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Production technology of Barley under Indian condition

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Abstract
Barley (*Hordeum vulgare*) is one of the important and popular cereal crop grown in India and other parts of the world. It is grown in our country in 0.63 million ha with a production of 1.20 million tones and an average productivity of 1.94 tons per ha. The present study was designed to know the extent of Knowledge level of farmers about improved production technology of barley crop. Maximum knowledge was noticed in the practice of field preparation, fertilizer requirement, irrigation management and plant protection measure. However, barley food use today remains important in some cultures around the world, particularly in Asia and northern Africa, and there is renewed interest throughout the world in barley food because of its nutritional value. This article covers basic and general information on barley production as well as different aspects of production technology under Indian condition as well as an in-depth look at several major aspects/traits of interest for barley including kernel hardness and color, grain starch content etc.

Keywords: Barley, production, nutritional value, kernel, color etc.

Introduction
Barley (*Hordeum vulgare*) is an important cereal crop in the world. It is one of the earliest domesticated food crops since dawn civilization. Barley grain contains 12.5 percent moisture 11.5 percent albuminoids, 74 percent carbohydrates, 3.9 percent crude fiber and 1.5 percent ash. It is a major source of food for large number of people living in cooler semi-arid areas of the world. The seeds of barley are used for malting which is a midway product used in bakery preparations and energy rich foods for human consumption.
It is grown in our country in 0.63 million ha with a production of 1.20 million tones and an average productivity of 1.94 tons per ha. The leading countries of its production are USSR, China, France, Canada, USA and Spain. The major barley growing regions in India are Central parts of eastern Uttar Pradesh, Eastern parts of Rajasthan and North western parts of Bihar. As barley is harder than wheat and is inherently equipped to adapt itself admirably well under limited inputs and marginal lands. It can be grown in diverse agro climatic conditions like drought, salinity, alkalinity, rain-fed or irrigation ecosystems, plains or hilly areas where owing to some agro – climatic constraints wheat cannot be grown successfully. Barley is also suitable for late sown condition.
Since production capacity of the crop may be more however, the capacity of this crop is not high at present. Therefore, pushing up the production good production technology should be practiced.

Area and Distribution
Barley is one of the important cereals of the world cultivated over an area of 57.62 million ha with a total production of 154 million tons in 2004. Russia, China, France, USA, Spain, India are the major barley producing countries. The chief barely-growing regions in India are Uttar Pradesh, Rajasthan, Madhya Pradesh, Bihar, Haryana and Punjab.

Table 1: Area, production and productivity of barley in the year of 2011

Year	Area harvested (Million ha)	Yield (Metric tons /ha)	Production (Million metric tons /ha)
2019-2020	0.66	0.57	1.63

***Source*:** USDA (ipad.fas.usda.gov/cropexplorer)

Classification

It has been classified into different types by different authors depending upon one or many morphological features.

Classification based on fertility of lateral spikelet's

- **Two rowed type (*Hordeum distichon* L.):** In the two row barley the two lateral spikelets are sterile, thus each spike has only two vertical rows of kernels.
- **Six rowed type (*Hordeum Vulgare* L.):** In six row barley both the florets are fertile both the lateral florets are fertile but their size may vary from slightly to moderately smaller than the central floret.
- **Irregular type (*Hordeum irregular* L.):** Central florets are fertile, whereas the lateral florets are reduced to rachilla.

Classification based on awns

- **Awned type:** Presence of awns takes place on grains.
- **Awnless type:** These are also called hooded because of the hood shaped structure that develops in place of awn.

Classification based on adherence of chaff to grain

- **Hulled type:** In this the floral glumes also called chaff remains attached to grains resulting in poor flour making.
- **Hull- less:** In this type husk readily falls after threshing and naked grains free of chaff can be obtained.

Morphology of the crop

The botanical description of main parts of barley plant is given below:

- **Root System:** It consists of shallow and deep roots. The shallow roots arise near the soil surface spread laterally about 15-30 cm while the deep root extends downwards in deep layers of soil may be from 0.75 to 150 cm.
- **Stem (Culm):** The stem is cylindrical and contains 5 to 7 hollow internodes separated by solid nodes.
- **Leaves:** Leaves are usually broader and of lighter green color than wheat. Each leaf consists of a sheath, ligule and auricle.
- **Inflorescence:** The inflorescence is called spike or head. Each spikelet has two glumes and a floret with three stamens and a pistil with a single ovule and a stigma.
- **Kernel (Grain):** The grain of barley is a caryopsis composed of the pericarp, endosperm and endosperm.

