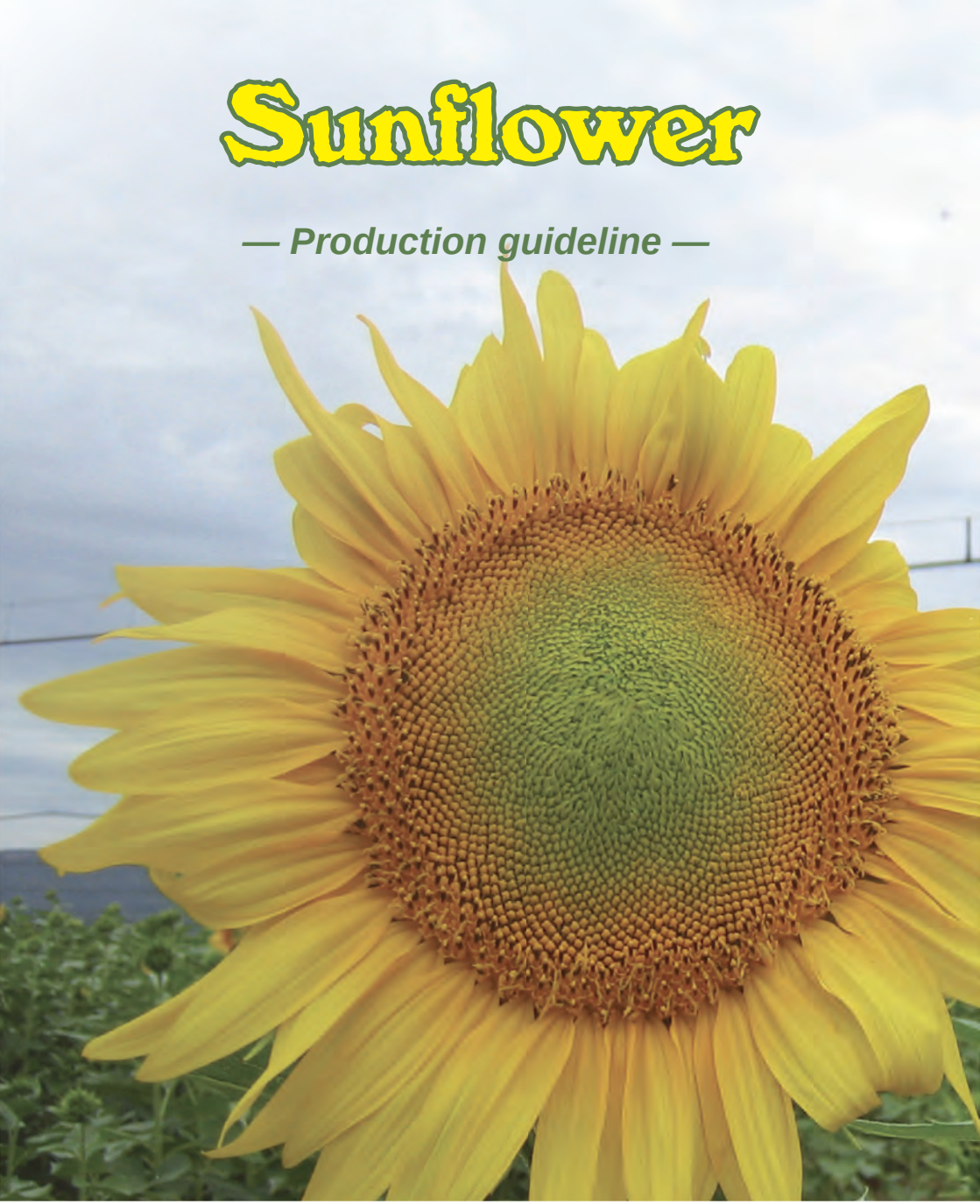
Sunflower

— Production guideline —



agriculture,
forestry & fisheries

Department:
Agriculture, Forestry and Fisheries
REPUBLIC OF SOUTH AFRICA

Sunflower

— Production guideline —

March 2010

Department of Agriculture, Forestry and Fisheries

2010

Printed and published by

Department of Agriculture, Forestry and Fisheries

Compiled by

Directorate Plant Production
Private Bag X250
PRETORIA 0001

Tel: +27 12 319 6072
Fax: +27 12 319 6372
E-mail: DPP@daff.gov.za

Design and layout by

Directorate Agricultural Information Services

Obtainable from

Resource Centre
Directorate Agricultural Information Services
Private Bag X144
PRETORIA
0001

