1. INTRODUCTION
Cotton is grown chiefly for its fiber which is used in the manufacture of cloth for mankind. It is also used for several other purposes such as for making threads for mixing with other fibers and for extraction of oil from cotton seed. All these uses give a high industrial value to this crop and as such a handsome remuneration to the growers.

Cotton is grown almost all over the world from times immemorial and perhaps earlier that the time when Peruvian mummies were clothed in it. At present cotton is grown all over the world, i.e. in India, USA, Russia, China, Brazil, Egypt, Pakistan, Turkey, Mexico and Sudan are leading cotton growing countries. Cotton is most important fiber crop which plays an important role in economic and social affairs of people. It is also an important cash crop of Pakistan known as “white gold”. It accounts for 8.2 percent of the value added in agriculture and about 3.2 percent to GDP; around two thirds of the country’s export earnings are from the cotton made-up and textiles which adds over $2.5 billion to the national economy; while hundreds of ginning factories and textile mills in the country heavily depends upon cotton.
Pakistan is the fourth largest producer of cotton in the world, with average production of 1,610 TMT (Thousand Metric Ton). Pakistan is also the fourth largest consumer of cotton, with average consumption of 1,573 TMT. An average Pakistan imports 92 TMT and exports 98 TMT. The province of Punjab accounts for the majority of the nation’s production, producing 85 percent of Pakistan’s total cotton, while the province of Sind produces the other 15% of Pakistan’s cotton.

BT cotton Bacillus Thuringiensis is a naturally occurring soil bacterium used by farmers to control Lepidopteran insects because of a toxin it produces. Through genetic engineering, scientists have introduced the gene responsible for making the toxin into a range of crops, including cotton. BT expresses the qualities of the insecticidal gene throughout the growing cycle of the plant. Cotton crops are very susceptible to pest attacks and use up more than 10 per cent of the world's pesticides and over 25 per cent of insecticides.

Now the most of the farmers of Pakistan prefer to cultivate BT cotton because its yield is more than local developed varieties and it needs fewer insecticides. Only sucking insects are attacks on cotton and it is not susceptible for chewing pests (borers).
2. GROWTH STAGES

<table>
<thead>
<tr>
<th>Growth Stages</th>
<th>Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planting to emergence</td>
<td>4 – 9</td>
</tr>
<tr>
<td>Emergence to first square</td>
<td>27 – 28</td>
</tr>
<tr>
<td>Square to flower</td>
<td>20 – 25</td>
</tr>
<tr>
<td>Planting to first flower</td>
<td>60 – 70</td>
</tr>
<tr>
<td>Flower to boll open</td>
<td>45 – 65</td>
</tr>
<tr>
<td>Planting to 1st picking ready</td>
<td>125 – 135</td>
</tr>
</tbody>
</table>

i. Germination and Seedling Development

Germination begins as the seed absorbs water and oxygen through its chalaza after planting. The water swells the dormant tissues and cell growth and division begin to take place. The radicle emerges through the micropyle, turns downward and grows deeper into the soil, providing a taproot that will supply water and nutrients throughout the life of the plant. Lateral roots and taproot collectively make up the basal root system. As the plant matures, the roots continue to spread and probe deeper in the soil profile for water and nutrients. Therefore, the distribution of roots tends to match the most fertile soil zones.

ii. The Cotyledons and First True Leaves

The cotyledons serve a dual role in germination. Before they unfold, they supply stored food to the germinating seedling. After the cotyledons unfold, they produce chlorophyll, become green, and produce energy through photosynthesis. A week or so after seedling establishment the first true leaf appears above the cotyledons.
iii. Formation of the Cotton Bud From Square to Bloom

Signs of reproductive growth begin to appear about four to five weeks after planting with the formation of the floral buds or squares in the terminal of the plant. During the 21-day period from square to bloom, there are several recognized developmental stages of the cotton flower bud. A “pinhead” square is the first stage at which the square can be identified. The next stage of square growth is “match-head” or “one-third grown” square. Just prior to the time the flower opens a candle shape can be seen. This period of square development prior to bloom is called “squaring.”

