PRODUCTION GUIDELINE FOR WHEAT

agriculture,
forestry & fisheries

Department:
Agriculture, Forestry and Fisheries
REPUBLIC OF SOUTH AFRICA

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General Aspects

1. CLASSIFICATION

Scientific name: *Triticum aestivum*

Common names: Wheat, korong, koring, Kolo, Nqolowa

2. ORIGIN AND DISTRIBUTION0

Wheat (*Triticum aestivum)* is believed to have originated in the Near East, in the areas now occupied by Syria, Turkey, Afghanistan, Iraq and Iran. Grains of domesticated wheat were found in the archaeological remains in Ali Koshi in Iranian Khusistan, dating back to 6 500 BC, as well as in Anatolia in Turkey, dating back to 5 500 BC.

Cultivation of wheat spread from its origin to India, Pakistan and China in the east, to the Mediterranean countries in the west and the U.S.S.R and other countries in the north. In South Africa, Jan van Riebeeck introduced it in the middle of the 17th century upon arrival in the Cape in 1652. Thereafter, it spread to the Western Cape, South Western Cape and Free State Provinces. Knowledge of *T. aestivum's cultivation origin* has been lost. The precise origin of the wheat plant as we know it today is not known. Wheat evolved from wild grasses, probably somewhere in the Near East. A very likely place of origin is the area known in early historical times as the Fertile Crescent—a region with rich soils in the upper reaches of the Tigris-Euphrates drainage basin.

3. PRODUCTION LEVELS IN SOUTH AFRICA

Wheat is an important cereal crop ranking second after maize in terms of the area planted and production. It is grown on an area which ranges from 417 500 to 757 700 ha on total average area of 533 000 ha during production seasons from 2004 to 2015, which produces an average annual production of 1.3 to 2 million tons. However, the most significant decline in hectares occurred in Free State, which resulted in a 50% drop in production. Production in the irrigation and winter wheat areas were also down, but only marginally. The provinces that produce wheat are Free State, followed by the Western Cape and Northern Cape. Other provinces produce smaller amounts. The total requirement for wheat in South Africa is 2.7 million tons, which is higher than the total production. In order for South Africa to meet its requirements, wheat is imported from Argentina, United States of America, Germany, Canada, Ukraine and the United Kingdom. Annual wheat production in South Africa ranges from 1,3 to 2 million t/ha at the rate of 2 to 2,5 t/ha under dryland and about 5 t/ha under irrigation.

The south western parts of the Western Cape (Swartland and Ruens) contribute about 697 000, Northern Cape about 262 800 tons, Free State about 224 000 tons, Northwest about 91 500 tons, Mpumalanga about 20 300 tons, Limpopo 151 200 tons, KwaZulu-Natal about 41 610 tons each, Gauteng 1 500 tons and Eastern Cape contribute about 14 880 tons in 2015 production season. South Africa is the net importer of wheat, importing about 300 000 tons per annum.

YIELD PER HECTARE WHEAT IN SOUTH AFRICA

Province	2004/05 t/ha	2005/06 t/ha	2006/07 t/ha	2007/08 t/ha	2008/09 t/ha	2009/10 t/ha	2010/11 t/ha	2011/12 t/ha	2012/13 t/ha	2013/14 t/ha	2014/15* t/ha
W. Cape	1.47	2.14	2.50	2.50	2.46	2.38	2.00	2.68	3.30	2.99	2.90
N. Cape	5.87	6.31	6.25	6.30	6.64	6.30	6.64	8.00	6.49	7.62	7.50
Free State	1.45	1.526	2.167	2.651	2.00	2.65	1.85	2.45	2.77	3.00	3.53
E. Cape	3.50	3.63	2.86	4.00	4.00	4.00	4.00	4.20	4.11	4.40	4.00
KwaZulu-Natal	5.15	4.61	4.43	4.80	5.09	5.00	5.00	5.40	5.00	6.00	6.00
Mpumalanga	5.10	5.11	5.13	5.00	5.63	5.49	5.20	6.22	5.40	6.22	6.10
Limpopo	4.06	4.55	4.50	5.50	5.50	5.50	5.20	5.68	4.70	5.21	5.00
Gauteng	5.60	5.60	5.00	6.50	6.40	6.40	6.40	6.65	5.61	6.20	6.23
North West	5.18	5.40	4.93	5.24	6.00	5.70	5.60	5.70	5.70	5.95	5.95
TOTAL	2.02	2.37	2.75	3.01	2.85	3.05	2.56	3.32	3.66	3.70	3.67

