

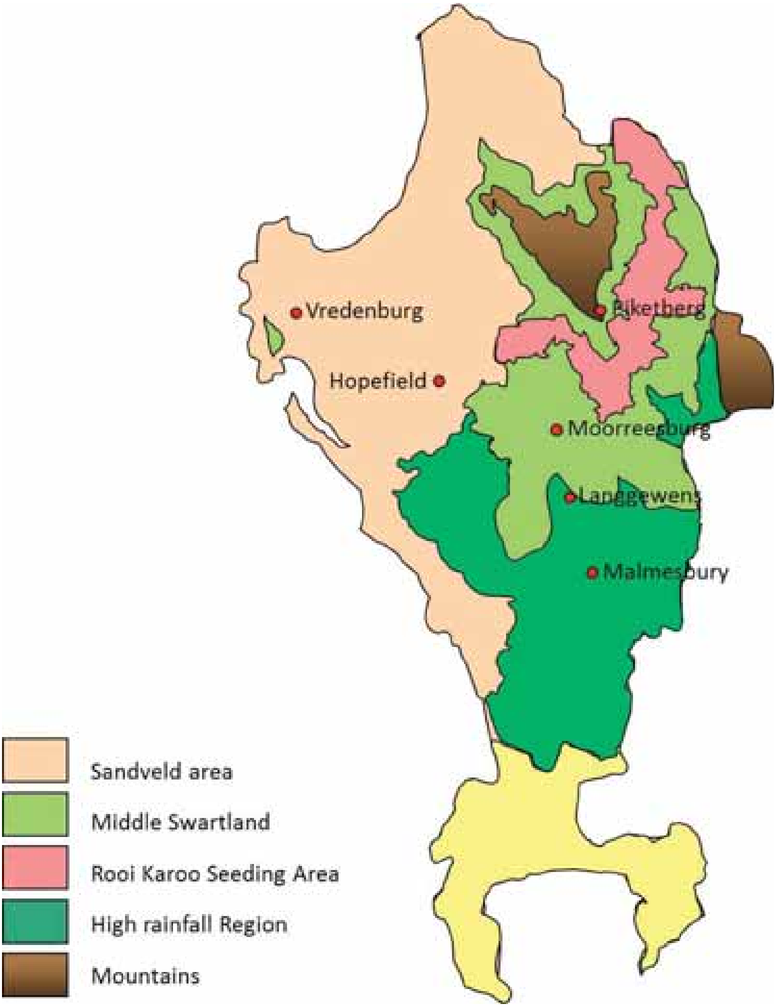
GUIDELINE

PRODUCTION OF SMALL GRAINS IN THE WINTER RAINFALL AREA

ARC-Small Grain Institute

2014

ARC • LNR


Vredenburg
Piketberg
Hopefield
Moorreesburg
Langgewens
Malmesbury
Sandveld area
Middle Swartland
Rooi Karoo Seeding Area
High rainfall Region
Mountains


Swellendam
Heidelberg
Tygerhoek
Roodebloem
Caledon
Rietpoel
Protem
Klipdale
Napier
Bredasdorp
Wes-Rûens
Suid-Rûens
Oos-Rûens

GUIDELINES FOR THE PRODUCTION OF SMALL GRAINS IN THE WINTER RAINFALL REGION 2014

Compiled by

ARC-Small Grain Institute University of Stellenbosch SABBI

SAB Maltings (Pty) Ltd

Department of Agriculture: Western Cape

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FOREWORD

That the wheat and barley industries in South Africa are under significant pressure to become more competitive and profitable for the producers, is probably the understatement of the year. As a result, the hectares under wheat production reached an all-time low the previous season. Reasons behind this phenomenon are many fold, amongst others are that we do not realise the high intrinsic quality value of our wheat crop in monetary terms, that the cultivars at our disposal are lacking in competitive yields and that the varying climate also play a significant role.

Then came the 2012/2013 harvesting season and on the back of a similar 2011/2012 season (excluding the Free State) proved beyond any doubt that our recommended dryland and irrigation wheat cultivars have the genetic potential to yield up to four tons and nine tons to the hectare respectively. For the first time in many years this was backed-up by a significantly higher and more competitive wheat price. As a result, the wheat production regained its competitiveness to some extend in the Western and Southern Cape, both the warmer and cooler irrigation areas as well as certain parts of the Eastern and North-Western Free State. Wheat production needs to increase this level of competitiveness even in relation to maize, soybeans and canola production. In addition we realised that the genetic potential to achieve this is available in the cultivars available to us, but then we need to use them wisely.

In achieving this, the **2014 Guidelines for the Production of Small Grains by the Small Grain Institute** as proven by its many annual predecessors, is a most important decision-making database. The information, which is based on sound objective and scientifically proven replicated trials (2-4 years data) is representative of all major production areas and will assist you to make the correct cultivar choice for your specific production area.

Performance data of each cultivar is supported by disease, insect and weed control information as well as related crop production practices, soil, water and fertilisation management recommendations. This publication will certainly lower your risks and increase your productivity and cost efficiency.

Most importantly, do remember that productivity and profitability are not measured in tons/ha, but in profit/ha. Only the latter will ensure our competitiveness.

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GENERAL CROP MANAGEMENT

The aim of this publication is to highlight the management of the wheat crop in a sustainable crop rotation system to increase the competitiveness of the crop. Although there is not one single best management practice for all situations, this publication will discuss the principles of the growth and management of the wheat crop, so that applicable management decisions can be made as the specific situation arises.

The major consideration in dryland wheat production is profitability. The traditional wheat-fallow-wheat system that had been followed for many years had become unprofitable, mainly due to soil water availability restrictions and increased disease occurrence. This system has also led to degradation of soils via decreased organic carbon (humus), and increased soil acidity and soil erosion. Increased profitability can only be achieved by maximising the yield potential of the crop/soil/climate combination, while input costs are also strictly managed.

In striving to achieve greater productivity with the available resources invested in crop production, and not necessarily higher total production, it is important to consider a few basic principles of crop management.

- **Soil selection** is critical, requiring each land to be reviewed individually to realise its potential;
- Analyse soil samples to evaluate **the fertility status** of the soil;
- Follow an **effective liming** program;
- Do **fertilisation planning** including all important plant mineral elements;
- Apply appropriate **soil cultivation methods**. These include: alleviation of compaction layers, crop residue management, weed control and seedbed preparation, with the main aim of maximising soil water conservation in the soil profile. Each soil cultivation input must have a specific objective;
- Plant a number of **cultivars** with a high yield potential and relevant disease and insect resistance;
- Calibrate **planters** to ensure the correct seeding density, fertiliser application and planting depth for seed germination;
- Select the optimal **planting time** for a particular cultivar, and plant at the recommended seeding density to ensure optimal emergence and seedling establishment;
- Follow an effective **spraying programme** for control of weeds, insects and diseases during the growing season;
- **Timely harvest** of the crop and post-harvest storage can impact on optimal yield and grain quality;
- **Effective marketing** of the grain for successful financial management.

Crop Rotation Management

From an economical and agronomical viewpoint it is beneficial to cultivate wheat in a suitable crop rotation system. Grain yields are increased, while weed, insect and disease problems are reduced.

Yield limiting factors

The major factors that limit crop yields are:

- Unsuitable soil selection;
- Restricted soil water availability and climatic stresses;
- Low soil fertility and nutritional deficiencies;
- Plant diseases;
- Weed competition;
- Insects;
- Sub-optimal planting dates and cultivar choices;
- Poor seed germination and crop establishment.

These factors arise because of poor cultivation methods, inappropriate soil selection and low water retention practices, soil water accumulation, and crop rotation.

Long-term rotations require planning

Good crop rotation planning is the single most important management practice determining yields and profitability. It is an investment in risk aversion. A well planned and managed crop rotation system decreases input costs, increases yields and spreads production risks.

What is the best crop rotation system?

There is not **one single** crop rotation system that will be suitable for all production regions. Every farmer must plan and develop a long-term system that is adaptable and sustainable, incorporating the principles of agronomic management and farm planning. The choice of crop for each field must be based on an objective determination of gross income, input costs, field, and crop rotation history.

A crop rotation system for any given situation will be determined by:

- The objectives and attitude of the farmer;
- The different enterprises on the farm and relevant commodity prices;
- The cash flow and economics of the cultivated crops;
- Agronomic management principles;
- Soil depth, structure and texture;

- Soil fertility status and acidity;
- Total rainfall and distribution in the growing season;
- Spectrum of weeds occurring in the fields;
- The rotation of nitrogen fixing and nitrogen dependent crops;
- Occurrence of plant diseases;
- The prevention in the build-up of soilborne diseases;
- Available machinery and equipment, and
- Livestock needs and fodder flow requirements.

Benefits of a sustainable crop rotation system

Reduced diseases

A factor emerging as a major threat to wheat yields and thus income in recent years, is the increasing incidence of root diseases. The only practical control strategy is a well planned and managed crop rotation system, which is aimed at eliminating annual grasses and volunteer wheat, which may serve as a source of inoculum for these diseases at least 12 months prior to crop establishment.

Decrease weed burden

Weeds compete with crops for water, nutrients, sunlight, and field space and can significantly reduce yields. Weeds limit grain yields by approximately 20% annually. By alternating crops and rotating 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 for expensive selective herbicides. Rotating crops and herbicides reduces 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.

Increased soil fertility

The aim of a suitable crop rotation is to include a nitrogen-fixing crop (legumes) that replenishes the nitrogen exploited by the grain cropping phases. Yield and grain protein increases in wheat, following legume crops have been widely demonstrated. The accumulation of soil organic material and residual nitrogen in the soil, is linked to the recovery of soil structure and increased soil water accumulation capability, which in turn favours improved yields.

Increased profits

The inclusion of a legume in the crop rotation system generally increases profitability by increasing grain yields. Economic sustainability is also ensured, because production risks are spread over different crops and growing seasons.

MANAGEMENT OF WHEAT PRODUCTION

Good yields and profitability can only be achieved through careful planning and management. Higher yields imply higher profits, since production costs per ton of grain declines relatively as yields increase.

Avoid having an inflexible approach to crop management. Learn to adapt and revise management strategies as the cropping environment, yield potential, commodity prices and input costs changes.

What determines wheat yield?

Total grain yield per hectare is the result of:

- The number of plants per hectare;
- The number of ears per plant;
- The number of grains per ear;
- Individual grain weight.

Above-mentioned yield components and eventually grain yield is determined during the three main development phases and relevant growth stages. It is possible that a yield component that kicks in at a later growth phase, partially compensate for reductions in a yield component determined at an earlier development stage. The development stages for the different yield components overlap to some degree in their respective effect on potential grain yield, and they are determined in a definite sequence, as indicated in the following schematic representation (Figure 1).

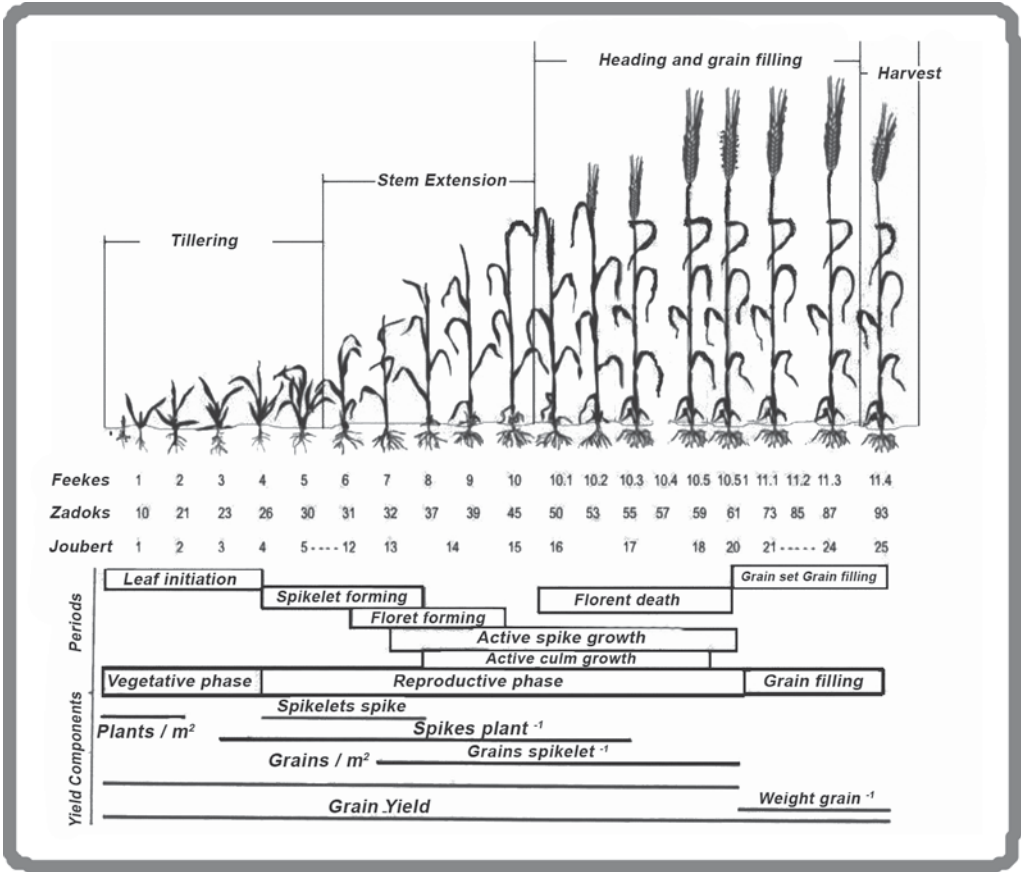
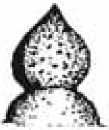


Figure 1. Growth and development stages of wheat during the growing season

**Adapted from:*

- *Ohio Agronomy guide 14th edition.*
  Bulletin 472-05.
- *Slafer & Rawson, 1994*
- *Wheat growth and physiology.A.Acevedo, P.Silva & H.Silva, 2002. FAO Corporate document respository (www.fao.org).*
- *Bread wheat, 2002 (B.C. Curtis, S. Rajaram & H.Gomez MacPherson, eds.) FAO Plant Productions and Protection Series, no 30, Rome, 2002.*

Growth stages (sketches according to dr Gideon Joubert)



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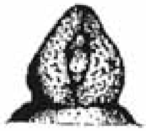

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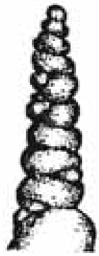

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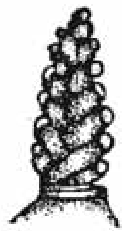

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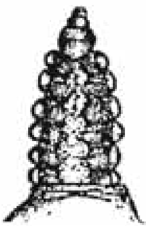

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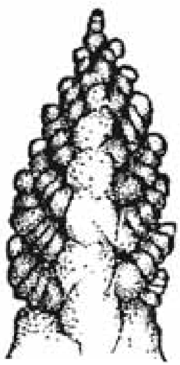

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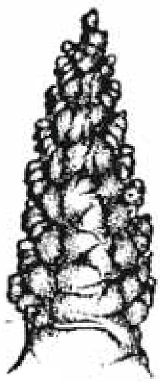

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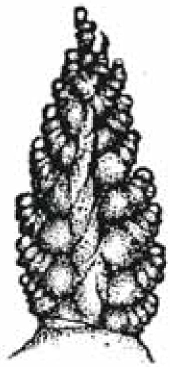

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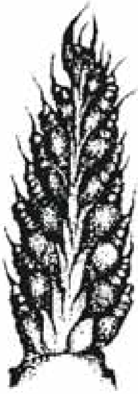
Growth stages (continued)



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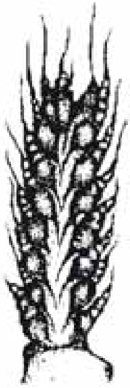

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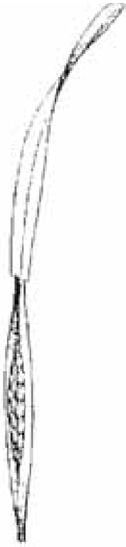

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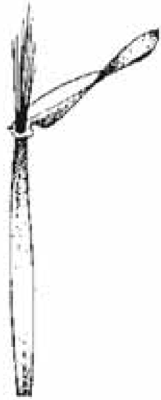

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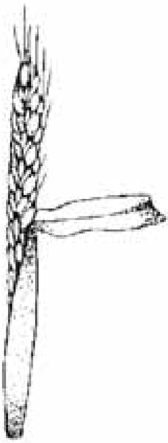

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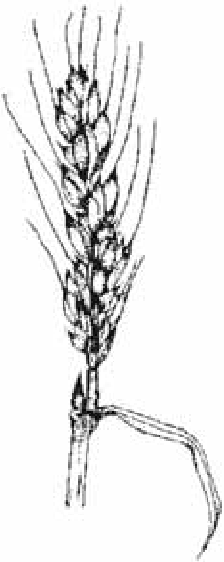

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Growth stages (continued)

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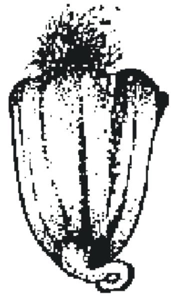

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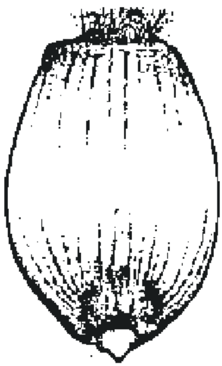

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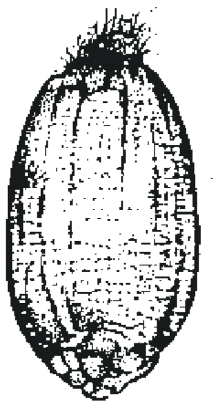

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Growth stages (photos by Robbie Lindeque)


GS2


GS3


GS4


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GS10


GS11


GS12


GS13

Growth stages (continues)

GS14

GS15

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Factors influencing yield components

Management phase	Factors	Yield components
Planting	Seed density (kg/ha) Thousand kernel mass Seed germination percentage Seed vigour Coleoptile length Soil structure and texture Seedbed preparation Soil water content at planting Planting method / depth Fertiliser application at planting Seed treatment	Number of plants established per hectare
Vegetative and reproduction phase	Cultivar Planting date Soil fertility (N, P, K, pH) Soil water availability Temperature (minimum and maximum) Insects / weeds / diseases	Number of tillers/ ears per hectare
Grain filling	Cultivar Nitrogen availability Soil water availability Temperature (maximum and /or cold damage) Diseases/insects	Grains per ear and single grain mass

Establish target yields

Set a realistic target yield for your cropping programme, taking into consideration all the available resources. Target yields form the foundation for crop management decisions. Cultivar selection, fertiliser rates, herbicide and insecticide applications and especially the yield planning and other management decisions can only be made with the aid of target financial objectives.

Various factors should be considered when setting a target yield:

- Experience: historical yield data of the past five years;
- Plant available water: sum of stored soil water at planting plus average growing season effective rainfall; and
- Use long-term climate projections.

The risk associated with your selected yield target should be carefully considered. Profit is the compensation for taking risks, but be realistic: certain management practices and target yield goals have a higher risk component.

Achieving target yields

The key management decisions to achieve target yields and to maximise profits include the following:

- Total farm planning including soil selection;
- A well planned crop rotation system;
- Effective management of plant available soil water;
- Soil analysis for a relevant fertilisation and liming programme;
- Setting realistic target yield;
- Application of effective soil cultivation practices;
- informed cultivar selection;
- Use of high quality seed;
- Correct planting dates and seedling densities of selected cultivars;
- Appropriate planter speed and planting depth;
- Monitor the crop development and note observations;
- Make timely decisions on weed, insect and disease control;
- Timely harvest of grain crop ;
- Develop a financially sound marketing strategy;
- Apply sound agronomic management principles.

SOIL TILLAGE GUIDELINES

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Objectives of soil tillage

Soil tillage is simply too expensive to practice without having well defined and specific objectives in mind. In monoculture systems in the Western Cape, the overriding objective is to improve the cultivation conditions of small grains and wheat in particular. Where wheat is cultivated in short crop rotation systems with medics and clovers, the effect of the tillage method on the re-establishment of these pastures also has to be considered. Knowledge of the factors that thus limit grain yield in the Western Cape, and the influence of different soil tillage methods thereon, are a prerequisite to ensure optimal tillage practises.

Influence of soil tillage on yield-limiting factors

Plant density

Despite drastic increases in seeding rates over the past decade, the plant density at seeding establishment is often still below 200 plants/m^2, which must be considered to be the general target for conventional tillage systems. Contributing to this problem is an uneven stand establishment that causes both an excessive and low stand on the same field.

Low and uneven germination and establishment can be prevented by using good quality seed, creating favourable seedbed conditions and by implementing seeding methods that ensure the seed is placed at an even depth and good contact with the soil should be achieved.

Trials have confirmed that different seeding/planting methods, under identical seedbed conditions, can cause differences in seedling establishment of up to 30%. The results also indicate that seeding implements with good depth control, give the best results, while presswheels and rollers also benefited establishment. The greatest advantage with presswheels and rollers is, however, achieved under fairly dry conditions, and in sandy soils and rough seedbeds with plenty of unwithered stubble. Rollers must, however, be avoided on fine seedbeds and in very wet conditions.

The establishment of an even seedling stand will also benefit from an early planting, when soil temperatures still tend to be higher, in conditions where adequate soil moisture is available. In this regard, a fairly thick layer of stubble on the soil surface may be advantageous. Stubble could also prevent or limit the formation of surface crusting, which strongly inhibits establishment. The optimal quantity of crop residue to be left on the soil surface, will depend on the availability of suitable implements. It is important that implements must be able to handle the residue without blocking. The use of straw choppers and spreaders will be a necessity in most cases, to ensure an even distribution of residue.

Although a wide variety of disc- and tine drills are on offer, their suitability will depend on specific on-farm soil type, stoniness and topography. Because new implements are very costly, advice from a machinery expert may be needed. Old on-farm machinery may in some cases also be quite effective after modification.

Soil moisture supply

Due to the limited depth of most small grain soils in the Western and Southern Cape and an erratic rainfall distribution pattern, small grain crops are often limited by both water-logged and drought conditions within the same season. Since the amount of rainfall is a fixed production factor, the producer can only strive for better utilisation of the rainfall to ensure an optimal moisture supply for his crop.

While different methods of soil tillage do affect the soil moisture content during the growing season, the effect thereof on the number of days that the crop is subject to drought is minimal in the Western and Southern Cape, due to the low soil moisture storage capacity of the soil. The soil water storage capacity of the soil can, however, be increased slightly by creating ridged beds, for example when practising open furrow drainage. This technique has the added advantage that it also limits waterlogged conditions. Unfortunately, large areas of the Western and especially the Southern Cape are too hilly to apply this technique. In these areas producers can do little more than utilise available soil moisture optimally by arranging planting/seeding dates so that the growth cycle of the crops falls as far as possible within the rainfall season. Crops must thus be planted/ seeded directly after the onset of the rainfall season. In the Southern Cape, where part of the annual rainfall occurs in the summer, crops can even be planted just prior to the onset of the rainfall season. These objectives are, however, only achievable if the soil has good structure so that the minimum of tillage will be necessary and early rainfall is conserved by a mulch of stubble on the soil surface.

Root development

This limiting factor largely overlaps with the previous discussion due to the influence of soil depth on root development. Rooting depths of less that 200 mm often occur on soils of 300-400 mm. Shallow root development can thus also be the result of other factors, such as high soil bulk densities, low soil pH (soil acidity) and compacted layers.

Shallow tillage practices and no-till result in an increased soil bulk density at most soil depths. The effect thereof on root development will largely depend on soil type and soil structure. On very sandy and heavy clay soils this effect may be permanent, but the results of previous research, indicates that the effect on shale soils (Glenrosa soil type) decreases as the duration of minimum tillage increases. Due to the important role of soil structure, which takes considerable time to improve, a gradual decrease in the frequency of deep tillage practices is advisable. Crop rotation systems with leguminous crops can help to speed up this process. On lime-poor soils, soil acidity may in any case necessitate deep application of lime. Due to high nitrogen fertilisation levels in monoculture systems, the rate of acidification in these soils will be considerably higher than in systems that include leguminous crops.

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 crops is the most efficient method of controlling these problems. In such systems the effective chemical control of grass weeds, which may harbour disease inoculum, in the non-grass crops is essential. Should monoculture, however, be practiced, these problems may be curtailed by burning the residue or by deep mouldboard ploughing. Due to the high costs associated with mouldboard ploughing, the first alternative is preferred. The continuous burning of stubble residue will, however, increase the erodability of the soil and damage the soil structure. For this reason it must be applied judiciously.

Plant nutrition

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 fertilisers is affected by fertiliser placement (uptake) and root distribution. To improve their uptake, fertilisers (like phosphorus) that do not move easily in the soil, must be placed near the roots. As already discussed, efficient root distribution is affected by soil strength.

N-mineralization of the soil is determined by climate, soil conditions and method of soil tillage. N-mineralisation in the soil could provide large amounts of nitrogen in crop rotation systems, which include legume plants and in 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. From Table

1 it is, therefore, clear that optimum N-rates for different crop rotation and methods of tillage will differ.

Table 1. Effect of crop rotation, method of soil tillage and N-fertilisation on grain yield (kg/ha)

Production system	N-Rate		
	60	100	140
Wheat monoculture:			
Mouldboard ploughing*	3516	3724	3744
Minimum tillage**	3303	3640	3973
No tillage***	2390	3105	3363
Wheat in rotation with lupins conola:			
Mouldboard*	3098	3038	3093
Minimum tillage**	2864	3408	3159
No tillage***	3147	3516	2537

* *Tine tillage (150 mm deep) in April; mouldboard plough and tine cultivator at seeding.*

** *Tine tillage (75 - 150 mm deep) in April; chemical weed control with non-selective herbicide at seeding.*

*** *No tillage prior to planting; weed control with in-selective herbicide.*

Proposed tillage systems

The use of conservation tillage systems are increasing in the Western and Southern Cape, due to increased economic and biological sustainability of these systems, but a conventional approach is often still needed within these systems. The following guidelines and practises can be applied for use in conventional and conservation tillage systems.