![Image of Cotton Bud Development Stages](image)

iv. Vegetative Growth

The first vegetative structures that appear on the main stem are main stem leaves. Leaf photosynthesis does not remain constant as the leaf grows and develops. A cotton leaf reaches its maximum photosynthetic capacity at about 20 days of age, after which it declines. Main stem leaves and branches form at points of attachment on the main stem called nodes. Premature aging of the cotton leaf canopy due to water stress, low fertility and other stresses further reduces the photosynthetic capacity of the crop.

The stem-like structure that connects the leaf with the stem is called a petiole. Leaves that arise directly from the main stem are referred to as main stem leaves, while leaves that arise from the fruiting branch are referred to as subtending leaves.

v. Development of Branches

The branches on a cotton plant can be classified as either vegetative branches (monopodia) or fruiting branches (sympodia). Vegetative branches, like the main stem are referred to as monopodia (meaning “single foot”) since they have only one meristem. Because vegetative branches have only one meristem, they grow straight and erect much like the main stem. Vegetative branches can also produce fruiting branches.
vi. Flowering and Fruiting

The cotton flower buds take 18-24 days to develop into a flower. Flowers are bisexual. The fruit is enlarged ovary called boll, containing 24-50 seeds. The cotton fiber (fluffy mass) is an elongation of an epidermal cell of the seed coat. The long growth is called lint while short growth is called fuzz. The lint or staple is the economic part for which the crop is grown.

When a pollen grain reaches the stigma, it germinates into a pollen tube. The pollen tube grows through the style, the micropyle and into the ovule chamber, where fertilization takes place. Anything that reduces egg or pollen viability or tube growth in a flower adversely affects the final yield for that boll.

Pollination of that flower usually occurs within a few hours after the white flower opens. On the second day the flower will have a pink-like color and a red color on the third day. Approximately 5 to 7 days after a flower appears it usually dries and falls from the plant exposing the developing boll. After pollination boll begins to develop and it takes under optimum conditions approximately 50 days to open. Boll development can be characterized by three phases: enlargement, filling and maturation.

3. CLIMATE
Cotton is a tropical as well as subtropical crop and its cultivation is restricted up to an altitude of 1000 m from sea level. It is a long day crop. Seed germination
AGRONOMY

takes place when average temperature range is 16°C and vegetative growth is satisfactory at 430 C. It is a warm season crop and grows well in areas having annual rainfall of 50 cm with heavy showers at the time of ball formation.

Cotton is very sensitive to fluctuations in atmospheric temperature and rainfall. A very low temperature below 16 °C at the time of sowing results in poor germination, whereas high temperature results in etiolation (falling of buds) and poor crop-stand. Humid and warm climate during plant growth periods is favorable for insects, pests and diseases that cause much damage to quantity and quality of its fiber. Heavy rains and stagnant water is harmful at all the stages of its development. A heavy rain during fruiting stage encourages the boll shedding.

4. SOIL

Basically the best soils for cotton are those which have the capacity of water holding and retention of moisture. Medium loams to sandy loam fertile soils are best for cotton cultivation. It can be grown on red, light red and ashy colored loam soils. Alkaline and saline soils are not suitable for cotton cultivation; moreover insufficient drainage is also harmful for its growth.

5. VARIETIES

Bt cotton varieties yielded significantly more per acre as compare to non Bt cotton varieties - an average 23-28 maund (1 Maund = 40 Kg) per acres versus 17-20 maund to traditional cotton varieties. This translates into more than 30 percent increase in yield.

Bt cotton is being grown with different names i.e. IR-901, IR-2403, IR-2316, Bt-1524, IR-1000, IR-2389, IR-2456, NIBGE 1, ASR-10, ASR-5, ASR-12, ASR-2, ASR-7, Bt-446, Bt-473, Bt-496, CP-140, Bt-121, BR-102, BT 009, BT 886, BR-103, Bt-448/10, MG-1, MG-2, MG-3, FH-113, Bt-196, Bt-133, Bt-Karishma, Bt-448-133, IR-3701, GM-2085, Ali Akbar-802 & 703, MG-6 & Sitara-008 developed by M/s Nawab Gurmani Foundation and Bt-101. Of all these genotypes Bt-121 occupied more than 40 per cent and was relatively better than other BT cotton as regard to uniformity.

