Cotton
Production guideline

agriculture,
forestry & fisheries

Department:
Agriculture, Forestry and Fisheries
REPUBLIC OF SOUTH AFRICA

Cotton
Production guideline

2016

Design and layout by
Directorate Communication Services

Compiled by
Directorate Plant Production

Private Bag X144,
Pretoria 0001

DISCLAIMER

The Directorate: Communication Services and its sub-directorates will not be held responsible for any documents that were brought for layout (Design and Publications Services Sub-directorate) without it having gone through for editing (Editorial Services Sub-directorate) this goes for all documents that are brought forward by the Directorate: Communication Services and it's sub-directorates for thorough analysis of the content(s) thereof as this will compromise the quality of the work. Therefore, the authors or compilers of the original document(s) within the department are responsible for making sure that the proper channels and procedures are followed in ensuring that the document receives the required attention.

CONTENTS

PART I: GENERAL ASPECTS

1. Classification

Scientific name: *Gossypium hirsutum*
Common names: Cotton (English), Katoen (Afrikaans), Ukotini (isiZulu), Katuni (Sepedi)

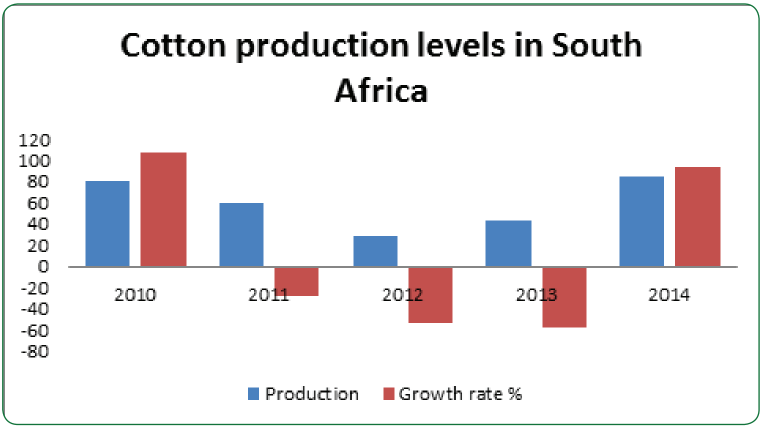
2. Origin and distribution

The word "cotton" originated from the Arabic term al qutn, which became algodón in Spanish and cotton in English. Scientists searching caves in Mexico found pieces of cotton bolls and parts of cotton cloth that proved to be at least 7 000 years old. They also found that the cotton itself was much like that grown in America today. Cotton seeds are believed to have been planted in Florida in 1556 and in Virginia in 1607. By 1616, colonists were growing cotton along the James River in Virginia. In the Indus River valley in Pakistan, cotton was being grown, spun and woven into cloth 3 000 years BC. At about the same time, natives of Egypt's Nile valley were making and wearing cotton clothing. In South Africa cotton was planted in the Western Cape as early as 1690 and was reintroduced in 1846. It was planted on a large scale in the former Natal and the Cape colony from 1860 to 1870 owing to its high demand. A cotton gin was erected in the Tzaneen area, where cotton was ginned and baled mechanically. The cooperative movement with regard to cotton had its origins in 1922 when a cooperative and ginnery were established at Barberton. By 1969 about 80% of the total crop was being produced in the irrigation areas of Loskop, Vaalharts and Upington.

3. Production levels

3.1 South Africa

3.1.1 THE INTERIOR



As far as the local outlook is concerned, the first estimate for the 2014/15 production year indicates a total crop of 98 925 lint bales, up 105% from the previous season mainly because of interventions implemented under the South African Clothing and Textile Cluster, which was established last year. About 95 325 lint bales are estimated to be produced from Republic of South Africa grown seed cotton, up 118% from the previous season. The balance of 3 600 lint bales relates to the expected Swaziland produced crop to be ginned by the Swaziland gin (Cotton SA, 2015).

Cotton production in South Africa has been declining owing to competition from other countries where government support programmes sustain the local farming community, and the relative returns that can be made from competing crops such as maize and sunflower in the South African markets. Several Southern African Development Community countries are producers and with the abolition of import duties, this cotton is being used in South African mills. The wide-scale introduction of Genetically Modified (GM) cotton varieties by both commercial and developing farmers has contributed significantly to improving the yields and profitability of cotton, but has failed to induce expansion of planted areas.

