mean	1059	1464	1134	858	1590	
	CV	16.94	18.80	19.67	25.21	15.96	
	LSD	352	539	437	424	497	
	H2	0.46	0.75	0.40	0.52	0.69	



DIIVA barley trial (2018-19) BY (Kg/Ha)

Entry	Cross.name	ANA	JMA	MAR	SAA	TSA	MBY
8	Moroc9-75//WI2291/WI2269/5/SLB15-05/4/H.spont.96-3/3/Roho//Alger/Ceres362-1-1	3727	4130	3727	2931	6101	4123
21	Clipper//WI2291*2/WI2269/5/SLB15-05/4/H.spont.96-3/3/Roho//Alger/Ceres362-1-1	3799	3945	3623	2932	6187	4097
4	Soufara-02/3/RM1508/Por//WI2269/4/Hml-02/ArabiAbiad//ER/Apm/5/SLB15-05/4/H.spont.96-3/3/Roho//Alger/Ceres362-1-1	3695	4041	3693	2942	6114	4097
1	SLB15-05/4/H.spont.96-3/3/Roho//Alger/Ceres362-1-1/5/Roho/4/Zanbaka/3/ER/Apm//Lignee131	3780	3991	3596	2941	6143	4090
24	Clipper//WI2291*2/WI2269/5/SLB15-05/4/H.spont.96-3/3/Roho//Alger/Ceres362-1-1	3791	3977	3677	2897	6085	4086
17	Moroc9-75//WI2291/CI01387/3/H.spont.41-1/5/Clipper/Volla/3/Arr/Esp//Alger/Ceres362-1-1/4/Hml	3739	3995	3553	2922	6182	4078
27	Furat-3	3669	4001	3611	2884	6086	4090
28	Tamellalt	3676	4037	3636	2892	6042	4077
12	ChiCm/An57//Albert/3/Alger/Ceres362-1-1/4/Arta/5/SLB15-05/4/H.spont.96-3/3/Roho//Alger/Ceres362-1-1	3671	4062	3670	2864	6058	4065
10	ChiCm/An57//Albert/3/Alger/Ceres362-1-1/4/Arta/5/SLB15-05/4/H.spont.96-3/3/Roho//Alger/Ceres362-1-1	3734	4033	3592	2900	6049	4061
26	Adrar	3646	3977	3550	2918	6108	4060
25	WI2291	3633	3896	3669	2908	6156	4052
	Mean	3700	3980	3589	2910	6106	4057
	CV	14.67	16.65	12.88	36.67	12.07	
	LSD	1064	1299	906	2091	1445	
	H2	0.13	0.51	0.12	0	0.42	