Source: Grain SA 2015

4. MAJOR PRODUCTION AREAS IN SOUTH AFRICA

Province	District	Towns
Free State	Xhariep	Bethulie, Bloemfontein area, Orange West, Petrusburg, Jagersfontein, Springfontein, QwaQwa
	Lejweleputswa	Bothaville, Allanridge, Boshof, Dealesville, Goldfields
	Thabo Mofutsanyane	Bethlehem, Arlington, Clarens, Clocolan, Ficksburg, Harrismith
	Northern Free State	Cornelia, Edenville, Frankfurt, Kroonstad, Heilbron, Deneysville
Western cape	West Coast	Bitterfontein, Clanwilliam, Malmesbury, Koringberg, Rietpoort, Vredendal, West Coast
	Boland	Matroosberg TRC, Breërivier, Witzenberg, Paarl
	Overberg	Overberg, Swellendam, Hermanus, Caledon, Swartland
	City of Cape Town	Blaauwberg, Tygerberg, Helderberg, Oostenburg, South peninsula, West Coast
North West	Dr Ruth Segomotsi Mompati	Vryburg, Christiana, Schweizer-Reneke, Reivilo, Taung
	Dr Kenneth Kaunda	Klerksdorp, Potchefstroom, Wolmaransstad
	Bojanala	Rustenburg, Brits
Northern Cape	Francis Baard	Hartswater, Jan Kempdorp, Pampierstad, Warrenton, Vaalharts
Mpumalanga	Gert Sibande	Badplaas, Carolina, Standerton, Ermelo
	Nkangala	Highveld DC, Delmas, Kriel, Ogies, Hendrina, Middelburg, Groblersdal

Limpopo	Waterberg	Thabazimbi and vicinity Marble Hall
Eastern Cape	Amatole Ukhahlamba Chris Hani	Keiskammahoek, Sterkspruit, Whittlesea

Small quantities have been reported in the Eastern Cape and Gauteng Province.

5. CULTIVARS

Cultivar choice is an economic and important production decision by which the producer aims to achieve highest return with the lowest risk and if correctly planned, could contribute greatly to reducing risk and optimising yields. It is important for farmers to realise that there are cultivars for dryland and irrigation planting producers should also plant cultivars that are preferred by the miller.

The decision is complicated by all the different factors that contribute to the adaptability, yield potential, grading and quality, diseases and pests, seed price, hectoliter mass, straw strength, aluminium tolerance, photoperiod and vernalisation, shatterproof and preharvest sprouting tolerance agronomic characteristics and disease risks of the current commercially available cultivars. The correct cultivar choice contributes to management of risk and achieving optimal grain yield in a given situation. A few important guidelines to consider when the producer is deciding on cultivar choice are:

- Plant a few different cultivars so as to spread production risks, especially in terms of drought and disease occurrence. Utilise the optimum planting spectrum of the cultivars in an area.
- Do not, within one season, replace tested cultivars with a new and unknown cultivar. Rather plant the new cultivar alongside the stalwart for at least one season to compare them and to get to know the new cultivar.
- Cultivars that are able to adapt to specific yield potential conditions should be chosen.
- Revise cultivar choice annually so as to adapt to changing circumstances and especially to consider new cultivars.

The National Chamber of Milling annually publishes a list of preferred cultivars that are acceptable for commercial purposes and this list must be considered in cultivar choice. The Chamber of Milling does, however, point out that individual miller's choices are not restricted to the list. The list of preferred cultivars is divided into three categories: cultivars for dryland production in the north, cultivars for the southern production area and the irrigation cultivars.

Miller's preference list of preferred bread wheat for 2013/14 northern dryland production areas

NORTHERN DRYLAND PRODUCTION AREAS

Miller's preference		
SST 3137	Kouga	Komati
SST 316	PAN 3111	SST 399
Selati	SST 356	Elands
Senqu	SST 954	PAN 3377
Hartbees	PAN 3144	SST 983
Koonap	SST 935	Caledon
PAN 3198	SST 347	SST 1327
PAN 3195	Matlabas	PAN 3364
SST 398	Nossob	SST 972

SST 374	PAN 3120	SST 964
SST 387	PAN 3122	SST 367
PAN 3172	SST 322	SST 363
PAN 3379	SST 334	PAN 3349
PAN 3161	PAN 3118	SST 936
PAN 3368	Tarka	SST 966
SST 963	Carina	Belinda
SST 366	Carol	Betta DN
SST 308	SST 317	SST 333
SST 319	Gariep	SST 107
PAN 3355	Hugenoot	SST 124
SST 946	Limpopo	

NORTHERN IRRIGATION AREAS

Miller's preference		
PAN 3623	PAN 3489	PAN 3478
PAN 3515	SST 895	SST 8134
Timbavati	SST 896	SST 8126
Tamboti	Sabie	SST 815
SST 805	Afgri 75-3	SST 816
Uhmlaz	SST 884	SST 877
PAN 3497	PAN 3471	SST 875
Buff els	Krokodil	Baviaans
SST 867	SST 835	SST 8135
PAN 3434	CRN 826	SST 8136
Duzi	Olifants	SST 8125
PAN 3400	SST 802	Steenbras
SST 885	SST 886	SST 876
Inia	Kariega	Marico
SST 822	SST 825	SST 802

MILLER'S PREFERENCE LIST OF PREFERRED BREAD WHEAT FOR 2013/2014 IN THE SOUTHERN PRODUCTIONS AREAS

SST 0147	SST 096	SST 056
RATEL	SST 087	PAN 3471
Kwartel	Tankwa	Baviaans
PAN 3434	SST 047	SST 027
PAN 3404	Biedou	PAN 3492

PAN 3408	SST 0137	PAN 3490
Steenbras	SST 0127	SST 57
SST 015	SST 017	kariega

6. DESCRIPTION OF THE PLANT

MATURE PLANT

Wheat is an annual grass with basic, erect, hollow or pithy culms. The plant can grow up to 1,2 m tall. The leaves are flat and narrow while they can extend up to 38 cm long. The spikes are long, slender, dorsally compressed and somewhat flattened. The rachis is tough and not separated from the spikelet at maturity. The spikelets have two to five flowers which are relatively far apart on the stem and slightly overlapping. They are also erect and pressed close to the rachis. The glumes which are firm, glabrous and shorter than the lemmas appear on the upper half of the spikelets. The lemmas may either be awned or awnless and less than 1,3 cm long. The palea is as long as the lemma and remains entirely green until maturity. The caryopsis may either be soft or hard and red or white and it frees easily with threshing.