6. LAND PREPARATION

Various field operation are necessary before planting so as to get optimum soil conditions at the same time enabling plants to establish easily. Cotton is a deep rooted crop which needs fine good tilth and well prepared field for successful germination and growth of crop. To get this, plough the field with deep plough then harrowed with planking each time to make the soil loose, fine, leveled and pulverized. Remove all the stubbles of the previous crop left in the field.
7. **SEED and SOWING**

Proper seed selection and timely sowing of cotton are important key factors to influence the cotton yield. These are described here as under.

i. **Seed Selection**

Seed selected for sowing should be free from diseases, pests, cuts or damages etc. The quantity of the selected seed depends upon the variety, soil fertility, climatic conditions and management of the crop. Seed rate for drilling is 8 – 12 kg and for ridges sowing 4 - 6 kg per acre is recommended.

ii. **Seed Treatment**

Delinting is done with concentrated sulphuric acid or mechanically. This kills the hibernating larvae and helps in even distribution of seed while sowing. Delinted seed is treated with fungicide Actara ST 70 WS, Dividend Star 036 FS and Dynasty CST 125 FS or with any other suitable fungicide.

iii. **Time of Sowing**

The quality of the mature cotton fiber is influenced by the time of sowing. If cotton sowing early or late, results in reduction in fiber characters. In southern parts of the country cotton sowing is started from April and then upward to the northern parts ends in May.

iv. **Method of Sowing**

Before cotton sowing seed should be soaked in water for about 9 to 15 hours. Early in the morning it should be rubbed (if seed is fuzzy) with sweet soil or ash to enable the seeds to separate from each other. There are two methods of cotton sowing drilling and ridges. Drilling is mostly done by mechanical seed drill and ridges sowing by hand.

v. **Gap-Filling**

Gap-filling i.e. planting seedling of cotton in those places, where seed has not germinated or is weak and less vigorous, Healthy seedlings from the places where plants are in excess are pulled out without damaging the roots, soaked in water for two hours and again planted in places of gaps to get uniform crop stand in the field.

8. **FERTILIZER APPLICATION**

To get higher yields it is very important to apply recommended doses of fertilizers.

- One bag of DAP or 2.5 bags of Nitrophos at the time of sowing incorporated in the soil and 2 – 3 bags of urea are applied (per acre) in different splits i.e. at vegetative growth, squaring, flowering and boll formation stages.
• Potassium and micronutrients (boron) should be applied on the basis of soil analysis. Boron is important for cotton, but one has to be careful because the difference between deficiency and toxicity is very narrow.
• For heavy soils four to five bags of SSP plus one bag of Urea at sowing time and one bag urea at flowering time are applied.

**Note:** The dose of Nitrogen and phosphorus can be increased or decreased keeping in view the fertility of soil.

9. **IRRIGATION**

Cotton is a deep rooted crop and the effects of excessive or less irrigations are not visible immediately. The growers have to be very careful while applying irrigations which depend upon the frequency and system of irrigation. Total crop water requirement is 35 – 45 inches to get an acceptable yield. The most critical stages for irrigation are early flowering to first boll opening and maturity.

**Typical Cotton Irrigation Scheduling For Hyderabad Region**

<table>
<thead>
<tr>
<th></th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>ETo mm</td>
<td>6.9</td>
<td>8.6</td>
<td>7.9</td>
<td>6.2</td>
<td>5.6</td>
<td>6.1</td>
<td>4.9</td>
<td></td>
</tr>
<tr>
<td>Kc</td>
<td>0.35</td>
<td>1.15</td>
<td>1.15</td>
<td>1.20</td>
<td>1.20</td>
<td>0.70</td>
<td>0.50</td>
<td></td>
</tr>
<tr>
<td>ET mm</td>
<td>2.41</td>
<td>9.89</td>
<td>9.08</td>
<td>7.44</td>
<td>6.72</td>
<td>4.27</td>
<td>2.45</td>
<td></td>
</tr>
<tr>
<td>Days</td>
<td>30</td>
<td>31</td>
<td>30</td>
<td>31</td>
<td>31</td>
<td>30</td>
<td>31</td>
<td></td>
</tr>
<tr>
<td>ET for the Period</td>
<td>72</td>
<td>306</td>
<td>272</td>
<td>230</td>
<td>208</td>
<td>128</td>
<td>76</td>
<td>1292</td>
</tr>
<tr>
<td>Precipitation for the Period mm</td>
<td>24.0</td>
<td>15.0</td>
<td>15.0</td>
<td>61.0</td>
<td>44.0</td>
<td>16.0</td>
<td>5.0</td>
<td>180</td>
</tr>
<tr>
<td>Net CWR in mm</td>
<td>48</td>
<td>291</td>
<td>257</td>
<td>169</td>
<td>164</td>
<td>112</td>
<td>71</td>
<td>1112</td>
</tr>
</tbody>
</table>