3.2 Internationally

Rising world cotton stocks outside China and reduced imports are continuing to place downward pressure on international cotton prices. The latest indicator of international cotton prices of about 66 US c/lbs is reported to be down by 33%

compared to the peak of eight months ago. Similarly, cotton futures are down to the levels that were last seen seven years ago. However, the 2014/15 season is reported to be the fifth consecutive season in which cotton production will exceed consumption. Because of lower average world cotton yields the International Cotton Advisory Committee (ICAC) forecasts world cotton production to remain stable at 26,2 million tons in 2014/15 despite a 3% increase in global numbers of hectares. Cotton-production of the world's four largest cotton producing countries (China, India, USA and Pakistan) is, however, expected to increase by 3% in 2014/15. In contrast, the ICAC expects cotton production to decrease by 18% in the Southern Hemisphere in 2014/15. In Brazil and Australia, the Southern Hemisphere's largest cotton-producing countries, production is forecast by the ICAC to decline by 13% and 35% respectively, mainly owing to high production costs in Brazil and the drought and insufficient irrigation water in Australia. After declining by 1% in 2013/14, world cotton consumption is expected to recover by 3,8% to 24,4 million tons in 2014/15. The world cotton trade is forecast by the ICAC to decrease by nearly 1 million tons in 2014/15, the third consecutive season in which imports have dropped. This is mainly owing to the decline in China's imports from over 5,3 million tons in 2011/12 to less than 2 million tons in 2014/15. In the SADC region cotton is produced in countries such as Namibia, Swaziland, Botswana, Malawi, Angola, Mozambique, Tanzania, Democratic Republic of Congo (DRC), Zambia and Zimbabwe.

3.3 Major production areas in South Africa

Traditional cotton production areas in South Africa are as follows: Limpopo Province in Loskop, North and South flats from Bela-Bela to Mokopane, Dwaalboom, Thabazimbi and Weipe, North West Province covering the areas of Taung, Stella, Delareyville and Mareetsane, KwaZulu-Natal on the Makhathini Flats, Mpumalanga and Northern Cape in the lower Orange River, Vaalharts, Douglas and Prieska districts. This situation has slightly changed over the years with the result that during 2010/11 in North West Province, cotton was only grown in Taung and Stella.

4. Plant description

4.1 Mature plant

A cotton plant has a single, ascending main stem that bears a leaf at each node and usually has one branch. Vegetative branches (monopodia) tend to be produced lower down on the plant, while reproductive branches (sympodia) are produced higher up or on the monopodia (Figure 1.1). The sympodia are generally short and terminate in a flower bud.

4.2 Leaves

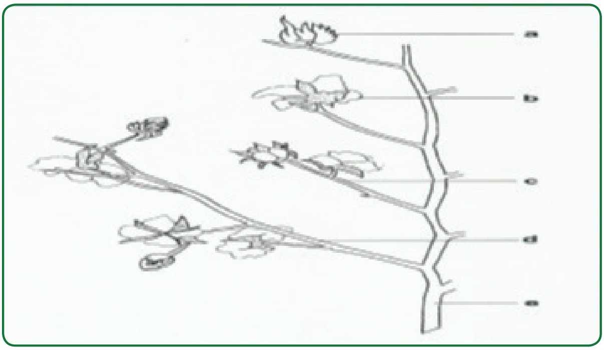
Cotton leaves are large, palmately lobed (three, five or seven lobed) and covered with multicellular stellate hairs.

4.3 Flowers

Plants in the genus Gossypium have showy flowers, each with five sepals united into a cuplike calyx and five petals of whitish or yellowish colour that often turn pink with age.

Pollination usually occurs in the early afternoon. By late afternoon the corolla begins to change colour, first becoming a faint pink and later a deep red-mauve. At the same time, the bracts (calyx) close round the ovary. At this stage, the bud is termed a square. As the square develops, the fruit increases in size and protrudes beyond the bracts.

Figure 1: Morphology of the cotton plant (Bennett, 1991)



a - square
b - burst boll
c - sympodium
d - monopodium
e - main stem

5. Cultivars

There are various most commonly cultivated cotton cultivars in South Africa which includes: LS9219, NuOPAL, Delta Opal RR or SZ9314 and Delta OPAL Yield. These cultivars are preferred in terms of fibre length, fibre strength, micronaire value, fibre percentage, good adaptability and tolerance to disease.

6. Climatic requirements

6.1 Temperature

Cotton is essentially a tropical crop. Favourable weather conditions for cotton production are when summer temperatures do not drop below 25 °C. The cotton production zone lies between 37° north and 32° south latitude.

Although cotton originated as a tropical or subtropical plant, most cotton is produced outside the tropics. The temperature factor is therefore of vital importance when considering areas suitable for economic cotton production. Yield and fibre quality are to a great extent determined by air temperature during the growing season.