Conventional production system

Wheat-legume/Canola crop rotation

- Control grass weeds chemically (herbicides) in legume/canola phase.
- Till to a depth of 75-100 mm with a tine implement after the first autumn rain of wheat year 1. Deeper tillage (150-200 mm) may be necessary on soils that tend to compact, but then the tine implement must be followed up by a spiral or "band roller".
- Control weeds with a non-selective herbicide.
- Select a seeding implement according to the quantity of plant material/ residue left on the soil surface.
- If tine-dulls are used, pre-plant tillage will in most cases not be necessary. In the case of perennial legumes, especially in low rainfall areas, this cultivation can be done at the end of the previous winter season while the soil is still wet. The tine implement may also be substituted with a disc implement if necessary. This tillage method may also be used in situations where long fallow periods are necessary, due to a lack of implements.

Wheat monoculture system

- If grass weeds and diseases, especially root diseases, are not a problem, the above-mentioned tillage system can also be implemented in this case.
- If diseases and non-selectively controlled grass weeds are the most yield limiting factors, the pre-establishment weed spray can be substituted by a deep plough tillage, followed by a harrow or sweep to bury weed seeds and contaminated/diseased residue.

Conservation tillage systems

Conservation tillage systems differ from conventional tillage systems in that soil disturbance is kept at a minimum, soil is hardly ever inverted and stubble is purposefully retained to protect the soil against erosion. The retention of stubble will improve the production potential of soil over time by altering the soils physical, chemical and biological properties and improve soil water usage. However, the retention of stubble also causes problems and difficulties that need to be managed in the system. The use of crop rotation systems, especially the inclusion of pasture phases, is of utmost importance to ensure effective control of weeds, especially herbicide resistant grasses. When wheat is planted in monoculture, especially in conservation tillage systems where stubble is retained, the incidence of diseases like take-all, crown rot, Septoria, eyespot and head blight can increase drastically due to inoculum that is associated with the stubble. Control of herbicide resistant weeds may be more troublesome, due to a smaller range of herbicides (with similar modes of action) that can be applied. Wheat and barley must therefore be rotated with canola, lupines or pasture crops to break these disease cycles and the build-up of inoculum and seed banks of herbicide resistant weeds.

Within conservation tillage systems, a variety of planting methods can be used. These planting methods are sometimes closely related, and can often be confusing. The following definitions can help to clarify these methods:

The no-till planting method

The no-till method (short for no-tillage) is most often used in South Africa and Australia. The planter is fitted with knife-point openers and press wheels, that to some extent, cultivate the soil during the planting process. However, less than 20% of the soil should be disturbed.

Direct seeding

More or less the same as no-till, but stubble openers can also include discs and/or coulters that cause more than 20% of the soil on the surface to be disturbed. This method is often used in Canada, North- and South America and the eastern parts of Australia. In South Africa, it is more often used in heavy stubble situations, such as under irrigation.

Zero till

Refers to the planting method where planters are equipped only with coulters or discs, without knife-point openers that penetrate the soil. No mechanical loosening of the soil occurs during the planting process. The disc openers cut a groove in the soil in which the seed is placed and then closed. This planting method is extremely fast (up to 16 km/h) and suitable to be used when the crop is established in dry soil because no surface clods are formed. The use of "Star-wheel" planters (that cause the absolute minimum soil disturbance), can also be considered a zero-till planting method. Zero-till will, however, not be suitable for most soils in the Western Cape as they have very high stone and gravel fractions. This planting method is only practical if the soil has already been improved by years of conservation tillage, stubble retention and crop rotation. All three of these planting methods are similar in terms of stubble retention, pre-emergence herbicide application and planting without prior cultivation.

Conversion to conservation tillage

Traditionally, in the Western Cape Province, winter cereals are either broadcasted or sown in 170 mm rows at densities of as much as 130 kg/ha. These sowing methods, however, create problems for farmers who changed from conventional mouldboard and disc-ploughing to more sustainable systems of conservation tillage such as no-till, where crop residues are left on the soil surface and the soil is not disturbed before the planting process. No-till tine drills with knife-point openers are now commonly used, but heavy stubble can still cause blockages of planting equipment. Wider row spacing, distribution of planting units and two or more bars and higher vertical clearance of no-till planters offer better stubble flow than conventional planters. Wide row widths also reduce planting cost by increasing efficiency and decreasing the energy needed for the planting process. This is achieved by using the same fuel to plant a given area in a shorter time. Over time, wider row spacing also reduce the initial cost of the implement and maintenance cost.

For instance, if the row width of a 12 row planter is increased from 250 mm to 300 mm and the planter plants at a speed of 8 km/h, the planter will plant 0.4 hectare per hour more. For a typical 12 hour working day, the planter will plant 4.8 ha per day more, using the same fuel and at no extra cost. Increasing planting rate (ha/day) is by itself a major advantage in the Western Cape, due to the short planting window available in the region.

It is important to address any physical or chemical problems in the soil (eg. liming to adjust soil pH) before starting with conservation tillage as it will be difficult to address these problems adequately once the system is implemented and deep tillage is eliminated.

Research results

The ARC-Small Grain Institute has conducted research, with regard to the possible effects wider rows may have on spring wheat production in the Western Cape. A commercially available no-till planter with knife-point openers and band placing of fertiliser was used to plant trials in the Southern Cape (Caledon, Swellendam and Riversdale) and in the Swartland (Moorreesburg and Hopefield). Where possible, trials were planted only on fields that had been used for canola, clovers or lupines in the previous season, but in some cases the trials were planted on first year wheat stubble. During these seasons, a wide variation of conditions was experienced ranging from excellent to very poor.

Two or three row widths including 250 mm, 300 mm and 350 mm were used at each site. In addition, different cultivars were also included and planted at different seeding densities according to recommendations for the area. The experiments were all executed on the farms of commercial farmers and the producer (except for the planting and harvesting processes) managed the whole trial site.

Seedling survival

Seedling survival in the Western Cape is generally low, due to the shallow soils with limited water holding capacity and high stone and gravel fractions and therefore relatively high planting densities are needed to ensure a stand of at least 200 plants /m². Normally, only 50% seedling survival was achieved with the broadcast planting method, while 60-70% survival could be achieved with conventional planters in conventional tillage systems. Research indicated that 80% seedling survival can be achieved with no-till planters equipped with knife-point openers and press wheels in most seasons. Seedling survival lower than 80% was noted at some localities and in some seasons due to unfavourable conditions after planting, but these conditions would have had a similar effect on other planting methods. Increased seedling survival makes the use of lower planting densities possible without significant yield loss, but it remains important to ensure sufficient plant stands, especially in high potential areas. In these areas, 200 established plants/m² remain a realistic target to ensure optimum grain yield.

Row widths

No-till planters must make use of row widths wider than 170 mm that was used formerly in order to achieve sufficient stubble flow through the system. No-till planters are currently produced with 250, 275 or 300 mm row widths. In general, the wider row option will have the following advantages:

- Lower input and capital costs (fuel, maintenance and initial buying price);
- Reduced risk with regard to the use of pre-emergence herbicides and faster planting speed;
- More efficient stubble flow; and
- Less competition with weeds between rows, especially in poor sessions when sunlight can enter between the rows.

Unfortunately, the use of the wider row option can also have the following disadvantages:

- Increased competition with weeds in the row, especially herbicide resistant grasses.
- In poor seasons, wide rows can cause problems during the pick-up process if the crop is swathed.

Research findings from twenty trials indicated that the use of the wider row width option (300 mm vs 250 mm) did not necessarily lead to a negative yield response, but that significant yield loss can occur under certain conditions. In four of the twenty trials, significant yield reductions were measured with the use of 300 mm vs 250 mm row widths. Significant interactions between cultivars, row widths and planting density indicated that cultivars may respond differently to planting density and row widths in this region. When yield loss occurs, it is usually in the order of 200 kg/ha, which can constitute a loss of 5-10% at yield levels of 2-4 ton/ha.

These reductions in grain yield can be attributed to a reduction in the number of heads/ m^2 that was noted in almost all trials when row widths increased. The reduced head populations due to wider row widths can probably be attributed to an increase in inter- plant competition for resources (water, nutrients and light). Similar grain yield with wide row widths can therefore only be achieved if compensation by the plant (increased kernels/head or increased kernel weight) occurs. This compensation depends heavily on growing conditions late in the season (in the period just before and after flowering) when the number of kernels/head is set and during the grain filling stage when the final kernel weight is determined. Unfortunately, water availability during these two critical periods cannot be controlled and a lack of compensation will lead to reduced yields with wide row widths. Row widths, not wider than 300 mm, will give acceptable results in most seasons and in most production areas, but the risk of yield loss due to the use of the wider row option cannot be excluded. The Swartland and especially the Sandveld are more sensitive to the use of wider row widths.

Recommendations

Row widths

The choice of the row width option used (250, 275 or 300 mm) is left to the producer after considering the advantages of the wider row width option in relation to the risk in his specific area. Requirements with regards to swathing and planting speed when pre-emergence herbicides are used must also be considered. A row width of 275 mm in the Swartland and Sandveld seems to be a good compromise between safety of applying herbicides, planting speed and reduction of risk for yield loss. Row widths wider than 300 mm do not serve any purpose and are not recommended in this region.

Planting density

New planting density recommendations, based on five season's data from field trials executed in conservation tillage systems, are made for the no-till planting method in the Western Cape. These recommendations require lower planting densities than recommended by owners of cultivars for use in conventional planting methods and are made with the following prerequisites:

- The planter used is specifically designed to plant effectively through stubble left on the surface by the conservation tillage/crop rotation system;
- A seed survival percentage of 80% or better is easily obtainable with the planter;
- Row widths of 250-300 mm are used;
- Cultivars with above average tillering ability are used;
- Good quality seed with known germination percentage is used;
- Sufficient soil water is available during planting time;
- Early planting dates, well within the optimal planting time, are used;
- A positive outlook on rainfall during the season is expected;

- Fertiliser is placed accurately with the majority of fertiliser placed safely away from the seed. Not more than 15 kg N/ha should be placed in close proximity to the seed, to reduce the risk of fertiliser toxicity;
- Safe application of registered pre-emergence herbicides is ensured;
- Good control over herbicide resistant grasses through the crop rotation system and other practices; and
- Pests that are able to reduce seedling survival, like slugs and isopods, are not present in very large numbers.

If it is not possible to adhere to these prerequisites, it is in the interest of the producer to adhere to the planting densities as recommended by the owner of the cultivar. These planting density recommendations include a large safety factor and will ensure sufficient seedling survival in almost all conditions. If the producer plans a reduced planting density and conditions deteriorate during the planting season, the planting density should be increased to cater for these conditions. The recommendations for lower planting density are linked to target plants/ m^2 and the necessary conversion to kg/ha must be made by taking into account the thousand kernel mass (TKM) for each cultivar to be planted, (Tables 1, 2 and 3 on pages 34 and 35).

Planting densities for wheat under the above-mentioned prerequisites is given in Table 2.

Table 2. Recommendations for planting density of wheat with the use of planters in conservation tillage systems in the Western Cape.*

Production areas	Yield potential	Plants/ m^2	Planting density (kg/ha)**
Eastern Rûens, Similar to Napkei	Low	150-175	68-79
Eastern Rûens, Similar to Riversdale Flats	Medium	125-150	56-68
Southern and Western Rûens	High	175-200	79-90
Swartland and Sandveld	Medium-high	175-200	79-90

* *Planting density calculated at 80% seedling survival percentage.*

** *Planting density given in kg/ha is calculated for a thousand kernel mass of 36.*

Producers can achieve a significant cost saving by using these recommendations and managing planting density more precisely. However, lower planting densities as recommended here,does increase the risk of achieving an unacceptable plant population if external factors that affect seedling survival and tillering ability play an overriding role during the growing season. If any uncertainty exists about conditions that will effect germination, seedling development, seedling survival and tillering negatively, producers must opt for the seeding rates recommended by the owner of the cultivar to be planted.

GUIDELINES FOR WHEAT CULTIVAR CHOICE

Cultivar choice is an important production decision and if planned correctly, could contribute greatly to reducing risk and optimising yields. The decision is complicated by all the different factors that contribute to the adaptability, yield potential, agronomic characteristics and disease risks of the current commercially available cultivars. The correct cultivar choices contribute to management of risk and achieving optimal grain yield in a given situation.

To fully utilise this cultivar diversity and to make an informed decision, it is important that the producer knows the beneficial and limiting characteristics of each cultivar. For this reason, additional information regarding cultivar characteristics, long-term yield data and relative yields are made available to the producer.

There are a few important guidelines that the producer must consider when deciding on his cultivar choice:

- Plant a range of cultivars 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 a well-known cultivar 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 to adapt to changing circumstances, as well as to consider new cultivars; and
- Take the disease/insect resistance levels as well as the quality characteristics of each recommended cultivar into consideration when finalising your cultivar choice annualy.

Plant Breeders' Rights (Act 15 of 1976)

This act renders legal protection to breeders and owners of cultivars. The awarding of rights procedure stipulate that cultivars must be new, distinguishable, uniform and stable, and protection is granted for a 20 year period. The rights of the owner/breeder entail that no party may multiply propagating material (seed), process it for planting, sell it, import it, export it and keep it in stock without the necessary authorisation or license of the holders of right. The act makes provision for the court to grant compensation of R10 000-00 to the holder of the Plant Breeders' Rights in cases of breaching of rights.

Seed certification and Table 8, as described in the Plant Improvement Act

The main aim of certification of seed is to ensure the proper maintenance of cultivars. Seed laws and regulations prescribe the minimum physical requirements, while certification of seed strives to achieve high standards of genetic purity and other quality requirements. Seed certification is a voluntary action that is managed by SANSOR on behalf of the Minister of Agriculture. However, if a cultivar is listed in Table 8, it is subject to compulsory certification. This scheme specifically guarantees cultivar purity, as well as good seed quality, renders protection and peace of mind to the buyer (producer), as well as an improved control system for acting on complaints and claims. The costs involved are a minimal price to pay for this peace of mind to both buyer and seller of certified seed. Remember that all retained seed looses the accountability of owner of the cultivar in relation to seed quality and performance of the cultivar.

Factors determining cultivar choice

Cultivar choice is an economic decision by which the producer aims to achieve the highest return with the lowest risk. Factors determining cultivar choice are thus fundamental to this decision. The most important factors are briefly discussed and for this reason a table is included that characterise the released cultivars.

Yield potential

The genetic yield potential of the available cultivars is higher than the yields currently realised under commercial conditions. These differences in yields are mainly due to environmental conditions (climatic and production conditions), crop management decisions, disease, insect and weed pressures.

Cultivars differ in their yield reaction to changing yield potential conditions. Some cultivars perform better at a lower yield potential, while others utilise higher potential conditions better. The ideal cultivar would yield the highest at all yield potential conditions. This would indicate excellent adaptability, but usually high yield is negatively related to other economically important factors, such as protein content, baking quality and hectolitre mass. It is especially important that under dry land conditions the producer should know the yield potential of his farm and fields according to soil, climate and managerial ability. Thereby a realistic target yield can be determined, that will aid cultivar choice and also other production options like fertiliser planning.

Grading and quality

According to the grading system promulgated under the Act on Agricultural Products, only one bread wheat class exists with four grades, viz. B1, B2, B3 and B4, that are determined according to the protein content of the grain, the hectolitre mass and the falling number (Table 1). Hectolitre mass and especially protein content are largely determined by the environment during the grain filling period to maturity, and also by management practices including soil water and fertiliser management.

Table 1. Classes and grades of bread wheat

Grading regulation of Bread wheat - Class B			
Grade	**Minimum protein (12% moisture)**	**Minimum hectolitre mass (kg/hl)**	**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 others	Do not comply to the above-mentioned or any other grading regulations		

All bread wheat cultivars mentioned in these guidelines qualify for all grades depending on the protein content, hectolitre mass and falling number.

Hectolitre mass

Hectolitre mass is a density parameter, and gives a direct indication of the potential flour extraction of the grain sample. Flour extraction is a critical parameter to the miller as it largely influences profitability.

Hectolitre mass is therefore part of the grading regulations that determines the grade of the grain delivered. Although this characteristic is genetically associated with a particular cultivar, it is affected by environmental conditions during the grain filling period. In particular in regions where extreme soil water and heat stresses occur during this critical period, when continuous rain events happen during harvest, and when diseases like rust and head blight infect the crop, losses can be suffered due to the downgrading of the grain, because of low hectolitre mass values. The large price differences between the B-grades and Utility grade can therefore influence cultivar choice if these conditions occur regularly in a specific region. Optimum soil water and temperature conditions during grain filling also favour the development of high hectolitre mass values.

Grain protein content

A high protein content (>11%) is necessary to ensure that the commercial bakery can produce a loaf of bread that will meet consumer requirement. Therefore grain protein is part of the grading regulations of harvested grain. The cultivars available for commercial production have acceptable genetic grain protein composition, but grain protein content is determined by the relationship between nitrogen availability and grain yield, which is affected by management practices, in particular fertilisation.

Falling number

Falling number is an indication of the alpha-amylase enzyme activity in the grain. High alpha-amylase activity (low falling number) is an indication that the starch molecules have to a large extent been broken down to sugars (maltose especially) and that such grain is unacceptable for commercial milling and baking purposes.

Preharvest sprouting tolerance

This refers to the tolerance a cultivar has against germination in the ear during physiological maturity prior to harvesting. Genetic variation exists between cultivars for preharvest sprouting resistance. It is important to note that none of the available cultivars will sprout in the ear under normal conditions. Certain cultivars are, however, more prone to preharvest sprouting than others under continuous rain and high humidity conditions during the harvest period.

Diseases and insects

The occurrence of diseases and insects in a region and the susceptibility of cultivars to these diseases and damage by insects must be considered in cultivar planning. In this way, risk and input costs (chemical spraying costs) can be reduced (see the Diseases and Insect Control Section). Keep in mind that the intensity can change from year to year and in certain exceptional situations also the susceptability.

Seed quality

Buy high quality seed (without shriveled and broken seeds) with a germination percentage of 90% or higher. When the producer buys more expensive hybrid seed, the additional seed costs must be recovered through higher yields. Plant the chosen cultivar at the recommended seeding density and also be aware of the coleoptiles length of a cultivar when planting deeper into a dry seedbed.

Straw strength

The lodging of spring wheat cultivars often leads to yield losses. It is usually a problem when high yield potential conditions occurs, but factors such as wind and storm occurrence, high seeding densities, row widths and excessive nitrogen fertilisation also play a role. In areas and situations where lodging is widespread, cultivars prone to lodging must be managed carefully. Chemical growth regulators are available on the market that can limit lodging significantly by limiting plant height. These products can be considered for cultivars with high yield potential prone to lodging in high yielding conditions. There are also cultivars available with genetic resistance to lodging.

Aluminium tolerance

In acidic soils [pH (KCl) <4,5 and acid saturation >8%] in certain wheat producing areas, the Al^3+-concentration levels in the soil reach levels toxic to the root growth and development of certain wheat cultivars. Cultivars differ in their tolerance to these harmful levels of aluminium. If these acidic soils are to be planted, it would aid the producer to adapt his cultivar choice to manage this production risk (see table for aluminium tolerant cultivars).

Although a corrective liming program is the only sustainable long-term solution, tolerant cultivars can be considered as an interim measure (see Fertilisation Guidelines).

Photoperiod and vernalisation

Photoperiod and vernalisation control the growth period and are important factors determining cultivar adaptation. Cultivars must be chosen that are adapted to climatic conditions such as growing season length, planting spectrum, rainfall pattern during the growing season, soil water availability at planting, temperature during the growing season and the first and last frost dates. In this regard, the cultivars have been evaluated and this is reflected in the recommended optimum planting spectrum for each cultivar. Ideally, the choice of cultivars to be planted must cover the available planting spectrum of the specific region, so that the period from maturity to harvesting is increased to some extent. The growth period of a cultivar also gives an indication when the cultivar will be in the anthesis and grain filling growth stages.

Shatterproof

This factor refers to the measure of how well the ripe kernel is attached to the ear, as well as to what extent the chaff of the spikelet covers and protects the kernel. Certain cultivars are more susceptible to bird damage and losses due to shattering before and during harvesting. These cultivars must be carefully evaluated in regions where bird damage to the crop is a major concern, as well as areas where strong winds occur during maturity and harvest.

The Chamber of Milling preferred list

The National Chamber of Milling annually publishes a list of 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 dry land production in the north, cultivars for the southern production area and the irrigation cultivars.

Table 2. Miller's preference list of preferred bread wheat *Southern production area*

Miller's preference		
Ratel	PAN 3471	SST 0137
Kwartel	Baviaans	SST 0127
PAN 3434	SST 027	SST 017
SST 096	PAN 3404	PAN 3492
SST 087	PAN 3408	PAN 3490
Tankwa	Steenbras	SST 88
SST 047	SST 015	SST 57
SST 056	Biedou	Kariega

RECOMMENDATIONS AND SUMMARY OF RESULTS 2013

The most promising cultivars of all institutions involved in the small grain industry are annually included in the National Small Grain Cultivar Programme of the Small Grain Institute. Every year the results are evaluated and the guidelines for cultivar choice revised by a committee consisting of officials from ARC-Small Grain Institute, SANSOR, SABM, Sensako, PANNAR, AFGRI, various Departments of Agriculture and the Universities of the Free State and Stellenbosch. The following guidelines for cultivar choice are a summary of the results per region and only cultivars of which at least two year's data are available are included. The guidelines act as reference within which more specific recommendations should fall. With the compilation of the guidelines, the following factors were considered:

- Grain yield
- Adaptability and yield stability
- Grain quality
- Disease resistance
- Agronomic characteristics such as lodging, threshability, preharvest sprouting, etc.
- The recommendations have been made after consideration of these factors and include the following:
- Cultivars and class division
- Optimum planting date for each cultivar
- Optimum seeding rate for each cultivar. Seeding rate in kg/ha is also influenced by thousand kernel mass and planting date
- Recommendations are for grain production only
- Cultivars are not listed according to yield potential

Seeding rate

Heads/m^2 is the yield component that makes the greatest contribution to grain yield. The number of heads is, amongst others, determined by tillering ability, seeding rate and survival of seedlings, and since the spring type cultivars tiller poorly in the winter rainfall region, seeding rate is the most important controllable factor that determines the number of heads/m^2. Seeding rate must also compensate for low germination, poor emergence and "damping off" of seedlings. Thousand kernel mass is an important characteristic that determines the number of kernels per kilogram seed and this can vary from 25-45 g per 1000 kernels, which can have a distinct influence on seeding rate. Thousand kernel mass must thus be considered in determining seeding rate.

$$\text{Seeding rate (kg/ha)} = \frac{\text{Plants/m}^2 \times \text{1000 kernel mass (g)}}{\text{survival \%}}$$

The following table (Table 1) can be used in the calculation of seeding rate. Survival percentage was taken as 80% in the table. Similar tables for use with other planters where lower seedling survival is expected are also given in tables 2 and 3.

Table 1. Table for calculation of seeding rate (kg/ha) for use with no-till planters in conservation tillage, where a seedling survival rate of more than 80% can be expected.

Plants/m²	Thousand kernel mass							
	28	**30**	**32**	**34**	**36**	**38**	**40**	**42**
100	35	38	40	43	45	48	50	53
125	44	47	50	53	56	59	63	66
150	53	56	60	64	68	71	75	79
175	61	66	70	74	79	83	88	92
200	70	75	80	85	90	95	100	105
225	79	84	90	96	101	107	113	118
250	88	94	100	106	113	119	125	131
275	96	103	110	117	124	131	138	144
300	105	113	120	128	135	143	150	158

Example: Thousand kernel mass of your seed = 32

The plant establishment that you are looking for = 200 plants per m²

Estimated survival % is above 80% Therefore you need 80 kg/ha of seed

Table 2. Table for calculation of seeding rate (kg/ha) for use with no-till planters in conservation tillage, where a seedling survival rate of 70 to 80% can be expected.

Plants/m²	Thousand kernel mass							
	28	**30**	**32**	**34**	**36**	**38**	**40**	**42**
100	40	43	46	49	51	54	57	60
125	50	54	57	61	64	68	71	75
150	60	64	69	73	77	81	86	90
175	70	75	80	85	90	95	100	105
200	80	86	91	97	103	109	114	120
225	90	96	103	109	116	122	129	135
250	100	107	114	121	129	136	143	150
275	110	118	126	134	141	149	157	165
300	120	129	137	146	154	163	171	180

Table 3. Table for calculation of seeding rate (kg/ha) for use with no-till planters in conservation tillage, where a seedling survival rate of 60 to 70% can be expected.

Plants/m^2	Thousand kernel mass							
	28	**30**	**32**	**34**	**36**	**38**	**40**	**42**
100	47	50	53	57	60	63	67	70
125	58	63	67	71	75	79	83	88
150	70	75	80	85	90	95	100	105
175	82	88	93	99	105	111	117	123
200	93	100	107	113	120	127	133	140
225	105	113	120	128	135	143	150	158
250	117	125	133	142	150	158	167	175
275	128	138	147	156	165	174	183	193
300	140	150	160	170	180	190	200	210

Characteristics of cultivars

In selecting the correct cultivar to produce in a specific region, it is important to take into account certain characteristics other than the yield performance. These characteristics include agronomic characteristics of the cultivars recommended in the area (Table 4) and data on the disease susceptibility of the cultivars (Table 5).

Table 4. Agronomic characteristics of wheat cultivars recommended for dryland cultivation in the Western Cape production region

Cultivar	Growth period	Shatter-proof	Hectolitre mass	Straw strength	Sprouting tolerance
Baviaans (PBR)	Medium	**	**	**	***
Kariega	Medium	**	***	**	***
Kwartel (PBR)	Medium	**	**	**	***
PAN 3408 (PBR)	Medium	**	**	**	#
PAN 3471 (PBR)	Short-Medium	**	***	**	*
Ratel (PBR)	Medium	**	**	**	*
SST 015 (PBR)	Short	**	**	**	***
SST 027 (PBR)	Medium-Long	**	**	**	**
SST 047 (PBR)	Medium	**	**	*	***
SST 056 (PBR)	Short-Medium	**	**	**	***
SST 087 (PBR)	Long	**	**	**	**
SST 88 (PBR)	Long	**	**	**	***
Tankwa (PBR)	Long	**	**	**	*

** Reasonable   ** Good   *** Excellent   # Poor   ? Unknown*

PBR Cultivars protected by Plant Breeders' Rights

Table 5. Disease resistance or susceptibility of wheat cultivars recommended for dryland cultivation in the Western Cape production region

Cultivar	Stem rust	Leaf rust	Stripe rust
Baviaans (PBR)	S	MS	R
Kariega	S	MS	R
Kwartel (PBR)	S	R*	R
PAN 3408 (PBR)	MSS	MS	R
PAN 3471 (PBR)	S	MRMS	R
Ratel (PBR)	MR	MS	R
SST 015 (PBR)	S	MS	R
SST 027 (PBR)	MRMS	MS	R
SST 047 (PBR)	R	R	R
SST 056 (PBR)	MS	MR	MR
SST 087 (PBR)	S	R	R
SST 88 (PBR)	S	S	MR
Tankwa (PBR)	MS	R	R

R = Resistant MR = Moderately resistant S = Susceptible MS = Moderately susceptible

PBR Cultivars protected by Plant Breeders' Rights
**Some S and MS plants may occur*
Variation in rust races may affect cultivars differently. Reactions given here are based on existing data for the most virulent rust races occurring in South Africa. Distribution of races may vary between production regions.