10. **WEED MANAGEMENT IN COTTON CROP**

Seed cotton yield is the product of interaction of several agronomic and environmental factors. Among agronomic factors weed control is very important for profitable seed cotton yield. Weeds reduce the yield both directly and indirectly. Directly they compete with the crop for space, water, light and nutrients. Indirectly they give shelter to insects and disease casual organisms. Nature has given certain peculiar (unique) characters for their existence in the fields. Weed seeds stay dormant for very long time, germinate earlier, their seedlings grow faster, flower earlier, form seeds in abundance and scatter seeds before maturity of main crop. Only small seedlings of weeds can be killed easily therefore proper timing of the inter-cultivation is essential for effective control. In fact tillage is still the basis upon which a sound weed management program could be built. With the proper choice, adjustment and the use of cultivation tools can reduce the weed problems.
Cotton crop grows in rainy season therefore gets heavy infestation of weeds. Control of weeds is done manually which creates mulch, aeration, enhances water holding capacity of the soil and removes the weeds. Many weedicides are available to economize the weed control process.

Local and botanical names of major weeds associated with cotton crop in Pakistan

<table>
<thead>
<tr>
<th>Botanical Name</th>
<th>Local Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trianthema monogyna</td>
<td>It-Sit</td>
</tr>
<tr>
<td>Cyperus rotundus</td>
<td>Deela, Kal, Morak, Kabah</td>
</tr>
<tr>
<td>Dactyloctenium aegyptium / Eleusine indica</td>
<td>Madhana</td>
</tr>
<tr>
<td>Echinocloa colonum</td>
<td>Swanki ghass, Sanwari</td>
</tr>
<tr>
<td>Cynodon dactylon</td>
<td>Khabball ghass, Chabbar</td>
</tr>
<tr>
<td>Setaria verticillate</td>
<td>Loomar ghass</td>
</tr>
<tr>
<td>Digera arvensis</td>
<td>Tandla, Lular</td>
</tr>
<tr>
<td>Cucumis melo</td>
<td>Chibhar</td>
</tr>
<tr>
<td>Tribulus terrestris</td>
<td>Bhakhra</td>
</tr>
<tr>
<td>Convolvulus arvensis</td>
<td>Lehil, Naro</td>
</tr>
<tr>
<td>Euphorbia helioscopia</td>
<td>Dhodak</td>
</tr>
<tr>
<td>Euphorbia granulata</td>
<td>Hazardani</td>
</tr>
<tr>
<td>Corchorus tridens</td>
<td>Jangli Patsun, Jangli Jute, Mundheri</td>
</tr>
<tr>
<td>Portulaca oleracea</td>
<td>Kulf, loonak</td>
</tr>
<tr>
<td>Amaranthus viridis</td>
<td>Chulai, kurand</td>
</tr>
<tr>
<td>sorghum halepense</td>
<td>Beru, Jhonson grass</td>
</tr>
<tr>
<td>Melilotus</td>
<td>Sinjhi, senji</td>
</tr>
</tbody>
</table>

Chemical Weed Control

<table>
<thead>
<tr>
<th>S. No</th>
<th>Weeds</th>
<th>Recommended Herbicide</th>
<th>Dose/Acre</th>
<th>Time Of Application</th>
<th>Name of Company</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Broad leaf weeds Grasses &amp; sedges</td>
<td>Pendimethlin 330EC</td>
<td>1000 ml</td>
<td>spray on ridges after sowing Or In drilling method before sowing. Spray on ridges within 24 hours of sowing. Spray on soil before sowing. Or Within 24 hours of sowing.</td>
<td>Pak Agro Chemicals/ Agri Farm Services</td>
</tr>
<tr>
<td></td>
<td>Waho, Lulur, Bhurt, Kal/Kabah &amp; Sawri</td>
<td>Stomp 330EC</td>
<td>1000-1250 ml</td>
<td>Or In drilling method before sowing. Spray on ridges within 24 hours of sowing. Spray on soil before sowing. Or Within 24 hours of sowing.</td>
<td>BASF</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dual Gold 960EC</td>
<td>800-1000 ml</td>
<td>Or In drilling method before sowing. Spray on ridges within 24 hours of sowing. Spray on soil before sowing. Or Within 24 hours of sowing.</td>
<td>Syngenta</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Stomp 455 G/L CS</td>
<td>750 ml</td>
<td>Or In drilling method before sowing. Spray on ridges within 24 hours of sowing. Spray on soil before sowing. Or Within 24 hours of sowing.</td>
<td>BASF</td>
</tr>
</tbody>
</table>
11. INSECT PESTS OF COTTON
a. Boll worms
i. American Bollworm—Helicoverpa armigera

