E-CONTENT

UDAI PRATAP COLLEGE, VARANASI-221002

Programme/Class: Diploma in Plant Identification, Utilization & Ethnomedicine/BSc-IV Semester

UG, Year: II, Semester: IV, Paper: I, UNIT-I

Subject: Botany; Course Code: BO40401T

Course Title: Economic Botany, Ethnomedicine and Phytochemistry

Topic: Cultivation, Production & Uses of Cereals-WHEAT

Name: Prof. Ajai Kumar Singh, **Department of Botany**, Faculty of Science,
Mobile No. 9450538149, E-mail: ajaiupcollege@gmail.com

CEREALS

A cereal is any grass cultivated for the edible components of their grain (botanically, a type of fruit called a caryopsis), composed of the endosperm, germ, and bran. Cereals grains are grown in greater quantities and provide more food energy worldwide than any other type of crop; cereal crops therefore can also be called STAPLE crops.

The ten common cereals are:

I. WHEAT;
II. MAIZE;
III. RICE;
IV. BARLEY;
V. OAT;
VI. RYE;
VII. SORGHUM

In addition to these Millet, and Triticale are also well known cereals. Some pseudocereals are colloquially called cereal, even though botanically they do not belong to the Poaceae family; these include BUCKWHWAT, QUINOA, and AMARANTH.

Cereals are rich in vitamins, carbohydrates, minerals, fats and oil. Cereals are used for both human and animal food and as an industrial raw material. Although milled white flour is largely used for bread production, especially in industrialized countries, the grain may be converted to food in other ways.

In ancient Roman religion, CERES was a goddess of agriculture, grain crops, fertility and motherly relationships. She had the power to fertilize, multiply and fructify plant and animal seed, and her laws and rites protected all activities of the agricultural cycle. In January, Ceres (alongside the earth-goddess Tellus) was offered spelt wheat and a pregnant sow, at the movable Feriae Sementivae.

Goddess CERES

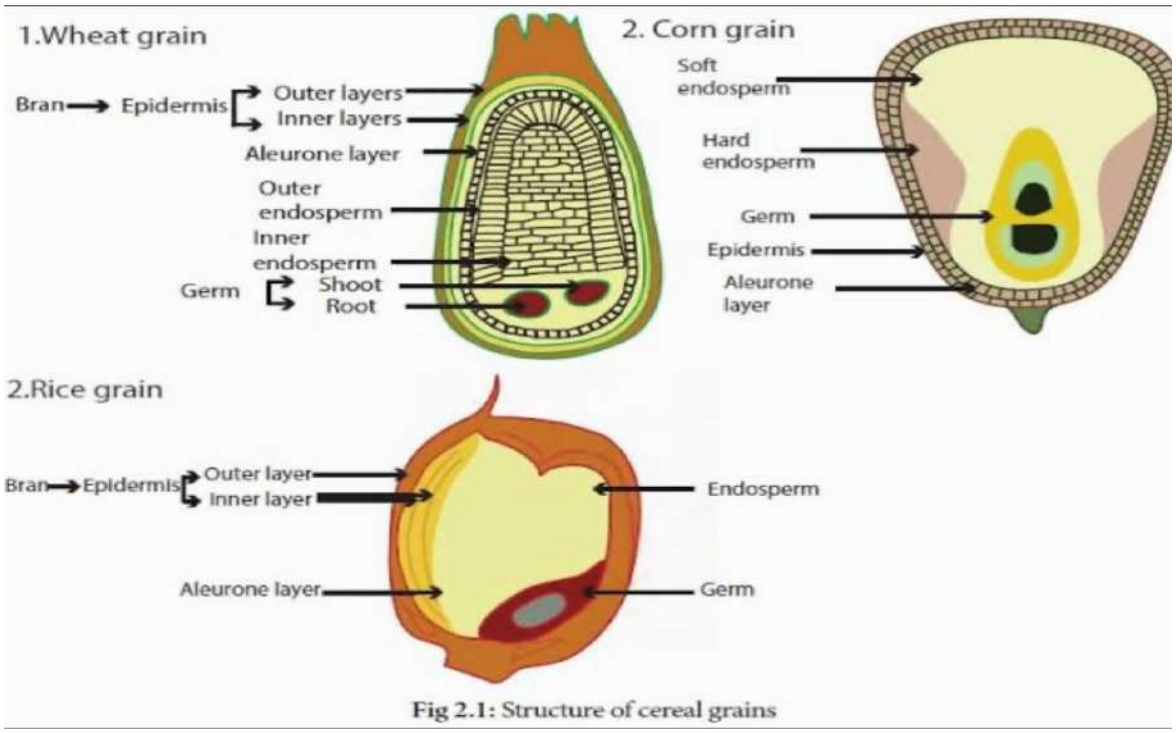
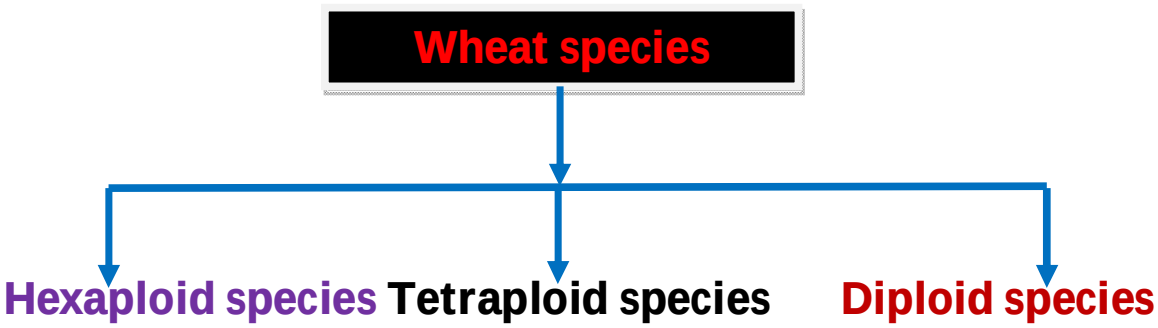