Temperatures under 20 °C have a slowing down effect on the growth of the plant, especially during the flowering and boll phases. In practice, low temperatures directly after planting time, when germination occurs, as well as low night temperatures during any growth stage can be potentially harmful to the plant. The soil temperature in the seedbed should at least be 18 °C to ensure good germination.

In South Africa this requirement as a rule does not present any problems in the recognised cotton production areas. Cold weather after emergence of the plants can be harmful to seedlings. Sufficient knowledge of weather conditions in springtime is required in order for the grower to ensure the most advantageous growing season for his/her crop. Particularly low temperatures (15 °C or lower) during the period of boll development will adversely affect both fibre yield and quality. Cotton growth and development is at an optimum when the average summer temperature is above 25 °C. The most critical period is the three-month period from December to February when boll development normally takes place.

6.2 Moisture requirements

Cotton is a drought tolerant plant and can still provide relatively good yields under dryland conditions, even in areas where the annual rainfall is less than 500 mm annually, however, for profitable yields which comply with quality requirements, a higher rainfall, evenly spread, is required. High air moisture during the ripening stage and the period directly before harvesting can on the other hand lead to boll decay. Globally, the quantity of moisture needed to ensure an average crop varies from about 500 mm to 1 250 mm. In South Africa, with its erratic rainfall, an average summer rainfall of 600 mm can be considered as the minimum for reasonably consistent production. All seed requires moisture to germinate and grow. Insufficient moisture during these planting stages will be detrimental to the crop. The most critical period, however, as far as moisture requirements are concerned, is from the flowering stage up to maturing of the bolls. Insufficient moisture during this period can result in excessive weaning of flowers and bolls. Too much moisture can also lead to undesirable, excessive vegetal growth. Both insufficient and excessive moisture will lead to lower yields. Because of the fact that the most favourable combination of the abovementioned aspects is mostly absent under dryland conditions, cotton in South Africa is mostly cultivated under irrigation.

7. Soil requirements

The cotton plant performs best in deep, highly fertile, sandy loam soils with reasonably good drainage. Cotton does not do well in sandy soils as well as heavy clay soils as the latter present problems with the germination of seedlings. Generally, deep soil, one metre or more is preferred and any impenetrable layers such as plough soles or stone reefs or even a high water table, can be detrimental to root development and result in poor yields. As cotton is highly susceptible to waterlogged conditions, soils with poor drainage should be avoided. Although cotton crop is relatively tolerant as far as pH is concerned, the best results are obtained with a pH of between 5,5 and 7,5. The plant also has a relatively high tolerance to brackish soil. Cotton is quite sensitive to aluminium toxicity and should therefore not be planted in soils with a pH value of below 5,5 (determined in water) where the aluminium concentration is high. A concentration of above 0,2 m e/100 g soil is regarded as high but it should be kept in mind that the activity of aluminium is influenced by factors such as clay and organic material content.

PART II: CULTIVATION PRACTICES

1. Soil preparation

The purpose of primary cultivations is to aerate the seedbed, improve saturation of irrigation and incorporate large quantities of plant residue into the soil. The soil water status should be low for efficient and cost-effective cultivation. Soil that is too wet or too dry when cultivation takes place may result in breakdown of the soil structure.

2. Planting

Cotton is propagated from seed by planting directly in a prepared field when growing conditions are favourable (suitable temperature, adequate rainfall, etc.). Cotton should only be planted when the soil temperature is at least 18,3 °C. Generally, seeds should be sown at a depth of 0,25 cm with 3 to 6 seeds sown in each hole. Soil ridging is recommended as it promotes drainage in wet conditions and water-conservation in dry conditions. Plant spacing depends on the variety; however, generally 20 to 100 cm should be left between plants. Various mechanical cotton planters are available in South Africa. Precision planters which space seeds in groups of three to four at a desired intra-row spacing are also available on the market. Planting to stand is only advisable under conditions that are extremely favourable for germination. For the development of strong, healthy seedlings, seeds should be planted about 20 mm deep in clayey soil, or to a maximum depth of 30 mm in sandy soil. Plant populations of approximately 70 000 plants per hectare under irrigated conditions and 30 000 plants per hectare under dry land conditions, are recommended.

3. Fertilisation

NITROGEN (N)

Nitrogen has the greatest influence on yield. Cotton requires 112 kg N/ha for a 4-ton

crop. This implies an application of 140 kg N/ha if the efficiency factor of 80% for a sandy soil is taken into consideration. Fertiliser applications must be complemented by good irrigation to keep the effective soil depth in the 0,9 m root zone at field capacity. Sandy soils that are prone to leaching should receive split applications of nitrogen. Half of the N can be applied at planting, with the second application (half) at 7 to 8 weeks after planting. Under irrigation cotton requires up to 200 kg N/ha to achieve maximum yield.