**Nature of damage**

On hatching, the larvae bore into squares, flowers, bolls and locules (boll compartments), usually with their head inserted inside and the remaining part of the body outside.

**Damage symptoms**

- Affected squares show “symptoms of flaring up”, with bracts spreading out.
- Internal tissues are hollowed out by the larval feeding and holes can be seen on squares, bolls or locules.
- In the absence of the squares or after total damage of the squares, larvae can survive by feeding even on the foliage.
- Presence of granular faecal pellets outside the bore hole.
- A single larva can damage 30-40 bolls.

ii. Pink Bollworm: Pectinophora gossypiella

**Nature of damage**

In green cotton bolls larvae generally enter through the tip of 14-28 day old bolls) leaving a yellow spot on the lint at entry point. It feeds on the boll contents, including the lint near the entry point at least for 24 hours. It feeds on lint, seed coat and kernel completely before attacking the second seed.

**Damage symptoms**

- Rosetted flowers
- The holes of entry plugged by excreta of larvae which are feeding inside the seed kernels.
- They cut window holes (interlocular burrowing) in the two adjoining seeds thereby forming "**double seeds**"
- The attacked buds and immature bolls drop off.
- Discolored lint and burrowed seeds.
iii.  **Spotted Bollworms: *Earias vittella***

**Nature of damage**

Pest remain active round the year on different host plants, caterpillars soon after hatching start feeding on tender leaves and damage squares, flowers and bolls resulting in poor yield.

**Damage symptoms**

- Drying and drooping of terminal shoots during pre–flowering stage
- Shedding of squares and young bolls
- Flaring up of bracts during square and young boll formation stage
- Holes on bolls and rotting of bolls.

### CHEMICAL CONTROL OF BOLLWORMS

<table>
<thead>
<tr>
<th>S. No</th>
<th>INSECT PESTS</th>
<th>RECOMMENDED INSECTICIDE</th>
<th>DOSE/ACRE</th>
<th>NAME OF THE COMPANY</th>
</tr>
</thead>
<tbody>
<tr>
<td>i.</td>
<td>American Bollworm</td>
<td>Proclaim 019EC, Larvin 80DF, Tracer 240SC, Shogan 1.8EC, Deltaphos 360EC, Match 050EC</td>
<td>200 ml, 450 gm, 80 ml, 250 ml, 700 ml, 800 ml</td>
<td>Syngenta, Bayer Crop Science, D.E.United, Pak Agro Chemicals, Agri Farm Services, Bayer Crop Science</td>
</tr>
<tr>
<td>ii.</td>
<td>Pink Bollworm</td>
<td>Deltaphos 360EC, Karate 2.5EC, Talstar 10EC</td>
<td>600 ml, 400 ml, 250 ml</td>
<td>Bayer Crop Science, Syngenta, F.M.C.</td>
</tr>
<tr>
<td>iii.</td>
<td>Spotted bollworms</td>
<td>Deltaphos 36EC, Karate 2.5EC, Match 50EC, Talstar 10EC, Sumi Alpha 110EC</td>
<td>600 ml, 400 ml, 800 ml, 250 ml, 200 ml</td>
<td>Bayer Crop Science, Syngenta, Syngenta, F.M.C., Arysta</td>
</tr>
</tbody>
</table>
b. Sucking Pests

i. Whitefly - *Bemisia tabaci*

**Symptom of damage**
- Chlorotic spots on the leaves which latter coalesce forming irregular yellowing of leaf tissue which extends from veins to the outer edges of the leaves
- Severe infestation results in premature defoliation
- Development of sooty mould
- Shedding of buds and bolls and poor boll opening
- It also transmits the leaf curl virus diseases of cotton.

ii. Dusky cotton bug, *Oxycarenus hyalinipennis*

**Nature of damage:**
Adults and nymphs feed on the sap of immature and partially matured seeds gregariously and impart a yellow tinge to the lint.