Fig 2.1: Structure of cereal grains

WHEAT [Gehun] : 'KING OF CEREAL CROP'

B otanical Name: *Triticum aestivum*, Family: Poaceae (Gramineae)



(i) . Hexaploid Species: In Hexaploid species three genomes are present which came from three different genes such AABBDD, e.g. *T. aestivum, T. vulgare.*

In India ***T. aestivum*** is mostly cultivated in about 87% area. It is called common bread wheat which came from Mexico (**Mexican Dwarf wheat**).

T. vulgare is called as **Poulard wheat** [English wheat] and it is cultivated in America

(ii) . Tetraploid Species: Two genomes are present in tetraploid species which came from two different genes, such as AAB, e.g. *T. durum, T. dicocum*.

T. durum is cultivated in about 12% area of India and is used in making Dalia, Macroni, Rava etc. Commonly called **Macroni wheat**.

T. dococum: It is also known as **Emmer wheat**. In India it is cultivated in about 1% land area and mainly used in making UPPMA in South India.

(iii) . Diploid Species: Only one genome present in diploid species, came from one gene such as AA. e.g. **T monococcum, T. spherococcum**

T monococcum called as Einkorn wheat.

T. spherococcum called as Indian Dwarf wheat.

Bread wheat, or common wheat, is the primary species. Other closely related species include durum, spelt, emmer, einkorn, and Khorasan wheat.

Origin and Distribution

It is the world's most widely cultivated staple crop of the temperate regions of the world. Wheat is being cultivated since pre-historic times. From all possible records, it seems that its centre of origin is South Western Asia. It is believed that Aryans brought wheat grains to India. According to De Candolle, the wheat was originated in the Eupharates and Tigris and spred from there to China, Egypt and other parts of the world. As per M.A. de Candolle and recent investigations it is revealed that the cultivation of wheat was started in Egyptian Mountains some 10,000 years ago and was

originated from a still living ancestor plant known as emmer. Its traces have also been found in South East Turkey (region of the Euphrates), it was called *Einkorn* (*T. monococcum*), and genetically described diploid. At the same time emmer wheat (*T. dicoccum*, tetraploid) was being domesticated , but the region of its domestication is still debatable. Vavilov (1950), after extensive studies came to the conclusion that the origin of the durum wheat was probably in the region of Abyssinia, where as the whole group of soft wheat , which includes bread wheats, probably originated in the region of Pakistan, South-Western Afganistan and the Southern parts of mountainous Bokhara. T. dicoccum or T. dicoccoides is self-pollinating winter annual grass and was distributed throughout the modern countries of Israel, Jordon, Syria, Lebnon, Eastern Turkey and Western Iran.

Today about 25,000 different cultivated varieties of wheat divided into two broad groups called bread or **Common wheat** (**Soft wheat** or *T. aestivum*, hexaploid) and **Durum wheat** (**Hard wheat**, tetraploid).