7. CLIMATIC REQUIREMENTS

TEMPERATURE

Warm temperatures are suitable for summer wheat (22 °C to 34 °C) and cool temperatures are suitable for winter wheat (5 °C to 25 °C). An ideal climate for planting wheat can be described as cool and moist, followed by a warm dry season for harvesting. Such a climate is encountered mostly in winter rainfall areas. In South Africa, wherein most of the country receives summer rainfall, winter wheat production is dependent on sufficient residual soil moisture.

8. RAINFALL REQUIREMENTS

The water requirement for wheat is about 600 mm per annum. In dry areas where cultivation practices such as zero tillage and minimum tillage are practiced, stubble mulching is recommended for moisture conservation. Frost can damage wheat, especially after the formation of ears in spring resulting in low yield. Hail can also result in serious damage on the summer wheat resulting in low yield. Wet weather during harvesting contributes to disease prevalence and quality deterioration of grains. Almost all cultivars are susceptible to preharvest sprouting and must be harvested as soon as possible to prevent low falling number or sprouting of the crop. Wheat that is not harvested in time can quickly deteriorate in terms of quality (reduced hectolitre mass) and become infected with fungi (mould), indicated by a change of colour in the ears (golden yellow to white to black). Hail during or after emergence of the ear can cause severe yield loss and the only recourse farmers have, is to take out insurance against hail damage.

The moisture application under irrigation should be lowered during flowering, increased during pod filling and ceased during ripening. Planting each cultivar within the recommended planting time for each area will help to minimise the risk of damage by climatic factors such as drought, heat, cold and rain. As all recommended cultivars are tested over many seasons in each environment, keeping to recommendations will offer the best chance of getting a successful harvest.

9. SOIL REQUIREMENTS

Wheat requires well-drained fertile loamy to sandy loam with a pH of 6, 0 to 7,5. Soil temperatures of less than 5 °C are not suitable for seed germination. Wheat is adversely affected by acidic soils, which are associated with high (Al_{3+}) content, particularly during the early development stages of the crop. The acidic pH makes other soil nutrients to be fixed or to become unavailable, leading to a need for liming. Wheat is also sensitive to very high salinity that can occur under irrigation and some highly saline soils are not suitable for production.

For dryland production in the summer rainfall region, special soils with large water holding capacity are needed to ensure sufficient soil water storage. These soils must be able to store at least 180 mm water before planting and mostly consist of the duplex soil types. Soil types such as Avalon, Westleigh, Clovelly, Longlands and Pinedine have a heavy clay layer or barrier layer that prevents stored water from draining and are therefore suitable for soil water storage. Very well drained soils like Hutton soil type (deep red soils) are not suitable for dryland production but very suitable if irrigation can be applied.

Cultivation Practices

1. PROPAGATION

Wheat is propagated by seeds.

2. SOIL PREPARATION

Soil tillage is one of the most important production practices over which the farmer has full control. The effect of tillage cannot be predicted for any season. Therefore, the farmer has to plan his actions to solve specific problems. Unnecessary cultivations cost money, time and effort, while valuable soil water is lost in the process. Such cultivations also cause recompaction that has to be addressed later. Minimum tillage (75 mm to 130 mm deep), deep tillage (150 mm to 300 mm) or no till can be practiced depending on the type of the soil, moisture availability, type of cultivar and the previous crop planted.

For the summer wheat production that is under irrigation, immediately after harvesting the previous crop in May, the land is ploughed, disked and planted wheat. No fallow period is allowed, only two weeks in between is used for field operations. The conventional tillage is recommended for wheat –on- wheat cropping systems in which the risk of root disease is high and the risk of wind and water erosion minimal. The harvesting is done in December to January. As soon as soil conditions allow, disking of the soil is done. Ploughing is done between ends of January to end of February in the drier areas and between mid-February to the end of March in the wetter areas.

3. FIELD LAYOUT AND DESIGN

Firm, smooth, well-drained fields should be selected. The fields should be free from weeds, stones and waterlogged conditions. Contour ridges, ridges, field waterways, terraces or windbreaks should be introduced to the field to prevent wind and water erosion. Avoid using fields where wheat was planted the previous or same year.

4. PLANTING

Wheat is planted under dryland and irrigation conditions in the summer rainfall region, while in the winter rainfall region it is planted under dryland conditions only. It is planted mainly between mid-April and mid-June in the winter rainfall areas (western and southern Cape) and between mid-May and the end of July in the summer rainfall areas (eastern Free State).

Seeding rate ranges from 20 kg/ha to 25 kg/ha under dryland conditions. Conversely, the seeding rate ranges from 90 kg/ha to 120 kg/ha under irrigation conditions. The inter-row and intra-row spacing are 40 cm to 50 cm and 7 cm to 15 cm respectively, when using a planter. Seed should be placed 5 cm deep. Always use treated seed for soil-borne fungal diseases control.