DIIVA barley trial (2018-19) Farmers fields







Promising spring barely genotypes in 2018-19

Promising entries identified better then best checks across ICARDA locations

Most stable entries across environments and over all basis

Better at least at two environments as well as over all basis

Frequency of promising entries in BYTs 2018-19

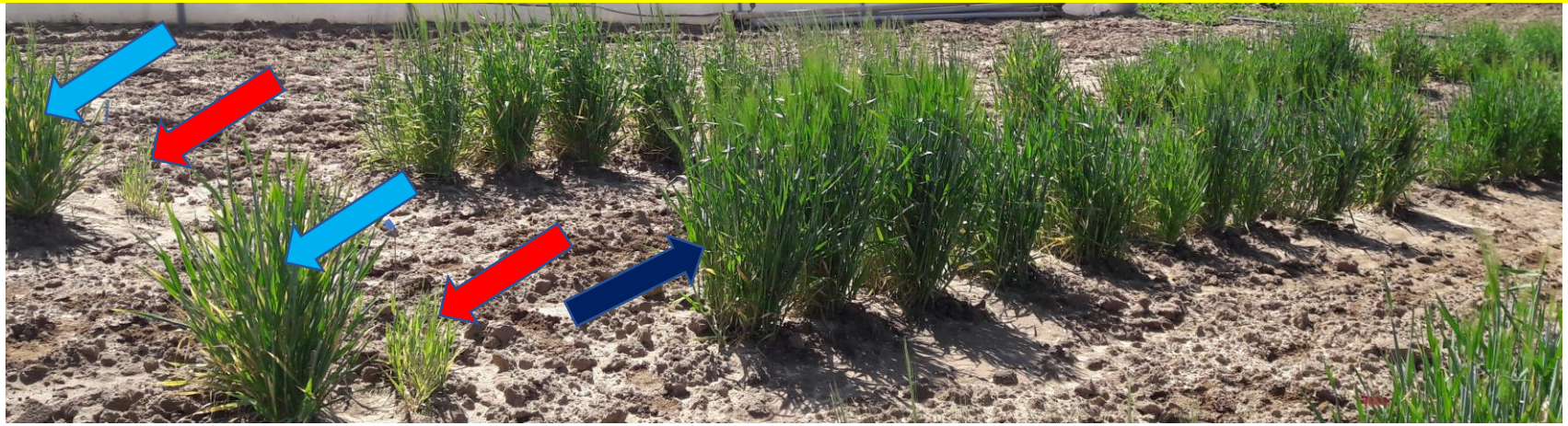
2R LIBYT	Locations				
T 180	AML	JMA	KFA	MAR	MGY
P Ent	8	88	55	72	42
Max	2967	2991	8822	5245	4793
Mean	2188	1984	7858	4589	4155
LSD	782	667	1429	1120	
CV	18.24	17.14	9.28	12.46	
H2	0.7	0.71	0.52	0.35	

2R HIBYT	Locations			
T 180	AML	MAR	TER	MGY
P Ent	71	86	90	96
Max	4724	6311	9788	6424
Mean	3006	4992	8372	5456
CV	19.24	13.86	9.35	
LSD	1133	1356	1534	
H2	0.67	0.42	0.71	

6R LIBYT					
T 153	AML	JMA	KFA	MAR	MGY
P Ent	61	41	74	67	57
Max	3449	3013	10479	5817	5323
Mean	2477	1905	9181	4760	4581
CV	19.49	21.18	5.47	13.06	
LSD	946	791	984	1218	
H2	0.71	0.67	0.84	0.39	

Trial	MBT	EMB
T Ent	120	70
P Ent	18	42
Max	5341	4827
Mean	4401	4220
CV	12.8	14.7
LSD	1107	1222
H2	0.53	0.42

BYDV success story : Pyramiding of Ryd3 with Ryd2 through MAS





Rihane 03 - Susceptible

ICBO1-1108 : R line with Yd2

Test line with Yd2 + Yd3

72 Barley elite germplasm with Yd2+Yd3 genes F7 (from ICARDA Morocco) evaluated for BYDV (Mornag station, Tunis, 2018/2019),
30 seeds/30 cm row in 2 replicates (BYDV and control)
DOS: 13/12/2018 Date of inoculation: 9 January 2019 Date of final reading: March 27, 2019