Bread wheat and Durum wheat are both domesticated forms of wild Emmer wheat.

According to Jared Diamond spread of cultivated Emmer wheat began before 8800 B.C. in ***FERTILE CRESCENT REGION***. Archaeological analysis revealed that wild emmer was cultivated in the Southern Levant (an archaeological site in Euphrates valley in Modern Syria).

Emmer (*T.dicoccum*, tetraploid) was a natural hybridization between two wild grasses-*T. uratu* and *Aegilops* species. Both of these were diploid. Durum wheat is also a tetraploid and developed through natural hybridization. Wild emmer is the progenitor of cultivated wheat and played key role to wheat domestication.

The main difference between the wild forms and domesticated wheat is that domesticated forms have larger seeds with hulls and a non-shattering rachis.


Caucasus
Anatolia
Aşıklı Höyük
Hallan Cemi
Tigris
Shanidar
Hacilar
Catalhöyük
Nevali Cori
Çayönü
Jerf el Ahmar
Göbekli Tepe
Tell Mureybit
Jarmo
Abu Hureyra
Parekklishia-
Shillourokambos
Zeribar
Cyprus
Euphrates
Ganj Dareh
Tell Aswad
Mesopotamia
Huleh
Ali Kosh
Jericho
Enyan
Ain Ghazal
Egypt
Elkab
Kiseiba
Nile
Nabta
Playa


Black Sea
Caucasus Mts.
Caspian Sea
ASIA
MINOR
FERTILE CRESCENT
ASSYRIA
Nineveh
Assur
Çatal Hüyük
Taurus Mts.
Zagros Mountains
IRAN
Euphrates
Tigris
AKKAD
Ebla
Cyprus
PHOENICIA
Tyre
Babylon
Umma
Lagash
Uruk
SUMER
Syrian Desert
Mediterranean Sea
PALESTINE
Jordan R.
Jericho
Ur
Eridu
Jerusalem
Dead Sea
Arabian Desert
LOWER
EGYPT
SINAI
Sahara
Nile R.
Red Sea
0 200 400 600 Kilometers
0 200 400 Miles

The cultivation of emmer began in Greece, Cyprus and India around 5600 B.C., Egypt by 6000 B.C. and Germany and Spain by 500 B.C. Egyptian were the first to develop bread and developed baking as one of the largest food production industries. By 3000 B.C., it reached British Isles and Scandinavia and around 2000 B.C., it reached China. The first bread wheat (*T. aestivum*) with sufficient gluten for yeasted breads has been identified using DNA analysis in samples recovered from a granary at dating to approximate 1350 B.C., Assiros village in Macedonia (Greece).

Wheat is extensively cultivated in different parts of the world, like USA, Russia, China, India, Turkey, Italy etc.

Botanical Description

It is third most produced grain after corn and rice. An annual grass, height upto 0.6 to 1.5 m. In Wheat two types of roots are found. First root appears only for 20-25 days are called as SEMINAL ROOT. The second root appears above the seed, appears like a crown hence called CROWN ROOT. At this stage first irrigation is needed to the crop. The stem is hollow (culms) differentiated into nodes and internodes and produces tillers at the base. Leaves grow from the nodes with two parts-the petiole sheath and the blade with parallel veins. Wheat is a $C_{3,}$ long day plant. Its flowering depends on the duration of day and night. Inflorescence is called Ear / Spikelet. The seed has a central zig-zag line called as rachis. The wheat has a protein namely **GLUTEN**.

Genetic Constitution of Wheat

Genetic constitution of different wheat species varies. Some species are diploid (2n) and many are tetraploid or hexaploid, e.g. Einkorn wheat is diploid (2n=14), while emmer and durum wheat are tetraploid. The wild hybridized (AABB) emmer is evolved by natural selection. Modern hexaploid wheat (also known as **DINKEL WHEAT / HULLED WHEAT /COMMON WHEAT / BREAD WHEAT**) evolved through hybridization between either domesticated emmer or durum wheat with another wild goat grass (*Aegilops touschii*).