PHOSPHORUS (P)

Phosphate fertilisation stimulates more even boll splitting and improves fibre quality. The P (Bray 1) in the top 30 cm of soil should be 20 to 30 mg P kg/ha. On the slightly alkaline soils often associated with irrigation areas, the efficiency factor on a build-up soil (20 to 30 mg P/kg) may be as high as 80%.

POTASSIUM (K)

Potassium plays an important role in respiration, protein synthesis and carbohydrate metabolism. No potassium is normally applied when soils have concentrations of higher than 80, 100 and 120 mg K/kg respectively for sand, loam and clay soils. Potassium uptake can be prevented or reduced by poorly aerated soil, compacted layers, or a high calcium or magnesium content of irrigated soils.

4. Weed control

Effective, economical weed control in cotton requires an integrated approach that includes cultural, mechanical, biological and chemical methods. Controlling undesirable vegetation round field roadsides, fencerows, and ditch banks is also an integral part of an effective weed control programme in cotton. These areas are prime sources of weed seed production for subsequent field infestation. Special effort should be made to eradicate perennial grasses, nightshades, field bindweed and other competitive weeds in these areas. An important component of a successful weed management programme is crop rotation. Whenever the same crop is planted in successive years, there is a good chance that one or more weed species will increase because they are adapted to the same conditions as the crop. Also, repeated use of the same herbicides (same mode of action) will favour increased populations of resistant weed species. Rotating with another crop disrupts weeds' adaptation to cotton-growing conditions and enables the use of different herbicides (different modes of action) so that the resistant weed species in cotton can be controlled. Annual weed problems can be minimised by a rotational system that includes cereals and alfalfa. Herbicides can be used to minimise weed management costs.

5. Pest control

Until the introduction of genetically modified (GM) cotton, the main cotton insect pests were the larvae of Helicoverpa armigera and H. punctigera. These pests were generally controlled with synthetic insecticides, which also controlled the majority of other cotton pests. Currently, over 90% of the cotton area is planted with varieties that have been genetically modified to produce highly specific toxins that kill off Helicoverpa larvae and most other caterpillar pests when these feed on the cotton plant. However, plant sucking insects may require greater management on Bt cotton compared to conventional cotton. Insect-resistant or GN cotton is often called ''Bt cotton.'' The genes used to produce the toxin in GM cotton are obtained from a naturally occurring bacterium called Bacillus thuringiensis (commonly known as Bt). The introduction of Bt cotton has resulted in a significant reduction of insecticide use by growers. A resistance management plan is essential to ensure that these valuable traits remain effective.

5.1 Frequent pests affecting cotton

5.1.1 *HELICOVERPA*

Helicoverpa species remain a major pest on conventional (non-genetically modified) cotton. The two species H. armigera and H. punctigera are very similar, both in appearance and the damage they cause to cotton. However, correct identification of the species is important because H. armigera has developed high levels of resistance to insecticides. Species composition in the crop will be influenced by the time of year and location. In temperate regions, the majority of the H. armigera population over winter from mid-March onwards and emerge during September/ October. H. punctigera is usually the dominant species through September.

DAMAGE

Cotton plants in all growth stages may be attacked; however, reproductive tissue is preferred. Seedlings can be ‘‘tipped out’’ when the terminal buds are eaten. Chewing damage to squares and small bolls may cause these to shed, and the damage to maturing bolls may prevent normal development and can lead to secondary fungal infections such as boll rot.

MONITORING AND THRESHOLDS

Regular monitoring of the crop for the presence of larvae and/or damage is necessary in order to make timely control decisions. This is especially important when targeting small and possibly insecticide-resistant larvae. Visual sampling is the recommended method. Inspect at least 30 plants or 3 separate row metres for every 50 ha (larger samples give more accurate estimates). Eggs are not necessarily a good basis for thresholds as not all hatch and very small larvae have high mortality rates. Assess beneficial insect numbers and note parasitised eggs and larvae.

When making pest management decisions for cotton, insect numbers alone may not be sufficient. Plant monitoring (fruit load, yield and maturity) assists in decision-making when pest levels are slightly below the threshold or when there are pest combinations.

Thresholds for conventional cotton depend on crop stage and are:

- Seedling to flowering: 2 larvae per 1 m or 1 larvae (>8 mm)per m.
- Flowering to cut-out: 2 larvae per 1 m or 1 larvae (>8 mm)/m or 5 brown eggs per 1 m.
- Cut-out: 15% open bolls - 3 larvae per 1 m or 1 larva (>8 mm)/m or 5 brown eggs per 1 m.
- 15%-40% open bolls: 5 larvae per 1 m or 2 larvae (>8 mm)/m or 5 brown eggs per 1 m.

