

**Activities:2.5.1.1-Implementing breeding programs for high- & low-input, spring and winter barley**

The breeding program was implemented in four countries viz. Lebanon (Terbol & AUB), Morocco (Rabat, Jemma Shaim, Allal Tazi), India (Amlaha) and Mexico (Toluca/ Obregon) to fulfil the objectives. More than 1800 new crosses were attempted for at in the hybridization process. New genotypes/ varieties with known malting quality have been introduced in ICARDA material for use in breeding from UC Davis California, USDA, Idaho and other sources. From ICARDA-IASA project (public- private partnership) superior lines with better MQ, disease resistance and local adaptability have been identified. Since the project ended during the year, the full set of material (1582 genotypes spread over seven filial generations) has been transferred to Morocco for inclusion in the ICARDA main breeding program. Germplasm evaluation in India for stripe rust, leaf blights and salinity was also completed at Jaipur, Varanasi, and Kanpur respectively in collaboration with ICAR institution/ SAUs. One set of all yield trials was conducted at ICARDA South Asia Platform Amlaha, M.P., India for agronomic evaluation. The seedling resistance to different stripe rusts pathotypes was done at Shimla under controlled conditions, and several lines with resistance to pathotypes were identified in an association mapping population.

The selections in different generations of the low input barley were made at Terbol in Lebanon as well as in Morocco and different locations. However, the yield trials of the program failed in Morocco because of the most severe drought in recent history. The data from Lebanon was considered for promotion to new trials/ generations. The drought in Morocco provided an opportunity to make selection of tolerant genotypes performing under most severe conditions in Marchouch and Jemma Shaim locations. The table 2.3 provides an indication that more than 19000 genotypes/ families were selected for further multi-location evaluation in 2016-17 crop season for the spring barley breeding program at ICARDA to identify the desirable combination of agronomic, abiotic and biotic stresses and quality traits to address the global demand for feed, food, forage and malting in particular for Asia and Africa. Similarly, more than 3400 genotypes were evaluated under winter barley program at Turkey, making overall total of 22422 genotypes evaluated under ICARDA barley program.

**Table 2.3: Summary of the spring barley breeding material selected for 2016-17 at different locations/ countries during 2016.**

Category/ Generation	High input				Low input			Total
	MOR	IND	LEB	MEX	LEB	MOR	IND	
Crossing block	480			69				549
New crosses & F <sub>2</sub> *			1054		776			1830
F <sub>3</sub>	460			54	596	85		1195
F <sub>4</sub>	345			457				802
F <sub>5</sub>	162			109	1110			1381
F <sub>6</sub>	527			317	6420	1000		8264
F <sub>7</sub>	140			416	1095	768		2419
Yield Trials	440	440	440		400	400	280	2400
IN Increases	192		192		149	149		341
Spring barley Total								19181
Winter barley								3422
Overall total								22603

\*Crosses made and advanced to F<sub>2</sub> in off season, MOR= Morocco, LEB=Lebanon, IND= India and MEX= Mexico

## Publications:

2. Sneh Narwal<sup>1</sup>, Dinesh kumar and R. P. S. Verma.2016. Effect of genotype, environment and malting on the antioxidant activity and phenolic content of Indian barley. **Journal of Food Biochemistry**. 40, 91-99.
4. **R.P.S. Verma**, R. Selvakumar, O.P. Gangwar, P.S. Shekhawat, S.C. Bhardwaj, S. Rehman, D.S. Poudyal and S. Gyawali. 2015. Identification of additional sources of resistance to stripe rust in barley. **Plant Disease**. (Accepted).
1. Naval Kishore, Vishnu Kumar and RPS Verma.2016. Barley. In: Broadening the Genetic Base of Grain Cereals. Ed: M. Singh, S. Kumar. Pp 89-125, 2016. Springer, New Delhi, India.
1. R.P.S. Verma, S. Gyawali, A. Amri, Z. Bishaw, A. Niane, A. Al-Abdallat, S. Udupa, A. Visioni, S. Rehman, and M. Baum. 2016. Addressing the global challenges for barley improvement through CGIAR Research Program on Dryland Cereals. 2016. Abstract: 12<sup>th</sup> International Barley Genetic Symposium, 2016. Minneapolis, MN, USA.
4. R. Amezrou, R.P.S Verma, L. Belqadi, S. Chao, M. Arbaoui, S. Rehman, S. Gyawali. Genome wide association studies of barley net blotch resistance in Morocco. Abstract: 12<sup>th</sup> International Barley Genetic Symposium, 2016. Minneapolis, MN, USA.
7. Dinesh Kumar, RPS Verma, Sneh Narwal, Jogendra Singh, Rekha Malik, Vishnu Kumar, Anil Khippal, Lokendra Kumar, AS Kharub and Indu Sharma. Genotypic and location effect on grain protein content of barley under sub-tropical climates. 2016. Abstract: 12<sup>th</sup> International Barley Genetic Symposium, 2016. Minneapolis, MN, USA.
8. R. Malik, J. Singh, S. Verma, R. Kumar, D. Kumar, V. Goyal, L. Kumar, A.S. Kharub, R.P.S. Verma, and I. Sharma.2016. Genetic relatedness studied at molecular level for huskless barley (*Hordeum vulgare*). Abst. In: 12<sup>th</sup> International Barley Genetics Symposium.26-30 June 2016. Minneapolis, MN. USA. Pp. 118.
9. L. Kumar, RPS Verma, J. Singh, D. Kumar, A.S. Kharub, A. Khippal, R. Malik, A. Kumar Sharma, and I. Sharma. Genetic evaluation of barley germplasm for lodging tolerance under sub-tropical climates of India. Abst. In: 12<sup>th</sup> International Barley Genetics Symposium.26-30 June 2016. Minneapolis, MN. USA.Pp.101.
10. A.S. Kharub, D. Kumar, V. Kumar, R. Malik, R.P.S. Verma and I. Sharma.2016. Barley research in India: challenges and opportunities. Abst. In: 12<sup>th</sup> International Barley Genetics Symposium.26-30 June 2016. Minneapolis, MN. USA.Pp.94.

11. A. K. Khippal, D. Kumar, J. Singh, R. P. S. Verma, J. Singh, R. Sheokand, A. Kumar, L. Kumar, R. Malik and I. Sharma. 2016. Conservation agricultural practices to improve quality and productivity of malt barley. Abst. In: 12<sup>th</sup> International Barley Genetics Symposium. 26-30 June 2016. Minneapolis, MN. USA. Pp.95.

13. J. Singh, RPS Verma, D. Kumar, L. Kumar, A. Khippal, R. Malik, V. Kumar, S. Ahlawat, K.P Singh, A. S. Kharub and I. Sharma. 2016. Association and multivariate analysis of yield and its components in hulless barley (*Hordeum vulgare* L). Abst. In: 12<sup>th</sup> International Barley Genetics Symposium. 26-30 June 2016. Minneapolis, MN. USA. Pp.178.