Growth stages of the crop

- **Germination:** This stage is marked by the exhaustion of endosperm and initiation of crown root. This stage lasts up to 20 - 25 days from sowing.
- **Tillering:** The seedling after initial establishment of crown root system starts tillering. This phase of growth may continue up to 30-35 days after sowing.
- **Jointing:** It is called shooting. Here the plant develops its vegetative part. Jointing may last up to 55 - 65 days after sowing.
- **Heading:** This stage is known as earing and ear head emergence. This stage ends with the production of watery ripe grains. The crop will be in this phase up to 75-85 days after sowing.
- **Ripening:** This stage includes the sub-phases of post milking, grain filling and grain development. The soft dough turns dough. This stage lasts up to 90-100 days after sowing.
- **Maturity:** In this stage the plants loosing moisture and plants to dry, the plants turn yellowish, loose stiffness and become droopy. The physiological maturity of the seed is completed and ready for the harvest.

Improved Varieties

Table 2: Improved Varieties

Variety	Area of adaptation	Characteristics
Jagrati	Eastern U.P	Medium tall, semi erect, tolerant to stripe and rust disease.
Ritambhara	Eastern U.P, Bihar, Orissa, West Bengal	Suitable for malting and brewing
Narendra Barley -1	Uttar Pradesh	Dwarf, early, resistant to rust and smut, suitable for saline/alkaline conditions.
Narmada	Eastern U.P, Bihar, Jharkhand.	Resistance to rusts and smut.
PL 751	M.P, Gujarat, South Rajasthan.	Semi-dwarf, stiff straw, responsive to high fertility.

Varieties suitable for malting purpose

Table 3: Varieties suitable for malting purpose

Vijay M130	North Karnataka	Suitable for malting and brewing. Tall, lodging resistant, medium maturity.
Malty	Karnataka, Maharashtra	Suitable for malting, semi-dwarf, resistance to yellow rust, tolerant to salinity conditions.
DWR28	Punjab, Haryana, Delhi, Northern Rajasthan	Good malting quality, highest grain yield, resistant to yellow rust.
RD2503	Punjab, Western UP, Delhi	Suitable for malting, medium tall.

Seed and Sowing Seed treatment: For normal conditions before sowing seed should be treated with 1:1 mixture of Thiram + Bavistin or Vitavax @ 2.5 g per kg seed.

Table 4: Sowing methodology for different conditions

Particulars	Rainfed	Irrigated	Late sown (irrigated)
Time of sowing	Oct last week to Nov first week	Mid of Oct to Mid of Nov	Mid of Dec to First week of Jan
Seed rate	80-100 kg/ha	75-80 kg/ha	100 -120 kg /ha
Row spacing	22.5 -25 cm	22.5 cm	20-22.5 cm
Depth	6-8 cm	4-5 cm	4-5 cm
Method of sowing	Line sowing	Line sowing, seed drill, broadcasting	Line sowing, Seed drill.

Water Management
Basically barley is a winter season drought tolerant crop having limited water requirement. In barley following critical growth stages have been identified for irrigation:
First irrigation: Seedling or sprouting stage which requires sufficient moisture at the time of sowing.
Second irrigation: Active tillering stage (about 30-35 DAS)
Third irrigation: Flag leaf /booting stage (about 60-65 DAS)
Fourth irrigation: Soft dough or grain filling stage (about 80-85 DAS) Out of these stages active tillering and grain filling stages are most critical ones. Waterlogging or heavy irrigation should be avoided.

Nutrient Management
Manures and fertilizers both plays significant role in barley cultivation. Application of manures should be done in the field about a one month before @ of 10-12 t/ha. The following fertilizer dose has been found economic in many barley growing areas.

Table 4: Nutrient Management

Conditions	N kg /ha	P2O5 kg /ha	K2O kg / ha
Irrigated	60	30	30
Rainfed(Hills)	40	20	20
Rainfed (Plains)	30	30	20
Irrigated malt barley	80	40	30

Plant: Protection Measures
Diseases
1. Stripe disease
Symptoms
- This disease is caused by fungus Helminthosporium gramineum.
- The symptoms start appearing from the late tillering stage and continue up to maturity.
- Yellow stripes shows up on the older leaf blades and sheaths as initial symptoms.
- Later the stripes turn brown as the tissue dries up and the leaf blade becomes shredded in advance stage of the disease.