Thresholds for Bollgard II® cotton are the same for the entire season at two larvae (>3 mm) per 1 m in two consecutive checks or one larvae (>8 mm) per 1 m.

RESISTANCE

Helicoverpa armigera developed resistance against most insecticides in the late 1990s. However, with the introduction of GM cotton, biopesticides and more selective insecticides, insecticide resistance to older chemical formulations has decreased in recent years. Helicoverpa punctigera has no known resistance to any insecticides but the use of more selective options is encouraged to help preserve the natural enemies.

In order to prevent insecticide resistance, the cotton industry has developed the Insecticide Resistance Management Strategy (IRMS). This strategy is reviewed annually to delay development of resistance of H. armigera to conventional insecticides. The core IRMS principles include:

- rotation between chemical groups with different modes of action
- limiting the time period during which an insecticide can be used
- limiting the number of applications of one particular insecticide.

CULTURAL CONTROL

Post-harvest cultivation (pupae busting) to reduce the overwintering stage of Helicoverpa is one of the most important cultural control practices available. Cultivation to a depth of at least 10 cm will harm or disturb pupae, seal off their emergence tunnels and trap the emerging moths. Cultivation also renders survivors vulnerable to attack by birds, mice, earwigs and wasp parasites.

NATURAL ENEMIES

Beneficial insects can affect all Helicoverpa life stages.

PREDATORS

- **Egg:** Red-and-blue beetles, damsel bugs, green lacewings, brown lacewing, night-stalking spiders and various ants.
- **Larvae:** Glossy, brown and predatory shield bugs, big-eyed bugs, damsel bugs, assassin bugs, red-and-blue beetles, brown lacewings, common brown earwigs and spiders
- **Pupae:** Common brown earwigs and wireworm larvae
- **Moth:** Spiders

5.1.2 SPIDER MITES

The two-spotted mite (Tetranychus urticae) is the most common mite species on cotton. Other species that may occur are bean spider mite and strawberry spider mite. Mites live on the underside of leaves and are difficult targets for aerial sprays. Mites prefer more mature leaves and the highest populations are usually found near the top of the plant on main stem nodes (3 to 5 below the terminal). Heavy mite infestations on cotton can originate from adjoining fields of early sown maize from where they are carried by air currents.

DAMAGE

Mite infestations in seedling cotton rarely justify control. However, these may be a useful indicator of potential problems and should be monitored closely. The first sign of damage is bronzing of the upper leaf surface near the petiole or leaf fold. As the numbers increase, the leaves turn red and become covered in fine webs and effected leaves may dry out and drop off. High mite populations can significantly affect cotton yields and quality. The earlier in the season that infestations develop, the greater the potential yield loss and quality downgrades.

MONITORING AND THRESHOLDS

Start sampling at seedling emergence and continue at least weekly. In low numbers, mites are difficult to find. Mites are often too many for individual counts, so infestations can be rated on a presence/absence system. The general threshold for mites for most of the growing season is 30% of plants infected. The threshold depends more on when mite populations begin to increase and how quickly these increase rather than the actual number of mites. To estimate the percentage of yield reduction caused by mites, a chart has been prepared by the cotton industry for the different cotton-growing regions.

CONTROL

- Mite infestations increase after the application of some broad-spectrum insecticides for the control of other pests.
- Control weeds within fields and along field boundaries that serve as over-wintering sites for mites.

Thrips are the major mite predator in cotton. Others include damsel bugs, big-eyed bugs, ladybird beetles, brown smudge bugs, apple dimpling bugs, brown lacewing adults, and tangle web spiders.

5.1.3 MIRIDS *(CREONITIADES SPP.)*

As an important sap-sucking pest of cotton, mirids are abundant from early to mid-season.

DAMAGE

Adults and nymphs feed by piercing plant tissue and releasing a chemical that destroys cells in the feeding zone, resulting in the following symptoms:

- localised leaf damage
- terminal wilting of young plants

- deformed plants (broom shaped)
- shedding of squares and small bolls
- boll damage (up to 15 days old) by causing warty growths inside the carpel, which results in discoloration lint
- malformed bolls, delay of maturity
- reduced lint and fibre quality.