CONTENT

Classification

Scientific name: *Helianthus annuus*
Common name: Sunflower

Origin and distribution

Sunflower (*Helianthus annuus* L.) is one of the few crop species that originated in North America (most originated in the Fertile Crescent, Asia or South or Central America). It was probably a “camp flower” of several of the western native American tribes (North American Indians) who domesticated the crop (possibly 1000 BC) and then carried it eastward and southward in North America. The first Europeans observed sunflower cultivation in many places from southern Canada to Mexico and Spain.

Sunflower was probably first introduced to Europe through Spain, and spread through Europe until it reached Russia, where it was adapted readily. Selection for high oil in Russia began in 1860 and was largely responsible for increasing the oil content from 28 % to almost 50 %. The high-oil lines from Russia were reintroduced into the U.S. after World War II, which rekindled interest in the crop. However, it was the discovery of the male-sterile and restorer gene system that made hybrids feasible and increased the commercial interest in the crop.

Production levels in South Africa

The production of sunflower, which is the important source of vegetable oil in South Africa, is most prevalent in the summer rainfall areas. Local annual production for sunflower seed ranges between 500 000 to 700 000 tons. The fluctuations in production levels are mainly caused by uncertain price expectations, high input cost and high stock levels. The average yield ranges from 1,2 to 1,8 t/ha under dry land.

Major production areas in South Africa		
Province	**District**	**Towns**
North West	Bojanala	Rustenburg, Moretele, Koster, Brits, Madikwe
	Ngaka Modiri Malema	Mafikeng, Delareyville, Litchenburg, Stella
		Zeerust, Sannieshof
	Dr Ruth Segomotsi Mompati	Schweizer-Reneke, Bloemhof
	Dr Kenneth Kaunda	Ventersdorp, Potchefstroom, Klerksdorp
Free State	Motheo	Bloemfontein area, Ladybrand, Morojaneng, Botshabelo, Eastern Free State, Thaba Nchu, Wepener
	Lejweleputswa	Bothaville, Bultfontein, Dealesville, Allanridge, Boschoff, Goldfields
	Thabo Mofutsanyane	Arlington, Bethlehem, Clarens, Clocolan, Harrismith, Lindley, Maluti, Kestell
	Northern Free State	Cornelia, Edenville, Frankfort, Kroonstad, Heilbron, Koepel, Koppies, Kroonkop
Limpopo	Capricorn	Dendron, Moletjie, Dikgale, Lebowakgomo, Zebediela, Mankweng, Noko-tlou
	Waterberg	Bosveld, Northam, Vaalwater, Tswelopele, Mookgopong, Bela-Bela, Mokopane.
Mpumalanga	Gert Sibande	Eastvaal, Badplaas, Carolina, Ekulindeni, Breyten, Empuluzi
	Nkangala	Highveld DC, Middelburg, Belfast, Delmas, Kriel, Hendrina
	Ehlanzeni	Lowveld Escarpment, Lydenburg, Mbombela, White River

Cultivars

Proper cultivar choice is one method of ensuring higher profits at no extra costs. Because sunflower is not prone to major diseases and pests, cultivar selection is generally based on yield and yield reliability. Performance of varieties tested over several environments is the best basis for select-

ing sunflower hybrids. The choice should consider yield, oil percentage, maturity, seed size (for non-oilseed markets), and lodging and bird resistance. Farmers should select cultivars best suited to their production area. The following is a non-exhaustive list of available cultivars. It is, however, important to realise that cultivars are updated on a regular basis and therefore could change over time.