The seed should be planted evenly and shallowly in a moist firm seedbed. Germination, emergence and development of adventitious roots occur within four to six weeks after planting under proper soil conditions. The required depth for seeding is 2 to 5 cm. The required spacing in the row is about 30 cm and 50 cm to 100 cm between the rows, depending on the available soil moisture or the farming method (wide rows under dryland and narrow rows under irrigation). A no-till planter can be used for seeding or a planter fitted with tines can be used for planting. The planting density ranges from 20 kg/ha to 100 kg/ha depending on the type of cultivar and the moisture availability. Lime can also be used to correct the soil pH under acidic soil. $MgCO_3$ or $CaCO_3$ can be used to correct the soil pH; the rate will depend on the available Mg or Ca in the soil.

5. FERTILISATION

FERTILISATION IN THE WINTER RAINFALL REGION

The contribution of plant nutrition to the total production cost for wheat in the Swartland wheat producing area may be well in excess of 30%. The soil tillage method may have an effect on both the efficient use of fertiliser applications and N-mineralisation that contributes to the cost of plant nutrition. Efficient use of fertiliser is affected by fertiliser placement (uptake) and root distribution. To improve their uptake, fertilisers such as phosphorus that do not move easily in the soil, must be placed near the roots. Efficient root distribution is affected by soil strength.

N-mineralisation of the soil is determined by climate, soil conditions and method of soil tillage. N-mineralisation in the soil could provide large quantities of nitrogen in crop rotation systems, which include legume plants and systems such as conservation farming where microbial activity in the soil is high. Although aggressive mouldboard ploughing may enhance N-mineralisation on the short term, negative effects on soil structure, organic content and soil microbial activity may result in a reduction on the long term.

EFFECT OF CROP ROTATION, METHOD OF SOIL TILLAGE AND N-FERTILISATION ON GRAIN YIELD (KG/HA)

Production system	N rate (kg N/ha)		
	60	100	140
Wheat monoculture:			
Mouldboard*	3 516	3 724	3 744
Minimum tillage**	3 303	3 640	3 973
No tillage***	2 390	3 105	3 363
Wheat in rotation with lupins and canola:			
Mouldboard*	3 098	3 038	3 093
Minimum tillage**	2 864	3 408	3 159
No tillage***	3 147	3 516	3 537

Fertilisation guidelines in the summer rainfall regions

NITROGEN FERTILISATION (KG N/HA) ACCORDING TO TARGET YIELD UNDER IRRIGATION

Target yield (ton/ha)	Nitrogen (kg N/ha)
4-5	80-130
5-6	130-160
6-7	160-180
7-8	180-200
8+	200+

SPLIT APPLICATION OF N DURING THE GROWING SEASON AT DIFFERENT LEVELS OF YIELD POTENTIAL

Yield (ton/ha)	Nitrogen split applications (kg N/ha)		
	Plant to tillering	Tillering to stem elongation	Flag leaf to anthesis
4-5	80-100	30	0
5-6	100	30	30
6-7	100-130	30	30
7-8	130-160	30	30
>8	160	30-60	30-60

PHOSPHORUS FERTILISATION UNDER DRYLAND

PHOSPHORUS FERTILISATION (KG P/HA) ACCORDING TO TARGET YIELD AND SOIL STATUS ACCORDING TO THE BRAY 1 ANALYSIS METHOD

Target yield (ton/ha)	Soil phosphorus status (mg/kg)			
	> 5*	5-18	19-30	>30
1,0	6	5	4	4
1,5	9	8	6	5
2,0	12	12	8	7
2,5+	18	15	12	10

*Minimum quantity that should be applied at the low soil phosphorus level.

PHOSPHORUS FERTILISATION UNDER IRRIGATION

PHOSPHORUS FERTILISATION (KG P/HA) ACCORDING TO TARGET YIELD AND SOIL STATUS ACCORDING TO THE BRAY 1 ANALYSIS METHOD

Target yield (ton/ha)	Soil phosphorus status (mg/kg)			
	> 5*	5 - 18	19-30	>30
4-5	36	28	18	12
5-6	44	34	22	15
6-7	52	40	26	18
7+	>56	>42	>28	21

POTASSIUM FERTILISATION UNDER DRYLAND CONDITIONS

GUIDELINES FOR POTASSIUM FERTILISATION (KG K/HA) UNDER DRYLAND CONDITIONS ACCORDING TO SOIL TEXTURE, SOIL POTASSIUM LEVELS AND TARGET YIELD

Target yield (ton/ha)	Soil potassium status (mg/kg)			
	<60	61-80	81-120	>120*
1-2	20	15	15	0
2-3	30	20	20	0
3+	40	25	25	0

Soil with >35% clay (soil with <35% clay content, no potassium recommended, but potassium applications may be done for maintenance of soil K values).

GUIDELINES FOR POTASSIUM FERTILISATION (KG K/HA) UNDER DRYLAND CONDITIONS ACCORDING TO SOIL POTASSIUM LEVELS AND TARGET YIELD

Target yield (ton/ha)	Soil potassium status (mg/kg)			
	<60	61-80	81-120	>120*
4-5	50	25	25	0
5-6	60	30	30	0
6-7	70	35	35	0
7+	80	40	40	0

*Soil with >35% clay (soil with <35% clay content, no potassium recommended)

*On <35% clay soils, K applications may be split during the growing season to ensure K availability in the top soil.

