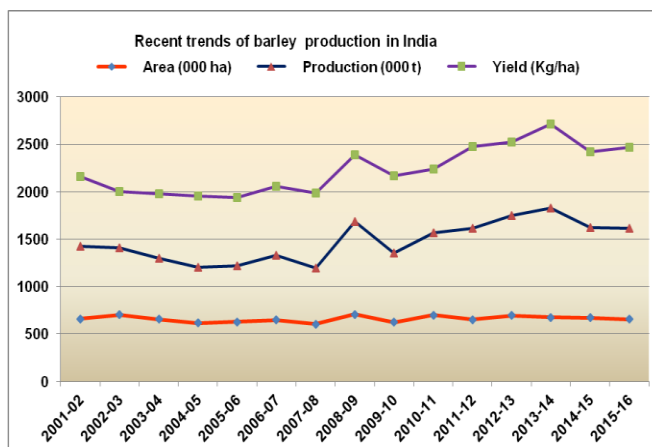


RESEARCH HIGHLIGHTS OF BARLEY NETWORK

The crop season 2015-16 was quite good in terms of production. According to 3rd advance estimates for Rabi 2015-16, nearly 1618 thousand tons of barley production in 655.0 thousand ha area with a productivity of 24.7 q/ha. In India Rajasthan is the largest state having >50% in production and 50% area followed by Uttar Pradesh. During the season crop damage due to lodging was observed in pockets because of rains and strong winds at maturity stage. There was also aphid infestation in congenial atmosphere where not much winter rains occurred and caused damage in certain areas. A concern is usually raised at various platforms for barley area decline, however, in last 15 years, the area has stabilized and there has been gain in productivity and productivity resulting in higher production. Though the MSP of barley (Rs.1225/-) is much lower than wheat (Rs.1525/-), but during current season the market price of barley remained higher (up to Rs. 1300/q and in August it goes up to Rs 1500/q). The monitoring teams surveyed the major barley growing areas during the season in addition to visiting the experiments at coordinated centres. The observations indicate that the crop season was by and large a disease free year in major barley growing areas, with some incidence of yellow rust in foothills and mid hills. The incidence of leaf blights was observed in the eastern zone.



Estimates of barley area, production and productivity in major barley growing states

State	Area (000 ha)			Production (000 T)			Yield (q/ ha)		
	2013-14	2014-15	2015-16	2013-14	2014-15	2015-16	2013-14	2014-15	2015-16
Bihar	10.5	10.5	10.9	14.3	14.8	14.4	13.9	14.1	13.2
Haryana	39.0	33.0	24.0	153.0	99.0	84.0	39.2	30.0	35.0
H.P.	17.3	20.1	19.2	28.2	30.1	26.0	16.2	15.0	13.5
J&K	12.0	12.6	6.70	7.1	7.2	4.30	5.7	5.7	6.42
M.P.	86.7	43.0	97.0	153.0	54.0	184.6	17.3	12.6	19.0
Punjab	12.0	18.0	17.0	46.0	65.0	62.0	38.3	36.1	36.5
Rajasthan	309.3	340.7	309.4	942.0	840.9	856.7	30.4	24.7	27.7
U. P.	157.0	167.0	146.0	450.0	481.0	358.0	28.6	28.8	24.5
Uttarakhand	23.3	21.0	19.0	31.5	29.0	22.0	13.5	13.8	11.6
All India	674.0	67.2	655.2	1830	1626.3	1618.5	27.1	24.2	24.7

*Third advance estimates

New initiatives were undertaken to improve productivity of food purpose barley through screening of germplasm and pre-breeding and to popularize the health benefits of barley (higher beta glucan content, improvement in lodging resistance and to enhance yield and quality of malt purpose barley through pre-breeding, churning germplasm and integration of molecular breeding, Linkages with national and international organisations, industries and farmers were also strengthened.

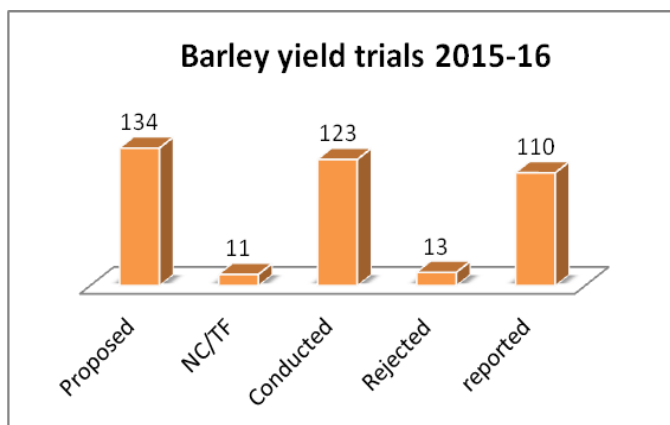
Novel Genetic stock Registered during 2015-16

Genetic stock	Characteristics
DWRB 30	High beta Glucan
BK 1127	High thousand grain weight with high protein

CROP IMPROVEMENT

COORDINATED YIELD EVALUATION TRIALS

- Out of 134 yield evaluation trials proposed, 123 (91.8%) trials were conducted. Eleven trials were either not conducted/failed and data were not received in time. After the analysis, only 110 trials (82.1% of proposed 89.4% of conducted) were found good for reporting.
- These trials were conducted at 12 main centres and 47 testing centres (including ICAR, SAUs and State Department of Agriculture) during *rabi* 2015-16.
- In all 114 test entries contributed by 12 centres, were evaluated against 30 checks in the coordinated yield trials under rainfed (plains and hills), Irrigated (plains) and saline soils conditions under timely/ late sown conditions. The new barley entries include malt, feed or dual purposes types and mostly were hulled type with a few hull-less types in northern hills zone.