Planting dates and seeding rates

The recommended planting dates and seeding rates for wheat cultivars, as decided upon at the meeting of the National Cultivar Evaluation Workgroup, are given in the following figures:

Optimum planting dates and seeding rates for wheat cultivars in the Swartland

Cultivar *	Planting date (weeks)								Seeding rate (kg/ha)
	April		May				June		
	3	4	1	2	3	4	1	2	
Baviaans (PBR)			■	■	■	■			**100-120**
Kariega			■	■	■	■			**100-120**
Kwartel (PBR)			■	■	■	■			**100-120**
PAN 3408 (PBR)			■	■	■	■			**100-120**
PAN 3471 (PBR)			■	■	■	■			**100-120**
Ratel (PBR)			■	■	■	■			**100-120**
SST 015 (PBR)			■	■	■	■			**110-120**
SST 027 (PBR)		■	■	■	■	■			**100-120**
SST 047 (PBR)		■	■	■	■	■			**100-120**
SST 056 (PBR)		■	■	■	■	■			**110-120**
SST 087 (PBR)		■	■	■	■	■			**110-120**
SST 88 (PBR)		■	■	■	■	■			**100-120**
Tankwa (PBR)			■	■	■	■			**100-120**

All the abovementioned cultivars qualify for all the grades of the bread class.

PBR Cultivars protected by Plant Breeders' Rights
Use Tables 1 to 3 to calculate the seeding rate
Producers are solely responsible for the marketing of grain of cultivars planted by them. See Bakers and Millers annual press release regarding cultivar requirements and consult with local co-operative and marketing agents prior to planting.

Optimum planting dates and seeding rates for wheat cultivars in the Western and Southern Rûens

Cultivar *	Planting date (weeks)								Seeding rate (kg/ha)
	April		May				June		
	3	4	1	2	3	4	1	2	
Baviaans (PBR)									100-130
Kariega									100-130
Kwartel (PBR)									100-130
PAN 3408 (PBR)									100-130
PAN 3471 (PBR)									100-130
Ratel (PBR)									100-130
SST 015 (PBR)									110-130
SST 027 (PBR)									100-130
SST 047 (PBR)									100-130
SST 056 (PBR)									110-130
SST 087 (PBR)									110-120
SST 88 (PBR)									100-120
Tankwa (PBR)									100-130

All the abovementioned cultivars qualify for all the grades of the bread class.

** PBR Cultivars protected by Plant Breeders' Rights*
Use Tables 1 to 3 to calculate the seeding rate
Producers are solely responsible for the marketing of grain of cultivars planted by them. See Bakers and Millers annual press release regarding cultivar requirements and consult with local co-operative and marketing agents prior to planting.

Optimum planting dates and seeding rates for wheat cultivars in the Eastern Rûens

Cultivar *	Planting date (weeks)								Seeding rate (kg/ha)
	April		May				June		
	3	4	1	2	3	4	1	2	
Baviaans (PBR)									100-130
Kariega									100-130
Kwartel (PBR)									100-130
PAN 3408(PBR)									100-130
PAN 3471 (PBR)									100-130
Ratel (PBR)									100-130
SST 015 (PBR)									110-130
SST 027 (PBR)									100-130
SST 047 (PBR)									100-130
SST 056 (PBR)									110-130
SST 087 (PBR)									110-120
SST 88 (PBR)									100-120
Tankwa (PBR)									100-130

** All the abovementioned cultivars qualify for all the grades of the bread class.*

PBR Cultivars protected by Plant Breeders' Rights
Use Tables 1 to 3 to calculate the seeding rate
Producers are solely responsible for the marketing of grain of cultivars planted by them. See Bakers and Millers annual press release regarding cultivar requirements and consult with local co-operative and marketing agents prior to planting.

Summary of results obtained during 2013

The results obtained in the cultivar evaluation programme in the winter rainfall area over the last seasons (2010 to 2013) are summarised in the following tables.

The value of this information is that cultivar performance can be evaluated for a specific season, as well as over the medium term. The variation in climatic conditions between seasons, and the unpredictability thereof, necessitates cultivar choices that will decrease the risk as far as possible.

If this information is interpreted with other cultivar characteristics, discussed earlier, more informed decisions can be made on the group of cultivars that will perform the best.

Swartland Combined

Average yield (ton/ha) of entries for the Swartland area during the full or partial period from 2010 - 2013

Cultivar	2013	R	2012	R	2011	R	2010	R	4 year average 2010-2013	R	3 year average 2011-2013	R	2 year average 2012-2013	R
Baviaans			4.07	8	3.54	9	3.07	8						
Kariega			3.95	10	3.48	10	3.08	6						
Kwartel	4.26	12	3.82	15	3.56	8					3.88	12	4.04	12
PAN 3408	4.96	3	4.22	3	3.86	1	3.26	2	4.07	1	4.34	1	4.59	2
PAN 3434			3.90	12	3.40	12	3.18	4						
PAN 3471	4.64	9	4.18	4	3.78	3	3.08	6	3.92	6	4.20	4	4.41	8
Ratel	4.75	8	4.04	9	3.77	4					4.19	5	4.40	9
SST 015	4.94	4	4.23	2	3.79	2	3.04	10	4.00	2	4.32	2	4.59	1
SST 027	4.76	6	4.08	7	3.58	7	3.06	9	3.87	7	4.14	9	4.42	7
SST 047	4.57	11	3.88	14	3.37	14	2.97	11	3.70	8	3.94	11	4.23	11
SST 056	4.78	5	4.26	1	3.60	5	3.17	5	3.95	3	4.21	3	4.52	5
SST 087	4.97	2	4.15	5	3.39	13	3.20	3	3.93	5	4.17	6	4.56	3
SST 096	5.16	1	3.89	13	3.45	11					4.17	7	4.52	4
SST 88	4.76	7	4.12	6	3.58	6	3.29	1	3.94	4	4.15	8	4.44	6
Tankwa	4.63	10	3.91	11	3.33	15	2.91	12	3.70	9	3.96	10	4.27	10
Average	**4.77**		**4.05**		**3.56**		**3.11**		**3.90**		**4.14**		**4.42**	
LSD_t(0,05)	**0.19**		**0.17**		**0.16**		**0.14**		**0.09**		**0.10**		**0.13**	

Swartland Combined

Average hectolitre mass (kg/hl) of entries for the Swartland area during the full or partial period from 2010 - 2013

Cultivar	2013	R	2012	R	2011	R	2010	R	4 year average 2010-2013	R	3 year average 2011-2013	R	2 year average 2012-2013	R
Baviaans			81.98	5	79.08	6	79.33	7						
Kariega			81.69	6	78.98	7	79.24	8						
Kwartel	75.28	12	80.66	13	78.24	12					78.06	11	77.97	12
PAN 3408	76.41	7	81.01	12	78.27	11	78.95	9	78.66	7	78.56	7	78.71	8
PAN 3434			81.68	7	79.23	5	79.79	5						
PAN 3471	78.78	1	82.98	2	80.44	1	80.90	1	80.78	1	80.73	1	80.88	1
Ratel	76.01	10	80.45	14	78.29	10					78.25	10	78.23	10
SST 015	77.16	4	81.67	8	79.25	4	79.36	6	79.36	5	79.36	5	79.42	5
SST 027	77.69	3	83.03	1	78.95	8	80.51	2	80.05	3	79.89	3	80.36	2
SST 047	77.94	2	82.44	3	80.01	2	80.18	3	80.14	2	80.13	2	80.19	3
SST 056	76.26	9	81.15	11	78.09	13	78.82	10	78.58	8	78.50	9	78.71	9
SST 087	75.69	11	80.28	15	77.36	15	78.72	12	78.01	9	77.78	12	77.99	11
SST 096	76.35	8	81.26	10	77.95	14					78.52	8	78.81	7
SST 88	76.87	5	82.02	4	79.27	3	79.93	4	79.52	4	79.39	4	79.45	4
Tankwa	76.78	6	81.46	9	78.36	9	78.81	11	78.85	6	78.87	6	79.12	6
Average	**76.77**		**81.58**		**78.78**		**79.55**		**79.33**		**79.00**		**79.15**	
LSD_t(0,05)	**0.41**		**0.46**		**0.47**		**0.28**		**0.20**		**0.26**		**0.29**	

Swartland Combined

Average protein content (%) of entries for the Swartland area during the full or partial period from 2010 - 2013

Cultivar	2013	R	2012	R	2011	R	2010	R	4 year average 2010-2013	R	3 year average 2011-2013	R	2 year average 2012-2013	R
Baviaans			12.21	8	11.95	6	12.79	5						
Kariega			12.51	5	11.97	5	12.99	4						
Kwartel	13.13	2	12.62	4	12.34	3					12.70	3	12.88	4
PAN 3408	12.75	6	12.32	6	11.64	11	12.67	7	12.35	4	12.24	6	12.54	6
PAN 3434			11.82	12	11.87	8	12.61	8						
PAN 3471	12.68	8	11.91	10	11.16	15	12.17	10	11.98	6	11.92	9	12.30	8
Ratel	12.99	5	12.19	9	11.95	6					12.38	5	12.59	5
SST 015	12.69	7	12.29	7	11.45	13	12.74	6	12.29	5	12.14	7	12.49	7
SST 027	13.12	3	12.82	3	12.12	4	13.11	3	12.79	3	12.69	4	12.97	3
SST 047	14.80	1	14.73	1	13.59	1	14.99	1	14.53	1	14.37	1	14.77	1
SST 056	12.15	10	11.76	13	11.43	14	12.47	9	11.95	7	11.78	10	11.96	10
SST 087	12.02	11	11.53	14	11.49	12	11.99	11	11.76	9	11.68	12	11.78	11
SST 096	12.56	9	11.83	11	11.74	10					12.04	8	12.20	9
SST 88	11.93	12	11.47	15	11.75	9	11.98	12	11.78	8	11.72	11	11.70	12
Tankwa	13.04	4	13.07	2	12.55	2	13.43	2	13.02	2	12.89	2	13.06	2
Average	**12.82**		**12.34**		**11.93**		**12.83**		**12.49**		**12.38**		**12.60**	
LSD_t(0,05)	**0.28**		**0.27**		**0.30**		**0.20**		**0.14**		**0.16**		**0.19**	

Swartland Combined

Average falling number (s) of entries for the Swartland during the full or partial period from 2010 - 2013

Cultivar	2013	R	2012	R	2011	R	2010	R	4 year average 2010-2013	R	3 year average 2011-2013	R	2 year average 2012-2013	R
Baviaans			366	8	390	6	341	8						
Kariega			374	5	392	4	341	7						
Kwartel	365	2	377	4	388	7					377	4	371	3
PAN 3408	340	9	354	12	359	12	335	9	347	6	351	9	347	9
PAN 3434			372	7	392	5	345	5						
PAN 3471	356	4	386	2	393	3	358	2	373	2	378	3	371	4
Ratel	375	1	385	3	398	2					386	1	380	1
SST 015	347	7	372	6	382	8	352	3	363	3	367	5	359	5
SST 027	345	8	360	10	365	11	319	11	347	7	356	8	352	7
SST 047	357	3	394	1	399	1	373	1	381	1	383	2	375	2
SST 056	347	6	357	11	365	10	343	6	353	5	356	7	352	8
SST 087	333	12	332	15	346	14	334	10	336	8	337	12	332	12
SST 096	340	9	335	14	350	13					342	10	338	11
SST 88	335	11	342	13	345	15	307	12	332	9	341	11	338	10
Tankwa	351	5	364	9	373	9	345	4	358	4	363	6	357	6
Average	**349**		**365**		**376**		**341**		**355**		**361**		**356**	
$LSD_t(0,05)$	**6.88**		**6.34**		**7.38**		**9.52**		**4.06**		**4.01**		**4.61**	

Swartland

Average yield (ton/ha) of entries for the High Rainfall area during the full or partial period from 2010 - 2013

Cultivar	2013	R	2012	R	2011	R	2010	R	4 year average 2010-2013	R	3 year average 2011-2013	R	2 year average 2012-2013	R
Baviaans			4.90	10	4.73	6	3.41	5						
Kariega			5.00	6	4.42	12	3.38	7						
Kwartel	5.23	12	4.70	13	4.27	13					4.73	12	4.96	12
PAN 3408	5.92	5	5.26	2	4.95	1	3.38	6	4.88	1	5.38	1	5.59	2
PAN 3434			4.91	9	4.64	8	3.62	1						
PAN 3471	5.85	6	5.27	1	4.71	7	3.31	9	4.79	3	5.28	3	5.56	3
Ratel	6.10	3	4.98	7	4.73	4					5.27	4	5.54	4
SST 015	5.60	9	4.76	12	4.49	11	3.18	10	4.51	7	4.95	9	5.18	9
SST 027	5.94	4	5.11	5	4.73	5	3.34	8	4.78	4	5.26	5	5.52	5
SST 047	5.28	11	4.92	8	4.19	15	3.15	11	4.39	8	4.80	11	5.10	11
SST 056	5.78	7	5.24	4	4.55	9	3.49	3	4.76	5	5.19	7	5.51	6
SST 087	6.17	2	5.25	3	4.55	10	3.52	2	4.87	2	5.32	2	5.71	1
SST 096	6.35	1	4.64	15	4.74	3					5.25	6	5.50	7
SST 88	5.74	8	4.85	11	4.83	2	3.45	4	4.72	6	5.14	8	5.29	8
Tankwa	5.53	10	4.69	14	4.23	14	3.07	12	4.38	9	4.82	10	5.11	10
Average	**5.79**		**4.97**		**4.58**		**3.36**		**4.67**		**5.11**		**5.38**	
LSD_t(0,05)	**0.40**		**0.47**		**0.38**		**0.29**		**0.24**		**0.25**		**0.32**	

Swartland

Average hectolitre mass (kg/hl) of entries for the High Rainfall area during the full or partial period from 2010 - 2013

Cultivar	2013	R	2012	R	2011	R	2010	R	4 year average 2010-2013	R	3 year average 2011-2013	R	2 year average 2012-2013	R
Baviaans			82.61	4	80.51	4	79.93	8						
Kariega			82.68	3	80.01	8	79.98	6						
Kwartel	74.94	12	80.92	14	79.56	13					78.47	12	77.93	12
PAN 3408	76.44	6	82.13	7	79.56	12	79.75	9	79.47	6	79.38	6	79.29	5
PAN 3434			81.84	8	80.36	5	80.58	5						
PAN 3471	78.60	1	83.64	1	81.51	1	81.81	1	81.39	1	81.25	1	81.12	1
Ratel	76.18	8	81.55	11	79.97	9					79.23	7	78.87	8
SST 015	76.99	4	82.49	6	80.24	7	79.54	11	79.81	5	79.91	4	79.74	4
SST 027	77.53	3	83.37	2	80.28	6	81.14	2	80.58	3	80.39	3	80.45	2
SST 047	77.68	2	82.53	5	81.48	2	81.08	3	80.69	2	80.56	2	80.11	3
SST 056	76.29	7	81.73	9	79.46	14	79.12	12	79.15	8	79.16	9	79.01	6
SST 087	75.83	11	81.32	13	78.98	15	79.68	10	78.95	9	78.71	10	78.58	10
SST 096	75.90	10	80.33	15	79.66	11					78.63	11	78.12	11
SST 88	76.54	5	81.46	12	80.81	3	80.72	4	79.88	4	79.60	5	79.00	7
Tankwa	76.01	9	81.63	10	79.95	10	79.95	7	79.39	7	79.20	8	78.82	9
Average	**76.58**		**82.02**		**80.15**		**80.27**		**79.92**		**79.54**		**79.25**	
$LSD_t(0,05)$	**0.50**		**0.75**		**0.48**		**0.39**		**0.26**		**0.30**		**0.39**	

Swartland

Average protein content (%) of entries for the High Rainfall area during the full or partial period from 2010 - 2013

Cultivar	2013	R	2012	R	2011	R	2010	R	4 year average 2010-2013	R	3 year average 2011-2013	R	2 year average 2012-2013	R
Baviaans			11.83	8	11.55	12	11.54	6						
Kariega			11.91	6	11.78	5	11.69	4						
Kwartel	12.37	6	11.97	5	12.04	4					12.13	4	12.17	5
PAN 3408	12.24	8	11.55	10	11.69	8	11.62	5	11.78	5	11.83	7	11.90	7
PAN 3434			11.56	9	11.75	6	11.17	8						
PAN 3471	12.18	9	11.42	11	11.34	15	11.09	9	11.51	6	11.65	9	11.80	8
Ratel	12.38	5	11.90	7	11.70	7					11.99	6	12.14	6
SST 015	12.40	4	12.32	4	11.61	11	11.46	7	11.95	4	12.11	5	12.36	4
SST 027	13.07	2	12.52	2	12.08	3	12.05	3	12.43	3	12.56	3	12.80	2
SST 047	14.70	1	14.37	1	14.08	1	14.00	1	14.29	1	14.38	1	14.54	1
SST 056	11.94	10	11.15	14	11.45	14	11.00	10	11.39	7	11.51	10	11.55	10
SST 087	11.48	11	10.66	15	11.51	13	10.46	12	11.03	9	11.22	12	11.07	12
SST 096	12.31	7	11.29	12	11.69	9					11.76	8	11.80	8
SST 88	11.12	12	11.16	13	11.66	10	10.61	11	11.14	8	11.31	11	11.14	11
Tankwa	12.67	3	12.36	3	12.64	2	12.18	2	12.46	2	12.56	2	12.52	3
Average	**12.41**		**11.87**		**11.90**		**11.57**		**12.00**		**12.08**		**12.15**	
LSD_t(0,05)	**0.45**		**0.45**		**0.43**		**0.36**		**0.24**		**0.26**		**0.32**	

Swartland

Average falling number (s) of entries for the High Rainfall area during the full or partial period from 2010 - 2013

Cultivar	2013	R	2012	R	2011	R	2010	R	4 year average 2010-2013	R	3 year average 2011-2013	R	2 year average 2012-2013	R
Baviaans			336	15	394	5	322	4						
Kariega			348	11	395	4	307	10						
Kwartel	342	2	366	5	391	6					366	4	354	3
PAN 3408	324	7	345	12	372	10	308	9	337	7	347	8	335	8
PAN 3434			357	7	387	7	329	3						
PAN 3471	332	3	368	3	402	2	340	2	360	2	367	3	350	4
Ratel	361	1	376	2	404	1					380	1	368	1
SST 015	315	8	367	4	381	9	311	8	344	3	355	6	341	6
SST 027	325	4	359	6	382	8	302	11	342	5	355	5	342	5
SST 047	325	5	399	1	401	3	340	1	366	1	375	2	362	2
SST 056	324	6	357	7	372	11	319	6	343	4	351	7	341	7
SST 087	306	12	344	13	353	15	311	7	328	9	334	12	325	12
SST 096	310	11	343	14	354	14					336	11	327	11
SST 88	311	10	351	10	361	13	293	12	329	8	341	10	331	10
Tankwa	312	9	354	9	366	12	320	5	338	6	344	9	333	9
Average	**324**		**358**		**381**		**317**		**343**		**354**		**342**	
LSD_t(0,05)	**15.27**		**14.66**		**14.9**		**16.9**		**8.36**		**8.60**		**10.37**	

Swartland

Average yield (ton/ha) of entries for the Middle Swartland area during the full or partial period from 2010 - 2013

Cultivar	2013	R	2012	R	2011	R	2010	R	4 year average 2010-2013	R	3 year average 2011-2013	R	2 year average 2012-2013	R
Baviaans			4.34	6	3.70	7	3.46	10						
Kariega			4.09	12	3.60	9	3.42	11						
Kwartel	3.83	12	4.18	11	3.88	5					3.96	12	4.00	12
PAN 3408	4.53	7	4.41	4	3.99	2	3.83	2	4.19	3	4.31	3	4.47	5
PAN 3434			3.76	15	3.37	15	3.50	7						
PAN 3471	4.43	10	4.44	3	3.94	3	3.48	9	4.07	5	4.27	4	4.43	6
Ratel	4.15	11	4.25	10	3.93	4					4.11	7	4.20	11
SST 015	4.82	3	4.82	1	4.22	1	3.62	4	4.37	1	4.62	1	4.82	1
SST 027	4.47	9	4.32	7	3.67	8	3.48	8	3.99	6	4.16	6	4.40	8
SST 047	4.57	5	4.28	8	3.45	13	3.50	6	3.95	8	4.10	9	4.42	7
SST 056	4.62	4	4.68	2	3.88	6	3.58	5	4.19	2	4.39	2	4.65	2
SST 087	4.83	2	4.27	9	3.58	10	3.68	3	4.09	4	4.23	5	4.55	3
SST 096	4.86	1	3.87	14	3.51	12					4.08	10	4.36	9
SST 88	4.52	8	3.95	13	3.58	11	3.88	1	3.98	7	4.01	11	4.23	10
Tankwa	4.54	6	4.41	4	3.37	14	3.35	12	3.92	9	4.11	8	4.48	4
Average	**4.51**		**4.27**		**3.71**		**3.56**		**4.08**		**4.20**		**4.42**	
LSD_t(0,05)	**0.30**		**0.32**		**0.35**		**0.27**		**0.16**		**0.19**		**0.22**	

Swartland

Average hectolitre mass (kg/hl) of entries for the Middle Swartland area during the full or partial period from 2010 - 2013

Cultivar	2013	R	2012	R	2011	R	2010	R	4 year average 2010-2013	R	3 year average 2011-2013	R	2 year average 2012-2013	R
Baviaans			81.80	6	81.07	5	79.36	12						
Kariega			81.30	9	80.75	7	79.69	9						
Kwartel	75.29	12	80.90	12	80.31	10					78.83	10	78.10	11
PAN 3408	76.27	8	81.22	10	80.12	11	79.73	8	79.33	8	79.20	9	78.75	9
PAN 3434			80.66	14	81.23	4	79.93	6						
PAN 3471	78.73	1	83.71	1	82.13	1	81.39	1	81.49	1	81.52	1	81.22	1
Ratel	75.56	11	80.67	13	79.79	13					78.67	11	78.12	10
SST 015	76.74	6	82.54	4	80.80	6	80.15	5	80.06	5	80.03	5	79.64	4
SST 027	77.63	2	82.94	3	80.75	7	80.54	4	80.47	3	80.44	3	80.29	3
SST 047	77.61	3	83.09	2	81.94	2	80.66	3	80.83	2	80.88	2	80.35	2
SST 056	75.97	10	81.59	7	80.60	9	79.92	7	79.52	6	79.39	7	78.78	8
SST 087	76.05	9	79.76	15	79.34	15	79.68	10	78.71	9	78.38	12	77.91	12
SST 096	76.92	5	81.07	11	79.79	13					79.26	8	79.00	7
SST 88	77.10	4	81.89	5	81.30	3	81.14	2	80.36	4	80.10	4	79.50	5
Tankwa	76.73	7	81.42	8	80.05	12	79.44	11	79.41	7	79.40	6	79.08	6
Average	**76.72**		**81.64**		**80.66**		**80.13**		**80.02**		**79.68**		**79.23**	
LSD_t(0,05)	**0.71**		**0.83**		**0.70**		**0.51**		**0.35**		**0.44**		**0.56**	

Swartland

Average protein content (%) of entries for the Middle Swartland area during the full or partial period from 2010 - 2013

Cultivar	2013	R	2012	R	2011	R	2010	R	4 year average 2010-2013	R	3 year average 2011-2013	R	2 year average 2012-2013	R
Baviaans			12.00	6	10.28	7	12.83	6						
Kariega			12.27	5	10.38	6	13.21	3						
Kwartel	14.09	2	12.53	4	10.67	2					12.43	2	13.31	3
PAN 3408	13.66	7	11.95	7	10.00	11	12.83	5	12.11	4	11.87	6	12.81	6
PAN 3434			11.94	8	10.09	8	12.68	8						
PAN 3471	13.91	4	11.66	12	9.83	13	12.21	10	11.90	6	11.80	7	12.79	7
Ratel	14.02	3	11.79	10	10.52	4					12.11	5	12.91	5
SST 015	13.37	8	11.83	9	9.95	12	12.79	7	11.98	5	11.72	8	12.60	8
SST 027	13.83	5	12.76	3	10.40	5	13.18	4	12.54	3	12.33	4	13.30	4
SST 047	15.33	1	14.51	1	11.72	1	14.90	1	14.11	1	13.85	1	14.92	1
SST 056	12.67	11	11.52	14	9.74	14	12.60	9	11.63	7	11.31	11	12.10	12
SST 087	12.63	12	11.68	11	9.60	15	12.19	11	11.52	9	11.30	12	12.16	10
SST 096	13.27	9	11.57	13	10.02	10					11.62	9	12.42	9
SST 88	12.83	10	11.37	15	10.03	9	12.03	12	11.56	8	11.41	10	12.10	11
Tankwa	13.71	6	12.96	2	10.57	3	13.57	2	12.70	2	12.41	3	13.34	2
Average	**13.61**		**12.16**		**10.25**		**12.92**		**12.23**		**12.01**		**12.89**	
LSD_t(0,05)	**0.42**		**0.41**		**0.43**		**0.40**		**0.23**		**0.26**		**0.30**	

Swartland

Average falling number (s) of entries for the Middle Swartland area during the full or partial period from 2010 - 2013