MICRONUTRIENTS

Iron, manganese, zinc, copper and boron are essential for normal development and growth of wheat. If one or more of them become deficient, visual deficiency symptoms will appear on the leaves. Deficiency must be corrected early in the growing season to prevent any further yield losses. At this stage micronutrients are not generally recommended under dryland practices because of the risk involved to recover the additional input costs. Under specific conditions, where micronutrients are the yield limiting factor (plant analysis), the following table can be used to determine which nutrient is causing the problem.

PLANT ANALYSIS VALUES OF WHEAT AT FLAG LEAF STAGE

Element	Low (deficient)	Marginal	High (sufficient)
N (%)	<3,4	3,7-4,2	>4,2
P (%)	<0,2	0,2-0,5	>0,5
K (%)	<1,3	1,5	>1,6
S (%)	<0,15	0,15	>0,4
Ca (%)	<0,1	0,2	>0,2
Mg (%)	<5	0,15	0,15-0,3
Cu (mg/kg)	<20	5-10	10
Zn (mg/kg)	<30	20-70	>70
Fe (mg/kg)	<25	35-100	>100
Mo (mg/kg)	<0,05	50-180	>180
B (mg/kg)	<6	0,05-0,1	>0,1
		6-10	10

6. IRRIGATION

Irrigation scheduling must be according to evaporation and needs, as per growth stage. It is, however, very important that irrigation is not stopped too early and the last irrigation must be applied when the whole plant is almost discoloured. This is to ensure an even ripening and to produce grain with a high percentage plumpness and acceptable nitrogen content. Proper irrigation scheduling can also minimise lodging and disease occurrence and optimise yield quality. The method of irrigation will depend on the water availability and the available irrigation equipment.

7. PEST CONTROL

A variety of insects with different feeding habits are found on wheat but not all these pests are equally harmful. Therefore, the decision to control should be made individually for each pest using the guidelines provided and the particular control measure should be chosen to give the best results in both economic and environmental terms. The correct identification of pests is of utmost importance to ensure that the appropriate control measure is followed.

A FIELD GUIDE FOR THE IDENTIFICATION OF INSECTS IN WHEAT IS AVAILABLE FROM THE ARC-SMALL GRAIN INSTITUTE AND ALSO INFORMATION ON THE REGISTERED INSECTICIDES.

PESTS IN THE WINTER RAINFALL REGIONS AND IRRIGATION

- **Aphids**

Aphid species, causing problems in the winter rainfall area are mainly oat aphid, the English grain aphid and rose grain aphid. Russian wheat aphid, which is the most severe wheat aphid in SA, is a sporadic pest in this area. The former aphids prefer thick plant densities with damp conditions, which are typical of the winter rainfall regions as well as irrigated fields. During dry conditions in this area aphid numbers are low, with the exception of the Russian wheat aphid, which prefers dry conditions.

OTHER INSECT PESTS

- **Bollworm (*Helicoverpa armigera*)**

The presence of bollworm is generally noticed only once the larvae have reached the mid-instar stage inside the awns. Young larvae of early season generations initially feed on the chlorophyll of leaves, later migrating into the awn to feed on the developing kernels. Producers should scout their fields in order to detect the younger larvae, as the older, more matured larvae are generally less susceptible to insecticides and obviously cause more damage compared with small larvae. Chemical intervention can be considered when five to eight larvae per square meter are present. However, producers should take care in applying the correct dose of registered insecticide under weather conditions conducive to insect control.

- **Grain chinch bug (Macchaidemus diplopterus), or Grain stinkbug**

Damage is more pronounced under warm, dry conditions as stressed plants have less ability to tolerate/recover from chinch bug damage. There are no insecticides registered against this insect on wheat.

- **Grain slug (*Lema erythrodera*)**

The symptoms include a white longitudinal stripe development on damaged leaves. Currently, no insecticides are registered on wheat.

- **Black sand mite or red-legged earth mite (*Halotydeus destructor*)**

Symptoms: silvery white scars adjacent to the main vein of especially older leaves. High infestations could lead to dying off of small plants. A single systematic insecticide is registered although no threshold value is available.

7.2. PESTS IN THE SUMMER RAINFALL REGIONS

Five aphid species are commonly found on wheat in the summer rainfall production areas in SA. The Russian wheat aphid (*Diuraphis noxia)* is the most important with outbreaks occurring annually, while the other aphids, namely green bug (*Schizaphis graminum),* bird-cherry oat aphid (*Rhopalosiphum padi*) and brown ear aphid (*Metopolophium dirhodum*) occurs sporadically. Generally, Russian wheat, bird-cherry, oat aphid, and green bug occur in dryer, lower potential circumstances, while bird cherry, oat aphid, brown ear aphid and rose grain aphid occur in wetter, high potential environments.

The Russian wheat aphid and other aphids that were discussed earlier, brown wheat mite, false wireworm, Black maize beetle, leafhoppers and maize streak virus.