BYDV success story : Pyramiding of Ryd3 with RYd2 through MAS



Next step
Molecular verification
Distribution to NARS

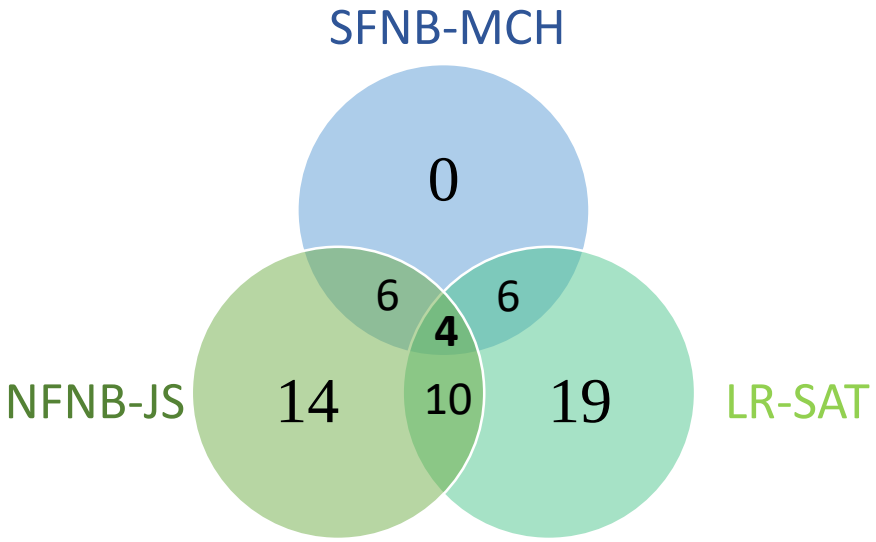
Cross	Parentage	Score 0	Score 1	Score 2	Total Fam
1	L94/Msel//BCD-TTA-N/Msel	0	6	4	10
2	L94/MP20	1	10	1	12
3	BUTTA12//L94/MP103R	0	7	0	7
4	ORCA//L94/MP103R	12	9	1	22
5	L94/MP103R	16	5	0	21
	Rihane03 (S check)	0	0	0	Score= 9
	ICBO1-1108 (R line with Yd2)	0	0	all	Score= 2

Adult plant resistance in barley

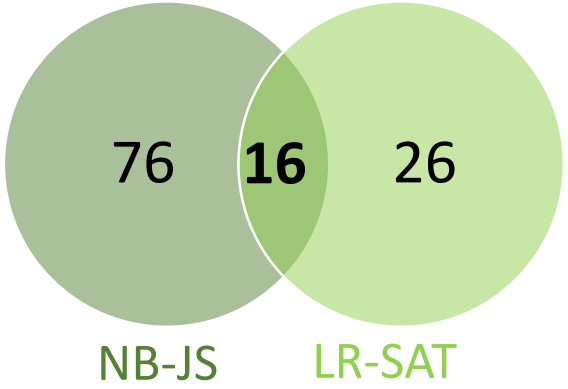
		Jemaat Shiaam		*Sidi Allal Tazi*		*Marchouch*			
		Net blotch		Leaf Rust		Spot form net blotch		Powdery mildew	
Trials	**# of Lines**	**R**	**MR**	**R**	**MR**	**R**	**MR**	**R**	**MR**
2R HIBYT19	176*3	34	68	35	36	16	111	-	-
6R HIBYT19	170*3	11	41	1	20	43	103	0	30
2R LIBYT19	183*3	41	60	1	7	18	83	-	-
6R LIBYT19	146*3	17	32	0	16	28	47	0	42
NBYT19	85*2	14	16	0	4	-	-	-	-
BDYT19	140	4	28	-	-	-	-	-	-
CB-19	493*2	49	174	2	36	-	-	-	-
AM-17	320*2	23	92	6	42	-	-	-	-
Aust. Lines	370*2	10	55	6	24	-	-	-	-
DIIVA	24	18	6	-	-	-	-	-	-
Dual Purpose	40	-	-	-	-	0	21	11	10
Total	**4765**	**221**	**572**	**51**	**185**	**105**	**365**	**11**	**82**

Adult plant stage resistance in barley

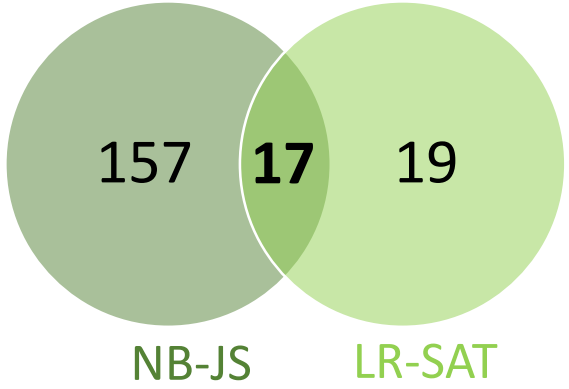
Resistant entries to
NFNB/SFNB/LR
In 2R HIBYT