MONITORING AND THRESHOLDS

Mirids are a highly mobile pest and populations can fluctuate rapidly. Sampling therefore has to be undertaken every three days. The beat sheet is the most effective means for estimating mirid numbers. Monitor the number of mirids as well as tip damage and fruit retention on cotton plants. Adults cause greater damage than the first three nymphal instars while damage of the fourth and fifth instars is comparable to that of the adults. Severe tip damage and high fruit retention levels can also have an impact on control decisions.

CONTROL

- Control alternative hosts, including native weeds, before crop establishment.
- Avoid broad-spectrum insecticides.
- Spray only when both insects and damage reach threshold levels.

There is a potential to use lucerne as a trap crop for mirids. Lucerne should be established two weeks before cotton.

Research has shown that the addition of petroleum spray oils to some chemicals improves product efficacy at lower (half) label rates and helps to protect the natural enemies. Research has also demonstrated that the addition of salt (5g/l of water) to Dimethoate greatly improves that product's efficacy against mirid nymphs and adults at rates as low as 33% of the registered rate, while reducing the spray's impact on natural enemies. A number of beneficial species are known to feed on mirids, yet none of these are recognised as regulators of mirids in cotton populations. Adults, nymphs and eggs fall prey to damsel bugs, big-eyed bugs, predatory shield bugs, and a number of spider species.

5.1.4 APHIDS

Cotton aphid (Aphis gossypii) is the most frequent aphid pest. Green peach aphid is an occasional pest in the early season and cowpea aphids can colonise cotton but rarely become problematic.

DAMAGE

Aphids cause early to late season-damage to terminals, leaves, buds and stems and are known transmitters of cotton bunchy top (CBT) diseases. The honeydew secreted by aphids can contaminate lint once the bolls begin to open.

MONITORING AND THRESHOLDS

Aphids tend to have a patchy distribution, so samples must be taken at several locations. At each location collect 20 leaves from different plants (one leaf per plant) by choosing main-stem leaves from 3 to 4 nodes below the terminal of the plant. Samples of winged and wingless adults as well as nymphs should be taken. Non-winged adults indicate that the population has become established in the crop. Aphids prefer new growth; the focus should be therefore placed on terminals and recently unfurled leaves. Start weekly sampling at seedling emergence until defoliation. Where concentrations of aphids are evident, also monitor cotton for CBT. Aphid numbers are determined by a scoring system. Seasonal aphid scores are obtained by using the table in the Cotton CRC's pest management guide. Significant yield loss can occur if aphid populations are allowed to reach high levels (>90% of plants infested) for a period of 2 to 3 weeks. Thresholds depend on the estimated yield loss which, when compared to cotton price and control costs, helps determine whether control is warranted. When open bolls are present, thresholds should be lowered to 50% of plants infested (or 10% of plants if honeydew is present) to prevent contamination lint.

CONTROL

- Control weeds that serve as alternative hosts for aphids, including marshmallow, Capeweed, thistles, nightshade, bladder ketmia and thorn apples.
- Ratoon and volunteer cotton plants should be controlled as they are winter hosts and may also transmit CBT disease.
- Cotton aphid has developed widespread resistance to a number of insecticides, and cotton farmers should adhere to the cotton IRMS.

5.1.5. WHITEFLY

Silverleaf whitefly (Bemisia tabaci B-biotype) (SLW) and Bemisia tabaci Q-biotype are the most serious whitefly pests in cotton because of their resistance to many insecticides and rapid reproduction rate. SLW is more prevalent in warm areas. Hosts include cotton, sunflower, tomato, rockmelon and the sowthistle weed. In cotton- growing areas, SLW normally starts to reach pest levels in December through to cotton harvesting.

DAMAGE

SLW feeds on plant sap and causes plants to wilt, drop leaves and under severe pest pressure, plants may die off. Excretion of honeydew contaminates the lint. One of the sugars in SLW honeydew has a lower melting point than those found in aphid honeydew and creates problems during processing. Honeydew promotes sooty mould, which reduces potential crop yield by blocking out sunlight and reducing assimilation of nutrients for plant growth.

MONITORING AND THRESHOLDS

Sampling should be done once a week from first flower and then twice a week from peak flowering. It should be undertaken on an area of about 25 ha. Count the number of adults per fifth node leaf (sample one leaf per plant). Thresholds are based on a scoring system. Score each leaf as either uninfested (0 or 1 adult per leaf) or infested (2 or more adults per leaf). Calculate the percentage of the crop infested and the crop age in day degrees as thresholds are relative to crop development stages.

CONTROL

- Control alternate weed host plants and consider planting cotton away from other hosts such as soya beans, sunflower and cucurbit crops.
- Develop an area-wide management strategy with neighbours, including a tight planting window so that whitefly does not migrate to successive plantings.
- Avoid early season broad-spectrum insecticides that kill off beneficial insects and subsequently boost whitefly populations. Natural enemies play a vital role in the management of SLW.