Pest	Symptoms	Control measure/s
Russian wheat aphid *(Diuraphis noxia)*	Young plants: stunted and the leaves rolled tightly closed Mature plants: longitudinal, white or pale yellow stripe, later purple, tightly rolled leaves and trapped heads	Plant cultivar with RWASA1
Brown wheat mite (*Petrobia latens*)	Mottled leaves due to sap-feeding and later yellow or bronze, resulting in yellow or brown patches	Chemical control
False wireworm (*Somaticus sp., Gonocephalium sp*)	Feeding on seed, roots and seedling stems by larvae, and adults damage emerging seedlings	Cultural practices to reduce population as adults cannot fly Seed treatment
Black maize beetle (*Heteronychus arator*)	Adults chew on seedling stem, resulting in reduced stand	Seed treatments
Leafhoppers and maize streak virus	Young plants are stunted with curled leaves with white longitudinal stripes	No chemical control of leafhoppers on wheat Can be prevented by later planting dates in areas away from maize field

AVAILABLE CULTIVARS WITH RESISTANCE TO RWASA1 DEVELOPED BY DIFFERENT ORGANISATIONS

ARC-SCI	MONSANTO	PANNAR
Betta-DN	SST 966	PAN 3364
Gariep	SST 399	PAN 3235
Matlabas	SST 322	PAN 3144*
Limpopo	SST 334	PAN 3355
Caledon	SST 935	
Elands	SST 946	
Komati		

8. DISEASES AND WEEDS

While wheat diseases such as eyespot, take-all and crown rot, as well as weeds such as gut brome and ryegrass, are important grain yield limiting factors in the Western and Southern Cape, it is a well-known fact that crop rotation with leguminous crop is the most efficient method of controlling these problems. In such systems the effective chemical control of grass weeds in the non-grass crop is essential. Should monoculture, however, be practiced, these problems can be curtailed by burning the residue or by deep mouldboard ploughing. Owing to the high costs associated with mouldboard ploughing, the first alternative is preferred. The continuous burning of stubble residue will, however, increase the erodibility of the soil and damage the soil structure. For this reason it must be applied judicially.

Weeds limit grain yields by approximately 20% annually. By alternating the crops and changing herbicides, it is possible to control a wider spectrum of weeds. Effective weed control in one crop often means that the following crop can be grown without the need of expensive selective herbicides. Rotating crops and herbicides reduce the potential for herbicide resistance to develop in target species, for example wild oats. This can also reduce the potential for herbicide residue accumulation in the soil.

DISEASES OF SMALL GRAINS IN THE WINTER RAINFALL REGIONS

Disease group	Disease	Symptoms	Control
Rusts	Stem rust	Big parts of the stem appear reddish brown	Foliar fungicides at the seven-leaf and again at flag leaf stages
	Leaf rust	Orange-brown elliptical pustules on the leaves and on the ears under high-disease pressure	
	Stripe rust	Yellow-orange postules in narrow stripes of the leaf sheaths and inner surfaces of glumes and lemmas of the heads	
	Crown rust	Bright orange to yellow coloured elongated oval postules on leaves, sheaths and floral structures	
Mildew	Powdery Mildew	Fluffy white postules become grey, age and later white fungal growth covers the entire plant	Foliar application of fungicides
Spots and blotches	Scald or leaf blotch	Pale grey patches on the leaf surfaces and later the whole leaf, and the leaf may die off	Planting disease free seed, removal of volunteer plants and foliar fungicides
	Net blotch	Dark brown streaks across leaf length with a net-like appearance or brown to black elliptical lesions	Planting high quality disease free seed, the use of resistant cultivars, though not available in SA yet
	Tan spot	Small tan coloured flecks occur on leaves and sheath	Use registered fungicides, e.g. Carbendazim/ Epoxiconazole
Septoria	Leaf blotch	Small brown spots which later form elongated ovals then fruiting bodies. Severe necrosis	Disposal of contaminated crop debris by burning or ploughing it into the soil. Foliar fungicides
	Glume blotch	Oval lesions that coalesce to form larger areas of necrotic tissues form on the leaf	Disposal of contaminated crop debris by burning or ploughing it into the soil. Foliar fungicides
Ear and grain	Loose smut	Early emergence on ears with dark colour and slightly longer than the healthy ones. Spikelets transformed into powdery masses of dark brown teliospores	The use of high quality, disease free seed
	Karnal bunt	Kernels become blackened, eroded and emit a foul "fishy" odour	Preventing the entry of the pathogen to a certain area

Stem base and root	Take-all	Infected plants ripen prematurely and are stunted, die off prematurely	Crop rotation Volunteer plants, grassy weeds and crop residue should be destroyed
	Eye spot, Strawbreaker	Eye or lens-shaped eye spot lesion on mature wheat below the first node, premature ripening of the ears	The ploughing or burning of small grain cereal crop residue. Application of fungicides, e.g. Carbendazim/ Epoxiconazole

OTHER DISEASE IN THE SUMMER RAINFALL REGION

VIRUS DISEASE

Maize streak

The symptoms of this disease include fine, linear, chlorotic leaf streaks, shortened tillers, leaves and spikes and excessive tillering and sometimes leaves have bent and curled tips. The disease can be avoided by planting in areas where maize and grasses are infected, planting resistant cultivars and controlling leafhopper populations.