**Symptom of damage**
- Sucks the sap from developing seeds in open bolls and stains the lint black.
- Seeds discolored and shrunken.


**Nature of Damage:** It feeds on the sap of the plant and releases toxic substances causing injury, curling and drying of leaves which damages fruiting and drastically decrease the yield. Mealy bug also attacks the roots just below the level of the soil, especially where the root and the stem meet.

**Symptom of damage**
- Heavy clustering of mealy bugs usually seen under surface of leaves as a thick mat with waxy secretion.
- Excrete copious amount of honey dew on which the fungus sooty mould grow.
- Affected plants appear sick and black, resulting reduced fruiting capacity.
- White fluffy mass on buds, stems, fruit and roots
- Presence of honeydew, black sooty mold, and ants.
- Unopened flowers which often shrivel and die.
- Small deformed fruits.
iv. **JASSID or LEAFHOPPER: Amrasca (biguttula) devastans**

**Nature of Damage:** Cotton Jassids starts infesting the crop when it is about one and half month old. The peak infestation is reached in July and August. Continuous light rains are most favorable to increase jassids population and its infestations.

**Symptoms of damage**
- Tender leaves become yellow.
- The margin of the leaves start curling downwards and reddening sets in.
- In the case of severe infestation, leaves get a bronze or brick red color which is typical “hopper burn” symptom.
- The margin of the leaves get broken and crumble into pieces when crushed.
- The leaves dried up and are shed and the growth of the crop is retarded.

v. **THRIPS- *Thrips tabaci***

**Nature of damage:**
- Both nymphs and adults lacerate the underside of leaf tissues and imbibe the oozing sap.
- These lacerate the epidermal cells and suck the sap.

**Damage symptoms:**
- Leaves with white specks initially which later coalesce and result in silvery shining on the surface along the veins of leaf and leaf curl up.
- Silvery undersurface of leaves
- Leaves loose the natural luster
- Leaf loses its succulence and at the lower surface, bronzing is seen.
- Leaves appear sickly and may show uneven surface.
CHEMICAL CONTROL OF SUCKING INSECT PESTS OF COTTON

<table>
<thead>
<tr>
<th>S. No</th>
<th>Insect Pests</th>
<th>Recommended Insecticide</th>
<th>Dose/Acre</th>
<th>Name of The Company</th>
</tr>
</thead>
<tbody>
<tr>
<td>i.</td>
<td>Whitefly</td>
<td>Polo 500SC</td>
<td>250 ml</td>
<td>Syngenta</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Confidor 200SL</td>
<td>250 ml</td>
<td>Bayer Crop Science</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mospilan 20SP</td>
<td>125 gm</td>
<td>Arysta</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Danitol 30EC</td>
<td>200 ml</td>
<td>Arysta</td>
</tr>
<tr>
<td>ii.</td>
<td>Thrips</td>
<td>Confidor 200SL</td>
<td>80ml 5 gm/kg seed</td>
<td>Bayer Crop Science</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Confidor 70WS</td>
<td>125 gm</td>
<td>Bayer Crop Science</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mospilan 20SP</td>
<td>600 ml</td>
<td>Arysta</td>
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<td></td>
<td></td>
<td>Thiodan 35EC</td>
<td></td>
<td>Bayer Crop Science</td>
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<tr>
<td>iii.</td>
<td>Mealy Bug</td>
<td>Asophate 75SP</td>
<td>750 gm</td>
<td>Welcon Co.</td>
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<td></td>
<td></td>
<td>Curacron 400EC</td>
<td>800 ml</td>
<td>Syngenta</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lorsban 40EC</td>
<td>1000 ml</td>
<td>D.E.United</td>
</tr>
<tr>
<td>iv.</td>
<td>Jassid</td>
<td>Baythroid TM 525EC</td>
<td>500 ml</td>
<td>Bayer Crop Science</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nurelle D 505EC</td>
<td>500 ml</td>
<td>Dow Agro Sciences</td>
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</tbody>
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12. DISEASES OF COTTON

i. Cotton Leaf Curl Virus (geminivirus) CLCuV

Cotton leaf curl (CLCuV) geminivirus causes a major disease of cotton in Asia and Africa. Leaves of infected cotton curl upward and bear leaf-like enations on the underside along with vein thickening. Plants infected early in the season are stunted and yield is reduced drastically. Severe epidemics of CLCuV have occurred in Pakistan in the past few years, with yield losses as high as 100% in fields where infection occurred early in the growing season.