6. Disease control

6.1 Bacterial blight/ Angular leaf spot

DESCRIPTION

Bacterial blight is caused by the bacterium called Xanthomonas campestris. The disease is favoured by wet weather, temperatures above 25 °C and a relative humidity exceeding 85%.

SYMPTOMS

On the leaves the disease causes water-soaked spots which are surrounded by leaf veins, giving them an angular shape; lesions increase in size and turn black and necrotic; the leaves drop off from the plant; disease may also cause elongated greyish-black lesions extending from the leaves to the petioles and stem, which are known as the “blackarm” phase; severe blackarm symptoms may cause the stem to be girdled; water-soaked lesions may be present on bolls and boll lesions enlarge and become sunken and brownish black in colour.

CONTROL

- Using resistant cotton varieties is the most effective method of controlling the disease.
- Cultural control such as deep burying of crop residue into the soil after harvest.
- Use certified, high-quality, disease-free seeds.
- If the symptoms are observed, keep the plant canopy as open as possible to reduce humidity and promote drying of the foliage, which may be beneficial in limiting the progress of this disease.
- Practise good field sanitation.

6.2. Boll rot

DESCRIPTION

Boll rot is caused by a number of pathogens, including fungi and bacteria. The pathogens include Phytophthora spp. and Alternaria macrospora. The disease attacks the lower bolls when these are about to reach maturity. The disease is favoured by warm, humid conditions.

SYMPTOMS

Boll rot caused by Alternaria macrospora begins as small spots with dark margins. The spots enlarge and may eventually affect the entire boll.

Bolls infected by Phytophthora appear dark brown to black, sometimes with areas of white mould on the surface. Locks from affected bolls often have brown stains. They remain hard and do not fluff out. Affected bolls either fail to open at all, or open prematurely, with the compact locks easily dislodged and dropping to the ground.

CONTROL

- Use a certified, treated seeds treatment
- Use resistant varieties as well
- Use systemic fungicides

6.3. Root rot

DESCRIPTION

Cotton root rot is caused by a fungus called Phymatotrichum omnivorum. The fungus survives well in alkaline soils which are low in organic matter. The fungus has unique biological characteristics that contribute to management difficulties. Phymatotrichum omnivorum has a wide host range (infecting over 2 300 species apart from cotton), although it attacks only mature plants and does not easily spread between fields. The fungus can also survive for long periods of time in the soil and often deep in the soil as the roots penetrate deeper into the soil. This explains why fungicides are not an effective treatment. The fungus is only active when air and soil temperatures are high. When environmental conditions are conducive to its development, the fungus invades the plants through their root systems.

SYMPTOMS

Infected plants can die off in two weeks. The first disease symptom is slight yellowing of the leaves, which then quickly turn to a bronze colour and begin to wilt. Permanent wilt occurs, followed by die off. The leaves remain firmly attached to the stem. Affected plants can be pulled out easily from the soil. Root bark decay and brownish and bronze coloured woolly fungus strands are clearly visible on the root surface.

CONTROL

- Use a 3 to 4-year rotation system in the case of the monocotyledons crops, shorter rotations are ineffective as the fungus can survive for long periods in the soil.
- Deeply plough the infected area (15 to 25 cm deep); this is known to reduce 90% of the fungus. This must be done immediately after harvesting the cotton.
- Use the plant barrier technique. This technique consists of planting a resistant grass crop such as sorghum round an infected area in a field. These barriers limit the spread of disease within the field.
- Use early-maturing varieties so that the crops reach maturity before the plant is killed off by the disease.

6.4. Cotton leaf curl virus

DESCRIPTION

Cotton leaf curl disease is caused by a complex pathogen of a virus belonging to the Begomovirus genus. The virus is spread between plants by Bemisia tabaci (whitefly), and movement of the insect can rapidly spread the disease through a crop and over large distances. Other hosts include okra, cowpea, radish, tobacco, tomato, chilli and papaya which may act as reservoirs for the pathogens during and between cotton crops. These plant species are also the hosts of the whitefly vector.

SYMPTOMS

Leaves of infected plants curl upward or downward, accompanied by foliar discoloration and mosaic. These leaves may bear leaf-like enations (growth) on the underside along with vein thickening. Plants infected early in the season are stunted and yield is reduced severely.

CONTROL

- Plant varieties that are resistant to leaf curl
- Eradicate weeds in and near cotton fields. This may have some advantage in reducing virus and insect vector reservoirs.