Control Measures
- Treat the seeds with 1:1 mixture of Thiram + Bavistin @ 2.5 g per kg seed.
- Exposure of seeds to the high temperature (40-45 degree celcius).High temperature kills the fungus rendering the seeds free from infection.

2. Molya disease
Symptoms
- This disease is caused by a nematode Heterodera avanae.
- It occurs in small patches.
- Plants stunted, leaves are discolored to yellow and often become reddish from the tip.
- The growing point of root is inhibited and often killed.

Control Measures
- Adopt crop rotations of 3-4 years with non-cereal crops.
- Grow resistant varities like RD -2035, Karan -16 etc.
- Two- deep ploughings during summer will also reduce the nematode population.

3. Rusts
Symptoms
- **Yellow rust:** This rust is caused by Puccinia striiformis is identified by parallel rows of pale to orange-yellow pustules occur in rows on the foliage, stems or ears.
- **Black rust:** This rust is caused by P. graminis tritici is identified by reddish brown rows of spots on stems and leaves.
- **Leaf rust:** This rust is caused by P. hordei is, identified by numerous small round yellow to orange brown pustules, scattered over leaf blades and sheaths.

Control Measures
- Cultivation of rust resistant varieties like RD-2503, RD-2508, and DL-88 offers the best result.
- Four sprays of Zineb @ 2kg per hectare in 700-800 litres of water, at fortnightly intervals offers effective control.

Insect –PESTS
Some of the important and common insects-pests of barley are given below:

1. Termites
Symptoms
- They attack the root system of plants and plants start showing wilting, later on dry up completely causing poor crop stand.

Control Measure
- For the control of these insects use 2% Methyl parathion or 5% Malathion dust @ of 20-25 kg per hectare and mix it well in the soil at the time of last ploughing before sowing.
- Deep ploughing during fallow period and exposing the termites to sunlight limits the attack of termites.

2. Aphids
Symptoms
- Subsequently infested plants turn pale green in colour and remained stunted.
- Aphids also serve as vectors for virus causing barley yellow dwarf disease.

Control Measure
- Spray methyl parathion at 0.025% or Dimethoate at 0.03%. The spray should be repeated at 10-15 days intervals.

Harvesting and Threshing
The crop will be harvested when plant becomes yellow and dry up. The grains become hard, moisture content will be around 18-20% and plants become brittle and rigid. Stem breaks down with light pressure. The crop after harvesting moved to threshing yard. It is further dried there and threshed by allowing bullocks to trample or by using stone rollers or mechanical threshers.

Yield
When cultivation of high yielding varieties of barley is done with improved scientific methods, they produce about 30-35 quintals of grain and 40-45 quintals of straw per hectare.

Quality aspect
Quality aspects of barley consist of two major parts:
1. Physical appearance and colour of the grains

- Barley grains consists of grains 15-20% husk. Because of husk, consumers do not like to eat barley as a food grain.
- As animal feed too husked grain has poor market because of high crude fiber percentage (8-10%)
- Hull-less amber coloured barley types will be attractive for human consumption and as animal feed.

2. Chemical composition of grains

- Barley is highly digestible because of negligible gluten content.
- Uniform kernel size, free from insect or fungal infection and cuts is an important factor to the malting industry.
- The preferred protein content >9% is not preferred for malting, high protein prolongs the time required for stepping and causes uneven germination produces malt with excessive enzyme activity, reduces the mellowness of malt.

Constraints in barley production

The major constraints responsible for stagnation in area and production are as follows:

Agro-Ecological Constraints

1. Photo sensitive barley varieties, normally carry vernal and photo period sensitivity traits which induce lateness.
2. Higher temperatures are known to induce abnormalities. Floret number are reduced at higher temperature of 24 degree Celsius in comparison to 18 degree Celsius. Tillering is also affected by the day and night regimes.
3. It is cultivated on poor and marginal soils with poor soil fertility.

Agronomical Constraints

1. Negligible coverage under improved varieties.
2. Limited use of cash inputs like fertilizers and plant protection measures.
3. Second preference to barley sowing compared to wheat.

Socio-Economic Constraints

1. Demand for barley is almost constant due to the biased policies towards the fine cereals (Rice, Wheat).
2. There is no incentives whatsoever for the farmers to raise barley production.
3. Change in to lifestyle of population. People turned to tine cereals.

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