The virus of disease is transmitted by whitefly. The first symptoms of infection in cotton appear within 2-3 weeks of inoculation and are initially characterised by deep downward cupping of the youngest leaves. This is followed by either upward or downward curling of the leaf margins and swelling, darkening and formation of enations on the veins, which frequently (depending on cultivar) develop into cup-shaped, leaf-like structures.
ii. **Boll Rot Disease**

**Cause:** Aspergillus Niger, Fusarium oxysporium, Rhizopus oryzae (belongs to fungi) and a bacterium Xanthomonas malvacearum reported as predominant causes of boll rot

**Symptoms:** The research studies revealed that four different types of symptoms may occur, which can be distinguished on the basis of their specific causal agent, as below:

- **Black boll or Aspergillus rot:** Affected bolls start losing green color altogether, become pinkish brown and finally sooty black due to over growth of fungus.
- **Rhizopus rot:** Infected portions become grayish along with softening of internal tissues. The fungus grows abundantly and covers many bolls under moist conditions.
- **Fusarium rot:** The bolls become dried with color assuming reddish and brownish tinge and showing dry and white fluffy fungal growth inside the bolls on opening.
- **Bacterial or Xanthomonas rot:** Water soaked areas developed on the bolls giving out gummy substance and foul smell.

iii. **Root Rot (Rhizoctonia bataticola and R. solani):**

**Cause:** The fungi Macrophomina phaseoli, Rhizoctonia spp., Fusarium spp. etc. are predominantly isolated from diseased roots.

**Symptoms:** The disease affects the roots exclusively causing pre-wilt shedding of leaves, yellowing of foliage, disintegration of root tips, discoloration and shredding of roots, exudation of drops of smelly liquid from the rotted plant.
parts. Mostly wilting of shoots occurs in only few diseased plants, which ultimately results in the death of entire plant. This disease generally appears, when plants are about 4-6 weeks old and continue up to boll formation. Diseased plants can be easily pulled out of from soil and it appears in patches. Roots and root-lets are show rotting, yellowing, disintegration and shredding.

**CONTROL MEASURES FOR ALL ABOVE DISEASES**

Following disease management practices may help to save the crop from all above major and minor diseases of cotton.

- Cultivation of disease resistant variety is only safe measure of all different diseases.
- Eradication including collection and burning of plant debris may help to control seedling, root and boll rots as well as bacterial blight, because disease inoculum may also survive through plant debris.
- Deep plowing with short duration at least two months before sowing help to control seedling and root rot.
- Proper land leveling is a preventive measure against seedling and root rot.
- Use of healthy seed, acid delinting and chemical seed treatment minimize the disease incidence of seedling, root and boll rots as well as bacterial blight.
- Crop rotation with non-host i.e. sowing of sorghum for 3 to 4 years is useful for control of seedling and root rot.
- Mixed cropping with kidney bean or fodder and leguminous crops saves the cotton crop from root rot.
- Proper use of irrigation and chemical fertilizers improves the disease resistant power in cotton plants.
- Early sowing of crop is preventive measure for control of boll rot.
- White fly transmits cotton leaf curl virus from diseased plant to healthy one, whereas, different cotton boll worms may play a role to transmit the boll rot diseases, hence white fly and boll worms must be controlled.

**13. COTTON PICKING AND HARVESTING**

In Pakistan mostly cotton is picked manually but in developed countries harvesting usually done mechanically. Cotton picking should start when dew has dried on cotton plants. Lower bolls should be picked first to reduce the contamination of cotton with leaves and dust. Before storing, which should be ensured that cotton has been completely dried otherwise it can result in heat up of cotton thus damaging the lint and seed. Farmers should not mix bad cotton with good cotton. However, there is a bid market of bad cotton as well.
14. YIELD

Hybrid varieties, scientific management of production and climatic conditions all tremendously account for yield and quality of cotton flux and its lint. An average yield of lint is 12-15 maunds and 40-45 maunds seed cotton per acre can be easily obtained.

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