Further details on specific cultivars (updated annually) are available from the ARC-Grain Crops Institute (Potchefstroom) on request.

Sunflower cultivars		
270 (32)	HV 3037 (254)	Sirena (1421)
AFG 271 (1)	Hysun 3.33 (1421)	AGSUN 4672 (254)
AFG 272 (1)	Hysun 346 (1421)	AGSUN 4683 (254)
AGSUN 5261 (1)	Hysun 3.34 (1421)	PAN 7034 (1412)
AGSUN 5282 (1)	Hysun 3.50 (1421)	PAN 7033 (1412)
AGSUN 5383 (1)	LG 5630 (254)	PAN 7010 (1412)
DK 4040 (80)	NK FERTI (809)	PAN 7031 (1412)
DKF 68-22 (80)	NK ARMONI (809)	PAN 7009 (1412)
DKF 68-22 (80)	NK ADAGIO CL (809)	PAN 7001 (1412)

Description of the plant

Sunflower is an annual, erect, broadleaf plant with a strong taproot and prolific lateral spread of surface roots. Stems are usually round early in the season, angular and woody later in the season, and normally unbranched. Sunflower leaves are phototropic and will follow the sun's rays with a lag of 120 behind the sun's azimuth. This property has been shown to increase light interception and, possibly, photosynthesis. In temperate regions, sunflower requires approximately 11 days from planting to emergence, 33 days from emergence to head visibility, 27 days from head visibility to first anther, 8 days from first to last anther, and 30 days from last anther to maturity.

Cultivar differences in maturity are usually associated with changes in vegetative period before the head is visible. Its total growing period ranges from 125 to 130 days. The sunflower head is not a single flower (as the name implies) but is made up of 1,000 to 2,000 individual flowers joined at a mutual receptacle. The flowers around the circumference are ligulate ray flowers without stamens or pistils; the remaining flowers are perfect flowers (with stamens and pistils). Anthesis (pollen shedding) begins at the periphery and proceeds to the centre of the head. As many sunflower varieties have a degree of self-incompatibility, pollen movement among plants by insects is important, and bee colonies have generally increased yields.

Climatic requirements

Temperature

It is tolerant of both low and high temperatures, however, more tolerant to low temperatures. The crop is particularly sensitive to high soil temperature during emergence. In South Africa, this problem is aggravated in the sandy soils of the Western Free State and North West, resulting in a poor or erratic plant stand. Sunflower seeds will germinate at 5°C, however, temperatures of at least 14 to 21°C are required for satisfactory germination.

Seeds are not affected by vernalisation (cold) in the early germination stages. At later stages freezing temperatures could damage the crop. Temperatures lower than the freezing levels are required before maturing sunflower plants would die off. The optimum temperature for growth is 23 to 28 °C, however, a wider range of temperatures up to 34 °C show little effect on productivity. Extremely high temperatures have been shown to lower oil percentage, reduce seed fill and germination.

Rainfall

The rainfall requirement ranges from 500 to 1 000 mm. Sunflower is an inefficient user of water, as measured by the volume of water transpired per gramme of plant above-ground dry matter. It is a crop which, compared to other crops, performs well under drought conditions; this is probably the main reason for the crop's popularity in the marginal areas of South Africa. However, the crop is not considered highly drought tolerant, but often produces satisfactory results while other crops are damaged during drought. Its extensively branched taproot, penetrating to 2 m, enables the plant to survive times of water stress. A critical time for water stress is the period 20 days before and 20 days after flowering. If stress is likely during this period, irrigation will increase yield, oil percentage and test weight. Protein percentage, however, will decrease.

Soil requirements

Sunflower will grow in a wide range of fertile soil types; sandy loam to clays with pH value ranging from 6,0 to 7,5. Traditionally, sunflower cultivation has been limited to soils where the clay percentage varies between 15 and 55 % (in other words, sandy loam to clay soil types). At present the major planting areas are in soils with a clay percentage of less than 20. Sunflower has a low salt tolerance, however, it is somewhat better than field bean or soya-bean in this respect. Good soil drainage is required for sunflower production, but this crop does not differ substantially from other field crops in flooding tolerance. Soils with good water-holding capacity (clays) will be preferred under dryland conditions.