Malt Barley Evaluation

Timely sown

- The AVT-MB (IR-TS) was proposed and conducted at 12 centres in NWPZ with 3 test entries and 5 checks viz. BH 902 (six-row, feed barley) and DWRB92, DWRB101, DWRUB52 and RD2849 (all two-row malt barley), where entry DWRB123 was in the final year of evaluation. The incidences of loose and covered smuts were noticed in check varieties BH902 and DWRUB52 and stripe rust reaction of 10S was also observed in check BH902. The trial mean grain yield was exhibited as 45.3 q/ha, which ranged from 32.3 q/ha (Karnal) to 64.2 q/ha (Sri Ganganagar) indicating a wide difference across the centres. The entry RD2917 (47.1 q/ha) ranked first followed by the best check DWRB101 (46.7 q/ha), and comprised in the first Non-Significant Group. The final year entry DWRB123 (46.3 q/ha) and also comprised in the first Non-Significant Group.
- The IVT malt barley timely sown was proposed and conducted at 9 locations in NWPZ with 20 entries including 5 checks namely BH 902 (six-row feed barley) and DWRB92, DWRB101, DWRUB52 and RD2849 (two-row malt barley) for irrigated timely sown conditions of NWPZ. The genotypes namely BH 1011, BH1012 and RD2943 were having some off types, while the entry RD2941 was reported as mixture/segregating. The entry KWS AMADORA was late and showed up to 57 double digit score for spot blotch. The trial mean ranged from 32.0 q/ha (Bathinda) to 64.2 q/ha (Durgapura), with 42.2 q/ha NWPZ mean. The feed barley check BH902 ranked first (49.5 q/ha) followed by the test entry DWRB150 (47.3 q/ha) and both were grouped in the first non-significant group.

Late sown

- The AVT malt barley late sown was proposed and conducted at 8 centres in NWPZ with 6 test entries and 3 checks viz. BH 946 (six-row, feed barley) and DWRB91 (two-row malt barley) and DWRUB64 (six-row malt barley). Entry RD2919 had few off types at some locations, while BH1001 was rejected due to mixture. The trial mean ranged from 26.9 q/ha

(Pantnagar) to 48.4 q/ha (SG Nagar), with 34.1 q/ha NWPZ mean. The genotype RD2917 ranked first (37.5 q/ha) followed by check DWRB 91 (37.00 q/ha) and feed barley check BH946 (36.9 q/ha) in the first non-significant group.

- The IVT Malt Barley late sown was proposed and conducted at 7 locations in NWPZ with 14 entries including 3 checks viz. BH 946 (six-row, feed barley) and DWRB91 (two-row malt barley) and DWRUB64 (six-row malt barley). The entries namely BH1016, RD2944, RD2945 and RD2946 were observed as mixture/segregating, while few off types were noticed in the entries viz. BH1015 and DWRB152. The trial mean grain yield was observed as 33.7 q/ha, which ranged from 30.7 q/ha (Karnal & Modipuram) to 38.0 q/ha (Durgapura). The feed barley check BH946 ranked first (39.1 q/ha) followed by the test entries DWRB154 (38.6 q/ha), DWRB152 (38.3 q/ha) and malt barley check variety DWRB91 (37.4 q/ha) and all were grouped in the first non-significant group.

Feed Barley Evaluation

Irrigated

AVT-IR-NWPZ

The AVT (Irrigated) was conducted at 10 locations in NWPZ. The trial consisted of one test entry and four checks. The results showed that the best check BH902 ranked first with 50.80 q/ha mean grain yield and was in the first non-significant group.

AVT-IR-NEPZ

The AVT (Irrigated) for NEPZ comprising one test entry and four checks was tested at six locations in NEPZ. In this trial, test entry DWRB137 showed rank first with 38.8 q/ha mean grain yield and was in the first non-significant group. This entry performed numerically superior over the best check.

AVT-IR-Central zone

This trial involving three test entries and three checks were evaluated at seven locations in central zone. The test entry DWRB137 ranked first with 45.26 q/ha mean grain yield followed by RD 2899 (45.16 q/ha) and were in the first non-significant group. Both entries were numerically superior over all the checks.

IVT-IR-TS

The IVT feed barley trial consisted of 21 test entries along with 6 checks was evaluated at 17 locations scattered in NWPZ (6), NEPZ (5) and Central zone (6). As a result, in NWPZ and central zone check varieties BH946 (45.9 q/ha) and RD2552 (51.44 q/ha) ranked first and were in first non-significant group, respectively. However, In NEPZ, test entry HUB250 (40.2 q/ha) ranked first for grain yield and was in first non-significant group. This test entry outperformed over the best check BH902 (36.37 q/ha). On national basis, test entry JB 322 (41.85 q/ha) ranked first and was in the first non-significant group.

Rainfed Plains

AVT-RF-NEPZ

AVT-RF-NEPZ trial consisted of 4 test entries and three checks were tested at nine locations in NEPZ. The overall results of grain yield indicated that the best check K 603 ranked first with 30.47 q/ha mean grain yield followed by test entry HUB 242 (29.58 q/ha) in the first non-significant group.