Cultivar	2013	R	2012	R	2011	R	2010	R	4 year average 2010-2013	R	3 year average 2011-2013	R	2 year average 2012-2013	R
Baviaans			364	10	386	3	340	11						
Kariega			377	5	379	6	353	8						
Kwartel	363	2	375	6	374	7					371	4	369	2
PAN 3408	318	12	356	12	352	10	354	7	345	7	342	9	337	9
PAN 3434			379	4	384	5	344	9						
PAN 3471	345	7	388	2	385	4	367	3	371	2	373	3	367	4
Ratel	364	1	390	1	395	2					383	1	377	1
SST 015	347	5	365	9	370	8	370	2	363	3	360	6	356	6
SST 027	333	8	366	8	343	12	341	10	346	6	347	8	349	8
SST 047	351	3	388	3	397	1	388	1	381	1	378	2	369	3
SST 056	347	5	359	11	350	11	359	5	354	5	352	7	353	7
SST 087	326	10	332	14	335	13	357	6	338	8	331	10	329	11
SST 096	327	9	330	15	329	14					329	12	329	12
SST 88	325	11	342	13	320	15	335	12	331	9	329	11	334	10
Tankwa	350	4	368	7	365	9	360	4	361	4	361	5	359	5
Average	**341**		**365**		**364**		**356**		**354**		**355**		**352**	
LSD_t(0,05)	**10.78**		**14.03**		**13.04**		**15.70**		**7.31**		**7.64**		**9.20**	

Swartland

Average yield (ton/ha) of entries for the Koringberg area during the full or partial period from 2010 - 2013

Cultivar	2013	R	2012	R	2011	R	2010	R	4 year average 2010-2013	R	3 year average 2011-2013	R	2 year average 2012-2013	R
Baviaans			3.61	6	2.95	13	2.80	11						
Kariega			3.44	11	3.12	7	2.98	6						
Kwartel	4.01	12	3.37	12	3.08	9					3.49	12	3.69	12
PAN 3408	4.91	1	3.70	4	3.40	1	3.25	1	3.81	1	4.00	1	4.30	2
PAN 3434			3.37	12	2.95	12	3.04	3						
PAN 3471	4.34	10	3.55	8	3.31	2	3.03	4	3.56	4	3.73	6	3.94	9
Ratel	4.56	4	3.53	9	3.22	4					3.77	4	4.05	7
SST 015	4.85	3	3.80	1	3.31	2	2.92	8	3.72	2	3.99	2	4.32	1
SST 027	4.36	8	3.62	5	3.16	6	2.81	10	3.49	7	3.72	8	3.99	8
SST 047	4.29	11	3.31	14	3.02	10	2.84	9	3.36	8	3.54	10	3.80	10
SST 056	4.54	5	3.58	7	3.10	8	2.95	7	3.54	5	3.74	5	4.06	6
SST 087	4.50	6	3.74	2	2.90	14	3.00	5	3.53	6	3.71	9	4.12	4
SST 096	4.86	2	3.46	10	2.87	15					3.73	6	4.16	3
SST 88	4.49	7	3.73	3	3.21	5	3.25	2	3.67	3	3.81	3	4.11	5
Tankwa	4.35	9	3.22	15	2.98	11	2.79	12	3.34	9	3.52	11	3.79	11
Average	**4.50**		**3.54**		**3.10**		**2.97**		**3.56**		**3.73**		**4.03**	
LSD_t(0,05)	**0.34**		**0.28**		**0.27**		**0.27**		**0.15**		**0.18**		**0.22**	

Swartland

Average hectolitre mass (kg/hl) of entries for the Koringberg area during the full or partial period from 2010 - 2013

Cultivar	2013	R	2012	R	2011	R	2010	R	4 year average 2010-2013	R	3 year average 2011-2013	R	2 year average 2012-2013	R
Baviaans			81.87	7	78.35	8	80.24	6						
Kariega			81.77	8	78.95	4	80.16	8						
Kwartel	75.51	11	81.14	11	77.68	12					78.11	11	78.33	11
PAN 3408	76.71	7	80.82	13	77.78	10	79.99	9	78.83	7	78.44	8	78.77	9
PAN 3434			82.62	3	78.51	6	80.54	4						
PAN 3471	78.99	1	82.61	4	80.19	1	81.70	1	80.87	1	80.60	1	80.80	1
Ratel	76.30	10	80.72	15	78.09	9					78.37	9	78.51	10
SST 015	77.67	4	81.49	10	79.22	3	80.24	6	79.66	5	79.46	5	79.58	7
SST 027	77.89	3	83.17	1	78.49	7	81.18	2	80.18	3	79.85	3	80.53	2
SST 047	78.42	2	82.57	5	79.47	2	80.90	3	80.34	2	80.15	2	80.50	3
SST 056	76.62	9	80.92	12	77.30	13	79.71	10	78.64	8	78.28	10	78.77	8
SST 087	75.13	12	80.74	14	76.87	15	79.40	11	78.03	9	77.58	12	77.94	12
SST 096	76.69	8	82.75	2	77.69	11					79.04	6	79.72	5
SST 88	77.11	6	82.54	6	78.94	5	80.34	5	79.73	4	79.53	4	79.83	4
Tankwa	77.62	5	81.72	9	77.29	14	79.21	12	78.96	6	78.88	7	79.67	6
Average	**77.06**		**81.83**		**78.32**		**80.30**		**79.47**		**79.02**		**79.41**	
LSD_t(0,05)	**0.79**		**0.96**		**0.99**		**0.42**		**0.39**		**0.55**		**0.64**	

Swartland

Average protein content (%) of entries for the Koringberg area during the full or partial period from 2010 - 2013

Cultivar	2013	R	2012	R	2011	R	2010	R	4 year average 2010-2013	R	3 year average 2011-2013	R	2 year average 2012-2013	R
Baviaans			12.02	7	12.70	4	13.01	4						
Kariega			12.53	3	12.39	6	12.99	5						
Kwartel	12.65	2	12.42	6	12.73	3					12.60	3	12.54	3
PAN 3408	12.13	6	12.50	5	11.90	11	12.49	9	12.26	4	12.18	5	12.32	5
PAN 3434			11.49	15	12.52	5	12.85	7						
PAN 3471	11.90	8	11.89	8	11.38	15	12.16	12	11.83	8	11.72	11	11.90	8
Ratel	12.31	5	11.79	11	12.27	8					12.12	6	12.05	6
SST 015	12.07	7	11.73	12	11.62	14	12.90	6	12.08	5	11.81	8	11.90	7
SST 027	12.49	3	12.52	4	12.38	7	13.13	3	12.63	3	12.46	4	12.51	4
SST 047	14.19	1	14.43	1	13.63	1	15.02	1	14.32	1	14.08	1	14.31	1
SST 056	11.65	11	11.84	9	11.78	13	12.69	8	11.99	6	11.76	10	11.75	10
SST 087	11.71	10	11.73	12	11.84	12	12.34	10	11.91	7	11.76	9	11.72	11
SST 096	11.90	8	11.81	10	11.99	9					11.90	7	11.86	9
SST 88	11.50	12	11.60	14	11.91	10	12.28	11	11.82	9	11.67	12	11.55	12
Tankwa	12.44	4	12.74	2	13.14	2	13.54	2	12.97	2	12.77	2	12.59	2
Average	**12.25**		**12.20**		**12.28**		**12.95**		**12.42**		**12.24**		**12.25**	
LSD_t(0,05)	**0.60**		**0.71**		**0.66**		**0.37**		**0.29**		**0.37**		**0.46**	

Swartland

Average falling number (s) of entries for the Koringberg area during the full or partial period from 2010 - 2013

Cultivar	2013	R	2012	R	2011	R	2010	R	4 year average 2010-2013	R	3 year average 2011-2013	R	2 year average 2012-2013	R
Baviaans			387	6	397	5	335	8						
Kariega			391	5	401	2	352	4						
Kwartel	373	3	394	4	393	7					387	4	384	4
PAN 3408	364	6	371	10	347	13	334	9	354	6	360	8	367	7
PAN 3434			384	8	397	5	343	6						
PAN 3471	371	4	399	3	398	4	355	3	381	2	389	3	385	3
Ratel	387	1	403	1	405	1					399	1	395	1
SST 015	358	9	386	7	385	8	344	5	368	4	376	5	372	5
SST 027	359	8	368	11	353	11	318	11	350	7	360	9	363	8
SST 047	376	2	403	1	399	3	376	1	389	1	393	2	390	2
SST 056	355	10	367	12	364	10	338	7	356	5	362	7	361	9
SST 087	353	11	337	14	344	14	332	10	341	8	345	11	345	11
SST 096	360	7	344	13	347	12					351	10	352	10
SST 88	349	12	333	15	332	15	309	12	331	9	338	12	341	12
Tankwa	366	5	376	9	384	9	358	2	371	3	375	6	371	6
Average	**364**		**376**		**376**		**341**		**360**		**369**		**369**	
LSD_t(0,05)	**12.57**		**11.53**		**11.69**		**19.47**		**7.24**		**6.76**		**8.04**	

Swartland

Average yield (ton/ha) of entries for the Sandveld area during the full or partial period from 2010 - 2013

Cultivar	*2013	R	2012	R	2011	R	2010	R	4 year average 2010-2013	R	3 year average 2011-2013	R	2 year average 2012-2013	R
Baviaans			3.64	8	2.72	8	2.50	2						
Kariega			3.54	11	2.69	9	2.42	6						
Kwartel	4.07	1	3.26	15	2.98	5					3.43	6	3.66	8
PAN 3408	3.97	4	3.75	5	2.99	4	2.43	5	3.29	1	3.57	1	3.86	3
PAN 3434			3.80	2	2.56	14	2.40	7						
PAN 3471	2.99	12	3.74	6	3.09	3	2.38	9	3.05	7	3.27	10	3.37	12
Ratel	3.87	6	3.63	9	3.17	1					3.56	2	3.75	6
SST 015	3.87	6	3.68	7	3.11	2	2.30	11	3.24	3	3.55	3	3.77	4
SST 027	3.99	3	3.53	12	2.59	12	2.47	3	3.15	4	3.37	7	3.76	5
SST 047	3.62	9	3.27	14	2.78	6	2.22	12	2.97	8	3.22	11	3.45	10
SST 056	3.41	10	3.78	3	2.78	7	2.54	1	3.13	5	3.32	8	3.59	9
SST 087	3.83	8	3.61	10	2.43	15	2.47	4	3.09	6	3.29	9	3.72	7
SST 096	4.01	2	3.76	4	2.62	11					3.47	5	3.89	2
SST 88	3.89	5	4.14	1	2.57	13	2.40	7	3.25	2	3.53	4	4.02	1
Tankwa	3.39	11	3.50	13	2.66	10	2.33	10	2.97	9	3.18	12	3.44	11
Average	**3.74**		**3.64**		**2.78**		**2.41**		**3.12**		**3.40**		**3.69**	
LSD_t(0,05)	**0.63**		**0.29**		**0.28**		**0.26**		**0.16**		**0.20**		**0.27**	

*** Only Hopefield (Enkelvlei) data**

Swartland

Average hectolitre mass (kg/hl) of entries for the Sandveld area during the full or partial period from 2010 - 2013

Cultivar	*2013	R	2012	R	2011	R	2010	R	4 year average 2010-2013	R	3 year average 2011-2013	R	2 year average 2012-2013	R
Baviaans			81.79	4	75.75	6	77.43	5						
Kariega			81.24	7	75.32	8	76.62	8						
Kwartel	75.30	11	79.76	13	74.67	11					76.58	10	77.53	11
PAN 3408	75.70	10	80.14	12	74.88	10	75.66	11	76.60	8	76.91	7	77.92	8
PAN 3434			81.64	5	76.25	3	77.69	3						
PAN 3471	78.60	1	82.11	2	77.18	1	78.15	2	79.01	1	79.30	1	80.36	1
Ratel	76.20	5	79.14	15	74.41	12					76.58	9	77.67	10
SST 015	77.30	4	80.36	11	75.93	4	77.05	6	77.66	4	77.86	4	78.83	5
SST 027	77.50	3	82.74	1	75.52	7	78.87	1	78.66	2	78.59	3	80.12	2
SST 047	78.20	2	81.59	6	76.36	2	77.58	4	78.43	3	78.72	2	79.90	3
SST 056	75.80	9	80.53	10	74.27	13	75.96	10	76.64	7	76.87	8	78.17	7
SST 087	76.10	6	79.56	14	73.37	15	75.51	12	76.13	9	76.34	11	77.83	9
SST 096	74.00	12	80.67	9	73.63	14					76.10	12	77.34	12
SST 88	75.90	7	82.05	3	75.07	9	76.92	7	77.48	5	77.67	5	78.98	4
Tankwa	75.90	7	81.12	8	75.77	5	76.11	9	77.23	6	77.60	6	78.51	6
Average	**76.38**		**80.96**		**75.23**		**76.96**		**77.54**		**77.43**		**78.59**	
LSD_t(0,05)	**1.66**		**0.97**		**1.47**		**0.96**		**0.55**		**0.71**		**0.64**	

*** Only Hopefield (Enkelvlei) data**

Swartland

Average protein content (%) of entries for the Sandveld area during the full or partial period from 2010 - 2013

Cultivar	*2013	R	2012	R	2011	R	2010	R	4 year average 2010-2013	R	3 year average 2011-2013	R	2 year average 2012-2013	R
Baviaans			12.89	9	13.45	9	14.05	6						
Kariega			13.19	7	13.64	7	14.33	3						
Kwartel	13.48	3	13.41	4	14.32	2					13.74	3	13.45	3
PAN 3408	13.16	6	13.08	8	13.29	12	14.00	8	13.38	5	13.18	7	13.12	7
PAN 3434			12.23	13	13.33	11	14.04	7						
PAN 3471	12.39	11	12.57	10	12.30	15	13.49	10	12.69	9	12.42	12	12.48	10
Ratel	13.39	4	13.21	6	13.63	8					13.41	5	13.30	4
SST 015	13.29	5	13.31	5	12.95	14	14.09	5	13.41	4	13.18	6	13.30	4
SST 027	12.90	8	13.42	3	14.03	4	14.33	3	13.67	3	13.45	4	13.16	6
SST 047	15.42	1	15.52	1	15.36	1	16.30	1	15.65	1	15.43	1	15.47	1
SST 056	12.69	9	12.36	12	13.08	13	13.85	9	13.00	6	12.71	9	12.53	9
SST 087	12.39	11	11.85	14	13.39	10	13.21	12	12.71	8	12.54	11	12.12	11
SST 096	13.14	7	12.50	11	13.71	6					13.12	8	12.82	8
SST 88	12.44	10	11.66	15	13.91	5	13.26	11	12.82	7	12.67	10	12.05	12
Tankwa	13.83	2	14.05	2	14.07	3	14.69	2	14.16	2	13.98	2	13.94	2
Average	**13.21**		**13.02**		**13.63**		**14.14**		**13.50**		**13.32**		**13.14**	
LSD_t(0,05)	**0.82**		**0.49**		**0.73**		**0.44**		**0.29**		**0.39**		**0.42**	

*** Only Hopefield (Enkelvlei) data**

Swartland

Average falling number (s) of entries for the Sandveld area during the full or partial period from 2010 - 2013

Cultivar	*2013	R	2012	R	2011	R	2010	R	4 year average 2010-2013	R	3 year average 2011-2013	R	2 year average 2012-2013	R
Baviaans			369	5	379	9	371	4						
Kariega			375	3	392	5	355	7						
Kwartel	410	1	369	6	397	3					392	2	389	4
PAN 3408	387	11	343	12	373	14	348	8	363	6	368	11	365	10
PAN 3434			363	8	399	2	367	5						
PAN 3471	410	1	384	2	382	8	375	3	387	2	392	3	397	1
Ratel	410	1	370	4	382	7					388	4	390	3
SST 015	397	8	368	7	393	4	391	1	387	3	386	5	383	5
SST 027	397	9	347	10	389	6	314	11	362	7	378	7	372	7
SST 047	407	5	386	1	399	1	390	2	395	1	397	1	396	2
SST 056	388	10	346	11	378	11	357	6	367	5	370	9	367	9
SST 087	364	12	318	15	356	15	337	10	344	9	346	12	341	12
SST 096	405	6	324	14	376	13					368	10	365	11
SST 88	398	7	342	13	379	10	288	12	352	8	373	8	370	8
Tankwa	407	4	357	9	377	12	343	9	371	4	380	6	382	6
Average	**398**		**357**		**383**		**353**		**370**		**378**		**376**	
$LSD_t(0,05)$	**16.61**		**10.37**		**21.16**		**24.28**		**10.10**		**9.77**		**9.27**	

*** Only Hopefield (Enkelvlei) data**

Rûens combined

Average yield (ton/ha) of entries for the Rûens area during the full or partial period from 2010 - 2013

Cultivar	2013	R	2012	R	2011	R	2010	R	4 year average 2010-2013	R	3 year average 2011-2013	R	2 year average 2012-2013	R
Baviaans			3.89	8	4.46	4	2.60	8						
Kariega			3.89	9	4.29	10	2.61	7						
Kwartel	3.38	11	3.87	10	3.98	15					3.74	12	3.63	12
PAN 3408	3.56	8	4.00	6	4.34	7	2.83	1	3.68	4	3.97	6	3.78	6
PAN 3434			3.71	15	4.35	6	2.62	6						
PAN 3471	3.73	4	4.05	4	4.04	13	2.78	4	3.65	5	3.94	8	3.89	4
Ratel	3.79	2	4.01	5	4.36	5					4.06	4	3.90	3
SST 015	3.33	12	4.12	3	4.17	12	2.56	9	3.55	7	3.87	10	3.73	8
SST 027	3.67	6	3.97	7	4.66	1	2.53	11	3.71	3	4.10	2	3.82	5
SST 047	3.51	9	3.82	12	4.01	14	2.55	10	3.47	9	3.78	11	3.67	11
SST 056	3.65	7	4.19	2	4.34	8	2.81	3	3.75	2	4.06	3	3.92	2
SST 087	4.30	1	4.33	1	4.49	3	2.82	2	3.98	1	4.37	1	4.31	1
SST 096	3.75	3	3.78	13	4.31	9					3.95	7	3.76	7
SST 88	3.48	10	3.86	11	4.58	2	2.16	12	3.52	8	3.97	5	3.67	10
Tankwa	3.71	5	3.72	14	4.23	11	2.67	5	3.58	6	3.89	9	3.72	9
Average	**3.66**		**3.95**		**4.31**		**2.63**		**3.65**		**3.97**		**3.82**	
LSD_t(0,05)	**0.14**		**0.16**		**0.18**		**0.15**		**0.08**		**0.10**		**0.11**	

Rûens combined

Average hectolitre mass (kg/hl) of entries for the Rûens area during the full or partial period from 2010 - 2013

Cultivar	2013	R	2012	R	2011	R	2010	R	4 year average 2010-2013	R	3 year average 2011-2013	R	2 year average 2012-2013	R
Baviaans			79.48	5	79.86	5	76.95	6						
Kariega			79.42	6	79.79	7	76.60	9						
Kwartel	72.96	12	78.62	9	78.67	15					76.75	12	75.79	12
PAN 3408	74.98	5	78.39	14	79.01	13	75.26	12	76.91	9	77.46	6	76.69	5
PAN 3434			79.67	4	79.83	6	77.24	4						
PAN 3471	76.48	1	80.32	2	80.61	2	77.81	3	78.81	1	79.14	1	78.40	1
Ratel	74.15	10	78.60	10	79.01	13					77.25	11	76.38	9
SST 015	75.11	4	78.53	12	79.40	8	76.14	10	77.30	5	77.68	5	76.82	4
SST 027	75.95	2	80.13	3	80.15	4	77.90	2	78.53	3	78.74	2	78.04	2
SST 047	75.31	3	80.56	1	80.29	3	78.55	1	78.68	2	78.72	3	77.94	3
SST 056	74.32	8	78.45	13	79.11	12	75.77	11	76.91	8	77.29	8	76.39	8
SST 087	74.68	6	78.03	15	79.13	11	76.73	7	77.14	7	77.28	9	76.36	10
SST 096	74.02	11	78.60	10	79.17	10					77.26	10	76.31	11
SST 88	74.41	7	78.81	7	80.74	1	76.67	8	77.66	4	77.99	4	76.61	6
Tankwa	74.23	9	78.67	8	79.23	9	76.97	5	77.28	6	77.38	7	76.45	7
Average	**74.72**		**79.09**		**79.60**		**76.88**		**77.69**		**77.75**		**76.85**	
LSD_t(0,05)	**0.32**		**0.55**		**0.61**		**0.38**		**0.27**		**0.31**		**0.32**	

Rûens combined

Average protein content (%) of entries for the Rûens area during the full or partial period from 2010 - 2013

Cultivar	2013	R	2012	R	2011	R	2010	R	4 year average 2010-2013	R	3 year average 2011-2013	R	2 year average 2012-2013	R
Baviaans			11.39	11	11.81	10	11.83	8						
Kariega			11.70	5	11.81	10	12.36	4						
Kwartel	13.28	5	11.57	8	12.32	3					12.39	4	12.43	6
PAN 3408	13.24	7	11.74	4	11.87	7	12.22	5	12.27	4	12.28	7	12.49	5
PAN 3434			11.12	13	11.58	12	12.07	7						
PAN 3471	12.98	9	11.66	6	12.25	4	11.55	12	12.11	5	12.30	6	12.32	7
Ratel	12.87	10	11.50	9	11.85	9					12.07	9	12.19	10
SST 015	13.13	8	11.43	10	11.98	5	11.72	10	12.07	6	12.18	8	12.28	9
SST 027	13.98	3	12.42	2	11.95	6	12.64	3	12.75	3	12.78	3	13.20	3
SST 047	15.71	1	13.54	1	13.79	1	14.25	1	14.32	1	14.35	1	14.63	1
SST 056	13.28	5	11.30	12	11.51	13	11.83	8	11.98	7	12.03	10	12.29	8
SST 087	12.31	11	10.99	15	11.22	15	12.10	6	11.66	8	11.51	11	11.65	11
SST 096	13.51	4	11.61	7	11.86	8					12.33	5	12.56	4
SST 88	12.01	12	11.06	14	11.45	14	11.61	11	11.53	9	11.51	12	11.54	12
Tankwa	14.49	2	12.23	3	12.39	2	12.92	2	13.01	2	13.04	2	13.36	2
Average	**13.40**		**11.68**		**11.98**		**12.26**		**12.41**		**12.40**		**12.58**	
LSD_t(0,05)	**0.25**		**0.30**		**0.32**		**0.36**		**0.16**		**0.17**		**0.19**	

Rûens combined

Average falling number (s) of entries for the Rûens area during the full or partial period from 2010 - 2013

Cultivar	2013	R	2012	R	2011	R	2010	R	4 year average 2010-2013	R	3 year average 2011-2013	R	2 year average 2012-2013	R
Baviaans			328	13	393	6	360	3						
Kariega			349	8	398	3	374	1						
Kwartel	312	2	352	4	391	8					351	1	332	2
PAN 3408	249	12	314	14	374	10	285	12	305	9	312	12	281	12
PAN 3434			351	5	397	5	355	5						
PAN 3471	278	11	307	15	398	4	359	4	335	5	328	11	293	11
Ratel	307	3	343	11	400	2					350	2	325	4
SST 015	306	4	330	12	392	7	346	6	343	2	342	5	318	10
SST 027	297	6	347	9	374	11	307	10	331	7	339	7	322	7
SST 047	297	7	346	10	402	1	364	2	352	1	348	3	321	9
SST 056	296	8	349	7	379	9	318	8	336	4	342	6	323	6
SST 087	299	5	350	6	360	13	305	11	328	8	336	10	324	5
SST 096	295	9	356	3	357	15					336	9	326	3
SST 88	315	1	357	2	359	14	308	9	335	6	343	4	336	1
Tankwa	281	10	363	1	372	12	342	7	339	3	339	8	322	8
Average	**294**		**343**		**383**		**335**		**334**		**339**		**318**	
LSD_t(0,05)	**10.38**		**10.82**		**7.40**		**12.26**		**5.21**		**5.59**		**7.56**	

Rûens

Average yield (ton/ha) of entries for the Western Rûens area during the full or partial period from 2010 - 2013

Cultivar	2013	R	2012	R	2011	R	2010	R	4 year average 2010-2013	R	3 year average 2011-2013	R	2 year average 2012-2013	R
Baviaans			3.99	9	4.40	3	2.73	9						
Kariega			4.13	5	4.26	8	2.80	4						
Kwartel	3.50	10	4.04	8	4.13	13					3.89	10	3.77	9
PAN 3408	3.84	6	4.09	6	4.33	7	2.99	2	3.81	3	4.08	4	3.96	5
PAN 3434			3.56	14	4.16	11	2.78	6						
PAN 3471	3.89	4	4.17	4	4.10	14	3.02	1	3.79	4	4.05	5	4.03	4
Ratel	3.94	3	4.34	1	4.38	5					4.22	2	4.14	2
SST 015	3.19	11	4.04	7	4.14	12	2.66	10	3.51	8	3.79	11	3.62	11
SST 027	3.61	9	3.87	11	4.64	1	2.58	11	3.68	5	4.04	6	3.74	10
SST 047	3.83	7	3.96	10	4.07	15	2.74	8	3.65	6	3.95	7	3.89	6
SST 056	3.88	5	4.34	1	4.36	6	2.90	3	3.87	2	4.19	3	4.11	3
SST 087	4.36	1	4.21	3	4.38	4	2.76	7	3.93	1	4.32	1	4.28	1
SST 096	4.05	2	3.51	15	4.20	9					3.92	9	3.78	8
SST 88	3.04	12	3.67	13	4.48	2	2.05	12	3.31	9	3.73	12	3.36	12
Tankwa	3.77	8	3.85	12	4.19	10	2.79	5	3.65	7	3.94	8	3.81	7
Average	**3.74**		**3.98**		**4.28**		**2.73**		**3.69**		**4.01**		**3.87**	
LSD_t(0,05)	**0.23**		**0.33**		**0.29**		**0.20**		**0.13**		**0.17**		**0.21**	

Rûens

Average hectolitre mass (kg/hl) of entries for the Western Rûens area during the full or partial period from 2010 - 2013