CULTIVATION PRACTICES

Propagation

Sunflower is propagated by seed.

Soil preparation

Many different tillage systems can be used effectively for sunflower production. Soil preparation should be focused on decreasing runoff, especially in the case of soils with a low infiltration rate. These losses can be limited to a great extent by applying the correct soil cultivation practices. Conventional systems of seedbed preparation consist of mouldboard plowing or chisel plowing. The aim of the cultivation is to break up limiting layers, destroy weeds, provide a suitable seedbed and to break the soil surface and at

the same time to ensure maximum rainfall infiltration, as well as to prevent wind and water erosion. Both germination percentage and lodging have been shown to increase in ridge-till systems vs. level plantings. Several tillage systems have been used with some success in specific environments. Major considerations are:

- firm placement of seed near moist soil
- absence of green vegetation during emergence
- maintaining an option to cultivate
- reducing the risk of soil erosion

Field layout and design

The field should be free of weeds, hardpans, stones and water logged conditions. Ridges, field waterways, terraces or contours and water harvesting basins should be constructed. Avoid fields that were planted to sunflower the previous year.

Planting

The planting density for sunflower ranges from 25 000 to 35 000 plants per hectare, depending on the yield potential of the area. Row width has little influence on grain yield. It can range from 90 to -100 cm, however, wider rows such as 1,5 m to 2,1 m can also be used, particularly to accommodate other farm implements. The required spacing in the row is about 30 cm. In South Africa, sunflower is planted from the beginning of November to the end of December in the eastern areas and to mid-January in the western areas. Sunflower seeds are planted at relatively shallow depths. In soil with a high clay content, seeds are planted at a depth of 25 mm. In sandy soils, seeds can be planted at a depth of up to 50 mm.

Fertilisation

Compared to grain crops, sunflower utilises soil nutrients exceptionally well. The main reason for this is the finely branched and extensive root system. The roots come into contact with nutrients which cannot be utilised by other crops.

Macro-nutrients

Sunflower normally reacts well to nitrogen and phosphorus fertilisation, where there is a shortage of these elements in the soil. It is therefore essential that any fertilisation programme for sunflower should be based on soil analyses. Soil analyses will not only lead to more appropriate fertilisation levels, but can also significantly limit unnecessary fertilisation costs.

Nitrogen

When there is a shortage, the growth rate decreases dramatically, leaves turn to pale green and the lower leaves die-off.

Guidelines for nitrogen fertilisation (kg/ha)

Target yield (kg/ha)	N- guidelines (kg/ha)	
	Clay soils	All other soils
1 000	0	0–15
1 500	0–15	25–35
2 000	40–50	60–70

Phosphorus

A shortage of phosphorus is characterised by retarded growth. In serious cases necrosis can be detected on the tips of the lower leaves. Factors which should be taken into account when planning a phosphorus fertilisation programme, are the following:

- Attempts should be made to build up the phosphorus content of the soil over time.
- The optimum soil phosphorus level for sunflower is about 10 mg/kg (Ambic 1).

This means that phosphorus fertilisation is essential when the level of phosphorus in the soil is below 10 mg/kg. However, at a higher level, the crop will probably not respond to phosphorus fertilisation.

Guidelines for phosphorus fertilisation (kg/ha)

Soil P (mg/ha)		Target yields (kg/ha)		
Ambic 1	**Bray 2**	**1 000**	**1 500**	**2 000**
2	7	11	16	21
4	10	9	14	18
6	12	8	12	16
8	15	7	11	15
10	18	6	9	12
12	21	3	5	10
14	24	0	4	8

Potassium

Although sunflower draws large quantities of potassium from the soil, potassium fertilisation is usually unnecessary, as South African soils generally have adequate quantities of this nutrient.