IVT-RF-NEPZ

The IVT (rainfed) trial was conducted at nine locations in NEPZ. Trial consisted of 17 test entries and two checks, namely Lakhan and K 603. At all locations, no rust disease was observed in any of the test entries and checks. The results from eight locations revealed that at test entry JB 328 ranked first with 30.40 q/ha grain yield and was in the first non-significant group.

Rainfed Hills

AVT-RF-NHZ was evaluated at 11 locations in the northern hills. This trial comprising of 15 test entries and four checks. The test entry VLB149 (33.37 q/ha) ranked first in the first non-significant group in NH zone, which was significantly superior over the best check BHS 400 (31.0 q/ha).

Salinity-alkalinity

A special alkalinity/salinity trial consisting of 15 test entries and 4 checks was conducted at 8 locations. The overall results of grain yield indicated that test entry RD2907 (31.85 q/ha) ranked first and was in the first non-significant group. This entry was numerically superior over the best check RD2974 (31.84 q/ha).

Dual purpose

IVT-IR-TS-Plains

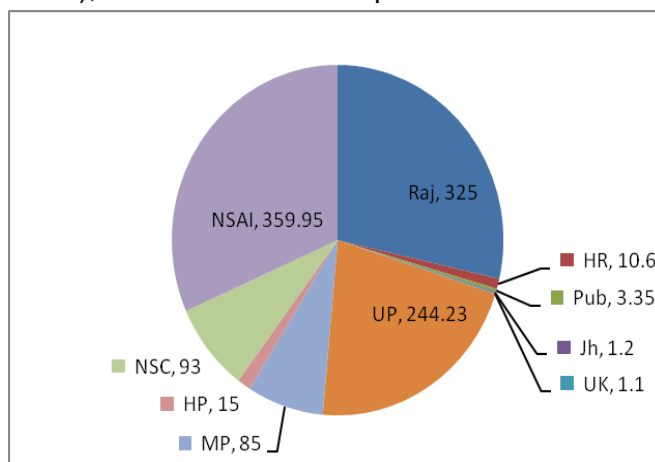
The IVT dual purpose trial comprising of 14 test entries and 4 checks was evaluated at 16 locations of all three zones. The result indicated that at national level, check variety RD2552 (32.88 q/ha) showed rank first for grain yield while test entry RD 2928 (182.84 q/ha) ranked first for forage yield and were in first non significant group. Based on grain and forage yields together, there is no entry for promotion to AVT for dual purpose in irrigated timely sown conditions at national level.

AVT-RF-TS-NH zone

The Advanced varietal trial for dual purpose was conducted at 5 locations under rainfed conditions of Uttarakhand and Himachal Pradesh in the NH zone. The trial consisted of 17 entries and three checks were evaluated at five locations. The test entry VLB 147 ranked first with grain yield (19.74 q/ha) while entry VLB 149 (41.53 q/ha) showed rank first for forage yield and were in first NSG. Based on grain and forage yields together, no entry was superior over the checks for promotion to AVT final year evaluation for dual purpose in NH zone under rain fed conditions.

Breeder seed production

A consolidated indent of 1138.43q breeder seed of 36 varieties was received from Deputy Commissioner (Seeds), DAC, Ministry of Agriculture & Farmers Welfare, Govt. of India. The indent included requirement of eight states (Rajasthan, Uttar Pradesh, Uttarakhand, Haryana, Madhya Pradesh, Punjab, Jharkhand and Himachal Pradesh), National Seeds Corporation and National Seed Association of India for the season Rabi 2016-17. The major proportion of the breeder seed indent was placed from NSAI (359.95q) followed by Rajasthan (325.00q), Uttar Pradesh (244.23q), National Seed Corporation (93.00q), Madhya Pradesh (85.00q) etc. The lowest demand of breeder seed was made from Uttarakhand (1.10q) followed by Jharkhand (1.20q) and Punjab (3.35q). From variety point of view, the highest indent was received for variety RD2786 (137.00q) followed by RD2715 (107.00), BH902 (103.40) etc. and the lowest indent was obtained for variety PL807 (0.35q) followed by DWRB92 (1.00q) and BHS400 (1.00q).



A net production of 1123.57q breeder seed was reported, which was slightly deficit (-14.86q) in comparison to the total allocated quantity of 1138.43q. The maximum production was reported for

RD 2035(125.00q) followed by BH902 (114.4q), RD2786 (112.0q) etc. The nucleus seed 47.45q was produced against the targeted quantity of 45.60q of 29 varieties.

GERMPLASM EVALUATION & EXCHANGE

An Elite International Barley Germplasm Nursery (EIBGN) constituted with 45 genotypes selected from international trials/nurseries was supplied for evaluation at all locations of Barley Network under AICW&BIP. A National Barley Genetic Stock Nursery (NBGSN) was constituted with promising entries and comprised of 22 entries endowed sources for malting quality traits, yield and its components and disease resistance. Germplasm accessions (495) from the IIWBR active collection were rejuvenated as regular maintenance activity and 100 accessions were evaluated for yield and its component traits at Hisar farm of IIWBR, Karnal. In addition, 330 barley germplasm lines collected from ICARDA, Morocco were evaluated at Hisar farm. This year 3 International trials and 3 nurseries including 472 germplasm lines, received from ICARDA were evaluated at different centres under barley network. In addition, 445 barley promising entries were selected by the breeders from these trials/nurseries during field day organized by IIWBR, Karnal.