On the basis of chromosome number, the most common species of wheat:

Diploid (7 pairs)	Tetraploid (14 pairs)	Hexaploid (21 pairs)
T. monococcum	*T. dicoccum*	*T. aestivum*
T. aegilopoides	*T. durum*	*T. compactum*
	T. polinicum	*T. spelta*
	T. turgidum	

Nutritive value of wheat grain

Component	% in grain	% in flour
Moisture	9-18	13-15
Protein (%N x 5.7)	8-15	8-13
Cellulose (Fibre)	2-2.5	0.2
Oil & Fat	1.5	0.8-1.5
Mineral matter (Ash)	1.5-2	0.3-0.5
Carbohydrates	62-71	65-70

Whole-Grain Wheat Flour (100 grams)

- **Calories: 340**
- **Water: 11%**
- **Protein: 13.2 grams**
- **Carbohydrates [Starch >90%] 72 grams**
- **Sugar: 0.4 grams**
- **Fiber: 10.7 grams**
- **Fat: 2.5 grams**

Cultivation

Wheat is a Rabi season crop and seeds are sown in winter season from Nov-Dec and harvesting in the month of March-April. There are two stages like vegetative and reproductive stage.

Vegetative stage requires cool and moist climate while for reproductive stage warm day climate is needed. The average temperature required for the growth of plant is $23^0 – 25^0$ C.

The alluvial soil is the best soil required for the growth. There must be deep ploughing done by MB plough and after that 2-3 times cultivator has to applied and level the field with the help of leveller.

Once the field is ready or prepared for sowing the sowing is done.

Climate Requirements

Wheat has wide adaptability. It can be grown not only in tropical and sub-tropical zones but also in the temperate zone and the cold tracts of the far north, beyond even the 60^0 north latitude. Wheat can be cultivated from sea level to as high as 3,300 m.

Other parameters are following:

Optimum Temperature Range- $20^0 – 25^0$ C (Ideal germination of wheat seed)

[3.50 – 350 C (Seed germination Temperature range]

[14-150C (Optimum average temperature at the time of maturity]

Rainfall 25-150cm/year

Humidity 50-60%

Classification of Indian Wheat

Emmer wheat (*T. dicoccum*) : Reported to grown in MP, Tamilnadu, and Karnataka. Believed to be evolved from *T. diccoides* (a wild form). It is also cultivated in Spain, Italy, Germany and Russia.	**Macroni wheat** (T. durum) : Best wheat for drought conditions in MP, Punjab, Karnataka, Gujrat, TN, W. Bengal and HP. It is used to prepare a coarse flour semolina (SUJI). It is hard and light coloured and rich in gluten protein.	**Common bread wheat** (*T. aestivum vulgare*) : It is a typical wheat of alluvial soil of Indo-gangetic plains, i.e. Punjab, UP, Bihar, Haryana and part of Rajasthan. Mainly used to make bread an chapati.	**Indian dwarf wheat :** (*T. spherococcum*) Belongs to the club wheat of Western countries. It is grown in limited areas of MP and UP. This is characterized by very short and compact heads with smaller grains.

Improved varieties

HS 542 (Pusa Kiran), HW 1098 (Nilgiri Khapli), HDCSW 18, HD3117, HD 4728 (Pusa Malvi), HS 562.

Soil

The ideal soil is neutral or alkaline with a pH range of 5.5 to 7.

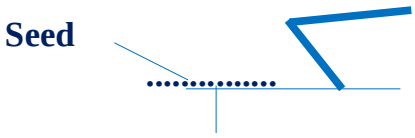
Sowing time: Wheat is mainly Rabi crop, which is sown in the beginning of winter (October). The time of sowing differs in different regions due to climate variations.

Month of sowing

Month of sowing	Area
September-October	MP, Maharastra, Karnataka, and AP
October-November	UP, Bihar, Punjab, Haryana and Rajasthan
November-December	HP and Jammu & Kashmir

Method of Sowing

- **(i). Broad casting:** Easy and cost efficient method.
- **(ii).Sowing behind plough:** It has two methods.
  In the first method seed sowing by hand in the furrow made by plough. In the second method Keep with long pipe fitted behind plough is used.
- **(iii).Dibbling method:** In this method a furrow is made with the help of hand only. **Plant to plant** and row to row distance should be maintained.
- **(iv).Seed drill:** This method is a common method of sowing. It is useful for large area.
- **(v).FIRB System:** The furrow irrigated raised bed (FIRB) has been recently developed and is being promoted by the Rice-Wheat consortium of the CGIAR institute.



Plough making furrow

Seed rate:

Seed rate of wheat under various sowing methods

Method of Sowing	Seed rate (kg/ha)
Line sowing behind plough	90-100
Sowing by kera/pora method	80-100
Sowing by dibbling	25-30
Late sowing by seed drill	125-155
Broadcasting Method	100-120

Spacing:

For normal sown crop, 22-22.5cm (Row spacing)
For irrigated, timely sown wheat, a row spacing of 15 to 22.5 cm.
Under irrigated late-sown conditions 15-18 cm.