7. Harvesting

Cotton can be handpicked or harvested mechanically. Harvesting begins about six months after planting and is the most expensive operation of cotton cultivation. Cotton is picked as soon as the boll opens. If left in the field for a longer period, it may drop out or become damaged by rain. Hand-picking is continued over a period of two months or more because all the bolls do not ripen at the same time. It is desirable to pick dry cotton free from debris. In general, hand-picking produces considerably cleaner cotton when compared with mechanical harvesting.

PART III: POST-HARVEST HANDLING

1. Grinding

New spinning technologies have an impact on cotton fibre properties and therefore there is an increasing need for finer, stronger and cleaner cotton types. The changing emphasis in fibre selection has already had, and will continue to have, a far-reaching impact on breeding, farming, ginning and merchandising cotton. Cotton is classed to determine the grade, staple and character, which indicate to a large extent the spinning utility and therefore the market value of each bale. There are three factors that determine grade, namely: Colour, leaf residue (impurities) and preparation (the degree of smoothness or coarseness of the cotton lint after ginning). The high volume instrument is the established instrument for determining fibre quality for cotton. Measurements obtained by the Uster HVI classing include:

Length, uniformity, strength and elongation, micronaire value and maturity, colour and debris, and short fibre index (Uster ® HVI Classing, 2004).

2. Storage

Cotton is stored in an open area. Cotton stored in this way has an opportunity to dry off thoroughly. However, plastic bags are the most popularly used containers today. Plastic fertiliser bags can be effectively used if these are attached to a belt round the body in such a way that the ''mouth'' hangs open. The effectiveness of plastic bags can further be increased by making a light metal framework to serve as support.

3. Transport

Trucks can be used to transport cotton.

4. Marketing

Marketing of cotton can be divided into two stages, namely from the producer to the ginner and from the ginner to the spinner. In the first marketing phase the producer sends his/her cotton to the ginner of choice. The ginner grades the cotton according to seed-cotton grades and the producer is given an advance payment for his/her cotton. The second phase, namely the marketing of cotton fibre after it has been ginned, is organised by a cotton marketing agreement between the ginner and spinner

PART IV: PRODUCTION SCHEDULES

ACTIVITIES	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
Soil sampling	■	■	■									
Soil preparation						■	■	■	■			
Planting										■	■	
Thinning											■	■
Fertilisation			■	■						■	■	
Top dressing	■											■

ACTIVITIES	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
Growth regulator	■	■										
Irrigation	■	■								■	■	■
Pest control	■	■										■
Disease control	■	■										■
Weed control	■	■									■	■
Pruning												
Leaf sampling												
Harvesting			■	■	■							
Marketing	■	■	■	■	■	■	■	■	■	■	■	■

PART V: UTILISATION

The main products of cotton lint are weaving yarns (used for towelling, denim, sheets, etc.) and knitting yarns (used in knitted fabrics for T-shirts, underwear, etc.). Major products from cotton seeds are feeds meal; oil (used in margarine, soaps, explosives etc.); hulls (used for feed, fertilisers, synthetic rubber, etc.); linters (used in pulp, medical appliances, yarns and felts) and, lastly, for planting.

REFERENCE

ARC – Tobacco and Cotton Research Institute (1996). *Management guide for the cotton producer, (revised edition).*

Arora, R. V., Jindal, P., Rathore, R., Kumar, V., Singh V. and Baja, L. 2009. *Integrated Pest Management of Cotton.*

Bennett A (2001). *The impact of Bt cotton on smallholder production on the Makhathini Flats, South Africa.* Available on the Worldwide Web at http://www.monsantoafrica.com/reports/bt_report/BtCottonReport.html.

Bissdore, J. 2005. *Field guide to non-chemical pest management in cotton production,* Editor: Weber, C. Pesticide Action Network.

Cotton SA, 2008. *Annual Report.* CottonSA. http://www.cottonsa.org.za (accessed 14/01/2009.)

FARRELL M.J. (1957). *The measurement of productive efficiency.* Journal of the Royal Statistical Society A120, part 3: 253-281.

GREY F. (2002). *Personal communication.* Vunisa Cotton, Pongola.

OLIVIER D. (2002). *Personal communication.* Delta Pineland South Africa, Groblersdal.

VAN JAARSVELD J. (2002). *Personal communication.* Delta Pineland South Africa, Makhathini Flats.

FURTHER INFORMATION CAN BE OBTAINED FROM:

Directorate Plant Production
Private Bag X250
Pretoria
0001

Tel.: +27 12 319 6072
Fax.: +27 12 319 6353
E-mail: Thabo.Ramashala@daff.gov.za

Notes

Notes

Notes

Notes