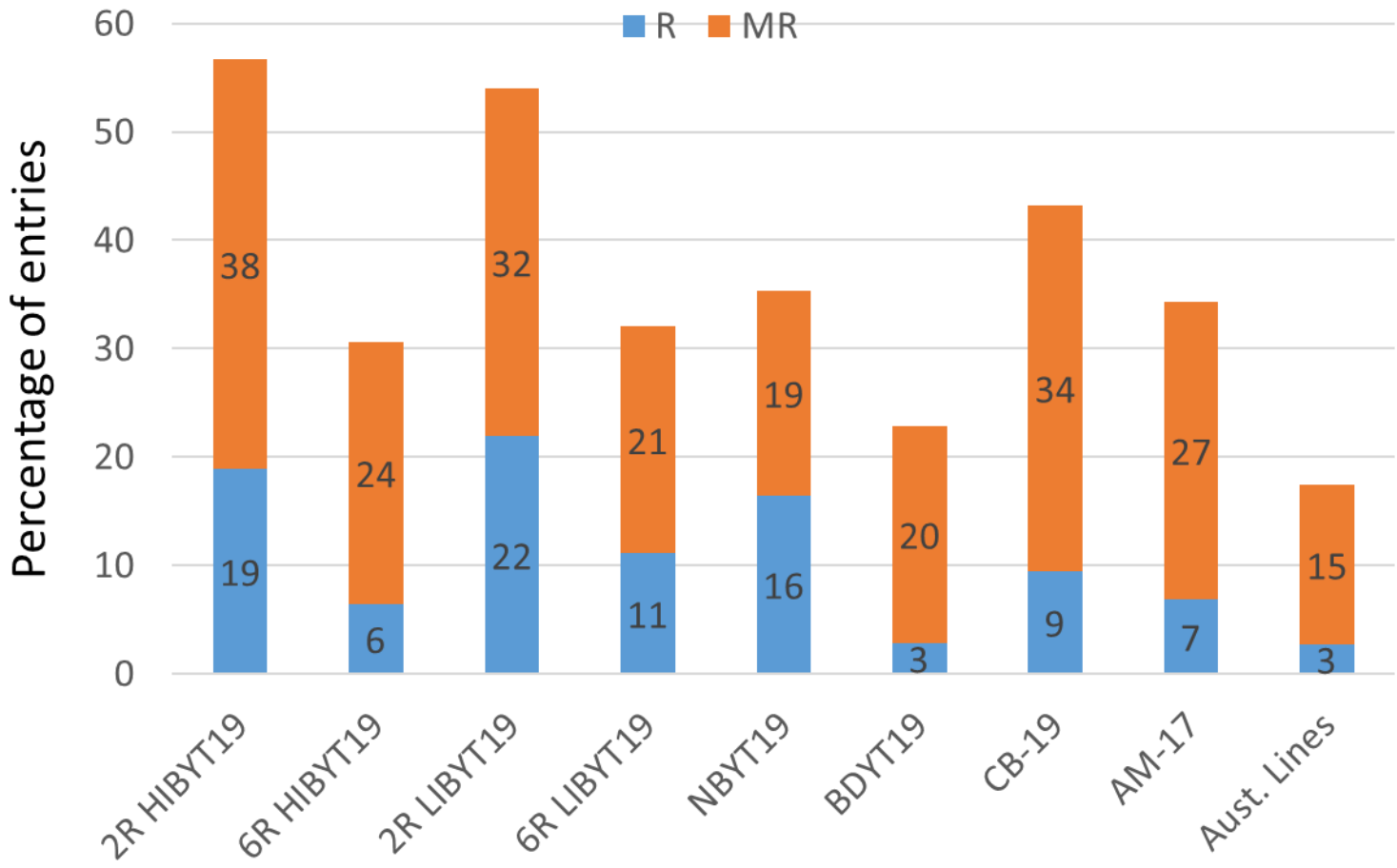
MR entries to NB and LR
In AM-17



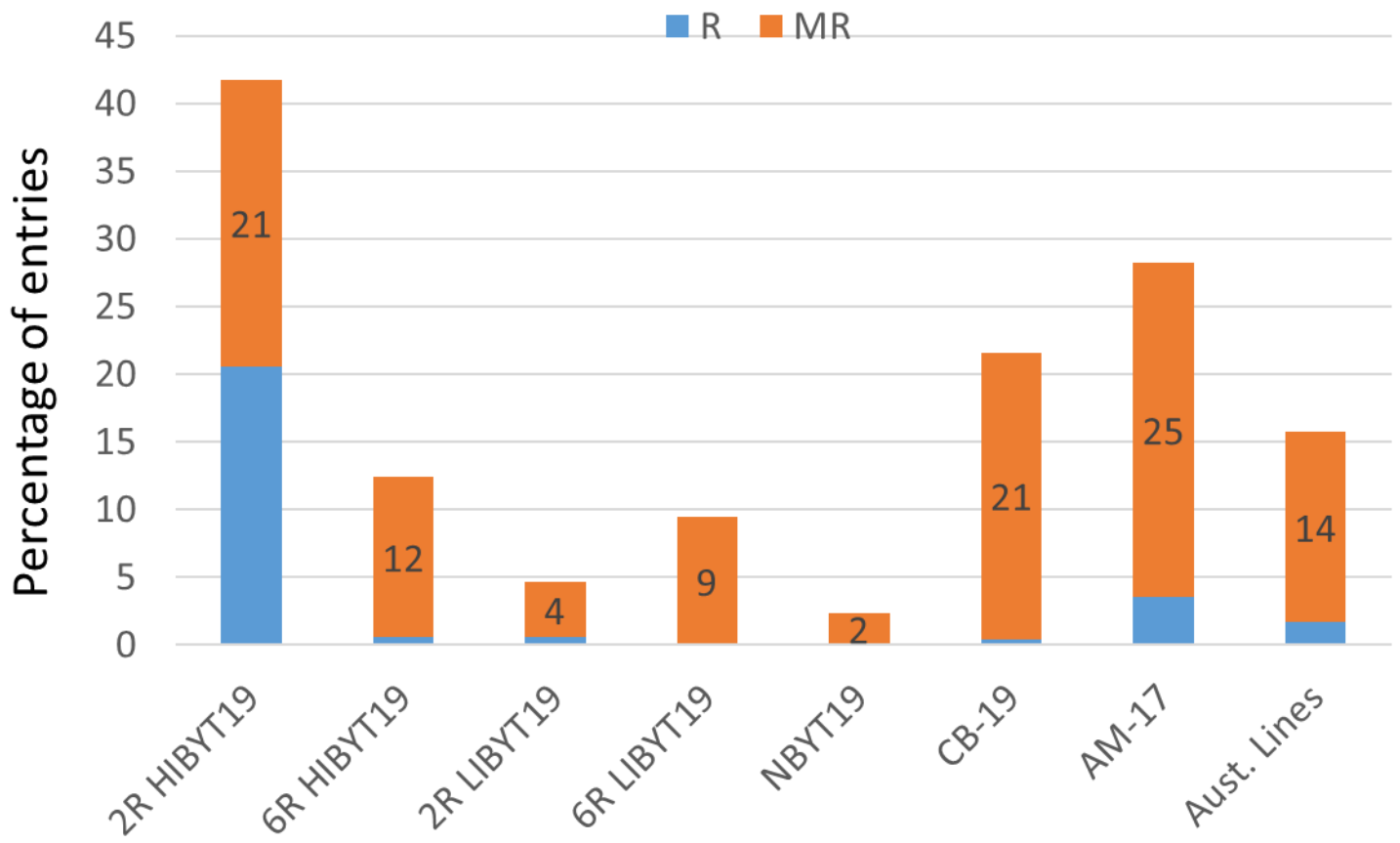
MR entries to NB and LR
In CB-19



Percentage of R and MR entries in barley trials to net blotch in Jemaa Shaim



Percentage of R and MR entries in barley trials to leaf rust in Sidi Allal Tazi



Status of DH populations



Cross	Cross
1	Alanda01/ Zanbaka
2	Rihane03/ Zanbaka
3	Alanda01/ Rihane03
4	NB-R/NB-S

