**1. Wheat (*Triticum aestivum* L.):**

**A) Crop Botany:**

It belongs to family Poaceae.

i) Root: it has fibrous root system that consists of seminal (primary) rot and crown roots or adventitious (secondary) roots which develop from noes just below sol surface.

ii) Stem: hallow cylindrical stem called as culm consisting of nodes and internodes. The upper most internode called peduncle bears inflorescence.

iii) Leaves: It has narrow leaves. Each leaf has basal leaf sheath which encircles the stem and upper expanded leaf blade. The upper most leaf is called flag leaf.

iv) Inflorescence: It is called ear or spike which consists of many spikelets with seeds in them. The mode of pollination is self-pollination.

v) Seed: it is called grain or caryopsis. Seed coat is fixed with pericarp (ovary wall).

**B) Agro-meteorology:**

i) Climate: Wheat is adapted to temperate regions from 30-60oN and 27-40oS latitudes which receive annual rainfall of about 500-1200 mm. It is a long day plant and tillering is stimulated by shorter days. About 22-23oC average diurnal; temperature is optimum for germination. Cardinal temperatures for growth are minimum 3-4oC, optimum 18-25oC and maximum 30-32oC.

ii) Soil: It can be grown on sandy-loam to clayey soils. However, silt to clay loam soils are best for it.

**C) Economic Importance:**

It is most important food crop of the world. In Pakistan, it is main staple diet and largest grown crop and contributes 13.1% to the value added in agriculture and 2.8% to GDP. Area of Pakistan under wheat is 8.74 million ha, production 25.2 million tonnes and average yield is 2.88 tonnes / ha.

Uses: Its flour is used to make *chapaati*, bread and other bakery products. Its starch is used in paper and food industry. The byproduct of flour mills (choker) is used for livestock.

**D) Production Technology:**

**1) Seed bed preparation:** 2-3 ploughings, 2 cultivations followed by planking are sufficient to prepare seed bed.

**2) Sowing time:** It is rabi season crop. In barani areas: 20th October – 10th November

In irrigated areas, optimum sowing time is 1st November – 15th November

Sowing after November results in 10-12 kg grain yield reduction per acre per day.

**3) Seed rate:** 40-50 kg / acre (60 kg / acre in case of December sowing). If germination is less than 90%, then seed rate should be increased.

**4) Sowing method:** In barani areas: Line sowing with pora or drill

In irrigated areas: Sowing with automatic rabi drill is best. If drill is not available, then kera. Or seed can be broadcasted but seed rate should be increased by about 5%.

In case of late sowing or saline soils, shallow dry sowing followed by irrigation is the best.

The optimum plant population of wheat is 10-12 lac plants per care.

**5) Fertilizer:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Areas** | **Rainfall / Fertility** | **N** | **P2O5** | **K2O (kg/acre)** |
| Barani areas | Moderate rainfall | 34 | 23 | 25 |
| High rainfall | 46 | 34 | 25 |
| Irrigated areas | Moderate fertility | 42 | 34 | 25 |
| Low fertility | 52 | 46 | 25 |

Fertilizer should be applied according to fertility status of soil (in irrigated areas) and according to rainfall (in barani areas). Less fertile soils require more fertilizer and more rainfall areas require more fertilizer.

In irrigated areas, whole of P and K should be applied at seed bed preparation. But N is applied in 2 splits, ½ N at seed bed preparation and ½ N with 1st or 2nd irrigation.

**6) Irrigation:** It requires 3-4 irrigations:

1st irrigation: 20-25 days after sowing (DAS) at Crown root initiation (CRI) stage (when adventitious root development starts), 30-40 DAS in rice areas.

2nd irrigation: 15-45 DAS at tillering (in which secondary shoots arise from the main or primary shoot). Tiller is a shoot having its own root, stem, leaves and inflorescence. First tiller arises 15 Das with a new tiller after every 4-5 days and continues till 45 DAS. Irrigation during this stage enhances tiller development.

3rd irrigation: 80-90 DAS at booting stage when spike is developing within flag leaf and near to emergence. Irrigation during this stage enhances spike length and number of tillers per spike.

4th Irrigation: 125-130 DAS during milking stage of grain development. Irrigation during this stage increases grain size and weight.

If sufficient water is not available, then reduce the number of irrigations to 2-3 at the most important critical growth stages i.e. CRI, booting and milking stages.