Molybdenum and boron

Shortages of boron and molybdenum often limit the growth and yield of sunflower in the eastern parts of the country. To avoid problems concerning these two elements, care should be taken to apply fertiliser containing boron and to ensure that seeds are treated with molybdenum prior to planting. Local seed companies usually treat their seed with molybdenum. If no soil analysis is available, 50 to 100 kg/ha of a 3:2:1 (25) fertiliser mixture applied at planting is adequate for a yield potential of 1 000 to 1 500 kg/ha.

Irrigation

In most cases South African sunflower is cultivated under dry land during the summer rainfall season (November to March). In areas with low rainfall, water supply can be supplemented with irrigation in order to increase yield. The method of irrigation will depend on the water availability and the available irrigation equipments. The pH of the irrigation water should be slightly neutral.

Weed control

Efficient weed control is a prerequisite for high sunflower yields. It is achieved by a combination of mechanical and chemical practices. Young

plants are highly sensitive to strong weed competition and cannot develop fast enough to form a full shade covering which can suppress weed seedlings. Therefore, the first 6 weeks after planting are a critical period for the crop.

Yields can be increased significantly by keeping fields free of weeds during this time.

Mechanical weed control

Mechanical weed control can be very effective, provided it is done in time and with care not to damage the crop. Chemical weed control can be applied successfully together with mechanical methods and cultivation practices to bring about better weed control. The following tips are given for mechanical control:

- Cultivate before the sunflower is too tall for equipment, or the plants will be damaged easily.
- To prevent damaging the sunflower roots, cultivation should be shallow (less than 75 mm).
- Throw loose soil onto the row—this will assist in suffocating weeds which sprout in the row.
- Smaller weeds die-off easily when dry soil is hoed.
- Hoe during the hottest part of day when the sunflowers are wilted—this reduces stem damage.

Chemical weed control

The use of herbicides has many advantages, of which the most important is that effective weed control can be applied during wet periods when mechanical weed control is impossible. If sunflower is cultivated in crop rotation with maize, weeds can be controlled more effectively in both crops as grass and broadleaf herbicides can be used in continuous succession.

Pest control

Insect pests have become major potential yield-reducing factors in sunflower producing areas.

Frequent insects in sunflower

These potential risks require that growers follow integrated pest management (IPM) practices. IPM means using a combination of pest control

methods to maintain pest populations below levels which result in unacceptable losses to crop quality or yield. IPM includes biological, cultural, physical and chemical control. Resistance to insects can be improved by the presence of a dark- coloured “armour” layer on the seed coats. Resistance to midges has been suggested, however, it is not presently effective. Only currently approved insecticides should be used for control of insects. Birds can be major pests in sunflowers, especially blackbirds, goldfinches, doves, grosbeaks and sparrows. Many approaches to feed disruption have been tried, including scarecrows, fright owls, aluminum strips that flutter in the wind and carbide exploders. No technique is 100 % effective, as birds will adapt to many of these techniques. Currently, no chemicals are approved for bird control in sunflower.

Control measures for pests on sunflower

Pests	Pest description	Symptoms	Control measures
American bollworm	First instar larvae almost black Colour of the older larvae can vary from nearly black to brownish, green or even pink Underside dirty white with a stripe along each side with very distinct spiracles	Feeds mainly on young heads	Crop rotation, grow resistant cultivars, use of certified seeds
Astylus beetle (larvae)	Hairy grub of medium size	Feeds mainly on decomposing organic matter,however, will also attack young seedlings	
Black maize beetle	Shiny, black beetle approximately 12 mm long. Very active and a good flier	Eats holes in plants below soil level just above germinating seed Larvae feed on dead organic matter in the soil	
Nematodes	Microscopic slender transparent worms in the soil	Attacks roots of plants causing lesions that make these susceptible to bacterial or fungal attack, resulting in poor growth of plants	

Pests	Pest description	Symptoms	Control measures
Weevils	Small, wingless beetles with distinct snouts Larvae are whitish and legless		

Disease control

The most serious diseases of sunflower are caused by fungi. The major diseases include rust, downy mildew, Verticillium wilt, Sclerotinia stalk and head rot, Phoma black stem and leaf spot. Resistance to rust, downy mildew, and Verticillium wilt has been incorporated into improved sunflower germplasm. The severity of these diseases effects on total crop yield could be ranked:

1. *Sclerotinia*
2. *Verticillium*
3. rust (recently more severe)
4. Phoma
5. downy mildew.