International trials/nurseries conducted during crop season 2014-15

Sr. No.	Trial/Nursery	Origin	No. of Entries	Set No.	Location
1.	2 nd GSBYT	ICARDA	25	4	Karnal, Faizabad, Rewa, Kanpur
2.	IBYT-HI	ICARDA	25	4	Karnal, Ludhiana, Hisar, Durgapura
3.	INBYT-HI	ICARDA	25	3	Karnal, Bajaura, Ludhiana
4.	2 nd GSBSN	ICARDA	150	4	Karnal, Faizabad, Durgapura, Kanpur
5.	IBON-HI	ICARDA	167	4	Karnal, Durgapura, Ludhiana, Hisar
6.	INBON	ICARDA	80	3	Karnal, Bajaura, Shimla

ZONAL MONITORING

The teams constituted for monitoring of Barley Network Yield Trials & Nurseries in central zone, NWPZ, NEPZ and NH Zone, visited different locations of the three zones at the most appropriate stage of the crop and recorded observations about the varietal performance, conduct of trials, disease/ pest incidence and genetic purity of the test entries. The team in NHZ was common for wheat and barley crops, while in other two zones barley monitoring was done little earlier keeping the crop stage in mind. On the spot decisions were taken about the rejection of trials and purity of test entries through consensus. The proceedings of these team meetings have been circulated for necessary action by concerned breeders and other scientists and copies of the same is appended in the report for record.

Zonal monitoring visits of the barley teams

Zone	Date	Centres visited
CZ	16-19 Feb., 2016	Kota Udaipur, Banswara
NEPZ	25-29 Feb., 2016	Rewa, Mirzapur, Tisuihi, Varanasi, Faizabad, Kanpur, Dalipnagar
NWPZ & CZ	29Feb,- 03March, 2016	Mathura, Kumher, Morena, Gwalior and Sagar
NWPZ	10-11, March	Modipuram, Dhoulakuan
NWPZ II	07-11, March, 2016	Ludhiana, Bhatinda, Sriganaganagar, Hisar, Bawal, Durgapura, Banasthli, Tabiji
NHZ I	18-20, April, 2016	Almora, Majhera, Ranichauri
NHZ II	10-15 April, 2016	Dhaulakuan, Shimla, Berthein, Una, Akrot, Kangra, Malan, Palampur, Bajaura, Katrain

CROP PROTECTION

Barley Crop Health Report

During crop season 2015-16, stripe rust appeared at very few places with very low intensity. There was no report of natural occurrence of black rust in barley from any of the barley growing areas of India. Cover smut and loose smut were observed in some of the barley fields in the Rajasthan. Heavy infestation of aphid was also noted in some barley fields nearby Jaipur, Rajasthan, however in other areas some field were observed with aphid with low incidence. During the survey the barley crop was at ear-head emergence to milking stage. In the central India, leaf blight and foliar aphids were observed in few areas. Leaf blight severity was at moderate level under natural condition in area surveyed. Loose smut, covered smut and powdery mildew were also observed at low incidence.

Seedling Resistance Test (SRT)

Rust resistance in NBDSN lines

During 2015-16, a total of 143 entries from AVT and IVT yield trials including checks were screened for seedling resistance test against stripe rust, leaf rust and stem rust races. Entries VLB147 and PL891 were resistant to all three rusts. Eight entries (HBL113, HBL748, RD2715, RD2928, RD2930, RD2932, RD2935, and RD2938) were resistant to brown and yellow rusts. BH1008, BHS448, KB1434 and NDB1445 were resistant to black and brown rust only.

Rust resistance in NBDSN lines

Resistant to	Number of lines	Detail of lines
All	02	VLB147 and PL891
Black and brown	04	BH1008, BHS448, KB1434 and NDB1445
Brown and yellow	8	HBL113, HBL748, RD2715, RD2928, RD2930, RD2932, RD2935, and RD2938
Black and yellow	01	BH1011

Rust resistance in EBDSN lines

During the crop season 2015-16, in total there were 66 entries screened for seedling resistance test against stripe rust, leaf rust and stem rust races in EBDSN. Two EBDSN lines viz. BCU7911 and VLB140 were resistant to all the tested pathotypes of black, brown and yellow rusts. There was only one entry (BH995) showing resistance to black and brown rusts and two entries (BH981 and VLB130) showing resistance to black and yellow rusts. Eight entries were resistant to both brown and yellow rusts.

Rust resistance in EBDSN lines

Resistant to	Number of lines	Detail of lines
All	02	BCU7911 and VLB140
Black and brown	01	BH995
Brown and yellow	08	BCU7595, BCU7758, KB1318, KB1367, RD2900, RD2906 and RD2910
Black and yellow	02	BH981 and VLB130

Adult plant resistance (APR)

Out of 442 EBDSN entries tested, 52 entries were found free from yellow rust (ACI = 0) and 243 entries showed resistant reaction have ACI less than 10. In case of leaf blight screening, 40

entries were found moderately resistant with average score upto 35 and the highest score below 57. Among 143 NBDSN lines, 17 were free from yellow rust infection whereas three lines viz. BH1003, PL891 and HBL113 (c) found moderately resistant to leaf blight. Out of 66 EBDSN lines 15 were free from yellow rust and 9 were moderately resistant to leaf blight.