**E) Plant protection measures:**

**i) Weeds:** 15-20% reduction in yield occurs due to weeds.

Cultural control: 1. *Daab* (delayed planting) is carried out with double rauni irrigation.

2. Crop rotation in which wheat field is sown with another rabi crop in the next season e.g. berseem etc. With it, serious weeds like wild oat or dumbi sitti are controlled.

3. Hoeing or interculturing with bar harrow after 1st or 2nd irrigation.

Chemical control: Pre-emergence herbicides e.g. Stomp or Treflan @ 1.3-2 L /acre for controlling BL weeds and grasses.

Post-emergence herbicides e.g. Buctril Super for BL weeds; Topic, Puma Super for grasses.

**ii) Insect-pests:** Grasshoppers, crickets, aphids, army worms and white ants

Grasshopper and white ants attack at seedling stage and are more serious in ranfed areas.

Aphid, Armyworm attack at heading.

Spray of suitable insecticides is recommended before grain development.

**iii) Diseases:** Stem rust, leaf rust or black rust and stripe rust are serious. In tem rust, brick-red spore-containing postules appear on all parts of plant in patches. In loose smut, floral parts are transformed into black powdery mass.

**9) Harvesting and Storage:** Crop matures when plants start drying and yellowing. In plane areas, areas of Punjab, wheat harvesting starts in mid-April and continues till end May. In hilly areas, wheat is harvested in June and July. Crop is harvested by sickle or by combine harvester or tractor mounted reapers. Combine harvester harvests as well as thresh the crop. After harvesting, the grain must be dried enough for safe storage. Bags, bins and stores must be fumigated to avoid the attack of stored grain pest and rats.

**Varieties:**

**2. Rice (*Oryza sativa* L.)**

**A) Crop Botany:**

It is a self-pollinated plant. It produces 4 to 5 tillers. The stem or culm is hollow, erect and smooth. It consists of nodes and internodes. The leaf consists of long and narrow leaf-blade, and an open leaf sheath with characteristically long ligule. The inflorescence is loose, many branched panicle, each bearing many spikelets. Root system is shallow and thus concentrates in the upper soil layer to a depth of 20 to 25 cm. It consists of seminal or seed root, and adventitious root, arising from nodes near the soil surface. Edible seeds are borne in a dense head (called panicle) on separate stalks. It is a long day plant which is self-pollinated

**B) Agro-meteorology:**

It is a short day summer crop. It grows well in humid tropical region with high temperature, plenty of rainfall and sunshine. Heavy clay or clay –loam soils are most suitable for rice. Rice is tolerant to a range of soil pH. Thus it can be gown successfully on saline or sodic soils with pH range of 4.5 to 8.5. However, it performs well in acidic soils. After seedling emergence, oxygen released during photosynthesis is transported from the leaves to submerged roots. In this respect, rice is unique and different from all other cereals, which cannot germinate and grow in an aquatic environment. That is why; rice is frequently grown on soils that are not suitable for other food crops. Rice growing areas of Sheikhupura, Lahore, Gujranwala, Sialkot, Hafizabad and Nankana belt is known as Kallar Tract rice is also grown in Sahiwal, Kasur and Sargodha and different areas of Sindh.

**C) Economic Importance:**

It is important food crop of world and is the staple food in South East Asia and at present time more than half of world population depends upon this crop for its dietary needs. It occupies 2nd position after wheat in Pakistan and play vital role in Pakistan’s economy as billions of dollars are earned each year by its export. In Pakistan during year of 2018-19 its area is 2.8 million ha with total production of 7.20 million tons with average paddy yield is 2562 kg/ha.

**D) Production Technology:**

**1. Nursery sowing time**

Rice nursery must not be sown before May 20 to prevent the insect attack.

**Table: Optimum time for sowing and transplanting rice**

|  |  |  |  |
| --- | --- | --- | --- |
| **Sr.** | **Variety** | **Time of sowing** | **Time of transplanting** |
| **1** | Super Basmati, PS 2, Basmati 385, Basmati 515, Basmati Pak(kernel Basmati), PK 386, Chenab Basmati, Punjab Basmati, Noor Basmati, NIAB Basmati 2016 | 1ST Jun-20 Jun | 1ST July-20 July |
| **2** | Shaheen basmati, Kisan basmati | 15 Jun- 30 Jun | 15 July- 31 July |
| **3** | KS 282, NIAB ARRI 9, IR 6, KSK 133, KSK 434. Niab 2013 | 20 May- 7 Jun | 20 Jun-7 July |
| **4** | Y 26, Pride 1, Shenhsha 2, PHB 71, Aarise Soift | 20 May- 15 Jun | 25-30 days |

**2. Methods of nursery sowing**

Method of sowing of nursery depends on the type of soil, water availability, and local custom.