FUNGAL DISEASES CHEMICAL CONTROL

FUNGICIDES ARE ROUTINELY USED FOR CONTROL OF FOLIAR DISEASE, EAR AND GRAIN AND STEM DISEASES. IN SOUTH AFRICA VARIOUS ACTIVE INGREDIENTS ARE REGISTERED FOR THE CONTROL OF FOLIAR DISEASES ON WHEAT

Active ingredient	Wheat diseases			
	Stem rust	Leaf rust	Stripe rust	Powdery mildew
Azoxystrobin/Cyproconazole®		■		■
Azoxystrobin/epixiconazole®	■			■
Azoxystrobin/tebuconazole®				■
Bromuconazole®		■	■	■
Carbendazim/Cyproconazole®			■	■
Carbendazim/Epoxiconazole®		■	■	■
Carbendazim/Propiconazole®		■		■
Carbendazim/Triadimefon®		■	■	■
Cyproconazole®		■		■
Epoxiconazole®		■	■	■
Flusilazole®			■	■
Flusilazole/Carbendazim®		■	■	■
Propiconazole®	■	■		■
Propiconazole/Cyproconazole®	■	■	■	■
Prothioconazole®	■	■		■
Tebuconazole®	■	■	■	■
Tebucorazole®	■	■		■
Tetraconazole®	■	■	■	■
Triadimefon®		■	■	

ACTIVE INGREDIENT/S OF FUNGICIDES REGISTERED FOR THE CONTROL OF SEED-BORNE DISEASES OF SMALL GRAINS

Active ingredient	Seed-borne disease				
	Loose smut wheat	Loose smut barley	Loose smut oats	Covered smut barley	Covered smut oats
Carbonxin/Thiram®					
Mancozeb®					
Prothioconazole®					
Tebuconazole®					
Thiram®					
Triadimefon®					
Triadimenol®					
Triticonazole®					

Harvesting

HARVEST MATURITY

Wheat grains must be dry before it can be harvested. Wheat is harvested in the November/December period, but later harvestings are applicable in case of spring and summer wheat. Only fully ripened grains should be harvested. Harvesting should commence at 16% grain moisture content while lower moisture contents up to 13% are preferred for storage. The shattering types must be harvested earlier and dried artificially.

HARVESTING METHODS

A machine called a combine is used to cut, separate and clean the grain. A combine must be properly adjusted to minimise grain losses.

Special tools were developed for harvesting wheat:

- **Reaping** the sickle and scythe are tools that are used to cut and harvest wheat in the past. Mechanical reapers eventually replaced the hand tools.
- **Threshing** this is the separating of the grain or seeds from the plant material. The cutting and threshing process was combined into one machine called the combine. It can cut wheat, thresh out the grain, and store it in a bin on the machine.
- **Winnowing** is the process of separating threshed grain from the chaff.

POST-HARVEST HANDLING

SORTING

Sorting should be done after harvesting ensuring that all seeds of wheat must:

- Be free of any toxin, chemical or other substances that renders it unsuitable for commercial purposes: Provided that not more than 10 microgramme per kilogramme aflatoxin, of which not more than 5 microgramme per kilogramme will be aflatoxin B1, is permissible
- Contain no more noxious seeds or ergot sclerotia than permitted in terms of the Foodstuffs, Cosmetics and Disinfectants Act, 1972 (Act No. 54 of 1972)
- Be free of organisms of phytosanitary importance as determined in Terms of the Agricultural Pests Act, 1983 (Act No. 36 of 1983)
- Be free of mould, infected, sour and rancid other grain, foreign matter and any other matter

- Be free of any odour, taste or colour not typical of undamaged and sound wheat
- With the exception of Class Other Wheat, be free of insects
- With the exception of Class Other Wheat, be free from stinking smut infection
- With the exception of Class Other Wheat, have a moisture content not exceeding 13%.

GRADING

According to the grading system promulgated under the Agricultural Product Standard Act, 1990 (Act No. 119 of 1990) only one bread wheat class exists with four grades, namely; B1, B2, B3 and B4 that are determined according to the grain protein content, the hectolitre mass and the falling number. Hectolitre mass and especially protein content are largely determined by the environment during the grain filling period to maturity, and also by management practices, which include soil, water and fertiliser management.

SCHEMATIC PRESENTATION OF CLASSES AND GRADES OF BREAD WHEAT

Grading regulations			
Bread wheat – Class B			
Grade	**Minimum protein (12% moisture basis)**	**Minimum hectoliter mass (kg/ha)**	**Minimum falling number (seconds)**
B1	12	77	220
B2	11	76	220
B3	10	74	220
B4	9	72	200
Utility	8	70	150
Class other	**Do not comply to abovementioned or any other grading regulations**		

PACKING

Wheat of different classes shall be packed in different containers. Every container or the accompanying sale documents of a consignment of wheat shall be marked or endorsed by means of appropriate symbols specified in subregulation (2), with:

(a) The class of the wheat;

(b) The grade, in the case of Class Bread Wheat, Class Biscuit Wheat and Class Durum Wheat.

The symbols referred to in subregulation (1) shall appear in the order of class and grade.

The symbols used to indicate the different -

(a) Classes shall be -

(i) B in the case of Class Bread Wheat

(ii) C in the case of Class Biscuit Wheat

(iii) D in the case of Class Durum Wheat and

(iv) O in the case of Class Other Wheat.