Chemical control of barley foliar blight and stripe rust

Seed treatment with Vitavax @ 2g/Kg followed by two spraying with Propiconazole/ Tebuconazole @ 0.1% spray is effective for management of leaf blight. Spraying with Propiconazole @ 0.1% recorded lower stripe rust severity.

Screening of NBDSN barley entries against CCN and barley aphids

Majority of the entries at all the locations harboured large number of aphids and were categorized as either susceptible (grade 4) or highly susceptible (grade 5) to aphids. However, few entries were also categorized as either moderately resistant (grade 3) or resistant (grade 2). At Durgapura location, two entries; DWRB154, and RD2945 showed moderately resistant reaction. Similarly, three entries at Pantnagar; NDB1639, RD2922 and RD2932 and at Karnal; NDB1639, RD2922 and RD2932 were categorized moderately resistant. One entry at Pantnagar RD2928 even gave resistant reaction. The differential reaction of aphids on entries showed the availability of biotypes of foliar aphids in various locations.

All the entries were found to be either S or HS to CCN and none of the entries shown resistance. The entries viz., HUB 242, HUB 246,, JB 238, NDB 1173RD 2925, UPB 1054, DWRB 92, DWRUB 64, PL 751, RD 2035 in NBDSN and BCU 7594, 7601,7602, 7732, HUB 241, HUB 242, DWRB 127, DWRB 137, KB 1367 , RD 2903 in EBDSN are susceptible to CCN and rest all are highly susceptible.

Chemical control of Aphid

Clothianidin and imidacloprid at Durgapura, thiamethoxam at Ludhiana, acetamiprid and flubendiamide at Vijapur, flubendamide, clothianidin, thiamethoxam and imdacloprid at Kanpur and Karnal were found equally effective.

RESOURCE MANGEMENT

The AVT entries were evaluated under irrigated conditions with different nitrogese levels and sowing conditions in North Western Plains Zone. Out of the 08 proposed trials for varietal evaluation, all were conducted and reported. In special trials (weed management, integrated nutrient management, spacing, PGRs, N doses & its scheduling, different source of potash effects), out of 46 proposed at different locations, 42 were reported.

Irrigated, timely sown malt barley (different N levels) NWPZ

The performance of test entry DWRB123 was evaluated against four checks (DWRUB52, DWRB101, BH902 and RD2849) at different nitrogen levels. The test entry DWRB123 recorded highest grain yield (4906 kg ha⁻¹) when N was applied @ 90 kg ha⁻¹. On mean basis, the test entry DWRB 123 was numerically superior to all checks except BH 902, whereas, it was statistically at par with all the checks. The test entry DWRB 123 was also better in earhead /m2 and 1000 grain weight as compared to checks.

Irrigated, timely sown malt barley trials (timely and late sown) NWPZ

All the checks yielded more than the test entry DWRB 123 under timely and late sown conditions. Check variety BH 902 recorded highest grain yield (5200 kg ha⁻¹ and 4182 kg ha⁻¹) closely followed by DWRB 101(5065 kg ha⁻¹and 3797 kg ha⁻¹) under timely and late sown conditions respectively. The grain yield reduced by 20.2 % under late sown condition as compared to normal sown conditions on mean basis.

SPL1 Effect of dose and time of nitrogen application under rainfed condition in NHZ

The trial was conducted with an objective to optimise dose (0, 20, 40, 60 and 80 kg/ha) and time (Full basal, 1/2 at basal+1/2 after 1st rain, 2/3 at basal+1/3 1st rain) of N application to increase barley productivity at Almora, Bajaura and Malan. The results revealed that the grain yield increased significantly with the increase in the level of nitrogen only up to 60 kg N ha⁻¹, whereas significantly higher grain yield was recorded by applying half N as basal and remaining half after 1st rain or 2/3 N as basal and remaining 1/3 after 1st rain. Similar results were observed on the basis of three years pooled data.

SPL 2 Weed management in Barley (NEPZ and NWPZ)

The trial was conducted to manage the broad leaved weeds through herbicides at Kanpur and Varanasi in NEPZ and at Durgapura in NWPZ. Eleven treatments of metsulfuron and carfentrazone in combination or alone, weedy check and weed free were used. The results revealed that grain yield in Metsulfuron+ Carfentrazone @ 20g+ NIS 0.2% and Metsulfuron+Carfentrazone @ 25g+ NIS 0.2% treatments was significantly superior to other herbicide treatments and weedy check condition. Similar results were obtained from pooled data of three years. Application of Metsulfuron+Carfentrazone @ 25g+ NIS 0.2% resulted in maximum reduction in dry weight of weeds.

In NWPZ, The grain yield was statistically at par in the treatments Metsulfuron +Carfentrazone @ 20g ha⁻¹, Metsulfuron +Carfentrazone @ 25 g ha⁻¹, Metsulfuron+Carfentrazone @ 15g ha⁻¹ + NIS 0.2%, Metsulfuron+Carfentrazone @ 20 g ha⁻¹ + NIS 0.2%, Metsulfuron+Carfentrazone @ 25 g ha⁻¹ + NIS 0.2% , Metsulfuron @ 4g ha⁻¹ and weed free treatments. Almost similar results were obtained from pooled data of three years.