1. Wet bed method
2. Dry bed method
3. Rabi method

**i. Wet bed method**

* Soak the seed in water for 24 hours, after that cover the seed with wet jute bags and place it under shade.
* Seed will germinate after 36-48 hours.
* Irrigate, plow, puddle and level the field.
* Prepare beds of 1 to 1.5 m width, 4-5 cm height & any convenient length.
* Germinated seed is sown with broadcast method @ 1kg/Marla for ARRI varieties and @ 500-750g/Marla for Basmati varieties.
* 1-1.5-inch water should be present before broadcasting the pre-germinated seed in evening.
* Drainage the water in next evening and again irrigate in next morning. Repeat it for one week.
* Maintain a water level of 2-5 cm, depending on the height of seedlings.
* Apply urea 250g per Marla, if seedling is weak.
* Seedlings will be ready for transplanting in 25-30 days.

**ii. Dry bed method**

* Practiced where puddling is impossible as soils are loamy or silt loam.
* Plot is prepared in watter conditions after irrigation.
* Dry seed is sown with broadcast method @ 1.5 kg/Marla for ARRI varieties and @ 750g/Marla for Basmati varieties.
* Straw layer is spread and irrigation is applied.
* Straw layer is removed after some days to facilitate sunlight.
* Seedling will be ready in 35-40 days.

**iii. Raab method**

* Practiced in areas of D.G. khan and Muzaffargarh where soil is hard.
* Uprooting of nursery is difficult.
* Nursery plots are levelled.
* Crop residues (5cm layer) spread uniformly and burnt.
* Ash is pressed on soil after cooling.
* Dry seed is sown with broadcast method @ 2kg/Marla for ARRI varieties and @ 1kg/Marla for Basmati varieties.
* Seedling will be ready in 35-40 days.

**3. Land preparation for transplanting**

* Irrigate the field till standing water condition minimum three days before puddling.
* In wet lands an impervious layer is created at a depth of about 20cm.
* Level the field during puddling.
* Use ‘Raja Hal” in high clayey soils with more water availability before puddling.
* Transplant the nursery as soon as possible after field preparation.
* Puddling is not done salt affected soils as salts will not leach down.

**Transplanting**

* Seedling age should not be more than 30-40 days at the transplanting.
* Irrigate the field 1-2 days before uprooting the seedling as it helps in uprooting.
* Transplanting should be done in 1.5-inch-deep water.
* Maintain water depth at 1.5 inch for first week of transplanting and after that at 3-inches.
* Do not use damaged or diseased plants for transplanting.
* Use two plants per hole with 9 × 9-inch distance.
* As 80000 holes and 160000 plants per acre.
* Place some seedling bundles near field banks in water to fill up the gaps in 7-10 days’ period.

**3. Fertilizer application**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Variety** | **N** | **P** | **K** | **Remarks** | **Fertilizer bags** |
| IRRI-6, KS 282, NIAB IRRI-9, KSK 133, KSK 434, NIAB 2013 | 69 | 41 | 32 | When sown after wheat | 11/2urea+41/2SSP (18%)+11/4 K2SO4 |
| IRRI-6, KS 282, NIAB IRRI-9, KSK 133, KSK 434, NIAB 2013 | 57 | 41 | 32 | When sown after legume or berseem | 11/4urea+41/2SSP (18%)+11/4 K2SO4 |
| Basmati 385, Super Basmati, Basmati 515, Shaheen Basmati, PS 2, Kisan Basmati, Chenab Basmati, Punjab Basmati, Noor Basmati, NIAB Basmati 2016 | 55 | 36 | 25 | When sown after wheat | 11/4urea+31/2SSP (18%)+1 K2SO4 |
| Basmati 385, Super Basmati, Basmati 515, Shaheen Basmati, PS 2, Kisan Basmati, Chenab Basmati, Punjab Basmati, Noor Basmati, NIAB Basmati 2016 | 41 | 36 | 25 | When sown after legume or berseem | 3/4urea+31/2SSP (18%)+1 K2SO4 |
| PHB-71, Shenhshah-2, Pride-1, Y-26, PK 386, NIAB 2013, Aarise soft | 69 | 41 | 32 | Moderate fertility | 1urea+41/2SSP (18%)+11/4 K2SO4(16%) |

**4. Irrigation**

* Standing water should be present in rice field for 25-30 days after transplanting.
* Water depth should be 1-2 inch.
* Stop irrigation before 15 days of ripening.