Cultivar	2013	R	2012	R	2011	R	2010	R	4 year average 2010-2013	R	3 year average 2011-2013	R	2 year average 2012-2013	R
Baviaans			80.51	4	81.27	7	77.45	5						
Kariega			80.51	4	81.17	9	77.04	6						
Kwartel	73.19	12	79.86	9	80.13	15					77.73	12	76.53	12
PAN 3408	75.35	6	80.33	6	80.76	14	75.66	12	78.03	7	78.81	5	77.84	5
PAN 3434			79.51	13	81.39	6	77.57	4						
PAN 3471	77.30	1	81.37	1	82.92	1	78.09	3	79.92	1	80.53	1	79.34	1
Ratel	74.72	10	80.31	7	81.01	11					78.68	8	77.52	6
SST 015	75.46	5	78.84	15	81.17	9	76.00	10	77.87	9	78.49	11	77.15	10
SST 027	77.20	2	80.73	3	82.05	4	78.10	2	79.52	3	79.99	3	78.97	2
SST 047	76.74	3	81.06	2	82.52	3	78.78	1	79.78	2	80.11	2	78.90	3
SST 056	75.11	7	79.73	10	80.91	13	75.90	11	77.91	8	78.58	9	77.42	7
SST 087	75.11	7	79.54	12	80.92	12	76.71	8	78.07	6	78.52	10	77.33	9
SST 096	75.09	9	79.59	11	81.52	5					78.73	6	77.34	8
SST 88	74.31	11	78.98	14	82.85	2	76.41	9	78.14	5	78.71	7	76.65	11
Tankwa	75.59	4	80.10	8	81.19	8	76.94	7	78.46	4	78.96	4	77.85	4
Average	**75.43**		**80.06**		**81.45**		**77.05**		**78.63**		**78.99**		**77.73**	
LSD_t(0,05)	**0.57**		**1.13**		**0.56**		**0.60**		**0.38**		**0.43**		**0.61**	

Rûens

Average protein content (%) of entries for the Western Rûens area during the full or partial period from 2010 - 2013

Cultivar	2013	R	2012	R	2011	R	2010	R	4 year average 2010-2013	R	3 year average 2011-2013	R	2 year average 2012-2013	R
Baviaans			11.47	9	11.18	5	11.88	8						
Kariega			11.71	5	11.04	9	12.42	4						
Kwartel	12.38	4	11.41	10	11.52	3					11.77	4	11.90	5
PAN 3408	11.91	7	11.70	7	11.17	6	12.31	5	11.77	4	11.59	6	11.81	7
PAN 3434			11.06	14	11.08	7	12.13	6						
PAN 3471	11.63	10	11.86	3	11.23	4	11.76	10	11.62	5	11.57	7	11.75	8
Ratel	11.70	9	11.24	11	11.01	11					11.32	9	11.47	10
SST 015	11.93	6	11.71	5	10.88	12	11.61	11	11.53	6	11.51	8	11.82	6
SST 027	12.79	3	11.58	8	11.08	8	12.72	3	12.04	3	11.82	3	12.19	3
SST 047	14.55	1	12.54	1	13.04	1	14.58	1	13.68	1	13.38	1	13.55	1
SST 056	11.87	8	11.09	12	10.73	13	11.87	9	11.39	7	11.23	10	11.48	9
SST 087	11.41	11	11.07	13	10.57	14	12.07	7	11.28	8	11.02	11	11.24	11
SST 096	12.28	5	11.84	4	11.03	10					11.72	5	12.06	4
SST 88	11.09	12	10.74	15	10.40	15	11.37	12	10.90	9	10.74	12	10.92	12
Tankwa	13.26	2	11.87	2	11.64	2	12.93	2	12.43	2	12.26	2	12.57	2
Average	**12.23**		**11.53**		**11.17**		**12.31**		**11.85**		**11.66**		**11.89**	
LSD_t(0,05)	**0.51**		**0.58**		**0.54**		**0.48**		**0.28**		**0.32**		**0.38**	

Rûens

Average falling number (s) of entries for the Western Rûens area during the full or partial period from 2010 - 2013

Cultivar	2013	R	2012	R	2011	R	2010	R	4 year average 2010-2013	R	3 year average 2011-2013	R	2 year average 2012-2013	R
Baviaans			375	15	391	7	357	5						
Kariega			392	2	397	3	380	1						
Kwartel	330	2	392	3	392	6					371	2	361	2
PAN 3408	265	12	381	12	376	11	306	10	332	9	341	12	323	12
PAN 3434			388	5	394	5	372	4						
PAN 3471	297	10	386	7	395	4	374	3	363	3	359	7	341	10
Ratel	331	1	392	4	398	2					373	1	361	1
SST 015	325	4	385	8	389	8	352	6	363	2	366	4	355	3
SST 027	316	6	384	10	381	9	306	9	347	5	360	5	350	6
SST 047	317	5	393	1	401	1	377	2	372	1	370	3	355	4
SST 056	313	7	384	9	381	10	315	8	348	4	360	6	349	7
SST 087	306	9	382	11	361	13	293	12	335	8	350	10	344	9
SST 096	308	8	381	13	365	12					351	9	344	8
SST 88	326	3	377	14	356	15	302	11	340	7	353	8	352	5
Tankwa	288	11	388	6	361	14	344	7	345	6	346	11	338	11
Average	**310**		**385**		**382**		**340**		**349**		**358**		**348**	
LSD_t(0,05)	**17.09**		**10.87**		**13.02**		**16.74**		**7.58**		**8.14**		**10.23**	

Rûens

Average yield (ton/ha) of entries for the Southern Rûens during the full or partial period from 2010 - 2013

Cultivar	2013	R	2012	R	2011	R	2010	R	4 year average 2010-2013	R	3 year average 2011-2013	R	2 year average 2012-2013	R
Baviaans			3.46	13	4.12	4	2.81	8						
Kariega			3.42	14	3.91	10	2.67	10						
Kwartel	3.65	11	3.63	9	3.72	12					3.66	12	3.64	11
PAN 3408	3.68	10	3.55	11	3.89	11	3.08	3	3.55	7	3.71	10	3.62	12
PAN 3434			3.50	12	4.01	8	2.80	9						
PAN 3471	3.95	5	3.83	6	3.42	15	3.02	4	3.55	6	3.73	9	3.89	6
Ratel	4.10	3	3.58	10	4.01	7					3.90	6	3.84	7
SST 015	3.82	9	4.05	3	3.57	14	2.86	7	3.57	5	3.81	7	3.94	5
SST 027	4.17	2	3.87	5	4.32	3	2.86	6	3.81	3	4.12	2	4.02	2
SST 047	3.64	12	3.72	8	3.68	13	2.55	12	3.40	9	3.68	11	3.68	9
SST 056	3.88	8	4.16	2	4.03	6	3.22	2	3.82	2	4.02	4	4.02	3
SST 087	4.78	1	4.30	1	4.33	2	3.33	1	4.19	1	4.47	1	4.54	1
SST 096	3.89	7	3.77	7	4.08	5					3.91	5	3.83	8
SST 88	3.92	6	3.97	4	4.37	1	2.57	11	3.71	4	4.09	3	3.95	4
Tankwa	3.95	4	3.35	15	3.92	9	2.93	5	3.54	8	3.74	8	3.65	10
Average	**3.95**		**3.74**		**3.96**		**2.89**		**3.68**		**3.90**		**3.88**	
LSD_t(0,05)	**0.26**		**0.21**		**0.28**		**0.33**		**0.14**		**0.15**		**0.17**	

Rûens

Average hectolitre mass (kg/hl) of entries for the Southern Rûens during the full or partial period from 2010 - 2013

Cultivar	2013	R	2012	R	2011	R	2010	R	4 year average 2010-2013	R	3 year average 2011-2013	R	2 year average 2012-2013	R
Baviaans			80.12	7	78.20	7	76.70	8						
Kariega			80.19	6	78.14	8	76.26	10						
Kwartel	72.23	12	79.53	12	76.59	15					76.12	12	75.88	12
PAN 3408	75.01	3	79.15	13	77.59	13	75.42	12	76.79	9	77.25	7	77.08	6
PAN 3434			80.82	4	78.52	5	77.07	7						
PAN 3471	76.47	1	81.45	2	78.85	4	77.97	3	78.68	1	78.92	1	78.96	1
Ratel	74.04	9	79.15	13	77.36	14					76.85	11	76.60	10
SST 015	74.90	4	79.59	10	77.89	9	76.50	9	77.22	6	77.46	5	77.25	5
SST 027	75.67	2	81.53	1	78.91	3	78.20	2	78.58	2	78.70	2	78.60	2
SST 047	74.54	6	81.22	3	78.96	2	78.83	1	78.39	3	78.24	3	77.88	3
SST 056	74.08	8	79.61	9	77.84	10	75.98	11	76.88	8	77.18	8	76.85	8
SST 087	74.68	5	79.14	15	78.32	6	77.50	5	77.41	5	77.38	6	76.91	7
SST 096	73.34	11	79.63	8	77.73	11					76.90	10	76.49	11
SST 88	74.32	7	80.65	5	79.21	1	77.19	6	77.84	4	78.06	4	77.49	4
Tankwa	73.67	10	79.58	11	77.61	12	77.60	4	77.11	7	76.95	9	76.63	9
Average	**74.41**		**80.09**		**78.11**		**77.10**		**77.66**		**77.50**		**77.22**	
LSD_t(0,05)	**0.58**		**0.55**		**0.75**		**0.57**		**0.34**		**0.39**		**0.41**	

Rûens

Average protein content (%) of entries for the Southern Rûens during the full or partial period from 2010 - 2013

Cultivar	2013	R	2012	R	2011	R	2010	R	4 year average 2010-2013	R	3 year average 2011-2013	R	2 year average 2012-2013	R
Baviaans			11.85	8	12.18	9	11.27	11						
Kariega			11.95	7	12.01	11	11.76	6						
Kwartel	13.37	9	11.77	10	12.60	4					12.58	8	12.57	8
PAN 3408	13.46	8	12.13	4	12.17	10	11.75	7	12.38	5	12.59	7	12.80	5
PAN 3434			11.63	13	11.91	14	11.64	9						
PAN 3471	13.53	6	11.79	9	12.80	2	11.08	12	12.30	6	12.71	5	12.66	6
Ratel	12.99	10	11.96	6	12.25	8					12.40	9	12.48	10
SST 015	13.60	5	11.72	11	12.69	3	11.76	5	12.44	4	12.67	6	12.66	6
SST 027	14.14	3	13.20	2	12.43	6	12.16	3	12.98	3	13.26	3	13.67	3
SST 047	16.10	1	14.61	1	13.64	1	13.28	1	14.41	1	14.78	1	15.36	1
SST 056	13.48	7	11.66	12	11.95	13	11.34	10	12.11	7	12.36	10	12.57	8
SST 087	12.17	11	11.17	15	11.55	15	11.82	4	11.68	9	11.63	12	11.67	12
SST 096	13.72	4	12.06	5	12.39	7					12.72	4	12.89	4
SST 88	12.15	12	11.39	14	12.00	12	11.73	8	11.82	8	11.85	11	11.77	11
Tankwa	14.71	2	12.75	3	12.55	5	12.38	2	13.10	2	13.34	2	13.73	2
Average	**13.62**		**12.11**		**12.34**		**11.83**		**12.58**		**12.74**		**12.90**	
LSD_t(0,05)	**0.35**		**0.43**		**0.63**		**0.65**		**0.29**		**0.29**		**0.28**	

Rûens

Average falling number (s) of entries for the Southern Rûens during the full or partial period from 2010 - 2013

Cultivar	2013	R	2012	R	2011	R	2010	R	4 year average 2010-2013	R	3 year average 2011-2013	R	2 year average 2012-2013	R
Baviaans			314	11	395	8	364	4						
Kariega			319	10	402	4	367	3						
Kwartel	286	6	331	6	399	7					339	2	308	5
PAN 3408	259	12	308	13	386	10	308	12	315	9	318	12	283	12
PAN 3434			328	7	401	5	358	5						
PAN 3471	287	5	306	14	402	3	380	1	344	2	332	8	297	10
Ratel	281	8	310	12	404	2					331	9	295	11
SST 015	303	2	304	15	401	6	357	6	341	3	336	4	304	9
SST 027	280	9	333	5	383	12	341	8	334	6	332	7	306	8
SST 047	274	10	339	3	409	1	379	2	350	1	341	1	307	7
SST 056	293	4	327	9	388	9	320	11	332	7	336	5	310	4
SST 087	299	3	327	8	366	14	328	9	330	8	331	10	313	3
SST 096	285	7	344	1	357	15					329	11	315	2
SST 88	310	1	335	4	369	13	324	10	335	5	338	3	323	1
Tankwa	271	11	344	1	384	11	345	7	336	4	333	6	308	6
Average	**286**		**325**		**390**		**347**		**335**		**333**		**306**	
LSD_t(0,05)	**19.87**		**16.35**		**13.88**		**20.48**		**9.77**		**9.75**		**12.88**	

Rûens

Average yield (ton/ha) of entries for the Eastern Rûens during the full or partial period from 2010 - 2013

Cultivar	2013	R	2012	R	2011	R	2010	R	4 year average 2010-2013	R	3 year average 2011-2013	R	2 year average 2012-2013	R
Baviaans			4.26	3	4.88	4	1.90	7						
Kariega			4.18	6	4.69	8	1.96	2						
Kwartel	3.02	11	3.98	13	4.10	15					4.04	3	3.50	11
PAN 3408	3.23	8	4.37	2	4.81	5	1.95	3	3.59	2	3.71	5	3.80	2
PAN 3434			4.05	10	4.89	3	1.92	6						
PAN 3471	3.38	4	4.18	7	4.60	12	1.77	12	3.48	5	3.52	10	3.78	3
Ratel	3.37	5	4.19	5	4.69	9					4.44	1	3.78	4
SST 015	2.96	12	4.25	4	4.78	6	1.82	11	3.45	8	3.62	7	3.60	10
SST 027	3.22	9	4.16	8	5.04	1	1.88	8	3.58	3	3.69	6	3.69	6
SST 047	3.13	10	3.81	15	4.28	14	1.87	9	3.27	9	3.32	12	3.47	12
SST 056	3.24	7	4.11	9	4.63	11	1.94	5	3.48	7	3.56	8	3.67	8
SST 087	3.76	1	4.45	1	4.77	7	2.22	1	3.80	1	3.81	4	4.11	1
SST 096	3.36	6	4.00	11	4.66	10					4.33	2	3.68	7
SST 88	3.40	3	3.89	14	4.90	2	1.86	10	3.52	4	3.55	9	3.65	9
Tankwa	3.42	2	3.98	12	4.57	13	1.95	3	3.48	6	3.50	11	3.70	5
Average	**3.29**		**4.12**		**4.69**		**1.92**		**3.52**		**3.76**		**3.70**	
LSD_t(0,05)	**0.24**		**0.30**		**0.37**		**0.24**		**0.16**		**0.18**		**0.20**	

Rûens

Average hectolitre mass (kg/hl) of entries for the Eastern Rûens during the full or partial period from 2010 - 2013

Cultivar	2013	R	2012	R	2011	R	2010	R	4 year average 2010-2013	R	3 year average 2011-2013	R	2 year average 2012-2013	R
Baviaans			78.01	5	80.10	2	75.83	8						
Kariega			77.80	6	80.07	3	75.78	9						
Kwartel	73.50	12	76.72	10	79.30	8					76.51	6	75.11	10
PAN 3408	74.66	5	76.07	14	78.67	11	73.80	12	75.80	9	76.47	7	75.37	6
PAN 3434			78.66	2	79.58	5	76.53	5						
PAN 3471	75.84	1	78.34	3	80.05	4	76.73	3	77.74	2	78.08	1	77.09	2
Ratel	73.82	10	76.68	11	78.67	11					76.39	9	75.25	8
SST 015	75.03	3	77.22	7	79.14	9	76.03	7	76.86	5	77.13	5	76.13	4
SST 027	75.23	2	78.27	4	79.49	6	76.85	2	77.46	3	77.66	3	76.75	3
SST 047	74.94	4	79.51	1	79.41	7	77.43	1	77.82	1	77.95	2	77.23	1
SST 056	73.92	8	76.27	13	78.59	13	75.08	11	75.97	7	76.26	11	75.10	11
SST 087	74.35	7	75.70	15	78.14	15	75.65	10	75.96	8	76.06	12	75.03	12
SST 096	73.84	9	76.79	9	78.24	14					76.29	10	75.32	7
SST 88	74.56	6	76.83	8	80.16	1	76.68	4	77.06	4	77.18	4	75.70	5
Tankwa	73.71	11	76.63	12	78.88	10	76.10	6	76.33	6	76.41	8	75.17	9
Average	**74.45**		**77.30**		**79.23**		**76.04**		**76.78**		**76.87**		**75.77**	
LSD_t(0,05)	**0.50**		**1.10**		**1.55**		**0.61**		**0.62**		**0.68**		**0.62**	

Rûens

Average protein content (%) of entries for the Eastern Rûens during the full or partial period from 2010 - 2013

Cultivar	2013	R	2012	R	2011	R	2010	R	4 year average 2010-2013	R	3 year average 2011-2013	R	2 year average 2012-2013	R
Baviaans			10.88	13	12.07	11	12.54	8						
Kariega			11.45	5	12.40	5	13.10	4						
Kwartel	13.90	7	11.50	4	12.82	3					12.74	4	12.70	5
PAN 3408	14.09	6	11.37	6	12.26	9	12.64	5	12.59	4	12.57	5	12.73	4
PAN 3434			10.66	15	11.76	14	12.56	7						
PAN 3471	13.52	10	11.37	6	12.71	4	11.63	12	12.31	6	12.53	6	12.45	9
Ratel	13.70	8	11.24	8	12.30	8					12.41	8	12.47	8
SST 015	13.61	9	10.92	12	12.38	6	11.98	11	12.22	7	12.30	10	12.27	10
SST 027	14.78	3	12.31	2	12.36	7	13.11	3	13.14	3	13.15	3	13.55	3
SST 047	16.26	1	13.27	1	14.68	1	14.70	1	14.73	1	14.74	1	14.77	1
SST 056	14.21	5	11.10	9	11.85	13	12.42	9	12.39	5	12.39	9	12.66	6
SST 087	13.17	11	10.75	14	11.55	15	12.61	6	12.02	8	11.82	12	11.96	11
SST 096	14.27	4	10.98	11	12.17	10					12.47	7	12.63	7
SST 88	12.60	12	10.99	10	11.97	12	12.14	10	11.92	9	11.85	11	11.80	12
Tankwa	15.26	2	12.01	3	12.97	2	13.69	2	13.48	2	13.41	2	13.64	2
Average	**14.11**		**11.39**		**12.42**		**12.76**		**12.76**		**12.70**		**12.80**	
LSD_t(0,05)	**0.43**		**0.47**		**0.45**		**0.41**		**0.24**		**0.26**		**0.31**	

Rûens

Average falling number (s) of entries for the Eastern Rûens during the full or partial period from 2010 - 2013

Cultivar	2013	R	2012	R	2011	R	2010	R	4 year average 2010-2013	R	3 year average 2011-2013	R	2 year average 2012-2013	R
Baviaans			305	13	392	6	366	2						
Kariega			344	6	396	4	368	1						
Kwartel	323	1	341	8	381	8					348	2	332	2
PAN 3408	225	12	266	14	361	11	188	12	260	9	284	12	245	12
PAN 3434			345	5	394	5	298	9						
PAN 3471	253	11	246	15	396	3	285	10	295	8	298	11	249	11
Ratel	314	2	336	9	399	1					350	1	325	3
SST 015	293	8	312	12	385	7	313	5	326	5	330	9	302	10
SST 027	299	5	332	10	358	12	258	11	312	7	330	10	316	7
SST 047	304	4	316	11	397	2	303	7	330	4	339	5	310	9
SST 056	286	9	344	7	370	10	323	4	331	3	333	6	315	8
SST 087	295	6	346	4	352	13	309	6	325	6	331	8	321	6
SST 096	294	7	349	3	350	15					331	7	322	5
SST 88	311	3	362	2	352	13	302	8	331	2	341	3	336	1
Tankwa	285	10	362	1	372	9	330	3	337	1	339	4	323	4
Average	**290**		**327**		**377**		**304**		**316**		**330**		**308**	
LSD_t(0,05)	**16.27**		**23.97**		**11.49**		**33.99**		**9.77**		**10.52**		**14.62**	

BARLEY PRODUCTION

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Barley is, after wheat, the most important small grain in South Africa. The cultivation area for malting barley under dryland conditions is at present restricted to a very specific region, viz. the Southern Cape, which stretches from Bot River in the west to Heidelberg in the east.

There are various advantages attached to the arrangement that production of a relatively minor commodity, such as malting barley, is restricted to certain and specific areas. Production is concentrated, which facilitates transport, storage and control. Extension and research are cheaper and facilitated more readily. The single most important disadvantage is, however, that the risk of unpredictable weather conditions cannot be reduced and therefore barley production has also been introduced to the cooler central irrigation areas.

For the purpose of these production guidelines only malting barley cultivars will be discussed.

Plant Breeders' rights (Act 15 of 1976)

The act renders legal protection to the breeders and owners of cultivars. The awarding of rights stipulates that cultivars must be new, distinguishable, uniform and stable, and protection is granted for a 20 year period. The rights of the owner/ breeder entail that no party may multiply propagating material (seed), process it for planting, sell it, import it, export it or keep it in stock without the necessary authorization or licence of the holders of the rights. The act makes provision for the court to grant compensation of R10 000.00 to the holder of Plant Breeder's Rights in cases of breaching of rights.

Seed certification and Table 8, as described in the Plant Improvement Act

The main aim of certification of seed is to maintain cultivars. Seed laws and regulations prescribe the minimum physical requirements, while certification of seed strives to achieve high standards of genetic purity and other quality requirements. Seed certification is a voluntary action that is administered by SANSOR on behalf of the Minister of Agriculture. However, if a cultivar is listed in Table 8, it is subject to compulsory certification. Hereby cultivator purity as well as good seed quality is guaranteed, and renders protection and peace of mind to the buyer (farmer), as well as an improved control system for acting on complaints and claims. The costs involved are surely a minimal price to pay forthis peace of mind to both the buyer and seller of certified seed.

Cultivars

At present four cultivars are recommended for malting barley production in the Southern Cape, viz. SabbiErica, SabbiNemesia, S5 and SabbiDisa. The malting characteristics of these cultivars differ especially in terms of their dormancy (period from harvesting up to the stage where the barley meets the germination requirements for malting), and for that reason the mixing of these cultivars must be prohibited at all costs. It is thus imperative that the different cultivars are transported, handled and stored separately.

As it is difficult to distinguish between some cultivars in the field, it is imperative that chances for mixing are prevented. The first possibility for mixing is on the farm itself. This can be prevented by not planting a different cultivar to the one planted on that land the previous year. Producers must also ensure that planters and harvesters are cleaned thoroughly before moving to a field with a different cultivar. The chances of mixing are also greatly reduced if only one cultivar is grown on a farm.

The retaining of grain as seed for the next year is strongly discouraged. The problems of maintaining cultivar-pure and insect free seed with good viability safely on the farm is the reason why seed should not be kept back by producers.

Agronomic characteristics

Economically cultivar choice is a very important decision for the producer as it is one of the easiest ways to achieve higher and more stable income with the least risk. Factors that determine cultivar choice are thus fundamental to this decision. Only the most important factors are discussed briefly and for this reason Table 1, which characterises cultivars in terms of agronomic and quality characteristics, is included.

Table 1. Agronomic and quality characteristics of barley cultivars

Cultivars	Growth period	Straw length	Straw strength	Peduncle strength	Kernel plumpness
SabbiErica	M	M	G	MGG	M
SabbiNemesia	M	MS	G	MG	M
S5	M	MS	G	MG	H
SabbiDisa	M	ML	G	MG	H

E	=	*Early*	*ME*	=	*Medium early*	*M*	=	*Medium*	*S*	=	*Short*
MS	=	*Medium short*	*ML*	=	*Medium long*	*L*	=	*Long*	*MG*	=	*Medium good*
G	=	*Good*	*MH*	=	*Medium high*	*H*	=	*High*	*P*	=	*Poor*

Growth period

Growth period refers to the average number of days that it takes from emergence to physiological maturity (Tabel 1). For this reason cultivars must be planted that are adapted to the climatic conditions, such as growing season, rainfall pattern and temperature, of the area.

Straw strength

Straw strength is the ability of a cultivar to remain standing (unlodged) under extreme conditions and is largely determined by straw length and thickness. The lodging of barley often results in considerable yield and grain quality losses, which can largely be attributed to the resulting increased infestation of fungal plant diseases. It is largely a problem where critical yield potential conditions have been exceeded, but rain with a strong wind and excessive nitrogen fertilisation can also play a role.

Peduncle strength

This characteristic refers to the strength of the culm between the flag leaf and the head/ear, and thus to the susceptibility of the cultivar to wind damage (Table 1). The greatest risk of the latter is just prior to harvesting. It is advisable to rather cut the crops into windrows prior to harvesting if the cultivar is susceptible to this phenomenon.

Kernel plumpness

The percentage plump kernels largely determine the grade of the grain. This characteristic is strongly cultivar related (Table 1). In areas where soil water deficits and heat stress occur during the grain filling period and where certain plant diseases, such as *Rhynchosporium secalis* (scald), are common, considerable losses could occur with the downgrading of the crop due to a low kernel plumpness percentage.

Disease characteristics

In the Southern Cape, barley cultivars are often infected by various fungal diseases. Depending on environmental conditions, the levels of infestation differs from year to year. Although different levels of resistance against these fungal diseases exists, a complete spraying programme should still be followed. High levels of infestation has a negative influence on the yield and quality of the harvest.

Table 2 gives an indication of the resistance status of the cultivars to the most important fungal diseases in the area. The nomenclature used to indicate status can be explained as follow:

- Susceptible: The cultivar has no resistance against the pathogen and the disease spreads fast when conditions are favourable.
- Moderately susceptible: The cultivar has no resistance against the pathogen but the spreading of the disease is slightly slower under favourable conditions and under less favourable conditions it can be less harmful.

- Moderately resistant: The cultivar has quite good but not complete resistance against the pathogen. Although symptoms can be observed, the development of the disease is slow and it normally has little effect.
- Resistant: No scars or evidence of the disease is visible.