Disease control mechanisms

Disease	Symptoms	Control mechanisms
Downy mildew (*Plasmopara halstedi*)	Stunted growth, yellow-green and green lesions on the leaves Cottony fungus on the underside of the leaves Blackening and swelling on the stem Severe in humid areas	Crop rotation Conservation Tillage, scheduled irrigation Disease resistant cultivars Drought resistance cultivars Registered seeds
Powdery mildew (*Erysiphe cichoracearum*)	Cottony fungus on green leaves late in summer (no large-scale damage)	
Leafspot (*Septoria helianthi*)	Dead lesions on flower leaves before heading Not causing appreciable loss	
Verticillium wilt (*Sclerotinia sclerotiorum*)	Dead areas along leaf veins, bordered by light yellow-green margins Decayed vascular tissue in cross-section of the stem	
Rust (*Puccini helianthi*)	Rust coloured postules on leaves, latter black speck on stems	

Disease	Symptoms	Control mechanisms
Sclerotinia head and stem rot (*Verticillium dahliae*)	Wilt soon after flowering Light tan band around the stem at the soil level Grey-black *sclerotia* (seed size) in rotted heads and stems	
Phoma black stem (*Phoma macdonaldii*)	Large chocolate coloured lesions on stems at maturity	

Crop rotation

Sunflower should be grown in rotation with other crops as:

- The risk of diseases and weeds increase with monocropping.
- A yield and quality advantage is often measured in a follow-up maize or sorghum crop.
- Weed and pest problems decrease with crop rotation.

However, take note that some herbicides do have a long residual period and could damage the follow-up crop in a rotation system. It is therefore important to strictly follow instructions on herbicide labels.

Harvesting

Harvest maturity

Harvesting should commence as soon as 80 % of the sunflower heads are brown in order to minimise losses caused by birds, lodging and shattering. The leaves turn yellowish during harvesting maturity. Sunflower is generally mature long before it is dry enough for combining. The sunflower plant is physiologically mature when the back of the head has turned from green to yellow and the bracts are turning brown, about 30 to 45 days after bloom, and seed moisture is about 35 %. The total growing period (from seeding to harvesting) for sunflower ranges from 125 to 130 days.

Harvesting methods

Harvesting is done either manually or mechanically. Manual harvesting is practiced by cutting the crop with a sickle or knife. Commercially available sunflower headers are useful in decreasing loss of seed as the crop is direct combined. The combines are used to perform several operations such as cutting the crop, separating the grain from the straw, cleaning the grain from chaff and transporting grains to the storage tank. This equipment

usually includes 20 to 90 cm width metal pans for catching matured seed and a three-armed or similar reel. A narrower (23 cm) pan width enables harvesting diagonal to the row, which produces smaller harvest losses in some situations. Harvesting with a combine harvester will save more time than manual harvesting.

POST-HARVEST HANDLING

Sorting

After harvesting all foreign materials, weed seeds, undesired seeds, stones and leaves should be sorted out from the desired seeds. Seeds should be sorted small according to their colours and size in order to meet the market standards.

Grading

Classes of sunflower seed

Sunflower seed shall be classified as:

Class FH

Class FS

Class FGP

Class Other Sunflower Seed.