**Direct sowing of rice**

* In foreign countries, 30% rice cultivation is done via direct sowing method.
* Our farmers are getting high yield with transplanting method but it is laborious and costly method due to lack of labour.
* In direct sowing method, farmers can get not only desired plant population but it also reduces input cost.
* By direct sowing method, more area can be cultivated in short time as compare to traditional method (nursery transplanting).
* 15-20% irrigation cost is less in this method.
* It is easy to prepare soil for next crop after harvesting in direct sowing method as compare to puddling soil method.
* Many research stations have conducted experiments for direct sowing of rice crop.

**Production technology of direct sowing**

* **Preparation of soil**
* Land levelling is more important in this method for germination and water management.
* In third week of May, twice plough, press and level the soil and then irrigate.
* Prepare the field at watter stage.
* Salt affected soils are not suitable for direct sowing method.
* **Suitable varieties**

**Basmati varieties** (Super Basmati, PS 2, Basmati 385, Basmati 515, Basmati Pak (kernel Basmati), PK 386, Chenab Basmati, Punjab Basmati, Noor Basmati, Niab Basmati 2016, Shaheen basmati, Kisan basmati).

**Fine varieties** (PS-2, PK-386)

**Hybrid varieties (**Y 26, Pride 1, Shenhsha 2, PHB 71, Aarise Soift)

* **Seed rate**
* 12-15 kg/acre for fine varieties
* 10-12 kg/acre for basmati varieties
* **Seed treatment**
* Seed is treated with appropriate fungicide.
* **Sowing time**
* 20 May-7 June for fine varieties.
* 1st June-30 June for basmati varieties.
* **Sowing via broadcast method**
* Soak the seeds in fungicide for 24 hours and dry for few hours.
* Prepare the field in watter condition, broad cast the seed and press the soil with sohaga.
* Apply light irrigation after germination.
* 1st irrigation is applied after 5-7 days of sowing.
* After that irrigation is applied when needed.
* **Sowing via drill**
* Fungicide treated and dried seed is sown with drill.
* Line distance should be 9×9 inch.
* Seed is not sown in depth more than 11/2 inch.
* Sometimes, drill`s pipes are closed with soil, so check it.
* Seeds are sown with hands and covered with soil in drill missing places.

**5. Plant Protection measures:**

**i. Weed management:**

**Weeds of rice:** Dhidan, swanki, deela, ghoin, bhoin, khabbal, lumb grass, naru grass, itsit, etc.

**Weed Control measures:**

* All weeds should be removed within month after transplanting.
* Weeds reduce the yield and deteriorate the quality.
* Crop rotation technique helps to control weeds.
* Maintain water level up to 3-inches for 30 days if water is available.
* Use recommended herbicide in 3-5 days after transplanting.
* Consult the agricultural experts for recommended herbicides.
* Do not let the field to dry for one week after herbicide application.

**ii. Diseases**

Brownish spots on leaves, bacterial leaf blight, paddy blast, bakanae/foot rot, stem rot

**Treatment**

* Use disease resistant varieties.
* Treat the seed with recommended fungicide.
* Burn the crop residues after harvesting.
* Concern the agriculture staff for further guidance.

**Iii. Insects**

Grasshopper, stem borers, leaf folder, white-backed plant hopper, rice hispa, army worm

**Control**

* Destroy the insect eggs and nymphs.
* Use alternative plants or weeds for insect feed.
* Biological control method can also be used.
* Light trapper can also help to control insects.
* Crop rotation can reduce the chances of insect attack.
* Use appropriate insecticide for insects.

**6. Harvesting and threshing**

* Timely harvesting is essential for optimum yield.
* 20-22% moisture in grain is best time for harvesting.
* After harvesting yield should be reached in market timely.
* Store the yield after 4-6 days drying (at 12-13 % moisture).
* Traditional harvesting is more laborious and time consuming method.

Japanese head-feeding combines are more suitable for paddy harvesting.