Depth:

Maximum cultivars is about 5 cm.
Semi-dwarf (One gene dwarf) 5-6 cm.
For dwarf wheat depth should be between 5 and 6 cm.

Seed treatment:

The seed of loose smut-susceptible varieties should be given solar or hot-water treatment. If the wheat seed is used only for sowing, it can be treated with Vitavax, thyram 2.5 gm/kg seed.

Fertilizers

With assured fertilizer supply:

N @ 60-80 kg/ha.

Phosphorous (P_2O_5 @ 40-60kg/ha.

Potash (K_2O) @ 40 kg/ha.

It is desirable that 2 to tonnes of farmyard manure per hectare or some other organic matter is applied 5 or 6 weeks before sowing The fertilizers of NPK is needed in a ratio of 120:60:40 respectively. Total quantity of Phosphorous and Potash and half the quantity of Nitrogen should be applied at the time of sowing. Remaining quantity of Nitrogen should be applied at the time of crown root initiation.

Azotobacter is also used as bio fertilizer.

Irrigation

Ideally wheat crops need maximum 6 irrigation by **border strip method**. The stages of irrigation are as follows:

(i). CRI (Crown Root Initiation) stage-First irrigation after 20-25 days of sowing.
(ii). Tillering stage-Second irrigation after 40-45 days.
(iii). Later joining
(iv). Flowering stage irrigation
(v). Milking stage
(vi). Grain Filling stage

Weed management

There are number of weeds which are present in the wheat field. The most common and dominant weed is *Phalaris minor*. It is very similar in appearance as wheat. That is why it is commonly called as **'mimicry weed'**, as it looks like wheat crop at initial stages of growth. *Convolvulous arvensis* is another common weed, commonly called **'crop binder'**. *Sorghum halepense* is also a common weed in wheat fields.

Generally weeding is done after 1½ to 2 months after sowing or weedicides like 2,4 D, Avadex or Nitrofen (Tok E-25), Isoproturon, and Sulfosulfuron are applied for controlling *Phalaris minor, Chenopodium album, Anagallis arvensis, Sorghum halepense, Convolvulous arvensis, Asphodelus sp.,* of weeds.

Plant Protection

Diseases-

Wheat crops suffer from several diseases causing reduced yield and quality. The major diseases are: Black/Stem rust, Yellow/Stripe rust, Brown/Leaf rust, Alternaria leaf blight, Pwdery mildew, Loose smut, Karnal bunt, Molya nematode.

Harvesting

The crop is harvested when plants become dry, the grains become hard and the straw become dry and brittle. The harvesting is done mostly by sickles or reaping machines in big farms. The crop is threshed by power-driven thresher or combines. It involves separation of grains from the spikes.

Uses

Wheat is typically milled into flour which is then used to make a wide range of foods including bread, crumpets, spaghetti, muffins, noodles, pasta, biscuits, cakes, pastries, cereal bars, crackers, crip-breads, sauces. cookies, semolina, bulgur, couscous, macaroni and confectionery (e.g. liquorice). Wheat is also used in the manufacture of beer and other alcoholic beverages. It provides antioxidants, vitamins, minerals, and fiber.

Wheat is highly controversial because it contains a protein called ***GLUTIN***, which can trigger a harmful immune response in predisposed individuals. *Glutin is responsible for the unique elasticity and stickiness of wheat dough, the properties that make it so useful in breadmaking.*

Celiac diseases:

Celiac diseases is characterized by a harmful immune reaction to GLUTIN. This disease damage the small intestine, resulting in impaired absorption of nutrients. Associated symptoms include weight loss,. Bloating, flatulence, diarrhea, constipation, stomach pain, and fatigue. It has also been suggested that gluten may contribute to brain disorders in people with Celiac disease, such as Schizophrenia and Epilepsy.