SPL 3 Weed management in Barley (NWPZ and NHZ)

Experiments were conducted to manage the grasses and broad leaves weeds through herbicides at Karnal, Ludhiana, Hisar, Durgapura. Eleven treatments of pinoxaden and isoproturon in combination with metsulfuron /carfentrazone / 2,4 D or alone were evaluated. The results revealed that the application of Pinoxaden @ 40g ha⁻¹ +Carfentrazone @ 20g ha⁻¹ and Pinoxaden @ 40g ha⁻¹ followed by Metsulfuron @ 4g ha⁻¹ resulted statistically at par with weed free treatment, but the highest yield (5168 kg ha⁻¹) was recorded in weed free treatment. Similar results were obtained from pooled data of three years. Application of Pinoxaden @ 40g ha⁻¹ +Carfentrazone @ 20g ha⁻¹ and Pinoxaden @ 40g ha⁻¹ followed by Metsulfuron @ 4g ha⁻¹ resulted in maximum reduction in dry weight of weeds.

The trial was also conducted in NHZ at Bajaura and Malan and pooled data revealed that the grain yield was statistically at par in the treatments Pinoxaden @ 40g ha⁻¹ +Carfentrazone @ 20g ha⁻¹, Pinoxaden @ 40g ha⁻¹ followed by Metsulfuron @ 4g ha⁻¹, Pinoxaden @ 40g ha⁻¹ + Metsulfuron @ 4g ha⁻¹, Isoproturon @ 750g ha⁻¹+ Metsulfuron @ 4g ha⁻¹, Isoproturon @ 750g ha⁻¹+ 2,4-D @ 500g ha⁻¹ and weed free treatments. Application of Pinoxaden @ 40g ha⁻¹ followed by Metsulfuron @ 4g ha⁻¹, Isoproturon @ 750g ha⁻¹+ Metsulfuron @ 4g ha⁻¹ and Pinoxaden @ 40g ha⁻¹ + Metsulfuron @ 4g ha⁻¹ resulted in maximum reduction in dry weight of weeds.

SPL-4 Integrated Nutrient Management in Barley (NWPZ)

The trial was conducted with an objective to reduce the dependency on chemical fertilizers and their effect on barley productivity. Three doses of fertilizers (50% recommended dose of fertilizer(RDF), 75% RDF and 100% RDF) with four bio-fertilizer (Azotobacter, Phosphosolubilizing bacteria, Azotobacter + Phosphosolubilizing bacteria, Biomix) and one control treatment were undertaken in split plot design. Pooled data revealed that significantly higher grain yield was obtained with the application of 100 % recommended dose of fertilizer with biofertiliser. Reduction in dose of fertilizer with biofertiliser reduced the grain yield.

In NHZ, the highest grain yield was obtained with the application of 100 % recommended dose. Use of bio-fertilizers has no significant effect on grain yield and yield attributing characters.

In NEPZ, the highest grain yield (3800 kg ha⁻¹) was obtained when 100 % recommended dose of fertilizer was applied and seed was treated with azotobacter + phosphosolubilizing bacteria. Similar trend was observed in yield attributing characters.

In Central Zone, a significantly higher grain yield was obtained when 100 % recommended dose of fertilizer was applied and seed was treated with biomix or azotobacter + phosphosolubilizing bacteria. Similar trend was observed in yield attributing characters.

SPL-5 Source of potash x varieties (NWPZ)

The trial was conducted in NWPZ (Durgapura, Hisar, Ludhiana and Karnal) with an objective to observe the effect of different sources of potash on barley quality and productivity. Two sources of potash (murate of potash and sulphate of potash) with five varieties (DWRB101, DWRUB52, DWRB 92, BH 902 and BH 946) were undertaken in split plot design. Pooled data revealed that there was no significant difference in grain yield among different varieties due to different sources of potash.

SPL-6 N levels X PGRs (NWPZ&NEPZ)

The trial was conducted with an objective to observe the effect of different plant growth regulators on barley productivity. Three levels of nitrogen (100% recommended dose of nitrogen (RDN), 125% RDN and 150% RDN) with three PGRs (Chlormequat-chlorid (CCC) @1.25 L ha⁻¹ at GS₃₀₋₃₁, Ethephon(Cerone) @1.0 L ha⁻¹ at GS₃₉₋₄₀, CCC + Ethephon) and one control treatment were undertaken in split plot design. A significantly higher grain yield was obtained with the application of PGRs as compared to control. Significantly highest grain yield, earhead/m² and grains per earhead were recorded when barley crop was sprayed with chlormequat-chlorid (CCC) @1.25 L ha⁻¹ at GS₃₀₋₃₁ followed by ethephon(Cerone) @1.0 L ha⁻¹ at GS₃₉₋₄₀. Grain yield reduced significantly with increase in dose of nitrogen to 150% of RDN as compared to 100 % recommended dose of nitrogen. Lodging score increased significantly with increase in nitrogen dose whereas, lodging score was reduced significantly when barley crop was sprayed with chlormequat-chlorid (CCC) @1.25 L ha⁻¹ at GS₃₀₋₃₁ followed by ethephon(Cerone) @1.0 L ha⁻¹ at GS₃₉₋₄₀.