Table 2. Disease resistance of cultivars in the Southern Cape

Cultivars	Leaf blotch	Net form Net blotch	Leaf rust	Spot form Net blotch
SabbiErica	S	S	S	S
SabbiNemesia	S	S	R	S
S5	S	S	R	S
SabbiDisa	R	MS	MS	MS

S = Susceptible *MS = Moderately Susceptible*

MR = Moderately resistant *R = Resistant*

Quality

Maltsters require barley that malts homogeneous and modifies quickly, requires no or little cleaning and that will deliver malt of an acceptable and consistent brewing quality. Therefore maltsters set certain quality standards for malting barley to ensure that the end product is produced in the most economical way possible.

Nine characteristics, viz. cultivar purity, germination, nitrogen content, kernel plumpness, screenings, foreign matter, mechanical damage, fungal infestation and moisture content are of critical importance in grading and are discussed briefly.

Germination/cultivar purity

Malting barley differs from most cereals as it has to germinate again during processing. Germination refers to the percentage barley kernels that are viable within a specified time. It is the most important characteristic of malting barley and must be higher than 97% after the breaking of the dormancy period. It is very important that cultivars are not mixed, but stored separately due to the fact that they differ with regards to their malting characteristics.

The viability or germination energy of barley can be affected by rain prior to harvesting. If barley is subjected to rain when ripe, biochemical processes in the kernel are initiated that precede germination. The result is that the barley then germinates unevenly or poorly during the malting process and produces a poor end-product.

Nitrogen content

Barley with extensively high or low nitrogen content cannot produce malt of the required quality for brewing purposes. The sliding scale according to which the price of barley is determined, is based on a base price onto which premiums are added for certain nitrogen levels in the grain. Although grain with a nitrogen content of between 1.50% and 2.00% is accepted as malting barley, the premium is only payable on grain with a nitrogen content of between 1.60% and 1.90%. It is important to note that the cut-off and turning points can differ from season to season and must be confirmed with grain traders.

Nitrogen content of barley is a characteristic that is genetically, as well as environmentally, influenced. Certain cultivars produce lower nitrogen content despite higher nitrogen fertilisation. Such a characteristic of a cultivar would be beneficial as it is not only high nitrogen fertilisation that increases the nitrogen levels in the grain, but also uncontrollable factors such as drought and heat stress during the grain filling period and the nitrogen supply capacity of the soil. The producer must at all times consider the nitrogen supply capability of his soils, and here soil tillage and the preceding crop are of importance.

Kernel plumpness

Kernel plumpness is important for homogeneous malting. Thin kernels absorb water faster than plump kernels. Thin kernels also have a relatively higher percentage husk, which gives beer an astringent taste. Therefore, uniform plumpness will result in better malting quality. According to the sliding scale for plump kernels, more is paid for barley with a kernel plumpness that increases from 70% to 100%, measured above a 2.5 mm sieve. As in the case of nitrogen content, the cut-off point must be confirmed with the grain handlers.

It is also important to note that plump kernels produce malt with a higher extract, which is an important aspect in the brewing process. A low kernel plumpness percentage is the result of unfavourable conditions during the grain filling period, such as late ears that have ripened too fast or if an initial yield potential exceeds the capacity of the environment at the grain-filling stage. Certain cultivars however, also genetically tend to have low kernel plumpness and therefore breeders specifically select for lines with high kernel plumpness. The kernel plumpness of all the present barley cultivars currently in the market can be described as good to very good.

Screenings, foreign matter and mechanical damage

The material that is so small they fall through a 2.2-mm sieve are called screenings. This material generally consists of shrivelled kernels, broken kernels, small weed seeds, glumae, awns, dead insects and dust. There is a base price for barley deliveries with between 4.1% to 5.0% screenings and an increasing premium for deliveries with a screenings content between 4.0% and 0.0%. The top limit at which screenings can still be delivered is 5%. Again the cut-off points must be confirmed with the grain handlers. Thin kernels can be ascribed to factors noted, while broken kernels, glumae, awns and dust generally reflect on harvester adjustments. For this reason it is imperative that the producer adjusts his harvester accordingly to ensure good quality, a good grade and thus a good price.

Dead weevils in the screenings are usually an indication of a possible infestation and this would require further investigation. The presence of weevils can lead to downgrading of the crop due to live insects on the one hand, or the presence of insect damaged kernels on the other hand.

Foreign matter's cut off point is 2%, while a price incentive applies for foreign matter under 1%. A base price is applicable for barley with a foreign matter content between 1% and 2%, but a feed grade price is applicable for barley with a foreign matter content >2%.

Mechanical damage from harvesters decreases the percentage of usable barley kernels. When embryos are damaged or husk over the embryo is removed, the kernels cause problems in the malting process. Too high percentage of endosperm exposed kernels results in several processing problems in the malting process (fungal growth, foam in steep tanks etc).

Fungal infestation

Malting barley infested with fungi is not fit for human consumption and is downgraded to undergrade. Some fungi produce mycotoxins (DON) when under stress. Fungal infestation usually takes place when windrows are subjected to continual moist conditions or when barley with a too high moisture content is harvested and stored on the farm under unfavourable conditions. Barley with a high moisture content (>13%) should be dried according to specifications as soon as possible. Barley cultivars have no genetic resistance to these grain fungi.

Moisture content

Malting barley that is delivered and stored with too high a moisture content can result in fungal development and also a decrease in germination capacity. Therefore no malting barley with a moisture content of higher than 13% are accepted and a pro rata premium is paid for grain with the moisture content decreasing from 13% to 9.5%.

Barley Passport

In the 2005 season, a system was implemented by which the producer is obliged to submit a passport before he can deliver his barley. This barley passport entails a schedule that has to be completed by the producer in co-operation with his chemical agent and must clearly stipulate which chemicals have been applied on the barley as well as when it was applied, how it was applied and the dosage used. It is therefore of the utmost importance that the passport has to be fully completed and handed in at the delivery depot before any grain will be accepted.

It is also important to note that no grain will be accepted that was treated with an unregistered chemical, unregistered dosage or unregistered application method. For more information the local SAB Maltings representative can be contacted.

Recommendations

The yield and quality data for the previous four seasons are shown in the following tables (Tables 3 – 11).

Table 3. Average yield (ton/ha) of barley cultivars in the Southern Rûens for the period 2010 - 2013 (Localities: Napier, Klipdale, Bredasdorp and Protem)

Cultivar	2010	2011	2012	2013	Average
SabbiErica	2.98	6.22	5.87	6.03	**5.28**
SabbiNemesia	2.48	5.78	5.25	5.69	**4.80**
S5	2.27	6.13	5.18	-	**4.53**
SabbiDisa	2.28	6.14	5.21	5.70	**4.83**
Average	**2.50**	**6.07**	**5.38**	**5.81**	**4.86**

Table 4. Average yield (ton/ha) of barley cultivars in the Western Rûens for the period 2010 - 2013 (Localities: Caledon, Rietpoel, Greyton and Riviersonderend)

Cultivar	2010	2011	2012	2013	Average
SabbiErica	4.21	6.98	6.87	6.95	**6.25**
SabbiNemesia	3.94	6.68	6.79	6.95	**6.09**
S5	3.06	6.48	6.26	-	**5.27**
SabbiDisa	3.01	6.77	6.44	6.49	**5.68**
Average	**3.56**	**6.73**	**6.59**	**6.80**	**5.82**

Table 5. Average yield (ton/ha) of barley cultivars in the Eastern Rûens for the period 2010 - 2013 (Localities: Napkei, Swellendam, Heidelberg and Heidelberg Flats)

Cultivar	2010	2011	2012	2013	Average
SabbiErica	2.30	6.89	6.54	5.30	**5.25**
SabbiNemesia	2.08	6.77	6.09	5.41	**5.09**
S5	2.06	6.56	5.96	-	**4.86**
SabbiDisa	1.73	6.06	6.00	5.78	**4.89**
Average	**2.04**	**6.57**	**6.15**	**5.50**	**5.02**

Table 6. Average kernel plumpness (%) of barley cultivars in the Southern Rûens for the period 2010 - 2013 (Localities: Napier, Klipdale, Bredasdorp and Protem)

Cultivar	2010	2011	2012	2013	Average
SabbiErica	84.9	74.3	86.0	84.5	**82.4**
SabbiNemesia	88.5	80.3	90.0	90.7	**87.4**
S5	92.4	86.6	92.3	-	**90.4**
SabbiDisa	82.8	86.7	91.6	94.8	**89.0**
Average	**87.2**	**82.0**	**90.0**	**90.0**	**87.4**

Table 7. Average kernel plumpness (%) of barley cultivars in the Western Rûens for the period 2010 - 2013 (Localities: Caledon, Rietpoel, Greyton and Riviersonderend)

Cultivar	2010	2011	2012	2013	Average
SabbiErica	95.1	81.3	91.1	93.7	**90.3**
SabbiNemesia	95.9	89.1	90.3	95.7	**92.8**
S5	98.1	86.6	94.2	-	**93.0**
SabbiDisa	97.2	94.8	95.5	94.8	**95.6**
Average	**96.6**	**88.0**	**92.8**	**94.7**	**92.9**

Table 8. Average kernel plumpness (%) of barley cultivars in the Eastern Rûens for the period 2010 - 2013 (Localities: Napkei, Swellendam, Heidelberg and Heidelberg Flats)

Cultivar	2010	2011	2012	2013	Average
SabbiErica	91.3	89.2	92.0	95.8	**92.1**
SabbiNemesia	90.6	91.6	94.5	96.4	**93.3**
S5	95.8	95.0	94.5	-	**95.1**
SabbiDisa	88.0	93.6	94.0	94.6	**92.6**
Average	**91.4**	**92.4**	**93.8**	**95.6**	**93.3**

Table 9. Average kernel nitrogen (%) of barley cultivars in the Southern Rûens for the period 2010 - 2013 (Localities: Napier, Klipdale, Bredasdorp and Protem)

Cultivar	2010	2011	2012	2013	Average
SabbiErica	1.94	2.10	2.02	1.94	**2.00**
SabbiNemesia	1.88	2.20	2.00	1.91	**2.00**
S5	1.95	2.10	2.01	-	**2.02**
SabbiDisa	1.94	2.10	1.86	1.83	**1.93**
Average	**1.93**	**2.13**	**1.97**	**1.89**	**1.99**

Table 10. Average kernel nitrogen (%) of barley cultivars in the Western Rûens for the period 2010 - 2013 (Localities: Caledon, Rietpoel, Greyton and Riviersonderend)

Cultivar	2010	2011	2012	2013	Average
SabbiErica	1.67	1.95	1.92	1.79	**1.83**
SabbiNemesia	1.77	1.86	1.90	1.77	**1.83**
S5	1.70	1.95	1.85	-	**1.83**
SabbiDisa	1.69	1.93	1.89	1.75	**1.82**
Average	**1.71**	**1.92**	**1.89**	**1.77**	**1.83**

Table 11. Average kernel nitrogen (%) of barley cultivars in the Eastern Rûens for the period 2010 - 2013 (Localities: Napkei, Swellendam, Heidelberg and Heidelberg Flats)

Cultivar	2010	2011	2012	2013	Average
SabbiErica	2.11	1.94	1.74	2.03	**1.96**
SabbiNemesia	2.15	1.98	1.78	2.01	**1.98**
S5	2.20	1.95	1.72	-	**1.96**
SabbiDisa	1.99	1.94	1.75	1.86	**1.89**
Average	**2.11**	**1.95**	**1.75**	**1.97**	**1.94**

Planting date

Despite barley being planted over a relatively short period, it is common knowledge that the earlier plantings generally have a higher yield potential. This results in greater yield increases with disease and pest control programmes in earlier plantings. Barley thus planted later than the optimum planting date, as indicated in Table 12, is therefore at greater risk in terms of yield and quality.

Table 12. Optimum planting date of barley cultivars for the Southern Cape

Region	Cultivar *	Planting date (weeks)							
		April		May				June	
		3	4	1	2	3	4	1	2
Western-Rûens: Caledon	SabbiErica (PBR)			■	■	■	■		
	SabbiNemesia (PBR)			■	■	■	■		
	S5 (PBR)			■	■	■	■		
	SabbiDisa (PBR)			■	■	■	■		
Western-Rûens: Riviersonderend	SabbiErica (PBR)		■	■	■	■	■		
	SabbiNemesia (PBR)		■	■	■	■	■		
	S5 (PBR)		■	■	■	■	■		
	SabbiDisa (PBR)		■	■	■	■	■		
Southern-Rûens: Western Strandveld region	SabbiErica (PBR)			■	■	■			
	SabbiNemesia (PBR)			■	■	■			
	S5 (PBR)			■	■	■			
	SabbiDisa (PBR)			■	■	■			
Southern-Rûens: East and Flats area	SabbiErica (PBR)		■	■	■	■			
	SabbiNemesia (PBR)		■	■	■	■			
	S5 (PBR)		■	■	■	■			
	SabbiDisa (PBR)		■	■	■	■			
Eastern-Rûens	SabbiErica (PBR)		■	■	■				
	SabbiNemesia (PBR)		■	■	■				
	S5 (PBR)		■	■	■				
	SabbiDisa (PBR)		■	■	■				

** These cultivars are accepted for malting purposes by SAB Maltings*

PBR: Cultivars protected by Plant Breeders' Rights

Planting rate

Heads/m^2 is the yield component that makes the greatest contribution to grain yield. The number of heads is, amongst others, determined by tillering ability, seeding rate and survival of seedlings. Seeding rate must also compensate for lower germinative capacity, poor emergence, "damping off" of seedlings and the planting method used. Thousand kernel mass is an important characteristic that determines the number of kernels per kilogram seed and this can vary from 36 - 54 g/1000 kernels, which can have a distinct influence on seeding rate. Typically 130-

170 plants/m^2 will be sufficient.

Planting rate (kg/ha) = Plants per m^2 x 1 000 kernel mass / Survival %

The following table can be used in the calculation of seeding rate for the conventional sowing method. Survival percentage for this method was taken at 70%.

Table 13. Table for the calculation of planting rate

Plant establishment (plants/m^2)	Thousand kernel mass (g/1000 kernels)									
	36	38	40	42	44	46	48	50	52	54
100	51	54	57	60	63	66	69	71	74	77
110	57	60	63	66	69	72	75	79	82	85
120	62	65	69	72	75	79	82	86	89	93
130	67	71	74	78	82	85	89	93	97	100
140	72	76	80	84	88	92	96	100	104	108
150	77	81	86	90	94	99	103	107	111	116
160	82	87	91	96	101	105	110	114	119	123
170	87	92	97	102	107	112	117	121	126	131
180	93	98	103	108	113	118	123	129	134	139
190	98	103	109	114	119	125	130	136	141	147
200	103	109	114	120	126	131	137	143	149	154
210	108	114	120	126	132	138	144	150	156	162
220	113	119	126	132	138	145	151	157	163	170
230	118	125	131	138	145	151	158	164	171	177
240	123	130	137	144	151	158	165	171	178	185
250	129	136	143	150	157	164	171	179	186	193

Example: Thousand kernel mass of seed = 40

The preferred plant establishment = 130 - 170 plants/m^2

Required planting rate: 74 - 97 kg/ha

The following table can be used in the calculation of seeding rate for producers using planters. Surival percentage for this method was taken at 85%.

Table 14. Table for the calculation of planting rate

Plant establishment (plants/m²)	Thousand kernel mass (g/1000 kernels)									
	36	**38**	**40**	**42**	**44**	**46**	**48**	**50**	**52**	**54**
100	42	45	47	49	52	54	56	59	61	64
110	47	49	52	54	57	60	62	65	67	70
120	51	54	56	59	62	65	68	71	73	76
130	55	58	61	64	67	70	73	76	80	83
140	59	63	66	69	72	76	79	82	86	89
150	64	67	71	74	78	81	85	88	92	95
160	68	72	75	79	83	87	90	94	98	102
170	72	76	80	84	88	92	96	100	104	108
180	76	80	85	89	93	97	102	106	110	114
190	80	85	89	94	98	103	107	112	116	121
200	85	89	94	99	104	108	113	118	122	127
210	89	94	99	104	109	114	119	124	128	133
220	93	98	104	109	114	119	124	129	135	140
230	97	103	108	114	119	124	130	135	141	146
240	102	107	113	119	124	130	136	141	147	152
250	106	112	118	124	129	135	141	147	153	159

Example: Thousand kernel mass of seed = 40

The preferred plant establishment = 130 - 170 plants/m²

Required planting rate 61 - 80 kg/ha of seed

OAT PRODUCTION

Oats has been cultivated in the past mainly for grazing purposes and hay production. Grain production of oats make a limited contribution to the developing breakfast cereal market, with the majority of grain produced ending in the animal feed market. Human consumption of oats is currently the only organised market, with competitive grain prices being paid for a product with suitable grain quality.

Other attributes of oats are also of importance. The introduction and expansion of no-till practices and reduced cultivation systems necessitates the use of suitable cover crops to achieve significant ground cover. Oats fits into this scenario due to the wide planting spectrum, wide adaptability and high biomass production, and can be planted with available cultivation equipment. Furthermore, oats have a depressing effect on soil borne diseases, like take-all, in these crop rotation systems.

Grazing, silage and hay production

Oat grain is widely used by horse owners and other producers in feed mixtures. Well fertilised oats produces high quality hay and grain with a high nutritional value. Oat grain that does not qualify for suitable grades, due to low hectolitre mass values, is also utilised in the animal feed market.

Oats play a significant part in a balanced grazing availability program, with several cultivars suited for this purpose. The wide adaptability, nutritional value and regrowth characteristics of oats create the situation of available grazing over a long period.

Grain quality

The quality standards applied at present are directly related to the processing of the oats. To develop an understanding of these standards it is necessary to briefly note the most important processes during processing. Firstly, all impurities and foreign material such as chaff, stones, weed seeds, wheat and barley are removed. The groat or kernel is the economically valuable part of the grain, while the hulls have no commercial value. The hulls are removed by two rotating milling stones that are set fractionally closer to one another than the thickness of the grain, and literally rub off the hulls. It is thus understandable that the hulls of twin oats cannot be removed and that naked oats will be damaged in this process. After this process, the oats undergoes specific processing for the purpose for which it is needed.

Hectolitre mass

Large and well filled groat/kernels are in big demand by the processors and hectolitre mass is an indication of this quality aspect. The minimum hectolitre mass depending on the grade, is shown in Table 1.

Table 1. Grading requirements for oats

Grade	Minimum hectolitre mass (kg/hl)
Grade 1	53
Grade 2	48
Feed Grade	38

Just as in the case of wheat and barley, hectolitre mass of oats is determined during the grain filling stage. Abnormal leaf senescence prior to or during flowering and grain filling due to malnutrition, diseases or stress, causes low hectolitre mass. The deficiencies must be corrected before the flag leaf stage to ensure a positive effect on hectolitre mass.

Groat: hull relation

The oat kernel is enclosed by two hulls that are worthless to the industry. Plenty of groat and little hull are thus required and processors require no more than 30% hulls against 70% or more groat. This characteristic is generally also reflected in the hectolitre mass and is environmentally, as well as genetically determined. In shrivelled oat grains the hulls make out a greater percentage of the groat:hull relation and in this case it is undesirable.

Seed size

During processing, the oat grain is sieved into different class sizes. This process is done very accurately, as an important quality component of the end product rests on the effectivity of the sieving process. The largest seeds are more desirable, while the smallest seeds are generally worthless. Uniform seed size is thus ideal. As the largest seeds ripen first and tend to fall out first, it is important not to delay harvesting.

Twin oat grains often occur. This characteristic is cultivar specific but can also be the result of environmental conditions and the harvesting process. Twin oat grains are undesirable as they go through the sieving process as large seeds and are later separated as two small oat grains that cannot be dehulled later. The harvester must thus be set in such a way that a minimum of twin oat grains is harvested.

Naked oat grains are grains of which the hulls have been removed in the harvesting process and are totally undesirable as they are separated into the small and medium seed sizes in the sieving process and are ground and not dehulled in the dehulling process. The adjustment of the harvester is thus critical and requires special and specific attention by the producer.

As with wheat, planting date, fertilisation, pest and weed control, timely harvesting and correct adjustment of the harvester are of critical importance to produce grain of high quality. Locally available oat cultivars do have the potential to produce suitable quality grain, and this potential must be utilised.

Oat grain production

General production practices for oats production in the winter rainfall area are similar to that of wheat production.

Cultivation

Irrespective of the crop rotation system followed, the main aim is to accumulate the maximum amount of soil water, alleviate compacted soil layers, and prepare a seedbed that will ensure good germination and seedling establishment. Planting activities of oats is similar to that of wheat with regard to planting depth and row widths used.

Seed treatment for oats

The standard seed treatment against seed borne diseases must be applied in grain productions, while it is optional in grazing and hay productions.

Cultivar choice, planting spectrum and seeding density

The producer must decide on the end market for the production that being grain, grazing or feed. Cultivars more suited for grazing and hay production have different characteristics, and a cultivar for grain production must be chosen in correspondence with the needs of the buyer and end user of the product, but it should also fit into the production system of the farmer. Once this decision has been made, plant the chosen cultivar and optimise all production practices (Table 2). Use certified seed to ensure that the correct cultivar is planted according to the proposed end user, and to ensure good germination and seedling establishment.

Table 2. Oat cultivar planting spectrum

Cultivar	Planting date (weeks)							
	April				May			
	1	2	3	4	1	2	3	4
Kompasberg								
Sederberg								
Overberg								
Heros								
SSH 405								
SSH 491								
Pallinup								
Simonsberg								
Towerberg								

Seeding density: The target plant population is 250 plants/m². Depending on the specific seed lot and thousand-kernel mass the seeding density can range from 60 - 100 kg seed/ha. The planting spectrum is based on available data. Plantings outside this spectrum is at the producers own risk.

Fertiliser requirement

Oats generally has similar soil requirements as wheat with regard to the macro and micro nutrients (Fe, Cu, Zn, Mn and Mo) that have major influence on production. Soil acidity levels between (pH 4.8 to 5.5 (KCl) are regarded as being optimal. Oats is more acid tolerant (up to 15% acid saturation) than wheat, but less saline tolerant when compared with wheat and barley.

Nitrogen management of the oat crop is determined by soil and nutrient management strategies including the previous crop, soil water availability, soil nitrogen availability, yield potential, risk of lodging, timing of nitrogen applications and nitrogen sources available.

For hay production 100 kg N/ha is recommended, with an additional 30 kg N/ha after each grazing and/or fodder harvest depending on production level.

For grain production the general recommendation is 80 kg N/ha, 15 kg P/ha and 15 kg K/ha for a grain yield potential of 2.5 ton/ha. Phosphorus is important especially early in the growing season for establishment, while sufficiently available potassium can reduce lodging and ensure uniform ripening.

A maximum of 20 kg N/ha or a total of 50 kg N+K/ha can be seed placed safely, and higher applications must be banded away from the seed. The phosphorus fertiliser recommendations (kg P/ha) at the yield potential levels and soil analysis value (mg/kg P-Bray 1), as well as the potassium fertiliser recommendations (kg K/ha) at the relevant yield potential levels and soil potassium analysis value (mg/kg K) currently used for wheat production can also be applied for oat production. Keep in mind that the yield potential of oats is lower than that of wheat. The same fertiliser recommendations can be used for grazing plantings, with the option of additional N applications after grazing events combined with rainfall occurrence.

Diseases and control

Oats is susceptible to crown and stem rust, and to "Barley yellow dwarf virus" which is spread by aphid infestations. It is economically viable to control diseases at yield potential levels above 2 ton/ha. Diseases generally lower the kernel weight and hectolitre mass, and discolour the grain, resulting in downgrading of the product resulting in a lower price per ton grain. Regular field inspections in the growing season must be done to ensure timely disease control and prevent yield and quality losses.

At seedling stage and in the field, the cultivars Simonsberg and Towerberg showed resistant to low susceptibility while Kompasberg, Sederberg and SSH 491 showed mild susceptibility to the current crown rust races. The other cultivars are highly susceptible. In a season when the climatic conditions are favourable towards crown rust development, cultivars will have to be inspected regularly to ensure timely control of the disease. Simonsberg and Towerberg showed mild resistance to stem rust infection at the seedling stage and in the field.

Harvesting, storage and marketing

Oats can be harvested at a grain moisture content below 20%, but can only be stored safely at a grain moisture below 12.5%. Shattering in the field can be a problem, and rain during harvesting can discolour kernels, resulting in downgrading of the crop. There are various options (including cleaning and sieving) to improve grain quality parameters, especially hectolitre mass, to attain better prices per ton of grain.

Problems in oat production

Grasses in oat productions can be a huge problem as it cannot be chemically controlled, and these grasses and volunteer wheat must be controlled beforehand, especially if take-all depression is one of the production objectives. Lodging of the crop causes yield losses and non-uniform ripening and hence difficulties in timely harvesting, and can result in reduced grain quality. Lodging can be managed by cultivar choice, seeding density and nutrient management. In particular, seeding density is a major factor with regard to the incidence of lodging. Because of the lower kernel weight of oat seed, lower seeding densities (kg seed/ha) are needed to achieve target plant populations. Cultivars also differ in tillering capacity that can influence seeding density for a yield target. Bird damage is also a limiting factor in some areas.