Progress 2018-19

- The DH populations were grown in Marchouch, Jemma Shaim, SA Ayidi and SAT,
- The grain samples of crosses 1-3 are collected and will be analyzed for Fe, Zn
- Cross 4 (NB-R/ NB-S) was recorded for NB at Marchouch, while the experiment failed in SA Ayidi and SAT

Contribution to capacity building







- Training program organized on GWAS 17-22 June 2019 at ICARDA Rabat for students at ICARDA supported by **ICARDA, Global Crop Diversity Trust CWR Pre Breeding Project and AFESD.**
- 18 students across the crops participated / benefitted

Contribution to capacity building

Training program organized on barley improvement covering breeding and pathology aspects at ICARDA Rabat for two trainees (from India) from 9-20 April, 2019 under ICAR-ICARDA collaboration



Publications

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Publications

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2. S. Gyawali, A. Reda, R.P.S. Verma, R. Brueggeman, S. Rehman, L. Belqadi, M. Arbaoui, P. Tamang and M. Singh. 2019. Seedling and adult stage resistance to spot form of net blotch (SFNB) in spring barley and stability of adult stage resistance to SFNB in Morocco. ***Eur J Plant Pathol,*** 153:475–487. Doi. 10.1007/s10658-018-1575-8.
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Proposed Program 2019-20

Breeding stations



Evaluation Sites

Morocco

Yield	Marchouch, Annaceur
Quality	Rabat
Drought	Jemma Shaim
Diseases	Allal Tazi, Sidi Al Ayidi
	Marchouch, Jemma Shaim

Lebanon

Terbol	Yield potential
Kfardan	Drought/cold/ Low inputs

India

South Asia Platform, Amlaha,

Drought & heat	Amlaha,
Short winter	
Salinity	Kanpur, Faizabad, Hisar
Blights	Varanasi, Faizabad
Rusts	Durgapura, Shimla (SRT)

Ethiopia

Scald, Net blotch	Holetta, Bekoji
BYDV	Sinana

Tunisia

BYDV

Iran

Salinity

BYTS reduced by half nearly

SN	Name	Entries	Plots	Entries	Plots
1	HIBYT-2R-19	180	408	88	200
2	HIBYT-6R-19	180	408	85	200
3	LIBYT-2R-19	187 +3C	440	85	200
4	LIBYT-6R-19	153+3C	360	72	180
5	NBYT-19	85 +3C	200	51	120
6	EMBT	64 + 4C	170	41	80
7	MBT	117+4 C	306	?	?
8	HIPYT-2R-19	375	425	less	
9	HIPYT-6R-19	525	595	less	
10	LIPYT-2R-19	234 +3C	260	less	
11	LIPYT-6R-19	335	400	less	
12	NPYT-18	96 + 4C	120	less	
13	Dual Purpose Trial	37	80	?	?
14	DIIVA Trial	28	56	?	?
15	BDM	18	144	?	?
16	IBYT-HI-19	25	50	NC	NC
17	6th GSBYT-19	25	50	NC	NC
18	IBON-HI-19	99	112	NC	NC
19	6th GSBON-19	140	161	NC	NC

The Barley Team

Name	Position
Sajid Rehman	Cereal Pathologist
Andrea Visioni	Winter barley Breeder
Kehel Zakaria	Biometrician
Ahmed Amri	Head GRS
Sripada Udupa	Biotechnologist
Zewdie Bishaw	Seed Unit
Abdoul-Aziz, Niane	IN Program
Safaa Kumari	Seed Health
Mesut Keser	Consultant (WB)
Ramesh Verma	Barley Breeder
Michael Baum	Director – BCIP

Research Support
Raafat (Lebanon)
Rachid & Boukri (Morocco)
Sunil (Amlaha)


Thank you