In NEPZ, a significantly higher grain yield was obtained with the application of PGRs as compared to control. Significantly higher grain yield, earhead/m², 1000 grain weight and grains per earhead were recorded when barley crop was sprayed with chlormequat-chlorid (CCC) @1.25 L ha⁻¹ at GS₃₀₋₃₁ followed by ethephon(Cerone) @1.0 L ha⁻¹ at GS₃₉₋₄₀ and nitrogen dose was 150% of RDN. No lodging was observed when PGRs were sprayed.

SPL-7 Spacing X Varieties(NWPZ, NEPZ, CZ & NHZ)

The trial was conducted with an objective to observe the effect of different spacing on barley productivity. Three spacing (20 cm, 22.5 cm and 25 cm) with three varieties were undertaken in split plot design. Pooled data of NWPZ revealed that all the varieties registered significantly higher grain yield at spacing of 22.5 cm. Significantly higher grain yield was observed at all the spacing by RD 2552 compared to BH 902.

In NHZ, A significantly higher grain yield was recorded at spacing of 20 cm and variety VLB 130 recorded significantly higher grain yield compared to other varieties on mean basis. Earhead/m² were also significantly more at spacing of 20 cm, whereas no effect of spacing was observed on grains / earhead.

In NEPZ, grain yield and yield attributing characters were superior at spacing of 22.5 cm and non - significant difference in yield of different varieties were observed.

In Central Zone, grain yield and yield attributing characters were at par when sowing of barley was done at spacing of 20 cm and 22.5 cm. BH 959 and RD 2786 recorded significantly higher grain yield as compared to RD 2715 on mean basis.

QUALITY EVALUATION

Malting Quality

The Barley Network Unit took up the evaluation of grain samples of Advanced Varietal Trial (AVT) and Initial Varietal Trial (IVT) on malt barley received from various test sites at its central facility for malting quality evaluation. The malt barley varietal trials were conducted in NWPZ during Rabi 2015-16, in two sowing dates as separate sets. The trial conducting centers were requested to provide about 500 gm grain sample of each genotype. The grain samples were received from eight locations (Hisar, Karnal, Bawal, Ludhiana, Mathura, Bathinda, Durgapura and Pantnagar) in timely sown and from six locations (Hisar, Karnal, Bathinda, Ludhiana, Pantnagar and Durgapura,) in late sown conditions. This year a total of 354 coded entries were received. There were 19 test entries in IVT (TS) which were analyzed with five checks, while 11 test entries in IVT (LS) were evaluated with three checks. In case of AVT (TS), three entries (DWRB 123, DWRB 136 and RD 2917) with five checks were analyzed; while in AVT (LS) six entries (BH 1001, BH 1003, DWRB 140, DWRB 141, RD 2917 and RD 2919) were analyzed with three checks.

There were several entries observed promising for individual traits, after the detailed analysis across locations in the NWP Zone. This was done by the system of scoring giving due weightage to important traits. Thus based on the ten important traits (a maximum possible score of 30), entry DWRB 123 was having better overall malting quality score under timely sown conditions. In late sown trials BH 1003, DWRB 154, RD 2946 were found promising.

Barley Quality Screening Nursery

This year promising genotypes selected from INBON-36 (2014-15) and INBYT-HI-15 grown at Karnal location during 2014-15 season, with respect to grain physical quality traits were screened at four location. In case of INBON-36 (2014-15) the genotype nos 49 and 68 had higher hectoliter weight as compared to best check Atahulapa. The genotypes found promising in bold grain percentage were 11, 12, 13, 14, 18, 24, 43, 68 and 71. In case of INBYT-HI-15, only one genotype E 18 was found better than the best check Atahulapa with respect to bold grain percentage.

Promising entries* for individual malting quality trait

Traits	Promising entries	
	Timely sown	Late sown
Test Weight	BH 1011, BH 1013	RD 2919, PL 890, DWRB 140, BH 1014
Bold Grains (%)	DWRB 123, RD 2943, BH 1012, RD 2940, DWRB 147, DWRB 148	RD 2919, DWRB 154, RD 2946
Thousand grain weight	RD 2943, KB 1405	DWRB 153, RD 2946, DWRB 154,
Protein content	-	DWRB 154
Husk Content	DWRB 123	RD 2919, DWRB 140, PL 890
Beta glucan	PL 890	BH 1001, RD 2919, BH 1003, RD 2945, RD 2946, RD 2944
Malt Friability	RD 2917, RD 2940, RD2943	BH 1003, DWRB 141, BH 1001, RD 2917, DWRB 140, BH 1016, DWRB 154
Hot water extract	RD 2939, BH 1011, BH 1013	-
Filtration Rate	DWR 123, PL 890, RD 2943, BH 1011	BH 1003, DWRB 141, BH 1001, RD 2917, DWRB 140, BH 1016, DWRB 154
Diastatic Power	DWRB 136	RD 2946, BH 1016, BH 1015, DWRB 153, DWRB 153
Kolbach Index	RD 2940	BH 1003, RD 2917
Over all MQ	DWRB 123	BH 1003, DWRB 154, RD 2946

*Superior or at par to best check

FEED BARLEY

The feed grain samples from various trials and grown at different locations were analysed for few physical parameters and protein content. Each centre was requested to provide a grain sample of 250 g. The parameters analysed included grain crude protein content (%), test weight (kg/hl), thousand grain weight (g) and grain plumpness. A total of 819 samples were received encompassing seven trials and grown over in their respective zones. The entries with highest value for each of the parameter analyzed are listed below:

S.No	Trial	Zone	Test weight	Thousand grain weight	Bold grain (%)	Thin grain (%)
1	AVT (RF)	NHZ	HBL755	BHS450	BHS450	VLB149
2	AVT (IR)	NWPZ	DWRB137	DWRB137	DWRB137	DWRB137
3	AVT (IR)	NEPZ	DWRB137	DWRB137	DWRB137	DWRB137
4	AVT (IR)	Central Zone	DWRB137	DWRB137	DWRB137	RD2786 (c)
5	AVT (RF)	NEPZ	KB1323	KB1323	HUB242	HUB242
6	IVT (IR-FB)	NWPZ/NEPZ/ CZ	KB1434	PL890	RD2921	PL890
7	IVT (Rainfed)	NEPZ	PL890	JB331	PL890	JB331
8	AVT (SAL/ALK)	NWPZ/NEPZ	DWRB159	KB1426	DWRB159	DWRB159
9	IVT (DPB)	NWPZ/NEPZ/ CEN	KB1420	BH1010	BH1010	BH1010
10	AVT (DPB)	NHZ	HBL276 (c)	BHS447	BHS447	BHS447

Molecular Profiling of AVT Final Year Entries

Total 45 SSR/STS markers covering all the seven chromosomes of barley were screened with final year test entry (DWRB123) and five check varieties (BH902, DWRUB52, DWRB92, DWRB101 and RD2849) to develop molecular profiles. In total 80 alleles were scored in selected genotypes for PCR based amplification profiles of AVT final year entry. The number of alleles ranged from 1 to 3 with an average of 1.69 alleles per locus. The band fragment sizes varied from 109 bp to 1500 bp with PIC values ranging from 0 to 0.67. Out of 45 molecular markers screened, 28 were found polymorphic for the entry and checks thus indicating sufficient coverage of barley genome during molecular screening. Molecular statistics were comparable with previous crop season (2014-15) final year AVT entries. This suggested that genetic variability of barley genotypes has maintained for major barley sowing region (NWPZ) of India. During molecular analysis, chromosome 7H was found most variable followed by 6H whereas chromosome 5H was observed least variable followed by 2H chromosomes. Average PIC across seven linkage groups of barley varies from 0.34 to 0.55 for final year AVT. The dendrogram generated clearly indicates that the final year test entry does not cluster at one place and is quite diverse from five check lines. The six genotypes grouped within similarity coefficient (GS) value from 0.57 to 1.0 and showed sufficient genetic variability at molecular level. The cluster tree for six genotypes is divided into two sub-clusters at GS= 0.57. The cluster I grouped four genotypes including test entry (DWRB123) and three check varieties viz. DWRUB52, DWRB101 and RD2849 developed for NWPZ sowing zone for similar end use i.e. malt barley whereas group II comprised rest of two checks (DWRB92 and BH902). All six genotypes under study could be distinguished using screened markers.

Salient activities during 2014-15

External Review Panel meeting for ICAR ICARDA collaborations, Dr A Sarkar, from ICARDA and Dr Fred, USDA consultant visited IIWBR on April 13, 2015.

Dr Indu Sharma, Dr Dinesh Kumar and Dr Vishnu Kumar visited ICARDA, Rabat, Morocco for interaction meeting of ICAR ICRISAT ICARDA Collaborative project and germplasm selection during April, 24-26, 2015

Dr RPS Verma Barley breeder, ICARDA and Dr Shobha Sivsankar, Director, Dryland Cereals, ICRISAT visited Durgapura, Hisar, Ludhiana, Shimla and Karnal, monitored international nurseries and collaborative research experiments and participated in Barley field days in Rajasthan during March 8-13, 2015

Awareness programme on DUS Barley under PPVFRA was organised at Morena (MP) on March 17, 2015

Field day for germplasm selection was organised at IIWBR, Karnal, on March 27, 2015 and various co-operators participated.

Meeting with local biscuit manufacturer to see the possibility of making barley biscuits on January 01, 2015

Mr Arnoud, from Boortmalt Pvt. Ltd visited contractual barley varietal evaluation trials at IIWBR New Farm on December 9, 2014.

Tracking barley and lentil improved cultivars adoption in India: Workshop cum training organised by ICRISAT at IIWBR, October 28-30, 2014

CGIAR Research Programme on Dryland Cereals: Biannual planning meeting at ICRISAT attended by Drs AS Kharub and Randhir Singh during October 9-11, 2014

Details of foreign collaborated / externally funded projects on barley at IIWBR Karnal

S.No.	Title	Funding agency	Participating Institutes	Duration	Budget (in INR lakhs)
1.	Dryland Cereal project on Hulless Barley	ICRISAT	IIWBR, Karnal	1 years	22.0
2.	Enhancing	Plan project in EFC Memo	IIWBR, Karnal, RARI Durgapura JNKVV, Rewa NDU&T, Faizabad		
3.	DUS project on Barley	Protection of Plant Varieties and Farmers Rights	IIWBR, Karnal; NDU&T, Faizabad RARI, Durgapura	Continuing since 2011	5.0

		Authority, New Delhi			
4.	Evaluation of different oat genotypes for agronomic and quality parameters	PepsiCo India Ltd.	IIWBR, Karnal	1 year	3.61