Yield results

The yield results hectolitre mass values obtained in the oat cultivar evaluation programme over the past seasons are summarised in the following tables:

Average yield (ton/ha) of oat cultivars in the Swartland and Rûens during the full or partial period from 2010 - 2013

Cultivar	2013	R	2012	R	2010	R	3 year average 2010-2013	R	2 year average 2011-2013	R
H06/15					2.22	4				
H07/04					2.03	7				
Heros					1.63	12				
Kompasberg	4.14	1	4.05	1	2.68	1	3.62	1	4.10	1
Overberg	3.13	4	2.93	6	1.76	10			3.03	5
Pallinup	3.10	5	3.12	5	2.23	3	2.82	4	3.11	4
Sederberg					1.88	8				
Simonsberg	3.81	3	3.41	2	2.11	5	3.11	3	3.61	3
SSH 405	2.36	7	2.37	8	1.76	9	2.17	6	2.37	7
SSH 421	2.55	6	2.43	7	1.70	11	2.22	5	2.49	6
SSH 491			3.34	3	2.52	2				
Towerberg	4.04	2	3.23	4	2.09	6	3.12	2	3.63	2
Average	**3.30**		**3.11**		**2.05**		**2.84**		**3.19**	
LSD_t(0,05)	**0.24**		**0.17**		**0.17**		**0.11**		**0.14**	

Average hectolitre mass (kg/hl) of oat cultivars in the Swartland and Rûens during the full or partial period from 2010 - 2013

Cultivar	2013	R	2012	R	2010	R	3 year average 2010-2013	R	2 year average 2011-2013	R
H06/15					46.84	10				
H07/04					47.36	8				
Heros					47.50	6				
Kompasberg	45.39	6	50.52	6	46.62	11	47.51	6	47.96	6
Overberg	42.82	7	49.24	8	47.15	9			46.03	7
Pallinup	48.56	1	53.05	2	47.49	7	49.70	1	50.81	1
Sederberg					45.16	12				
Simonsberg	46.58	5	51.69	5	48.28	4	48.85	4	49.14	4
SSH 405	46.62	4	52.81	3	48.41	3	49.28	2	49.72	2
SSH 421	46.79	3	52.21	4	48.07	5	49.02	3	49.50	3
SSH 491			55.13	1	51.83	1				
Towerberg	47.14	2	50.18	7	48.70	2	48.67	5	48.66	5
Average	**46.27**		**51.85**		**47.78**		**48.84**		**48.83**	
LSD_t(0,05)	**0.85**		**0.17**		**0.17**		**0.48**		**0.63**	

TRITICALE

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Triticale is a versatile crop that fits in well with producer's existing farming practices, competes very well with weeds and is more disease and pest resistant than most other cereals. As a multi end-use crop, it can be grazed initially while achieving a grain yield. It is also excellent for the making of silage, either by itself or with oats. Triticale is also an excellent cover crop in vineyards.

Cultivars

During 2014, Ibis (KaapAgri), US2007 (OverbergAgri) and AgBeacon (Agricol) are available and recommended for the Southern and Western Cape. Ibis is extremely susceptible to stem and leaf rust. It was selected mainly for fodder yield as it is significantly taller than the other cultivars. US2007 and AgBeacon exhibit excellent disease resistance and are of medium maturity and length. The average yield of the respective cultivars over a 1, 2 and 3-year period is shown in Table 1.

Table 1. The average grain yield (t/ha) of the respective cultivars over a 1, 2 and 3 year period.

Cultivars	2013	R	2012-2013	R	2011-2013	R
AgBeacon	4.56	1	3.96	1	3.21	1
US2007	4.42	2	3.76	2	2.94	2
Ibis	3.76	3	2.54	3	2.1 1	3

R=Ranking

The agronomic and quality characteristics, as well as the disease resistance of triticale cultivars are given in Table 2.

Fertilisation

The fertilisation practises are the same as for wheat. Although it is commonly accepted that less fertiliser is applied to triticale, the crop thrives on a nitrogen topdressing.

Herbicides

Generally triticale is more susceptible to hormone-type herbicides than wheat and the application of such herbicides are thus not recommended. For the rest, the same herbicides and quantities are recommended as for wheat.

Diseases and pests

In general, triticale is more resistant to diseases and aphid damage than wheat. Several new leaf and stem rust races have been observed over the past few seasons. All cultivars are resistant to powdery mildew, stripe rust as well as to the Russian wheat aphid. The newest cultivars, US2007 and AgBeacon are resistant to all rust races (as observed during the 2011 - 2013 seasons).

Table 2. Agronomic and disease resistance of triticale as determined over 5 sites.

Cultivars	AgBeacon	US2007	Ibis
Days to heading	95	95	100
Height (cm)	105	110	135
Hectolitre mass (kg/hl)	75	70	68
Leaf rust	R	R	S
Stem rust	R	R	S
Stripe rust	R	R	R
Russian wheat aphid	R	R	R

R =Resistant; *S = Susceptible*

Planting and seeding rate

Table 3. Optimum planting date and seeding rate of triticale for the Rûens and Swartland

Cultivars	Plant date		Seeding rate (kg/ha)
	Rûens	Swartland	
AgBeacon	24/4-*	1/5-*	90-110
US2007	24/4-*	1/5-*	90-110
Ibis	24/4-*	1/5-*	100-130

** Plant triticale before wheat when soil water is adequate*

METHODS TO INCREASE HERBICIDE EFFICACY

There are various methods to increase herbicide efficacy.

Increase the herbicide rate

Herbicide efficacy usually increases with rate. Higher rates will often overcome poor performance as a result of adverse environments. Increase in herbicide rate to overcome environmental constraints has disadvantages and should not be regarded as the only option to enhance herbicide efficacy. The disadvantages of high rates are discussed below.

Cost ineffective

High herbicide use rates are costly and should only be used when other options are unavailable.

Environmental concern

Most herbicides are safe at recommended rates, but some may have soil residual or may leach. High rates increase the potential of residual in the soil, surface water or ground water. Every effort should be made to optimise herbicide efficacy with methods which do not involve higher rates.

Unstable performance

Herbicide absorption is often very dependent on the climatic conditions during and just after spraying. If the rate of a herbicide is increased to a level that acceptable control is obtained under sub-optimal conditions, then probably too much herbicide is applied under optimal conditions. The same argument applies to crop damage. A high herbicide rate, which causes no damage under poor conditions, could injure a crop under optimal conditions.

Avoiding limiting factors

Another way of getting the most from a herbicide is to always spray under optimal climatic conditions. This will ensure adequate absorption in most cases. The limiting factors which should be avoided include the following:

- Low humidity
- Moisture stressed plants
- Wind
- Rain directly after application
- Water with high salt concentrations

Avoiding these limiting factors sounds good on paper, but is almost impossible in practice. However, herbicides should be applied under favourable conditions whenever possible. The variability, unpredictability and harshness of the South African climate is well known. Other methods for optimising herbicide efficacy must be investigated.

Adjuvants

Adjuvants are substances which compensate, to a degree, for herbicide limiting environmental factors. They stabilise herbicide efficacy under various conditions, increase efficacy under harsh conditions and reduce the potential the crop injury under optimal conditions compared to the use of high rates. Most herbicides are used at lower rates when applied with adjuvants accounting for the reduced crop injury under optimal environments. Adjuvants may not be needed with a high rate of herbicide or when avoiding stress conditions. Higher rates however, could be expensive and avoiding stress conditions is not always possible. Adjuvants often are only effective with certain herbicides and may not totally overcome harsh conditions. The important point is that herbicides often are specific and consideration must still be given to stress conditions, specific herbicides, spray volume and spray carrier salts.

MISCONCEPTIONS REGARDING ADJUVANTS AND HERBICIDE EFFICACY

There are many misconceptions about adjuvants.

Wetting/Spreading

The most common misconception is that adjuvants which wet the leaf effectively are always the most effective. It is true that certain herbicides are more effective with "effective spreaders", but this is not a general rule with all herbicides.

Crop damage (phytotoxicity)

It is extremely convenient to blame crop damage of certain herbicides on the adjuvant applied with the herbicide. Adjuvants are often characterised as "too hot" for certain herbicides. One must however bear in mind that adjuvants only improve the activity of herbicides and seldom have phytotoxic effects of their own. Crop damage results from too much herbicide penetrating and damaging the crop. It is then ultimately an excess of herbicide which causes the damage and not the adjuvant. Herbicides, at recommended lower rates applied with adjuvants, normally result in more stable herbicides as far as efficacy and selectivity on the crop is concerned. This is a result of similar amounts of herbicide penetrating the weeds and crop under most climatic conditions, adjuvants are therefore, not the cause of herbicide damage on crops. On the contrary, they may decrease crop damage by allowing for lower herbicide use rates under various conditions.

Similar adjuvant enhancement of herbicide efficacy

Another misconception is that adjuvants are all similar in action and that one adjuvant may be substituted for another. This may be true if the rate of the herbicide is high enough to give total weed control, but not when the herbicide is applied at low economical rates under adverse climatic conditions. The sole purpose of adjuvants is to increase the efficacy of herbicides when using low, economical rates.

Certain adjuvants are superior to others and may be used universally

Since the first adjuvants were applied it has always been the aim of adjuvant manufacturers and scientists alike to create a "blockbuster" adjuvant which may be used universally with all herbicides. Up to date there is no such miracle adjuvant and adjuvants are normally only beneficial to certain herbicides. Adjuvants have limitations just as any other agricultural product. Both advantages and disadvantages of adjuvants need to be understood for correct usage. Advantageous adjuvants could become disadvantageous if used incorrectly. Poor efficacy or crop damage could result.

ACIDIFICATION

Some herbicides applied at low pH are more effective than at high pH for certain reasons. Before herbicides are acidified as a standard practice, it is important to understand the reasons for acidification and that acidification is not always beneficial. It is also necessary to understand that there are, barring the acid products, also surfactants which without the addition of any acid have the ability to acidify the spray solution. These surfactants include the phosphate esters and have the dual purpose of acidification and the other properties contained by surfactants.

When must spray solutions be acidified?

Only when specified on the label.

- Never omit the registered acidifier or buffer.
- Do not acidify spray solutions as a standard practice when not recommended.
- Never substitute one buffer or acidifier with another as the acids differ in different products. If necessary only substitute products with the same acids.

Method of acidification

Labels are very specific on the amount of acidifier to be added and the sequence order of addition. Buffers and acidifiers are normally added prior to the herbicide and the other adjuvants. Excess acidification may cause herbicide breakdown or interfere with uptake by the plant. Label recommendations on amount of product and sequence of mixing are designed to optimise compatibility over a wide range of conditions.

Acidification is not always beneficial

Although acidification is sometimes advantageous, it may be disadvantageous with certain herbicides. This once again proves that no adjuvant is universal in its use and that adjuvants are herbicide specific.

CONDITIONS DURING AND JUST AFTER SPRAYING

Optimal conditions for herbicide application could allow for efficacy even when recommendations are not followed. Improper applications however, will severely reduce efficacy under adverse conditions such as low humidity. These improper applications could be omission of or use of the wrong adjuvant or unregistered mixtures. The following conditions may adversely affect herbicide absorption, especially when the right choice of adjuvant and herbicide mixtures determine efficacy:

Low humidity and wind

Spray solution droplets on weed leaf surfaces under low humidity and windy conditions are prone to rapid evaporation. Adjuvants which increase the rate of penetration or decrease the rate of evaporation under these conditions will increase herbicide penetration and increase herbicide efficacy. On the other hand, any factor which decreases rate of penetration will decrease the amount of herbicide absorbed and the subsequent efficacy of the herbicide. These factors include the omission of the registered adjuvant, the use of the wrong adjuvant or the application of antagonistic mixtures of herbicides.

Sunlight (Ultraviolet light)

Certain herbicides are prone to breakdown by ultraviolet light on the leaf surface. Any factors decreasing the rate of uptake of these herbicides will increase the chance of ultraviolet breakdown and decrease herbicide efficacy. These factors could include wrong choice or omission of the registered adjuvant, antagonistic mixtures or the time of day applied.

Rain

Herbicides are classified as rainfast after a certain period of time. This means that rain after this period of time will not decrease herbicide efficacy. Rainfastness in many instances just indicates that the herbicide has been absorbed into the weed. Rate of penetration will decrease the effect of wash-off from raindrops and will make the herbicide rainfast. Rapid penetration could have additional advantages such as protecting the herbicide droplet against factors such as low humidity, wind or ultraviolet light breakdown.

Moisture stress

Weeds under soil moisture stress do not grow actively and are not receptive to efficient herbicide uptake. Any factor which decreases absorption or rate of absorption will devastate herbicide efficacy on moisture stressed weeds. Even adjuvants cannot negate the negative absorption response from moisture stressed plants.

Chemical factors

Adjuvants

Adjuvants partially overcome the influence of stress conditions on herbicides. The wrong adjuvant choice can therefore decrease herbicide efficacy under stress conditions. A good knowledge of adjuvants is therefore essential if replacing one adjuvant with another.

Mixtures

Antagonistic herbicide mixtures are a major source for decreased herbicide efficacy. Antagonistic herbicides affect one another's absorption and the resulting efficacy. These mixtures are most pronounced under adverse climatic conditions.

INSECT CONTROL

A variety of insects with different feeding habits are found on wheat but not all these pests are equally injurious. 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 result 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 ARC-Small Grain Institute at a cost of R50 (+ R6 postage). This full-colour guide contains a short description and photograph of each insect and includes both pests and beneficial insects. A pamphlet containing information on the registered insecticides is also included. It is helpful to make use of a magnifying glass when identifying wheat insects, as most of them are quite small. Dr Goddy Prinsloo, Dr Justin Hatting, Dr Vicki Tolmay and Dr Astrid Jankielsohn can be contacted for more information. Guidelines for the control of insect pests are discussed below. Most of these insects are sporadic pests, while aphids and bollworm occur annually.

Aphid

Aphid species, causing problems in the winter rainfall area are mainly oat aphid, English grain aphid and rose-grain aphid. Russian wheat aphid, which is the most severe wheat aphid in South Africa, is a sporadic pest in this area. Presently four RWA biotypes are known to occur in South Africa. Since 2009 RWASA2 and RWASA3 were present every year in the wheat production areas in South Africa and in 2011 RWASA4 was recorded in the Eastern Free State. Although RWASA2 and RWASA3 occur in the Western Cape, RWASA1 is still the predominant biotype (Fig: 1) The former aphids prefer thick plant densities with damp conditions, which are typical of the winter rainfall region 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.

Figure 1b: Oat aphid

Figure 1c: English Grain aphid

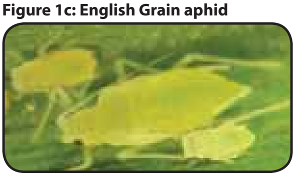


Figure 1d: Rose grain aphid

Oat aphid, English grain aphid and rose-grain aphid

The Oat aphid (*Rhopalosiphum padi*) has a dark green pear shaped body with a red-coloured area between the siphunculi on the rear end of the aphid (Fig 1b). A green and brown form of the English grain aphid *(Sitobion avenae)* (Fig 1c) can be found. Long black siphunculi on the rear end are the most outstanding characteristic of this aphid. The rose-grain aphid *(Metopolophium dirhodum)* is pale yellow-green in colour with a dark green longitudinal stripe on the back (Fig 1d). The siphunculi of this aphid are the same colour as the body.

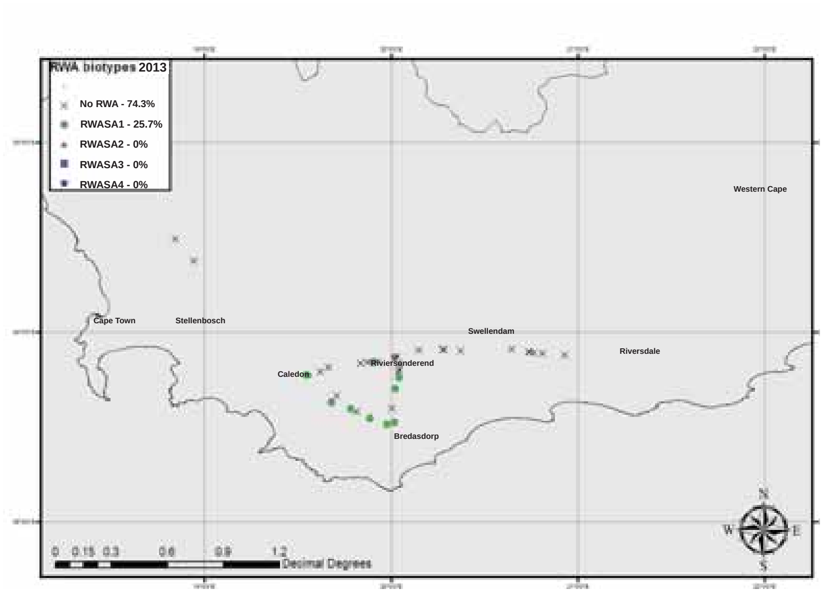


Fig1: Distribution of Russian wheat aphid biotypes in the Winter rainfall area in South Africa during in 2013

Oat aphid prefers to feed on the stems of plants and when present early in the season, they feed on the stems close to the soil surface. At a later stage they feed on the stem beneath the ear and can move into the ear. English grain and rose-grain aphids feed on the underside of the upper leaves and after heading, English grain aphid will also move into the ear.

These aphids are less harmful than Russian wheat aphid and all three species can occur simultaneously. Aphid populations increase rapidly after the flag leaf stage. Chemical control can be applied between flag leaf appearance (GS14)* and full ear appearance (GS17)* when 20 – 30% of the tillers are infested with 5-10 aphids per tiller. Be sure that chemical control is applied correctly when necessary - read the label and do the application accordingly. Be careful to apply the correct dosage. A wrong dosage could lead to inadequate control necessitating another application, which will have financial implications and creates a risk of resistance development in aphids. Unnecessary applications of insecticides should be reduced to a minimum, because they also kill the natural enemies, which are important in the control of aphids. When the environment around the fields reaches an ecological balance, an increase in natural enemies should occur, which will aid the control of aphids, and reduce the control costs.

** Joubert Growth stages pg 9*

Other insect pests

Except for aphids, Bollworm *(Helicoverpa armigera)*, Grain chinch bug *(Macchiademus diplopterus)*, Grain slug *(Lema erythrodera)* and Black sand mite or red-legged earth mite *(Halotydeus destructor)* are considered sporadic, secondary pests of small grains in the winter rainfall region.

Bollworm

The adult moths are light brown to grey with a wingspan of about 20mm. The moths fly at dawn and dusk laying their eggs directly on the plant. Young larvae of early season generations initially feed on the chlorophyll of leaves, later migrating into the head to feed on the developing kernels. Moths of later generations deposit their eggs directly on the head. Final instar larvae can vary from bright green to brown and have a characteristic lateral white stripe on either side. The larva can reach up to 40mm in length and can cause considerable damage, especially in terms of quality loss and subsequent downgrading of grain. The presence of bollworm is generally noticed only once the larvae have reached the mid-instar stage inside the ear. Producers should monitor their fields in order to detect the younger larvae, as the older, more mature larvae, are generally less susceptible to insecticides and obviously cause more damage compared to small larvae. Chemical intervention can be considered when 5-8 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. Waiting periods after applying insecticide should also be adhered to.

Grain chinch bug

These narrow elongated bugs are sap-feeders and measure 4-5mm in length. The eggs are deposited in rows of up to 150 on the leaf sheaths and the young wingless nymphs with yellow to orange coloration appear during spring. Both nymphs and adults feed by extracting sap from the host plant leading to a slightly yellow, withered appearance. Sap may also be sucked from the seed. Damage is more pronounced under warm, dry conditions as stressed plants have a lower ability to tolerate/recover from chinch bug damage. During early summer adults migrate to alternate host plants where they over summer before re-infesting the wheat crop during the winter. Although no insecticides are registered against this insect on wheat, the closely related false chinch bug, *Nysius natalensis*, does have systemic insecticides registered. However, no threshold values are currently available for either species on wheat.

Grain slug

Although the name implies otherwise, this is not a slug but the larva of a metallic green beetle. The adult measures about 5mm in length and occurs on cereals from June onwards. Eggs are deposited in groups of 2-5 in rows along the main vein of the leaf. The larvae are pale, but soon cover their bodies with a blackish substance giving them a slug-like appearance. The larvae feed between the veins resulting in white longitudinal stripes developing on damaged leaves. Currently, no insecticides are registered for the control of grain slug on wheat.

Black sand mite or red-legged earth mite

These are small black mites, 0.5mm in length with red legs, first appearing after good autumn or winter rains. The mites feed on plant sap resulting in silvery white scars adjacent to the main vein of especially older leaves. High infestations could lead to dying off of small plants. The mites over-summer in eggs retained by the female inside her body until after her death. A single systemic insecticide is registered although no threshold value is available.

DISEASES OF SMALL GRAINS

Diseases of small grains affect small grain production by reducing yield and impairing quality. To maximize profits, producers need to understand the influences that diseases have on crop potential. The purpose of this section is to assist with the identification of small grain diseases most commonly found in the winter rainfall areas of small grain production. The information contained here is intended to increase the producer's knowledge of small grain diseases and so indirectly assist with the control of the plant diseases that they may encounter.

A single fungal pathogen may infect a range of small grains, while other small grain pathogens may be confined only to infecting a specific host. Additionally, cultivars may vary in their susceptibility to different diseases. In this section, the most important diseases of small grains in the winter rainfall areas are discussed. After the scientific name of a certain disease, the hosts that are attacked by the specific disease are listed. Advice is given on means of control. In the case of chemical control, the active ingredients registered in South Africa against the disease are listed in Tables 4 to 6.

Leaf and stem diseases

Rusts

The rusts are widespread and important diseases of small grains, but they also infect many other wild and cultivated grasses. In South Africa, urediniospores play a major role in the development of rust epidemics. In the non-crop season, rust pathogens are able to survive on volunteer plants. The wind dispersed urediniospores formed on these plants are a source of inoculum for the disease. In the following season, small grain crops are infected by the urediniospores and first symptoms are typical urediniospore pustules. Later in the season, as another kind of dark coloured spore, known as teliospores, develop within lesions, the lesions start to appear black in colour. In other countries, teliospores infect an alternate host and play an important role in the sexual disease cycle but the alternate host plants, that these spores infect, do not occur within the small grain production areas in South Africa and thus teliospores are not of importance in our cultivation systems.

All the rust diseases can affect grain yield and quality, although the extent to which a cultivar will be affected will depend on the level of susceptibility of that cultivar, environmental conditions that favour the proliferation of the disease and the levels of inoculum present. In general, stem rust is more devastating than leaf rust or stripe rust. Devastating crop losses and even total crop losses have been experienced as a result of rust diseases and it remains one of the biggest challenges to the successful cultivation of small grains. Breeding and planting cultivars that are resistant to rust is one of the most important ways of controlling the disease. Accordingly, several research groups in South Africa are dedicated to the development of rust resistant cultivars. However, the process of breeding resistant lines takes time and it usually takes a number of years before a new resistant cultivar becomes commercially available. Rust diseases have the ability to overcome host plant resistance over time and this can be prevented by icluding a combination of minor and major genes to ensure durable rust resistance. In South Africa the use of systemic and protective fungicides form an important part of the control of these diseases. The application of foliar fungicides, for the control of rust, is widely practiced. Foliar fungicides are generally applied twice in a season.

Stem rust

Puccinia graminis f. sp. ***tritici*** – wheat, barley, triticale

Puccinia graminis f. sp. ***avenae*** – oats

Puccinia graminis f. sp. ***secalis*** – rye

Stem rust (photos 1, 2 and 3), also known as black rust, is a widespread and economically important disease of a number of cereal grains. It commonly occurs in the Western Cape from September onwards. Disease symptoms occur on leaf sheaths, leaf blades, stems and spikes. The epidermis is ruptured by elongated oval shaped pustules (uredinia), which contain masses of red-brown coloured urediniospores. These pustules may converge so that large parts of the stem appear red-brown in colour.

Leaf rust

Puccinia triticina – wheat, triticale

Puccinia hordei – barley

Leaf rust (photo 4), also known as brown rust, occurs commonly in areas where wheat and barley are grown. This disease generally appears on wheat as early as the end of July in the Western Cape. In this area, leaf rust on barley is not as common as leaf rust on wheat, but in favourable years, leaf rust on barley has been observed. Orange-brown elliptical pustules are found scattered at random on the leaves. The pustules may be surrounded by a yellow halo. Under high disease pressure, pustules appear on the ears of the grain as well.

Stripe rust

Puccinia striiformis f. sp. ***tritici*** – wheat, barley

Puccinia striiformis f. sp. ***hordei*** – barley

Stripe rust (photos 5, 6 and 7), also known as yellow rust, occurs throughout the small grain production areas of South Africa, but is found more frequently in the cooler production areas of the Free State. Typical stripe rust symptoms consist of yellow to orange coloured pustules that develop in narrow stripes on the leaf sheaths and on the inner surfaces of glumes and lemmas of the heads.

Crown rust

Puccinia coronata f. sp. ***avenae*** – oats

Crown rust is a widespread and damaging disease of oats. On susceptible cultivars, bright orange to yellow coloured elongated oval pustules occur mainly on leaves but can also occur on the sheaths and floral structures. The yield and quality of the oats are affected by this disease as the groat mass can be reduced. Planting resistant cultivars is the most effective method of controlling crown rust although there are currently no resistant cultivars commercially available. Several of the breeders' lines in the SGI oats selection program show resistance to crown rust and may potentially be released in future. Spraying foliar fungicides can be highly effective for controlling crown rust, but it is often, especially when the oats is produced as animal feed, not economically justified.

Mildew

Powdery mildew

Erysiphe [Blumeria] graminis f. sp. ***tritici*** – wheat
Erysiphe [Blumeria] graminis f. sp. ***hordei*** – barley
Erysiphe [Blumeria] graminis f. sp. ***avenae*** – oats
Erysiphe [Blumeria] graminis f. sp. ***secalis*** – rye

Powdery mildew (photos 8 and 9) is a very common disease of cereals worldwide. Symptoms are most often seen on leaves and include fluffy white pustules that become grey as they age. As the infection progresses the white fungal growth can cover the whole plant. These pustules can be scraped off the surface of the plant, as the infections are very superficial. Later in the season, black dots may be found embedded in the white pustules. These dots are the fruiting bodies of the mildew causing fungus. The fungus survives non-crop seasons as dormant mycelium or as fruiting bodies on host debris or volunteer crops. Conidiospores formed on volunteer plants form a major source of inoculum. The disease is more prevalent in densely planted fields that are over fertilised. In the United Kingdom, up to 25% loss in yield has been recorded, however yield losses in South Africa have not been measured. Small grain producers should take note that powdery mildew can cause losses if not controlled. The foliar application of fungicides is a reliable method of controlling the disease and it is widely practiced.

Spots and blotches

Scald or Leaf Blotch

Rhynchosporium secalis - barley, rye

Scald is mainly a disease of barley but can also occur on rye. It is common in the cooler areas of barley production. Symptoms include pale grey patches on the leaf surfaces that enlarge within a few days. These patches then take on a brown colour and a dark brown edge develops around the lesions. Eventually, the symptoms may cover the whole leaf and as a result, the leaf dies. Scald may lead to great yield losses. The initial source of inoculum often comes from small grain cereal debris, on which the fungus sporulates and the spores are disseminated to infect barley plants. However, the pathogen can also survive the non-crop season on volunteer plants. This disease is seed borne and planting disease free seed will supress the disease to a certain extent. Removal of volunteer plants and barley residues that may harbour the pathogen is an important measure of controlling the disease. The correct application of foliar fungicides can also greatly reduce the levels of scald infection.