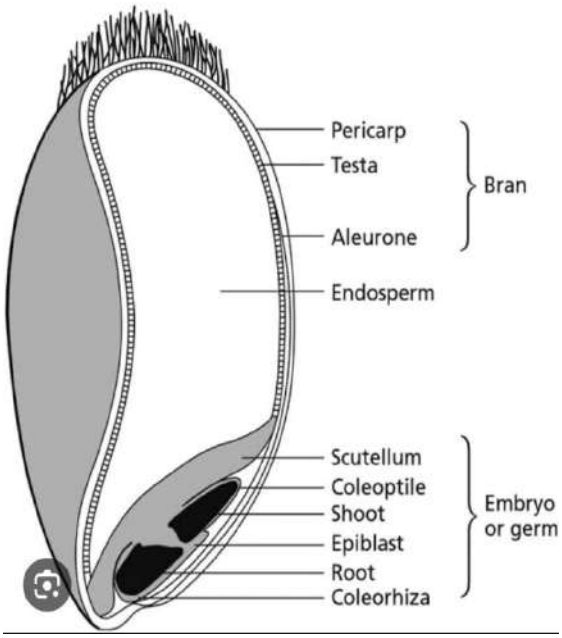
Some Important Facts:

-Wheat started being cultivated 10,000 years ago;

-Pharaohs in ancient Egypt were buried with wheat;

-Wheat is the most widely grown commercial crop in the World;

-Wheat occupies a central place in human nutrition, providing 20% of the daily protein and food calories.



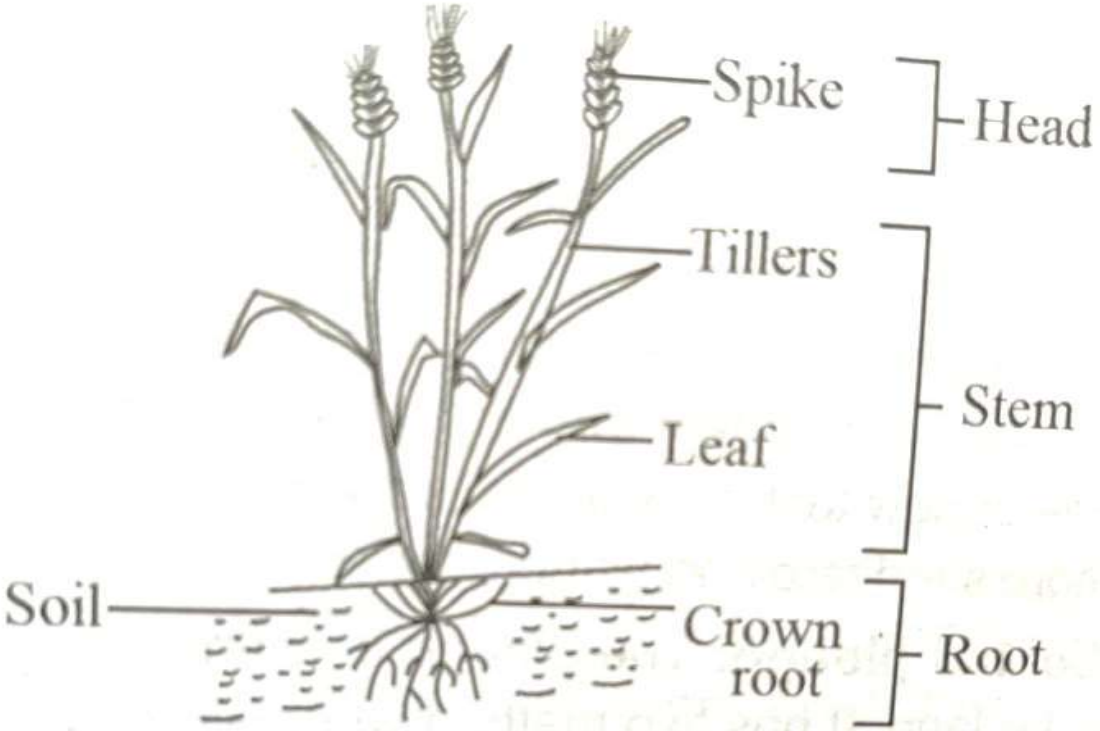
Structure of Wheat Grain

DIBBLER

BULLOCK DRAWN SEED DRILL

TRACTOR DRAWN SEED DRILL

SEED CUM FERTLIZER DRILL



WHEAT Plant

YELLOW RUST (Sripe rust)

Black Rust (Stem rust)

Brown Rust (Leaf rust)

DISEASES

LOOSE SMUT

POWDERY MILDEW

FLAG SMUT

DISEASES

Anagallis arvensis

Chenopodium album

Covolvulous arvensis

Phallaris minor

Soprghum halipense

WEEDS

Declaration

This E-content is exclusively meant for academic purposes and for enhancing teaching and learning only. Any other use for economic/commercial purpose is strictly prohibited. The users of the content shall not distribute, disseminate or share it with anyone else and its use is restricted to advancement of individual knowledge. The information provided in this e-content is authentic and best as per knowledge.

THANX