Standards for classes of sunflower seed

- A consignment of sunflower seed shall be classified as Class FH if it:
  - consists mainly of sunflower seeds with a high oil content
  - does not contain more than 20 % sunflower seed of Class FS or Class FGP
  - complies with the standards for Grade 1 set out in regulation 6
- Class FS:
  - consists mainly of white sunflower seeds or clearly white-striped sunflower seeds or a mixture of white and white-striped sunflower seeds registered and described as a variety suitable for bird feed, in terms of the Plant Improvement Act, 1976 (Act No. 53 of 1976)
  - does not contain more than 20 % sunflower seed of Class FH or Class FGP
  - complies with the standards for Grade 1 set out in regulation 6
- Class FGP:
  - consists of large sunflower seeds of which not more than 5 % passes through a 5,5 mm round hole screen
  - complies with the standards for Grade 1 as set out in regulation 6
- Class Other Sunflower Seed:
  - does not comply with the requirements for Class FH, Class FS or Class FGP

Grades for sunflower seed

There is only one grade for the Classes FH, FS and FGP Sunflower Seeds.

A consignment of Grade I sunflower seed should:

- be free of a musty, sour, khaki-weed or other undesirable smell
- be free of any substance that renders it unsuitable for human or animal consumption or for processing into or utilisation as food or feed
- contain not more than 5 noxious seeds per 400 g, of which no more than one may be of Crotalaria species and of which none may be of *Ricinus communis*
- be free of stones, glass, metal, coal or dung

- be free of insects
- not exceed the maximum permissible deviation
- contain not more than 10 % moisture

Packing

Sunflower seed of different classes and grades should be packed in different containers or stored separately.

Storage

Seeds should be below 12 % moisture for temporary storage and below 10 % for long-term storage. Seed up to 15 % moisture is satisfactory for temporary storage in freezing weather, however, spoilage is likely after a few days of warm weather. It is best to have on-farm storage available; however, storage in silos is the usual approach in South Africa.

Aeration is essential, especially in the larger bins now available. Aeration may be accomplished with floor-mounted dusts or portable aerators. Sunflower should be rotated between bins when aeration is not available. An air space should be left in the top of the bin to facilitate checking the condition of stored seed. Sunflower can be stored more than one season under proper conditions (dry, clean, aerated, and in tight bins), however, processors of non-oilseed sunflower for human consumption prefer not to use seed that has been stored more than one season.

Transport

The most frequent mode of transport for sunflower grain is by road trucks, rail trucks and by ships.

Marketing

The sunflower marketing in South Africa commences on 1 January and ends on 31 December of the calendar year. No levies are applicable and the marketing of oilseeds is free of statutory intervention. The seeds can be sold to the international and domestic processing companies, firm or industries for multipurpose processing (e.g. oil, biodiesel and feedstock/ oilcake production). The total demand for sunflower in South Africa decreased by 1,9 %, from 674 000 tons in 2004 to 661 tons in 2005 owing to carryover stocks.

The demand is expected to increase because of the biofuel production initiative which will give rise to maximising of production. The most important countries from which seed were imported is the Ukraine, while exports are mainly to Pakistan and Thailand.

PRODUCTION SCHEDULES

Activities	January	February	March	April	May	June	July	August	September	October	November	December
Soil sampling												
Soil preparation												
Planting												
Fertilisation												
Irrigation												
Pest control												
Disease control												
Weed control												
Leaf sampling												
Harvesting												
Marketing												

UTILISATION

Human use

It can be used as edible oil in form of margarine, salad dressing oil and cooking oil, it can also be used as snacks.

Animal use

The non-dehulled or partly dehulled sunflower meal can be used for ruminant animals, pigs and poultry feeds because of its high protein percentage (28–42). Sunflower can be used as silage for animal feeds. Sunflower silage is richer in nutrients than corn but lower than alfalfa hay.

Industrial use

It can be used in certain paints, varnishes and plastics because of good semi-drying properties without colour modification associated with oils high in linolenic acid. It can be also used to manufacture soaps and detergents. Other industrial use include production of agrichemicals or pesticides, surfactants, adhesives, fabric softeners, lubricants and coatings. A future high-potential use will be on diesel engines as the world is striving for a non-polluted environment.

ACKNOWLEDGEMENTS

ARC: Grain crops Institute is acknowledged for the contribution made in the development of this production guideline.

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: DPP@daff.gov.za

NOTES