(b) Grades shall be -

(i) S in the case of Super Grade

(ii) 1 in the case of Grade 1

(iii)2 in the case of Grade 2

(iv)3 in the case of Grade 3

(v) 4 in the case of Grade 4

(vi)UT in the case of Utility Grade.

STANDARDS FOR GRADES OF CLASS BREAD WHEAT, CLASS BISCUITS WHEAT AND CLASS DURUM WHEAT

Nature of deviation	Maximum percentage permissible deviation (m/m)					
	Super Grade*	Grade 1	Grade 2	Grade 3	Grade 4	Utility Grade
(a) Heavily frost-damaged kernels	5	5	5	5	5	10
(b) Field fungi infected kernels	2	2	2	2	2	2
(c) Storage fungi infected kernels	0,5	0,5	0,5	0,5	0,5	0,5
(d) Screenings	3	3	3	3	3	10
(e) Other grain and unthreshed ears	1	1	1	1	1	4
(f) Gravel, stones, turf and glass	0,5	0,5	0,5	0,5	0,5	0,5
(g) Foreign matter including gravel, stones, turf and glass	1	1	1	1	1	3
(h) Heat-damaged kernels	0,5	0,5	0,5	0,5	0,5	0,5
(i) Damaged kernels, including heat-damaged kernels	2	2	2	2	2	2
(j) Deviations in terms (d) (e) (g) and (i) collectively: provided that such deviations are individually within the limits of the mentioned items	5	5	5	5	5	5

* Only in the case of Class Durum Wheat

STORAGE

Wheat should be stored in the silos or dry conditions after harvest in order to avoid damage by moisture, pests, high and very low temperatures. When the produce dry and cool, physiological process, fungal and insect activities are low. Storage of wheat may take many forms depending on the market price. Some farmers prefer to store wheat in their farms for some time while studying the markets. Others sell their harvests on contracts or spot price through SAFEX. Some farmers may prefer to store their wheat at the silos at a predetermined rate. However, in most cases the harvest is sold to millers by the time it is transported to the silos. The following are conditions that need to be taken into consideration when storing wheat crops:

(a) Immature or damaged seed cannot survive for long storage periods; seed should be harvested when properly matured

(b) Mechanical injury to seed during harvesting makes it more susceptible to deterioration in storage

(c) Seed must be properly dried before going into storage and protected from moisture and high humidity

(d) Insects should be controlled by a combination of insecticides and fumigants; Phostoxin is the safest while methyl bromide may affect the produce

(e) Controlled and airtight storage atmosphere is of utmost importance.

TRANSPORT

Wheat has to be transported to the silos after harvest. Rail trucks and road trucks can be used to transport wheat locally and ships may be used for exporting and importing.

MARKETING

The South African wheat market was deregulated on 1 November 1997 and wheat can therefore be traded freely. All grain producers, traders and processors are now able to trade in a free market, responding to forces of worldwide supply and demand in setting prices. The only government intervention in the market is the tariff on wheat imports. The wheat prices are influenced by factors such as international wheat prices, the strengthening of the rand against other currencies, international and local wheat supply and weather conditions. The market price is also directed by the future level of prices of different commodities and the expected increase in demand of wheat owing to the biofuel project and the fact that South Africa is importing wheat from other countries for consumption. Farmers can sell their wheat on contracts through SAFEX while the wheat is in the field. The wheat marketing season in South Africa commences on 1 October and ends on 30 September the following year.

Part IV: Production Schedules

ACTIVITIES	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
Soil sampling		■	■	■								
Soil preparation			■	■	■							
Planting: winter summer			■	■	■	■	■					
Fertilisation			■	■	■	■	■					
Irrigation: winter summer			■	■	■	■	■	■	■			
Pest control					■	■	■	■	■			
Disease control					■	■	■	■	■	■		
Weed control			■	■	■	■	■	■	■	■		
Thinning: winter summer						■	■	■	■			
Leaf sampling	Before side dressing or two months after planting											

Harvesting: winter summer												
Marketing												

Utilisation

Human consumption: Wheat is used mostly for human food worldwide. History shows that the first people to consume wheat probably did so 17 000 years ago by chewing kernels of the wild grain. Today the best known and most widely cultivated wheat is used for grain either whole or ground. Fine ground wheat is the source of flour for the world's bread-making industry. In South Africa, wheat is mainly used for human consumption with a small portion as animal feed. Grain is also a source of alcoholic beverages in some parts of the world.

Industrial utilisation: Other countries produce industrial alcohol into synthetic rubber and explosives. Starch is used for pastes and sizing textiles. Straw is made into mats, carpets, baskets, and used for packing material, cattle bedding, and paper manufacturing. Scientists are studying ways to use wheat for other non-food products such as medicines, makeup, and biodegradable plastics.

Livestock feed: Bran from flour milling is an important livestock feed while germ is a valuable addition to feed concentrate. Grain can be fed to livestock whole or coarsely ground. Some wheat is cut for hay. Wheat grown for grain is also used for pasture before the stems elongate and as a temporary pasturage; it is nutritious and palatable.

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FURTHER INFORMATION CAN BE OBTAINED FROM:

Directorate: Plant Production

Grain Division

Private Bag X250

PRETORIA 0001

Tel.: +27 12 319 6072

Fax: +27 12 319 6372

E-mail: Thabo.Ramashala@daff.gov.za

NOTES

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