Net blotch

Pyrenophora teres – barley

Net blotch (photos 13 and 14) only occurs on barley and it does not infect other small grain cereals. In South Africa, net blotch mainly occurs in the dry land barley cultivation areas of the Western Cape. The occurrence of the disease is strongly related to environmental conditions. The disease expresses two kinds of symptoms. The net form symptoms are dark brown streaks across the length of the leaf with a net-like appearance, while the spot type symptoms are brown to black elliptical lesions. Both the symptom types may be surrounded by dead tissue that is also known as necrotic tissue. Either one of these symptoms or both may appear on the barley leaves. The main source of inoculum is infected stubble, but seed can also be infected with net blotch. Ascospores (sexual spores) from the fruiting bodies on infected residue may cause primary infections, but conidiospores (asexual spores) that form on the infected leaves are mostly responsible for the initiation and spread of the disease. High infections of net blotch can cause significant losses in yield, of up to 30%, and reduce the quality of the barley. The disease is controlled by planting high quality disease free seed, disposing of volunteer plants and crop residue that serve as a source of inoculum and by the use of seed treatments and foliar fungicide applications. Although resistant cultivars may also be planted as a measure of control, such cultivars are not available in South Africa.

Septoria diseases

Several species of *Septoria* are pathogens of small grains. In many wheat growing areas, these diseases are of significant economic importance. Septoria diseases occur more frequently in areas where crops are planted densely and receive great amounts of fertiliser. Different Septoria diseases may occur in combinations within fields and on individual plants. The diseases are difficult to differentiate from each other without careful microscopic examination of the fruiting bodies and spore morphologies. The Septoria complex is believed to destroy two percent of the world's wheat annually. It reduces seed set, impairs seed filling and shriveled grain is lost with the chaff at harvest time. Greatest losses are incurred when significant disease infections occur before heading. The pathogens are weakly virulent on barley, rye, triticale and other wild grasses, but lesions are small and sporulation of the fungi are restricted.

Septoria leaf and glume blotch *Septoria tritici* - wheat, triticale

Septoria leaf blotch is a common disease of especially wheat in areas where wet and windy conditions prevail during the growing season. It occurs frequently in the wheat production areas of the Western Cape. Two different pathogenic organisms can cause Septoria leaf blotch and the symptoms vary slightly. When the plant is infected by *Septoria tritici,* leaf lesions first appear as small brown spots, which develop in a longitudinal direction along with the veins of the leaf and later form elongated ovals. These lesions develop grey water soaked areas in the centre in which black pycnidia, the fruiting bodies of the fungus, are formed. Lesions may merge gradually as the season progresses and can affect the majority of the leaf area and cause severe necrosis.

Similarly, when the plant is infected with *Stagonospora nodorum*, oval lesions that coalesce to form larger areas of necrotic tissue form on the leaf. However, the distinctive black pycnidia, or fruiting bodies, that form on the inside of the lesion when it is infected with *Septoria tritici* cannot be seen and these lesions are often surrounded by a clearly visible yellow chlorotic halo. During prolonged wet weather, masses of pink spores are exuded by the pycnidia of *Stagonospora nodorum*. Septoria leaf blotch lesions first appear on the lower leaves and dependent on favourable environmental conditions, spread to the upper leaves. These pathogens survive the non-crop season on cereal stubble and debris and on volunteer plants.

Septoria leaf blotch can lead to devastating crop losses. As the crop matures the *Stagonospora nodorum* pathogen becomes more aggressive and nodes and glumes are infected. [*Stagonospora nodorum* (previously known as *Septoria nodorum*) only infects the leaves of rye plants, and not the heads]. The glume blotch infection starts at the tips of the glumes and lemas as grey discolouration across the glume with a brown lower border. The disease develops in a downward direction and the lower brown border is replaced by grey discolouration. Pycnidia, the fruiting bodies of the fungus, can form within these lesions. An important measure for control of the disease is crop rotation with broad leaf non-host plants and disposal of contaminated crop debris. Genetic resistance is an important measure for control of the disease, although several of the cultivars planted in the Western Cape are susceptible to Septoria leaf blotch. The correct application of foliar fungicides to control the Septoria diseases can be highly effective.

Ear and grain diseases

Fusarium head blight *(Gert van Coller Dept. of Agriculture, Elsenburg) Fusarium graminearum (*previously known as *F. graminearum* Group 2*)* - wheat, barley, triticale, oats

Fusarium head blight is one of the most important diseases of wheat, barley and triticale in most grain producing regions of the country. The disease is less important in the Western Cape, although it does occur here. It is especially important in regions where small grains are produced under irrigation. Infection of florets take place as a result of spore release and high humidity during flowering. The disease is characterised by the discolouration of infected florets about 2-3 weeks after flowering. The florets become light coloured and appear blighted. Under high disease pressure the whole wheat head may become infected. The symptoms become less visible as the heads ripen. Infected kernels become shrivelled and contain much less starch and proteins than uninfected kernels. Fusarium head blight can be distinguished from take-all (which also occurs under irrigation) where the entire tiller and head dies and whitens, as opposed to Fusarium head blight where the tiller still remains green and bands of blighted florets form on the wheat heads. The fungus survives primarily on crop residues; therefore retention of stubble is needed for the fungus to survive. It is important to note that the fungus can also infect maize and production systems where barley and wheat are produced in rotation with maize, can lead to higher disease pressure in subsequent years. Chemical applications with fungicides can help to manage the disease; however, there are currently no fungicides registered against Fusarium head blight in South Africa. Research to evaluate different fungicides as well as methods of application is underway. Resistant cultivars are currently not available in South Africa.

Bunts and smuts

Smuts and bunts infect small grain cereals and several grass species. These fungi produce masses of black spores that partially or completely replace the heads, spikelets and kernels. In South Africa, these diseases are controlled by the routine application of seed treatments by seed distributing companies. Farmers who retain seed to plant must use seed dressings against bunts and smuts. Failure to treat seed, in order to save on input costs, leads to the increased incidence of these diseases.

Loose smut

Ustilago tritici – wheat

Ustilago nuda – barley

Ustilago avenae – oats

Loose smut (photo 15) is a common small grain disease that occurs widely in areas where wheat, oats and barley are grown. Symptoms are not apparent until ear emergence. Infected ears emerge earlier, have a darker colour and are slightly longer than those of healthy plants. Infected spikelets are transformed into powdery masses of dark brown teliospores. Within a few days, the spores are blown away and only the rachis remains. When a spore lands on a flower of a small grain plant in the surrounding area, it germinates and infects the reproductive tissues of the grain so that the embryos of developing seeds are also infected. The fungus then survives as dormant hyphae in infected seed. Infected seeds are not visually different from healthy seed. After seed germination, the fungus forms a systemic infection in the plant and later, as the plant approaches heading, the fungus penetrates the head tissues and converts it to a brown powdery mass of teliospores. Yield losses are roughly equal to the percentage of infected ears. In contrast to stinking smut (*Tilletia* spp.), the quality of the harvested grain is not affected. In the Western Cape, this disease is effectively managed by the application of seed treatments (Table 6), although some seed treatments may impede seed germination. The use of high quality, disease free seed is also an effective way of controlling the disease, as the only source of inoculum is infected seed.

Covered smut

Ustilago hordei - barley, oats, rye

Covered smut is a common disease of mainly oats and barley, but it also infects rye and other wild grasses. Symptoms are not obvious until after ear emergence. Smutted heads emerge later than healthy heads and may become trapped in the flag leaf sheath and fail to emerge. With severe infections, plants become dwarfed. Parts of the infected ear or the whole ear are transformed into powdery masses of dark brown spores, known as teliospores, which are covered by a persistent membrane. The covered smut fungus survives in soil and on the surface of seed. The fungus infects the germinating seed through the coleoptile. After seed germination, the fungus forms a systemic infection in the plant and later, as the plant approaches heading, the fungus penetrates the head tissues and converts it to the brown powdery masses of teliospores. The teliospores are generally released at harvest, when this membrane is disrupted. The dark powder from the teliospores discolours grain and affects grain quality and marketability. Covered smut is of economical importance in areas where seed treatments are not routinely used. Several systemic and protective seed treatments are registered for the control of covered smut in South Africa (Table 6).

Karnal Bunt

Tilletia indica - wheat, triticale

Historically, Karnal bunt did not occur in South Africa. It was identified for the first time in December 2000 from the Douglas irrigation area. Currently, measures are in place to restrict the spread of this disease throughout the country. These measures include testing of registered seed units and commercial grains for the presence of teliospores and quarantine regulations on the transport and entry of grains to mills and other delivery points. Since Karnal bunt is regarded as a quarantine disease according to South African regulations, all occurrences of this disease should be reported to the National Department of Agriculture (NDA).

Karnal bunt infected kernels appear blackened, eroded and emit a foul 'fishy' odour. In infected spikes, the glumes may also appear flared and expose bunted kernels. Spikes of infected plants are generally reduced in length and in number of spikelets. However, only a few florets per spike might be affected and it may be difficult to identify the disease in the field, as the whole ear does not necessarily become infested. Microscopic examination of the seed to detect the presence of the teliospores is a more reliable method of identification. The primary inoculum source is soil or seed contaminated with teliospores. These teliospores germinate and generate another kind of spore, known as basidiospores. One teliospore can produce up to 200 basidiospores that germinate and infect the head tissues of the plant. The infection is localised and not systemic as with loose smut and covered smut. Individual fungal cells within the kernel are converted to teliospores and parts of, or the whole of the diseased kernel is completely displaced by masses of teliospores as the kernel matures. Karnal bunt is of economical importance mainly due to the reduction in flour quality of grain infected with the disease. The flour will have a disagreeable odour and depending on the percentage infection, be darkened by the teliospores. This disease does not lead to yield losses as such. Karnal bunt is difficult to control. A first measure of protecting plants is preventing the entry of the pathogen to a certain area. Therefore, it is of utmost importance to adhere to quarantine regulations and to plant seed that has been certified to be disease free. Some fungicides applied at ear emergence may reduce the incidence of the disease but it is unlikely that they will prevent infection.

Stem base and root diseases

Fusarium crown rot *(Dr Sandra Lamprecht, ARC-Plant Protection Research Institute)*

Fusarium pseudograminearum (previously known as F. *graminearum* Group 1) – wheat, barley, triticale Fusarium crown rot is one of the most important soilborne diseases of wheat, barley and triticale in the Western Cape, but it is also present in other small grain producing areas in the country. The disease is especially important in areas where wheat is cultivated under dryland conditions. Oats is susceptible, but is a symptomless host. The disease is characterized by the honey-brown discolouration of the lower parts of the tillers and necroses of the crown tissue and subcrown internodes. A pink discolouration can sometimes be observed under the lower leaf sheaths. The most characteristic symptom is, however, the formation of whiteheads, but this depends on water stress during grain fill. The disease can be confused with take-all which also causes whiteheads. The fungus requires moisture for infection, but subsequent disease development is favoured by moisture stress. The fungus survives primarily on crop residues between host crops and the retention of stubble therefore favours its survival, especially where small grain crops are grown in monoculture. The disease is therefore favoured by conservation tillage which is increasingly adopted by small grain farmers. Fusarium crown rot can be reduced with an integrated disease management strategy which include practices such as crop rotation with non-host crops (broadleaf crops such as canola, lupin, medic, lucerne etc.), control of grass weeds (most grass weeds are hosts), alleviation of zinc deficiency and reduction of moisture stress by practices that conserve soil moisture such as conservation tillage. Research conducted in the Western Cape showed that rotation systems where wheat was planted after 3 years of broadleaf crops had the lowest incidence of this disease. Resistant cultivars are not available, but tolerant cultivars with partial resistance have been identified in other countries such as Australia. South African wheat and barley cultivars will be evaluated for resistance/tolerance in the near future.

Take-all

Gaeumannomyces graminis var. graminis - wheat, barley, rye, triticale

Gaeumannomyces graminis var. tritici - wheat, barley, rye

Gaeumannomyces graminis var. avenae - oats

Take-all (photo 12) occurs widely throughout the small grain producing areas in South Africa. This disease affects the roots, crowns and basal stems of small grains, wheat in particular, and wild grasses. It is an important disease in areas where wheat is cultivated intensively, the soil pH is neutral or alkaline, moisture is abundant and soils are deficient in manganese and/or nitrogen. Mildly infected plants appear to have no symptoms of the disease, while more severely infected plants ripen prematurely and are stunted. Take-all symptoms are more apparent during heading, as infected plants are uneven in height, die prematurely and plants discolour to the colour of ripe plants. A typical take-all infestation is characterised by the appearance of patches of white heads amongst areas with healthy green plants before ripening. The heads that ripen prematurely tend to be sterile or to contain shriveled grain. Diseased plants pull up easily. Roots appear blackened and brittle and lower stems may take on a black colour, which is indicative of the disease. The pathogen persists in infected host residues from where the ascospores can act as sources of inoculum. Roots growing near infected residues become infected and early infections may progress to the crown. The disease is favoured by poorly drained soils, high seedling densities and high organic matter content in the soil. As the pathogen is favoured by wet conditions, the disease is more prominent in wet years or in irrigated fields. If conditions become dry, the pathogen becomes less active. The best way to control take-all is by crop rotation. A one-year break from barley or wheat can be sufficient to control the disease. Volunteer plants, grassy weeds and crop residues, that may harbour the pathogen, should be destroyed. A newly registered seed treatment Galmano Plus® can be applied to support root health and decrease the incidence of take-all. Take-all can also be controlled to a certain extent by ensuring that the wheat plants have sufficient nutrients to promote healthy root growth.

Eyespot, Strawbreaker

Helgardia herpotrichoides - wheat, barley, oats, triticale

Helgardia acuformis - wheat, barley, rye

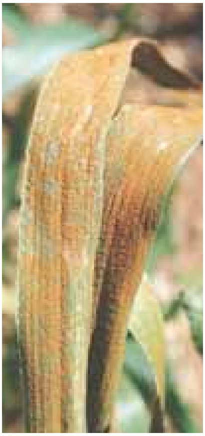
Eyespot (photo 16) is a disease that affects the crown of the small grain plant. Wheat is more susceptible than other small grains and wheat grown in the winter rainfall areas of the Western Cape are more often affected than the wheat cultivated in other areas. The disease is more prevalent in early sown, over fertilised crops and in areas with moisture retentive soils. After infection, the symptoms are not visible for up to a few months. The characteristic eye-or lens-shaped eye spot lesion only appears on mature wheat. This light brown lesion generally appears below the first node. Grey mycelium of the fungus can also be found inside the stem cavity. The disease does not kill plants as such, but weakens the individual tillers so that the tillers lodge and complicates harvesting of the fallen heads. Lodging of the plants is a result of a breakage in the stem at the point of the lesion. Kernel size and number is also reduced. Severe eyespot may lead to premature ripening of the ears. Eyespot inoculum (asexual spores), arises from cereal stubble and debris and is dispersed by the splashing of raindrops. The spores infect coleoptiles and leaf sheaths and secondary conidiospores form within four to 12 weeks. The secondary conidiospores do not contribute to the epidemic, but rather serves as a source of inoculum for the following season's crop. Control of eyespot includes the ploughing or burning of small grain cereal crop residues. Crop rotation, away from a host for 2 years will lead to a decline of the inoculum present on residues. Eyespot can successfully be controlled by the timely application of fungicides. In South Africa, resistant cultivars are not commercially available.

Symptoms of small grain diseases (Photos by Dr Ida Paul)

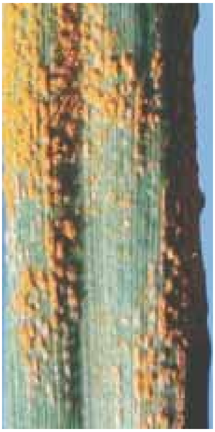
1. Uredinia of stem rust on a wheat ear

2. Uredinia of stem rust on a oat stem

3. Uredinlospores and teliospores of stem rust on a wheat stem



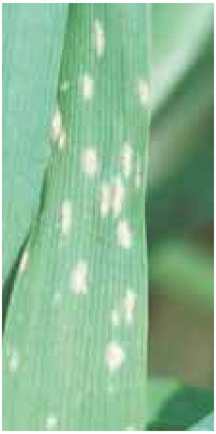
4. Uredinia of leaf rust on wheat leaves



5. Uredinia of stripe rusts on a wheat leaf

6. Uredinia of stripe rust on wheat spikelets

7. Stripe rust infection in the field causes a yellow discolouration of the ears



8. Cottony white growth of powdery mildew on a barley leaf

Symptoms of small grain diseases (Photos by Dr Ida Paul)

9. Cottony white growth of powdery mildew on the ear of wheat

10. Wheat ear infected with loose smut

11. Oats ear infected with loose smut

12. Blackened crowns of wheat with take-all infection

13. Net form symptom of net blotch on a barley

14. Spot form symptom of net blotch on a barley leaf

15. Wheat ear infected with loose smut

16. A typical eyespot symptom on wheat

Control of Fungal Diseases

Genetic control of fungal diseases

Breeding for resistance is an economically important and environmentally friendly way of controlling fungal diseases of small grains. The objective of breeding programmes is the incorporation of resistance genes into agronomically well adapted cultivars. The susceptibility or resistance of some wheat cultivars to some diseases are indicated in Tables 1 to 3. However, no one cultivar can be resistant to all the fungal diseases that might infect it. Therefore, fungicides remain of importance in the production of small grains in South Africa.

Table 1. Disease resistance or susceptibility of wheat cultivars recommended for dryland cultivation in the Western Cape production region

Cultivar	Stem rust	Leaf rust	Stripe rust
Baviaans (PBR)	S	MS	R
Kariega	S	MS	R
Kwartel (PBR)	S	R*	R
PAN 3408 (PBR)	MSS	MS	R
PAN 3471 (PBR)	S	MRMS	R
Ratel (PBR)	MR	MS	R
SST 015 (PBR)	S	MS	R
SST 027 (PBR)	MRMS	MS	R
SST 047 (PBR)	R	R	R
SST 056 (PBR)	MS	MR	MR
SST 087 (PBR)	S	R	R
SST 88 (PBR)	S	S	MR
Tankwa (PBR)	MS	R	R

R = Resistant MR = Moderately resistant S = Susceptible MS = Moderately susceptible

PBR Cultivars protected by Plant Breeders' Rights
Variation in rust races may affect cultivars differently. Reactions given here are based on existing data for the most virulent rust races occurring in South Africa. Distribution of races may vary between production regions.

Table 2. Disease resistance of barley cultivars in the Southern Cape

Cultivars	Leaf blotch	Net form Net blotch	Leaf rust	Spot form Net blotch
SabbiErica	S	S	S	S
SabbiNemesia	S	S	R	S
S5	S	S	R	S
SabbiDisa	R	MS	MS	MS

S = Susceptible *MS = Moderately Susceptible*
MR = Moderately resistant *R = Resistant*

Table 3. Resistance or susceptibility of oat cultivars to leaf diseases

Cultivar	Crown Rust	Stem Rust
Overberg	S	MS
Heros	S	S
Sederberg	S	S
Pallinup	S	S
Kompasberg	S	MS
SSH 405	S	R
SSH 491	MR	S

R = Resistance MR = Moderate resistance MS = Moderately susceptible S = Susceptible

Chemical control of fungal diseases

Fungicides are routinely used to control small grain diseases that are caused by fungi. In South Africa various active ingredients are registered for the control of foliar diseases on small grains (Tables 4 and 5). Several active ingredients are registered for the control of seed and/or soil borne diseases (Table 6).

In order to apply fungicides successfully for disease control, the following aspects must be taken into account:

- The disease and causal organism of the disease should be identified correctly;
- A fungicide registered against the observed disease should be chosen;
- The susceptibility of the particular cultivar to the disease should be considered.
- In most cases resistant cultivars will not need fungicide protection against the disease to which it is resistant, unless new races of the pathogen develop;
- Timing of application is critical. One application at the correct timing can give more protection to the plants than three badly timed spray applications;
- Protection of the flag leaf is important, as this leaf greatly contributes to the productivity of the plant;
- Some fungicides require intervals before harvest or consumption of produce and this should be considered;
- Use the correct amount of water so as to ensure adequate coverage.

Diseases must be identified correctly. For this purpose the reader may consult relevant publications such as the booklet “Wheat Diseases in South Africa” by D B Scott, which is obtainable from the ARC-Small Grain Institute, Private Bag X29, Bethlehem 9700, at the price of R20-00 (VAT included). Postage amounts to R10-00.

Table 4. Active ingredient/s of fungicides for the control of selected diseases of wheat*

Active ingredient/s	Wheat disease							
	Stem rust	Leaf rust	Stripe rust	Powdery mildew	Septoria Leaf blotch	Glume blotch	Eyespot	Take-all
Carbendazim/Epoxiconazole		x	x		x	x	x	
Carbendazim/Flusilazole		x	x	x	x	x	x	
Carbendazim/Propiconazole		x	x	x	x	x	x	
Carbendazim/Cyproconazole		x	x	x	x	x	x	
Carbendazim/Tebuconazole		x	x	x	x	x	x	
Carbendazim/Triadimefon		x		x			x	
Epoxiconazole		x			x	x	x	
Flusilazole			x				x	
Fluquinconazole/Prochloraz		x						x
Propiconazole	x	x	x	x	x	x	x	
Propiconazole/Cyproconazole	x	x	x	x	x	x	x	
Prothioconazole/Tebuconazole		x		x		x		
Tebuconazole	x	x	x	x	x	x	x	

**The booklet can be obtained from http://www.croplife.co.za/docs/Fungicides.pdf and the webpage of the National Department of Agriculture http://www.nda.agric.za/act36/AR/AR%20Lists.htm. Please note that although some formulations of fungicide are registered against a wide range of diseases, some formulations may only be effective for the control of one disease. Always be sure to consult the label for exact specifications.*

Table 5. Active ingredient/s of available fungicides registered for the control of selected diseases of barley*

Active ingredient/s	Barley disease				
	Leaf rust	Powdery mildew	Net blotch	Scald	Eyespot
Carbendazim/Epoxiconazole				x	
Carbendazim/Flusilazole	x	x	x	x	
Carbendazim/Propiconazole	x	x	x	x	
Carbendazim/Cyproconazole	x	x	x	x	x
Carbendazim/Tebuconazole	x	x	x	x	
Carbendazim/Triadimefon	x	x	x	x	
Epoxiconazole	x	x	x	x	
Flusilazole					x
Picoxystrobin + Carbendazim/Flusilazole (tank mixture)	x	x	x	x	
Propiconazole			x	x	
Prothioconazole/Tebuconazole	x	x	x	x	
Tebuconazole	x	x	x	x	x

**The booklet can be obtained from http://www.croplife.co.za/docs/Fungicides.pdf and the webpage of the National Department of Agriculture http://www.nda.agric.za/act36/AR/AR%20Lists.htm. Please note that although some formulations of fungicide are registered against a wide range of diseases, some formulations may only be effective for the control of one disease. Always be sure to consult the label for exact specifications.*

Table 6. Active ingredient/s of available fungicides registered for the control of selected seedborne diseases of small grains*

Active ingredient/s	Seedborne diseases					
	Loose smut (wheat)	Loose smut (barley)	Loose smut (oats)	Covered smut (barley)	Covered smut (oats)	Scald
Benomyl	x					
Carboxin/Thiram	x	x		x		
Difenoconazole	x					
Mancozeb				x	x	
Prothioconazole	x	x		x		
Tebuconazole	x	x		x		
thiram			x	x	x	
Triadimefon						x
Triadimenol	x		x	x	x	
Triticonazole	x	x		x		x

**The booklet can be obtained from http://www.croplife.co.za/docs/Fungicides.pdf and the webpage of the National Department of Agriculture http://www.nda.agric.za/act36/AR/AR%20Lists.htm. Please note that although some formulations of fungicide are registered against a wide range of diseases, some formulations may only be effective for the control of one disease. Always be sure to consult the label for exact specifications.*

ARC-SMALL GRAIN INSTITUTE SERVICES

The laboratories of ARC-Small Grain Institute are well known for their fast, accurate and reliable services to you as producer.

Seed Testing Laboratory

The Seed Testing Laboratory is registered with the Department of Agriculture and ISTA (International Seed Testing Association)-rules are strictly applied to comply with international standards in determining the quality characteristics of seed. Tests include the following:

Germination tests and physical purity analysis package

The germination test is an indication of the percentage seed that will, under favourable conditions, produce normal seedlings. Together with the germination results, the percentage of seed from other crops and weeds are determined. This is also subject to requirements set by law. Each seedlot planted in the field must be tested so that the producer is assured that the seed planted has a germination percentage greater than 80%, which is the minimum for making wheat production a viable proposition.

Coleoptile length

Coleoptile length is the length of the sheath that enfolds the first leaf. The coleoptile provides the force that carries the leaf to the soil surface. To prevent emergence problems under dryland conditions, coleoptile length determinations are recommended. It is important to remember that planting depth is critical where cultivars with short coleoptile lengths are planted.

Seed analyses testing chemical treatments

A seed treatment can be tested for its effect on South African small grain cultivars and even its compatibility with other seed treatments. These services will be provided on contract basis only.

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Wheat Quality Laboratory

The Wheat Quality Laboratory participates in two external quality control schemes. The Premier Foods Ring test samples are analysed monthly and the Southern African Grain Laboratory (SAGL)'s Ring test samples are analysed quarterly. The laboratory offers the following analyses on whole wheat kernels:

- Hectolitre mass / Test weight
- Single Kernel Characterisation System (SKCS) analyses, which includes thousand kernel mass, kernel hardness index, kernel diameter and kernel moisture content
- Kernel colour
- Flour yield potential

Analyses that can be performed on flour include:

- Flour colour
- Protein content
- Falling number
- Sodium Dodecyl Sulphate (SDS) sedimentation volume
- Wet gluten content
- Moisture content

Analyses indicative of dough properties and end-use quality include:

- Mixograph analyses
- Farinograph analyses
- Alveograph analyses
- Mixolab analyses
- Loaf volume

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Soil Analyses Laboratory

The Analyses Laboratory specializes in soil analyses and is an active member of the Agri-LASA control scheme.

Soil analyses

pH (KCl)

Ca, Mg, Na, K (Ammonium Acetate)

Phosphate (Bray 1)

% Acid Saturation

Other analyses:

Lime requirement Zinc (HCl)

% Total Carbon (TOC)

Clay % (Hydrometer Method)

Particle size

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